2. DESCRIPTION OF THE EXISTING ENVIRONMENT

2.1 POPULATION DENSITY

The nearest town is Newberry, South Carolina, (population 9,200), 16 miles to the west and the nearest large urban area is Columbia (population 113,500) 28 miles to the southeast. Approximately 681,000 people live within 50 air miles of the Parr project, and about 2,520,000 within 100 air miles. Fairfield County, in which the major portion of the new construction is proposed, had a 1970 population of 19,999 and an average density of 29 people per square mile. Newberry County's population for the same year was 29,273 with an average density of 46 people per square mile.

Table 2-1 shows the population of communities within a 30-mile radius of the site.

2.2 GEOLOGY AND PHYSICAL FEATURES

The Parr site lies within the southern part of the Piedmont physiographic province, a band of rolling topography of generally low relief lying south and east of the higher Appalachian Mountains and extending from central Mississippi to the west bank of the Hudson River in southern New York.

The Piedmont of South Carolina is bounded on the northwest by the Blue Ridge Mountains and on the southeast by the Fall Line and the Atlantic Coastal Plain. The land surface slopes from the crest of the Blue Ridge southeastward to the Atlantic Ocean, and all major streams flow southeastward down this slope.

Table 2-1

1970 Population of Communities
Within a 30-Mile Radius of the Site

COMMUNITY	POPULATION	DISTANCE FROM SITE IN MILES	DIRECTION
Peak	87	4	S
Pomaria	264	6	W
Little Mountain	240	9	SW
Chapin	342	9	S
South Congaree	1,434	29	S
Summit	130	26	S
Gilbert	186	26	S
Leesville	1,907	28	S
Lexington	969	22	S
Batesburg	4,036	30	SW
Prosperity	762	14	SW
Newberry	9,218	17	W
Silverstreet	156	22	W
Joanna	1,631	30	W
Whitmire	2,226	22	NW
Winnsboro Mills	2,312	15	E
Ridgeway	437	22	E
Irmo	517	16	SE
Columbia	113,542	26	SE
West Columbia	7,838	26	SE
Pineridge	633	29	SE
Cayce	9,967	27	SE
Springdale	2,638	27	SE
Arcadia Lakes	741	28	SE
Ardincaple	726	28	SE
Boyden Arbor	416	27	SE
Forest Acres	6,808	27	SE
Forest Lake	39	27	SE
Carlisle	670	22	N
Baldwin-Argon Mills	1,042	29	N
Chester	7,045	29	N
Eureka	1,524	29	N
Winnsboro	3,411	15	NE
Great Falls	2,727	30	NE

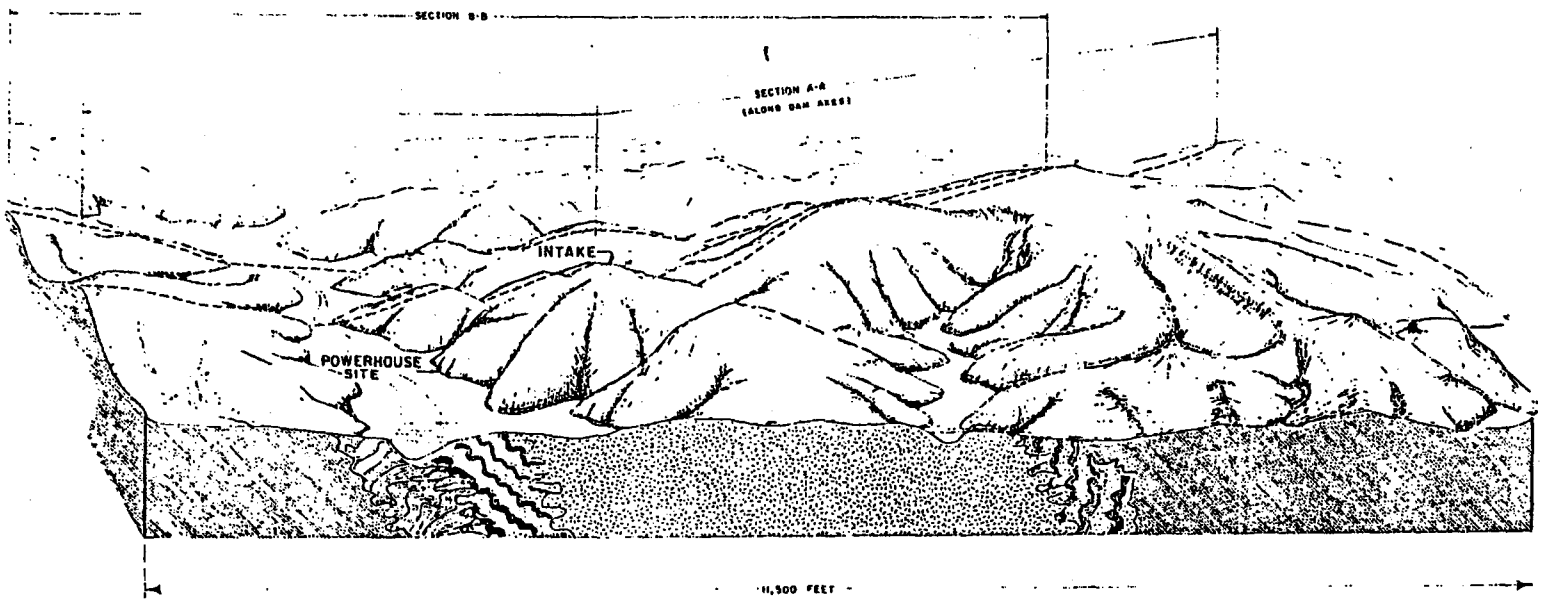
Reference: 1970 Census of Population, South Carolina, U. S. Department of Commerce, Bureau of the Census.

The bedrock within the Piedmont province is a complex of late Pre-Cambrian to middle Paleozoic metamorphosed sediments and intrusives. Among the metamorphosed group are slate, schist, gneiss, and granitelike rock known as migmatite. Intruded into the metamorphic rocks are younger crystalline rocks, generally granitic in composition. A geologic block diagram and section shown in Figures 2-1 and 2-2 illustrate the area.

The bedrock is mantled almost everywhere by a thick saprolitic soil, the in-site product of the decomposition of the underlying bedrock. The soil is of low fertility and best suited for forest and pasture.

The site lies within a forested area (oak, hickory, and pine) dotted by a few clearings for farms and dwellings. The topography is characterized by gently to steeply rolling hills and well-drained valleys. Branching from the gently winding course of the Broad River, the tributary streams form a trellis-dendritic system of high-gradient valleys in the adjacent upland. On the steeper slopes of the natural topography are deep gullies. Elevations above sea level within the Jenkinsville quadrangle, where the project is located, range from a low of 210 feet msl to a high of 481 feet msl, giving a maximum relief of 271 feet.

The waters of the area are relatively pure although high in suspended matter. The surface waters generally contain less than 100 ppm of dissolved salts, chiefly



KEY:

- GRANODIORITE
- MIGMATITE OF GRANODIORITE COMPOSITION
- MIGMATITE OF GNEISSIC COMPOSITION
- CHARLOTTE BELT GNEISS

NO SCALE - DIAGRAMMATIC ONLY

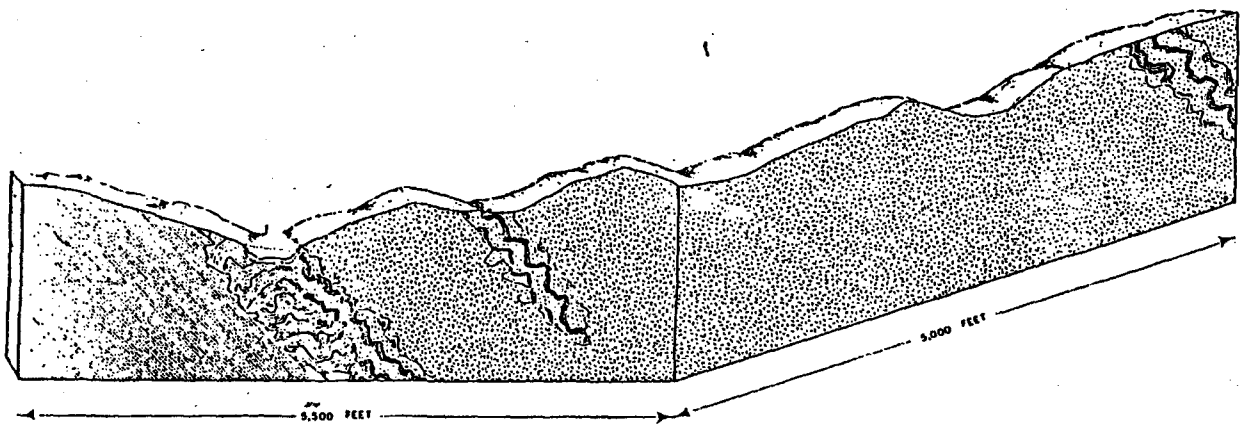
NOTES:

1) THE DIAGRAMMATIC SECTIONS SHOWN REPRESENT OUR EVALUATION OF THE MOST PROBABLE CONDITIONS BASED UPON INTERPRETATION OF PRESENTLY AVAILABLE DATA. SOME VARIATIONS FROM THESE CONDITIONS MUST BE EXPECTED.

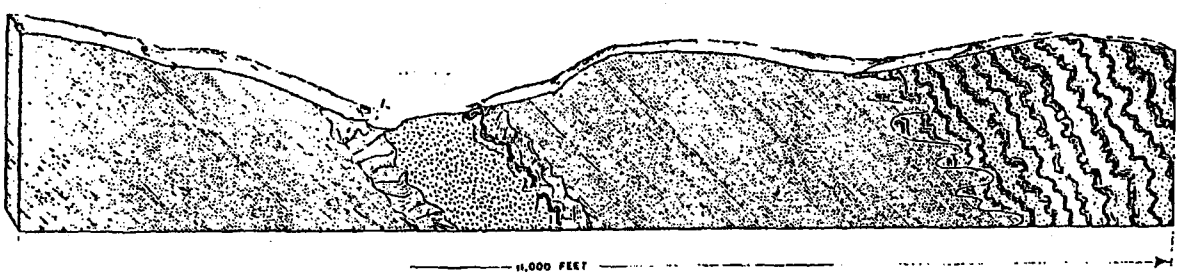
2) DIAGRAMMATIC SECTIONS A-A AND B-B ARE SHOWN ON FIGURE 2-20.

Source: South Carolina Electric & Gas
July , 1972 Revised Application

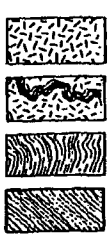
Figure 2-1. Diagrammatic View of Area Geology Parallel to the Broad River



DIAGRAMMATIC SECTION A-A ALONG PROPOSED DAM AXIS



DIAGRAMMATIC SECTION B-B THROUGH SITE



GRANODIORITE

MIGMATITE OF GRANODIORITE COMPOSITION

MIGMATITE OF GNEISSIC COMPOSITION

CHARLOTTE BELT GNEISS

Figure 2-2. Diagram of Area Geology

NO SCALE - DIAGRAMMATIC ONLY

calcium and magnesium bicarbonates. The little utilized ground waters contain less than 1,000 ppm of dissolved salts. The sediment concentration in the streams is normally about 300 ppm.

Except for river sands and gravels, no mineral deposits of commercial value are known at the site, and there are no known commercial deposits of metallic ores. No deposits of fossil fuels are known, nor are any likely to be found in the crystalline basement rock beneath the site. A gravel quarrying operation is being carried on at Rocky Creek, approximately 10 miles upstream from Parr Dam.

2.3 CLIMATE

The climate of the project area is one of warm humid summers and mild winters. The average air temperatures vary from about 45°F during the winter to about 80°F during the summer. The annual precipitation averages about 45 inches and monthly amounts vary from 2-1/2 inches in November to 6 inches in July. Severe droughts are rare, but floods are common and may occur during any month of the year. The types of severe weather which may affect the proposed project include tornadoes, hurricanes with a frequency of about one every two years, and thunderstorms in about 54 days per year. The prevailing winds for both annual and stable conditions are from the western sector.

2.4 WATER QUALITY

Approximately 4,750 square miles of the entire watershed extending northwest into North Carolina are drained by the Broad River at the project site. The average annual runoff at Parr dam is about 4.3 million acre-feet, creating an average annual flow of 6,100 cfs. The largest flood of record, 228,000 cfs on October 3, 1929, was recorded at the Richtex gage 11 miles downstream of Parr dam. The lowest instantaneous flow measured at Richtex was 105 cfs, and the lowest average daily flow was 149 cfs. Ninety-five percent of the time the 7-day lowflow exceeds 700 cfs. The lowest average monthly flows for a 40-year record occurred in June, July, September, and November.

The existing Parr hydroelectric project operates as a run-of-the-river plant with outflow from the Parr reservoir being equal to inflow minus evaporation.

Streamflow from Frees Creek into the Broad River has not been measured, but runoff is roughly proportional to the size of the drainage basins. Frees Creek has a ratio of about 17 square miles to about 4,500 square miles for the Broad River at the point of confluence, or about 0.4 percent of the Broad River flow.

The Broad River in the vicinity of the project site is about 2,000 feet wide and ranges in depth from a few feet to around 15 feet. During normal flow, several islands appear in the reservoir; shallow depths are due largely to siltation.

Chemical analyses indicate that the water is low in alkalinity and total dissolved solids and that there is little variability in water quality with discharge rate. Water quality data from three locations upstream of the Parr dam are given in Table 2-2.

Dissolved oxygen is normally high and near saturation. No dissolved oxygen problems have been reported downstream of the Parr dam. Water temperatures range from the low forties in the winter to the low eighties (°F) in the summer.

Heavy metal determinations have been made by the South Carolina Department of Health and Environmental Control in the vicinity of the Parr Reservoir (Table 2-3). Heavy metal accumulation is caused by settling of soil or silt particles to which heavy metals are adhering and settling of dead plantonic organisms in which these heavy metals may concentrate. Heavy metals as well as other chemical constituents in the water can be expected to accumulate to some extent in the sediments, with the exception of that amount remaining in solution. Concentration of mercury, copper and cadmium are below levels found to be toxic to some aquatic organisms, but chromumium and lead approach levels that could be harmful. 60/ Much research has been done on heavy metal toxicity to aquatic organism; however, no toxic levels have been specified that

Table 2-2

Chemical Water Analysis of Broad River Study Area, Parr, South Carolina, March 4, 1971

Tests	Station 2	Station 3	Station 4
Total Dissolved Solids, at 105°C	47	45	45
Total Hardness, as $CaCO_3$	42	42	42
Calcium Hardness, as $CaCO_3$	24	30	18
Magnesium Hardness, as $CaCO_3$	18	12	24
Calcium, as Ca	9.6	12	7.2
Magnesium, as Mg	4.4	2.9	5.8
Alkalinity (Phenolphthalein), as $CaCO_3$	0	0	0
Alkalinity (Total), as $CaCO_3$	36	36	36
Carbonate Alkalinity, as $CaCO_3$	0	0	0
Bicarbonate Alkalinity, as $CaCO_3$	36	36	36
Hydroxides, as OH	0	0	0
Carbon Dioxide, as CO_2	-	18	54
Carbonates, as CO_3	0	0	0
Bicarbonates, as HCO_3	44	44	44
Chlorides, as Cl	0	0	0
Iron, as Fe	5.5	4.8	4.5
Manganese, as Mn	0	0	0
Sulfate, as SO_4	1	1	1
Fluorides, as F	0	0	0
Silica, as SiO_2	10	11	11
Copper, as Cu	0	0	0
Phosphate (total), as PO_4	1.5	1.2	1.2

Table 2-2 (Cont'd.)

Color, Standard Platinum Cobalt Scale	45	40	40
Odor	0	0	0
pH (Laboratory)	4.8	6.6	6.1
Turbidity, Silica Scale	500	360	400
Total Nitrogen	2.73	2.50	2.57
Ammonia Nitrogen	1.00	0.82	0.82
Organic Nitrogen	1.73	1.68	1.75
$NO_3 + NO_2$ - Nitrogen	0.30	0.28	0.26
NO_2 - Nitrogen	0.10	0.05	0.05
NO_3 - Nitrogen	0.20	0.23	0.21
Total Phosphorus (PO_4-P)	0.27	0.27	0.25
Ortho Phosphorus (PO_4-P)	0.21	0.20	0.21
Total P - Filtered	-	-	-
Ortho P - Filtered	-	-	-
COD	15	21	21

Source: South Carolina Electric & Gas - Environmental Report Supplement I- Virgil C. Summer Nuclear Station

TABLE 2-3

TOTAL CONCENTRATION OF CERTAIN HEAVY METALS
ABOVE AND BELOW PARR RESERVOIR

Above Parr Reservoir (S.C. Highway #34)					
Sampling Period	Cu (mg/l)	Cr (mg/l)	Pb (mg/l)	Hg (mg/l)	Cd (mg/l)
8/28/62	Min. 0.050	Min. 0.100	Min. 0.100	Min. 0.0002	Min. 0.005
	Avg. 0.050	Avg. 0.234	Avg. 0.157	Avg. 0.0004	Avg. 0.059
12/7/73	Max. 0.050	Max. 0.480	Max. 0.200	Max. 0.0005	Max. 0.100

Below Parr Reservoir (S.C. Highway #213)					
Sampling Period	Cu (mg/l)	Cr (mg/l)	Pb (mg/l)	Hg (mg/l)	Cd (mg/l)
6/25/70	Min. 0.050	Min. 0.100	Min. 0.034	Min. 0.0000	Min. 0.005
	Avg. 0.055	Avg. 0.358	Avg. 0.349	Avg. 0.0003	Avg. 0.056
12/7/73	Max. 0.070	Max. 1.090	Max. 1.210	Max. 0.0005	Max. 0.100

Source: South Carolina Department of Health and Environmental Control

would apply to all fresh water; therefore, each case of suspected heavy metal concentration should be evaluated individually. Toxicity of heavy metals varies widely with such factors as organism involved, temperature, dissolved oxygen, pH, valence of the metal, concentrations of other heavy metals, and resulting synergism and hardness of the water. No reported instances of mortality to aquatic organisms from heavy metals in the Broad River are known to Staff. Applicant has indicated that heavy metals determination will be included in its monitoring program, and Staff has included this as a recommendation in Section 10.

The Broad River is designated Class B water4/, and standards for this designation are given in Table 2-4.

Groundwater 5/ in the region occurs in two types of formations: (1) jointed and fractured crystalline bedrock, and (2) the lower zones in the residual soil overburden. Recharge to these formations is by infiltration of precipitation in the upland areas. Some of the water infiltrating the surface soils evaporates, transpires from plants, or reemerges at the surface downslope at short distances from points of infiltration. A small portion of the water percolates to perched water zones in the lower soils and into the water table in the underlying jointed bedrock.

The groundwater table follows the land surface but with more subdued relief, discharging as visible seeps and springs and/or percolating through the ground into creeks and streams. Some groundwater is discharged via wells, but the amount pumped is very small because the formations generally are not pervious enough to sustain well yields greater than 5 to 10 gallons per minute.

The overburden soils release water slowly to the lower, more pervious units. As a result of this storage effect, yields of wells and flows of springs remain rather constant and are sustained during periods of deficient moisture.

Use of groundwater in the region is principally for households and livestock. Within 20 to 30 miles of the site, approximately 55 wells are used for municipal and industrial purposes. Wells in the region are commonly less than 200 feet deep and yield about 10 gpm or less. The only nearby public water supply is a well field at Jenkinsville, about 3 miles southeast of the site. It is understood that a surface water supply is being planned for this community.

The quality of groundwater at 200 feet below the surface in the region is satisfactory for most industrial and domestic purposes. The water is low in dissolved solids but high in iron.

Parr steam plant, located near Parr dam, uses water from Parr reservoir for cooling and discharges it back into the reservoir. The maximum temperature rise over the condensers is 15°F, with a maximum cooling water flow of 207 cfs. Temperatures reaching 92°F have been recorded at the intake at Parr steam plant. This is due, however, to intake and outlet structures located in such a manner that recirculation occurs at the intake. The maximum temperatures over most of Parr reservoir are between 80° and 90°F.

The persistant turbidity of the Broad River is due to the type of soils occurring in the watershed. These soils are mainly clays and silts which erode readily. Secchi disc readings in the turbid waters reportedly range from 6 to 21 inches. These readings indicate a very high to moderately high turbidity that reduces the penetration of sunlight to a very limited depth and consequently adversely affects the biological productivity of the Broad River and Parr reservoir. The deposition of sand and silt associated with high turbidities renders the substrate unsuitable for habitation by benthic organisms, 6/ and this also adversely affects the biological carrying capacity of the reservoir.

Since the spring of 1969 the Columbia, South Carolina, water treatment plant which takes its drinking water supply from the Broad River, some 6 to 8 hours flow time downstream from the Parr Reservoir has experienced taste and odor problems. During the spring of 1972, personnel from the Surveillance and Analysis Division of Region IV of the U. S. Environmental Protection Agency conducted an investigation for the South Carolina Pollution Control Authority to determine the source and cause of these taste and odor problems. Results of the study were published by EPA under the title, "The Relationship between Substrate Content, Water Quality Actinomycetes, and Musty Odors in the Broad River System." Conclusions and recommendations from this study are included in Appendix E.

2.5 CURRENT LAND USE

Land within 50 air miles of the site is relatively uniform with forests covering 50 to 80 percent in the counties within that radius. Fairfield county, in which the major portion of the project would be located, is about 80 percent forested, 13 percent agricultural, three percent urban and suburban, and four percent in other miscellaneous uses. Tables 2-5 and 2-6 show existing land use in the site vicinity (10-mile radius) and region (50-mile radius). Table 2-7 presents agricultural data and cash returns from the farms in Fairfield and Newberry Counties.

Table 2-5

Land Use in Vicinity of the Project

Land Use	Fairfield County			Newberry County			Two-County Averages	
	1958 (%)	1967 (%)	Change 1958-67 (%)	1958 (%)	1967 (%)	Change 1958-1967 (%)	1967 (%)	Change 1958-1967 (%)
Federal Land	2.7	2.7	0	13.6	13.6	0	8.2	0
Urban and Built-Up	1.3	2.8	+1.5	4.4	4.5	+0.1	3.6	+0.8
Cropland	11.2	6.0	-5.2	19.8	12.4	-7.4	9.2	-6.3
Pasture	7.5	7.1	-0.4	4.3	8.8	+4.5	7.9	+2.0
Agricultural (Cropland Plus Pasture)	18.7	13.1	-5.6	24.1	21.2	-2.9	17.1	-4.3
Forest Land	75.5	80.0	+4.5	55.1	58.3	+3.2	69.1	+3.8
Other Land	1.7	0.9	-0.8	2.5	2.1	-0.4	1.5	-0.6

NOTES:

1. The area within 10 miles of the site is principally located within two counties: about two-thirds in Fairfield County, one-third in Newberry County.

2. Reference: "South Carolina Soil and Water Conservation Needs Inventory," May, 1970.

Table 2-6

Land Use in the Region

		Chester	Fairfield	Greenwood	Kershaw	Lancaster	Laurens
Total County Land (Acres)		374,000	447,000	286,000	503,000	323,000	449,000
Federal Land (%)	1958	3.2	2.7	3.5	0	0	4.5
	1967	3.2	2.7	3.5	0		4.5
Urban and Suburban (%)	1958	4.3	1.3	5.2	2.1	2.3	3.9
	1967	4.2	2.8	6.3	2.9	9.3	5.4
Cropland (%)	1958	15.2	11.2	17.9	19.1	16.9	24.2
	1967	13.0	6.0	11.2	13.0	10.0	15.0
Pasture (%)	1958	12.1	7.5	10.8	2.0	5.4	9.4
	1967	11.2	7.1	14.1	3.2	6.6	11.1
Agricultural (Cropland plus Pasture) (%)	1958	17.6	18.7	28.7	21.1	25.3	23.6
	1967	24.2	13.1	25.3	16.2	16.6	26.1
Forest (%)	1958	61.7	75.5	60.0	72	66.9	54.7
	1967	66.6	80.0	65.0	79.5	69.3	61.2
Other Land (%)	1968	3.5	1.7	2.1	3.9	7.4	3.1
	1967	1.8	0.9	1.4	2.9	3.7	2.4

Table 2-6 (Cont.)

Land Use in the Region

		Lexington	Newberry	Richland	Saluda	Union	York	Average 12-County Area
Total County Land (Acres)		455,040	405,120	479,000	283,000	330,000	438,000	
Federal Land (%)	1958	0	13.6	11.5	1.4	17.0	0.7	3.9
	1967	0	13.6	11.5	1.7	17.0	0.7	3.9
						Percent	Change	0
Urban and Built-Up (%)	1958	6.9	4.4	10.2	0.8	2.7	6.0	4.2
	1967	10.5	4.5	17.6	1.2	3.2	9.2	6.4
						Percent	Change	+2.2
Cropland (%)	1958	22.6	19.8	15.6	25.2	12.0	21.2	18.4
	1967	21.1	12.4	13.1	19.5	7.6	15.3	13.1
						Percent	Change	-5.3
Pasture (%)	1958	2.7	4.3	3.5	11.8	6.5	10.4	7.2
	1967	3.5	8.8	2.9	17.3	9.4	11.8	8.9
						Percent	Change	+1.7
Agricultural (Cropland plus Pasture) (%)	1958	25.3	24.1	19.1	37.0	18.5	31.6	24.2
	1967	24.6	21.2	16.0	36.8	17.0	27.1	22.0
						Percent	Change	-2.2
Forest (%)	1958	64.3	55.1	56.1	57.6	55.6	55.7	61.3
	1967	61.8	58.3	52.7	57.0	61.2	58.0	64.2
						Percent	Change	+2.9
Other Land (%)	1958	2.8	2.5	2.7	2.8	6.1	4.8	3.6
	1967	2.4	2.1	0.7	2.8	1.5	3.5	2.2
						Percent	Change	-1.4

Notes:
1. The area within 50 miles of the site takes in all or parts of the twelve counties listed in this Table.
2. Reference: South Carolina Soil and Water Conservation Needs Inventory, May, 1970.

Source: South Carolina Electric & Gas, July 1972 Revised Application.

Table 2-7

Agricultural Data, Farms, Acreage, and Value, 1964 1/

ITEM	FAIRFIELD COUNTY	NEWBERRY COUNTY
Number of Farms	455	1,018
Average Size of Farms (Acres)	278	179
Average Value Per Acre (Dollars)	109	117

CASH RECEIPTS FROM FARM MARKETINGS - 1969 2/

(Percent of Total 1969 County Cash Receipts/Rank in State)

ITEM	FAIRFIELD COUNTY	NEWBERRY COUNTY
Cotton and Cotton Seed	1.3/40th in 46	0.4/38th in 46
Soybeans	--	4.6/24
Oats	--	0.4/9
Wheat	0.8/31	0.6/19
Other Crops 3/	4.0/38	1.7/25
Forest Products 4/	24.3/3	3.2/5
Dairy Products	16.4/29	29.0/2
Cattle and Calves	33.7/27	13.1/7
Hogs	4.8/45	5.6/18
Eggs	8.6/45	29.6/1
Other Livestock and Livestock Products 5/	6.1	11.8

Table 2-7 (Cont.)

LIVESTOCK AND POULTRY STATISTICS - 1969 6/		
SPECIES AND CLASS	FAIRFIELD COUNTY	NEWBERRY COUNTY
All Cattle	9,500 head	22,300 head
All Beef Cattle	8,500 head	13,400 head
All Milk Cows	750 head	6,200 head
Beef Cows 2 yrs. and Over	5,200 head	6,800 head
Hogs	900 head	9,000 head
All Chickens	27,000 head	470,000 head
Egg Production (1968)		
Avg. Number of Layers During year	22,000 head	353,000 head
Total Eggs Produced	4,700,000	81,200,000
Milk Production (1968)		
Avg. Number of Cows Milked During year	700	6,100
Total Milk Produced	4,000,000 lbs.	43,000,000 lbs.

NOTES:

1. Reference: 1964 United States Census of Agriculture

2. Reference: South Carolina - Cash Receipts From Farm Marketing, September, 1970.

3. Includes nursery and greenhouse products, peanuts, hay crops, seed crops, other miscellaneous crops, fruits and nuts except peaches.

4. Relates only to sales from 1964 census defined farms.

5. Includes farm chickens, turkeys, turkey eggs, other poultry, honey, beeswax, sheep, lambs, wool, horses, mules.

6. Reference: South Carolina - Livestock and Poultry Statistics, June, 1969.

7. Cows and heifers two years old and over kept for milk. Includes two-year old heifers not yet fresh.

Source: South Carolina Electric & Gas July, 1972 Revised Application

A 40-year land use projection for the site vicinity (all land within a 10-mile radius of the proposed project) estimates that 85 percent of the land will be used for forestry, 10 percent for urban and built-up area, and 5 percent for agricultural and other uses.

State and regional planning authorities have developed no long range comprehensive county or regional plans, but general plans concerning water supply and recreation have been developed. For example, the Fairfield County water and sewerage plan includes improvements in domestic water supply in the Jenkinsville-Monticello area. The U. S. Forest Service has long-range plans for recreational development in its Broad River Management Area, upstream of the existing Parr reservoir. Fairfield and Newberry Counties have at present no zoning or land use regulations in the site vicinity.

Other than a small plastics processing plant in Jenkinsville about 3 miles southeast of the site, there are no industrial developments in the site vicinity. Local residents find employment in industries located in the Columbia area, 26 miles to the southeast, and in Winnsboro, 15 miles northeast. Forestry is the only industry of commercial importance in the area and the major commerical resource that would be affected by the proposed project.

Fairfield County was the most heavily forested county in the State in 1967, with the majority of the forest land privately owned. Approximately 76,200 acres within the county are owned by 5 major pulp and paper companies, and Sumter National Forest occupies another 12,100 acres in the northwest section of the county. Several forestry-related industries operating in the county include saw mills, planing mills, and pulpwood dealers. Since 1958, the size of the county's forest industry has increased considerably. The volume of softwood, particularly pines, has shown a substantial increase, but the volume of hardwood has decreased. Efforts are presently being made to encourage quality hardwood species in the limited suitable lands available. The dominant trees in the area are pines on the uplands and mixed hardwoods in the stream bottom lands. The creation of Monticello reservoir will inundate about 3,000 acres of mixed pine and hardwood bottom lands, another 3,000 acres of pine plantation, and about 300 acres of Sumter National Forest.

Agriculture in the vicinity of the site is neither a major land use nor source of income and has declined to 17 percent of total land use in Fairfield and Newberry Counties. Besides the decline in farmland in the region, there has also been a substantial change in farm enterprises from intertilled crops such as cotton to livestock and poultry.

Due to the low fertility and high erodibility of the soils, few of the farms are economically viable, with most of the cleared land being in pasture or idle. Most of the farms are owned by part-time farmers who work in nonagricultural industries in the area. The families that could be displaced by the project are primarily using their lands for small scale crop production and small woodlot operations.

2.6 TRANSPORTATION CORRIDORS

State Route 215 is the nearest highway to the proposed project and would be the only one of some importance to be affected. County Route 99, carrying a low volume of local traffic, would be completely relocated in the project area. Interstate 26, running in a northwest-southeast direction, is approximately 5 miles southwest of Parr dam at the nearest point. Figure 1-1 shows highways adjacent to the project.

Three of Applicant's transmission line corridors lead from the Parr hydroelectric plant and the Parr steam plant, but none of them would be affected by the project. A 100-kv transmission line owned by Duke Power Company crosses the proposed Monticello reservoir and would have to be relocated.

Southern Railway has a one-track right-of-way along the east bank of the Broad River. The raising of Parr reservoir level and excavations in Frees Creek for the

Fairfield pumped storage plant tailrace would necessitate relocating and raising a portion of the tracks and building a 1,000-foot trestle. This line does not receive heavy use presently, and rail traffic would be disrupted for about 12 to 30 months by the project.

The Columbia Airport is located approximately 25 miles southeast of Parr dam. The project is expected to have no effect on the air corridors into the airport.

2.7 EMPLOYMENT AND ECONOMY OF THE AREA

The economy and population of Newberry and Fairfield Counties are typical of rural South Carolina. Agriculture has declined considerably in the area since the 1930's, accompanied by a rise in importance of industries such as textile mills, furniture factories, and chemical industries. The location of these industries in the larger urban centers has resulted in migration from rural areas (such as the project area) to the cities.

The 1970 income per capita was $1,642 for Fairfield County, $2,284 for Newberry County, and $2,313 for South Carolina, as compared to the national per capita figure of $3,139 for the same period.

2.8 FISH AND WILDLIFE

A checklist of flora and fauna whose range includes the area of Parr hydro project has been prepared by Staff and is attached (Appendix B); however, not all species listed occur within the project site. A vegetative cover map of the project area is attached as Appendix H.

The persistent turbidity of the Broad River places a limit on the river's fish carrying capacity (pounds of fish per acre). Since turbidity restricts sunlight penetration, periphyton (attached algae) are not able to build suitable populations to support a large biomass. Furthermore, settling out of suspended particles reduces the amount of suitable habitat for benthic organisms.

The Broad River within the project supports a limited warm water sport fishery. Principal species sought by anglers include catfish, largemouth bass, and sunfish with catfish the most intensively fished. Other species within the project area can be characterized as "rough fish," undesirable to fishermen, but important links in the food chain of the predators. Four basic aquatic habitats are represented within the proposed project area: free flowing Broad River, Parr Reservoir, embayments within Parr Reservoir, and Frees Creek (Appendix D).

Rabbit, squirrel, quail, and dove are the primary game species found within the project area. White-tailed deer, the most important big game species in South Carolina, is found here; however, it is presently not considered to be abundant within the project area. 59/ Occasional sightings of wild turkey have been reported for the project area and

have been attributed to an expansion of its range from adjacent National Forest lands where it was reintroduced in the early 1950's.59/ Waterfowl have historically used the Broad River as a migratory flyway and meeting area. Several species of ducks have been reported as transient; however, only the wood duck is considered to be a resident species. The Broad River is one of the major wood duck production areas in the Piedmont system. Other wildlife in the area includes various mammals, birds, reptiles, amphibians, and numerous macro- and micro-invertebrates. Although of apparently little direct sport or commercial value, these organisms form a necessary part of the ecological community.

The proposed facility would be located in an area dominated by pine plantations. Historically, this region was cleared of its native vegetation to allow the production of cotton in the uplands and corn and grain in the lowlands. The area suffered greatly with the advent of the boll weevil, and during the depression years farmers largely abandoned the area.

In the early 1930's, programs of the Civilian Conservation Corps and Works Progress Administration provided the manpower and the means to plant badly eroded areas with pines. Private

paper companies continue to clear existing vegetation and establish pine plantations. The dominant species is loblolly pine and is found primarily on the slopes and uplands in the project area. Other upland species include white and red oak and hickory. Very little understory vegetation is present because of the shading effect of the deciduous trees. The pines provide some soil protection and cover, but they produce very little food for deer and other wildlife species.

The bottomlands are inhabited by cottonwood, sweetgum, Nuttall oak, willow oak, and white ash. Honeysuckle and greenbriar are important ground cover species. Bottom land vegetation provides necessary nesting, roosting, shelter, and food for many wildlife species. The honeysuckle, found almost exclusively in the lowlands, provides the primary food source for the deer population. According to South Carolina game biologists, the lush growth and nutrient value of honeysuckle has a direct influence on the excellent growth rates and physical condition of the deer. Acorns provide another major source of food for wildlife. Smartweed, an excellent waterfowl food, is also quite abundant in the bottom land. A terrestrial monitoring program has been initiated to establish a more complete baseline inventory (Appendix D).

One southern bald eagle was spotted in the project area during a migration season by Applicant's consultants, but no evidence of nests has been discovered. No other rare or endangered plant or animal species is known to occur within the project area.

2.9 EXISTING RECREATION

There are no developed recreational facilities at the existing Parr reservoir, although fishing and waterfowl hunting are a recreational use.

The "consumptive" wildlife on the project area includes such game birds as bobwhite quail, mourning dove, and turkey, and such mammals as squirrel, cottontail rabbit, and white-tailed deer. The population of each species is low and hunting is probably only by local residents. However, no harvest information is available for the project area.

The project area is in the Central Piedmont Hunt Unit (South Carolina Wildlife and Marine Resources Department) where 2,135 deer were harvested before November 20, 1973, and 2,452 deer were killed during the entire 1972 hunting season. A record harvest occurred in 1972 and the harvest was expected to be even higher by the end of the 1973 hunting season.

Based on the habitat available and the observation of deer and signs of deer, the populations within the project

area are considered low. The number of deer that were probably harvested in the project area is estimated by the Applicant at less than six.

The Central Piedmont, with 552,156 acres, reported 92 gobblers harvested during the 1973 spring season, compared to 72 gobblers harvested in 1972. Very few, if any, were probably harvested in the project area. The area of Frees Creek and the Broad River is believed to be good to excellent turkey range within the Central Piedmont, according to a South Carolina Wildlife Resources Department District Biologist. However, the seasonal abundance of the wild turkey in the Frees Creek area and/or the Central Piedmont Hunt Unit has not been estimated. Turkey that presently occur within the Frees Creek area are "spill-over" from adjacent National Forest Land where re-introduction of turkey took place during 1953-1956. This "spillover" is fairly recent and accounts for occasional sightings of single turkeys, as well as small flocks in the project area.

Although there is potential non-consumptive recreational use of wildlife on project lands, it has not been realized. The major reason appears to be that this area is not unique within the Piedmont. New transmission line rights-of-way could enhance habitat for both consumptive and non-consumptive wildlife, and, therefore, provide greater recreational use.

Consumptive recreational use of aquatic resources involves the catching of fish, frogs, turtles, or invertebrates from Parr Reservoir, the Broad River within the zone to be inundated, and Frees Creek. Presently there are no quantitative data available to estimate fisherman-use of the area. Observations by field crews have not revealed any heavy usage of Parr Reservoir either by boat or bank fishermen. Access is difficult at most places on the bank, and the muddy waters, as well as the better fishing in other lakes, tends to limit the use of the reservoir. At no time during survey operations by the Applicant were more than 10-20 fishermen seen in any day at the reservoir during the prime fishing seasons (spring, early summer and fall). During non-prime seasons, 0-10 fishermen utilized the reservoir. Consumptive use of Frees Creek aquatic life is not known but would have to be slight, since it supports only small fish and the creek itself does not serve as a spawning area for larger fish. Presently, little is known of the consumptive use of the Broad River in the zone which will be inundated. The river as a whole, however, is not noted for good fishing.

Non-consumptive recreational use of aquatic organisms would involve observation of fish and invertebrates informally during picnics or other outings, or at specific times when

unusual movements (spawning) or other activities of aquatic organisms make them especially interesting to the public. Based on observations during field sampling, these uses are very low to non-existant in the site area. The turbid nature of the waters for much of the year, the relative lack of access to the water, the lack of use of the area as a picnicking or camping area, and the lack of interesting visible activities of aquatic life serve to make this area undesirable for non-consumptive uses.

Various parks and other recreational areas are within the region, but the only significant public land available for recreational use within a 10-mile radius is the Enoree Division of the Sumter National Forest. Here, picnicking, hiking, hunting, and limited boating and fishing occur. One boat ramp on nearby Cannons Creek serves the immediate vicinity of the Parr reservoir.

2.10 SCENIC, NATURAL, AND HISTORIC VALUES

A large portion of the land in the vicinity of the upper reservoir is covered with loblolly pines of varying ages. Most of the roadside scenery is pines, which occur both in plantations and as part of the natural succession in the abandoned fields and pastures of the area. State Route 215, running generally along the ridge top at the eastern

edge of the proposed upper reservoir, is essentially a narrow corridor with pine walls. This view is broken occasionally by small communities (two or three houses), and fields and pastures. At the town of Monticello, the view broadens considerably, due to the pastures around Davis plantation. Most of the proposed upper reservoir and the hills and saddles (sites of dikes) that would form the western edge of the proposed reservoir can be seen from this vantage point.

Figure 2-3 shows the historic sites near Monticello reservoir. Davis Plantation, located about a quarter of a mile south of Monticello on Route 215, is the only registered national historic site that would be affected by the project. The white wooden frame structure, with tall columns and a pecan and oak-lined drive in front, is well kept and still in use. The area around it is mainly in cattle pasture and some of these lands would be flooded. Staff, pursuant to Section 106 of the Historic Preservation Act, consulted the National Register of Historic Sites and afforded the Advisory Council on Historic Preservation opportunity to comment on the DEIS.

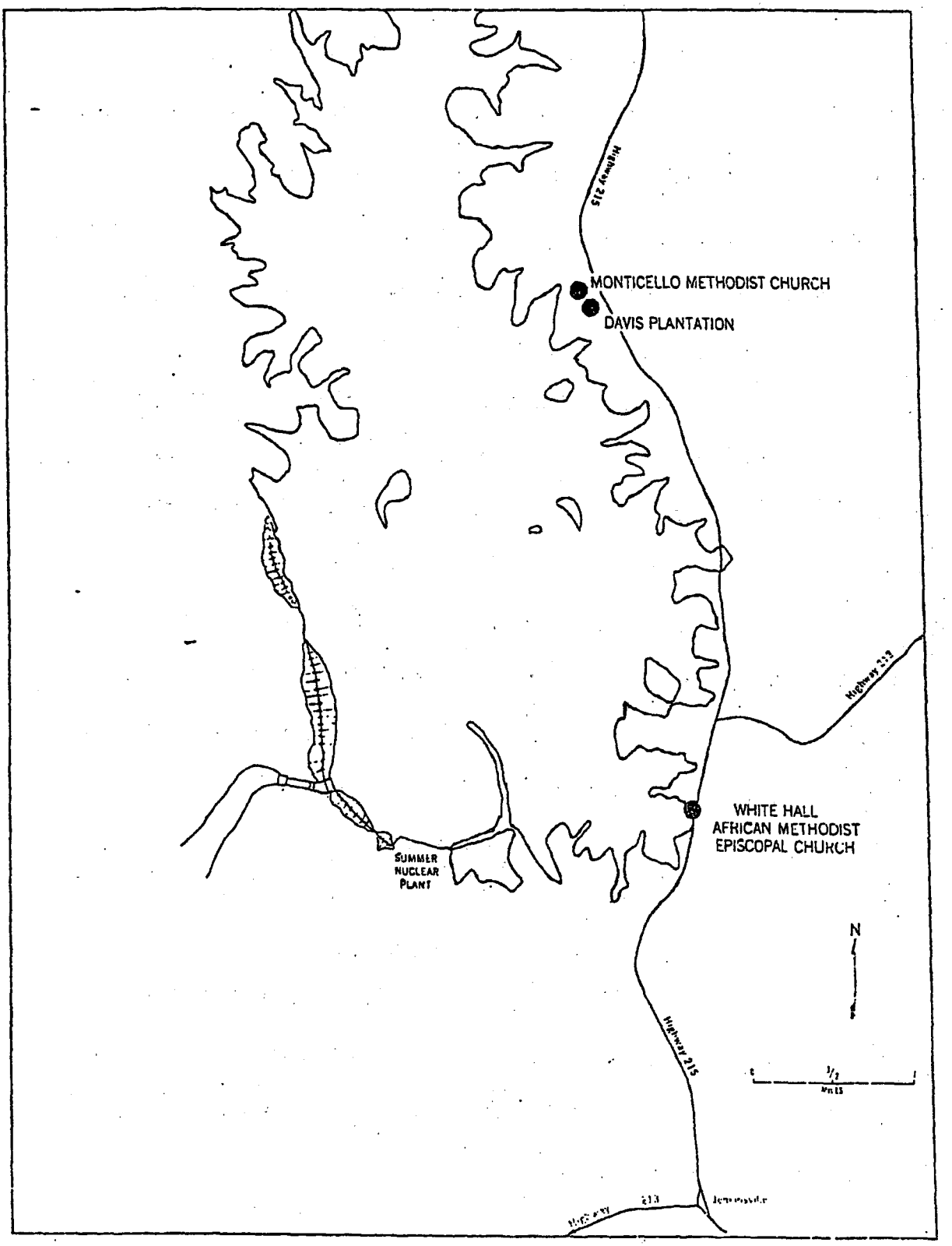


Figure 2-3. Locations of Historical Sites Near Monticello Reservoir

There is a small, picturesque Methodist Church, approached by a wooded lane, at the southern edge of Monticello on Route 215; this church is of some local historical value and is on the State historic list. An old graveyard on the southern side of the church looks out across a pasture over the proposed reservoir area, but it will not be inundated. Fonti Flora, another State Historic site (not shown on the map) will not be affected. Although not a national or State historic site, the White Hall African Methodist-Episcopal Church, established in 1867, will have some lands flooded by the project.

Historically, the lower settlement of the Great Cherokee Nation extended to the Broad River, and the area between the Broad and Catawba Rivers was a common hunting ground for the Cherokee and Catawba tribes. 7/ Four archaeological sites associated with Indian habitation have been identified, none of which would be inundated. The State Archaelogist has recommended that two of the sites be excavated, and prior to construction a detailed survey of the area be conducted to determine whether additional sites exist, and, if so, to determine whether detailed excavation and analysis are warranted.

The Applicant has stated that it will support and finance such a study to be conducted by the University of South Carolina Institute of Archaeology and Anthropology.

3. ENVIRONMENTAL IMPACT OF THE PROPOSED ACTION

The primary benefit derived from the proposed project would be the production of peak electric energy in the Applicant's system to serve the growing power needs of the public. Also, the upper pumped storage pool, Monticello reservoir, would provide cooling water for the proposed Virgil C. Summer nuclear station. Thus, the combined projects (nuclear and pumped storage) would serve both base load and peaking power needs.

The proposed recreational facilities would be the first in Fairfield County and would provide increased outdoor activities, including harvest of possibly enlarged sport fish populations due to construction and management of the subimpoundment.

Sport fishing in Parr reservoir would probably be curtailed or fishing success decreased by the almost 10-foot daily fluctuation resulting from pumped-storage operations.

The quality of the existing fishery in Parr reservoir and Broad River is classed as very poor due to turbidity. The recreational fishing provided by the proposed subimpoundment on Monticello reservoir should offset any losses to the fishing in Parr reservoir.

In the project area, following issuance of a license for construction and operation of the project, increased job opportunities would arise, and there would be an expanded tax base providing additional economic gains.

3.1 HUMAN ELEMENTS

The greatest impact on the communities of the area would result from the influx of the construction work force. Approximately 600 workers would be employed at the pumped storage project and about 1,200 workers at the atomic plant site. 8/

A study of similar construction projects has shown that an influx of 1,800 workers into such an area results in a population increase of 5,110 people, including 1,000 school children, and requires about 700 mobile home accommodations. 9/

Of the 1,800 workers for the two projects, approximately 30 percent would come from permanent residents within a 25-mile radius of the project area. 10/ The majority of those workers relocating in the project area would probably settle in Columbia, South Carolina. 11/ The number of workers actually locating in the project vicinity should be relatively small, and the local area service facilities should absorb the increased load without any great difficulty.

Population increase resulting from the project should occur gradually, building up to a peak and tapering off during the construction period. A small permanent increase would result from the professional and skilled workers required for the operation of the pumped storage plant and the nuclear station.

The commuting workers, heavy construction equipment, and trucks transporting construction materials would probably damage the relatively light duty roads of the area. However, no estimate of the increased maintenance costs is available. The increased traffic could cause some inconvenience to, and increase the driving hazards for, local residents using the roads.

The major adverse impact on the human resources of the area would result from the relocation of as many as 25 families (9 by the nuclear station), 5 small abandoned cemeteries, and portions of State Route 215 and County Route 99. The enlargement of Parr Reservoir would require the elevation of sections of Newberry County Road 28 and of a section of railroad track over Frees Creek. Relocation of the homes, cemeteries, and roads would be required by inundation of the 6,800 acres of land by the upper reservoir. Raising the elevation of the existing Parr reservoir and excavations in Frees Creek area

would require the relocation of a short section of the Southern Railroad tracks.

The total land area to be acquired or controlled by the Applicant for both the proposed Fairfield pumped storage facility and the Virgil C. Summer nuclear station would involve approximately 11,000 acres. This would include both inundated lands and lands required for buildings, access roads, the nuclear safety exclusion zone, and other project elements.

Construction of the combined projects as proposed would result in the loss of about 700 acres of agricultural land in the areas of the upper reservoir and the nuclear station, and a few small cleared tracts in the Broad River bottomlands. 12/ Most of these lands are either in pasture or are not currently planted in crops. Due to long overuse and to high erodibility, the land in this area is generally not suitable for intertilled crops. Agriculture in the site vicinity is not a major source of income, having decreased in Fairfield and Newberry Counties by 4 percent of the land area within the last decade. Agricultural data for these two counties are given in Tables 2-6 and 2-7.

Inundation of land by creation of the upper reservoir would result in the loss of about 3,000 acres of pine plantations and about 3,000 acres of mixed pine and bottom land hardwoods.

About 2,550 acres of bottomland hardwoods would be lost by the flooding of new lands in Parr reservoir. Approximately 300 acres of national forest that have been used as waterfowl management area would be lost. The total loss of forested lands (8,550 acres) would represent a decrease of about 1.4 percent of the total forested lands in Fairfield and Newberry Counties. The pine forests in Fairfield County that would be lost have commercial value as timber and pulp. The bottomland hardwood trees around the Parr reservoir are primarily important in providing wildlife cover and food, and have secondary value as timber.

Sand and gravel deposits in the Broad River would be lost. An existing quarrying operation on Rocky Creek, about 10 miles upstream from the existing Parr Dam, would not be affected, however, because the present quarry site would be above the Parr Reservoir's proposed maximum elevation of 266 feet msl. Any expansion of the quarry further downstream could be hampered by the proposed project, although the rise in water levels at the Rocky Creek and Broad River confluence would be only 4 or 5 feet.

3.2 FISH AND WILDLIFE

The U. S. Fish and Wildlife Service lists the following species as endangered in South Carolina: American alligator, eastern brown pelican, southern bald eagle, Eskimo curlew, American ivory-billed woodpecker, and Bachman's warbler. However, none of these species is

known to nest or reside within the project area.

One of the most significant impacts on the existing terrestrial biota would result from the inundation of about 2,550 acres of bottomlands due to enlargement of Parr reservoir. These bottomlands along the river provide habitat and produce food for many species of wildlife both on and beyond the 2,550 acres. The loss will adversely affect the existing wildlife resources to an undetermined degree. If these habitat and food producing areas are flooded, the animals would migrate to adjacent land areas. This migration would place an added strain on the habitat of the wildlife species resident in these areas, thereby disturbing an existing balanced ecosystem. In areas with populations below the carrying capacity of the land, these displaced species might be absorbed without having any significant impact on resident species. On those lands becoming overpopulated, the habitat would suffer from overuse until the surplus populations are harvested by hunters, die from disease or starvation, or move into areas where they can be sustained by the habitat. The creation of the upper reservoir would involve the inundation of approximately 6,800 acres of wildlife habitat, from which terrestrial wildlife species would be similarly displaced.

The inundation of 2,550 acres of bottomlands will eliminate some wood duck nesting sites along Parr reservoir. The absence of broad nesting habitat now appears to be a major limiting factor controlling wood duck production within the project area; however, breeding habitat appears to be abundant. 59/ The daily fluctuation of Parr reservoir is not expected to preclude waterfowl usage for feeding, but successful shoreline nesting and rearing of young would be curtailed.

The type of aquatic habitat developed by creation of the upper reservoir would depend largely upon the effect of a daily 4-foot fluctuation, thermal discharges from the Virgil C. Summer nuclear plant, exchange of organisms between the two reservoirs, and the quality of the water, including turbidity.

Fish and associated aquatic organisms would be exchanged between Monticello reservoir and Parr reservoir during pumping and generating cycles of operation. Consequently, some mortalities would occur, as has been indicated in numerous studies made on the fish passing through conventional hydroelectric turbines, both Kaplan and Francis types. These mortalities are related to pressures and mechanical injury, and vary with the operation of the plant and the hydraulic head. The studies generally show high mortalities occurring with negative pressures from

cavitation (partial vacuum pockets produced around the runners), with higher heads (where cavitation is more likely) and with less efficient operations than those for which a specific unit is designed. Combination pump-turbines are usually free of cavitation because of deep submergence of the runners and the configuration of the runner blades. In reviewing the design of the pump-turbines with operational data, such as volumes and velocities of water, clearance, speed of rotation, and the species and populations of fish involved, fish mortalities would probably not be significantly high at the project. 13/

Daily fluctuations in Parr reservoir would be as much as 10 feet, and in Monticello reservoir as much as 4-1/2 feet. While the water rise in Parr reservoir would result in 2,550 surface acres of new potential aquatic habitat, a corresponding increase in the total amount of biomass would probably not occur, due to the probable adverse influence of water fluctuations on benthic organisms and spawning activities of nest building centrarchids. Benthic organisms have limited means of locomotion and are unable to travel long distances, and if these relatively nonmotile organisms are subjected to a daily water level change of 10 feet, many would be stranded well above the new water level and would subsequently perish. As a result of this benthic loss, an increase in biomass and carrying capacity of Parr reservoir would not be realized.

Spawning success of centrarchids would be adversely affected by the decreased surface area caused by the daily 10-foot fluctuation in Parr reservoir, while the 4-1/2-foot fluctuation in Monticello reservoir would have a minimal adverse effect on spawning. The effect, if any, that thermal discharges accompanied by daily water level fluctuations in Monticello reservoir would have on centrarchid spawning is unknown. Daily fluctuations of up to 4 feet in Leesville reservoir did not directly affect spawning of the largemouth bass and bluegill. 14/ Baren and Howelett (1971) reported similar findings and concluded that these fishes adapted to uniform water level fluctuations. 15/ Vogele (1969) found "black basses" nesting to a depth of 15 feet in an Arkansas reservoir, but the greatest depth at which largemouth bass were observed to be nesting was 5 feet. 16/

The daily water level fluctuation of 10 feet in the Parr reservoir would adversely affect habitation by the existing small population of fur bearers, such as muskrat, as at times lodges and dens would be completely submerged or left exposed some distance from the water's edge.

During construction, turbidity of the Broad River would increase due to runoff from these disturbed areas, and this effect would be exerted largely on the downstream aquatic

habitat. Increased turbidity would restrict sunlight penetration and thereby inhibit periphyton (attached algae) growth needed to support other aquatic organisms. Siltation would depend upon the rate of flow from Parr Dam. (The adverse effects of siltation upon the aquatic habitat have been the subject of several investigations. 17/, 18/, 19/, 20/.) The Applicant's proposed measures to reduce soil erosion during construction are discussed in Section 4.

Noise and activities associated with construction would disrupt wildlife in the area, and thus many of the vertebrates could be displaced. The effect of this disruption would be different for each species, and would be influenced by how well the animals could be absorbed by new areas. After construction is completed and human activity reduced, some species of wildlife would probably return to the old areas.

The effect of noise levels from project operation on resident species is unknown.

Significant changes in flow, temperature, or chemical composition of the Broad River could affect the spawning of the striped bass in the Congaree River downstream. A landlocked population of the striped bass in the Santee-Cooper Reservoir complex is reportedly the only well established one in the world. This species lives in the reservoir complex but spawns in the Congaree River, formed by the confluence of the Saluda and Broad Rivers near Columbia.

Spawning occurs in late March to late May when water temperatures are about 60°F. After fertilization, the eggs become water hardened and semibuoyant. Hatching occurs at from 30 to 72 hours depending upon water temperature. If spawning occurs in water above 70°F, high egg mortality usually results. Flow velocity is also important for survival of the eggs, which should be kept suspended in the water column until hatching. If riverflow is too slow, the eggs settle out, or if flow is too fast, they reach the reservoir before hatching and then settle out.

Some heated water would be discharged from Monticello reservoir to Parr reservoir during the spawning months of the striped bass. The interaction of this heated water with that of the reservoir is still under evaluation, but presently it is expected that a measurable temperature increase, if any, would only occur in the tailwater of the Fairfield powerhouse. No significant temperature increase would be expected in the Broad River below Parr dam, and no detrimental impact on striped bass spawning activities would be anticipated. Flow data over the past 40 years show highest flows occurring between January and April of each year, indicating that flows have historically been compatible with striped bass spawning. Low flows usually occur during summer and fall.

The Applicant and the South Carolina Wildlife and Marine Resources Department reached an agreement (Appendix A) that assures maintenance of adequate flows for striped bass spawning during operation of the proposed project.

Construction of the 1-mile long Fairfield-Summer transmission tieline and relocation of the Duke Power Company transmission line would displace some wildlife during the work period. Some ground cover as well as some den or nesting trees would be eliminated. Wildlife forced into adjacent areas might be assimilated without upsetting an existing balanced ecosystem, or they could create imbalances to the disadvantage of resident wildlife. Clearing of the proposed transmission line rights-of-way (approximately 121 and 67 acres, respectively) would create about 11 miles of edge habitat along the Duke Power Company right-of-way and about 2 miles along the Fairfield-Summer tieline right-of-way. With proper management, this edge habitat could enhance production of wildlife by providing a greater variety and abundance of food and cover for wildlife than was previously available. In turn, the carrying capacity of the land would be increased.

Some loss of bird life could occur from collision with conductors or by electrocution. The extent to which this could occur is related to the visibility and the capacity of the line and clearance between conductors. Waterfowl flying into Monticello reservoir during twilight would be the main species affected.

Recreational development would disturb wildlife habitat, probably even displacing some existing wildlife populations. Such displacement would disrupt adjacent balanced ecosystems, as was described above. During the recreation season, human activities associated with use of facilities could affect wildlife by altering behavioral patterns.

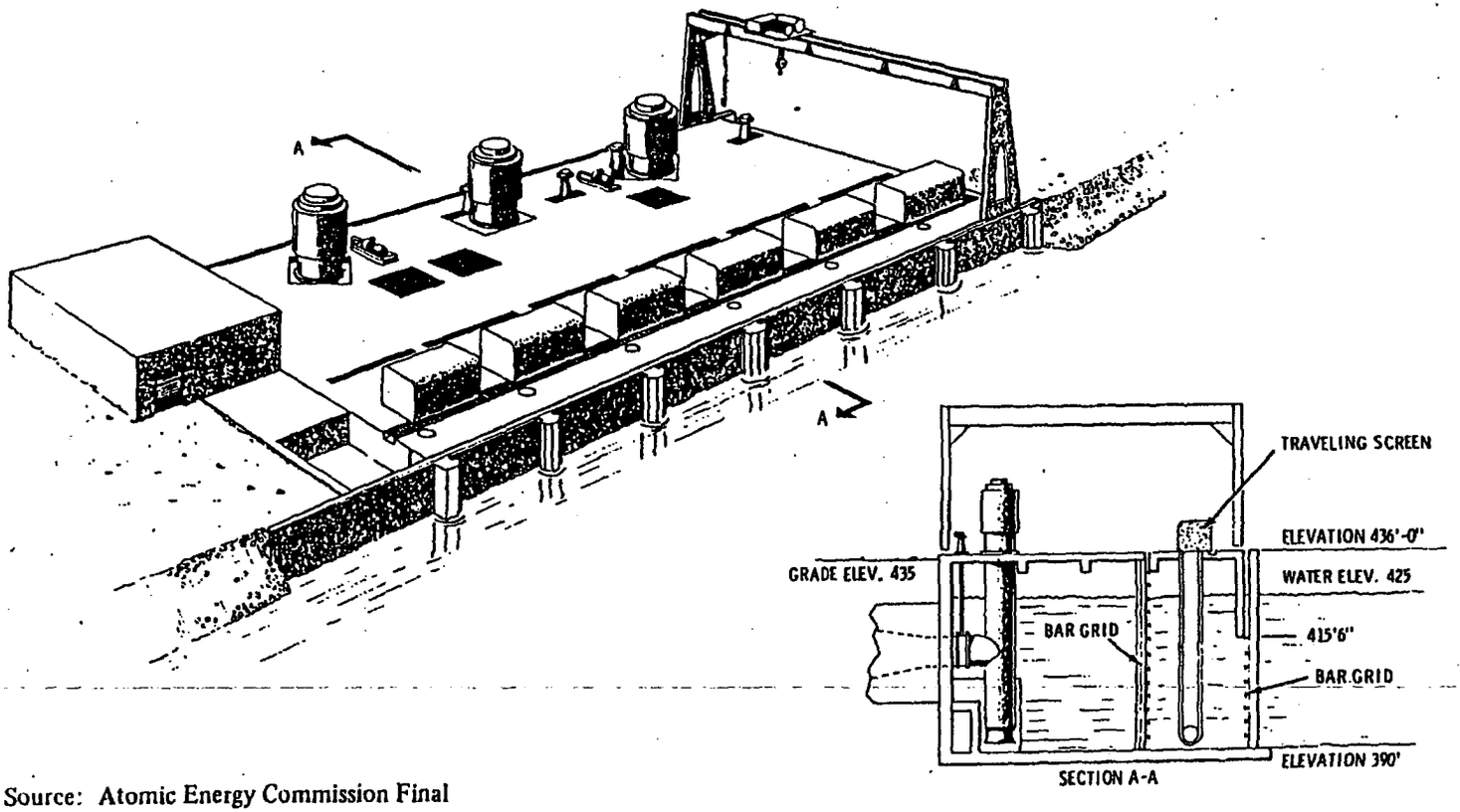
Approximately 300 acres of the upper end of Monticello reservoir would be impounded for a fishing area. This fishing area would draw water from runoff and Monticello reservoir as required, and would probably be clearer than Monticello and Parr reservoirs. Only slight water fluctuations would likely occur. This proposed fishing area would be stocked with bluegill and largemouth bass and should provide an excellent sport fishery.

Operation of the Virgil C. Summer nuclear station would involve the joint use of project waters (Monticello reservoir) for cooling purposes. Impacts on the aquatic ecosystems are discussed by AEC in its environmental statement and are presented below.

3.3 NUCLEAR STATION AND MONTICELLO RESERVOIR 21/

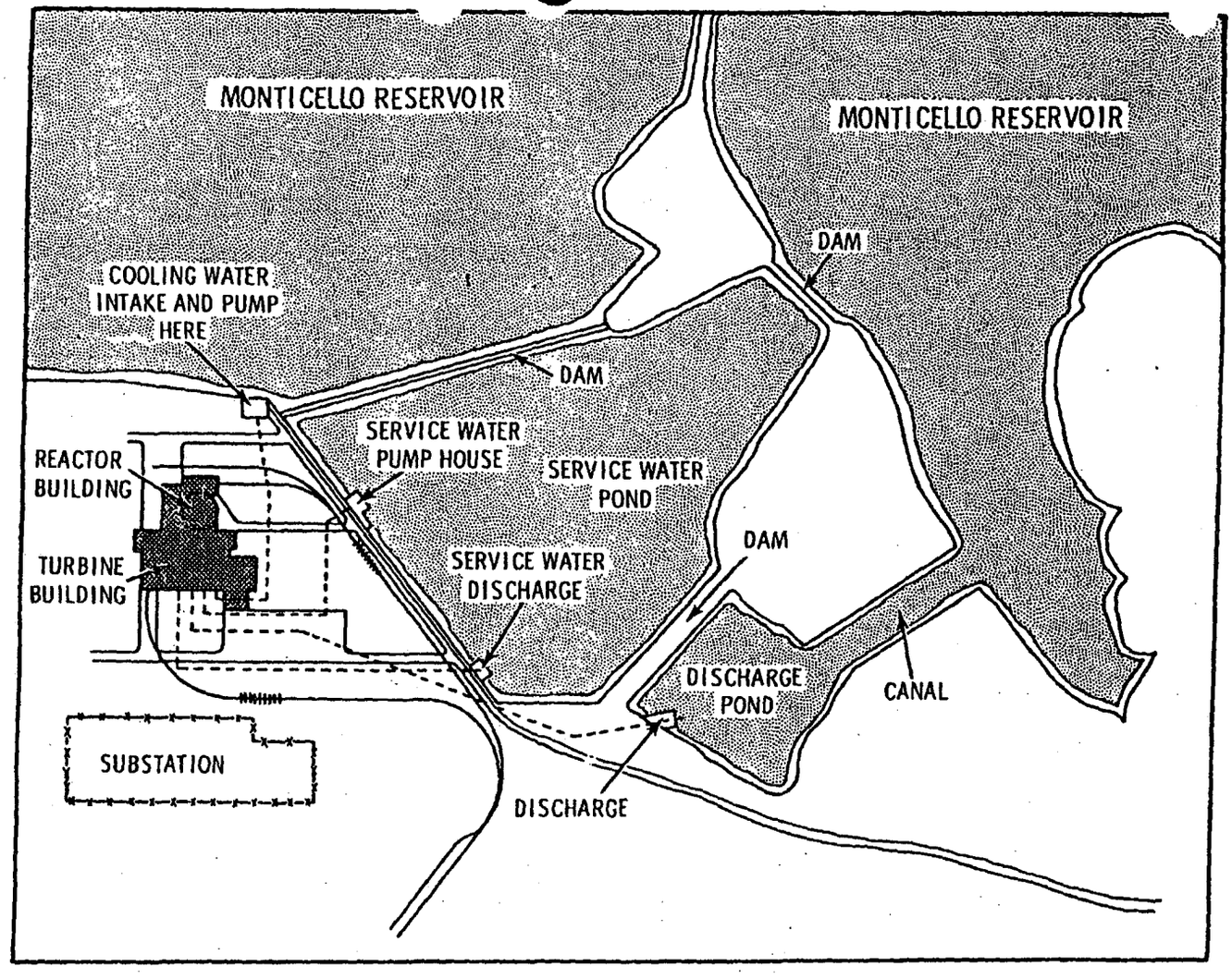
Operation of the Summer station would have a significant impact on the biota of Monticello reservoir in the intake structure, heat exchangers effluent discharge canal, and mixing zone. Some mixing with Parr reservoir water would occur as a result of discharges from Monticello reservoir during the generating cycle of the Fairfield pumped storage hydro station.

The cooling water intake structure (see Figures 3-1 and 3-2) would be located flush with the shoreline, where it would not be expected to attract fish or interfere with their movements along the shoreline. The cooling water would be withdrawn from below the surface of the impoundment by use of a skimmer wall extending to a depth of about 10 feet. There would be a possibility, particularly because of anticipated high turbidity, that fish swimming between the skimmer wall and the traveling screens would be unable to find their way out again and would become trapped. 22/ The approach velocity of the intake water would probably be about 0.7 fps, which should be sufficiently low to allow most small fish to successfully avoid being swept into and impinged on the traveling screens. 23/ Water temperature during the time of year young fish would be present in the reservoir would be near optimum (60°F) for swimming performance and thus should not contribute to any significant impingement problem.



Source: Atomic Energy Commission Final Environmental Statement Virgil C. Summer Nuclear Station January 1973

Figure 3-1. Intake Structure and Condenser Cooling Water at Monticello Reservoir



Source: Atomic Energy Commission Final Environmental Statement Virgil C. Summer Nuclear Station January 1973

Figure 3-2. Plan of Nuclear Station and Condenser Cooling Facilities

The water velocity through the screens should be about 1.3 fps, sufficiently low to allow most fish near or on the screen to work their way free by moving laterally across it. Some fish could become caught on the screens and suffocate, or pass through the screens despite the small mesh size, and thus be subjected to thermal and mechanical stresses as they pass through the condenser system. However, the number of fish so affected should be low, and thus the well-being of the fish population of the reservoir should be secure. Because the integrity of the shoreline would be maintained and the velocity of the intake water would be relatively low, the intake structure would probably not cause serious adverse effects.

Any organisms (particularly plankton) entrained in the cooling water as it is withdrawn from the impoundment would be pumped through the condenser system along with the lake water and subjected to thermal and mechanical stresses. At full power operation, the temperature rise across the condensers would be about 25°F, which during the warm months would be superimposed on lake temperatures ranging from the low to high 80°'s. Effluent temperatures of from 105° to as high as 113°F, meanwhile, could also be expected during these months, and temperatures of this magnitude are considered higher than those plankton can tolerate without ill effects. 24/, 25/ During the remaining months, effluent temperatures would be within acceptable limits.

The length of time an organism is exposed to the higher temperature cooling water is also of significance in assessing the impact of passage through the condenser system. At the temperatures often encountered in condenser systems, thermal dose (the combined effect of temperature and time) determines lethality. 26/ During the cooler months of the year when intake water temperatures would be low, effluent temperatures would also be relatively low. During these cooler months the travel time (23 minutes) of the effluent would probably not be of consequence. However, during May through September when intake and effluent temperatures would be high, travel time could be of sufficient consequence to cause significant mortality of entrained plankton.

The mortality of organisms entrained in cooling water could, under certain conditions, present a problem. 27/ If mortality is high and the volume of cooling water pumped through the condenser system is a significant part of the lake or river from which it is being withdrawn, then a serious threat to the viability of the ecosystem could exist. On the other hand, if mortality is high but the affected volume is small, compared to the volume of the cooling water source, then any mortality as a result of condenser passage would not necessarily be of consequence to the ecosystem.

The volume of cooling water which would be used in the Summer station condenser system in a day would be small in comparison to the volume of Monticello reservoir. The reservoir would contain about 440,000 acre-feet. Approximately 530,000 gallons per minute per unit (2,350 acre-feet daily), or about 0.5 percent of the reservoir volume, would be pumped through the condenser system daily.

If this water contained the maximum number of plankton found in a water sample from Parr reservoir (7,000 organisms/liter, each assumed to weigh 10^{-5} grams), 28/, 29/ then as much as 33,150 tons of plankton could, under the worst temperature conditions, be destroyed each year (221 tons daily) during the warmer months of May through September. If the same number of plankton are distributed throughout the lake, a complete kill in the condenser system would be small compared to the size of the standing crop.

Organisms in the water pumped from Parr reservoir to Monticello reservoir would temper consequences resulting from entrainment losses. Approximately 29,000 acre-feet would be pumped into the reservoir each day during the pump cycle of the Fairfield facility. This water would contain entrained organisms, since no screening would be used on the penstocks. This amount of water represents more than 12 times the amount to be used in the condenser system, so any loss of plankton due to entrainment in the cooling water would not

be significant in Monticello reservoir. The Applicant would monitor this aspect of the operation to measure the actual effects of entrainment and to evaluate its impact on the reservoir.

A mechanical cleaning system, rather than biocides, will be used to prevent fouling of the condenser tubes. Therefore, any adverse impact on entrained plankton will not be aggravated by the condenser cleaning system.

During the summer months the water temperature in the discharge canal and pond would range to 113°F. Temperatures of this magnitude are higher than even warm water fish can tolerate; therefore, fish could not occupy the discharge system at this time of year. 30/, 31/, 32/ During the colder months, the warmer temperatures in the discharge canal and pond would probably attract fish. The attraction of fish in winter to thermal discharges in both marine and freshwater environments is well documented. 33/, 36/

It has been suggested that zones of above normal temperature may adversely affect fish through change in maturation time, disease resistance, behavior, metabolic rate, and resistance to low temperatures. 37/ If the nuclear power station is temporarily shut down during winter, fish mortality could result from "cold shock," due to the abrupt decrease in temperature in the discharge canal and pond. At the Northport nuclear station, Long Island, New York, striped bass and bluefish were killed during winter when

temperatures in the effluent discharge area were reduced from 51°F to 31°F following shutdown of the plant. 38/ More recently, large numbers of juvenile menhaden were lost near the Oyster Creek nuclear power station in New Jersey, when a natural drop of 11°F in the receiving waters was accompanied by a plant shutdown. 39/

At Summer station, approximately 40 acre-feet of water would be contained in the discharge pond and canal, a very small fraction of the 440,000 acre-feet volume of Monticello reservoir. But a rather large number of fish would probably winter in the discharge pond and canal when the water temperatures in this heated area ranges from about 60 to 90°F. A sudden drop of 25°F produced by a station shutdown would probably kill a large percentage of the more heat-sensitive fish in the discharge pond and canal. The actual number of fish which would perish, however, cannot be predicted, since the ultimate fish population in Monticello reservoir cannot be determined until the lake is filled and an equilibrium established with Parr reservoir.

The impact of any fish kill on commercial or sport fishing would be slight, since Monticello reservoir would not be used for commercial fishing, and sport fishing would be principally confined to a stocked and isolated pond at its northern end. Structures between this pond and the main body of water of Monticello reservoir would keep the sport fish from seeking the warm water of the discharge canal. Should

winter shutdown be necessary, and if winter fish kills become a significant problem, measures could be taken at a later date (for example,placing screens or some other device) to discourage fish from entering the canal.

At the Virgil C. Summer plant, fish could also be subjected to rapid increases in water temperature when plant operation is resumed after a shutdown during the winter. Fish in the discharge canal would have to acclimate to the temperature rise or vacate the canal. If fish are unable to avoid the thermal rise, mortality to some would result. This adverse impact should be minimal, however, because fish can avoid adversely high temperatures, and because there would be no concentration of fish in the canal after the plant had been inoperative for a period of time.

The cooling water would be discharged to the surface of the impoundment at a velocity of less than 1 fps, to effect minimal mixing and rapid evaporative heat dissipation to the atmosphere. Vertical mixing of the cooling water would be limited to the upper 10-15 feet of the reservoir; below 15 feet little mixing would be expected. Water temperature would therefore be highest in the surface and near-surface waters close to the outfall. Temperature would decrease with depth to ambient, or slightly above, below 15 feet with increasing distance from the outfall.

As a result of stratification, surface temperatures in part of the mixing zone during the summer months would be higher than would be compatible with fish life. 40/ In July, for example, temperatures in the immediate area of the outfall would range to 113°F. Temperatures this high would be directly lethal to centrarchids. 41/ Subsurface temperatures below the mixing zone and relatively close to the outfall would, however, be acceptable. For example, the temperature preferential for bluegill is about 88°F. 42/ In general, since the fish in the reservoir would be free to move about, they would avoid areas of unfavorable temperatures created by the mixing zone. 43/ Since the effluent would be discharged on the surface of the lake, the mixing zone would not affect the benthos. Some blue-green algal growth could be encouraged close to the outfall because of the elevated temperatures which would occur in that area.

The principal effect on Parr reservoir would be that resulting from the fluctuating level caused by operating the Fairfield pumped storage project. The temperature rise of the water to be released from the proposed Monticello reservoir via the pumped storage plant to Parr reservoir is estimated by the Atomic Energy Commission Staff to be less than 3°F under worst conditions of low water and high withdrawal rates. This would be somewhat less than the 3.5°F to 4.2°F increment indicated by the Applicant's model tests.

This temperature increment, although small, could alter species diversity of the aquatic organisms of Parr reservoir in the vicinity of Frees Creek. No discernible effects on fish in Parr reservoir and the Broad River would result. 44/, 45/, 46/

Nuclear plant start-up wastes, containing primarily phosphate and detergents, would be treated in the sanitary system. Soluble phosphate would be reduced to 5 ppm by precipitation with lime or alum and then sent to the oxidation pond, a part of the sanitary system. The effluent would be discharged to Monticello reservoir along with the water pumped through the turbine condenser system. The rate of water use in flushing prior to start-up is not stated; the Atomic Energy Commission Staff assumed that the rate would be of the order of 30,000 gallons/day, since the total discharge would be about 600,000 gallons, and the cleaning period could encompass 3 weeks. Assuming a steady flow into the condenser water discharge of 530,000 gpm, the AEC Staff estimates that phosphates would be diluted 1:25,000 prior tc entering Monticello reservoir, and greatly diluted further in the reservoir. Phosphate would be present in the discharge at a concentration of about 0.2 ppb. Similarly, detergent would be present at about 10 ppb. Because of these very low concentrations and the short term of disposal, the flushing wastes would have virtually no detrimental impact on aquatic life in Monticello reservoir. 47/ Phosphates discharged would serve as a nutrient to plant

growth, but the levels to be discharged are too low to be of concern.

The sludge from phosphate precipitation, which the AEC Staff estimated would consist of about 2 tons of calcium phosphate, would be buried. This would pose no threat to human or wildlife communities since it would be a relatively small amount of a very insoluble compound.

Oil-contaminated wastes from floor drains would be a subject of concern. Oil would be separated from the water prior to oxidation ponding; the water would be discharged in the condenser water channel to Monticello reservoir. Between 10,000 and 30,000 gallons/day would be processed, with a resulting biochemical oxygen demand (BOD) of 6 to 167 pounds/day in the effluent. Upon dilution with condenser cooling water, the BOD of the water entering Monticello reservoir would range from about 1 ppb to 20 ppb. No discernible effects would be produced by this discharge. 48/

The concentration of sodium sulfate would be 0.09 to 0.23 ppm in the condenser water canal. These levels would be far below the existing concentration of salts in the Broad River, and the AEC Staff concluded that disposal to Monticello reservoir would be innocuous.

Effluent from the sewage treatment plant could be chlorinated and discharged to Monticello reservoir by way of the discharge canal. The many thousandfold dilution and the high temperature of the condenser water would reduce

chlorine levels to a concentration far below the point of concern for any effects on aquatic life in Monticello reservoir. If chlorinated to 1 ppm at the sewage plant discharge, the effluent would have a resulting concentration of about 0.04 ppb, assuming a sewage plant flow of 30,000 gpd (estimated from the floor drain system). This low concentration would quickly be reduced to even lower concentrations. 49/

Steam generator blowdown would initially contain salts in the makeup water, small amounts of phosphates, corrosion products, and chemicals for pH control. The dilution in the condenser discharge that would result in concentrations of the salts in blowdown would be inconsequential to biota occurring in Monticello reservoir.

3.4 WATER QUALITY

Water quality of the project reservoir and the Broad River would be affected to some degree by redevelopment of the Parr hydro plant, construction and operation of the Fairfield pumped storage facility, and the joint use of project waters (Monticello reservoir) for once-through condenser cooling by the Virgil C. Summer nuclear plant. Monitoring of inflow upstream and downstream from the project would make it possible to determine any water quality changes attributable to construction and operation of project facilities.

During the construction phase, turbidity and siltation of the Broad River downstream would increase due to erosion from disturbed areas. Presently the Broad River carries a substantial silt load which limits its biological productivity. This turbidity is largely natural and is attributed to the characteristics of the area soils, farming, and development in the watershed.

Any adverse effects on downstream water quality should be short term (the more pronounced during construction and for a few years thereafter), but would depend upon an effective erosion control program which would limit the length of time any area would remain without a stabilizing vegetative cover.

It is possible that enlargement of Parr reservoir would result in an enlarged "sink" for organic matter and other nutrients that provide the necessary substrate conducive to actinomycete growth and odor production. The study conducted by EPA to determine the source and cause of odor problems in the Columbia municipal water supply pointed out that tributaries to the Broad River upstream of the Parr reservoir were the major sources of these nutrients. The EPA indicated that treatment at the sources of industrial and municipal wastes should be implemented,

commensurate with available technology. It is not expected that the 3°F increase in temperature of water reaching Parr reservoir as a result of cooling water from the Virgil C. Summer nuclear station will greatly enhance actinomycete development. This water would be diluted by waters of the Broad River so that no increase would be apparent below Parr dam. Furthermore, this temperature change would affect only a small portion of the Parr reservoir.

Monticello reservoir would provide water for once through cooling for the Virgil C. Summer nuclear station. A hydraulic model study of the overall hydrologic system is being conducted by Alden Research Laboratories at Worcester Polytechnic Institute, Massachusetts. This model simulates Monticello reservoir, Parr reservoir, and Broad River inflows and outflows. Superimposed on the model are the thermal and/or hydraulic characteristics of the proposed Fairfield pumped storage facility, Units I and II of the Summer station, Parr steam electric station, and Parr hydro station. Conclusions reached from preliminary model studies by Alden Research Laboratories are as follows:

(1) The overall concept of the Parr hydroelectric project is feasible.

(2) The average daily water temperature increase at the discharge of the pumped storage plant into the Broad River would be less than 3°F, with a 25°F temperature rise at the discharge channel for two nuclear units. The maximum measured temperature rise in the Broad River during any phase of the pumped storage process would be 4.2°F. These predicted temperature increases would fall well within the 5.0°F limit set by the South Carolina Pollution Control Authority.

(3) Maximum heat transfer in the upper impoundment would be achieved by stratifying the upper impoundment through use of a low velocity surface discharge. Maintenance of the stratification would be necessary to keep the water temperature discharged into the Broad River at a minimum.

(4) Heat transfer to the atmosphere would be less in the colder months than the warmer months.

(5) A 25°F temperature rise would be experienced by the cooling water as it passed through the Virgil C. Summer nuclear plant condensers, without exceeding a maximum daily average temperature rise of 3°F in the Broad River at the Frees Creek confluence.

(6) Damming off a small northern portion of the upper impoundment for recreation would have no measurable effects on the overall heat distribution in the project.

(7) Further testing is required of undistorted models of the nuclear plant structures and the pumped storage structures to maximize stratification and minimize recirculation.

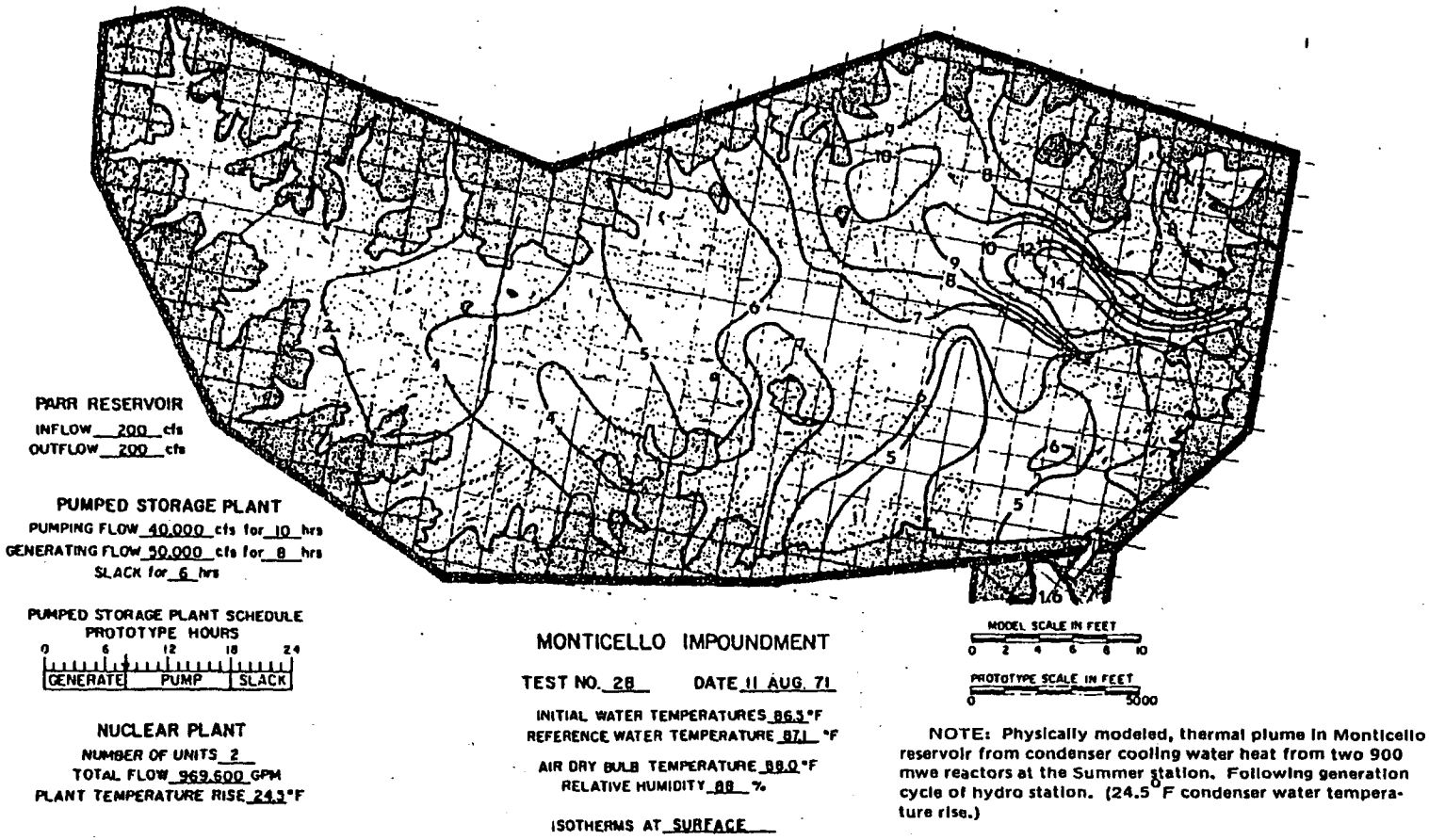
Vertical mixing of the nuclear plant heated effluent with reservoir waters would be limited to the upper 10-15 feet of Monticello reservoir with little mixing below 15 feet. Water temperatures would be highest at the surface and near-surface waters of the outfall. July temperatures in the immediate vicinity of the outfall could range to 113°F. Predicted surface isotherms from Alden studies for the project at 24.5°F temperature rise (Figure 3-3) and at 14.7°F temperature rise (Figure 3-4) for two different flow rates indicate the configuration of the thermal plume as well as temperature at Frees Creek. These figures substantiate conclusions 2 and 5 above.

Further model testing by Alden Research Laboratories indicates that the project will meet the State of South Carolina temperature criteria when operating a nuclear unit with a condenser flow of 530,000 gallons per minute with a temperature rise of 25°F. Conclusions are presented in Appendix F on Alden's Progress Report No. 2 on one-unit and two-unit operation at ambient river water temperatures of 45°F and 60°F.

No temperature increase in the subimpoundmount is foreseen due to thermal discharges from the nuclear station. Mixing of waters would not occur under normal operating procedures and little conduction would be expected through the dike separating the impoundments.

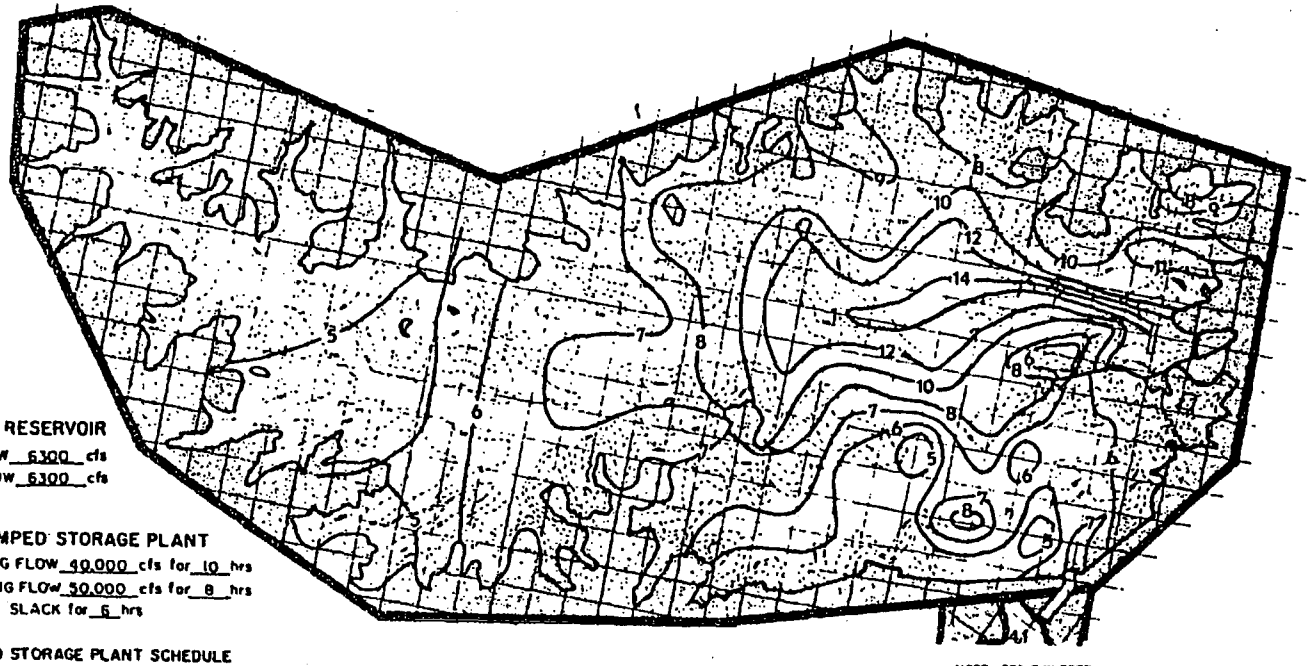
Presently it is unknown to what degree dissolved oxygen (DO) would be affected by discharge of heated water from the proposed nuclear station into the Monticello reservoir. However, it is well known that temperature is important in determining the solubility of oxygen in water: the solubility of oxygen decreases with the increasing water temperature. No significant reduction in the DO content of the condenser cooling water is expected. 50/ However, some DO reduction could occur in the mixing zone of Monticello reservoir. Any DO reduction in the mixing zone would be determined by the saturation value at the discharge temperature. A further decrease of DO could occur in this region, due to increased rates of organic decomposition or an increase in metabolic activities of aquatic organisms brought about by the increased temperatures.

A reduction in DO could occur as a result of release of subsurface water from Monticello reservoir via the Fairfield facility. However, due to the turbulence and agitation that would take place in the tailrace, deficient DO concentration should not occur. It has been reported



Source: Alden Research Laboratories Report to South Carolina Electric & Gas

Figure 3-3. Thermal Plume in Monticello Reservoir from Condenser Cooling Water Heat (24.5 Degree Condenser Water Temperature Rise)



PARR RESERVOIR
INFLOW 6300 cfs
OUTFLOW 6300 cfs

PUMPED STORAGE PLANT
PUMPING FLOW 40,000 cfs for 10 hrs
GENERATING FLOW 50,000 cfs for 8 hrs
SLACK for 6 hrs

PUMPED STORAGE PLANT SCHEDULE
PROTOTYPE HOURS
0 6 12 18 24
GENERATE | PUMP | SLACK

NUCLEAR PLANT
NUMBER OF UNITS 2
TOTAL FLOW 1,616,000 GPM
PLANT TEMPERATURE RISE 14.7 °F

MONTICELLO IMPOUNDMENT

TEST NO. 9 DATE 22 APRIL 71

INITIAL WATER TEMPERATURES 52.5 °F
REFERENCE WATER TEMPERATURE 52.9 °F

AIR DRY BULB TEMPERATURE 56.7 °F
RELATIVE HUMIDITY 83 %

ISOTHERMS AT SURFACE

MODEL SCALE IN FEET
0 2 4 6 8 10

PROTOTYPE SCALE IN FEET
0 5000

Note: Physically modeled, thermal plume in Monticello reservoir from condenser cooling water heat from two 900 mwe reactors at the Summer station, following generation cycle of hydro-station, (14.7°F condenser water temperature rise.)

Source: Alden Research Laboratories Report to South Carolina Electric & Gas

Figure 3-4. Thermal Plume in Monticello Reservoir from Condenser Cooling Water Heat (14.7 Degree Condenser Water Temperature Rise)

that tailwater fishing for brown trout and striped bass is good at the Saluda hydro plant. 51/ Here waters are released from a depth of 145 feet, where DO depletion would be expected, but the water is aerated in the tailrace to such a degree that these fish are able to survive.

Due to the relatively large daily drawdown and inflow and mixing of reservoir water with that from Monticello reservoir, stratification would not occur in Parr reservoir. Therefore, operation of the redeveloped Parr hydro plant would not adversely affect DO in the Broad River downstream of Parr dam. Thermal stratification would be artificially increased in Monticello reservoir as a result of surface discharge of heated condenser water from the nuclear station. This warmer layer would act as a lid on the hypolimnetic layer and thereby prevent total reservoir mixing. Stratification could decrease water quality downstream when water is withdrawn from the hypolimnion, which is usually very low in DO. However, DO concentration would probably not be deficient downstream, due to the turbulence and mixing action that would occur in the tailrace area.

The adverse effects on water quality of chemicals discharged from the nuclear station to Monticello reservoir have been discussed in the Atomic Energy Commission's Final Environmental Statement. These chemical discharges were separated into the following categories: start-up water, floor drain and oil-contaminated wastes, ion exchange

regenerant wastes, sewage and other sanitary wastes, and steam generator blowdown. According to AEC Staff, none of the above discharges would significantly alter water quality and adversely effect aquatic biota. All the discharges coupled with the thermal discharge could have a cumulative adverse effect.

3.5 OUTDOOR RECREATION

The overall impact on land and water resources of the project area resulting from increased recreational use would probably not be significant. Provisions to dispose of solid and other wastes generated through increased recreational use, as proposed by the Applicant, are considered adequate. The Applicant's proposed radioactive waste processing system would be adequate for protection of persons using the subimpoundment fishing area and Parr reservoir.

Two of the proposed facilities, however, are of concern. Initial development, as proposed by the Applicant, could lead to maximum use of the picnic area on Monticello reservoir and possible overuse of the fishing subimpoundment.

The three recreation areas planned for initial development, the boat launching area on Parr reservoir, the scenic overlook on Monticello reservoir, and the subimpoundment fishing area,would occupy 2, 30, and 300 acres,respectively. An additional 1,082 acres would be reserved for future recreational developments. Future recreational facilities proposed within the project boundary would include areas for general recreational development for which the specific uses

would be determined later. Future facilities considered by the Applicant would be the expansion and/or addition of boat landings, picnic areas, and camping sites.

Physical features of the project area would be altered to provide for recreational facilities as proposed by the Applicant. Those facilities intended for use by the general public, such as visitor overlook, fishing impoundment, and boat launching areas, would allow for controlled management in channeling visitor use to specific developed sites.

Most areas of Parr reservoir would not be considered suitable for recreational use, due to an anticipated 10-foot daily water level fluctuation. This fluctuation would probably result in reduction of the biological carrying capacity of the reservoir, which would decrease the present fishing success. In addition, the exposed shoals caused by the fluctuations would be extensive, reaching an average horizontal distance of 375 feet from the high water mark in some areas. Such extensive mudflats would greatly curtail the boating potential of the reservoir. The fluctuation would likewise reduce waterfowl feeding areas, and consequently adversely affect the waterfowl hunting in the area. The high turbidity of Parr reservoir and the somewhat lesser turbidity expected in Monticello reservoir would be aesthetically unappealing.

Daily downstream flow releases, averaging at least 300 cubic feet per second, would have no adverse effects on public recreational use and development below Parr powerhouse. On the other hand, recreational use of Frees Creek immediately below the Southern Railroad trestle would be inhibited due to the combined effects of drawdown and rapid stream flow.

Water within the recreational subimpoundment would initially be turbid and aesthetically unappealing after filling from Broad River. Furthermore, the periodic intermixing of the partially turbid waters of Monticello reservoir with subimpoundment waters could increase the turbidity of the subimpoundment. Nevertheless, the water in the subimpoundment is expected to be clearer after initial filling than the water in Monticello reservoir proper.

3.6 SCENIC, NATURAL, AND HISTORIC AREAS

The proximity of Monticello reservoir to State Route 215 for several miles would create a visual edge, providing relief from the narrow corridors formed by the pines bordering the road. Road stretches enclosed by trees could have openings that would increase the visual complexity and interest of the area. The spatial sense of the area would change from that of a narrow monotonous feeling to wider changing spaces

with visual interest provided by glimpses of a nearby body of water.

The pines within the project boundary adjacent to Monticello reservoir would, in time, be succeeded by hardwoods and water-associated plants that would increase both the biological and visual complexity of the area.

The 4-1/2-foot, almost daily fluctuation in the Monticello reservoir would create mud flats, which affects detrimentally the scenic qualities of a normal land-water edge of a nonfluctuating lake. A distinct visual edge would attract a viewer's attention, and in the case of a fluctuating reservoir, his attention would be drawn to its worst feature, the mud flats. Further, the upper reservoir would be at its lowest elevation during the late afternoon and early evening during times available for recreation in the summer. Operation of this reservoir would, however, be limited essentially to weekdays, with less fluctuation during the weekend periods of highest visitation and recreational use.

The more extensive fluctuation of Parr reservoir from the proposed higher elevation would create extensive unsightly mud flats, with an estimated average width of 375 feet when the reservoir was drawn down to its minimum elevation.

Much of the land between elevation 256 feet msl and 266 feet msl, including the islands formed in Parr reservoir, would be cleared. The only road near the reservoir is a secondary hard-surface one that, except for two points, is

from 0.3 to 1 mile away. All views of Parr reservoir, except at the crossing of Cannons Creek and Hellers Creek, would be blocked by mature bottomland forests. The crossings of Cannons and Hellers Creeks would present extensive, unsightly views of mud flats and snags during low water stages. The greatest exposure to this view of mud flats would occur during early morning hours of weekdays and on weekends. This is because the operation schedule would have Parr reservoir drawn down during the weekend when most family pleasure driving and other recreational activities occur.

The only registered national historic site directly affected by construction of the project would be the Davis Plantation, 1/4 mile south of the town of Monticello. The plantation house is on a prominent hill that overlooks the proposed Monticello reservoir. The upper reservoir edge would be 1,000 feet from the house at the nearest point, inundating several acres of existing pasture land. While this would not directly affect the plantation house itself, the scenery would be greatly altered from rolling wooded hills to a large expanse of water.

The four archaeological sites located in the area would not be inundated by the project. However, the occasional find of arrowheads or other artifacts in the project area indicates the likelihood that some unknown

archaeological sites could be covered by water.

3.7 NOISE LEVELS AND AIR QUALITY

Noise, dust, and engine exhaust would be undesirable effects associated with the construction of the proposed project. The exhausts of construction equipment and vehicles of commuting workers would be an added stress on the residents and wildlife of the area. However, the low population density and large forested areas around the project should render such effects negligible. To some extent, noise and traffic would displace wildlife during construction activities, some species more than others.

The project would have little or no effect on air quality at the site during operation. Most of the pumping energy would be furnished by nuclear power. Noise associated with the Fairfield pumped storage project, such as that from generation and pump operation and flowing water, would not be audible more than 100 yards away from the powerhouse.

The effects of the construction and operation of the Virgil C. Summer nuclear plant on the quality of the air and noise pollution are discussed in the AEC Environmental Impact Statement. Compliance with State and Federal regulations is expected, and monitoring would occur to assure such compliance.

Applicant has stated that any necessary burning of vegetation during clearing operations would be carried on in compliance with South Carolina State Regulations. Air quality would not be significantly affected.

4. MEASURES TO ENHANCE THE ENVIRONMENT OR TO AVOID OR MITIGATE ADVERSE ENVIRONMENTAL EFFECTS

The most obvious adverse environmental effects would occur during construction of the proposed project with accompanying excavation, clearing, diking, flooding, and other activities. The Applicant has stated that the contractors would employ specific construction practices associated with minimizing detrimental effects. The proposed measures would include: 52/

(1) Soil erosion protection: reducing the duration of soil exposure to a minimum, retaining and protecting the natural vegetation whenever possible, and installing conduits and settling basins. A storm water drainage system would be installed as soon as practicable.

(2) Dust control: frequent water sprinkling of roads, parking lots, and construction staging areas.

Other erosion control procedures would include the development of appropriate temporary and/or permanent ground cover such as planting downstream faces of the dams, replanting construction lay-down areas, and placing rip-rap on the upstream faces of the dams where support for vegetation growth is unavailable. Prior to initiating licensed project construction activities, the Applicant would prepare job specifications to include practices for soil and water conservation as advised by the Fairfield County Soil and Water Conservation District office located in Winnsboro, South Carolina.

Borrowing would take place in the cleared Monticello reservoir area, so that when the project is completed there would be no unsightly scars on the landscape. Dredge spoils would be disposed of by placement behind nearby embanked areas. After the water is drained, the areas would be planted with appropriate vegetation consistent with the precepts of the land management program discussed below.

Construction debris not salvaged and used could be disposed of in several ways. For the trash and combustible materials appropriate disposal permits from the South Carolina Pollution Control Authority and the South Carolina Forestry Commission would be obtained. These materials would be placed in carefully constructed areas within the boundary of Monticello reservoir, and burned under proper supervision, with fire-fighting equipment present. For the incombustibles, hauling, burial, and special use could be employed. Unsightly materials of no use would either be transported to a State-approved disposal site or disposed of by burial or other appropriate means. As part of the management program, an evaluation would be made to see if this debris could be used in the upper impoundment as fish habitat enhancement materials.

4.1 MITIGATION OF ADVERSE EFFECTS ON HUMAN ELEMENTS

The impact of construction of the proposed project in such a sparsely populated rural area could disrupt local

services, traffic, schools, school busing, and local businesses.

The Applicant, aware of the problems that rapid changes would create, informed the people of the area about the proposed project through local meetings held in Newberry and Fairfield Counties. To facilitate communications, the Applicant helped form a citizens committee composed of seven area residents. 53/ The Applicant arranged trips for the committee to a pumped storage project in Pennsylvania, to the Alden Research Laboratories in Massachusetts where the project was modelled, and to the Keowee-Toxaway nuclear plant in South Carolina. 54/ The committee met with both area residents and company representatives to discuss problems associated with the plants in Pennsylvania and South Carolina.

Three basic areas of human concern on project construction were defined by the committee: (1) increased road hazards, (2) development of undesirable businesses, and (3) a possible heavy influx of construction workers which could strain area service facilities.

The Applicant discussed the traffic problem with officials of the South Carolina Highway Department and advised them of the anticipated increase in traffic due to the construction work force. They were informed that the traffic flow of State Highway 215, the primary road

in the area, would not be heavy enough, even with the construction increase, to justify a four-lane road. 55/ Two particular places on Highway 215 that could prove hazardous were discussed, one in Jenkinsville at the intersection of Highways 213 and 215, and the other one at the entrance of the proposed nuclear plant. The highway department stated that they were familiar with both locations and felt that improvements would be necessary and would be made to insure maximum highway safety. 56/

The Applicant also met with the School Bus Division of the South Carolina Department of Education to discuss the need to arrange construction shift times and related travel to avoid times of school busing. 57/

Recognizing the concern regarding undesirable businesses in the community, the Applicant consulted with members of the Fairfield County Council, the County Planning Commission, and the Central Midlands Planning Commission to determine what could be done to insure the stability of the community. This problem was discussed in depth with the Central Midlands Commission and arrangements were made for a commission representative and a member of the Fairfield County Planning Commission to meet with the community

committee to review countywide zoning and mobile park locations. The community was informed, however, that zoning could be accomplished only by local legislation.

Consultation with the Applicant's construction contractor indicated that approximately 30 percent of the work force would comprise residents within a 25-mile radius of the project, and that most of those relocating would probably find housing in the Columbia, South Carolina, area (as discussed in Section 3).

4.2 LAND MANAGEMENT PROGRAM

The Applicant has proposed a land management program to alleviate the adverse effects of construction and speed the ecological adjustment of the project area. The program would include aesthetic improvements and enhancement of recreational facilities and wildlife habitat. The program would be fully integrated with overall facility planning, the monitoring programs, and the ecological study programs. The Applicant's land management proposal would include:

(1) Erosion control: A program would be instituted by the Applicant for preservation of ground cover to control erosion during construction. Cover of land areas along access roads and transmission lines would also be protected. Control measures during construction would also include the scheduling of clearing and grading operations to minimize the susceptibility of the area to

erosion. The Applicant would also work with the U.S. Department of Agriculture, Soil Conservation Service, and the Fairfield Soil and Water District, to minimize erosion by incorporating recommended soil and water conservation practices. The protective measures would be integrated with wildlife management and landscape programs so as to obtain the greatest enhancement benefits.

(2) Timber management: A program would be put into effect on the Applicant's lands to develop and utilize the forest potential. This program would consider the multipurpose use of these lands for wildlife and recreation as well as forestry. It would be integrated with the wildlife management and recreational programs. The options that the Applicant has with the present owners reserve to the owners the right to remove the present timber within a stated period of time.

(3) Wildlife management: This program would be conducted in conjunction with the improvement of habitat through selective plantings of appropriate food and cover plants, particularly in cleared and idle buffer areas. Suitable areas could be developed and set aside as wildlife refuges, depending on the results of ecological studies. The U. S. Forest Service has negotiated an agreement with the Applicant to develop wildlife habitats along the Broad River (Appendix G, attachment to South Carolina Electric & Gas Company letter, dated February 1, 1974).

(4) Recreational potential: Recreational facilities and activities compatible with the area needs, normal project operations, and public safety would be developed. Land areas for recreational facilities planned for Monticello reservoir would be acquired prior to 1977 and would accommodate picnic sites, primitive campsites, boat launching ramps, and a scenic overlook. In conjunction with the construction of the nuclear station, a visitor center would be constructed on a site overlooking the project area. This center would contain educational exhibits of both the nuclear station and the Fairfield facility and provide a panoramic view of the project. The center would be built during the early construction stage of the project. The recreational development plan is described in Section 1 of this statement.

(5) Impoundment management: Both the Monticello impoundment and Parr reservoir would be developed with consideration of the potential recreational benefits, as well as thermal cooling and power generation purposes. The uppermost (northern) portion of Monticello reservoir, impounded by a roadway fill, would not be affected by the daily impoundment fluctuations and would be developed as a fishing area. The southeast shore near the nuclear station would be developed as a scenic overlook. A boat launching facility would be constructed on Parr reservoir.

Impoundment management would be consistent with the safe operation of the facility and in accordance with all applicable requirements of the South Carolina Pollution Control Authority and the South Carolina State Board of Health.

(6) Vector control: As a result of the clearing operation, both Parr and Monticello reservoirs would be clear cut around the periphery of the impoundments between maximum and minimum water levels so that no timber would be exposed. Standing trees would be topped 5 feet below minimum water level, except for some areas in the fishing subimpoundment. Periodic patrols would be established to remove floating materials. Steps would be taken to eliminate stagnant pool formation due to incomplete drainage of the reservoirs during drawdown. Partially submerged underbrush around the shoreline would be eliminated. Fluctuations of the reservoir due to operation of the pumped storage facility would also control mosquito breeding and larvae production. Periodic inspections would be made around the perimeter of the reservoirs after they were filled to determine the effectiveness of the control procedures. If the need for spraying is indicated, the Applicant would consult with the South Carolina State Health Department and implement a spraying program to assure that no objectionable vector problems occur.

(7) Landscaping: Landscaping would improve the aesthetic qualities of the areas. This program would be integrated with the other land management programs to insure maximum benefit. Maximum utilization would be made of native vegetation with formal landscaping confined to localized areas on the site.

4.3 MEASURES TO MITIGATE ADVERSE EFFECTS ON FISH AND WILDLIFE

The Applicant's environmental report stated that the Applicant would conduct a biological monitoring program on both reservoirs to assess the effects of construction and operation of the Fairfield pumped storage facility and the Virgil C. Summer nuclear station. 58/

Primary emphasis would be placed on any species representing a unique group and on species important from a sport or commercial standpoint. Lower food chain organisms would also be studied. Specifically, the program would be designed to:

(1) Document the present biological characteristics of the site environs.

(2) Provide a basis for selecting measures which could minimize any projected adverse effects (including thermal, chemical, radiological, biological, hydrological, and mechanical effects).

(3) Evaluate the effects of construction and operation of the proposed facilities on the biota.

The program would be conducted in two phases: Preoperational and operational. The preoperational phase would provide baseline information on the various aquatic and terrestrial biota in the site environs. A report on this phase is presently being finalized. The operational phase would identify and evaluate changes in the baseline characteristics as a result of construction and operation of the facilities.

The aquatic portion of preoperational monitoring is presently underway. The initial survey was performed in March 1971 (spring sample), and the summer sampling commenced in June 1971. The monitoring consists of the following:

(1) Collection of fish samples at various points on the Broad River.

(2) Collection of samples of the various bottom types in the river (benthos).

(3) Collection of plankton for identification and counting.

(4) Field and laboratory examination of species collected to aid in the identification, estimation of age, and growth rates would also determine pertinent population parameters, and evaluate taxonomic characteristics.

Preoperational terrestrial biological monitoring began in June 1971 and involves a habitat classification and wildlife survey. Habitat classification consists of mapping the various vegetative types in the site environs.

Care is taken to note and evaluate any enhancement potential arising during the conduct of the study. Particular emphasis is placed on potential waterfowl habitat development.

The wildlife survey would consider the most predominant forms of both vertebrates and invertebrates.

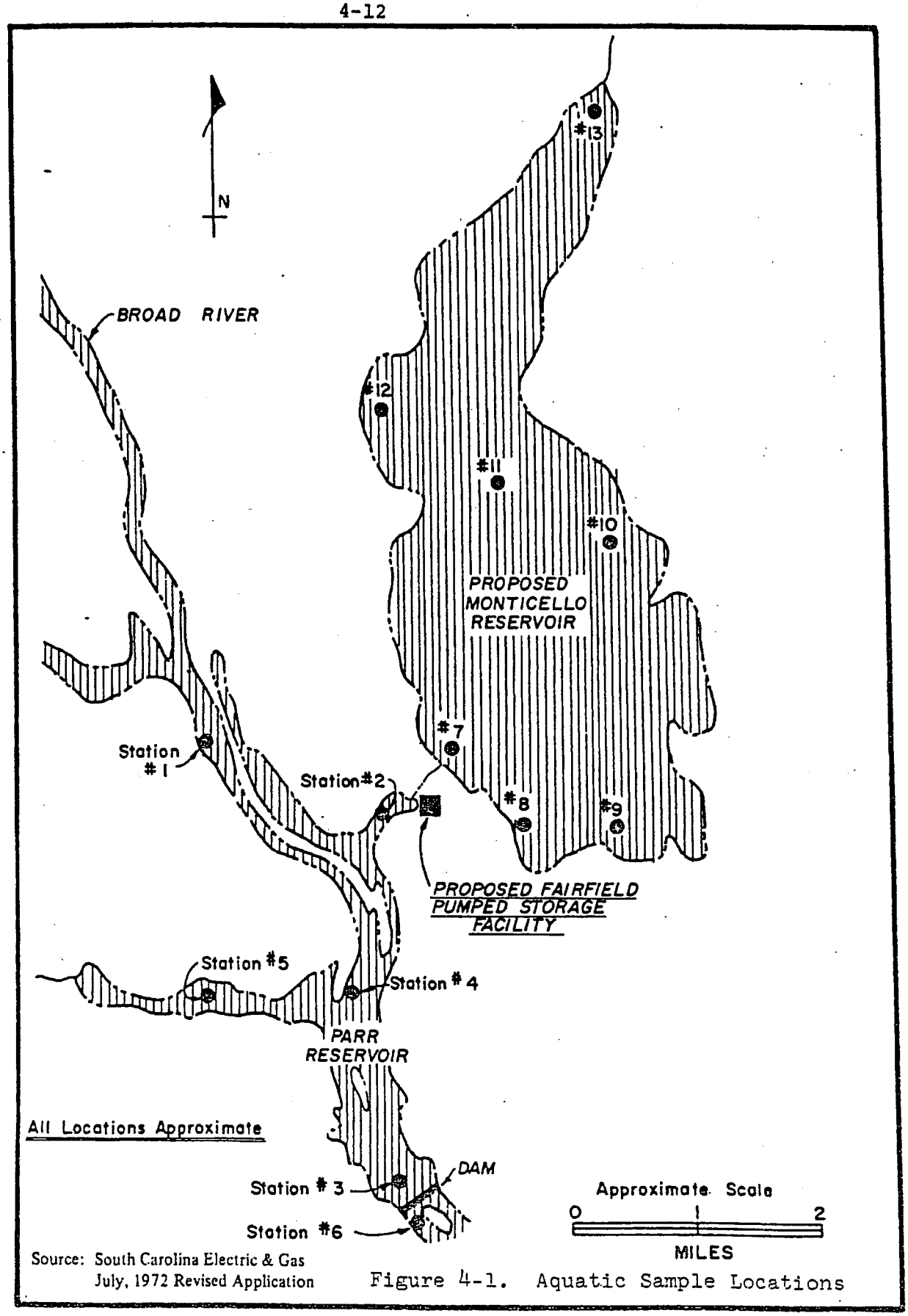
The operational biological monitoring would involve Parr reservoir and also include Monticello reservoir sampling and taxonomic work similar to the preoperational efforts, and would consist of the following:

(1) Specific studies to evaluate the effects of the various facility operations on aquatic organisms.

(2) Tagging and studying of key species to evaluate the impact of the project on the life history of these species.

(3) An evaluation of the changes in ecological conditions as compared to the baselines established in the preoperational phrase.

Quarterly or seasonal migration and spawning data would be taken from wildlife and fish samples. Aquatic sampling was begun in 1971. The initial sampling locations are shown on Figure 4-1. Certain sampling points have been and may be relocated to conform with seasonal requiements, as determined by the results of the monitoring as it progresses. Details of the biological monitoring program are presented in Table 4-1.



Source: South Carolina Electric & Gas
July, 1972 Revised Application

Figure 4-1. Aquatic Sample Locations

Table 4-1

Biological Monitoring Programs

PROGRAM	VECTOR OR INDEX	FREQUENCY OF SAMPLING	ANALYSIS	LOCATION 1/
Aquatic	Fish	Quarterly	Species inventory, population composition, age growth rates, condition factors and life cycles of important game species.	Stations 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, and 13
	Plankton	Quarterly	Quantitative and qualitative analysis of phytoplankton and zooplankton. Development of food web relationships and indicator organisms.	Stations 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, and 13
	Benthos	Quarterly	Same as plankton	Same
Terrestrial	Habitat	Quarterly	Classification and Mapping of vegetative types correlated with soil studies.	Project Area
	Wildlife	Quarterly	Species inventory, population trends, life cycle and home range of important game species.	Project Area

A waterfowl habitat improvement plan would be carried out around both reservoirs. The impoundments would attract waterfowl during spring and fall migrations. Standard techniques would be used to provide food and additional resting areas. This plan would be a significant contribution to the Broad River waterfowl plan which has been developed by the South Carolina Wildlife and Marine Resources Department in cooperation with the U.S. Forest Service. The management plan report lists the following "built-in" features of the area: (1) natural ponds and ox-bows, (2) open fields which can be utilized for game food production, (3) greentree reservoir sites, (4) suitable private lands already under cooperative agreement, (5) hydroelectric reservoirs, (6) a native wood duck population, and (7) suitable habitat in the Tyger and Enoree bottoms for future additional development.

The principal methods for attracting and holding waterfowl are:

(1) Planting food patches, (2) flooding certain areas during the fall with the aid of control dams and (3) providing several "refuge-type" resting and feeding areas.

An agreement concerning protection of fish and wildlife has been reached between the Applicant and the South Carolina Wildlife and Marine Resources Department.

Two major points of the agreement are: (1) a continual release of water (150 cfs minimum flow) from the Parr reservoir necessary for the survival, reproduction, and normal life cycle of all species of fish with particular concern to striped bass during the spawning period of March, April, and May; and (2) the dedication by the Applicant of approximately 90 acres of land for a greentree reservoir site.

An additional fish mitigative measure for Parr reservoir, if found to be desirable during operational studies, would be regulation of reservoir fluctuations during spawning activities of warm water species, to provide more stable elevations and improve spawning success.

4.4 MEASURES TO MITIGATE ADVERSE EFFECTS ON WATER QUALITY

The Applicant has proposed to plant ground cover to control erosion on disturbed land areas, i.e., access roads, saddle dam sites, and transmission line rights-of-way. Clearing and grading operation would be scheduled by the Applicant to minimize susceptibility of the area to erosion. The Applicant has also stated that it would work with the U.S. Department of Agriculture, Soil Conservation Service, and the Fairfield Soil and Water District, to minimize erosion by incorporating recommended soil and water conservation practices.

The possibility of accumulation of some heavy metals, i.e., chromium, copper, cadmium, lead, and mercury in Parr and Monticello Reservoirs has been raised. Any water quality monitoring program should include analysis for these metals.

Water quality monitoring sponsored by the Applicant would:

(1) Evaluate the baseline physical and chemical characteristics of Broad River and Frees Creek before and during construction,

(2) Determine the quality of the water in Monticello and Parr reservoirs and the Broad River after construction,

(3) Compare the quality of water in the subimpoundment reservoir and river with applicable standards to assure compliance with regulations, and

(4) Provide data for an evaluation of the impact of the project on the aquatic biota.

Two continuous recording stations would be operated by the Applicant so that information could be obtained before and during construction and during operation. Tentatively, these stations would be located near the mouth of Frees Creek and approximately 5 miles upstream from Parr dam on the Broad River. The stations would utilize complete portable, battery-operated recording instruments to measure dissolved oxygen, temperature, stream flow, conductivity, and pH. Each station would consist of the instrumentation, an all-weather enclosure, and a permanent enclosure stand. The instrumentation would be the portable recording series type. These instruments are battery-operated with individual strip-chart recorders for each parameter.

In addition, the Applicant would secure bottle samples from various locations on a monthly basis to verify the recorder results and provide a more complete analysis. The sample locations would tentatively be as follows:

(1) Frees Creek, two samples: A station 1 mile upstream and one approximately 2 miles upstream from the mouth of the creek, and

(2) Broad River, four samples: One approximately one-half mile upstream, one approximately 3 miles upstream, one 5 miles upstream, and one approximately 1 mile downstream from Parr dam.

Table 4-2 describes the type of analyses to be performed in accordance with standard methods.

During project operation, the monitoring would continue, with deletion of the Frees Creek stations and addition of new stations to correspond to the project development. The monitoring would therefore be implemented in stages as project development and operation progress.

After Monticello reservoir is filled, a continuous recording station would be installed by the Applicant in the vicinity of the pumped storage inlet to monitor the quality of water in the impoundment and record temperature, dissolved oxygen, conductivity, pH, and turbidity.

Table 4-2

Hydrologic Monitoring Programs

Frequency of Sampling	Vector or Index	Analysis	Location
Continuous	Surface Water	Dissolved Oxygen Temperature Stream Flow Conductivity pH	1. Near mouth of Frees Creek 2. Five miles upstream of Parr Dam 3. Monticello Reservoir near pumped storage intake
Continuous	Monticello Reservoir Water	Temperature Dissolved Oxygen	1. V.C. Summer Nuclear Station intake and discharge
Monthly for pre-operational and for first year operational. This frequency may be reduced with time.	Surface Water (laboratory analysis)	Temperature Carbon Dioxide (CO_2) pH Dissolved Oxygen (O_2) Total Dissolved Solids (TDS) Conductivity Total Alkalinity ($CaCO_3$) Total Hardness ($CaCO_3$) Chloride (Cl) Sulfate (SO_4) Silica (SiO_2) Iron (fe) Calcium (Ca) Magnesium (Mg) Sodium (Na) Phosphate (PO_4) Ammonia (NH_3) Nitrate (NO_3) Biochemical Oxygen Demand (BOD) Chemical Oxygen Demand (COD) Heavy Metals Turbidity	1. Both continuous recording stations 2. 2 Samples on Frees Creek (pre-operational), 1 & 2 miles upstream from Broad River 3. 4 samples on Broad River 1/2, 3 & 5 miles upstream & 1 mile downstream from Parr Dam 4. 3 stations in Monticello Reservoir (operational)
Quarterly	Groundwater	Same as monthly surface water	Springs & wells, at least 8 locations; piezometers
	Monticello Reservoir	Total Nitrogen Ammonia Nitrogen Nitrate Nitrogen Total Phosphorus Orthophosphate BOD or TOC Dissolved Oxygen (O_2)	3 stations in Monticello Reservoir

Source: South Carolina Electric & Gas July 1972 Revised Application

Three sampling stations, in addition to the continuous recording station, would be established in Monticello reservoir. Monthly measurements of temperature and dissolved oxygen on the surface and at 3, 5, 10, and 15-foot depths would be taken at these stations.

To evaluate the trophic conditions of the impoundment, the Applicant plans to make quarterly analyses of selected bottle samples for total nitrogen, ammonia nitrogen, nitrate nitrogen, total phosphorus, and orthophosphate. The oxygen consumption or demand properties of the water would be determined by a biochemical oxygen demand (BOD) method or by the total organic carbon (TOC) means. The TOC means is preferred over the BOD method because it is more readily accomplished and is reproducible. Also, TOC is less likely to be erroneous due to interference of other chemical constituents. However, the present generally unpolluted conditions of the Broad River water and the expectation that little organic material would be added to the system as a result of operation of the facility suggests that BOD would be an adequate measure of the oxygen demand in the system. The dissolved oxygen would be measured in conjunction with the oxygen demand measurements.

After completion of the nuclear station, continuous recording stations would be installed near the condenser intake and discharge. These stations would provide data on the temperature and dissolved oxygen content of the water passing through the condensers.

Monitoring would provide data on the physical and chemical properties of the groundwater in the site vicinity. Samples would be taken at various springs and wells in the vicinity of the project. The exact number and location of these samples would be determined in the field, but at least eight points would be sampled. Water quality samples would be collected and subjected to laboratory analyses; water level and spring flow measurements would be made quarterly.

4.5 MITIGATION OF ADVERSE EFFECTS OF RECREATIONAL DEVELOPMENT

The environmental impacts associated with construction of the proposed recreational developments would include: (1) erosion from clearing for parking areas and access roads, (2) run-off, carrying sediment and debris from the hard surfaced and natural areas, (3) run-off, carrying sediment and debris from construction of the subimpoundment dam, and (4) loss of wildlife habitat.

Operation of the proposed recreational developments would increase stress on the area to assimilate the wastes

generated and increase traffic in recreational areas and on the highways.

All recreational site areas covered by water would be cleared and grubbed to varying extents according to the planned use of a specific water area, including fishing, boat launching, and swimming.

To the fullest extent possible, all marketable timber would be removed by the present land owners or by the Applicant prior to land inundation. The Applicant would also remove the necessary timber only from lands set aside for recreational purposes and those required for construction purposes.

The Monticello subimpoundment would be clear-cut from elevation 420 feet to elevation 425 feet. The timber and undergrowth of shallow inlets and portions of the shoreline would remain undisturbed. Where trees would be cut below the water surface, a 5-foot water clearance would be maintained over stumps. Where the tops of stumps would be above elevation 420, the upslope side of the stumps would not exceed 6 inches in height. The underwater area for 100 feet around the boat launching ramps would be cleared and grubbed to elevation 425. In the subimpoundment, the potential swimming area and the underwater area within 100 feet of the shoreline would be clear-cut and grubbed to a depth of 15 feet from elevation 425 feet.

Boat launching areas planned for Parr reservoir would be cleared and grubbed from elevation 266 feet to elevation 257 feet for a distance of 100 feet on each side of the ramp.

All cut but unused trees and brush would be windrowed and burned in accordance with Regulation No. 2A of the South Carolina Pollution Control Authority. Inaccessible areas containing large amounts of forest debris would be burned in small plots by controlled forest fire. Parr reservoir would be filled and large floating debris would be removed, allowed to dry, and burned in accordance with South Carolina Pollution Control Regulation No. 2A.

When Parr reservoir, Monticello reservoir, and Monticello subimpoundment are full, the Applicant would establish a routine shoreline patrol to remove all dying trees, large floating debris, and other hazards to aquatic activities.

The Applicant's proposed vector control program would be initiated during the clearing operation. The impoundments would be clear-cut around their periphery between maximum and minimum water levels so that no timber or brush would be exposed. Steps would be taken to eliminate stagnant pool formation due to incomplete drainage during drawdown of the reservoirs. Areas around the shoreline containing partially submerged underbrush would be eliminated. Fluctuations of the reservoirs due to operation of the pumped

storage facility would aid in controlling mosquito breeding and larvae production. Periodic inspections would be made around the perimeter of the reservoirs after filling to determine the effectiveness of the control procedures.

Signs located at the entrance to each public access area would indicate the type and location of facilities, and the special use and occupancy rules. Appropriate warning signs and maps would be located at all of the Applicant's boat landings. Reevaluation of the restricted areas for public use would be made after the project is in operation and during the biennial review of the recreational needs of the area.

The public would be excluded from certain areas within the project due to the potential dangers. These areas would include, but would not be limited to, a 300-foot maximum approach distance to all points where intake or discharge structures have been placed on the Monticello impoundment shoreline that would be part of the operation of the Fairfield pumped storage facility or the Virgil C. Summer nuclear station. All restricted areas of Monticello reservoir would be marked with can buoys. Also excluded from public use would be the tailrace of the Fairfield powerhouse, which would be marked by the use of can buoys and by signs facing Parr reservoir on both ends of the Southern Railway Company trestle.

The area upstream of Parr powerhouse is already marked with 11 buoys and 11 more would be added. The Parr dam and

Bascule gates would be flood-lighted at night and the tail-race of Parr powerhouse would be marked with can buoys bearing the standard inland waterways "No Boats Allowed" symbol.

The proposed project boundary would surround the recreation areas, but otherwise generally would follow a minimum of 25-foot horizontal distance upslope from the 266-foot contour for the lower reservoir and the 425-foot contour for the upper reservoir. Adequate shoreline control could not be achieved unless a perimeter of land were maintained around the reservoir,to protect scenic values and permit orderly development of the recreation program as proposed by the Applicant.

4.6 MEASURES TO MITIGATE ADVERSE EFFECTS ON NATURAL, SCENIC, HISTORIC, AND ARCHAEOLOGICAL VALUES

During construction, the scenic values of the area would be disrupted until completion of all plant seeding programs. While the proposed land management program would not completely correct this problem, it would soften any harsh visual effects associated with the construction. Landscaping and replanting disturbed areas with indigenous plant species would soon heal the construction scars and soften the outlines of the project facilities. The proposed Fairfield powerhouse and penstocks and the raised Parr dam would not be visible from any hard surface highway. Even so, the penstocks would be painted a dark muted color to blend into the hillside and the face of the Frees Creek dam. The nearest view of any of the dikes would be from 1 mile away. The

nearest view of the main Frees Creek dam would be from approximately 1-1/2 miles. However, the nuclear plant would be highly visible from many points on State Route 215 adjacent to Monticello reservoir and from Davis Plantation.

The most difficult adverse scenic effects to deal with would be those resulting from project operation. Water-level fluctuations in Parr and Monticello reservoirs would periodically present some unsightly mud flats and bared shoals. The greatest water-level fluctuations would occur in Parr reservoir (about 10 feet) and would expose a substantial amount of the near-shore bottomland. The visual impact of these exposed areas around Parr reservoir would be mitigated somewhat, because the lowest water levels would occur largely at night when the Fairfield facility is operating in the pumping mode and during the morning part of the generating mode. The impact of the exposed shoreline in Monticello reservoir would be limited since the water level lowering will be about 4-1/2 feet. The adverse effects on the Davis Plantation would be the change from rolling, wooded hills in the background to a broad water view of Monticello reservoir. The nearest points of the Monticello reservoir (the 425-foot contour) would be approximately 1,000 feet from the plantation. While the change in view would be unalterable, the effects of the fluctuation could be mitigated and the reservoir edge softened by plantings (bald cypress and several species of

grasses should prove successful under the fluctuating conditions).

The South Carolina State archaeologist, Dr. Robert Stephenson, indicated four recorded archaeological sites in or near the boundary of the proposed project, none of which would be inundated. The density of these sites and the findings of occasional artifacts, such as arrowheads, in the project area indicate the probability of other such sites. The Applicant has donated $10,000 to the University of South Carolina Institute of Anthropology and Archaeology for excavation of two of the four known sites and for a detailed survey of the project area to determine whether additional sites exist and if detailed excavation and analysis are warranted.

5. UNAVOIDABLE ADVERSE ENVIRONMENTAL EFFECTS

5.1 ON THE HUMAN ENVIRONMENT

The displacement of as many as 25 families and five cemeteries would be the most significant adverse human impact caused by construction of the project. The loss of approximately 700 acres of agricultural lands would be a less serious impact, since farming in the area is usually for supplemental income. There would also be a loss of approximately 3 percent of the counties' forested lands. The influx of construction workers would create a strain on area service systems, and cause the disorderly growth of trailer parks and some undesirable businesses in a rural area without the zoning controls to cope with such problems.

During construction and for several years thereafter, the effects on the scenic and aesthetic qualities of the area would be noticeable, especially in the area of the Davis Plantation and Monticello Church. The visual impact of mud flats created by the fluctuating reservoirs would last until these areas are successfully seeded with amphibious plants.

The value of lost archaeological sites is difficult, if not impossible, to assess. A detailed survey would be required to determine their existence and nature. Whenever land is flooded, however, there is risk of losing unknown sites.

No known metallic resources are present in the project area, but construction materials such as sand and gravel deposits would be lost.

Some degree of dust and noise pollution would be unavoidable, transitory effects associated with the construction of the project. Good construction practices, normal rainfall, and the nature of the soil and its ground cover could minimize the dust problem.

The remoteness of the project, intervening forests, and the low population density of the area should keep the construction noises at a low pitch for the human population. The adverse impacts of noise on animal populations would be of temporary duration.

5.2 ON WATER QUALITY

During the construction phase, erosion of disturbed areas would result in increased turbidity and siltation of the Broad River in the vicinity of the Parr dam and downstream. Some erosion of banks would occur during the early stages of operation of the combined projects. The extent to which erosion of disturbed areas occurred would be dependent upon the amount of rainfall and the effectiveness of erosion control measures taken during this period. In any event, the disruption of existing water quality, due to runoff from disturbed areas and erosion of banks, would probably be of short duration.

Operation of the Virgil C. Summer nuclear station would entail the use of project waters (Monticello reservoir) for condenser cooling, and the discharge of heated

effluent into the reservoir. Chemicals from the nuclear station would reach Monticello reservoir and eventually the Broad River. All discharges (thermal and chemical) to the aquatic environment must meet applicable South Carolina water quality standards and should not have any significant detrimental effects on the aquatic life. The cumulative or synergistic effects of these discharges, however, is presently unknown, but could be measured during the operation.

No significant unavoidable adverse effects on water quality are foreseen due to operation of the redeveloped Parr hydro station and the Fairfield pumped storage facility. The Parr reservoir would not stratify thermally,due to the daily drawdown and mixing of reservoir water with that from Monticello reservoir through operation of the Fairfield facility. Surface discharge of heated effluent from the nuclear station would enhance stratification in Monticello reservoir. Since subsurface waters would be withdrawn from Monticello for operation of the Fairfield facility, a slight oxygen deficiency could occur in the Parr reservoir and possibly downstream in the Broad River.

5.3 ON FISH AND WILDLIFE

Approximately 9,400 acres of wildlife habitat would be inundated as a result of increasing the height of the Parr dam and creation of the Monticello reservoir for the Fairfield pumped storage facility. For relocation of the Duke power line and construction of the Fairfield-Summer tieline, approximately 80 acres of land would be required. These

activities would result in displacement of wildlife to adjacent areas, thereby upsetting any existing balanced ecosystems, but the extent and severity of this disruption is presently unknown. Transmission line rights-of-way would create edge habitats which could provide for a more diverse fauna.

Some 15 miles of poor quality stream fish habitat would be inundated as a result of construction and operation of the project. Enlargement of Parr reservoir is not expected to result in an increased carrying capacity of fish due to the daily fluctuating water level. Organic production in the littoral zone would be reduced and spawning success of centrarchids would be curtailed.

Mortality of some larger organisms (i.e., fish) could occur from physical injuries caused by passage through the pumped storage pump-turbines, to and from Monticello reservoir. Fish screens would be impractical on the intake structure of the pump-turbines, due to high flow rates, and would probably cause greater fish losses due to impingement.

Organisms (particularly plankton) entrained in the cooling water during withdrawal from Monticello reservoir and pumping through the condensers of the Virgil C. Summer nuclear plant would be subjected to mechanical and thermal stresses, and many, if not all, would perish, especially during the warmer months of the year. AEC Staff has estimated that under the worst temperature conditions as much

as 33,000 tons might be destroyed during May - September, or about 220 tons daily. Plankton forms are usually short lived, and heavy mortalities to populations occur under certain natural conditions, including exclusion of light by turbid water, overpopulation, and extreme changes in water temperature.

6. RELATIONSHIP BETWEEN LOCAL AND SHORT-TERM ENVIRONMENTAL USES AND MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY.

The short-term environmental use of the project site has been considered to be a 50-year period. Although the proposed nuclear unit could have an operating period of 40 years, the operating life of the entire power complex would be indefinite.

The short-term use of the environment would include a number of disruptive elements. The inundation of 2,550 additional acres of land by enlargement of the existing Parr reservoir and construction of the 6,800-acre Monticello reservoir would result in the relocation of as many as 25 families and loss of forest and agricultural resources and wildlife habitat. The construction of roads, project structures, and transmission lines would be disruptive both during building and operating periods. Construction would preclude use of project lands for other purposes for as long as the project lasted.

Long-term benefits include generation of power to meet a growing consumer demand, tax revenues for governmental uses, permanent job opportunities for plant maintenance and operation, and expanded recreational facilities.

Long-term benefits in human consideration would be enhanced by the Applicant's proposed land management program for project land and water resources. Thus, for example, provisions for enlarged recreational areas

and improved sport fishery resources would be long-term enhancements of the area.

7. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

Numerous resources would be used in the construction and operation of the Fairfield facility, including land, material, and supplies; water from the river; and human skill and labor, as well as capital. Some of these resource commitments would be irreversible and irretrievable, such as the construction materials and supplies which could not be salvaged after their use. In addition, water would be lost through evaporation from both Parr and Monticello reservoirs.

The only known economic mineral resources in the vicinity are sand and gravel deposits in the Broad River flood-plain and the gravel quarry on Rocky Creek. Commercial dredging of these materials has been conducted a few miles upstream from the Parr reservoir until recently. Within 10 to 15 miles of the site is a noncommercial kyanite deposit at Little Mountain; a proposed granite quarry operation is located downstream on the Broad River. However, it appears that no economic mineral resources underlie the site, and loss of mineral resources due to construction and operation of the Fairfield facility would, therefore, be negligible. Should such resources exist, the project would not preclude their exploitation by future generations.

Other resource commitments such as the use of land for construction operations would only be temporary, and the lands could be returned to former or other uses following construction. When the useful lifetime of the project is completed, it would be possible to remove structures, drain the impoundment, and replant trees. While this would essentially return the area to a natural condition, it is doubtful that this would ever be done. Thus, the elimination of forest land, particularly the hardwood forest land and its associated wildlife habitat to be flooded by Parr and Monticello reservoirs, would be an irretrievable commitment of resources.

8. ALTERNATIVES TO PROPOSED ACTION

The purpose of the redeveloped Parr-Fairfield project is twofold: To provide the Applicant with 518.4 mw of new peaking generating capacity; and to provide a source of condenser cooling water for the 1,800-mw Summer nuclear steam-electric plant, 900 mw of which is authorized by the Atomic Energy Commission and is presently under construction. This peaking capacity and cooling capability could be supplied from alternative sources; however, the location of the nuclear plant is fixed, and therefore its cooling system must be located nearby. The Parr-Fairfield project and the Summer nuclear station were conceived and designed as an integral generating complex.

8.1 COOLING CAPACITY

If a license for the redeveloped Parr-Fairfield project were not to be issued, then the Applicant would have to apply to the Atomic Energy Commission for authorization to construct an alternative condenser cooling system, in order to meet its scheduled completion date of 1977 for the first unit of the Summer plant. Such an application would consist of a specifically proposed alternative, an environmental impact report on this alternative, and a preliminary safety analysis of this proposed alternative.

If the staff of the AEC should then determine that this alternative would have a significant environmental impact, a revision to the AEC's final environmental impact

statement on the Summer nuclear plant would be required. Possibly, the hearing on the nuclear plant would have to be reopened.

Alternative type cooling systems for the Summer nuclear plant would include mechanical draft evaporative towers, natural draft evaporative towers, a spray cooling pond, and a nonspray cooling pond.

8.1.1 Mechanical Draft Evaporative Towers

Mechanical draft evaporative cooling towers use powered fans to blow air upward or across flowing water. The towers would be grouped in structures about 30 to 40 feet in height. Cooling takes place largely by evaporation of part of the water. The total capital cost for cooling two 900-mw nuclear units would be about $30,600,000, or $17 per kw. Total annual operating costs, assuming an 80 percent plant factor, would be about $3,400,000,or 0.27 mills per kwh. Water loss due to evaporation would be about 32,000 acre-feet annually. This amount of localized evaporation would have a potential for creating low-level fog in the immediate surrounding area.

8.1.2 Natural Draft Evaporative Towers

Natural draft evaporative cooling towers are large hyperbolic structures designed to create a flow of air through the water by means of the chimney effect created by a difference in density between internal and external air. The towers are very large, as much as 400

feet high and 400 feet in diameter at ground level. They would create a fog plume at high altitudes, which could carry downwind for several miles. The total capital cost for cooling two 900-mw nuclear units would be about $43,200,000, or $24 per kw. Total annual operating costs, assuming an 80 percent plant factor, would be about $2,500,000, or 0.20 mills per kwh. Water consumption would be about 27,000 acre-feet annually.

8.1.3 Spray Cooling Pond

A spray cooling pond utilizes pumps and nozzles to spray the condenser cooling water into the air, increasing evaporation and releasing heat to the atmosphere. The water is recirculated in a relatively small pond. Ground fog formation (somewhat similar to that experienced with mechanical draft towers) with some downwind drift would be expected at certain times, depending on atmospheric conditions. The total capital cost for cooling two 900-mw nuclear units would be about $32,400,000, or $18 per kw. Total annual operating costs, assuming an 80 percent plant factor, would be about $3,400,000, or 0.27 mills per kwh. The pond would require an area of about 120 acres. Water consumption would be about 29,000 acre-feet annually.

8.1.4 Nonspray Cooling Pond

A nonspray cooling pond would recirculate water in a similar manner to the proposed Monticello reser-

voir; however, it would require a surface area of about 3,200 acres, as compared to 6,800 acres for the proposed Monticello reservoir. Annual water consumption would be about 34,000 acre-feet. The total estimated capital cost for cooling two 900-mw nuclear units would be about $27,000,000, or $15 per kw. The total annual operating cost, assuming an 80 percent plant factor, would be about $600,000, or .05 mills per kwh.

8.2 GENERATING CAPACITY

Possible alternatives to the proposed project, assuming adequate condenser cooling facilities would be provided for the Summer nuclear plant, would include (1) no further increase in capacity, (2) power purchased from other systems, (3) nuclear-fueled steam-electric generating plants, (4) coal-fueled steam-electric generating plants, (5) oil-fueled gas turbines, (6) conventional hydroelectric plants, (7) other pumped storage projects, (8) a modified Fairfield Project, and (9) conservation of energy.

8.2.1 No Increase in Capacity

The Applicant will need new sources of generating capacity in future years. Staff's studies of the Applicant's system show the need for additional electric power. The annual growth rate in peak demand has been projected as 11.3 percent, which approximates the historic annual growth rate during the 5-year period from 1965 to 1970. This projection, along

with planned capacity additions, is shown in Table 1-1. Even if the projected need for electric power is reduced by conservation practices, the system would still be expected to grow, although at a slower rate.

Not to expand system generating capacity would result in the Applicant being unable to provide an adequate, reliable source of power to its customers. The theoretical alternative of no further additions to Applicant's overall generating capacity is, therefore, considered as not being feasible.

8.2.2 Purchased Power

The Applicant has a purchase agreement with Carolina Power and Light Company for 140 mw of generating capacity from the Sutton No. 3 generating unit, which terminates May 1, 1977. After that date, there appears to be no foreseeable surplus of capacity available from neighboring systems.

The southeastern region of the United States, which includes the Applicant's system, is experiencing load growth rates substantially greater than the national average. The Southeastern Electric Reliability Council report to the Federal Power Commission shows that projected load forecasts and planned generating capacity instal-

lations through 1990 will not provide any significant surplus generating capacity which could be made available for the Applicant's system under a long-term purchase agreement.

Purchase of power from neighboring power systems would not provide a viable long-range alternative.

8.2.3 Baseload Nuclear-Fueled Steam-Electric Plant

A baseload nuclear-fueled steam-electric plant would provide the Applicant with a large block of capacity operating at a high plant factor, probably on the order of 70 percent over its lifetime. Because of its low fuel cost, it would displace older fossil-fueled plants, which would then operate fewer hours on the system load, or would stand by as system reserves.

Construction of a nuclear-fueled plant would require securing Federal, State, and local licenses and permits requiring the meeting of stringent safety and environmental standards. The nuclear plant site would require an adequate supply of cooling water and a cooling system that would meet environmental temperature standards.

The estimated capital cost of nuclear generating capacity equivalent to the Fairfield plant would be about $143,000,000, or $297 per kw. This includes the fixed nuclear fuel cost, and the estimated cost of the condenser cooling system. The estimated variable operating and fuel costs would be about 2.00 mills per kwh.

8.2.4 Baseload Coal-Fueled Steam-Electric Plant

A baseload coal-fueled steam-electric plant would provide the Applicant's system with a comparatively high efficiency source of generating capacity. It would operate at a high plant factor during its early years and would have a lifetime average plant factor of from 50 to 60 percent. These steamplants are available in a wide range of unit sizes, operating temperatures, and pressures to accommodate most system needs.

Construction of a coal-fueled plant would require securing State and local licenses and permits and finding an adequate water supply and available adequate fuel transportation. Detrimental effects of a coal-fueled base load plant would include air pollution from stack emissions, the depletion of fossil-fuel resources, consumptive use of water by cooling towers, and in the absence of cooling towers, heated water discharges. The construction and operation of a thermal unit would also have an adverse aesthetic impact. Adverse impacts to scenic values would be caused by the construction of cooling towers, smoke-stacks, new transmission lines, stack discharges, and fuel storage areas.

The estimated capital cost of coal-fueled generating capacity equivalent to the Fairfield plant

would be about $91,200,000,or $190 per kw. This includes the estimated cost of the cooling system and electrostatic precipitators, but not the cost of sulfur removal equipment. The estimated variable operating and fuel cost would be about 6.24 mills per kwh.

8.2.5 Oil-Fueled Gas Turbines

Oil-fueled gas turbines would provide the system with a peaking source of power in contrast to nuclear and coal-fueled steam-electric plants which would provide base load capacity. Gas turbines have a relatively low capital cost, are quick-starting compared to steam-electric plants, are adaptable to a wide variety of site locations, and are readily automated. Typically, these plants include provision for remotely controlled unattended operation and are furnished with a self-contained cooling system and weatherproof housing. They are equipped to burn either liquid petroleum fuels or natural gas, and may be installed to burn either fuel interchangeably. These units can be started, synchronized,and loaded automatically within 5 to 20 minutes. On a typical utility system load, they would operate 500 to 1,000 hours per year and serve as ready reserve when shut down.

Disadvantages of gas turbines would include the consumption of fossil derivative fuels currently in short supply; low efficiency; high operation and maintenance costs, making them uneconomic for generating large amounts of energy; high noise levels; and introduction of combustion by-products into the atmosphere. Gas turbines are less reliable than conventional hydro or pumped storage hydro units for quick starts in emergency situations. Recent shortages could also decrease the reliability of this type of fuel supply.

The estimated capital cost of oil-fueled gas turbine capacity equivalent to the Fairfield plant would be about $57,900,000, or $121 per kw, including the cost of oil storage tanks at the sites. The estimated variable operating and fuel costs would total about 15.32 mills per kwh.

8.2.6 Comparison of Annual Costs of Thermal Generating Alternatives

Table 8-1 shows the Staff's comparison of annual costs between the Fairfield plant and each of the three thermal generating alternatives listed previously. The annual costs are shown for the year 1982, the year that the second Summer nuclear unit is expected to be available to supply additional low cost pumping energy for the Fairfield plant. In common with all pure pumped storage developments, the Fairfield plant would require about 1.5 kwh of pumping energy for every kwh of energy

generated on the system load. In 1982 it is estimated that 80 percent of this pumping energy would be supplied from nuclear-fueled plants and 20 percent from coal-fueled plants.

The cooling water benefit of the Fairfield development has been subtracted from the cost, reflecting that if Fairfield were not built, the cost of an alternative cooling system for the Summer nuclear station would have to be added to the cost of the alternative thermal capacity built to replace Fairfield.

Table 8-1 shows that when the power generation costs and the cooling water benefits of the Fairfield development are considered together, they show an annual savings of $1,849,000 over the next most economical alternative, gas turbine capacity.

8.2.7 Hydroelectric Alternatives

The Applicant and the FPC staff studied several hydroelectric conventional and pumped storage sites to determine their suitability for development as alternatives to the Fairfield project. The Applicant's study was of its service territory while the FPC Staff study included both the service territory and the adjacent area up to a distance of about 120 miles from the Fairfield site.

The Applicant's alternative sites were selected for suitability as multi-generation complexes with the view of concentrating thermal and hydro generating plants

Table 8-1

Comparison of Annual Costs for 1982
(Thousands of Dollars)

	Fairfield	Nuclear	Coal	Gas Turbine
Energy (800,000 mwh)	$ 3,418 1/	$ 1,600	$ 4,992	$ 7,569
Capacity (480 mw)	16,347	23,191 2/	16,714 2/	9,148
Cooling Benefit (1,800 mw)	-4,897	———	———	———
TOTAL	$14,868	$24,791	$21,706	$16,717
Savings, Pumped Hydro	-	$ 9,923	$ 6,838	$ 1,849

1/ Cost of 1,200,000 mwh of pumping energy.

2/ Includes separate nonspray cooling pond.

together to minimize environmental impact, especially relocations, service roads, and transmission lines. Besides the Fairfield site, the Applicant considered a site on the adjacent Little River a few miles southeast of Parr, and the Blair site on the Broad River 11 miles upstream from Parr dam.

(a) Blair. This site is on the main stem of the Broad River and is potentially both a conventional and pumped storage hydro development. The scheme considered by the Applicant would require a reservoir area of 21,430 acres and would develop a head of about 50 feet. Besides the relatively low head, disadvantages of this site are the necessity of extensive relocations and the difficulty of meeting thermal discharge regulations if the reservoir were used as a thermal plant cooling pond.

(b) Little River. This site would require an upper reservoir off the main stem of the Broad River and is similar to the Fairfield site with regard to environmental impact, except that it does not make use of an existing hydroelectric development for the lower reservoir. Also, the cooling surface area of the upper reservoir would be somewhat smaller than Fairfield's, thus providing less cooling capacity.

The FPC Staff studied potential conventional and pumped storage hydroelectric sites located within a radius of about 120 miles of Parr dam. None of the sites located

within the Applicant's service area are economically feasible for development. The Greater Lockhart site was the most economical potential site studied within the Applicant's service area. The site is located on the Broad River about 30 miles north of the Parr project and would be developed as a combination conventional and pumped storage hydroelectric project, with an installed capacity of 250,000-kw conventional and 750,000-kw pumped storage. The estimated capital cost of the Greater Lockhart project would be about $312,000,000, including transmission lines, or about $312 per kw. This compares with the estimated capital cost of $220 per kw for the Fairfield development.

The most economical alternative sites studied are located within the service area of the Duke Power Company, 85 to 120 miles from Parr Shoals, where the mountainous topography would permit high head development. Many of these sites will be needed in the future as the load requirements of the Duke Power Company and other neighboring utilities increase.

8.2.8 Fairfield Project with Small Upper Reservoir

The Department of the Interior has suggested, as an alternative to the proposed project, the use of a smaller upper reservoir for pumped storage and make-up water along with cooling towers for the two 900-mw Summer nuclear units.

The staff has studied this possibility by modifying the proposed project with the objective of reducing the size of Monticello Reservoir from 6,800 acres to about 1,200 acres. The smaller upper reservoir would be formed by a long dike extending east from the proposed Fairfield intake structure to a point just west of the community of Jenkinsville, enclosing the southern end of the proposed Monticello Reservoir.

The smaller reservoir would require live storage of about 32,000 acre-feet, compared to 29,000 acre-feet for the proposed project, to compensate for a lower average operating head between the two reservoirs. The size of Parr Reservoir would be increased by about 200 acres to provide this additional live storage, so the net decrease in land use would be about 5,400 acres.

The smaller reservoir would require about 68 percent more earth volume for the dams. The drawdown for the smaller upper reservoir would be about 33 feet, compared with 4.5 feet for the proposed Monticello Reservoir. Despite the

savings in land area, this scheme would be about 12 percent higher in capital cost, chiefly due to additional earthwork and slightly larger capacity turbines and waterways.

The main disadvantage of the small reservoir alternative is that it provides no cooling water benefit to the Summer nuclear station, since a cooling tower system would have to be constructed to avoid unacceptable temperature increases in the Broad River. This cooling water benefit is estimated as about $4.9 million per year, as shown in Table 8-1, and gives the proposed Fairfield project its economic advantage over other alternatives. The small reservoir scheme would not have this benefit, and consequently is economically unattractive.

8.3 CONSERVATION OF ENERGY

During the next two decades a program for conservation of electric energy must focus principally on modifying traditional patterns of energy use toward reduced energy requirements. Although of long range importance, further improvements in generation and equipment efficiencies will come slowly, and many years will elapse before such improved equipment could constitute a sufficiently large proportion of the total to significantly raise the average efficiencies of generation and utilization.

The Federal Power Commission in its 1970 National Power Survey projected the growth in power requirements and installed generating capacity through the next two decades as follows:

	1970	1980	1990
Installed Capacity (millions of kw)	340	665	1260
Energy Demand (trillions of kwh)	1.6	3.2	6.0
Population	203,235,298	227,765,000	251,431,000
Energy per Capita (kwh)	7,950	13,780	22,450

The 20-year projection (through 1990) indicates an annual growth rate in electrical energy demand amounting to about 6.7 percent, but it does not specifically consider the effect of a national commitment to energy conservation. The Staff knows of no comprehensive validated analysis of potential electrical energy savings from conservation measures, but notes that most speculative estimates appear to be in the range of a 5 to 7 percent reduction, which might be achieved in 5 to 10 years. These estimates are for voluntary conservation measures, not for a forced program of energy-use reduction with restrictions on kinds of energy use, embargoes on sale of electric equipment, or similar measures which might be employed in a power emergency.

Some electric utilities have promoted conservation programs and report a degree of success. Thus, for example, Consolidated Edison in the New York Metropolitan Area was faced with heavy demands for peak power and inadequate generating capacity, and launched a "Save a Watt" campaign. It was partly a voluntary promotional effort aimed at greater conservation in the use of electrical energy, and together with a voltage reduction of about 5 percent reportedly resulted in reducing the summer peak load by as much as 400 mw. This was about 5 percent of the peak load and may have prevented power failures in New York. Though it might be difficult to sustain such load reductions indefinitely, the promotional campaign apparently had some success in limiting power demands.

Utility promotional efforts aimed at conservation are therefore desirable. Conservation-conscious operation of ranges, dishwashers, and laundry facilities; better use of heating and air conditioning equipment through stabilized settings of thermostats; effective insulation and use of storm windows; improved lighting practices--these are some of the ways the consumer can be encouraged to save in the home. Similar potential savings exist in office buildings, stores, and industrial plants.

There are economic and environmental-protection benefits from energy conservation that can be directly rewarding to individuals. As consumers waste less power and more efficiently use what is available, they reduce the monthly electrical bills. As a consequence of reduced generation, atmospheric emissions and waste heat discharges are less.

Though conservation cannot eliminate growth in energy demand and the need to expand electric generating capacity, Staff believes that conservation practices have the potential of reducing the annual growth rate by perhaps one point--that is, from the projected 6.7 percent to 5.7 percent--at the end of the next decade. Such savings could effect a significant reduction in the need for new generating capacity during that period.

9. DISCUSSION OF COMMENTS ON DEIS

Notice of availability to the public of the Draft Environmental Statement was published and copies were mailed to appropriate Federal, State, and local agencies for comment on September 7, 1973.

Comments were due on October 22, 1973. Staff began preparing its Final Environmental Impact Statement on December 1, 1973.

Comments were received from:

FEDERAL AGENCIES

Department of Agriculture, U.S. Forest Service

Department of Army, Chief of Engineers

Department of Commerce

Department of Health, Education, and Welfare

Department of Housing and Urban Development

Department of the Interior

Department of Transportation, U.S. Coast Guard

REGIONAL AGENCIES

Central Midlands Regional Planning Council

STATE AGENCIES

Department of Agriculture

Department of Archives and History

STATE AGENCIES (Cont.)

Forestry Commission

Highway Department

Office of Economic Opportunity

Water Resources Commission

LOCAL AND OTHER PARTIES

South Carolina Electric & Gas Company

South Carolina Environmental Coalition.

Copies of the letters of comment received are provided in Appendix G.

Comments received from the various agencies on their review of new environmental matters or those discussed in the DEIS have been considered in finalizing the EIS. Only those agency comments requiring response are summarized in this Section, followed by the appropriate response thereto.

U. S. Department of Agriculture, Forest Service Comments on the environmental statement in the U.S. F.S. letter of January 10, 1974, are discussed in the text of the FEIS.

U.S. Department of the Interior, Office of the Secretary

Comment a: Interior finds it difficult from a recreational standpoint to assess the environmental effects of this proposal because Interior does not consider the Exhibit R to be acceptable. Interior urges the Commission

to require the Applicant to develop an acceptable Exhibit R as soon as possible and hopefully before the final environmental impact statement is developed for this project.

Response a: Section 10 of the FEIS describes procedures to provide adequate public recreational opportunities and the capability of expanding those features.

Comment b: Concerning geology and physical features as set forth in Section 2.2, the following points are noted: (1) transmissivity of geological materials beneath the dams impounding the upper reservoir and implications of seeps and springs below one or more of the dams; (2) analyses of embankment deformation and the limit of settlement that could be tolerated without danger of internal cracking of the embankments; (3) dynamic stability of the embankments in relation to local soil conditions; and (4) stability of natural slopes at the construction sites. Assurances should be given that these points have been adequately considered either in the environmental statement of the nuclear plant or the safety analysis report for that plant; Interior therefore suggests reference to the pertinent documentation in the final environmental impact statement.

Response b: Details of the project's geologic data are contained in Geologic and Seismic Report, Parr Hydroelectric Project, FPC Project No. 1894, South Carolina Electric & Gas Company, a copy of which is in the public files of the Federal Power Commission.

The engineering staff of the FPC has reviewed the general design drawings of the project structures, including the earth embankment and foundations, and has concluded that the design is safe and adequate. In addition, as indicated in Section 10, an independent board of consultants will review the project design and will make periodic inspections and reports during all phases of construction. Finally, the Commission staff and the board of consultants will review the project prior to the initial filling of Monticello Reservoir.

Comment c: Concerning the discussion of water quality in Section 2.4, there is no indication that chemical analyses have been made for the detection of heavy metals in the Broad River. Data taken by the South Carolina Pollution Control Authority at Parr on December 8, 1971, revealed the presence of chromium, lead, and mercury at more than trace levels. The potential concentration of these pollutants in Parr reservoir, Monticello reservoir, and the recreational subimpoundment, and the effects of heavy metal concentrations on the biotic community and recreational potential should be discussed in this section.

Response c: Additional information has been incorporated into section 2 of the FEIS.

Comment d: Section 2.4 should also discuss the loss of reservoir storage capacity because of sedimentation. The potential loss of pumped storage capacity and thus project benefits should be adequately treated.

Response d: Sedimentation in Monticello subimpoundment from Frees Creek will not present a problem because of the very small tributary drainage area involved. The amount of sedimentation in Monticello reservoir caused by pumping of turbid waters from Parr Reservoir is not known, although the large amount of dead storage space should prevent a loss of useable storage.

Sedimentation in Parr reservoir has been a significant factor in reducing reservoir capacity in the past. However it is estimated that an equilibrium condition has been reached, and any further sedimentation of the proposed live storage space will be prevented by the functioning of the Bascule gates at Parr dam. Natural floods will be passed down the Broad River by lowering one or more of the Bascule gates and permitting high river velocities to pass any additional sediment over the dam.

Comment e: Section 2.5 should present a detailed discussion of the various vegetative types that will be inundated, together with their acreage and distribution. The statement that creation of Monticello reservoir will inundate about 6,000 acres of pine-forested land is misleading. Actually the site supports about 3,000 acres of bottom land hardwoods and mixed pine-hardwood stands and about 3,000 acres of pine plantation.

Response e: This information has been incorporated into Section 2.5 of the FEIS. Detailed information can be found in Appendices D and H.

Comment f: In Section 2.8 of fish and wildlife, the final statement should identify the quantity and quality of fish and wildlife habitat to be affected by project implementation. Discussions should also indicate relative abundance and population densities for game and nongame wildlife species indigenous to the project area.

Response f: Additional information is furnished in Appendices D and H of the FEIS.

Comment g: This portion of the FEIS should also recognize white-tailed deer as the most important big game species in South Carolina and one of the primary game species within the project area. The abundance of escape cover and herbaceous and woody browse plants within the bottom lands, plus the mast production in the mixed stands and the interspersion of uneven-aged timber stands, help make this excellent habitat and this is responsible for the maintenance and productivity of deer populations.

Response g: This suggestion has been incorporated into Section 2 of the FEIS.

Comment h: In Section 3 on the environmental impact of the proposed action, the second paragraph on page 3-1 should be deleted in the final environmental impact statement.

Interior does not agree that the proposed boat launching ramp with its 10 parking spaces and the recreational subimpoundment will offer unique features in Fairfield County. Interior agrees that the scenic overlook will provide the first area view of a combination pumped storage and cooling impoundment, but questions the influence of this facility on overall recreational activities. Furthermore, there is no evidence to support the presumption that sport fishery populations will be increased by construction of this project.

Response h: The word "unique" was neither used nor implied to describe the proposed recreational facilities.

The 300 acre subimpoundment is to be managed exclusively for sport fish species and should provide for increased populations of these species. Presently the Broad River within the project area is not being managed for sport fish production and the quality of the fishery is classed as very poor, due largely to the turbidity of the water.

Comment i: In Section 3.2 on fish and wildlife, the inundation of 2,550 acres of bottom lands by enlargement of Parr reservoir and the further inundation of about 3,000 acres of bottom lands and mixed pine-hardwoods by construction of Monticello reservoir will result in significant losses of wildlife habitat and a severe reduction in the carrying capacity of area lands for most native wildlife species. Contrary to the discussion in the DEIS, the displaced wildlife species would not be absorbed by the surrounding habitat.

Response i: It is Staff's opinion that any areas which have populations below carrying capacity might be able to support displaced wildlife without having a significant impact on the resident species. Carrying capacity of surrounding areas could be increased by proper management practices. However, Staff does not have data to make specific conclusions.

Comment j: More specifically concerning Section 3.2, the bottom land and mixed hardwood sites provide a majority of the foods, especially winter browse, as well as escape cover for the white-tailed deer. It is biologically misleading to suggest that destruction of about 6,000 acres of these vegetative types will not severely decrease the area carrying capacity for this species. South Carolina bottom lands support an estimated 1 deer per 13 acres, while loblolly pine-hardwood and longleaf pine support 1 deer per 30 to 50 acres and 73 acres, respectively. Therefore, bottom lands are three times as valuable as the higher elevation forest types for deer production.

Response j: Staff is unable to find anywhere in Section 3.2 of the DEIS where it is suggested that destruction of about 6,000 acres of wildlife habitat will not severely decrease the area's carrying capacity for deer.

Comment k: Interior also notes that the DEIS has failed to recognize the effects of this proposal on waterfowl populations in the project area. The destruction of vegetation and the daily water level fluctuations in 2,550 acres of bottom lands adjacent to Parr reservoir will preclude any significant waterfowl usage. Of particular importance is the potential destruction of valuable nest sites for the wood ducks. This section should also recognize the proposed inundation of 235 acres of U.S. Forest Service lands that have been proposed as a waterfowl management area, and the Dawkins Wildlife Management Area that has been managed by the South Carolina Wildlife and Marine Resources Department for about 13 years.

Response k: Refer to sections 3 and 10 of the FEIS.

Comment l: This section indicates the importance of the striped bass fishery downstream of the project, but no data are given on the downstream flows to be released by the Applicant to insure the continued production of resident and anadromous fish species. These data should represent both quantitative and qualitative aspects below Parr dam.

Response l: Refer to Sections 4 and 10 and Appendix A of the FEIS.

Comment m: In Section 4 on measures to enhance the environment or to avoid or mitigate adverse environmental effects, Interior suggests that 4.2 on land management should be deleted from the final statement until such time as the

Applicant and the Commission can present detailed and comprehensive discussions of the measures proposed by the section title. It is unreasonable to assume that enumeration of vague biological monitoring programs and fish and wildlife management schemes can be considered as environmental enhancement or mitigation of adverse effects. Proposed biological studies should be finalized and reviewed by the appropriate State and Federal agencies prior to completion of the final statement.

Response m: The purpose of the proposed monitoring programs is to determine existing resources to aid in formulating more specific management programs for mitigating some resource losses. Should a license be granted, final plans would then be developed, in some cases even after construction, when losses and needs could be more clearly delineated.

Comment n: The South Carolina Pollution Control Authority has placed restrictions on the use of Monticello reservoir to exclude bank fishing, primitive camping on islands, or water contact sports. Therefore, the statement that recreational facilities and activities compatible with the area's needs will be enhanced is totally misleading. Furthermore, the limited project lands around the reservoir sites, the large daily fluctuations in Parr reservoir, and the exclusion zones around the nuclear and powerhouse facilities would severely

limit recreational opportunities at the project site.

Response n: Definite limitations will exist due to (1) South Carolina Pollution Control Authority's restrictions on the use of Monticello reservoir, (2) the proposed fluctuation of Parr and Monticello reservoirs, and (3) the exclusion zones around the nuclear and powerhouse facilities. Nevertheless, recreational development as outlined and suggested in Section 10 of the FEIS will provide recreational facilities and activities that are compatible with area needs, and will adequately meet area demand.

Regarding the present classification of Monticello reservoir waters, which restrict water contact sports on the reservoir, Applicant indicated on page R-1 of its Amended Application for New License, filed July 26, 1972, that after reservoir filling, it will seek approval from the South Carolina Pollution Control Authority and the South Carolina State Health Department for public use of the major portion of Monticello reservoir. If the classification of Monticello reservoir was changed to allow water contact sports, normal project operations would allow canoeing, rowing, primitive camping, picnicking, and fishing on a major portion of the 6,800 acre reservoir and its islands.

The recreational opportunities in Parr reservoir will be severely limited due to extreme daily fluctuations.

There will be ample project lands around the reservoir sites that will provide adequate recreational opportunities. Applicant has proposed a total recreational development that includes a 300-acre subimpoundment and 1,116.5 acres of land for recreational use.

The exclusion zones around the nuclear and powerhouse facilities will not severely limit recreational opportunities at the project site. The Atomic Energy Commission's regulations (10 CFR §100.3(a), 1973), defines exclusion area as "that area surrounding the reactor, in which the reactor licensee has the authority to determine all activities including exclusion or removal of personnel and property from the area. This area may be traversed by a highway, railroad or waterway... provided appropriate and effective arrangements are made to control traffic on the highway, railroad, or waterway, in case of emergency, to protect the public health and safety." The regulations further state that "activities unrelated to operation of the reactor may be permitted in an exclusion area under appropriate limitations, provided that no significant hazards to the public health and safety will result." (10 CFR §100.3(a), 1973).

Comment o: Interior further referred to Section 4 as it pertains to the proposed mitigation measures of minimum flow releases from Parr dam and the dedication of a 90-acre

greentree reservoir site. The minimum flow designation cannot be considered as mitigation, but is instead a project design feature to avoid downstream fishery losses. As stated previously, there are no data to suggest that these minimum releases would be sufficient to accomplish the intended purpose. The proposed greentree site has little or no mitigation value for the inundation of 235 acres of U. S. Forest Service lands slated for waterfowl management and the destruction of about 9,000 acres of productive wildlife habitat. Interior suggested various mitigation measures to the Applicant and the Federal Power Commission in a June 15, 1973, letter. These and additional measures should be given utmost consideration in the preparation of the final statement.

Response o: There is no proposed site for the greentree reservoir. Instead, the site will be determined after the filling of the reservoirs. Furthermore, the Applicant and the U. S. Forest Service have entered into a memorandum of agreement (attached to the Forest Service letter of December 20, 1973, in Appendix F) to mitigate losses that would be incurred by construction of the proposed project.

Since "mitigate" means "to moderate, to make less severe," maintenance of downstream flow releases to provide sufficient water for existing fisheries is a "mitigation measure." The memorandum of agreement between SCE&G and South Carolina Wildlife and Marine Resources (Appendix A)

furthermore assures that sufficient releases will be maintained.

Comment p: Concerning Section 5 on unavoidable adverse environmental effects, a revision should be made in light of previous comments. The unavoidable adverse environmental effects of construction and operation of the project will be the destruction of over 9,000 acres of productive wildlife habitat, the inundation of nearly 15 miles of river and stream fish habitat, a reduction in the carrying capacity of existing Parr reservoir, and a possible reduction in productivity of downstream fisheries.

Response p: Refer to Section 5 of the FEIS.

Comment q: Interior suggests that the Commission give serious consideration to the inclusion and environmental assessment of a small upper reservoir alternative to that presently proposed for pumped storage and make-up cooling water. Interior's calculations indicate that the use of cooling towers for the proposed nuclear powerplants would only require about 130 acre-feet per day of make-up water. Since 29,000 acre-feet of water will be pumped into Monticello reservoir daily, the size of this reservoir could be reduced to provide only enough storage for peak generation and residual storage for make-up water. Further, a display of the environmental effects of such a proposal may well demonstrate its superiority

over the proposed project insofar as fish and wildlife resources are concerned.

Response q: A small upper reservoir alternative to the proposed project has been studied by the staff and is discussed in Section 8 of the FEIS. It is not considered a feasible alternative to the proposed project because it would have no cooling water benefits for the Summer nuclear station. Although the land requirement is much less than that for Monticello reservoir, the 33-foot drawdown of the smaller reservoir is a serious disadvantage for a body of water located adjacent to the community of Jenkinsville.

A greatly reduced Monticello reservoir would support no fisheries, whereas the proposed 4-foot fluctuation would have minimal effects on the development of a fishery in Monticello. Although water contact sports will not presently be allowed in the main part of the proposed upper reservoir, the possibility remains for such usage being allowed in the future.

In light of the possibilities of probable expanded nuclear facilities, the larger impoundment would be a better use of resources.

Comment r: In further discussion of this section, Interior states that the Applicant has various alternatives available for the avoidance or mitigation of adverse environmental effects. For example, the impoundment of Hellers and Cannons Creeks for waterfowl mitigation, and the resultant

loss of usable storage in Parr reservoir, would result in only a 20 minute loss of generation time during the daily pumped storage cycle.

Response r: Any reduction in usable storage capacity in Parr reservoir would jeopardize the energy-generating benefits of the project, because the 29,000 acre-foot capacity of the lower reservoir determines the capacity of the entire project. SCE&G estimates the loss of 20 minutes generation each week-day would mean a loss of 41,600 mwh per year with a value of about $260,000.

FPC staff studies indicate that a subimpoundment on Hellers Creek only would result in a storage loss in Parr reservoir of 1,085 acre-feet, or a 3.74 percent loss. Assuming 5 days of generation per week, this gives a loss of $233,000 per year with a subimpoundment in Hellers Creek. If Cannons Creek were impounded also, the loss in generation would be at least twice as much.

Comment s: In concluding remarks about this section, Interior recognized the need for maximum head development to meet projected peak loads. But maximum head development could be realized by the Applicant by location of a smaller upper reservoir dam site at a higher elevation in the Frees Creek Watershed. Further, Interior suggests that the final

statement identify and evaluate another alternative--the development of necessary peak load facilities in alternative locations outside the Applicant's service area. On page 8-13 of the DEIS, the FPC staff indicated that the most feasible sites studied were located in Duke Power Company's service area.

Response s: The topography of the Frees Creek Watershed precludes the development of a significantly higher head pumped storage project in the area. Any small increase in head would be more than offset by uneconomic lengthening of the waterway between the upper reservoir and Parr reservoir. Also, any small upper reservoir located in the head-waters of Frees Creek could not serve the Summer station as a source of make-up water.

U.S. Department of Health, Education, and Welfare, Region IV Office

Comment: HEW notes an area of secondary impact which appears not to be fully clarified in the DEIS. As stated in the DEIS, a majority of the transient workers would reside in the Columbia area. In the event 30 percent resided in the project area, 7 additional classrooms would be required by the Local Education Authority (LEA). The two counties to be affected are rural and appear to have a stable school population. Consequently, HEW recommends that FPC consult with the LEA on the potential impact of additional classrooms on their physical plant facilities.

Response: The FEIS, in Section 3.2, indicates that approximately 30 percent of the work force would come from permanent residents within a 25-mile radius of the project area. Since they are already residents, they should cause no new impacts. The school age children of these families would already be in the area schools.

Office of the Assistant Secretary, U. S. Department of Commerce

Comment: Parr project could produce adverse effects on striped bass and blueback herring spawning downstream from the development due to fluctuating water levels. The agreement between the South Carolina Wildlife and Marine Resources Department and the South Carolina Electric & Gas Company should provide for necessary flows to assure successful spawning of these species. Also, the final impact statement should include studies to monitor the spawning of these fish and the feasibility of altering flows, if necessary, during the spawning season.

Response: One of the major reasons for this agreement was to assure an adequate flow from Parr reservoir by South Carolina Electric & Gas for striped bass spawning, as recommended by the South Carolina Wildlife and Marine Resources Department as stated in their agreement (Appendix A). Further, staff has recommended in Section 10 of the FEIS that provision be made in any license issued for modification of the

agreed-upon flow regime should it be found to be inadequate to provide the amount of flow necessary to protect the downstream aquatic environment.

South Carolina Environmental Coalition

Comment: A report by the Environmental Protection Agency (EPA) suggests that odor problems in the Broad River, from which the City of Columbia, South Carolina, draws its drinking water, may be attributed to algal and fungal organisms. This report further states that as temperature increases, the activity of actinomycetes, the bacteria causing the odors, increases. The proposed Parr project would create a large warm water "sink" due to its use for cooling waters for a nuclear station, and could create ideal conditions for growth of the actinomycetes. The DEIS does not analyze the problem and ignores existing data. This is a significant problem and is directly related to the Parr project. Thorough, independent studies should be conducted before a Final Environmental Impact Statement is released.

Response: This comment is considered in Section 2.4 of the FEIS and the conclusions and recommendations from a 1973 Environmental Protection Agency Report concerning musty odors in the Broad River are included in the FEIS (Appendix E).

10. DISCUSSION OF SIGNIFICANT ENVIRONMENTAL MATTERS

10.1 LAND USE

Licensee should acquire in fee title, or the right to use in perpetuity, and include within the project boundary all lands other than lands of the United States necessary for construction, maintenance, and operation of the project. Lands around the recreation subimpoundment and other lands proposed for recreational development should also be included within the project boundary.

The project boundary should be as follows:

(1) The project boundary around Monticello reservoir should include any islands and all lands below the 430-foot contour elevation msl, except that the project boundary should provide a strip of land around the reservoir not less than 50 feet and generally no more than 200 feet wide from the 425-foot contour elevation. The project boundary around the Monticello reservoir subimpoundment should include a strip of land not less than 150 feet wide from the 425-foot contour elevation, together with all other lands necessary to serve project recreational purposes, including buffer zones around recreational sites.

(2) To protect the remaining wildlife habitat along the Broad River bottom lands, the project boundary around Parr should include any islands and all other lands up to the 270-foot contour elevation msl. In any case, the project boundary should include a strip of land a minimum of 50 feet wide and generally not more than 200 feet wide, together

with all other lands necessary for project recreation purposes. To maintain the benefits of a shoreline buffer strip, access should be controlled by the Licensee. Furthermore, the design of public access areas and associated facilities should be submitted for Commission approval.

No disposal of any interest in project lands or waters should be allowed without prior approval of the Commission.

Licensee should retain all project lands, works, and rights essential to the development, transmission, or distribution of power and for other project purposes. None of these should be disposed of without approval of the Commission.

The Licensee should take reasonable measures to minimize soil erosion on project lands and siltation of the project reservoir and streams. If the Commission should deem it necessary, after notice and opportunity for hearing, the Licensee should be required to construct and maintain soil surfaces.

Licensee should provide for the joint use by the United States agency having jurisdiction over any project lands, or by persons or corporations occupying United States lands under permit, of water from any stream, conduit, or any natural or artificial body of water for fire suppression.

10.2 RECREATION

The Applicant's amended application for a new license reports that a visitor center and construction observation point would be built on the south shoreline of Monticello reservoir. The Applicant should consult with the South Carolina Department of Parks, Recreation, and Tourism in planning the facilities, and file with the Commission appropriate site development plans, construction costs, and schedules.

During initial development, picnic areas and additional parking spaces should be provided at or near the proposed boat ramp on the Monticello subimpoundment. Initial development, as proposed by the Applicant, would provide only 10 parking spaces for cars with connected trailers, and no picnic facilities. Due to the small number of picnic facilities to be provided at Monticello and Parr reservoirs (10 picnic tables) and the proposed swimming beach to be provided adjacent to the boat ramp, picnicking and additional parking facilities should be constructed at the Monticello reservoir subimpoundment during initial development of outdoor recreation facilities.

All islands formed as a result of impounding Monticello reservoir should be reserved with their natural vegetation as wildlife refuge areas. Although the South Carolina Pollution Control Authority has classified the waters of Monticello Reservoir as a waste heat impoundment (letter of June 6, 1972),

noncontact water recreation such as canoeing or rowing (nonpowered boating only) may be allowed in the future. This would permit picnicking and primitive camping on the approximately 50 acres of islands that would be available for this use. Picnicking and primitive camping on the islands would not interfere with project operations. Sanitary facilities and a waste collection program would become necessary.

The Applicant's plan provides for initial recreational development in several areas and reserves other areas for future recreational needs. The Licensee should consult with appropriate Federal and State agencies periodically to determine future area recreational needs and should report these needs to the FPC in its biennial Form 80 filing. Licensee should file all plans developed from such consultation with the Commission for approval as amendments to the Exhibit R.

The Broad River is presently a turbid and somewhat polluted stream which the South Carolina Pollution Control Authority has rated "Class B" waters. The Broad River and Parr reservoir presently have little recreational appeal except for fishermen and hunters. The U.S. Department of the Interior cites a hunting visitor-day use of 187,000 on the Enoree Ranger District of the Sumter National Forest in 1970. (The existing Parr project is partly within the forest.) Waterfowl-hunting visitor-day use was 1,300 for 1970, and this is expected to exceed 10,000 in 1975. It should be noted,

however, that Parr is a very small part of the Enoree District. The enlargement of Parr reservoir would inundate 300 acres of national forest lands, including the entire Dawkins Waterfowl Management Area presently being developed to meet the increasing public demand for waterfowl hunting and viewing.

The Applicant has proposed approximately 1,110 acres of project land for recreational development. Two of the areas that would be reserved for future recreational use border on Parr reservoir. A 187-acre section is located on the reservoir at the mouth of Hellers Creek between County Road 28 and Parr reservoir (Figure 1-1). A boat landing area on Hellers Creek is one of the three initial recreational developments planned. A second recreational area of 387 acres is proposed for the north side of the mouth of Frees Creek between Parr and Monticello reservoirs.

Recreational use of these areas would be greatly limited by the reduced surface area caused by the 10-foot daily fluctuation that would occur on Parr reservoir. The average width of the mudflats on Parr reservoir would be approximately 375 feet, with range of about 25 to 1,000 feet. At low water, primarily in the evenings and night, numerous snags and extensive mudflats would be exposed in Hellers and Cannon Creeks. Under these conditions, boating would be severely limited and the scenic values of the area would be degraded.

Frees Creek would form the tailrace for the Fairfield Pumped Storage Project, and therefore the proposed adjacent recreation area would not only have mudflats but would be

adjacent to the high water velocities that would occur in Frees Creek below the powerhouse. Furthermore, the terrain is steep and dissected by drainage channels. The Southern Railway tracks cross the western edge of the area. These factors greatly limit the area's recreational potential.

As a mitigative measure to offset loss of waterfowl habitat and the associated hunting and viewing recreation, the possibility has been studied of creating a 165-acre subimpoundment containing storage of 1,204 acre-feet on the Hellers Creek arm of Parr reservoir (utilizing the entire acreage upstream of the Route 28 causeway). This would cause a loss of storage capacity of 1,085 acre-feet from the total usable storage capacity of Parr reservoir (29,000 acre-feet). Such loss of storage capacity could have a significant adverse effect on the power value of the project.

As an alternative to a Hellers Creek subimpoundment, public recreation needs and waterfowl habitat conservation would be better served by: (1) Creating several small greentree ponds of a few acres each in tributaries leading into the Cannons and Hellers Creek arms of Parr reservoir; and (2) Possible reassignment of portions of the presently proposed 387 and 180-acre recreational areas located adjacent to Frees and Hellers Creeks, respectively, to provide access areas at the suggested greentree subimpoundments on Cannons and Hellers Creeks for fishing and waterfowl hunting and viewing.

Plans for recreational development filed as part of the application are satisfactory to the extent that they provide for: (1) The creation of a 300-acre subimpoundment on Monticello reservoir; (2) Development on Monticello subimpoundment to include a 2-acre boat launch area with a boat ramp, parking for 10 cars with trailers, a swimming area, and sanitary facilities; (3) Construction of a 30-acre scenic overlook area along the east shore of the main body of Monticello reservoir to include 10 picnic tables, two benches, a covered platform, walkways, potable water, and sanitary facilities; (4) Provisions for possible future boat launching facilities on the main body of the Monticello reservoir; (5) Development of a 2-acre boat launch area on Parr reservoir to include a boat ramp, parking for five cars with trailers, and sanitary facilities; (6) Provisions for possible primitive camping areas and wildlife preserves on the main bodies of Monticello and Parr reservoirs; and (7) The acquisition of approximately 1,200 acres of land for initial and future recreational development.

To supplement its plans for recreational development, Licensee should, within one year following the issuance of any license for the proposed project, be required to file for Commission approval the following:

(1) Appropriate site development plans, construction costs, and development schedules for the visitors center and construction observation point, as proposed in the July 1972 amendment to the application for license; and

(2) Plans for additional recreational development at the proposed Monticello subimpoundment boat launch area, such as provisions for drinking water, picnicking, and additional parking facilities should they be needed.

Furthermore, within one year following commercial operation, the Licensee should file the results of a study showing the feasibility of constructing small greentree reservoirs at suitable locations on Cannons and Hellers Creeks, including costs of development; the effects, if any, and the magnitude of those effects on project operation; and plans for the development of such greentree reservoirs.

Licensee should construct, maintain, and operate or should arrange for the construction, maintenance, and operation of recreational facilities, including such modifications of access roads, trails, launching ramps, beaches, picnic and camping areas, sanitary facilities, and utilities as may be prescribed by the Commission to utilize the natural resources and recreational values of the project area without impairment to its wilderness character.

The Licensee should consult and cooperate with Federal, regional, State, and local agencies in determining any additional need for recreational development at Project 1894.

The Licensee, when consistent with proper operation of the project and public safety, should allow the public free access to project waters and adjacent project lands for the purpose of optimum public utilization of such lands and waters for recreational purposes, including hunting and fishing.

10.3 PUBLIC SAFETY

The Company should retain a board of independent consultants to review the proposed design of the project and to periodically review its construction in order to assure a completely safe project.

Licensee should require its employees, contractors, and employees of contractors to prevent, to make advanced preparation for suppression of, and to suppress fires on lands occupied under the license.

Location and standards of roads, trails, quarries, borrow pits, spoil disposal areas, and sanitary facilities should be subject to the approval of any department or agency of the United States having supervision over the lands involved.

Licensee should place and maintain suitable structures and devices to reduce the possibility of contact between its telegraph and telephone transmission lines and other signal or power lines owned by itself or other organizations. Licensee should take necessary measures to minimize the possibility of any structures and wires falling and obstructing traffic and endangering life on project lands and waters.

Construction, operation, and maintenance of sanitary facilities, including septic tanks, sewage treatment plants, and solid waste land fills located in the project area, should comply with standards and regulations of the Federal, State, and local environmental agencies.

The Licensee should develop and implement a waste management plan for the project in cooperation with the appropriate Federal, State, and local agencies.

10.4 PROJECT VEGETATION AND SCENIC VALUES

In addition to the proposals in the July 1972 Exhibit V (Appendix C), the Licensee should:

(1) Conduct a study to determine plant species (trees and grasses) that would be suited to the project area and the fluctuation zones of the Monticello reservoir shoreline, and that could function as wildlife food and cover. This study should be conducted in cooperation with appropriate State agencies, following issuance of any license by the Commission, and should be completed and the results filed with the Commission prior to the beginning of operations of the pumped storage project.

(2) Establish test plots of plants found to be feasible in the above mentioned study in the reservoir fluctuation zone, following the startup of pumped storage operations, and study these plots over a period of two years to determine the survival capabilities and values of the vegetation for wildlife habitat and for scenic improvements. The results of such an experiment should be filed with the Commission following its completion.

(3) File planting plans for Commission approval within one year after completion of the experimental studies outlined in (1) and (2) above.

10.5 WATERFOWL AND FISH HABITAT

Approximately 2,550 acres of bottom land hardwoods would

be flooded by raising the height of the existing Parr Dam. This additional surface acreage would not provide suitable wildlife habitat, especially for water fowl, due to the 10-foot daily fluctuation of Parr reservoir. As mitigation for this loss, the Applicant and the South Carolina Wildlife and Marine Resources Department have agreed upon a 90-acre greentree reservoir. About 300 acres of U.S. Forest Service land proposed for waterfowl management will be flooded by the enlarged Parr Reservoir. The Applicant has cooperated with the U. S. Forest Service to develop a mitigation plan for this potential loss (Appendix G). While these agreements could cover provisions to mitigate loss of some waterfowl habitat, it would not provide for mitigating the loss of habitat for other wildlife or the effect of fluctuation on fish habitat and fisheries in Parr reservoir. Even though the present Parr reservoir offers limited sport fishing, the future development of a potential fishery should not be overlooked.

Following issuance of any license for construction of the project, Licensee, in cooperation with South Carolina Wildlife and Marine Resources Department and the U.S. Bureau of Sport Fisheries and Wildlife, should be required to conduct a study to determine the sport fishing potential in Parr reservoir. Modification of project operation during the spawning periods of nest builders in Parr reservoir should be given consideration in such a study.

10.6 WATER QUALITY

Changes in water quality will occur as a result of construction and operation of the combined generating facilities

(hydro and nuclear). The extent of these changes and the resultant effect, if any, on the aquatic biota can be best determined by pre- and post-construction studies. The Applicant has proposed a preoperational and an operational water quality monitoring program as described in Section 4. The Applicant's program should adequately assess any changes in water quality due to operation of the project. Also, a monitoring station should be established by the Applicant in the Broad River downstream of Parr dam to measure dissolved oxygen, temperature, stream flow, conductivity, pH, and heavy metal concentrations. Dissolved oxygen, temperature, flow, conductivity, and pH should be monitored on a continuous basis. Turbidity and heavy metal determinations should be done with monthly grab samples. This would permit comparison with data collected at similar stations to be established above Parr dam. To assist personnel of the Columbia, South Carolina, water treatment plant in early detection of musty odors in the Broad River, the Licensee should include odor samples in its water quality monitoring program.

In order that the quality of the aquatic environment of the 300-acre subimpoundment may be known and can be maintained so that its potential recreational use is realized, the Applicant should conduct water quality analyses at selected locations. Sampling should be conducted on a monthly basis and should include those parameters listed in Table 4-2.

10-7 DOWNSTREAM FLOW RELEASES

Water releases from Parr reservoir into the Broad River

are needed to protect striped bass spawning in the Congaree River below the confluence of the Broad and Saluda Rivers. Striped bass spawning occurs in the upper reaches of the Congaree during March, April, and May. Adequate flow is necessary to insure successful spawning and hatching of striped bass eggs before they reach the Santee-Cooper reservoir. The Applicant and the South Carolina Wildlife and Marine Resources Department reached an agreement (Appendix A) on the rate of water release from Parr reservoir during the striped bass spawning period. The minimum release during this period is proposed to be 1,000 cfs and the daily average release would be the natural inflow of the Broad River into Parr reservoir. During the other months of the year, the minimum release would be 150 cfs, with a minimum daily average of 800 cfs. Any license issued should contain such provisions as well as provide for modifications of these flow regimes, should they prove inadequate in the future to protect the downstream aquatic habitat.

10.8 NUCLEAR STATION COOLING CAPACITY

The Applicant requested authorization from the Federal Power Commission to use Monticello reservoir for nuclear plant cooling purposes. The proposal is for use of project water for once-through cooling for the Virgil C. Summer nuclear complex. A future 900-mw nuclear station, to be built at a nearby location, utilizing cooling towers conjointly with the waters of Monticello reservoir is under consideration by the Applicant.

The Atomic Energy Commission has issued a construction permit for the 900-mw Unit I of the Summer plant. The Applicant will apply for permission to construct Unit II sometime after the first unit has gone on line, as the need arises for increased baseload generating capacity.

Although Applicant has requested permission for cooling waters for only one 900-mw unit, both Units I and II at the Virgil C. Summer plant site have been considered in environmental studies. Any license issued by the Federal Power Commission should include authorization for the use of the waters of the Monticello reservoir for cooling both 900-mw units of the Virgil C. Summer nuclear complex. However, the South Carolina Pollution Control Authority issued the water quality certificate (Appendix A), pursuant to Section 401 of the Federal Water Pollution Control Act Amendments of 1972, authorizing use of Monticello reservoir water for cooling only one 900-mw unit of the proposed Virgil C. Summer plant. Therefore, approval of Monticello reservoir for use as a heatsink for two 900-mw units should be dependent upon Applicant's filing with the Commission a valid water quality certificate from the State of South Carolina, authorizing the discharge of heated waters from a second 900-mw unit into Monticello reservoir prior to construction of such a unit.

The Applicant should file an application with the FPC for amendment to any license issued by the Commission for the presently proposed Project No. 1894, seeking authorization for any proposed joint use of project waters for cooling purposes for a future thermal plant beyond the two units of the Virgil C. Summer Nuclear Station.

10.9 ARCHEOLOGY

Should construction or operation of the project during the term of a license uncover any presently unknown archaeological sites, the Licensee should be required to consult with appropriate agencies to determine the need for and to pay the costs of archaeological survey and salvage work at the project prior to inundation.

10.10 TAKEOVER

No Federal department or agency has recommended that the United States exercise its right to take over the present project pursuant to Section 14 of the Federal Power Act.

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Appendix A

DEPARTMENT OF THE ARMY
CHARLESTON DISTRICT, CORPS OF ENGINEERS
P. O. BOX 919
CHARLESTON, S.C. 29402

SANVK

19 August 1971

South Carolina Electric
& Gas Company
ATTN: Mr. W. E. Moore
P. O. Box 764
Columbia, S. C. 29202

Dear Mr. Moore:

I write in response to your letter dated 13 August 1971 requesting information on Department of the Army permits for your proposed Parr Hydroelectric Project 1894. The maps included with the subject letter have been reviewed and since the Broad River above Columbia, S. C. is not presently considered by the Corps to be a navigable water, Section 10 permits (required for work in navigable waters) will not be required for any of the work as depicted. However, since the proposed project will create a thermal discharge into the Broad River, a tributary of a navigable water, a permit authorizing this discharge will be required by my office. This type of permit is required by Section 13 of the River and Harbor Act of 1899. Included herewith is a package of documents pertinent to the discharge permit system. This package includes the necessary application forms together with instructions on how to complete it.

I trust that the above supplies the information requested but, if I may be of further assistance, please do not hesitate to call.

Sincerely,

John E. Romanowicz
for CHARLES E. EASTBURN
LTC, Corps of Engineers
Acting District Engineer

Incl
as

South Carolina Pollution Control Authority

A-4

HUBERT J. WEBB, PH.D.
EXECUTIVE DIRECTOR
OWEN BUILDING
1321 LADY STREET P. O. BOX 11528
Columbia, South Carolina 29211

AREA CODE 803
TELEPHONE: 758-2815

January 11, 1973

South Carolina Electric and Gas Company
P. O. Box 764
Columbia, South Carolina 29202

Attention: Mr. E. H. Crews, Jr.

Re: Water Quality Certificate
Monticello Impoundment and
Fairfield Pumped Storage Facility
Condition: Nuclear Unit # 1 only
in operation

Dear Sir:

The South Carolina Pollution Control Authority has reviewed technical information submitted relative to the referenced facilities. Based on this review the Pollution Control Authority certifies that there is reasonable assurance that the construction and operation of the impoundment and pump storage facilities will not violate applicable water quality standards as regards operation of nuclear generation unit # 1.

As of this date there is no applicable effluent limit or other limitation under Section 301 (b) and 302 nor is there an applicable standard under Sections 306 and 307 of the Federal Water Pollution Control Act (PL92-500) dated October 18, 1972.

Sincerely yours,

R. Kenneth Tinsley

R. Kenneth Tinsley, Chief
Water Pollution Control Division

RKT/CRJ:as

COPY COPY COPY COPY

A-5

South Carolina Pollution Control Authority

HUBERT J. WEBB, PH.D.
EXECUTIVE DIRECTOR
OWEN BUILDING
1321 LADY STREET P. O. BOX
Columbia, South Carolina 29

AREA CODE 803
TELEPHONE: 755-2915

February 13, 197

Mr. E. H. Crews, Jr.
South Carolina Electric and Gas Company
P. O. Box 764
Columbia, South Carolina 29202

Re: Proposed Dredging of a tailrace canal along Frees Creek from the proposed Fairfield Pump Storage Facility to the Broad River Fairfield County.

Dear Mr. Crews:

This is to certify that there is reasonable assurance that the proposed dredging work will be carried out in a manner which will not violate the applicable water quality standards. You may use this letter as the approval of the South Carolina Pollution Control Authority to perform the referenced work.

Yours truly,

SIGNED

R. Kenneth Tinsley, Chief
Water Pollution Control Division

RKT.RC:as

ENVIRONMENTAL PROTECTION AGENCY
A-6
REGION IV
1421 Peachtree St., N.E., Atlanta, Georgia 30309

January 18, 1973

Dr. Hubert J. Webb, Executive Secretary
South Carolina Pollution Control Authority
Owen Building, 1321 Lady Street
P. O. Box 11628
Columbia, South Carolina 29201

Dear Dr. Webb:

Section 303(a)(1) of the Federal Water Pollution Control Act, as amended, on October 18, 1972 requires that interstate water quality standards adopted by any state and submitted to, and approved by, or awaiting approval by the Administrator, shall remain in effect unless the Administrator determines that such standards are not consistent with the Act as in effect immediately prior to the date of the 1972 amendments. Further, it requires that each state be notified of any required changes no later than January 18, 1973.

The Act states in Section 101 that it is the national goal that, wherever attainable, an interim goal of water quality that provides for the protection and propagation of Fish, Shellfish, and Wildlife and provides for Recreation in and on the waters be achieved by July 1, 1983.

The Environmental Protection Agency policy to carry out the intent of the 1972 amendments requires that all streams be classified as a minimum for Fish and Wildlife protection and propagation and secondary contact recreation. This policy is consistent with the stated goal in Section 101 of the 1972 amendments and, further, only these uses with their associated water quality criteria adequately protect public health and welfare and enhance water quality as required by Section 10(c)(3) of the previous Act. The complete policy is attached for your information.

A review of the South Carolina Standards including the stream use classifications approved by this office on January 15, 1973 indicates that these standards are in compliance with the requirements of the Act.

No further action is required at this time. We urge you to continue your current efforts to implement these Water Quality Standards at the earliest date possible.

We look forward to continuing our cooperative relationship with the South Carolina Pollution Control Authority.

Sincerely yours,

Jack E. Ravan
Regional Administrator

Attachment

MEMORANDUM OF UNDERSTANDING BETWEEN SOUTH CAROLINA WILDLIFE AND MARINE RESOURCES DEPARTMENT AND SCE&G CONCERNING PARR HYDRO-ELECTRIC PROJECT - FPC PROJECT - FPC PROJECT NO. 1894.

I. PREAMBLE

South Carolina Electric & Gas Company (hereinafter referred to as SCE&G) has filed with the U. S. Federal Power Commission an application for a new license for the Parr Hydro-electric Project - FPC Project No. 1894.

Maintaining that the statements appearing therein indicating a desire of SCE&G to cooperate with the S. C. Wildlife and Marine Resources Department (hereinafter referred to as Department) for minimizing environmental impact are sincere; SCE&G proposes the following statements of understanding between SCE&G and the Department to strengthen areas of the project's environmental program dealing with two specific practices that include the following:

(1) Further assurance of a continual flow of water downstream from Parr Powerhouse necessary for the survival, reproduction and normal life cycle activities of all species of fish with particular regard to the striped bass spawn during the months of March, April and May.

(2) Plans of the Land Management Program to offset the disturbance as a result of the project on the terrestrial ecological system that will include planting appropriate ground cover for wildlife food source and dedicating approximately 90 acres of suitable lands adjacent to the Reservoirs to the Department for a green tree reservoir site.

II. WATER FLOW FROM PARR POWERHOUSE

SCE&G agrees to supply the necessary needed instantaneous and daily minimum flow of water from Parr Powerhouse as follows:

A. During all months of the year except March, April and May, and so long as the minimum daily average inflow of the Broad River into Parr Reservoir is not less than the following indicated minimum daily flow, the water release from the Parr Powerhouse less evaporation loss of the Parr and Monticello pools will be 150 CFS instantaneous and 800 CFS minimum daily average.

B. During the months of March, April and May and so long as the daily average inflow of the Broad River into Parr Reservoir is not less than the following indicated minimum instantaneous daily flow, the water release from the Parr Powerhouse less evaporation loss of the Parr and Monticello pools will be 1000 CFS instantaneous and the daily average release will be the natural inflow of Broad River into Parr Reservoir. The maximum anticipated increase loss of water due to evaporation losses will be approximately 88 CFS and will occur during the months of July and August of a calendar year.

C. SCE&G agrees that for the duration of its FPC License that the Department shall have access to all water monitoring stations maintained in connection with the project; SCE&G gives further assurance that such stations shall be maintained for the duration of the License.

III. LAND MANAGEMENT PROGRAM

In order to clarify the Land Management Program in those areas of specific interest to the Department, SCE&G will provide the following:

A. General Practice for Management of Timber and Lands of Parr Hydroelectric Project

Due to the changing of the water level, there will be scattered tree mortality around the reservoir. Associated with these dead and weakened trees exists the potential for a high forest insect buildup. To reduce this threat to the woodlands surrounding the reservoir a small crew will patrol the area, remove, burn or spray with B.H.C. dead or dying trees for a period of two years following the raising of the water level, if desirable and recommended by the Department, PCA or other state agency.

After clearing the area around the reservoir, some floating debris will exist. SCE&G will remove this floating debris as required. Other than in areas designated for recreation or necessary to the construction of the reservoir no cutting will be allowed except for dead or dying trees.

During construction steep banks and areas subject to erosion are to be secured. The method of preventing this erosion will vary with slope and accessibility. Methods employed will be water bars, planting, riprap, etc.

Temporary roads and construction areas when no longer in use will be disced, fertilized and planted, including the following designated areas of right-of-way. Planting will be in accordance with the general specifications described in part IV of this Memorandum of Understanding.

B. Special Areas for Green Tree Reservoir

Upon completion of the site topographic survey, SCE&G will dedicate approximately 90 acres of suitable Broad River bottom land to the Department for development as a green tree reservoir site.

C. Construction Areas Planned for Planting

The maps of the areas involving construction are not completed, however, the area to be planted will not be less than 50 acres. The 50 acres will include the surface area of dams, temporary construction roads, temporary construction lay down areas, temporary parking areas, and spoil areas.

D. Areas of Transmission Line Right-of-Way Areas Follows:

Right-of-Way Areas:

Fairfield Summer 230 KV line.

From N-470,500; E-1,899,750 to N-472,880; E-1, 902,100 plant type A (see IV). This area is approximately 3200' long X 170' wide or about 12 Acres.

Remainder of line to be left for natural growth or included in the plant landscape.

Total estimated planted area - 12 Acres.

The relocated Duke Power Company Great Falls-Newberry 100 KV Double Circuit Line.

All areas between coordinates N-479,820; E-1, 899,580 to N-476,000; E-1,900,325 plant type A (see IV). This area is approximately 4000' long X 100' wide or about 8 Acres.

All areas from N-476,000; E-1,900,325 to N-474, 500; E-1,900,930 are to be cleared as required and left for natural growth or included in plant landscape.

All areas from N-474,500; E-1,900,930 to N-472, 960; E-1,902,160 to be planted type A (see IV). This area is approximately 2000' long X 100' wide or about 5 Acres.

From N-472,960; E-1,902,160 to N-470,730; E-1,906,270 to be cleared as required and left for natural growth or included in plant landscape.

All areas from N-470,730; E-1,906,270 to N-471,400; E-1,910,000. This area is approximately 3000' long X 100' wide or about 6 Acres (roadway not included).

Total estimated planted area 19 Acres.

IV. GENERAL PLANTING SPECIFICATIONS

These specifications are to provide for establishment of ground cover for the purposes of erosion control and development of food sources for wildlife in the vicinity of FPC Project 1894 (Parr Hydroelectric Project). The areas, as previously described, will include transmission line right-of-way, construction areas no longer in use, temporary roads, lay down, temporary parking, dam faces and spoil areas. Planting techniques for all available areas will be either by procedure A or B as described in Section IV and will be accomplished during the spring season following completion of construction.

Current plans are that the contractors working for SCE&G are to provide all labor, equipment, supervision and if specified in the individual contract, all fertilizer and seed

to fulfill all requirements of the Land Management Programs, however, SCE&G assumes complete responsibility to accomplish the work described.

Ground maintenance of planted areas shall be to bush hogging or otherwise cut undesirable growth as required (estimated at 2 to 3 year intervals). Fertilizing shall be carried out if required at this same time.

Type B planting will normally be used but type A will be used for small areas with slight slopes and where larger quantities and/or earlier production of food may be required.

Additional planting areas may be designated by SCE&G in cooperation with the U. S. Soil Conservation Service and after consultation with the Department.

Type A - Machine

In those areas designated by SCE&G, the A type preparation and planting will be carried out during the first planting season after construction is completed.

The area to be planted will be thoroughly worked up with a bush and hog harrow (or equal equipment) to a depth of about 2-4 inches. In the case of line rights-of-way, this shall be along the entire width of the right-of-way in the

planting area except for roads or trails and within 2 to 5 feet of a drainage ditch. Soil preparation shall be dressed to parallel the natural existing contours.

Planting areas will not include permanent swamps, marshes or other consistently wet areas.

All areas of type "A" shall be fertilized evenly at the rate and with the type seeding specified. The appropriate seed shall be sown evenly over the entire prepared area.

Sowing shall be accomplished between April 1 and May 30 or at such other date that SCE&G and the Department shall deem more appropriate of the year following the completion of construction.

Water bars or other means shall also be employed to prevent erosion on slopes exceeding 2 degrees.

The seed or seeds used shall be as specified by the Department .

Type B - Helicopter

In those areas designated by SCE&G, the "B" type of planting will be carried out during the first planting season after construction is completed.

The area designated will be sown and fertilized in a simultaneous flyover with a low, slow flying helicopter. The planting area will not receive seed bed preparation as Type A. All slopes will be planted. Erosion control measures such as ditches, terraces, etc. will be completed at the time of initial area clearing or during line construction if the area is a right-of-way.

Planting areas will not include permanent swamps, marshes, or other consistently wet areas.

Sowing shall be accomplished between April 1 and May 30 or at such other time of the year immediately following completion of construction of the line. The appropriate seed and fertilizer mixture will be spread evenly over the entire width of the designated right-of-way.

The seed or seeds used shall be as specified by the Department.

Fertilizer for type A and B may be varied based on recommendations by the U. S. Department of Agriculture, Soil Conservation Services.

DATED this 15th day of Feb., 1973, at Columbia, South Carolina.

In the Presence of:

South Carolina Wildlife and Marine Resources Department

BY: _____

South Carolina Electric & Gas Company

By: _____
V. C. Summer, Senior Vice President

C O P Y

UNITED STATES

A-19

ATOMIC ENERGY COMMISSION

WASHINGTON, D.C. 20243

SOUTH CAROLINA ELECTRIC AND GAS COMPANY

(Virgil C. Summer Nuclear Station, Unit 1)

DOCKET NO. 50-395

CONSTRUCTION PERMIT

Construction Permit No. CPPR-94

1. Pursuant to Section 103 of the Atomic Energy Act of 1954, as amended (the Act), and Title 10, Chapter 1, Code of Federal Regulations, Part 50, "Licensing of Production and Utilization Facilities," and pursuant to the Initial Decision of the Atomic Safety and Licensing Board, the Atomic Energy Commission (the Commission) hereby issues a construction permit to the South Carolina Electric and Gas Company (the applicant) for a utilization facility (the facility), designed to operate at 2775 megawatts thermal with a net electrical output of approximately 900 megawatts as described in the application and amendments thereto, (the application), filed in this matter by the applicant and as more fully described in the evidence received at the public hearing upon that application. The facility, known as the Virgil C. Summer Nuclear Station, Unit 1, will be located at the applicant's site in Fairfield County, South Carolina. The site is located immediately north of Parr, South Carolina, and is adjacent to the Monticello Reservoir created by placing a series of dams across Frees Creek, a tributary of the Broad River. The Reservoir is located east of the Broad River and west of South Carolina State Highway 215, about 26 miles north of Columbia, in western Fairfield County, South Carolina.

2. This permit shall be deemed to contain and be subject to the conditions specified in Sections 50.54 and 50.55 of said regulations; is subject to all applicable provisions of the Act, and rules, regulations, and orders of the Commission now or hereafter in effect; and is subject to the conditions specified or incorporated below:

C O P Y

A. The earliest date for the completion of the facility is January 1, 1977, and the latest date for completion of the facility is January 1, 1978.

B. The facility shall be constructed and located at the site as described in the application, in Fairfield County, South Carolina.

C. This construction permit authorized the applicant to construct the facility described in the application, and the hearing record in accordance with the principal architectural and engineering criteria sit forth therein.

D. In view of the fact that the Attorney General has not recommended an antitrust hearing in this matter, that no antitrust issues have been raised by another in a manner according with the Commission's Rules of Practice, and that no finding has been made that an antitrust hearing is otherwise required (10 CFR, Part 2, §2.104(d)), antitrust review of the application for this construction permit under Section 105c of the Atomic Energy Act of 1954, as amended, has been completed and a hearing thereon determined to be unnecessary.

E. This construction permit is subject to the following conditions for the protection of the environment:

1. The applicant will perform preoperational measurements of the physical, chemical and biological parameters of the environment to establish baseline conditions upon which possible adverse effects of the station can be evaluated.

2. The applicant will submit to the regulatory staff (staff) a proposed plan for an operational environmental monitoring program. Staff approval of this plan will be obtained prior to the granting of an operating license.

3. The applicant shall select, design and construct the transmission lines in accordance with appropriate Federal guidelines.

4. The applicant shall use appropriate federal and state guidelines and regulations in matters concerning sanitation in recreational areas to be constructed as part of this project.

5. The applicant shall establish a radiation monitoring system to determine the radioiodine concentration at the site boundary, to insure that the 5 mrem/yr dosage to the 2-gram thyroid organ of a child through the pasture-cow-milk pathway will not be exceeded.

6. The applicant shall file an amendment to its application for the Virgil C. Summer Station requesting approval of an alternate method of cooling the reactor if the Monticello Reservoir is not created; such amendment shall include complete details of the environmental impact of the alternate cooling method, and details of feasible alternatives thereto.

3. The permit is subject to the limitation that a license authorizing operation of the facility will not be issued by the Commission unless (a) the applicant submits to the Commission, by filing an application for an operating license or by amendment to the application for a license to construct and operate the facility, a complete final safety analysis report, portions of which may be submitted and evaluated from time to time; (b) the Commission finds that the final design provides reasonable assurance that the health and safety of the public will not be endangered by the operation of the facility in accordance with procedures approved by it in connection with the issuance of said license; and (c) the applicant submits proof of financial protection and the execution of an indemnity agreement as required by Section 170 of the Act.

FOR THE ATOMIC ENERGY COMMISSION

/S/

A. Giambusso, Deputy Director
for Reactor Projects
Directorate of Licensing

Date of Issuance: MAR 21 1973

South Carolina Department of Archives and History
1430 Senate Street
Columbia, S.C.

P. O. Box 11,188
Capitol Station 29211

June 1, 1972

Mr. W. E. Moore
Senior Engineer
South Carolina Electric & Gas Co.
P.O. Box 764
Columbia, South Carolina 29218

Dear Mr. Moore:

This letter is in reference to the South Carolina Electric & Gas Company's proposed Parr Hydroelectric Project (No. 1894) in Fairfield County.

The site of the nuclear station and the proposed area to be included in the man-made lakes has been checked with the South Carolina Department of Archives and History and the Fairfield County Historical Commission. We have determined that no adverse effects to historic properties in the area will result from the project as explained to us in the fall of 1971.

The only historically or architecturally important places recorded by us from this area are the Davis Plantation (on the National Register), Fonti Flora, and Monticello Church. We have been assured by SCE&G that none of these will be affected. The only historic areas of importance which will be adversely affected by the nuclear project are three cemeteries and SCE&G has agreed to move these.

The SCE&G Company has been extremely cooperative in assuring that no historic properties will be harmed by the proposed nuclear project.

Sincerely,

Charles E. Lee

Charles E. Lee
State Liaison Officer for
Historic Preservation

CEL/pn

South Carolina Department of Archives and History
1430 Senate Street
Columbia, S.C.

P. O. Box 11,188
Capitol Station 29211

October 20, 1972

Mr. Kenneth F. Plumb
Secretary
Federal Power Commission
Washington, D. C. 20426

Dear Mr. Plumb:

In reference to the new license for South Carolina Electric and Gas Company's Project No. 1894 including a proposal to construct a pumped storage development, we have determined that no adverse effects to historic properties will result from the project.

As we indicated in earlier correspondence pertaining to environmental impact of Project No. 1894, the only historically important places recorded by us in this area are the Davis Plantation (which is on the National Register of Historic Places) and two properties which are listed on our statewide survey of historic places: Fonti Flora and Monticello Church.

As South Carolina's State Liaison Officer for Historic Preservation, I appreciate the exceptionally fine cooperation of the South Carolina Electric and Gas Company in protecting the environmental quality of the project area insofar as historical aspects are concerned. Not only has SCE&G been diligent in supplying our Historic Preservation Division with the necessary statistics and map data, but the company has also been cooperative and generous in relocating and marking five small cemeteries in the area. In fact, we like to point to this particular project as a good example of coordinated planning with industry to protect environmental quality.

Sincerely,

Charles E. Lee
State Liaison Officer
for Historic Preservation

CEL:czf
CC: Environmental Protection Agency
Mr. E. L. Pressley--SCE&G
Mr. Robert Garvey--Advisory Council on Historic Preservation
Mr. George Knighton--United States Atomic Energy Commission

Appendix B

CHECKLIST OF FLORA AND FAUNA OCCURING IN THE AREA OF THE PARR HYDROELECTRIC PROJECTS -- FAIRFIELD AND NEWBERRY COUNTIES, SOUTH CAROLINA

TREES

Common Name	Scientific Name
Red Maple	*Acer rubrum*
Silver Maple	*Acer saccharinum*
River Birch	*Betula nigra*
Bitternut Hickory	*Carya cordiformis*
Mockernut Hickory	*Carya tomentosa*
Pignut Hickory	*Carya glabra*
Shagbark Hickory	*Carya ovata*
Georgia Hackberry	*Celtis tenuifolia*
Sugarberry	*Celtis laevigata*
Flowering Dogwood	*Cornus florida*
Pagoda Dogwood	*Cornus alternifolia*
Common Persimmon	*Diospyros virginia*
American Beech	*Fagus grandifolia*
White Ash	*Fraxinus americana*
Green Ash	*Fraxinus pennsylvanica*
American Holly	*Ilex opaca*
Black Walnut	*Juglans nigra*
Butternut	*Juglans cinerea*
Eastern Redcedar	*Juniperus virginiana*
Sweetgum	*Liquidambar styraciflus*
Yellow Poplar	*Liriodendron tulipifera*
Cucumbertree	*Magnolia accuminata*
Black Tupelo	*Nyssa sylvatica*

Common Name	Scientific Name
Eastern Hophornbeam	*Ostrya virginiana*
Loblolly Pine	*Pinus taeda*
Shortleaf Pine	*Pinus echinata*
Virginia Pine	*Pinus virginiana*
American Sycamore	*Platanus occidentalis*
Eastern Cottonwood	*Populus deltoides*
White Poplar	*Populus alba*
Black Cherry	*Prunus serotina*
Black Oak	*Quercus velutina*
Chestnut Oak	*Quercus prinus*
Chinkapin Oak	*Quercus muchlenbergii*
Blackjack Oak	*Quercus marilandica*
Red Oak	*Quercus rubra*
Post Oak	*Quercus stellata*
Scarlet Oak	*Quercus coccinea*
Southern Red Oak	*Quercus falcata*
Water Oak	*Quercus nigra*
White Oak	*Quercus alba*
Willow Oak	*Quercus phellos*
Overcup Oak	*Quercus lyrata*
Black Willow	*Salix nigra*
Sassafras	*Sassafras albidum*
White Basswood	*Tilia heterophylla*
American Elm	*Ulmus americana*
Slippery Elm	*Ulmus rubra*

Common Name	Scientific Name
Winged Elm	*Ulmus alata*
Red Mulberry	*Morus rubra*
Ironwood	*Carpinus caroliniana*
Pear	*Pyrus communis*
Mimosa	*Albizia julibrissin*
Honey Locust	*Gleditsia triacanthos*
Tree of Heaven	*Ailanthus altissima*
China-Berry	*Melia azedarach*
Hercules Club	*Aralia spinosa*
Sourwood	*Oxydendrum arboreum*
Pawpaw	*Asimina triloba*
Witch Hazel	*Hamamelis virginiana*

WOODY SHRUBS & VINES

Common Name	Scientific Name
Hazel-Nut	*Corylus americana*
Tag	*Alnus serrulata*
Sweet-Shrub	*Calycanthus floridus*
Mock Orange	*Philadelphus inodorus*
Briar	*Rubus sp.*
Macartney Rose	*Rosa bracteata*
Wild Rose	*Rosa carolina*
Hawthorn	*Crataegus sp.*
Juneberry	*Amelanchier canadensis*
Chickasaw Plum	*Prunus angustifolia*
American Plum	*Prunus pensylvanica*
Hog Plum	*Prunus umbellata*
Amphora	*Amphora sp.*
Clammy Locust	*Robinia viscosa*
Dwarf Sumac	*Rhus copallina*
Smooth Sumac	*Rhus glabra*
Possum Haw	*Ilex decidua*
Strawberry Bush	*Euonymus americanus*
New Jersey Tea	*Ceanothus americanus*
Buckthorn	*Rhamnus caroliniana*
Virginia Creeper	*Parthenocissus cinquefolia*
Muscadine	*Vitis rotundifolia*
Possum Grape	*Vitis baileyana*

Summer Grape	Vitis aestivalis
Silverberry	Elaegnus umbellata
Leatherwood	Pirca palustris
Swamp Dogwood	Cornus stricta
Silky-Stem Dogwood	Cornus amomum
Wild Azalea	Rhododenron canescens
Pinxter-Flower	Rhododendron atlanticum
Sparkleberry	Vaccinium arboreum
Gooseberry	Vaccinium stamineum
Elliott's Blueberry	Vaccinium elliottii
Low Bush Blueberry	Vaccinium vacillans
Southern Buckthorn	Bumelia lycioides
Storax	Styrax grandifolia
Fringe-Tree	Chionanthus virginicus
Privet	Ligustrum sinense
Yellow Jessamine	Gelsemium sempervirens
Climbing Dogbane	Trachelospermum difforme
French Mulberry	Callicarpa americana
Cross Vine	Anisostichus capreolata
Trumpet Vine	Campsis radicans
Button Bush	Cephalanthus occidentalis
Japanese Honeysuckle	Lonicera japonica
Coral Honeysuckle	Lonicera sempervirens
Blue Haw	Viburnum rufidulum
Southern Arrow-Wood	Viburnum dentatum
Elderberry	Sambucus canadensis
Grondsel-Tree	Baccharis halimifolia
Fleabane	Erigeron sp.
Horseweed	Erigeron candensis

FERNS AND MISCELLANEOUS PLANTS

Common Name	Scientific Name
Christman Fern	*Polystichum acrostichoides*
Ebony-Stem Spleenwort	*Asplenium platyneuron*
Netted Chain-Fern	*Woodwardia areolata*
Royal Fern	*Osmunda regalis*
Hairy Lip Fern	*Cheilanthes lanosa*
Bracken Fern	*Pteridium aquilinum*
Resurrection Fern	*Polypodium polypodioides*
Common Cat-Tail	*Typha latifolia*
Pondweed	*Potamogeton diversifolius*
Water Plantain	*Alisma subcordatum*
Duck Potato	*Sagittaria latifolia*

GRASSES, SEDGES, AND RUSHES

Giant Reed	*Arundo donax*
Purpletop	*Tridens flavus*
Wild Oats	*Uniola latifolia*
Love Grass	*Eragrostis hirsuta*
Quaking Grass	*Briza minor*
Cheat Grass	*Bromus secalinus*
Brome Grass	*Bromus sp.*
Blue Grass	*Poa annua*
Melic Grass	*Melica mutica*
Manna Grass	*Glyceria striata*
Fescue	*Festuca sp.*

Common Name	Scientific Name
Rye Grass	*Lolium multiflorum*
Wheat	*Triticum aestivum*
Barley	*Hordeum pusillum*
Bottlebrush Grass	*Hystrix patula*
Wild Rye Grass	*Elymus virginicus*
Wedge Grass	*Sphenopholis sp.*
Oat Grass	*Danthonia sp.*
Hairgrass	*Aira sp.*
Needle Grass	*Stipa avenacea*
Dropseed	*Sporobolus clandestinus*
Bent Grass	*Agrostis sp.*
Wood Reed	*Cinna arundinacea*
Crowfoot Grass	*Dactyloctenium aegyptium*
Goose Grass	*Eleusine indica*
Bermuda Grass	*Cynodon dactylon*
Beard Grass	*Gymnodogon ambiguous*
Canary Grass	*Phalaris caroliniana*
Foxtail Grass	*Setaria sp.*
Sandspurs	*Cenchrus incertus*
Barnyard Grass	*Echinochloa sp.*
Paspalum	*Paspalum sp.*
Crab Grass	*Digitaria sanguinalis*
Carpet Grass	*Axonopus sp.*
Panic Grass	*Panicum sp.*
Beard Grass	*Erianthus contortus*
Broom-Straw	*Andropogon sp.*

Common Name	Scientific Name
Gamma Grass	*Tripsacum dactyloides*
Umbrella Sedge	*Cyperus sp.*
Spike-Rush	*Eleocharis obtusa*
Bulbostylis	*Bulbostylis sp.*
Fimbristylis	*Fimbristylis sp.*
Bulrush	*Scirpus sp.*
Umbrella Grass	*Fuirena squarrosa*
Beak Rush	*Rhyncnospora sp.*
Sedge	*Carex sp.*
Rush	*Juncus sp.*

HERBACEOUS PLANTS

Day Flower	*Commelina sp.*
Spiderwort	*Trandescantia sp.*
Pickerelweed	*Pontederia cordata*
Asparagus	*Asparagus officinalis*
Greenbriar	*Similax sp.*
Trillium	*Trillium catesbaei*
False Solmon's Seal	*Smilacina racemosa*
Solomon's Seal	*Polygonatum biflorum*
Bear Grass	*Yucca filamentosa*
Blazing Star	*Chamaelirium luteum*
Grape Hyacinth	*Muscari racemosum*
Daylily	*Hemerocallis fulya*
Bellwort	*Uvularia perfoliata*
Wild Onion	*Allium sp.*
Wild Yam	*Dioscorea villosa*

Common Name	Scientific Name
Atamasco Lily	*Zephryanthes atamasco*
Agave	*Agave virginica*
Blackberry Lily	*Belamcanda chinensis*
Blue-Eyed Grass	*Sisyrinchium sp.*
Yellow-Fringed Orchid	*Habenaria cristata*
Crane-Fly Orchid	*Tipularia discolor*
Lizard's Tail	*Saururus cernuus*
Wood-Nettle	*Laportea canadensis*
False Nettle	*Boehmeria cylindrica*
Birthwort	*Aristolochia serpentaria*
Wild Ginger	*Hexastylis arifolia*
Dock	*Rumex sp.*
Knotweed	*Polygonum sp.*
Lamb's Quarters	*Chenopodium album*
Pigweed	*Amaranthus hybridus*
Thorny Amaranthus	*Amaranthus spinosus*
Cottonweed	*Froelichia floridana*
Poke	*Phytolacca americana*
Carpet-Weed	*Mullugo verticillata*
Talinum	*Talinum teretifolium*
Scleranthus	*Scleranthus annus*
Stipulicida	*Stipulicida setacea*
Chickweed	*Stellaria sp.*
Mouse-Ear Chickweek	*Cerastium holosteoides*
Pearl Wort	*Sagina decumbens*

Common Name	Scientific Name
Sandwart	*Arenaria serpyllifolia*
Pink	*Dianthus armeria*
Corn-Cockle	*Agrostemma githago*
Soapwort	*Saponaria officinalis*
Sleepy Cathfly	*Silene antirrhia*
Wild Pink	*Silene caroliniana*
Larkspur	*Delphinium ajacis*
Leather-Flower	*Clematis viorna*
Windflower	*Thalictrum thalictroides*
Meadow Rue	*Thalictrum revolutum*
Mouse-Tail	*Myosurus minimus*
Buttercup	*Ranunculus sp.*
Round-Lobed Liverleaf	*Hepatica americana*
Anemone	*Anemone lancifolia*
May-Apple	*Podophyllum peltatum*
Coralbeads	*Cocculus carolinus*
Bloodroot	*Sanguinaria canadensis*
Drapa	*Drapa brachycarpa*
Whitlow-Grass	*Drapa verna*
Poor-Man's Pepper	*Lepidium virginicum*
Wart-Cress	*Coronopus didymus*
Shepherd's Purse	*Capsella bursa-pastoris*
Mouse-Ear Cress	*Arabidopsis thaliana*
Hedge Mustard	*Sisymbrium officinale*
Winter Cress	*Barbarea verna*
Bitter Cress	*Cardamine hirsuta*

Common Name	Scientific Name
Sibara	*Sibara virginica*
Rock-Cress	*Arabis canadensis*
Stonecrop	*Sedum pusillum*
Ditch Stonecrop	*Penthorum sedoides*
Alumroot	*Heuchera americana*
Foamflower	*Tiarella cordifolia*
Strawberry	*Fragaria virginiana*
Cinquefoils	*Potentilla sp.*
Geum	*Geum sp.*
Cocklebur	*Agrimonia rostellata*
Sicklepod	*Cassia obtusifolia*
Wild Sensitive Plant	*Cassia nictitans*
False Indigo	*Baptisia sp.*
Rattleboxs	*Crotalaria sp.*
Clover	*Trifolium sp.*
Sour Clover	*Melilotus indica*
Alfalfa	*Medicago sativa*
Black Medic	*Medicago lupulina*
Spotted Medic	*Medicago arabica*
Lotus	*Lotus helleri*
Samson Snakeroot	*Psoralea psoralioides*
Pencil Flower	*Stylosanthes biflora*
Beggar's Ticks	*Desmodium sp.*
Lespedezas	*Lespedeza sp.*
Glottidium	*Glottidium vesicarium*
Wisteria	*Wisteria sinensis*

Common Name	Scientific Name
Goat's Rue	*Tephrosia sp.*
Vetchs	*Vicia sp.*
Vetchling	*Lathryrus hirsutus*
Everlasting Pea	*Lathryrus latifolius*
Butterfly Pea	(*Centrosema virginianum* (*Clitoria mariana*
Rhynchosia	*Rhynchosia sp.*
Wild Bean	*Strophostyles umbellata*
Kudzu	*Pueraria lobata*
Milk Pea	*Galactia sp.*
Flax	*Linum virginianum*
Wood Sorrel	*Oxalis sp.*
Wild Geranium	*Geranium sp.*
Polygala	*Polygala sp.*
Croton	*Croton glandulosus*
Hogwort	*Croton capitatus*
Three-Seeded Mercury	*Acalypha sp.*
Tragia	*Tragia urticifolia*
Flowering Spurges	*Euphorbia sp.*
Spotted Touch-Me-Not	*Impatiens capensis*
Modiola	*Modiola caroliniana*
Mallow	*Sida rhombifolia*
Rose Mallow	*Hibiscus moscheutos*
St. Andrew's Cross	*Hypericum hypericoides*
Pineweed	*Hypericum sp.*
Pin-Weed	*Lechea sp.*
Violet	*Viola sp.*

Common Name	Scientific Name
Maypops	*Passiflora incarnata*
Prickly Pear	*Opuntia compressa*
Meadow Beauty	*Rhexia mariana*
Ludwigia	*Ludwigia sp.*
Evening Primose	*Oenothera sp.*
Parrot-Feather	*Myriophyllum brasiliense*
Marsh Pennywort	*Hydrocotyle sp.*
Snakeroot	*Sanicula sp.*
Wild Carrot	*Daucus sp.*
Wild Chervil	*Chaerophyllum tainturieri*
Golden Alexander	*Taenidia integerrima*
Zizia	*Zizia sp.*
Meadow Parsnip	*Thaspium barbinode*
Marsh Parsley	*Apium leptophyllum*
Spermolepis	*Spermolepis divaricata*
Lovage	*Ligusticum canadense*
Water Hemlock	*Cicuta maculata*
Mock Bishop's-Weed	*Ptilimnium capillaceum*
Angelica	*Angelica venenosa*
Spotted Wintergreen	*Chimaphila maculata*
Fringed Loosestrife	*Lysimachia sp.*
Water Pimpernel	*Samolus parviflorus*
Indian Pink	*Spigelia marilandica*
Polypremum	*Polypremum procumbens*
Rose Pink	*Sabtia angularis*

Common Name	Scientific Name
Blue Star	*Amsonia tabernaemontana*
Indian Hemp	*Apocynum canabinum*
Butterflyweed	*Asclepias tuberosa*
Milkweed	*Asclepias sp.*
Matelea	*Matelea sp.*
Dodder	*Cuscuta pentagona*
Field Dodder	*Cuscuta campestris*
Dichondra	*Dichondra carolinensis*
Morning Glory	*Ipomoea sp.*
Man Root	*Ipomoea pandurata*
Phlox	*Phlox sp.*
Heliotrope	*Heliotropium amplexicaule*
Viper's Blugloss	*Echium vulgare*
Vervain	*Verbena sp.*
Blue Curls	*Trichostema dichotomum*
American Germander	*Teucrium canadense*
Skullcap	*Scutellaria sp.*
Heal-All	*Prunella vulgaris*
Henbit	*Lamium amplexicaule*
Lyre-Leaved Sage	*Salvia lyrata*
Blue Sage	*Salvia azurea*
Downy Wood Mint	*Blephilia ciliata*
Mountain Mint	*Pycnanthemum tenuifolium*
Common Dittany	*Cunila origanoides*
Bugleweed	(*Lycopus virginicus* (*Lycopus rubellus*

Common Name	Scientific Name
Peppermint	*Mentha piperita*
Ground Cherry	*Physalis sp.*
Salpichroa	*Salpichroa origanifolia*
Horse-Nettle	*Solanum carolinense*
Jimsonweed	*Datura stramonium*
Petunia	*Petunia atkinsiana*
Hedge Hyssop	*Gratiola virginiana*
False Pimpernel	*Lindernia dubia*
Monkey-Flower	*Mimulus ringens*
Mullein	*Verbascum sp.*
Toad-Flax	*Linaria canadensis*
Veronica	*Veronica arvensis*
Aureolaria	*Aureolaria virginica*
Gerardia	*Agalinis sp.*
Ruellia	*Ruellia sp.*
Plantain	*Plantago sp.*
Buttonweed	*Diodia sp.*
Richardia	*Richardia brasiliensis*
Partridge Berry	*Mitchella repens*
Bluets	*Hudstonia sp.*
Field Madder	*Sherardia arvensis*
Bedstraw	*Galium sp.*
Corn Salad	*Valerianella radiata*
Creeping Cucumber	*Melothria pendula*
Venus Looking Glass	*Specularia perfoliata*

Common Name	Scientific Name
Cardinal Flower	*Lobelia cardinalis*
Lobelia	*Lobelia sp.*
Common Ragweed	*Ambrosia artemisifolia*
Cocklebur	*Xanthium strumarium*
Gall-Of-The-Earth	*Prenanthes serpentaria*
Prickly Lettuce	*Lactuca sp.*
Spiny-Leaved Sow Thistle	*Sonchus asper*
Common Sow Thistle	*Sonchus oleraceus*
Rattlesnake-Weed	*Hieracium venosum*
Hawkweed	*Hieracium gronovii*
Hawk's-Beard	*Crepis pulchra*
Cat's Ear	*Hypochoeris sp.*
Dwarf Dandelion	*Krigia sp.*
False Dandelion	*Pyrrhopappus carolinianus*
Pale Indian Plantain	*Cacalia atriplicifolia*
Butterweed	*Senecio glabellus*
Groundsel	*Senecio smallii*
Fireweed	*Erechites hieracifolia*
Bachelor's Button	*Centaurea cyanus*
Bull Thistle	*Carduus lanceclatus*
Yellow Thistle	*Carduus spinopissimus*
Thistle	*Carduus repandus*
Ironweed	*Veronia sp.*
Elephant's Foot	*Elephantopus sp.*
Blazing Star	*Liatris sp.*

Common Name	Scientific Name
Thoroughwort	Eupatorium dubium
Joe-Pye Weed	Eupatorium fistulosum
Thoroughworts	Eupatorium sp.
Climbing Hempweed	Mikania scandens
Marsh Fleabane	Pulchea camphorata
Facelis	Facelis retusa
Pussy-Toes	Antennaria plantaginifolia
Rabbit Tobacco	Gnaphalium obtusifolium
Catfoot	Gnaphalium purpureum
Asters	Aster sp.
Goldenrod	Solidago sp.
Camphorweed	Heterotheca sp.
Green and Gold	Chrysogonum virginianum
Wild Quinine	Parthenium integrifolium
Yerba-De-Tajo	Eclipta alba
Coneflower	Rudbeckia fulgida
Black-Eyed Susan	Rudbeckia hirta
Sunflower	Helianthus sp.
Jerusalem Artichoke	Helianthus tuberosus
Crown-Beard	Verbesina occidentalis
Calliopsis	Coreopsis tinctoria
Beggar's Ticks	Bidens frondosa
Sneeze Weed	Helenium sp.
Bitter Weed	Helenium amarum
Yarrow	Achillea millefolium
Dog Fennel	Anthemis sp.
Ox-Eye Daisy	Chrysanthemum leucanthemum

WATERFOWL

Common Name	Scientific Name
Common Loon	*Gavia immer*
Red-necked Grebe	*Podiceps grisegena*
Least Grebe	*Podiceps dominicus*
Mallard	*Anas plalyrhinchos*
Black Duck	*Anas rubripes*
Pintail	*Anas acuta*
Gadwall	*Anas strepera*
American Widgeon	*Mareca americanus*
Shoveler	*Spatula clypseata*
Blue-winged Teal	*Anas discors*
Green-winged Teal	*Anas carolinensis*
Wood Duck	*Aix sponsa*
Redhead	*Aythya americana*
Canvasback	*Aythya valisineria*
Ring-necked Duck	*Aythya collaris*
Greater Scaup	*Aythya morila*
Lesser Scaup	*Aythya affinis*
Common Goldeneye	*Bucephala changula*
Bufflehead	*Bucephala albeola*
Ruddy Duck	*Oxyura jamaicensis*

Red-breasted Merganser	Mergus serrator
Hooded Merganser	Lophodytes cucullatus

RAPTORS

Turkey Vulture	Cathartes aura
Black Vulture	Coragyps atratus
Cooper's Hawk	Accipiter cooperii
Sharp-shinned Hawk	Accipiter striatus
Maesh Hawk	Circus cyaneus
Red-tailed Hawk	Buteo jamaicensis
Red-shouldered Hawk	Buteo lineatus
Broad-winged Hawk	Buteo platypterus
Golden Eagle	Aquila chrysaetos
Bald Eagle	Haliaeetus leucocephalus
Osprey	Pandion haliaetus
Merlin	Falco columbarius
Kestrel	Falco sparverius
Bobwhite	Colinus virginianus
Screech Owl	Otus asio
Great Horned Owl	Bubo virginianus
Longed-eared Owl	Asio otus
Short-eared Owl	Asio flammeus
Barn Owl	Tyto alba
Barred Owl	Strix varia

Saw-whet Owl	*Aegolis acadicus*

SHORE BIRDS

Common Egret	*Casmerodius albus*
Cattle Egret	*Bubulcus ibis*
Great Blue Heron	*Ardea herodias*
Green Heron	*Butorides virescens*
Black-capped Night Heron	*Nycticorax nycticoras*
American Bittern	*Botarus lentiginosus*
Least Bittern	*Ixobrychus exilis*
Sora	*Porzana carolina*
Yellow Rail	*Coturnicops noveboracensis*
Black Rail	*Laterallus jamaicensis*
King Rail	*Rallus elegans*
Common Gallinule	*Gallinula chloropus*
American Coot	*Fulica americana*
Turkey	*Meleagus gallopavo*
Black-bellied Plover	*Squatarola squatarola*
Semipalmated Plover	*Charadrius semipalmatus*
Kildeer	*Charadrius vociferus*
Upland Plover	*Bartramia longicauda*
Solitary Sandpiper	*Tringa solitaria*
Spotted Sandpiper	*Actitis macularia*

Greater Yellowlegs	Totanus melanoleucus
Lesser Yellowlegs	Totanus flaviceps
Stilt Sandpiper	Micropalama himantopus
Short-billed Dowitcher	Limnodromus griseus
Long-billed Dowitcher	Limnodromus scolopaceus
Ruddy Turnstone	Arenaica interpres
Pectoral Sandpiper	Erolia melanotos
Dunlin	Erolia alpina
Sanderling	Crocethia alba
White-rumped Sandpiper	Erolia fuscicollis
Least Sandpiper	Ereunets pusillus
Western Sandpiper	Ereunetes mauri
American Woodcock	Philohela minor
Common Snipe	Capella gallinago
Herring Gull	Larus argentatus
Ring-billed Gull	Larus delawarensis
Bonaparte's Gull	Larus philodelphia
Common Tern	Sterna hirundo
Caspian Tern	Hydroprogne caspia
Black Tern	Chlidonias niger

PASSERINES

Rock Dove	Columba livia
Mourning Dove	Zenaidura macroura

Eastern Wood Pewee	Contopus virens
Horned Lark	Eremophila alpestris
Barn Swallow	Hirundo rustica
Cave Swallow	Petrochelidon fulva
Tree Swallow	Iridoprocne bicolor
Bank Swallow	Riparia riparia
Rough-winged Swallow	Stelgidopteryx ruficollis
Purple Martin	Progne subis
Blue Jay	Cyanocitta cristate
Common Crow	Corvus brachyrhynchos
Carolina Chickadee	Parus carolinensis
Tufted Titmouse	Parus bicolor
White-breasted Nuthatch	Sitta carolinensis
Red-breasted Nuthatch	Sitta canadensis
Brown-headed Nuthatch	Sitta pusilla
Brown Creeper	Certhia familiaris
House Wren	Troglodytes aedon
Carolina Wren	Thyothorus ludovicianus
Long-billed Marsh Wren	Telmatodytes palustris
Short-billed Marsh Wren	Cistothorus platensis
Mockingbird	Mimus polyglottos
Catbird	Dumetella carolinensis

Yellow-billed Cuckoo	Coccyzus americanus
Black-billed Cuckoo	Coccyzus erythropthalmus
Chuck-will's-Widow	Caprimulgus carolinensis
Whip-poor-will	Caprimulgus vociferus
Common Nighthawk	Chordeiles minor
Chimney Swift	Chaetura pelagica
Ruby-throated Hummingbird	Archilochus colubris
Belted Kingfisher	Megaceryle alcyon
Yellow-shafted Flicker	Colaptes auratus
Pileated Woodpecker	Dryocopus pileatus
Red-bellied Woodpecker	Centurus carolinus
Red-headed Woodpecker	Melanerpes erythrocephalus
Yellow-bellied Sapsucker	Sphyrapicus varius
Hairy Woodpecker	Dendrocpus villosus
Downy Woodpecker	Dendrocpus pubescens
Eastern Kingbird	Tyrannus tyrannus
Great Created Flycatcher	Myiarchus crinitus
Eastern Phoebe	Sayornis phoebe
Yellow-bellied Flycatcher	Empidomas flaviventris
Acadian Flycatcher	Empidomax virescens
Traill's Flycatcher	Empidomas trailii
Least Flycatcher	Empidomax minimus

Brown Thrasher	Torostoma rufum
Robin	Turdus migratorius
Wood Thrush	Hylocichla mustelina
Hermit Thrush	Hylocichla guttata
Swainson's Thrush	Hylocichla guttata
Gray-cheeked Thrush	Hylocichla minima
Veery	Hylocichla fuscescens
Eastern Bluebird	Sialia sialis
Golden-crowned Kinglet	Regulus satropa
Ruby-crowned Kinglet	Regulus colendula
Water Pipit	Anthus spinoletta
Cedar Waxwing	Bombycilla cedrorum
Loggerhead Shrike	Lanius ludovicianus
Starling	Sturnus vulgaris
Solitary Vireo	Vireo solitarius
White-eyed Vireo	Vireo griseus
Yellow-throated Vireo	Vireo flavifrons
Red-eyed Vireo	Vireo olivaceous
Warbling Vireo	Vireo gilvus
Black-and-white Warbler	Mniotilta varia
Prothonotary Warbler	Protonatoria citrea
Tennessee Warbler	Vermivora peregrina

Wilson's Warbler	Wilsonia pusilla
Canada Warbler	Wilsonia canadensis
American Redstart	Setophago ruticilla
House Sparrow	Passer domesticus
Bobolink	Dolichonyx oryzivorus
Eastern Meadowlark	Sturrella magna
Tricolored Blackbird	Agelaius tricolor
Rusty Blackbird	Euphagus carolinus
Common Grackle	Quiscalus quiscala
Brown-headed Cowbird	Malothrus ater
Orchard Oriole	Icterus spurius
Baltimore Oriole	Icterus galbula
Scarlet Tanager	Pironga olivacea
Summer Tanager	Pironga rubra
Cardinal	Richmondena cardinalis
Evening Grossbeak	Hesperiphona vespertina
Rose-breasted Grosbeak	Pheucticus ludovicianus
Blue Grossbeak	Guiraca caerulea
Indigo Bunting	Passerina cyanea
Purple Finch	Carpodacus purpureus
American Goldfinch	Spinus tristis
Rufous-sided Towhee	Pipilo erythrophthalmus

Nashville Warbler	Vermivora rufiscapilla
Parula Warbler	Parula americana
Yellow Warbler	Dendroica petechia
Myrtle Warbler	Dendroica coronata
Black-throated Green Warbler	Dendroica virens
Black-throated Blue Warbler	Dendroica caerulescens
Yellow-throated Warbler	Dendroica dominica
Chestnut-sided Warbler	Dendroica pensylvanica
Bay-brested Warbler	Dendroica castanea
Blackpoll Warbler	Dendroica striata
Pine Warbler	Dendroica pinus
Prairie Warbler	Dendroica discolor
Palm Warbler	Dendroica palmarum
Yellowthroat	Geothlypis trichas
Yellow-breasted Chat	Icteria virens
Ovenbird	Seiurus aurocapillus
Northern Water Thrush	Seiurus noveboracensis
Louisiana Waterthrush	Seiurus motacilla
Kentucky Warbler	Opornis formosis
Mourning Warbler	Opornis philadelphia
Hooded Warbler	Wilsonia citrina
Connecticut Warbler	Opornis agilis

Savannah Sparrow	*Passerculus sandwichensis*
Grasshopper Sparrow	*Ammodromus survannarum*
Henslow's Sparrow	*Passerherbulus henslowii*
LeConte's Sparrow	*Passerherbulus caudacutus*
Sharp-tailed Sparrow	*Ammospiza caudacuta*
Vesper Sparrow	*Pooecetes gramineus*
Slate-colored Junco	*Junco hyemalis*
Chipping Sparrow	*Spizella passerina*
Field Sparrow	*Spizella pusilla*
White-crowned Sparrow	*Zonotrichia leucophrys*
White-throated Sparrow	*Zonotrichia albicollis*
Fox Sparrow	*Passerella iliaca*
Swamp Sparrow	*Melospiza georgiana*
Song Sparrow	*Melospiza melodia*

AMPHIBIANS

Common Name	Scientific Name
Narrow-Mouthed Toad	*Gastrophryne carolinensis*
Eastern Spadefoot Toad	*Scaphiopus holbrooki*
Oak Toad	*Bufo quercicus*
Southern Toad	*Bufo terrestris*
Woodhouse's Toad	*Bufo woodhousei*
Common Treefrog	*Hyla versicolor*
Spring Peeper	*Hyla crucifer*
Green Treefrog	*Hyla cinerea*
Barking Treefrog	*Hyla gratiosa*
Squirrel Treefrog	*Hyla squirella*
Piney Woods Treefrog	*Hyla femoralis*
Southern Cricket Frog	*Acris gryllus*
Northern Cricket Frog	*Acris crepitans*
Least Treefrog	*Limnaoedus ocularis*
Brimley's Chorus Frog	*Pseudacris brimleyi*
Chorus Frog	*Pseudacris nigrita*
Ornate Chorus Frog	*Pseudacris ornata*
Green Frog	*Rana clamitans*
Pickerel Frog	*Rana palustris*
Leopard Frog	*Rana pipiens*
Crawfish Frog	*Rana areolata*
Carpenter Frog	*Rana virgatipes*
Bull Frog	*Rana catesbeiana*
River Frog	*Rana heckscheri*

Greater Siren	Siren lacertikla
Lesser Siren	Siren intermedia
Amphiuma	Amphiuma means
Dwarf Waterdog	Necturus punctatus
Newt	Notophthalmus viridescens
Marbled Salamander	Ambystoma opacum
Spotted Salamander	Ambystoma maculatum
Dusky Salamander	Desmognathus fuscus
Four-Toed Salamander	Hemidactylium scutatum
Dwarf Four-Toed Salamander	Eurycea quadridigitatus
Mud Salamander	Pseudotrion montanus
Two-Lined Salamander	Eurycea bislineata
Long-Tailed Salamander	Eurycea longicauda
Slimy Salamander	Plethodon glutinosus

REPTILES

Spiny Softshell Turtle	Trionyx spinifer
Mud Turtle	Kinosternon subrubrum
Stinkpot	Sternotherus oporatus
Box Turtle	Terrapene carolina
Spotted Turtle	Clemmys guttata
Painted Turtle	Chrysemys picta
Pond Sliper	Chrysemys scripta
River Cooter	Chrysemys concinna
Slender Glass Lizard	Ophisaurus attenuatus
Ground Skink	Scincella laterale
Southeartern Five-Lined Skink	Eumeces inexpectatus

Broad-Headed Skink	Eumeces laticeps
Five-Lined Skink	Eumeces fasciatus
Green Anole	Anolis carolinensis
Eastern Fence Lizard	Sceloporus undulatus
Six-Lined Racerunner	Cnemidophorus sexlineatus
Pigmy Rattlesnake	Sistrurus miliaris
Timber Rattlesnake	Crotalus horridus
Pine Snake	Pituophis melanoleucas
Ribbon Snake	Thamnophis sauricus
Garter Snake	Thamnophis sirtalis
Scarlet Snake	Cemophora coccinea
Common Kingsnake	Lampropeltis getulus
Milk Snake	Lampropeltis triangulum
Prairie Kingsnake	Lampropeltis calligaster
Crowned Snake	Tantilla coronata
Red-Bellied Snake	Storeria occipitomaculata
Brown Snake	Storeria dekayi
Worm Snake	Carphophis amoenus
Rough Earth Snake	Virginia striatula
Smooth Earth Snake	Virginia valeriae
Eastern Hognose Snake	Heterodon platyrhinos
Southern Hognose Snake	Heterodon simus
Rough Green Snake	Opheodrys aestivus
Queen Snake	Regina septemvittata
Brown Water Snake	Natrix taxispilota
Common Water Snake	Natrix sipedon

Coachwhip	*Masticophis flagellum*
Black Racer	*Coluber constrictor*
Corn Snake	*Elaphe guttata*
Black Rat Snake	*Elaphe obsoleta*
Eastern Ringneck Snake	*Diadophis punctatus*

MAMMALS

Common Name	Scientific Name
Common Opossum	*Didelphis marsupialis*
Whitetail Deer	*Odocoileus virginianus*
Eastern Cottontail	*Sylvilagus floridanus*
Marsh Rabbit	*Sylvilagus palustris*
Common Mole	*Scalopus aquaticus*
Short-Tailed Shrew	*Blarina brevicauda*
Least Shrew	*Cryptotis parva*
Long-Nosed Shrew	*Sorex longirostris*
Gray Fox	*Urocyon cinereoargenteus*
Red Fox	*Vulpes fulva*
Raccoon	*Procyon lotor*
Bobcat	*Lynx rufus*
Common Striped Skunk	*Mephitis mephitis*
River Otter	*Lutra canadensis*
Mink	*Mustela vison*
Long-Tailed Weasel	*Mustela frenata*
Hoary Bat	*Lasiurus cinereus*
Red Bat	*Lasiurus borealis*
Seminole Bat	*Lasiurus seminola*
Evening Bat	*Nycticeius humeralis*
Big Brown Bat	*Eptesicus fuscus*
Rafinesque's Big-Eared Bat	*Plecotus rafinesquii*
Silver-Haired Bat	*Lasionycteris noctivagans*
Eastern Pipistrelle	*Pipistrellus subflavus*

Keen's Bat	*Myotis keenii*
Little Brown Bat	*Myotis lucifugus*
Woodchuck	*Marmota monax*
Southern Flying Squirrel	*Glaucomys volans*
Eastern Chipmunk	*Tamias striatus*
Eastern Fox Squirrel	*Sciurus niger*
Eastern Gray Squirrel	*Sciurus carolinensis*
Beaver	*Castor canadensis*
Meadow Jumping Mouse	*Zapus hudsonicus*
House Mouse	*Mus musculus*
Norway Rat	*Rattus norvegicus*
Eastern Harvest Mouse	*Reithrodontomys humulis*
Common Cotton Rat	*Sigmodon hispidus*
Eastern Rice Rat	*Oryzomys palustris*
Golden Mouse	*Ochrotomys nuttalli*
Beach Mouse	*Peromyscus polionotus*
Wood Mouse	*Peromyscus leucopus*
Muskrat	*Ondatra zibethicus*
Pine Vole	*Microtus pinetorum*
Meadow Vole	*Microtus pennsylvanicus*
Bear	*Ursus americanus*

FISH OF PARR RESERVOIR

Common Name	Scientific Name
Largemouth Bass	*Micropterus salmoides*
White Crappie	*Poxomis annularis*
Redear Sunfish	*Lepomis microlophus*
Pumpkinseed Sunfish	*Lepomis gibbosus*
Warmouth Sunfish	*Lepomis gulosus*
Bluegill Sunfish	*Lepomis machrochirus*
Redbreasted Sunfish	*Lepomis auritus*
Longear Sunfish	*Lepomis megalotis*
Black Crappie	*Pomoxis nigromaculatus*
White Bass	*Morone chrysops*
Green Sunfish	*Lepomis cyanellus*
White Catfish	*Ictalurus catus*
Yellow Bullhead	*Ictalurus natalis*
Channel Catfish	*Ictalurus punctatus*
Flat Bullhead	*Ictalurus platycephalus*
Brown Bullhead	*Ictalurus nebulosus*
Madtom	*Noturus leptacanthus*
Carpsucker	*Carpiodes carpio*
Quillback Carpsucker	*Carpiodes cyprinus*
White Sucker	*Catostomus commersoni*
Spotted Sucker	*Minytrema melanops*
Carp	*Cyprinus carpio*
Spotfin Shiner	*Notropis spilopterus*

Common Name	Scientific Name
Golden Shiner	*Notemigonus crysoleucas*
Darter	*Etheostoma sp*
Longnose Gar	*Lepisosteus osseus*
Gizzard Shad	*Dorosoma cepedianum*
American Eel	*Anguilla rostrata*

APPENDIX C

EXHIBIT V OF SCE&G's APPLICATION FOR LICENSE, NATURAL, AND SCENIC VALUES AND RESOURCES

The construction and operation of Fairfield Facility will effect the environment in several ways. Building of the Facility structures and systems and subsequent operation will have a local impact on those natural, historic, and scenic values and resources within the project area, including natural scenery and wildlife habitat, old cemeteries, and archeological sites. SCE&G will take steps to minimize the impact of the project construction and operation as explained in the following paragraphs.

Many people feel that an undisturbed natural landscape possesses beauty and, thus, is aesthetically pleasing. At the same time, most people are aware of the human comforts that are made available to them through the generation of electrical energy. Ultimately, certain environmental effects must be accepted as unavoidable in the provision of electrical energy. It is emphasized that all effects are not necessarily adverse; and that those which are adverse will be minimized to the extent feasible. Furthermore, programs to monitor effects on the environment and management of land resources to minimize and offset adverse impact and to improve existing resource conditions will be undertaken as outlined in Section 2.2.5.3 of the Environmental Report.

The proposed Fairfield Pumped Storage Facility will be located on Frees Creek in Fairfield County, in an area which is sparsely populated, and which is not easily accessible to the public. The Fairfield Powerhouse, as shown on the following page, is designed to contrast pleasantly with and to complement the natural surroundings. Both the powerhouse and the penstocks present sleek, low-profile lines, and nestle into the surrounding hillsides with few visible protrusions. The long, straight line of the penstocks leads the eye up and away from the powerhouse and into the nearby hills.

The Fairfield Powerhouse will remain the color of natural concrete. The penstocks will be painted a color aesthetically compatible with the natural surroundings. The necessary outstanding features, such as cranes and generator covers, will be painted green and brown to harmonize with local natural colors. Landscaping and planting of the dams and areas around the powerhouse which are disturbed by construction will be as natural as possible, and will consist of trees and shrubs common to the local area. SCE&G will work with the U. S. Department of Agriculture Soil Conservation Service - Fairfield Soil and Water Conservation District to plan appropriate types of planting for all areas within the project boundary other than transmission line rights-of-way, which are covered in detail later in this exhibit. (See letter and contract at the end of Exhibit V.) Also, the irregular shorelines of Parr and Monticello Reservoirs and the general remoteness of the site will limit exposure of the facility.

The addition of bascule gates to Parr Dam will add approximately

nine feet to the height of the dam, as shown on the following page. The most significant visual change resulting from the addition of the gates will be the broadened water area behind the dam.

The impoundment of Monticello Reservoir will change the site from one of a predominantly forested, hilly view to that of a broader water view. This will have the result of creating a somewhat more expansive view due to the relective character of the impoundment surface.

Water level fluctuations in Parr Reservoir and Monticello Reservoir will periodically present some unsightly mud flats and bared shoals. The greatest water level fluctuations will occur in Parr Reservoir (about ten feet) and will expose a substantial amount of near shore bottom land. The visual impact of these exposed areas will be mitigated somewhat by the fact that the lowest water levels will occur largely at night when the Fairfield Facility is operating in the pumping mode. The impact of the exposed shoreline in Monticello Reservoir will be limited since the water level fluctuation will be on the order of four and one-half feet.

During project construction, SCE&G will require the contractor(s) to employ specific construction practices at the site, including those associated with minimizing environmental effects. Some of the measures that will be used are:

1. Soil erosion procedures: These will include such features as reducing the area and duration of exposed soils to a minimum, retaining and protecting the natural vegetation whenever possible, and installation of conduits and settling basins. A

storm water drainage system will be installed as soon as practicable.

2. Dust control: Dust control measures will consist of frequent water sprinkling of roads, parking lots and construction staging areas.

Other erosion control procedures used by SCE&G will include the development of appropriate temporary and/or permanent ground cover such as planting the downstream faces of the dams, replanting construction lay down areas, and placing rip rap on the upstream faces of the dams where support for vegetation growth is unavailable. Prior to initiating licensed project construction activities SCE&G will prepare job specifications that will include the recommended practices for soil and water conservation as advised by the Fairfield County Soil and Water Conservation District office located in Winnsboro, South Carolina.

Borrowing will take place in the cleared Monticello Reservoir area, so that when the project is completed, there will be no unsightly scars on the landscape. It is planned to dispose of dredge spoils by placement behind nearby embanked areas. After the water drains, the areas will be planted with appropriate vegetation consistent with the precepts of the Land Management Program discussed in Section 2.2.5.3 of the Environmental Report.

Construction debris which cannot be salvaged and used may be disposed of in several ways. For the trash and materials which are combustible, appropriate permits from the South Carolina Pollution Control Authority and the South Carolina Forestry Commission will be obtained. These materials will be placed in carefully constructed areas within the boundary of Monticello

Reservoir, and burned under proper supervision. Fire-fighting equipment will be available on-site. For the incombustibles the alternatives are hauling, burial,and special use. It has been SCE&G's practice to maintain "clean jobs" and, therefore, unsightly materials which have no use will either be transported to a state-approved disposal site or disposed of by burial or other appropriate means. As part of the Land Management Program an evaluation will be made to see if this debris can be used in the upper impoundment as fish habitat materials.

There are likely to be some chemicals used whose disposal will need special consideration. As on other projects of this type, pipelines and other materials may require flushing with alkaline chemical solutions. The resulting waste will be placed in a lagoon of state approved design for simultaneous neutralization. The waste products from the field coating of tanks, sandblasting materials, possible acid etching wastes and the muriatic acid wastes from concrete treatment will also be put into this holding lagoon. As required, liquid wastes will either be hauled away or mixed with neutralizing agents and covered over with earth in accordance with State regulations.

The operation of construction vehicles will result in the by-products of diesel air emissions and waste oils and gasoline, and all construction activities will create noise; however, because of the remote location and sparse population, the impact on the human environment should be minimal. There will also be possible noise and traffic congestion entering and leaving the job site, particularly at starting and quitting time; but, these effects

should be confined to the immediate locale.

Construction and operation of the Fairfield Facility will have some unavoidable adverse effects on the land and wildlife resources in the project area. To alleviate the removal of woodland habitat, plans are being developed to create and improve other woodland habitat, to set aside appropriate areas as wildlife preserves, and to establish a waterfowl management program. These are discussed in Section 2.2.5.3 of the Environmental Report. Thus, SCE&G Co. will be undertaking measures to enhance or improve upon the existing resources, where practical and compatible with the operation of the Fairfield Facility.

Transmission lines to be built in connection with the project consist of the Fairfield-Summer 230 KV tie lines (two lines) and in addition, impoundment of Monticello Reservoir will require the relocation of a portion of a 100 KV double circuit steel tower, Duke Power Company transmission line. The proposed right-of-way locations for these lines are indicated on Exhibits K-2 and K-8. Slight adjustments and modifications may be made to the locations of the proposed rights-of-way when location surveys are made.

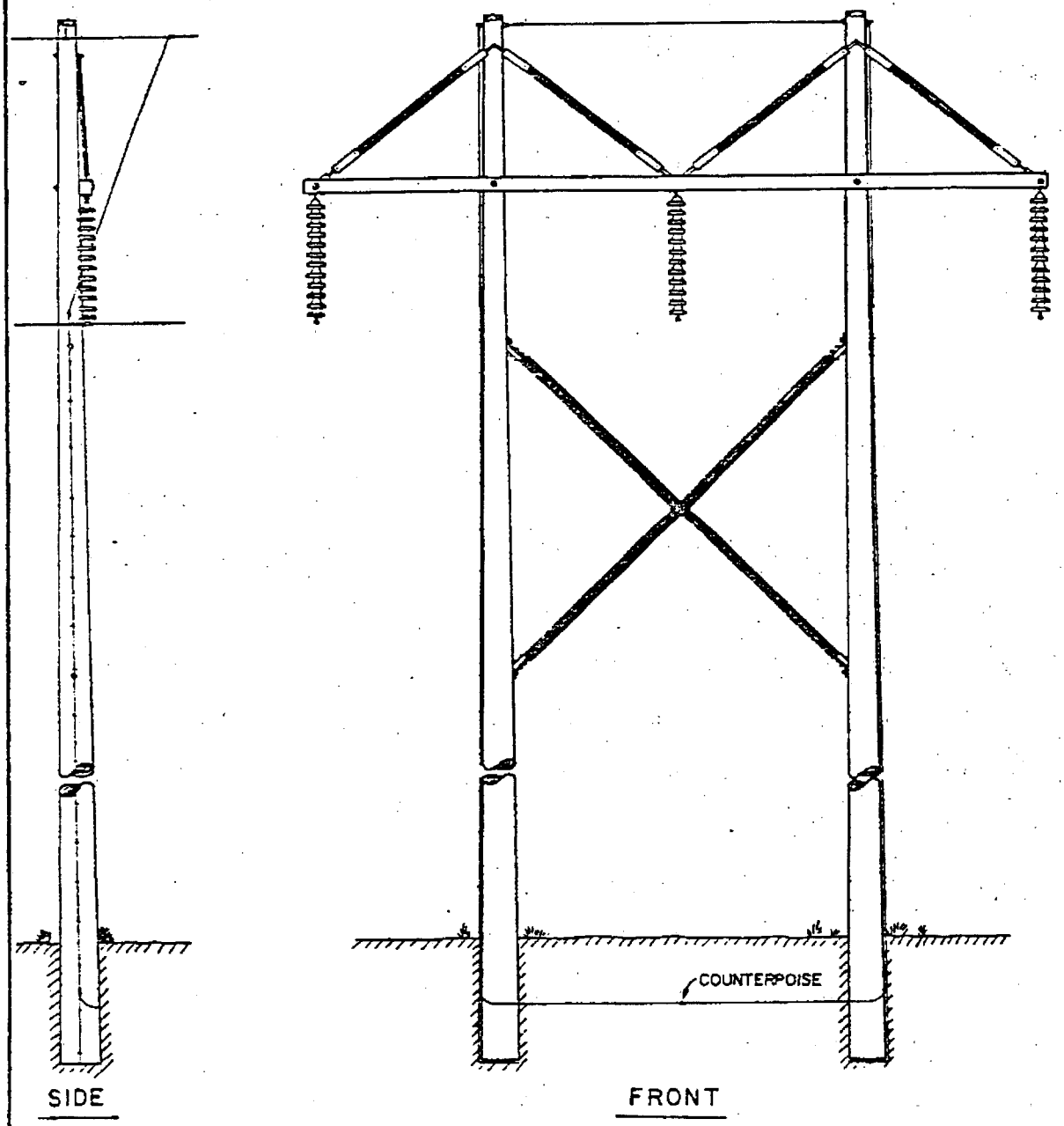
The proposed transmission lines will be constructed in a rural area which consists of hilly, rolling terrain. In Fairfield County, where these lines will be located, forest land occupies about 80% of the total land area. The next predominant lan. use is agricultural (crop land plus pasture), accounting for about 13%. Surface soils are typical of those encountered in the Piedmont region, and consists generally of stiff reddish-brown silts and clays. Maximum relief over the rights-of-way is on the order of 200 feet,

ranging from Elevation 460 feet MSL to about Elevation 260 feet MSL near Fairfield Powerhouse.

The closest towns are Jenkinsville and Monticello, which are small unincorporated rural communities. In Fairfield County, the total estimated population (1970 Census) was 19,999 with an average density of less than 30 people per square mile. No increase in population in the general area is expected in the next 40 years; in fact, a decrease is anticipated.

No parks, national forests, or designated scenic, recreational or wildlife areas are near the proposed transmission lines routes. The closest approach of Sumter National Forest to the transmission line rights-of-way is about four miles. The proposed rights-of-way do not infringe upon any national or local historic areas or landmarks. The Davis Plantation, the closest area of historical importance (listed in the National Register of Historic Places) is approximately five miles away from the closest approach of the proposed rights-of-way.

The Fairfield-Summer 230 KV lines will connect the Fairfield Pumped Storage Facility to the Virgil C. Summer Nuclear Station and will be approximately one mile in length. The structures will be of wood H-frame construction, and it is estimated that approximately 8 structures per circuit, or a total of approximately 16 structures, wi be required. A drawing of a typical tangent H-frame structure is shc on the following page. The right-of-way will be about 170 feet wide, requiring a land area of approximately 20 acres. Wood Pole structure will be about 65 to 70 feet in height. The proposed tie line will be



NO.	DATE	REVISION

DR. TC 6-19-72 DATE
CK. DATE
APP. ENG. DATE
APP. PROD. DATE
APP. TRANS. DATE
APP. DIST DATE
APP. OTHER DATE

SOUTH CAROLINA ELECTRIC & GAS CO.

FOR 230 KV S.A. TANGENT STRUCTURE

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SUPERSEDES

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constructed in a forest area entirely within the exclusion zone (approximately one mile radius) of the Virgil C. Summer Nuclear Station The land along the proposed right-of-way is owned by SCE&G. No roads are crossed by the proposed Fairfield-Summer line, and the closest residence is more than one mile away.

The existing Duke Power Company line crosses the proposed Monticello Reservoir in an approximate east-west direction starting at the north abutment of the main Frees Creek Dam, as shown on Exhibit K-2. The relocated line will start south of the north abutment and will pass on the down stream side of the main Frees Creek Dam, cross over the intake channel of the Fairfield Powerhouse, pass the Virgil C. Summer Nuclear Station on the reservoir side, cross over the access road to the nuclear station at two locations, and cross State Highways 215 and 213 before tying back into the existing line east of Highway 215. The proposed right-of-way of the relocated Duke Power line will be approximately 5 1/2 miles in length. Double-circuit lattice-type steel towers, similar to the towers on the existing line, will be utilized. There will be an average of about eight towers per mile. The right-of-way will be approximately 100 feet in width, except along the portion of the right-of-way between the Fairfield Pumped Storage Facility and the Virgil C. Summer Nuclear Station, where the Duke line will utilize the same right-of-way as the Fairfield-Summer tie line for a distance of about 2000 feet. The proposed routes of the Fairfield-Summer tie lines and Duke line relocation were selected to permit the maximum practical use of a common right-of-way. The common right-of-way will be approximately 240 feet in width. Where the Duke line relocation passes the nuclear station, the

structures will be constructed on small fingers of fill extending out from the shoreline. An estimated 60 acres of new right-of-way will be required for the relocated Duke line. The proposed structures will be on the order of 85 feet in height.

The proposed right-of-way for the relocated Duke line will be constructed in a predominantly forest area. About 50% of the proposed right-of-way will be constructed within the Virgil C. Summer Nuclear Station exclusion zone. Beyond the exclusion zone, the proposed right-of-way will pass near an estimated 15 to 20 residences; however, most of these residences will be more than a few hundred feet from the right-of-way and no residence is expected to be closer than 200 feet from the proposed right-of-way. A few small open areas will be crossed by the proposed right-of-way.

The proposed relocated line will be owned, operated and maintained by Duke Power Company. A portion of the right-of-way is on lands owned by SCE&G. Negotiations are presently underway to obtain other portions of the right-of-way.

In addition to the relocation of that part of the Duke double circuit steel tower line in the area of the Monticello Reservoir, it will be necessary to raise this line where it presently crosses the Parr Reservoir, (Broad River). The present clearance of this line over the existing reservoir level is approximately 42'. Since the level of this reservoir is to be raised approximately 9' by increasing the height of the Parr Dam, it is planned to raise the elevation of the transmission line at this crossing by 12' which will provide a clearance of approximately 45' over the new level of the reservoir. This will be accomplished by the construction of new foundations

and raising the existing steel towers at their present locations. The estimated cost of raising these two towers is $50,000.00.

The environmental impact of the proposed transmission lines on population and land use is judged to be slight. The Summer-Fairfield tie lines will be constructed in a hilly, forested area that is remote from any residences. About half of the relocated Duke line will also be constructed through an area which is remote from any residences, and the remaining portion will pass through a rural area that is generally sparsely populated. In these areas, it is planned that the proposed relocated Duke line would pass no closer than 200 feet from existing residences. The proposed lines, therefore, should have practically no effect on the residences in the area from a safety or a nuisance standpoint. Since the proposed rights-of-way will not pass through cultivated land areas, there will be no impact on agricultural activities.

It is estimated that more than 95% of the proposed rights-of-way will pass through forested areas. Forestry products represent a significant source of income (24.3% in 1969) in Fairfield County from farm marketings, but the total land area required by the rights-of-way for the proposed lines will amount to only about 0.02% of the total forested land in the county. The main effects of clearing the rights-of-way through the forested areas would be related to disturbance to a small part of the natural setting and resulting changes in wildlife habitat.

The dominant stand type in the forested land surrounding the proposed rights of way is a coniferous species, the loblolly pine. Other species found in the upland environment include the white oak, red oak, and hickory. In the lowlands and bottoms, the species foun

include cottonwood, sweetgum, nuttal oak, willow oak, and white ash.

The ground cover species include a predominance of honeysuckle and greenbriar. Dense ground cover is not abundant because of the great density of deciduous and coniferous stand types. Historically, the growth of pine and hardwood in the area is tied to the decline of cotton and grain crops in the early 1930's. The revegetation is largely a result of public revegetation programs of the WPA and CCC.

Terrestrial wildlife field surveys in the general area during 1971 and 1972 have identified or received confirmed reports of 13 species of mammals and approximately 65 species of birds. The mammals include species of shrew, mice, and rats, eastern cottontail rabbit, gray squirrel, raccoon, bobcat, and whitetail deer. The southern cougar,which had not previously been known to exist in the area, was recently sighted. The game species of most importance in the area is the deer. Mammals are more abundant in the bottomlands, areas where hardwoods or mixed conifer-hardwood associations provide a more varied habitat and food supply. The proposed transmission rights-of-way mainly traverse stands of conifers, and these routes are expected to have fewer mammals than a route through predominantly hardwoods. Results of small mammal trapline surveys in the study area have shown few rodents in conifer transects compared to mixed hardwood or cutover transects. It is expected, therefore, that carnivórous animals, such as bobcat, that may feed on the rodents would be less abundant along most of the proposed route. Bird species in the general study area include a great many of the small native song birds, migratory waterfowl, heron, dove, quail, turkey and raptors. Turkey populations have

been increasing in the Broad River area, and these birds along with quail and dove are the main species of sport interest. Since most of the transmission line route is away from the water's edge, fewer species of birds are expected along the transmission line route.

The clearing of the rights-of-way through the dense stands of pine and hardwood will provide a margin or partial firebreak for the protection of the surrounding forested areas during fire conditions. This is a beneficial impact resulting from transmission line construction.

The clearing of the proposed transmission line rights-of-way will create a margin or "edge" which will enhance production of wildlife in the general area of the rights-of-way. This enhancement takes the form of increased understory vegetation which provides a greater variety and abundance of food and cover for the wildlife than previously available. The "edge effect," in turn, increases the "carrying capacity" of the land by providing food for more animals than would otherwise be able to live in the area.

The elimination of "danger trees" (trees tall enough to potentially fall and interfere with the power lines) within close proximity to the transmission line rights-of-way, will serve to reduce the vegetative cover in addition to that removed for construction. This removal will serve to clear the margin of forest canopy adjacent to the rights-of-way and will allow more light to enter the cleared area as well as the margins of the forested area and thus effectively extend the edge effect benefits.

It is concluded that the creation of a cleared zone through the predominantly pine stands would have an overall beneficial effect with regard to the wildlife of the area. Additional measures will be taken, however, to insure that the changes brought about are of a positive nature for habitat improvement of desired species. These measures are discussed in subsequent paragraphs.

One of the most important effects on the environment due to construction of the proposed lines would be related to aesthetics. An evaluation of this impact, however, is difficult to make, even in a qualitative manner, since there obviously can be many diverse points of view depending upon an individual's background and experience. Evaluation of the aesthetic impact of transmission line construction has been based on the premise that, regardless of an individual's opinion of the transmission lines, he must first see it in order to react; that is, it must be so apparent within his range of perception that he cannot help but take note of its presence. Therefore, one method to evaluate the impact of transmission lines on aesthetics is to consider its ease of visibility from vantage points which would be ordinarily available to the largest proportion of people living in or traveling through the area. The ease with which people would be able to see the transmission lines varies with distances from the line and whether their views are screened by intervening hills, vegetation or other obstructions.

The Fairfield-Summer tie lines will be constructed in a remote forested area within the Virgil C. Summer Nuclear Station exclusion zone, away from residences and roads. Thus, the opportunities to view the line would be restricted. Along a short length of the

line, the upper portion of one or two structures may be visible from boats on Monticello Reservoir. Boating activity in the lower portion of Monticello Reservoir, however, is expected to be slight, since it is anticipated that most of the recreational activity will be in the upper portion of the reservoir or in the sub-impoundment recreational and fishing area. An area on the north side of the Frees Creek tailrace will be set aside for future recreational use (see Exhibit R-3), and it would be possible to view portions of the line from this location. It may also be possible to view portions of the transmission line from Parr Reservoir. The closest approach to the transmission lines, however, would be a few thousand feet where the tailrace enters Parr Reservoir. Present use of the reservoir for boating is very limited, however, and because of the fluctuations during operation of the pumped storage facility, recreational use of Parr Reservoir is expected to diminish. From this standpoint, the aesthetic impact of the proposed Fairfield-Summer tie lines would be minimal.

In general, there will be little opportunity for the general public to view the relocated Duke transmission line. Along that length of the line located below Frees Creek dam and running towards the nuclear station, the upper portions of certain transmission towers will likely be observable from Monticello Reservoir. Portions of the line would also be observable from the future recreational area north of the tailrace and possibly from Parr Reservoir. There would also be a possibility of viewing the relocated line where it passes near the nuclear station along the shore of the Monticello Reservoir. As previously stated,however, the number of

people viewing the line from these areas is expected to be small. Within the exclusion zone, the Duke line crosses the access road to the nuclear plant at two locations. Public travel on this road, however, is not expected to be significant.

The most significant visual impact of the relocated Duke line will be at the crossings of State Highways 215 and 213, which are light to moderately traveled two-lane roads. Steps will be taken, however, to mitigate the visual effects of the transmission line crossing, as described in a subsequent paragraph.

In evaluating alternative rights-of-way locations, selecting measures to minimize environmental impact and to provide for environmental enhancement where feasible, the criteria presented in FPC Order No. 414 and the U. S. Department of Interior and Department of Agriculture booklet, "Environmental Criteria for Electric Transmission Systems" were utilized as guides. Various alternative routes were considered for the proposed transmission rights-of-way.

The consideration of alternate routes for the location of the two tie lines from the Fairfield Pumped Storage Plant to the Summer Nuclear Station was constricted by the short length of these lines which will be approximately one mile. This short length made it impractical to consider the construction of the two lines on separate rights-of-way. Also, the location of the two lines on a common right of-way will require less total acreage and consequently will require less clearing. The locations of the terminal structures for these two lines at Fairfield and Summer have been established by the sub-station design and other construction factors. The

first route considered for these lines was a direct, straight line between the terminal structures. This route would obviously result in the shortest possible length and probably the lowest cost. Inspection of this route showed it crossed near the top of some ridges or hills where it may be visible from the reservoir. It also crossed over or near the construction areas for some of the dam sites for the Monticello Reservoir. For these reasons it was deemed unsuitable.

We next considered a route which basically followed the lowest practical contours and valleys. We selected this route to minimize the visual impact of the tie lines. This particular route, however, required approximately 5 angles and was much longer than the direct route. This would require more right-of-way and more clearing, but it would eliminate long tunnel views along the line. It would require, due to the added length, more structures and be more expensive to construct.

A third route was considered. This route was a compromise between the first and second routes. This route is located below, in so far as practical, the crests of ridges and avoids hill tops. It generally uses contours which are below the dam crests by an amount equal to or greater than the anticipated maximum structure height, therefore providing a high degree of visual screening from Monticello Reservoir Three angles are used to minimize tunnel views. The length of the lines is less than the lower route, resulting in less acreage for right-of-way and less clearing. The reduced length will also result in a lower cost and possibly fewer structures.

Underground cable was also considered. We determined that for

reliability, 3 cables would be required, two for normal operations and one for use in the event of failure on either of these two cables. The cost of the necessary switching devices and associated equipment, installed, plus the cost of the cable in place is estimated to be over 15 times the cost of the overhead lines. The route would involve a change in elevation of about 145' (from elevation 435 to elevation 290) and cross some ridges and valleys. In order to place these cables, the vegetation along the route will be cut and removed or otherwise destroyed. This, coupled with the slopes involved and the type soil in the area will result in erosion problems somewhat greater than the overhead type construction.

Due to the problem of erosion, the fact that the route must be cut through wooded land, the high costs of this method and the fact that an overhead route is in close proximity, it was decided not to use the underground construction.

After careful weighing of visual considerations, the amounts of right-of-way involved, amount and methods of clearing, costs, and proximity to other construction, the third overhead route was selected for the Fairfield-Summer 230 KV tie lines.

Alternative routes evaluated for the relocated Duke line included:

1. Construction of the relocated line in its present position.
2. Relocation of the line a maximum of 3500 feet south of the present location to utilize islands and shallow water areas.
3. Relocation of the line around the west and north side of the Monticello Reservoir.
4. Routing of the line to the south of Virgil C. Summer Nuclear Station, utilizing the existing 115 KV Parr-Midway right-of-way and the existing 115 KV Parr-Winnsboro right-of-way to the maximum extent practical.

Alternatives 1 and 2 were considered to be infeasible because of the high costs (approximately $1,800,00 for both alternates versus approximately $500,000 for the right-of-way as planned); also, construction of the line across Monticello Reservoir would result in an adverse visual impact and and an additional danger to boating. Alternative 3 would require an additional seven miles of right-of-way with an estimated total cost of $1,300,000. Furthermore, many road crossings would be made, increasing the possibilities of public viewing. For Alternative 4, the advantages gained by utilizing existing transmission line rights-of-way were more than offset by the additional distance and land required. This alternative would also necessitate crossing under nine or more transmission lines emanating from the substation of the Virgil C. Summer Nuclear Station. In evaluating alternative routes for the relocated Duke line, the proposed right-of-way was selected as representing a reasonable balance between environmental impact considerations and engineering and construction considerations. While SCE&G believes that the proposed transmission line rights-of-way are optimum solutions which minimize environmental effects, additional measures will be undertaken by the Company to further reduce environmental impact and to provide for environmental enhancement.

Since the Fairfield-Summer tie lines are in a remote, forested area, there would be little possibility of people viewing these lines Nevertheless, SCE&G plans to use wood H-frame construction for this line so that there will be maximum compatibility with the environment The generally low height of the poles (65 to 70 feet) would also provide for maximum screening. The proposed right-of-way was kept as

low as practicable on the slopes of hills to reduce visual impact.

In general, the right-of-way selected for the relocated Duke line results in screening of most of the line from the view of travelers in the area by trees, vegetation, high ground; or would usually be at a distance great enough to reduce visual impact. At the crossing of State Highways 215 and 213, where the line will most frequently be viewed, measures to reduce the visual impact will consist of a change in alignment, screen planting in the right-of-way at the road crossing or leaving in of existing vegetation to provide screening. Road crossings will also be made at low points if practicable to reduce visual impact. The proposed right-of-way has been kept as low as practicable on hillsides and well back from travelled roads (Highway 215) to provide for maximum screening.

The clearing of rights-of-ways will be performed in accordance with the guidelines contained in FPC Order #414 as completely and conscientiously as practicable. Rights-of-way clearings will be kept to the minimum width necessary to prevent interference of trees and other vegetation with the proposed transmission facilities. In scenic areas a concept of selective clearing will be followed wherever practicable, and only those trees which could cause damage to the transmission lines will be cleared. Trees and other vegetation cleared in areas of public view will be disposed of and stumps will be cut close to the ground line. Grass and other ground cover and all topsoil will be protected from damage as completely as practicable during construction. At road crossings and other special locations exposed to frequent public view, particular care will be used to allow

small trees and plants to remain in place and, if necessary or appropriate, additional plantings of suitable shrubs will be made to establish an acceptable screen on the rights-of-way. Where practicable, plantings would be arranged with taller plants along the edge of the right-of-way and successively small plants and grass toward the centerline. These procedures are expected to provide maximum erosion protection along the rights-of-way while also enhancing habitat in the area.

Access roads to the rights-of-way will be kept to a minimum. It is SCE&G's policy not to construct roads to gain access to the rights-of-way; existing roads are used to the maximum extent possible. Construction operations will be monitored by SCE&G to assure that all construction debris is removed from the rights-of-way when construction is completed. Burning of vegetation will be performed in accordance with South Carolina Pollution Control Authority standards. When temporary access roads have been constructed which are not needed for maintenance purposes, they will be obliterated and restored to the original slopes and natural ground cover replanted. No extensive cuts or fills are planned along the rights-of-way. For the most part, the rights-of-way will follow the natural ground contour; any grading which is done will conform with the terrain and adjacent land.

Members of the South Carolina State Archives and Historical Department indicated that there are three places of historical importance near the project area. (See correspondence at the end of Exhibit V.) These include two homes, Fonti Flora and the Davis Plantation, and the Monticello Church. (See Exhibit K-8.) Of these, the Davis

Plantation is listed in the National Register of Historic Places. None of the three locations will be affected by the project. The Fairfield County Historical Society mentioned the historical importance of cemeteries in the project area. There are five small, now abandoned cemeteries which will be relocated and marked in a socially acceptable manner. (See Exhibit K-8)

Dr. Robert Stephenson, State Archeologist, indicated that there are four recorded archeological sites within or near the boundary of the proposed project (See Appendix A, Environmental Report, and Exhibit K-8). This concentration of archeological sites within a small area suggests that others may be present, and Dr. Stephenson recommended that two of the sites be excavated and that prior to construction a detailed survey be made of the area to discover if additional sites exist. SCE&G will support and finance a study to be conducted by the University of South Carolina Institute of Archeology and Anthropology amounting to approximately $10,000. (See correspondence in Appendix A of the Environmental Report.)

There are a number of parks and recreational areas within the general region of the proposed project. Within ten miles of the site, however, the only significant public land available for recreational use is the Enoree Division of the Sumter National Forest, a portion of which is within six miles of the site. These areas provide recreational activities including picnicking, hiking, hunting, and limited boating and fishing, none of which will be affected by the project.

Hunting is a major visitor use, and there are two successful private waterfowl hunting clubs owning covelands upstream. These clubs are cooperators in the Broad River Waterfowl Management Program.

Since the lowlands may be affected by the increased water level of Parr Reservoir, discussions will be held with these clubs concerning the possible effects of the project.

According to preliminary data, the increased elevation of Parr Reservoir will flood certain properties of the U. S. Forest Service located upstream near Terrible Creek. Plans have been drawn for a waterfowl habitat area on Terrible Creek and development is expected soon. SCE&G has made contact with the U. S. Forest Service concerning the possible effects of the project on this development. Further discussions will be held as project plans are solidified, and SCE&G will cooperate with the U. S. Forest Service on a value for value land exchange as found mutually agreeable.

Impoundment of Monticello Reservoir and raising of the existing Parr Reservoir will require the relocation of portions of Route 99 where it crosses the north end of the Monticello Reservoir, and a small section of Route 215 on the west shore of Monticello Reservoir. The roadbed of S. C. Highway 28 approaching the bridges across Cannon's and Heller's Creeks will have to be raised to accommodate the daily water fluctuations of Parr Reservoir. Dependent on final topographic surveys, bridge approach sections of S. C. Highway 97 may also require raising. Negotiations are underway with the South Carolina Highway Department concerning these road relocations. SCE&G will coopeate with all appropriate State and Federal agencies to minimize the environmental impact of these highway relocations.

The enlargement of Parr Reservoir will require the relocation of a portion of the existing Southern Railroad line on the

east bank of the Broad River crossing Frees Creek, and modifying the existing road bed for several thousand feet adjacent to the river. SCE&G has contacted the Southern Railway concerning this matter and is currently working with consultants of the Southern Railway on the required relocations and modifications.

Care will be taken to see that the above relocations create as little distrubance to the natural landscape as possible, and have minimal environmental impact. SCE&G will cooperate with all State and Federal agencies involved with the construction and relocation of all highways and railroads.

Estimated costs of preserving and enhancing natural, historic, and scenic values and resources in the construction and operation of the Fairfield Pumped Storage Facility are as follows:

To be completed at a later date.

Should the construction or operation of the Fairfield Facility produce any unforseen adverse effects on natural, historic, or scenic values and resources, SCE&G will cooperate with the involved persons or agencies to alleviate the impact of the project.

Appendix D

FISH AND WILDLIFE HABITAT DATA FOR THE PROJECT AREA

There are four basic aquatic habitat types represented in the project area that may be affected.

(a) A section of the free flowing Broad River above the present Parr Reservoir level.

This 23 km section of the river is relatively constant in width (ranging from approximately 350 to 700 feet) and has a low gradient of less than 1 ft per mile. The river is generally shallow with maximum depths of less than 20 feet and much of the river of five feet or less.

There is little to no aquatic macrophyte growth in the river, however, the banks are characteristically grassy with trees near the edge or overhanging the water. Banks are generally steep-sided, and there are few islands in this section of the river.

Bottom types vary from silty sand in the slower areas to sand in the more scoured areas. Rocks occur infrequently and are primarily in the area immediately below Henderson Island. Downed trees occurred along the river bottom.

This section of the river is suitable for a variety of fish species that prefer moving water and provides little quiet water and back eddies. It is

suitable spawning area for many fish species that require moving water and firmer bottoms than are present in Parr Reservoir.

(b) A semi-free flowing habitat within Parr Reservoir.

Because of a siltation and shallowing a large part of Parr Reservoir has become riverine in nature and experiences water movements similar to the river but of generally lesser magnitude. The riverine habitat within Parr Reservoir ranges from a relatively straight narrow upper end with few islands to larger open areas characterized by vegetated islands and shifting shallows and backwaters.

Reservoir width varies greatly, from approximately 500 feet at its upper end to 2,800 feet near the dam. Depths may be 20 to 25 feet, in the channel near the dam, but most of the lake has depths averaging only 3-4 feet.

The bottom is primarily silt, sand and muck with many submerged or semi-submerged trees. The sides are often steep and overhung by trees.

This section of the river provides habitat for all species of fish known to be in the reservoir, but is probably less productive than embayment portions.

(c) Embayment habitats within Parr Reservoir

Frees Creek, Hellers Creek, and Cannons Creek embayments are the major representatives of this lentic type of environment. Together they form about 22% of the total Parr Reservoir surface acreage.

Embayment widths vary from a few hundred feet to nearly 3/4 mile, and in length from 0.6 to 5.3 miles. Channel depths are 12-15 feet, however, depths just out of the channel quickly change to 4-6 feet and become shallow toward shore. Embayments are characterized by little current flow, an abundance of submerged partly emerging dead trees, and the variable influence of their small feeder streams.

Banks are generally only moderately to slightly steep and often overhung by trees which extensively shade the margins. Bottoms are silty, becoming more sandy as the creek mouth is approached.

These embayments are generally richer in fish habitat than the more open water, however, Cannons Creek Embayment appears to support several times the standing crop of fish than does Frees Creek Embayment.

(d) The free-flowing portion of Frees Creek

About 7 miles of Frees Creek will be affected. This small stream flows from an elevation of approximately 450 feet and has an average drop of about 20 feet per mile. The drop is greatest in the upper 1/4 of the creek,

averaging 33 feet per mile and lesser in the lower 3/4, averaging 12 feet per mile.

The stream is small, the width averaging 10 feet or less. Water depth is generally less than a foot and is usually a few inches. There are some deeper pools formed around branches and debris, but most of the creek is riffle or shallow pool. The stream bottom is generally of sand, ranging from coarse to fine. There is very little rock and thus the bottom tends to be unstable.

The creek runs through a mixed deciduous and pine forest and is heavily shaded. No rooted macrophytes are present. In contrast to the Broad River, Frees Creek is often clear, and turns trubid only after heavy rains.

The stream appears to provide poor fish habitat because of its shallowness and shifting bottom. No fish from Parr Reservoir are known to use Frees Creek as a spawning area.

	Category	Shoreline Miles*	Acreage
(a)	Broad River	16	740
(b)	Reservoir without embayments	18	2,300
(c)	Embayments	11	660
(d)	Frees Creek	14	-

* Includes both sides of the stream or embayment.

There are four terrestrial habitat types within the project area that may be affected.

Four major habitat categories were identified on the project area and include the following: pine plantation, mixed pine-deciduous woodlands, deciduous woodlands, and grasslands (cultivated and abandoned farmland). The approximate percentage of each major type that will be inundated by the project impoundments is as follows:

	Parr Reservoir	Monticello Impoundment
Pine	2%	47%
Mixed	8%	26%
Deciduous	86%	15%
Grasslands	4%	12%

The quality of the woodland communities to support a diverse and an abundant fauna is dependent upon the site characteristics, age structure of the forest, and density of the canopy. These factors have a direct influence on the development of herbaceous vegetation and shrubs which, in turn, is part of the life-support system of woodland wildlife.

The site characteristics that influence lower story productivity include the slope, moisture retention properties, and organic content of soils. Pine plantations

usually occur on the upland sites that are well drained and slightly acidic (pH 5.0 to 5.5). The nutrient levels in the uppermost soil layer are not well developed because pine needles decompose slowly. Deciduous leaved shrubs and herbaceous vegetation do not grow readily in these mildly adverse conditions.

The deciduous leaved tree sites, along the Broad River and tributary creeks, are moderate to poorly drained and provide a better substrate for the growth of herbaceous or shrub vegetation. The decomposition of deciduous leaves results in more nutrients available and an improved nutrient exchange between the soil and vegetation.

The age-structure and density of a forest influences the penetration of sunlight to the forest floor. The amount of sunlight that reaches the substrata is reduced in a mature and/or even-aged stand of trees having a dense canopy. A stand composed of uneven-aged trees will allow sunlight to reach the substrata more readily.

The monitoring program included the analysis of vegetation on five study sites representative of the four major communities on the project area. The five sites include the following: two sites in pine plantations of two different-age classes, one site in a mixed pine-deciduous community, one in a predominantly deciduous

forest, and one site in a grassland where pine seedlings had been planted. All five sites are in the vicinity of the Monticello Impoundment. Each habitat community is described in more detail in the following paragraphs.

Pine Habitat

The coniferous communities to be inundated consisted mainly of loblolly pine which produces a closed canopy forest with a sparse understory of herbaceous vegetation. Only limited numbers of pine seedlings and saplings are capable of growing under the dense canopy which reduces light penetration to the substrate.

Two pine plantations representative of the project area were described by the following techniques: the point-centered-quarter method was used to obtain relative density, relative frequency, and relative dominance of trees over 2.5 cm d.b.h.; diameter at breast height (d.b.h.) was measured to characterized age-classes; and the frequency of occurrence was obtained for shrubs, herbaceous vegetation and other ground species from 40 one-meter square quadrants systematically placed in each habitat. Tables 1 and 2 show the diversity and the relative frequency, density, and dominance, and importance value for trees found on the two pine plantations sampled. Loblolly pine is the most importanct species on both sites. Herbaceous and woody vegetation is not abundant on

either site (Table 3). In the first pine plantation, Schribner's panicum, blackberry and dandelion occurred in more than 25 percent of the quadrants. The second pine plantation sampled shows a greater diversity and frequency of herbaceous and woody vegetation. The understory vegetation in the second plantation was studied one year following the selective removal of the mature pine for pulpwood.

The quality of the pine communities in regard to supporting wildlife is considered to be very poor because of the sparse understory. Neither shelter, forage nor browse was significantly available to wildlife.

A variety of songbirds were recorded in pine plantations during two seasons (Table 4). The density of birds was low in the pine plantations. Game birds such as turkey and bobwhite are also low in abundance because the available nuts, fruits, seeds and shelter is sparse.

Small mammals were censused in two pine plantations for five days in each of four seasons (Table 5). Of the total small-mammals collected, seventy-eight percent were in the second pine plantation where the understory vegetation was more abundant. Golley, et al. (1965) also found small mammals to be low in abundance in pine plantations.

No furbearing or game mammals were observed or trapped in pine plantations. Cottontail rabbits, however, were occasionally seen near an ecotone between a pine plantation and grassland where food and protective cover were more plentiful. Browse for white-tailed deer is very sparse in pine plantations with only limited amounts of Walter's smilax, honey-suckle, blackberry, and dogwood.

Mixed Pine-Deciduous Habitat

Of the mixed pine-deciduous communities to be inundated by Monticello Impoundment, 73 percent consists of areas where pine was selectively removed. The hardwood understory was predominant on aerial photographs, resulting in those areas being classified as mixed pine-hardwood community.

The mixed pine-deciduous study site was located along the sloping shoreline of Frees Creek, near the Broad River. Loblolly pine, eastern red cedar, and red maple were the most important species (Table 6). Loblolly pine was the dominant species within the area, but eastern red cedar was the most dense.

A variety of species comprised the understory with Walter's smilax being the most frequent woody plant and sedge the most frequent herbaceous plant (Table 3). The understory was diverse because sunlight could

penetrate the multi-aged diverse forest to reach the understory and substrate and deciduous leaves provided a better humus layer on the soil.

The quality of the "mixed" habitat for wildlife is probably fair but limited in distribution as ecotones between pine plantations and the deciduous forests on the bottomlands. The distribution of "mixed" habitats on the project area and the low frequency of potential food plants is representative of the over-all low quality of the project area for native wildlife species. The understory vegetation includes a variety of plants valuable as browse or food for white-tailed deer, turkey and bob-white quail. However, none of these species were abundant.

Native wildlife populations in the "mixed" community were low in abundance. Song birds were more abundant in pine habitat than "mixed" habitat (Table 4). However, the "mixed" habitat, where bird were censused, contained significantly more mature deciduous woodland habitat than pine habitat. Small mammals were more abundant in "mixed" habitat than the pine habitat (Table 5).

Medium sized mammals recorded in "mixed" habitat include an occasional gray squirrel and white-tailed deer. Four opossum and one raccoon were livetrapped along upper Frees Creek.

The northern two thirds of Frees Creek flows through

habitat that includes all four major types, but with a dominance of "mixed" and deciduous woodlands. Openings created along the creek by highway intrusion or farming activity, or tree windfalls exhibit a fairly lush growth of shrubs, vines, and some herbaceous vegetation. This narrow band of habitat along the creek represents the best qualtiy habitat for mammals and birds. Its distribution, however, is limited.

Deciduous Woodlands

Deciduous woodlands are distributed primarily along the flood plain of the Broad River and its tributaries. These woodlands are typically composed of mature, dense stands that restrict the light penetration which inhibits the growth of understory vegetation.

One study site was established among hardwoods on a tributary of Frees Creek. The stand was not described by the point-centered quarter method, but the frequency of understory vegetation was obtained within the stand (Table 3). Herbaceous vegetation is almost absent while woody plants were present but not abundant. Walter's smilax was the most frequently occurring understory species in this hardwood stand. The understory of hardwood forest along the bottomlands of the Broad River was often limited to sedge and bamboo. Woody plants in the understory were generally absent except where light

reaches the substrate along the stream banks and in man-made openings are not common in the deciduous woodlands along the Broad River in the project area.

The deciduous forests in the bottomlands along the Broad River and tributaries will not support many white-tailed deer, turkey, bobwhite, and squirrel. Although the mature trees produce an annual mast crop (acrons, seed, et.), the mast is generally available to turkey and squirrel, but not readily available to white-tailed deer. Browse and forage for deer is not abundant either as indicated by the low abundance and diversity of woody and herbaceous vegetation. Understory vegetation increases abruptly in openings created by abandoned farm fields, railroad and transmission line rights-of-way, and abandoned roads. These openings do not contribute sufficiently to the wildlife cover to warrant the classification of the Broad River bottomlands as productive wildlife habitat.

Grasslands

The grassland community type included seven percent cultivated or pasture and five percent abandoned farmland. Abandoned farmland included communities representing several seral stages of succession.

The study site consisted of plantation pine approximately three years after planting with no tree having a

d.b.h. grater than 2.5 cm. Vegetation on the site typifies an early successional stage of a disturbed site. Broomsedge was the most important grass species on the site (Table 7) with triple-awned grass being the next most important. The density of grass species (6,756 plants/ha) contributed to a total ground cover of 9.8 percent.

Grasslands provide an important link in the requirements of wildlife on the project area. The quality of grasslands to support wildlife is variable according to the current land-uses. Grazed pasture and cultivated fields are important to the few mourning dove and bobwhite. Abandoned farmland in various stages of succession are important to such game species as bobwhite, mourning dove, turkey, white-tailed deer, and cottontail rabbit.

Mourning dove call counts conducted on the project area during the same period that the national surveys are conducted showed the population to be low on the project area. An average of 7.5 doves were heard per route on the project area in 1973 as compared to an average of 49 doves heard per route in 1970 on the best region of South Carolina, the Carolina Sandhills National Wildlife Refuge. Small grain cultivation is important to this game bird, and not abundant on the project area. Song birds were most abundant in the

abandoned fields studied on the project area (Table 4). The highest diversity and often the highest abundance of small mammals was collected in a grassland (Table 5).

The distribution of abandoned farmland is another limitation on the carrying capacity for native wildlife species on the project area.

The ecotone that forms between grassland and forest land also is important in the distribution of wildlife. The edge provides nesting sites for many song birds, as well as a diversity of plants for cover and food for bob-white quail, turkey, white-tailed deer, and cottontail rabbit.

Summary

The overall quality of the environs on the project area is low. Mixed habitat of pine and deciduous trees is the best quality because of an uneven aged stand of timber. The broad age distribution increases the probability of shrubs and herbaceous vegetation growing near the ground. The mature trees of the deciduous forests and the dense stand in pine plantations retard the development of understory vegetation important to woodland wildlife. A few, but insufficient, openings occur among the deciduous forests and pine forests where understory vegetation is present and encourages some fauna development.

The overall quality of the habitat to support wildlife will improve slightly as a result of lumbering operations. Timber cutting activities throughout the region are increasing forest openings. Understory woody and herbaceous vegetation will increase under these openings and an increase in the carrying capacity of the project area for wildlife is anticipated.

Table 1 Relative frequencies, densities, dominance and importance values of tree species (2.5 cm or greater dbh) growing in Site 1A of the Broad River Study Area, June 1971.

Species	Relative Frequency	Relative Density	Relative Dominance	Importance Value
Loblolly Pine	52.9	69.4	80.8	203.1
Sweet Gum	21.4	18.0	13.9	53.3
Flowering Dogwood	11.4	6.3	2.7	20.4
Eastern Red Cedar	7.1	3.1	1.5	11.7
Tulip Tree	2.9	1.3	.6	4.8
Hop-hornbeam	2.9	1.3	.4	4.6
Red Maple	1.4	0.6	.2	2.2
Totals	100.0	100.0	100.1	300.1

Table 2 Relative frequencies, densities, dominance and importance values of tree species (2.5 cm or greater dbh) growing in Site 4 of the Broad River Study Area, June 1971.

Species	Relative Frequency	Relative Density	Relative Dominance	Importance Value
Loblolly Pine	60.7	81.3	85.9	227.9
Eastern Red Cedar	12.2	6.3	5.1	23.6
Holly	6.1	3.1	1.5	10.7
Black Cherry	4.5	2.5	2.4	9.4
Oak sp. 1	4.5	1.9	1.8	8.2
Red Maple	4.5	1.9	0.9	7.3
White Oak	1.5	0.6	0.9	3.0
Hop-hornbeam	1.5	0.6	0.6	2.7
Oak sp. 2	1.5	0.6	0.3	2.4
Willow Oak	1.5	0.6	0.3	2.4
Sweet Gum	1.5	0.6	0.3	2.4
Totals	100.0	100.0	100.0	300.0

Table 3 Frequency of occurrence (%) of understory, herbaceous, and woody plant species growing within pine, hardwood, mixed pine-hardwood, and grassland environs in the Broad River Study Area.

Growth Form / Common Name	COLLECTION SITES				
	1 Pine 1	1B Hard-wood	2 Grass-land	3A Mixed	4 Pine 2
Vascular Cryptogams					
Fern	4	-	-	10	-
Herbaceous Forbs					
Arrowhead	-	-	10	10	-
Aster	-	-	10	-	10
Bundle Flower	-	-	-	-	15
Cinquefoil	-	8	-	5	-
Common Ragweed	-	-	5	-	-
Dandelion	28	-	-	-	-
Goldenrod	12	-	20	-	5
Heartleaf	-	-	-	20	-
Lespedeza	-	-	5	-	10
Pussy's Toes	-	-	-	-	5
St. John's Wort	4	-	-	-	-
Wild Ginger	-	-	-	20	-
Wood Sorrel	20	-	-	-	-
Grasses					
Bamboo	-	-	-	35	-
Bermuda Grass	24	-	-	-	-
Broom Sedge	-	-	65	-	40
Drownseed	-	-	10	-	-

Table 3 (Continued)

Growth Form / Common Name	COLLECTION SITES				
	1 Pine 1	1B Hard-wood	2 Grass-land	3A Mixed	4 Pine 2
Cane Bluestem	-	-	4	-	-
Indiangrass	-	-	-	10	30
Little Bluestem	-	-	45	-	30
Scribner's Panicum	28	-	30	15	25
Three-awned Grass	-	-	40	-	-
Sedges					
Sedge	-	20	-	45	-
Woody					
Shrubs					
American Holly	8	16	-	15	15
Blackberry	28	-	5	-	-
Rose	4	8	15	-	-
Trees (<5 cm d.b.h.)					
American Hornbeam	-	4	-	-	-
Black Cherry	4	-	-	-	-
Black Oak	-	8	-	-	-
Dogwood	-	4	-	-	15
Eastern Red Cedar	4	-	-	10	-
Hawthorn	4	4	-	-	-
Laurel Oak	4	28	-	15	10
Loblolly Pine	40	20	5	35	25
Pignut Hickory	-	-	-	5	-

Table 3 (Continued)

Growth Form Common Name	COLLECTION SITES 1 Pine 1	1B Hard-wood	2 Grass-land	3A Mixed	4 Pine 2
Red Maple	-	-	-	5	-
Sugarberry	-	8	-	-	-
Sweet Gum	8	4	-	5	-
Water Oak	4	8	-	5	5
White Ash	-	-	-	5	-
Winged Elm	12	20	-	15	-
Vines					
Honeysuckle	72	16	25	-	-
Walter's Smilax	4	52	-	50	15

Tables 4-A summary of birds recorded during strip censuses in three habitats.

Season Number of Birds[3]	Pine		Grassland[1]		Mixed[2]	
	Spr	Sum	Spr	Sum	Spr	Sum
Hawks	1	0	0	0	2	0
Bobwhite	0	0	2	7	6	0
Mourning Doves	0	0	0	1	0	0
Woodpeckers	3	0	1	0	2	2
Flycatchers	0	2	0	4	0	8
Swallows	0	2	0	4	0	0
Blue Jay	1	5	0	1	0	1
Brown-headed nuthatch	2	0	0	0	0	0
Carolina Wren	1	0	0	0	6	0
Thrushes	3	2	0	0	3	2
Kinglets	2	0	0	0	3	0
Warblers	6	18	0	15	12	0
Eastern Meadowlark	0	0	22	9	0	0
Cardinal	0	2	0	0	1	1
Sparrows	9	8	18	15	13	0
Total Species	17	15	8	20	17	10
Total Birds per 40 hectares	92	216	89-201	252-378	63	-

[1]Birds of two grassland communities were censused and combined to form this summary.

[2]Mixed refers to a mixture of pine and deciduous leaved trees.

[3]A selected list of the total species counted.

Table 5 Relative abundance of small mammals collected along traplines in Study Sites 1A, 2, 3A, and 4.

Study Site / Animal	6/71 Survey Total No. Caught	6/71 Survey Trap-nights/ Animal*	9/71 Survey Total No. Caught	9/71 Survey Trap-nights/ Animal*	1/72 Survey Total No. Caught	1/72 Survey Trap-nights/ Animal*	3/72 Survey Total No. Caught	3/72 Survey Trap-nights/ Animal*
Site 1A (Pine)								
Total Trapnights	300		360		240		240	
Cotton mouse	2	150	0	--	0	--	2	120
Site 2 (Grassland)								
Total trapnights	240		360		240		240	
Cotton Rat	2	120	6	60	2	120	0	--
House mouse	4	60	7	51	0	--	0	--
Cotton mouse	0	--	1	360	3	80	3	80
Cottontail rabbit	0	--	2	180	0	--	0	--
Harvest mouse	0	--	0	---	1	240	3	80
Site 3A (Mixed)								
Total Trapnights	240		360		240		240	
Shortail shrew	1	240	4	90	3	80	1	240
Cotton mouse	4	60	5	72	0	--	3	80
Cotton rat	0	--	0	--	0	--	1	240
Site 4 (Pine)								
Total Trapnights	180		360		240		240	
Cotton mouse	3	60	4	90	1	240	1	240
Golden mouse	2	90	1	360	0	--	0	--
Shorttail shrew	0	--	1	360	0	--	0	--
Pine vole	0	--	0	--	1	240	0	--

* Trapnights per animal caught.

Table 6 Relative Frequencies, densities, dominance and importance values of tree species (2.5 cm or greater dbh) growing in Site 3A of the Broad River Study Area, June 1971.

Species	Relative Frequency	Relative Density	Relative Dominance	Importa Value
Loblolly Pine	16.0	18.6	21.7	56.3
Eastern Red Cedar	16.0	19.2	13.0	48.2
Red Maple	13.4	14.8	13.5	41.7
Ash	8.4	6.2	9.2	23.8
Hop-hornbeam	7.6	5.6	6.8	20.0
Oak sp. 1	7.6	6.2	5.4	19.2
Shagbark hickory	5.9	4.7	6.0	16.6
Hickory sp.	5.0	4.7	4.3	14.0
Oak sp. 2	3.4	3.8	4.6	11.8
Oak sp. 3	4.2	3.1	4.1	11.4
Ironwood	2.5	4.7	3.3	10.5
Basswood	3.4	3.8	3.3	10.5
Live Oak	2.5	1.8	3.0	7.3
Flowering Dogwood	1.7	1.2	0.5	3.4
Redbud	1.7	1.2	0.5	3.4
Willow Oak	0.7	0.6	0.8	2.1
Totals	100.0	100.2	100.0	300.2

Table 7 Relative frequency, density, and dominance of the various grass species within a pine plantation in the Broad River Study Area.

Species	Relative Frequency	Relative Density	Relative Dominance	Importance Value *
Broomsedge	34.1	38.7	61.3	134.1
Triple-awned Grass	31.7	27.5	14.7	73.9
Little Bluestem	22.0	23.7	16.6	62.3
Witchgrass	7.3	6.3	3.5	17.1
Brownseed	4.9	3.7	3.9	12.5
Totals	100.0	99.9	100.0	299.9

* Importance value is the sum of relative density, relative dominance, and relative frequency.

Appendix E

APPENDIX E. Conclusions and Recommendations from the Relationship Between Substrate Content, Water Quality Actinomycetes, and Musty Odors in the Broad River Basin. Environmental Protection Agency, 1973.

The musty odors found in the Columbia, South Carolina, municipal water supply are not unique to that area, but a widespread phenomenon in the Broad River Basin. Actinomycetes, common throughout the basin, are the organisms producing the musty odors; however, actinomycete growth and musty odor production appear to be dependent on the influx and storage of organic matter and other nutrients, air and water temperature, rainfall, and stream flow during the spring season. The major tributaries in South Carolina appear to be a primary source of organic matter and other nutrients, while the canals and reservoirs act as a "sink" for these nutrients, thus providing a substrate conducive to actinomycete growth and odor production.

Columbia water treatment plant personnel should create an odor panel and regularly sample upstream in the vicinity of Parr Dam for odors during the spring of the year. Personnel should be prepared to treat the water with activated carbon when air temperatures and water temperatures of 17°C or greater occur during extended spring-time low-flow (less than 6,500 cfs) periods (2 to 5 weeks) and upstream threshold odors are 4 or greater. When the above conditions occur, severe odor problems can be expected; therefore, treatment should begin as soon

possible.

Inputs of wastes from municipalities and industries in the Broad River Basin should be reduced to levels commensurate with available waste treatment technology. Particular attention should be given to wastes from Lockhardt and Carlisle textile mills and discharges into tributary streams draining the Greenville-Spartanburg area.

Appendix F

CONCLUSIONS FROM PROGRESS REPORT NO. 2, PARR HYDROELECTRIC PROJECT, BY ALDEN RESEARCH LABORATORIES, JUNE 1973, FOR SOUTH CAROLINA ELECTRIC AND GAS COMPANY

The main conclusions drawn to date from the model studies are:

(1) The overall concept of the Parr Hydroelectric Project was feasible.

(2) The daily average water temperature rise at the discharge of the pumped storage plant into the Broad River (Parr Reservoir) was less than the 3F criteria established by the state of South Carolina. This is true for all model tests conducted to date which includes 2 unit (nuclear plant) tests with ambient water temperatures of 45F and 60F and 1 unit (nuclear plant) tests with ambient water temperatures of 45F and 60F.

The maximum water temperature rise at the discharge of the pumped storage plant into the Parr Reservoir was 4F for one nuclear unit operating continuously at full load (see Test No. 70, Fig. 24). The average daily temperature rise for this test was 1.3.

(3) The average surface temperature rises in the Monticello Impoundment and Parr Reservoir were greater with tests conducted with the colder ambient water temperatures since the heat transfer to the atmosphere was less with the colder ambients.

(4) The average daily temperature rise at the discharge of the Parr Hydro plant was less than the state of South Carolina criteria of 5F except when the Broad River flow was 860 cfs for more than 7 continuous days at the same time that the ambient water temperature was 45F. The model tests were conducted with 24 hour a day operation of the Parr Steam plant located immediately upstream of the hydro plant. Normal operation of this plant would only be for 8 hours daily.

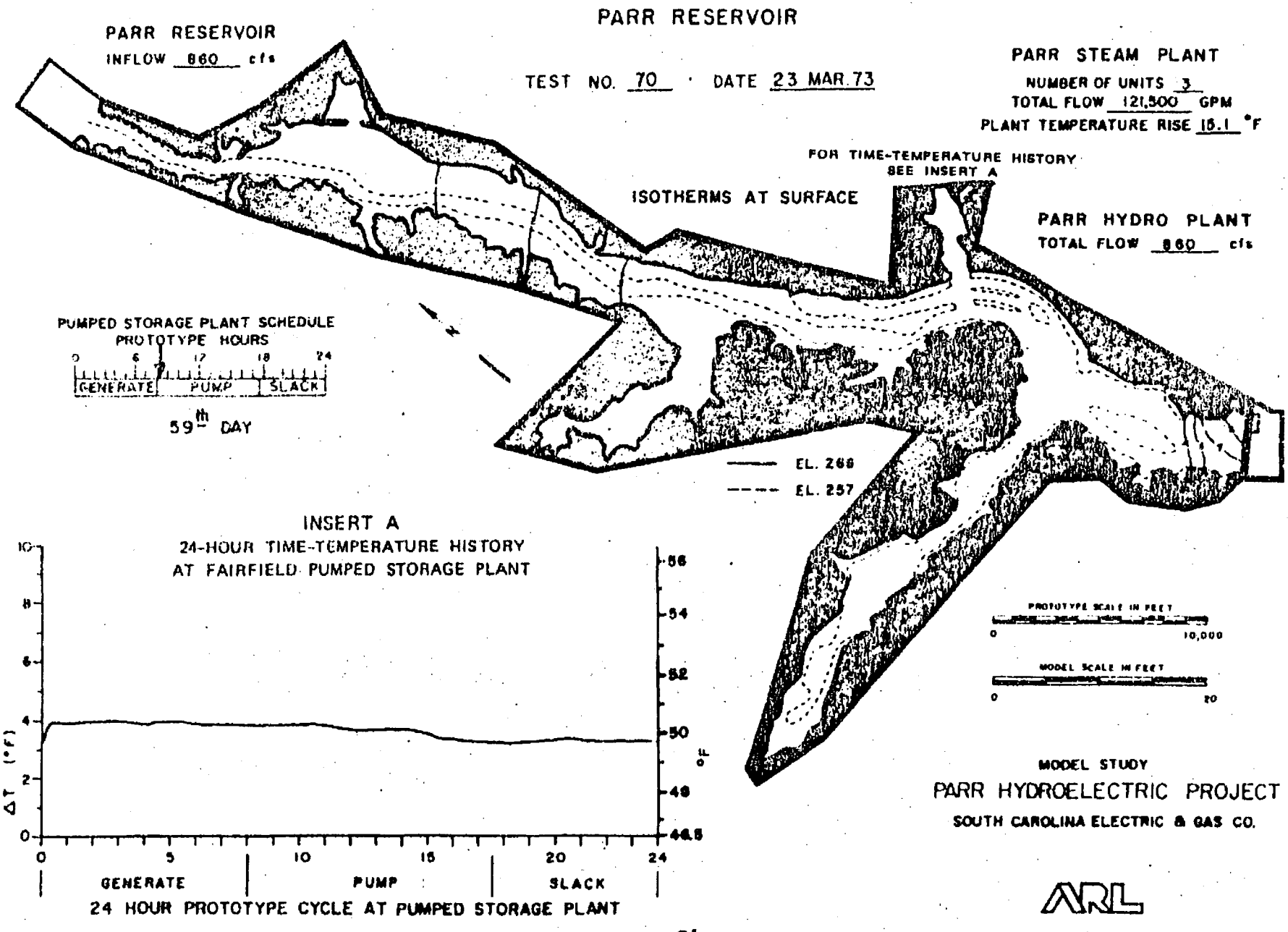
PARR RESERVOIR
PARR RESERVOIR
INFLOW 860 cfs
TEST NO. 70 · DATE 23 MAR.73
PARR STEAM PLANT
NUMBER OF UNITS 3
TOTAL FLOW 121,500 GPM
PLANT TEMPERATURE RISE 15.1 °F
FOR TIME-TEMPERATURE HISTORY SEE INSERT A
ISOTHERMS AT SURFACE
PARR HYDRO PLANT
TOTAL FLOW 860 cfs
PUMPED STORAGE PLANT SCHEDULE
PROTOTYPE HOURS
0 6 12 17 18 24
GENERATE PUMP SLACK
59th DAY
EL. 268
EL. 257
PROTOTYPE SCALE IN FEET
0 10,000
MODEL SCALE IN FEET
0 20
INSERT A
24-HOUR TIME-TEMPERATURE HISTORY
AT FAIRFIELD PUMPED STORAGE PLANT
ΔT (°F)
°F
0 2 4 6 8 10
46.5 48 50 52 54 56
0 5 10 15 20 24
GENERATE PUMP SLACK
24 HOUR PROTOTYPE CYCLE AT PUMPED STORAGE PLANT
MODEL STUDY
PARR HYDROELECTRIC PROJECT
SOUTH CAROLINA ELECTRIC & GAS CO.
ARL

Figure 24

Appendix G

LETTERS OF COMMENT ON DEIS

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
Washington, D.C. 20250

JAN 4 1974

2770 (7100)

Honorable Kenneth F. Plumb
Secretary, Federal Power Commission
Washington, D.C. 20426

P-1894

Dear Mr. Plumb:

Please refer to your letter of September 7, 1973, on Parr Project No. 1894 - South Carolina, South Carolina Electric and Gas Company.

We have reviewed the Draft Environmental Impact Statement for the subject project. We have the following comments.

Description of the Proposed Action

Page 1-7, Figure 1-1

Project boundary line is not defined for most of the project area.

Page 1-37, Last Paragraph

South Carolina Electric and Gas Company's (licensee) Exhibit R makes no mention of a swimming area in the Monticello sub-impoundment. Monticello Reservoir will have Class B water and will be unsuitable for swimming under existing State water quality criteria.

Page 1-38, First Paragraph

This Draft Environmental Statement states that "no bank fishing, primitive camping on islands or water contact sports would be allowed on the main body of Monticello reservoir, due to restrictions by the South Carolina Pollution Control Authority." However, frequent reference is made to the recreational value of fishing, and particularly of primitive camping on islands.

Description of Existing Environment

Page 2-27, Second Paragraph

The statement that no known rare or endangered species occur within the project area is inaccurate. The presence of Southern Bald Eagles in the project area has been confirmed.

Environmental Impact of the Proposed Action

Page 3-5, First Paragraph

The licensee with the assistance of U.S. Geological Survey, is recalculating the area to be inundated by redeveloping Parr Reservoir. The new National Forest area to be inundated will be approximately 300 acres.

Page 3-5 Second Paragraph

The Southern Bald Eagle does occur within the project area.

Fish and Wildlife

Aside from the immediate effects of losing considerable acreage of prime wildlife habitat through inundation, there are several long term ramifications which require consideration. Based on ecological phenomena occuring at the Atomic Energy Commission's Savannah River Plant, the following may be pertinent:

No reference is made on chemical analysis for mercury in the environmental report. Since the facility will be using water from the Broad River any mercury present (now or later) may be concentrated in the Parr and Monticello impoundments. Since this element is readily degraded to the methyl form which is assimilated and concentrated in animal flesh, a potential hazard exists.

The licensee cites developments at Par Pond as indicators of thriving game fish population in a cooling reservoir. The fish in Par Pond at the Savannah River Plant exhibit high concentrations of methyl mercury compounds. These compounds resulted in part from continued evaporation of Savannah River water.

Other heavy metals also affect plant and animal life in an aquatic environment. The lower forms of aquatic life (plankton) are extremely sensitive to chromium, regardless of valence. Lead concentrations are moderately high and may hinder survival of smaller fish and plankton. South Carolina Pollution Control Authority sampled the Broad River at Parr (Route 213) for heavy metals on December 8, 1971. The results are as follows:

Chromium	1.09 mg/L
Copper	Not detectable
Cadmium	Not detectable
Lead	34 mg/L
Total Mercury	0.06 mg/L

Data from the Sandhill's Experiment Station indicates an open water evaporation loss averaging 45 inches/year. (Approximately 3 3/4 ft.)

Monticello Reservoir will lose about 25,200 acre-feet of water annually. Parr Reservoir will lose about 16,100 acre-feet annually. This is 6.3 percent of the volume of Monticello Reservoir and 50 percent of the volume of Parr Reservoir. The Reservoirs, Monticello in particular, will become repositories for heavy metals. Monticello Reservoir will accumulate about 4.2 lbs. of mercury, 2,310 lbs. of lead, and 37 tons of chromium annually. Accumulations in Parr Reservoir will be about 60 percent of those in Monticello Reservoir.

Radionuclides released into waterways will be accumulated in vegetation growing along these areas. Will these controlled (through dilution) releases remain benign, or will the effects be passed on to the animal consumers in the local ecosystem -- and ultimately to man, through deer, turkey, and waterfowl?

Page 3-34, Second Paragraph

What sort of provisions have been made to dispose of recreation-generated wastes, particularly those wastes associated with primitive camping on islands?

Page 3-39

The statement makes no mention of the probability of fogs from Monticello Reservoir obscuring Routes 215 and 99. These fogs will be a permanent impact and will create a traffic hazard. The licensee's environmental report discusses the problem but fails to mention any reasonable solutions.

<u>Relationship between local and short-term environmental uses and maintenance and enhancement of long-term productivity</u>

The Draft Environmental Statement defines short term environmental use as 40 years, the operating period of the nuclear plant as 40 years and the operating life of the complex as an indefinite time. It also identifies as short-term uses of the environment items as project structures (including the Frees Creek Dam and penstocks), and the creation of a man made impoundment.

However, page 2.6-2 more appropriately identifies the flooding of the Forest land and the loss of associated wildlife habitat as an irretrievable commitment of resources.

The Draft Environmental Statement on page 2.5-2 mentions contribution to "long-term" productivity of the community from the project and an enhancement of long-term productivity of the land and water resources in the site area. We fail to recognize how these benefits will be generated by the project and feel that the analysis should better describe and evaluate them.

Alternatives to Proposed Action

Page 8 - 1, 2, & 3

Water losses are stated for the various cooling tower alternatives. These water losses should be compared with the water losses calculated for the proposed project. Fog potential of the proposed project and the non-spray cooling pond alternative should also be discussed.

Staff Position on Matters Having Significant Environmental Impact

Section 9.1

Land Use

Page 9-1

1. The Forest Service agrees with the proposed project boundaries for Monticello Reservoir, except to suggest that the entire area within the triangle bounded by State Route 215, relocated Route 99 and County Road 347 should be dedicated to public recreation.

2. The Forest Service is of the opinion that boundaries for Parr Reservoir should not be fixed until recalculation of the inundated area is accomplished. The eastern boundary of Parr Reservoir should be the Southern Railway track, except for places where inundation would go beyond the track. Raising Parr Reservoir will make lands between the railway and the reservoir commercially non-viable because of inundation patterns, ownership patterns, and access.

The Forest Service has recently negotiated a Memorandum of Agreement with the licensee, in which land exchange is a major item. Adjustment of the Parr Project boundary to accomplish this exchange will be in the public interest and will be of benefit to both the project and the Sumter National Forest.

Page 9-4, Last Sentence

Change "...inundate 236 acres of National Forest land" to "300 acres."

Page 9-5

The entire existing Parr Reservoir is a part of the Broad River Waterfowl Management Area. A management plan for that area was made in 1965 by the South Carolina Wildlife and Marine Resource Department, the U. S. Bureau of Sport Fisheries and Wildlife and the U. S. Forest Service.

Under that plan, a Greentree Reservoir was being developed when the Parr Project was made public. Development was suspended until after the Parr Project was in operation. The Memorandum of Agreement between the Forest Service and the licensee provides for replanning the Broad River Waterfowl Management Unit.

Page 9-7

The first 13 lines are repeated from the preceding page.

Sincerely,

Deputy Chief

G-8

OGC
Pmes
UPF
OEQ
P-1894

DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON, D.C. 20314

REPLY TO ATTENTION OF:
DAEN-CWE-Y

19 October 1973

RECEIVED
SECRETARY'S OFFICE
OCT 30 1973
AM PM

Honorable John N. Nassikas
Chairman, Federal Power Commission
Washington, D. C. 20426

Dear Mr. Chairman:

This is in reply to the Commission's letter dated 7 September 1973 requesting comments on the Draft Environmental Statement prepared by the Commission's staff in connection with the application filed by South Carolina Electric & Gas Company for new license for Parr Project No. 1894.

Parr Project No. 1894 is located on the Broad River in South Carolina. The applicant seeks, as part of the new license application, authorization to redevelop the existing Parr project to include pumped storage facilities with ultimate dependable capacity of 480 megawatts. In addition, the applicant proposes to use the upper pool of the proposed pumped storage development as a cooling impoundment for the planned Virgil C. Summer nuclear station.

The Draft Environmental Statement for the applicant's project and its proposed redevelopment is generally adequate as related to the Corps of Engineers responsibilities with respect to navigation and flood control. It is assumed that the views of the agencies responsible for other environmental aspects will be a matter of record.

As requested, ten copies of this letter are being sent to the Council on Environmental Quality.

Sincerely yours,

JOHN [illegible] HALL
LTC, Corps of Engineers
Assistant Director of Civil Works,
Environmental Programs

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NOV 01 1973
DIVISION OF LICENSED PROJECTS

OFFICE OF THE ASSISTANT SECRETARY OF COMMERCE
Washington, D.C. 20230

November 15, 1973

Mr. Kenneth F. Plumb
Secretary
U.S. Federal Power Commission
Washington, D. C. 20426

Dear Mr. Plumb:

The Department of Commerce has reviewed the draft environmental impact statement for "Parr Project No. 1894 - South Carolina," which accompanied your letter of September 7, 1973, (reference my letter of October 18, 1973) and we offer the following comments.

Although this project is located in inland South Carolina and is unlikely to greatly affect estuarine and marine fishery resources, it could produce adverse effects on anadromous species (e.g., striped bass and blueback herring spawning downstream) due to fluctuating water levels. The agreement between the South Carolina Wildlife and Marine Resources Department and South Carolina Electric and Gas Company should provide the necessary flows for successful spawning of these species. Additionally, we suggest that the final impact statement include studies to monitor the spawning of these fish and the feasibility of altering flows, if necessary, during the spawning season.

Thank you for giving us an opportunity to provide these comments, which we hope will be of assistance to you. We would appreciate receiving a copy of the final statement.

Sincerely,

Sidney R. Galler

Sidney R. Galler
Deputy Assistant Secretary
for Environmental Affairs

G-10

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
REGION IV
50 7TH STREET N.E.
ATLANTA, GEORGIA 30323

OFFICE OF THE
REGIONAL DIRECTOR

1894

October 23, 1973

Re: 350-9-73

Mr. Kenneth F. Plumb
Secretary
Federal Power Commission
Washington, D. C. 20426

Dear Mr. Plumb:

Subject: Project No. 1894
Parr Hydroelectric Project
Parr, South Carolina

We have reviewed the draft Environmental Impact Statement on the above subject project. We note an area of secondary impact which appears not to be fully clarified in your draft EIS.

In Section 3.1, Human Elements, it is estimated that approximately 1,000 school children would result from a combination of the two projects proposed for the area. The draft EIS estimates that approximately 30 percent would be school children of permanent residents employed on the project. This would result in approximately 700 school children of transient workers. As stated in the draft EIS, a majority of the transient workers would reside in the Columbia area. In the event 30 percent resided in the project area, a need of seven classrooms would be required by the Local Education Authority (LEA). The two counties to be affected are rural and appear to have a stable school population. Consequently, we recommend that you consult with the LEA's on the potential impact of additional classrooms on their physical plant facilities.

Sincerely yours,

James E. Yarbrough
Regional Environmental Officer

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DIVISION OF LICENSED PROJECTS

FEDERAL POWER COMMISSION
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DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
COLUMBIA AREA OFFICE
1801 MAIN STREET, JEFFERSON SQUARE
COLUMBIA, SOUTH CAROLINA 29201

REGION IV
Peachtree-Seventh Building
50 Seventh Street, N.E.
Atlanta, Georgia 30323

1894

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FEDERAL POWER COMMISSION

October 17, 1973

IN REPLY REFER TO:
4.3PP

Mr. Kenneth F. Plumb
Secretary
Federal Power Commission
Washington, D. C. 20426

Dear Mr. Plumb:

Subject: Draft Environmental Impact Statement
Project No. 1894
Parr, South Carolina

The subject document has been reviewed by the staff of our Area Office, and it is our determination that this proposal will have no adverse effects on existing or proposed HUD projects.

We have noted that some relocation will be required; if relocation assistance is desired, please contact the Planning and Relocation Branch in our Area Office.

We appreciate the opportunity to have reviewed this project.

Sincerely,

Franklin H. Corley, Jr.
Acting Director

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OCT 24 1973
DIVISION OF LICENSED PROJECTS

OFFICIAL FILE COPY

TO	INIT.	DATE
DOCKET		
CENTRAL FILES		

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

ER-73/1245

NOV 7 1973

P-1894

Dear Mr. Plumb:

Thank you for the letter of September 7, 1973, requesting our views and comments on a draft environmental statement for the Parr Project, FPC No. 1894, located on the Broad River in Fairfield and Newberry Counties, South Carolina.

We have completed our review of the draft statement and submit the following comments for your consideration and use in preparing a final statement for this proposal.

General Comments

We believe the draft statement fails to overcome the major shortcomings of the applicant's environmental report as noted in our letter to you dated June 15, 1973. In particular, the draft statement offers superficial and misleading discussions on the fish and wildlife resources and the project's impact on these resources. The applicant has proposed various biological studies for identification of the fish and wildlife resources and environmentally desirable project modifications. However, there is no evidence to indicate that the details of these proposals have been finalized or reviewed by the appropriate State and Federal agencies. The intent to carry out such studies is laudable but it does little to aid the draft statement in describing the fish and wildlife resources in the study area or identifying the project's impact on these resources. Accordingly, from a fish and wildlife standpoint, the statement will be deficient in its environmental assessment of these resources and in developing any meaningful measures to mitigate any adverse impacts of the project on the resources.

The draft statement appears to be less than satisfactory in discussing the available alternatives to the proposed project and in describing the environmental impacts of the alternatives. The proposed project will cause some significant losses of wildlife habitat and has a potential to adversely affect

fishery populations in the Broad River system. For this reason, we urge full consideration of all reasonable alternatives and an impact assessment for each alternative.

From a recreation standpoint, we find it difficult to assess the environmental effects of this proposal. This problem stems from the lack of an acceptable Exhibit R. We urge the Commission to require the applicant to develop an acceptable Exhibit R as soon as possible and hopefully before the final statement is developed for this project. The inadequacies in the present Exhibit R are set forth in our letter to you dated June 15, 1973.

The following comments will be directed to specific sections of the draft statement.

Description of the Existing Resources

2.2 Geology and Physical Features - Sand and gravel has been dredged from the Broad River and granite has been quarried near the project. The Monticello Reservoir is underlain by the Abbeville-York zone which extends across the State; this zone contains several mineral commodities other than granite which have been mined in the past in places outside the project area.

There is a slight chance that the granite quarry at Blair, on Rocky Creek (Blair Quadrangle, South Carolina), may be affected by the 9-foot rise of the Blair River. This possibility is currently being investigated by the South Carolina Electric & Gas Company. This potential impact should be determined and expressed in the environmental statement.

The supply of sand and gravel and granite in the region is such that the commitment of these resources to the project would be relatively minor. There are no other known mineral commodities which would be affected by this project.

The fact that the upper reservoir would be used as a source of cooling water for a nuclear powerplant has raised questions regarding the integrity of the embankments and related subjects. These have been expressed in a letter of January 4, 1973, from H. W. Coulter, Geological Survey, to W. P. Gammill of the Atomic Energy Commission. Concerns expressed at that

time centered around the following items: (1) transmissivity of geologic materials beneath the dams impounding the upper reservoir and implications of seeps and springs below one or more of the dams; (2) analyses of embankment deformation and the limit of settlement that could be tolerated without danger of internal cracking of the embankments; (3) dynamic stability of the embankments in relation to local soil conditions; and (4) stability of natural slopes at the construction sites.

The above questions are of concern mainly in relation to the availability of cooling water for the nuclear plant. However, if these subjects are not covered in the environmental statement for the present hydroelectric project, assurances should be given that they have been adequately considered either in the environmental statement for the nuclear plant or the safety analysis report for that plant; we suggest reference to the pertinent documentation in the final environmental statement.

2.4 Water Quality - There is no indication in this section that chemical analyses have been made for the detection of heavy metals in the Broad River. Data taken by the South Carolina Pollution Control Authority at Parr (Route 213) on December 8, 1971, revealed the presence of chromium, lead, and mercury at more than trace levels. The potential concentration of these pollutants in Parr Reservoir, Monticello Reservoir, and the recreational subimpoundment and the effects of heavy metal concentrations on the biotic community and recreational potential should be discussed in this section.

This section should also acknowledge the potential increase of sedimentation in Parr Reservoir that will result from the increase of retention time of Broad River waters. It is our understanding that the existing Parr Reservoir has suffered a 75 percent loss of storage capacity because of sedimentation since initial construction. The potential loss of pumped storage capacity and thus project benefits should be adequately discussed in this section.

2.5 Current Land Use - This section should present a detailed discussion of the various vegetative types that occur in the project area, including total acreage and relative distribution of each type within lands to be inundated. The present statement that creation of Monticello Reservoir will inundate about

6,000 acres of pine forested land is misleading. In reality, this site supports about 3,000 acres of bottomland hardwoods and mixed pine-hardwood stands and about 3,000 acres of pine plantation.

2.8 Fish and Wildlife - This section of the final statement should identify the quantity and quality of fish and wildlife habitat to be affected by project implementation. In addition, discussions related to existing populations should include the relative abundance and population densities for game and non-game wildlife species indigenous to the project area.

The final statement should recognize white-tailed deer, the most important big game species in South Carolina, as one of the primary game species within the project area. Several years ago, the South Carolina Wildlife and Marine Resources Department expanded their Central Piedmont Game Management Area to include the project area. The excellent habitat in the Parr Reservoir and Frees Creek area is typical of the habitat responsible for the markedly increased populations of deer and turkey in the entire game management area. The abundance of escape cover and herbaceous and woody browse plants within the bottomlands, mast production in the mixed stands, and the interspersion of uneven-aged timber stands are responsible for the maintenance and productivity of these populations.

The statement that several species of ducks, other than wood ducks, have been reported as "transients" in the project area implies the relative unimportance of these species. We point out, however, that the majority of waterfowl in the Broad River area and South Carolina is composed of wintering species that are not permanent residents.

2.9 Existing Recreation - This section should quantify the total consumptive and non-consumptive fish and wildlife oriented recreational use of project lands; in particular, the proposed reservoir sites and transmission line corridors.

The proposed action will not directly affect any existing or proposed unit of the National Park System nor will it affect any registered National Historic, Natural or Environmental Education Landmark or any site now being processed for registration.

2.10 Cultural Resources - We are pleased to note the attention shown to cultural (historic, archeological, architectural) resources in the planning of the project. It is indicated that the applicant will fund archeological investigations in the project area under the guidance of the State Archeologist. However, one can interpret the statement to imply either that a thorough survey and salvage program for the entire area will be conducted, or only that four previously identified sites will be investigated. We believe that only the former course of action would adequately assure full consideration of the integral portion of the environment represented by cultural values. We also wish to point out that, to fully assess the project's effects on cultural values, the survey should cover not only the reservoir area, but lands affected by transmission lines, road construction, borrow pits, and other construction activity. On the basis of such an archeological survey, the full effects of the project on cultural resources can be determined and appropriate steps to avoid or mitigate adverse effects initiated, including salvage excavation. We trust the final statement will clear up this question.

We are further pleased to note the evidence of compliance with Section 106 of the National Historic Preservation Act, and the close cooperation with the South Carolina State Historic Preservation Officer.

3. Environmental Impact of the Proposed Action - The second paragraph, page 3-1, should be deleted in the final statement. We do not agree that the proposed boat launching ramp with its 10 parking spaces and the recreational sub-impoundment will offer unique features in Fairfield County. We do agree that the scenic overlook will provide the first area view of a combination pump storage and cooling impoundment but question the influence of this facility on overall recreational activities. Furthermore, there is no evidence to support the presumption that sport fishery populations will be increased by construction of this project.

3.2 Fish and Wildlife - The inundation of 2,550 acres of bottomlands resulting from the enlargement of Parr Reservoir and about 3,000 acres of bottomlands and mixed pine-hardwoods by construction of Monticello Reservoir will result in significant losses of wildlife habitat and a severe reduction in the carrying capacity of area lands for most native wildlife

species. The immediate result of this habitat destruction will be the dispersion of existing populations to adjacent land areas. Contrary to discussions in the draft statement, there is little possibility that many of the displaced wildlife species will be absorbed by the surrounding habitat. It is well documented that bottomland hardwood areas are centers of high energy assimilation and that these areas provide den sites and escape cover for various wildlife species. For example, the best white-tailed deer habitat is characterized by a diversity of vegetative types and age classes such as presently exist at the Parr and Monticello sites.

The bottomland and mixed hardwood sites provide a majority of the foods (particularly winter browse) and escape cover for this species. It is biologically misleading to suggest that destruction of about 6,000 acres of these vegetative types will not severely decrease the area carrying capacity for this species. Stransky (1969)[1], in a comparison of forest types, reported: (1) there is more and better deer food in bottomlands than on uplands; (2) South Carolina bottomlands support an estimated one deer per 13 acres while loblolly pine-hardwood and longleaf pine support one deer per 30 to 50 acres and 78 acres, respectively. Therefore, bottomlands are three times as valuable as the higher elevation forest types for deer production.

The statement has failed to recognize the affects of this proposal to waterfowl populations in the project area. The destruction of vegetation and the daily water level fluctuations in 2,550 acres of bottomlands adjacent to Parr Reservoir will preclude any significant waterfowl usage. Of particular importance is the potential destruction of valuable nest sites for the wood duck, an important resident waterfowl species. It has long been recognized that the major limiting factor in most wood duck populations is the

---

[1]Stransky, J. J. 1969 - Deer Habitat Quality of Major Forest Type in the South, Pages 42-45 IN: White-Tailed Deer in the Southern Forest Habitat Proceedings of a Symposium. Sou. Forest Exp. Station F.S. USDA Forest Game Comm. of S.E. Sect. of the Wildlife Soc. and School of Forestry, Stephen F. Austin State University. 130 Pages

lack of suitable nest cavities. This section should also recognize the proposed inundation of 235 acres of U.S. Forest Service lands that have been proposed as a waterfowl management area, and the Dawkins Wildlife Management Area that has been managed by the South Carolina Wildlife and Marine Resources Department for about 13 years.

The statement has recognized the importance of the striped bass fishery downstream of the project. However, there are no data to indicate that the downstream flows proposed to be released by the applicant will insure the continued productivity of resident or anadromous fish species. This section should present the results of a hydrological study to indicate the desired flow releases for the maintenance of these downstream fisheries. These data should represent both quantitative and qualitative aspects of flows below Parr Dam.

3.3 Nuclear Station and Monticello Reservoir - We have commented on this aspect of the project in our letter to the Atomic Energy Commission concerning the draft environmental impact statement for the Virgil C. Summer Nuclear Powerplant. Furthermore, we have expressed our concerns about the cumulative operational affects of the pumped-storage and nuclear facilities in our letter of June 15, 1973, to your agency.

For this reason, we will defer all comments on the proposed nuclear facility until the Alternatives Section (Section 8).

4. Measures to Enhance the Environment or to Avoid or Mitigate Adverse Environmental Effects

4.2 Land Management - This section of the draft should be deleted from the final statement until such time as the applicant and the Federal Power Commission can present detailed and comprehensive discussions of the measures proposed by the section title. It is unreasonable to assume that enumeration of vague biological monitoring programs and fish and wildlife management schemes can be considered as environmental enhancement or mitigation of adverse environmental effects. We suggest that the details of proposed biological studies be finalized and reviewed by the appropriate State and Federal agencies prior to completion of the final statement.

Specifically, the applicant's Land Management, Timber Management, and Wildlife Management Programs are non-descript and will depend on the results of ecological study programs that appear to be nonexistent at present. The statement that recreational facilities and activities compatible with the area needs, normal project operations, and public safety would be developed is totally misleading. The South Carolina Pollution Control Authority has placed restrictions on the use of Monticello Reservoir to exclude bank fishing, primative camping on islands, or water contact sports. Furthermore, the limited project lands around the reservoir sites, the large daily fluctuations in Parr Reservoir, and the exclusion zones around the nuclear and powerhouse facilities will severely limit recreational opportunities at the project site.

4.3 Measures to Mitigate Adverse Effects on Fish and Wildlife - The measures proposed in this section consist largely of the initiation of monitoring programs for use in selecting measures which could minimize any projected adverse effects. However, since it appears that the applicant has not seriously considered alternative project plans, the yet uncompleted studies will be of little value. The results of these baseline studies should be available now to facilitate a comparison of the environmental commitments of all project alternatives.

In view of the continual destruction of wildlife habitat by reservoir inundation, poor agricultural practices, and urban development, we suggest that the applicant consider reducing the size of the proposed reservoirs to that needed for pumped-storage and make-up cooling water. The proposed Impoundment Management Program seems of questionable value in view of the presence of the 50,000-acre Lake Murray less than 15 miles from the Parr Dam.

The applicant has proposed the mitigation measures of minimum flow releases from Parr Dam and the dedication of a 90-acre greentree reservoir site. However, the minimum flow designation cannot be considered mitigation but is instead a project design feature to avoid downstream fishery losses. Moreover, as stated previously, there are no data to suggest that these minimum releases will be sufficient to accomplish the intended purpose. The proposed greentree site has little or no mitigation value for the inundation of 235 acres of U.S. Forest Service lands previously slated for waterfowl management and the destruction of about 9,000 acres of productive wildlife habitat.

We suggested various mitigation measures to the applicant and the Federal Power Commission in our June 15, 1973, letter to your agency. These and additional measures should be given utmost consideration in the preparation of the final statement.

5. Unavoidable Adverse Environmental Effects - This section should be revised in view of previous comments. The unavoidable adverse environmental effects of construction and operation of this project will be the destruction of over 9,000 acres of productive wildlife habitat, including the Dawkins Wildlife Management Area and lands in the U. S. Forest Service's Broad River Composite, the inundation of nearly 15 miles of river and stream fish habitat, a reduction in the carrying capacity of existing Parr Reservoir and a possible reduction in productivity of downstream fisheries.

6. Relationship Between Local and Short-Term Environmental Uses and Maintenance and Enhancement of Long-Term Productivity - Statements such as long-term benefits in human consideration would be enhanced by the applicant's proposed Land Management Program for project land and water resources are totally unfounded in the absence of details concerning the mentioned programs.

In view of the present potential of project-associated lands to support extensive consumptive and nonconsumptive fish and wildlife-oriented recreational activities, we disagree that project implementation will provide enlarged recreational areas. Furthermore, the last sentence in this section should be deleted until data are presented to support the claim of a long-term improvement in sport fishery resources.

8. Alternatives to the Proposed Action - The National Environmental Policy Act of 1969 requires a ". . . rigorous exploration and objective evaluation of alternative actions that might avoid some or all of the adverse environmental effects. Sufficient analysis of such alternatives and their impact on the environment should accompany the proposed action through the agency review process in order not to foreclose prematurely options which might have less detrimental effects . . . ." We trust the alternative section of the final statement will be revised to more fully meet the above requirements of the National Environmental Policy Act.

We suggest that the Commission give serious consideration to the inclusion and environmental assessment of an alternative of reduced reservoir size to that needed for pumped-storage and make-up cooling water, only. Our calculations indicate that at no time will forced consumptive water losses due to the operation of two 900 MWe Nuclear Units exceed about 65cfs or 130 acre-feet/day. That is, the use of cooling towers for the proposed Virgil Summer Nuclear Powerplant would only require about 130 acre-feet/day of make-up water. Since 29,000 acre-feet of water will be pumped into Monticello Reservoir daily, the size of this reservoir could be reduced to provide only enough storage for peak generation and residual storage for make-up water. Further, a display of the environmental effects of such a proposal may well demonstrate its superiority over the proposed project insofar as fish and wildlife resources are concerned.

It is our opinion that the applicant has various alternatives available for the avoidance or mitigation of adverse environmental effects. For example, the impoundment of Hellers and Cannons Creeks for waterfowl mitigation and the resultant loss of usable storage in Parr Reservoir would result in only a 20 minute loss of generation time during the daily pumped-storage cycle.

We recognize the need for maximum head development to meet projected peak loads. Maximum head development could be realized by the applicant by location of a smaller upper reservoir dam site at a higher elevation in the Frees Creek Watershed. Further, we suggest that the final statement identify and evaluate another alternative. This alternative is the development of necessary peak load facilities in alternative locations outside the applicant's service area. On page 8-13 of the draft statement, the staff indicated that the most feasible sites studies were located in Duke Power Company's Service Area.

In summary, this Department has serious reservations as to whether the applicant's proposal is the best overall solution. The present proposal has significant adverse impacts on the fish and wildlife resources of the study area, and these concerns were set forth in our letter to you of June 15, 1973, when the applicant's licensing information was reviewed. We

also suggested further consideration of an alternative proposal dealing with a smaller sized project and also recommend its inclusion in the alternative section of the environmental statement. Accordingly, we trust the Commission will fully assess the merits of the alternatives to the applicant's proposal when making the licensing decision for the Parr Project.

Sincerely yours,

Deputy Assistant Secretary of the Interior

Honorable Kenneth F. Plumb
Secretary
Federal Power Commission
Washington, D. C. 20426

DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

MAILING ADDRESS:
U.S. COAST GUARD (G-WS)
400 SEVENTH STREET S.W.
WASHINGTON, D.C. 20590
PHONE: 426-2262

17 OCT 1973

P-1894

Mr. Kenneth F. Plumb
Secretary
Federal Power Commission
Washington, D. C. 20426

Dear Mr. Plumb:

This is in response to your letter of September 7, 1973 addressed to Mr. Benjamin O. Davis, Jr. and concerning the licensing application to utilize the upper pumped storage reservoir of the Parr Hydroelectric Project as a source of cooling water for a nuclear steam-electric plant located in Fairfield County, South Carolina.

The concerned operating administrations and staff of the Department of Transportation have reviewed the material submitted. We have no comments to offer, nor do we have any objection to this project.

The opportunity to review this draft statement is appreciated.

Sincerely,

R. J. [illegible]
Captain, U.S. Coast Guard
Acting Chief, Office of Marine Environment and Systems

G-24

1894

RICHLAND COUNTY
FAIRFIELD COUNTY
LEXINGTON COUNTY

CENTRAL MIDLANDS REGIONAL PLANNING COUNCIL
1125 BLANDING STREET COLUMBIA, SOUTH CAROLINA 29201 PHONE (803) 779-3300

October 10, 1973

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OCT 10 1973
BUREAU OF POWER

Federal Power Commission
Washington, D.C. 20426

Re: PWR-LP
Project No. 1894-South Carolina
South Carolina Electric & Gas Company

Dear Sir:

The Draft Environmental Impact Statement, Parr Project, No. 1894-South Carolina, September 1973 has been reviewed by this office.

The findings of this report appear reasonable which indicate that the positive impact of this proposed project outweighs the negative implications and that the application should be approved.

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FEDERAL POWER COMMISSION

Sincerely yours,

Sidney F. Thomas, Jr.
Executive Director

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OCT 1 8 1973
DIVISION OF LICENSED PROJECTS

SFTJr/mas

cc: Honorable Russell E. Train, Chairman
Council on Environmental Quality
Executive Office of the President
722 Jackson Place, N.W.
Washington, D.C. 2006

FEDERAL POWER COMMISSION
DOCKETED
October 12, 1973
DOCKET SECTION

Department of Agriculture
G-25
WADE HAMPTON OFFICE BUILDING
P. O. BOX 11280
COLUMBIA, S. C. 29211

WILLIAM L. HARRELSON
COMMISSIONER

1894

October 24, 1973

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BUREAU OF POWER

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OCT 29 10 41 '73
OFFICE OF THE SECRETARY

Mr. Kenneth F. Plumb
Secretary
Federal Power Commission
Washington, D. C. 20426

Re: PWR-LP Project 1894
S. C. Electric & Gas Co.

Dear Mr. Plumb:

Thank you for the opportunity to review the Draft Environmental Statement on the renewal of the S. C. Electric and Gas Company's Parr Project No. 1894.

This Department has no adverse comment and finds the project consistent with the Department's policies.

Yours very truly,

William L. Harrelson

William L. Harrelson
Commissioner of Agriculture

WLH:b

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OCT 31 1973
DIVISION OF LICENSED PROJECTS

South Carolina Department of Archives and History
1430 Senate Street
Columbia, S.C.

P. O. Box 11,188
Capitol Station 29211

1894

October 8, 1973

Mr. Kenneth F. Plumb
Secretary
Federal Power Commission
Washington, D. C. 20426

Dear Mr. Plumb:

In reference to the Draft Environmental Impact Statement for South Carolina Electric and Gas Company's Project No. 1894, we find that the environmental impact of the proposed project will be negligible upon sites of historical importance.

As stated in the Draft Environmental Impact Statement, the proposed Monticello Reservoir Project will flood some lands belonging to the Davis Plantation near Monticello, the Monticello Methodist Church, and the White Hall African Methodist Episcopal Church. None of these buildings themselves, however, will be flooded or otherwise affected.

This project will also flood the sites of five small cemeteries, but we understand that South Carolina Electric and Gas Company is in the process of locating and contacting the descendants of people buried there.

We have no objections to South Carolina Electric and Gas Company's Parr Project (No. 1894). Thank you for sending us the Draft Environmental Impact Statement.

Sincerely,

Charles E. Lee
State Historic Preservation Officer

CEL:CZF:sa
CC: Mr. E. H. Crews, Jr.
Vice-President Construction, Production Engineering
South Carolina Electric and Gas Company
Post Office Box 764
Columbia, South Carolina 29202

G-27

RECEIVED
OCT - 5 1973
DIVISION OF LICENSED PROJECTS

South Carolina
State Commission of Forestry

JOHN R. TILLER
STATE FORESTER

P. O. BOX 267
COLUMBIA, S. C. 29202

1894

October 1, 1973

Federal Power Commission
Washington, D. C. 20426

Re: FWR-LP
Project No. 1894- South Carolina
South Carolina Electric & Gas Company

Gentlemen:

We have reviewed the environmental impact statement of the Parr Project # 1894 as to its effects on forestry. It appears that 8,550 acres will be directly affected through inundation and undoubtedly additional acreage lost for transmission lines later.

There does not seem to be a reasonable alternative for the loss of this land to forest production in exchange for the needed electrical energy. So, we therefore offer no objections or suggestions for this project.

RECEIVED
OCT 3 7 58 AM '73
FEDERAL POWER COMMISSION

Very truly yours,

John R. Tiller
State Forester

JRT:sbf

cc: James Addison
S. C. Electric & Gas Co.
Box 764
Columbia, S. C. 29210

RECEIVED
OCT - 1973
BUREAU OF POWER

SOUTH CAROLINA
STATE HIGHWAY DEPARTMENT
DRAWER 191
COLUMBIA, S. C. 29202

1894

October 3, 1973

Mr. Kenneth Plumb
Secretary
Federal Power Commission
Washington, D.C. 20426

RE: Project No. 1894 - South Carolina
South Carolina Electric & Gas Company

Dear Mr. Plumb:

Reference is made to your letter of September 7, 1973, concerning the Draft Environmental Impact Statement on the above referenced project.

We have reviewed the statement and note that several roads and bridges under our jurisdiction would be affected by the proposed project. However, we have no objections to this proposed action by the South Carolina Electric & Gas Company as long as affected roads are adequately relocated and bridges raised to our satisfaction. We understand that engineering studies relative to adjustments in affected roads and bridges are currently underway.

Sincerely yours,

J. D. McMahan, Jr.
State Highway Engineer

G-29

1894

State of South Carolina

JOHN C. WEST
GOVERNOR
J. LEE SPRATT
DIRECTOR

October 2, 1973

OFFICE OF THE GOVERNOR
DIVISION OF ECONOMIC OPPORTUNITY
P. O. Box 1520
Columbia, S. C. 29202

Mr. Kenneth F. Plumb, Secretary
Federal Power Commission
825 North Capitol Street, N. E.
Washington, D. C. 20426

Re: Project 1894, South Carolina

Dear Mr. Plumb:

We have reviewed in detail the above captioned program at Parr Shoals, South Carolina, submitted by the South Carolina Electric and Gas Company. In addition to our review at the state level, we had the local community action agency Executive Director review this proposal also since it is in his geographical territory.

We feel that this is a necessary program and one which will produce much needed services.

This project has our complete concurrence, and we recommend its approval.

With kind regards, I am

Sincerely yours,

J. Lee Spratt

J. Lee Spratt
State Director

JLS:blm

State of South Carolina
Water Resources Commission

G-30

1894

Clair P. Guess, Jr.
Executive Director

October 19, 1973

Mr. Kenneth F. Plumb
Secretary
Federal Power Commission
Washington, D. C. 20426

REFERENCE: Project No. 1894 - South Carolina
South Carolina Electric and Gas Company

Dear Mr. Plumb:

The South Carolina Water Resources Commission has reviewed the Federal Power Commission's Draft Environmental Impact Statement concerned with the application by South Carolina Electric and Gas Company for a new license for the existing Parr Project No. 1894. Parr Project No. 1894 is to be redeveloped to include a pumped-storage project and use of the upper pumped-storage reservoir as condenser cooling water for the Virgil C. Summer Nuclear Station Unit No. 1 and a proposed Unit No. 2.

When the staff of the South Carolina Water Resources Commission initially reviewed the Draft Enviornmental Impact Statement prepared by the Atomic Energy Commission for the Virgil C. Summer Nuclear Station Unit No. 1, we considered the total project which consists of both the V. C. Summer Station and the redevelopment of Parr Project No. 1894. At that time we offered no objections to the project and that position stands today. We feel that the total project will have less environmental effects than the alternatives and urge the issuance of a construction permit by the Federal Power Commission for their portion of the proposed development.

The South Carolina Water Resources Commission appreciates the opportunity to comment on this Draft Statement and offers any assistance we might provide.

Sincerely yours,

Clair P. Guess, Jr.
Executive Director

CPGJr:se

10 Copies furnished
Council on Environmental Quality

SOUTH CAROLINA
environmental coalition
P.O. BOX 5761 COLUMBIA, SOUTH CAROLINA 29250
(803) 253-1098

G-31

DOCKET
CENTRAL FILES

Mr. Kenneth F. Plumb, Secretary
Federal Power Commission
Washington, D.C. 20426

October 27, 1973

Dear Sir,

Please accept the following comments of the South Carolina Environmental Coalition with respect to the Draft Environmental Impact Statement for Project No. 1894-South Carolina, FPA-LP, the Paar Project of the South Carolina Electric and Gas Company.

We are aware that the comments on the Draft statement were requested to be submitted on October 23; It was originally not our intention to comment but a re-examination of the water quality portions of the Draft based on information we only this week received has raised new concern in our mind about the adequacy of the Draft statement. The South Carolina Environmental Coalition is a statewide citizens group. We hope that our comments will aid in your evaluation of the Draft Environmental Impact Statement and will lead to further study of water quality factors at the project site.

On October 25, 1973 we received in the mail at our request a report entitled The Relationship between Substrate Content, Water Quality, Actinomycetes, and Musty Odors in the Broad River Basin, dated January 1973, written by the Environmental Protection Agency, Surveillance and Analysis Division, Athens, Georgia. This report is not referred to in the References of the Draft Environmental Impact Statement for the Paar Project.

The report by EPA was prepared because of reports of musty odors in the drinking water system of the city of Columbia (the state capital and one of the state's largest cities). Columbia receives its drinking water system's supply from the Broad River six to eight hours flow time downstream from the Paar Reservoir site. However, the Draft Environmental Impact Statement does not mention that Columbia takes its water from the Broad, nor does the Draft describe water quality problems of the river in relation to the musty odor problems of Columbia. Our concern is that the musty odor of water that the city of Columbia depends upon is directly related to the proposed Paar Project, and that inadequate consideration of this crucial environmental factor is provided in the Draft.

The report by EPA suggests that the odor problems of the drinking water of Columbia may be attributed to algal and fungal organisms, and cites numerous studies showing the relationship of actinomycetes to odor problems in water. The EPA report (page 36) further states that as temperature increases, the activity of actinomycetes is enhanced. At the Paar Project and at the canals of the intake system at Columbia, (page 37), the EPA report notes a "sink" effect that may create "culture-like" conditions for actinomycetes. The proposed Paar Project would create a greatly enlarged sink, much of which would be warmed by use as cooling water for the Virgil C. Summer nuclear station; conditions might become almost ideal for contamination of the Broad River's waters with an odor problem. However, the Draft statement does not analyze the potential problem and ignores existing data on the subject. Clearly, the odor problem of the Columbia water

system is an environmental problem of the utmost concern and is directly related to the Paar Project. Thorough, independant studies should be conducted before a Final Environmental Impact Statement is released. Nor can the public place any confidence in the assertions such as those in the Draft that analysis of water quality at the project will be made during operation, as on page 4-15. Rather, providing for cooling towers, vastly reduced reservoir size below that which is proposed, and more stringent regulation of discharge rates from the impoundments are positive and feasible alternatives to the existing proposal and should be fully explored before approval of the project or its Environmental Impact Statements.

We are also concerned with losses to fisheries, recreation, and wildlife in the proposed project and we are hopeful that comments of others will be made on those areas of concern. We understand that some environmental damage may be necessary for the production of energy needed by society, but we are hopeful the comments we have made will help to minimize the risks. The suitability of water to be drunk by tens of thousands of persons is, however, of paramount importance and well worth the time and expense further study of the Paar proposal would require.

Respectfully yours,

Ann R. Jennings

Ann R. Jennings
President

Brion Blackwelder

Brion Blackwelder
Director

SOUTH CAROLINA ELECTRIC & GAS COMPANY
POST OFFICE BOX 764
COLUMBIA, SOUTH CAROLINA 29202

October 18, 1973

RECEIVED

OFFICIAL FILE COPY

TO	INIT.	DATE
DOCKET		
CENTRAL FILES		

F. Plumb, Secretary
FEDERAL POWER COMMISSION
1425 K Street, N. W.
Washington, D. C. 20426

RE: FWR-LP
Comments on FPC Draft Environmental
Impact Statement - Project No. 1894
South Carolina Electric & Gas Company

Dear Mr. Plumb:

Attached are the South Carolina Electric & Gas Company's comments on the FPC's September 1973, Draft Environmental Impact Statement for Project No. 1894. The comments are divided into the following three categories:

I. Modifications SCE&G feels should be made in the text.

II. Comments by SCE&G for the Commission's consideration.

III. Typographical errors found in the text.

As requested in the letter of transmittal sent to all concerned agencies, we are sending ten copies of this letter with attached comments to the Honorable Russell E. Train, Chairman of the Council on Environmental Quality.

Yours very truly,

V. C. Summer

KLM:VCS:gj
Attachments

cc: The Honorable Russell E. Train, Chairman
Council on Environmental Quality (10)

I. MODIFICATIONS SCE&G FEELS SHOULD BE MADE IN THE TEXT:

1. Page 1-2, line 9: 90 MW should be changed to 900 MW. (900 MW is the correct capacity of one unit of the V. C. Summer Nuclear Station).

2. Page 1-38, line 12: 4116 acres should be changed to 4400 acres. (Correct value obtained from Figure 1-9, page 1-41 of text).

3. Page 1-38, line 14: The phrase slightly more than 800 acres should be changed to about 1400 acres. (Correct value obtained from Figure 1-9, page 1-41 of text.

4. Page 1-38, line 15: 800 acre-feet should be changed to 2500 acre-feet. (Correct value obtained from Figure 1-9, page 1-41 of text).

5. Page 1-54, line 15: 100 feet should be changed to approximately 200 feet. (200 feet is the figure given in Exhibit R of SCE&G's amended application for new license for Project No. 1894, filed with the Commission on July 26, 1972.

6. Page 1-59, line 8: The words South Carolina Route 34 and should be removed. (This road will not be affected by the raising of Parr Reservoir).

7. Page 1-60, line 5: This line should be changed to read "...zation to use the 300 acre Monticello subimpoundment for swimming, after filling."

   It is not presently proposed to use the lower part of Monticello Reservoir for swimming or other water contact activity, just the sub-impoundment. This is consistent with the requirements of the state of South Carolina as stated in the third paragraph of page R-1 of Exhibit R included as Appendix F of the applicant's Appendicies to the Environmental Report-Parr Hydroelectric Project, FPC Project 1894, filed with the Commission July 26, 1972; and in the Amended Application for New License for Parr Hydroelectric Project, FPC Project 1894 (Exhibit R - Page R-1, third paragraph), also filed on July 26, 1972.).

8. Page 1-60, bottom line: The words White Hall Methodist Church should be deleted from this santence. (The June 1, 1972 letter from the S. C. Department of Archives & History does not include this item). We also point out to the Commission's attention that Ponti Flora is not included on the map of historical sites on page 2-29, or in the text on page 2-30.

9. Page 2-12 (Table 2-2, Cont'd.). The source of this table is not SCE&G's Environmental Report for Project 1894, filed on July 26, 1972. The Commission apparently obtained this table from another source and it appears that the other source was Appendix A-1, page 27, of the Supplement 1 of the Environmental Report for the Virgil C.

CEAG FEELS SHOULD BE MADE IN THE TEXT: (CONT'D.)

.r Nuclear Station, Unit I.

.age 2-28, line 23: The word Episcopal should be deleted. (This church is listed by the S. C. Department of Archives and History as the Monticello Methodist Church, and is located on S. C. Route 215 immediately north of the Davis Plantation and near the Town of Monticello).

11. Page 3-3, line 19: The words South Carolina Route 34 and should be deleted. (This road will not be affected by the raising of Parr Reservoir).

12. Page 4-11, line 20: Proposed should be changed to initial. (The sampling began in 1971).

13. Page 4-11, line 21: This line should be changed to read "...4-1. Certain sampling points have been and may be relocated to conform with...". (Since the sampling is already in progress, some changes have been made).

14. Page 4-16, line 18: The word turbidity should be deleted and replaced with stream flow. (Due to the lack of proper instrumentation to adequately monitor turbidity, as well as heavy metals, on a continuous basis, we recommend that these measurements be determined by grab samples taken at monthly intervals, and at a time that would coincide with approximately the 14,500 acre-feet release point from Monticello Reservoir.) These changes should be reflected in Table 4-2, page 4-18.

15. Page 9-8, line 6 and ff: Should be changed to read "within one year following commercial operation of the project".

reasonable

This modification is requested by the applicant due to the fact that low flat areas appropriate for development as green tree reservoirs can be positively identified after operation of the project has begun.

fine

The applicant requests the Commission to note in the attached memorandum of understanding with the U. S. Forest Service, page 3, item 6, that location of green tree reservoir site, will be deferred for one year following initial operation of the project.

Page 9-8: The applicant requests that a new paragraph be inserted between existing paragraphs three and four (numbered by the Commission as Items (1) and (2). This paragraph should read identical to the existing paragraph two, page 9-8.

This change is requested since the applicant is in agreement with

I. MODIFICATIONS SCE&G FEELS SHOULD BE MADE IN THE TEXT: (CONT'D.)

the Commission's timing (i.e. "within one year following issuance of any license for the proposed project") as set forth by the Commission in existing paragraph two, page 9-8.

This change, if incorporated by the Commission, will necessitate renumbering existing paragraphs four and five (numbered by the Commission as Items 2 & 3) to Items (1) & (2).

16. Page 9-13, last paragraph: The applicant notes for the Commission's attention that this paragraph implies that the applicant will request permission to construct a second 900 MW nuclear unit as part of the V. C. Summer Nuclear Station upon completion and commercial operation of the currently authorized 900 MW unit. Although the applicant has specific intentions to construct a second 900 MW nuclear unit, the applicant respectfully requests that the Commission delete reference that closely brackets the timing of the second nuclear unit.

17. Page 9-12, lines 18 & 19: SCE&G feels that the words turbidity and heavy metal concentrations be deleted. Due to the lack of proper instrumentation to adequately monitor turbidity and heavy metal concentrations on a continuous basis, we recommend that these measurements be determined by grab samples taken at monthly intervals, and at a time that would coincide with approximately the 14,500 acre-feet release point from Monticello Reservoir.

II. COMMENTS BY SCE&G FOR THE COMMISSION'S CONSIDERATION:

1. Page 3-9, lines 10-13: Results of SCE&G's Baseline Biotic Survey to date have indicated no beaver in the project area.

2. Page 3-29, paragraph (7): As indicated on page 17 of the December 29, 1971, Model Study Progress Report by Alden Research Laboratories (see Appendix I of SCE&G's Environmental Report for Project No. 1894, filed July 26, 1972), other distorted model tests remain to be made.

3. Page 4-6, paragraph (3): SCE&G and the U. S. Forest Service have signed a Memorandum of Agreement. A copy of this Agreement is attached to these comments.

4. Page 4-10, second and last paragraphs: The Biological Monitoring program is continuing on a quarterly basis, for both aquatic and terrestrial habitat and wildlife.

5. Page 4-14, last paragraph: The memorandum of Agreement between SCE&G and the S. C. Department of Wildlife and Marine Resources is only tentative relative to the issuance of a license for Project No. 1894. (See the copy of this agreement included in the FPC Draft Environmental Impact Statement).

6. Page 4-15, second paragraph: SCE&G does not disagree with the intention of this paragraph, but we point out that we have recognized that the daily fluctuations in Parr Reservoir would have an adverse effect on the existing sport fishery in Parr Reservoir. To offset this effect, the 300-acre fishing subimpoundment in Monticello Reservoir, to be stocked with bass and bream will be developed.

7. Page 4-16, lines 13-16: The locations of these monitoring stations are no longer tentative. There are four stations located as follows:

   Upstream Stations

   (a) At S.C. Route 72 and 121, Bridge across Enoree River: 10' x 10' concrete block building.

   (b) At S. C. Route 72 and 121, Bridge across Tyger River: 8'x8' lined steel building on concrete foundation.

   (c) At S. C. Route 72 and 121, Bridge across Broad River: 8'x8' lined steel building on concrete foundation.

   Downstream Stations

   (a) At Parr Hydro Plant, just below Parr Dam: 10'x10' concrete block building.

II. COMMENTS BY SCE&G FOR THE COMMISSION'S CONSIDERATION: (CONT'D.)

All instruments are operated on electricity supplied by local utilities.

These changes in location should be reflected in Table 4-2, page 4-18.

8. Page 9-11, last 7 lines, and page 9-12, first 5 lines: SCE&G points out that we have recognized that the daily fluctuations in Parr Reservoir would have an adverse effect on the existing sport fishery there. To offset this effect, the 300 acre fishing subimpoundment in Monticello Reservoir, to be stocked with bass and bream, will be developed.

9. It appears that page R-3 should follow page R-5.

III. TYPOGRAPHICAL ERRORS FOUND IN THE TEXT:

1. Page 1-6, line 16: The word steam should be changed to stem.

2. Page 2-3, line 10: The word in-site should be changed to in-situ.

3. Page 4-22, line 1: The word areas should be changed to area.

4. Page 4-24, line 21: The words hear and often should be changed to heal and soften.

5. Page 9-5, line 20: The word Canaan should be changed to Cannon's.

6. Page 9-7, first two paragraphs: These should be deleted, as they are repeated from page 9-6.

G-40

1. (DOCKET) FPC-NA
2. CENTRAL FILES

SOUTH CAROLINA ELECTRIC & GAS COMPANY
POST OFFICE BOX 764
COLUMBIA, SOUTH CAROLINA 29202

V. C. SUMMER
SENIOR VICE-PRESIDENT

December 11, 1973

FEDERAL POWER COMMISSION
DOCKETED
Dec. 14, 1973
DOCKET SECTION

Mr. Kenneth F. Plumb, Secretary
FEDERAL POWER COMMISSION
1425 K Street, N. W.
Washington, D. C. 20426

Re: SCE&G Response to Comments by Others on FPC Draft Environmental Impact Statement—FPC Project No. 1894—South Carolina Electric & Gas Company (Addenda I to SCE&G's October 18, 1973 Comments on FPC Draft Environmental Impact Statement.)

Dear Mr. Plumb:

South Carolina Electric & Gas Company has previously commented on the FPC Draft Environmental Impact Statement of September, 1973, for Parr Hydroelectric Project (FPC Project No. 1894) in a letter dated October 18, 1973. We have recently studied the comments on the same Environmental Impact Statement made by the Environmental Coalition in a letter of October 27, 1973, and by the U. S. Department of Health, Education, and Welfare in a letter of October 23, 1973, and we wish to make the following response to these comments as an Addenda to our comments of October 18, 1973.

I. Response to Environmental Coalition Comments

The Environmental Coalition's major concern in their October 27, 1973 letter was that the Draft Impact Statement does not describe the water quality problems of the river in relation to the musty odor problems of Columbia. They are concerned that the proposed Parr project would create a greatly enlarged sink which would be warmed by cooling water from the Virgil C. Summer nuclear station and provide conditions which would enhance the odor problem of the Columbia water system.

Their concern is based on a report entitled The Relationship between Substrate Content, Water Quality, Actinomycetes, and Musty Odors in the Broad River Basin. This report was prepared by the Environmental Protection Agency, Surveillance and Analysis Division, Athens, Georgia, in January 1973 and reported the following conclusions and recommendations:

"The musty odors found in the Columbia, South Carolina, municipal water supply are not unique to that area, but are a

widespread phenomenon in the Broad River Basin. Actinomycetes, common throughout the basin, are the organisms producing the musty odors; however, antinomycete growth and musty odor production appear to be dependent on the influx and storage of organic matter and other nutrients, air and water temperature, rainfall, and stream flow during the spring season. The major tributaries in South Carolina appear to be a primary source of organic matter and other nutrients, while the canals and reservoirs act as a 'sink' for these nutrients, thus providing a substrate conducive to actinomycete growth and odor production."

"Columbia water treatment plant personnel should create an odor panel and regularly sample upstream in the vicinity of Parr Dam for odors during the spring of the year. Personnel should be prepared to treat the water with activated carbon when air temperatures and water temperatures of 17°C or greater occur during extend springtime low flow (less than 6,500 cfs) periods (2 to 5 weeks) and upstream threshold odors are four or greater. When the above conditions occur, severe odor problems can be expected; therefore, treatment should begin as soon as possible."

"Inputs of wastes from municipalities and industries in the Broad River Basin should be reduced to levels commensurate with available waste treatment technology. Particular attention should be given to wastes from Lockhardt and Carlisle textile mills and discharges into Tributary streams draining the Greenville-Spartanburg area."

It should be pointed out that musty odor problems are not unique to the Columbia area but are common and widespread throughout the world. These odors are usually associated with metabolites of bacteria, fungi or blue-green algae.

The EPA concluded that the musty odor being produced in the Broad River system is the result of actinomycete activity. This fungus is known to produce two metabolites with powerful musty/earthy odors. These are geosmin and 2-methylisoborneol, both aliphatic alcohols. Very little is known on the ecology of these organisms. It is known that organic material is necessary for their proliferation and that the metabolites appear to be dependent on the organic matter. Organic materials may originate from natural runoff or municipal or industrial wastes and can be "trapped" by impoundments providing a suitable substrate for actinomycete growth. The EPA report, thus, recommends that more efficient municipal and industrial waste treatment processes be applied upstream to help alleviate this problem.

Increased temperature of water reaching Parr Reservoir as a result of cooling water from the Virgil C. Summer nuclear station is

expected to be a maximum of 3°C as it enters Parr Reservoir and would be further diluted by the waters of the Broad River so that no perceptible increase would be apparent below Parr Dam. This small temperature change would affect only a portion of the reservoir and, therefore, is not expected to greatly enhance actinomycete development.

Musty odors can be treated by activated carbon or charcoal. If Columbia water treatment plant personnel sample upstream for odors as recommended by EPA, odor problems could be diagnosed and properly treated before severe odor problems develop.

If it is deemed necessary SCE&G could take odor samples on a weekly basis along with other routine water quality analyses.

11. Response to Department of Health, Education and Welfare Comments

The major concern of the Department of Health, Education and Welfare in their October 23, 1973 letter was that additional school class rooms would be required in the project area schools due to the attendance of children of the 30% of the Project Work Force living in or near the project area. It is anticipated that this 30% of the work force will be permanent residents who already live within 25 miles of the site, and since their children will already be attending local schools, no large additional burden on the local schools is anticipated.

We hope that the above comments will be helpful to the FPC staff in their preparation of the final Environmental Impact Statement for Project No. 1894. SCE&G will continue to respond to other comments made to the FPC on their Draft Environmental Impact Statement for Project No. 1894, as these comments are made available to the company.

Yours very truly,

V. C. Summer
Senior Vice-President

KLM:VCS:ii

G-43

SOUTH CAROLINA ELECTRIC & GAS COMPANY
POST OFFICE BOX 764
COLUMBIA, SOUTH CAROLINA 29202

V. C. SUMMER
EXECUTIVE VICE PRESIDENT

COPY SENT TO REGULATORY
REGIONAL OFFICE

January 2, 1974

JAN 4 1974
FEDERAL POWER COMMISSION

Mr. Kenneth F. Plumb, Secretary
FEDERAL POWER COMMISSION
1425 K Street, N. W.
Washington, D. C. 20426

Re: Correction in SCE&G's December 11, 1973 Response to Comments by Others on FPC Draft Environmental Impact Statement-FPC Project No. 1894-South Carolina Electric & Gas Company

Dear Mr. Plumb:

It has come to our attention that there is an error in our December 11, 1973 letter to you giving SCE&G's response to comments by the Environmental Coalition and the U. S. Department of Health, Education, and Welfare on the FPC Draft Environmental Impact Statement for Project No. 1894-Parr Hydroelectric Project.

On line one of page three, the phrase "a maximum of 3°C" should be changed to read "a maximum of 3°F". This correction should be marked on your copy of the letter.

Yours very truly,

V. C. Summer

KLM:VCS:ii

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JAN 17 1974
DIVISION OF LICENSED PROJECTS

FEDERAL POWER COMMISSION
RECEIVED
Jan. 4, 1974

SOUTH CAROLINA ELECTRIC & GAS COMPANY
COLUMBIA, SOUTH CAROLINA 29202

January 2, 1974

Mr. Kenneth F. Plumb, Secretary
FEDERAL POWER COMMISSION
1425 K Street, N. W.
Washington, D. C. 20426

Re: Clarification of a Statement in FPC Draft Environmental Impact Statement for Project No. 1894-Parr Hydroelectric Project.

Dear Mr. Plumb:

In reviewing the FPC Draft Environmental Impact Statement for Project No.1894 (Parr Hydroelectric Project), the South Carolina Electric & Gas Company has encountered a statement with a possible dual interpretation. On page 9-2, line 2 of the Draft Environmental Statement, the following sentence seems to have more than one possible meaning: "To maintain the benefits of a shoreline buffer strip, access should be controlled by the Applicant."

SCE&G would like the FPC to clarify this statement so that we can more readily finalize our land acquisition program for Project No. 1894. We would like to know if it will be Commission policy in this project 1) that the quoted statement will require the Applicant to purchase all the lands within the shoreline buffer strip in fee, in order to have complete control of the area, or 2) that the statement will be adequately covered by the Applicant's purchasing easements restricted by the necessary covenants to give SCE&G the required shoreline control.

At the present time SCE&G is negotiating with one of the large landowners in the project area, who wishes only to grant easement for his lands between the maximum Monticello Reservoir elevation and the project boundary, instead of selling the land in fee. Clarification by the FPC of the statement on page 9-2 of the FPC Draft Environmental Impact Statement would help SCE&G to conclude its dealings with this landowner and with others, and would facilitate the timely removal of marketable timber in the project area, thereby avoiding destruction of a valuable natural resource.

Yours very truly,

Senior Vice-President

SOUTH CAROLINA ELECTRIC & GAS COMPANY
POST OFFICE BOX 764
COLUMBIA, SOUTH CAROLINA 29202

V. C. SUMMER
SENIOR VICE-PRESIDENT

9 January 1974

Mr. Kenneth F. Plumb, Secretary
FEDERAL POWER COMMISSION
1425 "K" Street, N.W.
Washington, D.C. 20426

RE: SCE&G'S Response to Comments by Others on FPC Draft Environmental Impact Statement - FPC Project No. 1894 South Carolina Electric & Gas Company (Addenda II to SCE&G's October 18, 1973 Comments on FPC Draft Environmental Impact Statement)

Dear Mr. Plumb:

South Carolina Electric & Gas Company has previously commented on the FPC Draft Environmental Impact Statement of September 1973 for Parr Hydroelectric Project (FPC Project No. 1894) in a letter dated October 18, 1973 and in a letter of December 11, 1973 (Addenda I).

We have considered comments on the same Environmental Impact Statement made by (1) The United States Department of Interior in their letter received by the Commission's Docket Section November 9, 1973, and (2) the Office of the Assistant Secretary of Commerce in their letter mailed to the Commission and dated November 19, 1973. Our responses to the comments made by these agencies are attached.

Very truly yours,

V.C. Summer
Senior Vice President

VCS/sgp
Attachment

I. RESPONSE TO DEPARTMENT OF INTERIOR COMMENTS DATED NOVEMBER 9, 1973 BY THE COMMISSION'S DOCKET SECTION.

Department of Interior Letter, page 1 (General Comments)

Comment

"There is no evidence to indicate the details of these proposals (for various biological studies to identify the fish and wildlife resources and environmentally desirable project modifications) have been finalized or reviewed by the appropriate State and Federal agencies."

Response

The details of proposed or existing biological studies or project modifications for fisheries resources are:

a) A continuing biological program for water quality and aquatic resources that began in 1971 and is presently in progress. This program forms the basis of baseline conditions and predictive effects. Details of the sampling program, including stations, sampling frequency, and data obtained are contained in the annual report which will be shortly available.

b) The proposed construction phase of the biological sampling program is essentially a continuation of the existing program with increased emphasis in areas where construction effects may occur. Birds are considered good indicators of terrestrial environmental change, and the following is a description of the construction phase bird monitoring program:

To complete the second full year of baseline information, a January 1974 survey is necessary and will include the auto survey, strip census, and the waterfowl census. The auto survey will then be discontinued until the filling of Monticello Impoundment. The waterfowl census, which is also associated mainly with the pumped storage facility, would be run again during late May or early June after dredging has begun.

The strip census will be used to determine effects brought about by the construction of the nuclear facility. This census would be run in the construction area as well as control areas; areas unaffected by construction activity. Changes in species composition and abundance will be noted. Census dates were selected to observe greatest avian activity during the four seasons; January,- March, late May or early June, and September.

Aerial color infrared photographs of the project area will be obtained in 1974 and continued on an annual basis through the second year of commercial operation of the Pumped Storage Project. This data will provide a history of lumbering and construction operations as well as more clearly delineate forest type, possible disease and insect infestations which may otherwise be speculated as being a result of the plant operation.

The planned photographic flight will obtain color infrared exposures at the scale of 1" = 2,000' utilizing ASTACS (Automatically Stabilized Airborne Camera Systems) and precision Zeiss RMK A 15/32 mapping camera. The mapping flight will cover an area of approximately 30 square miles and will be conducted during the spring, immediately after the hardwoods have leafed out. Analysis will be conducted utilizing an electronic multi-spectral scanner.

The aquatic program is scheduled to begin during the spring of 1974. Efforts will be concentrated on determining dredging effects on the aquatic biota. Four stations will be sampled for plankton, benthos, and fish to monitor changes in species composition and abundance. Special emphasis will be placed on turbidity effects as they relate to primary productivity, adverse silting effects on benthos, and spawning activities of fish. It is anticipated that three surveys will be conducted during 1974; block-netting and rotenoning to determine fish biomass would be conducted during the summer survey. Methods utilized will be the same as those established during the baseline survey.

c) The proposed operation phase monitoring program has not been finalized at this time. Its major outline will be similar to the baseline and construction phases. However, specific studies will be undertaken to determine effects of entrainment, impingement, thermal and chemical effluents, and water-level fluctuations.

The existing water quality and biological monitoring programs have not officially been reviewed by state or Federal agencies with the exception of the AEC review in the 1972 Environmental Report. This report, however, has been circulated to all interested agencies for comment and it is assumed that questions or comments relative to the monitoring programs would have come forth.

Dept. of Interior - pg. 3 (Water Quality 2.4)

Comment:

No data on heavy metal content of incoming waters and sediments was presented. Concern was shown for the potential concentration and accumulation of heavy metals in Parr, Monticello, and the recreation lake impoundments and their potential affect on aquatic life.

Response:

A program to define current levels of heavy metals in the water will begin in 1974. The parameters and frequency of sampling has been outlined in response to the comment on monitoring programs.

Suspended solids in river water are known to scavenge heavy metals from solution and result in their deposition in the sediments of lakes and streams. There, these metals may be available to benthic feeding fish and invertebrates, particularly those that are detritivores. Therefore, the sediments were analyzed for certain heavy metals as well as pesticide concentrations.

Concentrations of DDE, DDD, and DDT from all samples were generally very low and were often below the detectable limits of 0.005 ppm. No other pesticides were detected in the bottom sediments. Similar findings were made for surface soils of the surrounding study area, although the frequency of occurrence of samples containing no pesticide residue was greater. Concentration (in ppm) of pesticides found in the bottom sediments are as follows:

Transect	DDE	DDD	DDT
A	0.005	0.005	0.005
B	0.009	0.007	0.012
C	0.007	0.005	0.005
D	0.007	0.007	0.009
E	0.005	0.008	0.009
F	0.005	0.005	0.005

Polychlorinated bi-phenyls (PBCs) were present in moderate concentrations ranging from 0.010 to 0.044 ppm. The highest concentration was found at Transect E, directly below Parr Dam.

Boron was present in the highest concentration (100-194 ppm) of the minerals measured in bottom sediments (Table 1). Concentration of all other minerals measured were low. Lithium and zinc concentrations were generally low, but in all cases higher than those in the surrounding topsoil. With the exception of lithium, mineral concentrations were highest in and below the reservoir. Lithium, zinc, and arsenic concentrations were greatest at Transect E, directly below Parr Dam.

The following heavy metals will be analyzed during the first quarter of 1974 to document their concentrations and to determine if further monitoring is warranted because of excessively high concentrations:

Aluminum	Magnesium	Silver
Beryllium	Manganese	Strontium
Boron	Molybdenum	Tin
Cobalt	Selenium	Vanadium

The following heavy metals will be analyzed on a monthly basis beginning with the first quarter of 1974:

Arsenic	Copper	Mercury
Cadmium	Iron	Nickel
Chromium	Lead	Zinc

The samples for heavy metal analysis will be taken at the following locations:

1. Broad River at Highway 34.
2. Frees Creek at Southern Railroad.
3. Frees Creek 1 mile upstream from Southern Railroad.
4. Frees Creek at Highway 99.
5. Broad River at Parr (Parr Reservoir at Dam)
6. Broad River at Highway 213.
7. Broad River at Richtex.
8. Broad River at I-20 Bridge

Monthly analyses for oil and grease will be made on samples taken at the following locations:

1. Broad River at Highway 34.
2. Broad River at Parr (Parr Reservoir at Dam).
3. Frees Creek at Southern Railroad Trestle.
4. Broad River at Highway 213.

Table 1 Concentration of minerals in bottom sediment samples from the Broad River Study Area at Parr, South Carolina, February 1972. All values are in parts per million.

Transect	Arsenic	Copper	Zinc	Lead	Mercury	Boron	Chromium	Lithium
A	0.020	6.96	27.0	6.24	0.008	100	22.80	3.92
B	0.020	13.90	30.2	18.40	0.042	142	36.50	2.80
C	0.020	21.70	30.3	20.20	0.033	160	25.20	2.32
D	0.027	25.20	30.4	14.60	0.038	174	35.40	3.64
E	0.160	10.70	36.9	8.83	0.017	168	24.60	8.28
F	0.107	5.40	24.9	5.42	0.021	108	20.40	4.20

RESPONSE TO DEPARTMENT OF INTERIOR COMMENTS.

Dept. of Interior - pg. 4 (Fish and Wildlife Sect. 2.8)

Comment: "This section of the final statement should identify the quantity and quality of fish habitat to be affected by project implementation."

Response A of A and B:

There are four basic aquatic habitat types represented in the project area that may be affected. NOTE: Terrestrial habitat types discussed in Response B that follows.

a) A section of the free flowing Broad River above the present Parr Reservoir level.

This 23 km section of the river is relatively constant in width (ranging from approximately 350 to 700 feet) and has a low gradient of less than 1 ft per mile. The river is generally shallow with maximum depths of less than 20 feet and much of the river of five feet or less.

There is little to no aquatic macrophyte growth in the river, however, the banks are characteristically grassy with trees near the edge or overhanging the water. Banks are generally steep-sided, and there are few islands in this section of the river.

Bottom types vary from silty sand in the slower areas to sand in the more scoured areas. Rocks occur infrequently and are primarily in the area immediately below Henderson Island. Downed trees occurred along the river bottom.

This section of the river is suitable for a variety of fish species that prefer moving water and provides little quiet water and back eddies. It is suitable spawning area for many fish species that require moving water and firmer bottoms than are present in Parr Reservoir.

b) A semi-free flowing habitat within Parr Reservoir.

Because of a siltation and shallowing a large part of Parr Reservoir has become riverline in nature and experiences water movements similar to the river but of generally lesser magnitude. The riverine habitat within Parr Reservoir ranges from a relatively straight, narrow upper end with few islands to larger open areas characterized by vegetated islands and shifting shallows and backwaters.

Reservoir width varies greatly, from approximately 500 feet at its upper end to 2800 feet near the dam. Depths may be 20 to 25 feet, in the channel near the dam, but most of the lake has depths averaging only 3-4 feet.

The bottom is primarily silt, sand and muck with many submerged or semi-submerged trees. The sides are often steep and overhung by trees.

This section of the river provides habitat for all species of fish known to be in the reservoir, but is probably less productive than embayment portions.

c) Embayment habitats within Parr Reservoir

Frees Creek, Bellas Creek, and Cannons Creek embayments are the major representatives of this lentic type of environment. Together they form about 22% of the total Parr Reservoir surface acreage.

Embayment widths vary from a few hundred feet to nearly 3/4 mile, and in length from 0.6 to 5.3 miles. Channel depths are 12-15 feet, however, depths just out of the channel quickly change to 4-6 feet and become shallow toward shore. Embayments are characterized by little current flow, an abundance of submerged partly emerging dead trees, and the variable influence of their small feeder streams.

Banks are generally only moderately to slightly steep and often overhung by trees which extensively shade the margins. Bottoms are silty, becoming more sandy as the creek mouth is approached.

These embayments are generally richer in fish habitat than the more open water, however, Cannons Creek Embayment appears to support several times the standing crop of fish than does Frees Creek Embayment.

d) The free-flowing portion of Frees Creek

About 7 miles of Frees Creek will be affected. This small stream flows from an elevation of approximately 450 feet and has an average drop of about 20 feet per mile. The drop is greatest in the upper 1/4 of the creek, averaging 33 feet per mile and lesser in the lower 3/4, averaging 12 feet per mile.

The stream is small, the width averaging 10 feet or less. Water depth is generally less than a foot and is usually a few inches. There are some deeper pools formed around branches and debris, but most of the creek is riffle or shallow pool. The stream bottom is generally of sand, ranging from coarse to fine. There is very little rock and thus the bottom tends to be unstable.

The creek runs through a mixed deciduous and pine forest and is heavily shaded. No rooted macrophytes are present. In contrast to the Tyger River, Frees Creek is often clear, and turns turbid only after heavy rains.

The stream appears to provide poor fish habitat because of its [illegible] and [illegible] bottom. No fish from Parr Reservoir are known to [illegible]

Category	Shoreline Miles	Acreage
a) Broad River	16	740
b) Reservoir without embayments	18	2300
c) Embayments	11	660
d) Frees Creek	* 14	-

* includes both sides of the stream or embayment

Response B of A and B:

There are four terrestrial habitat types within the project area that may be affected.

Four major habitat categories were identified on the project area and include the following: pine plantation, mixed pine-deciduous woodlands, deciduous woodlands, and grasslands (cultivated and abandoned farmland). The approximate percentage of each major type that will be inundated by the project impoundments is as follows:

	Parr Reservoir	Monticello impoundment
Pine	2%	47%
Mixed	8%	26%
Deciduous	86%	15%
Grasslands	4%	12%

The quality of the woodland communities to support a diverse and an abundant fauna is dependent upon the site characteristics, age structure of the forest, and density of the canopy. These factors have a direct influence on the development of herbaceous vegetation and shrubs which, in turn, is part of the life-support system of woodland wildlife.

The site characteristics that influence lower story productivity include the slope, moisture retention properties, and organic content of soils. Pine plantations usually occur on the upland sites that are well drained and slightly acidic (pH 5.0 to 5.5). The nutrient levels in the uppermost soil layer are not well developed because pine needles decompose slowly. Deciduous leaved shrubs and herbaceous vegetation do not grow readily in these mildly adverse conditions.

The deciduous leaved tree sites, along the Broad River and tributary creeks, are moderate to poorly drained and provide a better substrate for the growth of herbaceous or shrub vegetation. The decomposition

of deciduous leaves results in more nutrients available and an improved nutrient exchange between the soil and vegetation.

The age-structure and density of a forest influences the penetration of sunlight to the forest floor. The amount of sunlight that reaches the substrata is reduced in a mature and/or even-aged stand of trees having a dense canopy. A stand composed of uneven-aged trees will allow sunlight to reach the substrate more readily.

The monitoring program included the analysis of vegetation on five study sites representative of the four major communities on the project area. The five sites include the following: two sites in pine plantations of two different-age classes, one site in a mixed pine-deciduous community, one in a predominantly deciduous forest, and one site in a grassland where pine seedlings had been planted. All five sites are in the vicinity of the Monticello Impoundment. Each habitat community is described in more detail in the following paragraphs.

Pine Habitat

The coniferous communities to be inundated consisted mainly of loblolly pine which produces a closed canopy forest with a sparse understory of herbaceous vegetation. Only limited numbers of pine seedlings and saplings are capable of growing under the dense canopy which reduces light penetration to the substrate.

Two pine plantations representative of the project area were described by the following techniques: the point-centered-quarter method was used to obtain relative density, relative frequency, and relative dominance of trees over 2.5 cm d.b.h.; diameter at breast height (d.b.h.) was measured to characterize age-classes; and the frequency of occurrence was obtained for shrubs, herbaceous vegetation and other ground species from 40 one-tenth square meter plots systematically placed in each habitat.

Tables 2 and 3 show the diversity and the relative frequency, density, and dominance, and importance value for trees found on the two pine plantations sampled. Loblolly pine is the most important species on both sites. Herbaceous and woody vegetation is not abundant on either site (Table 4). In the first pine plantation, Schribner's panicum, blackberry and dandelion occurred in more than 25 percent of the quadrants. The second pine plantation sampled shows a greater diversity and frequency of herbaceous and woody vegetation. The understory vegetation in the second plantation was studied one year following the selective remove of the mature pine for pulpwood.

The quality of the pine communities in regard to supporting wildlife is considered to be very poor because of the sparse understory. Neither shelter, forage nor browse was significantly available to wildlife.

A variety of songbirds were recorded in pine plantations during two seasons (Table 5). The density of birds was low in the pine plantations. Game birds such as turkey and bobwhite are also low in abundance because the available nuts, fruits, seeds and shelter is sparse.

Small mammals were censused in two pine plantations for five days in each of four seasons (Table 6). Of the total small-mammals collected, seventy-eight percent were in the second pine plantation where the understory vegetation was more abundant. Golley, et al. (1965) also found small mammals to be low in abundance in pine plantations.

No furbearing or game mammals were observed or trapped in pine plantations. Cottontail rabbits, however, were occasionally seen near an ecotone between a pine plantation and pasteland where food and

protective cover were more plentiful. Browse for white-tailed deer is very sparse in pine plantations with only limited amounts of Walter's smilax, honey-suckle, blackberry, and dogwood.

Mixed Pine-Deciduous Habitat

Of the mixed pine-deciduous communities to be inundated by Monticello Impoundment, 73 percent consists of areas where pine was selectively removed. The hardwood understory was predominant on aerial photographs, resulting in those areas being classified as mixed pine-hardwood community.

The mixed pine-deciduous study site was located along the sloping shoreline of Frees Creek, near the Broad River. Loblolly pine, eastern red cedar, and red maple were the most important species (Table 7). Loblolly pine was the dominant species within the area, but eastern red cedar was the most dense.

A variety of species comprised the understory with Walter's smilax being the most frequent woody plant and sedge the most frequent herbaceous plant (Table 4). The understory was diverse because sunlight could penetrate the multi-aged and diverse forest to reach the understory and substrate and deciduous leaves provided a better humus layer on the soil.

The quality of the "mixed" habitat for wildlife is probably fair but limited in distribution as ecotones between pine plantations and the deciduous forests on the bottomlands. The distribution of "mixed" habitats on the project area and the low frequency of potential food plants is representative of the over-all low quality of the project area for native wildlife species. The understory vegetation includes a variety

of plants valuable as browse or food for white-tailed deer, turkey and bob-white quail. However, none was abundant.

Native wildlife populations in the "mixed" community were low in abundance. Song birds were more abundant in pine habitat than "mixed" habitat (Table 5). However, the "mixed" habitat, where birds were censused, contained significantly more mature deciduous woodland habitat than pine habitat. Small mammals were more abundant in "mixed" habitat than the pine habitat (Table 6).

Medium sized mammals recorded in "mixed" habitats include an occasional gray squirrel and white-tailed deer. Four opossum and one raccoon were livetrapped along upper Frees Creek.

The northern two thirds of Frees Creek flows through habitat that includes all four major types, but with a dominance of "mixed" and deciduous woodlands. Openings created along the creek by highway intrusion or farming activity, or tree windfalls exhibit a fairly lush growth of shrubs, vines, and some herbaceous vegetation. This narrow band of habitat along the creek represents the best quality habitat for mammals and birds. Its distribution, however, is limited.

Deciduous Woodlands

Deciduous woodlands are distributed primarily along the flood plain of the Broad River and its tributaries. These woodlands are typically composed of mature, dense stands that restrict the light penetration which inhibits the growth of understory vegetation.

One study site was established among hardwoods on a tributary of Frees Creek. The stand was not described by the point-centered quarter method, but the frequency of understory vegetation was obtained

within the stand (Table 4). Herbaceous vegetation is almost absent while woody plants were present but not abundant. Walter's smilax was the most frequently occurring understory species in this hardwood stand. The understory of hardwood forest along the bottomlands of the Broad River was often limited to sedge and bamboo. Woody plants in the understory were generally absent except where light reaches the substrate along the stream banks and in man-made and naturally occurring openings. Man-made openings are not common in the deciduous woodlands along the Broad River in the project area.

The deciduous forests in the bottomlands along the Broad River and tributaries will not support many white-tailed deer, turkey, bobwhite, and squirrel. Although the mature trees produce an annual mast crop (acorns, seed, etc.), the mast is generally available to turkey and squirrel, but not readily available to white-tailed deer. Browse and forage for deer is not abundant either as indicated by the low abundance and diversity of woody and herbaceous vegetation. Understory vegetation increases abruptly in openings created by abandoned farm fields, railroad and transmission line rights-of-way, and abandoned roads. These openings do not contribute sufficiently to the wildlife cover to warrant the classification of the Broad River bottomlands as productive wildlife habitat.

Grasslands

The grassland community type included seven percent cultivated or pasture and five percent abandoned farmland. Abandoned farmland included communities representing several seral stages of succession.

The study site consisted of plantation pine approximately three years [illegible] with [illegible] a d.b.h. greater than 2.5 cm.

Vegetation on the site typifies an early successional stage of a disturbed site. Broomsedge was the most important grass species on the site (Table 8) with triple-awned grass being the next most important. The density of grass species (6,756 plants/ha) contributed to a total ground cover of 9.8 percent.

Grasslands provide an important link in the requirements of wildlife on the project area. The quality of grasslands to support wildlife is variable according to the current land-uses. Grazed pasture and cultivated fields are important to the few mourning dove and bobwhite. Abandoned farmland in various stages of succession are important to such game species as bobwhite, mourning dove, turkey, white-tailed deer, and cottontail rabbit.

Mourning dove call counts conducted on the project area during the same period that the national surveys are conducted showed the population to be low on the project area. An average of 7.5 doves were heard per route on the project area in 1973 as compared to an average of 49 doves heard per route in 1970 on the best region of South Carolina, the Carolina Sandhills National Wildlife Refuge. Small grain cultivation is important to this game bird, and not abundant on the project area. Song birds were most abundant in the abandoned fields studied on the project area (Table 5). The highest diversity and often the highest abundance of small mammals was collected in a grassland (Table 6).

The distribution of abandoned farmland is another limitation on the carrying capacity for native wildlife species on the project area.

The ecotone that forms between grassland and forest land also is important in the distribution of wildlife. The edge provides nesting

sites for many song birds, as well as a diversity of plants for cover and food for bobwhite quail, turkey, white-tailed deer, and cottontail rabbit.

Summary

The overall quality of the environs on the project area is low. Mixed habitat of pine and deciduous trees is the best quality because of an uneven aged stand of timber. The broad age distribution increases the probability of shrubs and herbaceous vegetation growing near the ground. The mature trees of the deciduous forests and the dense stand in pine plantations retard the development of understory vegetation important to woodland wildlife. A few, but insufficient, openings occur amoung the deciduous forests and pine forests where understory vegetation is present and encourages some fauna development.

The overall quality of the habitat to support wildlife will improve slightly as a result of lumbering operations. Timber cutting activites throughout the region are increasing forest openings. Understory woody and herbaceous vegetation will increase under these openings and an increase in the carrying capactiy of the project area for wildlife is anticipated.

Table 2 Relative frequencies, densities, dominance and importance values of tree species (2.5 cm or greater dbh) growing in Site 1A of the Broad River Study Area, June 1971.

Species	Relative Frequency	Relative Density	Relative Dominance	Importance Value
Loblolly Pine	52.9	69.4	80.8	203.1
Sweet Gum	21.4	18.0	13.9	53.3
Flowering Dogwood	11.4	6.3	2.7	20.4
Eastern Red Cedar	7.1	3.1	1.5	11.7
Tulip Tree	2.9	1.3	.6	4.8
Hop-hornbeam	2.9	1.3	.4	4.6
Red Maple	1.4	0.6	.2	2.2
Totals	100.0	100.0	100.1	300.1

Table 3 Relative frequencies, densities, dominance and importance values of tree species (4.5 cm or greater dbh) growing in Site 4 of the Broad River Study Area, June 1971.

Species	Relative Frequency	Relative Density	Relative Dominance	Importance Value
Loblolly Pine	60.7	81.3	85.9	227.9
Eastern Red Cedar	12.2	6.3	5.1	23.6
Holly	6.1	3.1	1.5	10.7
Black Cherry	4.5	2.5	2.4	9.4
Oak sp. 1	4.5	1.9	1.8	8.2
Red Maple	4.5	1.9	0.9	7.3
White Oak	1.5	0.6	0.9	3.0
Hop-hornbeam	1.5	0.6	0.6	2.7
Oak sp. 2	1.5	0.6	0.3	2.4
Willow Oak	1.5	0.6	0.3	2.4
Sweet Gum	1.5	0.6	0.3	2.4
Totals	100.0	100.0	100.0	300.0

Table 4 Frequency of occurrence (%) of understory, herbaceous, and woody plant species (mostly shade plant, hardwood, mixed pine-hardwood, and grassland environs in the Broad River Study Area.

Growth Form / Common Name	COLLECTION SITES 1 Pine 1	1B Hard-wood	2 Grass-land	3A Mixed	4 Pine 2
Vascular Cryptogams					
Fern	4	-	-	10	-
Herbaceous Forbs					
Arrowhead	-	-	10	10	-
Aster	-	-	10	-	10
Bundle Flower	-	-	-	-	15
Cinquefoil	-	8	-	5	-
Common Ragweed	-	-	5	-	-
Dandelion	28	-	-	-	-
Goldenrod	12	-	20	-	5
Heartleaf	-	-	-	20	-
Lespedeza	-	-	5	-	10
Pussy's Toes	-	-	-	-	5
St. John's Wort	4	-	-	-	-
Wild Ginger	-	-	-	20	-
Wood Sorrel	20	-	-	-	-
Grasses					
Bamboo	-	-	-	35	-
Bermuda Grass	24	-	-	-	-
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Brownseed	-	-	10	-	-

Table 4 (Continued)

Growth Form / Common Name	COLLECTION SITES				
	1 Pine 1	1B Hard-wood	2 Grass-land	3A Mixed	4 Pine 2
Cane Bluestem	-	-	4	-	-
Indiangrass	-	-	-	10	30
Little Bluestem	-	-	45	-	30
Scribner's Panicum	28	-	30	15	25
Three-awned Grass	-	-	40	-	-
Sedges					
Sedge	-	20	-	45	-
Woody					
Shrubs					
American Holly	8	16	-	15	15
Blackberry	28	-	5	-	-
Rose	4	8	15	-	-
Trees (<5 cm d.b.h.)					
American Hornbeam	-	4	-	-	-
Black Cherry	4	-	-	-	-
Black Oak	-	8	-	-	-
Dogwood	-	4	-	-	15
Eastern Red Cedar	4	-	-	10	-
Hawthorn	4	4	-	-	-
Laurel Oak	4	28	-	15	10
Loblolly Pine	40	[illegible]	5	[illegible]	[illegible]
Pignut Hickory	-	-	-	5	-

Table 4 (Continued)

Growth Form Common Name	COLLECTION SITES 1 Pine 1	1B Hard-wood	2 Grass-land	3A Mixed	4 Pine 2
Red Maple	-	-	-	5	-
Sugarberry	-	8	-	-	-
Sweet Gum	8	4	-	5	-
Water Oak	4	8	-	5	5
White Ash	-	-	-	5	-
Winged Elm	12	20	-	15	-
Vines					
Honeysuckle	72	16	25	-	-
Walter's Smilax	4	52		50	15

Table 5 A summary of birds recorded during strip censuses in three habitats.

Season Number of Birds[3]	Pine		Grassland[1]		Mixed[2]	
	Spr	Sum	Spr	Sum	Spr	Sum
Hawks	1	0	0	0	2	0
Bobwhite	0	0	2	7	6	0
Mourning Doves	0	0	0	1	0	0
Woodpeckers	3	0	1	0	2	2
Flycatchers	0	2	0	4	0	8
Swallows	0	2	0	4	0	0
Blue Jay	1	5	0	1	0	1
Brown-headed nuthatch	2	0	0	0	0	0
Carolina Wren	1	0	0	0	6	0
Thrushes	3	2	0	0	3	2
Kinglets	2	0	0	0	3	0
Warblers	6	18	0	15	12	0
Eastern Meadowlark	0	0	22	9	0	0
Cardinal	0	2	0	0	1	1
Sparrows	9	8	18	15	13	0
Total Species	17	15	8	20	17	10
Total Birds per 40 hectares	92	216	89-201	252-378	63	-

[1]Birds of two grassland communities were censused and combined to form this summary.

[2]Mixed refers to a mixture of pine and deciduous leaved trees.

[3]A selected list of the total species counted.

Table 6 Relative abundance of small mammals collected along traplines in Study Sites 1A, 2, 3A, and 4.

Study Site / Animal	6/71 Survey Total No. Caught	6/71 Survey Trap-nights/ Animal*	9/71 Survey Total No. Caught	9/71 Survey Trap-nights/ Animal*	1/72 Survey Total No. Caught	1/72 Survey Trap-nights/ Animal*	3/72 Survey Total No. Caught	3/72 Survey Trap-nights/ Animal*
Site 1A (Pine)								
Total Trapnights	300		360		240		240	
Cotton mouse	2	150	0	--	0	--	2	120
Site 2 (Grassland)								
Total trapnights	240		360		240		240	
Cotton Rat	2	120	6	60	2	120	0	--
House mouse	4	60	7	51	0	--	0	--
Cotton mouse	0	--	1	360	3	80	3	80
Cottontail rabbit	0	--	2	180	0	--	0	--
Harvest mouse	0	--	0	---	1	240	3	80
Site 3A (Mixed)								
Total Trapnights	240		360		240		240	
Shortail shrew	1	240	4	90	3	80	1	240
Cotton mouse	4	60	5	72	0	--	3	80
Cotton rat	0	--	0	--	0	--	1	240
Site 4 (Pine)								
Total Trapnights	180		360		240		240	
Cotton mouse	3	60	4	90	1	240	1	240
Golden mouse	2	90	1	360	0	--	0	--
Shorttail shrew	0	--	1	360	0	--	0	--
Pine vole	0	--	0	--	1	240	0	--

* Trapnights per animal caught.

Table 7 Relative Frequencies, Densities, Dominance and Importance values of tree species (2.5 cm or greater dbh) growing in Site 3A of the Broad River Study Area, June 1971.

Species	Relative Frequency	Relative Density	Relative Dominance	Importance Value
Loblolly Pine	16.0	18.6	21.7	56.3
Eastern Red Cedar	16.0	19.2	13.0	48.2
Red Maple	13.4	14.8	13.5	41.7
Ash	8.4	6.2	9.2	23.8
Hop-hornbeam	7.6	5.6	6.8	20.0
Oak sp. 1	7.6	6.2	5.4	19.2
Shagbark hickory	5.9	4.7	6.0	16.6
Hickory sp.	5.0	4.7	4.3	14.0
Oak sp. 2	3.4	3.8	4.6	11.8
Oak sp. 3	4.2	3.1	4.1	11.4
Ironwood	2.5	4.7	3.3	10.5
Basswood	3.4	3.8	3.3	10.5
Live Oak	2.5	1.8	3.0	7.3
Flowering Dogwood	1.7	1.2	0.5	3.4
Redbud	1.7	1.2	0.5	3.4
Willow Oak	0.7	0.6	0.8	2.1
Totals	100.0	100.2	100.0	300.2

Table 8 Relative frequency, density, and dominance of the various grass species within a pine plantation in the Dorr's Mill Study Area.

Species	Relative Frequency	Relative Density	Relative Dominance	Importance Value *
Broomsedge	34.1	38.7	61.3	134.1
Triple-awned Grass	31.7	27.5	14.7	73.9
Little Bluestem	22.0	23.7	16.6	62.3
Witchgrass	7.3	6.3	3.5	17.1
Brownseed	4.9	3.7	3.9	12.5
Totals	100.0	99.9	100.0	299.9

* Importance value is the sum of relative density, relative dominance, and relative frequency.

FISH AND WILDLIFE SECT 2.8 CONTINUED

Comment: The final statement should recognize white-tailed deer, the most important big game species in South Carolina, as one of the primary game species within the project area. Several years ago, the South Carolina Wildlife and Marine Resources Department expanded their Central Piedmont Game Management Area to include the project area. The excellent habitat in the Parr Reservoir and Frees Creek area is typical of the habitat responsible for the markedly increased populations of deer and turkey in the entire game management area. The abundance of escape cover and herbaceous and woody browse plants within the bottomlands, mast production in the mixed stands, and the interspersion of uneven-aged timber stands are responsible for the maintenance and productivity of these populations.

Response: The white-tailed deer is probably as important a game animal on the project area as are bobwhite and cottontail rabbit. However, population levels are low for all three species. The habitat characteristics of the area bordering Parr Reservoir and Frees Creek does not provide an abundance of woody browse for deer, or herbaceous cover for quail and rabbit. The bottomlands of the Broad River are composed primarily of mature, dense stands of cottonwood with some oak, maple, and sweetgum. The trees bordering Frees Creek represent a narrow stand of mature oak, maple, hickory, and sweetgum that merge with the pine plantations or grasslands on the slopes and uplands. The dense canopy restricts the amount of light that penetrates to the forest floor and inhibits the development of an understory. Only a limited number of openings near ponds, grasslands, and along the right-of-ways for roads, transmission lines, and the railroad have a diverse understory of plants suitable for browse or cover. The majority of bobwhite and rabbit utilize cover in or near these openings, particularly near abandoned farmland.

Although habitat quality for the entire Central Piedmont Game Management Area is reportedly high, the present quality of the project area is capable of supporting only a low density population of white-tailed deer due to lack of sufficient browse and cover.

FISH AND WILDLIFE SECT 2.8 continued

Comment: The statement that several species of ducks, other than wood ducks, have been reported as "transients" in the project area implies the relative unimportance of these species. We point out, however, that the majority of waterfowl in the Broad River area and South Carolina is composed of wintering species that are not permanent residents.

Response: A total of 188 ducks of eight species were recorded on the project area during a November 1972, waterfowl survey. Survey, conducted in March of 1972 and 1973 revealed 195 ducks (6 species) and 231 ducks (8 species), respectively, on the project area. On 5 January 1972, South Carolina State Game Biologists conducted a midwinter waterfowl survey on the Broad River from Lockhart through Parr Dam. The biologists counted 40 mallard, 6 black duck, and 51 wood duck (Walter Schroder pers. comm.). Wood ducks represent 51 percent of the total counted in November, 13 and 20 percent counted in March 1972 and 1973, respectively, and 52 percent of the total counted by state game biologists in January 1972.

South Carolina is in the Atlantic Flyway and the 1972 winter survey, conducted during the period January 3-10, counted 238,000 dabbling ducks and 31,800 game divers in the census region of the Coastal Plain.[1] These figures represent approximately 32 percent of the total dabblers and 4 percent of the total divers censused from Maine to Flordia. Migratory waterfowl is an important resource in South Carolina.

Although transient waterfowl are found in the project area, the numbers are relatively insignificant compared to the waterfowl that reside in South Carolina during the winter.

[1]Addy, C.E. 1972. 1972 Winter Survey-Atlantic Flyway. Mimeo. 7 p.

Dept. of Interior - Pg. 4 (Existing Recreation Sect 2.9)

Comment: "This section should quantify the total consumptive, and non-consumptive fish and wildlife oriented recreational used of project lands; in particular, the proposed reservoir sites and transmission line corridors."

Response: Response for fish and wildlife are made separately.

The "Consumptive" wildlife on the project area include such game birds as bobwhite quail, mourning dove, and turkey, and such mammals as squirrel, cottontail rabbit, and white-tailed deer. The abundance of each species is low and hunting is probably only by local residents, however, no harvest information is available for the project area.

The project area is in the Central Piedmont Hunt Unit where 2,135 deer were harvested before November 20, 1973 and 2,452 deer were killed during the entire 1972 hunting season. A record harvest occurred in 1972 and will be even higher by the end of the 1973 hunting season.

Based on the habitat available and the observation of deer and signs of deer, the populations within the project area are considered low. The number of deer that were probably harvested in the project area is speculated to be less than six.

The Central Piedmont, with 552,156 acres, reported 92 gobblers harvested during the 1973 spring season compared to 72 gobblers harvested in 1972. Very few, if any, were probably harvested in the project area. The area of Frees Creek and the Broad River is believed to be good to excellent turkey range within the Central Piedmont according to a South Carolina Wildlife Resources Department District Biologist. However, the seasonal abundance of the wild turkey in the Frees Creek area and/or the Central Piedmont Hunt Unit has not been estimated. Turkey that presently occur within the Frees Creek area are "spillover" from adjacent U.S. National Forest Land where re-introduction of turkey took place during 1953-1956. This "spillover" is fairly recent and accounts for occasional sightings of single turkeys as well as small flocks in the project area.

Although there is potential non-consumptive recreational use of wildlife on project lands, it has not been realized. The major reason appears to be that this area is not unique within the Piedmont. New transmission line right-of-ways should enhance habitat for both consumptive and non-consumptive wildlife, and, therefore, provide greater recreational use.

Consumptive recreational use of aquatic resources involves the catching of fish, frogs, turtles or invertebrates from Parr Reservoir, the Broad River within the zone to be inundated, and Frees Creek. Presently there are no quantitative data available to estimate fisherman use of the area. Observations by field crews have not revealed any heavy usage of Parr Reservoir either by boat or bank fishermen. Access is difficult at most places on the bank, and the muddy waters and better fishing in other lakes tends to limit the use of the reservoir. At no time were more than 10-20 fishermen seen in any day at the reservoir during the prime fishing seasons (spring, early summer and fall). During non-prime seasons, 0-10 fishermen utilized the reservoir. Consumptive use of Frees Creek aquatic life is not known but would have to be slight since is supports only small fish and the creek itself does not serve as a spawning area for larger fish. Presently little is known of the consumptive use of the Broad River in the zone which will be inundated. The river as a whole, however, is not noted for good fishing.

Non-consumptive recreational use of aquatic organisms would involve observation of fish and invertebrates informally during picnics or other outings or at specific times when unusual movements (spawning) or other activities of aquatic organisms make them especially interesting to the public. Based on observations during field sampling, these uses are very low to non-existant in the site area. The turbid nature of the waters for much of the year, the relative lack of access to the water, the lack of use of the area as a picnicking or camping area, and the lack of interesting visible activities of aquatic life serve to make this area undesirable for non-consumptive uses.

Department of Interior - pg. 5 (Environmental Impact Sect. 3.0)

Comment: "Furthermore, there is no evidence to support the assumption that sport fishery populations will be increased by construction of this project."

Response: Increases or decreases in sport fish populations due to the project will be the net result of the magnitude of potential losses to the existing Parr Reservoir and the section of Broad River to be inundated, combined with potential gains from Monticello Reservoir and the smaller Recreation Reservoir.

The following is based on a qualitative assessment of existing or likely production from the system before and after project implementation. It assumes there will be no net damage or benefit to fish stocks downstream of Parr Reservoir. The present productivity of Parr Reservoir is considered 1 and is used as a basis of comparison for other conditions. A quality factor is used to indicate the relative proportion of desirable sport fish being produced compared to the total fish productivity. Explanatory remarks follow.

		Without Project			With Project		
Acres	Body of Water	Productive Factor	Quality Factor	Sport Fish Production	Productive Factor	Quality Factor	Sport Fish Production
3000	Parr Reservoir	1	3/4	2250	1/2	1/2	750
6500	Monticello Reservoir	-	-	-	1/2	3/4	2438
300	Recreation Reservoir	-	-	-	1-1/2	1	450
	TOTAL			2250	..		3638

Parr Reservoir - Current biological studies indicate that there are 9 species that can be considered sport species and approximately 75% of the biomass would be sport species (see standing crop estimates from semi-annual report). A 50% loss in productivity of Parr Reservoir is conservatively estimated to be due to plant operations, primarily the extreme water level fluctuations. These fluctuations are also expected to disfavor nest building centrarchids which constitute the greatest proportions of sport fish. Therefore, the quality factor is reduced to 1/2 with the project.

Monticello Reservoir - Productivity is expected to be low because of entrainment, heat effects, and water level fluctuations. Less effect on spawning centrarchids is expected than for the modified Parr Reservoir resulting in a quality factor the same as for the unmodified Parr Reservoir.

Recreation Lake - Because of near-constant water level and much greater clarity, productivity is assumed to be 50% higher than the existing Parr Reservoir. Also, this lake will be managed for sport species exclusively, resulting in a quality factor of 1.

The net result is that there will be 3628 units of sports fish production "with project" and only 2250 units "without project."

Dept. of Interior - pg. 5 (Fish and Wildlife Sect 3.2)

3.2 FISH AND WILDLIFE

Comment: "The inundation of 2,550 acres of bottomlands resulting from the enlargement of Parr Reservoir and about 3,000 acres of bottomlands and mixed pine-hardwoods by construction of Monticello Reservoir will result in significant losses of wildlife habitat and a severe reduction in the carrying capacity of area lands for most native wildlife species."

Response: A loss of wildlife habitat will occur. The relative abundance of game animals, however, is low on the project area. A common assumption is that the density of animal populations is representative of the carrying capacity of the land. If the assumption is correct, the low population levels of most native wildlife is an indication of a low carrying capacity of the project lands.

The removal of selected forest trees (pine and hardwood) through current lumbering activities will promote an increase in the understory plant diversity and density. This increase in woody and herbaceous vegetation is anticipated to result in an increase in carrying capacity of the project lands and surrounding area. Consequently, population levels of many native wildlife species are anticipated to gradually increase throughout the region. Since the carrying capacity of the project area is already low and an increase in the carrying capacity of the surrounding area is anticipated, it is expected that the existing carrying capacity of the entire area will not be significantly reduced.

SCE&G has prepared agreements with the South Carolina Wildlife Resources Department to develop a management program for seeding transmission line rights-of-way, construction areas no longer in use, temporary roads, lay-down, temporary parking, dam faces and spoil areas for the benefit of native wildlife.

FISH AND WILDLIFE [illegible] 3.2 [illegible]

Comment: "The immediate result of this habitat destruction will be the dispersion of animal populations to adjacent land areas. Contrary to statements in the draft statement, there is little possibility that many of the displaced wildlife species will be absorbed by the surrounding habitat."

Response: As stated in the draft EIS (page 3-6)

"If these habitat and food producing areas are flooded, the animals would migrate to adjacent land areas. This migration would place an added strain on the habitat of the wildlife species resident in those areas, thereby disturbing an existing balanced ecosystem. In areas with populations below the carrying capacity of the land, these displaced species might be absorbed without having any significant impact on resident species. On those lands becoming overpopulated, the habitat would suffer from overuse until the surplus populations are harvested by hunters, die from disease or starvation, or move into areas where they can be sustained by the habitat. The creation of the upper reservoir would involve the inundation of approximately 6,800 acres of wildlife habitat from which terrestrial wildlife species would be similarly displaced."

The ability of the surrounding habitat to absorb native wildlife that disperse from the project area, however, has not been assessed. It is assumed that the quality of the habitat in the surrounding area is similar to the quality of the habitat on the project area and does not presently support an abundant population of game and non-game animals.

An increase in lumbering activity on the project area and in the surrounding area will reduce the forests canopy and promote an increase in understory vegetation. Where deciduous shrubs and herbaceous vegetation increase, there will be an increase in carrying capacity for many native wildlife. A lag time of a few generations occurs from the time this increase in carrying capacity is produced to the time when the populations have increased to meet this new level. It is possible that the surrounding habitat will have reached a higher carrying capacity with low densities of wildlife when construction of the project is completed. When the project forces resident species to emigrate into the surrounding habitat, the habitat may be able to absorb them.

FISH & WILDLIFE CHAP 3.2 CONTINUED

Comment: "It is well documented that bottomland hardwood areas are centers of high energy assimilation and that these areas provide den sites and escape cover for numerous wildlife species. For example, the best white-tailed deer habitat is characterized by a diversity of vegetative types and age classes such as presently exist at the Parr and Monticello sites."

- "The bottomland and mixed hardwood sites provide a majority of the foods (particularly winter browse) and escape cover for this species. It is biologically misleading to suggest that destruction of about 6,000 acres of these vegetative types will not severely decrease the area carrying capacity for this species. Stransky (1969)[1], in a comparison of forest types, reported: (1) there is more and better deer food in bottomlands than on upland ; (2) South Carolina bottomlands support an estimated one deer per 13 acres while loblolly pine-hardwood and longleaf pine support one deer per 30 to 50 acres and 78 acres, respectively. Therefore, bottomlands are three times as valuable as the higher elevation forest types for deer production."

Response: (1) we agree that bottomland hardwood areas are generally centers of high energy assimilation.
(2) we agree that the best white-tailed deer habitat is characterized by a diversity of vegetative types and age classes - but disagree that this habitat is characteristic of the project area (See response to wildlife habitat comment)
(3) Stransky's statements are generally true, however, deer production in the project area is much lower than that stated because habitat suitable for browse and cover is lacking.

Since the area presently supports only a few deer, a severe decrease in the area's carrying capacity is not anticipated.

Comment:

The [illegible] has failed to properly address the effects of this project to waterfowl production in the project area. The destruction of vegetation and the daily water level fluctuations in 2,[illegible] acres of bottomlands [illegible] to Lake Greenwood will preclude any significant waterfowl usage. Of particular importance is the potential destruction of valuable nest sites for the wood duck, an important resident waterfowl species. It has long been recognized that the major limiting factor in most wood duck populations is the lack of suitable nest cavities. This section should also recognize the proposed inundation of [illegible] acres of U.S. Forest Service lands that have been proposed as a waterfowl [illegible] area, and the Dawkins Wildlife Management Area that has been managed by the South Carolina Wildlife and Marine Resources Department for about 13 years.

Response:

The following information was taken from pages 2.2.-26 to 2.2.5-30 of the Environmental Report:

"Waterfowl have historically utilized the Broad River as a migratory flyway and nesting area. Many species are reported as transients. However, only wood ducks are considered resident species. The Broad River is one of the major wood duck production areas in the Piedmont System."

"The decrease of waterfowl populations along the river in recent years has been attributed to the decline of the agricultural practices in the bottomlands. Although there are a few small farms, they do not supply grain feed for the migrant flights."

"Because of the area's waterfowl potential, the South Carolina Wildlife Resources Department, in cooperation with the U.S. Forest Service, has developed a 'Waterfowl Management Plan for the Broad River Composite.' The objective of the program is to meet the increasing public demand for waterfowl hunting and viewing by restoring waterfowl resources in the area."

"The general geographic boundary of the program is a 5-10 mile wide band bisected by the Broad River extending from the City of Lockhart south to the City of Dawkins. One major development of this program is located near Dawkins on Terrible Creek. This project includes 123 acres of open fields, 293 acres of bottomland hardwoods, and 619 acres of loblolly pine. The southern boundary adjoins the northern limits of the site."

"According to preliminary data, the increased elevation of Lake Reservoir may flood certain prop[illegible] of the U.S. Forest Service located upstream near Terrible Creek. Plans have been drawn for a waterfowl habitat area on Terrible Creek and development is expected soon. SCE&G has made contact with the U.S. Forest Service concerning the possible effects of the project on this development. Further discussions will be held as project plans are refined, and SCE&G will cooperate with the U.S. Forest Service on a [illegible] land exchange to forest mutually agreeable."

ADDENDA II, Page 1[illegible]

Surveying was not completed at the time the environmental [illegible] was written, therefore, the following statement was made in Exhibit G:

"The full potential for utilization of anadrom of wildlife resources will not be realized until detailed topographic surveys and other [illegible] details are completed; however, SCE&G will cooperate with the S.C. Wildlife Resources Department, the U.S. Fish and Wildlife Service, and the U.S. Forest Service to offset any undesirable situations."

"Probably the most significant impact on the terrestrial biota will result from the inundation of approximately 2,550 acres of bottomlands due to the enlargement of Parr Reservoir. These bottomlands up and down the river constitute an important food production area and serve as a primary food source for wildlife (primarily deer, turkey and wood ducks) both on and beyond the 2,550 acres. As a result, the loss of this food source will affect the wildlife resources in the surrounding locale. As these food source areas become unavailable, the motile forms will migrate to different areas. This migration of displaced wildlife will place a new stress on these invaded areas and disturb their dynamic equilibrium." (17, page 2.25-29)

The Broad River and its tributaries provide very good wood duck habitat for wintering and staging. McGilvrey (1968) describes such habitat as any flooded timber or shrub area that affords visibility of the surroundings. Tree cavities that may be potential nest sites are numerous near the Broad River.

The present major limiting factor controlling wood duck populations within the project area appears to be the low quality brood rearing habitat which is below optimum as described by McGilvrey (1968). A few ponds in the Broad River Floodplain and some shrub covered shoreline along the tributaries provide the limited amount of suitable brood rearing habitat.

The inundation of 2,550 acres of bottomlands adjacent to Parr Reservoir will destroy some of the wood duck nesting sites and, therefore, as stated on pages 2.2.5-29 and 2.2.5-30 of the ER:

"A waterfowl habitat improvement plan will be carried out around both reservoirs as part of the total Land Management Plan. Standard techniques will be utilized to provide food and additional nesting areas."

D. of I. - pg. 9.

Comment: 5. [illegible] - This section should be revised in view of [illegible]. The unavoidable adverse environmental effects of construction and operation of this project will be....., the inundation of nearly 35 miles of river and stream fish habitat, a reduction in the carrying capacity of existing Farm Reservoir and a possible reduction in productivity of downstream fisheries.

Response: The major unavoidable adverse environmental effect on the aquatic system will not be the enlargement of Farm Reservoir, since inundated areas were found to support increased numbers of sport fishes, but the water-level fluctuations during operation of the pumped storage facility. This water fluctuation is expected to reduce the fish carrying capacity of Farm Reservoir by decreasing benthic production in the littoral zone and reducing spawning success, especially of centrarchids. Since the same amount of water coming into the reservoir will be discharged downstream, minus loss from evaporation, and temperature changes below Farm Dam will be negligible, no reduction in productivity of downstream fisheries is anticipated.

Comment: 6. Relationship Between Local and Short-Term Environmental Uses and Maintenance and Enhancement of Long-Term Productivity. In view of the present potential of project-affected lands to support extensive consumptive and nonconsumptive fish and wildlife-oriented recreational activities, we disagree that project implementation will provide enlarged recreational areas. Furthermore, the last sentence in this section should be deleted until data are presented to support the claim of a long-term improvement in sport fishery resources.

Response: Presently, the project area provides little fish and wildlife-oriented recreational activities because of its limited access and low fish and wildlife production as compared to other areas in this locality. The proposed upper fishing impoundment should provide better sports fishing with easy access, while increased undisturbed vegetation from lumbering activities and revegetated transmission line right-of-ways will provide better and more diversified habitats for wildlife. Recreational areas for boating, swimming, hiking and picnicking will also be established.

II [illegible] TO [illegible] OF [illegible] ON [illegible]

c) Secretary of Commerce - pg. 1

Comment: Comments by the Office of the Assistant Secretary of Commerce refer to a concern over anadromous species (striped bass and blueback herring) in downstream waters

In this regard they comment that:

a) The agreement between SCE&G and the South Carolina Wildlife & Marine Resources Department should provide necessary flows for successful spawning of these species.

b) Studies should be implemented to monitor the spawning of these fish, and

c) Studies should be done to determine the feasibility of altering flows during the spawning season.

Response: Presently the only anadromous species known to be in the waters of concern are the striped bass and blueback herring. There are little data available on the abundance or distribution of the latter species, however, it is considered a desirable forage species for striped bass.

a) Meetings have been held with the South Carolina Wildlife & Marine Resources Dept. regarding the flows required. As a result, a memorandum of understanding between SCE&G and the Department has been issued and is contained in the F.P.C report, Appendix A. pg. A-8 to A-11. Minimum flows that would be maintained are given in this memorandum as 1,000 CFS instantaneous and the natural inflow into the Broad River as a daily average (less evaporation losses of 88 CFS or less) for the striped bass spawning period March-May. This agreement has appeared to be satisfactory to the Department for the maintenance of successful spawning of this important species.

b) There are no plans to monitor spawning of the striped bass. The spawning occurs in the Congaree River up to the dam at Columbia, approximately 26 miles downstream from the site. Because of South Carolina Electric & Gas' commitments with respect to water flow from Parr Reservoir into the Broad River and since there would be an insignificant increase in water temperature downstream of Parr Dam due to project operations (on the order of a few degrees F or less), little or no change in the spawning area downstream will occur.

c) [illegible]

G.86

c) Presently no data exists to document what are flows that are "too high", the resulting in passage of striped bass eggs into the down stream reservoir from the Congaree River, or "too low", thus resulting in eggs dropping into river sediments. Until state or federal fisheries agencies establish what these flows are, there is little basis for flow modification agreements. Because of the concern of S.C.E.&G. with respect to the striped bass, the Company is committed to taking whatever measures, in cooperation with the South Carolina Wildlife and Marine Resources Department, are feasible, including alteration of flows beyond those agreed to, to assure that the striped bass spawning is not indangered.

G-87

SOUTH CAROLINA ELECTRIC & GAS COMPANY
POST OFFICE BOX 764
COLUMBIA, SOUTH CAROLINA 29202

V. C. SUMMER
SENIOR VICE-PRESIDENT

January 21, 1974

Mr. Kenneth F. Plumb, Secretary
FEDERAL POWER COMMISSION
1425 K Street, N. W.
Washington, D. C. 20426

Re: SCE&G's Response to Comments by U. S. Forest Service on Amended Application for New License and Environmental Report for Project No. 1894 (Addenda III to SCE&G's October 18, 1973 Comments on FPC Draft Environmental Impact Statement)

Dear Mr. Plumb:

SCE&G has previously commented on the FPC Draft Environmental Impact Statement for Parr Hydroelectric Project (FPC Project No. 1894) in letters dated October 18, 1973; December 11, 1973 (Addenda I); and January 9, 1974 (Addenda II).

In this letter we are responding to the December 20, 1973 comments of the U. S. Forest Service, received approximately one year late, on SCE&G's Amended Application for New License and Environmental Report for Project No. 1894. We feel that the comments of the Forest Service should have been made earlier in order to be of help to the FPC in preparing its Draft Environmental Impact Statement, but we are nevertheless responding to them in hope of assisting the FPC's preparation of the final Environmental Impact Statement for Project No. 1894.

Very truly yours,

V. C. Summer
Senior Vice-President

KLM:VCS:ii

Attachment

RESPONSE TO USDA - FOREST SERVICE'S DECEMBER 20, 1973, REPLY TO FPC LETTER OF SEPTEMBER 15, 1972 REQUESTING COMMENTS ON SCE&G'S AMENDED APPLICATION FOR NEW LICENSE AND ENVIRONMENTAL REPORT FOR FPC PROJECT No. 1894.

I. Comment

General

The written portions are too broad consisting of phrases such as the licensee will cooperate, will survey, will make plans, will study, etc. It is recommended that license provisions require a submission of firm and detailed plans to comply with the Commission's Regulations under the Federal Power Act, Section 4.41, Required Exhibits. These license provisions should also establish firm dates for the submission of the detailed plans and surveys.

Response

At the time SCE&G's Application for New License and Environmental Report for Project No. 1894 were prepared, preliminary surveys of land, wildlife, etc., had just begun and commitments made in the texts of the Application and Environmental Report were necessarily broad, SCE&G is in the process of completing necessary surveys and studies and fully intends to comply with FPC Regulations as to requirements for detailed Exhibits and plans. We have developed agreements with the USDA Soil Conservation Service, the USDA Forest Service, and the S. C. Department of Wildlife and Marine Resources which substantiate our intention to cooperate with these and other agencies.

II. Comment

Exhibits R & S

1. A detailed developments plan by stages for the 300 acre sub-impoundment should be provided.

2. The size of the parking lot for the sub-impoundment is too small. A minimum of a 40-car lot should be considered.

4. Recommend that the entire area within the triangle bounded by State Route 215, relocated Route 99, and County Road 347 be considered for dedication to public recreation.

Response

The extent of SCE&G's present plans for recreation at the Parr Project can be seen in Exhibit R of the Amended Application for New License for Project No. 1894, filed July 26, 1972. SCE&G consulted with the FPC; the S.C. Department of Wildlife and Marine Resources; the S.C. Department of Parks, Recreation, and Tourism; the S.C. Pollution Control Authority; the S.C. Department of Health; the U.S. Bureau of Outdoor Recreation; the U.S. Forest Service; and other agencies during the preparation of Exhibit R, and we feel that the present plans are adequate for initial development of recreational resources at the project. SCE&G intends to provide recreational facilities to meet the demand in the project area in accordance with FPC recommendations following odd-year reviews of the recreational facilities. Viewpoints of other organizations such as the Fairfield County Recreation Commission will also be considered in planning any future recreational facilities at the Parr Project.

III. Comment

Exhibits R & S

3. Recommend the construction of an additional sub-impoundment to be located with the National Forest boundary to serve as partial mitigation for the loss of habitat through inundation and disruption of the Broad River Waterfowl Management Plan.

Response

SCE&G has held numerous meetings with the U. S. Forest Service, resulting in the signing of the attached agreements of October 11,1973, and December 17 and 18, 1973. The October 11 Agreement provides for SCE&G to pay for replanning of the Broad River Waterfowl Management Plan, to exchange Forest Service lands to be flooded with other lands, and to provide a minimum of 90 acres of sub-impoundments in the form of Greentree Reservoirs. In doing these things, SCE&G has made a commitment to help preserve and better the area wildlife habitat.

SOUTH CAROLINA ELECTRIC & GAS COMPANY
POST OFFICE BOX 764
COLUMBIA, SOUTH CAROLINA 29205

V. C. SUMMER
SENIOR VICE PRESIDENT

February 1, 1974

Mr. Kenneth F. Plumb, Secretary
FEDERAL POWER COMMISSION
1425 K Street, N. W.
Washington, D. C. 20426

Re: SCE&G's Response to Comments by Others on FPC Draft Environmental Impact Statement-FPC Project No. 1894 - South Carolina Electric & Gas Company (Addenda IV to SCE&G's October 18, 1973 Comments on FPC Draft Environmental Impact Statement)

Dear Mr. Plumb:

South Carolina Electric & Gas Company has previously commented on the FPC Draft Environmental Impact Statement of September, 1973 for Parr Hydroelectric Project (FPC Project No. 1894) in letters dated October 18, 1973; December 11, 1973 (Addenda I); January 9, 1974 (Addenda II); and January 21, 1974 (Addenda III).

In this letter we are considering the USDA Forest Service comments on the FPC Draft Environmental Impact Statement for Project No. 1894, received by the FPC Secretary's office on January 10, 1974. Our response to ten of the Forest Service comments is attached, and our response to the remaining comments will follow shortly.

Very truly yours,

V. C. Summer
Senior Vice-President

KLM:VCS:ii

Attachment

RESPONSE TO USDA FOREST SERVICE COMMENTS ON
FPC DRAFT ENVIRONMENTAL IMPACT STATEMENT FOR
FPC PROJECT No. 1894 ——— PART I

I. Description of the Proposed Action

Comment: Page 1-7, Figure 1-1

Project boundary line is not defined for most of the project area.

Response: The project boundary line will be appropriately illustrated on all required FPC License Application Exhibits upon completion of field surveys. The project boundary line will be located consistant with regulations of the FPC and will include only that land necessary for maintenance and safe operation of the project and any other land deemed necessary by the FPC.

Comment: Page 1-37, Last Paragraph

South Carolina Electric and Gas Company's (licensee) Exhibit R makes no mention of a swimming area in the Monticello sub-impoundment. Monticello Reservoir will have Class B water and will be unsuitable for swimming under existing State water quality criteria.

Page 1-38, First Paragraph

This Draft Environmental Statement states that "no bank fishing, primitive camping on islands or water contact sports would be allowed on the main body of Monticello reservoir, due to restrictions by the South Carolina Pollution Control Authority." However, frequent reference is made to the recreational value of fishing,

and particularly of primitive camping on islands.

Response: The potential swimming area is mentioned on pages 1, 2, and 3 of Exhibit R-4, Land Clearing Plan, in the Amended Application for New License for Project No. 1894. Swimming and other water contact sports, bank fishing, and primitive camping on islands are all activities which depend upon the water quality of Monticello Reservoir. Whether or not these activities are allowed will depend upon the quality of the water, as determined by the S. C. Department of Health and Environmental Control, after the reservoir is filled. In making plans for future recreational use, SCE&G has considered the possibility that these water-related activities might be allowed.

II. Description of Existing Environment

Comment: Page 2-27, Second Paragraph

The statement that no known rare or endangered species occur within the project area is inaccurate. The presence of Southern Bald Eagles in the project area has been confirmed.

Response: One Southern Bald Eagle was spotted in the project area during a migration season, but there has been no evidence discovered of Southern Bald Eagle nests in the project area.

III. Environmental Impact of the Proposed Action

Comment: Page 3-5, First Paragraph

The licensee with the assistance of U. S. Geological Survey, is recalculating the area to be inundated by redeveloping Parr Reservoir.

The new National Forest area to be inundated will be approximately 300 acres.

Response: This area of National Forest lands to be inundated will be determined in a manner acceptable to the U. S. Forest Service and in accordance with procedures described in the Memorandum of Agreement between SCE&G and the Forest Service, dated October 11, 1973.

Comment: Page 3-5 Second Paragraph

The Southern Bald Eagle does occur within the project area.

Response: See above response to comment on "Page 2-27, Second Paragraph".

IV. Fish and Wildlife

Comment: Page 3-34, Second Paragraph

What sort of provisions have been made to dispose of recreation-generated wastes, particularly those wastes associated with primitive camping on islands?

Response: As indicated on pages R-7 and R-8 of Exhibit R of the Amended Application for New License for Project No. 1894, anchored trash disposal containers and pit-type sanitary facilities will be provided at all public recreation areas. SCE&G also states responsibility for maintaining the recreation areas in a manner consistant with all applicable State Pollution Control and Health Department requirements.

V. Staff Position on Matters Having Significant Environmental Impact

Comment: Section 9.1

Land Use

Page 9-1

1. The Forest Service agrees with the proposed project boundaries for Monticello Reservoir, except to suggest that the entire area within the triangle bounded by State Route 215, relocated Route 99 and County Road 347 should be dedicated to public recreation.

2. The Forest Service is of the opinion that boundaries for Parr Reservoir should not be fixed until recalculation of the inundated area is accomplished. The eastern boundary of Parr Reservoir should be the Southern Railway track, except for places where inundation would go beyond the track. Raising Parr Reservoir will make lands between the railway and the reservoir commercially non-viable because of inundation patterns, ownership patterns, and access.

The Forest Service has recently negotiated a Memorandum of Agreement with licensee, in which land exchange is a major item. Adjustment of the Parr Project boundary to accomplish this exchange will be in the public interest and will be of benefit to both the project and the Sumter National Forest.

Response: The project boundary line will be located consistant with regulations of the FPC and will include only that land necessary for maintenance and safe operation of the project and any other land deemed necessary by the FPC. All National Forest lands to be inundated will be determined, and necessary land exchange with the Forest Service completed in accordance with the Memorandum of Agreement between SCE&G and the Forest Service signed October 11, 1973.

Comment: Page 9-4, Last Sentence

Change "... inundate 236 acres of National Forest land" to "300 acres."

Response: See above response to comment on "Page 3-5, First Paragraph."

Comment: Page 9-5

The entire existing Parr Reservoir is a part of the Broad River Waterfowl Management Area. A management plan for that area was made in 1965 by the South Carolina Wildlife and Marine Resource Department, the U. S. Bureau of Sport Fisheries and Wildlife and the U. S. Forest Service.

Under that plan, a Greentree Reservoir was being developed when the Parr Project was made public. Development was suspended until after the Parr Project was in operation. The Memorandum of Agreement between the Forest Service and the licensee provides fo replanning the Broad River Waterfowl Management Unit.

Page 9-7

The first 13 lines are repeated from the preceding page.

Response: SCE&G concurs with these comments.

MEMORANDUM OF AGREEMENT

BETWEEN

The Forest Service, U.S. Department of Agriculture

And

The South Carolina Electric and Gas Company

Concerning Parr Hydroelectric Project, F. P. C. No. 1894

The Agreement, made and entered into this 11th day of July 1973, by the South Carolina Electric and Gas Company, hereafter referred to as the Cooperator, and the Forest Service, USDA, hereafter referred to as Forest Service, under the authority of the Department of Agriculture Organic Act of 1862 (7 U.S.C. 2201), and the Act of June 30, 1914 (16 U.S.C 498), ~~is required by the Federal Power Commission.~~

WHEREAS, it is the desire of South Carolina Electric and Gas Company and the Forest Service to work in harmony for the common purpose of developing, maintaining, and managing all of the available resources of the Parr Hydroelectric Project, F.P.C. No. 1894, in the best interests of the people of South Carolina and the United States.

Therefore, under this Agreement:

I. THE COOPERATOR AGREES

A. To enter into one or more cooperative agreements with the Forest Service on the following items:

1. The Cooperator will agree to make men and equipment available to suppress any non-operation fire which threatens National Forest land on a reimbursable basis. All decisions as to the fire's status will be made by the Forest Service or the South Carolina State Commission of Forestry Fire Boss.

2. The Cooperator will agree to reimburse the Forest Service for all costs of suppressing fires on or endangering National Forest land and pay tangible damages resulting from fires on National Forest land when caused by the cooperator's operations.

3. The Cooperator will submit and follow a burning plan approved by the Forest Service and the State Comission of Forestry. The Plan will contain an agreement that the Cooperator will abide by all laws pertinent to burning. The Cooperator will request permission to burn from the Forest Service, Enoree Ranger District, Newberry, South Carolina, and the South Carolina State Commission of Forestry and will have a man controlling their fires at all times.

4. The Cooperator will agree to conduct cadastral surveying operations. Work may be done in either of two ways:

a. Work may be done by the Forest Service on a cooperative deposit basis. The Cooperator will make an initial advance deposit of $5,500.00 and other additional deposits as needed. The unused portion of these deposits along with itemized statements for all charges to the deposits will be returned to the cooperator following completion of land exchange.

b. Work may be done by the Cooperator. If this is the case, the work must be done to Forest Service standards. The Forest Service will inspect this work. Any work not done to Forest Service standards will

be resurveyed to standard. The Cooperator will pay for inspection by the Forest Service. An initial advanced deposit of $500.00 will be required and other initial deposits as needed. The unused portion of these deposits, along with itemized statements for all charges to the deposits will be returned to the cooperator following completion of land exchange.

5. The Cooperator agrees to pay for replanning the Broad River Waterfowl Management Plan on a cooperative deposit basis with the Forest Service. The Cooperator will make an initial advance deposit of $4,000.00 and additional deposits as needed.

6. Within one year of the completion and commercial operation of the initial phase of the project, and following the completion of the revised Broad River Waterfowl Management Plan, the Cooperator will construct a minimum of 90 acres of Greentree Reservoirs in one or more impoundments at a site or sites to be determined by a cooperative effort of S.C. Wildlife and Marine Resources Department, the Forest Service, and the Cooperator.

7. The Cooperator agrees to develop an erosion control plan for all National Forest lands disturbed during construction with the contracted assistance of the U.S. Soil Conservation Service. Final approval of this erosion control plan rests with the Forest Service.

B. To enter into a land exchange with the Forest Service. The Cooperator intends to clear all timber on lands to be inundated in accordance with the land clearing plan filed with the FPC, in which the Cooperator has stated that, to the extend possible, all marketable timber will be removed by the land owner or SCE&G from areas to be inundated. On Page 2.2.5-41 of the project environmental report, the Cooperator also states that

the options it has with the present owners reserve to the owners the right to remove the present timber within a stated period of time.

C. To turn over to the Forest Service any private lands purchased for construction of Greentree Reservoirs and buffer zones when within the National Forest boundary, and to the South Carolina Wildlife and Marine Resources Department if outside the boundary.

D. To amend FPC License No. 1894 to include this Memorandum of Agreement.

E. To obtain individual Special Use Permits for each temporary road, access road, right-of-way, or other use of National Forest land.

II. The Forest Service Agrees

A. To enter into one or more cooperative agreements with the cooperation on the following items:

1. To enter into fire suppression activities stated in items I A 1, 2 and 3.

2. To perform on a cooperative work basis, all cadastral surveying land line location, corner establishment, witness corner mounumentations, or to inspect Cooperator's work and to resurvey all unacceptable work on cooperative deposit basis.

3. To replan, as required, on a cooperative work basis with the S.C. Wildlife and Marine Resources Department and the Cooperator, the Broad River Waterfowl Management Plan.

4. To develop an annual maintenance plan for Greentree Reservoirs in cooperation with the S.C. Wildlife and Marine Resources Department.

5. To perform annual maintenance of Greentree Reservoirs in accordance with Item II A 4 of this memorandum of agreement.

6. To collect necessary data, design Greentree Reservoirs, and conduct water level surveys on a cooperative deposit basis in accordance with item I A 6 of this Memorandum of Agreement.

7. To cooperate in the development of an erosion control plan in accordance with item I A 7 of this Memorandum of Agreement.

B. To enter into exchange offer with the Cooperator.

C. To accept any private lands acquired by the Cooperator under Item I C of the Memorandum of Agreement.

III. IT IS JOINTLY AGREED

A. That both parties will name liaison officers designated by the Forest Service and South Carolina Electric & Gas Company.

B. That the Cooperator and the Forest Service agree to enter into a land exchange, subject to laws and regulations concerning both parties. The specific details of the exchange will be set forth in a separate exchange agreement. Greentree acreage and status will not enter into the exchange offer. The selected tracts (areas to be inundated) are generally the lands lying between the Southern Railroad and the left (east) bank of the Broad River. Acreages listed are estimated.

1. U. S. Tract 97 -55 acres.
2. U. S. Tract 458 - 385 acres.
3. U. S. Tract 478b - 14 acres.
4. U. S. Tract 478c - 21 acres
5. U. S. Tract 148 - 15 acres.
6. U. S. Tract 70 - 5 acres.

Acceptable offered tracts, generally on the right (west) bank of the Broad River, are those that fit into the National Forest Land Adjustment Plan. Priority tracts are:

1. Trudy Henderson Tract (Glymph Island): Newberry County, Deed Book 87, Page 44.

2. Henderson Estate Tracts, Newberry County, Deedk Book 47, Page 33.

3. Kennedy Tracts, Newberry County, Deed Book 35, Page 148, Deed Book 90, Page 3, Deed Book 90, Page 4.

4. Bursinger Tract, Newberry County, Deed Book 49, Page 235.

5. Bursinger Tract, Newberry County, Deed Book 42, Page 410.

C. Greentree Reservoir shall be defined as:

A reservoir which controls fall and winter water levels on oak flats for the purpose of attracting ducks for shooting or overwintering. Generally, these cannot be managed as brood rearing habitat since flooding and draining requirements are opposed. However, wood ducks are yearlong residents in South Carolina and careful selection of possible greentree sites should take into account the need for permanent yearlong water. The Greentree Reservoir will be at least 30 acres and have at least three of the six following species present and in or near mast-bearing conditions: Water oak, willow oak, swamp white oak, black gum, cherry bark oak, and American beech. Water depth of the Greentree Reservoir must be at least 3 inches and no more than three feet, except in existing channels.

D. No Member of, or Delegate to, Congress or Resident Commissioner shall be admitted to any share or part of this Agreement, or to any benefit that may arise therefrom; but this provision shall not be construed to extend to this Agreement if made with a corporation for its general benefit.

E. The United States shall not be liable for any damage incident to the performance of work under this agreement to any depositors or, landowners who are parties to the Agreement, and all such depositors or landowners hereby expressly waive any and all claims against the United States of America for compensation for any loss, damage, personal injury, or death occurring in consequence of the performance of this Agreement.

F. Nothing herein shall be construed as obligating the Forest Service to expend, or as involving the United States in any contract or other obligations for further payment of money in excess of appropriations authorized by law.

G. That this Memorandum of Agreement shall become effective when signed by both parties and shall continue in effect until supplemented or terminated at any time by mutual consent of both parties.

H. No contribution to the cooperative fund herein provided for shall entitle the cooperator to any share or interest in the said improvements or land other that the right to use the same under the regulations of the Forest Service. All improvements shall be and remain the property of the United States.

IN WITNESS WHEREOF, the parties hereto have executed this Memorandum of Agreement as of the date written previously.

SOUTH CAROLINA ELECTRIC AND GAS COMPANY

BY D. C. Summer

TITLE Senior Vice-President

U. S. DEPARTMENT OF AGRICULTURE

FOREST SERVICE

FRANCIS MARION AND SUMTER NATIONAL FORESTS

[illegible]

[illegible]

COOPERATIVE AGREEMENT

BETWEEN

THE SOUTH CAROLINA ELECTRIC AND GAS COMPANY

AND

THE FRANCIS MARION AND SUMTER NATIONAL FORESTS, U. S. D. A.

THIS COOPERATIVE AGREEMENT, made and entered into by and between the South Carolina Electric and Gas Company, hereinafter referred to as the Company and the Forest Service, U.S. Department of Agriculture, hereinafter referred to as the Forest Service, under the provisions of the Act of June 30, 1914 (16 USC 498).

WITNESSETH:

WHEREAS, the Company is planning to conduct cadastral surveying on National Forest lands of the Enoree District of the Sumter National Forest necessary for developing the Parr Shoal Hydroelectric Project, F.P.C. 1894 and

WHEREAS, the Company desires to conduct such surveying in accordance with Forest Service standards and is willing to pay for the inspection

WHEREAS, the Forest Service is willing to provide the Company with Forest Service cadastral surveying standards and a qualified employee for inspection

NOW THEREFORE, the parties hereto agrees as follows:

A. <u>The Company shall:</u>

1. Make advance payments, as requested by the Forest Service in $500.00 amounts to be deposited in the Forest Service cooperative work fund.

2. Advise the Forest Service ahead of time when they plan to work on National Fores land.

3. Perform cadastral surveying on National Forest lands according to Forest Service standards which are attached and made a part of this agreement.

4. Replace with witness cornets all corners adjacent to project area boundary and which will be or may be inundated.

5. Provide the Forest Service with copies of field notes concerning these witness corners.

6. Provide the Forest Service with plats showing the location of the project area boundary on National Forest lands with tie-ins to property corners.

7. Provide the Forest Service with standard acceptable plats and survey descriptions of offerred and selected lands involved in the proposed exchange.

8. Survey, post and establish exterior land lines of offerred and selected tracts (if they are portions of National Forest tracts).

B. <u>The Forest Servie shall:</u>

1. Provide the Company with a copy of Forest Service cadastral surveying standards.

2. Provide the Company with steel pipe and aluminum caps for witness corners.

3. Provide the Company with posters and red paint for witness trees.

4. Provide the Company with survey notes, plats and other information when available concerning National Forest lands.

5. Provide inspection service to the Company and inform the Company whether work is satisfactory.

6. Refund any unexpended balances of funds so deposited by the Company over and above the cost of inspection.

C. It is Mutually Agreed and Understood By and Between the Said Parties That:

1. No member of, or Delegate to, Congress or Resident Commissioner, shall be admitted to any share or part of this agreement, or to any benefit that may arise therefrom; but this provision shall not be construed to extend to this agreement if made with a corporation for its general benefit.

2. Nothing herein shall be construed as obligating the Forest Service to expend or as involving the United States in any contract or other obligation for the future payment of money in excess of appropriations authorized by law.

3. Representatives for each party hereto will be designated in writing to coordinate the administration of this agreement.

4. This agreement shall become effective upon signing of both parties and receipt of cooperative deposit and shall continue in effect until supplemented or terminated at anytime by mutual consent of both parties.

5. This agreement is supplemental to the MEMORANDUM OF AGREEMENT between the South Carolina Electric and Gas Company and Forest Service dated October 11, 1971 and as such is subject to all provisions of that agreement.

IN WITNESS WHEREOF, the parties hereto have executed this agreement as of the last date written below:

12/17/73 — William E. Moore
Title
South Carolina Electric & Gas Company

12/18/73 — [illegible]
Title
Forest Supervisor, Francis Marion & Sumter National Forests

SPECIFICATIONS FOR CONTRACT CADASTRAL SURVEYING

DIVISION 100 - GENERAL SPECIFICATIONS

110 - Scope of Contract

a. Notifying adjoining landowners that survey will be conducted.

b. Researching of such records and field investigation as is necessary.

c. Identification, restoration, monumentation of land and/or property corners involved.

d. Accurate running of all random survey lines to connect, prove, or establish property corners.

e. Re-running or offsetting of random lines to locate the true property lines between the U. S. Forest Service and private lands.

f. Placing intervisible hubs on the true line.

g. Blazing the property lines between Forest Service and private lands.

h. Painting and posting the property lines between Forest Service and private lands.

i. Preparation of survey notebooks.

j. Preparation of survey plat or plats at a scale of 1" multiples of 5 chains with the original to the Forest Service.

k. Preparation of Form 7100-52, Corner Record, for each property corner.

l. Completion of corner registration certificates and/or plats.

m. Recording of certificates and/or plats in the county records, after approval of the Contracting Officer's Representative.

120 - Description and Location (See attached map)

130 - Government Furnished Items (As applicable)

a. Blank field notebooks.

b. Corner or witness monuments, either iron pipes with brass or aluminum caps or precast concrete monuments with brass or aluminum tablets.

c. Blank corner registration certificates and corner cards.

d. Boundary signs #54-2 and 54-3 in states governed by BLM surveys, and corner location posters.

e. Treated wood posts and/or metal posts.

f. Red paint, brushes and nails.

g. All records, tract plats, maps, descriptions, abstracts of title or previous surveys pertinent to the area involved that are in the possession of the Forest Service. These will be kept on file in the Forest Supervisor's Office or District Ranger's Office.

140 - Contractor Furnished Items (As applicable)

a. All labor, equipment, instruments, and tools necessary to accomplish the work.

b. Field maps and plats.

c. Records or expenses incidental thereto required to successfully complete this work.

150 - Definitions

151 - Property line - the true line, usually straight, between two established property corners, or between meander points on an irregular boundary (such as creeks, ridges, roads, irregular fences) between property corners. Property lines which follow the curve(s) of the center line or right-of-way line of engineered roads may be surveyed and/or described by complete curve data, chord traverse, or offsets with adequate ties to the property corners.

152 - Tie line - any line run between a corner not a part of the instant tract and/or a corner, meander point or collateral call of the instant tract for purpose of proving and/or locating specific details of the instant tract.

153 - Trial line - any straight (tangent) line run from a corner of the instant tract toward any succeeding corner of the instant tract on an assumed, estimated or approximate bearing for the purpose of computing the true bearing and distance, and (right angle) offsets from the trial line to the true line.

154 - Random line - a series of courses, beginning at an identified point, usually a proven corner, in the general direction of, and to a succeeding corner. A random line may be used in connection with either property or tie lines. It is to be used for computational purposes and/or proving the location

of property corners, or other record data, of the instant tract, or corner(s) or other record data on adjacent or nearby tracts.

DIVISION 200 - TECHNICAL SPECIFICATIONS G-109

210 - Property Corners

211 - Restoration of existent, lost or obliterated corners:

(a) BLM States - The principles and practices as set forth in the Bureau of Land Management publication "Restoration of Lost or Obliterated Corners and Subdivision of Section" shall be the basic guide in corner work as well as applicable state laws.

(b) Metes and Bounds States - The "Manual of Practice for Land Surveying" providing they are not less than requirements set forth in the following paragraphs, will govern. If no Manual is in force, state laws will govern.

212 - [illegible] Corners - The survey or resurvey of any tract of land shall begin at, or be tied into, an original corner (GLO, grant, lot, survey or tract) or any existing corner which has been previously proven or identified by the Contractor. The accuracy of the point of beginning and procurement of the original survey notes, plats, and/or descriptions or adjoining boundaries shall be the responsibility of the Contractor. The Forest Service will make available any notes, recovery notes or field books that are available.

213 - Monumentation - All corners involved in this contract shall be established or perpetuated, using the type of monument provided. The blank caps or tablets are to be stamped as directed by the Contracting Officer and will include year, surveyor's registration number, and corner identification. (See Exhibit "A") The top of the monument shall extend about 4" above the top of the ground. Rocks, when available, will be piled around each corner and painted red.

214 - Witness Corners - When a corner falls within a road right-of-way or in a body of water and the monument cannot be placed in the road, two witness corners shall be set exactly on line, as nearly as possible to the true corner or as directed by the Contracting Officer. (See Exhibit "B") Each cap will be stamped "Wit. Cor.".

215 - Bearing Trees - Each property corner or witness corner shall be witnessed by at least three healthy bearing trees when available, 6" DBH or over two of which will be located on Government land. When possible and practical, the true corner will be witnessed. The original trees called for are to be checked, and new ones will be established when needed. All bearing trees will have blazed at ground level into the wood and scribed BT facing the corner. Bearing trees to witness corners will be scribed WCBT. All distance measurement will be to center of the tree. Witness trees located on Government land will then have a red 6" band painted 6' above the ground. A 54-3, bearing tree sign, will be placed on each Forest Service bearing tree with the bearing and distance to the corner noted.

220 - Property Lines

221 - Preparation - The Contractor shall begin his work from a proven corner. The invisible [illegible] will be set on the measured trial or random line. The

departure from the end of line to the true corner will be measured as a means of calculating the correct bearing and true length of the line, and therefore calculating the offset from each reference stake to the corrected line. A transit or other optical instrument will be used to measure angles and a chain or tape of good quality will be used for measurements. Electronic measuring instruments may be used. Final distance will be converted to chains. All angular measurements will be in true bearings. The point of reference, known corners, solar or polaris observations, triangulation stations, will be noted in the notebook. Agonic charts are not suitable for declination determination.

222 - Offsetting from Random and/or Trial Lines - True lines may be established by offsetting from the random line. The true or final line will be re-run using the corrected bearings or located by offsetting from stakes on the random line. All distances will be measured horizontally. The method used will be noted in the field book. Intervisible stakes will be set along the true property line so that at least 3 stakes will be visible at one time.

The error of closure on a closed traverse will be at least 1:2,000, unless otherwise specified by state standards. When the survey is so that a closed traverse is not practicable, the contractor shall use methods of surveying commensurate to obtain this accuracy.

223 - Clearing, Blazing, Posting and Painting of True Property Lines - Only sufficient clearing as to permit line of sight will be done on all random lines. On the true line, in accordance with arrangements with adjoining property owners or applicable state laws, the boundary will be brushed for a distance of 3 links on each side of the boundary line, unless it is defined by such features as roads, hedges, or streams. Whenever possible, shrubs and saplings will be trimmed with stems and tops left intact. No line trees are to be cut.

a. Blazes and Hacks

(1) Blaze - Blazes will be made into a cambium layer of tree not less than 4' above ground, and will be 2" to 4" wide and 6" to 8" long.

(2) Hack - A single horizontal cut made with the heel of an axe 4" above and below the blaze, penetrating the wood but not notched.

b. Standards

(1) Line trees on boundary line will be face blazed only, on opposite sides of the tree, along the line. They will not be hacked.

(2) Trees on Government side of line will be quarter blazed with hacks 4' to 5' above the ground. No trees beyond 5 links of the line will be blazed. All blazes are to be painted with red paint on the Government side of the line.

(3) Trees on private land will be face blazed 4' to 5' above the ground. No tree beyond 5 links of the line is to be blazed. Blazing and painting on private land are to be in accordance with prior arrangements with property owners.

(4) Sign 54-2, Property Boundary, will be placed on line on treated posts, metal posts, or line trees. Posts should be placed firmly, extending about 4' above ground.

An unmounted sign will be placed on line trees, with nails left protruding at least 1". Location of signs 54-2 will be:

(a) At each corner facing private land and bisecting the angle.
(b) Intervisible along the line, but not to exceed 10 chains.
(c) At stream, trail, and road crossings, and at ridge tops.

Only wooden posts are to be used at road crossings. A line tree may be substituted for a post whenever its location along the line permits.

In GLO states, a location poster will be placed on one of the Government witness trees.

230 - Notebooks - Plats - Corner Cards - Certificates

A. Survey Notes - The surveyor shall keep an accurate and complete record of his survey in a standard field notebook, such as, standard transit book or mining book, using a 4H pencil and making no erasures. Corrections will be made by lining out erroneous detail. The completed field notebooks shall be delivered to the COR together with the invoice for job, and shall become the property of the Forest Service. If errors are found in field notebooks, the COR will return them to the contractor for correction at no expense to the Government.

(1) Bearings and distances of all lines and the corrected bearings and distances of each such line will be shown in a progressive manner for all closed traverse surveys. Open traverse surveys will be adequately cross-referenced to permit a clear interpretation of the work and will require the same stipulations as to recording.

(2) Each page of the surveyor's notebook will be numbered and the description of such work shall appear in an index, front of book, with reference to the page number.

(3) Surveyor will properly record his place of beginning, describing the means by which it was identified. If the corner has acceptance of the adjoining landowners and said owners were present or contacted, he will record such facts, with names, addresses and dates. State whether or not they concurred in the survey.

(4) Distances to all definite, reasonably permanent topographic or cultural features which will assist in future identification of lines or corners shall also be recorded. Artificial objects which are material to identification will also be noted. Any enclosures or habitation which appear on the line of survey or on Government lands within contractor's scope of vision shall be recorded as to size, description, name of claimant or occupant, on a suitable sketch shown on right hand page of surveyor's notebook, as they appear in relation to the course of the line. Distances from the beginning corner to such features, objects, or evidence of use or possession will be shown as a plus number of chains and offset distances in chains to the right of left.

(5) Surveyor will also record all corners to adjoining property found along the line of survey; making references to the type and size of corner monument and the bearing and distance to witness trees, giving the species, size and markings of each tree. When corners are not evidenced by monument of any type, he should so state. Corners which are in conflict with the results of contractor's survey should also be recorded in a like manner. When the performance of contractor's survey results in the retracement of a previous survey, and the person making that survey is known, the contractor should make a record of same in notebook with the date of survey.

(6) Any additional necessary markings of contractor's survey will be described in detail and the date on which marking was done.

(7) State method of establishing the true meridian and give declination of date of survey. (By solar or polaris observations, USC and GS triangulation station or taken from line between two known points or corners).

(8) A small scale summary sketch is to be prepared in the notebook to the general area, the lines run, lines painted, corners set. Page number(s) of notes may be shown.

(9) Date each days work and record names of party members, instrument used and whatever information is considered pertinent.

(10) Surveyor's certificate - Immediately following the last page used in notebook, a proper statement of certification is to be made as to his work which is contained in the numbered pages of the book, as follows:

State of _____
County of _____

I hereby certify that the survey covered by the foregoing notes was well and carefully done, the bearings and distances were actually measured, the corners established and witnessed, and the lines marked all as indicated by the notes.

Date _____

_____
Signature

_____
Title

State Registration No. _____

B. Plats - A plat will be prepared showing true property lines actually run similar to Exhibits C, D, E, and G. Those lines that are old Forest Service lines or tie lines will be noted. The seal of Registered Surveyor will be affixed.

C. Corner Cards - Form 7100-52 - One original 7100-52 will be completed for each corner set by the contract surveyor. All information placed on the card will agree with information in the field books. These cards will be signed by the surveyor and then become the property of the Forest Service.

D. Corner Registration Certificate - When requested, the contractor will complete a corner certificate for each corner. These will be recorded in the county courthouse by the contractor.

b. Conflicts - Where adjoining landowners refuse to deny permission for marking and painting lines, such lines and cases are to be reported in writing to the COR. These lines shall be corrected lines staked ready for marking. If the case is settled prior to the completion of the contract, the contractor will mark the line. Otherwise, the contractor will be paid as if the line has been marked.

G-113

If during the survey any claim arises along any segment of a line, the contractor will survey such areas as directed by the COR, keeping full notes thereof and furnish a separate plat of the disputed line and the land involved to the Contracting Officer's Representative.

240 - Exhibits A through G (As Applicable)

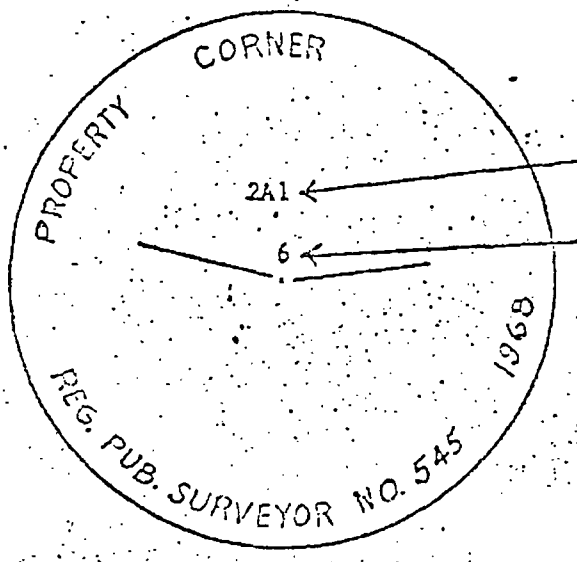
DIVISION 300 - INSPECTION AND ACCEPTANCE

(Reference Article 7 of 6300-38, General Provisions)

DIVISION 400 - MEASUREMENT AND PAYMENTS

(Reference Article 9 of 6300-38, General Provisions)

METES and BOUNDS STATES

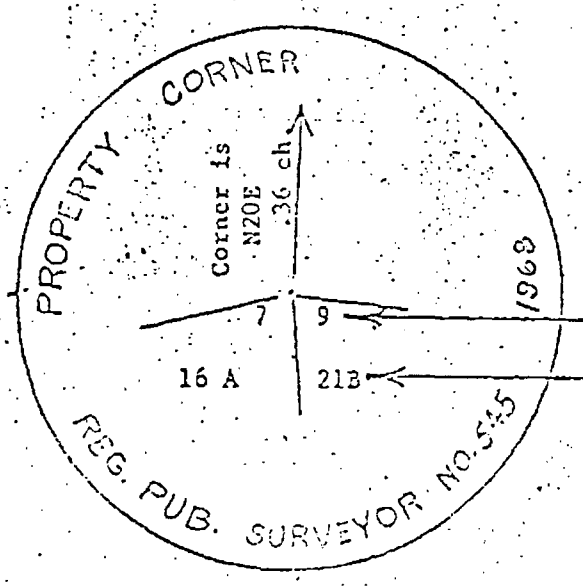


U.S.
Tract Number

Corner Number

All stamped letters
1/8 to 3/16 inch

METHOD OF STAMPING A REFERENCE MONUMENT

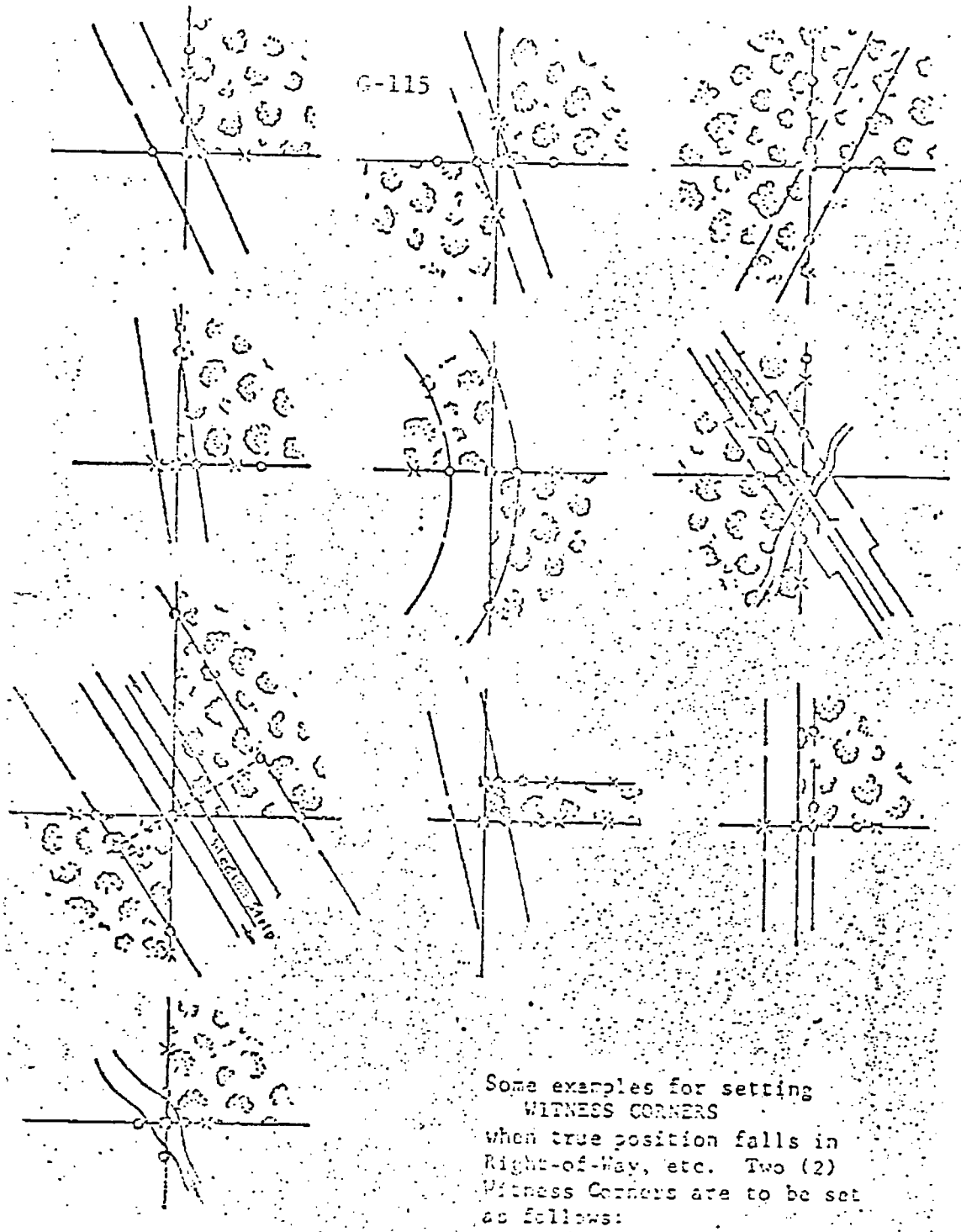


Corner number

Tract number

Corner common to two or more tracts

G-115

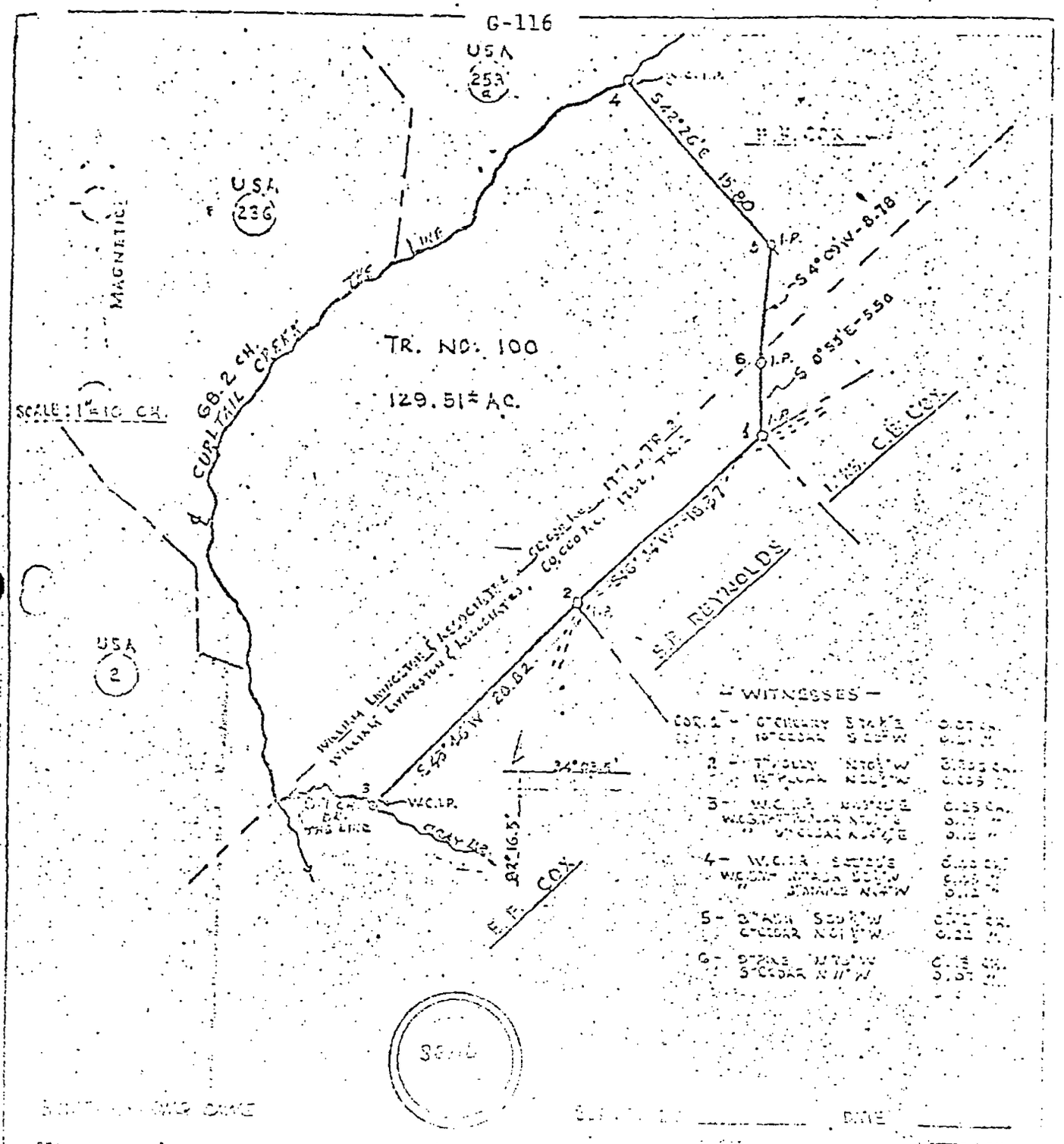


Some examples for setting
WITNESS CORNERS
when true position falls in
Right-of-Way, etc. Two (2)
Witness Corners are to be set
as follows:

- ⊙ First choice location
- X Second choice location
- o Third choice location - to be used ONLY if others are impossible.

THIS FORMAT FOR : CAROLINA ONLY

G-116

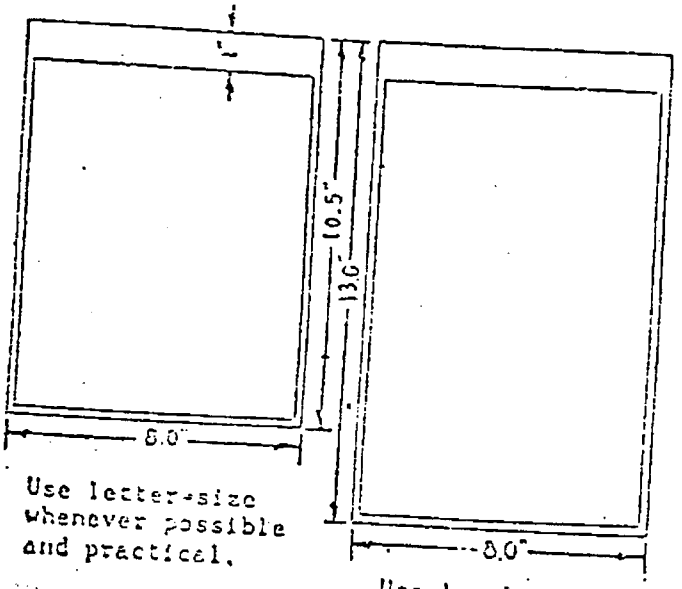


DATE

TRACT NO. 100

PAGE

RECORDED IN PLAT BOOK PAGE



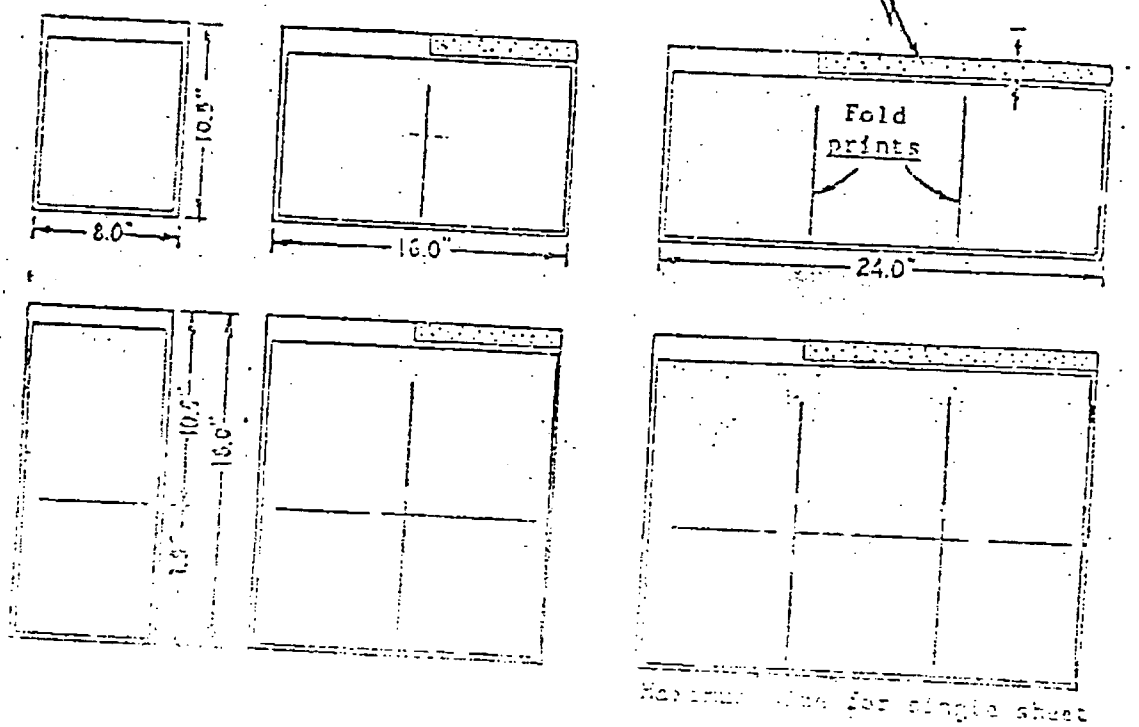
Use letter-size whenever possible and practical.

Use legal-size as requested by attorney.

PREPARATION OF PLATS

Draw plats in India ink. Draw plats on film, vellum or linen. For areas too large for maximum size sheet, use 2 or more sheets, showing match lines. DO NOT FOLD ORIGINALS. Send flat or in a tube.

Cut out PRINTS to permit use after binding.



Maximum size for single sheet

SOUTH CAROLINA ELECTRIC & GAS COMPANY
POST OFFICE BOX 764
COLUMBIA, SOUTH CAROLINA 29202

V. C. SUMMER
SENIOR VICE-PRESIDENT

February 12, 1974

Mr. Kenneth F. Plumb, Secretary
FEDERAL POWER COMMISSION
1425 K Street, N. W.
Washington, D. C. 20426

Re: SCE&G's Response to Comments by Others on FPC Draft Environmental Impact Statement — FPC Project No. 1894 — South Carolina Electric and Gas Company (Addenda V to SCE&G's October 18, 1973, Comments on FPC Draft Environmental Impact Statement.)

Dear Mr. Plumb:

South Carolina Electric & Gas Company has previously commented on the FPC Draft Environmental Impact Statement of September, 1973 for Parr Hydroelectric Project (FPC Project No. 1894) in letters dated October 18, 1973; December 11, 1973 (Addenda I); January 9, 1974 (Addenda II); January 21, 1974 (Addenda III); and February 1, 1974 (Addenda IV).

In this letter we are completing our response, begun in Addenda IV, to the USDA Forest Service comments on the FPC Draft Environmental Impact Statement for Project No. 1894, received by the FPC Secretary's office on Jan. 10, 1974.

Very truly yours,

V. C. Summer
Senior Vice-President

KLH:[illegible]

Attachments

OFFICIAL FILE COPY

TO	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

Response to USDA Forest Service Comments on
FPC Draft Environmental Impact Statement for
FPC Project No. 1894 — Part II

<u>Comment IV (b)</u>: No reference is made on chemical analysis for mercury in the environmental report. Since the facility will be using water from the Broad River any mercury present (now or later) may be concentrated in the Parr and Monticello Impoundments. Since this element is readily converted to the methyl form which is assimilated and concentrated in animal flesh, a potential hazard exists.

Response: Mercury levels in bottom sediments taken from the Broad River Study area in February, 1972, are .008, .042, [illegible], .005, [illegible] and .021 ppm at transects A through F respectively (see Map of Study Area included in Baseline Biotic Survey Report for transect locations). Additional data obtained on mercury levels by the South Carolina Water Pollution Control Authority in the Broad River are presented in response to Comment IV (c).

The mercury concentrations indicated by these limited data are not considered to be potentially hazardous. Because the existing Parr Reservoir has been present as a potential accumulator of heavy metals, including mercury, for many years, the present levels of mercury found should be a good indication of future levels in the sediments. This is based on the following:

a) Evaporation rates (at or near the existing level) will not sufficiently concentrate metal levels in the water to cause any change in deposition rates. Rate of deposition is tied to sediment loading rates and is not expected to increase in Parr Reservoir during project operation.

b) [illegible] mercury will enter [illegible]

[illegible]

1974 prior to any dredging activity. The parameters and frequency of sampling has been outlined in the response contained in Addenda II, pages 3-6, S.C.E. & G. letter to FPC 9 January, 1974.

Comment IV (b): The licensee cites developments at Par Pond as indicators of thriving game fish population in a cooling reservoir. The fish in Par Pond at the Savannah River exhibit high concentrations of methyl mercury compounds. These compounds resulted in part from continued evaporation of Savannah River water.

Response: High concentrations of mercury in fish found at Par Pond are not expected to be found in fish in Parr and Monticello Reservoirs since the hydrologic conditions are not analogous. There will be a continuous external inflow of water into the Parr-Monticello Reservoir system. Furthermore, operation of the pumped storage project will result in a continual interchange and mixing of water between Parr and Monticello Reservoirs, thereby decreasing sedimentation that might otherwise occur. Sedimentation rates are the primary factor causing mercury accumulation in bottom sediments since the greatest portion of metals can be expected to be adsorbed to sediment particles. Evaporation is less of a factor. Since the sedimentation rate is not expected to increase in Parr Reservoir, no increase in mercury concentrations over the present low levels is anticipated. See response to Comment IV (d) regarding sedimentation in Monticello Reservoir. Also refer to response to Comment IV (a).

Comment IV (c): Other heavy metals also affect plant and animal life in an aquatic environment. The lower forms of aquatic life (plankton) are extremely sensitive to chromium, regardless of valence. Lead concentrations are moderately high and may hinder survival of smaller fish and plankton. South Carolina Pollution Control Authority sampled the Broad River at Parr (Route 215) for heavy metals on December 5, 1971. The results are as follows:

Chromium	1.09 mg/l
Copper	Not detectable
Cadmium	Not detectable
Lead	34 mg/l
Total mercury	0.06 mg/l

Response: Several values reported in the comments are not correct. Lead listed as 34 mg/l is actually 34 μg/l. Mercury given as 0.06 mg/l is actually 0.1 μg/l. The data reported are not extensive; however, the values do not indicate a serious biological problem.

The following data are a summary of data collected by the South Carolina Pollution Control Authority beginning in 1960. (note values are in milligrams per liter not micrograms per liter.)

Chromium	Above Reservoir*	Below Reservoir*
N =	5	5
max =	48	1.09
min =	10	0.10
average	23	0.36
Cadmium		
N =	4	4
max =	0.10	0.10
min =	0.005	0.005
average	0.059	0.056
Lead		
N =	4	5
max =	0.20	1.21
min =	0.10	0.034
average	0.16	0.35
Copper		
N =	4	4
max =	0.03	0.70
min =	0.03	0.05
average	0.03	0.55

Mercury	Above Reservoir*	Below Reservoir*
N =	4	5
max =	.0005	.0005
min =	.0002	0
average	.0004	.0003

*Above reservoir station at crossing of South Carolina Highway #34 about 10 miles above Parr Reservoir.

*Below Reservoir station at crossing of South Carolina Highway #213 with Broad River, about 0.7 miles downstream of Parr Dam.

Comment IV (d): Monticello Reservoir will lose about [illegible] acre-feet of water annually. Parr Reservoir will lose about 16,100 acre/feet annually. This is 3.[illegible] percent of the volume of Monticello Reservoir and 30 percent of the volume of Parr Reservoir. The Reservoirs, Monticello in particular, will act as repositories for heavy metals. Monticello Reservoir will accumulate about 4.2 lbs of mercury, [illegible],310 lbs of lead, and 37 tons of chromium annually. The concentration in Parr Reservoir will be about 60 percent of those in Monticello Reservoir.

Response: The water losses estimated for Monticello and Parr Reservoirs have no necessary relationship to the deposition of any heavy metal in the reservoirs. During an average annual period, 157,000 acre/feet will flow through Parr Reservoir; thus the average concentration of minerals due to evaporation is only 10 percent. A similar analogy applies to Monticello Reservoir.

It is not stated on what basis the poundages of various heavy metals calculated are based. They should primarily be a function of sedimentation rate since the greatest portion of metals can be expected to be adsorbed to sediment particles. Regardless of this, however, the importance of deposition is relatively [illegible] in biological availability.

[illegible]

in sediment during operation as opposed to without operation, the concentration factor of any organisms ingesting sediments will remain the same. If the total amount of sedimentation is increased, the total amount potentially available to organisms is potentially increased. In Furr Reservoir there is no indication that sedimentation will be increased significantly and there are indications there will be a net reduction in bottom organisms. In Monticello Reservoir, sedimentation will occur with or without plant operation, although an area for sedimentation will be present that did not exist before. No additional concentrating processes will be present in Monticello Reservoir and because of the deep water nature of the bottom, benthic production that could be expected to bring heavy metals into the food chain will be quite limited.

Note: The water losses calculated in the U. S. Forest Service's comment are for equilibrium conditions. Higher losses are anticipated because of the heated discharge into Monticello Reservoir by the Nuclear Station.

Comment IV (e): Radionuclides released into waterways will be accumulated in vegetation growing along these areas. Will these controlled (through dilution) releases remain benign, or will the effects be passed on to the animal consumers in the local ecosystem—and ultimately to man, through deer, turkey and waterfowl?

Response: Radionuclides released from any surface source may ultimately reach man through the food web pathway. It is therefore reasonable to predict that some small amount of the radionuclides released into waterways from the Virgil C. Summer Nuclear Station will be placed up by vegetation and animal life. The crucial [illegible] concentration of any particular radionuclide within organisms or parts of [illegible] is the severity of damage that may

result from this level of contamination.

The radiological safety factors for specifying maximum releases of radionuclides take into account the chemical and radiological characteristics for each radioelement and the biological characteristics (concentration factors) of biota that may internalize these elements. The concentration factors and pathways of radionuclides potentially released from the Summer Nuclear Station have been discussed in the PSAR, ER and AEC Final Environmental Statement for the Summer Nuclear Station. These levels have all been approved as acceptably safe by the conservative standards set by the U. S. Atomic Energy Commission. In addition, a field sampling program for establishing existing radiological levels will be carried out two years before start of the nuclear reactor. Subsequently, field radiological monitoring of air, water and selected biota during plant operation will be performed to insure compliance with the AEC standards.

Comment V

Relationship between local short-term environmental uses and maintenance and enhancement of long-term productivity

The Draft Environmental Statement defines short term environmental use as [illegible] the operating period of the nuclear plant as 40 years and the operating life of the plant as an indefinite time. It also identifies as [illegible] permanent impacts on project structures (including the [illegible] roads, and the creation of a man-made impoundment [illegible]

[illegible] the heading of the Forest [illegible]

The Draft Environmental Statement on page 2.5-2 mentions contribution to "long-term" productivity of the community from the project and an enhancement of long-term productivity of the land and water resources in the site area. We fail to recognize how these benefits will be generated by the project and feel that the analysis should better describe and evaluate them.

Response: It is recognized that the flooding of forested land, particularly the hardwoods and associated wildlife habitat along Parr Reservoir and Frost Creek, will represent an irretrievable commitment of resources. Forested land in Fairfield County represents approximately 80 percent (1967) of the total land area; the forested areas to be inundated by the proposed Monticello Reservoir and enlargement of Parr Reservoir will be less than three percent of the total forested land in Fairfield County.

The present sport fishing in the project area is considered to be relatively poor. Only one unimproved boat landing exists in the project area, at Cannon's Creek. As part of the project, an approximately 300 acre fishing sub-impoundment will be created in the northernmost portion of Monticello Reservoir. The fishing lake will undergo only minimum fluctuations in water level, if at all, and will be stocked with bass, bream and crappie. A boat launching ramp, together with parking spaces and sanitary facilities, will be provided in the fishing area. This represents the first such facility of its kind in Fairfield County and is considered a long-term enhancement of water resources. More details are provided in page 31, Enclosure II of SCE&G letter to FPC of 9 January, 1974.

[illegible] will also be constructed in Parr Reservoir and [illegible] [illegible] include [illegible] [illegible]

Recreational facilities such as additional boat landings, picnic areas and camping sites may also be constructed in the future depending on recreational demand. All such facilities would be accomplished in consultation with the Federal Power Commission as well as with the South Carolina Department of Parks, Recreation and Tourism; the South Carolina Wildlife Department; the U. S. Bureau of Outdoor Recreation; the U. S. Forestry Service and other agencies.

Wildlife habitat, to some extent, may be enhanced by project construction. For example, it is generally considered that the extensive growth of bushy vegetation on cut-over land following logging of major forests is a factor in helping to increase deer population. Similarly, the added edge created by clearing a corridor through heavily wooded areas will permit greater sunlight penetration and favor the growth of low growing weeds and woody plants that are important food sources to certain species. Selective plantings will be made in transmission line corridors as appropriate. A waterfowl habitat improvement plan will be carried out around both reservoirs. SCE&G, in an agreement with the South Carolina Wildlife and Marine Resources Department, is committed to development of a green-tree reservoir site or sites. The Company is sponsoring exploration of archaeology sites on project lands. These efforts on the part of SCE&G not only help offset the loss of forest lands but are also considered to enhance in some respects the present land and water resources of the site area.

Not to be forgotten are the benefits of the proposed project to the general population of this area. In addition to recreation opportunities not now available in Fairfield County, employment opportunities will be available to the location population.

It is anticipated that county taxes on the project and possible influx of new businesses into the area will provide a boost to the local economy resulting in a higher standard of living.

Forested lands lost cannot be replaced by the project, but on balance it is felt that the loss of less than three percent of Fairfield's County's forested area and associated wildlife habitat is a small price to pay for the increase in human enjoyment and quality of life that will accrue as a result of project development.

Comment [illegible] The statement makes no mention of the probability of fogs from the reservoir occurring Routes [illegible] and 99. These fogs will be a permanent [illegible] and will create a traffic hazard. The licensee's environmental report discusses visibility but fails to mention any reasonable solutions.

Response [illegible] 8-2 in the Applicant's Environmental Report, which is attached, lists the [illegible] in fog frequency anticipated as a result of the Reservoir, for both steam and [illegible] type fogs.

Steam fog [illegible] occurs over water, dissipating a few feet inland of the shoreline. It is [illegible] estimated that 10 percent of the steam fogs move beyond the reservoir [illegible] Since the maximum monthly estimate of steam fog frequency with visibility [illegible] 6 miles is 15.8 percent, the frequency of such fog moving overland is about [illegible] percent.

The increase in the [illegible] in advection fog frequency with visibility below [illegible] is [illegible] percent, being essentially zero except [illegible] [illegible] time of [illegible] highway

traffic is a small fraction of the fog occurrence.

It is concluded that the interference of highway traffic by fog formed by the reservoir is not significant.

(1) Page 2581-4 Supplement No. 2, to the Environmental Report, Virgil C. Summer Nuclear Station

TABLE B-2

PROJECTED IMPACT OF MONTICELLO RESERVOIR ON FOG* FREQUENCY

MONTH	FOG FREQUENCY (%) AT COLUMBIA	NET FREQUENCY (%) INCREASE DUE TO: ADVECTION FOG	STEAM FOG
June, 1965	-	**	**
July, 1965	8.5	0	6.4
Aug., 1965	-	**	**
Sep., 1965	12.9	0	9.2
Oct., 1965	9.3	0	11.7
Nov., 1965	9.6	0.4	15.8
Dec., 1965	6.9	3.6	12.9
Jan., 1966	19.8	2.0	7.6
Feb., 1966	18.8	0.4	4.0
Mar., 1966	-	**	**
Apr., 1966	-	**	**
May, 1966	12.9	0	5.6

*Defined by visibilities less than or equal to six miles.

** Not computed.

Comment: Page F - 1, 2, & 3: Water losses are stated for the various cooling tower alternatives. These water losses should be compared with the water losses calculated for the proposed project. Fog potential of the proposed project and the non-spray cooling pond alternative should also be discussed.

Response:

The evaporative losses from an equilibrium (open water) pond, in the region of the Monticello Reservoir, average about 42 to 45 inches per year. In the absence of thermal input to the Monticello Reservoir from its use as a cooling pond, this reservoir approximates an equilibrium pond. Its evaporative losses from its 6,800 acres would be, therefore, about 23,800 to 25,200 acre feet per year.

The evaporative losses from the Monticello Reservoir serving both pump storage and cooling functions are estimated at 70 cfs or 50,680 acre feet per year. (Environmental Report, Parr Hydroelectric Project, FPC Project 1394, page 2.2.2-1 Table 2.)

The difference in loss rates between the reservoir serving both pump storage and cooling functions and the reservoir as a pump storage facility only is the water consumption attributable to the cooling function. This value is 26,880 acre feet per year.

The following table compares this water loss for the proposed project with the alternatives, where consumption is reported in the Draft Environmental Impact Statement, Parr Hydroelectric Project, prepared by the FPC.

Cooling [illegible]	Consumptive Water Losses [illegible] Year
[illegible]nical Dr[illegible]	[illegible]
[illegible]ut Draft [illegible]	[illegible]
[illegible] Pond	[illegible]

Sec 4.2 Ref 3

D H E C

PROMOTE PROTECT PROSPER

South Carolina Department of Health and Environmental Control

www.scdhec.gov/water

South Carolina

NPDES GENERAL PERMIT FOR STORM WATER DISCHARGES FROM LARGE AND SMALL CONSTRUCTION ACTIVITIES

In compliance with the provisions of the SC Pollution Control Act (S.C. Code Sections 48-1-10 *et seq.*, 1976) and with the provisions of the Clean Water Act, 33 U.S.C. §1251 et. seq., (hereafter CWA or the Act), as amended by the Water Quality Act of 1987, P.L. 100-4, Operators of large and small construction activities that are described in Subpart 1.3 of this National Pollutant Discharge Elimination System (NPDES) general permit, except for those activities excluded from authorization of discharge in Subpart 1.3.C of this permit, are authorized to discharge pollutants to Surface Waters of the State in accordance with the conditions and requirements set forth herein. Permit coverage is required from the "commencement of construction activities" until "final stabilization" as defined in Appendix A.

M. Rheta Geddings

M. Rheta Geddings, Assistant Chief

Bureau of Water

Permit No.: **SCR100000** **Issued: August 1, 2006**

Effective: **September 1, 2006** **Expires: August 31, 2011**

NPDES General Permit for Storm Water Discharges From Construction Activities

Table of Contents

PART 1: COVERAGE UNDER THIS PERMIT

1.1 Introduction

This Construction General Permit (CGP) authorizes storm water discharges from large and small construction activities where those discharges enter Surface Waters of the State or a municipal separate storm sewer system (MS4) leading to Surface Waters of the State subject to the conditions set forth in this permit. This permit also authorizes storm water discharges from any other construction activity designated by DHEC where DHEC makes that designation based on the potential for contribution to a violation of a water quality standard or for significant contribution of pollutants to Surface Waters of the State. This permit replaces the storm water construction general permit (NPDES # SCR100000) issued January 15, 1998. Any references to the 1998 CGP in this permit refer to that permit.

This permit is presented in a reader-friendly, plain language format. This permit uses the terms "you" and "your" to identify the person(s) who owns or operates a "facility" or "activity" as defined in Appendix A and who must comply with the conditions of this permit. This format should allow you, the permittee and Operator of a large or small construction activity, to easily locate and understand applicable requirements. The goal of this permit is to reduce or eliminate storm water pollution from construction activity by requiring that you plan and implement appropriate pollution control practices to protect water quality.

1.2 Permit Area

This permit covers all areas of South Carolina including Indian lands.

1.3 Eligibility

Permit eligibility is limited to discharges from "large" and "small" construction activity as defined in Appendix A. This general permit contains eligibility restrictions, as well as permit conditions and requirements. You may have to take certain actions to be eligible for coverage under this permit. In such cases, you must continue to satisfy those eligibility provisions to maintain permit authorization. If you do not meet the requirements that are a pre-condition to eligibility, then resulting discharges constitute un-permitted discharges. By contrast, if you do not comply with the requirements of the general permit, you may be in violation of the general permit for your otherwise eligible discharges.

A. Allowable Storm Water Discharges

Subject to compliance with the terms and conditions of this permit, you are authorized to discharge pollutants in:

1. Storm water associated with large and small construction activity as defined in Appendix A;

2. Storm water discharges designated by DHEC as needing a storm water permit under §122.26(a)(1)(v) or §122.26(b)(15)(ii) of SC Regulation 61-9;

3. Discharges from support activities (e.g., concrete or asphalt batch plants, equipment staging yards, material storage areas, excavated material disposal areas, borrow areas) provided:

   a. The support activity is directly related to the construction Site required to have NPDES permit coverage for discharges of storm water associated with construction activity;

   b. The support activity is not a commercial operation serving multiple unrelated construction Projects by different Operators, and does not operate beyond the completion of the construction activity at the last construction Project it supports; and

   c. Appropriate controls and measures are identified in a Storm Water Pollution Prevention Plan (SWPPP) covering the discharges from the support activity areas.

4. Discharges composed of allowable discharges listed in Subparts 1.3.A and 1.3.B commingled with a discharge authorized by a different NPDES permit and/or a discharge that does not require NPDES permit authorization.

B. Allowable Non-Storm Water Discharges

You are authorized for the following non-storm water discharges, provided the non-storm water component of the discharge is in compliance with Subpart 3.5 (Non-Storm Water Discharge Management):

1. Discharges from fire-fighting activities;

2. Fire hydrant flushings;

3. Waters used to wash vehicles where detergents are not used;

4. Water used to control dust in accordance with Subpart 3.4.J;

5. Potable water including uncontaminated water line flushings;

6. Routine external building wash down that does not use detergents;

7. Pavement wash waters where spills or leaks of toxic or hazardous materials have not occurred (unless all spilled material has been removed) and where detergents are not used;

8. Uncontaminated air conditioning or compressor condensate;

9. Uncontaminated ground water or spring water;

10. Foundation or footing drains where flows are not contaminated with process materials such as solvents;

11. Uncontaminated excavation dewatering;

12. Landscape irrigation.

C. Limitations on Coverage

1. This permit does not authorize post-construction discharges that originate from the Site after construction activities have been completed and the Site has achieved final stabilization, including any temporary support activity. Post-construction storm water discharges from industrial sites may need to be covered by a separate NPDES permit.

2. This permit does not authorize storm water discharges associated with construction activity that have been covered under an individual permit or required to obtain coverage under an alternative general permit in accordance with Subpart 4.2.

3. This permit does not authorize discharges that DHEC, prior to authorization under this permit, determines will cause, have the reasonable potential to cause, or contribute to a violation of any applicable water quality standard. Where such a determination is made prior to authorization, DHEC may notify you that an individual permit application is necessary in accordance with Subpart 4.2. However, DHEC may authorize your coverage under this permit after you have included appropriate controls and implementation procedures in your SWPPP designed to bring your discharge into compliance with water quality standards.

4. Discharging into Receiving Waters With an Approved Total Maximum Daily Load Analysis

   a. You are not eligible for coverage under this permit for discharges of pollutants of concern to waters for which there is a total maximum daily load (TMDL) in effect that is applicable stormwater construction discharges unless you incorporate into your SWPPP measures or controls that are consistent with the assumptions and requirements of such TMDL. To be eligible for coverage under this general permit, you must incorporate into your SWPPP any conditions applicable to your discharges necessary for consistency with the assumptions and requirements of such TMDL. If a specific wasteload allocation has been established that would apply to your discharge, you must incorporate that allocation into your SWPPP and implement necessary steps to meet that allocation.

   b. In a situation where a TMDL has specified a general wasteload allocation applicable to construction storm water discharges, but no specific requirements for construction Sites have been identified in the TMDL, you should consult with the Department to confirm that adherence to a SWPPP that meets the requirements of the CGP will be consistent with the TMDL. Where a TMDL has not specified a wasteload allocation applicable to construction storm water discharges, but has not specifically excluded these discharges, adherence to a SWPPP that meets the requirements of the CGP will generally be assumed to be consistent with the approved TMDL. If the TMDL specifically precludes such discharges, the Operator is not eligible for coverage under the CGP.

1.4 Waivers for Certain Small Construction Activities

Three scenarios exist under which small construction activities (see definition in Appendix A) may be waived from the NPDES permitting requirements detailed in this CGP. These exemptions are predicated on certain criteria being met and proper notification procedures being followed. Details of the waiver options and procedures for requesting a waiver are provided in Appendix B.

PART 2: AUTHORIZATION FOR DISCHARGES OF STORM WATER FROM CONSTRUCTION ACTIVITY

Except for Projects that are located in Horry, Georgetown, Berkeley, Charleston, Dorchester, Colleton, Beaufort, or Jasper County and disturb 0.5 acres or less, to obtain coverage under this CGP, you, the Owner or Operator, must prepare and submit a complete and accurate Notice of Intent (NOI) and the other required information, as described in this Part. Discharges will not be authorized if your NOI is incomplete or inaccurate or if you are not eligible for permit coverage. Unless the Department specifically requests that an NOI be submitted, all Projects that are located in Horry, Georgetown, Berkeley, Charleston, Dorchester, Colleton, Beaufort, or Jasper County and disturb 0.5 acres or less are not required to submit an NOI, but are automatically granted coverage under this general permit provided the appropriate Best Management Practices are being used.

2.1 Authorization to Discharge Date

This permit is effective on September 1, 2006 and is effective for five years, expiring at midnight on August 31, 2011.

A. **For all Projects except for SC Department of Transportation Projects.**

1. When your SWPPP is reviewed and approved by an implementing entity under SC Regulation 72-300 (if applicable); another local government program acceptable to DHEC; or, when applicable, the owner of the municipal separate storm sewer system that receives your storm water discharges, and if DHEC does not send a letter within 7 business days of the receipt of a complete NOI authorizing coverage, denying coverage, requesting additional information or advising you that DHEC has decided to also review the SWPPP, coverage under this CGP is automatically granted.

2. When DHEC reviews your SWPPP, if DHEC does not send a letter authorizing coverage, denying coverage, or requesting additional information within 20 days of the receipt of the complete NOI, coverage under this CGP is automatically granted.

B. **For SC Department of Transportation Projects,** your SWPPP must be submitted to DHEC. DHEC may require review and approval of your SWPPP prior to granting you coverage under this CGP. If DHEC does not send a letter authorizing coverage, denying coverage, or advising that a review of the SWPPP will take place within 10 business days of receipt of the NOI, coverage will automatically be granted.

C. If a US Army Corps of Engineers' 404 Permit is required by Section 404 of the CWA Act for permanent or temporary storm water control structures, DHEC may not grant you coverage under this CGP until the 404 Permit has been issued and is effective.

1. In situations where the 404 Permit decision will not affect the implementation of the SWPPP, the Department will issue approval of the SWPPP and grant coverage under this permit before the 404 Permit decision is effective.
2. In situations where the 404 Permit decision will affect only a portion of the "Project Area", the Department may grant the unaffected portion of the "Project Area" coverage under this permit. The remaining portion of the "Project Area" will be considered after the 404 Permit is issued and effective.

3. In situations where the entire "Project Area" is affected by the 404 Permit decision, the Department will not grant coverage under this general permit until the 404 Permit decision is issued and effective.

D. When permanent or temporary structures will be placed in State Navigable Waters, the Department will address any issues related to State Navigable Waters' Program under SC Regulation 19-450 during the review of the SWPPP rather than requiring a separate State Navigable Waters Permit.

E. DHEC may deny or delay your coverage based on eligibility considerations of Subpart 1.3 (e.g., TMDL concerns).

2.2 Notice of Intent Contents and Other Required Information

A. You must use the NOI form (or a photocopy thereof) provided by the Department. This form will be made available on our WEB site at:

http://www.scdhec.net/eqc/admin/html/eqforms.html#Water

If DHEC makes other NOI forms available (either directly, by public notice, or by making information available on the Internet), you may take advantage of any of those options to satisfy the NOI use requirements of this Subpart.

B. You must provide the following information on the NOI form:

1. Operator name, address, telephone number, and Employer Identification Number (EIN) as established by the U.S. Internal Revenue Service;

2. Project/Site name, address, county or similar governmental subdivision, and latitude/longitude of your construction Project or Site;

3. Whether your Site is located in Indian country and if so, the name of the Reservation, if applicable;

4. Whether the SWPPP has been prepared in accordance with this CGP;

5. Name of the Water(s) of the State into which your Site discharges;

6. Indication whether your discharge is consistent with the assumptions and requirements of applicable TMDLs;

7. Estimated dates of commencement of construction activity and final stabilization (i.e., Project start and completion dates);

8. Total acreage (to the nearest tenth acre) to be disturbed for which you are requesting permit coverage; and

9. A certification statement, signed and dated by an authorized representative as defined in §122.22 of SC Regulation 61-9 (see Appendix C of this permit), and the name and title of that authorized representative.

C. The following information must also be submitted with the NOI form for the NOI application to be complete:

1. The fee for coverage under this CGP. A check made payable to SC DHEC must be submitted. SC Regulation 61-30, Environmental Protection Fees, governs this fee. At the time of issuance of this CGP the fee was $125.

2. a. For Projects not owned or managed by the SC Department of Transportation:

i. If approval of the SWPPP is required under either SC Regulation 72-300 or an applicable MS4 Program or other local program acceptable to DHEC:

(1) A copy of the State, MS4, or local application;

(2) For non-linear Projects, a copy of the approved SWPPP with the supporting documents and calculations. For linear Projects, this is only applicable if specifically requested. This information is not required if there is a written agreement or memorandum of understanding between DHEC and the Operator of the applicable MS4 or other local program acceptable to DHEC that addresses the availability of the approved SWPPP to DHEC through the local entity that maintains a copy of the approved SWPPP;

(3) A copy of the approval of the SWPPP from the entity implementing SC Regulation 72-300 or an applicable MS4 Program or other local program acceptable to DHEC; and

(4) If DHEC's Bureau of Water also reviews your SWPPP prior to granting coverage under this CGP, the NPDES plan review fee of $100 per disturbed acre not to exceed $2,000.

ii. If approval of the SWPPP is not required under SC Regulation 72-300 or an applicable MS4 program or other local program acceptable to DHEC:

(1) Three copies of the SWPPP;

(2) For non-linear Projects, the supporting calculations and documents. Linear Projects must submit supporting calculations and documents when requested; and

(3) The plan review fee of $100 per disturbed acre not to exceed $2,000.

b. For SC Department of Transportation Projects:

i. The SWPPP;

ii. The supporting calculations and documents, when requested; and

iii. The plan review fee of $100 per disturbed acre not to exceed to $2000. The plan review fee is applicable only if DHEC reviews your SWPPP prior to granting coverage under this CGP.

3. For Projects located in Horry, Georgetown, Berkeley, Charleston, Dorchester, Colleton, Beaufort, or Jasper County, a copy of a letter from DHEC's Office of Ocean and Coastal Resource Management that states the proposed Project is consistent with the Coastal Zone Management Plan.

2.3 Submission Deadlines

A. New Projects: Except as given in the first paragraph of Part 2, to obtain coverage under this permit, you must submit a complete and accurate NOI with the other required information and be authorized consistent with Subpart 2.1 prior to your commencement of construction activities.

B. Permitted Ongoing Projects: If you previously received authorization to discharge for the current phase of your Project under the 1998 CGP, you are automatically covered under this permit without resubmitting an NOI.

1. You must comply with the terms and conditions of the 1998 CGP under which you were previously authorized.

2. Future phases of the Project must submit an NOI to be covered under this CGP.

C. Un-permitted Ongoing Projects (only applicable for first 90 days after this permit is issued): If you previously did not receive authorization to discharge for your Project under the 1998 CGP and you wish to obtain coverage under this permit:

1. Except as noted in 2.3.C.2, you must:

a. Submit an NOI with the required other information within 90 days of the issuance date of this permit; and

b. Until you are authorized under this permit consistent with Subpart 2.1, comply with an interim Storm Water Pollution Prevention Plan (SWPPP) consistent with the 1998 CGP.

2. If you meet the termination of coverage requirements in accordance with Subpart 5.1 within 90 days of the issuance date of this permit (e.g., construction will be finished and final stabilization achieved) you must comply with an interim Storm Water Pollution Prevention Plan (SWPPP) consistent with the 1998 CGP until permit coverage is no longer required.

D. *Late Notifications*: Operators are not prohibited from submitting NOIs after initiating clearing, grading, excavation activities, or other construction activities. When a late NOI is submitted, authorization for discharges occurs consistent with Subpart 2.1. DHEC may take enforcement for any unpermitted discharge or violations of laws or regulations that occur between the time construction commenced and discharge authorization.

2.4 Where to Submit

You must send your complete and accurate NOI application to DHEC at the following address:

Construction Storm Water Notice of Intent
Bureau of Water
SC DHEC
2600 Bull Street
Columbia, SC 29201

PART 3: STORM WATER POLLUTION PREVENTION PLANS (SWPPPS)

3.1 Storm Water Pollution Prevention Plan Framework

A. A SWPPP must be prepared prior to submission of an NOI as required in Part 2. At least one SWPPP must be developed for each construction Project covered by this permit and a qualified individual in accordance with good engineering practices must prepare such SWPPP. For Projects that disturb more than 2 acres, the SWPPP must be prepared, amended when necessary, certified, and stamped by a qualified individual who is licensed as follows:

1. Registered professional engineers as described in Title 40, Chapter 22;

2. Registered landscape architects as described in Title 40, Chapter 28, Section 10, item (b);

3. Tier B land surveyors as described in Title 40, Chapter 22; or

4. Federal government employees as described by Title 40, Chapter 22, Section 280(A)(3).

B. The SWPPP must:

1. Identify all potential sources of pollution which may reasonably be expected to affect the

quality of storm water discharges from the construction Site:

2. Describe practices to be used to reduce pollutants in storm water discharges from the construction Site; and

3. Assure compliance with the terms and conditions of this permit when properly implemented.

C. Once a definable area has been finally stabilized, you may mark this on your SWPPP and no further SWPPP or inspection requirements apply to that portion of the Site (e.g., earth-disturbing activities around one of three buildings in a complex are done and the area is finally stabilized, one mile of a roadway or pipeline Project is done and finally stabilized, etc).

D. You must implement the SWPPP as written from commencement of construction activity until final stabilization is complete.

3.2 Requirements for Different Types of Operators

You may meet one or both of the operational control components in the definition of Operator found in Appendix A. Subpart 3.2.C applies to all permittees having control over only a portion of a construction Site.

A. If you have "operational control over construction plans and specifications" as defined in the definition of "Operator" in Appendix A, you must ensure that:

1. The specifications for the BMPs meet the minimum requirements of this Subpart and all other applicable permit conditions;

2. The SWPPP indicates the areas of the Site where the Operator has operational control over specifications, including the ability to make modifications in specifications and plans including the SWPPP;

3. All other co-permittees implementing portions of the SWPPP (or their own SWPPP) who may be impacted by a change to the construction plan are notified of such changes in a timely manner;

4. The SWPPP indicates the name(s) of the Operator(s) with day-to-day operational control of those activities necessary to ensure compliance with the SWPPP or other permit conditions; and

5. For non-linear Projects that disturb 10 acres or more, you must conduct a pre-construction conference with each co-permittee and contractor who is not a co-permittee in person at the Site prior to that co-permittee or contractor performing construction related work intended to disturb soils at the Site that may affect the implementation of the SWPPP unless it is justified in the SWPPP and approved by the Department to conduct the conference off-site. This pre-construction conference can be with all contractors or the pre-conference may be conducted separately with one or more contractors present so that all contractors who perform land

disturbing activity or construction activity are aware of the requirements of the SWPPP before they start construction.

6. For linear construction of roads or utilities (such as roads built by the SC Department of Transportation and utility construction including electrical power lines, gas lines, main sewer trunk lines, and water distribution lines that are not part of a development) neither of which are a part of a subdivision of other type of development, the conferences with each co-permittee and contractors who are not co-permittees may be conducted off-site unless specifically required by the Department in writing to be conducted onsite. The purpose of the conference is for the preparer of the SWPPP, someone with a registration equivalent to that of the preparer of the SWPPP, or the person with operational control of the plans and specifications to explain the whole SWPPP to the co-permittees and contractors who are not co-permittees and to specifically go over the areas of the SWPPP that are related to the work to be performed by the co-permittee and contractor who is not a co-permittee.

B. If you have "operational control over day-to-day activities" as defined in the definition of "Operator" in Appendix A at the Project that are necessary to ensure compliance with the SWPPP or other Permit conditions, you must ensure that:

1. The SWPPP identifies the parties responsible for implementation of control measures identified in the plan;

2. The SWPPP indicates areas of the Project where you have operational control over day-to-day activities;

3. The SWPPP indicates the name of the party(ies) with operational control over Project specifications (including the ability to make modifications in specifications); and

4. All appropriate contractors have signed either the Co-permittee or non Co-permittee certification and copies of these certifications are in the SWPPP.

C. If you have operational control over only a portion of a larger Project (e.g., one of four homebuilders in a subdivision), you are responsible for compliance with all applicable terms and conditions of this permit as it relates to your activities on your portion of the construction Site, and implementation of best management practices (BMPs) and other controls required by the SWPPP. You must ensure either directly or through coordination with other permittees, that your activities do not render another party's pollution control ineffective. You must either implement your portion of a common SWPPP or develop and implement your own SWPPP.

For more effective coordination of BMPs and opportunities for cost sharing, a cooperative effort by the different Operators at a Site to prepare and participate in a comprehensive SWPPP is encouraged. Individual Operators at a Site may, but are not required to, develop separate SWPPPs that cover only their portion of the Project provided reference is made to other Operators at the Site. In instances where there is more than one SWPPP for a Site, cooperation between the permittees is encouraged to ensure the storm water discharge controls and other measures are consistent with one another.

D. Contractor Certifications and Co-permittee Status.

1. The Owner of a Project, as the applicant for the NPDES permit, is responsible for compliance with all the terms and conditions of this permit and the SWPPP. The Owner may rely on other Persons to assist in compliance with this permit and the SWPPP. As such, the Project Owner and contractors and subcontractors who will conduct construction activities intended to disturb soils may elect to be Co-permittees. Further, all contractors who will conduct construction related work intended to disturb soils at the Site that may affect implementation of the SWPPP, regardless of whether or not they are Co-permittees, must be listed in the SWPPP and attend a pre-construction conference before they can conduct construction activity at the Site.

2. All contractors and subcontractors identified in the plan as Co-permittees must sign a copy of the certification statement given below:

   "I certify by my signature below that: a) for Sites that disturb 10 or more acres, I participated in a pre-construction conference onsite or, when allowed, offsite with the individual who is responsible for the operational control of the Storm Water Pollution Prevention Plan (SWPPP); and b) I accept the terms and conditions of SWPPP as required by the general National Pollutant Discharge Elimination System (NPDES permit number SCR100000) issued to the Owner/Operator of the construction activity for which I have been contracted to perform construction related professional services. Further, by my signature below, I understand that I am becoming a Co-permittee with the Owner/Operator and other contractors that have become Co-permittees to the general NPDES permit issued to the Owner/Operator of the facility for which I have been contracted to perform professional construction services. As a Co-permittee, I understand that I, and my company, as the case may be, am legally accountable to the SC Department of Health and Environmental Control (DHEC), under the authorities of the CWA and the SC Pollution Control Act, to ensure compliance with the terms and conditions of the SWPPP. I also understand that DHEC enforcement actions may be taken against any specific Co-permittee or combination of Co-permittees if the terms and conditions of the SWPPP are not met. Therefore, having understood the above information, I am signing this certification and am receiving Co-permittee status to the aforementioned general NPDES permit."

3. All contractors and subcontractors identified in the plan to perform construction related work intended to disturb soils at the Site that may affect the implementation of the SWPPP but who will not be Co-permittees must sign the certification statement given below:

   "I certify by my signature below that: a) for Sites that disturb 10 or more acres, I participated in a pre-construction conference onsite or, when allowed, offsite with the individual who is responsible for the operational control of the Storm Water Pollution Prevention Plan (SWPPP); and b) I understand the terms and conditions of SWPPP as required by the general National Pollutant Discharge Elimination System Permit (NPDES permit number SCR100000) issued to the Owner/Operator of the construction activity for which I have been contracted to perform construction related professional services. I understand that I, and my company, as the case may be, may be legally accountable to the SC Department of Health and Environmental Control (DHEC), under the authorities of the CWA and the SC Pollution Control Act, to ensure

compliance with the terms and conditions of the SWPPP."

4. The date of the signature, the title of the Person providing the signature, and the name, address, and telephone number of the contracted firm, shall also be provided. In the event the owner amends the SWPPP, such amendments should be incorporated to the plan and the contractors and subcontractors should acknowledge by signature. Co-permittees who have completed their work prior to the amendments do not have to sign the amendments.

5. The signatory requirements of §122.22 of South Carolina Regulation 61-9 (see Appendix C of this permit) are applicable to each contracted entity that must sign one of the contractor's certification statements. Upon signing the Co-pemittee certification, the contractor is a Co-permittee and becomes accountable to DHEC to ensure the terms and conditions of this permit are implemented. All Co-permittees are subject to DHEC enforcement actions if permit conditions are not met. Enforcement actions may be taken against any specific Co-permittee or combination of Co-permittee, with consideration given to the party responsible for the violation. The Owner/Operator submitting the NOI shall retain all contractor certifications for at least three years after a contractor has completed work at the Site. Contractors who sign the certification for being a Co-permittee may be liable to DHEC enforcement actions related to their work at the Site. All certifications must be included in the storm water pollution prevention plan.

6. Copies of all contractor certifications and a copy of this permit shall be kept with the SWPPP. For construction Sites that disturb 10 acres or more, the first monthly report or copies of the first month's inspection forms (refer to Part 3.10.H) submitted by the Owner/Operator to the Department after construction begins on the facility must include the original and one copy of all Co-permittee and other contractor certifications. If additional Co-permittees or other contractors are added later on, the original and one copy of the additional Co-permittee or contractor certifications must be submitted along with the monthly reports or copies of the inspection forms submitted after the signing of the certification. For construction Sites that disturb less than 10 acres, the Owner/Operator of the facility covered by this permit shall make all contractor certifications available to DHEC upon request. The Department may on a case-by-case basis require the submittal of the Co-permittee and other contractor certifications.

3.3 Pollution Prevention Plan Contents: Site and Activity Description

A. The SWPPP must identify all Operators for the Project Site, and the areas of the Site over which each Operator has control.

B. The SWPPP must describe the nature of the construction activity, including:

1. The function of the Project (e.g., low density residential, shopping mall, highway, etc.);

2. The intended sequence and timing of planned major activities that disturb soils such as clearing and grubbing, initial and final grading, and cut and fill activities at the Site (except for SC Department of Transportation Projects, unless known at the time the SWPPP is prepared);

3. Estimates of the total area expected to be disturbed by excavation, grading, or other construction activities, including dedicated off-site borrow and fill areas; and

4. A general location map (e.g., USGS quadrangle map, a portion of a city or county map, or other map) with enough detail to identify the location of the construction Site and Surface Waters of the State within one mile of the Site.

C. The SWPPP must contain a legible Site map, showing the entire Site, identifying:

1. Direction(s) of storm water flow and approximate slopes anticipated after major grading activities;

2. Areas of soil disturbance and areas that will not be disturbed;

3. Locations of structural and nonstructural BMPs identified in the SWPPP;

4. Locations where stabilization practices are expected to occur;

5. Locations of off-site material, waste, borrow or construction equipment storage areas, excluding rolloff containers (not applicable to SC Department of Transportation Projects);

6. Locations of all Surface Waters of the State (including wetlands);

7. Locations where storm water discharges to a surface water; and

8. Areas where final stabilization has been accomplished and no further construction-phase permit requirements apply.

D. The SWPPP must describe and identify the location and description of any storm water discharge associated with industrial activity other than construction at the Site. This includes storm water discharges from dedicated asphalt plants and dedicated concrete plants, that are covered by this permit.

3.4 Pollution Prevention Plan Contents: Controls to Reduce Pollutants

A. The SWPPP must include a description of all pollution control measures (i.e., BMPs) that will be implemented as part of the construction activity to control pollutants in storm water discharges. For each major activity identified in the Project description, the SWPPP must clearly describe control measures necessary to comply with this permit and applicable laws and regulations, the general sequence during the construction process in which the measures will be implemented, and which Operator is responsible for the control measure's implementation.

B. The SWPPP must include a description of interim and permanent stabilization practices for the Site, including a schedule of when the practices will be implemented. Site plans should ensure that existing vegetation is preserved where possible and that disturbed portions of the Site are stabilized. Use of impervious surfaces for stabilization should be avoided.

C. For Sites with storm water discharges to a receiving water that is listed as impaired in South Carolina's 303(d) List of Impaired Waters the following requirements apply:

1. If a TMDL that is applicable to stormwater construction discharges has been established and is in effect, the requirements of Part 1.3.C.4 must be met.

2. If a TMDL has not been established or is not in effect, you must ensure that your SWPPP does not allow storm water discharges that will contribute to the violations of the water quality standards. To accomplish this, you must:

   a. First determine whether or not your discharge may contain any pollutant that has caused the impairment.

   b. If your storm water discharges will not contain the pollutant(s) of concern, no additional requirements are necessary.

   c. If your discharge will contain the pollutant(s) of concern, you must carefully evaluate your selected BMPs and their performance to ensure that stormwater discharges will not contribute to or cause a violation of water quality standards. For Projects that disturb 25 acres or more, your SWPPP must contain a written quantitative and qualitative assessment that the BMPs selected will control your stormwater discharges so that they will not contribute to or cause a violation of water quality standards. For more information on this subject, please see the DHEC publication entitled "Antidegradation for Activities Contributing to NonPoint Source Pollution to Impaired Waters." This publication can be downloaded at the following DHEC WEB site:

   www.scdhec.gov/eqc/water/pubs/antidegnps.pdf

3. A copy of the most current 303(d) List of Impaired Waters can be obtained from:

   Water Quality Division
   Bureau of Water
   SC DHEC
   2600 Bull Street
   Columbia, SC 29201

   or it can be downloaded at the following DHEC WEB site:

   http://www.scdhec.gov/water/tmdl/

D. The following records must be maintained as part of the SWPPP:

1. Dates when major grading activities as identified in Part 3.3.B occur;

2. Dates when construction activities temporarily or permanently cease on a portion of the Site.

Notes: Temporarily ceasing construction means ceasing construction on a portion of the Site for more than 14 days. A portion of the Site, means but is not limited to, portions of the Site with dedicated controls (see also Subpart 3.13.D of this permit): and

3. Dates when stabilization measures are initiated.

Electronic storage of the above mentioned information is acceptable provided that it is referenced in the SWPPP and it is readily available.

E. The SWPPP must include a description of structural practices: to divert flows from exposed soils: to retain/detain flows; or to otherwise limit runoff and the discharge of pollutants from exposed areas of the Site. Placement of structural practices in floodplains must be in accordance with applicable regulations.

F. The SWPPP must include a description of all post-construction storm water management measures that will be installed during the construction process to control pollutants in storm water discharges after construction operations have been completed.

G. Structural measures should be placed on upland soils to the degree practicable. Such measures must be designed and installed in compliance with applicable federal, local, state or tribal requirements.

1. Permanent structural controls can only be placed in Surface Waters of the State (including wetlands and ephemeral and intermittent streams) if the US Army Corps of Engineers issues a permit for the activity under Section 404 of the CWA. When State Navigable Waters may be affected, the SWPPP must include appropriate requirements applicable to State Navigable Waters under SC Regulation 19-450.

2. Temporary structural controls can only be placed in perennial Surface Waters of the State if the US Army Corps of Engineers issues a permit for the activity under Section 404 of the CWA. When State Navigable Waters may be affected, the SWPPP must include appropriate requirements applicable to State Navigable Waters under SC Regulation 19-450. All temporary structural controls placed in perennial streams must be removed after final stabilization has been accomplished.

3. Temporary structural controls may only be placed in ephemeral and intermittent streams when there is no other feasible alternative. All temporary structural controls placed in ephemeral and intermittent streams must be removed after final stabilization has been accomplished. After removal of the temporary structural controls, the ephemeral or intermittent stream must be restored to its original condition.

H. The SWPPP must describe measures to prevent the discharge of building or other similar materials to Surface Waters of the State, except as authorized by a permit issued under section 404 of the CWA.

I. The SWPPP must describe measures to minimize, to the extent practicable, off-site vehicle

tracking of sediments onto paved surfaces and the generation of dust.

J. The SWPPP must include a description of construction and waste materials expected to be stored on-site with updates as appropriate. The SWPPP must also include a description of controls, including storage practices such as rolloff containers, to minimize exposure of the materials to storm water, and spill prevention and response practices.

K. The SWPPP must include a description of pollutant sources from areas other than construction (including storm water discharges from dedicated asphalt plants and dedicated concrete plants), and a description of controls and measures that will be implemented at those Sites to minimize pollutant discharges. If these areas are located off the construction area on property not owned by the owner of the Project, they can be either included in the SWPPP for the construction Site with the owner of the dedicated facility being a Co-permittee under the construction general permit or the owner of the dedicated facility can obtain: 1) his own construction general permit coverage to build the dedicated facility; and 2) his own coverage under the Stormwater General Permit for Industrial Activity, Permit # SCR000000 or other appropriate permit. The method(s) selected to deal with dedicated facility areas must be addressed in the SWPPP.

3.5 Management of Non-Storm Water Discharges Allowed Under Part 1.3.B

The SWPPP must identify all allowable sources of non-storm water discharges listed in Subpart 1.3.B of this permit, except for flows from fire fighting activities, that are combined with storm water discharges associated with construction activity at the Site. Non-storm water discharges should be eliminated or reduced to the extent feasible. The SWPPP must identify and ensure the implementation of appropriate pollution prevention measures for the non-storm water component(s) of the discharge allowed under Part 1.3.B.

3.6 Maintenance of Controls

A. All erosion and sediment control measures and other protective measures identified in the SWPPP must be maintained in effective operating condition. If Site inspections required by Subpart 3.10 identify BMPs that are not operating effectively, maintenance must be performed as soon as practical or as reasonably possible and before the next storm event whenever practicable to maintain the continued effectiveness of storm water controls.

B. If existing BMPs need to be modified or if additional BMPs are necessary to comply with the requirements of this permit and/or SC's Water Quality Standards, implementation must be completed before the next storm event whenever practicable. If implementation before the next storm event is impracticable, the situation must be documented in the SWPPP and alternative BMPs must be implemented as soon as reasonably possible.

C. Sediment from sediment traps or sedimentation ponds must be removed as indicated in the SWPPP or when the design capacity has been reduced by 50 percent, which ever occurs first.

3.7 Reserved

3.8 Copy of Permit Requirements

Copies of this permit, the signed and certified NOI form that was submitted to DHEC, the Co-permittee certifications required by Subpart 3.2.D, and, if applicable, any local approval must be included in the SWPPP. Also, upon receipt, a copy of the letter from the DHEC authorizing your coverage under this CGP must also be included as a component of the SWPPP.

3.9 Applicable State, Tribal, or Local Programs

The SWPPP must be consistent with all applicable federal, state, tribal, or local requirements for soil and erosion control and storm water management, including updates to the SWPPP as necessary to reflect any revisions to applicable federal, state, tribal, or local requirements for soil and erosion control. Except for Projects exempted from the requirements of SC Regulation 72-300 by Section 72-302 of SC Regulation 72-300, all Projects located outside MS4s must after June 30, 2006 meet the minimum standards and criteria of South Carolina Regulation 72-300.

3.10 Inspections

A. After construction begins, inspections must be conducted at a minimum in accordance with one of the two schedules listed below and you must specify in your SWPPP which schedule you will be following.

   1. At least once every 7 calendar days, or

   2. At least once every 14 calendar days and within 24 hours of the end of a storm event of 0.5 inches or greater.

B. Inspection frequency may be reduced to at least once every month if the entire Site is temporarily stabilized.

C. The Department on a case-by-case basis may require any permittee who has coverage under this CGP to conduct inspections on a more frequent basis than prescribed in this CGP. Examples include, but are not limited to, permittees who have compliance problems and permittees whose Site's stormwater discharges to environmental sensitive waters (such as waters classified as Trout Waters, Outstanding Resource Waters, Shellfish Harvesting Waters, etc.).

D. Inspections must be conducted by qualified personnel (provided by the Operator or cooperatively by multiple Operators). For Projects that disturb more than 2 acres, "Qualified personnel" means a person knowledgeable in the principles and practice of erosion and sediment controls who possesses the skills to assess conditions at the construction Site that could impact storm water quality and to assess the effectiveness of any sediment and erosion control measures selected to control the quality of storm water discharges from the construction activity. After June 30, 2006, this person must be either the preparer of the SWPPP or an individual who is under the direct supervision of the preparer of the approved SWPPP and who meets the requirements in this paragraph or an individual who has been certified through a Construction Site Inspector Certification Course that has been approved by DHEC. Inspections may also be conducted by a

person with a registration equivalent to the registration of the preparer of the SWPPP and who meets the qualifications of this paragraph or an individual who is under the direct supervision of the person with an equivalent registration and who meets the requirements in this paragraph. For Projects that disturb 2 acres or less, the permittee or his designee may perform these inspections provided the preparer of the SWPPP or someone with a registration equivalent to that of the preparer of the SWPPP explains the SWPPP including implementation along with the inspection requirements to the person who will be conducting the inspections.

E. Inspections must include all areas of the Site disturbed by construction activity and areas used for storage of materials that are exposed to precipitation. Inspectors must look for evidence of, or the potential for, pollutants entering the storm water conveyance system. Sedimentation and erosion control measures identified in the SWPPP must be observed to ensure proper operation. Discharge locations must be inspected to ascertain whether erosion control measures are effective in preventing violations to SC's Water Quality Standards, where accessible. Where discharge locations are inaccessible, nearby downstream locations must be inspected to the extent that such inspections are practicable. Locations where vehicles enter or exit the Site must be inspected for evidence of off-site sediment tracking.

F. Utility line installation, pipeline construction, and other examples of long, narrow, linear construction activities may limit the access of inspection personnel to the areas described in Subpart 3.10.E above. Inspection of these areas could require that vehicles compromise temporarily or even permanently stabilized areas, cause additional disturbance of soils, and increase the potential for erosion. In these circumstances, controls must be inspected on the same frequencies as other construction Projects, but representative inspections may be performed. For representative inspections, personnel must inspect controls along the construction Site for 0.25 mile above and below each access point where a roadway, undisturbed right-of-way, or other similar feature intersects the construction Site and allows access to the areas described above. The conditions of the controls along each inspected 0.25 mile segment may be considered as representative of the condition of controls along that reach extending from the end of the 0.25 mile segment to either the end of the next 0.25 mile inspected segment, or to the end of the Project, whichever occurs first. Representative inspections must include any areas where stormwater discharges to environmental sensitive waters (such as waters classified as Trout Waters, Outstanding Resource Waters, Shellfish Harvesting Waters, etc.).

G. For each inspection required above, you must complete an inspection report. At a minimum, the inspection report must include:

1. The inspection date;

2. Names, titles, and, if not previously given in an inspection report, the qualifications of personnel making the inspection, unless those qualifications change;

3. Weather information for the period since the last inspection (or since commencement of construction activity if the first inspection) including a best estimate of the beginning of each storm event, duration of each storm event, approximate amount of rainfall for each storm event (in inches), and whether you know if any discharges occurred;

4. Weather information and a description of any discharges occurring at the time of the inspection;

5. Location(s) of discharges of sediment or other pollutants from the Site;

6. Location(s) of BMPs that need maintenance;

7. Location(s) of BMPs that failed to operate as designed or proved inadequate for a particular location;

8. Location(s) where additional BMPs are needed that did not exist at the time of inspection; and

9. Corrective action required including any changes to the SWPPP necessary and implementation dates.

A record of each inspection and of any actions taken in accordance with this Part must be retained as part of the SWPPP for at least three years from the date that permit coverage expires or is terminated. The report must be signed in accordance with §122.22 of SC Regulation 61-9 (see Appendix C of this permit).

H. For construction Sites disturbing 10 acres or more, a monthly report must be submitted to DHEC and, if applicable, the appropriate MS4. The report must be signed in accordance with §122.22 of SC Regulation 61-9 (see Appendix C of this permit). In lieu of submitting monthly reports, the reports may be stored electronically in a manner in which DHEC personnel will have access to review this data, such as on a dedicated website that DHEC personnel will have unlimited access to. Other forms of electronic storage of monthly reports may be utilized once arrangements have been made with DHEC. For construction Sites that disturb less than 10 acres, DHEC may require monthly reports to be submitted on either a Project-by-Project basis or Operator-by-Operator basis. If the information required in this Subpart is already included on the inspection forms, only copies of the inspection forms need to be submitted to DHEC. If the information required in this Subpart is not included on the inspection form, then the monthly reports must include, at a minimum, the following additional information:

1. A summary of the results of the inspections conducted during the month;

2. A listing of all deficiencies noted during inspections with the date the deficiency was noted;

3. For each deficiency noted that required corrective action:

   a. A listing of the name(s), address(es), and telephone number(s) of the party or parties responsible; and

   b. A statement whether this deficiency was previously listed in a monthly report;

4. A listing of the corrective actions that were taken to remedy any deficiencies noted and the date

the corrective actions were completed;

5. A statement on whether or not the SWPPP was updated to deal with any deficiencies noted; and

6. A copy of each inspection conducted during the month attached in an appendix to the monthly report.

I. For construction Sites disturbing 10 acres or more, in addition to the information required in subpart 3.10.H above, the first monthly report submitted after construction has started must include the original and one copy of the Co-permittee and contractor certifications. Subsequent monthly reports on construction Sites that disturb 10 acres or more must include the original and a copy of the certification for the Co-permittees and contractors added after construction has started. For each Co-permittee and contractor certification submitted to the Department, the preparer of the SWPPP or someone with a registration equivalent to that of the preparer of the SWPPP must certify that either an on-site or, when applicable, off-site pre-construction conference was held with the Co-permittee or contractor in accordance with this permit. This certification must give the date of the conference and the responsibilities of each Co-permittee and contractor.

J. For construction Sites disturbing less than 10 acres, the Owners/Operators may be required to submit the Co-permittee and contractor certifications on a case-by-case basis. When the Owner/Operator is required to submit the Co-permittee and contractor certifications, the preparer of the SWPPP or someone with a registration equivalent to that of the preparer of the SWPPP must certify that either an on-site or off-site pre-construction conference was held with the Co-permittees and contractors in accordance with this permit. This certification must give the date of the conference and the responsibilities of each Co-permittee and contractor.

K. Each monthly report with one copy must be submitted to DHEC on or before the 28th day of the month following the reporting period. For example, the monthly report for July 2006 is due after July 31, 2006 and on or before August 28, 2006.

L. Until construction starts, the monthly report may just state that construction activity has not started.

M. Monthly reports, when required, must be submitted until the Notice of Termination is submitted to DHEC. When the Notice of Termination is submitted, it must contain a signed statement by the preparer of the SWPPP or a person with a registration equivalent to that of the preparer of the SWPPP that all work was completed to the best of his or her knowledge and belief in accordance with the approved SWPPP and this CGP. For Projects disturbing more than 2 acres, the certifying person's knowledge and belief must be based on the results of the periodic inspections conducted by the preparer of the SWPPP (or a person with an equivalent registration) or by a qualified individual under his or her direct supervision in accordance with this CGP or by an individual certified through a Construction Site Inspector Certification Course that has been approved by DHEC.

N. Copies of inspection forms and monthly reports (reports required only if information requested in Part 3.10.H is not included on the inspection form) must be submitted to DHEC at the following address:

Compliance Assurance Division
Bureau of Water
SC DHEC
2600 Bull Street
Columbia, SC 29201

or to a designated DHEC email address, when available.

A copy of the inspection forms or monthly reports must be submitted to the MS4 that receives your stormwater discharges when requested in writing by the MS4.

3.11 Maintaining an Updated Plan

A. The SWPPP, including the Site map, must be amended whenever there is a change in design, construction, operation, or maintenance at the construction Site that will result in discharges that will cause, have the reasonable potential to cause, or contribute to violations to SC's Water Quality Standards.

B. The SWPPP must be amended if during inspections or investigations by Site staff, or by local, state, tribal or federal officials, it is determined that the SWPPP is ineffective in either eliminating, when reasonably possible, or significantly minimizing pollutants in storm water discharges from the construction Site.

C. Based on the results of an inspection, the SWPPP must be modified as necessary to include additional or modified BMPs designed to correct problems identified. Revisions to the SWPPP must be completed within seven (7) calendar days following the inspection. Implementation of these additional or modified BMPs must be accomplished as described in Subpart 3.6.B.

D. All design modifications of the SWPPP must be made in accordance with Subpart 3.1.A.

3.12 Signature, Plan Review and Making Plans Available

A. A copy of the SWPPP (including a copy of the permit), NOI, and CGP coverage letter from DHEC must be retained at the construction Site (or other location easily accessible during normal business hours to: DHEC, EPA, tribal or local agency approving sediment and erosion plans, grading plans, or storm water management plans; local government officials; and the Operator of a Municipal Separate Storm Sewer System (MS4) receiving discharges from the Site) from the date of commencement of construction activities to the date of final stabilization. If you have day-to-day operational control over SWPPP implementation, you must have a copy of the SWPPP available at a central location on-site for the use of all those identified as having responsibilities under the SWPPP whenever they are on the construction Site. If an on-site location is unavailable to store the SWPPP when no personnel are present, notice of the plan's location must be posted near the main entrance at the construction Site. For linear construction of roads or utilities (such as roads built by the SC Department of Transportation and utility construction including electrical power lines, gas lines, main sewer trunk lines, and water distribution lines that are not part of a development)

neither of which are a part of a subdivision or other type of development Projects, the updated copies of the approved SWPPP must be sent to the appropriate EQC Regional Office in situations where it is not practical to have the approved SWPPP on location. For SC Department of Transportation Projects where there is no construction trailer on Site, the SWPPP may be kept in the office of the SC DOT resident engineer.

B. SWPPPs must be made available upon request by EPA; DHEC; a tribal or local agency approving sediment and erosion plans, grading plans, or storm water management plans; local government officials; and the Operator of a Municipal Separate Storm Sewer System (MS4) receiving discharges from the Site to the requestor. The copy of the SWPPP that is required to be kept on-site or locally available must be made available, in its entirety, to DHEC or the EPA staff for review and copying at the time of an on-site inspection.

C. All SWPPPs must be signed and certified in accordance with §122.22 of SC Regulation 61-9 (see Appendix C of this permit).

3.13 Management Practices

A. All control measures must be properly selected, installed, and maintained in accordance with any relevant manufacturer specifications and good engineering practices. If periodic inspections or other information indicates a control has been used inappropriately, or incorrectly, the Operator must replace or modify the control for Site situations as soon as practicable.

B. If sediment escapes the construction Site, off-site accumulations of sediment must be removed at a frequency sufficient to minimize off-site impacts unless: access to the off-site property cannot be reasonably obtained from the property owner and DHEC is also unable to get permission for you to access the off-site property; or DHEC agrees that it is appropriate to leave the off-site accumulations in place.

C. Litter, construction debris, oils, fuels, and building products with significant potential for impact (such as stockpiles of freshly treated lumber) and construction chemicals that could be exposed to storm water must be prevented from becoming a pollutant source in storm water discharges.

D. Except as provided below, stabilization measures must be initiated as soon as practicable in portions of the Site where construction activities have temporarily or permanently ceased, but in no case more than 14 days after the construction activity in that portion of the Site has temporarily or permanently ceased.

   1. Where stabilization by the 14th day is precluded by snow cover or frozen ground conditions, stabilization measures must be initiated as soon as practicable.

   2. Where construction activity on a portion of the Site is temporarily ceased, and earth-disturbing activities will be resumed within 14 days, temporary stabilization measures do not have to be initiated on that portion of the Site.

E. A combination of sediment and erosion control measures is required to achieve maximum pollutant

removal.

1. Sediment Basins: For common drainage locations that serve an area with 10 or more acres disturbed at one time, a temporary (or permanent) sediment basin that provides storage for a calculated volume of runoff from the drainage area from at least a 10-year, 24-hour storm, or equivalent control measures, must be provided where attainable until final stabilization of the Site. Where no such calculation has been performed, a temporary (or permanent) sediment basin providing at least 3,600 cubic feet of storage per acre drained, or equivalent control measures, must be provided where attainable until final stabilization of the Site. When computing the number of acres draining into a common location, it is not necessary to include flows from off-site areas and flows from on-site areas that are either undisturbed or have undergone final stabilization where such flows are diverted around both the disturbed area and the sediment basin. In determining whether installing a sediment basin is attainable, the Operator may consider factors such as Site soils, slope, available area on-site, etc. In any event, the Operator must consider public safety as a design factor for the sediment basin, and alternative sediment controls must be used where Site limitations would preclude a safe design.

2. For drainage locations that serve 10 or more disturbed acres at one time and where a temporary sediment basin or equivalent controls are not attainable, smaller sediment basins and/or sediment traps should be used. Silt fences, vegetative buffer strips, or a combination of sediment controls that are equivalent to sediment basins and/or sediment traps are required for all down slope boundaries (and for those side slope boundaries deemed appropriate as dictated by individual Site conditions).

3. For drainage locations serving less than 10 acres, smaller sediment basins and/or sediment traps should be used. At a minimum, silt fences, vegetative buffer strips, or equivalent sediment controls are required for all down slope boundaries (and for those side slope boundaries deemed appropriate as dictated by individual Site conditions) of the construction area unless a sediment basin providing storage for a calculated volume of runoff from at least a 10-year, 24-hour storm or at least 3,600 cubic feet of storage per acre drained is provided. If a basin is not provided, each structural control used must be designed to handle the entire drainage area it serves.

4. The Department may on a case-by-case or watershed-by-watershed basis require the use of a larger storm event and/or a larger storage volume when designing sediment basins.

F. Velocity dissipation devices must be placed at discharge locations and along the length of any outfall channel to provide a non-erosive flow velocity from the structure to a water course so that the natural physical and biological characteristics and functions are maintained and protected (e.g., no significant changes in the hydrological regime of the receiving water).

3.14 Documentation of Permit Eligibility Related to Total Maximum Daily Loads That Are Effective and Applicable to Stormwater Construction Discharges

The SWPPP must include documentation supporting a determination of permit eligibility with regard to waters that have a TMDL that is effective and applicable to stormwater construction discharges,

including:

A. Identification of whether your discharge (construction stormwater) is identified, either specifically or generally, in a TMDL and any associated allocations, requirements, and assumptions identified for your discharge;

B. Measures taken by you to ensure that your discharge of pollutants from the Site is consistent with the assumptions and requirements contained in the TMDL that is applicable to your stormwater discharge, including any specific wasteload allocation that has been established that would apply to your discharge.

See Subpart 1.3.C.4 for further information on determining permit eligibility related to TMDLs.

PART 4: SPECIAL CONDITIONS, MANAGEMENT PRACTICES AND OTHER NON-NUMERIC LIMITATIONS

4.1 Continuation of the Expired General Permit

If this permit is not reissued or replaced prior to the expiration date, it will be administratively continued in accordance with the SC Administrative Procedures Act and SC Regulation 61-9 and remain in force and effect. If you were granted permit coverage prior to the expiration date, you will automatically remain covered by the continued permit until the earliest of:

A. Reissuance or replacement of this permit, at which time you must comply with the conditions of the new permit to maintain authorization to discharge; or

B. Your submittal of a Notice of Termination; or

C. Issuance of an individual permit for the Project's discharges; or

D. A formal permit decision by DHEC to not reissue this general permit, at which time you must seek coverage under an alternative general permit or an individual permit.

4.2 Requiring an Individual Permit or an Alternative General Permit

A. In accordance with Section 122.28(b)(3) of SC Regulation 61-9, DHEC may require you to apply for and/or obtain an individual NPDES permit. Any interested person may petition DHEC to take action under this paragraph. If DHEC requires you to apply for an individual NPDES permit, DHEC will notify you in writing that a permit application is required. This notification will include a brief statement of the reasons for this decision and an application form. In addition, if you are an existing permittee covered under this permit, the notice will set a deadline to file the application, and will include a statement that on the effective date of issuance or denial of the individual NPDES permit or the alternative general permit as it applies to you, coverage under this general permit will automatically terminate. Applications must be submitted to DHEC at the address given in Subpart 2.4. DHEC may grant additional time to submit the application upon your request. If you are covered under this permit and you fail to submit in a timely manner an individual NPDES

permit application as required by DHEC, then the applicability of this permit to you is automatically terminated at the end of the day specified by DHEC as the deadline for application submittal.

B. If an alternate general permit that is more appropriate for your construction activity is available, DHEC may grant you coverage under the alternate general permit in lieu of granting you coverage under this general permit. In accordance with applicable state law and regulation, you have a right to appeal the Department's decision.

C. You may request to be excluded from the coverage of this general permit by applying for an individual permit. In such a case, you must submit an individual application in accordance with the requirements of §122.26(c)(1)(ii) of SC Regulation 61-9, with reasons supporting the request, to:

Storm Water and Agricultural Section
Bureau of Water
SC DHEC
2600 Bull Street
Columbia, SC 29201

The request may be granted by issuance of an individual permit or an alternative general permit if your reasons are adequate to support the request.

D. When an individual NPDES permit is issued to you, who are otherwise subject to this permit, or you are authorized to discharge under an alternative NPDES general permit, the applicability of this permit to you is automatically terminated on the effective date of the individual permit or the date of authorization of coverage under the alternative general permit, whichever the case may be. If you, who are otherwise subject to this permit, are denied an individual NPDES permit or an alternative NPDES general permit, the applicability of this permit to you is automatically terminated on the date of such denial, unless otherwise specified by DHEC.

4.3 Releases in Excess of Reportable Quantities

A. You must prevent or minimize the discharge of hazardous substances or oil in storm water discharges from the construction Site in accordance with the SWPPP. This permit does not relieve you of the federal reporting requirements of 40 CFR Part 110, 40 CFR Part 117 and 40 CFR Part 302 relating to spills or other releases of oils or hazardous substances.

B. Where a release containing a hazardous substance or oil in an amount equal to or in excess of a reportable quantity established under either 40 CFR Part 110, 40 CFR Part 117 or 40 CFR Part 302, occurs during a 24-hour period:

1. You must notify the Department's Emergency Response Section at (803) 253-6488 and the National Response Center (NRC) (800) 424–8802 in accordance with the requirements of 40 CFR Part 110, 40 CFR Part 117 and 40 CFR Part 302 as soon as Site staff have knowledge of the discharge; and

2. You must modify the SWPPP as required under Subpart 3.11 within 14 calendar days of knowledge of the release to: provide a description of the release, the circumstances leading to the release, and the date of the release. In addition, you must review your SWPPP to identify measures to prevent the reoccurrence of such releases and to respond to such releases, and you must modify your SWPPP where appropriate.

4.4 Attainment of Water Quality Standards After Authorization

You must select, install, implement and maintain BMPs at your construction Site that minimize pollutants in the discharge as necessary to meet applicable water quality standards. In general your SWPPP developed, implemented, and updated consistent with Part 3.0 is considered as stringent as necessary to ensure that your discharges do not cause or contribute to a violation of any applicable water quality standard.

All written responses required under this part must include a signed certification consistent with §122.22 of SC Regulation 61-9 (see Appendix C of this permit).

PART 5: TERMINATION OF COVERAGE

5.1 Requirements

You may only submit a Notice of Termination (NOT) after one or more of the following conditions have been met:

A. Final stabilization has been achieved on all portions of the Site for which you are responsible;

B. Another Operator has assumed control, according to §122.41(l)(3) of SC Regulation 61-9 (see Appendix C of this permit), over all areas of the Site that have not been finally stabilized;

C. Coverage under an individual or alternative general NPDES permit has been obtained; or

D. For residential construction only, temporary stabilization has been completed and the residence has been transferred to the homeowner.

The NOT must be submitted within 30 days of one of the above conditions being met. Authorization to discharge terminates at midnight of the day the NOT is signed.

5.2 Submitting a Notice of Termination

It is your responsibility to submit a complete and accurate Notice of Termination (NOT), using the form (or a photocopy thereof) provided by the Department. The NOT will be made available at our WEB site at:

http://www.scdhec.net/eqc/admin/html/eqforms.html#Water

If DHEC notifies dischargers (either directly, by public notice, or by making information available on

the Internet) of other NOT form options (e.g., electronic submission), you may take advantage of those options to satisfy the requirements of Part 5.

The Notice of Termination must include the following information:

1. Your CGP NPDES coverage number for the storm water discharge;

2. The basis for submission of the NOT, including: final stabilization has been achieved on all portions of the Site for which the permittee is responsible; another Operator/permittee has assumed control over all areas of the Site that have not been finally stabilized; coverage under an alternative NPDES permit has been obtained; or, for residential construction only, temporary stabilization has been completed and the residence has been transferred to the homeowner;

3. You, the Operator's name, address, telephone number and your organization's Employer Identification Number (EIN) as established by the U.S. Internal Revenue Service;

4. The name of the Project and address (or a description of location if no street address is available) of the construction Site for which the notification is submitted; and

5. A certification statement, signed and dated by an authorized representative as defined in §122.22 of SC Regulation 61-9 (see Appendix C of this permit) and the name and title of that authorized representative.

6. For Projects disturbing more than 2 acres, a certification statement, signed and dated by the preparer of the SWPPP or other person with a registration equivalent to that of the preparer of the SWPPP, that to the best of his or her knowledge and belief all work was conducted and completed in accordance with the approved SWPPP and this CGP. This certification must be based on the inspections performed in accordance with this Subpart 3.10 of this CGP and must state that any deficiencies that were noted have been corrected.

5.3 Where to Submit

A. All original NOTs must be submitted to DHEC at the following address:

Storm Water and Agricultural Section
Bureau of Water
SC DHEC
2600 Bull Street
Columbia, SC 29201

And a copy of the NOT to the MS4 that received your stormwater discharges when requested in writing by the MS4.

PART 6: RETENTION OF RECORDS

Copies of the SWPPP and all documentation required by this permit, including records of all data used

to complete the NOI to be covered by this permit, must be retained for at least three years from the date that permit coverage expires or is terminated. This period may be extended by request of DHEC at any time.

PART 7: REOPENER CLAUSE

7.1 Procedures for Modification or Revocation

Permit modification or revocation will be conducted according to §122.62, §122.63, §122.64, and §124.5 of SC Regulation 61-9.

7.2 Water Quality Protection

If there is evidence indicating that the storm water discharges authorized by this permit cause, have the reasonable potential to cause or contribute to a violation of any applicable water quality standard, you may be required to obtain an individual permit in accordance with Part 4.2 of this permit, the permit may be modified in accordance with Section 122.62 of SC Regulation 61-9 to include different limitations and/or requirements as addressed or your coverage may be terminated in accordance with Section 122.64 of SC Regulation 61-9.

7.3 Timing of Permit Modification

DHEC may elect to modify the permit prior to its expiration (rather than waiting for the new permit cycle) to comply with any new statutory or regulatory requirements, such as for effluent limitation guidelines that may be promulgated in the course of the current permit cycle.

PART 8: STANDARD PERMIT CONDITIONS

South Carolina regulations require that the Standard Conditions provisioned at §122.41 of SC Regulation 61-9 be applied to all NPDES permits. You are required to comply with those Standard Conditions, details of which are provided in Appendix C of this permit, that are applicable to storm water discharges.

APPENDIX A - DEFINITIONS AND ACRONYMS DEFINITIONS

"Best Management Practices" (BMPs) means schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the discharge of pollutants to Surface Waters of the State. BMPs also include treatment requirements, operating procedures, and practice to control plant Site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

"Co-Permittee" means a permittee to an NPDES permit that is only responsible for permit conditions relating to the discharge for which it is Operator.

"Commencement of Construction Activities" means the initial disturbance of soils associated with clearing, grading, or excavating activities or other construction-related activities (e.g., stockpiling of fill material).

"Control Measure" as used in this permit, refers to any BMP or other method used to prevent or reduce the discharge of pollutants to "Waters of the State".

"CWA" means the Clean Water Act or the Federal Water Pollution Control Act, 33 U.S.C. section 1251 et seq.

"DHEC" means the South Carolina Department of Health and Environmental Control's Office of Environmental Quality Control.

"Discharge" when used without qualification means the "discharge of a pollutant."

"Discharge of Storm Water Associated with Construction Activity" as used in this permit, refers to a discharge of pollutants in storm water from areas where soil disturbing activities (e.g., clearing, grading, or excavation), construction materials or equipment storage or maintenance (e.g., fill piles, borrow area, concrete truck washout, fueling), or other industrial storm water directly related to the construction process (e.g., concrete or asphalt batch plants) are located.

"Eligible" means qualified for authorization to discharge storm water under this general permit.

"Facility" or "Activity" means any "point source" or any other facility or activity (including land or appurtenances thereto) that is subject to regulation under the NPDES program.

"Federal Facility" means any buildings, installations, structures, land, public works, equipment, aircraft, vessels, and other vehicles and property, owned by, or constructed or manufactured for the purpose of leasing to, the Federal government.

"Final Stabilization" means that:

1. All soil disturbing activities at the Site have been completed and either of the two following criteria are met:

a. A uniform (e.g., evenly distributed, without large bare areas) perennial vegetative cover with a density of 70 percent of the native background vegetative cover for the area has been established on all unpaved areas and areas not covered by permanent structures; or

b. Equivalent permanent stabilization measures (such as the use of riprap, gabions, or geotextiles) have been employed.

2. When background native vegetation or other appropriate vegetation will cover less than 100 percent of the ground (e.g., arid areas, beaches), the 70 percent coverage criteria is adjusted as follows: if the native vegetation or other appropriate vegetation covers 50 percent of the ground, 70 percent of 50 percent (0.70 X 0.50 = 0.35) would require 35 percent total cover for final stabilization. On a beach with no natural vegetation, no stabilization is required.

3. For individual lots in residential construction, final stabilization means that either:

   a. The homebuilder has completed final stabilization as specified above; or

   b. The homebuilder has established temporary stabilization including perimeter controls for an individual lot prior to occupation of the home by the homeowner and informing the homeowner of the need for, and benefits of, final stabilization.

4. For construction Projects on land used for agricultural purposes (e.g., pipelines across crop or range land, staging areas for highway construction, etc.), final stabilization may be accomplished by returning the disturbed land to its preconstruction agricultural use. Areas disturbed that were not previously used for agricultural activities, such as buffer strips immediately adjacent to "Surface Waters of the State," and areas which are not being returned to their preconstruction agricultural use must meet the final stabilization criteria (1) or (2) or (3) above.

"Indian country" is defined at §122.2 of SC Regulation 61-9 to mean:

1. All land within the limits of any Indian reservation under the jurisdiction of the United States Government, notwithstanding the issuance of any patent, and, including rights-of-way running through the reservation;

2. All dependent Indian communities with the borders of the United States whether within the originally or subsequently acquired territory thereof, and whether within or without the limits of a state; and

3. All Indian allotments, the Indian titles to which have not been extinguished, including rights-of-ways running through the same.

"Large Construction Activity" is the construction industrial activity as defined at §122.26(b)(14)(x) of SC Regulation 61-9 and incorporated here by reference. A large construction activity includes clearing, grading, and excavating resulting in a land disturbance that will disturb equal to or greater than five acres of land or will disturb less than five acres of total land area but is part of a larger common plan of

development or sale that will ultimately disturb equal to or greater than five acres. Large construction activity does not include routine maintenance that is performed to maintain the original line and grade, hydraulic capacity, or original purpose of the Site.

"Municipal Separate Storm Sewer System" or "MS4" is defined at §122.26(b)(8) of SC Regulation 61-9 to mean a conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, manmade channels, or storm drains):

1. Owned and operated by a state, city, town, borough, county, parish, district, association, or other public body (created by or pursuant to State law) having jurisdiction over disposal of sewage, industrial wastes, storm water, or other wastes, including special districts under State law such as a sewer district, flood control district or drainage district, or similar entity, or an Indian tribe or an authorized Indian tribal organization, or a designated and approved management agency under section 208 of the CWA that discharges to Surface Waters of the State;

2. Designed or used for collecting or conveying storm water;

3. Which is not a combined sewer; and

4. Which is not part of a Publicly Owned Treatment Works (POTW) as defined at §122.2 of SC Regulation 61-9.

"New Project" means the "commencement of construction activities" occurs after the effective date of this permit.

"Ongoing Project" means the "commencement of construction activities" occurs before the effective date of this permit.

"Operator" for the purpose of this permit and in the context of storm water associated with construction activity, means any party associated with a construction Project that meets either of the following two criteria:

1. The party has operational control over construction plans and specifications. Note: A party has "operational control over construction plans and specifications" if they have the authority to prepare or modify such plans and specifications under Subpart 3.1.A; or

2. The party has "operational control over day-to-day activities" at a Project that are necessary to ensure compliance with a SWPPP for the Site or other permit conditions (e.g., they are authorized to direct workers at a Site to carry out activities required by the SWPPP or comply with other permit conditions). This definition is provided to inform permittees of EPA's interpretation of how the regulatory definitions of ''Owner or Operator'' and ''facility or activity'' are applied to discharges of storm water associated with construction activity.

"Owner or Operator" means the owner or Operator of any ''facility or activity'' subject to regulation under the NPDES program. For purposes of this permit, when local governments (counties, cities,

etc.) construct or improve state roads, the owner of these road construction projects during the construction is the local government.

"Permitting Authority" means the United States Environmental Protection Agency, EPA, a Regional Administrator of the Environmental Protection Agency or an authorized representative.

"Person" means any individual, public or private corporation, political subdivision, association, partnership, corporation, municipality, State or Federal agency, industry, copartnership, firm, trust, estate, any other legal entity whatsoever, or an agent or employee thereof.

"Point Source" means any discernible, confined, and discrete conveyance, including but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock concentrated animal feeding operation, landfill leachate collection system, vessel or other floating craft from which pollutants are or may be discharged. This term does not include return flows from irrigated agriculture or agricultural storm water runoff.

"Pollutant" is defined at §122.2 of SC Regulation 61-9. A partial listing from this definition includes: dredged spoil, solid waste, sewage, garbage, sewage sludge, chemical wastes, biological materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt, and industrial or municipal waste.

"Project" means an undertaking such as, but not limited to, construction of commercial development, residential development, industrial development, roadways, railways, and utility lines.

"Project Area" means:

1. The areas on the construction Site where storm water discharges originate and flow toward the point of discharge into the receiving waters (including areas where excavation, Site development, or other ground disturbance activities occur) and the immediate vicinity. (Example: 1. Where bald eagles nest in a tree that is on or bordering a construction Site and could be disturbed by the construction activity or where grading causes storm water to flow into a small wetland or other habitat that is on the Site that contains listed species.)

2. The areas where storm water discharges flow from the construction Site to the point of discharge into receiving waters. (Example: Where storm water flows into a ditch, swale, or gully that leads to receiving waters and where listed species (such as amphibians) are found in the ditch, swale, or gully.)

3. The areas where storm water from construction activities discharge into receiving waters and the areas in the immediate vicinity of the point of discharge. (Example: Where storm water from construction activities discharges into a stream segment that is known to harbor listed aquatic species.)

4. The areas where storm water BMPs will be constructed and operated, including any areas where storm water flows to and from BMPs. (Example: Where a storm water retention pond would be built.)

5. The areas upstream and /or downstream from construction activities discharges into a stream segment that may be affected by the said discharges. (Example: Where sediment discharged to a receiving stream settles downstream and impacts a breeding area of a listed aquatic species.)

"Receiving water" means the "Waters of the State" as defined in §122.2 of SC Regulation 61-9 into which the regulated storm water discharges.

"Runoff coefficient" means the fraction of total rainfall that will appear at the conveyance as runoff.

"Site" means the land or water area where any "facility or activity" is physically located or conducted, including adjacent land used in connection with the facility or activity.

"Small Construction Activity" is defined under the definition of "Stormwater discharge associated with small construction activity" at §122.26(b)(15) of SC Regulation 61-9 as follows: "Storm water discharge associated with small construction activity means the discharge of storm water from:

(i) Construction activities including clearing, grading, and excavating that result in land disturbance of equal to or greater than one acre and less than five acres and, in coastal counties within one-half (1/2) mile of a receiving water body (but not for single-family homes which are not part of a subdivision development), that result in any land disturbance less than five acres. Small construction activity also includes the disturbance of less than one acre of total land area that is part of a larger common plan of development or sale if the larger common plan will ultimately disturb equal to or greater than one and less than five acres. Small construction activity does not include routine maintenance that is performed to maintain the original line and grade, hydraulic capacity, or original purpose of the facility. The Department may waive the otherwise applicable requirements in a general permit for a storm water discharge from construction activities that disturb less than five acres where:

(A) The value of the rainfall erosivity factor ("R" in the Revised Universal Soil Loss Equation) is less than five during the period of construction activity. The rainfall erosivity factor is determined in accordance with Chapter 2 of Agriculture Handbook Number 703, Predicting Soil Erosion by Water: A Guide to Conservation Planning With the Revised Universal Soil Loss Equation (RUSLE), pages 21-64, dated January 1997. The Director of the Federal Register approves this incorporation by reference in accordance with 5 U.S.C 552(a) and 1 CFR part 51. Copies may be obtained from EPA's Water Resource Center, Mail Code RC4100, 401 M St. S.W., Washington, DC 20460. A copy is also available for inspection at the U.S. EPA Water Docket , 401 M Street S.W., Washington, DC. 20460, or the Office of the Federal Register, 800 N. Capitol Street N.W. Suite 700, Washington, DC. An Operator must certify to the Department that the construction activity will take place during a period when the value of the rainfall erosivity factor is less than five; or

(B) Storm water controls are not needed based on a "total maximum daily load" (TMDL) approved or established by EPA that addresses the pollutant(s) of concern or, for non-impaired waters that do not require TMDLs, an equivalent analysis that determines allocations for small construction Sites for the pollutant(s) of concern or that determines that such allocations are not needed to protect water quality based on consideration of existing in-stream

concentrations, expected growth in pollutant contributions from all sources, and a margin of safety. For the purpose of this paragraph, the pollutant(s) of concern include sediment or a parameter that addresses sediment (such as total suspended solids, turbidity or siltation) and any other pollutant that has been identified as a cause of impairment of any water body that will receive a discharge from the construction activity. The Operator must certify to the Department that the construction activity will take place, and storm water discharges will occur, within the drainage area addressed by the TMDL or equivalent analysis.

(ii) Any other construction activity designated by the Department, or in States with approved NPDES programs either the Department or the EPA Regional Administrator, based on the potential for contribution to a violation of a water quality standard or for significant contribution of pollutants to waters of the United States."

"Storm Water" means storm water runoff, snowmelt runoff, and surface runoff and drainage.

"Storm Water Discharge-Related Activities" as used in this permit, include: activities that cause, contribute to, or result in storm water point source pollutant discharges, including but not limited to: excavation, Site development, grading and other surface disturbance activities; and measures to control storm water including the siting, construction and operation of BMPs to control, reduce or prevent storm water pollution.

"Surface Waters of the State" means "Waters of the State" as defined in §122.2 of SC Regulation 61-9 except for groundwater.

"Total Maximum Daily Load" or "TMDL" means the sum of the individual wasteload allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources and natural background. If a receiving water has only one point source discharger, the TMDL is the sum of that point source WLA plus the LAs for any nonpoint sources of pollution and natural background sources, tributaries, or adjacent segments. TMDLs can be expressed in terms of either mass per time, toxicity, or other appropriate measure.

"Waters of the State" is defined in §122.2 of SC Regulation 61-9.

"Wetland" means those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

ACRONYMS

BMP - Best Management Practices

CGP - Construction General Permit

CFR - Code of Federal Regulations

CWA - Clean Water Act

EPA - United States Environmental Protection Agency

MS4 - Municipal Separate Storm Sewer System

NOI - Notice of Intent

NOT - Notice of Termination

NPDES - National Pollutant Discharge Elimination System

POTW - Publicly Owned Treatment Works

SWPPP - Storm Water Pollution Prevention Plan

TMDL - Total Maximum Daily Load

APPENDIX B - SMALL CONSTRUCTION WAIVERS AND INSTRUCTIONS

These waivers are only available to storm water discharges associated with small construction activities (i.e., 1-5 acres). As the Operator of a small construction activity, you may be able to qualify for a waiver in lieu of needing to obtain coverage under this general permit based on: (A) a low rainfall erosivity factor, (B) a TMDL analysis, or (C) an equivalent analysis that determines allocations for small construction Sites are not needed. Each Operator, otherwise needing permit coverage, must notify DHEC of its intention for a waiver. It is the responsibility of those individuals wishing to obtain a waiver from coverage under this general permit to submit a complete and accurate waiver certification as described below. Where the Operator changes or another is added during the construction Project, the new Operator must also submit a waiver certification to be waived.

A. Rainfall Erosivity Waiver

Under this scenario the small construction Project's rainfall erosivity factor calculation ("R" in the Revised Universal Soil Loss Equation) is less than 5 during the period of construction activity. The Operator must certify to the Permitting Authority that construction activity will occur only when the rainfall erosivity factor is less than 5. The period of construction activity begins at initial earth disturbance and ends with final stabilization. Where vegetation will be used for final stabilization, the date of installation of a stabilization practice that will provide interim non-vegetative stabilization can be used for the end of the construction period, provided the Operator commits (as a condition of waiver eligibility) to periodically inspect and properly maintain the area until the criteria for final stabilization as defined in the construction general permit have been met. If use of this interim stabilization eligibility condition was relied on to qualify for the waiver, signature on the waiver with its certification statement constitutes acceptance of and commitment to complete the final stabilization process. The Operator must submit a waiver certification to DHEC prior to commencing construction activities.

> *Note: The rainfall erosivity factor "R" is determined in accordance with Chapter 2 of Agriculture Handbook Number 703, Predicting Soil Erosion by Water: A Guide to Conservation Planning With the Revised Universal Soil Loss Equation (RUSLE), pages 21–64, dated January 1997; United States Department of Agriculture (USDA), Agricultural Research Service.*

EPA funded a cooperative agreement with Texas A&M University to develop an online rainfall erosivity calculator. You can access the calculator from EPA's website at:

www.epa.gov/npdes/stormwater/cgp

Use of the calculator allows you to determine potential eligibility for the rainfall erosivity waiver. It may also be useful in determining the time periods during which construction activity could be waived from permit coverage. You may find that moving your construction activity by a few weeks or expediting Site stabilization will allow you to qualify for the waiver.

If you are the Operator of the construction activity and eligible for a waiver based on low erosivity potential, you must provide the following information on the waiver certification in order to be waived

from permitting requirements:

1. Name, address and telephone number of the construction Site Operators;

2. Name (or other identifier), address, county or similar governmental subdivision, and latitude/longitude of the construction Project or Site;

3. Estimated construction start and completion (i.e., final stabilization) dates, and total acreage (to the nearest quarter acre) to be disturbed;

4. The rainfall erosivity factor calculation that applies to the active construction phase at your Project Site; and

5. A statement, signed and dated by an authorized representative, as provided in §122.22 of SC Regulation 61-9 (see Appendix C of this permit), that certifies that the construction activity will take place during a period when the value of the rainfall erosivity factor is less than five.

At the time of publication, a Low Erosivity Waiver Form is not available. If EPA or DHEC does create a form, it will be noticed (either directly, by public notice, or by making information available on the Internet at:

www.epa.gov/npdes/stormwater/cgp or http://www.scdhec.gov/stormwater

Note: If the R factor is 5 or greater, you cannot apply for the rainfall erosivity waiver, and must apply for permit coverage as per Subpart 2.1 of the construction general permit, unless you qualify for the Water Quality Waiver as described below.

If your small construction Project continues beyond the projected completion date given on the waiver certification, you must recalculate the rainfall erosivity factor for the new Project duration. If the R factor is below five (5), you must update all applicable information on the waiver certification and retain a copy of the revised waiver as part of the Site SWPPP. The new waiver certification must be submitted prior to the projected completion date listed on the original waiver form to assure your exemption from permitting requirements is uninterrupted. If the new R factor is five (5) or above, you must submit an NOI as per Part 2.

B. TMDL Waiver

This waiver is available if a TMDL that addresses the pollutant(s) of concern and has determined that controls on storm water discharges from small construction activity are not needed to protect water quality. The pollutant(s) of concern include sediment (such as total suspended solids, turbidity or siltation) and any other pollutant that has been identified as a cause of impairment of any water body that will receive a discharge from the construction activity. Information on TMDLs that have been established is available from EPA online at www.epa.gov/owow/tmdl/ and from DHEC at: www.scdhec.gov/water/tmdl/.

If you are the Operator of the construction activity and eligible for a waiver based on compliance with

a TMDL, you must provide the following information on the Waiver Certification form in order to be waived from permitting requirements:

1. Name, address and telephone number of the construction Site Operator(s);

2. Name (or other identifier), address, county or similar governmental subdivision, and latitude/longitude of the construction Project or Site;

3. Estimated construction start and completion (i.e., final stabilization) dates, and total acreage (to the nearest quarter acre) to be disturbed;

4. The name of the water body(s) that would be receiving storm water discharges from your construction Project;

5. The name and approval date of the TMDL; and

6. A statement, signed and dated by an authorized representative, as provided in §122.22 of SC Regulation 61-9 (see Appendix C of this permit), that certifies that the construction activity will take place and that the storm water discharges will occur, within the drainage area addressed by the TMDL.

C. Equivalent Analysis Waiver

This waiver is available for non-impaired waters only. The Operator can develop an equivalent analysis that determines allocations for his small construction Site for the pollutant(s) of concern or determines that such allocations are not needed to protect water quality. This waiver requires a small construction Operator to develop an equivalent analysis based on existing in-stream concentrations, expected growth in pollutant concentrations from all sources, and a margin of safety.

If you are a construction Operator who wants to use this waiver, you must develop your equivalent analysis and provide the following information to be waived from permitting requirements:

1. Name, address and telephone number of the construction Site Operator(s);

2. Name (or other identifier), address, county or similar governmental subdivision, and latitude/longitude of the construction Project or Site;

3. Estimated construction start and completion (i.e., final stabilization) dates, and total acreage (to the nearest quarter acre) to be disturbed;

4. The name of the water bodies that would be receiving storm water discharges from your construction Project;

5. Your equivalent analysis; and

6. A statement, signed and dated by an authorized representative, as provided in §122.22 of SC

Regulation 61-9 (see Appendix C of this permit), that certifies that the construction activity will take place and that the storm water discharges will occur, within the drainage area addressed by the equivalent analysis.

D. Waiver Deadlines and Submissions

1. Waiver certifications must be submitted prior to commencement of construction activities.

2. If you submit a TMDL or equivalent analysis waiver request, you are not waived until DHEC approves your request. As such, you may not commence construction activities until receipt of approval from DHEC.

3. Late Notifications: Operators are not prohibited from submitting waiver certifications after initiating clearing, grading, excavation activities, or other construction activities. DHEC may take enforcement for any unpermitted discharge or violations of laws or regulations that occur between the time construction commenced and waiver authorization is granted.

Submittal of a waiver certification is an optional alternative to obtaining permit coverage for discharges of storm water associated with small construction activity, provided you qualify for the waiver. Any discharge of storm water associated with small construction activity not covered by either a permit or a waiver may be considered an unpermitted discharge under the Clean Water Act and the SC Pollution Control Act. As mentioned above, DHEC may take enforcement for any unpermitted discharge or violations of laws or regulations that occur between the time construction commenced and either discharge authorization is granted or a complete and accurate waiver certification is submitted. DHEC may notify any Operator covered by a waiver that they must apply for a permit. DHEC may notify any Operator who has been in non-compliance with a waiver that they may no longer use the waiver for future Projects. Any member of the public may petition DHEC to take action under this provision by submitting written notice along with supporting justification.

Complete and accurate Rainfall Erosivity waiver certifications must be sent to the following address:

Storm Water and Agricultural Permitting Section
Bureau of Water
SC DHEC
2600 Bull Street
Columbia, SC 29201

Complete and accurate TMDL or equivalent analysis waiver requests must be sent to the following address:

Storm Water and Agricultural Permitting Section
Bureau of Water
SC DHEC
2600 Bull Street
Columbia, SC 29201

APPENDIX C – SECTIONS 122.41 AND 122.22 OF SC REGULATION 61-9

Section 122.41 of SC Regulation 61-9.

122.41. Conditions applicable to all permits. The following conditions apply to all NPDES permits. Additional conditions applicable to NPDES permits are in section 122.42. All conditions applicable to NPDES permit shall be incorporated into the permits either expressly or by reference. If incorporated by reference, a specific citation to the federal regulations (or the corresponding approved State regulations) must be given in the permit.

(a) Duty to comply. The permittee must comply with all conditions of the permit. Any permit noncompliance constitutes a violation of the Clean Water Act and the Pollution Control Act and is grounds for enforcement action; for permit termination, revocation and reissuance, or modification; or denial of a permit renewal application. The Department's approval of wastewater facility Plans and Specifications does not relieve the permittee of responsibility to meet permit limits.

(1) The permittee shall comply with effluent standards or prohibitions established under section 307(a) of the Clean Water Act for toxic pollutants and with standards for sewage sludge use or disposal established under section 405(d) of the CWA within the time provided in the regulations that establish these standards or prohibitions or standards for sewage sludge use or disposal, even if the permit has not yet been modified to incorporate the requirement.

(2) Failure to comply with permit conditions or the provisions of this regulation may subject the permittee to civil penalties under S.C. Code Section 48-1-330 or criminal sanctions under S.C. Code Section 48-1-320. Sanctions for violations of the Federal Clean Water Act may be imposed in accordance with the provisions of 40 CFR Part 122.41(a)(2) and (3).

(3) A person who violates any provision of this regulation, a term, condition or schedule of compliance contained within a valid NPDES permit, or the State law is subject to the actions defined in the State law.

(b) Duty to reapply. If the permittee wishes to continue an activity regulated by this permit after the expiration date of this permit, the permittee must apply for and obtain a new permit. (But see 122.4(g)(2)).

(c) Need to halt or reduce activity not a defense. It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

(d) Duty to mitigate. The permittee shall take all reasonable steps to minimize or prevent any discharge or sludge use or disposal in violation of this permit which has a reasonable likelihood of adversely affecting human health or the environment.

(e) (1) Proper operation and maintenance. The permittee shall at all times properly operate and maintain in good working order and operate as efficiently as possible all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the

permittee to achieve compliance with the terms and conditions of this permit. Proper operation and maintenance includes effective performance based on design facility removals, adequate funding, adequate operator staffing and training and also includes adequate laboratory controls and appropriate quality assurance procedures. This provision requires the operation of back-up or auxiliary facilities or similar systems which are installed by a permittee only when the operation is necessary to achieve compliance with the conditions of the permit.

(2) The permittee shall develop and maintain at the facility a complete Operations and Maintenance Manual for the waste treatment facilities and/or land application system. The manual shall be made available for on-site review during normal working hours. The manual shall contain operation and maintenance instructions for all equipment and appurtenances associated with the waste treatment facilities and land application system. The manual shall contain a general description of: the treatment process(es), the operational procedures to meet the requirements of (e)(1) above, and the corrective action to be taken should operating difficulties be encountered.

(3)(i) Except as stated in (ii) below, the permittee shall provide for the performance of daily treatment facility inspections by a certified operator of the appropriate grade as defined in the permit for the facility. The inspections shall include, but should not necessarily be limited to, areas which require visual observation to determine efficient operation and for which immediate corrective measures can be taken using the O & M manual as a guide. All inspections shall be recorded and shall include the date, time, and name of the person making the inspection, corrective measures taken, and routine equipment maintenance, repair, or replacement performed. The permittee shall maintain all records of inspections at the permitted facility as required by the permit, and the records shall be made available for on-site review during normal working hours.

(ii) The Department may make exceptions to operating requirements, if stated in the permit, as follows:

(A) Attendance by the certified operator of the appropriate grade ("the operator") is normally required only on days when treatment or discharge occurs.

(B) For performance of daily inspections, permits may allow a reduced grade of operator for limited time periods under specific circumstances when justified by the permittee in a staffing plan and approved by the Department.

(C) Reduced inspection frequency, but in no case less than weekly, may be suitable when specified in the permit, if there is complete telemetry of operating data and there is either a simple treatment system with a low potential for toxicity but requiring pumps or other electrical functions or the ability to stop the discharge for an appropriate period when necessary.

(D) In other circumstances where the permittee demonstrates the capability to evaluate the facility in an alternative manner equivalent to the inspection requirements in subparagraph 3(i).

(E) Any exceptions allowed under (A), (B), (C), and (D) above may be subject to compliance with the permit conditions.

(4) (i) Purpose. This regulation establishes rules for governing the operation and maintenance of wastewater sewer systems, including gravity or pressure interceptor sewers. It is the purpose of this rule to establish standards for the management of sewer systems to prevent and/or minimize system failures that would lead to public health or environmental impacts.

(ii) Authority and applicability. Under Section 48-1-30 of the Code of Laws of South Carolina (1976 as amended), the Department is authorized to adopt such rules and regulations as may be necessary to implement the Pollution Control Act. This regulation applies to all sewer systems that have been or would be subject to a DHEC construction permit under Regulation 61-67 and whose owner owns or operates the wastewater treatment system to which the sewer discharges and which discharges under NPDES. Nothing in this regulation supersedes a more stringent requirement that may be imposed by sewer system owners that manage wastewater from satellite systems. This regulation (122.41(e)(4)) is effective when published in the State Register.

(iii) General requirements. The requirements to properly operate and maintain sewer systems are the responsibility of the system owner. General Standards. The sewer system owner must:

(A) Properly manage, operate, and maintain at all times all parts of its sewer system(s), to include maintaining contractual operation agreements to provide services, if appropriate;

(B) Provide adequate capacity to convey base flows and peak flows for all parts of the sewer system or, if capital improvements are necessary to meet this standard, develop a schedule of short and long term improvements;

(C) Take all reasonable steps to stop and mitigate the impact of releases of wastewater to the environment; and

(D) Notify the Department within 30 days of a proposed change in ownership of a sewer system.

(iv) [Reserved.]

(f) Permit actions. This permit may be modified, revoked and reissued, or terminated for cause. The filing of a request by the permittee for a permit modification, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance does not stay any permit condition.

(g) Property rights. This permit does not convey any property rights of any sort, or any exclusive privilege.

(h) Duty to provide information. The permittee shall furnish to the Department, within a reasonable time, any information which the Department may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit or to determine compliance with this

permit. The permittee shall also furnish to the Department upon request, copies of records required to be kept by this permit.

(i) Inspection and entry. The permittee shall allow the Department, or an authorized representative (including an authorized contractor acting as a representative of the Department), upon presentation of credentials and other documents as may be required by law, to:

(1) Enter upon the permittee's premises where a regulated facility or activity is located or conducted, or where records must be kept under the conditions of this permit;

(2) Have access to and copy, at reasonable times, any records that must be kept under the conditions of this permit;

(3) Inspect at reasonable times any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under this permit; and

(4) Sample or monitor at reasonable times, for the purposes of assuring permit compliance or as otherwise authorized by the Clean Water Act and Pollution Control Act, any substances or parameters at any location.

(j) Monitoring and records.

(1) (i) (A)Samples and measurements taken for the purpose of monitoring shall be representative of the monitored activity.

(B) Samples shall be reasonably distributed in time, while maintaining representative sampling.

(C) No analysis, which is otherwise valid, shall be terminated for the purpose of preventing the analysis from showing a permit or water quality violation.

(ii) Flow Measurements.

(A) Where primary flow meters are required, appropriate flow measurement devices and methods consistent with accepted scientific practices shall be present and used to ensure the accuracy and reliability of measurements of the volume of monitored discharges. The devices shall be installed, calibrated, and maintained to ensure that the accuracy of the measurements is consistent with the accepted capability of that type of device. Devices selected shall be capable of measuring flows with a maximum deviation of not greater than 10 percent from the true discharge rates throughout the range of expected discharge volumes. The primary flow device, where required, must be accessible to the use of a continuous flow recorder.

(B) Where permits require an estimate of flow, the permittee shall maintain at the permitted facility a record of the method(s) used in "estimating" the discharge flow (e.g., pump curves, production charts, water use records) for the outfall(s) designated on limits pages to monitor flow by an estimate.

(C) Records of any necessary calibrations must be kept.

(iii) The Department may designate a single, particular day of the month on which any group of parameters listed in the permit must be sampled. When this requirement is imposed in a permit, the Department may waive or alter compliance with the permit requirement for a specific sampling event for extenuating circumstances.

(iv) The Department may require that a permittee monitor parameters in the stream receiving his permitted discharge as necessary to evaluate the need for and to establish limits and conditions and to insure compliance with water quality standards (i.e., R.61-68).

(2) Except for records of monitoring information required by this permit related to the permittee's sewage sludge use and disposal activities, which shall be retained for a period of at least five years (or longer as required by R.61-9.503 or R.61-9.504); the permittee shall retain records of all monitoring information, including all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation, copies of all reports required by this permit, and records of all data used to complete the application for this permit, for a period of at least 3 years from the date of the sample, measurement, report or application. This period may be extended by request of the Department at any time.

(3) Records of monitoring information shall include:

(i) The date, exact place, and time of sampling or measurements;

(ii) The individual(s) who performed the sampling or measurements;

(iii) The date(s) analyses were performed;

(iv) The individual(s) who performed the analyses;

(v) The analytical techniques or methods used; and

(vi) The results of such analyses.

(4) Analyses for required monitoring must be conducted according to test procedures approved under 40 CFR Part 136 unless other test procedures have been specified in the permit or, in the case of sludge use or disposal, unless otherwise specified in R.61-9.503 or R.61-9.504.

(5) The PCA provides that any person who falsifies, tampers with, or knowingly renders inaccurate any monitoring device or method required to be maintained under this permit shall, upon conviction, be punished by a fine of not more than $25,000 or by imprisonment for not more than 2 years, or both. If a conviction of a person is for a violation committed after a first conviction of such person under this paragraph, punishment provided by the Clean Water Act is also by imprisonment of not more than 4 years.

(k) Signatory requirement.

(1) All applications, reports, or information submitted to the Department shall be signed and certified (See section 122.22).

(2) The PCA provides that any person who knowingly makes any false statement, representation, or certification in any record or other document submitted or required to be maintained under this permit, including monitoring reports or reports of compliance or non-compliance shall, upon conviction, be punished by a fine of not more than $25,000 per violation, or by imprisonment for not more than two years per violation, or by both.

(l) Reporting requirements.

(1) Planned changes. The permittee shall give notice to the Department as soon as possible of any planned physical alterations or additions to the permitted facility. Notice is required only when:

(i) The alteration or addition to a permitted facility may meet one of the criteria for determining whether a facility is a new source in section 122.29(b); or

(ii) The alteration or addition could significantly change the nature or increase the quantity of pollutants discharged. This notification applies to pollutants which are subject neither to effluent limitations in the permit, nor to notification requirements under section 122.42(a)(1).

(iii) The alteration or addition results in a significant change in the permittee's sewage sludge or industrial sludge use or disposal practices, and such alteration, addition, or change may justify the application of permit conditions that are different from or absent in the existing permit, including notification of additional use or disposal sites not reported during the permit application process or not reported pursuant to an approved land application plan (included in the NPDES permit directly or by reference);

(2) Anticipated noncompliance. The permittee shall give advance notice to the Department of any planned changes in the permitted facility or activity which may result in noncompliance with permit requirements.

(3) Transfers. This permit is not transferable to any person except after notice to the Department. The Department may require modification or revocation and reissuance of the permit to change the name of permittee and incorporate such other requirements as may be necessary under the Pollution Control Act and the Clean Water Act. (See section 122.61; in some cases, modification or revocation and reissuance is mandatory.)

(4) Monitoring reports. Monitoring results shall be reported at the intervals specified in the permit.

(i) Monitoring results must be reported on a Discharge Monitoring Report

(DMR) or forms provided or specified by the Department for reporting results of monitoring of sludge use or disposal practices.

(ii) If the permittee monitors any pollutant more frequently than required by the permit using test procedures approved under 40 CFR Part 136 or, in the case of sludge use or disposal, approved under 40 CFR Part 136 unless otherwise specified in R.61-9.503 or R.61-9.504, or as specified in the permit, the results of this monitoring shall be included in the calculation and reporting of the data submitted in the DMR or sludge reporting form specified by the Department.

(iii) Calculations for all limitations which require averaging of measurements shall utilize an arithmetic mean unless otherwise specified by the Department in the permit.

(5) Compliance schedules. Reports of compliance or noncompliance with, or any progress reports on, interim and final requirements contained in any compliance schedule of this permit shall be submitted no later than 14 days following each schedule date.

(6) Twenty-four hour reporting.

(i) The permittee shall report any noncompliance which may endanger health or the environment. Any information shall be provided orally within 24 hours from the time the permittee becomes aware of the circumstances. A written submission shall also be provided within 5 days of the time the permittee becomes aware of the circumstances. The written submission shall contain a description of the noncompliance and its cause; the period of noncompliance, including exact dates and times, and if the noncompliance has not been corrected, the anticipated time it is expected to continue; and steps taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance.

(ii) The following shall be included as information which must be reported within 24 hours under this paragraph.

(A) Any unanticipated bypass which exceeds any effluent limitation in the permit. (See section 122.44(g)).

(B) Any upset which exceeds any effluent limitation in the permit.

(C) Violation of a maximum daily discharge limitation for any of the pollutants listed by the Department in the permit to be reported within 24 hours (See section 122.44(g)).

(iii) The Department may waive the written report on a case-by-case basis for reports under paragraph (l)(6)(i) of this section if the oral report has been received within 24 hours.

(7) Other noncompliance. The permittee shall report all instances of noncompliance not reported under paragraphs (l)(4), (5), and (6) of this section, at the time monitoring reports are submitted. The reports shall contain the information listed in paragraph (l)(6) of this section.

(8) Other information. Where the permittee becomes aware that it failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application or in any report to the Department, it shall promptly submit such facts or information.

(m) Bypass.

(1) Definitions.

(i) "Bypass" means the intentional diversion of waste streams from any portion of a treatment facility.

(ii) "Severe property damage" means substantial physical damage to property, damage to the treatment facilities which causes them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of a bypass. Severe property damage does not mean economic loss caused by delays in production.

(2) Bypass not exceeding limitations. The permittee may allow any bypass to occur which does not cause effluent limitations to be exceeded but only if it also is for essential maintenance to assure efficient operation. These bypasses are not subject to the provisions of paragraph (m)(3) and (m)(4) of this section.

(3) Notice.

(i) Anticipated bypass. If the permittee knows in advance of the need for a bypass, it shall submit prior notice, if possible, at least ten days before the date of the bypass.

(ii) Unanticipated bypass. The permittee shall submit notice of an unanticipated bypass as required in paragraph (l)(6) of this section (24-hour notice).

(4) Prohibition of bypass

(i) Bypass is prohibited, and the Department may take enforcement action against a permittee for bypass, unless:

(A) Bypass was unavoidable to prevent loss of life, personal injury, or severe property damage;

(B) There were no feasible alternatives to the bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment downtime. This condition is not satisfied if adequate back-up equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass which occurred during normal periods of equipment downtime or preventive maintenance; and

(C) The permittee submitted notices as required under paragraph (m)(3) of this section.

(ii) The Department may approve an anticipated bypass, after considering its adverse effects, if the Department determines that it will meet the three conditions listed above in paragraph (m)(4)(i) of this section.

(n) Upset.

(1) Definition. "Upset" means an exceptional incident in which there is unintentional and temporary noncompliance with technology based permit effluent limitations because of factors beyond the reasonable control of the permittee. A upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventive maintenance, or careless or improper operation.

(2) Effect of an upset. An upset constitutes an affirmative defense to an action brought for noncompliance with such technology based permit effluent limitations if the requirements of paragraph (n)(3) of this section are met. No determination made during administrative review of claims that noncompliance was caused by upset, and before an action for noncompliance, is final administrative action subject to judicial review.

(3) Conditions necessary for a demonstration of upset. A permittee who wishes to establish the affirmative defense of upset shall demonstrate, through properly signed, contemporaneous operating logs, or other relevant evidence that:

(i) An upset occurred and that the permittee can identify the cause(s) of the upset;

(ii) The permitted facility was at the time being properly operated; and

(iii) The permittee submitted notice of the upset as required in paragraph (l)(6)(ii)(B) of this section (24 hour notice).

(iv) The permittee complied with any remedial measures required under paragraph (d) of this section.

(4) Burden of proof. In any enforcement proceeding, the permittee seeking to establish the occurrence of an upset has the burden of proof.

(o) Misrepresentation of Information.

(1) Any person making application for a NPDES discharge permit or filing any record, report, or other document pursuant to a regulation of the Department, shall certify that all information contained in such document is true. All application facts certified to by the applicant shall be considered valid conditions of the permit issued pursuant to the application.

(2) Any person who knowingly makes any false statement, representation, or certification in any application, record, report, or other documents filed with the Department pursuant

to the State law, and the rules and regulations pursuant to that law, shall be deemed to have violated a permit condition and shall be subject to the penalties provided for pursuant to 48-1-320 or 48-1-330.

Section 122.22 of SC Regulation 61-9.

122.22. Signatories to permit applications and reports.

(a) Applications. All permit applications shall be signed as follows:

(1) For a corporation: by a responsible corporate officer. For the purpose of this section, a responsible corporate officer means:

(i) A president, secretary, treasurer, or vice-president of the corporation in charge of a principal business function, or any other person who performs similar policy or decision-making functions for the corporation, or

(ii) The manager of one or more manufacturing, production, or operating facilities, provided, the manager is authorized to make management decisions which govern the operation of the regulated facility including having the explicit or implicit duty of making major capital investment recommendations, and initiating and directing other comprehensive measures to assure long term environmental compliance with environmental laws and regulations; the manager can ensure that the necessary systems are established or actions taken to gather complete and accurate information for permit application requirements; and where authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures.

(2) For a partnership or sole proprietorship: by a general partner or the proprietor, respectively; or

(3) For a municipality, State, Federal, or other public agency or public facility: By either a principal executive officer, mayor, or other duly authorized employee or ranking elected official. For purposes of this section, a principal executive officer of a Federal agency includes:

(i) The chief executive officer of the agency, or

(ii) A senior executive officer having responsibility for the overall operations of a principal geographic unit of the agency (e.g., Regional Administrator, Region IV, EPA).

(b) All reports required by permits, and other information requested by the Department, shall be signed by a person described in paragraph (a) of this section, or by a duly authorized representative of that person. A person is a duly authorized representative only if:

(1) The authorization is made in writing by a person described in paragraph (a) of this section;

(2) The authorization specifies either an individual or a position having

responsibility for the overall operation of the regulated facility or activity such as the position of plant manager, operator of a well or a well field, superintendent, position of equivalent responsibility, or an individual or position having overall responsibility for environmental matters for the company. (A duly authorized representative may thus be either a named individual or any individual occupying a named position.) and,

(3) The written authorization is submitted to the Department.

(c) Changes to authorization. If an authorization under paragraph (b) of this section is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new authorization satisfying the requirements of paragraph (b) of this section must be submitted to the Department prior to or together with any reports, information, or applications to be signed by an authorized representative.

(d) Certification. Any person signing a document under paragraph (a) or (b) of this section shall make the following certification: "I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

Sec 4.2 Ref 4

Gunter, Gary – NUS

From: Toby D Feaster [tfeaster@usgs.gov]
Sent: Tuesday, July 25, 2006 10:33 AM
To: Gunter, Gary – NUS
Cc: Noel M Hurley; Paul A Conrads; Toby D Feaster
Subject: Re: Data Request for 7Q10 info
Attachments: attvlfrz.dat

Gary,

I cannot speak for DHEC and DNR. Typically, if DHEC wants a 7Q10 updated, they will get the USGS to do it. It is my understanding that DNR is starting to do some lowflow analyses themselves but I do not know if they have looked at the Broad River stations. Below is the information that I spoke of in my voicemail.

Hope this helps,
Toby

Currently, we have published 7Q10 estimates for the following Broad River stations:

Station No.	*Station Name*	*Period of Record Used in Analysis*	*Drainage Area (square miles)*	*7Q10 (cubic feet per second)*
02153500	*Broad River near Gaffney*	*Oct. 1938-Mar. 1971, Jun. 1986-Mar. 1987*	*1,490*	*540*
02156500	*Broad River near Carlisle*	*Oct. 1938-Mar. 1987*	*2,790*	*730*
02161500	*Broad River at Richtex*	*Oct. 1925-Mar. 1987*	*4,850*	*1,000*

These estimates come from USGS Water-Resources Investigations Report 91-4170 "Low-flow frequency and flow duration of selected South Carolina Streams through 1987" by Michael G. Zalants. We have been pursuing cooperators with an interest in updating this statistics. So far, we have several cooperators that have the interest but not the revenue at this time. From time to time, we get request to update the low-flow statistics at a particular station and handle those on a per cost basis. That is, when the request comes in, we submit a time and cost estimate to the party requesting the update and move forward once we have an official agreement in place.

Toby D. Feaster
Hydrologist (Engineer)
USGS South Carolina Water Science Center
Clemson Field Office
405 College Ave., Suite 200
Clemson, SC 29631

Email: tfeaster@usgs.gov
Phone: (864) 656-6747
Fax: (864) 656-6779

"Gunter, Gary – NUS" <Gary.Gunter@ttnus.com>

To Toby Feaster <tfeaster@usgs.gov>

07/25/2006 10:19 AM

cc

Subject Data Request for 7Q10 info

Toby, thanks for the information. Would DHEC or DNR have determined their own 7Q10 data?

Gary L. Gunter
Earth Scientist
TETRA TECH NUS, Inc.
900 Trail Ridge Road
Aiken, South Carolina 29803
Direct Line: (803) 641-6318
FAX: (803) 642-8454
TtNUS office Line: (803) 649-7963, x 6318
Gary.Gunter@ttnus.com
<http://www.ttnus.com/ <http://www.ttnus.com/> >
<http://www.tetratech.com <http://www.tetratech.com> >

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Sec 4.3 Ref 2

Clark 2006)

South Carolina NPDES General Permit for Stormwater Discharges from Large and Small Construction Activities

Ann Clark, Manager

Stormwater, Dams, and Agricultural Permitting Section

DHEC

PROMOTE PROTECT PROSPER

South Carolina Department of Health and Environmental Control

SCEG-315

What activities require NPDES coverage?

Sites that disturb 1 acre or more

All sites within ½ mile of a receiving waterbody in the Coastal Zone [submission of the Notice of Intent (NOI) is not required for sites disturbing 0.5 acre or less]

Less than 1 acre on case-by-case basis (statewide)

Operators and Co-Permittees

Operator: The party with operational control over construction plans and specs or the party that has operational control over day-to-day activities at a Project that are necessary to ensure compliance with a SWPPP for the site and other permit conditions (authorized to direct workers at a Site to carry out activities required by the SWPPP or comply with other permit conditions)

Co-Permittee: a permittee to an NPDES permit that is only responsible for permit conditions relating to the discharge for which it is Operator

Co-Permittee and Contractor Certifications

If you will be performing land-disturbing activities on the site, you must sign one of the statements described below

All **co-permittees** must sign a certification statement that they accept the terms and conditions of the Stormwater Pollution Prevention Plan (SWPPP) as required by the CGP issued to the Owner/ Operator and have participated in the pre-construction meeting

All **contractors that are not co-permittees** must sign a certification statement that they understand they may be accountable to DHEC to ensure compliance with the SWPPP and that they have participated in the pre-construction meeting

Pre-Construction Meetings

Purpose: Explain the SWPPP to co-permittees and contractors before they perform land-disturbing activities at the site

Meetings required **onsite** (unless approved by DHEC to be conducted offsite)

Linear projects may conduct meeting offsite

All **co-permittees, contractors that are not co-permittees and preparer of the SWPPP** (or someone with registration equivalent) or person with operational control of plans and specs must attend

Certification of pre-construction meeting required for projects disturbing 10 acres or more

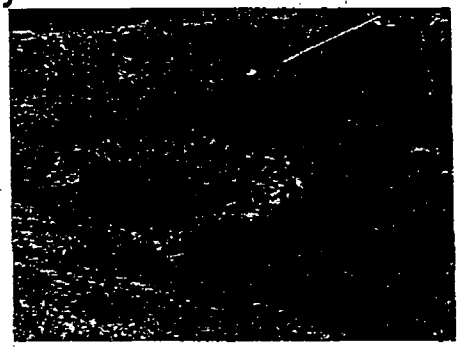
Inspection Frequency

Must choose one of the following schedules and indicate on the SWPPP

(1) Once every 7 calendar days; or

(2) Once every 14 calendar days and within 24 hours of the end of a storm event of 0.5 inches or greater

Inspection frequency may be reduced to at least once every month if the **entire** site is temporarily stabilized



Site Stabilization

Existing Permit

Stabilization measures shall be initiated as soon as practicable in portions of the site where construction activities have temporarily or permanently ceased, but in no case more than fourteen (14) days after work has ceased, unless activity in that portion of the site will resume within the next seven (7) days.

Sec 4.3 Ref 3

ERDC TN-DOER-E21
September 2005

(Francingues, N.R., and Palermo, M.R. 2005)

Silt Curtains as a Dredging Project Management Practice

INTRODUCTION: Environmental windows are imposed on many U.S. Army Corps of Engineers (USACE) dredging projects in both coastal and inland waterways. Over 83 protected or sensitive species that have been identified fall into at least 20 general categories of concern for potentially negative impacts from dredging and disposal operations. One of the most frequently cited reasons for establishing an environmental window is impacts from turbidity and suspended sediments (Reine, Dickerson, and Clarke 1998). Over the past 15 to 20 years there have also been increased concerns regarding the potential impacts that dredging of contaminated sediments may have on nearby environmental resources.

In response to the need to protect sensitive environmental resources, silt or turbidity curtains have been designated a "best management practice (BMP)" by the Corps of Engineers, other Federal Agencies, and state regulatory authorities. Silt curtains are devices that control suspended solids and turbidity in the water column generated by dredging and disposal of dredged material. Consequently, silt curtains are considered an integral and necessary part of the regulatory strategy for many dredging projects. Unfortunately, factors contributing to the effectiveness of silt curtains under different circumstances are poorly understood by dredging project regulators and the public alike. Dredging contractors attest to the fact that, in their experience, silt curtains do not work under many of the site conditions encountered in navigation and environmental dredging projects. The published literature contains few comprehensive studies that demonstrate how effective silt curtains have been in meeting the intended project objectives (Johanson 1976, 1977; JBF Scientific Corporation 1978; Lawler, Matusky and Skelly Engineers 1983).

One goal of the Dredging Operations and Environmental Research (DOER) Program is to provide current, accurate technical guidance on environmental controls for dredging operations. Remaining challenges include rigorous examination of silt or turbidity curtains as a temporary control measure to better define performance criteria and identification of technical guidelines for their selection and use in navigation and environmental dredging projects.

PURPOSE: This technical note reviews the basic types of silt curtains used in navigation and environmental dredging projects. The emphasis is on the state of the practice and circumstances under which silt curtains function best. A checklist is provided to aid in consideration of silt curtain applications, including selection, design, specifications, deployment, and maintenance of silt curtains at dredging projects. This note also serves to update and supplement earlier guidance (e.g., Johanson 1977 and JBF Scientific Corporation (1978)) published on the application and performance of silt curtains.

DEFINITIONS: Silt curtains, turbidity screens, silt/turbidity barriers, gunderbooms, etc., are not to be confused with silt fences used in terrestrial control of soil erosion. Silt curtains are designed specifically to control suspended solids and turbidity generated in the water column as a result of navigation and environmental dredging operations. Silt and turbidity control devices have many names that have been used interchangeably by the Corps of Engineers, the U.S. Environmental Protection Agency (USEPA), various State regulatory agencies, dredging contractors, consultants, and manufacturers and suppliers. The following terminology represents common usage:

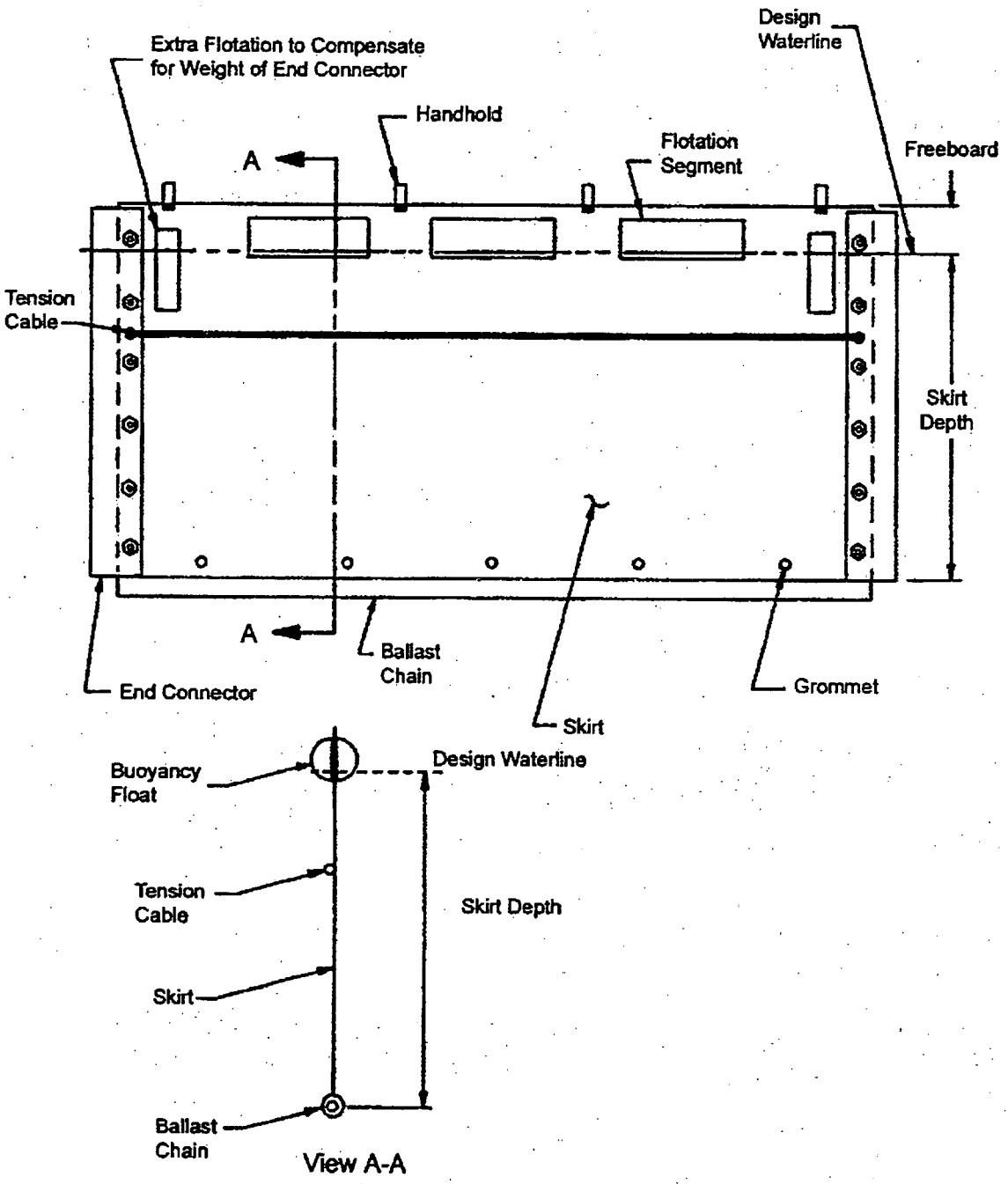
- *Silt* is defined as fine-grained suspended material that can be readily resuspended or stripped from sediment that is either being hydraulically or mechanically dredged from or placed in the water. Resuspended matter is generally measured gravimetrically and expressed as Total Suspended Solids (TSS) in milligrams per liter.
- *Turbidity* is a measure of the *optical properties* (amount of scattering and absorption of light rays) of the water in which dredging and dredged material disposal occur. Turbidity is frequently expressed in Nephelometric Turbidity Units (NTU).
- A *Silt/Turbidity Curtain* has traditionally been defined as an *impermeable* device for control of suspended solids and turbidity in the water column generated by dredging and dredged material disposal operations. Recently, the term "silt curtain" has been used to describe floating vertical barriers fabricated from either solid or permeable materials.
- A *Silt/Turbidity Screen* is a *flow-through filtering* device for control of suspended material and turbidity in the water column generated by dredging and dredged material disposal operations. All screens are composites of solid material (usually to facilitate flotation and mooring purposes) and permeable geosynthetic fabrics to filter water and reduce water pressure on the device.
- A *Gunderboom* is a device similar to a silt or turbidity screen that has been modified to control oil spills by adding adsorbent geotextile material.

For the purposes of this technical note, the term "*silt curtain*" will be used generically to describe devices deployed in water to control suspended solids or turbidity resulting from dredging operations.

TYPICAL QUESTIONS ON SELECTION AND USE OF SILT CURTAINS

What Are the Components of Silt Curtains? Silt curtains are vertical, flexible structures that extend downward from the water surface to a specified water depth. Typically fabricated of flexible, polyester-reinforced thermoplastic (vinyl) fabric, the curtain is maintained in a vertical position by flotation material at the top and a ballast chain along the bottom (Figure 1).

A tension cable is often built into the curtain immediately above or just below the flotation segments (top tension) to absorb stresses imposed by currents and hydrodynamic turbulence. The curtains are usually manufactured in standard sections (e.g., up to 50 ft) that can be joined together at a particular site to provide a curtain of specified length. Curtains are generally deployed to extend to 1-2 ft above the bottom to allow mudflow to pass beneath them. Anchored


Extra Flotation to Compensate for Weight of End Connector
Handhold
Flotation Segment
Design Waterline
Freeboard
A
Tension Cable
Skirt Depth
A
Ballast Chain
End Connector
Skirt
Grommet
Buoyancy Float
Design Waterline
Tension Cable
Skirt Depth
Skirt
Ballast Chain
View A-A

area is intended to provide residence time to allow soil particles to settle out of suspension and reduce flow to other areas where negative impacts could occur. Suspended solids can also conceivably be diverted from areas where environmental damages could occur from the settlement of these suspended particles. Silt curtains may also be used to protect specific areas (e.g., sensitive habitats, water intakes, or recreational areas) from suspended sediment and particle-associated contamination.

What Processes Affect Silt Curtains? In many cases where silt curtains are used, the concentration of fine-grained suspended solids inside the curtain enclosure may be relatively high (i.e., in excess of 1 g/L). The suspended material may be composed of relatively large, rapidly settling particles or flocs. In the case of a typical pipeline disposal operation surrounded by a silt curtain (Figure 2), where suspended solid concentrations are high and material usually flocculated, the vast majority (95 percent) of the fine-grained material descends rapidly to the bottom where it forms a fluid mud layer that slopes away from the source at an approximate gradient of 1:200. The other 5 percent of the material remains suspended in the water column above the fluid mud layer and is responsible for the turbid appearance of the water inside the curtain. While the curtain provides an enclosure where some of the fine-grained material may flocculate and/or settle, most of this fine-grained suspended material in the water column escapes with the flow of water and fluid mud under the curtain. The silt curtain does not indefinitely contain turbid water but instead controls the dispersion of turbid water by diverting the flow under the curtain, thereby minimizing the turbidity in the water column outside the silt curtain.

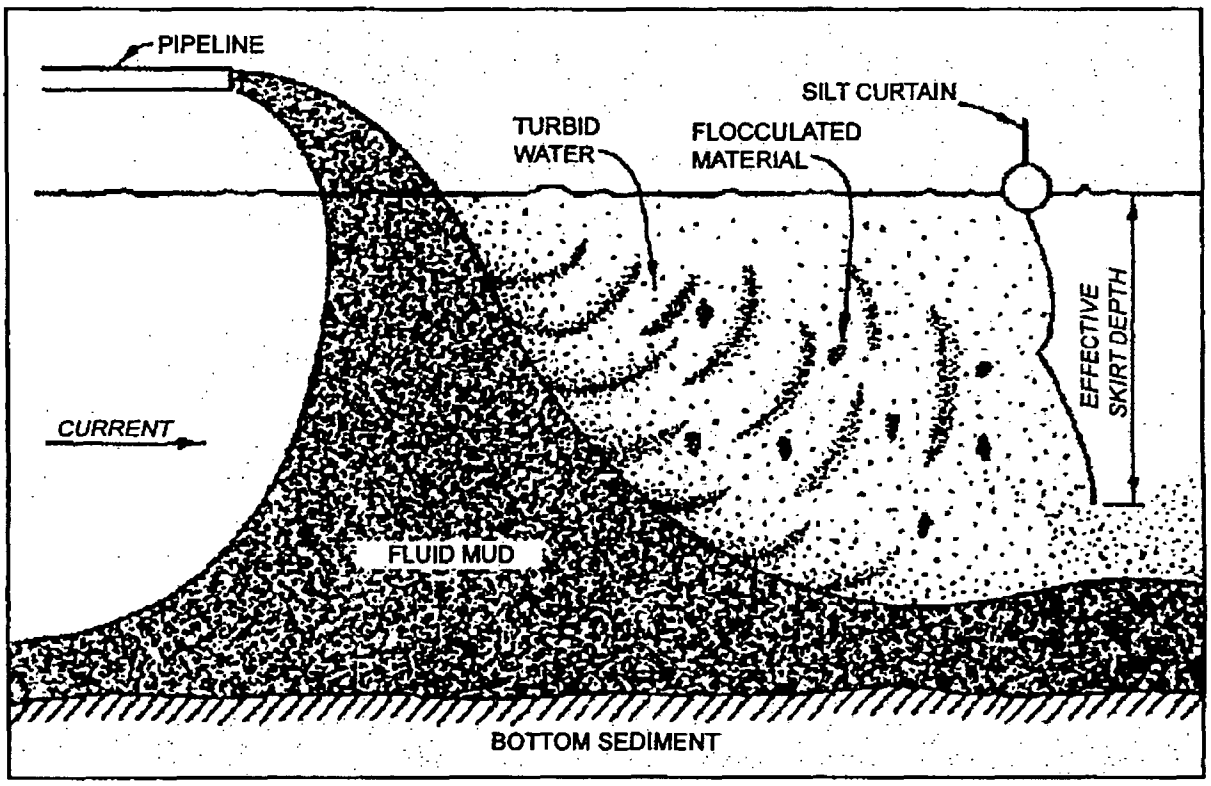


Figure 2. Processes affecting silt curtain performance (JBF Scientific Corporation (1978))

Whereas properly deployed and maintained silt curtains can effectively control the distribution of turbid water, they are not designed to contain or control fluid mud. In fact, when the accumulation of fluid mud reaches the depth of the ballast chain along the lower edge of the skirt, the curtain must be moved away from the discharge; otherwise sediment accumulation on the lower edge of the skirt can pull the curtain underwater and eventually bury it. Consequently, the rate of fluid mud accumulation relative to changes in water depth due to tides must be considered during a silt curtain operation.

How Are Silt Curtains Deployed? After the deployment site has been surveyed, the geometry of the deployed curtain should be determined based on the objectives of silt curtain application, the hydrodynamic regime at the project site, and factors such as boat traffic. Typical deployment configurations for silt curtains are shown in Figure 3. In some cases, the curtain may be deployed in an open-water environment in the form of a "maze," a semicircle or U, or a circle or ellipse.

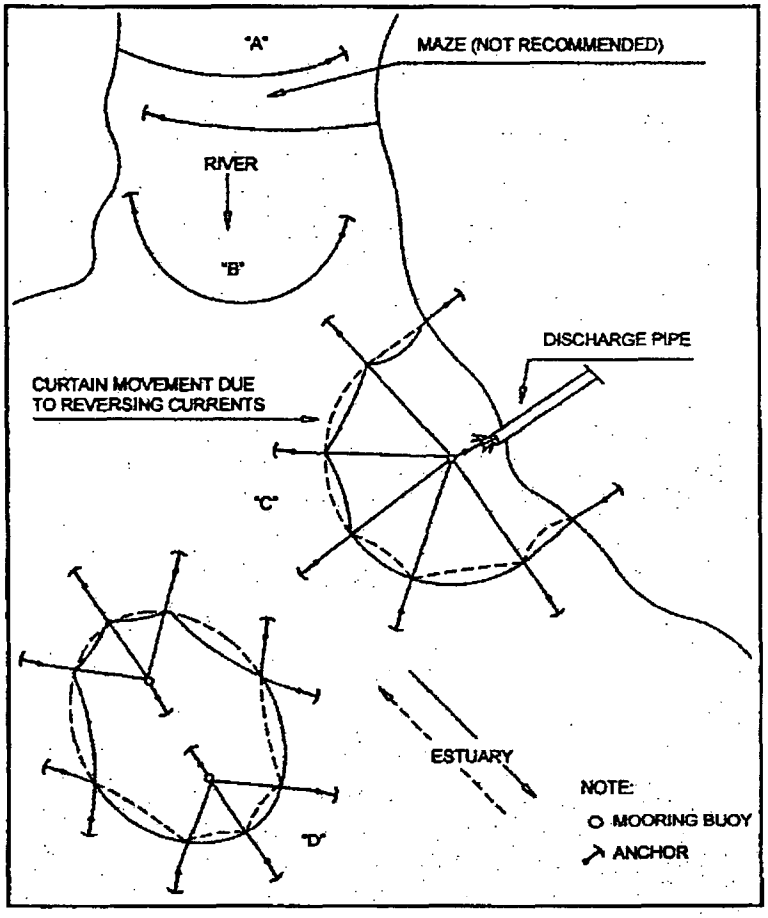


Figure 3. Typical silt curtain deployment configurations (JBF Scientific Corporation (1978))

The maze configuration ("A," Figure 3) has been used on rivers where boat traffic is present, but appears to be relatively ineffective due to direct flow through the aperture between the curtain sections. On a river where the current does not reverse, a U configuration ("B," Figure 3) is acceptable, but the distance between the anchored ends of the curtain (i.e., across the gap) should be large enough to prevent leakage of turbid water around the ends of the U. In situations where the turbid water is being generated by effluent from a containment area or a pipeline disposal operation close to the shoreline, the curtain can be anchored in a semicircular or U configuration ("C," Figure 3) with the ends of the curtain anchored onshore approximately equidistant from the discharge point. In a tidal situation with reversing currents a circular or elliptical configuration ("D," Figure 3) is necessary. This latter case requires a more extensive mooring system. A typical curtain might be 500 to 1500 ft for the U or semicircular configurations and 1000 to 3000 ft for the circular/elliptical case. Figure 4 shows a single floating silt curtain being deployed from a pier.

What Types of Silt Curtains Are Commercially Available for Silt Curtains? Many types of commercially available silt curtains are manufactured to perform specific functions. Names given by the manufacturers to describe the silt curtains include "floating," "floating diversion baffle," "fixed hanging," "permeable," "standing," "frame," "sinkable hanging," and "combination." Other names refer to the type of water or current where the curtain will be used (e.g., slack, slow, medium, fast, rough, tidal, etc.).

Figure 4. Single flotation silt curtain being deployed from shoreline (Courtesy of Marke Wilkie, Elastec/ American Marine, Inc., 401 Shearer Blvd., Cocoa, FL 32922)

Typical silt curtain types are shown in Figures 5 and 6. Most silt curtains incorporate the following common specification components:

- Flotation or buoyancy (e.g., solid or compressed air).
- Skirt depth (height between the top boom and the curtain bottom).
- Fabric (e.g., tensile strength, tear strength, abrasion resistance, material, coating, weight, seams/seals, drains, and color—bright yellow or international orange are recommended).
- Connectors (e.g., lace, bolt through, ASTM universal, PVC slotted tube, hook and O-ring).
- Ballast (e.g., type and weight).
- Tension member or load line (i.e., upper, mid, or bottom).

What Is Known about the Effectiveness of Silt Curtains? Silt curtains have been evaluated since the early 1970's. One of the most definitive early studies on the functional capabilities and performance of silt curtains in the United States was completed by JBF Scientific Corporation (1978) during the Corps of Engineers' Dredged Material Research Program. The study consisted of evaluating past and present uses, effectiveness of various applications, deployment guidelines and specifications, deployment methods, and environmental conditions that might limit the use of silt curtains. Much of the technical guidance presented in the study report is still valid and represents a fundamental source of information currently used by silt curtain design practitioners. Summarizing the JBF Scientific Corporation study, silt curtain effectiveness depends on many factors such as:

- Nature of the operation (i.e., navigation or environmental dredging).
- Quantity and type of material in suspension within or upstream of the curtain (including debris, oils, and chemicals).
- Characteristics, construction, and condition of the curtain as well as the area and configuration of the barrier enclosure (e.g., partial or full depth containment, either solid or permeable).

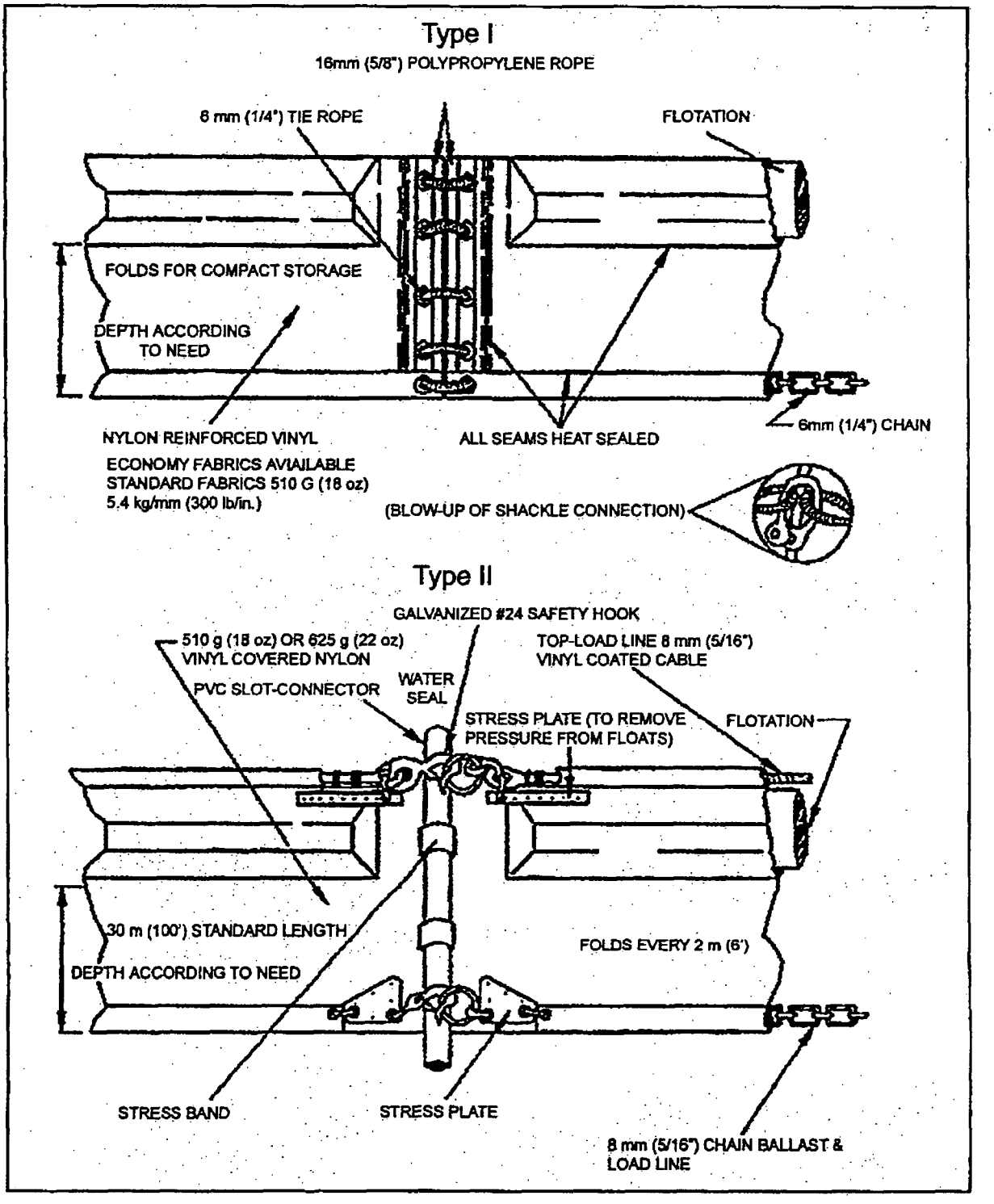


Figure 5. Types I and II silt curtains (USACE EP 1110-1-16, Appendix C, BMP-27, page C-167)

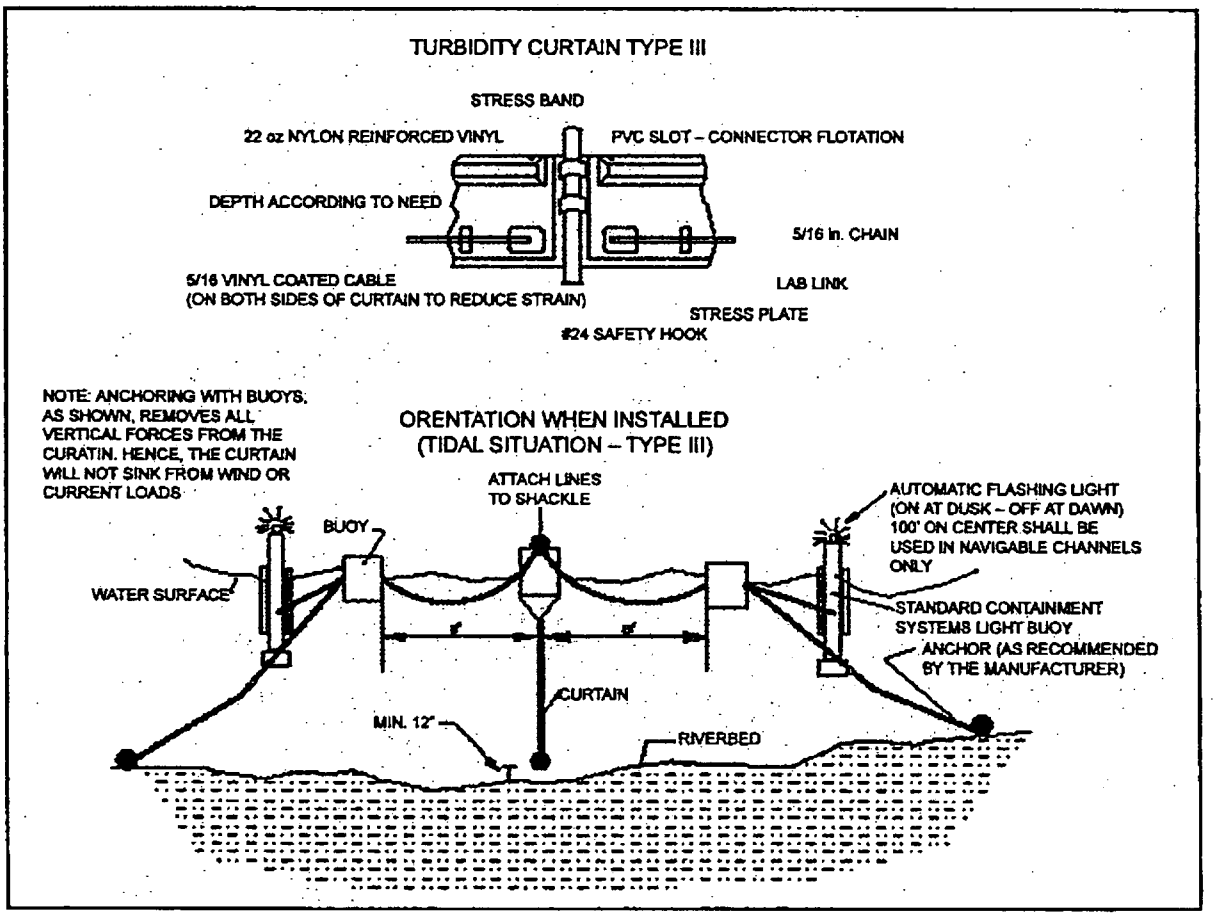


Figure 6. Type III silt curtain (USACE EP 1110-1-16, Appendix C, BMP-27, page C-167)

- Method of deployment.
- Hydrodynamic conditions (e.g., strong currents [>1 knot or 1.5 fps], high winds [especially with long fetch areas], fluctuating water levels [i.e., tides], excessive wave height including ship wakes, and drifting debris and ice).

Figure 7 shows a silt curtain installation in San Francisco Bay during a moderate squall.

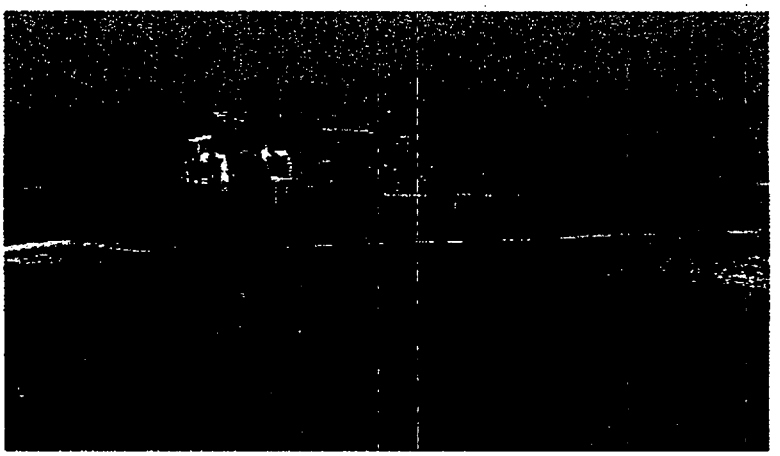


Figure 7. Floating curtain deployed in San Francisco Bay (courtesy of Julie Kistle, KFM-Joint Venture, San Francisco-Oakland Bay Bridge East Span Skyway Project Turbidity Monitoring Project)

JBF Scientific Corporation (1978) defined effectiveness as "the degree of turbidity reduction outside the curtain relative to the turbidity levels inside the curtain enclosure." They also concluded that:

> In some cases, turbidity levels in the water column outside the curtain can be 80-90 percent lower than levels inside or up-current of the curtain enclosure. High currents and energy environments cause silt curtains to flare, thus reducing the curtain's effective depth. At a current of 1 knot, the effective skirt depth of a 1.5-m curtain is approximately 0.9 m. Increased turbulence around the curtain also tends to cause resuspension of the fluid mud layer and may cause increased turbidity levels in the upper water column beyond the curtain. Tidal currents that dominate the hydrodynamic regime may cause the fluid mud to be resuspended, especially if the curtain is not properly deployed. Frequently, changes in the direction of the current will dominate the direction and movement (flapping) of an improperly anchored curtain. Where anchoring is inadequate and particularly at sites where tidal currents dominate the hydrodynamic regime and probably cause resuspension of the fluid mud as the curtain sweeps back and forth over the fluid mud with changes in the direction of the tidal currents, the turbidity levels outside the curtain can be higher (as much as 10 times) than the levels inside the curtain.

Finally, JBF Scientific Corporation (1978) stated, "With respect to overall effectiveness and deployment considerations a current velocity of approximately 1 knot appears to be a practical limiting condition for silt curtain use."

In preparation for the construction of the Westway interstate highway in New York, a test program was established to determine the effectiveness and deployment configurations needed for the dredging activities associated with the highway construction project. Lawler, Matusky, and Skelly Engineers (1983) reported the results of the water quality tests performed on the prototype silt curtains used in the test program. They concluded, "Visual observations and field measurements showed the silt curtain to be an effective barrier to currents, dye, suspended solids, and turbidity. The curtain did not function as a permeable fabric as predicted; water appeared to flow around it rather than through it." The silt curtain contained most contaminants with the exception of ammonia. Mixing outside the curtain in the water column brought the levels down to background levels. Lawler, Matusky, and Skelly Engineers also concluded, "The low currents measured behind the curtain indicated that the curtain blocks flow patterns and creates a quiescent zone. The lack of flow through the curtain is probably attributable to the water taking the path of least resistance (i.e., under the piers or around the ends). Clogging of the curtain with suspended solids (either background or caused by dredging) would only aggravate this situation." At the time, the concept of enclosing a dredge was new and untested. Notably, a concern arose that enclosing the dredge with a silt curtain would create a settling basin for solids that could promote the concentration and release of oxygen-consuming suspended contaminants in violation of water quality standards. The exchange of water inside the curtain became a design topic and relief panels (flaps) were considered to allow a 25-percent exchange of basin volume over a 12-hr period.

In 1994, the USEPA published a remediation guidance document as part of the Assessment and Remediation of Contaminated Sediments (ARCS) Program (USEPA 1994). They concluded, "As a generalization, silt curtains and screens are most effective in relatively shallow quiescent water. As the water depth increases and turbulence caused by currents and waves increases, it

becomes increasingly difficult to effectively isolate the dredging operation from the ambient water. The St. Lawrence Centre (1993) advises against the use of silt curtains in water deeper than 6.5 m or in currents greater than 50 cm/sec (USEPA 1994)."

The USEPA also suggested that to be effective, curtains deployed around the remediation dredging operation must remain in place until the operation is completed at that site. For large projects, frequent relocation of the curtains may be necessary as the dredge moves to new areas. The USEPA also highlighted the fact that curtains should not impede navigation traffic, an important consideration during their deployment.

What Information Is Available on Selection, Design, Specification, and Deployment of Silt Curtains? Several types of guidelines are used to select, design, and deploy silt curtains for dredging projects. Guidelines available for silt curtains are contained in several technical and regulatory resource documents. Table 1 is a listing of technical guidelines and best management practices. Typically, topics covered include planning considerations (site-specific project conditions), design criteria, construction specifications (curtains and other materials), installation or deployment, removal, and maintenance. A notable exception is monitoring of curtain performance.

Selecting which guide or best management practice to follow depends on particular project requirements, site locations, and the type of silt curtain specification needed (i.e., performance of product). Table 2 is an example of the minimum recommended specification for a silt curtain (originally developed by JBF Scientific Corporation (1978)) that has been updated by a silt curtain manufacturer to reflect 2002 conditions.

What Should Be Done to Properly Select and Use a Silt Curtain? Table 3 is a checklist for selecting and applying silt curtains. The purpose of the checklist is to prompt the designer or reviewer to consider various critical aspects of selection, designation, and installation of silt curtains for typical dredging projects. However, the checklist should be considered as an aid and not be used as a specification requirement. The selection and use of silt curtains is extremely site-specific and requires both knowledge and practical experience for successful applications.

What Are Some "Lessons learned" Regarding Selection, Design, and Deployments of Silt Curtains? Silt curtains should be selected, designed, and installed to meet permit and water quality certification requirements where applicable.

- Very few silt curtain applications are alike. Each is unique and requires site-specific application and adaptation.
- Silt curtains should be designed to pass water either under or through their walls. Curtains are designed to confine suspended sediment and to allow it to settle or be filtered, not to impede the movement of water.

Table 1
Sources of Technical Guidelines on Silt Curtains

Source	Reference
Technical Reports	
US Army Corps of Engineers Exchange Bulletin Article	JBF Scientific Corporation. 1977. "Application and Performance of Silt Curtains," DMRP Work Unit 6C06, Dredged Material Research Exchange Bulletin Article - Vol. D-77-10, pp. 2-8.
Technical Report D-78-39	JBF Scientific Corporation. 1978. "An Analysis of the Functional Capabilities and Performance of Silt Curtains," Prepared for U.S. Army Engineer Waterways Experiment Station. Technical Report D-78-39. NTIS No. AD-A060 382
Manuals	
EM 1110-2-5025	USACE, "Dredging and Dredged Material Disposal," March 1983. p. 3-34
EM 1110-2-1614, 30 Jun 95	USACE, "Design of Coastal Revetments, Seawalls and Bulkheads," Chapter 6, Environmental Impacts, 6-3. Water Quality Impacts
EPA 905-B94-003	USEPA, "Great Lakes Contaminated Sediments: ARCS Remediation Guidance Document- Chapter 4 [EPA-905-B94-003]
Army TM 5-818-8/Air Force AFJMAN 32-1030-July 20, 1995	CEMP, "Engineering Use of Geotextiles," 20 Jul 95
Best Management Practices	
Section 404 (b)(1) Guidelines	Part 230.73: Section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material, Subpart H, Actions to Minimize Adverse Effects –Actions affecting the method of dispersion.
BMP – Turbidity Curtains	King County Courthouse, 516 Third Avenue, Seattle, WA 98104
EMP No. 0-16	AAPA, "Environmental Management Practices Activity: Dredging and Dredge Material Disposal (EMP No. 0-16)
Manufacturer's Guide	
Turbidity Curtain Selection Guide	Elastec/American Marine, Inc., 401 Shearer Blvd., Cocoa, Florida 32922
Turbidity Barrier Guide	ABBCO/American Boom & Barrier Corp., 7077 N. Atlantic Avenue Cape Canaveral, Florida 32920
Turbidity Screens	Section IV-6 - Final Construction and Contract Specifications, New Cut Dune/Marsh Restoration Project, Federal Project No. TE-37, Terrebonne Parish, Louisiana, June 2001

Table 2
Recommended Silt Curtain Specifications[1,2]

Parameter	Recommended Value
Skirt Depth	Up to 100 ft maximum allowing 1-2 ft clearance between skirt and bottom
Fabric	
Tensile strength grab	500 lb/in.
Tear strength strip 18 oz 22 oz	 320 lb – quiescent conditions 400 lb – medium to high current
Abrasion resistance	200 lb/in. tensile strength after abrasion
Material	Polyester
Coating	PVC
Weight	18-22 oz (depending on type of curtain design)
Seams	Heat sealed
Buoyancy	
Ratio	>5
Type	Solid, closed cell, and enclosed in a fabric pocket
Connector	Load transfer type – aluminum extrusion
Ballast	
Type	Noncorrosive galvanized chain
Weight	See Figures 16 and 17
Tension Member	
No current	Fabric only
Current (0.1-1.0 knots	Top or center tension; center tension provides slightly greater effective skirt depth

[1] In 2002, a 100-ft section of silt curtain with top tension member to the above specifications and a skirt depth of 5 ft could be purchased at an approximate cost of $1,100.00.

[2] Source: Elastic/American Marine, 401 Shearer Blvd., Cocoa, FL 32922 USA, Tel: 321-636-5783, Fax: 321-636-5787, E-mail: jpearce@wlastec.com, www.elastec.com.

Table 3
Checklist for Selection and Application of Silt Curtains

1) **Pre-dredging Site Survey –**
   a) Have background conditions at the site been established? Y__N__N/A__
   b) Has the site been adequately characterized with respect to Y__N__N/A__
      i) Current velocity, water depth (relative to tidal range)? Y__N__N/A__
      ii) Bottom sediment types? Y__N__N/A__
      iii) Background levels of turbidity? Y__N__N/A__

(Sheet 1 of 4)

Table 3 (Continued)

2)	**Deployment –**	
a)	Have maximum surface currents over a tidal cycle (12 or 24 hr) been established first to determine types of deployment configurations that may be needed?	Y__N__N/A__
b)	Have direction of current and water turbulence been defined?	Y__N__N/A__
c)	Have the minimum water depths been established at the lowest low tide?	Y__N__N/A__
d)	Has a minimum 0.5-m skirt depth been established between the lower edge of the skirt and the existing bottom of the disposal area at the lowest low tide during the operations?	Y__N__N/A__
e)	Have the effects of fluid mud accumulation on water depth as well as the proposed schedule for moving the silt curtain to prevent burial been considered when selecting the curtain skirt depth?	Y__N__N/A__
f)	Is the character of the bottom sediment/vegetation known?	Y__N__N/A__
g)	Have traffic- and boat-generated waves been determined?	Y__N__N/A__
h)	Are locations of launching ramps, crane services, etc. known?	Y__N__N/A__
i)	Have deployment geometry and configurations been determined for the site?	Y__N__N/A__
j)	Have curtain deployment lengths been established?	Y__N__N/A__
k)	Have different anchor types been considered?	Y__N__N/A__
l)	Have different curtain configurations been considered (e.g., U, V, circular, elliptical)?	Y__N__N/A__
3)	**Silt Curtain Specifications –**	
a)	Does the lower edge of the silt curtain extend a minimum of 0.5 m from the bottom at lower tide?	Y__N__N/A_
b)	Is skirt depth less than the recommended 3 m?	Y__N__N/A__
c)	Has fabric material been selected (PVC or equivalent) with a minimum tensile strength of 525 N/m?	Y__N__N/A__
d)	Has the fabric weight (minimum of 610 g/m^2 for low current conditions, and 746-g/m^2 for high current conditions) been designated?	Y__N__N/A__
e)	Has a tear strength (min of 445 for 610-g fabric or 890 N for 746-g fabric been designated?	Y__N__N/A__
f)	Has a tensile strength after abrasion (greater than 350 N/m) been designated?	Y__N__N/A__
g)	Has a material been selected that is easily cleaned and resistant to marine growth, ultraviolet light, and mildew?	Y__N__N/A__
h)	Are all fabric seams heat-sealed or equivalent?	Y__N__N/A__
i)	Has flotation been designated as sections of solid, closed-cell, plastic foam flotation material sealed into a fabric pocket that provide a buoyancy ratio (buoyant force/curtain weight) greater than 5?	Y__N__N/A__
j)	Is each flotation segment a minimum of 3 m in length so the curtain may be easily folded for storage or transport?	Y__N__N/A__
k)	Do connectors in low currents (<0.1 knot) maintain adequate physical contact along the entire skirt joint?	Y__N__N/A__

(Sheet 2 of 4)

Table 3 (Continued)

3) Silt Curtain Specifications – (continued)	
l) Have aluminum extrusion (or equivalent) load-transfer connectors been designated for current velocities exceeding 0.1 knot?	Y__N__N/A__
m) Have non-corrosive ballast chains with a weight ranging from approximately 1.5 kg/m for a 1.5-m skirt depth up to 3.0 kg/m for a 3-m skirt depth been selected?	Y__N__N/A__
n) Are tension members used as follows:	
i) Negligible current: no tension member?	Y__N__N/A__
ii) Current velocities between 0.1 and 1.0 knot?	Y__N__N/A__
iii) Galvanized or stainless steel wire rope as top or center tension member?	Y__N__N/A__
o) Have handholds been designated along the top of the curtain between the flotation segments for ease in handling?	Y__N__N/A__
p) Have repair kits been designated to patch minor tears in the fabric?	Y__N__N/A__
4) Transportation –	
a) Have furls (lightweight straps or rope) been specified every 1 to 1.5 m from storage to unloading site?	Y__N__N/A__
b) Has curtain been specified to be compactly folded accordion style, packaged into large bundles, and carefully lifted into transportation vehicle?	Y__N__N/A__
c) Will curtains be unloaded like a string of sausages and connected in appropriate sections (up to 30 m) as they are played out of the vehicle?	Y__N__N/A__
d) Will curtains be towed by boat (traveling at 2 to 3 knots) to the deployment site?	Y__N__N/A__
e) Will the curtain be kept furled except near the end of the connectors until it has been deployed at the site?	Y__N__N/A__
5) Mooring –	
a) Has the recommended mooring system consisting of an anchor, chain, an anchor rode (line or cable), and mooring and crown buoys been designated?	Y__N__N/A__
b) Has the anchor pattern been designated based on the curtain deployment geometry site conditions (e.g., from section joints every 30 m in a radial pattern and on both sides if the curtain is exposed to reversing tidal currents)?	Y__N__N/A__
c) Have sizes (e.g., ½ -inch etc.) of anchor lines and anchor weights (e.g., 4.5 kg for sandy bottoms and up to 34 kg for firm mud) been selected based on bottom conditions.?	Y__N__N/A__

(Sheet 3 of 4)

Table 3 (Concluded)

6) Deployment Model –	
a) Has the length of time for deployment before reconfiguration or movement been determined based on accumulation of fluid mud inside the curtain relative to the deployment geometry, the discharge (filling) rate, and the initial bottom gap (i.e., the distance between the lower skirt edge and the bottom sediment at the beginning of the operation)?	Y__N__N/A__
b) Is the total length of the curtain available for the project adequate for the size of the enclosure?	Y__N__N/A__
7) Maintenance –	
Has adequate attention been given to	
a) Moving the curtain away from the turbidity sources just before the fluid mud layer reaches the lower edge of the skirt?	Y__N__N/A__
b) Replacing worn or broken anchor lines?	Y__N__N/A__
c) Maintaining the integrity of the curtain by repairing leaking connectors and / or tears in the curtain fabric?	Y__N__N/A__
d) Repairing tears in the flotation pocket with hand-type pop rivet gun and rivets?	Y__N__N/A__
e) Repairing moderate tears in skirts on land with vinyl/nylon repair kit and VINYLFIX or PVC glue?	Y__N__N/A__
f) Keeping one or two spare sections of curtain for immediate replacement of unrepairable sections onsite?	Y__N__N/A__
8) Recovery –	
a) Will silt curtains be refurled after operations are completed?	Y__N__N/A__
b) Will anchor/mooring systems be recovered?	Y__N__N/A__
c) Will the curtains be returned to the launching site for repacking and subsequent storage?	Y__N__N/A__
9) Monitoring –	
a) Have plans been made for monitoring during dredging operations?	Y__N__N/A__
b) Will measurements of turbidity (NTU) and samples for TSS (mg/L) be taken on both sides of the silt curtain near the dredging operations and near any sensitive habitat?	Y__N__N/A__
c) Will tide, wind, wave, and current measurements be made?	Y__N__N/A__
d) Are there plans to monitor post-dredging operations with respect to limited measurements of current, tidal range, winds, turbidity (NTU), and samples for TSS (mg/L) for comparison with background conditions?	Y__N__N/A__

(Sheet 4 of 4)

- In applications where the curtain will be extended to the bottom of the waterway in tidal or moving water conditions, a heavy woven permeable filter fabric or tide flaps should be designed into the curtain to relieve pressure on the curtain wall.
- In general, silt curtains should be used on slow to moderate currents, stable water levels, and relatively shallow water depths.

- Currents greater than 1 to 1-1/2 knots are problematic, leading to difficult and often expensive curtain designs. Silt curtains should not be used in current velocities greater than 3-5 knots unless there are unusual circumstances and special designs are considered. Curtain deployments for deep, fast-flowing water and windy conditions require customized designs. However, for all practical purposes, the 1 to 1-1/2 knot value appears to be an industry standard.
- In slow currents, resuspension and turbidity are localized, so a fundamental question is whether or not a silt curtain is even necessary.
- In high currents where sediment plumes disperse rapidly, silt curtains are very difficult to maintain properly and can easily become dysfunctional.
- In all but the slowest current flows, curtains will "billow out" in the downstream direction, allowing water to pass beneath the curtain, thereby reducing the effective skirt depth.
- Extra length (up to 10-20 percent) and depth (slack) of curtains should be included in designs to allow for tidal fluctuations and exchanges of water within the curtain.
- Special designs may be required for applications of curtains at depths greater than 10-15 ft or with currents exceeding 1-1/2 knots, particularly in tidal waters. At greater depths, loads or pressures on curtains and mooring systems become excessive and could result in failure of standard construction materials.
- High winds can lift large curtains out of the water like a sail.
- Curtains can sink due to excessive biological fouling on the fabric.
- An attempt should be made to minimize the number of joints in the curtain; a minimum continuous span of 15 m (50 ft) between joints is a "good rule of thumb."
- Curtains should be a bright color (yellow or "international" orange are recommended) to enhance visibility for boaters.
- In tidal situations, where currents move in both directions, it is important to attach anchors on both sides of the curtain to hold the curtain in place and to not allow it to overrun the anchors and pull them out when the tide reverses.
- Anchor lines should be attached to the flotation device, not to the bottom of the curtain.
- Care should be taken during removal of silt curtains to avoid or minimize resuspension of settled solids.
- Removal of settled solids trapped by the silt curtain is optional and should only be considered if the resulting bottom contour elevation is significantly altered.
- When dredging contaminated sediment, installing silt curtains within continuous or intermittent sheetpile walls to provide anchoring points has proven to be more effective than using silt curtains alone.
- Silt curtains can be effective in containing floating debris, but not always in containing contamination. Soluble contaminants, particularly heavy metals, can flow through, around, or under the curtain.
- Aquatic habitat can be successfully protected with deflection curtains provided they are properly designed and deployed, taking into consideration site-specific conditions.
- Designs should conform to relevant contract specifications and manufacturer recommendations and guidelines for installation and safety measures.

- Silt curtains should not be considered a "one solution fits all" type of best management practice. They are highly specialized, temporary-use devices that should be selected only after careful evaluation of the intended function and designed based upon a detailed knowledge of the site where they will be used.

SUMMARY: The term "*silt curtain*" is used to describe devices deployed in water to control suspended solids or turbidity resulting from dredging operations. Almost every silt curtain application has unique features that require site-specific adaptations. Several sources of published technical guidelines and best management practices are identified and referenced in this note. Typical topics covered in these guides include planning considerations (site-specific project conditions), design criteria, construction specifications (curtains and other materials), installation or deployment, removal, and maintenance. A notable exception is monitoring of silt curtain performance.

For cost considerations, logistical constraints, and performance expectations, prevailing current velocities of 1 to 1-1/2 knots effectively limit deployments, with exceptions on a case-by-case basis. Unfortunately, few comprehensive studies are published on the actual performance of silt curtains under varying project conditions. Additional monitoring studies will be required to properly document the functional characteristics and incremental costs of silt curtains under demanding project conditions of moderate to high currents, winds, and waves.

Silt curtains should not be considered a "one solution fits all" type of best management practice. They are highly specialized, temporary-use devices that should be selected only after careful evaluation of the intended function and designed based on a detailed knowledge of the site where they will be used.

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> Francingues, N. R., and Palermo, M. R. (2005). "Silt curtains as a dredging project management practice," *DOER Technical Notes Collection* (ERDC TN-DOER-E21). U.S. Army Engineer Research and Development Center, Vicksburg, MS. http://el.erdc.usace.army.mil/dots/doer/doer.html.

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Referenced in Section 4.1

Santee Cooper undated. *Site/Routing Procedures.* Moncks Corner, South Carolina.

Referenced in Section 4.1

Santee Cooper 1996. Transmission Line Standards Reference Manual, Section 3, Transmission Line Location, Engineering Survey, and Right-of-Way Activities. Moncks Corner, South Carolina, June 1, 1996

Sec 4.3 Ref 7

D H E C

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South Carolina Department of Health and Environmental Control

SCEG-507

SOUTH CAROLINA

STORMWATER MANAGEMENT

AND SEDIMENT CONTROL HANDBOOK

FOR LAND DISTURBANCE ACTIVITIES

AUGUST 2003

SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL
ENVIRONMENTAL QUALITY CONTROL

BUREAU OF WATER
OFFICE OF OCEAN AND COASTAL RESOURCE MANAGEMENT

(rev. 08/03)

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APPENDICES:

S. C. DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL
STORMWATER MANAGEMENT AND SEDIMENT REDUCTION HANDBOOK

I. Synopsis:

This handbook is a compilation of existing South Carolina stormwater management regulations and supporting information that applicants will need to proceed through the land disturbance permitting process. The objective of this document is to create a comprehensive reference for individuals who will be submitting a stormwater management and sediment reduction permit application for approval to the Department of Health and Environmental Control (DHEC). This handbook summarizes the application process and sets forth the minimum standards and design specifications for land disturbing activities that require stormwater permits. The supporting information includes sediment control design aides and other useful information. This document references pertinent sections from the S. C. Stormwater Management and Sediment Reduction regulations, the NPDES General Permit for Stormwater Discharges from Construction Activities and the Coastal Zone Management Program Refinements which are included as appendices.

II. Scope:

A stormwater management plan in compliance with the requirements of existing regulations must be submitted for most land disturbing activities in South Carolina. Appendix A contains a copy of the S. C. Stormwater Management and Sediment Reduction regulations. The DHEC Office of Ocean and Coastal Resource Management (OCRM), formerly the S. C. Coastal Council, administers the stormwater management program in the following eight coastal counties: Beaufort, Berkeley, Charleston, Colleton, Dorchester, Georgetown, Horry, and Jasper. The stormwater permitting program for the rest of the state is implemented by DHEC's Bureau of Water, which now includes parts of the former Land Resources Conservation Commission.

III. Projects Requiring Permits:

All land disturbing activities in the state that will disturb greater than two (2) acres that are not specifically exempt require a stormwater management and sediment and erosion control permit prior to construction. In the eight (8) coastal counties, if the activity is within one-half (1/2) mile of a receiving waterbody, projects disturbing two (2) acres or less must also obtain a land disturbance permit (see next section). If the activity involves one (1) or more acres of land disturbance, it will also require NPDES General Permit coverage.

IV. Permit Applicability:

Specific requirements of the permit application and approval process are based on the amount of actual land disturbance and, if the activity is in the Coastal Zone, the project's proximity to a receiving waterbody. The permit application procedure is as follows:

(1) **For activities involving less than one (1) acre of actual land disturbance** and which are not part of a larger common plan of development or sale, the person responsible for the activity shall submit a simplified stormwater management and sediment control plan meeting the requirements of R.72-307H in Appendix A and the appropriate reporting form. This plan does <u>not</u> require approval by the Department of Health and Environmental Control and does <u>not</u> require preparation or certification by a registered engineer, landscape architect, or Tier B land surveyor. The DHEC staff does have the authority to conduct site inspections on these projects to insure compliance with the submitted plans.

(2) **For activities involving at least one (1) acre (and less than one (1) acre in certain cases) but two (2) acres or less of actual land disturbance** and which are not part of a larger common plan of development or sale, the person responsible for the activity shall submit a simplified stormwater management and sediment control plan meeting the requirements of R.72-307H in Appendix A and the appropriate reporting form. The applicant is also responsible for meeting the requirements of the NPDES General Permit SCR100000. This

plan does not normally require approval by the Department of Health and Environmental Control but does need to be prepared by a qualified individual. The Department has the right to require additional information on a case-by-case basis.

(3) **For activities involving two (2) acres or less of actual land disturbance which are within one-half (1/2) mile of a receiving waterbody in the Coastal Zone.** The Coastal Zone Management Program Refinements (Appendix B) state that "stormwater management and sediment reduction plan submittal and regulatory approval shall be required for those smaller projects located within 1/2 mile of a receiving waterbody." Particular emphasis shall be placed on the following projects in this category:

(a) All commercial buildings which will handle hazardous chemicals (including gasoline, kerosene, diesel fuel, nutrients, etc.).

(b) All commercial buildings and parking/runway areas with greater than one (1) acre of impervious surface (building and parking).

(c) All commercial buildings and parking/runway areas with greater than one-half (1/2) acre of impervious surface located directly adjacent to a saltwater (critical) area.

(d) All residential subdivision developments located directly adjacent to a saltwater (critical) area.

(e) All projects impacting Geographical Areas Of Particular Concern (GAPC's).

These activities (a-e) must meet the requirements of R.72-307I in Appendix A and must have the plans and specifications prepared by a registered engineer, landscape architect or Tier B land surveyor. Other activities in this category require a permit but must only meet the submittal requirements of R.72-307H which do not require preparation by a licensed professional. If an activity falls into this category and the actual land disturbance is greater than or equal to one (1) acre (or less than one (1) acre in certain cases), the requirements of the NPDES General Permit SCR100000 also apply as outlined above in item (2).

(4) **For activities involving more than two (2) acres of actual land disturbance** which are not part of a larger common plan of development or sale, the requirements of R.72-305 and R.72-307 from Appendix A and the requirements of the NPDES General Permit SCR100000 apply. Plans and specifications for these activities will be prepared by professional engineers, landscape architects or Tier B land surveyors.

Additional design requirements for certain projects in the Coastal Zone as adopted in the Coastal Zone Management Program Refinements are contained in Appendix B. These requirements address design needs for activities located in close proximity to receiving waterbodies, bridge projects, golf courses, mines and landfills.

V. Application Forms and Checklists:

All the necessary application forms must be submitted in order to complete a review of the submittal. Checklists and application forms may be found on the website at www.scdhec.net.

VI. Plan Submittal:

The responsible agent should do a preliminary analysis to determine which of the different categories a project would fall under and then submit the appropriate application form and information required on the checklist. The initial submittal package should include only one (1) paper copy of the stormwater management and sediment reduction plans and corresponding calculations. After the plans have been reviewed to determine compliance with the regulations, the DHEC plan reviewer will contact the applicant/engineer and request necessary changes or notify the individual that the plans are in compliance. When the plans have been determined to be in compliance then the applicant/engineer shall send four (4) additional paper copies for stamp approval. One copy of the plans is for the engineer/agent, one is for the owner, one is for the contractor and **must be available onsite at all times** and one copy is for the DHEC inspector.

VII. NPDES General Permit Coverage

Any construction project disturbing one (1) acre or greater (or less than one (1) acre in certain cases) must obtain either NPDES general permit coverage or an individual NPDES permit. NPDES General Permit coverage under SCR100000 can be obtained by the above referenced submittal information including application form # 3306 (9/94 or later), plans and specifications. Therefore, application form # 3306 (9/94 or later) shall serve as the Notice Of Intent (NOI) for NPDES general permit coverage for most land disturbance activities.

If a project has a disturbed acreage of one (1) acre or more and is exempt from the requirements of Title 48 Chapter 14 by Section 40 and by R.72-302 but not exempt from the requirements of 40 CFR 122 and SCR100000, then the EPA Notice of Intent (NOI) must be submitted. Filing this form guarantees that a Pollution Prevention Plan (PPP) has been developed and will be maintained on site.

The S. C. Department of Transportation (SCDOT) must comply with SCR100000 and Regulation 72-400. All Department of Transportation projects are required to file the EPA Notice of Intent (NOI) form at least 48 hours prior to start of construction. A copy of the plans developed in compliance with R.72-400 must be submitted at the time the contract is awarded.

VIII. Notification of Initiation of Land Disturbance Activity

Notification shall be sent to the appropriate DHEC plan review office with carbon copies to the local DHEC district offices prior to initiation of the land disturbing activity. A list of the DHEC District offices is included in the front of this handbook. Prior to completion of the project, a final inspection may be requested from the appropriate DHEC district or OCRM office.

IX. Design Guidelines For Sediment/Erosion Control

The stormwater management regulations require that when stormwater runoff drains to a single outlet from land disturbing activities which disturb ten (10) acres or more then a sediment basin must be designed to meet a removal efficiency of 80 percent for suspended solids or 0.5 ML/L peak settleable concentration, which ever is less. The efficiency shall be calculated for disturbed conditions for the 10-year 24-hour design event. There are computer software packages available that can be used to calculate the removal efficiencies of certain sediment control practices. In addition, Appendix C contains a report titled "Engineering Aids and Design Guidelines for Control of Sediment in South Carolina" which can be referenced when calculating sediment removal efficiencies.

Activities that have between five (5) and ten (10) acres of land disturbance area draining to a single outlet may incorporate other practices besides a sediment basin to achieve the equivalent removal efficiency of 80 percent for suspended solids or 0.5 ML/L peak settleable solids concentration. Specific site conditions and/or topography may eliminate the need for removal efficiency calculations. Construction activities that disturb less than five (5) acres do not require sediment calculations but the design of these projects must include sediment control best management practices during construction.

X. Rainfall Data for South Carolina

Appendix D contains rainfall data and rainfall-erosivity factors (R factors) for all South Carolina counties to be used in hydrology and sedimentology calculations.

XI. Fees:

A review fee of one hundred (100) dollars per disturbed acre up to a maximum of $2000 is required for all land disturbance activities over two (2) acres. There is no review fee charged for government activities (local, state, and federal) or for projects that disturb two (2) acres or less. An application for a waiver or a

variance must include a $100 fee. In order to estimate the area of land disturbance for subdivisions without exact build out plans, use the following formula:

Amount of Disturbance = 2[Max Restricted Building Size][Number of Lots] + ROW areas

Right of Way (ROW) areas include clearing for roads, utilities, easements etc.

There is an additional $125 fee for all projects that will disturb one (1) acre or more and must therefore obtain NPDES general permit coverage. There are no exemptions from this fee so local governments, schools and other entities that are exempt from the $100/disturbed acre review fee must submit this fee as part of their land disturbance package. If coverages are no longer necessary (i.e. site is stabilized), a Notice of Termination (NOT) must be filed to stop the coverage. All coverages under the General Permit SCR100000 must pay the $125 to begin coverage.

XII. Inspections:

The DHEC staff will conduct periodic site inspections on all land disturbing activities. The person responsible for the land disturbing activity shall notify the appropriate inspection agency before initiation of construction and upon project completion when a final inspection will be conducted to ensure compliance with the approved stormwater management and sediment control plan. DHEC or any other responsible inspection agency shall, for inspection purposes, do all of the following items:

(1) Ensure that the approved stormwater management and sediment control plans are on the project site and are complied with;

(2) Ensure that every active site is inspected for compliance with the approved plan on a regular basis;

(3) Provide the person responsible for the land disturbing activity a written report after every inspection.

(4) Notify the person responsible for the land disturbing activity in writing when violations are observed, describing the:

(a) Nature of the violation;

(b) Required corrective action; and

(c) Time period for violation correction.

XIII. Violations and Enforcement:

Violations of the stormwater regulations will occur when (a) a site with an approved stormwater permit is not in compliance with the issued permit or (b) a land disturbing activity is underway and the agent has not acquired the necessary permit. Enforcement procedures will vary according to the severity of the violation but might include imposing fines or issuing cease and desist orders. Violations of the S. C. Pollution Control Act as prescribed by SCR100000 may subject the applicant to a civil penalty of up to $10,000 per violation per day. Additional information on enforcement procedures is contained in Section 72-312 of Appendix A.

XIV. Best Management Practices (BMPs):

Appendix E contains a table of some of the stormwater management and sediment reduction best management practices (BMPs) used in South Carolina. The existing conditions determined from site surveys will aid in selecting the most effective BMPs to use when designing a plan for permit submittal. Additional methods of stormwater management and sediment control can be found in "A Guide to Site Development and Best Management Practices for Stormwater Management and Sediment Control" distributed by the Department.

APPENDIX A

S. C. STORMWATER MANAGEMENT AND SEDIMENT REDUCTION REGULATIONS

FINAL REGULATIONS

LAND RESOURCES CONSERVATION COMMISSION

CHAPTER 72

Statutory Authority: 1976 Code, Title 48, Chapter 14

72-300 Standards for Stormwater Management and Sediment Reduction

Synopsis:

These proposed regulations pursuant to the Stormwater Management and Sediment Reduction Act of 1991 establish the procedure and minimum standards for a statewide uniform program for stormwater management and sediment reduction with the option of being operated locally. The regulations establish the procedure for local governments or conservation districts to apply for program component delegation. They also establish the criteria to be met for delegation. Minimum standards and specifications are established for land disturbing activities that require a permit.

The proposed regulations encourage management of stormwater and sediment on a watershed basis. Criteria and procedures are established for designating watersheds and creating stormwater utilities.

When the law becomes effective, it will be implemented in a phased approach as listed in the regulations.

Instructions:

New regulations added.

Text:

72-300. Scope.

72-301. Definitions.

72-302. Exemptions, Waivers and Variances from Law.

72-303. Commission Responsibilities.

72-304. Criteria for Delegation/Revocation of Programs.

72-305. Permit Application and Approval Process.

72-306. Fees.

72-307. Specific Design Criteria, Minimum Standards and Specifications.

72-308. Maintenance Requirements and Off-Site Damage Correction.

72-309. Criteria for Designated Watersheds.

72-310. Criteria for Implementation of a Stormwater Utility.

72-311. Plan Review and Inspector Certification Program.

72-312. Review and Enforcement Requirements.

72-313. Hearings and Hearings Procedures.

72-314. Citizen Complaint Procedure on Delegated Program Components and Individual Sites.

72-315. Penalties.

72-316. Severability.

72-300. Scope.

A. Stormwater runoff is a source of pollution of waters of the State, and may add to existing flooding problems. The implementation of a statewide stormwater management and sediment control program will help prevent additional water quantity and quality problems and may reduce existing problems.

B. Stormwater management and sediment control plan approvals are necessary prior to engaging in any land disturbing activity related to residential, commercial, industrial or institutional land use which are not specifically exempted or waived by these regulations.

C. To the extent possible, the Commission intends to delegate the provisions of these regulations to local governments. Those program provisions which are subject to delegation include stormwater management and sediment control plan approval, construction and maintenance inspections, enforcement, and education and training.

D. The Commission encourages the implementation of the Stormwater Management and Sediment Reduction Act on a watershed basis by local governments. The Commission recognizes that all jurisdictions may not have the resources available to implement this type of program immediately. However, the comprehensive approach of implementing the program on the watershed basis will allow for planned, orderly development in a watershed.

E. The implementation of a stormwater utility represents a comprehensive approach to program funding and implementation. The activities which may be undertaken by a stormwater utility include not only assessment, collection, and funding activities, but also carrying out provisions of adopted stormwater management plans. These provisions may include contracting for such services as project construction, project maintenance, project inspection, and enforcement of installation and maintenance requirements imposed with respect to approved land disturbing activities.

72-301. Definitions.

As used in these regulations, the following terms shall have the meanings indicated below:

1. "Adverse Impact" means a significant negative impact to land, water and associated resources resulting from a land disturbing activity. The negative impact includes increased risk of flooding; degradation of water quality; increased sedimentation; reduced groundwater recharge; negative impacts on aquatic organisms; negative impacts on wildlife and other resources; and threatened public health.

2. "Applicant" means a person, firm, or governmental agency who executes the necessary forms to obtain approval or a permit for a land disturbing activity.

3. "Appropriate Plan Approval Agency" means the Commission, Local Government, or Conservation District that is responsible in a jurisdiction for review and approval of stormwater management and sediment control plans.

4. "As-Built Plans or Record Documents" means a set of engineering or site drawings that delineate the specific permitted stormwater management facility as actually constructed.

5. "Best Management Practices" means a wide range of management procedures, schedules of activities, prohibitions on practices and other management practices which have been demonstrated to effectively control the quality and/or quantity of stormwater runoff and which are compatible with the planned land use.

6. "Certified Construction Inspector" means a person with the responsibility for conducting inspections during construction and maintenance inspections after the land disturbing activity is completed as certified by the Commission.

7. "Certified Plan Reviewer" means a person with the responsibility for reviewing stormwater management and sediment control plans for an appropriate plan approval agency as certified by the Commission.

8. "Commission" means the South Carolina Land Resources Conservation Commission.

9. "Delegation" means the acceptance of responsibility by a Local Government or Conservation District for the implementation of one or more elements of the statewide stormwater management and sediment control program.

10. "Designated Watershed" means a watershed designated by a local government and approved by the Commission, Department of Health and Environmental Control and the South Carolina Water Resources Commission and identified as having an existing or potential stormwater, sediment control, or nonpoint source pollution problem.

11. "Detention Structure" means a permanent stormwater management structure whose primary purpose is to temporarily store stormwater runoff and release the stored runoff at controlled rates.

12. "Develop Land" means to change the runoff characteristics of a parcel of land in conjunction with residential, commercial, industrial, or institutional construction or alteration.

13. "Developer" means a person undertaking, or for whose benefit, activities covered by these regulations are commenced and/or carried out.

14. "District" means any soil and water conservation district created pursuant to Chapter 9, Title 48, S.C. Code of Laws.

15. "Drainage Area" means that area contributing runoff to a single point.

16. "Easement" means a grant or reservation by the owner of land for the use of such land by others for a specific purpose or purposes, and which must be included in the conveyance of land affected by such easement.

17. "Erosion" means the wearing away of land surface by the action of wind, water, gravity, ice, or any combination of those forces.

18. "Erosion and Sediment Control" means the control of solid material, both mineral and organic, during a land disturbing activity to prevent its transport out of the disturbed area by means of air, water, gravity, or ice.

19. "Exemption" means those land disturbing activities that are not subject to the sediment and stormwater requirements contained in these regulations.

20. "Grading" means excavating, filling (including hydraulic fill) or stockpiling of earth material, or any combination thereof, including the land in its excavated or filled condition.

21. "Implementing Agency" means the Commission, local government, or conservation district with the responsibility for receiving stormwater management and sediment control plans for review and approval, reviewing plans, issuing permits for land disturbing activities, or conducting inspections and enforcement actions in a specified jurisdiction.

22. "Infiltration" means the passage or movement of water through the soil profile.

23. "Land Disturbing Activity" means any use of the land by any person that results in a change in the natural cover or topography that may cause erosion and contribute to sediment and alter the quality and quantity of stormwater runoff.

24. "Natural Waterways" means waterways that are part of the natural topography. They usually maintain a continuous or seasonal flow during the year and are characterized as being irregular in cross-section with a meandering course. Construction channels such as drainage ditches shall not be considered natural waterways.

25. "Nonerodible" means a material, e.g., natural rock, riprap, concrete, plastic, etc., that will not experience surface wear due to natural forces of wind, water, ice, gravity or a combination of those forces.

26. "Local Government" means any county, municipality, or any combination of counties or

municipalities, acting through a joint program pursuant to the provisions of this chapter.

27. "Nonpoint Source Pollution" means pollution contained in stormwater runoff from ill-defined, diffuse sources.

28. "One Hundred Year Frequency Storm" means a storm that is capable of producing rainfall expected to be equaled or exceeded on the average of once in 100 years. It also may be expressed as an exceedence probability with a 1 percent chance of being equaled or exceeded in any given year.

29. "Person" means any State or federal agency, individual, partnership, firm, association, joint venture, public or private corporation, trust, estate, commission, board, public or private institution, utility, cooperative, municipality or other political subdivision of this State, any interstate body or any other legal entity.

30. "Person Responsible for the Land Disturbing Activity" means
    (a) the person who has or represents having financial or operational control over the land disturbing activity; and/or
    (b) the landowner or person in possession or control of the land who directly or indirectly allowed the land disturbing activity or has benefitted from it or who has failed to comply with any provision of the act, these regulations, or any order or local ordinance adopted pursuant to this act as imposes a duty upon him.

31. "Post-Development" means the conditions which exist following the completion of the land disturbing activity in terms of topography, vegetation, land use and rate, volume or direction stormwater runoff.

32. "Pre-Development" means the conditions which existed prior to the initiation of the land disturbing activity in terms of topography, vegetation, land use and rate, volume or direction of stormwater runoff.

33. "Redevelopment" means a land disturbance activity that alters the current use of the land but does not necessarily alter the pre-development runoff characteristics.

34. "Responsible Personnel" means any foreman, superintendent, or similar individual who is the on-site person in charge of land disturbing activities.

35. "Retention Structure" means a permanent structure whose primary purpose is to permanently store a given volume of stormwater runoff. Release of the given volume is by infiltration and/or evaporation.

36. "Sediment" means solid particulate matter, both mineral and organic, that has been or is being transported by water, air, ice, or gravity from its site of origin.

37. "Single Family Residence-Separately Built" means a noncommercial dwelling that is occupied exclusively by one family and not part of a residential subdivision development.

38. "Stabilization" means the installation of vegetative or structural measures to establish a soil cover to reduce soil erosion by stormwater runoff, wind, ice and gravity.

39. "Stop Work Order" means an order directing the person responsible for the land disturbing activity to cease and desist all or any portion of the work which violates the provisions of this act.

40. "Stormwater Management" means, for:
    (a) quantitative control, a system of vegetative or structural measures, or both, that control the increased volume and rate of stormwater runoff caused by manmade changes to the land;
    (b) qualitative control, a system of vegetative, structural, or other measures that reduce or eliminate pollutants that might otherwise be carried by stormwater runoff.

41. "Stormwater Management and Sediment Control Plan" means a set of drawings, other documents, and supporting calculations submitted by a person as a prerequisite to obtaining a permit to undertake a land disturbing activity, which contains all of the information and specifications required by an implementing agency.

42. "Stormwater Runoff" means direct response of a watershed to precipitation and includes the surface

and subsurface runoff that enters a ditch, stream, storm sewer or other concentrated flow during and following the precipitation.

43. "Stormwater Utility" means an administrative organization that has been created for the purposes of planning, designing, constructing, and maintaining stormwater management, sediment control and flood control programs and projects.

44. "Subdivision", unless otherwise defined in an ordinance adopted by a local government pursuant to Section 6-7-1010, means all divisions of a tract or parcel of land into two or more lots, building sites, or other divisions, or parcels less than five acres, for the purpose, whether immediate or future, of sale, legacy, or building development, or includes all division of land involving a new street or a change in existing streets, and includes resubdivision and, where appropriate, in the context, shall relate to the process of subdividing or to the land or area subdivided.

45. "Swale" means a structural measure with a lining of grass, riprap or other materials which can function as a detention structure and convey stormwater runoff without causing erosion.

46. "Ten-Year Frequency Storm" means a storm that is capable of producing rainfall expected to be equaled or exceeded on the average of once in 10 years. It may also be expressed as an exceedence probability with a 10 percent chance of being equaled or exceeded in any given year.

47. "Twenty-Five Year Frequency Storm" means a storm that is capable of producing rainfall expected to be equaled or exceeded on the average of once in 25 years. It also may be expressed as an exceedence probability with a 4 percent chance of being equaled or exceeded in any given year.

48. "Two-Year Frequency Storm" means a storm that is capable of producing rainfall expected to be equaled or exceeded on the average of once in two years. It may also be expressed as an exceedence probability with a 50 percent chance of being equaled or exceeded in any given year.

49. "Variance" means the modification of the minimum sediment and stormwater management requirements for specific circumstances where strict adherence of the requirements would result in unnecessary hardship and not fulfill the intent of these regulations.

50. "Waiver" means the relinquishment from sediment and stormwater management requirements by the appropriate plan approval authority for a specific land disturbing activity on a case-by-case review basis.

51. "Water Quality" means those characteristics of stormwater runoff from a land disturbing activity that relate to the physical, chemical, biological, or radiological integrity of water.

52. "Water Quantity" means those characteristics of stormwater runoff that relate to the rate and volume of the stormwater runoff to downstream areas resulting from land disturbing activities.

53. "Watershed" means the drainage area contributing stormwater runoff to a single point.

54. "Watershed Master Plan" means a plan for a designated watershed that analyzes the impact of existing and future land uses and land disturbing activities in the entire watershed and includes strategies to reduce nonpoint source pollution, to manage stormwater runoff and control flooding. The plan must be developed for the entire watershed, regardless of political boundaries, and must include appropriate physical, institutional, economic and administrative data needed to justify the plan.

72-302. Exemptions, Waivers, and Variances From Law.

A. The following activities are exempt from both the sediment control and stormwater management requirements established by these regulations:

(1) Land disturbing activities on agricultural land for production of plants and animals useful to man, including but not limited to: forages and sod crops, grains and feed crops, tobacco, cotton, and peanuts; dairy animals and dairy products; poultry and poultry products; livestock, including beef

cattle, sheep, swine, horses, ponies, mules, or goats, including the breeding and grazing of these animals; bees; fur animals and aquaculture, except that the construction of an agricultural structure of one or more acres, such as broiler houses, machine sheds, repair shops and other major buildings and which require the issuance of a building permit shall require the submittal and approval of a stormwater management and sediment control plan prior to the start of the land disturbing activity.

(2) Land disturbing activities undertaken on forest land for the production and harvesting of timber and timber products.

(3) Activities undertaken by persons who are otherwise regulated by the provisions of Chapter 20 of Title 48, the South Carolina Mining Act.

(4) Construction or improvement of single family residences or their accessory buildings which are separately built and not part of multiple construction in a subdivision development.

(5) Land disturbing activities, other than activities identified in R.72-302A(6), that are conducted under another state or federal environmental permitting, licensing, or certification program where the state or federal environmental permit, license, or certification is conditioned on compliance with the minimum standards and criteria developed under this act.

(6) Any of the following land disturbing activities undertaken by any person who provides gas, electrification, or communications services, subject to the jurisdiction of the South Carolina Public Service Commission, or corporations organized and operating pursuant to Section 33-49-10 et seq.:

(a) land disturbing activities conducted pursuant to a certificate of environmental compatibility and public convenience and necessity issued pursuant to Title 58, Chapter 33, of the South Carolina Code, or land disturbing activities conducted pursuant to any other certification or authorization issued by the Public Service Commission;

(b) land disturbing activities conducted pursuant to a federal environmental permit, including Section 404 of the Federal Clean Water Act, and including permits issued by the Federal Energy Regulatory Commission;

(c) land disturbing activities associated with emergency maintenance or construction of electric, gas, or communications facilities, when necessary to restore service or when the Governor declares the area to have sustained a disaster and the actions are undertaken to protect the public from a threat to health or safety;

(d) land disturbing activities associated with routine maintenance and/or repair of electric, gas, or communications lines;

(e) land disturbing activities associated with the placement of poles for overhead distribution or transmission of electric energy or of communications services;

(f) land disturbing activities associated with placement of underground lines for distribution or transmission of electric energy or of gas or communications services; or

(g) land disturbing activities conducted by a person filing environmental reports, assessments or impact statements with the United States Department of Agriculture, Rural Electrification Administration in regard to a project.

Any person, other than a person identified in R.72-302A(6)(g) who undertakes land disturbing activities described in R.72-302A(6)(d,e,f) must file with the South Carolina Public Service Commission, in a Policy and Procedures Manual, the procedures it will follow in conducting such activities. Any person, other than a person identified in R.72-302A(6)(g), who conducts land disturbing activities described in R.72-302A(6)(b), must address the procedures it will follow in conducting the activities in the Policy and Procedures Manual filed with the South Carolina Public Service Commission to the extent that the land disturbing activities are not specifically addressed in the federal permit or permitting process. If any person, other than a person identified in R.72-302A(6)(g), does not have a Policy and Procedures Manual on file with the Public Service Commission, such manual must be filed with the Public Service Commission not later than six months after the effective date of Chapter 14, Title 48 of the 1976 Code of Laws, South Carolina.

Any person who undertakes land disturbing activities described in R.72-302A(6)(g) of this subsection shall give the same written notice to the commission as given to agencies whose permits are required for project approval by the regulations of the United States Department of Agriculture, Rural Electrification Administration.

(7) Activities relating to the routine maintenance and/or repair or rebuilding of the tracks, rights-of-way, bridges, communication facilities and other related structures and facilities of a railroad company.
(8) Activities undertaken on state-owned or managed lands that are otherwise regulated by the provisions of Chapter 18 of this title, the Erosion and Sediment Reduction Act.
(9) Activities undertaken by local governments or special purpose or public service districts relating to the repair and maintenance of existing facilities and structures.

B. Implementing agencies with responsibility for plan review and approval may grant waivers from the stormwater management requirements of these regulations for individual land disturbing activities provided that a written request is submitted by the applicant containing descriptions, drawings, and any other information that is necessary to evaluate the proposed land disturbing activity. A separate written waiver request shall be required if there are subsequent additions, extensions, or modifications which would alter the approved stormwater runoff characteristics to a land disturbing activity receiving a waiver.

(1) A project may be eligible for a waiver of stormwater management for both quantitative and qualitative control if the applicant can demonstrate that the proposed project will return the disturbed area to a pre-development runoff condition and the pre-development land use is unchanged at the conclusion of the project.
(2) A project may be eligible for a waiver or variance of stormwater management for water quantity control if the applicant can demonstrate that:
(a) The proposed project will have no significant adverse impact on the receiving natural waterway or downstream properties; or
(b) The imposition of peak control requirements for rates of stormwater runoff would aggravate downstream flooding.
(3) The implementing agency will conduct its review of the request for waiver within 10 working days. Failure of the implementing agency to act by end of the tenth working day will result in the automatic approval of the waiver.

C. The implementing agency with responsibility for plan review and approval may grant a written variance from any requirement of these regulations if there are exceptional circumstances applicable to the site such that strict adherence to the provisions of these regulations will result in unnecessary hardship and not fulfill the intent of these regulations. A written request for variance shall be provided to the plan approval agency and shall state the specific variances sought and the reasons with supporting data for their granting. The plan approval agency shall not grant a variance unless and until sufficient specific reasons justifying the variance are provided by the applicant. The implementing agency will conduct its review of the request for variance within 10 working days. Failure of the implementing agency to act by the end of the tenth working day will result in the automatic approval of the variance.

72-303. Commission Responsibilities.

A. The Commission is responsible for the implementation and supervision of the stormwater management and sediment control program which is established by Chapter 14, Title 48, S.C. Code.

B. The schedule for implementing the Stormwater Management and Sediment Control Act (48-14-10, et. seq.) has been established by the Commission as follows:

(1) These regulations are effective and applicable to all land disturbing activities of five acres and greater on October 1, 1992 regardless of program status at the local level. Local governments with existing local programs as of this date shall require that persons responsible for land disturbing activities on sites with disturbed areas of five acres or greater comply with these regulations. Local governments may request assistance from the Commission to implement these regulations on these sites. If a local government does not have a local program on October 1,

1992, the Commission and others shall function as the implementing agencies.

(2) FY 1992-1993:
Greenville, Charleston, Richland, Spartanburg, Lexington, Anderson, Horry, York, Berkeley, Aiken, Florence, Sumter, Pickens, Beaufort, Orangeburg

(3) FY 1993-1994:
Dorchester, Darlington, Greenwood, Laurens, Oconee, Lancaster, Georgetown, Cherokee, Kershaw, Chesterfield, Williamsburg, Colleton, Marion, Newberry, Chester, Union

(4) FY 1994-1995:
Marlboro, Dillon, Clarendon, Abbeville, Fairfield, Barnwell, Lee, Edgefield, Hampton, Bamberg, Saluda, Jasper, Calhoun, Allendale, McCormick

C. This schedule may be modified by the Commission due to requests from local governments to develop and implement a program prior to the scheduled implementation date. The Commission may also modify this schedule due to personnel or financial resource limitations.

D. Local governments which adopted stormwater management and/or sediment control programs prior to the effective date of these regulations may continue to administer the existing program until the scheduled implementation date for the local government.

72-304. Criteria for Delegation/Revocation of Program Elements.

A. The Commission may delegate the following components of stormwater management and sediment control programs to local governments or conservation districts as follows:

(1) Stormwater management and sediment control plan review and approval/disapproval.
(2) Inspections during construction and maintenance inspections.
(3) Enforcement.
(4) Education and training.

B. The Commission shall grant delegation of one or more program elements to any local government or conservation district seeking delegation that is found capable and meets all of the criteria set forth herein for delegation to comply with Chapter 48, Title 14, 1976 Code and these regulations.

C. Request for delegation of more than one program element may be accomplished by the submission of one request for all the elements requested. A rejection by the Commission of one element will not jeopardize delegation of other requested program elements.

D. To be considered capable of providing compliance with Chapter 14 and these regulations, applications for delegation of program elements shall contain the following requisite items:

(1) Requests for delegation of stormwater management and sediment control plan review and approval responsibility shall include the following information:
(a) Copy of enacted ordinance or program information detailing the plan approval process,
(b) Plan review check lists and plan submission requirements,
(c) Stormwater management and sediment control criteria, including waiver and variance procedures, that meet minimum standards established by these regulations,
(d) Description of personnel allocations including qualifications and experience of personnel, description of computer hardware and software resources and expected time frames for plan review which meet the requirements of R.72-305B(2) and R.72-305M, and
(e) Name of the Certified Plan Reviewer.

(2) Requests for delegation of inspection during construction and of maintenance inspection responsibility shall include the following information:
(a) Inspection and referral procedures,
(b) Time frames for inspection of active land disturbing activities,
(c) Time frames for inspection of completed stormwater management structures,
(d) Inspection forms,
(e) Description of adequate personnel allocations including qualifications and experience of

personnel,

(f) Name of Certified Construction Inspector, and

(g) Procedures and time frames for processing complaints.

(3) Request for delegation of enforcement responsibility shall include the following information:

(a) Procedure for processing violations.

(b) Description of personnel allocations involved in enforcement actions including qualifications and experience of personnel.

(c) Description of citizen complaint process.

(d) Description of applicant appeal process.

(4) Requests for delegation of education and training responsibility shall include the following information:

(a) Types of educational and training activities to be accomplished,

(b) Frequency of activities,

(c) Names and backgrounds of those individuals conducting the training, and

(d) Procedures and timetables to notify the Commission of educational programs.

E. Requests for delegation of program elements must be submitted by local governments or conservation districts within six months of the effective date of these regulations, and by January first of subsequent years if delegation is desired at a future date. The Commission shall approve, approve with modification, or deny such a request on or before April first of the year for which delegation is sought.

F. The S.C. Coastal Council shall assist the Commission in reviewing all requests for delegation of program elements from local governments in the counties of Beaufort, Berkeley, Charleston, Colleton, Dorchester, Georgetown, Jasper and Horry to ensure that the delegated program elements are consistent with the Coastal Zone Management Program.

The S.C. Coastal Council, in coordination with the Commission, will serve as the implementing agency for these regulations in the jurisdictions of the local governments which do not seek delegation of program elements in the counties of Beaufort, Berkeley, Charleston, Colleton, Dorchester, Georgetown, Horry and Jasper.

G. If the Commission denies a request for delegation, the local government or conservation district may appeal the decision of the Commission by requesting an administrative hearing within 30 days after receipt of written notification as described in R.72-313.

H. Delegation of authority for one or more program elements may be granted for a maximum time frame of three years. After three years a new application to the Commission must be made. Over the time frame for which delegation has been granted, the Commission will evaluate delegation implementation, coordinate review findings with the delegated authority, and determine if the new delegation should be granted.

I. A delegated authority may sub-delegate program elements, with Commission concurrence, to a conservation district, regional council of government or other responsible entity or agency.

J. The Commission shall maintain, and make available upon request, a listing of the current status of delegation for all jurisdictions within the State.

K. Any local government that has adopted a stormwater management and/or sediment control program prior to the effective date of these regulations may request approval of any, or all, components of its existing program within six months of the effective date of these regulations. The Commission shall give priority to the approval, approval with modification or disapproval of these requests. The local government shall continue to administer the existing program during the review process by the Commission. Efficiency and effectiveness of the existing program shall be considered in the review process.

(1) The Commission shall approve a delegation request upon determining that the implementation of the existing program by the local government equal or exceed the requirements, criteria, standards and specifications of these regulations.

(2) If the request for delegation of program components are disapproved, the local government may

appeal the decision of the Commission by requesting an administrative hearing within 30 days after receiving written notification of the disapproval as described in R.72-313.

L. If the Commission determines that a delegated program falls below acceptable standards established by these regulations, delegation may be suspended. During a period of suspension, the Commission shall be responsible for implementation of the program element. The Commission shall collect fees based on R.72-306 for use when the delegation is suspended.

The following actions may be cause for suspension if they represent a continuing pattern of action or in-action:

(1) Failure of implementing agency with the responsibility for enforcement to issue a violation in the event of off-site sediment or stormwater damage resulting from non-compliance with the approved plan.
(2) Failure of the implementing agency to assess a fine when a violation has not been corrected within the specified time frame.
(3) Failure of the implementing agency to stop work when a violation has resulted in off-site damages.
(4) Failure of the implementing agency to force compliance with an approved plan.
(5) Failure of the delegated program to comply with the provisions of its application for delegation.

M. Upon suspension of the delegation, the implementing agency has the right to file an appeal within 30 days of the notification of the suspension following procedures listed in R.72-313. The Commission shall administer the program during the appeal process.

72-305. Permit Application and Approval Process.

A. After the effective date of these regulations, unless a particular activity is exempted by these regulations, a person may not undertake a land disturbing activity without an approved stormwater management and sediment control plan from the appropriate plan approval agency that is consistent with the following items:

(1) Chapter 14, Title 48, South Carolina Code, relating to erosion and sediment control and stormwater management, and
(2) These regulations, or duly adopted county or municipal ordinances or programs that are adopted as a part of the delegation process and set minimum standards equivalent to these regulations.

B. Specific requirements of the permit application and approval process are generally based on the extent of the land disturbing activity. The permit application and approval procedure is as follows:

(1) For land disturbing activities involving two (2) acres or less of actual land disturbance which are not part of a larger common plan of development or sale, the person responsible for the land disturbing activity shall submit a simplified stormwater management and sediment control plan meeting the requirements of R.72-307H. This plan does not require approval by the implementing agency and does not require preparation or certification by the designers specified in R.72-305H and R.72-305I.
(2) For land disturbing activities involving more than two (2) acres and less than five (5) acres of actual land disturbance which are not part of a larger common plan of development or sale, a simplified permitting and approval process will be used meeting the requirements of R.72-307I. These activities are required to utilize Best Management Practices (BMP's) to control erosion and sediment and to utilize appropriate measures to control the quantity of stormwater runoff. Plans and specifications for these activities will be prepared by the designers cited in R.72-305H and R.72-305I. The implementing agency will review these submissions within a ten working day period. If action is not taken by the end of the review period, the plan will be considered approved.
(3) For land disturbing activities disturbing five (5) acres or greater, the requirements of R.72-305 and R.72-307 will apply. However, the use of measures other than ponds to achieve water quality

improvement are recommended on sites containing less than ten (10) disturbed acres. Plans and specifications for these activities will be prepared by the designers specified in R.72-305H or R.72-305I.

(4) These requirements may be modified on a case-by-case basis to address specific stormwater quantity or quality problems or to meet S.C. Coastal Council or other regulatory requirements. Requests for waivers or variances from these requirements will be made in accordance with the provisions of R.72-302.

(5) When the land disturbing activity consists of the construction of a pond, lake or reservoir which is singly built and not part of a permitted land disturbing activity, the following procedures will apply:

(a) A stormwater management and sediment control plan will not be required if the pond, lake or reservoir is permitted under the S.C. Dams and Reservoirs Safety Act or has received a Certificate of Exemption from the S.C. Dams and Reservoirs Safety Act. Best management practices should be used to minimize the impact of erosion and sediment.

(b) A stormwater management and sediment control plan will be required for the construction of all ponds, lakes or reservoirs not meeting the conditions in R.72-305B(5)(a) that otherwise meet the size requirements for stormwater management and sediment control plan approval.

C. A stormwater management and sediment control plan or an application for a waiver shall be submitted to the appropriate plan approval agency by the person responsible for the land disturbing activity for review and approval for a land disturbing activity, unless otherwise exempted. The stormwater management and sediment control plan shall contain supporting computations, drawings, and sufficient information describing the manner, location, and type of measures in which stormwater runoff will be managed from the entire land disturbing activity. The appropriate plan approval agency shall review the plan to determine compliance with the requirements of these regulations prior to approval. The approved stormwater management and sediment control plan shall serve as the basis for water quantity and water quality control on all subsequent construction.

D. All stormwater management and sediment control plans submitted for approval shall contain certification by the person responsible for the land disturbing activity that the land disturbing activity will be accomplished pursuant to the approved plan and that responsible personnel will be assigned to the project.

E. All stormwater management and sediment control plans shall contain certification by the person responsible for the land disturbing activity of the right of the Commission or implementing agency to conduct on-site inspections.

F. The stormwater and sediment management plan shall not be considered approved without the inclusion of an approval stamp with a signature and date on the plans by the appropriate plan approval agency. The stamp of approval on the plans is solely an acknowledgement of satisfactory compliance with the requirements of these regulations. The approval stamp does not constitute a representation or warranty to the applicant or any other person concerning the safety, appropriateness of effectiveness of any provision, or omission from the stormwater and sediment plan.

G. When the local conservation district is not the plan approval agency, the conservation district may request to review and comment on stormwater management and sediment control plans. Failure of the conservation district to provide comments by the date specified by the local implementing agency will not delay the approval of the stormwater management and sediment control plans by the implementing agency.

H. All stormwater management and sediment control plans submitted to the appropriate plan approval agency for approval shall be certified by the designer. The following disciplines may certify and stamp/seal plans as allowed by their respective licensing act and regulations:

(1) Registered professional engineers as described in Title 40, Chapter 22.
(2) Registered landscape architects as described in Title 40, Chapter 28, Section 10, item (b).
(3) Tier B land surveyors as described in Title 40, Chapter 22.

I. Pursuant to Title 40, Chapter 22, Section 460, stormwater management and sediment control plans may be prepared by employees of the federal government and submitted by the person responsible for the land disturbing activity to the appropriate plan approval agency for approval.

J. These regulations do not prohibit other disciplines or Certified Professionals, including, but not limited to, Certified Professional Erosion and Sediment Control Specialists, which have appropriate background and experience from taking active roles in the preparation of the plan and design process. All plans and specifications submitted to the appropriate plan approval agency for approval shall be stamped/sealed by those listed in R.72-305H or prepared by employees of the federal government under R.72-305I.

K. Approved plans remain valid for 5 years from the date of an approval. Extensions or renewals of the plan approvals will be granted by the plan approval agency upon written request by the person responsible for the land disturbing activity.

L. Approvals of land disturbing activities which were approved prior to the effective date of these regulations shall remain in effect for the original term of the approval. For land disturbing activities which were not initiated during the original term of approval, the person responsible for the land disturbing activity shall resubmit the stormwater management and sediment control plan to the appropriate plan approval agency for review and approval subject to the requirements of these regulations.

M. Upon receipt of a completed application for sediment and stormwater management, the appropriate plan approval agency shall accomplish its review and have either the approval or review comments transmitted to the applicant within 20 working days. If notice is not given to the applicant or if action is not taken by the end of the 20 working day period, the applicants plan will be considered approved.

N. One year after the effective date of Chapter 14, Title 48 of the Code of Laws of South Carolina, a federal agency or facility may not undertake a land disturbing activity unless the agency has submitted a stormwater management and sediment control plan for the specific activity to the Commission and the plan has been approved.

In lieu of submitting individual plans for approval, the federal agency or facility may submit an application for a general permit to the Commission for approval.

O. A local government or special purpose or public service district may request a general permit for its regulated activities from the Commission. If a local government's or special purpose or public service district's request is approved, individual stormwater management and sediment control plans for regulated land disturbing activities will not be required.

72-306. Fees.

A. The fees associated with the plan review and approval process inspection and enforcement shall be set by the implementing agency. If permit fees are established, they shall be established in accordance with the following items:

(1) Delegation of program elements will depend, to a large extent, on funding and personnel commitments. If the delegated jurisdiction has a source of funding that is provided through local revenues, then the implementation of the delegated component will not necessitate the imposition of a permit fee to cover the cost of the delegated program component.

(2) In the event that one component of an overall stormwater management and sediment control program is not funded through the use of general or special funds, a non-refundable permit fee may be collected at the time that the stormwater management and sediment control plan or application for waiver or variance is submitted or approved. The permit fee will provide for the unfunded costs of plan review, administration and management of the permitting office, construction review, maintenance inspection, and education and training. The plan review or permit approval agency shall be responsible for the collection of the permit fee. Unless all program elements in a county or municipality have been delegated to a single agency, the funds

collected not supporting the plan review function shall be distributed to the appropriate agencies.

(3) The number of needed personnel and the direct and indirect expenses associated with those personnel shall be developed by the agencies requesting delegation in a specific jurisdiction. Those expenses will then form the basis for determining unit plan approval costs by the local government.

B. Where the Commission is the implementing agency, the Commission may assess a fee not to exceed $100.00 per disturbed acre up to a maximum of $2000.00. No fee will be charged for land disturbing activities which disturb two acres or less. The Commission may also charge a fee not to exceed $100.00 to review an application for a waiver or variance from the requirements of these regulations. No fee will be charged for extensions or renewal of plan approval unless there are significant changes to the plans.

C. A maintenance fee may be required on approvals granted for stormwater management structures that will be maintained by a local government.

72-307. Specific Design Criteria, Minimum Standards and Specifications.

A. General submission requirements for all projects requiring stormwater management and sediment control plan approval will include the following information as applicable:

(1) A standard application form,

(2) A vicinity map indicating north arrow, scale, and other information necessary to locate the property or tax parcel,

(3) A plan at an appropriate scale accompanied by a design report and indicating at least:

(a) The location of the land disturbing activity shown on a USGS 7.5 minute topographic map or copy.

(b) The existing and proposed topography, overlayed on a current plat showing existing and proposed contours as required by the implementing agency. The plat and topographic map should conform to provisions of Article 4, Regulations 400-490.

(c) The proposed grading and earth disturbance including:

1. Surface area involved; and
2. Limits of grading including limitation of mass clearing and grading whenever possible.

(d) Stormwater management and stormwater drainage computations, including:

1. Pre- and post-development velocities, peak rates of discharge, and inflow and outflow hydrographs of stormwater runoff at all existing and proposed points of discharge from the site,
2. Site conditions around points of all surface water discharge including vegetation and method of flow conveyance from the land disturbing activity, and
3. Design details for structural controls.

(e) Erosion and sediment control provisions, including:

1. Provisions to preserve top soil and limit disturbance;
2. Details of site grading; and
3. Design details for structural controls which includes diversions and swales.

(4) Federal Emergency Management Agency flood maps and federal and State wetland maps, where appropriate.

(5) The appropriate plan approval agency shall require that plans and design reports be sealed by a qualified design professional that the plans have been designed in accordance with approved sediment and stormwater ordinances and programs, regulations, standards and criteria.

(6) Additional information necessary for a complete project review may be required by the appropriate plan approval agency as deemed appropriate. This additional information may include items such as public sewers, water lines, septic fields, wells, etc.

B. Specific requirements for the erosion and sediment control portion of the stormwater management and sediment control plan approval process include, but are not limited to, the following items. The appropriate plan approval agency may modify the following items for a specific project or type of

project.

(1) All plans shall include details and descriptions of temporary and permanent erosion and sediment control measures and other protective measures shown on the stormwater and sediment management plan. Procedures in a stormwater and sediment management plan shall provide that all sediment and erosion controls are inspected at least once every seven calendar day and after any storm event of greater than 0.5 inches of precipitation during any 24-hour period.

(2) Specifications for a sequence of construction operations shall be contained on all plans describing the relationship between the implementation and maintenance of sediment controls, including permanent and temporary stabilization and the various stages or phases of earth disturbance and construction. The specifications for the sequence of construction shall, at a minimum, include the following activities:

(a) Clearing and grubbing for those areas necessary for installation of perimeter controls;
(b) Installation of sediment basins and traps;
(c) Construction or perimeter controls;
(d) Remaining clearing and grubbing;
(e) Road grading;
(f) Grading for the remainder of the site;
(g) Utility installation and whether stormdrains will be used or blocked until after completion of construction;
(h) Final grading, landscaping, or stabilization; and
(i) Removal of sediment controls.

Changes to the sequence of construction operations may be modified by the person conducting the land disturbing activity or their representative and do not constitute a violation unless measures to control stormwater runoff and sediment are not utilized.

(3) The plans shall contain a description of the predominant soil types on the site, as described by the appropriate soil survey information available through the Commission or the local Conservation District.

(4) When work in a live waterway is performed, precautions shall be taken to minimize encroachment, control sediment transport and stabilize the work area to the greatest extent possible during construction.

(5) Vehicle tracking of sediments from land disturbing activities onto paved public roads carrying significant amounts of traffic (ADT of 25 vehicles/day or greater) shall be minimized.

C. Specific requirements for the permanent stormwater management portion of the stormwater management and sediment control plan approval process include, but are not limited to, the following items. The appropriate plan approval agency may modify the following items for a specific project or type or project.

(1) It is the overall goal of the Commission to address stormwater management on a watershed basis to provide a cost effective water quantity and water quality solution to the specific watershed problems. These regulations will provide general design requirements that must be adhered to in the absence of Designated Watershed specific criteria.

(2) All hydrologic computations shall be accomplished using a volume based hydrograph method acceptable to the Commission. The storm duration for computational purposes for this method shall be the 24-hour rainfall event, SCS distribution with a 0.1 hour burst duration time increment. The rational and/or modified rational methods are acceptable for sizing individual culverts or stormdrains that are not part of a pipe network or system and do not have a contributing drainage area greater than 20 AC. The storm duration for computational purposes for this method shall be equal to the time of concentration of the contributing drainage area or a minimum of 0.1 hours, whichever is less.

(3) Stormwater management requirements for a specific project shall be based on the entire area to be developed, or if phased, the initial submittal shall control that area proposed in the initial phase and establish a procedure and obligation for total site control.

(4) Water quantity control is an integral component of overall stormwater management. The following design criteria for flow control is established for water quantity control purposes, unless

a waiver is granted based on a case-by-case basis:

(a) Post-development peak discharge rates shall not exceed pre-development discharge rates for the 2- and 10- year frequency 24-hour duration storm event. Implementing agencies may utilize a less frequent storm event (e.g. 25-year, 24-hour) to address existing or future stormwater quantity or quality problems.

(b) Discharge velocities shall be reduced to provide a nonerosive velocity flow from a structure, channel, or other control measure or the velocity of the 10-year, 24-hour storm runoff in the receiving waterway prior to the land disturbing activity, whichever is greater.

(c) Watersheds, other than Designated Watersheds, that have well documented water quantity problems may have more stringent, or modified, design criteria determined by the local government that is responsive to the specific needs of that watershed.

(5) Water quality control is also an integral component of stormwater management. The following design criteria is established for water quality protection unless a waiver or variance is granted on a case-by-case basis.

(a) When ponds are used for water quality protection, the ponds shall be designed as both quantity and quality control structures. Sediment storage volume shall be calculated considering the clean out and maintenance schedules specified by the designer during the land disturbing activity. Sediment storage volumes may be predicted by the Universal Soil Loss Equation or methods acceptable to the Commission.

(b) Stormwater runoff that drains to a single outlet from land disturbing activities which disturb ten acres or more shall be controlled during the land disturbing activity by a sediment basin where sufficient space and other factors allow these controls to be used until the final inspection. The sediment basin shall be designed and constructed to accommodate the anticipated sediment loading from the land-disturbing activity and meet a removal efficiency of 80 percent suspended solids or 0.5 ML/L peak settleable solids concentration, whichever is less. The outfall device or system design shall take into account the total drainage area flowing through the disturbed area to be served by the basin.

(c) Other practices may be acceptable to the appropriate plan approval agency if they achieve an equivalent removal efficiency of 80 percent for suspended solids or 0.5 ML/L peak settleable solids concentration, which ever is less. The efficiency shall be calculated for disturbed conditions for the 10-year 24-hour design event.

(d) Permanent water quality ponds having a permanent pool shall be designed to store and release the first ½ inch of runoff from the site over a 24 hour period. The storage volume shall be designed to accommodate, at least, ½ inch of runoff from the entire site.

(e) Permanent water quality ponds, not having a permanent pool, shall be designed to release the first inch of runoff from the site over a 24-hour period.

(f) Permanent infiltration practices, when used, shall be designed to accept, at a minimum, the first inch of runoff from all impervious areas.

(g) For activities in the eight coastal counties of Beaufort, Berkeley, Charleston, Colleton, Dorchester, Georgetown, Jasper and Horry, additional water quality requirements may be imposed to comply with the S.C. Coastal Council Stormwater Management Guidelines. If conflicting requirements exist for activities in the eight coastal counties, the S.C. Coastal Council guidelines will apply.

(6) Where ponds are the proposed method of control, the person responsible for the land disturbing activity shall submit to the approving agency, when required, an analysis of the impacts of stormwater flows downstream in the watershed for the 10- and 100-year frequency storm event. The analysis shall include hydrologic and hydraulic calculations necessary to determine the impact of hydrograph timing modifications of the proposed land disturbing activity, with and without the pond. The results of the analysis will determine the need to modify the pond design or to eliminate the pond requirement. Lacking a clearly defined downstream point of constriction, the downstream impacts shall be established, with the concurrence of the implementing agency.

(7) Where existing wetlands are intended as a component of an overall stormwater management system, the approved stormwater management and sediment control plan shall not be implemented until all necessary federal and state permits have been obtained.

(8) Designs shall be in accordance with standards developed or approved by the Commission.

(9) Ease of maintenance must be considered as a site design component. Access to the stormwater management structure must be provided.

(10) A clear statement of defined maintenance responsibility shall be established during the plan review and approval process.

(11) Infiltration practices have certain limitations on their use on certain sites. These limitations include the following items:

(a) Areas draining to these practices must be stabilized and vegetative filters established prior to runoff entering the system. Infiltration practices shall not be used if a suspended solids filter system does not accompany the practice. If vegetation is the intended filter, there shall be, at least a 20 foot length of vegetative filter prior to stormwater runoff entering the infiltration practice;

(b) The bottom of the infiltration practice shall be at least 0.5 feet above the seasonal high water table, whether perched or regional, determined by direct piezometer measurements which can be demonstrated to be representative of the maximum height of the water table on an annual basis during years of normal precipitation, or by the depth in the soil at which mottling first occurs;

(c) The infiltration practice shall be designed to completely drain of water within 72 hours;

(d) Soils must have adequate permeability to allow water to infiltrate. Infiltration practices are limited to soils having an infiltration rate of least 0.30 inches per hour. Initial consideration will be based on a review of the appropriate soil survey, and the survey may serve as a basis for rejection. On-site soil borings and textural classifications must be accomplished to verify the actual site and seasonal high water table conditions when infiltration is to be utilized;

(e) Infiltration practices greater than three feet deep shall be located at least 10 feet from basement walls;

(f) Infiltration practices designed to handle runoff from impervious parking areas shall be a minimum of 150 feet from any public or private water supply well;

(g) The design of an infiltration practice shall provide an overflow system with measures to provide a non-erosive velocity of flow along its length and at the outfall;

(h) The slope of the bottom of the infiltration practice shall not exceed five percent. Also, the practice shall not be installed in fill material as piping along the fill/natural ground interface may cause slope failure;

(i) An infiltration practice shall not be installed on or atop a slope whose natural angle of incline exceeds 20 percent.

(j) Clean outs will be provided at a minimum, every 100 feet along the infiltration practice to allow for access and maintenance.

(12) A regional approach to stormwater management is an acceptable alternative to site specific requirements and is encouraged.

D. All stormwater management and sediment control practices shall be designed, constructed and maintained with consideration for the proper control of mosquitoes and other vectors. Practices may include, but are not limited to:

(1) The bottom of retention and detention ponds should be graded and have a slope not less than 0.5 percent.

(2) There should be no depressions in a normally dry detention facility where water might pocket when the water level is receding.

(3) Normally dry detention systems and swales should be designed to drain within three (3) days.

(4) An aquatic weed control program should be utilized in permanently wet structures to prevent an overgrowth of vegetation in the pond. Manual harvesting is preferred.

(5) Fish may be stocked in permanently wet retention and detention ponds.

(6) Normally dry swales and detention pond bottoms should be constructed with a gravel blanket or other measure to minimize the creation of tire ruts during maintenance activities.

E. A stormwater management and sediment control plan shall be filed for a residential development and the buildings constructed within, regardless of the phasing of construction.

(1) In applying the stormwater management and sediment control criteria, in R.72-307, individual lots in a residential subdivision development shall not be considered to be separate land disturbing activities and shall not require individual permits. Instead, the residential subdivision development, as a whole, shall be considered to be a single land disturbing activity. Hydrologic parameters that reflect the ultimate subdivision development shall be used in all engineering calculations.

(2) If individual lots or sections in a residential subdivision are being developed by different property owners, all land-disturbing activities related to the residential subdivision shall be covered by the approved stormwater management and sediment control plan for the residential subdivision. Individual lot owners or developers may sign a certificate of compliance that all activities on that lot will be carried out in accordance with the approved stormwater management and sediment control plan for the residential subdivision. Failure to provide this certification will result in owners or developers of individual lots developing a stormwater management and sediment control plan meeting the requirements of R.72-307.

(3) Residential subdivisions which were approved prior to the effective date of these regulations are exempt from these requirements. Development of new phases of existing subdivisions which were not previously approved shall comply with the provisions of these regulations.

F. Risk analysis may be used to justify a design storm event other than prescribed or to show that rate and volume control is detrimental to the hydrologic response of the basin and therefore, should not be required for a particular site.

(1) A complete watershed hydrologic/hydraulic analysis must be done using a complete model/procedure acceptable to the implementing agency. The level of detail of data required is as follows:

(a) Watershed designation on the 7.5 minute topo map exploded to a minimum of 1" = 400'.

(b) Inclusion of design and performance data to evaluate the effects of any structures which effect discharge. Examples may be ponds or lakes, road crossings acting as attenuation structures and there may be others which must be taken into account.

(c) Land use data shall be taken from the most recent aerial photograph and field checked and updated.

(d) The water surface profile shall be plotted for the conditions of pre- and post-development for the 10-, and 100-year 24-hour storm.

(e) Elevations of any structure potentially damaged by resultant flow shall also be shown.

(2) Based on the results of this type of evaluation, the certified plan reviewer representing the implementing agency shall review and evaluate the proposed regulation waiver or change.

G. The general permit application for use by federal, local governments, or special purpose or public service districts shall contain, as a minimum, standard plans and specifications for stormwater management and erosion and sediment control; methods used to calculate stormwater runoff, soil loss and control method performance; staff assigned to monitor land disturbing activities and procedures to handle complaints for off-site property owners and jurisdictions.

This general permit will be valid for a period of three years and will be subject to the same review criteria by the Commission as that of the delegated program elements.

The use of the general permit classification does not relinquish a land disturbing activity from the requirements of these Regulations. Rather, the general permit precludes that activity from the necessity of a specific plan review for each individual project.

Approval of a general permit does not relieve any agency from the conditions that are part of the general permit approval regarding the implementation of control practices as required by the general permit. Failure to implement control practices pursuant to conditions included in the general permit may result in the revocation of the general permit and the requirement of the submission of individual plans for each activity.

H. The stormwater management and sediment control plan required for land disturbing activities of two (2) acres or less which are not part of a larger common plan of development or sale shall contain the

following information, as applicable:

(1) An anticipated starting and completion date of the various stages of land disturbing activities and the expected date the final stabilization will be completed;
(2) A narrative description of the stormwater management and sediment control plan to be used during land disturbing activities;
(3) General description of topographic and soil conditions of the tract from the local soil and water conservation district;
(4) A general description of adjacent property and a description of existing structures, buildings, and other fixed improvements located on surrounding properties;
(5) A sketched plan (engineer's, Tier B surveyor's or landscape architect's seal not required) to accompany the narrative which shall contain:
   (a) A site location drawing of the proposed project, indicating the location of the proposed project in relation to roadways, jurisdictional boundaries, streams and rivers;
   (b) The boundary lines of the site on which the work is to be performed;
   (c) A topographic map of the site if required by the implementing agency;
   (d) The location of temporary and permanent vegetative and structural stormwater management and sediment control measures.
(6) Stormwater management and sediment control plans shall contain certification by the person responsible for the land disturbing activity that the land disturbing activity will be accomplished pursuant to the plan.
(7) All stormwater management and sediment control plans shall contain certification by the person responsible for the land disturbing activity of the right of the Commission or implementing agency to conduct on-site inspections.
   The requirements contained above may be indicated on one plan sheet.

I. The stormwater management and sediment control plan for land disturbing activities of greater than two (2) acres but less than five (5) acres which are not part of a larger common plan of development or sale shall contain the following information, as applicable:

(1) An abbreviated application form;
(2) A vicinity map sufficient to locate the site and to show the relationship of the site to its general surroundings at a scale of not smaller than one (1) inch to one (1) mile.
(3) The site drawn to a scale of not smaller than one (1) inch to 200 feet, showing:
   (a) The boundary lines of the site on which the work is to be performed, including the approximate acreage of the site;
   (b) Existing contours and proposed contours as required by the implementing agency;
   (c) Proposed physical improvements on the site, including present development and future utilization if future development is planned;
   (d) A plan for temporary and permanent vegetative and structural erosion and sediment control measures which specify the erosion and sediment control measures to be used during all phases of the land disturbing activity and a description of their proposed operation;
   (e) Provisions for stormwater runoff control during the land disturbing activity and during the life of the facility, including a time schedule and sequence of operations indicating the anticipated starting and completion dates of each phase and meeting the following requirements:
      1. Post-development peak discharge rates shall not exceed pre-development discharge rates for the 2- and 10- year frequency 24-hour duration storm event. Implementing agencies may utilize a less frequent storm event (e.g. 25-year, 24-hour) to address existing or future stormwater quantity or quality problems.
      2. Discharge velocities shall be reduced to provide a nonerosive velocity flow from a structure, channel, or other control measure or the velocity of the 10-year, 24-hour storm runoff in the receiving waterway prior to the land disturbing activity, whichever is greater.
   (f) A complete and adequate grading plan for borrow pits and material processing facilities where applicable, including restoration and revegetation measures;

(g) A general description of the predominant soil types on the site;
(h) A description of the maintenance program for stormwater management and sediment control facilities including inspection programs.

(4) All stormwater management and sediment control plans submitted for approval shall contain certification by the person responsible for the land disturbing activity that the land disturbing activity will be accomplished pursuant to the approved plan.

(5) All stormwater management and sediment control plans shall contain certification by the person responsible for the land disturbing activity of the right of the Commission or implementing agency to conduct on-site inspections.

(6) All stormwater management and sediment control plans submitted to the appropriate plan approval agency for approval shall be certified by the designer. The following disciplines may certify and stamp/seal plans as allowed by their respective licensing act and regulations:
(a) Registered professional engineers as described in Title 40, Chapter 22.
(b) Registered landscape architects as describe in Title 40, Chapter 28, Section 10, item (b).
(c) Tier B land surveyors as described in Title 40, Chapter 22.

(7) Pursuant to Title 40, Chapter 22, Section 460, stormwater management and sediment control plans may be prepared by employees of the federal government and submitted by the person responsible for the land disturbing activity to the appropriate plan approval agency for approval.

72-308. Maintenance Requirements and Off-Site Damage Correction.

A. The Commission will provide technical assistance to local governments who choose to assume the maintenance responsibility for stormwater management structures on, at least, residential lands.

B. The person responsible for maintenance shall perform or cause to be performed preventive maintenance of all completed stormwater management practices to ensure proper functioning. The responsible inspection agency shall ensure preventive maintenance through inspection of all stormwater management practices.

C. Inspection reports shall be maintained by the responsible inspection agency on all detention and retention structures and shall include the following items (as applicable):

(1) The date of inspection;
(2) The name of the inspector;
(3) The condition of (if applicable):
(a) Vegetation,
(b) Fences,
(c) Spillways,
(d) Embankments,
(e) Reservoir area,
(f) Outlet channels,
(g) Underground drainage,
(h) Sediment load, or
(i) Other items which could effect the proper function of the structure.
(4) Description of needed maintenance.

D. Responsible inspection agencies shall provide procedures to ensure that deficiencies indicated by inspections are rectified. The procedures shall include the following:

(1) Notification to the person responsible for maintenance of deficiencies including a time frame for repairs;
(2) Subsequent inspection to ensure completion of repairs; and
(3) Effective enforcement procedures or procedures to refer projects to the Commission if repairs are not undertaken or are not done properly.

E. The following criteria shall be used by the appropriate implementing agency in evaluating and for correcting off-site damages resulting from the land disturbing activity:

(1) Determine the extent of damage by sediment resulting from non-compliance with the approved stormwater management and sediment control plan,
(2) Determine the classification of the impaired waterbody, if any,
(3) Determine the impact and severity of the damage resulting from non-compliance with the approved stormwater management and sediment control plan,
(4) Develop an agreement with landowners for cleanup and corrections, including a schedule of implementation.
(5) Evaluate the alternatives for correction of the damage and prevention of future damage, and
(6) Failure to implement the agreement in the required schedule will constitute a violation of these regulations.

72-309. Criteria For Designated Watersheds.

The concept of designated watersheds is intended, not only to prevent existing water quantity and water quality problems from getting worse, but also to reduce existing flooding problems and to improve existing water quality or meet State Water Quality Standards through a reduction of the impacts of NPS pollution in selected watersheds. Further, the designation of watersheds under this section may also be used to protect watersheds which do not currently have significant water quality or quantity problems, but which require protection in order to avoid or mitigate the occurrence of future problems which might impair current or protected multiple water uses or important water resources within the watershed. Criteria is established for designated watersheds and these criteria will depend on whether the specific problems of the watershed are water quantity or water quality oriented. Water quantity and water quality concerns will be considered in all designated watersheds, but the overall emphasis for each designated watershed will depend on its existing and future water quality and quantity issues as well as consideration of the multiple offstream and instream water uses within the watershed.

A. To initiate consideration of a watershed for Designated Watershed status, a watershed shall be recommended by a local government or combinations of local governments through the passage of a local ordinance to the Commission. Upon recommendation to the Commission, the Commission shall publish the request in the State Register and contact all involved agencies at the local and state level within 30 days after receipt of the designation request and their input received prior to any consideration of the designation is made.

B. Included with the recommendation of a watershed for Designated Watershed status to the Commission shall be an identification of the specific problems that exist in the watershed so that the pursuit of a watershed study is warranted. Designation as a Designated Watershed requires approval by the Commission, the South Carolina Water Resources Commission and the South Carolina Department of Health and Environmental Control. A significant water quantity or water quality problem must exist that would support this designation. Also, inclusion of a watershed as a Designated Watershed will necessitate a public hearing process. The process of designating a watershed shall be based on the following information:

(1) An estimate of the potential for land disturbing activities to be initiated in the basin which would be regulated under this regulation. This estimate could utilize historical and projected population growth, land use data, and other such appropriate measures to estimate the nonpoint source pollution contribution or stormwater runoff which could be reduced or avoided,
(2) An inventory of the offstream and instream water uses in the watershed to quantify and characterize the benefits associated with reducing current or avoiding future water resources problems in the watershed. These could include water supply intakes, State navigable waters, recreational resources, fisheries resources, wetlands, or other such important uses,
(3) Water quality data, collected through either the statewide water quality inventory, or other special studies inclusive of benthic macroinvertebrate data,
(4) Historical and estimated flood damage and/or estimated flood protection benefits to both private and public property in the watershed,
(5) Status of current or description of proposed State and Federal flood protection and flood plain management program(s) and activities in the watershed, and

(6) Dangers to public health and welfare.

C. Following an adequate review of the recommendation, staff of the Commission, South Carolina Water Resources Commission, and the South Carolina Department of Health and Environmental Control shall meet to review and discuss their decision regarding designation. The staff shall prepare a statement in support of, or objection to, the proposed designation within 120 days following receipt of the recommendation by the Commission. The statement shall be voted upon by the appointed commissioners of each respective agency. Ex-officio members of the South Carolina Water Resources Commission representing the Land Resources Conservation Commission and the South Carolina Department of Health and Environmental Control shall abstain from voting regarding designation at the meeting of the South Carolina Water Resources Commission. Approval by each of the three agencies shall constitute designation.

D. Upon approval of designation, a Watershed Advisory Committee shall be established to advise and provide guidance in the development and conduct of the watershed master plan. The Commission, South Carolina Water Resources Commission, and the South Carolina Department of Health and Environmental Control will appoint the Watershed Advisory Committee which shall include State, District, local government representatives, and also representatives of the regulated community within the watershed and other persons which may be affected by the plan.

E. The general components contained in the actual watershed study shall be the following items:

(1) Stormwater quantity or water quality problem identification,
(2) The overall needs of the watershed including the additional impacts of new land disturbing activities,
(3) Alternative approaches to address the existing and future problems,
(4) A selected approach that includes the overall costs and benefits,
(5) An economic impact analysis of the selected approach,
(6) Schedule for implementation,
(7) Funding sources that are available for the actual implementation of study recommendations, and
(8) A public hearing prior to final Commission, S.C. Water Resources Commission and S.C. Department of Health and Environmental Control approval of the watershed study.

F. The following goals are to be obtained through the implementation of the Designated Watershed program:

(1) Reduction of existing flooding or water quality impacts,
(2) Prevention of future flooding or water quality impacts, and
(3) Minimization of economic and social losses.

G. Specific plan components of a watershed study shall include, but not be limited to, the following items:

(1) The limits of the watershed.
(2) An inventory of existing water quality data.
(3) An inventory of areas having significant natural resource value as defined in existing State or local studies as they may be impacted by the construction of location of stormwater control structures.
(4) An inventory of areas of historical and archaeological value identified in existing State or local studies as they may be impacted by the construction or location of stormwater control structures,
(5) A map or series of maps of the watershed showing the following information:
   (a) Watershed topography,
   (b) Significant geologic formations,
   (c) Soils information,
   (d) Existing land use based on existing zoning,
   (e) Proposed land use based on expected zoning or comprehensive plans,
   (f) Locations where water quality data were obtained.
   (g) Locations of existing flooding problems including floor and corner elevations of structures already impacted, and

(h) 100-year floodplain delineations, water surface profiles, and storm hydrographs at selected watershed location.

(6) An inventory of the existing natural and constructed stormwater management system.

(7) An inventory of historic flood damage sites, including frequency and damage estimates,

72-310. Criteria For Implementation of a Stormwater Utility.

The implementation of a stormwater utility will necessitate the development of a local utility ordinance or special taxing assessment prior to its implementation, pursuant to Chapter 9, Title 4, 1976 Code of Laws as amended by Act 114 1991. There are essential components that an ordinance must contain to function as a funding mechanism for stormwater management and those components shall include, but not be limited to, the following items:

A. The financing of a stormwater utility with a user charge system must be reasonable and equitable so that each user of the stormwater system pays to the extent to which the user contributes to the need for the stormwater system, and that the charges bear a substantial relationship to the cost of the service. The use of county and municipal taxpayer rolls and accounting systems are allowed for the assessment and collection of fees.

B. The intent of the utility must be clearly defined regarding program components that are to be funded through the utility. Those components may include but not be limited to the following activities:

(1) Preparation of comprehensive watershed master plans for stormwater management,

(2) Annual inspections of all stormwater management facilities, both public and private,

(3) Undertaking regular maintenance, through contracting or other means, of stormwater management structures that have been accepted for maintenance.

(4) Plan review and inspection of sediment control and storm water management plans and practices, and

(5) Retrofitting designated watersheds, through contracting or other means, to reduce existing flooding problems or to improve water quality.

C. The authority for the creation of the stormwater utility and the imposition of charges to finance sediment and stormwater activities is conferred in Chapter 14, Title 48, South Carolina Code. The application of a stormwater utility by means of a local ordinance or other means shall not be deemed a limitation or repeal of any other powers granted by State statute.

D. The creation of a stormwater utility shall include the following components:

(1) The boundaries of the utility, such as watersheds or jurisdictional boundaries as identified by the local governing body,

(2) The creation of a management entity,

(3) Identification of stormwater problems,

(4) Method for determining utility charges,

(5) Procedures for investment and reinvestment of funds collected, and

(6) An appeals or petition process.

E. As established by local ordinance or special election or petition, the local government shall have responsibility for implementing all aspects of the utility including long range planning, plan implementation, capital improvements, maintenance of stormwater facilities, determination of charges, billing, and hearing of appeals and petitions. The local government also will have responsibility for providing staff support for utility implementation.

F. With the respect to new stormwater management facilities constructed by private developers, the local government shall develop criteria for use in determining whether these will be maintained by the utility or by the facility owner. Such criteria may include whether the facility has been designed primarily to serve residential users and whether it has been designed primarily for purposes of stormwater management. In situations where it is determined that public maintenance is not preferable, standards shall be developed to ensure that inspection of facilities occurs annually and that facilities are

maintained as needed.

G. The use of charges is limited to those purposes for which the utility has been established, including but not limited to: planning; acquisition of interests in land including easements; design and construction of facilities; maintenance of the stormwater system; billing and administration; and water quantity and water quality management, including monitoring, surveillance, private maintenance inspection, construction inspection, and other activities which are reasonably required.

72-311. Plan Review and Inspector Certification Programs.

A. The Commission shall require that local governments which request delegation of stormwater management and sediment control plan review and approval/disapproval shall have a Certified Plan Reviewer representing the implementing agency. Certified Plan Reviewers shall obtain certification from the Commission by successfully completing a Commission sponsored or approved training program. Exceptions to this requirement are limited to Registered Professional Engineers, Registered Landscape Architects and Registered Tier B Land Surveyors who can receive initial certification by demonstrating to the Commission a minimum of three (3) years experience in stormwater management and sediment control planning and design. For a period of one year after the effective date of these regulations, local governments may receive interim certification for plan reviewers during the period before attendance at a Commission sponsored or approved training course by submitting an enrollment form to the Commission. Interim certification shall be valid until the scheduled date of attendance.

B. The Commission shall require that local governments which request delegation of the construction and maintenance inspection component of the stormwater management and sediment control program shall have a Certified Construction Inspector representing the implementing agency. Certified Construction Inspectors shall obtain certification from the Commission by successfully completing a Commission sponsored or approved training program. For a period of one year after the effective date of these regulations, local governments may receive interim certification for construction inspectors during the period before attendance at a Commission sponsored or approved training course by submitting an enrollment form to the Commission. Interim certification shall be valid until the scheduled date of attendance.

C. Initial certification as a Certified Plan Reviewer or Certified Construction Inspector is good for a period of five years. Recertification is contingent on attending and successfully completing a Commission sponsored or approved recertification program. This continuing education requirement applies to all Certified Plan Reviewers, including, Registered Engineers, Landscape Architects, Tier B Land Surveyors and Construction Inspectors.

72-312. Review and Enforcement Requirements.

A. Items listed in this section are activities by the Commission in the event the Commission serves as the implementing agency. When the Commission is requested to assist the implementing agency, these are suggestions the Commission may submit to the implementing agency.

B. The person responsible for the land disturbing activity shall notify the appropriate inspection agency before initiation of construction and upon project completion when a final inspection will be conducted to ensure compliance with the approved stormwater management and sediment control plan.

C. The person responsible for the land disturbing activity shall, if required by the implementing agency during the plan approval process, submit "As Built or Record Document" plans. In addition, the person responsible for the land disturbing activity may be required to submit written certification from the professional engineer, landscape architect, or Tier B land surveyor responsible for the field supervision of the land disturbing activity that the land disturbing activity was accomplished according to the approved stormwater management and sediment control plan or approved changes.

D. The responsible inspection agency shall, for inspection purposes, do all of the following items:

(1) Ensure that the approved stormwater management and sediment control plans are on the project site and are complied with;
(2) Ensure that every active site is inspected for compliance with the approved plan on a regular basis;
(3) Provide the person responsible for the land disturbing activity, a written report after every inspection that describes:
    (a) The date and location of the site inspection;
    (b) Whether the approved plan has been properly implemented and maintained;
    (c) Approved plan or practice deficiencies; and
    (d) The action taken.
(4) Notification of the person responsible for the land disturbing activity in writing when violations are observed, describing the:
    (a) Nature of the violation;
    (b) Required corrective action; and
    (c) Time period for violation correction.

E. The Commission may investigate complaints or refer any complaint received to the local inspection agency if the activity is located in a jurisdiction that has received delegation of inspections during construction and maintenance inspections. In conjunction with a referral, the Commission may also initiate an on-site investigation after notification of the local inspection agency in order to properly evaluate the complaint. The Commission shall make recommendations on enforcement action when appropriate, and notify the local implementing agency in a timely manner of any recommendations.

F. The Commission, at its discretion and upon notification to the person responsible for the land disturbing activity may visit any site to determine the adequacy of stormwater management and sediment control practices. In the event that the Commission conducts site inspection, the appropriate inspection agency shall be notified of the inspection. The appropriate inspection agency shall establish a time frame to obtain site compliance. This notification shall, in no way limit the right to the Commission to take action subsequent to any provision of these regulations or Chapter. Formal procedures for interaction between the Commission and the appropriate inspection agency on-site inspection and referral will be developed on an individual basis.

G. The appropriate plan approval agency may require a revision to the approved plans as necessary due to differing site conditions. The appropriate plan approval agency shall establish guidelines to facilitate the processing of revised plans where field conditions necessitate plan modification. Where changes to the approved plan are necessary those changes shall be in accordance to the following:

(1) Major changes to approved stormwater management and sediment control plans, such as the addition or deletion of a sediment basin, shall be submitted by the applicant to the appropriate plan approval agency for review and approval.
(2) Minor changes to stormwater management and sediment control plans may be made in the field review report. The appropriate inspection agency shall develop a list of allowable field modifications for use by the construction inspector.

H. Stormwater management construction shall have inspections accomplished as needed.

I. The agency responsible for construction inspection may, in addition to local enforcement options, refer a site violation to the Commission for review.

J. Referral of a site violation to the Commission may initiate a Commission construction inspection of the site to verify site conditions. That construction inspection may result in the following actions:

(1) Notification through appropriate means to the person engaged in a land disturbing activity to comply with the approved plan within a specified time frame; and
(2) Notification of plan inadequacy, with a time frame for the person engaged in a land disturbing activity to submit a revised sediment and stormwater plan to the appropriate plan approval agency and to receive its approval with respect thereto.

The Commission shall notify the local inspection agency within five working days of what

recommendation for enforcement action should be taken on the site.

K. Failure of the person engaged in the land disturbing activity contractor to comply with Commission requirements may result in the following actions in addition to other penalties as provided in Chapter 14.

(1) The Commission shall have the power to request the implementing agency to order any person violating any provision of Chapter 14 and these regulations to cease and desist from any site work activity other than those actions necessary to achieve compliance with any administrative order.
(2) The Commission may request that the appropriate plan approval agency refrain from issuing any further building or grading permits to the person having outstanding violations until those violations have been remedied.
(3) The Commission may recommend fines to be levied by the implementing agency.

L. If the Commission or the implementing agency utilizes "stop work orders" as a part of its inspection and enforcement program, the following procedure shall be followed:

(1) The implementing agency may issue a stop work order if it is found that a land disturbing activity is being conducted in violation of this Act or of any regulation adopted or order issued pursuant to this Act, that the violation is knowing and willful, and that either:
   (a) Off-site sedimentation resulting from non-compliance with the approved stormwater management and sediment control plan has eliminated or severely degraded a use in a lake or natural waterway or that such degradation is imminent.
   (b) Off-site sedimentation resulting from non-compliance with the approved stormwater management and sediment control plan has caused severe damage to adjacent land.
   (c) The land disturbing activity which requires an approved plan under these regulations and is being conducted without the required approved plan.
(2) The stop work order shall be in writing and shall state what work is to be stopped and what measures are required to abate the violation. The order shall include a statement of the findings made by the implementing agency pursuant to (1) of this section and shall list the conditions under which work that has been stopped by the order may be resumed. The delivery of equipment and materials which does not contribute to the violation may continue while the stop work order is in effect. A copy of this section shall be attached to the order.
(3) The stop work order shall be served by the sheriff of the county in which the land disturbing activity is being conducted or by some other person duly authorized by law to serve process, and shall be served on the person at the site of the land disturbing activity who is in operational control of the land disturbing activity. The sheriff or other person duly authorized by law to serve process shall post a copy of the stop work order in a conspicuous place at the site of the land-disturbing activity. The implementing agency shall also deliver a copy of the stop work order to any person that the implementing agency has reason to believe may be responsible for the violation.
(4) The directives of a stop work order become effective upon service of the order. Thereafter, any person notified of the stop work order who violates any of the directives set out in the order may be assessed a civil penalty as provided in R.72-315. A stop work order issued pursuant to this section may be issued for a period not to exceed three calendar days.
(5) The implementing agency shall designate an employee to monitor compliance with the stop work order. The name of the employee so designated shall be included in the stop work order. The employee so designated shall rescind the stop work order if all the violations for which the stop work order are issued are corrected, no other violations have occurred, and all measures necessary to abate the violations have been taken. The implementing agency shall rescind a stop work order that is issued in error.
(6) The issuance of a stop work order shall be a final agency decision subject to judicial review in the same manner as an order in a contested case pursuant to Title 1, Chapter 23, Section 380 of the Code of Laws of South Carolina, 1976. The petition for judicial review shall be filed in the circuit court of the county in which the land-disturbing activity is being conducted.
(7) The Commission shall file a cause of action to abate the violations which resulted in the issuance

of a stop work order within three calendar days of the service of the stop work order. The cause of action shall include a motion for an ex parte temporary restraining order to abate the violation and to effect necessary remedial measures. The resident circuit court judge, or any judge assigned to hear the motion for the temporary restraining order, shall hear and determine the motion within two days of the filing of the complaint. The clerk of circuit court shall accept complaints filed pursuant to this section without the payment of fining fees. Filing fees shall be paid to the clerk of circuit court within 30 days of the fining of the complaint.

72-313. Hearings and Hearing Procedures.

A. An administrative hearing is available, following a timely request, to determine the propriety of:
   (1) The denial of delegation of a program component.
   (2) A revocation of a delegated program component.
   (3) A denial or revocation of a permit for stormwater management and sediment control.
   (4) A citizen complaint concerning program operation.
   (5) The requirements imposed by the implementing agency for approval of the stormwater management and sediment reduction plan.
   (6) The issuance of a notice of violation or non-compliance with the approved stormwater management and sediment reduction plan.
   (7) The issuance of fines by an implementing agency.
   (8) The issuance of a stop work order by an implementing agency.

B. Requests for administrative hearings and appeals may be made to local governments when program elements are delegated by the Commission or to the Commission when the Commission functions as the implementing agency. In addition, administrative hearings and appeals may be held by the Commission regarding decisions or actions of local implementing agencies. Procedures for acting on appeals and conducting administrative hearings by local implementing agencies will be specified in their request for delegation of program element. The Commission procedures for conducting administrative hearings is specified in R.72-313C through R.72-313Q.

C. A hearing may be requested by any person. If an adverse action is involved, the hearing may be requested provided that the written request is received within thirty (30) days after the notice is given to the person.

D. All hearings shall be initiated via correspondence approved by the Commission which shall give notice to all parties of the hearing.

   (1) All parties must receive notice of the hearing of not less than thirty (30) days;
   (2) The notice shall be sent by the designated hearing officer(s);
   (3) The notice shall include:
      (a) A statement of the time, place, and nature of the hearing;
      (b) A statement of the legal authority and jurisdiction under which the hearing is to be held;
      (c) A reference to the particular sections of the statutes and rules involved;
      (d) A short and plain statement of the matters asserted. If the hearing officer(s) is/are unable to state the matters in detail at the time the notice is served, the initial notice may be limited to a statement of the issues involved. Thereafter, upon application, a more definite and detailed statement shall be furnished.

E. All hearings shall be conducted by a hearing officer(s) appointed by the Commission.

F. All hearings shall be conducted in accordance with Section 1-23-10 et. seq. of the 1976 South Carolina Code of Laws.

G. The hearing officer(s) shall issue a proposal for decision which shall be mailed to the parties.

H. Within twenty (20) days after mailing of the proposal for decision, any party may file exceptions to the hearing officer's proposal for decision.

(1) Such exceptions shall be in written form, addressed to the Chairman of the Commission, and served upon all adverse parties;
(2) The exceptions shall list all the grounds upon which the exceptions are based.

I. If no exceptions are received by the Commission within the twenty (20) day period following the mailing of the proposal for decision, the Commission shall issue a final decision.

J. If timely exceptions are received, the Commission shall send notice to the parties that the appealing party(s) has thirty (30) days to submit a brief. Following the service of the appealing party's brief, or upon the expiration of the thirty (30) day period, whichever shall occur first, the other party shall have thirty (30) days to submit a brief. All briefs must be served on the opposing parties and filed with the Commission.

K. Following receipt of all briefs, the Commission shall schedule an oral argument if requested to do so by either party.

L. The request for an oral argument must be in writing, addressed to the Chairman of the Commission, and submitted with that party's brief.

M. The oral argument shall be scheduled for the next regular Commission meeting following the filing of the last brief.

N. The oral argument shall be heard by the members of the Commission present at the Commission meeting and shall be held in accordance with the following format:

(1) The appealing party shall be given twenty minutes to present his case;
(2) The opposing party shall be given twenty minutes to present his case;
(3) The appealing party shall be given a rebuttal period of five minutes.

O. The parties by written stipulation may agree that the hearing officer's decision shall be final and binding upon the parties.

P. The final order shall be issued by the Commission, and the decision of the Commission shall represent the view of a majority of the Commission members voting on the appeal.

Q. The final order shall be written and shall comply with the provisions of Section 1-23-10 et. seq. of the 1976 South Carolina Code of Laws.

72-314. Citizen Complaint Procedure on Delegated Program Components and Individual Sites.

A. Persons may become aggrieved by land disturbing activities and program implementation. The following describes the procedure for a person to complain concerning program operation:

(1) If the program component in question has been delegated to a local implementing agency, the complaint shall be registered first in writing with that agency. An attempt to resolve the problem shall be made with the local implementing agency.
(2) In the event a solution can not be reached, the citizen may forward the complaint to the Commission for review. The Commission shall attempt to resolve the problem with the implementing agency and notify the citizen of the outcome of these efforts.
(3) If the Commission determines, based on complaints indicating a continuing pattern, that implementation of delegated program elements falls below the acceptable standards established by these regulations, the Commission may suspend or revoke the delegation in accordance with R.72-304L.
(4) All complaints filed with the Commission shall be held for a period of three years and will be considered when delegation renewal is requested by the local government.

B. Persons may complain about individual site problems or damages. The procedure is as follows:

(1) The complaint will be registered in writing with the appropriate implementing agency.
(2) If the implementing agency is not the Commission and a solution can not be reached with the local

implementing agency, the complaint should be filed with the Commission. The Commission will follow procedures listed in R.72-312E.

72-315. Penalties.

A. Any person who violates any provision of this chapter or any ordinance or regulation promulgated, enacted, adopted, or issued pursuant to this chapter by the Commission or other implementing agency, or who initiates or continues a land disturbing activity for which a stormwater management and sediment control plan is required except in accordance with the terms, conditions, and provisions of an approved plan, is subject to a civil penalty of not more than one thousand dollars. No penalty may be assessed until the person alleged to be in violation has been notified of the violation. Each day of a violation constitutes a separate violation.

B. The implementing agency shall determine the amount of the civil penalty to be assessed under this section for violations under its jurisdiction. It shall make written demand for payment upon the person responsible for the violation and set forth in detail the violation for which the penalty has been invoked. If payment is not received or equitable settlement reached within thirty days after demand for payment is made, a civil action may be filed in the circuit court in the county in which the violation is alleged to have occurred to recover the amount of the penalty. If the implementing agency is the commission, the action must be brought in the name of the State. Local governments shall refer the matters under their jurisdiction to their respective attorneys for the institution of a civil action in the name of the local government in the circuit court in the county in which the violation is alleged to have occurred for recovery of the penalty.

72-316. Severability.

If any section, subsection, sentence, clause, phrase, or portion of these regulations are for any reason held invalid or unconstitutional by any court or competent jurisdiction, such provision and such holding shall not affect the validity of the remaining portions of these regulations.

Fiscal Impact Statement:

The South Carolina Land Resources Commission estimates that two additional staff engineers will be required to operate the program.

APPENDIX B

COASTAL ZONE MANAGEMENT PROGRAM REFINEMENTS FOR STORMWATER MANAGEMENT REGULATIONS

Chapter III Management of Coastal Resources

C. Uses of Management Concern

3. Resource Policies

XIII. Stormwater Management Guidelines (Page III-74)

Most land disturbing activities in South Carolina must comply with the requirements and applicable regulations of the Erosion and Sediment Reduction Act of 1983 (48-18-10, et. seq.), or the Stormwater Management and Sediment Reduction Act of 1991 (48-14-10, et. seq.). The final regulations, effective on June 26, 1992, pursuant to the Stormwater Management and Sediment Reduction Act of 1991, establish the procedure and minimum standards for a statewide stormwater program. Section R.72-304F of the regulations states that "the S.C. Coastal Council (now known as the Office of Ocean and Coastal Resource Management (OCRM), in coordination with the Commission, will serve as the implementing agency for these regulations in the jurisdictions of the local governments which do not seek delegation of program elements in the counties of Beaufort, Berkeley, Charleston, Colleton, Dorchester, Georgetown, Horry and Jasper." In addition, Section R.72-307C(5)(g) states that "For activities in the eight coastal counties, additional water quality requirements may be imposed to comply with the S.C. Coastal Council (OCRM) Stormwater Management Guidelines. If conflicting requirements exist for activities in the eight coastal counties, the S.C. Coastal Council (OCRM) guidelines will apply."

Pursuant to the Coastal Zone Management Act, the Coastal Council (OCRM) is responsible for protecting the environmentally sensitive areas of our coast. While the regulations of the Stormwater Management and Sediment Reduction Act adequately address most nonpoint source pollution problems, the need exists for establishing additional criteria to protect sensitive coastal waters.

A. Stormwater Runoff Storage Requirements

The regulations of the Stormwater Management and Sediment Reduction Act require that "permanent water quality ponds having a permanent pool shall be designed to store and release the first 1/2 inch of runoff from the site over a 24-hour period. The storage volume shall be designed to accommodate, at least, 1/2 inch of runoff from the entire site." For all projects, regardless of size, which are located within one-half (1/2) mile of a receiving waterbody in the coastal zone, this criteria shall be storage of the first 1/2 inch of runoff from the entire site or storage of the first one (1) inch of runoff from the built-upon portion of the property, whichever is greater. Storage may be accomplished through retention, detention or infiltration systems, as appropriate for the specific site. In addition, for those projects which are located within 1,000 (one thousand) feet of shellfish beds, the first one and one half (1 1/2) inches of runoff from the built-upon portion of the property must be retained on site.

Receiving waterbodies include all regularly tidally influenced salt and freshwater marsh areas, all lakes or ponds which are used primarily for public recreation or a public drinking water supply, and other water bodies within the coastal zone, excluding wetlands, swamps, ditches and stormwater management ponds which are not contiguous via an outfall or similar structure with a tidal water body.

B. Project Size Requiring Stormwater Management Permits

Section R.72-305B(1) states that "for land disturbing activities involving two (2) acres or less of actual land disturbance which are not part of a larger common plan of development or sale, the person responsible for the land disturbing activity shall submit a simplified stormwater management and sediment control plan meeting the requirements of R.72-307H. This plan does not require preparation or certification by the designers specified in R.72-305H and R.72-305I." Due to the potentially damaging effect of certain projects of less than two (2) acres of land disturbance, stormwater management and sediment reduction plan submittal and regulatory approval shall be required for those smaller projects located within 1/2 mile of a receiving waterbody. Single family homes that are not part of a subdivision development are exempt from this requirement.

C. Stormwater Management Requirements for Bridge Runoff

The following is the criteria used to address stormwater management for bridges traversing saltwater and/or critical areas.

(1) No treatment is necessary for runoff from bridge surfaces spanning SB or SA waters. This runoff can be discharged through scupper drains directly into surface waters. However, the use of scupper drains should be limited as much as feasibly possible.

(2) If the receiving water is either ORW or SFH then the stormwater management requirements shall be based on projected traffic volumes and the presence of any nearby shellfish beds. The following matrix lists the necessary treatment practices over the different classes of receiving waters.

(3) The Average Daily Traffic Volume (ADT) is based upon the design carrying capacity of the bridge.

Water Quality Class	Average Daily Traffic Volume (ADT)	
	0-30,000	G.T. 30,000
ORW (within 1000 ft of shellfish beds)	***	***
ORW (not within 1000 ft of shellfish beds)	**	**
SFH (within 1000 ft of shellfish beds)	**	***
SFH (not within 1000 ft of shellfish beds)	**	**
SA	*	*
SB	*	*

***The first one (1) inch of runoff from the bridge surface must be collected and routed to an appropriate stormwater management system or routed so that maximum overland flow occurs encouraging exfiltration before reaching the receiving body. Periodic vacuuming of the bridge surface should be considered.

** A stormwater management plan must be implemented which may require the overtreatment of runoff from associated roadways to compensate for the lack of direct treatment of runoff from the bridge surface itself. Periodic vacuuming should be considered. The use of scupper drains should be limited as much as feasibly possible.

* No treatment is required. The use of scupper drains should be limited as much as feasibly possible.

D. Golf Courses Adjacent to Receiving Waterbodies

Golf course construction and maintenance practices result in the potential for significant negative impacts from the runoff of sediments, pesticides, herbicides and other pollutants. For this reason, when golf courses are constructed adjacent to receiving waterbodies then the following practices are to be incorporated.

(1) Minimum setbacks from the receiving waterbody of 20 feet for all manicured portions of the golf course (fairways, greens and tees) are required unless other acceptable management techniques are approved and implemented to mitigate any adverse impacts.

(2) All drainage from greens and tees must be routed to interior lagoons or an equivalent stormwater management system.

(3) To prevent the conversion of the stormwater system to critical area and to maintain positive drainage at high tides, all outfalls from the lagoon system must be located at an elevation above the critical area (if the discharge is to critical area) AND above the normal water elevation a distance to allow for storage of the first one inch of runoff. The volume which must be stored shall be calculated by multiplying the area of all the greens and tees by one inch. (Previously constructed stormwater management systems which meet all current and future storage requirements will not be required to modify outfalls.)

(4) No greens or tees shall be located on marsh hummocks or islands unless all drainage can be conveyed to the interior lagoon system or to an equivalent onsite stormwater management system.

(5) Stormwater impacts to freshwater wetlands shall be limited by providing minimum 20 foot buffers, or an accepted alternative, between manicured areas (fairways, greens and tees) and the wetlands. This minimum buffer must be increased if land application of treated effluent is utilized in the area.

(6) An integrated pest management system designed in accordance with current best technology practices must be employed on the course to limit the application of chemicals which, if over applied, may leach into the ground and adjacent surface waters.

(7) In accordance with S.C. Department of Health and Environmental Control requirements, a two (2) foot separation must be maintained between the surface of the golf course and the ground water table where spray effluent is applied.

(8) The normal ground water elevation must be established by a registered engineer or soil scientist.

(9) All projects which are within 1000 feet of shellfish beds must retain the first 1 1/2 inches of runoff as otherwise described in item A above.

(10) If spray effluent or chemicals are applied to the turf via the irrigation system, all spray heads must be located and set so as to prevent any aerosols from reaching adjacent critical areas.

E. Mines and Landfills

Due to the significant amount of land disturbance involved in the construction of mines and landfills, these types of operations need to strictly adhere to sediment/erosion control requirements particularly when they are located near coastal waterways. When mining or landfill projects are located within 1/2 mile of receiving waterbodies, pumping of ground water from sediment basins must be done with floating intakes only. Pumping of these basins must cease whenever the water levels come to within two (2) feet of the pond bottom. In addition, landfill planning must be designed on a comprehensive site basis for stormwater management and sediment/erosion control to include management practices for each separate cell as it is phased into the landfill.

F. Notice of Approval

All notice of approval must be in written form.

APPENDIX C

ENGINEERING AIDS AND DESIGN GUIDELINES

FOR CONTROL OF SEDIMENT

IN

SOUTH CAROLINA

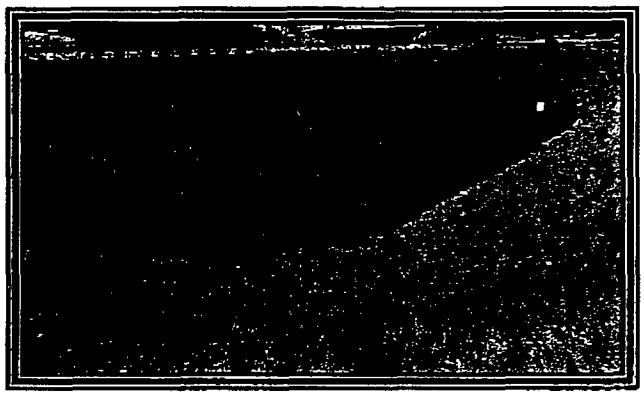
Sec 4.3 Ref 8

SC DHEC South Carolina Department of Health and Environmental Control

D H E C

PROMOTE PROTECT PROSPER

Ocean and Coastal Resource Management



South Carolina DHEC Storm Water Management BMP Handbook

August 2005

Appendices

List of Acronyms

AASHTO	American Association of State Highway and Transportation Officials
AMD	Acrylamide Polymer
BFM	Bonded Fiber Matrix
BMP(s)	Best Management Practice(s)
CFS	Cubic Feet Per Second
CMP	Corrugated Metal Pipe
DHEC	South Carolina Department of Health and Environmental Control
ECB	Erosion Control Blanket
EPA	United Stated Environmental Protection Agency
EPSC	Erosion Prevention and Sedimentation Control
FDA	United States Food and Drug Administration
FGM	Flexible Growth Matrix
HDPE	High Density Polyethylene
MS4	Municipal Separate Storm Sewer System
MSDS	Material Safety Data Sheets
NPDES	National Pollutant Discharge Elimination System
PAM	Polyacrylamide or Polymer
RCP	Reinforced Concrete Pipe
SCS	Soil Conservation Service
SWPPP	Storm Water Pollution Prevention Program
TRM	Turf Reinforcement Mat
VFS	Vegetated Filter Strip

Erosion Prevention and Sediment BMP Basic Design Procedures

Control of sedimentation from construction sites is accomplished through the utilization of a variety of erosion and sediment control Best Management Practices (BMPs). The complexity of the erosion prevention and sediment control (EPSC) plan varies depending on the individual site conditions. The goal of implementing the erosion control plan is to limit the quantity of sediment being eroded from, and leaving a construction site. This is partially accomplished through the implementation of sediment control BMPs. However, these sediment trapping controls typically only remove a small portion of the clay particles eroded from the site. The best protection is provided by a combination of practices including temporary and permanent stabilization, flow diversions, and streambank protection, all which minimize the amount of soil that is eroded from the site.

Plan land development to control and limit erosion and sediment discharge from construction sites using, but not limited to, the BMPs listed in this Manual. The goal of these erosion and sediment control BMPs is to:

- Minimize the extent and duration of disturbed soil exposure.
- Protect off-site and downstream locations, drainage systems and natural waterways from the impacts of erosion and sedimentation.
- Limit the exit velocities of the flow leaving the site to non-erosive or pre-development conditions.
- Design and implement an ongoing inspection and maintenance plan.

SCDHEC regulations require that when runoff drains to a single outlet from land disturbing activities which disturb ten (10) acres or more then a sediment basin must be designed to meet a removal efficiency of 80 percent for suspended solids or 0.5 mL/L peak settleable concentration, which ever is less. The design storm event associated with this level of control is the **10-year 24-hour SCS Type II, or Type III (coastal zone) storm event.** Computer software packages and the Design Aids contained in this handbook may used to calculate trapping efficiencies and peak settleable concentrations.

Land disturbance activities that are greater than five (5) acres require the development of EPSC plans to achieve an 80 percent design removal efficiency goal. Simply applied, when a site is completely denuded of vegetation, structural and nonstructural EPSC measures are designed to trap 80 percent of the total suspended solids (TSS) generated on the site.

Use SCS (Soil conservation Service) procedures to determine runoff amounts. It is important to note that when a BMP is designed for the 10-year 24-hour storm event, the BMP will have a greater trapping efficiency for more frequent events such as the 2-year 24-hour storm event.

EPSC plans delineate the following elements:

- All sensitive features.
- Sources of sediment that may potentially leave the site.

- The location and depth of all structural and nonstructural BMPs necessary to achieve the 80 percent design removal efficiency goal to protect receiving water bodies, off-site areas and all sensitive features.

- Installation and maintenance of required BMPs.

- The sequencing of construction activities to be utilized on the project.

Utilize the following nonstructural site management practices on the design plans where applicable:

- Minimize site disturbance to preserve and maintain existing vegetative cover.

- Limit the number of temporary access points to the site for land disturbing activities.

- Phase and sequence construction activities to minimize the extent and duration of disturbed soil exposure.

- Locate temporary and permanent soil disposal areas, haul roads and construction staging areas to minimize erosion, sediment transport and disturbance to existing vegetation.

Detailed EPSC plans comply with the following specific standards and review criteria:

- Sediment Tracking Control. Locate and utilize stabilized construction entrances at all points of ingress and egress on the construction site to prevent the transfer of sediment onto public roads and right-of-ways by motor vehicles and runoff.

- Crossings. Minimize the crossing of waterways during construction. Crossings must be approved by the U.S. Army Corps of Engineers and SCDHEC. Avoid encroachment into stream buffers, riparian areas, and wetlands when possible.

- Topsoil. Stockpile and preserve topsoil from erosion or dispersal both during and after site grading operations when applicable.

- Temporary Stabilization Measures. Temporary stabilization is required within 14 days after construction activity is complete **unless construction activity is going to resume within 21 days.**

- Final Stabilization. Prevent soil from eroding after the construction is complete. Final Stabilization of the site is required within 14 calendar days of construction completion.

- Temporary Structural Controls. Design to accomplish maximum stabilization, prevent erosion and control sedimentation. Design temporary structural controls to control the peak runoff resulting from the design storm event. Install, maintain, and remove temporary controls according to the specifications set forth in this BMP Manual.

- Permanent Structural Controls. Design all permanent controls including channels, storm sewer inlets, detention basins, and water quality structures according to State Regulations and to the standards set forth in the BMP Manual.

Erosion Prevention Measures

Use erosion prevention measures during and after construction site preparation in order to safely convey clean water to storm drains or adequate watercourses. One or more measures should be utilized as appropriate during the project's construction phase. Such measures may include but are not limited to: phasing and construction sequencing, surface roughening, temporary seeding, mulching, erosion control blankets, and reinforcement matting. Each of these measures is discussed in the Sections below.

In addition to site-specific erosion control measures, the grading plan includes the following general measures as a minimum:

- Vegetated finished cut and fill slopes should not be steeper than 3H:1V, unless an erosion control blanket or turf reinforcement mat is used.
- Do not place cuts or fills close to property, endangering adjoining property without adequately protecting such properties against erosion, sedimentation, slippage, settlement, subsidence, or other damages.
- Provide subsurface drainage in areas having a high water table to intercept seepage that affects slope stability, bearing strength, and undesirable wetness.
- Do not place fill material where it can slide or wash onto another property.
- Do not place fill adjacent to channel banks where it can create bank failure, reduce the capacity of the stream, or result in downstream sediment deposition.
- Include all borrow and disposal areas as part of the grading plan.
- Provide adequate channels and floodways to safely convey increased runoff from the developed area to an adequate outlet without causing significant channel degradation, or increased off-site flooding.
- Grade the site to direct flows to appropriate controls.

The following Erosion Prevention Measures are discussed in this handbook:

- Surface Roughening
- Temporary Seeding
- Mulching
- Erosion Control Blankets (ECBs)
- Turf Reinforcement Mats (TRMs)
- Flexible Growth Matrix (FGM)
- Bonded Fiber Matrix (BFM)
- Permanent Seeding
- Sodding
- Riprap
- Outlet Protection
- Dust Control
- Polyacrylamide (PAM)

Surface Roughening

Plan Symbol

LG OR

Description

Surface roughening is the creation of horizontal grooves, depressions, or steps that run parallel to the contour of the land. The following surface roughening measures are approved for use:

- Tracking (driving a crawler tractor up and down a slope, leaving the cleat imprints parallel to the slope contour).
- Stair-step grading.
- Grooving (using disks, spring harrows, or teeth on the bucket of a front-end loader).

Tracking

Description

Tracking is defined as driving tracked machinery up and down slopes, leaving the cleat imprints parallel to the slope contour.

When and Where to Use It

To slow erosion, perform tracking as soon as possible after the vegetation has been removed from the slope. Use tracking with temporary seeding and temporary mulching to stabilize an area.Perform tracking immediately after grading activities have ceased (temporarily or permanently) in an area.

Installation

Avoid excessive compacting of the soil surface when tracking since ~~because~~ soil compaction inhibits vegetation growth and causes higher runoff rates. As few passes as possible should be made with the machinery in order to minimize compaction

Seed and mulch surface roughened areas by the means of tracking within 14 days.

Inspection and Maintenance

- Inspect every 7 calendar days and within 24-hours after each rainfall event that produces ½-inches or more of precipitation.
- If rills (small watercourses that have steep sides and are usually only a few inches deep) appear, re-grade and re-seed immediately.

Stair-Step Grading

Description

Stair-Step Grading is defined as cutting stair-steps into slopes with each step having a maximum horizontal distance of 4-feet and a maximum vertical distance of 4-feet.

When and Where to Use It

To slow erosion, perform stair step grading within 7 days after the removal of vegetation from the slope. Stair step grading is applicable on cut slopes with a gradient steeper than 3H:1V but less than 2H:1V. Stair-step grading is applicable on any material soft enough to be moved with a bulldozer. Stair-step grading works well with soils containing large amounts of small rock. Prepare stairs wide enough to work with standard earth moving equipment. Stair-step grading is used with seeding to stabilize an area.

Installation

The ratio of vertical cut distance to horizontal distance is steeper than 1V:1H and the horizontal portion of the "step" slopes towards the vertical wall.

Seed and stabilize areas graded in this manner within 14 days.

Inspection and Maintenance

- Inspect every 7 calendar days and within 24-hours after each rainfall event that produces ½-inches or more of precipitation.
- If rills (small watercourses that have steep sides and are usually only a few inches deep) appear, re-grade and re-seed immediately.

Grooving

Description

Slope Grooving is defined as using machinery to create a series of ridges and depressions that run perpendicular to the slope on the contour.

When and Where to Use It

To slow erosion, perform slope grooving within 7 days after the removal of vegetation from the slope.

Groove cut and fill slopes with a gradient steeper than 3H:1V but less than 2H:1V. Grooving is done by any implement that is safely operated on the slope.

Slope Grooving is used with seeding and planting to stabilize an area.

Installation

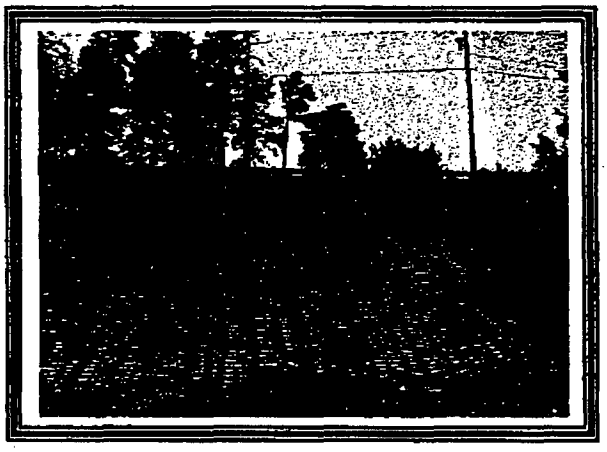
Install slope grooving with any appropriate implement that is safely operated on the slope not causing undue compaction. Suggested implements include discs, chisel plows, and the teeth on a front-end loader bucket. Install grooves a minimum of three inches deep and no further than 15 inches apart.

Seed and stabilize areas that are graded in this manner within 14 days.

Inspection and Maintenance

- Inspect every 7 calendar days and within 24-hours after each rainfall event that produces ½-inches or more of precipitation.
- If rills (small watercourses that have steep sides and are usually only a few inches deep) appear, re-grade and re-seed immediately.

Surface Roughening (Tracking)



Surface Roughening (Tracking)

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Rills appear.	Re-grade and re-seed area immediately.

Temporary Seeding

Plan Symbol

TS

Description

The purpose of temporary seeding is to reduce erosion and sedimentation by stabilizing disturbed areas that would otherwise lay bare for long periods of time before they are worked or stabilized. Temporary seeding is also used where permanent vegetation growth is not necessary or appropriate.

When and Where to Use It

Temporary seeding is used on exposed soil surfaces such as denuded areas, soil stockpiles, dikes, dams, banks of sediment basins, banks of sediment traps, and temporary road banks. Temporary seeding prevents and limits costly maintenance operations on other sediment control structures. Sediment clean-out requirements for sediment basins, sediment, traps, and silt fence is reduced if the drainage area is seeded when grading and construction operation are not taking place.

Temporary stabilization is required within 14 days after construction activity is complete **unless construction activity is going to resume within 21 days**. Cover seeded areas with an appropriate mulch to provide protection from the weather. When the temporary vegetation does not grow quickly or thick enough to prevent erosion, re-seed as soon as possible. Keep seeded areas adequately moist. Irrigate the seeded area if normal rainfall is not adequate for the germination and growth of seedlings. Water seeded areas at controlled rates that are less than the rate at which the soil can absorb water to prevent runoff. Runoff of irrigation water wastes water and can cause erosion.

Seed Selection

Seed selection is based on geographical location, soil type and the season of the year in which the planting is to be done. Use the tables in Appendix C as a guide for conventional tillage methods (plowing, seedbed preparation, hydroseeding, etc). If a fast growing crop to nurse the permanent specie or species is required, then use the mix rate. Failure to carefully follow agronomic recommendations results in an inadequate stand of temporary vegetation that provides little or no erosion control.

Installation

Tillage

If the area has been recently plowed, no tillage is required other than raking or surface roughening to break any crust that has formed leaving a textured surface. Disk the soil for optimal germination when the soil is compacted less than 6-inches.

Soil Testing

Soil testing is available through Clemson University Cooperative Extension Service.

Lime

Lime is not required for temporary seeding unless a soil test shows that the soil pH is below 5.0. It may be desirable to apply lime during the temporary seeding operation to benefit the long-term permanent seeding. Apply a minimum of 1.5 tons of Lime/acre (70 pounds per 1000 square feet) if it is to be used.

Fertilizer

Apply a minimum of 500 pounds per acre of 10-10-10 fertilizer (11.5 pounds per 1000 square feet) or equivalent during temporary seeding unless a soil test indicates a different requirement. Incorporate fertilizer and lime (if used) into the top 4-6 inches of the soil by disking or other means where conditions allow.

Seeding

Loosen the soil surface before broadcasting the seed. Apply seed evenly by the most convenient method available for the type of seed used and the location of the temporary seeding. Typical application methods include but are not limited to cyclone seeders, rotary spreaders, drop spreaders, broadcast spreaders, hand spreaders, cultipacker seeder, and hydro-seeders. Cover applied seed by raking or dragging a chain, and then lightly firm the area with a roller or cultipacker.

Mulching

Use mulch with temporary seed applications to retain soil moisture and reduce erosion during the establishment of vegetation. Typical mulch applications include straw, wood fiber, hydromulches, BFM and FGM. Use hydromulches with a minimum blend of 70% wood fibers.

The most commonly accepted mulch used in conjunction with temporary seeding is small grain straw. This straw should be dry and free from mold damage and noxious weeds. The straw may need to be anchored with netting or emulsions to prevent it from being blown or washed away. Apply the straw mulch by hand or machine at the rate 1.5-2 tons per acre (90 pounds per 1000 square feet). Frequent inspections are necessary to check that conditions for growth are good.

Irrigation

Seeded areas should be kept adequately moist. Irrigate the seeded area if normal rainfall is not adequate for the germination and growth of seedlings. Water seeded areas at controlled rates that are less than the rate at which the soil can absorb water to prevent runoff. Runoff of irrigation water wastes water and can cause erosion.

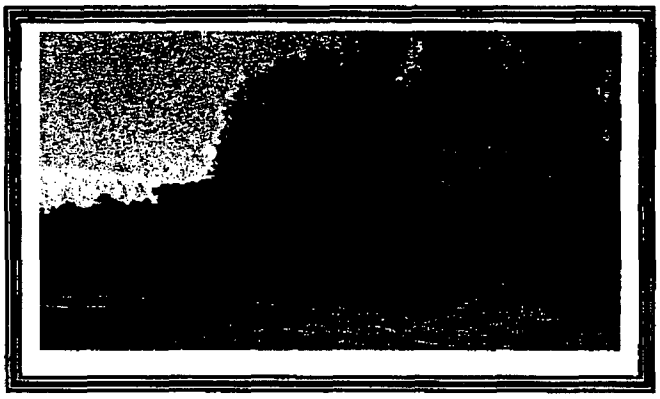
Re-seeding

Re-seed areas where seeding does not grow quickly, thick enough, or adequately to prevent erosion. Base seed selection should on the requirements of local Specifications.

Inspection and Maintenance

- Inspect every 7 calendar days and within 24-hours after each rainfall event that produces ½-inches or more of precipitation.
- Cover seeded with mulch to provide protection. Frequent inspections are necessary to check that conditions for growth are good.
- Supply temporary seeding with adequate moisture. Supply water as needed, especially in abnormally hot or dry weather or on adverse sites. Control water application rates to prevent runoff.

- Base seed selection on local Specifications.
- Re-seed areas where the plants do not grow quick enough, thick enough, or adequately enough to prevent erosion should be re-seeded.



Temporary Seeding

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Slope was improperly dressed before application.	Roughen slopes. Furrow along the contour of areas to be seeded.
Coverage is inadequate.	Follow recommended application rates. Count the number of seedbags to ensure the correct amount of material is being applied. Reapply to thin areas.
Seeds fail to germinate.	Apply straw mulch to keep seeds in place and to moderate soil moisture and temperature. In arid areas, temporary irrigation may be necessary.
Seeded slope fails.	Fill in rills and re-seed; fertilize, and mulch slopes.
Seeding is washed off slope.	Allow at least 24-hours for the materials to dry before a rain event. Follow manufacturer's recommendations. Reapply where necessary.
Excessive water flows across stabilized surface.	Use other BMPs to limit flow on stabilized area and to reduce slope lengths. Do not use to stabilize areas with swift moving concentrated flows.

Mulching

Plan Symbol

M

Description

Mulching is a temporary soil stabilization erosion control method where materials such as grass, hay, wood chips, wood fibers, or straw are placed on the soil surface. In addition to stabilizing soils, mulching enhancse the absorption of water by the soil, reduce evaporation losses, regulate soil temperatures, and reduce the speed of storm water runoff over an area.

When and Where to Use It

Use erosion control mulching on level areas or on slopes up to 50 percent. Where soil is highly erodible, nets should only be used in connection with organic mulch such as straw and wood fiber.

Mulch is an effective ground cover when the establishment of vegetation is improbable due to severe weather conditions (winter conditions), poor soil, or steep slopes.

Installation

Grading is not necessary before mulching but may be required if vegetation is expected to grow.

Anchor loose hay or straw by applying tackifier, stapling netting over the top, or crimping with a mulch-crimping tool.

Effective use of netting and matting material requires firm, continuous contact between the materials and the soil. If there is no contact, the material will not hold the soil and erosion will occur underneath the material.

Materials that are heavy enough to stay in place (for example, bark or wood chips on flat slopes) do not need anchoring.

Apply hydro-mulch in spring, summer, or fall to prevent deterioration of mulch before vegetation becomes established.

There must be adequate coverage to prevent erosion, washout, and poor plant establishment. If an appropriate tacking agent is not applied, or is applied in insufficient amounts, mulch is lost to wind and runoff.

Inspection and Maintenance

- Inspect every 7 calendar days and within 24-hours after each rainfall event that produces ½-inches or more of precipitation.
- Repair or replace damaged areas of mulch or tie-down material immediately.

Straw Mulch

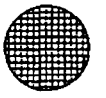
Straw Mulch with Tackifier

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Mulch blows away.	Anchor straw mulch in place by applying a tackifier, crimping, punching, or track walking. May need to use a different BMP.
Coverage is inadequate.	Follow recommended application rates. Ensure that the correct amount of material is implemented. Reapply as necessary.
Mulch has washed away.	Do not place mulch in concentrated flow areas. Reapply as necessary.
Area was improperly dressed before application.	Remove existing vegetation and roughen embankment and fill areas by rolling with a punch type roller or by track walking.
Excessive water flows across stabilized surface.	Use other BMPs to limit flow onto stabilized area and/or to reduce slope lengths. Do not use to stabilize areas with swift moving concentrated flows.

Erosion Control Blankets (ECBs)

Plan Symbol



Description

Temporary erosion control blankets (ECBs) are products composed primarily of biologically, photochemically or otherwise degradable constituents such as wheat straw, coconut fiber, or aged curled excelsior wood product with longevity of approximately 1- to 3-years.

When and Where to Use It

ECBs are used for the temporary stabilization of soil immediately following seeding until the vegetative cover has grown and becomes established. ECBs provide temporary protection by degrading over time as the vegetation becomes established. Some products are effective for a few months while others degrade slowly and are effective for up to 3-years.

ECB Categories

- Class A (Slope Applications Only)
- Class B (Channel Applications Only).

Class A ECBs are for **slope applications only**.

- Applicable for slopes **2H:1V or flatter** only. Slopes greater than 2H:1V require Turf Reinforcement Matting (TRM).

Class B ECBs are for **channel applications**.

- Applicable for channels and concentrated flow areas with a maximum calculated shear stress **less than 1.75 lb/ft^2**. Channels and concentrated flow areas with design shear stresses greater than 1.75 lb/ft^2 require TRM

All acceptable Class A and Class B temporary erosion control blankets consisting of straw, coconut, or straw-coconut blends meet the following requirements:

- Utilize non-organic, photodegradable or biodegradable polypropylene netting.
- Consist of **double netted matting**, defined as matting with netting on both sides of the blanket. The top netting is degradable polypropylene with a maximum mesh opening of 0.75 inches by 0.75 inches. The bottom is degradable polypropylene with a maximum mesh opening of 0.5 inches by 0.5 inches.
- Be sewn on center a maximum of 2.0 inches

All acceptable Class A and Class B temporary erosion control blankets consisting of curled excelsior fibers meet the following requirements:

- Utilize non-organic, photodegradable or biodegradable polypropylene netting
- Consist of double netted matting. Double netted matting is matting with netting on both sides of the blanket. The degradable polypropylene top netting requires a maximum mesh opening of 1.0-inches by 1.0-inches, while the degradable polypropylene bottom netting requires a maximum mesh opening of 1.0-inches by 1.0-inches
- Consist of curled excelsior interlocking fibers with 80% of the fibers a minimum of 6-inches long
- Sewn on center a maximum of 4.0-inches.

Use Class A and Class B temporary erosion control blankets having the following Minimum Average Roll Values (MARV) for physical properties, as derived from quality control testing performed by a Geosynthetic Accreditation Institute – Laboratory Accreditation Program (GAI-LAP) accredited laboratory:

- Minimum mass per unit area (ASTM D6475) of 6 oz/yd^2 (203 g/m^2)
- Minimum thickness (ASTM D6525) of 0.25-inches (6 mm)
- Minimum initial grab tensile strength (ASTM D6818) of 75 x 75 lb/ft. (1 x 1 kN/m)
- Minimum roll width of 48-inches (1.22 m)
- For Class B channel applications, a minimum unvegetated shear stress of 1.0 lb/ft^2 (48 N/m^2) based on short-term peak flow duration of 0.5 hour is required.

Installation

Grade and compact areas to be protected with ECBs as indicated on the plans.

Remove large rocks, soil clods, vegetation, and other sharp objects that could keep the ECB from intimate contact with subgrade.

Prepare seedbed by loosening 2 to 3 inches of soil above final grade.

The proper installation of ECBs is different for each product, therefore the recommended installation procedure from the specific manufacturer should be followed.

When requested, a Manufacturer's Representative may be required to be on-site to oversee and approve the initial installation of the ECB. When requested, a letter from the Manufacturer approving the contractor installation may be required.

Inspection and Maintenance

- Inspect areas protected by ECBs for dislocation or failure every 7 calendar days and within 24-hours after each storm that produces ½-inch or more of rain.
- Conduct regular inspections until grasses are firmly established.
- Adhere to the pinning or stapling pattern as shown on the Manufacturer's installation sheet. If there is evidence that the ECB is not securely fastened to the soil, require extra pins or staples to inhibit the ECB from becoming dislodged.
- If washout or breakage occurs, repair all damaged areas immediately by restoring the soil on slopes or channels to its finished grade, re-apply fertilizer and seed, and replacing the appropriate ECB material as needed.

ECB Channel Design Criteria

The design of a permanent conveyance with a grassed or vegetative lining should address the bare condition prior to vegetation being established. An ECB will protect the conveyance during this period. Use both the tractive force and the permissible velocity methods to determine the level of protection that is required.

The design of ECBs is based on the anticipated shear stresses and maximum flow velocities the fabric will encounter. Once the design shear stresses and maximum flow velocities are known, select a corresponding ECB that meets the conditions from the SCDOT approved product list.

- The governing equation for maximum channel shear stress is:

$$\tau = \gamma d_n S$$

Where:

τ	=	maximum shear stress (lbs/ft^2)
γ	=	unit weight of water = 62.4 lbs/ft^3
d_n	=	maximum normal channel flow depth (ft)
S	=	channel bed slope (ft/ft)

The following variables are required to determine the maximum velocity in a channel for a 10-year 24-hour storm event.

- Design peak flow rate value in cubic feet per second (cfs) for the 10-year 24-hour storm,
- Channel dimensions designed to carry the peak flow rate. For simplicity, all channels will be assumed to be trapezoidal in shape,
- Channel bed slope,
- Manning's channel roughness coefficient (n) of the ECB from the following conditions:
  - Bare ECB with no vegetation,
  - ECB with maintained vegetation, and
  - ECB with un-maintained vegetation, and
- Normal channel flow depth (d_n) based on peak flow rate, channel dimensions and Manning's n value.

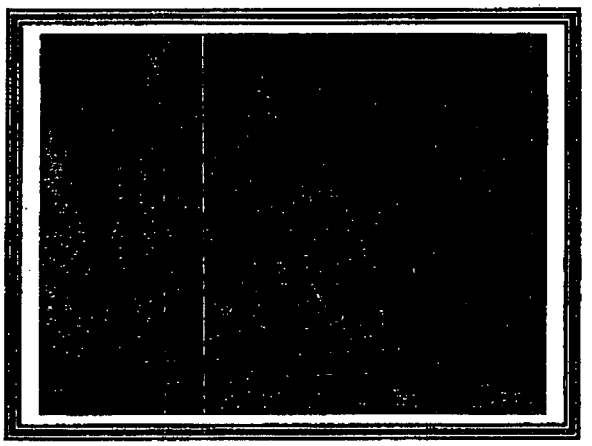
The governing equation for maximum velocity is Manning's Equation:

$$V = (1.49 / n)\ R^{2/3}\ S^{1/2}$$

Where :

V	=	Maximum velocity (ft/sec)
n	=	Manning's channel roughness coefficient
R	=	Hydraulic radius of the flow based on d_n (ft)
S	=	Channel bed slope (ft/ft)

ECB Slope Application



ECB Slope Application

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Undercutting occurs along the top of the slope.	Dig a 6-x 6-inch trench along the top of the slope and anchor blanket into trench by back filling and tamping the soil.
Blankets separate along the seams.	Overlap adjacent blanket 2- to 3-inch and staple every 3-feet.
Blankets separate where the rolls are attached end to end.	Shingle the blanket so the top blanket covers the bottom blanket by 6-inches and staple through the overlapped areas every 12-inches.
Blanket does not make complete contact with the soil surface.	Prepare the soil surface by removing rocks, clods, sticks and vegetation, fill in rill, and uneven areas.
Excessive water flows across stabilized surface.	Use other BMPs to limit flow on stabilized area. Use other BMPs to reduce slope lengths. Do not use to stabilize areas with swift moving concentrated flows.

Turf Reinforcement Mats (TRMs)

Plan Symbol

Description

Turf Reinforcement Mats are products composed primarily of nondegradable products that enhance the ability of living plants to stabilize soils. They bind with roots to reinforce the soil matrix with longevity greater than 5-years.

When and Where to Use It

Use TRMs where vegetation alone will not hold a slope or streambank. TRMs enable the use of "green" solutions in areas where only "hard" solutions such as riprap or concrete linings were viable in the past.

TRM Categories

- Type 1, Type 2, Type 3, and Type 4.

Types 1 & 2 TRMs are a strong three-dimensional stable net structure. A degradable fiber matrix may be included to provide immediate coverage for bare soil.

- **Type 1** matting should be placed on slopes **2H:1V or flatter** or in channels where the calculated design shear stress is **4.0 lb/ft2 or less** and the design flow velocity is **up to 10 fps**.
- **Type 2** matting should be placed on slopes **1.5H:1V or flatter** or in channels where the calculated design shear stress is **6.0 lb/ft2 or less** and the design flow velocity is **up to 15 fps**.
- **Type 3** TRMs are a strong three-dimensional stable net structure providing sufficient thickness, strength, and void space to capture and retain soil and allow for the development of root growth and vegetation within the matrix. Matting of this type should be placed on slopes **1H:1V or flatter** or in channels where the calculated design shear stress is **8.0 lb/ft2 or less** and the design flow velocity is **up to 20 fps**
- **Type 4** (High Survivability) TRMs are specially designed geosynthetics for erosion control applications on steep slopes and vegetated waterways.

  - All components of Type 4 TRMs should be 100% synthetic and resistant to biological, chemical, and ultraviolet degradation.

  - Matting of this type should be placed on slopes **1H:1V or greater** or in channels where the calculated design shear stress is **up to 12 lb/ft2** and the design flow velocity is **up to 25 fps**.

  - This category is used when field conditions exist with high loading and/or high survivability requirements such as maintenance, structural backfills protecting critical structures, utility cuts, potential traffic areas, abrasion, higher factors of safety and/or general durability concerns.

All primary TRM matrix materials are defined as long-term, non-degradable materials designed to reduce soil erosion and assist in the growth, establishment, and protection of vegetation for a period of time exceeding 5 years.
The major structural components of Type 1 and Type 2 TRMs are 100% synthetic and resistant to biological, chemical, and ultraviolet degradation. A degradable fiber matrix may be included to provide immediate coverage for bare soil. All components of Type 3 and Type 4 TRMs are 100% synthetic and resistant to biological, chemical, and ultraviolet degradation.

Installation

Grade and compact areas to be protected with TRMs as indicated on the plans.

Remove large rocks, soil clods, vegetation, and other sharp objects that could keep the TRM from intimate contact with subgrade.

Prepare seedbed by loosening 2 to 3 inches of soil above final grade.

The proper installation of TRMs is different for each product, therefore the recommended installation procedure from the specific manufacturer should be followed.

When requested, a Manufacturer's Representative may be required to be on-site to oversee and approve the initial installation of the TRM. When requested, a letter from the Manufacturer approving the contractor installation may be required.

Inspection and Maintenance

- Check areas protected by TRMs for dislocation or failure every 7 calendar days and within 24-hours after each storm that produces ½-inch or more of rain.
- Conduct regular inspections until grasses are firmly established.
- Adhere to the pinning or stapling pattern as shown on the Manufacturer's installation sheet. If there is evidence that the TRM is not securely fastened to the soil, install extra pins or staples to inhibit the TRM from becoming dislodged.
- If washout or breakage occurs, repair all damaged areas immediately by restoring the soil on slopes or channels to its finished grade, re-apply fertilizer and seed, and replacing the appropriate TRM material as needed.

TRM Channel Design Criteria

When designing a permanent conveyance with a grassed or vegetative lining, the design should address the bare condition prior to vegetation being established. A geotextile lining may be applied to protect the conveyance during this period. It is important to use both the tractive force and the permissible velocity methods to determine the level of protection that is required.

The design of TRMs is based on the anticipated shear stresses and maximum flow velocities the fabric will encounter. Once the design shear stresses and maximum flow velocities are known, a corresponding TRM that meets the conditions may be selected from the SCDOT approved products list.

- The governing equation for maximum channel shear stress is:

$$\tau = \gamma d_n S$$

Where :

τ	=	maximum shear stress (lbs/ft^2)
γ	=	unit weight of water = 62.4 lbs/ft^3
d_n	=	maximum normal channel flow depth (ft)
S	=	channel bed slope (ft/ft)

The following variables are required to determine the maximum velocity in a channel for a 10-year 24-hour storm event.

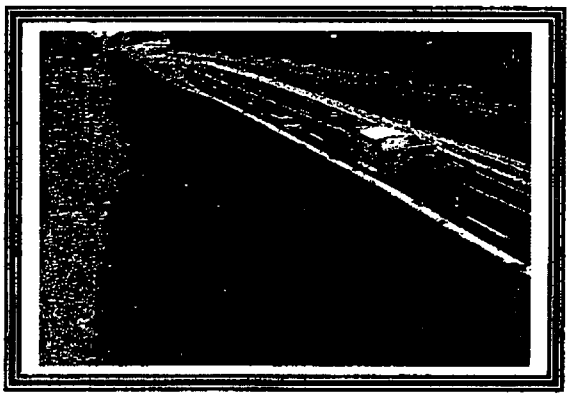
- Design peak flow rate value in cubic feet per second (cfs) for the 10-year 24-hour storm,
- Channel dimensions designed to carry the peak flow rate. For simplicity, all channels will be assumed to be trapezoidal in shape,
- Channel bed slope,
- Manning's channel roughness coefficient (n) of the TRM based on the following,
  - Bare matting with no vegetation,
  - Matting with maintained vegetation, and
  - Matting with un-maintained vegetation, and
- Normal channel flow depth (d_n) based on peak flow rate, channel dimensions, and Manning's n value.

- The governing equation for maximum velocity is Manning's Equation:

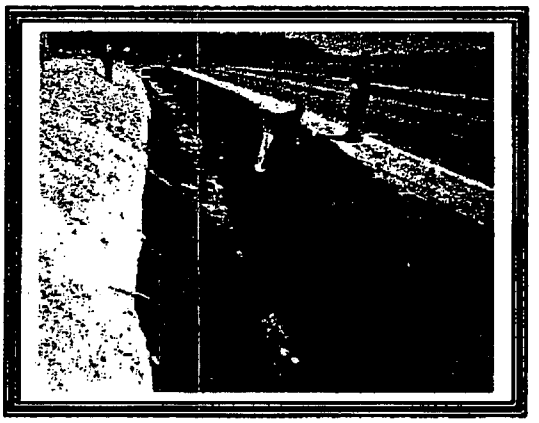
$$V = (1.49 / n)\ R^{2/3}\ S^{1/2}$$

Where :

V	=	Maximum velocity (ft/sec)
n	=	Manning's channel roughness coefficient
R	=	Hydraulic radius of the flow based on d_n (ft)
S	=	Channel bed slope (ft/ft)



TRM Slope Application



TRM Channel Application

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Improper anchoring.	Dig trench along the top and bury the blankets. Use staples to anchor according to manufacturer's recommendations.
Undercutting due to inadequate preparation.	Prepare the soil surface. Remove rocks, clods, and other obstructions. Fill in rills in uneven areas to promote good contact between mat and soil.
Excessive water flows across stabilized slope surface.	Use other BMPs to limit flow on stabilized area. Use other BMPs to reduce slope lengths. Do not use to stabilize areas with swift moving concentrated flows.

Flexible Growth Media/Matrix

Plan Symbol

FGM

Description

A Flexible Growth Matrix (FGM) combines both chemical and mechanical bonding techniques to lock the matrix in place. FGM is composed of crimped, manmade fibers, organic fibers, and performance-enhancing additives that form a lofty, interlocking matrix. FGM has air spaces and water-absorbing cavities that improve seed germination, reduce the impact of raindrop energy, and minimize soil loss. Water insoluble tackifiers and flocculants chemically bond the matrix to the soil surface.

When and Where to Use It

FGM is applicable for the following situations:

- As a Type A Temporary Erosion Control Blanket
- Slopes up to 2H:1V
- As an infill for TRMs on slopes greater than 2H:1V
- Environmentally sensitive areas not compatible for netting
- When the required longevity of soil protection is up to 1 year
- When the site requires immediate erosion protection and there is a risk of impending weather
- When fast vegetation establishment is required
- When a high factor of design safety is required.

FGM is <u>not</u> applicable as a channel liner or for areas receiving concentrated flow. Applicable FGM may be selected from the SCDOT approved products list.

Installation

All FGM components are pre-packaged by the Manufacturer to assure material performance. Under no circumstances is field mixing of materials, additives or components accepted. Examine substrates and conditions where materials will be applied. Apply FGM to geotechnically stable slopes that have been designed and constructed to divert runoff away from the face of the slope. Do not proceed with installation until satisfactory conditions are established.

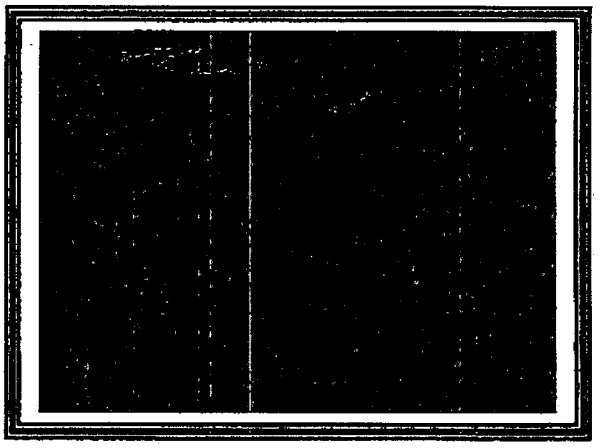
Install FGM with a contractor who is certified and trained by the Manufacturer in the proper procedures for mixing and applying the FGM. Strictly comply with the Manufacturer's mixing recommendations and installation instructions. Use approved hydraulic seeding/mulching machines with fan-type nozzle (50-degree tip) for FGM applications. Apply FGM from opposing directions to the soil surface in successive layers, reducing the "shadow effect" to achieve maximum coverage of all exposed soil. FGM does not require a cure time and is effective immediately such that FGM may be applied immediately before, during or after a rainfall event. Install FGM materials according to the Manufacturer's application rates.

Inspection and Maintenance

- Check areas protected by FGM for dislocation or failure every 7 calendar days and within 24-hours after each storm that produces ½-inch or more of rain.
- Reapply FGM to disturbed areas that require continued erosion control.

- Maintain equipment to provide uniform application rates. Rinse all mixing and application equipment thoroughly with water to avoid formation of residues and discharge rinse water appropriately.
- Degradation of FGM is expected to occur as a result of mechanical degradation, chemical and biological hydrolysis, sunlight, salt and temperature. Reapply FGM in accordance with the Manufacturer's instructions. Reapplication is not required unless FGM treated soils are disturbed or turbidity or water quality shows the need for an additional application.

FGM Application



FGM

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Slope areas have eroded due to concentrated flows.	Make sure the upper end of the slope has a berm constructed to eliminate concentrated flows from flowing down the slope. Slope length may be too long and concentrated flows are occurring. Use sediment tubes or other practices to provide slope breaks. Re-apply FGM to the eroded areas once the concentration problem has been resolved.
Rain event is impending.	FGM does not require a cure time and is effective immediately such that FGM may be applied immediately before, during or after a rainfall event.
FGM has degraded.	FGM has a longevity of soil protection up to 1 year. In some instances degradation of FGM occurs as a result of mechanical degradation, chemical and biological hydrolysis, sunlight, salt and temperature. Reapply FGM in accordance with the Manufacturer's instructions. Reapplication is not required unless FGM treated soils are disturbed or turbidity or water quality shows the need for an additional application.

Bonded Fiber Matrix (BFM)

Plan Symbol

BFM

Description

A Bonded Fiber Matrix (BFM) is a continuous layer of non-toxic, degradable, elongated fiber materials held together by water insoluble bonding agents. BFM eliminates direct raindrop impact on soil, allows no gaps between the product and the soil, and has a high water-holding capacity. BFMs do not form a water-insensitive crust that can inhibit plant growth. BFMs are completely photo- and biodegradable.

When and Where to Use It

BFMs are applicable when:

- Enhancement of temporary seeding operations to reduce erosion and expedite seed germination
- A high performance mulch is required for permanent seeding
- Seeding application will take place on highly erodible soil or slopes
- Slopes up to 1H:1V
- The required functional longevity of soil protection is 6 months or less
- The soil is dry and rain is not expected within 48 hours after application
- There is a high degree of certainty that heavy rains will not follow application.

BFMs are **not** applicable as Type A Temporary Erosion Control Blankets, channel liners or for areas receiving concentrated flow. Applicable BFM may be selected from the SCDHEC approved products list.

Installation

All BFM components are pre-packaged by the Manufacturer to assure material performance. Under no circumstances is field mixing of materials, additives or components accepted. Examine substrates and conditions where materials will be applied. Do not proceed with installation until unsatisfactory conditions are corrected. Apply BFM to geotechnically stable slopes that have been designed and built to divert runoff water away from the face of the slope, eliminating damage to the slope face caused by the surface flow from above the slope.

Install BFM with a contractor who is certified and trained by the Manufacturer in the proper procedures for mixing and applying the BFM. Strictly comply with the Manufacturer's mixing recommendations and installation instructions. Use approved hydraulic seeding/mulching machines with fan-type nozzle (50-degree tip) for BFM applications. Apply BFM from opposing directions to the soil surface in successive layers, reducing the "shadow effect" to achieve maximum coverage of all exposed soil. Do not apply the BFM immediately before, during or after rainfall. Allow the BFM a minimum of 24 hours to dry after installation. Do not exceed maximum slope length of 100 feet when slope gradients are steeper than 4H:1V. Install BFMs at a general application rate of 3500 pounds per acre.

Inspection and Maintenance

- Check areas protected by BFM for dislocation or failure every 7 calendar days and within 24-hours after each storm that produces ½-inch or more of rain.
- Reapply BFM to disturbed areas that require continued erosion control.
- Maintain equipment to provide uniform application rates.

- Rinse all BFM mixing and application equipment thoroughly with water to avoid formation of residues and discharge rinse water appropriately.
- Degradation of BFM is expected to occur as a result of mechanical degradation, chemical and biological hydrolysis, sunlight, salt and temperature. Reapply BFM in accordance with the Manufacturer's instructions. Reapplication is not required unless BFM treated soils are disturbed or turbidity or water quality shows the need for an additional application.

BFM Application

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Slope areas have eroded due to concentrated flows.	Make sure the upper end of the slope has a berm constructed to eliminate concentrated flows from flowing down the slope. Slope length may be too long and concentrated flows are occurring. Use sediment tubes or other practices to provide slope breaks. Re-apply BFM to the eroded areas once the concentration problem has been resolved.
Rain event is impending.	BFM requires a cure time. Do not apply the BFM immediately before, during or after rainfall. Allow the BFM a minimum of 24 hours to dry after installation.
BFM has degraded.	BFM has longevity of soil protection up to 6-months. In some instances degradation of BFM occurs as a result of mechanical degradation, chemical and biological hydrolysis, sunlight, salt and temperature. Reapply BFM in accordance with the Manufacturer's instructions. Reapplication is not required unless BFM treated soils are disturbed or turbidity or water quality shows the need for an additional application.

Permanent Seeding

Plan Symbol

PS

Description

Controlling runoff and preventing erosion by establishing a perennial vegetative cover with seed.

When and Where to Use It

A major consideration in the selection of the type of permanent grass to establish is the intended use of the land. Land use is separated in to two categories, high-maintenance and low-maintenance.

High-maintenance

High maintenance areas are mowed frequently, lime or fertilized on a regular basis, and require maintenance to an aesthetic standard. Land uses with high maintenance grasses include homes, industrial parks, schools, churches, and recreational areas such as parks, athletic fields, and golf courses.

Low-maintenance

Low maintenance areas are mowed infrequently, if at all, and lime and fertilizer may not be applied on a regular schedule. These areas are not subject to intense use and do not require a uniform appearance. The vegetation must be able to survive with little maintenance over long periods of time. Grass and legume mixtures are favored in these areas because legumes are capable of fixing nitrogen in the soil for their own use and the use of the grasses around them. Land uses requiring low-maintenance grasses include steep slopes, stream and channel banks, road banks, and commercial and industrial areas with limited access.

Seed Selection

The use of native species is preferred when selecting vegetation. Base plant seed selection on geographical location, the type of soil, the season of the year in which the planting is to be done, and the needs and desires of the permanent land user. Failure to carefully follow agronomic recommendations results in an inadequate stand of permanent vegetation that provides little or no erosion control.

Installation

Topsoil

Apply topsoil if the surface soil of the seedbed is not adequate for plant growth.

Tillage

If the area has been recently plowed, no tillage is required other than raking or surface roughening to break any crust that has formed leaving a textured surface. Disk the soil for optimal germination when the soil is compacted less than 6-inches. If the soil is compacted more than 6-inches, sub-soiled and disk the area.

Soil Testing

Soil testing is available through Clemson University Cooperative Extension Service.

Lime

Unless a specific soil test indicates otherwise, apply 1½ tons of ground course textured agricultural limestone per acre (70 pounds per 1000 square feet).

Fertilizer

Apply a minimum of 1000 pounds per acre of a complete 10-10-10 fertilizer (23 pounds per 1000 square feet) or equivalent during permanent seeding of grasses unless a soil test indicates a different requirement. Incorporate fertilizer and lime (if used) into the top 4-6 inches of the soil by disking or other means where conditions allow. Do not mix the lime and the fertilizer prior to the field application.

Seeding

Loosen the surface of the soil just before broadcasting the seed. Evenly apply seed by the most convenient method available for the type of seed applied and the location of the seeding. Typical application methods include but are not limited to cyclone seeders, rotary spreaders, drop spreaders, broadcast spreaders, hand spreaders, cultipacker seeder, and hydro-seeders. Cover applied seed by raking or dragging a chain or brush mat, and then lightly firm the area with a roller or cultipacker. Do not roll seed that is applied with a hydro-seeder and hydro-mulch.

Mulching

Cover all permanent seeded areas with mulch immediately upon completion of the seeding application to retain soil moisture and reduce erosion during establishment of vegetation. Apply the mulch evenly in such a manner that it provides a minimum of 75% coverage. Typical mulch applications include straw, wood fiber, hydromulches, BFM and FGM. Use hydromulches with a minimum blend of 70% wood fibers.

The most commonly accepted mulch used in conjunction with permanent seeding is small grain straw. Select straw that is dry and free from mold damage and noxious weeds. The straw may need to be anchored with netting or asphalt emulsions to prevent it from being blown or washed away. Apply straw mulch by hand or machine at the rate 2 tons per acre (90 pounds per 1000 square feet). Frequent inspections are necessary to check that conditions for growth are good.

Irrigation

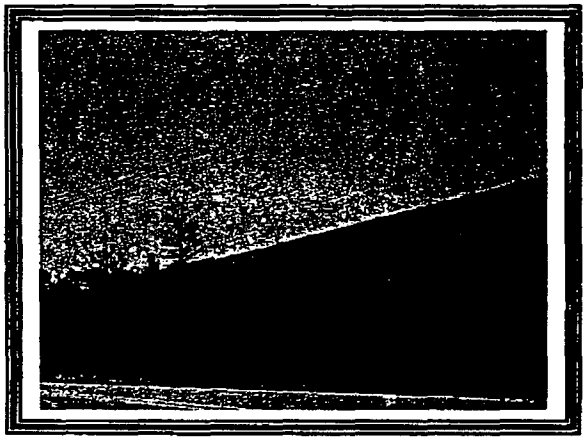
Keep permanent seeded areas adequately moist, especially late in the specific growing season. Irrigate the seeded area if normal rainfall is not adequate for the germination and growth of seedlings. Water seeded areas at controlled rates that are less than the rate at which the soil can absorb water to prevent runoff. Runoff of irrigation water wastes water and can cause erosion.

Re-seeding

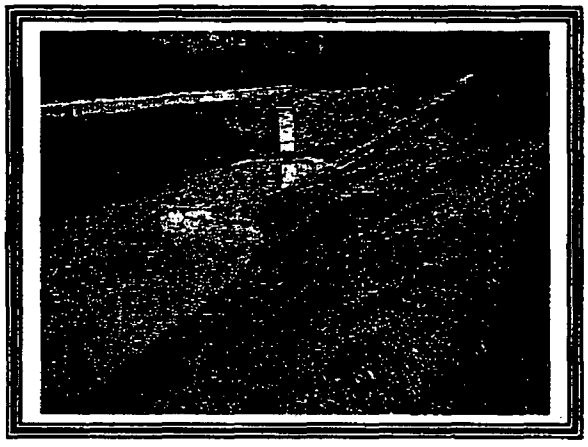
Inspect permanently seeded areas for failure, make necessary repairs and re-seed or overseed within the same growing season if possible. If the grass cover is sparse or patchy, re-evaluate the choice of grass and quantities of lime and fertilizer applied. Final stabilization by permanent seeding of the site requires that it be covered by a 70% coverage rate.

Inspection and Maintenance

- Inspect seeded areas for failure and make necessary repairs and re-seed immediately. Conduct a follow-up survey after one year and replace failed plants where necessary.
- If vegetative cover is inadequate to prevent rill erosion, overseed and fertilize in accordance with soil test results.
- If a stand of permanent vegetation has less than 40 percent cover, re-evaluate choice of plant materials and quantities of lime and fertilizer.
- Re-establish the stand following seed bed preparation and seeding recommendations, omitting lime and fertilizer in the absence of soil test results.
- If the season prevents re-sowing, mulch is an effective temporary cover.
- Final stabilization of the site requires a 70 percent overall coverage rate. This does not mean that 30 percent of the site can remain bare. The coverage is defined as looking at a square yard of coverage, in which 70 percent of that square yard is covered with vegetation.



Permanent Seeding



Permanent Seeding

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Areas have eroded.	Re-seed or replace eroded areas.
Vegetation cover is inadequate and rill erosion is occurring.	Overseed and fertilize in accordance with soil test results.
Stand of permanent vegetation has less than 40% cover.	Re-evaluate choice of plant materials and quantities of lime and fertilizer.
Vegetation show signs of wilting before noon.	Water vegetation by wetting soil to a depth of 4-inches.

Sodding

Plan Symbol

SO

Description

Sodding is transplanting vegetative sections of plant materials to promptly stabilize areas that are subject to erosion. Use commercial sod which is a cultured product utilizing specific grass species.

When and Where to Use It

Sodding is appropriate for any graded or cleared area that may erode, and where a permanent, long-lived plant cover is immediately needed. Examples of where sodding is used are yards, buffer zones, streambanks, dikes, swales, slopes, outlets, level spreaders, and filter strips.

Installation

In general, do not use sod on slopes greater than 2H:1V or 3H:1V if it is to be mowed. If sod is placed on steep slopes, lay it with staggered joints and/or staple the sod down.

Clear the soil surface of trash, debris, roots, branches and soil clods in excess of 2-inches length or diameter. Rake soil surface to break crust just before laying sod or irrigate soil lightly if the soil is dry. Do not install sod on hot, dry or frozen soil, gravel, compacted clay, or pesticide treated soils.

Harvest, deliver and install sod within a period of 36-hours. Store rolls of sod in shade during installation. Sod should be free of weeds and be of uniform thickness, about 1-inch, and should have a dense root mat for mechanical strength.

Lay strips of sod beginning at the lowest area to be sodded with the longest dimension of the strip perpendicular to the slope, and stagger in a brick-like pattern. Wedge strips securely in place. Square the ends of each strip to provide for a close, tight fit. Match angled ends correctly to prevent voids.

Roll or compact immediately after installation to ensure firm contact with the underlying topsoil.

Irrigate the sod until the soil is wet to a depth of 2-inches, and keep moist until grass takes root.

Inspection and Maintenance

- Watering may be necessary after planting and during periods of intense heat and/or lack of rain (drought). Keep soil moist to a depth of 2-inches until sod is fully rooted.
- Mow to a height of 2 to 3 inches after sod is well-rooted (2-3 weeks). Do not remove more than 1/3 of the shoot in any one mowing.
- Permanent, fine turf areas require yearly applications of fertilizer and lime.
- Inspect the sod frequently after it is first installed, especially after large storm events, until it has established a permanent cover.

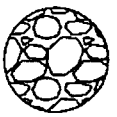
Sodding

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Drought	Keep soil moist to a depth of 2-inches until sod is fully rooted

Riprap

Plan Symbol



Description

Riprap is a permanent, erosion-resistant channel lining aggregate consisting of large, loose, angular stone with a filter fabric or granular underlining. The purpose of riprap is to:

- Protect the soil from the erosive force of concentrated runoff
- Slow runoff velocities while enhancing the potential for infiltration

The filter fabric or granular underlining prevents undermining of the riprap layer by the migration of soil particles under seepage forces through the riprap.

When and Where to Use It

The preferred method of slope and channel protection is the use of vegetation. If vegetation can not withstand the design flows, ECBs and TRMs are the preferred and suggested method of protection. When conditions are too severe for vegetation and TRMs, riprap may be used for erosion control and protection. Riprap is used, as appropriate, at storm drain outlets, on channel banks and/or bottoms, drop structures, at the toe of slopes, and in transitions from concrete channels to vegetated channels. Riprap sizes are designed by the diameter or by the weight of the stones. It is often misleading to think of riprap in terms of diameter, since the stones should be angular instead of spherical.

Installation

Place a lining of geotextile filter fabric or granular filter material between the riprap and the underlying soil surface to prevent soil movement into or through the riprap.

Inspection and Maintenance

- Once a riprap installation has been completed, it should require very little maintenance.
- It should, however, be inspected periodically to determine if high flows have caused scour beneath the riprap and filter fabric or dislodged any of the stone.
- Care must be taken to properly control sediment-laden construction runoff that may drain to the point of the new installation. If repairs are needed, they should be performed immediately.

Riprap Design Criteria

Riprap at Outlets

Design criteria for sizing the stone and determining the dimensions of riprap pads used at the outlet of drainage structure are given in the Outlet Protection section of this Manual.

Riprap for Channel Stabilization

Design of erosion protection within the channel can be accomplished using the FHWA Tangent Flow Method presented below. This method is applicable to both straight and curved channel sections where flows are tangent to channel bank. The Tangent Flow Method determines a stable rock size for straight and curved channel sections using known shape, flow depth, and channel slope dimensions. A stone size is chosen for the maximum depth of flow. If the sides of the channel are steeper than 3H:1V, the stone size must be modified. The final design size will be stable on both the sides and bottom of the channel.

Straight Channel Sections

1. Refer to the graph shown in Figures RR1 with the maximum flow depth (**d** in feet) and channel slope (ft/ft). Select the point where the maximum flow depth and channel slope intersect. Choose the $\mathbf{d_{50initial}}$ stone size based upon the location of the point of intersection.

2. This completes the design procedure for channels with side slopes 3H:1V and flatter. If the channel side slopes are steeper than 3H:1V, continue with step 3.

3. Refer to the graph shown in Figure RR2 with the side slope (**Z** in H:V) and the base width (**B**) to maximum depth (**d**) ratio (**B/d**). Where the two lines intersect, move horizontally left to read $\mathbf{K_1}$.

4. Determine from the graph in Figure RR3 the angle of repose for the $\mathbf{d_{50initial}}$ stone size and the channel side slope **Z**. (Use an angle of 42° for $\mathbf{d_{50initial}}$ >10-inches. Do not use riprap on slopes steeper than the angle of repose for the stone size.)

5. Refer to the graph shown in Figure RR4 with the side slope (**Z**) of the channel and the angle of repose for the $\mathbf{d_{50initial}}$ stone size. Where the two lines intersect, move vertically down to read $\mathbf{K_2}$.

6. Compute $\mathbf{d_{50initial} \times K_1/K_2 = d_{50design}}$ to determine the correct size stone for the bottom and side slopes of straight sections of channel.

Curved Channel Sections

1. Refer to steps 1-6 under Straight Channel Sections
2. Determine the radius of the curved section ($\mathbf{R_O}$) in feet.
3. Calculate the top width of the riprap at the design water surface ($\mathbf{B_S}$) in feet

B_S	=	$B_O + 2(Z*D)$
B_O	=	Bottom width of channel (feet)
Z	=	Channel sides slopes defined as ZH:1V
D	=	Depth of riprap (feet)

4. Calculate the Ratio $\mathbf{B_S / R_O}$
5. Knowing the value of the $\mathbf{B_S/R_O}$ ratio from step 4, use the graph in Figure RR5 and read the corresponding value of $\mathbf{K_3}$.
6. Compute $\mathbf{(d_{50design} \times K_3) = d_{50curve}}$ to determine the correct size stone for the bottom and side slopes of curved channel sections.

Straight Channel Design Example

Given: Trapezoidal channel depth (D) 3-feet, bottom width (B_o) 8-feet, side slopes (Z) 2H:1V, and a 2 percent slope.

Find: A stable riprap size for the bottom and side slopes of the channel.

Solution:

1. From Figure RR1, for a 3-foot-deep channel over a 2 percent grade,
   Read $d_{50initial}$ = 0.75-feet or 9-inches.

2. Since the side slopes are steeper than 3H:1V, continue with step 3
   **If side slopes were less than 3H:1V, the process would be complete.

3. From Figure RR2, $B_O/d = 8/3 = 2.67$, Side slopes Z = 2,
   Read $K_1 = 0.82$.

4. From Figure RR3, for $d_{50initial}$ = 9-inches,
   Read Angle of Repose = 41

5. From Figure RR4, side slopes Z = 2, and Angle of Repose = 41 ,
   Read $K_2 = 0.73$.

6. Stable Riprap = $d_{50design}$ x (K_1/K_2) = 0.75 x (0.82/0.73) = 0.84-feet or 10-inches

Curved Channel Design Example

Given: The preceding straight channel example has a curved section with a radius of 50-feet.

Find: A stable riprap size for the bottom and side slopes of the curved channel section.

Solution:

1. Stable Riprap = $d_{50design}$ 10-inches from straight channel calculations.

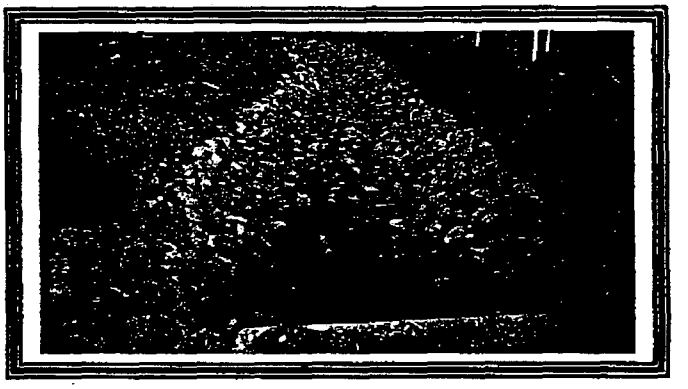
2. R_O = 50-feet.

3. Calculate Channel Top Width of Water Surface
   $B_S = B_O + 2(Z*D) = 8 + 2(2*3) = 20$-feet.

4. Calculate the Ratio B_S / R_O
   = 20/50 = 0.40

5. From Figure RR5, for $B_S / R_O = 0.40$
   Read $K_3 = 1.1$

6. $d_{50curve} = d_{50design}$ x K_3 = (0.84-ft. x 1.1) = 0.92-feet or 11-inches.



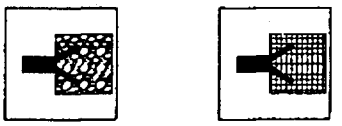
Riprap Lined Channel

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
High flows causing scour beneath riprap or filter fabric dislodging the stone.	Replace filter fabric and rearrange stone appropriately.
Riprap blocks channel, causing erosion along edges.	Make sure excavation is deep enough, rearrange riprap appropriately.
Piping or slumping occurs.	Make sure filter fabric was installed and make sure it isn't damaged.
Stones have moved and erosion of foundation has occurred.	Make sure riprap is properly graded.
Undercut riprap slope and slumping occurring.	Check to be sure that foundation toe is properly reinforced.
Stone displacement occurring.	Make sure fill slopes have been properly compacted, remove debris and make needed repairs.

Outlet Protection

Plan Symbol



Description

Outlet protection dissipates the energy of concentrated storm water flows reducing erosion or scouring at storm water outlets. In addition, outlet protection lowers the potential for downstream erosion. Outlet protection is achieved through a variety of techniques, including turf reinforcement mats (TRMs), riprap, concrete aprons, paved sections and other structural measures.

The techniques outlined in this section are not the only techniques that may be used for outlet protection design. This section shows one method for outlet protection design as an example of the variables that need to be considered in the design. Other methods utilized that are not discussed in this Handbook should include all graphs, charts, and calculations verifying that the protection will handle the peak flow velocity, flow depths, and shear stress.

Outlet Protection Design Criteria

The design of outlets for pipes and channel sections applies to the immediate area or reach below the pipe or channel and does not apply to continuous lining and protection of channels or streams. Notably, pipe or channel outlets at the top of cut slopes or on slopes steeper than 10 percent should not be protected using just outlet protection. This causes re-concentration of the flow resulting in increased velocities when the flow leaves the protection area. Outlet protection may be designed according to the following criteria:

1. The design flow velocity exiting the outlet at design capacity **should not** exceed the permissible velocity of receiving area.

2. Tailwater Depth:
   Tailwater is the water depth at the downstream end or outfall of the culvert. The depth of tailwater immediately below the outlet protection must be determined for the design capacity of the pipe.

   Minimum Tailwater Condition is defined as a tailwater depth less than ½ the diameter of the outlet pipe. Pipes that outlet onto flat areas with no defined channel have a minimum tailwater condition.

   Maximum Tailwater Condition is defined as a tailwater depth greater than ½ the pipe diameter.

3. Protection Length:
   The required protection length, L_a, according to the tailwater condition, should be determined from Figure OP1(minimum tailwater condition) or Figure OP2 (maximum tailwater condition).

4. Protection Width: When the pipe discharges directly into a well-defined channel, the protection should extend across the channel bottom and up the channel banks to an elevation one foot above the Maximum Tailwater depth or to the top of the bank (whichever is less).

- If the outlet discharges onto a flat area with no defined channel, the width of the protection should be determined with a Minimum Tailwater Condition:

  Design the upstream end of the protection, adjacent to the outlet, with a width three times the diameter of the outlet pipe (3D). Design the downstream end of the protection with a width equal to the pipe diameter plus the length of the apron ($D + L_a$).

- For a Maximum Tailwater Condition, design the downstream end of the protection with a width equal to the pipe diameter plus 0.4 times the length of the apron ($D + 0.4 * L_a$).

5. Bottom Grade: Construct the protection with no slope along its length (0 percent grade) where applicable. The downstream invert elevation of the protection is equal to the elevation of the invert of the receiving channel. There is no overfalling at the end of the protection.

6. Side Slopes: If the outlet discharges into a well-defined channel, the receiving side slopes of the channel should not be steeper than 3H: 1V.

7. Alignment: Locate the protection so there are no bends in the horizontal alignment.

8. Materials:

- The preferred protection lining is an appropriate permanent turf reinforcement matting (TRM). Calculate the shear stress and maximum velocity to determine the applicable TRM.
- When conditions are too severe for TRMs the protection may be lined with riprap, grouted riprap, concrete, or gabion baskets. The median-sized stone for riprap may be determined from design figures according to the tailwater condition.
- In all cases, place a non-woven geotextile filter cloth between the riprap and the underlying soil to prevent soil movement into and through the riprap. The material must meet or exceed the required physical properties for filter cloth.

Installation

- Do not protect pipe or channel outlets at the top of cut slopes or on slopes steeper than 10% with only outlet protection. This causes re-concentration of the flow that results in large velocities when the flow leaves the protection area.
- Follow specific standards for installation of the selected materials used for outlet protection.
- Follow all Manufacturer's installation procedures for TRMs and other manufactured products.
- A Manufacturer's Representative may be required to oversee all installation procedures and officially approve the installation of manufactured products used for outlet protection.

Inspection and Maintenance

- Periodically check all outlet protection, aprons, plunge pools, and structural outlets for damage. Immediately make all needed repairs to prevent further damage.
- If any evidence of erosion or scouring is apparent, modify the design as needed to provide long term protection (keeping in mind fish passage requirements if applicable).
- Inspect outlet structures after heavy rains to see if any erosion has taken place around or below the structure.

Outlet Protection Design Example

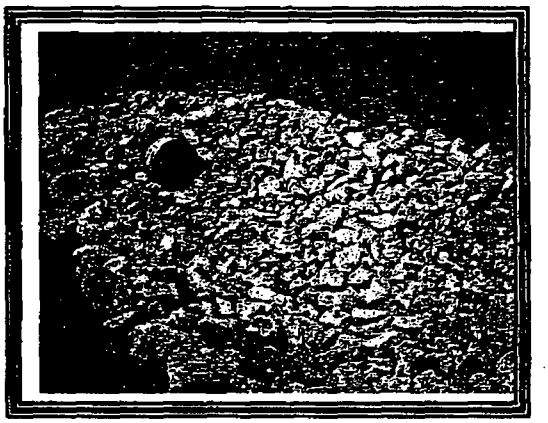
Given: An 18-inch pipe discharges 24 cfs at design capacity onto a grassy slope (no defined channel).
Find: The required length, width, and median stone size (d_{50}) for riprap lined protection.
Solution:

1. The pipe discharges onto a grassy slope with no defined channel, a **Minimum Tailwater Condition**.
2. From Figure OP1, the intersection of a discharge of 24 cfs and a pipe diameter (**d**) of 18-inches, Gives a protection length (L_a) of 20-feet.
3. From Figure OP1, the intersection of a discharge of 24 cfs and a pipe diameter (**d**) of 18-inches. Gives a median stone size (d_{50}) of 0.8-ft.
4. The upstream protection width equals 3 times the pipe diameter ($3D_o$) = 3 x 1.5-feet = 4.5-feet
5. The downstream protection width equals apron length (L_a)+ pipe diameter (**d**) ; = 20-feet + 1.5-feet = **21.5-feet**

The table below provides general information for sizing rock and outlet aprons for various sized pipes

Pipe Size (inches)	Average Rock Diameter (inches)	Apron Width (feet)	Apron Length for Low Flow (feet)	Apron Length for High Flow (feet)
8	3	2-3	3-5	5-7
12	5	3-4	4-6	8-12
18	8	4-6	6-8	12-18
24	10	6-8	8-12	18-22
30	12	8-10	12-14	22-28
36	14	10-12	14-16	28-32
42	16	12-14	16-18	32-38
48	20	14-16	18-25	38-44

Riprap Outlet Protection



Riprap Outlet Protection

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Riprap washes away.	Replace riprap with a larger diameter stone based on the pipe diameter and discharge velocity.
Apron is displaced.	Align apron with receiving water and keep it straight throughout its length. Repair damaged fabric and/or replace riprap that has washed away.
Scour occurs around apron or riprap.	Remove damaged TRM or riprap, fill in scoured areas, and repair damage to slopes channels or underlying filter fabric. Reinstall outlet protection.
Outlet erodes.	Stabilize TRM outlets with vegetation, replace eroded riprap; grout riprap.

Dust Control

Plan Symbol

DC

Description

Wind erosion occurs when the surface soil is loose and dry, vegetation is sparse or absent, the wind is sufficiently strong, and when construction traffic disturbs the soil. Wind erodes soils and transports the sediment off site in the form of fugitive dust, where it may be washed into receiving water bodies by the next rainfall event. Fugitive dust is a nuisance for neighbors. It settles on automobiles, structures and windows and finds its way into homes. It also makes breathing difficult for those with respiratory problems and becomes a safety problem when it blinds motorists, equipment operators, and laborers.

When and Where to Use It

Utilize dust control methods whenever there are offsite impacts, especially during periods of drought. Implemented dust control until final stabilization is reached.

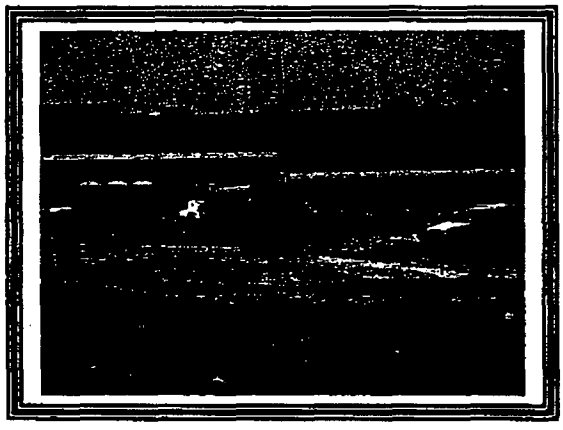
Dust Control Design Criteria

There are many methods to control dust on construction sites. These methods include but are not limited to :

- Phasing the Project. Phasing is done to decrease the area of disturbed soil that is exposed to erosion. The smaller the amount of soil that is exposed at one time, the smaller the potential for dust generation. Phasing a project and utilizing temporary stabilization practices can significantly reduce dust emissions.
- Vegetative Cover. A vegetative cover helps reduce wind erosion. Vegetative Cover is for disturbed areas not subject to traffic. Vegetation provides the most practical method of dust control.
- Mulch. Mulching offers a temporary way to stabilize the soil and prevent erosion. Mulching offers a fast, effective means of controlling dust.
- Sprinkling Water. Sprinkling helps control the suspension of dust particles and promotes dust to settle out of the air. Sprinkling water is effective for dust control on haul roads and other traffic routes.
- Spray-on-Adhesive. Adhesives prevent soil from blowing away. Latex emulsions, or resin in water is sprayed onto mineral soils to prevent their blowing away and reduce dust caused by traffic.
- Calcium Chloride. Calcium chloride keeps the soil surface moist and prevents erosion. Calcium chloride is applied by mechanical spreaders as loose, dry granules or flakes at a rate that keeps the surface moist but not so high as to cause water pollution or plant damage.
- Barriers. Barriers are fences that prevent erosion by obstructing the wind near the ground stopping the soil from blowing offsite. Broad, wind, or sediment fences can control air currents and blowing soil. Barriers are not a substitute for permanent stabilization. Perennial grass and strands of existing trees may also serve as wind barriers.

Inspection and Maintenance

- Add additional dust control or re-spray area as necessary to keep dust to a minimum.
- Spray exposed soil areas only with approved dust control agents as indicated by the SCDHEC Standard Specifications.



Dust Control by Sprinkling Water

Dust Control by Sprinkling Water

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Excessive dust leaves the site.	Increase frequency of dust control application. Consider using a palliative or binder on inactive areas.
Vehicles kick up dust.	Water more frequently. Limit vehicle speeds. Stabilize the roadway.
Watering for dust control causes erosion.	Reduce water pressure on the water truck. Check watering equipment to ensure that it has a positive shutoff. Water less frequently.
Sprayed areas are ineffective at limiting dust.	Re-spray areas and ensure that the application rate is proper. Try another product or method if current dust control is not effective.

Polyacrylamides (PAMs)

Plan Symbol

PAM

Description

Anionic polyacrylamides (PAM) are non-toxic chemical materials used for controlling soil erosion and sedimentation on construction and agricultural sites.

When and Where to Use It

Anionic PAM is available in emulsions, powders, gel bars, or logs. It is recommended that other BMPs be used in combination with anionic PAM. The use of seed and mulch for additional erosion protection beyond the life of the anionic PAM is required. Repeat application is recommended if disturbance occurs to target areas. The following are additional recommendations:

- Use setbacks when applying anionic PAM near natural waterbodies.
- Consider that decreased performance can occur due to ultra-violet light and time after mixing when applying anionic PAM.
- In concentration channels, the effectiveness of anionic PAM for stabilization decreases.
- If seed is applied with anionic PAM, mulch should be used to protect seed.
- Never add water to PAM, PAM must be slowly added to water.
- NOT ALL POLYMERS ARE PAM.

Installation

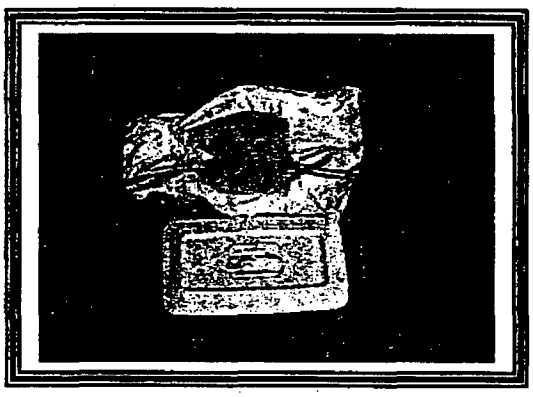
The manufacturer's guidelines for application should be followed.

- Only use the anionic form of PAM. Cationic PAM is toxic and should NOT be used.
- PAM and PAM mixtures have to be environmentally harmless, harmless to fish, wildlife, and plants.
- The pure form of anionic PAM should have less than or equal to 0.05 percent acrylamide monomer by weight, as established by FDA and EPA.
- In order to maintain less than or equal to 0.05 percent of acrylamide monomer, the maximum application rate of PAM, in pure form, should not exceed 200 pounds/acre/year. Do not over apply.
- Users of anionic PAM should obtain and follow all MSDS requirements and manufacturer's recommendations. The following criteria are generally included on the MSDS:
  - Ultra high molecular weight of 6 to 24 mg/mole (preferably 12-15 mg/mole)
  - Non-combustible
  - Does not change soil pH
  - Expiration date included
- Additives such as fertilizers, solubility promoters or inhibitors to PAM should be non-toxic.
- To prevent exceeding the acrylamide monomer limit in the event of a spill, the pure form of anionic PAM should not exceed 200 pounds/batch at 0.05 percent acrylamide monomer (AMD) or 400 pounds/batch at 0.025 percent AMD.

Inspection and Maintenance

- PAMs have been estimated to degrade approximately 10 percent per year. The effects are accelerated in highly exposed areas.
- If PAM treated soil is left undisturbed, reapplication may be necessary after 6-8 weeks.
- Further anionic PAM applications may be required for disturbed areas including highly silty and clayey soils, steep slopes, long grades, and high traffic or precipitation areas.
- All equipment should be maintained to provide the application rates recommended by the manufacturer.
- Rinse all equipment used to mix and apply anionic PAM thoroughly with water.

Liquid PAM



Solid/Block PAM

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Slope was improperly dressed before application.	Roughen slope and fill damaged areas.
Coverage is inadequate.	Follow recommended application rates. Reapply to thin areas.
Sprayed areas degrade or become ineffective.	Follow recommended application rates. Consider other or additional BMPs. Reapply as necessary.
Sprayed slope has spot failures.	Repair slopes, add jute netting and re-spray damaged areas.
Portions of the sprayed area have been disturbed.	Keep workers and equipment off sprayed areas. Repair and re-spray areas that have been damaged.
PAM is washed off slope.	Allow at least 24 hours for the materials to dry before a rain event. Follow manufacturer's recommendations. Reapply as necessary.
Excessive water flows across stabilized surface.	Use other BMPs to limit flow on stabilized area. Use other BMPs to reduce slope lengths. Do not use to stabilize slopes with swift moving concentrated flows.

Sediment Control BMPs

Uncontrolled runoff from construction sites is a water quality concern because of the devastating effects that sedimentation has on local water bodies, particularly small streams. Numerous studies show that the amount of sediment transported by storm water runoff from construction sites with no controls is significantly greater than from sites with controls. In addition to sediment, construction activities yield pollutants such as pesticides, petroleum products, construction chemicals, solvents, asphalts, and acids that contaminate storm water runoff. During storm events, construction sites are a source of sediment-laden runoff, which can overwhelm a small stream channel's capacity, resulting in streambed scour, streambank erosion, and destruction of near stream vegetative cover. Where left uncontrolled, sediment-laden runoff causes the loss of in-stream habitats for fish and other aquatic species, an increased difficulty in filtering drinking water, the loss of drinking water reservoir storage capacity, and negative impacts on the navigational capacity of waterways.

Polluted storm water runoff from construction sites often flows to Municipal Separate Storm Sewers (MS4s) and ultimately is discharged into local rivers and streams. Sediment is one of the main pollutant of concern. Sediment runoff rates from construction sites are typically 10 to 20 times greater than those of agricultural lands, and 1,000 to 2,000 times greater than those of forest lands. During a short period of time, construction sites have the potential to contribute more sediment to streams than is deposited naturally during several decades. The resulting siltation, and the contribution of other pollutants from construction sites, causes physical, chemical, and biological harm to our nation's waters. For example, excess sediment can quickly fill rivers and lakes, requiring dredging and destroying aquatic habitats.

There are numerous methods available to assist in the control of sediment. The following sediment control BMPs are discussed in this handbook:

- Temporary Sediment Basin
- Temporary Sediment Trap
- Silt Fence
- Rock Check Dams
- Sediment Tubes
- Stabilized Construction Entrances
- Storm Drain Inlet Protection
- Rock Sediment Dikes

Sediment Basin

Plan Symbol

Description

A Sediment Basin collects and traps sediment laden runoff from disturbed areas and slows down the flow so that soil particles fall from suspension and deposit in the basin. Drop inlet spillways, pipe spillways, rock fill outlets and weir spillways may be used for the design of the principal spillway.

When and Where to Use It

Temporary sediment basins are designed to have an 80 percent design removal efficiency goal for total suspended solids (TSS) or 0.5 mL/L peak settleable concentration, whichever is less. on sites where 10 or more acres are disturbed and drain to a single outlet point. A temporary sediment basin should not be built in wetlands, any active or live streams, ephemeral streams, or in Waters of State (defined to be all annual or perennial water bodies designated by a solid or dashed blue-line on USGS 7.5-minute quadrangle maps). Utilize temporary sediment basins until the contributing flow areas to the basin have undergone final stabilization.

Sediment Basin Design Criteria

Safety

Follow the design criteria such as those used by the USDA Soil Conservation Service (previously the Natural Resources Conservation Service), U.S. Army Corps of Engineers and the Dam Safety regulations.

Incorporate all possible safety precautions for ponds that are readily accessible to populated areas such as signs and fencing. The recommended inside pond slopes is 3H:1V with a 2H:1V maximum.

Design Aids

The Design Aids located in this section may be used to properly size sediment basins. Sedimot III, SEDCAD4 and other computer models that utilize eroded particle size distributions to calculate a corresponding trapping efficiency may also be utilized.

Riser Structure Design

Design the outlet riser to meet the discharge capacity of the 10-year 24-hour storm event.

General Design Requirements

a. Minimum drainage area - 5 acres
b. Maximum drainage area - 150 acres
c. 80 percent design removal efficiency goal for TSS.
d. The required draw down time of the basin is the time to detain flows to meet the 80 percent design removal goal. In many cases this will result in a draw down time longer than 36 hours. The maximum draw down time is 72 hours.

e. Basin Shape - Where applicable the effective flow length is at least twice the effective flow width . **(L = 2W minimum).**

f. Account for the sediment storage volume.

g. Outlet Riser and Barrel Requirements
   1. Discharge capacity - 10-year 24-hour storm event.
   2. Minimum outlet pipe diameter of 8-inches.
   3. Required 6-inch low flow orifice at bottom of riser structure.
   4. 2-year and 10-year 24-hour storm disturbed flow rates are ≤ to the pre-disturbance peak flow rates.
   5. Anti-vortex device / trash rack required.
   6. Minimum one-foot elevation difference from the top of riser to the crest of the emergency spillway.
   7. Sediment volume storage accounted for in design volume.

h. Embankment Requirements
   1. Maximum upstream slope – 2H:1V.
   2. Maximum downstream slope – 2H:1V.
   3. Freeboard - 12 inch minimum.
   4. Antiseep collars are required on all penetrations through the dam.

Inspection and Maintenance

The key to a functional sediment basin is continual monitoring, regular maintenance and regular sediment removal. Attention to sediment accumulations within the pond is extremely important. Continually monitor sediment deposition in the basin. Owners and maintenance authorities should be aware that significant concentrations of heavy metals (e.g., lead, zinc, and cadmium) as well as some organics such as pesticides, may be expected to accumulate at the bottom of these treatment facilities.

- Remove sediment when it reaches 50 percent of storage volume or reaches the top of the designed cleanout stake where applicable.
- Remove all temporary sediment basins within 30 days after final site stabilization is achieved or after it is no longer needed.
- Remove trapped sediment from the site , or stabilize on site.
- Permanently stabilize disturbed areas resulting from the removal of the sediment basin.

Sediment Basin Design Aids

Each soil type has an eroded particle diameter. See Appendix E. This data is required to determine the settling velocity of the particle, V_{15}. Figure SV-1 plots eroded particle diameter, d_{15}, versus settling velocity. Use this figure to determine the value of V_{15}. Use the basin ratio shown in the formula below to determine trapping efficiency. Figures SB-1 and SB-2 plot trapping efficiency versus the basin ratio. The basin ratio should be less than or equal to the curve value at any given trapping efficiency. The figures depicting trapping efficiency values are for the following two separate conditions:

- SB -1,basins not located in low lying areas and/or not having a high water table, and
- SB-2, basins located in low lying areas and/or having a high water table.

$$\text{Basin Ratio} = \frac{q_{po}}{A\,V_{15}}$$

Where:

q_{po} = Peak outflow rate from the basin for the 10-year 24-hour storm event (cfs),
A = Surface area of the pond at riser crest (acres),
V_{15} = Characteristic settling velocity (fps) of the characteristic D_{15} eroded particle (mm).

D_{15} is read from the tables in Appendix E, or is determined from a site specific soil eroded particle size distribution analysis. Never use the primary particle size distribution.

V_{15} is calculated or read from Figure SV1.

Constraints for use of Sediment Basin Design Aids:

- Watershed area less than or equal to 30 acres
- Overland slope less than or equal to 20 percent
- Outlet diameter less than or equal to 6-feet
- Basin Ratios above the design curves are not recommended for any application of the design aids. If the basin ratio q_{po}/AV_{15} intersects the curve at a point having a trapping efficiency less than the desired value, the design is inadequate and must be revised.

- A basin <u>not</u> located in a low lying area and not having a high water table, has a basin ratio equal to 2.20 E5 at 80 percent trapping efficiency as shown in Figure SB1.

- A basin that <u>is</u> located in a low lying area or in an area that has a high water table, has a basin ratio equal to 4.70 E3 at 80 percent trapping efficiency as shown in Figure SB2.

Sediment Basin Design Example

Given: Construct a sediment basin on a 14-acre (0.0219 mi^2) disturbed site.
The site is not located in a low lying area and does not have a high water table.
Peak discharge is limited to that of the current land use, established grass.
A pond site is available with an area at the riser crest of 0.75 ac.
Soil in the area is an Edisto with a Hydrologic Soil Group Type C.

Find: Trapping efficiency for a 10-year, 24-hour Type II storm if time of concentration is 20 minutes.

Solution:

1. Estimate the peak runoff allowed. The SCS curve number is found for a hydrologic soil group C with established grass as 74. Using a 10-year, 24-hour design storm of 6.0-inches, with this curve number yields a runoff volume of 3.2-inches using the SCS curve number method.

2. Using the SCS graphical method to estimate peak flow, the I_a/P ratio computes to approximately 0.12. Combining this and an estimated time of concentration equal to 0.33 hrs yields a q_u = 650 csm/in for a Type II storm distribution.

3. The peak discharge allowed is calculated by multiplying q_u times the runoff volume times the disturbed area in mi^2 and is approximately 46 cfs.

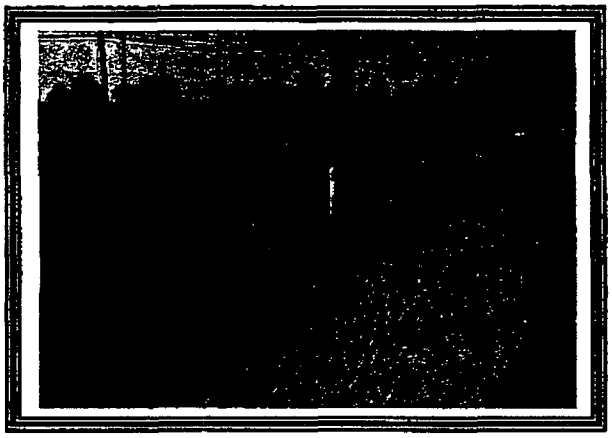
4. D_{15} for an Edisto sub-soil 0.0128. Using this diameter, V_{15} is estimated from Figure SV-1 as 3.7E-4 ft/sec.

5. The sediment basin ratio can now be calculated by calculating

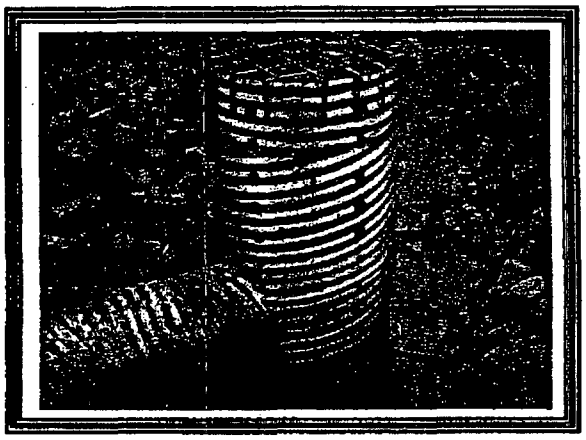
$$q_{po} / (AV_{1S}) = 46 / [(0.75)(3.7E\text{-}4)] = 1.70\ E5$$

6. Using Sediment Basin Design Aid (Figure SB-1) with this sediment basin ratio, read across to the curve and then turn down to the x-axis. The trapping efficiency is estimated to be 81%.

7. If the desired trapping efficiency was not obtained, the process would need to be repeated with a larger basin or decreased discharge until the desired trapping efficiency was found.



Temporary Sediment Basin



Temporary Sediment Basin Perforated Riser

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Outlet pipe is clogged with the debris.	Clean outlet pipe. Install a trash rack around pipe to hold back larger debris particles.
Spillway erodes due to high velocity flows.	Stabilize outlet with an ECB, TRM or riprap.
Side Slope eroding.	Stabilize slopes with vegetation, ECB, TRM, riprap or equivalent method.
Excessive accumulated sediment buildup.	Remove sediment to maintain the sediment storage capacity.
The upstream drainage area is too large.	Limit the contributing drainage area or expand basin. Ensure drainage area does not exceed recommended acreage. If the drainage area does exceed this limit, install diversion ditches and add additional BMPs to accommodate the diverted flow.

Sediment Trap

Plan Symbol

Description

A sediment trap is formed by excavating a pond or by placing an earthen embankment across a low area or drainage swale. An outlet or spillway is constructed using stones or aggregate to slow the release of runoff. The trap retains the runoff long enough to allow most of the silt to settle out. Design sediment traps to have an 80 percent design removal efficiency goal of the total suspended solids (TSS) in the inflow.

When and Where to Use It

A sediment trap may be formed completely by excavation or by construction of a compacted embankment. The outlet should be a rock fill weir/spillway section, with the area below the weir acting as a filter for sediment and the upper area as the overflow spillway depth. Temporary sediment traps should not be placed in Waters of the State or USGS blue-line streams (unless approved by SCDHEC, State, or Federal authorities).

Sediment Trap Design Criteria

To complete the design of the temporary sediment trap:

- Determine the required sediment storage volume.
- Determine the bottom and top surface area of the sediment storage volume using 3H:1V side slope from the bottom of the trap.
- Determine the total trap dimensions by adding the depth required for the 10-year, 24-hour design storm above the surface of the sediment storage volume, while not exceeding 2H:1V side slopes. Side slopes of 3H:1V are recommended, with a maximum of 2H:1V.
- Design temporary sediment traps with a minimum storage capacity of 1800 cubic feet of storage for each acre draining to them, regardless of the calculated trapping efficiency.

Design Aids

The Design Aids located in this section may be used to properly size sediment traps. Sedimot III, SEDCAD4, and other computer models that utilize eroded particle size distributions and calculates a corresponding trapping efficiency may also be utilized.

General Design Requirements

a. Maximum Drainage Area - 5 acres
b. Maximum Design Life - 18 months
c. 80 percent design removal efficiency goal for TSS
d. Basin Shape - The flow length is 2 times the flow width.
e. Embankment Requirements:
   1. Maximum dam height: 5-feet.
   2. Maximum stone height: 3.5-feet.
   3. Minimum rock bottom width: 3-feet.
   4. Discharge and treatment capacity for the 10-year 24-hour storm event.

Installation

Install a non-woven geotextile filter fabric before installing the stone for the outlet structure. Allow the stone to extend downstream past the toe of the embankment. Mark the sediment cleanout level of trap with a stake in the field. Seed and mulch all disturbed areas.

Inspection and Maintenance

The key to a functional sediment trap is continual monitoring, regular maintenance and regular sediment removal.

- Remove sediment when it reaches 50 percent of storage volume or top of cleanout stake.
- Inspect every 7 calendar days and within 24-hours after each rainfall event that produces ½-inches or more of precipitation.
- Remove all temporary sediment traps within 30 days after final site stabilization is achieved or after it is no longer needed.
- Remove trapped sediment from the site, or stabilized on site.
- Permanently stabilized disturbed areas resulting from the removal of sediment traps.

Sediment Trap Design Aids

The sediment trap design aid is a single line grouping all soil textures together. For the sediment trap, the ratio is:

$$\text{Sediment Trap Ratio} = \frac{q_{po}}{A\,V_{15}}$$

Where

q_{po} = Peak outflow for the 10-year 24-hour storm event (cfs)
A = Surface area at the elevation equal to the bottom of the rock fill outlet (acres)
V_{15} = Characteristic settling velocity (fps), of the characteristic D_{15} eroded particle (mm).

Read D_{15} is read Figure ST-1, or determine from a site specific soil eroded particle size distribution analysis. Never use the primary particle size distribution.

Read V_{15} from Figure SV1.

Constraints for the use of Sediment Trap Design Aids are:

- Watershed area less than or equal to 5 acres
- Overland slope less than or equal to 20 percent
- Rock fill diameter greater than 0.2-feet and less than 0.6-feet
- Rock fill height less than 5-feet
- Top width of rock fill between 2- and 4-feet
- Maximum Side slopes 1:1 to 1.5:1.

Sediment Trap Ratios above the design curves are not recommended for any application of the design aids. If the sediment trap ratio intersects the curve at a point having a trapping efficiency less than the desired value, the design is inadequate and must be revised.

A sediment trap ratio equal to 9.0 E4 has an 80 percent trapping efficiency

Route storm flows through sediment traps to calculate the required depth and storage volume of the trap.

Calculate a sediment storage volume and provide this volume below the bottom of the rock fill outlet structure.

Sediment trap Design Example

Given: A sediment trap designed for a 10-year, 24-hour storm is to be constructed on a development site as a temporary sediment control measure for a 3-acre drainage area that is totally disturbed.

The outlet is to be a rock fill constructed of rock with a mean diameter of 0.5-feet.

The soil is a Cecil sandy loam, the slope of the watershed is 5 percent, and the time of concentration is 6 minutes.

Find: If the desired trapping efficiency is 80 percent, what is the required peak discharge for trap areas of 0.10, 0.25, and 0.50 acres.

Solution:

1. Determine the Sediment Trap Ratio. From the Sediment Trap Design Aid (Figure ST1), the ratio for a design trapping efficiency of 80 percent is 9.0E4 ft^2/acre.

2. Determine the ratio of qpo/A required from the Sediment Trap Ratio,

$$Sediment\ Trap\ Ratio = 9.0x10^4 = qpo/A*V_{15}$$

3. The D_{15} for a Cecil soil is 0.0066 mm, and the corresponding V_{15} for a Cecil sandy loam soil is 1.2E-4 ft/sec. Hence,

$$9.0x10^4\ V_{15} = qpo/A = (9.0x10^4)(1.2x10^{-4}) = 11\ cfs\ /acre\ of\ pond.$$

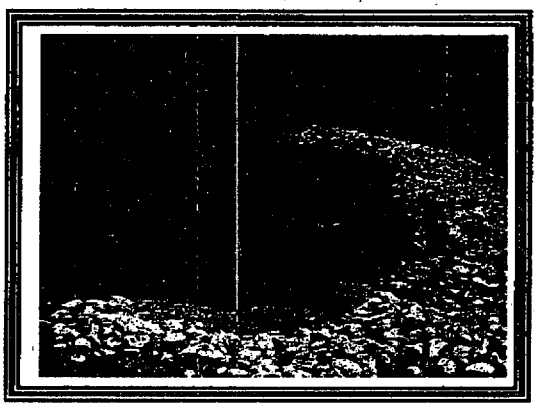
4. Determine qpo/A values. The following results are tabulated for the acreage shown:

Sediment Trap Bottom Area (acre)	qpo Through Rock Fill (cfs)
0.10	1.1
0.25	2.8
0.50	5.5

Each of these combinations will give the desired resulting 80 percent trapping efficiency.

The rock fill outlet structure must be designed to convey a peak flow of that shown in column two of the table above. See Section 6.4 for design details. If the check rock fill overtops, the trapping efficiency is assumed to be zero.

Sediment Trap



Sediment Trap

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Outlet spillway is clogged with the debris.	Remove debris by lightly raking debris from upstream side of spillway. If debris is excessive, remove smaller filter stone on upstream side of spillway and replace with new clean stone.
Spillway erodes due to high velocity flows.	Stabilize outlet with larger riprap on downstream side of spillway.
Side Slope eroding.	Stabilize slopes with vegetation, ECB, TRM, riprap or equivalent method.
Excessive accumulated sediment buildup.	Remove sediment to maintain sediment storage capacity.
Drainage area is too large.	Limit the contributing drainage area by installing diversion ditches and adding additional BMPs to accommodate the diverted flow.

Silt Fence

Plan Symbol

Description

Silt fence is used as a temporary perimeter control around sites where there will be soil disturbance due to construction activities. Silt fence consists of geotextile fabric stretched across steel posts. The lower edge of the fence is vertically trenched into the ground and covered by compacted backfill.

When and Where to Use It

Silt fence is applicable in areas:

- Where the maximum sheet or overland flow path length to the fence is 100-feet.
- Where the maximum slope steepness (normal [perpendicular] to fence line) is 2H:1V.
- That do not receive concentrated flows greater than 0.5 cfs.
- ¼ acre drainage per 100 linear feet

Do not place silt fence across channels or use it as a velocity control BMP.

Materials

Steel Posts

Use 48-inch long steel posts that meet the following minimum physical requirements:

- Composed of high strength steel with minimum yield strength of 50,000 psi.
- Have a standard "T" section with a nominal face width of 1.38-inches and nominal "T" length of 1.48-inches.
- Weigh 1.25 pounds per foot (± 8%).
- Have a soil stabilization plate with a minimum cross section area of 17-square inches attached to the steel posts.
- Painted with a water based baked enamel paint.

Use steel posts with a minimum length of 4-feet, weighing 1.25 pounds per linear foot (± 8%) with projections to aid in fastening the fabric. Except when heavy clay soils are present on site, steel posts will have a metal soil stabilization plate welded near the bottom such that when the post is driven to the proper depth, the plate will be below the ground level for added stability. The soil plates should have the following characteristics:

- Be composed of minimum 15 gauge steel.
- Have a minimum cross section area of 17-square inches.

Geotextile Filter Fabric

Filter fabric is:

- Composed of fibers consisting of long chain synthetic polymers composed of at least 85% by weight of polyolefins, polyesters, or polyamides.
- Formed into a network such that the filaments or yarns retain dimensional stability relative to each other.
- Free of any treatment or coating which might adversely alter its physical properties after installation.
- Free of defects or flaws that significantly affect its physical and/or filtering properties.
- Cut to a minimum width of 36 inches.

Use only fabric appearing on SCDOT Approval Sheet #34 meeting the requirements of the most current edition of the SCDOT Standard Specifications for Highway Construction.

Silt Fence Design Criteria

Design Aids

The Design Aids located in this section may be used to properly size silt fence. Sedimot III, SEDCAD4, and other computer models that utilize eroded particle size distributions and calculates a corresponding trapping efficiency may also be utilized. See Figure SF-1 for silt fence trapping efficiency.

General Design Requirements

a. 80 percent design removal efficiency goal for TSS
b. Maximum Slope Length - 100-feet
c. Maximum Slope Gradient – 2H:1V
d. Minimum Installed Fence Fabric Height – 18-inches
e. Maximum Installed Fence Fabric Height – 24-inches (exception for tidal areas)
f. Minimum Post Bury Depth – 18-inches
g. Maximum Post Spacing – 6-feet

Installation

Leave 10 feet between silt fence and creek or wetland.

Excavate a trench approximately 6-inches wide and 6-inches deep when placing fabric by hand. Place 12-inches of geotextile fabric into the 6-inch deep trench, extending the remaining 6-inches towards the upslope side of the trench. Backfill the trench with soil or gravel and compact.

Bury 12-inches of fabric into the ground when pneumatically installing silt fence with a slicing method.

Purchase fabric in continuous rolls and cut to the length of the barrier to avoid joints. When joints are necessary, wrap the fabric together at a support post with both ends fastened to the post, with a 6-inch minimum overlap.

Install steel posts to a minimum depth of 24-inches. Install steel posts a minimum of 1- to 2- inches above the fabric, with no more than 3-feet of the post above the ground. Space posts to maximum 6-feet centers.

Attach fabric to the steel posts using heavy-duty plastic ties that are evenly spaced and placed in a manner to prevent sagging or tearing of the fabric. In call cases, ties should be affixed in no less than 4 places.

Install the fabric a minimum of 24-inches above the ground. When necessary, the height of the fence above ground may be greater than 24-inches. In tidal areas, extra silt fence height may be required. The post height will be twice the exposed post height. Post spacing will remain the same and extra height fabric will be 4-, 5-, or 6-feet tall.

Locate silt fence checks every 100 feet maximum and at low points.

Install the fence perpendicular to the direction of flow and place the fence the proper distance from the toe of steep slopes to provide sediment storage and access for maintenance and cleanout.

Height of Fill (ft)	Fill Slope	Minimum Silt Fence Offset from Toe of Slope (ft)	Minimum right of Way Offset From Toe of Slope (ft)
< 6	2:1 4:1 6:1	2	3
6-10	2:1	12*	13*
	4:1 6:1	3	4
>10	2:1	12*	13*
	4:1 6:1	4	5

*These minimum offsets may be reduced when curb and gutter or some other feature reduces the flow of water down the slope. The smaller offsets of each group of height of fill can not be reduced.

Inspection and Maintenance

- Inspect every 7 calendar days and within 24-hours after each rainfall event that produces ½-inches or more of precipitation. Check for sediment buildup and fence integrity. Check where runoff has eroded a channel beneath the fence, or where the fence has sagged or collapsed by fence overtopping.
- If the fence fabric tears, begins to decompose, or in any way becomes ineffective, replace the section of fence immediately.
- Remove sediment accumulated along the fence when it reaches 1/3 the height of the fence, especially if heavy rains are expected.
- Remove trapped sediment from the site or stabilize it on site.
- Remove silt fence within 30 days after final stabilization is achieved or after temporary best management practices (BMPs) are no longer needed.
- Permanently stabilize disturbed areas resulting from fence removal.

Silt Fence Design Aids

This design aid for applies to silt fences placed in areas down slope from disturbed areas where it serves to retard flow and cause settling. Two conditions must be met for satisfactory design:

- Trapping efficiency must meet the desired level of control, and
- Overtopping of the fence must not occur.

The silt fence design aid is a single line grouping all soil textures together. A similar procedure was used for development of the ratio as used for the ponds and rock checks. For the silt fence, the ratio is:

$$\text{Silt Fence Ratio} = \frac{q_{po}}{V_{15} P_{area}}$$

Where:

q_{po} = Peak outflow through the fence for the 10-year 24-hour storm event (cfs),
V_{15} = Characteristic settling velocity (fps), of the characteristic D_{15} eroded particle (mm),
P_{area} = Potential ponding area up slope of the fence (ft^2).

Estimate the ponding area by using the height of the fence available for flow through and extending a horizontal line from the fence to an intersection with the ground surface upslope of the fence. Calculate the unit available area by multiplying the fence height by the ground slope. Obtain the potential ponding area by multiplying this unit area by the available fence length.

Using the calculated ponding area, calculate the ratio and enter the value in Figure SF-1 to determine the trapping efficiency. Perform an overtopping calculation using the slurry flow rate through the fence. Check this rate against the incoming flow to determine if enough storage exists behind the fence preventing overtopping.

Constraints for the use of Silt Fence Design Aids:

- Watershed area is less than or equal to 5 acres
- Overland flow length is less than or equal to 500-feet
- Overland slope is less than or equal to 6 percent
- Slurry flow rate through the fence is less than or equal to 10 gpm/ft
- Maximum height of the silt fence is less than or equal to 3-feet

Silt Fence Ratios above the design curves are not recommended for any application of the design aids. If the silt fence ratio intersects the curve at a point having a trapping efficiency less than the desired value, the design is inadequate and must be revised.

A silt fence ratio equal to 0.23 has an 80 percent trapping efficiency as shown in Figure SF-1.

Silt Fence Design Examples

Given: Design a silt fence 1.5 ft-tall at the toe of a 2.0 percent slope draining a linear construction site.

Topography will cause runoff to drain through 400-feet of total fabric length.
Peak flow from the 1.0-acre upslope area is estimated at 2.5 cfs using the rational equation with "C" equal to 0.25 and intensity equal to 10.0 iph.

Slurry flow rate for the filter fabric is 10 gpm/ft^2 of fabric according to manufacturer specifications or other source.

Find: (A) The trapping efficiency if the soil is Lakeland Sand with an eroded size distribution having a D_{15} equal to 0.0463 mm.

(B) The trapping efficiency if the soil is Cecil with an eroded size distribution having a D_{15} equal to 0.0066 mm.

Solution:

A:

1. The settling velocity V_{15} of the D_{15} particle (0.0463 mm) is read from Figure SV-1 as 5.1 E-3 ft/sec.

2. Estimate the ponded area using the geometry of the installation. With a fence length of 400 ft, maximum depth equal to 1.5 ft, and upstream slope of 2.0 percent, there will be ponded area of 75 ft^2/linear ft of fabric for a total ponded area of:

$$P_{area} = (75\ ft^2/ft)\ (400\ ft) = 30{,}000\ ft^2$$

The geometry calculates a required tie back of 75-feet to provide an adequate ponding area.

3. The silt fence ratio is calculated as:

$$\text{Silt Fence Ratio} = q_{po}/(V_{15}\ P_{area}) = 2.5/[(5.1E\text{-}3)(30{,}000)] = 0.017$$

4. Reading the trapping efficiency from the Silt Fence Design Aid (Figure SF-1) with the ratio equal to 0.017, the trapping efficiency is approximately **94 percent.**

- Check the fence for its ability to pass the design flow without overtopping.

5. Convert the peak flow from cfs to gpm:

$$q_{po} = (2.5\ ft^3/sec)(7.48\ gal/ft^3)(60\ sec/min) = 1122\ gpm$$

6. Divide the peak flow rate by the effective height (1.5-ft) and the slurry flow rate of 10 gpm/ft^2 of fabric to calculate the required fence length.

$$L = (1122)/\ (1.5)\ (10) = 75\ ft$$

7. 75 ft is less than the 400 ft available, so the fence will not overtop if it is properly maintained. Note: This analysis does not account for concentration of flows or strength of the posts, or fabric.

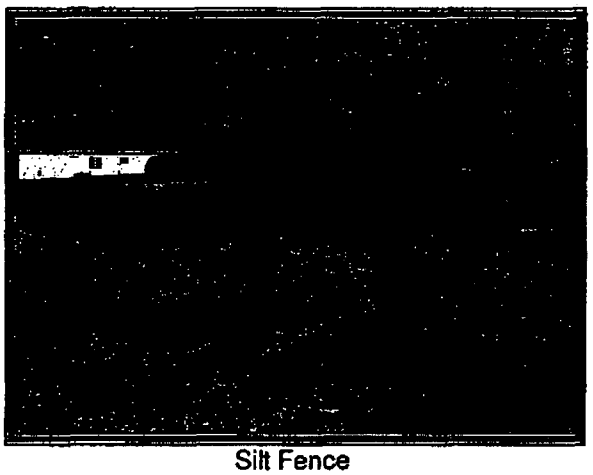
B.

1. A Cecil D_{15} topsoil is 0.0066 mm, and the settling velocity is found to be V_{15} = 1.2 E-4 fps.

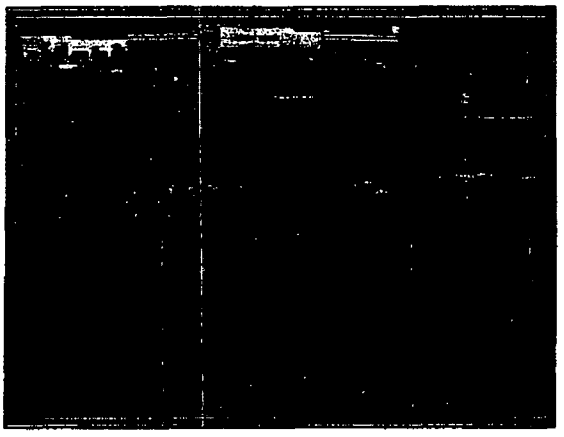
2. The filter fence ratio is calculated as:

$$\text{Silt Fence Ratio} = q_{po}/(V_{15}\ P_{area}) = 2.5/[(1.2E\text{-}4)(30{,}000)] = 0.70$$

3. Reading the trapping efficiency from the Silt Fence Design Aid (Figure SF1) with the ratio equal to 0.70, the trapping efficiency is approximately **70 percent.**



Silt Fence



Silt Fence

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Excessive sediment accumulation.	Remove sediment. Apply hydraulic mulch or straw mulch or other BMPs upstream to reduce eroded sediment.
Bottom of fence is not properly keyed in.	Dig trench, place fabric, and backfill.
Length of slope draining to silt fence is too long.	Shorten slope length using diversion ditches, additional silt fence runs, or other BMPs.
Storage capacity is inadequate due to sediment buildup.	Remove accumulated sediment when it reaches 1/3 the height of the barrier.
Lack of sufficient ponding area.	Install fence with at least a 5-feet setback from the toe of the slope where possible. Divert flow at top of slope with diversion ditches.
Erosion occurs around ends.	Turn ends into the up-slope area every 100 feet.
Silt fence is not installed along level contour.	Reinstall silt fence so that change in elevation does not exceed 1/3 the fabric height along the reach.
Slope draining to fence is too steep.	Shorten slope length using fiber rolls or equivalent. Increase setback of silt fence from the toe of slope.
Fence is installed in concentrated flow area.	Replace fence with proper BMP such as check dams, if appropriate.
Tie backs or j-hooks not installed or installed incorrectly.	Place Tie backs or j-hooks at a maximum separation of 100-feet.
Posts are too far apart.	Add stakes a maximum of 6-feet apart.
Concentrated flows causing erosion.	Place cross barrier check dams behind the silt fence.

Rock Check Dam

Plan Symbol

Description

A rock check dam is a small, temporary or permanent rock fill dam constructed across a drainage ditch, swale, or channel to lower the speed of concentrated flows. Design rock check dams to have an 80 percent design removal efficiency goal of the total suspended solids (TSS) in the inflow.

When and Where to Use It

Install rock check dams in steeply sloped swales, or in swales where adequate vegetation can not be established. Use rock check dams in small open channels. Do not place check dams in Waters of the State or USGS blue-line streams (unless approved by SCDHEC, State, or Federal authorities).

Rock Check Dam Design Criteria

Design Aids

The Design Aids located in this section (RC-C, RC-M, RC-F) may be used to properly size rock check dams. Sedimot III, SEDCAD4, and other computer models that utilize eroded particle size distributions and calculates a corresponding trapping efficiency may also be utilized.

General Design Requirements

a. 80 percent design removal efficiency goal for TSS
b. Maximum Drainage Area – 5 acres
c. Maximum Height – 2-feet
d. Spacing varies with the bed slope of the ditch. Space rock checks such that the toe of the upstream check is at the same elevation as the top of the downstream check.
e. If the rock check dam is not properly sized, the flow will overtop the structure and the Trapping Efficiency is assumed to be 0 percent when this failure takes place.

Installation

Install the center section of the rock check lower than the edges.

Inspection and Maintenance

- Inspect every 7 calendar days and within 24-hours after each rainfall event that produces ½-inches or more of precipitation.
- Inspect for sediment and debris accumulation.
- Inspect rock check dam edges for erosion and repair promptly as required.
- Remove sediment when it reaches 1/3 the original check height.
- In the case of grass-lined ditches and swales, remove rock check dams when the grass has matured sufficiently to protect the ditch or swale unless the slope of the swale is greater than 4 percent.
- After construction is complete, remove stone if vegetation is used for permanent stabilization.
- Seed and mulch the area beneath the rock ditch checks immediately after dam removal.

Rock Check Dam Design Aids

Design aids for rock check dams were developed similarly to those for ponds. Again, the D_{15} eroded particle size is used for the calculation of the characteristic settling velocity. The ratio for ditch checks is defined by:

The Rock Check Dam Design Aids have been designed for the following soil classifications:

- Coarse (sandy loam)
- Medium (silt loam)
- Fine (clay loam).

The design ratio should be less than or equal to the curve value at any given trapping efficiency.

$$\text{Rock Check Ratio} = \frac{Sq^{(1-b)}}{aV_{15}}$$

Where:

S = Channel slope (%),

q = Unit width flow through the check for the 10-year 24-hour storm event (cfs/ft),

V_{15} = Characteristic settling velocity (fps), of the characteristic D_{15} eroded particle (mm).

Coefficients *a* and Exponent *b* is interpolated from tables

Constraints for the use of Rock Check Dam Design Aids:

- Watershed area is less than or equal to 5 acres
- Overland flow length is less than or equal to 500-feet
- Overland slope is less than or equal to 15 percent
- Maximum depth of the ditch is less than or equal to 6-feet

Rock Check Ratios above the design curves are not recommended for any application of the design aids. If the Rock Check Ratio intersects the curve at a point having a trapping efficiency less than the desired value, the design is inadequate and must be revised.

A rock check dam located on coarse soils has a ditch check ratio equal to 1.10 E3 at 80 percent trapping efficiency as shown in Figure RC-C.

A rock check dam located on medium soils has a ditch check ratio equal to 5.80 E3 at 80 percent trapping efficiency as shown in Figure RC-M.

A rock check dam located on fine soils has a ditch check ratio equal to 1.20 E4 at 80 percent trapping efficiency as shown in Figure RC-F.

Rock Check Dam Design Examples

Given: Install a rock check dam with a channel slope of 1.0 percent in the Piedmont on an area having Cecil sandy loam soils with an eroded size distribution of medium texture.

The runoff coefficient "C" for the rational method is estimated as 0.4 with an intensity of 6.75 in/hr for the design storm.

Drainage area to the ditch check is 4.4 ac.

Average rock diameter of the ditch check is 0.10 m (4 in.).

Average width (perpendicular to flow) is 6.7 ft and ditch check length is 3.3 feet.

Find: The trapping efficiency for the rock ditch check.

Solution:

1. A Cecil D_{15} topsoil is 0.0066 mm, and the settling velocity is found to be V_{15} = 1.2 E-4 fps.

2. Peak flow is estimated from the given information by substituting into the rational formula so that:

$$q_p = C\,i\,A = 0.4\,(6.75)(4.4) = 11.9 \text{ cfs}$$

3. The flow rate should be converted to <u>flow per unit width</u> by dividing the peak flow by the check width to obtain the design q as

$$q = 11.9 \text{ cfs}/6.7 \text{ ft} = 1.78 \text{ cfs/ft}$$

4. Appropriate values of the coefficients a and b are interpolated from the table provided in the Design Aids Section of this Handbook.

- Rock diameter of 0.10 m
- Flow length of 1.0 m
  a = 4.13
  b = 0.6651

Substitute all values and calculate the ditch check ratio

$$Sq^{(1-b)}/a\,V_{15} = (1.0)(1.78^{(1-0.6651)})/(4.13)(1.2E\text{-}4) = 2448$$

5. Enter the Rock Check Dam Design Aids for medium texture soil (Figure RC-M) on the y-axis with Rock Check Ratio = 2.5E3, go to line and turn to the x-axis to read trapping efficiency.

6. Trapping efficiency equals 86 percent.

Note: The rock check dam must also be checked for overtopping since this is a common occurrence and results in total failure of the check. If the check overtops, the trapping efficiency is assumed to be zero.

Rock Check Dam

Rock Check Dam

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Too much sediment has accumulated.	Remove accumulated sediment to recover holding capacity.
There is insufficient ponding area.	Space check dams farther apart. Increase height of dam.
The check dam is higher than the drainage channel.	Lower check dam so that it is 6 inches lower than the channel side.
Check dams wash away.	Use larger stone for the body of the check dam. Decrease check dam spacing by adding more dams.
Wrong type of materials is used to construct check dam.	Use larger stones. Do not use straw bales or silt fence for checks.

Sediment Tubes

Plan Symbol

Description

Sediment tubes are elongated tubes of compacted geotextiles, curled excelsior wood, natural coconut fiber or hardwood mulch. Straw, pine needle, and leaf mulch-filled sediment tubes are not permitted.

When and Where to Use It

Install sediment tubes along contours, in drainage conveyance swales, and around inlets to help reduce the effects of soil erosion by energy dissipation and retaining sediment.

Materials

Sediment tubes for ditch checks and Type A Inlet Structure Filters exhibit the following properties:

- Produced by a Manufacturer experienced in sediment tube manufacturing.
- Composed of compacted geotextiles, curled excelsior wood, natural coconut fibers, hardwood mulch or a mix of these materials enclosed by a flexible netting material.
- Straw, straw fiber, straw bales, pine needles, and leaf mulch are not allowed under this specification.
- Utilizes outer netting that consists of seamless, high-density polyethylene photodegradable materials treated with ultraviolet stabilizers or a seamless, high-density polyethylene non-degradable materials.
- Diameter ranging from 18-inches to 24-inches.
- Curled excelsior wood, or natural coconut rolled erosion control products (RECPs) that are rolled up to create a sediment tube are <u>not</u> allowed under this specification.
- Select applicable Sediment Tubes from the SCDOT approved products list.

Installation

Proper site preparation is essential to ensure sediment tubes are in complete contact with the underlying soil or underlying surface. Remove all rocks, clods, vegetation or other obstructions so installed sediment tubes have direct contact with the underlying soil or surface.

Install sediment tubes by laying them flat on the ground. Construct a small trench to a depth that is 20% of the sediment tube diameter. Lay the sediment tube in the trench and compact the upstream sediment tube soil interface. Do not completely bury sediment tubes during installation. Review all project specifications for special installation requirements. Install sediment tubes so no gaps exist between the soil and the bottom of the sediment tube. Lap the ends of adjacent sediment tubes a minimum of 6-inches to prevent flow and sediment from passing through the field joint. Never stack sediment tubes on top of one another.

Avoid damage to sediment tubes during installation. Should the sediment tube become damaged during installation, place a stake on both sides of the damaged area terminating the tube segment and install a new tube segment. Perform field monitoring to verify that installation procedures do not damage sediment tubes. Replace all damaged sediment tubes damaged during installation as directed by the Inspector or Manufacturer's Representative at the contractor's expense.

Install sediment tubes in swales or drainage ditches perpendicular to the water flow and extend them up the side slopes a minimum of 1-foot above the design flow depth. Space sediment tubes according to the following table.

Slope	Maximum Sediment Tube Spacing
Less than 2%	150-feet
2%	100-feet
3%	75-feet
4%	50-feet
5%	40-feet
6%	30-feet
Greater than 6%	25-feet

Install sediment tubes using wooden stakes (2-inch x 2-inch) or steel posts (standard "U" or "T" sections with a minimum weight of 1.25 pounds per foot) a minimum of 48-inches in length placed on 2-foot centers. Intertwine the stakes with the outer mesh on the downstream side, and drive the stakes in the ground to a minimum depth of 24-inches leaving less than 12-inches of stake above the exposed sediment tube.

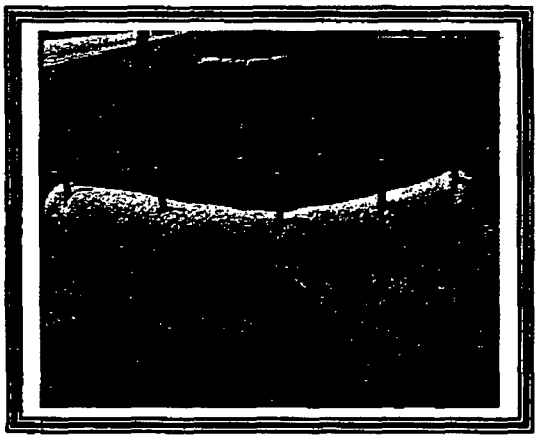
An acceptable alternative installation is driving stakes on 2-foot centers on each side of the sediment tube and connecting them with natural fiber twine or steel wire to inhibit the non-weighted sediment tube from moving vertically. Sediment tubes can also be secured by installing the stakes on 2-foot centers in a crossing manner ensuring direct soil contact at all times.

Select the sediment tube check length to minimize the number of sediment tubes needed to span the width of the drainage conveyance. If the required length (perpendicular to the water flow) is 15-feet, then one 15-foot sediment tube is preferred compared to two overlapping 10-foot sediment tubes.

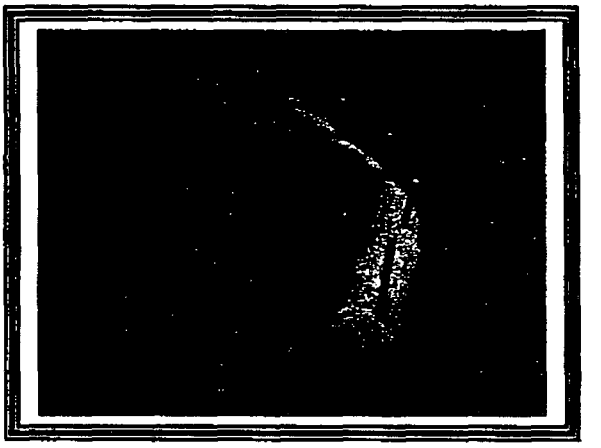
Install sediment tubes for ditch checks over bare soil, mulched areas, or erosion control blankets. Keep sediment tubes for ditch checks in place until fully established vegetation and root systems have completely developed and can survive on their own.

Inspection and Maintenance

- Inspect sediment tubes after installation for gaps under the sediment tubes and for gaps between the joints of adjacent ends of sediment tubes.
- Inspect every 7-days and within 24-hours of a rainfall event of 0.5-inches or greater.
- Repair all rills, gullies, and undercutting near sediment tubes.
- Remove all sediment deposits that impair the filtration capability of sediment tubes when the sediment reaches 1/3 the height of the exposed sediment tube.
- Remove and/or replace installed sediment tubes as required to adapt to changing construction site conditions.
- Remove sediment tubes from the site when the functional longevity is exceeded as determined by the Engineer, Inspector or Manufacturer's Representative. Gather sediment tubes and dispose of them in regular means as non-hazardous, inert material.
- Prior to final stabilization, backfill all trenches, depressions and other ground disturbances caused by the removal of sediment tubes.



Sediment Tube Check Dam



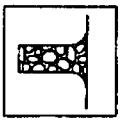
Sediment Tube Check Dam

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Too much sediment has accumulated.	Remove accumulated sediment to recover holding capacity. Remove accumulated sediment from the upstream side of the sediment tube when the sediment has reached a height of approximately one-third the original height of the tube (measured at the center).
There is insufficient ponding area.	Space sediment tubes farther apart or increase the sediment tube diameter.
Sediment tube washes away.	Use larger sediment tubes. Decrease post spacing, and add more posts. Install posts on both the upstream and downstream sides of the sediment tube. Decrease sediment tube spacing by adding more sediment tube check dams.
Other application used instead of sediment tubes	Do not use straw bales or silt fence as sediment tube check alternatives. In some situation rock check dams may be used as a sediment tube alternative.
Wrong type of materials or wrong type of sediment tube utilized.	Straw, pine needle and leaf mulch-filled sediment tubes are not permitted. Curled excelsior wood, or natural coconut rolled erosion control products (RECPs) that are rolled up to create a sediment tube are **not** permitted. Do not use straw bales or silt fence for checks.

Stabilized Construction Entrance

Plan Symbol



Description

A stabilized construction entrance is a temporary stone-stabilized pad located at all points of vehicular ingress and egress on a construction site to reduce the amount of mud, dirt, and rocks transported onto public roads by motor vehicles equipment and runoff.

When and Where to Use It

Use stabilized construction entrances whenever repetitive traffic will be leaving a construction site and moving directly onto a public road. Construction entrances provide an area where mud is removed from vehicle tires before entering a public road.

General Design Requirements

a. Minimum Entrance Dimensions
   1. Thickness = 6-inches
   2. Width of entrance area = 24-feet
   3. Length = 100-feet or required length for 10 tire revolutions
b. Material consisst of stone with a D_{50} diameter ranging from 2 to 3 inches.
c. Non-woven geotextile fabric is required to underlie the stone.

Installation

Remove all vegetation and any objectionable material from the foundation area.

Divert all surface runoff and drainage from stones to a sediment trap or basin.

Install a non-woven geotextile fabric prior to placing any stone.

Install a culvert pipe across the entrance when needed to provide positive drainage.

The entrance consists of 2 to 3 inch D_{50} aggregate with a minimum thickness of 6-inches.

Minimum dimensions of the entrance are 24-feet wide by 100-feet long, and may be modified as necessary to accommodate site constraints.

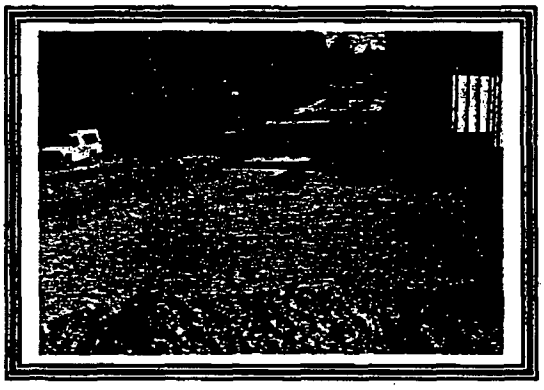
Taper the edges of the entrance out towards the road to prevent tracking of mud at the edge of the entrance.

Inspection and Maintenance

- Inspect every 7 calendar days and within 24-hours after each rainfall event that produces ½-inches or more of precipitation, or after heavy use.
- Check for mud and sediment buildup and pad integrity.
- Make daily inspections during periods of wet weather. Maintenance is required more frequently in wet weather conditions. Reshape the stone pad as needed for drainage and runoff control.
- Wash or replace stones as needed.

- Wash or replace he stone in the entrance whenever the entrance fails to reduce mud being carried off site by vehicles. Frequent washing will extend the useful life of stone.
- Immediately remove mud and sediment tracked or washed onto public roads by brushing or sweeping.
- Only use flushing when the water is discharged to a sediment trap or basin.
- Repair any broken pavement immediately.
- Inspect and clean sediment traps immediately following each rainfall.
- Dispose of sediment in a suitable area in such a manner that it will not erode.
- Remove as soon as they are no longer needed to provide access to the site. Bring the disturbed area to grade, and stabilize it using appropriate permanent stabilization methods.

Construction Entrance



Construction Entrance

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Access points require constant maintenance.	Select proper stabilization material or consider alternate methods for longevity, performance and site conditions.
Stone is tracked onto roadway.	Limit larger vehicles from construction exit or use larger diameter material.
Aggregate material is being incorporated into the soil.	Use geotextile fabric under base material.
Excessive sediment is tracked onto roadway.	Increase length of stabilized exit. Regularly maintain access area to remove sediment buildup.
Sediment-laden water is leaving the construction site.	Properly grade access points to prevent runoff from leaving site. Route runoff through a sediment-trapping device.
Sediment is being tracked from numerous locations.	Limit the number of access points and require their use. Stabilize designated access points.

Storm Drain Inlet Protection

Description

Storm drain inlet protection is achieved by placing a temporary filtering device around any inlet to trap sediment. This mechanism prevents sediment from entering inlet structures. Additionally, it serves to prevent the silting-in of inlets, storm drainage systems, or receiving channels.

There are six (6) types of inlet structure filters, including:

- Type A-Low Flow
- Type B-Medium Flow, Low Velocity
- Type C-Medium Flow, Medium Velocity
- Type D-High Flow, High Velocity
- Type E-Surface Course Curb Inlet
- Type F-Inlet Tubes

When and Where to Use It

Inlet protection may be installed prior to the construction of roads however, once the sub base is placed, a different type of inlet protection may be required. Inlet protection is required on all inlets that have outfalls that bypass sediment trapping structures and directly discharge off site. Use inlet protection as a last resort for sediment control when no other means are practical and do not use as the only means of protection.

General Design Requirements

Type A-Low Flow Inlet Filters include filter fabric inlet protection and 18-inch diameter sediment tubes.

- Applicable for inlets with peak flow rates **less than 1 cfs** where the inlet drain area has grades less than 5%. The immediate drainage area (5-foot radius around the inlet) has grades less than 1%. Areas receiving concentrated flows **are not** acceptable.

Type B-Medium Flow, Low Velocity Inlet Filters include hardware fabric and stone inlet protection.

- Applicable for inlets with peak flow rates **less than 3 cfs** where the inlet drain area has grades **less than 5%.** Flow velocities to the inlet may **not exceed 3 feet per second**. Applicable where an overflow capacity is **not** required to prevent excessive ponding around the structure.

Type C-Medium Flow, Medium Velocity Inlet Filters include block and gravel inlet protection.

- Applicable for inlets with peak flow rates **less than 3 cfs** where the inlet drain has grades **less than 5%.** Flow velocities to the inlet may **not exceed 5 feet per second**. Applicable where an overflow capacity is required to prevent excessive ponding around the structure. **Not applicable in areas exposed to traffic**, such as median drains

Type D-Rigid Inlet Filters include prefabricated inlet filters composed of a geotextile fabric connected to a rigid structure

- Applicable for drainage areas up to **2 acres** with peak flow rates **greater than 3 cfs** where the inlet drain area has grades **greater than 5%**. Flow velocities to the inlet may **exceed 3 feet per second**.
- These filters are used for median applications (Type D1) and for sump applications (Type D2). Applicable where an overflow capacity **is** required to prevent excessive ponding around the structure. Capable of protecting inlet structures not associated with curb inlets. The inlets may include, but are not limited to yard inlets, DI 24-inches by 24-inches, DI 24-inches by 36-inches and manholes.

Type E-Surface Course Curb Inlet Filters include prefabricated inlet filters composed of a synthetic material that has aggregate compartments for stone, sand, or other weighted mechanisms to hold the unit in place.

- Applicable for roadway catch basins after the road surface course is placed

Type F-Inlet Tubes are classified in two categories: weighted inlet tubes and non-weighted inlet tubes.

- Weighted inlet tubes are applicable for inlets with drainage areas less than 1 acre. Weighted inlet tubes are used for placement on gravel, concrete, asphalt or other hard surfaces around drainage inlets where stakes cannot be driven. Weighted inlet tubes are applicable where construction traffic may occur around the inlet. All weighted Type F Inlet Structure Filters are applicable as Type E Inlet Structure Filters.

- Non-weighted inlet tubes are inlet tubes applicable for Catch Basins with drainage areas less than 1 acre where stakes or posts are driven to hold the tube in place. For non-weighted inlet tube applications, an inlet tube is placed on subgrade and is applicable until the road base course is placed.

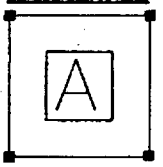
- Both weighted and non-weighted inlet tubes are applicable as weep hole inlet filters, although non-weighted inlet tubes can only be used in situations where stakes is driven into the ground or subgrade to secure the tube.

General Inspection and Maintenance

- Inspect every 7 calendar days and within 24-hours after each storm that produces ½-inches or more of rain. Handle any damage or needed repairs immediately.
- Inspect after installation for gaps that may permit sediment to enter the storm drainage system.
- Remove accumulated sediment and debris from the surface and vicinity of Inlet Filters after each rain event or as directed by the Engineer, Inspector or Manufacturer's Representative.
- Remove sediment when it reaches approximately 1/3 the height of the Inlet Filter. If a sump is used, remove sediment when it fills approximately 1/3 the depth of the hole. Maintain the pool area, always providing adequate sediment storage volume for the next storm event.
- Remove, move, and/or replace as required to adapt to changing construction site conditions.
- Remove Inlet Filters from the site when the functional longevity is exceeded as determined by the Engineer, Inspector or Manufacturer's Representative.
- Dispose of Inlet Filters no longer in use at an appropriate recycling or solid waste facility.
- Prior to final stabilization, backfill and repair all trenches, depressions, and other ground disturbances caused by the removal of Inlet Filters.
- Remove all construction material and sediment and dispose of them properly. Grade the disturbed areas to the elevation of the inlet structure crest. Stabilize all bare areas immediately.

Type A – Filter Fabric Inlet Protection

Plan Symbol



Design filter fabric inlet protection to have an 80 percent design removal efficiency goal of the total suspended solids (TSS) in the inflow. The Design Aids located in the Silt Fence section of this Handbook may be used to properly design filter fabric inlet protection.

Materials

Use filter fabric that conforms to SCDOT standard specifications for highway construction (latest edition). Refer to the silt fence geotextile fabrics SCDOT Approval Sheet #34.

Use 48-inch long wood posts that meet the following requirements.

- 2-inch by 2-inch size.
- Heavy-duty wire staples at least 1½-inch long, spaced a maximum of 6-inches apart to attach the filter fabric to wooden stakes.

Use 48-inch long steel posts that meet the following minimum physical requirements:

- Be composed of high strength steel with minimum yield strength of 50,000 psi.
- Have a standard "T" section with a nominal face width of 1.38-inches and nominal "T" length of 1.48-inches.
- Weigh 1.25 pounds per foot (± 8%).
- Be painted with a water based baked enamel paint.

Installation

Excavate a trench 6-inches wide and 6-inches deep around the outside perimeter of the inlet.

Extend the filter fabric a minimum of 12-inches into the trench. Backfill the trench with soil or crushed stone and compact over the filter fabric unless the fabric is pneumatically installed.

Install the filter fabric to a minimum height of 18-inches and maximum height of 24-inches above grade. Space the posts around the perimeter of the inlet a maximum of 3-feet apart and drive them into the ground a minimum of 24-inches.

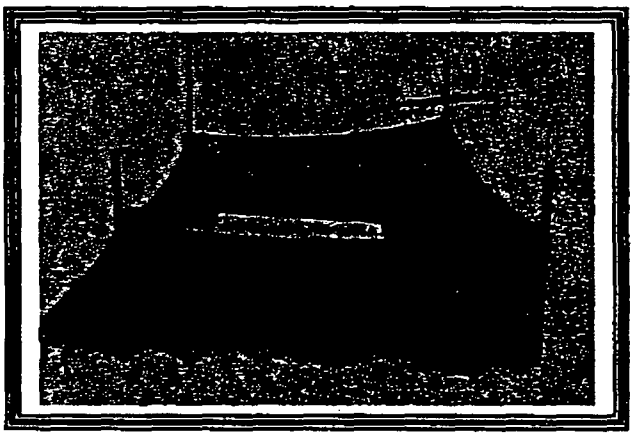
Cut the filter fabric from a continuous roll to the length of the protected area to avoid the use of joints. When joints are necessary, wrap filter fabric together only at a support post with both ends securely fastened to the post, with a minimum 6-inch overlap.

Attach fabric to wood posts using heavy-duty wire staples at least 1½-inch long, spaced a maximum of 6-inches apart.

Attach fabric to steel posts with heavy-duty plastic ties. Attach at least four (4) evenly spaced ties in a manner to prevent sagging or tearing of the fabric. In all cases, affix ties in no less than four (4) places.

Inspection and Maintenance

- Inspect every 7 calendar days and within 24-hours after each rainfall event that produces ½-inches or more of precipitation. Replace the fabric if it becomes clogged.
- Remove the sediment when it reaches 1/3 the height of the fabric. Take care not to damage or undercut fabric when removing sediment.
- If a sump is used, remove sediment when it fills 1/3 the depth of the hole.
- Maintain the pool area, always providing adequate sediment storage volume for the next storm.
- Remove storm drain inlet protection only after the disturbed areas are permanently stabilized.
- Remove all construction material and sediment, and dispose of them properly.
- Grade the disturbed area to the elevation of the drop inlet structure crest. Use appropriate permanent stabilization methods to stabilize bare areas around the inlet.



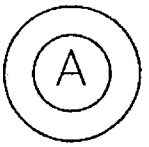
Filter Fabric Inlet Protection

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Excessive sediment entering inlet.	Ensure that soil stabilization and sediment control devices are installed upstream of inlets. Ensure that the barriers around the inlet are installed correctly. Filter fence needs to be keyed in so that water goes through filter fabric and not under it. Use a different type of inlet protection if concentrated flows are observed.
Filter fabric clogged by sediment or other debris.	Replace filter fabric.
Sediment reaches 1/3 the height of fabric.	Remove sediment.
Ponded water causes a traffic concern.	Use alternate BMPs upstream. Remove inlet protection if necessary.

Type A – Sediment Tube Inlet Protection

Plan Symbol



Materials

Sediment tubes for Type A Inlet Structure Filters exhibit the following properties:

- Produced by a Manufacturer experienced in sediment tube manufacturing.
- Composed of compacted geotextiles, curled excelsior wood, natural coconut fibers, hardwood mulch or a mix of these materials enclosed by a flexible netting material.
- Straw, straw fiber, straw bales, pine needles, and leaf mulch are not allowed under this specification.
- Utilizes outer netting that consists of seamless, high-density polyethylene photodegradable materials treated with ultraviolet stabilizers or a seamless, high-density polyethylene non-degradable materials.
- Diameter ranging from 18-inches to 24-inches.
- Curled excelsior wood, or natural coconut rolled erosion control products (RECPs) that are rolled up to create a sediment tube are **not** allowed under this specification.
- Select applicable Sediment Tubes from the SCDOT approved products list.

Use 48-inch long wood posts that meet the following requirements.

- 2-inch by 2-inch size.
- Heavy-duty wire staples at least 1½-inch long, spaced a maximum of 6-inches apart to attach the filter fabric to wooden stakes.

Use 48-inch long steel posts that meet the following minimum physical requirements:

- Be composed of high strength steel with minimum yield strength of 50,000 psi.
- Have a standard "T" section with a nominal face width of 1.38-inches and nominal "T" length of 1.48-inches.
- Weigh 1.25 pounds per foot (± 8%).
- Be painted with a water based baked enamel paint.

Installation:

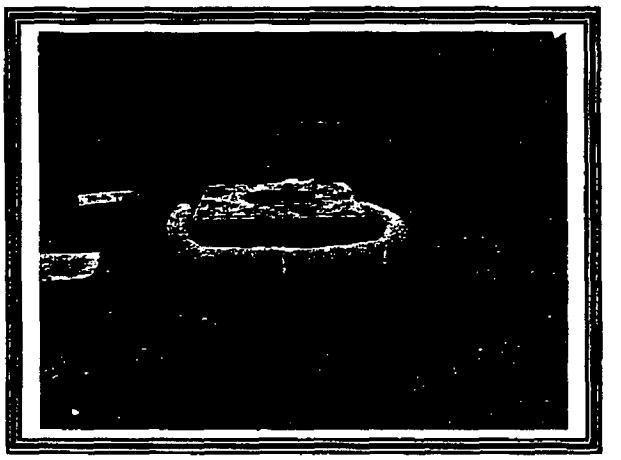
Remove all rocks, clods, vegetation or other obstructions so installed sediment tubes have direct contact with the underlying soil or surface.

Install sediment tubes by laying them flat on the ground. Construct a small trench to a depth that is 20% of the sediment tube diameter. Lay the sediment tube in the trench and compact the upstream sediment tube soil interface. Do not completely bury sediment tubes during installation. Lap the ends of adjacent sediment tubes a minimum of 6-inches to prevent flow and sediment from passing through the field joint. Never stack sediment tubes on top of one another.

Install sediment tubes using wooden stakes (2-inch x 2-inch) or steel posts (standard "U" or "T" sections with a minimum weight of 1.25 pounds per foot) a minimum of 48-inches in length placed on 2-foot centers. Intertwine the stakes with the outer mesh on the downstream side, and drive the stakes in the ground to a minimum depth of 24-incest leaving less than 12-inches of stake above the exposed sediment tube.

Inspection and Maintenance:

- Inspect every 7 calendar days and within 24-hours after each rainfall event that produces ½-inches or more of precipitation.
- Inspect sediment tubes after installation for gaps under the tubes and for gaps between joints of adjacent ends of sediment tubes. Repair rills, gullies, and all undercutting near sediment tubes.
- Remove and/or replace installed sediment tubes as required to adapt to changing construction site conditions.
- Remove all sediment tubes from the site when the functional longevity is exceeded as determined by the Engineer, Inspector or Manufacturer's Representative.
- Dispose of sediment tubes in regular means as non-hazardous, inert material.



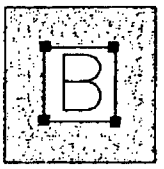
Sediment Tube Inlet Protection

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Too much sediment has accumulated.	Remove accumulated sediment to recover holding capacity. Remove accumulated sediment from the upstream side of the sediment tube when the sediment has reached a height of approximately one-third the original height of the tube (measured at the center).
Sediment tube washes away.	Use larger sediment tubes. Decrease post spacing, and add more posts. Install posts on both the upstream and downstream sides of the sediment tube.
Other application used instead of sediment tubes	Do not use straw bales as sediment tube alternatives.
Wrong type of materials or wrong type of sediment tube utilized.	Straw, pine needle and leaf mulch-filled sediment tubes are not permitted. Curled excelsior wood, or natural coconut rolled erosion control products (RECPs) that are rolled up to create a sediment tube are <u>not</u> permitted. Do not use straw bales.

Type B - Hardware Fabric and Stone Inlet Protection

Plan Symbol



Design hardware fabric and stone inlet protection to have an 80 percent design removal efficiency goal of the total suspended solids (TSS) in the inflow. The Design Aids located in the Rock Check Dam section of this Handbook may be used to properly design hardware fabric inlet protection.

Materials

Use hardware fabric or comparable wire mesh with maximum openings of 0.5-inches x 0.5-inches as the supporting material.

Use48-inch steel posts that meet the following minimum physical requirements:

- Be composed of high strength steel with minimum yield strength of 50,000 psi.
- Have a standard "T" section with a nominal face width of 1.38-inches and nominal "T" length of 1.48-inches.
- Weigh 1.25 pounds per foot (± 8%).
- Be painted with a water based baked enamel paint.

Use heavy-duty wire ties to attach the wire mesh material to the steel posts.

Place Aggregate No. 5 washed stone against the hardware fabric on all sides.

Installation

Excavate a trench 6-inches deep around the outside perimeter of the inlet.

Use hardware fabric or comparable wire mesh with maximum openings of 0.5-inches by 0.5-inches as the supporting material. Extended the fabric a minimum of 6-inches into the ground. Backfill the trench with soil or crushed stone and compact over the fabric.

Use steel posts with a minimum post length of 48-inches consisting of standard "T" sections with a weight of 1.25 pounds per foot (±8%). Install the wire mesh fabric above grade a minimum of 18-inches without exceeding 24-inches.

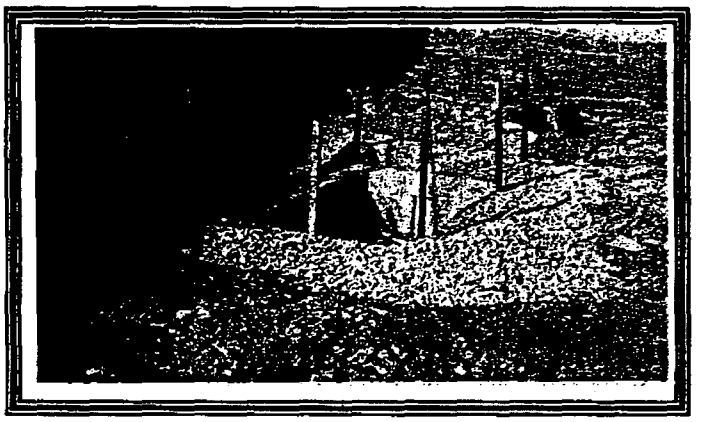
Space the steel posts a maximum of 3-feet apart around the perimeter of the inlet and drive them into the ground a minimum of 24-inches.

Use heavy-duty wire ties spaced a maximum of 6-inches apart to attach the wire mesh material to the steel posts.

Place Aggregate No. 5 washed stone to a minimum height of 12-inches, and a maximum height of 24-inches against the hardware fabric on all sides.

Inspection and Maintenance

- If the stone becomes clogged with sediment, pull the stones away from the inlet and clean or replace them.
- Since cleaning of gravel at a construction site may be difficult, an alternative approach would be to use the clogged stone as fill and put fresh stone around the inlet.



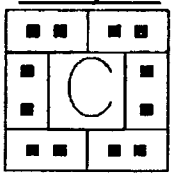
Hardware Fabric and Stone Inlet Protection

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Excessive sediment is entering the inlet.	Ensure that soil stabilization and sediment control devices are installed upstream of inlets. Ensure that the barriers around the inlet are installed correctly.
Sediment reaches 1/3 the height of the structure.	Remove sediment.
Stone filter material becomes clogged with sediment.	Pull stones away from inlet and clean them, or replace them with new stones.
Ponded water causes a traffic concern.	Use alternate BMPs upstream. Remove drain inlet protection if necessary.

Type C - Block and Gravel Inlet Protection

Plan Symbol



Block and gravel filters are used where heavy flows and higher velocities are expected and where an overflow capacity is necessary to prevent excessive ponding around the structure.

Materials

Use masonry blocks ranging from 8 to 12 inches wide.

Use hardware fabric or comparable wire mesh with maximum openings of ½-inches x ½-inches as the supporting material.

Use 1-inch D_{50} washed stone gravel.

Installation

Place the bottom row of the concrete blocks lengthwise on their side so that the open end faces outward, not upward.

The height of the barrier is varied, depending upon design needs by stacking a combination of blocks that are 8- and 12-inches wide.

Place wire mesh over the outside vertical face of the concrete blocks to prevent stones from being washed through the holes in the blocks. Use hardware cloth or comparable wire mesh with ½-inch x ½-inch openings.

Install 1-inch D_{50} washed stone to a height equal to the elevation of the top of the blocks.

Inspection and Maintenance

- Inspect every 7 calendar days and within 24-hours after each storm that produces ½-inches or more of rain. Any needed repairs should be handled immediately.
- Remove sediment when it reaches 1/3 the height of the blocks. If a sump is used, remove sediment when it fills 1/3 the depth of the hole.
- If the stone filter becomes clogged with sediment, the stones must be pulled away from the inlet and cleaned or replaced. Since cleaning of gravel at a construction site may be difficult, an alternative approach would be to use the clogged stone as fill and put fresh stone around the inlet.
- Remove inlet protection structures after the disturbed areas are permanently stabilized. Remove all construction material and sediment, and dispose of them properly.
- Grade the disturbed area to the elevation of the drop inlet structure crest.
- Stabilize all bare areas immediately.

Block and Gravel Inlet Protection

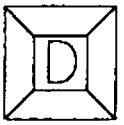
Block and Gravel Inlet Protection

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Excessive sediment is entering the inlet.	Ensure that soil stabilization and sediment control devices are installed upstream of inlets. Ensure that the block and gravel inlet protection is installed correctly.
Sediment reaches 1/3 the height of the blocks.	Remove sediment.
Stone filter material becomes clogged with sediment.	Pull stones away from inlet and clean them, or replace them with new stones.
Ponded water causes a traffic concern.	Use alternate BMPs upstream. Remove inlet protection if necessary.

Type D – Rigid Inlet Filters

Plan Symbol



There are two uses for rigid inlet filters: median applications (Type D1) and sump applications (Type D2). Type D1 filters have more overflow capacity and less filtration area than Type D2 to prevent ponding in medians. These filters are capable of protecting inlet structures not associated with curb inlets

Materials

Rigid inlet filters exhibit the following properties:

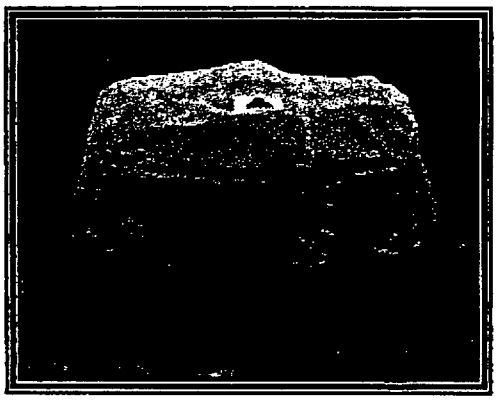
- Composed of a geotextile fabric connected to a rigid structure. The geotextile fabric is non-biodegradable and resistant to degradation by ultraviolet exposure and resistant to contaminants commonly encountered in storm water.
- Use a rigid structure composed of high molecular weight, high-density polyethylene copolymer with a UV inhibitor. Do not use structures that are not reusable and recyclable.
- Use a filter fabric constructed of 100% continuous polyester non-woven engineering fabric. The filter fabric is fabricated to provide a direct fit adjacent to the associated rigid structure.
- Rigid inlet filters have a two-stage design. The first stage conveys normal flows at a minimum clean water flow rate of 100 gallons per minute per square foot. The second stage conveys high flow rates, with a minimum apparent opening of 0.5-inch per square inch (No. 12 standard sieve opening).
- Type D1 inlet filters have a first stage minimum height of 9-inches and a maximum height of 12-inches in order to allow greater overflow capacity and prevent ponding in the median.
- Rigid inlet filters completely surround the inlet.
- Rigid inlet filters have lifting devices or structures to assist in the installation and to allow inspection of the storm water system.
- The filter fabric is capable of reducing effluent sediment concentrations by no less than 80% under typical sediment migration conditions.
- Select applicable Type D inlet filters from the SCDOT approved products list.

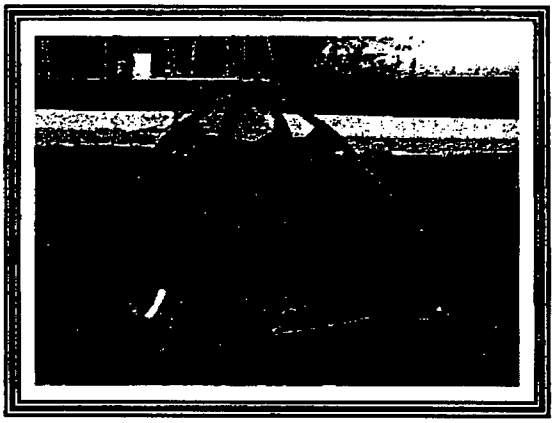
Installation

Install rigid inlet filters in accordance with the Manufacturer's written installation instructions. Properly install rigid inlet protection so the inlet is completely enclosed.

Inspection and Maintenance

- Inspect every 7 calendar days and within 24-hours after each storm that produces ½-inches or more of rain. Any needed repairs should be handled immediately.
- Inspect after installation to insure that no gaps exist that may permit sediment to enter the storm drain system.
- Remove and/or replace rigid inlet filters to adapt to changing construction site conditions.
- Clean the rigid inlet protection filter material when it becomes covered or clogged with deposited sediment.
- Replace the rigid inlet protection filter material as directed by the Engineer.





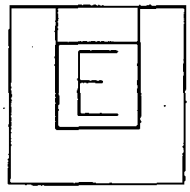
Rigid Inlet Filters

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Excessive sediment is entering the inlet.	Ensure that soil stabilization and sediment control devices are installed upstream of inlets. Ensure that the rigid inlet filters are installed correctly.
Sediment reaches 1/3 the height of the structure.	Remove sediment.
Rigid inlet filter material becomes clogged with sediment.	Pull rigid inlet filters from inlet and clean them, or replace rigid inlet filters with new filter material.
Ponded water causes a traffic concern.	Use alternate BMPs upstream. Remove rigid inlet filter if necessary.

Type E - Surface Course Curb Inlet Filters

Plan Symbol



Materials

Use surface course inlet filters that have a minimum height or diameter of 9-inches and have a minimum length that is 2-feet longer than the length of the curb opening. Surface course inlet filters are not designed to completely block the inlet opening.

Use surface course inlet filters constructed with a synthetic material that will allow storm water to freely flow through while trapping sediment and debris. Use a material that is non-biodegradable and resistant to degradation by ultraviolet exposure and resistant to contaminants commonly encountered in storm water. Straw, straw fiber, straw bales, pine needles, and leaf mulch are not permissible filter materials.

Surface course inlet filters have aggregate compartments for stone, sand or other weighted materials or mechanisms to hold the unit in place.

Use filter fabric that is capable of reducing effluent sediment concentrations by no less than 80% under typical sediment migration conditions.

Select Type E inlet filters from the SCDOT approved products list.

Installation

Surface course inlet filters are applicable for road Catch Basin after the road surface course is placed. Place surface course inlet filters where sediment may spill over sidewalks and curbs.

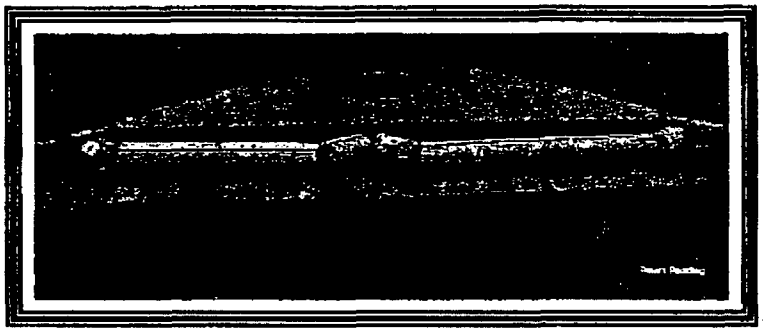
Install surface course inlet filters in front of curb inlet openings. The filter has a minimum height or diameter of 9-inches and has a minimum length that is 2-feet longer than the length of the curb opening to allow sufficient length to cover the inlet with at least 1-foot of clearance beyond the inlet on both ends.

Do not completely block the inlet opening with surface course inlet filters. Install surface course inlet filters in a manner to allow overflows to enter the catch basin.

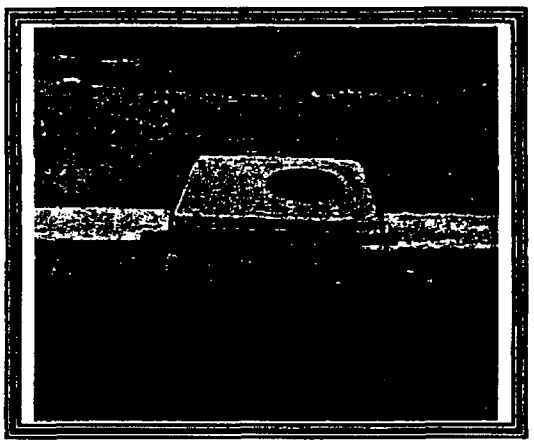
Fill the aggregate compartment to a level (at least ½ full) that will keep the surface course inlet filter in place and create a seal between the surface course inlet filter and the road surface.

Inspection and Maintenance

- Inspect every 7 calendar days and within 24-hours after each storm that produces ½-inches or more of rain. Any needed repairs should be handled immediately.
- Ponding is likely if sediment is not removed regularly.
- Inspect surface course curb inlet filters on a regular basis and immediately after major rain events.
- Clean the surface course curb inlet filter if a visual inspection shows silt and debris build up around the filter.



Surface Course Inlet Filter



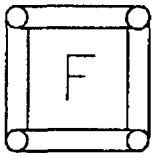
Surface Course Inlet Filter

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Excessive sediment is entering the inlet.	Ensure that soil stabilization and sediment control devices are installed upstream of inlets. Ensure that the surface course inlet filters are installed correctly.
Sediment reaches 1/3 the height of the structure.	Remove sediment.
Surface course inlet filter material becomes clogged with sediment.	Pull surface course filters from inlet and clean them, or replace surface course inlet filters with new filter material.
Ponded water causes a traffic concern.	Use alternate BMPs upstream. Remove surface course inlet filter if necessary.

Type F - Inlet Tubes

Plan Symbol



Inlet tubes are temporary filtering devices placed around inlet structures to trap sediment and keep silt, sediment and construction debris from entering pipe systems through open inlet structures. Additionally, inlet tubes prevent the silting-in of inlets, storm drainage systems and receiving channels.

Materials

Use inlet tubes that exhibit the following properties:

- Produced by a Manufacturer experienced in sediment tube manufacturing.
- Composed of compacted geotextiles, curled excelsior wood, natural coconut fibers or hardwood mulch or a mix of these materials enclosed by a flexible netting material.
- Do not use straw, straw fiber, straw bales, pine needles or leaf mulch under this specification.
- Utilize an outer netting that consists of seamless, high-density polyethylene photodegradable materials treated with ultraviolet stabilizers or a seamless, high-density polyethylene non-degradable materials.
- Curled wood excelsior fiber, or natural coconut fiber rolled erosion control products (RECP) rolled up to create an inlet tube devices are **not** allowed under this specification.

Weighted Inlet Tubes

Weighted inlet tubes are sediment tubes capable of staying in place without external stabilization measures and may have a weighted inner core or other weighted mechanism to keep them in place.

Materials

Weighted inlet tubes meet the minimum performance requirements shown in the table below.

PROPERTY	TEST METHOD	VALUE
Diameter	Field Measured	6.0 inch to 12.0 inch
Mass per Unit Length	Field Measured	6 inch = 6 lbs/ft minimum 12 inch = 12 lbs/ft minimum
Fiber Length	Field Measured	80% of the fiber materials at least 4-inches in length
Length per Tube	Field Measured	6 foot minimum
Netting Unit Weight	Certified	0.35 oz/ft minimum

Select Type F weighted inlet tubes from the SCDOT approved products list.

Installation

Install weighted inlet tubes lying flat on the ground, with no gaps between the underlying surface and the inlet tube. Never stack weighted inlet tubes on top of one another.

Do not completely block inlets with weighted inlet tubes.

Install weighted inlet tubes in such a manner that all overflow or overtopping water has the ability to enter the inlet unobstructed.

To avoid possible flooding, two or three concrete cinder blocks may be placed between the weighted inlet tubes and the inlet.

Non-Weighted Inlet Tubes

Non-weighted inlet tubes are defined as sediment tubes that require staking or other stabilization methods to keep them safely in place.

Materials

Non-weighted inlet tubes meet the minimum performance requirements shown in the table below.

PROPERTY	TEST METHOD	VALUE
Diameter	Field Measured	6.0 inch to 12.0 inch
Mass per Unit Length	Field Measured	6 inch = 1.0 lbs/ft minimum 12 inch = 2.0 lbs/ft minimum
Fiber Length	Field Measured	80% of the fiber materials at least 4-inches in length
Length per Tube	Field Measured	6 foot minimum
Netting Unit Weight	Certified	0.35 oz/ft minimum

Select Type F non-weighted inlet tubes from the SCDOT approved products list.

Installation

Install non-weighted inlet tubes immediately after grading and construction of catch basin boxes. Maintain non-weighted inlet tubes during subgrade and base preparation until the base course is placed.

For weep hole inlet protection applications, both weighted and non-weighted inlet tubes are applicable. Install non-weighted inlet tubes in situations when stakes can be driven into the ground or subgrade to secure the tube.

Review all project specifications for special installation requirements.

Install non-weighted inlet tubes using 2-inch x 2-inch wooden stakes or steel posts consisting of standard "T" sections weighing 1.25 pounds per foot (±8%), 3-feet in length placed on 2-foot centers. Intertwine the stakes with the outer mesh on the downstream side of the inlet tube.

Drive stakes in the ground to a minimum depth of 1-foot leaving less than 1-foot of stake exposed above the non-weighted inlet tube.

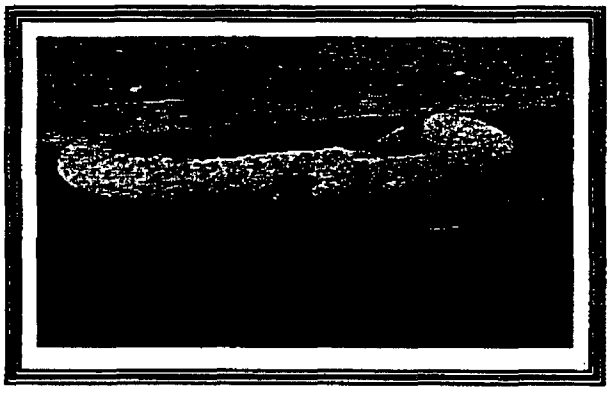
An acceptable alternative installation is driving stakes on 2-foot centers on each side of non-weighted inlet tubes and connecting them with natural fiber twine or steel wire to inhibit the non-weighted sediment tube from moving vertically.

Another acceptable alternative installation for non-weighted inlet tubes is installing stakes on 2-foot centers in a crossing manner maintaining direct soil contact at all times.

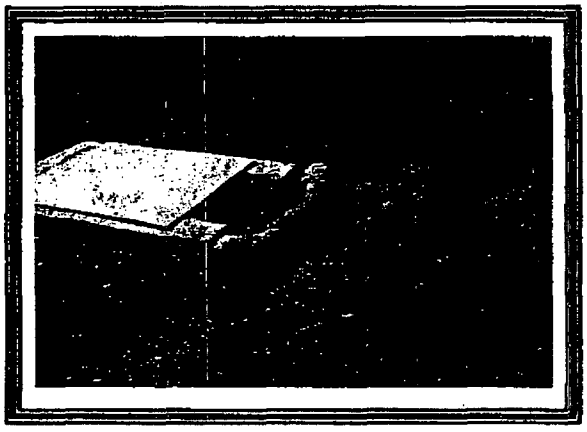
Install non-weighted inlet tubes so the top of the tube is below the top of the installed curb line to ensure that all overflow or overtopping water has the ability to enter the inlet unobstructed.

Inspection and Maintenance

- Inspect every 7 calendar days and within 24-hours after each storm that produces ½-inches or more of rain. Any needed repairs should be handled immediately.
- Inlet tubes may be temporarily moved during construction as needed.
- Replace inlet tubes damaged during installation as directed by the Inspector or Manufacturer's Representative at the contractor's expense.



Weighted Inlet Tube



Non-weighted Inlet Tube

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Excessive sediment is entering the inlet.	Ensure that soil stabilization and sediment control devices are installed upstream of inlets. Ensure that inlet tubes are installed correctly.
Sediment reaches 1/3 the height of the inlet tube.	Remove sediment.
Filter material becomes clogged with sediment.	Pull Inlet from tube and clean them, or replace clogged inlet tubes with inlet tubes
Ponded water causes a traffic concern.	Use alternate BMPs upstream. Remove inlet tubes if necessary.

Rock Sediment Dikes

Plan Symbol

Description

Rock sediment dikes are semi-circular sediment control structures constructed across drainage ditches, swales, low areas or other areas that receive concentrated flow. A rock sediment dike consists of a half-circular shaped rock embankment with a sump area constructed for sediment storage. Design rock sediment dikes to have an 80 percent design removal efficiency goal of the total suspended solids (TSS).

When and Where to Use It

Rock sediment dikes are most effective in areas where sediment control is needed with minimal disturbance. Use as a sediment control structures for the outfalls of diversion swales, diversion dikes, in low areas or other areas where concentrated sediment laden flow is expected. Use rock sediment dikes for drainage less than 2.0 acres. Do not place rock sediment dikes in Waters of the State (unless approved by SCDHEC, State, or Federal authorities).

Rock Sediment Dike Design Criteria

Design Aids

The Design Aids located in the rock check dam section of this handbook may be used to properly size rock sediment dikes. Sedimot III, SEDCAD4, Pond Pack and other computer models that utilize eroded particle size distributions and calculates a corresponding trapping efficiency may also be utilized.

General Design Requirements

a. Maximum Drainage Area – 2 acres
b. Maximum Design Life - 18 months
c. Maximum Rock Dike Height – 2-feet
d. Discharge and treatment capacity for the 10-year 24-hour storm event.
e. 80 percent design removal efficiency goal for TSS
f. Determine required sediment storage volume and ensure sediment dike sump provides the volume.
g. Size rock sediment dike to handle the receiving peak flow rates. Flows that overtop the structure have an assumed Trapping Efficiency of 0 percent.

Installation

Install a non-woven geotextile fabric over the soil surface where the rock sediment dike is to be placed.

Construct the body of the rock sediment dike with minimum 9-inch D_{50} Riprap. Construct the upstream face with a 1-foot thick layer of ¾-inch to 1-inch D_{50} washed stone placed at a slope of 2H:1V.

Construct rock sediment dikes with a minimum top flow length of 3-feet (two-foot flow length through the riprap and one-foot flow length through the washed stone).

Place the rock by hand or mechanical placement (no dumping of rock to form the sediment dike) to achieve the proper dimensions.

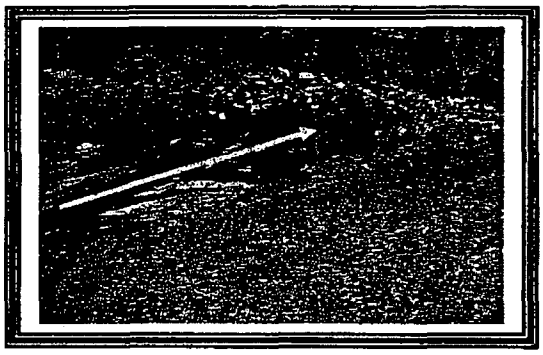
Install a sediment sump with a minimum depth of 2-feet on the upstream side of the structure to provide sediment storage. Install the upstream side of the sediment sump with a slope of 5H:1V to inhibit erosion of the sediment storage area.

Mark the sediment cleanout level of the sediment dike with a stake in the field.

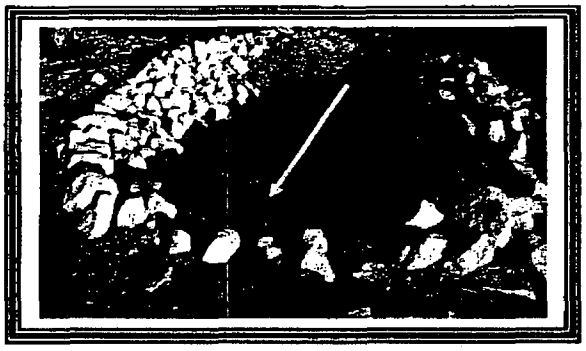
Seed and mulch all disturbed areas.

Inspection and Maintenance

- The key to a functional rock sediment dike is continual monitoring, regular maintenance and regular sediment removal.
- Inspect every 7 calendar days and within 24-hours after each rainfall event that produces ½-inches or more of precipitation.
- Remove sediment when it reaches 50 percent of the sediment storage volume or the top of the cleanout stake. Removed sediment from the sump should be removed from, or stabilized on site.
- Remove rock sediment dikes within 30 days after final site stabilization is achieved or after they are no longer needed. Permanently stabilize disturbed areas resulting from the removal.



Rock Sediment Dike



Rock Sediment Dike

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Sediment reaches 50 percent of the sediment storage volume or the top of the cleanout stake.	Remove accumulated sediment to recover holding capacity.
Rock sediment dikes wash away.	Replace rock sediment dikes using larger stone.
Final site stabilization is achieved.	Remove rock sediment dikes from site within 30 days after stabilization, and permanently stabilize the areas that were disturbed by the dikes.

Engineering Aids and Design Guidelines for Sediment Controls

This section presents design aids developed for use in designing four types of sediment control BMPs in South Carolina;

1. Sediment basins
2. Sediment traps
3. Silt fence
4. Rock check dams.

Each of these design aids is briefly described in this section. Specific BMP examples are located in the specific BMP sections of this Handbook to demonstrate their use in realistic problems. First a common feature of each design aid, settling velocity, is discussed.

Characteristic Settling Velocity and Eroded Particle Size

A common feature of each of the design aids is that a characteristic settling velocity for the eroded soil is obtained. For South Carolina conditions, this velocity corresponds to an eroded size such that 15 percent of the sediment has particles smaller than the size specified. The procedure for empirically estimating eroded size distributions is described by Hayes et. al (1996).

The characteristic settling velocity corresponds to an eroded particle diameter that is referred to as D_{15}. This diameter represents the point on the eroded particle size distribution curve where 15 percent of the particles (by weight) are equal to or smaller than this size. Estimated eroded size distributions for South Carolina soils using an adaptation of the method described by Foster et al. (1985) were developed. The procedure uses the primary particle size information reported by the USDA Soil Conservation Service (SCS) as part of county soil surveys. This procedure may be used with USDA Soil Survey Data or site specific soil boring data. Other procedures are given by Haan et. al. (1994) for physically based estimating procedures.

If the eroded particle size D_{15} is less than 0.01 mm, then the settling velocity based upon a simplified form of Stokes Law is:

$$V_s = 2.81d^2$$

Where:

V_s = settling velocity (ft/sec)
d = soil eroded particle size diameter (mm).

If the eroded particle size D_{15} is greater than or equal to 0.01 mm, then settling velocity is found using:

$$\log_{10}V_s = -0.34246\,(\log_{10}d)^2 + 0.98912\,(\log_{10}d) - 0.33801$$

Where:

V_s = settling velocity (ft/sec)
d = soil eroded particle size diameter (mm)
(Wilson et al., 1982)

The characteristic settling velocity is obtained using Figure SV-1. The eroded particle sizes (D_{15}) for soils found in South Carolina are provided in Appendix E.

It is important to remember that the eroded size distribution is the most critical parameter in sizing sediment controls. The eroded size distributions vary greatly from primary particle size distributions that are often determined as a result of soil strength investigations for construction purposes. Primary particle sizes yield erroneous results and should not be used. The user should note that D_{15} is often smaller for coarse textured (more sandy soils) because of the reduced clay content and the lack of aggregation.

Soil Classification by Texture

Land Resource Region	Coarse	Medium	Fine
Piedmont, Coastal	Sandy Loam	Silt Loam	Clay Loam
Sandhills	Sand	Sandy Loam	Silt Loam
Tidal with High Water Table	Sandy Loam	Silt Loam	Clay Loam

Sediment Basin Design Aids

The Sediment Basin Design Aids are designed for soils classed as either coarse (sandy loam), medium (silt loam), or fine (clay loam). The design ratio should be less than or equal to the curve value at any given trapping efficiency. The sediment basin Design Aids have been developed for the following two separate conditions:

- Basins <u>not</u> located in low lying areas and/or not having a high water table, and
- Basin located in low lying areas and/or having a high water table.

Design Aid Ratio

$$\text{Basin Ratio} = \frac{q_{po}}{A\,V_{15}}$$

Where:

q_{po} = Peak outflow rate from the basin for the 10-year 24-hour storm event (cfs)
A = Surface area of the pond at riser crest (acres)
V_{15} = Characteristic settling velocity (fps) of the characteristic D_{15} eroded particle (mm).

Constraints for use of Sediment Basin Design Aids:

- Watershed area less than or equal to 30 acres
- Overland slope less than or equal to 20 percent
- Outlet diameter less than or equal to 6-feet

Basin Ratios above the design curves are not recommended for any application of the design aids. If the basin ratio q_{po}/AV_{15} intersects the curve at a point having a trapping efficiency less than the desired value, the design is inadequate and must be revised.

- A basin **not** located in a low lying area and not having a high water table, has a basin ratio equal to 2.20 E5 at 80 percent trapping efficiency as shown in Figure SB-1.

- A basin that **is** located in a low lying area or in an area that has a high water table, has a basin ratio equal to 4.70 E3 at 80 percent trapping efficiency as shown in Figure SB-2.

Rock Check Dam Design Aids

Design aids for rock check dams were developed similarly to those for ponds. Again, the D_{15} eroded particle size is used for the calculation of the characteristic settling velocity.

The Rock Check Dam Design Aids have been designed for the following soil classifications:

- Coarse (sandy loam)
- Medium (silt loam)
- Fine (clay loam).

The design ratio should be less than or equal to the curve value at any given trapping efficiency. The ratio for rock check dams is defined by:

Design Aid Ratio

$$\text{Rock Check Ratio} = \frac{Sq^{(1-b)}}{aV_{15}}$$

Where:

S	=	Channel slope (%)
q	=	Unit width flow through the check for the 10-year 24-hour storm event (cfs/ft)
$\mathbf{V_{15}}$	=	Characteristic settling velocity (fps), of the characteristic D_{15} eroded particle (mm).

Coefficients *a* and Exponent *b* is interpolated from the following table.

Stone Flow Coefficient *a* and Exponent *b*

Stone Diameter(m)	Exponent b	Coefficient a		
		dl = 1m	dl = 2m	dl = 3m
0.01	0.6371	9.40	6.05	4.60
0.02	0.6540	7.40	4.65	3.55
0.03	0.6589	6.40	4.08	3.08
0.04	0.6609	5.85	3.65	2.80
0.05	0.6624	5.40	3.35	2.60
0.06	0.6635	5.05	3.15	2.40
0.08	0.6644	4.50	2.85	2.20
0.09	0.6648	4.28	2.70	2.10
0.10	0.6651	4.13	2.60	2.05
0.20	0.6662	3.20	2.05	1.57
0.30	0.6664	2.80	1.75	1.30
0.40	0.6665	2.50	1.55	1.16
0.50	0.6666	2.30	1.40	1.08

D_{50} = rock check dam average stone diameter in <u>meters</u>.
***dl* = average flow length through the rock ditch check in <u>meters</u>.**
Source: Haan et. al. (1994) pg. 151.

Constraints for the use of Rock Check Dam Design Aids:

- Watershed area is less than or equal to 5 acres
- Overland flow length is less than or equal to 500-feet
- Overland slope is less than or equal to 15 percent
- Maximum depth of the ditch is less than or equal to 6-feet

Rock Check Ratios above the design curves are not recommended for any application of the design aids. If the Rock Check Ratio intersects the curve at a point having a trapping efficiency less than the desired value, the design is inadequate and must be revised.

A rock check dam located on coarse soils has a ditch check ratio equal to 1.10 E3 at 80 percent trapping efficiency as shown in Figure DC-C.

A d rock check dam located on medium soils has a ditch check ratio equal to 5.80 E3 at 80 percent trapping efficiency as shown in Figure DC-M.

A d rock check dam located on fine soils has a ditch check ratio equal to 1.20 E4 at 80 percent trapping efficiency as shown in Figure DC-F.

Silt Fence Design Aids

This design aid for applies to silt fences placed in areas down slope from disturbed areas where it serves to retard flow and cause settling. Two conditions must be met for satisfactory design.

- Trapping efficiency must meet the desired level of control.
- Overtopping of the fence must not occur.

Design Aid Ratio

The silt fence design aid is a single line grouping all soil textures together. A similar procedure was used for development of the ratio as used for the ponds and rock checks. For the silt fence, the ratio is:

$$\text{Silt Fence Ratio} = \frac{q_{po}}{V_{15} P_{area}}$$

Where:

q_{po} = Peak outflow through the fence for the 10-year 24-hour storm event (cfs)
V_{15} = Characteristic settling velocity (fps), of the characteristic D_{15} eroded particle (mm)
P_{area} = Potential ponding area up slope of the fence (ft^2).

The ponding area is estimated by using the height of the fence available for flow through and extending a horizontal line from the fence to an intersection with the ground surface upslope of the fence. The unit available area is calculated by multiplying the fence height by the ground slope. Multiply this unit area by the available fence length for ponding to obtain the potential ponding area.

Using the calculated ponding area, calculate the ratio and enter the value to Figure SF-1 to determine the efficiency. Once an acceptable trapping efficiency is determined, a calculation for overtopping must be performed. The overtopping calculation must be performed using the slurry flow rate through the fence. This rate must be checked against the incoming flow to determine if enough storage exist behind the fence to prevent overtopping.

Constraints for the use of Silt Fence Design Aids:

- Watershed area is less than or equal to 5 acres
- Overland flow length is less than or equal to 500-feet
- Overland slope is less than or equal to 6 percent
- Slurry flow rate through the fence is less than or equal to 10 gpm / ft
- Maximum height of the silt fence is less than or equal to 3-feet

Silt Fence Ratios above the design curves are not recommended for any application of the design aids. If the silt fence ratio intersects the curve at a point having a trapping efficiency less than the desired value, the design is inadequate and must be revised.

A silt fence ratio equal to 0.23 has an 80 percent trapping efficiency as shown in Figure SF-1.

Sediment Trap Design Aids

Sediment traps, for the purposes of this document, are small excavated ponds with rock fill outlets. Their outlet hydraulics are different from a drop inlet structure, thus the Design Aid is slightly different with the area defined as being the area at the bottom of the outlet structure. Trapping efficiencies for sediment traps are plotted in Figure ST-1 as a function of the sediment trap ratio:

Design Aid Ratio

The sediment trap design aid is a single line grouping all soil textures together. A similar procedure was used for the development of the ratio as used for basins. For the sediment trap, the ratio is:

$$\text{Sediment Trap Ratio} = \frac{q_{po}}{A V_{15}}$$

Where

q_{po}	=	Peak outflow for the 10-year 24-hour storm event (cfs)
A	=	Surface area at the elevation equal to the **bottom** of the rock fill outlet (acres)
V_{15}	=	Characteristic settling velocity (fps), of the characteristic D_{15} eroded particle (mm).

Constraints for the use of Sediment Trap Design Aids are:

- Watershed area less than or equal to 5 acres
- Overland slope less than or equal to 20 percent
- Rock fill diameter greater than 0.2-feet and less than 0.6-feet
- Rock fill height less than 5-feet
- Top width of rock fill between 2- and 4-feet
- Maximum Side slopes 1:1 to 1.5:1.

Sediment Trap Ratios above the design curves are not recommended for any application of the design aids. If the sediment trap ratio intersects the curve at a point having a trapping efficiency less than the desired value, the design is inadequate and must be revised.

A sediment trap ratio equal to 9.0 E4 has an 80 percent trapping efficiency as shown in Figure ST-1.

Storm flows shall be routed through the sediment trap to calculate the required depth and storage volume of the trap.

A sediment storage volume should be calculated and provided below the bottom of the rock fill outlet structure.

Runoff Control and Conveyance Measures

Storm water runoff is rainfall or snowmelt that runs off the ground or impervious surfaces (buildings, roads, parking lots, etc.) and drains into natural or manmade drainage ways. In some cases, it drains directly into streams, rivers, lakes, sounds or the ocean. In other cases, particularly urbanized areas, it drains into streets and manmade drainage systems consisting of inlets and underground pipes commonly referred to as "storm sewers." Storm water entering storm sewers does not usually receive any treatment before it enters streams, lakes and other surface waters.

Storm water runoff problems and impacts are most evident in areas where urbanization has occurred. Changes in land use have a major effect on both the quantity and quality of Storm water runoff. Urbanization, if not properly planned and managed, can dramatically alter the natural hydrology of an area. Increased impervious cover decreases the amount of rainwater that can naturally infiltrate into the soil and increases the volume and rate of storm water runoff. These changes lead to more frequent and severe flooding and potential damage to public and private property. Under natural conditions, typically 10% of rainwater falling on a piece of property runs off the land surface into streams, rivers or lakes. The remainder either evaporates into the air or infiltrates into the soil replenishing groundwater supplies. Development of the site increases the percentage of impervious surfaces. As the percentage of impervious surfaces increases, the percentage of runoff increases since there is less vegetated area to soak up the rainwater.

The rate of runoff and streamflow after a storm event also shows dramatic increases under post versus predevelopment conditions. The higher and more rapid peak discharge of runoff and streamflow can overload the capacity of the stream or river, causing downstream flooding and streambank erosion. Local governments spend millions of dollars each year rectifying damage to public and private property caused by uncontrolled storm water runoff. In heavily developed areas, damage to public and private property occurs during heavy rains. This damage includes road, culvert, and water and sewer line washouts, flooded homes and yards, the deposition of sediment and debris on properties and roads, and damage to bridges. When streambanks erode they clog stream channels, culverts, and pipes with sediment contributing to flooding problems. Sediment is washed into ponds, lakes, and other impoundments reducing their capacity to store water and requiring costly removal efforts. The increased volume and velocity of runoff and streamflow can also cause accelerated channel erosion and changes in streambed composition. This can destroy fish habitat and disrupt the natural ecology of the stream or river.

The following runoff control BMPs are discussed in this handbook:

- Pipe Slope Drains
- Runoff Diversion Measures
- Level Spreader
- Temporary Stream Crossing
- Subsurface Drains
- Construction De-watering

Pipe Slope Drains

Plan Symbol

Description

Pipe slope drains reduce the risk of erosion by discharging concentrated runoff from the top to the bottom of slopes. Pipe slope drains is temporary or permanent depending on installation and material used.

When and Where to Use It

Use pipe slope drains when it is necessary for water to flow down a slope without causing erosion, especially before a slope has been stabilized or before permanent drainage structures are installed. Install temporary pipe slope drains prior to construction of permanent drainage structures. Bury permanent slope drains beneath the ground surface. Stabilize the inlets and outlets of pipe slope drains with flared end sections, Erosion Control Blankets (ECBs), Turf Reinforcement Mats (TRMs) or riprap. Fully compact the soil around the pipe entrance to prevent bypassing and undercutting of the structure. Stabilize the discharge end of the pipe and along the bottom of any swales that lead to sediment trapping structures.

General Design Requirements

Typical pipe slope drains are made of non-perforated corrugated plastic pipe and are designed to pass the peak flow rates for the 10-year 24-hour storm event.

The maximum drainage area per pipe is two acres.

Installation

Secure and fasten slope drain sections together with gasket watertight fittings. Securely anchor slope drains to the soil with wooden stakes or steel posts.

Direct runoff to slope drains with diversion berms, swales, or dikes. The minimum depth of these dikes or berms should be 1.5-feet. The height of the berm around the pipe inlet should be a minimum of 1.5-feet high and at least 0.5-feet higher than the top of the pipe. The berm at the pipe inlet shall be compacted around the pipe. The area around the inlet shall be properly stabilized with ECBs, TRMs, riprap or other applicable stabilization techniques.

The area below the outlet must be properly stabilized with ECBs, TRMs, riprap or other applicable stabilization techniques.

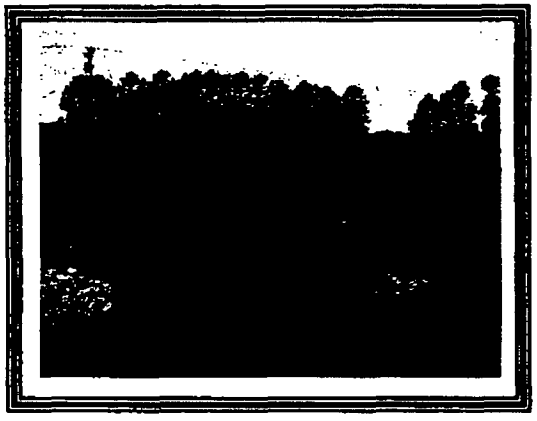
If the pipe slope drain is conveying sediment-laden water, direct all flows into the sediment trapping facility.

Permanent slope drains should be buried beneath the soil surface at minimum depth of 1.5-feet.

Inspection and Maintenance

- Inspect pipe slope drain inlet and outlet points every 7 calendar days and within 24-hours after each rainfall event that produces ½-inches or more of precipitation.
- Inspect the inlet for undercutting, and water bypassing the point of entry. If there are problems, reinforce the headwall with compacted earth or sandbags.

- Inspect the outlet point for erosion and appropriate outlet protection.
- Remove temporary pipe slope drains within 30 days after final site stabilization is achieved or after the temporary BMP is no longer needed.
- Permanently stabilize disturbed soil areas resulting from slope drain removal.



Pipe Slope Drain

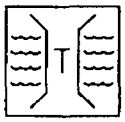
Pipe Slope Drain

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Pipe separates.	Reconnect pipe sections. Securely anchor and stabilize pipe into soil. Ensure that pipe connections are watertight.
Pipe outlet erodes.	Repair the damage and stabilize outlet with a flared end section, riprap, TRM or velocity dissipation device. If necessary, reduce flows being discharged.
Pipe becomes clogged.	Flush out pipe. Place a screen or grate at inlet to capture trash and large particles.
Erosion occurs around inlet.	Compact soil and stabilize area with flared end section, TRM or filter fabric and riprap. Re-grade around inlet to reduce the gradient angle.
Excessive sediment accumulates around inlet/outlet.	Remove accumulated sediment and stabilize upstream area.
Slope drain overtops.	Limit drainage area and flow velocity. Check pipe diameter to ensure that it is sized properly to accept flow. Add additional pipes to carry flows as necessary.

Temporary Stream Crossing

Plan Symbol



Description

A temporary stream crossing is a bridge or culvert across a stream or watercourse for short-term use by construction vehicles and heavy equipment. A stream crossing provides a means for construction vehicles to cross streams or watercourses without moving sediment to streams, damaging the stream bed or channel, or causing flooding. Prior to constructing a temporary stream crossing, the owner/person financially responsible for the project must submit an Application for Permit to construct across or along a stream to South Carolina Department of Health and Environmental Control (SCDHEC). Temporary stream crossings require authorization. Refer to the US Army Corps of Engineers and SCDHEC nationwide 401 and 404 regulations for information on permitting requirements.

When and Where to Use It

When feasible, attempt to minimize or eliminate the need to cross streams. Temporary stream crossings are a direct source of pollution; therefore, every effort should be made to use an alternate method (e.g., longer detour), when feasible. When it becomes necessary to cross a stream, a well-planned approach minimizes damage to streambanks and reduces erosion. The design of temporary stream crossings requires knowledge of the design flows.

Temporary Bridge Crossing Design Criteria

- Structures are designed in various configurations. Select construction materials capable of withstanding the anticipated heavy loading of the construction traffic.
- Crossing Alignment. Design temporary waterway crossing at right angles to the stream. Where approach conditions dictate, the crossing may vary 15° from a line drawn perpendicular to the centerline of the stream at the intended crossing location.
- Design a water diverting structure such as a dike or swale across the roadway on both roadway approaches 50-feet (maximum) on either side of the waterway crossing. This prevents roadway surface runoff from directly entering the waterway. Measure the 50-feet from the top of the waterway bank. Direct the flow captured in these dikes and swales to a sediment trapping structure. If the roadway approach is constructed with a reverse grade away from the waterway, a separate diverting structure is not required.
- Design appropriate perimeter controls such as silt fences, along stream banks.
- Design crossings with one traffic lane with a minimum width of 12-feet and a maximum width of 20-feet.

Temporary Culvert Crossing Design Criteria

- Limit the width of fill to that only necessary for the actual crossing.
- Use coarse aggregate of clean shot limestone rock and riprap with a 6-inch D_{50} or greater.
- Use clean shot rock and/or riprap as fill for crossings that will be in place for 6 to 12 months. Install a concrete cap over the rock for crossings that will be in place for more than 12 months.

- Design the stone cover over the culvert equal to ½ the diameter of the culvert or 12-inches, whichever is greater, but no greater than 18-inches.
- Design the culvert crossing to convey the flow from a two-year frequency storm without appreciably altering the stream flow characteristics.
- Place the maximum possible number of pipes within the streambanks with a maximum spacing of 12-inches between pipes.
- The minimum-sized pipe culvert used is 24-inches.
- Design culverts strong enough to support their cross-sectional area under the maximum expected heavy equipment loads.
- Design an adequate culvert length to extend the full width of the crossing, including side slopes.
- Design the minimum culvert slope to 3-inches per foot.
- Crossing Alignment. Design temporary culvert crossing at right angles to the stream. Where approach conditions dictate, the crossing may vary 15° from a line drawn perpendicular to the centerline of the stream at the intended crossing location.
- Design approaches to meet the following specifications:
  1. Clean stone or concrete fill only
  2. Minimum thickness: 6-inches
  3. Minimum width: equal to the width of the structure
  4. 20-feet minimum approach length
- Design a water diverting structure such as a dike or swale across the roadway on both roadway approaches 50-feet (maximum) on either side of the waterway crossing. This prevents roadway surface runoff from directly entering the waterway. Measure the 50-feet from the top of the waterway bank. Direct the flow captured in these dikes and swales to a sediment trapping structure. If the roadway approach is constructed with a reverse grade away from the waterway, a separate diverting structure is not required.
- The maximum design life of temporary culvert crossings is 24 months.

Installation

Install crossings prior to any other activities. Install and maintain pump-around diversions prior to any excavation and during the installation of the crossing. Place crossings in temporary construction easements only.

Minimize streambank clearing. Do not excavate rock bottom streambeds to install the crossing. Lay the culvert pipes on the streambed "as is" when applicable. Place as many pipes as possible within the low area of the stream. Place remaining pipes required to cross the stream on the existing stream bottom.

Install pipes with a maximum spacing of 12-inches between pipes. The minimum sized pipe culvert that may be used is 24-inches.

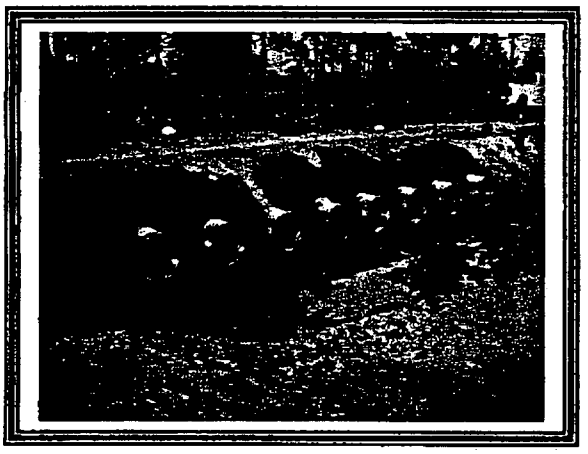
Install culverts with a length that extend the full width of the crossing, including side slopes.

Use coarse aggregate of clean limestone riprap with a 6-inch D_{50} or greater to form the crossing. Install the stone cover over the culvert equal to ½ the diameter of the culvert or 12-inches, whichever is greater, but no greater than 18-inches.

Limit all fill materials associated with the roadway approach to a maximum height of 2-feet above the existing flood plain elevation.

Inspection and Maintenance

- Inspect crossings every 7 calendar days and within 24-hours after each rainfall event that produces ½-inches or more of precipitation. Check the structure integrity and for excessive sediment deposition and replace fill stone as needed.
- Clean mud and/or sediment from the roadway and prevent it from entering the stream.
- The structure shall be removed when it is no longer required to provide access to the construction area. During removal, leave stone and geotextile fabric for approaches in place. Place fill over the approaches as part of the streambank restoration operation. A temporary culvert crossing should be in place no longer than 24 months.



Temporary Stream Crossing

Temporary Stream Crossing

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Slopes of temporary earthen crossing erodes.	Place rock layer on slope sides. Stabilize roadway at crossing.
Sediment and debris block culvert inlet.	Remove sediment and debris as necessary to keep pipe open.
Pipe outlet causes erosion.	Stabilize outlet with riprap or flared end section.
Overtopping occurs.	Incorrect design. Redesign crossing and obtain approval (stamp) of registered civil and/or structural engineer.

Runoff Diversion Measures (Diversion Berms/Dikes and Swales)

Plan Symbol

⟹DD⟹DB⟹

Description

Diversion dikes and berms (ridges of compacted soil) and diversion swales (excavated depressions) are used to divert upslope runoff from crossing areas where there is a high risk of erosion. Use runoff conveyance structures as temporary clean water diversions, temporary sediment laden diversions, or permanent clean water diversions. Use runoff control measures as either temporary or permanent storm water control structures.

When and Where to Use It

Runoff conveyance measures are installed around the perimeter of a construction sites before major disturbing activities takes place. When constructed along the upslope perimeter of a disturbed or high-risk area (though not necessarily all the way around it), clean water diversions prevent clear water runoff from flowing over unprotected down slope areas. Sediment laden diversions located on the downslope side of a disturbed or high-risk area prevent sediment-laden runoff from leaving the site before sediment is properly removed. For short slopes, runoff control measures at the top of the slope reduce the amount of runoff reaching the disturbed area. For longer slopes, several dikes or swales are placed across the slope at intervals. This practice reduces the amount of runoff that accumulates on the face of the slope and carries the runoff safely down the slope. In all cases, runoff is guided to sediment trapping area or a stabilized outfall before release.

General Design Requirements

Runoff conveyance measures are used in areas of overland flow. Direct runoff channeled by diversion dikes or swales to an adequate sediment trapping structure or stabilized outfall. Provide enough channel slope for drainage but not too much slope to cause erosion due to high runoff flow velocities. Temporary runoff control measures may remain in place as long as 12 to 18 months (with proper stabilization). Diversion dikes or swales remain in place until the area they were built to protect is permanently stabilized. Design permanent controls to handle runoff after construction is complete. Permanent controls should be permanently stabilized, and should be inspected and maintained on a regular basis.

Diversion Dike and Berm General Design Requirements

- Top Width. 2 foot minimum.
- Height of Dike or Berm 1.5 foot minimum measured from upslope toe.
- Side Slopes. 2H:1V or flatter.
- Grade. Limit grades between 0.5 percent and 1.0 percent.
- Stabilization. Stabilize slopes immediately using vegetation, sod, and erosion control blankets or turf reinforcement mats to prevent erosion.
- Outlet. Provide positive drainage to the upslope side of the dike so no erosion occurs at the outlet. Provide energy dissipation measures as necessary. Discharge sediment-laden runoff through a sediment trapping facility.
- Other. Minimize construction traffic over diversion dikes and berms.

Diversion Swale General Design Requirements

- Bottom Width. 2 foot minimum, with a level bottom.
- Depth. 1.5 foot minimum.
- Side Slope. 2H:1V or flatter.
- Grade. Maximum 5 percent, with positive drainage to a suitable outlet.
- Stabilization. Stabilize with erosion control blankets or turf reinforcement mats immediately.
- Outlet. Level spreader or riprap to stabilize outlet/sedimentation pond.

Installation

Stabilized using vegetation, sod, and ECBs or TRMs before any major land disturbing activity takes place.

Install the top width of diversion dikes at least 2-feet wide. Install the bottom width at ground level at least 8-feet wide.

The minimum height for earthen dikes is 18-inches, with side slopes no steeper than 2H:1V.

Minimize construction traffic over diversion dikes and berms. However, for points where vehicles must cross the dike, the slope should be no steeper than 3H:1V and the mound should be constructed of gravel rather than soil.

Prior to swale excavation or dike building, clear and grub all trees, brush, stumps, and other objects in the path of the diversion structure.

Ensure the minimum constructed cross section meets all dimensions shown on the plans.

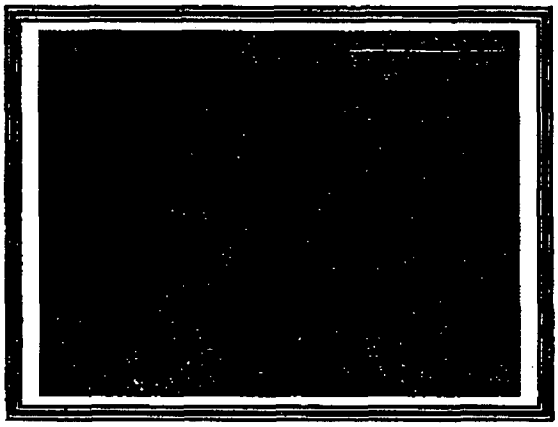
Immediately after construction establish vegetation by placing an Erosion Control Blanket on the diversion dikes and silt ditches.

Provide positive drainage to the upslope side of the dike so no erosion occurs at the outlet. Provide energy dissipation measures as necessary. Discharge sediment-laden runoff through a sediment trapping facility.

Inspection and Maintenance

- The runoff control measure should be inspected, every 7 calendar days and within 24-hours after each rainfall event that produces ½-inches or more of precipitation and repairs made as necessary.
- Damage caused by construction traffic or other activity must be repaired before the end of each working day.

Diversion Berm



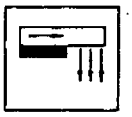
Diversion Berm

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Dikes wash out.	Re-grade, compact, and stabilize the soil used to build earthen dikes.
Area behind dikes eroded.	Stabilize the area. Use other BMPs to stabilize the uphill side of the dike.
Concentrated flow causes erosion.	Stabilize area and use check dams, ECBs, TRMs or riprap to prevent erosion.
Ditches and swales erode due to high velocity flows.	Stabilize and use check dams, ECBs, TRMs or riprap to prevent erosion.
Swales and ditches fill up with sediment.	Remove accumulated sediment from ditches and swales. Stabilize upstream contributing areas with appropriate erosion prevention BMPs.
Ditches and swales are overtaken by flows.	Determine the upstream contributing areas and size ditches and swales to handle anticipated flow velocities.
Outlet erodes.	Re-grade and stabilize outlet with ECBs, TRMs or riprap.

Level Spreader

Plan Symbol



Description

A level spreader is a permanent outlet for dikes and diversions consisting of an excavated channel constructed at zero grade across a slope that converts concentrated runoff to sheet flow and releases it onto areas stabilized by existing vegetation. Sediment-laden waters **should not** be directed towards level spreaders.

When and Where to Use It

Construct level spreaders on undisturbed areas that are stabilized by existing vegetation and where concentrated flows are anticipated to occur. Diversion channels call for a stable outlet for concentrated storm water flows. The level spreader is used for this purpose if the runoff is relatively free of sediment. If properly constructed, level spreaders significantly reduce the velocity of concentrated storm water and spread it uniformly over a stable undisturbed area.

Design Criteria

Design the grade of the channel transition for the last 20-feet before entering the level spreader less than or equal to 1 percent. The crest of the overflow is level (0 percent grade) to ensure uniform spreading of runoff.

Design the lip of the level spreader with a Turf Reinforcement Mat (TRM) able to withstand 5-lbs./ft shear stress.

Determine the spreader dimensions by estimating the flow expected from the 10-year, 24-hour design storm (Q_{10}). The maximum flow into the spreader should not exceed 30 cfs.

- The minimum width of the spreader is 6-feet.
- Design a minimum uniform depth of 0.5-feet across the entire length the of the spreader as measured from the crest of the lip.
- The maximum design the slope of the undisturbed outlet is 10 percent.

Installation

Care must be taken during construction to ensure the lower lip of the structure is level.

If there are any depressions in the lip, flow will tend to concentrate at these points and erosion will occur, resulting in failure of the outlet. Avoid the problem by using a grade board, a gravel lip or a TRM along the exit lip of the level spreader.

Extend the TRM 10-feet below the lip and bury it at least 6- inches within the spreader, and extend at least 12-inches beyond the lip on the outside of the spreader.

Install the grade of the channel transition for the last 20-feet before entering the level spreader less than or equal to 1 percent.

Install the crest of the overflow level (0 percent grade) to ensure uniform spreading of runoff.

Inspection and Maintenance

- The spreader should be inspected every 7 days and within 24-hours after each rainfall event that produces ½-inches or more of precipitation to ensure that it is functioning correctly.
- The contractor should avoid the placement of any material on the structure or prevent construction traffic across the structure.
- If the spreader is damaged by construction traffic, it should be immediately repaired.

Level Spreader

Level Spreader

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Spreader is damaged by construction traffic.	Repair immediately.
Water is channelizing and causing erosion.	Make sure level spreader lip was installed correctly, with a 0% grade to ensure a uniform distribution of flow, Repair immediately, as needed.
Too much sediment has accumulated.	Remove accumulated sediment to recover capacity. A sediment forebay may need to be constructed at the inlet of the level spreader.

Subsurface Drains

Plan Symbol

SSD SSD

Description

A subsurface drain is a perforated pipe or conduit placed beneath the surface of the ground at a designed depth and grade.

When and Where to Use It

Subsurface drains are used to do the following:

- Drain areas by intercepting and conveying groundwater.
- Lower the water table.
- Drain or de-water storm water detention structures.
- Prevent sloping soils from becoming excessively wet and subject to slippage.

There are two types of subsurface drains: relief drains and interceptor drains.

- Relief drains are used to de-water an area where the water table is high. They are placed in a gridiron, herringbone, or random pattern.
- Interceptor drains are used to remove water where soils are excessively wet or subject to slippage. They are usually placed as single pipes instead of patterns.

Subsurface drains are suitable only in areas where the soil is deep enough for proper installation. They are not recommended where they pass under heavy vehicle crossings.

General Design Criteria

- Size subsurface drains for the required flow capacity. The minimum diameter for subsurface drains is **4-inches.**
- The minimum velocity required to prevent silting is **1.4-feet/second**. Grade the line to achieve this velocity.
- Use filter material and/or fabric around all drains for proper bedding and filtration of fine materials. Place a minimum of 3-inches of material on all sides of the pipe.
- If free of sediment, design the outlet to discharge into a receiving channel, swale, or stable vegetated area adequately protected from erosion and undermining. Locate the outlet point above the mean water level of the receiving channel. The outlet consists of a 10-foot section of corrugated metal, cast iron, steel or schedule 40 PVC pipe without perforations.
- Acceptable materials for subsurface drains include perforated, continuous closed-joint conduits of corrugated plastic pipe meeting the requirements of AASHTO M252 for polyethylene tubing, AASHTO M278 Class PS 50 for polyvinyl requirements, or AASHTO A1 196 for Type III aluminum alloy pipe.
- Subsurface drains are not designed to flow under pressure and the hydraulic gradient is parallel with the grade line. The flow is considered to be open channel and Manning's Equations is used. The required subsurface drain size is determined from the following steps:
  - Determine the flow rate that the subsurface drain must carry.
  - Determine the gradient of the drain.
  - Determine the appropriate Manning's n value for the selected subsurface drain pipe.
  - Select the appropriate subsurface drain capacity chart.
  - Enter the gradient of the pipe and the design flow of the pipe.

Installation

Install relief drains through the center of wet areas that drain in the same direction of the slope.

Install interceptor drains on the up-slope side of wet areas and install them across the slope to drain to the side of the slope.

Locate subsurface drains in areas where there are no trees within 50-feet of the drain.

Construct the installation trench on a continuous grade with no reverse grades or low spots.

Stabilize soft or yielding soils under the drain with gravel or suitable material.

Do not use deformed, warped, or otherwise unsuitable pipe.

Place filter material at least 3-inches of material on all sides of pipe.

Backfill trenches after pipe placement with no pipe remaining uncovered overnight or during a rainstorm. Place backfill material in the trench so that the pipe is not displaced or damaged. Use highly permeable open granular soil for backfill.

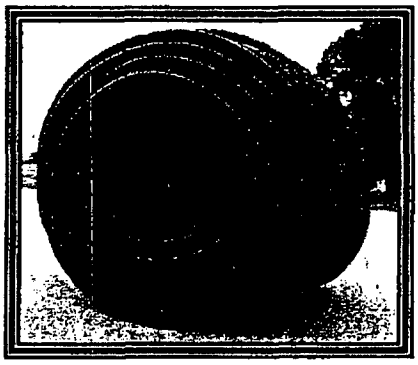
The outlet should consist of a 10-foot section of corrugated metal, cast iron, steel or schedule 40 PVC pipe without perforations. At least two-thirds of outlet pipe should be buried.

The outlet consists of a 10-foot section of corrugated metal, cast iron, steel or schedule 40 PVC pipe without perforations.

Inspection and Maintenance

- Inspect subsurface drains on a regular schedule and check for evidence of pipe breaks or clogging by sediment, debris, or tree roots.
- Remove blockage immediately, replace any broken sections, and re-stabilize the surface. If the blockage is from tree roots, it may be necessary to relocate the drain.
- Check inlets and outlets for sediment or debris. Remove and dispose of these materials properly.
- Check the drainage line where heavy vehicles cross drains to ensure that pipes are not crushed or damaged.

Subsurface Drain



Subsurface Drain Pipe

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Discharge or treated water causes erosion.	Install outlet protection or velocity dissipation device.
Treatment unit fills with sediment.	Remove sediment when unit reaches 1/3 its capacity to preserve settling efficiency.
Dewatering discharge flow is higher than expected.	Alter the treatment unit to handle increased flow.
Water spread on the construction site is not infiltrating fast enough and is entering the storm drain system or receiving water body.	Stop dewatering. Install a sediment treatment system and test discharge as necessary.

Construction De-Watering

Description

Construction de-watering involves removing storm water or ground water from bore pits, trenches, and other excavations on a construction site. Typically, this removal of water involves the pumping of the water to an appropriate receiving area. Direct pumping to lakes, rivers, and streams is illegal and must be avoided.

Design Criteria

Size the pump utilized for de-watering purposes properly. Each pump has its own unique rating curve, therefore it is not feasible to list them in this chapter. The pump rating curve is used to calculate pump design flows based on head loss through the pump system.

Pump sediment-laden groundwater directly to:

- A sediment control structure (sediment basin, sediment trap manufactured de-watering device)
- An infiltration trench
- A buffer strip or zone

Inspection and Maintenance

Pumping to a Sediment Control Structure:
It is recommended that sediment basins or temporary sediment traps receive sediment-laden water from bore pits and trenches. Ensure that the pumping of this water does not cause the sediment control structure to fail. In addition, ensure that erosion does not occur at the outlet of the hose from the pump due to high concentrated flows.

Pumping to an Infiltration Trench:
Ensure that erosion does not occur at the outlet of the hose from the pump due to high concentrated flows.

Pumping to a Vegetated Buffer Zone:
Ensure that erosion does not occur at the outlet of the hose from the pump due to high concentrated flows.

Construction Dewatering

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Discharge or treated water causes erosion.	Install outlet protection or velocity dissipation device.
Treatment unit fills with sediment.	Remove sediment when unit reaches 1/3 its capacity to preserve settling efficiency.
Dewatering discharge flow is higher than expected.	Alter the treatment unit to handle increased flow.
Water spread on the construction site is not infiltrating fast enough and is entering the storm drain system or receiving water body.	Stop dewatering. Install a sediment treatment system and test discharge as necessary.

Alternative Erosion Prevention and Sediment Control BMPs

To encourage the development and testing of innovative alternative EPSC BMPs, alternative management practices that are not included in the Handbook, Standard Specifications and Standard Drawings may be accepted upon review and approval. To use an alternative BMP, submit substantial evidence that the proposed measure will perform at least equivalent to currently approved BMPs contained in the Handbook, Standard Specifications, and Standard Drawings. Evidence may include, but is not limited to:

- Supporting hydraulic and trapping efficiency calculations.
- Peer-review by a panel of licensed professional engineers.
- Research results as reported in professional journals.
- Manufacturer literature.

To justify the efficiency of innovated EPSC BMPs, the owner may be required to monitor the trapping efficiency of the structure. If satisfactory results showing trapping efficiencies of greater than 80 percent are obtained, the innovative BMP may be used and no other monitoring studies should be required. If monitoring shows that a certain BMP is not sufficient or if SCDHEC finds that a BMP fails or is inadequate to contain sediment, other upstream and downstream BMPs should be implemented to reach the required efficiency.

Post Construction Water Quality Control

Post-construction storm water management in areas undergoing new development or redevelopment is necessary because runoff from these areas significantly affects receiving waterbodies. There are two forms of substantial impacts of post-construction runoff. The first is an increase in the type and quantity of pollutants in storm water runoff. As runoff flows over areas altered by development, it picks up harmful sediment and chemicals such as oil and grease, pesticides, heavy metals, and nutrients. These pollutants become suspended in runoff and are carried to receiving waters, such as lakes, ponds, and streams. Once deposited, these pollutants enter the food chain through small aquatic life, eventually entering the tissues of fish and humans.

The second kind of post construction runoff impact is increasing the quantity of water delivered to the waterbody during storms. Increased impervious surfaces interrupt the natural cycle of gradual percolation of water through vegetation and soil. Instead, water is collected from surfaces such as asphalt and concrete and routed to drainage systems where large volumes of runoff quickly flow to the nearest receiving water. The affects of this process include streambank scouring and downstream flooding, which often lead to a loss of aquatic life and damage to property.

Water Quality Regulations

Water quality control consists of post-development controls that reduce the impacts of development on the water quality of receiving downstream water bodies. Use the following design criteria for water quantity control unless a waiver is granted on a case-by-case basis.

- Design permanent water quality ponds and detention structures having a permanent pool elevation to store and release the first ½-inch of runoff from the site over a minimum period of 24-hours. Design the water quality storage volume of these water quality structures to accommodate at least one-half (½) inch of runoff from the contributing drainage area.

- Design permanent water quality structures <u>not</u> having a permanent pool elevation to store and release the first one 1-inch of runoff from the site over a minimum period of 24-hours.

- Design permanent water quality ponds and detention structures within ½-mile of a receiving water body in the coastal zone to store a volume of ½-inch of runoff from the entire site or the first 1 inch of runoff from built-upon portions of the property, which ever is greater.

- Design projects located within 1,000 feet of shellfish beds to retain the first 1.5 inches of runoff from built-upon portions of the property.

- Design permanent water quality infiltration practices to accommodate at a minimum the first 1-inch of runoff from impervious areas located on the site.

- When existing wetlands are intended to be water quality structures, the Storm Water Management Permit is not implemented until all necessary Federal and State permits have been obtained.

Water Quality Volume

The water quality volume is the storage needed within a water quality control BMP to control the "first flush" of runoff during a storm event. The water quality volume can be calculated as:

$$WQV = \frac{FFV * DA}{12}$$

Where:

FFV = First flush runoff depth inches (½, 1.0, or 1-½ dependent upon site conditions)
WQV = Water quality volume (acre-feet)
DA = Design drainage area to water quality BMP (acres)

Variances

SCDHEC may grant variances from the State Storm water Management Regulations for post-construction water quality if the applicant provides sufficient data and acceptable justification. The applicant must provide a written request for a variance in the Permit application package specifically stating the variances sought and all data that supports the variance. SCDHEC has the authority to reject a written request for a variance if the justification is deemed unacceptable or is associated with a project located in sensitive areas of South Carolina where variances have been deemed to be unacceptable.

A project may be eligible for a waiver from water quality control requirements if the applicant can justly verify that:

- The proposed land development activity will return the disturbed areas to the pre-development land use and runoff conditions.
- The proposed land development will create land use conditions that have the potential to discharge less pollutants than the pre-development land use conditions.
- The pre-development land use conditions are unchanged at the end of the project.
- An alternative water quality plan is designed that provides a reasonable alternative to water quality storage and release time requirements and that still fulfills the intent of the regulations. Specific development sites may not have enough land area to incorporate traditional water quality structures that provide the required storage volume. Alternative technologies and development techniques may be acceptable provided that sufficient documentation exists as to the effectiveness and reliability of the proposed structures or techniques.
- Exceptional circumstances exist such that strict adherence to the regulations could result in unnecessary hardship and not fulfill the intent of the regulations.

This variance does not exclude water quality, erosion prevention, sediment control from being implemented during the active construction phases of a particular project.

Water Quality BMPs

Water Quality control BMPs can be classified into two major classifications:

- Non-structural Controls
- Structural Controls.

The following post construction water quality BMPs are discussed in this BMP Manual:

Non-Structural Low Impact Development Controls

Vegetated Conveyance Systems
Stream Buffers
Disconnected Rooftop Drainage to Pervious Areas
Cluster Development
Natural Infiltration

Structural Controls

Wet Detention Ponds
Dry Detention Ponds
Underground Detention Systems
Storm Water Wetlands
Bioretention Areas
Infiltration Trench
Enhanced Grassed Swales
Pre-Fabricated Control Devices
Vegetated Filter Strips (VFS)
Grass Paving and Porous Paving Surfaces

Innovative Technologies

To encourage the development and testing of innovative alternative water quality BMPs, alternative management practices that are not included in the Handbook, Standard Specifications and Standard Drawings may be accepted upon review and approval.

Non-Structural Low Impact Development Controls

Vegetated Conveyance Systems

Plan Symbol

Description

Vegetated conveyances are designed and installed as an alternative to curb and gutter and hard piping storm water conveyance systems. Open vegetated conveyances improve water quality by providing partial pollutant removal as water is filtered by the vegetation and by the opportunity to infiltrate into the soil. Open vegetated conveyances also are designed to reduce flow velocities when compared to hard piping systems.

When and Where to Use It

Open vegetated conveyance systems are incorporated into moderate to low density development sites where land is available and where the land surface is gently sloping (less than 5 percent). The soil must be able to withstand the design tractive forces and flow velocities of the open conveyance, or an applicable

Design Criteria

Design Turf Reinforcement Mats or Erosion Control Blankets to protect the open conveyance. Install a dense cover of strong rooted vegetation in the conveyance systems. For maximum water quality benefits, design vegetated open conveyances with a flat longitudinal slope to promote low velocity flow.

Installation

Construct vegetated conveyances with trapezoidal or parabolic cross section with relatively flat side slopes (flatter than 3H:1V).

Install a flat bottom between 2 and 8 feet wide.

During construction, it is important to stabilize the channel before the turf has been established, either with a temporary grass cover or with the use of natural or synthetic erosion control products.

Inspection and Maintenance

- The useful life of a vegetated swale system is directly proportional to its maintenance frequency. If properly designed and regularly maintained, vegetated swales can last indefinitely.
- The maintenance objectives for vegetated swale systems include keeping up the hydraulic and removal efficiency of the channel and maintaining a dense, healthy grass cover.
- Maintenance includes periodic mowing (with grass never cut shorter than the design flow depth), weed control, watering during drought conditions, re-seeding of bare areas, and clearing of debris and blockages.
- Remove accumulated sediment manually to avoid the transport of resuspended sediments in periods of low flow and to prevent a damming effect from sand bars. Minimize the application of fertilizers and pesticides.
- Repair damaged areas within a channel.
- Inspect for a healthy thick grass cover. Re-seed as necessary.

Stream Buffers

Description

A stream buffer is an area along a shoreline, wetland or stream where development is restricted or prohibited. The primary function of the buffer is to physically protect and separate a stream, lake, or wetland from future disturbance or encroachment.

The general function of the buffer is to:

- Protect the overall stream quality by providing shade for the stream and provide wildlife habitat.
- Remove pollutants, sediments, bacteria, and excess nutrients from storm water runoff through infiltration and filtering.
- Help detain and slow down flow rates from developed areas.
- Provide a setback from the stream to prevent damage to structures or improved property due to flooding or changes in the stream channel.

When and Where to Use It

Effective water quality protection stream buffers consist of undisturbed natural vegetation including maintaining the original tree line along the stream or channel banks. Promptly stabilize disturbed buffers with a dense cover of strong rooted grasses, native plants, and native trees.

Buffer Classification

Major streams, drainageways and waterbodies are recommended to have buffer protection. Buffer recommendations are based on the following classifications:

Class 1: Streams thhave a drainage area greater than or equal to 100 acres.
Class 2: Streams that have a drainage area greater than or equal to 300 acres.
Class 3: Streams that have a drainage area greater than or equal to 640 acres.

Stream Buffer Recommendations

Stream Class	Stream Side Zone (ft)	Managed Use Zone (ft)	Upland Zone (ft)	Total Buffer Width on Each Side of the Stream (ft)
1	30	None	15	45
2	30	20	15	65
3	30	45	25	100

**All buffer widths are measured from the top of the streambank.

Stream Side Zone

This zone is the closest to the stream and this area and remains undisturbed. The stabilization and protection of this zone is critical to water quality. Clearing and cutting of vegetation is prohibited in this zone with the desirable vegetation being mature forest. Use of this zone includes flood control structures, streambank stabilization and restoration, footpaths, and utility or road crossings.

Managed Use Zone

This area provides space for the storage of floodwaters and the filtering of pollutants. A limited number of trees may be removed from this zone provided that the remaining tree density is a minimum of eight healthy trees of a minimum 6-inch caliper per 1,000 square feet. The vegetative target for this zone is managed forest but turfgrass can also be a vegetative target. Do not place fill materials in this area, and do not conduct grading and other land disturbing activities. Some storm water BMPs, greenway trails and bike paths may be designed in this area.

Upland Zone

This zone is located furthest from the streambank. Grading is permitted in this zone, in a manner that does not damage the roots of the trees located in the adjacent Managed Use Zone. Grass or other suitable ground covers may be planted in this zone. Do not place fill material in the Upland Zone unless the replacement of deficient soil is required. The volume of fill material shall not exceed the volume of deficient soil removed. Personal gardens, gazebos, decks, and storage building less than 150 square feet in size are permitted in the Uplands Zone.

Buffer Design Requirements

For optimal storm water treatment, the following buffer designs are recommended:

- The buffer consists of three lateral zones; Stream Side, Managed Use and Upland Zones.
- The buffer has a storm water depression area that leads to a grass filter strip before entering the Managed Use Zone. Design the storm water depression to capture the first flush runoff from the site and bypass larger storm flows directly to the receiving water body.
- Spread the captured runoff across a grass or wooded filter in a sheet flow condition. The forest buffer of the Stream Side and Managed Use Zones infiltrates the sheet flow and does not discharge any surface runoff to the receiving water body.

Buffer Maintenance

An effective buffer management plan includes establishment, management, and distinctions of allowable and unallowable uses in each Zone. Buffer boundaries are well defined and clearly marked during, and after construction is complete. Buffers designed to capture storm water runoff from urban areas require more maintenance if the first zone is designated as a bioretention or other engineered depression area.

Disconnected Rooftop Drainage to Pervious Areas

Description

Disconnected rooftop drainage reduces the runoff flow rates from developed areas. The disconnection involves directing storm water runoff from rooftops towards pervious areas where it is allowed to filter through vegetation and other landscaped material and infiltrate into the soil. Use erosion control devices such as splash blocks or level spreaders at the downspout discharge point to transfer the flow from concentrated flow to sheet flow.

Disconnected rooftop drainage has the following benefits:

- Increase the time of concentration by disconnecting runoff from any structural storm water drainage systems.
- Provide water quality benefits by allowing runoff to infiltrate into the soil. Downspouts from rooftops should discharge to gently sloping, well-vegetated areas, vegetated filter strips, or bio-retention areas.

When and Where to Use It

This practice is applicable and most beneficial in low-density residential or commercial developments having less than 50 percent impervious area. Disconnection is not applicable to large buildings where the volume of runoff from the rooftops will cause erosion or degradation to receiving vegetated areas.

Cluster Development

Description

Cluster development practices concentrate development away from environmentally sensitive areas such as streams, wetlands, and mature wooded areas. The clustering of development in one area reduces the amount of roadways, sidewalks, and drives required when compared to development sprawled over the entire land area.

Install clustering and conservation of natural area practices at least to some extent on all development sites not only to reduce the impacts to natural resources by minimizing disturbance and impervious areas, but also to maintain some of the natural beauty of the site.

Reducing the amount of disturbed area and impervious area reduces the amount of runoff volume treated for water quantity and water quality control. Concentrating development away from environmentally sensitive areas will also reduce the amount of time and expenses to get federal and state permits for impacting jurisdictional waters.

Concentrate development on the flattest part of the development parcel away from environmentally sensitive areas such as steep slopes, streams, and wetlands. This reduces the impacts to these areas, and reduces the amount of earth moving necessary for the development.

Natural Infiltration

Description

Natural infiltration is a method in which an undisturbed land area covered with natural vegetation accepts runoff from new development and infiltrates the runoff into the soil.

When and Where to Use It

Use natural infiltration areas only where the soils are suitable. The area is typically in a forested condition with the land surface covered by leaves, pine needles, and other forest floor organic materials. Natural infiltration areas are designated for passive recreation only.

Design Criteria

Use a natural infiltration area as a storm water quality control if it meets the design criteria of this section. The size of a natural infiltration area is calculated using the following equation:

$$A = \frac{(K\ T\ I)}{[(cd) - K]}$$

Where:

A	=	Natural infiltration area required (acres)
K	=	Runoff volume to infiltrate (inches)
T	=	Total site area or total drainage area (acres)
I	=	Built upon area ratio (Built upon area / T)
c	=	Effective water capacity (in/in), should be determined from site-specific soil samples.
d	=	Depth of soil A horizon (inches), should be determined from site-specific soil samples.

Runoff enters the infiltration area as sheet flow with a non-erosive velocity. Stabilize and vegetate the areas draining to the Natural Infiltration area a minimum of 20-feet in length.

Natural infiltration areas have the following characteristics:

- Appropriate soils that have a minimum infiltration rate of 0.3-inches per hour, low erosion potential, and good drainage (not in a wetland or floodplain).
- Mature forest cover (if the natural infiltration area (A) is not located in a mature forest, then double the area of that calculated by the equation above).
- Slopes less than 10 percent.
- Remains permanently undisturbed.

The limitations of natural infiltration areas include:

- Not suitable for soils that have greater than 30 percent clay content or greater than 40 percent clay and silt content.
- Not suitable in areas with high water tables or shallow depth to highly impervious strata such as bedrock or clay layers.
- High sediment loadings or lack of maintenance clogs the surface layer therefore inhibiting any water infiltration into the soil.

Structural Controls

Structural water quality control structures are recommended for use with a wide variety of land uses and development types. These controls have demonstrated the ability to effectively treat runoff volume to reduce the amounts of pollutants discharged to the downstream system. Structural storm water quality controls are classified into the following categories:

General Application Controls

General application structural controls are recommended for use in a wide variety of application situations. These structural controls have demonstrated the ability to effectively treat water quality volumes and are presumed to be capable of removing 80 percent of the total suspended solids (TSS) load typically found in urban post-development runoff.

Limited Application Controls

Limited application structural controls are those that are recommended only for limited use for special site or design conditions. Generally, these practices can not alone achieve 80 percent TSS removal goal and are intended for hotspots for specific land use constraints or conditions. Limited application controls may be used within a system of water quality controls and are very effective pre-treatment structures for the General Application Controls. Limited application structural controls should be designed and used only in development situations where regular maintenance is guaranteed.

Wet Detention Ponds

Description

A wet or permanent pool detention pond is one of the most commonly used BMPs to meet water quality protection requirements. The advantages of permanent pool ponds have over other water quality treatment controls are:

- Ponds are durable and require less maintenance than other applicable water quality controls.
- Ponds required for water quantity control are easily modified to treat storm water runoff for water quality.
- Well designed ponds are effective in treating storm water runoff for water quality control.

Wet storm water detention ponds are classified as being:

- Wet Detention Pond. Wet ponds have a permanent (dead storage) pool of water equal to the water quality volume. Temporary storage (live storage) may be added above the permanent pool elevation for larger flows.
- Wet Extended Pond. A wet extended pond is a wet pond where the water quality volume is split evenly between the permanent pool and extended detention storage provided above the permanent pool. During storm events, water is stored above the permanent pool and released over 24-hours. The design has similar pollutant removal efficiencies as traditional wet ponds, but consumes less space.
- Micropool Extended Pond. The micropool extended pond is a variation of the wet extended detention pond where only a small "micropool" is maintained at the outlet to the pond. The outlet structure is designed to detain the water quality volume for 24-hours. The micropool prevents resuspension of previously settled sediments and prevents clogging of the low flow orifice.

When and Where to Use It

Permanent pool ponds improve storm water quality by detaining storm water runoff for an extended period of time to allow pollutants that are suspended in the runoff to settle out. During any given storm event, runoff enters wet ponds and replaces the "treated" water in the permanent pool that has been detained from the previous storm event. As runoff enters the pond, the velocity is significantly decreased, allowing suspended pollutants to settle out of the runoff. Many pollutant particles suspended in storm water runoff are very small in size, therefore the pond must be designed to provide adequate detention time to allow the smaller particles to settle out.

Design Criteria

The components of wet detention ponds that help increase the pond's pollutant removal efficiency are:

- Permanent wet pool
- Temporary pool or overlaying zone
- Aquatic bench
- Forebay
- Flow length
- Low flow orifice
- Emergency spillway.

Permanent Wet Pool

A permanent wet pool is the design feature with the single greatest effect on water quality. Permanent pools have the following design requirements:

- For Wet Detention Ponds, the design permanent pool volume is equal to 1-inch of runoff per impervious acre on the site to reliably achieve moderate to high removal rates of storm water pollutants.
- For Wet Extended Ponds with an Aquatic Bench, the design permanent pool is equal to ½- inches of runoff per impervious acre on the site to reliably achieve moderate to high removal rates of storm water pollutants.
- For Micropool Extended Ponds, the design permanent pool volume is equal to 0.1-inches of runoff per impervious acre on the site to reliably achieve moderate to high removal rates of storm water pollutants.
- An average pool depth of 4 to 6 feet is optimal for water quality treatment. The depth of the permanent pool prevents particles that have settled to the pond bottom from re-suspending when runoff enters the pond.

Temporary Pool

The temporary pool is the designed storage above the permanent pool that controls the designed water quality volume. Consider storm water quantity management when designing the temporary pool volume. To increase the detention time of the runoff, the temporary pool is slowly released through a low flow orifice.

Aquatic Bench

Aquatic vegetation can play an important role in pollutant removal in a storm water pond. Vegetation can enhance the appearance of the pond and stabilize side slopes. The selection of the proper plant species and planting locations is an integral part in designing a successful aquatic bench in the wet detention pond. Prepare a planting plan by a qualified landscape architect or wetland ecologist for the aquatic bench.

Forebay

Provide a forebay for all inlets to a wet water quality pond and place the forebay upstream of the main wet pond area. Design the forebay to trap the majority of the coarse fractions of the suspended solids in the runoff before it enters the main wet pond area. The forebay is separated from the larger wet detention pond area by barriers or baffles that may be constructed of earth, stones, riprap, gabions, or geotextiles. Design the top of the forebay barrier ranging from foot below the normal pool elevation up to an elevation above the permanent pool. A forebay may be designed using manufactured treatment devices.

Flow Length

Optimizing the wet pond flow shape and flow distance through the pond promotes better water quality treatment. For maximum water quality benefits, design the ratio of flow length to flow width in the wet pond at least 3L:1W. Due to site constraints, the minimum allowable design ratio of flow length to flow width is 1.5L:1W. To increase the pond's flow length, the pond may be configured with baffles.

Low Flow Orifice

Design a low flow orifice to slowly release the water quality volume over a period of 24-hours or longer depending upon the design criteria for the water quality structure. These structures are prone to becoming clogged. Protect the low flow orifice from clogging by designing appropriate trash guards. Acceptable trash guards include:

- Hoods that extend at least 6-inches below the permanent pool water surface elevation.
- Reverse flow pipes where the outlet structure inlet is located below the permanent pool water surface elevation.
- Trash boxes made of sturdy wire mesh.

Emergency Spillway

Design emergency spillways to safely pass the post-development 100-year 24-hour storm event without overtopping any dam structures. Design the 100-year water surface elevation a minimum of 1-foot below the top of the embankment.

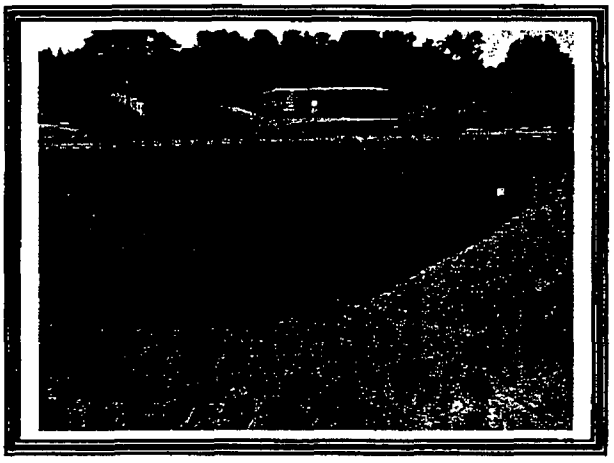
Inspection and Maintenance:

Regular inspection and maintenance is critical to the effective operation of storm water ponds as designed. Maintenance responsibility for a pond and its buffer should be vested with a responsible authority by means of a legally binding and enforceable maintenance agreement that is executed as a condition of plan approval. The agreement may contain but is not limited to the following items:

- Mow side slopes of the pond monthly.
- Since decomposing vegetation captured in the wet pond can release pollutants, especially nutrients, it may be necessary to harvest dead vegetation annually. Otherwise the decaying vegetation can export pollutants out of the pond and also can cause nuisance conditions to occur.
- Clear debris from all inlet and outlet structures monthly.
- Repair all eroded or undercut areas as needed.
- Place a sediment marker in the forebay to determine when sediment removal is required.
- Monitor sediment accumulations in the main pond area and remove sediment when the permanent pool volume has been significantly filled and/or the pond becomes eutrophic.

Average Pollutant Removal Capability

Total Suspended Solids:	65-80%	Metals:	35-75%
Copper:	40-65%	Lead:	60-85%
Zinc:	50-75%	Total Phosphorus:	50-70%
Total Nitrogen:	30-45%	Pathogens/Bacteria:	45-75%



Wet Pond

Wet Pond

Summary of Maintenance Requirements

Required Maintenance	Frequency
Clean and remove debris from inlet and outlet structures.	Monthly, or after large storm events
Mow side slopes.	Monthly, or as needed
Removal of invasive vegetation.	Semi-annual
Inspect for damage to control structure.	Annual
Inspect sediment accumulation in the facility and forebay.	Annual
Inspect for operational inlet and outlet structures.	Annual
Repair embankment, side slopes, undercut or eroded areas.	Annual, or as needed
Perform wetland plant management and harvesting.	Annual
Remove sediment from the forebay.	Per design cycle, as needed, after 50% of total forebay capacity is filled
Remove sediment accumulations in the main permanent pool.	5 to 10 year cycle, after 25% of the permanent pool volume is filled

Dry Detention Ponds

Description

A dry (extended) detention pond provides temporary storage of storm water runoff. Dry ponds have an outlet structure that detains runoff inflows and promotes the settlement of pollutants. Unlike wet ponds, dry detention ponds do not have a permanent pool.

A dry pond is designed as a multistage facility that provides runoff storage and attenuation for both storm water quality and quantity. Design dry detention ponds as either single-stage or two-stage. Single-stage ponds are normally used strictly for flood control and are not recommended for water quality benefits. A two-stage pond contains a water quality volume in the lower stage, and has an upper stage for detention of larger storms for flood control.

The lower stages of a dry pond are controlled by outlets designed to detain the storm water runoff for the water quality volume for a minimum duration of 24-hours, which allow sediment particles and associated pollutants to settle out. Higher stages in the pond detain the peak rates of runoff from larger storms for flood and erosion control. Dry detention ponds are designed for complete drawdown of runoff and normally remain dry between storm events.

When and Where to Use It

Apply dry detention ponds to new or existing developments. Dry ponds are considered permanent, year-round control measures. Use dry detention ponds at sites where significant increases in runoff are expected from site development. Use dry detention ponds for residential, commercial, or industrial development sites.

Do not use dry ponds in areas with a high water table. A permanently wet bottom is a mosquito breeding ground.

While dry extended detention ponds are widely applicable, they have some limitations that may make other storm water management options preferable. Dry pond limitations include:

- Possible nuisance due to mosquito breeding.
- While wet ponds can increase property values, dry ponds may detract from the value of a home.
- Dry detention ponds have only moderate pollutant removal when compared to other structural storm water practices, and have limited effectiveness in removing both particulate and soluble pollutants.

Design Criteria

Items to incorporate in dry pond design are: pretreatment, pond shape, pond volume, low flow channel, outfall, emergency spillway, and anti-seep collar.

- Ponds shall be designed for the 2 and 10-year storms
- The 10-year storm should not pass through the emergency spillway
- A minimum 6-inch freeboard between the 10-year water surface and emergency spillway is required
- The 100-year storm should not overtop the embankment

Pretreatment

Pretreatment extends the functional life and increases the pollutant removal capability of dry ponds. Pretreatment reduces incoming velocities and captures coarser sediments, trash, and debris, extending the life of the pond and reduce the frequency of long-term maintenance requirements.

Pretreatment is accomplished with vegetative filters, forebays, or manufactured treatment devices. Size the pretreatment to capture and hold the sediment volume expected between scheduled maintenance clean-outs.

Pond Shape

Design dry ponds with a high length to width ratio and incorporate other design features to maximize the flow path effectively increases the detention time in the system by eliminating the potential of flow to short circuit the pond. A dry pond relies on the process of sedimentation for removal of runoff pollutants. Therefore, design the pond to maximize the degree of sedimentation. Design flow path lengths with long, narrow pond configurations with length to width ratios of 2:1. Ponds that are shallow and have larger surface area to depth ratios provide better pollutant removal efficiencies than smaller, deeper ponds. Designing ponds with relatively flat side slopes also helps to lengthen the effective flow path.

Do not design dry pond inside side slopes should not be more than 2H:1V. The recommended inside pond slopes is 3H:1V with a 2H:1V maximum.

The pond floor should have a minimum slope of 0.5% toward the outlet or underdrain system. The recommended slope is 2.0% to ensure that the pond fully drains between storm events.

Provide adequate maintenance access for all dry detention ponds.

Pond Volume

Dry detention ponds are sized to temporarily store the runoff volume to provide normal peak flow reduction (reduce the post-development peak flow of the design storm event to the pre-development rate). Routing calculations must be used to demonstrate that the storage volume is adequate.

A properly designed dry pond will accumulate sediment over time, leading to the loss of detention volume, runoff quality control and quantity control. An increase in a dry detention pond's maximum design storm storage volume should be considered to compensate for this expected loss of storage volume.

Low Flow Channel

A low flow channel is recommended to prevent standing water conditions. Protect this channel with a TRM or other stabilization method to prevent scouring. Design the remainder of the pond to drain toward this channel. Where recreational uses are desired, design the low-flow channel to one side instead in the middle of the pond.

Outfall

Size the outlet structure for water quality control and water quantity control (based upon hydrologic routing calculations.) The outlet may consist of a weir, orifice, outlet pipe, combination outlet, or other acceptable control structure.

Provide a low flow orifice capable of releasing the water quality volume over 24 hours. The water quality orifice has a minimum diameter of 2-inches and is adequately protected from clogging by an acceptable external trash rack.

Stabilize the outfall of dry ponds to prevent scour and erosion. If the pond discharges to a channel with dry weather flow, care should be taken to minimize tree clearing along the downstream channel, and to reestablish a forested riparian zone in the shortest possible distance.

Emergency Spillway

Design an emergency spillway to pass the 100-year storm event. The spillway prevents pond water levels from overtopping the embankment and causing structural damage. Design the spillway to protect against erosion problems.

Anti-seep Collars

Provide seepage control or anti-seep collars for all outlet pipes.

Inspection and Maintenance

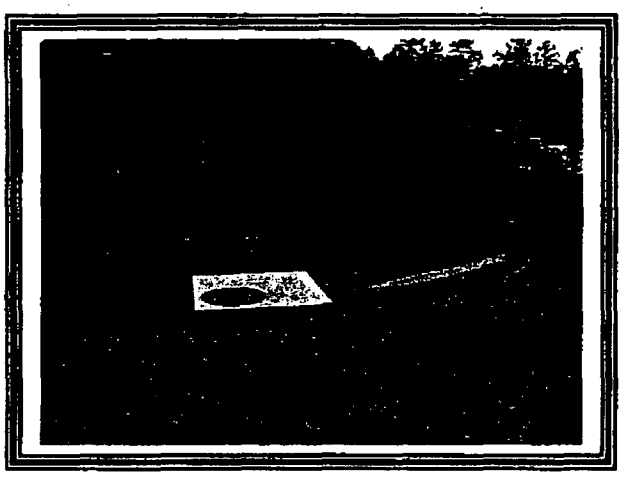
A Pond Maintenance Plan/Agreement is required before approval.

Regular inspection and maintenance is critical to the effective operation of dry ponds as designed. Maintenance responsibility for a pond should be vested with a responsible authority by means of a legally binding and enforceable maintenance agreement that is executed as a condition of plan approval.

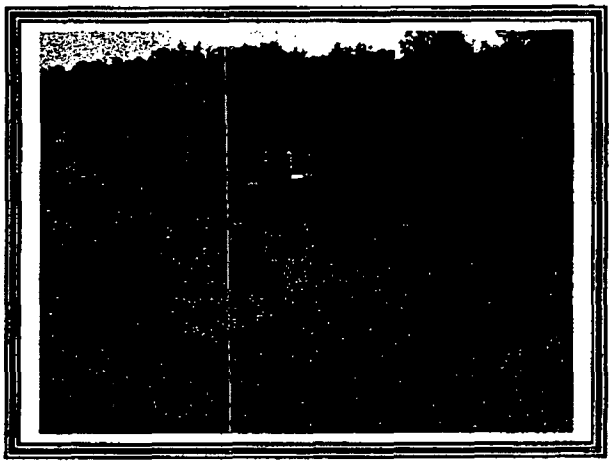
Conduct inspections semi-annually and after significant storm events to identify potential problems early. Direct maintenance efforts toward vegetation management and basic housekeeping practices such as removal of debris accumulations and vegetation management to ensure that the pond dewaters completely to prevent mosquito and other habitats.

Average Pollutant Removal Capability

Total Suspended Solids:	45%-68%	Metals:	26%-54%
Copper:	15%-38%	Lead:	31%-67%
Zinc:	15%-45%	Total Phosphorus:	14%-25%
Total Nitrogen:	19%-29%	Pathogens/Bacteria:	20%-50%



Dry Pond



Dry Pond

Summary of Maintenance Requirements

Required Maintenance	Frequency
Note erosion of pond banks or bottom	Semi-Annual Inspection
Inspect for damage to the embankment Monitor for sediment accumulation in the facility and forebay. Ensure that inlet and outlet devices are free of debris and operational	Annual Inspection
Repair undercut or eroded areas Mow side slopes Pesticide/ Nutrient management Litter/ Debris Removal	Standard Maintenance
Seed or sod to restore dead or damaged ground cover.	Annual Maintenance (As needed)
Removal of sediment form the forebay	5 to 7 year Maintenance
Monitor sediment accumulations, and remove sediment when the pond volume has been reduced by 25%.	25 to 50 year Maintenance
Repair undercut or eroded areas Mow side slopes Pesticide/ Nutrient management Litter/ Debris Removal	Standard Maintenance

Underground Detention Systems

Description

Detention tanks and vaults are underground structures used to attenuate peak storm water flows through detention or extended detention of storm water runoff. They are constructed out of concrete pipe (RCP), corrugated metal pipe (CMP), High Density Polyethylene Pipe (HDPE) or concrete vaults. The design and material selections considers the potential loading from vehicles on the vault or pipe.

When and Where to Use It

Due to the costs associated with underground detention systems for construction and maintenance, these systems are used when space is limited and there are no other practical alternatives.

In the ultra-urban environment, costs for developable land may be high enough that these systems become a feasible alternative.

Relatively expensive to construct, use concrete vaults in areas where system replacement costs are high.

Less expensive, use CMP or HDPE systems to control significant volumes of runoff in parking lots, adjacent to rights-of-way, and in medians, where they is replaced or maintained if necessary.

Design Criteria

Locate underground detention systems downstream of other structural storm water controls providing treatment of the water quality volume.

The maximum contributing drainage area to be served by a single underground detention vault or tank is 25-acres.

Size underground detention systems to mitigate flows from the 2- and 10 –year design storm event and up. Design the systems to meet detention and water quality requirements set forth in local and state regulations.

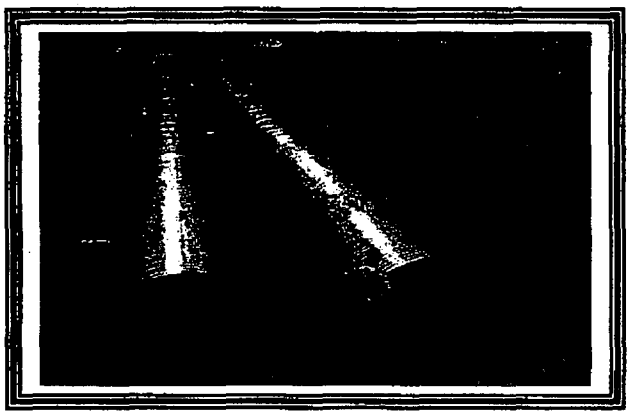
Use routing calculations to demonstrate that the storage volume is adequate.

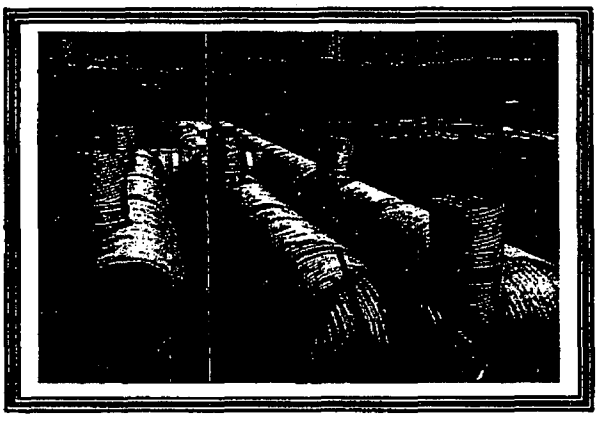
Inspection and Maintenance

- Design the system for easy access for inspection and maintenance.
- Remove any trash/debris and sediment buildup in the underground vaults or tanks annually by pumping them out.
- Perform structural repairs to inlet and outlets as needed based on inspections.

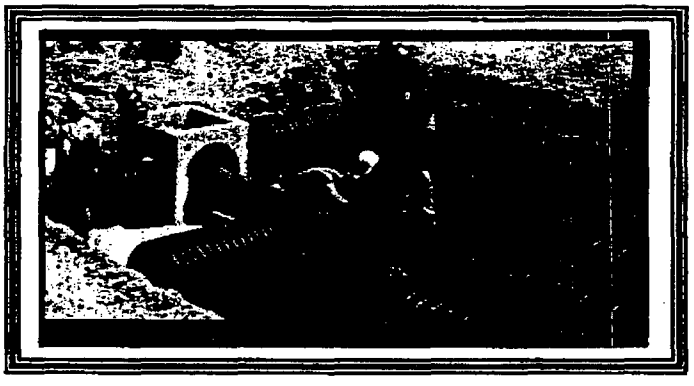
Average Pollutant Removal Capability

Total Suspended Solids:	50%-85%	Metals:	NA
Copper:	35%-70%	Lead:	50%-90%
Zinc:	35%-90%	Total Phosphorus:	55%-70%
Total Nitrogen:	35%-55%	Pathogens/Bacteria:	10%-60%





CMP Underground Detention



HDPE Underground Detention

Storm Water Wetlands

Description

Storm water wetlands remove pollutants primarily through physical filtration and settling, by biological processes of wetland plants, and bacteria in substrates. The storm water wetland is similar in design to the wet pond but has significant vegetation differences. The major difference in the wetland design is the creation of varying depth zones in the shallow marsh area of the wetland to support emergent wetland vegetation. Because consideration must be paid to creating various depth zones and establishing a plant community that can survive in the different zones, the design, construction, and maintenance of storm water wetlands is more complex than wet ponds. There are several different wetland applications including:

- Storm Water Wetland. Constructed shallow marsh system that is designed to treat both urban storm water runoff and control runoff volume. As storm water runoff flows through the wetland, pollutant removal is achieved through settling and uptake by marsh vegetation.
- Shallow Wetland. Most of the water quality treatment takes place in the shallow high marsh or low marsh depths. The only deep sections of the wetland are the forebay and the micropool at the outlet. A disadvantage of shallow wetlands is that a relatively large amount of land is required to store the desired water quality volume.
- Extended Detention Shallow Wetland. This design is similar to the shallow wetland, but part of the water quality treatment volume is provided as extended detention above the surface of the marsh and is released over a period of 24-hours. This application can treat a greater volume of storm water in a smaller space than the shallow wetland design. Plants that can tolerate both wet and dry periods are required in the extended detention area.
- Pond/Wetland System. The system has two separate cells, a wet pond and a shallow marsh. The wet pond is designed to trap sediment and reduce runoff velocities before the runoff enters the shallow marsh. The primary water quality benefits are achieved in the shallow wetland. Less land is required for the pond/wetland system than the shallow wetland and the extended detention shallow wetland.
- Pocket Wetland. A pocket wetland is intended for smaller drainage areas of 5 to 10 acres, and requires excavation down to the water table for a reliable source of water to support the wetland vegetation.

Design Criteria

Do not convert natural wetlands to storm water wetlands. Do not remove natural wetland soils and vegetation to provide a "seedbank" for a constructed storm water wetland without the regulating approval from the US Army Corps of Engineers by obtaining a Section 404 permit. Water quantity storage can be incorporated into the vegetated wetland if the vegetation selected can withstand being submerged for the depth and duration of the water quantity storage time.

Design the wetland with a minimum 2:1 length to width ratio, with 3:1 being the preferred ratio. Maximize the distance between the storm water wetland inlet and outlet to increase the flow length. The flowpath within the wetland is increased through the use of internal berms and shelves used to create the desired varying depth zones within the wetland.

Creating varying depth zones within the wetland increases the pollutant removal efficiency. These depth zones are classified as deep-water zones, which consist of the forebay and outlet micropool, and the shallow water zone that consists of the high marsh, and low marsh area of the wetland. Designing the wetland with varying depth zones prevents the wetland from being taken over by a dominant plant species such as cattails.

Shallow Water Zones

The shallow water zone is defined as being the zones within the constructed storm water wetland that have water depths ranging from 0 to 18 inches. The shallow water zone is designed to promote the growth of emergent wetland plantings and variations in depth allow for a diversity species to survive. Design a level bottom elevation across the width of a wetland cross-section to promote sheet flow and prevent short circuiting or the creation of stagnate dead areas.

High Marsh

Design one-half (½) of the total shallow water zone as high marsh. This zone extends up from 6-inches below the permanent pool water level (6-inches deep). This zone supports a greater density and diversity of wetland species than the low marsh zone.

Low Marsh

Design one-half (½) of the total shallow water zone as low marsh. This zone extends from a depth of 18- to 6-inches below the permanent pool water level. This zone is suitable for the growth of several emergent wetland plant species.

Deep Water Zones

The deep water zones ranges from a depth of 1.5- to 6-feet and includes the forebay, low flow channels, and the outlet micropool. This zone supports little emergent wetland vegetation, but may support submerged or floating vegetation.

Forebay

Design the forebay to reduce the incoming velocities into the wetland. The forebay provides initial settling for sediments, minimizing the amount of suspended sediments that enter the constructed wetland area. Design the forebay as a level spreader distributing the flow evenly and equally across the width of the wetland area. Construct the forebay of an earthen berm no lower than the normal permanent pool depth. Design all inlets to the constructed storm water wetland to discharge to the forebay, and be protected with a properly designed Turf Reinforcement Mat.

Low Flow Channels

A minimum dry weather flowpath is required from the inlet to the outlet for storm water wetlands.

Outlet Micropool.

Design an outlet micropool allowing adequate depth for the extended detention outlet to function properly. Design a drain in the outlet micropool to drain the wetland when needed. Design the outlet micropool 4- to 6-feet deep.

Semi-Wet Zones

The semi-wet zones includes the areas above the permanent pool that will be submerged during larger storm events. This zone supports vegetation that can survive during flooding.

Wetland Planting Plan

Design a wetland planting plan and submit it as part of all constructed wetland design submittals. The selection of the proper plant species and planting locations is an integral part in designing a successful storm water wetland. Have a qualified landscape architect or wetland ecologist prepare a wetland planting plan.

Water Quality Treatment Orifice

Design a low flow orifice to slowly release the water quality volume over a period of 24-hours. Place additional orifice at outlet structures above the temporary water quality pool to provide water quantity control. Protect the water quality orifice from clogging by incorporating an appropriate trash guard. Select a durable trash guard that extends at least 6-inches below the normal pool surface of the wetland.

Acceptable trash guards include:

- Hoods that extend 6-inches below the permanent pool water surface elevation.
- Reverse flow pipes where the outlet structure inlet is located 6-inches below the permanent pool water surface elevation.
- Trash boxes made of sturdy wire mesh.

Principle Spillway

Design the principle spillway of the constructed storm water wetland to safely pass the 2- and 10-year 24-hour storm event. Equip the spillway with a trash rack.

Emergency Spillway

Design the emergency spillway of the constructed storm water wetland to safely convey discharges resulting from the 100-year 24-hour storm event. Design the 100-year water surface elevation a minimum of 1-foot below the top of the embankment. The emergency spillway may be incorporated into the principle spillway where accommodating the emergency spillway elsewhere is not feasible for the given site characteristics.

Inspection and Maintenance

Regular inspection and maintenance is critical to the effective operation of storm water wetlands. Maintenance responsibility for the constructed storm water wetland should be vested with a responsible authority by means of a legally binding and enforceable maintenance agreement that is executed as a condition of plan approval.

- Maintenance requirements for constructed wetlands are particularly high while vegetation is being established. Monitoring during the first year is critical to the success of the wetland.
- Monitor wetlands after all storm events greater than 2-inches of rainfall during the first year to assess erosion, flow channelization and sediment accumulation. Inspection should be made at least once every six months during the first three years of establishment.
- Place a sediment cleanout stake in the forebay area to determine when sediment removal is required.
- Debris should be removed from the inlet and outlet structures monthly.
- Monitor wetland vegetation and replaced as necessary once every 6-months during the first three years of establishment.
- Annually inspect and maintain the depth of the zones within the wetland.
- Annually remove invasive vegetation.
- Repair all eroded or undercut areas as needed.

Average Pollutant Removal Capability

Total Suspended Solids:	66%-78%	Metals:	14%-72%
Copper:	29%-50%	Lead:	62%-76%
Zinc:	32%-52%	Total Phosphorus:	42%-53%
Total Nitrogen:	28%-39%	Pathogens/Bacteria:	58%-78%
Hydrocarbons:	80%		

Storm Water Wetland

Summary of Maintenance Requirements

Required Maintenance	Frequency
Replace wetland vegetation to maintain at least 50% surface area coverage in wetland plants.	Once every 6-months during the first three years of establishment
Clean and remove debris from inlet and outlet structures.	Frequently (3 to 4 times/year)
Mow side slopes.	Frequently (3 to 4 times/year)
Monitor wetland vegetation and perform replacement planting as necessary.	Semi-annual (every 6-months)
Examine stability of the original depth zones.	Annual
Inspect for invasive vegetation, and remove where possible.	Annual
Inspect for damage to the embankment and inlet/outlet structures.	Annual, repair as necessary
Monitor for sediment accumulation in the facility and forebay.	Annual
Inspect for operational inlet and outlet structures.	Annual
Repair undercut or eroded areas.	As needed
Harvest wetland plants that have been "choked out" by sediment buildup.	Annual
Removal of sediment from the forebay.	Per design cycle, as needed, after 50% of total forebay capacity is filled
Remove sediment accumulations in the main permanent pool.	5 to 10 year cycle, after 25% of the permanent pool volume is filled

Bioretention Areas

Description

Bioretention areas are designed to mimic natural forest ecosystems with a combination of soil filtration and plant uptake by utilizing a planting soil layer, mulch, plantings, and an underdrain system. Bioretention areas appear as landscaped or natural areas giving this BMP an appealing image. Storm water runoff enters the Bioretention area and is temporarily stored in a shallow pond on top of the mulch layer. The ponded water then slowly filters down through the planting soil mix and is absorbed by the plantings. As the excess water filters through the system it is temporarily stored and collected by an underdrain system that eventually discharges to a designed storm conveyance system.

When and Where to Use It

Bioretention areas are applicable for small sites where storm water runoff rates are low and typically are received into the Bioretention area as sheet flow. Bioretention drainage areas range from 1-2 acres and are well stabilized to prevent excessive debris and sediment from collecting in the Bioretention area. Because Bioretention areas are sensitive to fine sediments, they are not be placed on sites where the contributing area is not completely stabilized or is periodically being disturbed. Applicable sites include:

- Parking lots,
- Individual residential home sites, and
- Small commercial facilities.

Design Criteria

Bioretention areas work best when constructed off-line, capturing only the water quality volume. Divert excess runoff away from Bioretention areas or collect it with an overflow catch basin. Design Bioretention areas to fit around natural topography and complement the surrounding landscape. Design Bioretention areas with any reasonable shape that fits around sensitive areas, natural vegetation, roads, driveways, and parking lots. The minimum width of Bioretention areas is 10 feet in order to establish a strong healthy stand of vegetation.

Surface Area

The Bioretention surface area may be calculated by the following equation from research by the North Carolina Extension Service, 1999:

$$\mathrm{BSA} = \frac{(\mathrm{DA})(Rv)}{D_{avg}}$$

Where:

BSA	=	Bioretention surface area (feet^2)
DA	=	Contributing drainage area of Bioretention area (feet^2)
R_v	=	Runoff volume (feet) 0.083-feet (1-inch) for SCDHEC
D_{avg}	=	Average ponding water depth above ground (feet)

The Bioretention surface area may also be calculated by the following equation from research by Prince George's County, MD:

$$BSA = 0.1(Rv)(DA)$$

Where:

BSA	=	Bioretention surface area (feet^2)
0.1	=	Empirical conversion factor
R_v	=	Runoff volume (inches) 1-inch for SCDHEC
DA	=	Contributing drainage area of Bioretention area (feet^2)

Pre-treatment

Pre-treatment of storm water runoff is required to reduce the incoming velocities, evenly spread the flow over the entire Bioretention area, and provide for removal of coarse sediments. The pre-treatment may consist of the following:

- Gravel, landscape stone, or geotextile level spreader located along the upstream edge of the Bioretention area.
- Gently sloping vegetated filter areas along the upstream edge of the Bioretention area.
- Vegetated swale along the upstream edge of the Bioretention area.

The level spreader option is the most desirable because level spreaders successfully reduce incoming energy from the runoff and convert concentrated flow to sheet flow that is evenly distributed across the entire Bioretention area.

Planting Mix

Install the planting mix of the Bioretention area at level grade (0%) to allow uniform ponding over the entire area. The maximum ponding depth should be set at 6-inches to 12-inches to allow the cell to drain within a reasonable time and to prevent long periods of submerging the plantings. The planting mix provides a medium for physical filtration for the storm water runoff plus a source of water and nutrients for plant life. Select a soil mixture with a minimum hydraulic conductivity or permeability of 0.5 in/hour. The planting mix has a significant amount of organic content to support plant life. The average porosity of the planting mix is 0.45.

The planting mix is approximately 60-75 percent sand, 25 percent silt or topsoil, and 10 percent organic or leaf compost. The maximum clay content is less than 5 percent. The minimum depth of the planting mix is based on the following:

- 1.5-foot Bioretention areas utilizing grass as the only vegetative media,
- 3.0-feet for Bioretention areas that utilize shrubs, and
- 4.0-feet for Bioretention areas that utilize trees.

Mulch Layer

The mulch layer provides an environment for plant growth by reducing erosion of the filter bed, maintaining soil moisture, trapping fine sediments, and promoting the decomposition of organic matter. The mulch layer plays an important role in pollutant removal. Liberally apply shredded hardwood mulch 2- to 3-inches deep. Shredded hardwood mulch is the mulch of choice because it resists floatation better than other landscape covers. Pine needles are also applicable for certain situations. Avoid pine bark mulch due to its ability to float.

Water Draw Down Time

The under drain system is designed using the draw down time. The general equation used to determine draw down time is Darcy's Equation:

$$Q = 2.3e^{-5}\ K\ A \frac{\Delta H}{\Delta L}$$

Where:

Q	=	Flow rate through Bioretention (cfs)
K	=	Hydraulic conductivity of the planting mix (in/hr) This value will vary based on the actual planting mix used
A	=	Surface area of Bioretention (feet^2)
ΔH	=	Maximum ponding depth above bottom of soil mix (feet)
ΔL	=	Depth of soil mix (feet)

General Hydraulic Conductivity of Soils

Determining the total draw down time is a three-step process.

1. Determine the time it takes to drain the ponded water.
- Utilize Darcy's Equation to calculate the flow rate (cfs).
- Calculate the total ponded water volume (feet^3) by multiplying the Bioretention area (feet^2) by the ponded water depth (feet).
- Divide the total ponded water volume (feet^3) by the flow rate (cfs) to calculate the time to drain the ponded water (seconds)

2. Determine the time it takes to drain the saturated planting mix.
- Calculate the total volume of water contained in the planting mix (feet^3) by multiplying the Bioretention area (feet^2) by the planting mix depth (feet) by the porosity (dimensionless) of the planting mix.
- Divide the planting mix water volume (feet^3) by the flow rate from Darcy's Equation (cfs) to calculate the time to drain the ponded water (seconds).

3. Add up the time to drain the ponded water with the time that it takes to drain the planting mix to calculate the total Bioretention area draw down time.

Under Drain System

Many of the native soils found in South Carolina do not allow for adequate infiltration. Therefore, all Bioretention cells require an under drain system placed beneath the planting mix.

The under drain system consists of a minimum 4-inch diameter perforated PVC pipe (AASHTO M 252), an 8-inch minimum gravel jacket filter layer, and non-woven geotextiles to separate the piping from the native soils and the gravel from the planting mixture. Design the under drain system to safely pass the peak draw down rate calculated.

Select perforated, continuous closed-joint conduits of corrugated plastic pipe, placed on top of an underlying geotextile fabric. The longitudinal slope of the drain pipe is a minimum of 0.5 percent. The perforated drain pipe may be connected to a structural storm water conveyance system or receiving natural water system.

Place filter gravel around the drainage pipe at a minimum depth of 8-inches. Place a geotextile between the boundary of the gravel and the planting mix to prohibit the planting mix from filtering down to the perforated drain pipe.

Several non-perforated PVC pipes should vertically connect to the under drain pipe and extend to the surface of the planting mix to provide access to clean out the perforated drainage pipe.

Overflow System

Design an overflow system to pass runoff volumes greater than the water quality volume away from the Bioretention area. If the Bioretention area collects sheet flow from a parking area, design a catch basin at the elevation of the maximum 6-inch to 12-inch ponding depth of the Bioretention area to carry the excess runoff from the Bioretention area to the storm sewer system or receiving natural water system.

Planting Plan

A Bioretention landscape plan includes all vegetation types, total number of each species, and the location of each species. A description of the contractor's responsibilities including a planting schedule, installation specifications, initial maintenance, a warranty period, and expectations of plant survival. Include long-term inspection and maintenance guidelines in the planting plan. Have a qualified landscape architect, botanist or qualified extension agent prepare the planting plan.

Inspection and Maintenance

Regular inspection and maintenance is critical to the effective operation of Bioretention areas as designed. Maintenance responsibility of the Bioretention area should be vested with a responsible authority by means of a legally binding and enforceable maintenance agreement that is executed as a condition of plan approval.

The surface of the ponding area may become clogged with fine sediments over time. Core aeration or cultivating unvegetated areas may be required to ensure adequate filtration. Other required maintenance includes but is not limited to:

- Conduct pruning and weeding to maintain appearance as needed.
- Replace or replenish mulch as needed.
- Remove trash and debris as needed.

Average Pollutant Removal Capability

Total Suspended Solids:	50%-85%	Metals	NA
Total Phosphorus:	55%-70%	Lead:	50%-90%
Pathogens/Bacteria:	10%-60%	Copper:	35%-70%
Total Nitrogen:	35%-55%	Zinc:	35%-90%

Bioretention Area with uncut clean outs

Summary of Maintenance Requirements

Required Maintenance	Frequency
Pruning and weeding.	As needed
Remove trash and debris.	As needed
Inspect inflow points for clogging. Remove any sediment.	Semi-annual (every 6-months)
Repair eroded areas. Re-seed or sod as necessary.	Semi-annual (every 6-months)
Mulch void areas.	Semi-annual (every 6-months)
Inspect trees and shrubs to evaluate their health.	Semi-annual (every 6-months)
Remove and replace dead or severely diseased vegetation.	Semi-annual (every 6-months)
Removal of evasive vegetation.	Semi-annual (every 6-months)
Nutrient and pesticide management.	Annual, or as needed
Water vegetation, shrubs, and trees.	Semi-annual (every 6-months)
Remove mulch, reapply new layer.	Annual
Test planting mix for pH.	Annual
Apply lime if pH < 5.2.	As needed
Add iron sulfate + sulfur if pH > 8.0.	As needed
Place fresh mulch over entire area.	As needed
Replace pea gravel diaphragm.	Every 2 to 3 years if needed

Infiltration Trenches

Description

Infiltration trenches are excavations typically filled with stone to create an underground reservoir for storm water runoff. The runoff volume gradually exfiltrates through the bottom and sides of the trench into the subsoil over a maximum period of 72 hours (three days), and eventually reaches the water table. By diverting storm water runoff into the soil, an infiltration trench not only treats the water quality volume, but it also preserves the natural water balance by recharging groundwater and preserving channel baseflow. Using natural filtering properties, infiltration trenches remove a wide variety of pollutants from the runoff through adsorption, precipitation, filtering, and bacterial and chemical degradation.

When and Where to Use It

Infiltration trenches are limited to areas with highly porous soils where the water table and or bedrock are located well below the trench bottom. They are only applicable for Hydrologic Soil Group A soils, or soils that have a minimum infiltration rate of 0.3-inches per hour. Infiltration trenches are not intended to trap sediment and are designed with a sediment forebay or other pre-treatment measure to prevent clogging in the gravel. Infiltration trenches are used for medium- to high- density residential, commercial, and institutional developments. They are most applicable for impervious areas where there are low levels of fine particulates in the runoff and the site is completely stabilized and the potential for possible sediment loads is very low. Do not use Infiltration trenches for manufacturing and industrial sites where there is potential for high concentrations of soluble pollutants and heavy metals. Infiltration trenches are designed to capture sheet flow from a drainage area or function as an off-line device. Due to the relatively narrow shape, infiltration trenches are adapted to many different types of sites and are utilized in retrofit situations. Unlike some water quality BMPs, infiltration trenches can easily fit into margin, perimeter or other unused areas of development sites.

Design Criteria

- The maximum drainage area for any one infiltration trench is five (5) acres.
- Direct runoff from areas draining to infiltration practices thorough stabilized vegetated filters at least 20-feet in length.
- Underlying soils have an infiltration rate of 0.3-inches per hour or greater determined from site-specific field soil boring samples.
- Do not place infiltration practices in fill material because piping along the fill-natural ground interface may cause slope failure.
- The area of the infiltration trench is determined from the following equation:

$$A = \frac{V}{\left(nd + \frac{kT}{12}\right)}$$

Where:

A = Surface area of infiltration trench (feet^2)
V = Water Quality volume (1-inch)
n = Porosity of stone in infiltration trench (0.3 to 0.5 depending on stone)
d = Depth of trench (ft)
K = Percolation rate of soil (in/hour)
T = Fill time (hours) (A fill time of 2 hours is recommended for most design calculations).

- Use a conservative porosity value (**n**) of 0.32 in volume calculations unless an aggregate specific value is known.
- Design at least (½)-feet between the bottom of the infiltration trench and the elevation of the seasonally high water table, whether perched or regional.
- Determine the seasonally high water table using on-site soil borings and textural classifications to verify the actual site and seasonal high water table conditions.
- The minimum depth of the excavated trench is 3-feet, the maximum depth is 8-feet, and the trench is lined with a permeable geotextile filter fabric.
- Locate infiltration practices greater than 3-feet deep at least ten feet from basement walls.
- Locate infiltration practices a minimum of 150-feet from any public or private water supply well.
- The maximum width of the infiltration trench is 25-feet.
- The stone fill media consists of 1.0- to 2.5-inch D_{50} crushed stone with 6-inches of pea gravel located on top separated by a permeable geotextile filter fabric. This filter fabric prevents sediment from passing into the stone media, and should be easily separated from the geotextiles that protect the sides of the excavated trench.
- Install a 6-inch sand filter or permeable filter fabric on the bottom of the trench.
- The maximum slope bottom of the infiltration practice is 5 percent.
- Design the infiltration trench to fully de-watered within a 24- to 72-hour period depending on trench dimensions and soil type.
- Install an observation well spaced a maximum of 100-feet. The well is made of 4- to 6-inch PVC pipe. Extend the well to the bottom of the trench. The observation well shows the rate of de-watering after a storm event, and helps predict when maintenance is required. Install the observation well along the centerline of the trench, and flush with the ground elevation of the trench. Cap the top of the well and lock it to discourage vandalism and tampering.

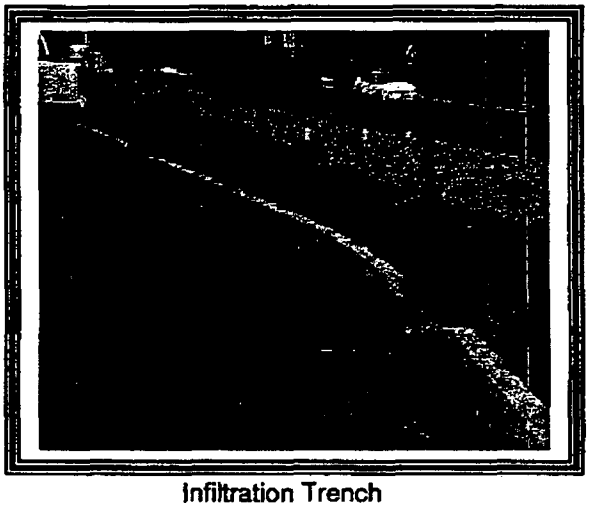
Inspection and Maintenance

Regular inspection and maintenance is critical to the effective operation of infiltration trenches as designed. Maintenance responsibility for the infiltration trench should be vested with a responsible authority by means of a legally binding and enforceable maintenance agreement that is executed as a condition of the Storm Water Management Permit approval. Typical maintenance responsibilities include:

- Keep a record of the average de-watering time of the infiltration trench to determine if maintenance is required.
- The top 6-inch layer of pea gravel and geotextile separating the pea gravel from the stone media serve as a sediment barrier and require replacement when full of sediment.
- Clear debris and trash from all inlet and outlet structures monthly.
- Check the observation well after three consecutive days of dry weather after a rainfall event. If complete de-watering is not observed within this period, there may be clogging within the trench requiring proper maintenance.
- Remove trees, shrubs, or invasive vegetation semi-annually.
- If complete failure is observed, perform total rehabilitation by excavating the trench walls to expose clean soil, and replacing the gravel, geotextiles, and topsoil.

Average Pollutant Removal Capability

Total Suspended Solids:	80%-90%	Metals:	70%-85%
Copper:	50%-60%	Lead:	80%-90%
Zinc:	80%-90%	Total Phosphorus:	50%-60%
Total Nitrogen:	35%-55%	Pathogens/Bacteria:	90%-98%
Hydrocarbons:	85%		



Infiltration Trench

Summary of Maintenance Requirements

Required Maintenance	Frequency
Ensure that the contributing area is stabilized with no active erosion.	Monthly
Grass filter strips should be mowed and grass clippings should be removed.	Monthly
Check observation wells after 72 hours of rainfall. Wells should be empty after this time period. If wells have standing water, the underdrain system or outlet may be clogged.	Semi-annual (every 6-months)
Remove evasive vegetation.	Semi-annual (every 6-months)
Inspect pretreatment structures for deposited sediment.	Semi-annual (every 6-months)
Replace pea gravel, topsoil, and top surface filter fabric.	When clogging or surface standing water is observed
Perform total rehabilitation of infiltration trench.	Upon observed failure

Enhanced Dry Swales

Description

Enhanced dry swales are conveyance channels engineered to capture, treat, and release the storm water quality runoff volume from a particular drainage area. Enhanced swales are different from normal drainage swales in that they have a designed structure implemented in them to enhance detention and storm water pollutant removal. Enhanced dry swale systems are designed primarily for storm water quality and have only a limited ability to provide storm water runoff volume control and downstream channel protection. Enhanced dry swales are vegetated channels designed to include a filter bed of prepared soil that overlays an underdrain system. Dry swales are sized to allow the entire water quality storage volume to be filtered or infiltrated through the swale bottom. Because these swales are predominantly dry, they are preferred in residential settings.

When and Where to Use It

Enhanced swales are applicable in moderate to large lot residential developments and industrial areas with low to moderate density where the impervious cover (parking lots and rooftops) of the contributing drainage areas is relatively small. Enhanced swales are also useful along rural roads and highways that have driveway entrances crossing the swale.

Design Criteria

Design enhanced swales with minimal channel slope, forcing the flow to be slow and shallow. This aspect of the enhanced swale allows particulates to settle out of the runoff and limits the effects of erosion. Place berms, check dams, weirs, and other structures perpendicular to the swale flow path to promote settling and infiltration.

- Enhanced swales are open conveyance channels that have a filter bed of permeable soils overlaying an underdrain system. Runoff is detained in the main swale section where it filters through the filter bed. The runoff is then collected and conveyed to the desired outlet through a perforated pipe and gravel system.
- The maximum designed de-watering time is 48 hours, with the recommended de-watering time being 24-hours.
- Enhanced swales have a contributing drainage area less than five (5) acres.
- Design the swale to capture the required water quality runoff volume, and safely pass larger flows. Flow enters the swale through a pretreatment forebay or along the sides of the swale as sheet flow produced by level spreader trenches along the top of the bank.
- Limit swale slopes between 1 and 2 percent, unless site topography dictates larger slopes. In this instance, place drop structures in the swale to limit the slope of a particular section of the swale. Set the spacing between drop structures a minimum of 50-feet. Add energy dissipation techniques on the downstream side of the drop structures.
- The maximum overall depth of the water quality runoff volume detained in the channel is 1.5-feet.
- The bottom width of the swale ranges between 2- and 8-feet where applicable to ensure an adequate filtration area. Wider channels may be designed to increase the filtration area, but consideration must be given to prevent uncontrolled sub-channel formation.
- The maximum side slopes of the swale are 2H:1V, and 4H:1V is recommended for ease of maintenance and for side inflow to remain as sheet flow.
- Design the peak velocity for the 2-year 24-hour storm event to be non-erosive for the soil and vegetation selected for the swale.

Filter Bed

The filter bed for an enhanced dry swale consists of a permeable soil layer at least 2.5-feet deep. The drainage pipe is a minimum 4-inch diameter perforated PVC pipe (AASHTO M 252) in a 6-inch gravel layer. Select a soil media that has a minimum infiltration rate of 1.0-foot per day, and a maximum infiltration rate of 1.5-feet per day. Place a permeable geotextile filter between the gravel and the overlaying permeable soil.

Forebay

Protect flow inlets to an enhanced dry swale forebay to reduce erosive forces of the runoff. The preferable material is a TRM. Riprap may also be used. Provide swale pretreatment with a sediment forebay. The pretreatment volume is equal to 0.1-inches per impervious acre of the drainage area. The forebay is typically provided by designing a check dam at the inlet of the swale.

Outlet Structures

The underdrain system of the enhanced dry swale discharges to the storm drainage system on site, or discharges to a stable protected outlet point.

Overflows

For maximum performance, enhanced dry swales are recommended to be off-line structures. If a swale is designed to be an online structure, it must be able to safely pass the 25-year 24-hour storm event.

Landscape Plan

Design the enhanced dry swale landscape plan to include the type of turf grass species required along with a permanent maintenance guideline. Have the planting plan prepared by a qualified landscape architect, botanist or qualified extension agent.

Inspection and Maintenance

Regular inspection and maintenance is critical to the effective operation of enhanced swales. Maintenance responsibility should be vested with a responsible authority by means of a legally binding and enforceable maintenance agreement that is executed as a condition of plan approval.

The surface of the filter bed may become clogged with fine sediments over time. Light core aeration is required to ensure adequate filtration. Other required maintenance includes but is not limited to:

- Mowing to maintain storage volume and appearance as needed.
- Remove trash and debris as needed.

Average Pollutant Removal Capability

Total Suspended Solids:	70%-80%	Hydrocarbons:	65%
Total Phosphorus:	35%-50%	Lead:	60%-70%
Pathogens/Bacteria:	10%-60%	Copper:	15%-45%
Total Nitrogen:	40%-60%	Zinc:	40%-65%

Enhanced Swales

Summary of Maintenance Requirements

Required Maintenance	Frequency
Mow grass to maintain design height and remove clippings.	As needed (frequent/seasonally)
Nutrient and pesticide management.	Annual, or as needed
Inspect side slopes for erosion and repair.	Annual, or as needed
Inspect channel bottom for erosion and repair.	Annual, or as needed
Remove trash and debris accumulated in forebay.	Annual
Inspect vegetation. Plant an alternative grass species if original cover is not established.	Annual (semi-annually first year)
Inspect for clogging and correct the problem.	Annual
Roto-till or cultivate the surface of the bed if swale does not draw down in 48 hours.	As needed
Remove sediment build-up within the bottom of the swale.	As needed, after 25% of the original design volume has filled

Pre-Fabricated Control Devices

Description

The need for urban water quality BMPs that are very efficient and present less space constraints has produced the industry of innovated storm water BMP technology and products. These pre-manufactured products combine settling, filtration, and various biological processes into one controlled system. By combining these different processes, these BMPs are designed to focus on removing many different types and concentrations pollutants. Even where pre-fabricated control devices are not able to meet the 80 percent TSS removal goal alone, they can provide excellent pre-treatment in a series of water quality control BMPs or inlet to permanent pool detention basins or storm water wetlands.

Post construction pre-fabricated storm water quality BMPs are designed to filter and trap trash, floatable contaminates, sediment, oil and grease, and other pollutants. These BMPs are incorporated into storm water conveyance systems for pretreatment of storm water runoff. In some instances, pre-fabricated storm water quality BMPs serve as the only treatment mechanism before the runoff is discharged. Post construction pre-fabricated storm water quality BMPs are classified in to three separate categories:

1. Catch Basin Inserts
2. Separation Devices
3. Filtration Devices

When and Where to Use It

Pre-fabricated control devices may be used to treat runoff as long as they are designed to treat the first 1-inch of runoff and/or are proven to provide 80 percent TSS removal. Pre-fabricated control devices include the following beneficial attributes for water quality control over conventional water quality BMPs:

- Pre-fabricated control devices are placed almost anywhere on a site where they can receive concentrated flows from storm drainage pipes.
- Pre-fabricated control devises are safe to the public because storm water is treated within the unit and no surfaces are open to the environment, unlike the permanent pool detention pond or storm water wetland.
- Minimal on-site construction is required because pre-fabricated control devices are typically assembled before they reach the site.

Design

Catch Basin Inserts

Catch Basin Inserts are defined as BMPs designed to be installed directly into storm drain catch basins to treat the runoff before it enters the primary conveyance system.

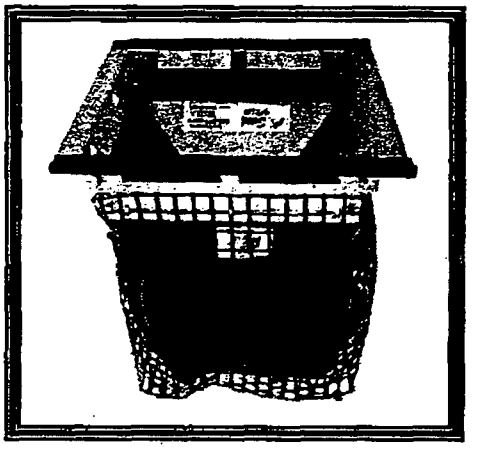
There are three basic Catch Basin Inserts available: tray, bag, and basket. These inlets typically are made of a stainless steel or a high strength corrugated plastic frame that supports a sedimentation chamber and filter media designed to absorb specific pollutants such as oil, grease hydrocarbons, and heavy metals. Catch Basin Inserts sometime include a high flow bypass mechanism to prevent scouring and re-suspension of previously trapped pollutants during larger rainfall events.

Pollutant removal efficiencies are variable and highly dependent on storm frequency, influent pollutant concentrations, rainfall intensity and other factors. Catch Basin Inserts exhibit the following properties:

- Utilize settling, separation, swirling, centrifugal force, and filtering techniques to remove pollutants from storm water runoff.
- Contain no moving components that require an external power source such as electricity, gas powered engines or generators.
- Have posted data from third party test results.

Catch Basin Insert Average Pollutant Removal Capability

Total Suspended Solids:	50%-85%	Metals	NA
Copper:	35%-70%	Lead:	50%-90%
Zinc:	35%-90%	Total Phosphorus:	55%-70%
Total Nitrogen:	35%-55%	Pathogens/Bacteria:	10%-60%



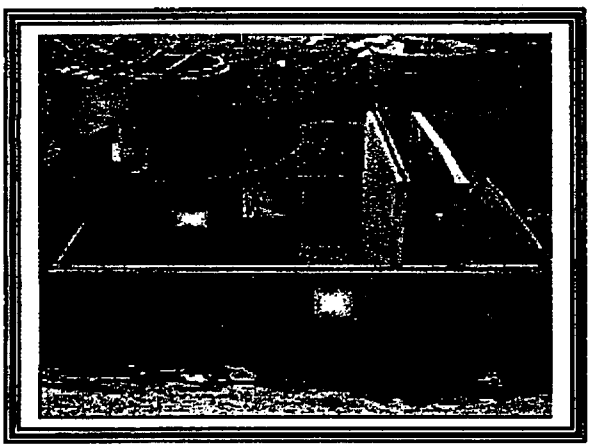
Catch Basin Inserts

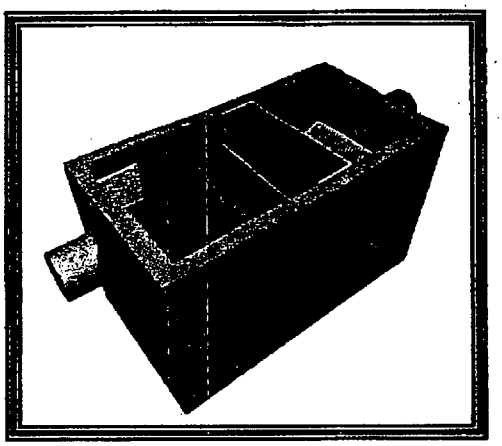
Separation Devices

Separation Devices are defined as BMPs designed and sized to capture and treat storm water runoff to prevent pollutants from being transported downstream. Separation Devices contain a sump for sediment deposition and a series of chambers, baffles, and weirs to trap trash, oil, grease and other contaminants. These BMPs are designed as flow-through structures where the inflow rate into the structure is regulated. These structures are not designed to store the entire water quality volume. Separation Devices sometime include a high flow bypass mechanism to prevent scouring and re-suspension of previously trapped pollutants during larger rainfall events.

Pollutant removal efficiencies are variable and are highly dependent on storm size, influent pollutant concentrations, rainfall intensity, and other factors. Separation Devices exhibit the following properties:

- Utilize settling, separation, swirling, and centrifugal force techniques to remove pollutants from storm water runoff.
- Contain no moving components that require an external power source such as electricity, gas powered engines or generators.
- Have posted data from third party test results.





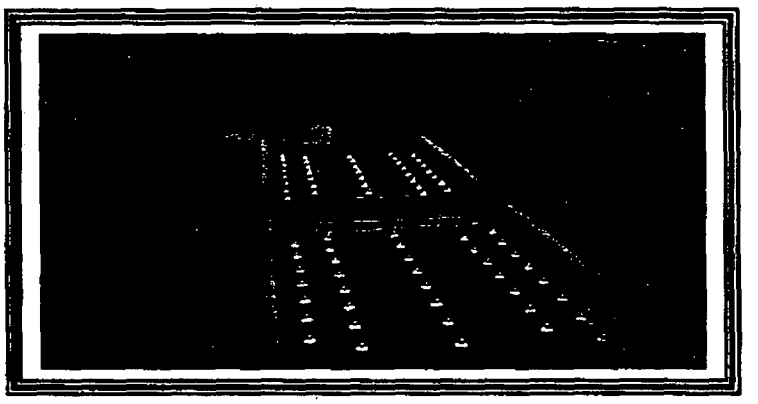
Separation Devices

Filtration Devices

Filtration Devices are defined as BMPs designed and sized to capture and treat storm water runoff to prevent pollutants from being transported downstream. Filtration Devices are used in areas with impaired receiving waters where high pollutant removal efficiencies are required. Filtration Devices usually contain a sedimentation chamber and a filtering chamber. These devices may contain filter materials or vegetation to remove specific pollutants such as nitrogen, phosphorus, copper, lead, or zinc.

Pollutant removal efficiencies are variable and are highly dependent on storm size, influent pollutant concentrations, rainfall intensity and other factors. Filtration Devices shall exhibit the following properties:

- Utilize filtering techniques to remove pollutants from storm water runoff.
- Have posted data from third party test results.



Filtration Device

Separation and Filtration Device Average Pollutant Removal Capability

Total Suspended Solids:	80%	Metals	60%
Copper:	50%	Lead:	60%
Zinc:	70%	Total Phosphorus:	40%
Total Nitrogen:	30%	Hydrocarbons:	80%

Products

There are many pre-fabricated water quality structures on the market that may be used as water quality control BMPs.

Installation

Install in accordance with the Manufacturer's written installation instructions and in compliance with all OSHA, local, state, and federal codes and regulations. A Manufacturer's representative is required to certify the installation of all post construction pre-fabricated storm water quality BMPs.

Proper site stabilization is essential to ensure that post construction pre-fabricated storm water quality BMPs function as designed. These structures are not interned to trap eroded sediment from during construction operations. Post construction pre-fabricated storm water quality BMPs are the last storm water runoff structures installed on-site, or shall remain off-line until final stabilization is achieved.

Inspection and Maintenance

- Inspect and maintain in accordance with the Manufacturer's written recommendations.
- The specific maintenance requirements and schedule prepared by the Manufacturer is signed by the owner/operator of the BMP.
- Require frequent inspection and maintenance to maximize pollutant removal.
- Maintain BMPs at least bi-annually to ensure that the BMPs are working properly.

- Keep a maintenance log to track routine inspections and maintenance. Lack of maintenance is the most common cause of failure for post construction pre-fabricated storm water quality BMPs.
- Remove accumulated sediment and other trapped pollutants when the BMP becomes full. Typical removal of pollutants requires the use of a Vactor truck.

Summary of Maintenance Requirements

Required Maintenance	Frequency
Inspect separation and filtration units.	Regularly (quarterly)
Clean out sediment, oil and grease, and floatables. Manual removal of pollutants may be necessary.	As needed
Perform requirements obtained from manufacturer.	As needed
Inspections.	Frequency of inspection and maintenance is dependent on land use, accumulated solids climatological conditions, and design of pre-fabricated device

Vegetated Filter Strips

Description

Vegetated Filter Strips (VFS) are zones of vegetation where pollutant-laden runoff is introduced as sheet flow. VFS may take the form of grass filters, grass filter strips, buffer strips, vegetated buffer zones, riparian vegetated buffer strips, and constructed filter strips.

When and Where to Use It

Applicable in areas where filters are needed to reduce pollutant impacts to adjacent properties and water bodies. VFS are used to remove pollutants from overland sheet flow but are not effective in removing sediment from concentrated flows. There are two main classifications of VFS:

- Constructed filter strips: Constructed and maintained to allow for overland flow through vegetation that consists of grass-like plants with densities approaching that of tall lawn grasses.
- Natural vegetative strips: Area where pollutant-laden flow is directed in an overland manner, including riparian vegetation around drainage channels. Vegetation ranges from grass-like plants to brush and trees with ground cover.

VFS remove pollutants primarily by three mechanisms:

1. Deposition of bedload material and its attached chemicals as a result of decreased flow velocities and transport capacity. This deposition takes place at the leading edge of the filter strip.
2. Trapping of suspended solids by the vegetation at the soil vegetation interface. When suspended solids settle to the bed, they are trapped by the vegetated litter at the soil surface instead of being re-suspended as would occur in a concentrated flow channel. When the litter becomes inundated with sediment, trapping no longer occurs by this mechanism.
3. Trapping of suspended materials by infiltrating water. This is the primary mechanism by which dispersed clay sized particles are trapped.

VFS effectiveness fluctuates considerably depending on vegetation type, vegetation height and density, season of the year, eroded particle characteristics, size of drainage area, and site topography.

Design Criteria

Select a vegetation type, a ground slope, filter strip width, and strip length. Locate VFS on the contour perpendicular to the general direction of flow. Select vegetation to be dense, turf-forming grass in order to minimize water channelization. Never assume that natural vegetation is adequate for VFS. Design a ponding area at the leading edge of the VFS for bedload deposition.

General Design Requirements

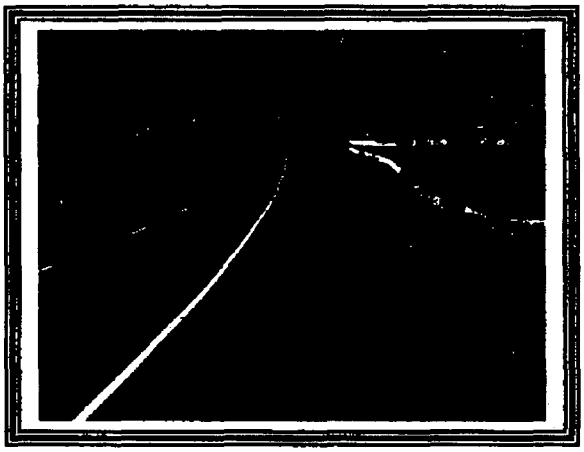
a. Select an applicable area for the VFS
   Minimum Ground Slope = 1 percent
   Maximum Ground Slope = 10 percent
b. Select a vegetation type.
c. Select the design life and maximum allowable sediment deposition. A design life of 10 years and deposition of 0.5-feet is recommended.
d. Estimate the long-term sediment yield entering the filter strip and a 10-year 24-hour design single-storm sediment yield.
e. Determine desired Trapping Efficiency- 80 percent design removal efficiency goal of the total suspended solids (TSS) in the inflow.
f. Estimate the filter length necessary to prevent deposition within the filter greater than 0.5-feet. (Assume filter width is equal to disturbed area width but no smaller than 15-feet.)
g. Use the filter length to calculate Trapping Efficiency for the design storm.
h. Repeat (d) and (e) until the lengths match.

Inspection and Maintenance

- Maintenance is very important for filter strips, particularly in terms of ensuring that flow does not short circuit the practice. They require similar maintenance to other vegetative practices.
- Inspect vegetation for rills and gullies annually and correct. Seed or sod bare areas.
- Inspect grass after installation to ensure it has established. If not replace with an alternative species.
- Inspect to ensure that grass has established annually. If not, replace with an alternative species.
- Mow grass to maintain a height of 3- to 4-inches.
- Remove sediment build-up from the bottom when it has accumulated to 25% of the original capacity.

Average Pollutant Removal Capability

75 feet in length		150 feet in length		Average	
Total Suspended Solids:	54%	TSS:	84%	TSS:	70%
Lead:	16%	Lead:	50%	Metals	40%-50%
Zinc:	47%	Zinc:	47%	Total N:	30%
Total Phosphorus:	- 25%	Total Phosphorus:	-40%	Total P:	10%
Nitrate Nitrogen:	-27%	Nitrate Nitrogen:	-20%	Nitrate Nitrogen:	0%
				Pathogens/Bacteria:	NA



Roadside Vegetated Filter Strip

Summary of Maintenance Requirements

Required Maintenance	Frequency
Mow grass to maintain design height.	Regularly (frequently)
Remove litter and debris.	Regularly (frequently)
Inspect for erosion, rills and gullies, and repair.	Annual, or as needed
Repair sparse vegetation.	Annual, or as needed
Inspect to ensure that grass has established. If not, replace with an alternative species.	Annual, or as needed
Nutrient and pesticide management.	Annual, or as needed
Aeration of soil.	Annual, or as needed

Grass Paving and Porous Paving Surfaces

Description

Grass Paving

Grass paving technology allows for the reduction of paved areas by implementing grass paving in areas that are infrequently used such as fire lanes and overflow parking where applicable. A variety of grass paving materials are available on the market. Grass paving units are designed to carry vehicular loading and may be composed of different types of materials. The pavers are typically covered with sod to make the areas indistinguishable from other grassed areas. Grass pavers allow water quality benefits by allowing storm water to infiltrate into the underlying soils and by the filtering of storm water as it flows through the grass.

Grass pavers provide a more aesthetically pleasing site and reduce the impact of complete asphalt surfaces. Grass pavers should not be used for frequently traveled or parked in areas. Grass pavers reduce the runoff volume and extend the time of concentration for a particular site. Some pavers provide enough infiltration to be considered a pervious area.

Porous Paving

Porous pavement is a permeable pavement surface with an underlying stone reservoir to temporarily store surface runoff before it infiltrates into the subsoil. This porous surface replaces traditional pavement, allowing parking lot storm water to infiltrate directly and receive water quality treatment, and also reducing runoff from the sit

When and Where to Use It

Porous pavement options include porous asphalt, pervious concrete, and grass pavers. The ideal application for porous pavement is to treat low-traffic or overflow parking areas. Porous pavement also has highway applications where it is used as a surface material to reduce hydroplaning.

Porous pavements are a good option in ultra-urban areas because they consume no space since there is very little pervious area in these areas. Since porous pavement is an infiltration practice, do not apply it on storm water hot spots due to the potential for ground water contamination. The best application of porous pavement for retrofits is on individual sites where a parking lot is being resurfaced.

Design Criteria

Take soil boring to a depth of at least 4 feet below bottom of stone reservoir to check for soil permeability, porosity, depth of seasonally high water table, and depth to bedrock.

Not recommended on slopes greater than 5% and best with slopes as flat as possible.

Minimum setback from water supply wells: 100 feet.

Minimum setback from building foundations: 10 feet down gradient, 100 feet upgradient.

Not recommended where wind erosion supplies significant amounts of sediment.

Use on drainage areas less than 15 acres.

Minimum soil infiltration rate of 0.3-0.5 inches per hour.

Typically design for storm water runoff volume produced in the tributary watershed by the 6-month, 24-hour duration storm event.

A typical porous pavement cross-section consists of the following layers:

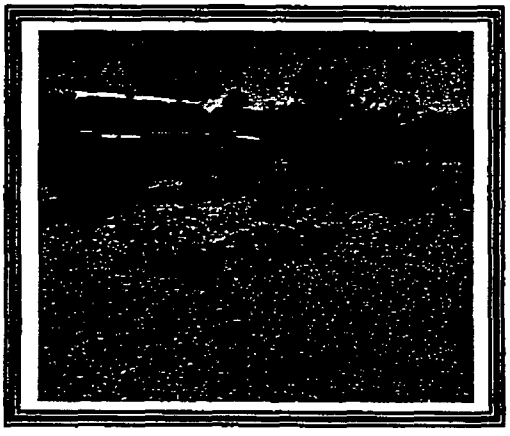
1) Porous asphalt course 2-4 inches thick,
3) Reservoir course of 1.5 to 3 inch stone,
2) Filter aggregate course, and
4) Filter fabric.

Use a geotextile meeting AASHTO M288 Class 1, 2, or 3 in all cases as a filter to protect the long-term performance of the system.

Inspection and Maintenance

- Porous pavement requires extensive maintenance compared with other practices.
- Avoid sealing or repaving with non-porous materials.
- Ensure that paving area is clean of debris, paving dewaters between storms, and that the area is clean of sediments monthly.
- Mow upland and adjacent areas, and seed bare areas as needed.
- Vacuum sweep frequently to keep the surface free of sediment as needed.
- Inspect the surface for deterioration or spalling annually.
- Perform high pressure hosing to free pores in the top layer from clogging as needed.

Grass Paver



Porous Paving

Innovative Technologies

Innovative technologies are encouraged and should be accepted providing there is sufficient documentation as to the effectiveness and reliability of the proposed structure. To justify the efficiency of innovated water quality control structures, the owner may be required to monitor the pollutant removal efficiency of the structure. If satisfactory results are obtained, the innovative water quality structure may be used and no other monitoring studies should be required. If the control is not sufficient, other on-site and/or downstream controls should be designed to trap the required pollutants.

Calculating Pollutant Loads Using IDEAL Model

Background

The intent of legislation such as the South Carolina Storm Water Management and Sediment Reduction Act is that developments in South Carolina will not negatively impact water quality and downstream habitats. The potential for problems present challenges to engineers and developers to design and install best management practices that will not cause the state's waters to be impaired by pollutants such as nutrients, sediment, or bacteria. Simplified methods and the IDEAL (Integrated Design and Assessment for Environmental Loadings) Model for calculating pollutant removal efficiency of BMPs and treatment systems will assist designers and regulators in meeting state and federal requirements.

The IDEAL Model provides SCDHEC specific design methods that give reasonable assurance that effluent meets desired performance without the lengthy design process typically associated with designs developed to meet a performance standard. The use of area specific design methods provides a means of achieving control without the steep learning curve associated with simulation techniques. For large-scale developments or in sensitive areas, it is still anticipated that site specific data and other procedures such as modeling be used for detailed evaluation of controls.

Approach

The IDEAL Model includes estimation of performance of detention/retention ponds, extended detention ponds, sand filters, and riparian buffers. The performance of each control is modeled using SCDHEC specific conditions (including soils, topography, and climate) and compared with removal efficiency. For each structure, spreadsheet modeling was developed that is consistent with performance standards.

Effectiveness of control, or removal efficiency, is commonly determined by either a water quality design standard or a performance standard. A water quality performance standard dictates a maximum acceptable level (i.e., concentration) in the effluent. The control is designed such that this level is not exceeded. On the other hand, a water quality design standard establishes a standard specification based on a given drainage area or similar criterion. There are obvious benefits associated with each method. Performance standards offer site specific water quality control, but require considerable on-site collection of information for design purposes and are much more difficult to design and review. Structures designed for performance standards have a higher design cost than structures designed for water quality design standards. However construction costs tend to be considerably less, since design standards are inherently conservative. Design standards, on the other hand, are more easily employed and complied with but often entail risk that the structure is either grossly over designed, resulting in added installation costs, or grossly under designed so that the measure may not perform satisfactorily, particularly in sensitive areas. A preferable alternative to these methods is to provide a design procedure that can meet a desired performance without incurring excessive design costs. To achieve this, the design is typically expected to be slightly conservative, but considerably less conservative than if developed from a design standard.

The IDEAL Model is based on site visits at numerous construction locations throughout South Carolina in order to see innovative BMPs, as well as areas needing improvement. Cooperation with regulatory personnel included discussions as to what specific BMPs should/should not be considered for evaluation. It is recognized that there are a large number of potential post construction BMPs that can potentially be used.

Evaluation of existing modeling capabilities led to the development of a new model known as IDEAL. The IDEAL Model, a model for hydrology, sedimentology, and water quality, contains much detail and ties water quality modeling together with physical, chemical, and biological relationships to provide a much more realistic description of reactions that are taking place in the real world.

It should be recognized that selection of an appropriate water quality model to allow evaluation of a wide range of pollutant control technologies in a seamless manner depends on the user's application. This process led to some modifications in the program to account for selected BMPs, treatment trains, topography, soil properties, and climate. Data bases of rainfall records for three SCDHEC locations were analyzed to simplify user data requirements and simplify input for spreadsheets.

Since the method selected for accomplishing the simulation is critical, several items were considered:

- Combine hydrologic, and hydraulic routines with accepted pollutant removal routines.
- Impact on channels or ponds on adjacent wetlands.
- Consider each of the pollutants of interest (nutrients, sediment, and bacteria indicator).

Each of these tasks was accomplished, and the results analyzed to produce spreadsheets that are used as an aid for designing BMPs based on pollutant removal. It should be recognized that aids such as these are developed for typical conditions. More detailed evaluation methods should be utilized if the situation is environmentally sensitive or hazardous. In all cases, good engineering judgment should be considered as an essential ingredient in design.

The IDEAL Model

The IDEAL Model is not a rule or regulation promulgated by the agency, but is guidance for evaluation and implementation of best management practices for storm water design. The IDEAL Model was developed by means of a comprehensive literature review and then use of best available science and valid scientific principles. State environmental agencies and the EPA have traditionally used guidance documents to provide preferred methodology to assist its staff with consistent application and to provide information and guidance to persons outside the agency to allow them to more effectively and efficiently implement program requirements. Because the IDEAL Model is not binding rules, alternative approaches, methodologies and solutions are allowed; however, it is incumbent on one proposing an alternative to adequately demonstrate both the effectiveness and equivalency of that alternative.

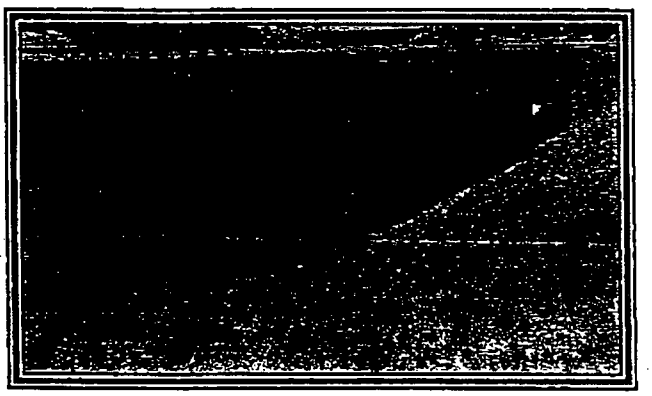
SCE&G COL 4.1 Land Use -(SCDHEC 2005)

SC DHEC South Carolina Department of Health and Environmental Control

D H E C

PROMOTE PROTECT PROSPER

Ocean and Coastal Resource Management



South Carolina DHEC Storm Water Management BMP Handbook

August 2005

South Carolina Department of Health and Environmental Control - www.scdhec.gov

OCRM: Publications Clearinghouse

Technical Documents - Water Resources

The SC OCRM Information Clearinghouse is a National Oceanic Atmospheric Administration Coastal Management Fellowship project funded by NOAA and the State of South Carolina.

General Environmental Quality

In South Carolina, the State's Pollution Control Act serves to implement the provisions of the Federal Clean Water Act. The quality of natural resource based planning should be enhanced as water quality can be assessed, and programs developed, on a watershed basis where natural system boundaries are utilized to limit planning areas.

- Overview of Water Quality Management Components in the Charleston Harbor Project Area by Milt Rhodes; 1996; Details of SC-DHEC different departments & their responsibilities, laws and histories.
  Citizens Guide to Clean Water by the Palmetto Conservation Foundation and SC-DHEC; 51 pp. Excellent description of water basics from rain to water bodies to the sea. Discusses point and nonpoint source pollution, wetlands, watersheds and regulations. (on the SC Bureau of Water site)
- The Facts on Groundwater a SC-DHEC Bureau of Water pamphlet; 2 pp. Defines and explains the where, what and how of groundwater, its uses and potential contamination sources. (on the SC Bureau of Water site)

Marina Dredging and Spoil Disposal

Depending on how and where it is accomplished, the disposal of dredged material may have substantial effects upon natural resources in the disposal area. Currently, more than 3.8 million cubic meters of material are removed annually from the channels of the estuary to maintain adequate water depths for Charleston's ship traffic.

- Dredging and Spoil Disposal Needs Assessment (123 pages, 5.5 MB)
- Questionnaire for marina owners and operators
- Dredging and Disposal Alternatives and Techniques for South Carolina Coastal Marinas
- A Cultural Resources Reconnaissance of Possible Dredge Disposal by Paul Brockington and E.C. Poplin; 1992; 60 pp. Analyzes the potential impacts of dredging and dredged material on known or suspected cultural resources.
- Environmental Assessment for Alternative Dredged Material for Disposal Sites in Charleston Harbor by Fred A. Holland, D.E. Porter, R.F. Van Dolah, R.H. Dunlap, G.A. Steele and S.M. Upchurch; 1993; 144 pp. Very well written, Threatened & Endangered Habitats listed in appendix.
- Spawning Locations Determined by Acoustic Sampling for Spotted Seatrout, Red Drum and Black Drum in Charleston Harbor by W.A. Roumillat; 1999; 18 pp. Looks at the spawning locations, particularly in regard to dredging and makes policy recommendations.

Chemical Contamination

In some cases, metal leachates may accumulate in sediments and oysters immediately adjacent to pilings, but do not appear to become concentrated in sediments or oysters elsewhere in the same creeks.

- A Study of Wood Preservative Leachates from Docks in an Estuarine Environment by P.H. Wendt, R. F. Van Dolah, M. Y. Bobo, T. D. Mathews and M. V. Levisen; 1995; 43 pp. Discusses variety of chemical pollutants.

Golf Courses

Maintain non-chemically treated vegetative buffer zones of at least fifty feet adjacent to all natural watercourses to assist in filtering nutrients and pesticides in runoff and to moderate water temperatures.

- Golf Course Best Management Practices Literature Review by Steve Klaine; 1994; 16 pp. with 8 pp. references. Introduction to basic golf best management practices. Easy to read.
- Environmentally Sensitive Techniques in Golf Course Management: A Model Study at the Ocean Course Kiawah Island, SC by Steve Klaine, Vincent A. Leopold, Michael J. Hooper, Ronald J. Kendall, James L. Cowles, Frank C. Bailey, Barry L. Forsythe II, Carol P. Weiskopf, Thomas W. Lapoint, Landon C. Miller, AA Fouts and Thomas R. Rainwater; 1995; 250 pp. A research study that is also interesting reading. Well done research of pesticides upon fish and birds.
- An Environmentally Friendly Coastal Golf Course: An Architect and Supertindents's Manual by Steve Klaine, Thomas Rainwater and Barry Forsythe; 1995; 47 pp. Easy to read, well organized.

Point Source Pollution

Lower flushing rates make the smaller tidal creeks more susceptible to human induced changes in water quality, including more frequent extreme fluctuations in salinity, changes in bottom sediments, and alterations in dissolved oxygen dynamics. Creeks draining relatively developed watersheds showed significantly more frequent violations of existing dissolved oxygen standards and appeared to have the greatest exposure to low dissolved oxygen conditions.

- Enforcement of NPDES Permits by G. I. Scott, T. Shearer and R.E. Thompson; 1998; 14 pp. Discusses Charleston Harbor Project estuary industries and the National Pollution Discharge Elimination System.

Nonpoint Source Pollution

Nonpoint source pollutants in runoff include pesticides, heavy metals, excess nutrients, suspended solids, and fecal coliform bacteria.

- Storm Water Impacts on Creeks, Variability of Secondary Estuarine Watershed Creeks by Phillip Dustin; 51 pp. & appendix of charts and maps; Compares developed & undeveloped watershed water quality in tidal creeks. (Part 1/Part 2/Part 3)
- 1994 Report of the Isle of Palms Connector Study for the Charleston Harbor Project by Philippe E. Ross and Paige A. Leitman; 1994; 57 pp. Good discussion of road contaminants and how to test, suggests better testing methodologies while using other relevant research.
- Building A Better Bridge: A Study of the Isle of Palms Connector by Philippe E. Ross; 1995; 24 pp. A continuation of the 1994 study.
- The Center for Watershed Protection A link to an excellent source for stormwater management and water quality planning. (a non-SC DHEC site)
- Stormwater Strategies: Community Responses to Runoff Pollution-Strategies in the South East by the Natural Resource Defense Council; 1999; html. This covers the most effective strategies being employed by communities in the South East to control urban runoff. It is intended to serve as a guide for local decisionmakers and municipal officials. It is also a resource for citizens concerned about the quality of their local environment. (a non-SC DHEC site)
- Maintaining Water Quality Through Stormwater Controls a SC-DHEC Bureau of Water pamphlet; 4 pp. Briefly outlines nonpoint source pollution concerns affecting the assimilative capacity of water bodies and the need for best management practices to deal with stormwater runoff. (on the SC Bureau of Water site)
- Polluted Runoff: Lessons Learned from the National Estuarine Research Reserve System (NERR) by the NERR/NOAA; 2000; 28 pp. Water quality research from the NERRs, summarized to apply at the local level. Easy to read. (a non-SC DHEC site)
- Review of Nonpoint Source Pollution and Best Management Practices Along the SC Coast by D. Mac Kelley, Jr.; 1993; 82 pp. Discusses Fed & State laws, BMPs; Gives design stats for detention and retention ponds, trench systems, porous pavement, vegetative strips and constructed wetlands. (Part 1/Part 2/Part 3)

On-Site Septic Systems

- Field Evaluation of Four Onsite Disposal Systems and Their Impacts to Shallow Ground Water in the Coastal Zone of SC by Lisa Hajjar. A good study to determine if septic systems installed under the current regulations protect shallow groundwater and closely connected surface waters. (Part 1/ Part 2)
- An Examination of Onsite Wastewater Disposal Policy in the Coastal Zone: Implications for the Charleston Harbor Project Area by David M. Szymanski; 1994; 70 pp. Gives Federal & State laws, and local framework suggestions. (Part 1/Part 2)
- Septic Tank Absorption System Design Aid and Site Suitability Evaluation Tool for South Carolina Coastal Soils by Michael E. Meadows; 1997; 14 pp. A technical research paper with useful examples. (Part 1/Part 2)
- Evaluation of Analytical Profile Indexing, Fatty Acid Profiling Analysis and Pulsed Field Gel Electrophoresis Analysis of E. Coli Bacteria in Environmental Samples to Identify Pollution Sources by G.P. Richards, G. Seaborn, B.C. Thompson & G.I. Scott, NMFS; 1997; 37 pp. A technical research paper to assess different methods of distinguishing human from non-human fecal coliform bacteria. (Part 1/Part 2)

Best Management Practices

The control of nonpoint pollution in the U.S. is based on the identification and promotion of best management practices or BMPs, including retention ponds (contain permanent water storage), detention and extended detention ponds (dry out between storms), vegetative filter strips or buffers, and infiltration BMPs, such as infiltration trenches, medians and swales.

- Review of Nonpoint Source Pollution and Best Management Practices Along the SC Coast by D. Mac Kelley, Jr.; 1993; 82 pp. Discusses Fed & State laws, BMPs; Gives design stats for detention and retention ponds, trenchs systems, porous pavement, vegetative strips and constructed wetlands. (Part 1/Part 2/Part 3)
- Stormwater Pond Maintenance by Ward Reynolds, Lisa Hajjar & Tess Rodgers; 2000; 20 pp. Descriptions of stormwater ponds function, maintenance and various problems with solutions.
- Maintaining Water Quality Through Stormwater Controls a SC-DHEC Bureau of Water pamphlet; 4 pp. Briefly outlines nonpoint source pollution concerns affecting the assimilative capacity of water bodies and the need for best management practices to deal with stormwater runoff. (on the SC Bureau of Water site)
- **New! DHEC OCRM Stormwater BMP Handbook**
  - Complete Handbook
  - Erosion Prevention Measures
  - Sediment Controls
  - Runoff Control and Conveyance Measures
  - Alternative Erosion Prevention and Sediment BMPs & Post Construction Water Quality Controls
  - Non Structural Low Impact Development Controls
  - Structural Controls
  - Innovative Technologies and Ideal Model
  - Appendices (zip)
  - Standard Details (zip)
  - Figures (zip)
- **New! DHEC OCRM BMP Field Manual**
  - Complete Handbook
  - Erosion Prevention BMPs
  - Sediment Control BMPs
  - Runoff Control and Conveyance Measures
  - Alternative Erosion Prevention and Sediment BMPs
  - Post Construction Water Quality Controls

- Non Structural Low Impact Development Controls
- Structural Controls
- Special Construction Operation BMPs
- Waste Management BMPs
- Standard Details Guide
- Standard Details
- References
- Autocad Files (zip)

Nutrient Loads

- Spatial and Temporal Patterns of Inorganic Nitrogen and Phosphorus Distributions in the Goose Creek Estuary: Cooper River/Charleston Harbor Estuary System by Adriene P. Douglas; 1995; 19 pp. Well-organized research outlines the cause and effects of nutrient pollution. This thesis is a basic example concerning watershed management effects on water resources.
- Harmful Algal Blooms in US Waters by the National Science and Technology Council Committee on Environment and Natural Resources; 2000; 47 pp. Easy to read, excellent description of "red tides". Discusses a variety of studies of the probable causes, the impacts, preventive measures, and management necessary when the toxins appear. (a non-SC DHEC site)
- Clean Coastal Waters: Understanding and Reducing the Effects of Nutrient Pollution by the National Research Council; 2000; 428 pp. A book the discusses the causes and effects of nutrient pollution on the coastal environment. (a non-SC DHEC site)

Sec 4.3 Ref 9 (SCDHEC 2005b)

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SCEG-508

Erosion Prevention BMPs

Use erosion prevention measures during and after construction site preparation in order to safely convey clean water to storm drains or adequate watercourses. One or more measures should be utilized as appropriate during the project's construction phase. Such measures may include but are not limited to: phasing and construction sequencing, surface roughening, temporary seeding, mulching, erosion control blankets, and reinforcement matting. Each of these measures is discussed in the Sections below.

In addition to site-specific erosion control measures, the grading plan includes the following general measures as a minimum:

- Vegetated finished cut and fill slopes should not be steeper than 3H:1V, unless an erosion control blanket or turf reinforcement mat is used.
- Do not place cuts or fills close to property, endangering adjoining property without adequately protecting such properties against erosion, sedimentation, slippage, settlement, subsidence, or other damages.
- Provide subsurface drainage in areas having a high water table to intercept seepage that affects slope stability, bearing strength, and undesirable wetness.
- Do not place fill material where it can slide or wash onto another property.
- Do not place fill adjacent to channel banks where it can create bank failure, reduce the capacity of the stream, or result in downstream sediment deposition.
- Include all borrow and disposal areas as part of the grading plan.

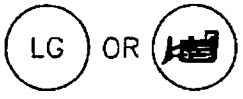
- Provide adequate channels and floodways to safely convey increased runoff from the developed area to an adequate outlet without causing significant channel degradation, or increased off-site flooding.
- Grade the site to direct flows to appropriate controls.

The following Erosion Prevention Measures are discussed in this handbook:

- Surface Roughening
- Temporary Seeding
- Mulching
- Erosion Control Blankets (ECBs)
- Turf Reinforcement Mats (TRMs)
- Flexible Growth Matrix (FGM)
- Bonded Fiber Matrix (BFM)
- Permanent Seeding
- Sodding
- Riprap
- Outlet Protection
- Dust Control
- Polyacrylamide (PAM)

Surface Roughening

Plan Symbol



Description

Surface roughening is the creation of horizontal grooves, depressions, or steps that run parallel to the contour of the land. The following surface roughening measures are approved for use:

- Tracking (driving a crawler tractor up and down a slope, leaving the cleat imprints parallel to the slope contour).
- Stair-step grading.
- Grooving (using disks, spring harrows, or teeth on the bucket of a front-end loader).

Tracking

Description

Tracking is defined as driving tracked machinery up and down slopes, leaving the cleat imprints parallel to the slope contour.

When and Where to Use It

To slow erosion, perform tracking as soon as possible after the vegetation has been removed from the slope. Use tracking with temporary seeding and temporary mulching to stabilize an area. Perform tracking immediately after grading activities have ceased (temporarily or permanently) in an area.

Installation

Avoid excessive compacting of the soil surface when tracking since soil compaction inhibits vegetation growth and causes higher runoff rates. As few passes as possible should be made with the machinery in order to minimize compaction.

Seed and mulch surface roughened areas by the means of tracking within 14 days.

Stair-Step Grading

Description

Stair-Step Grading is defined as cutting stair-steps into slopes with each step having a maximum horizontal distance of 4-feet and a maximum vertical distance of 4-feet.

When and Where to Use It

To slow erosion, perform stair step grading within 7 days after the removal of vegetation from the slope. Stair step grading is applicable on cut slopes with a gradient steeper than 3H:1V but less than 2H:1V. Stair-step grading is applicable on any material soft enough to be moved with a bulldozer. Stair-step grading works well with soils containing large amounts of small rock. Prepare stairs wide enough to work with standard earth moving equipment. Stair-step grading is used with seeding to stabilize an area.

Installation

The ratio of vertical cut distance to horizontal distance is steeper than 1V:1H and the horizontal portion of the "step" slopes towards the vertical wall.

Seed and stabilize areas graded in this manner within 14 days.

Grooving

Description

Slope Grooving is defined as using machinery to create a series of ridges and depressions that run perpendicular to the slope on the contour.

When and Where to Use It

To slow erosion, perform slope grooving within 7 days after the removal of vegetation from the slope.

Groove cut and fill slopes with a gradient steeper than 3H:1V but less than 2H:1V. Grooving is done by any implement that is safely operated on the slope.

Slope Grooving is used with seeding and planting to stabilize an area.

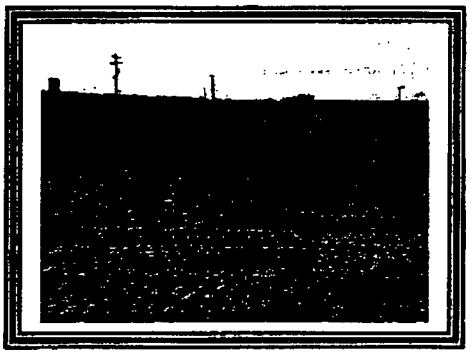
Installation

Install slope grooving with any appropriate implement that is safely operated on the slope not causing undue compaction. Suggested implements include discs, chisel plows, and the teeth on a front-end loader bucket. Install grooves a minimum of three inches deep and no further than 15 inches apart.

Seed and stabilize areas that are graded in this manner within 14 days.

Inspection and Maintenance

- Inspect every 7 calendar days and within 24-hours after each rainfall event that produces ½-inches or more of precipitation.
- If rills (small watercourses that have steep sides and are usually only a few inches deep) appear, re-grade and re-seed immediately.



Surface Roughening (Tracking)

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Rills appear.	Re-grade and re-seed area immediately.

Temporary Seeding

Plan Symbol

TS

Description

The purpose of temporary seeding is to reduce erosion and sedimentation by stabilizing disturbed areas that would otherwise lay bare for long periods of time before they are worked or stabilized. Temporary seeding is also used where permanent vegetation growth is not necessary or appropriate.

When and Where to Use It

Temporary seeding is used on exposed soil surfaces such as denuded areas, soil stockpiles, dikes, dams, banks of sediment basins, banks of sediment traps, and temporary road banks. Temporary seeding prevents and limits costly maintenance operations on other sediment control structures. Sediment clean-out requirements for sediment basins, sediment, traps, and silt fence is reduced if the drainage area is seeded when grading and construction operation are not taking place.

Temporary stabilization is required within 14 days after construction activity is complete **unless construction activity is going to resume within 21 days**. Cover seeded areas with an appropriate mulch to provide protection from the weather. When the temporary vegetation does not grow quickly or thick enough to prevent erosion, re-seed as soon as possible. Keep seeded areas adequately moist. Irrigate the seeded area if normal rainfall is not adequate for the germination and growth of seedlings. Water seeded areas at controlled rates that are less than the rate at which the soil can absorb water to prevent runoff. Runoff of irrigation water wastes water and can cause erosion.

Seed Selection

Seed selection is based on geographical location, soil type and the season of the year in which the planting is to be done. Use the tables in Appendix C as a guide for conventional tillage methods (plowing, seedbed preparation, hydroseeding, etc). If a fast growing crop to nurse the permanent specie or species is required, then use the mix rate. Failure to carefully follow agronomic recommendations results in an inadequate stand of temporary vegetation that provides little or no erosion control.

Installation

Tillage

If the area has been recently plowed, no tillage is required other than raking or surface roughening to break any crust that has formed leaving a textured surface. Disk the soil for optimal germination when the soil is compacted less than 6-inches.

Soil Testing

Soil testing is available through Clemson University Cooperative Extension Service.

Lime

Lime is not required for temporary seeding unless a soil test shows that the soil pH is below 5.0. It may be desirable to apply lime during the temporary seeding operation to benefit the long-term permanent seeding. Apply a minimum of 1.5 tons of Lime/acre (70 lbs./1000 ft^2) when used.

Fertilizer

Apply a minimum of 500 pounds per acre of 10-10-10 fertilizer (11.5 pounds per 1000 square feet) or equivalent during temporary seeding unless a soil test indicates a different requirement. Incorporate fertilizer and lime (if used) into the top 4-6 inches of the soil by disking or other means where conditions allow.

Seeding

Loosen the soil surface before broadcasting the seed. Apply seed evenly by the most convenient method available for the type of seed used and the location of the temporary seeding. Typical application methods include but are not limited to cyclone seeders, rotary spreaders, drop spreaders, broadcast spreaders, hand spreaders, cultipacker seeder, and hydro-seeders. Cover applied seed by raking or dragging a chain, and then lightly firm the area with a roller or cultipacker.

Mulching

Use mulch with temporary seed applications to retain soil moisture and reduce erosion during the establishment of vegetation. Typical mulch applications include straw, wood fiber, hydromulches, BFM and FGM. Use hydromulches with a minimum blend of 70% wood fibers.

The most commonly accepted mulch used in conjunction with temporary seeding is small grain straw. This straw should be dry and free from mold damage and noxious weeds. The straw may need to be anchored with netting or emulsions to prevent it from being blown or washed away. Apply the straw mulch by hand or machine at the rate 1.5-2 tons per acre (90 pounds per 1000 square feet). Frequent inspections are necessary to check that conditions for growth are good.

Irrigation

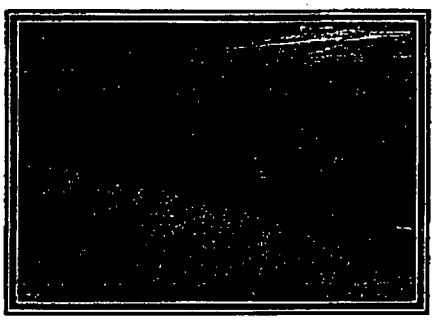
Seeded areas should be kept adequately moist. Irrigate the seeded area if normal rainfall is not adequate for the germination and growth of seedlings. Water seeded areas at controlled rates that are less than the rate at which the soil can absorb water to prevent runoff. Runoff of irrigation water wastes water and can cause erosion.

Re-seeding

Re-seed areas where seeding does not grow quickly, thick enough, or adequately to prevent erosion. Base seed selection should on the requirements of local Specifications.

Inspection and Maintenance

- Inspect every 7 calendar days and within 24-hours after each rainfall event that produces ½-inches or more of precipitation.
- Cover seeded with mulch to provide protection. Frequent inspections are necessary to check that conditions for growth are good.
- Supply temporary seeding with adequate moisture. Supply water as needed, especially in abnormally hot or dry weather or on adverse sites. Control water application rates to prevent runoff.
- Base seed selection on local Specifications.
- Re-seed areas where the plants do not grow quick enough, thick enough, or adequately enough to prevent erosion should be re-seeded.



Temporary Slope Stabilization

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Slope was improperly dressed before application.	Roughen slopes. Furrow along the contour of areas to be seeded.
Coverage is inadequate.	Follow recommended application rates. Count the number of seedbags to ensure the correct amount of material is being applied. Reapply to thin areas.
Seeds fail to germinate.	Apply straw mulch to keep seeds in place and to moderate soil moisture and temperature. In arid areas, temporary irrigation may be necessary.
Seeded slope fails.	Fill in rills and re-seed; fertilize and mulch slopes.
Seeding is washed off slope.	Allow at least 24-hours for the materials to dry before a rain event. Follow manufacturer's recommendations. Reapply where necessary.
Excessive water flows across stabilized surface.	Use other BMPs to limit flow on stabilized area and to reduce slope lengths. Do not use to stabilize areas with swift moving concentrated flows.

Mulching

Plan Symbol

M

Description

Mulching is a temporary soil stabilization erosion control method where materials such as grass, hay, wood chips, wood fibers, or straw are placed on the soil surface. In addition to stabilizing soils, mulching can enhance the absorption of water by the soil, reduce evaporation losses, regulate soil temperatures and reduce the speed of storm water runoff over an area.

When and Where to Use It

Use erosion control mulching on level areas or on slopes up to 50 percent. Where soil is highly erodible, nets should only be used in connection with organic mulch such as straw and wood fiber.

Mulch is an effective ground cover when the establishment of vegetation is improbable due to severe weather conditions (winter conditions), poor soil, or steep slopes.

Installation

Grading is not necessary before mulching but may be required if vegetation is expected to grow.

Anchor loose hay or straw by applying tackifier, stapling netting over the top, or crimping with a mulch-crimping tool.

Effective use of netting and matting material requires firm, continuous contact between the materials and the soil. If there is no contact, the material will not hold the soil and erosion will occur underneath the material.

Materials that are heavy enough to stay in place (for example, bark or wood chips on flat slopes) do not need anchoring.

Apply hydro-mulch in spring, summer, or fall to prevent deterioration of mulch before vegetation becomes established.

There must be adequate coverage to prevent erosion, washout, and poor plant establishment. If an appropriate tacking agent is not applied, or is applied in insufficient amounts, mulch is lost to wind and runoff.

Inspection and Maintenance

- Inspect every 7 calendar days and within 24-hours after each rainfall event that produces ½-inches or more of precipitation.
- Repair or replace damaged areas of mulch or tie-down material immediately.

Straw Mulching

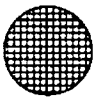
Straw Mulch

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Mulch blows away.	Anchor straw mulch in place by applying a tackifier, crimping, punching, or track walking. May need to use a different BMP.
Coverage is inadequate.	Follow recommended application rates. Ensure that the correct amount of material is implemented. Reapply as necessary.
Mulch is washed away.	Do not place mulch in concentrated flow areas. Reapply as necessary.
Area was improperly dressed before application.	Remove existing vegetation and roughen embankment and fill areas by rolling with a punch type roller or by track walking.
Excessive water flows across stabilized surface.	Use other BMPs to limit flow onto stabilized area and/or to reduce slope lengths. Do not use to stabilize areas with swift moving concentrated flows.

Erosion Control Blankets (ECBs)

Plan Symbol



Description

Temporary erosion control blankets (ECBs) are products composed primarily of biologically, photochemically or otherwise degradable constituents such as wheat straw, coconut fiber, or aged curled excelsior wood product with longevity of approximately 1- to 3-years.

When and Where to Use It

Use ECBs for temporary stabilization of soil immediately following seeding until the vegetative cover has grown and becomes established. ECBs provide temporary protection by degrading over time as the vegetation becomes established. Some products are effective for a few months while others degrade slowly and are effective for up to 3-years.

ECB Categories

- Class A (Slope Applications Only)
- Class B (Channel Applications Only).

Class A ECBs are for **slope applications only**.

- Applicable for slopes **2H:1V or flatter** only. Slopes greater than 2H:1V require Turf Reinforcement Matting (TRM).

Class B ECBs are for **channel applications**.

- Use for channels and concentrated flow areas with a maximum calculated shear stress **less than 1.75 lb/ft^2**. Design shear stresses greater than 1.75 lb/ft^2 require TRM applications.

All acceptable Class A and Class B temporary erosion control blankets consisting of straw, coconut, or straw-coconut blends meet the following requirements:

- Use non-organic, photodegradable or biodegradable polypropylene netting.
- Consist of **double netted matting**, defined as matting with netting on both sides of the blanket. The top netting is degradable polypropylene with a maximum mesh opening of 0.75 inches by 0.75 inches. The bottom is degradable polypropylene with a maximum mesh opening of 0.5 inches by 0.5 inches.
- Be sewn on center a maximum of 2.0 inches

All acceptable Class A and Class B temporary erosion control blankets consisting of curled excelsior fibers meet the following requirements:

- Use non-organic, photodegradable or biodegradable polypropylene netting
- Consist of double netted matting. Double netted matting is matting with netting on both sides of the blanket. The degradable polypropylene top netting requires a maximum mesh opening of 1.0-inches by 1.0-inches. The degradable polypropylene bottom netting requires a maximum mesh opening of 1.0-inches by 1.0-inches
- Consist of curled excelsior interlocking fibers with 80% of the fibers a minimum of 6-inches long
- Sewn on center a maximum of 4.0-inches.

Use Class A and Class B temporary erosion control blankets having the following Minimum Average Roll Values (MARV) for physical properties, as derived from quality control testing performed by a Geosynthetic Accreditation Institute – Laboratory Accreditation Program (GAI-LAP) accredited laboratory:

- Minimum mass per unit area (ASTM D6475) of 6 oz/yd^2 (203 g/m^2)
- Minimum thickness (ASTM D6525) of 0.25-inches (6 mm)
- Minimum initial grab tensile strength (ASTM D6818) of 75x75 lb/ft. (1x1 kN/m)
- Minimum roll width of 48-inches (1.22 m)

- For Class B channel applications, a minimum unvegetated shear stress of 1.0 lb/ft^2 (48 N/m^2) based on short-term peak flow duration of 0.5 hour is required.

Installation

Grade and compact ECB protected areas as indicated on the plans.

Remove large rocks, soil clods, vegetation, and other sharp objects that could keep the ECB from intimate contact with subgrade.

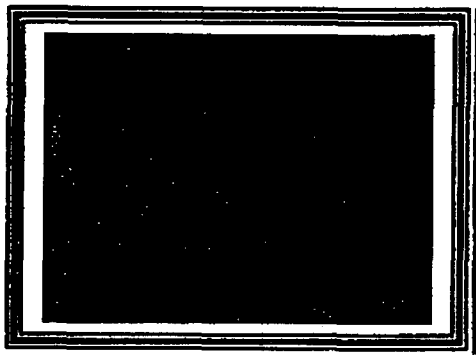
Prepare seedbed by loosening 2 to 3 inches of soil above final grade.

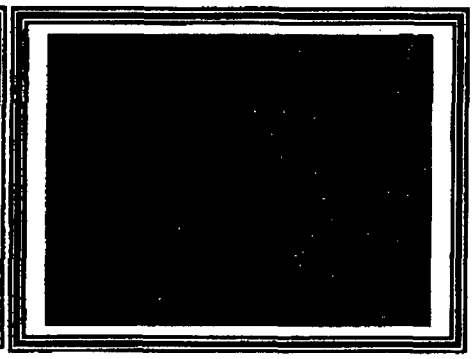
Proper ECB installation is different for each product, therefore follow the recommended installation procedure from the specific manufacturer.

When requested, a Manufacturer's Representative may be required to be on-site to oversee and approve the initial installation of the ECB. When requested, a letter from the Manufacturer approving the contractor installation may be required.

Inspection and Maintenance

- Inspect areas protected by ECBs for dislocation or failure every 7 calendar days and within 24-hours after each storm that produces ½-inch or more of rain.
- Conduct regular inspections until grasses are firmly established.
- Adhere to the pinning or stapling pattern as shown on the Manufacturer's installation sheet.
- If there is evidence that the ECB is not securely fastened to the soil, require extra pins or staples to inhibit the ECB from becoming dislodged.
- If washout or breakage occurs, repair all damaged areas immediately by restoring the soil on slopes or channels to its finished grade, re-apply fertilizer and seed, and replacing the appropriate ECB material as needed.





ECB Slope Applications

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Undercutting occurs along the top of the slope.	Dig a 6-x 6-inch trench along the top of the slope and anchor blanket into trench by back filling and tamping the soil.
Blankets separate along the seams.	Overlap adjacent blanket 2- to 3-inch and staple every 3-feet.
Blankets separate where the rolls are attached end to end.	Shingle the blanket so the top blanket covers the bottom blanket by 6-inches and staple through the overlapped areas every 12-inches.
Blanket does not make complete contact with the soil surface.	Prepare the soil surface by removing rocks, clods, sticks and vegetation, fill in rill and uneven areas.
Excessive water flows across stabilized surface.	Use other BMPs to limit flow on stabilized area. Use other BMPs to reduce slope lengths. Do not use to stabilize areas with swift moving concentrated flows.

Turf Reinforcement Mats (TRMs)

Plan Symbol

Description

Turf Reinforcement Mats are products composed primarily of nondegradable products that enhance the ability of living plants to stabilize soils. They bind with roots to reinforce the soil matrix with longevity greater than 5-years.

When and Where to Use It

Use TRMs where vegetation alone will not hold a slope or streambank. TRMs enable the use of "green" solutions in areas where only "hard" solutions such as riprap or concrete linings were viable in the past.

TRM Categories

- Type 1, Type 2, Type 3 and Type 4.

Types 1 & 2 TRMs are a strong three-dimensional stable net structure. A degradable fiber matrix may be included to provide immediate coverage for bare soil.

- **Type 1** matting should be placed on slopes **2H:1V or flatter** or in channels where the calculated design shear stress is **4.0 lb/ft2 or less** and the design flow velocity is **up to 10 fps**.

- **Type 2** matting should be placed on slopes **1.5H:1V or flatter** or in channels where the calculated design shear stress is **6.0 lb/ft2 or less** and the design flow velocity is **up to 15 fps**.

- **Type 3** TRMs are a strong three-dimensional stable net structure providing sufficient thickness, strength, and void space to capture and retain soil and allow for the development of root growth and vegetation within the matrix. Matting of this type should be placed on slopes **1H:1V or flatter** or in channels where the calculated design shear stress is **8.0 lb/ft2 or less** and the design flow velocity is **up to 20 fps.**

- **Type 4** (High Survivability) TRMs are specially designed geosynthetics for erosion control applications on steep slopes and vegetated waterways.

- All components of Type 4 TRMs should be 100% synthetic and resistant to biological, chemical, and ultraviolet degradation.

- Matting of this type should be placed on slopes **1H:1V or greater** or in channels where the calculated design shear stress is **up to 12 lb/ft2** and the design flow velocity is **up to 25 fps**.

- This category is used when field conditions exist with high loading and/or high survivability requirements such as maintenance, structural backfills protecting critical structures, utility cuts, potential traffic areas, abrasion, higher factors of safety and/or general durability concerns.

All primary TRM matrix materials are defined as long-term, non-degradable materials designed to reduce soil erosion and assist in the growth, establishment, and protection of vegetation for a period of time exceeding 5 years.
The major structural components of Type 1 and Type 2 TRMs are 100% synthetic and resistant to biological, chemical, and ultraviolet degradation. A degradable fiber matrix may be included to provide immediate coverage for bare soil. All components of Type 3 and Type 4 TRMs are 100% synthetic and resistant to biological, chemical, and ultraviolet degradation.

Installation

Grade and compact areas to be protected with TRMs as indicated on the plans.

Remove large rocks, soil clods, vegetation, and other sharp objects that could keep the TRM from intimate contact with subgrade.

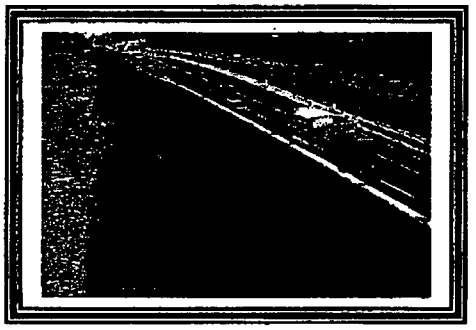
Prepare seedbed by loosening 2 to 3 inches of soil above final grade.

The proper installation of TRMs is different for each product, therefore the recommended installation procedure from the specific manufacturer should be followed.

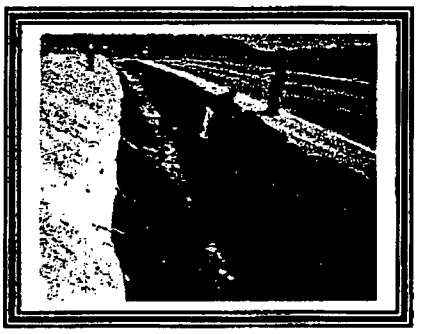
When requested, a Manufacturer's Representative may be required to be on-site to oversee and approve the initial installation of the TRM. When requested, a letter from the Manufacturer approving the contractor installation may be required.

Inspection and Maintenance

- Check areas protected by TRMs for dislocation or failure every 7 calendar days and within 24-hours after each storm that produces ½-inch or more of rain.
- Conduct regular inspections until grasses are firmly established.
- Adhere to the pinning or stapling pattern as shown on the Manufacturer's installation sheet. If there is evidence that the TRM is not securely fastened to the soil, require extra pins or staples to inhibit the TRM from becoming dislodged.
- If washout or breakage occurs, repair all damaged areas immediately by restoring the soil on slopes or channels to its finished grade, re-apply fertilizer and seed, and replacing the appropriate TRM material as needed.



TRM Slope Application



TRM Channel Application

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Improper anchoring.	Dig trench along the top and bury the blankets. Use staples to anchor according to manufacturer's recommendations.
Undercutting due to inadequate preparation.	Prepare the soil surface. Remove rocks, clods and other obstructions. Fill in rills in uneven areas to promote good contact between mat and soil.
Excessive water flows across stabilized slope surface.	Use other BMPs to limit flow on stabilized area. Use other BMPs to reduce slope lengths. Do not use to stabilize areas with swift moving concentrated flows.

Flexible Growth Media/Matrix

Plan Symbol

FGM

Description

A Flexible Growth Matrix (FGM) combines both chemical and mechanical bonding techniques to lock the matrix in place. FGM is composed of crimped, manmade fibers, organic fibers, and performance-enhancing additives that form a lofty, interlocking matrix. FGM has air spaces and water-absorbing cavities that improve seed germination, reduce the impact of raindrop energy, and minimize soil loss. Water insoluble tackifiers and flocculants chemically bond the matrix to the soil surface.

When and Where to Use It

FGM is applicable for the following situations:

- As a Type A Temporary Erosion Control Blanket
- Slopes up to 2H:1V
- As an infill for TRMs on slopes greater than 2H:1V
- Environmentally sensitive areas not compatible for netting
- When the required longevity of soil protection is up to 1 year
- When the site requires immediate erosion protection and there is a risk of impending weather
- When fast vegetation establishment is required
- When a high factor of design safety is required.

FGM is <u>not</u> applicable as a channel liner or for areas receiving concentrated flow. Applicable FGM may be selected from the SCDOT approved products list.

Installation

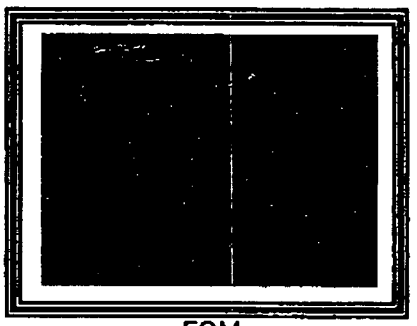
All FGM components are pre-packaged by the Manufacturer to assure material performance. Under no circumstances is field mixing of materials, additives or components accepted. Examine substrates and conditions where materials will be applied. Apply FGM to geotechnically stable slopes that have been designed and constructed to divert runoff away from the face of the slope. Do not proceed with installation until satisfactory conditions are established.

Install FGM with a contractor who is certified and trained by the Manufacturer in the proper procedures for mixing and applying the FGM. Strictly comply with the Manufacturer's mixing recommendations and installation instructions. Use approved hydraulic seeding/mulching machines with fan-type nozzle (50-degree tip) for FGM applications. Apply FGM from opposing directions to the soil surface in successive layers, reducing the "shadow effect" to achieve maximum coverage of all exposed soil. FGM does not require a cure time and is effective immediately such that FGM may be applied immediately before, during or after a rainfall event. Install FGM materials according to the Manufacturer's application rates.

Inspection and Maintenance

- Check areas protected by FGM for dislocation or failure every 7 calendar days and within 24-hours after each storm that produces ½-inch or more of rain.
- Reapply FGM to disturbed areas that require continued erosion control.
- Maintain equipment to provide uniform application rates. Rinse all mixing and application equipment thoroughly with water to avoid formation of residues and discharge rinse water appropriately.
- Degradation of FGM is expected to occur as a result of mechanical degradation, chemical and biological hydrolysis, sunlight, salt, and temperature. Reapply FGM in accordance with the Manufacturer's instructions. Reapplication is not required unless FGM treated soils are disturbed or turbidity or water quality shows the need for an additional application.

FGM Application



FGM

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Slope areas have eroded due to concentrated flows.	Make sure the upper end of the slope has a berm constructed to eliminate concentrated flows from flowing down the slope. Slope length may be to long and concentrated flows are occurring. Use sediment tubes or other practices to provide slope breaks. Re-apply FGM to the eroded areas once the concentration problem has been resolved.
Rain event is impending.	FGM does not require a cure time and is effective immediately such that FGM may be applied immediately before, during or after a rainfall event.
FGM has degraded.	FGM has longevity of soil protection up to 1 year. Reapply FGM in accordance with the Manufacturer instructions. Reapplication is not required unless FGM treated soils are disturbed or turbidity or water quality shows the need for an additional application.

Bonded Fiber Matrix (BFM)

Plan Symbol

BFM

Description

A Bonded Fiber Matrix (BFM) is a continuous layer of non-toxic, degradable, elongated fiber materials held together by water insoluble bonding agents. BFM eliminates direct raindrop impact on soil, allows no gaps between the product and the soil, and has a high water-holding capacity. BFMs do not form a water-insensitive crust that can inhibit plant growth. BFMs are completely photo- and biodegradable.

When and Where to Use It

BFMs are applicable when:

- Enhancement of temporary seeding operations to reduce erosion and expedite seed germination
- A high performance mulch is required for permanent seeding
- Seeding application will take place on highly erodible soil or slopes
- Slopes up to 1H:1V
- The required functional longevity of soil protection is 6 months or less
- The soil is dry and rain is not expected within 48 hours after application
- There is a high degree of certainty that heavy rains will not follow application.

BFMs are **not** applicable as Type A Temporary Erosion Control Blankets, channel liners or for areas receiving concentrated flow. Applicable BFM may be selected from the SCDHEC approved products list.

Installation

All BFM components are pre-packaged by the Manufacturer to assure material performance. Under no circumstances is field mixing of materials, additives or components accepted. Examine substrates and conditions where materials will be applied. Do not proceed with installation until unsatisfactory conditions are corrected. Apply BFM to geotechnically stable slopes that have been designed and built to divert runoff water away from the face of the slope.

Install BFM with a contractor who is certified and trained by the Manufacturer in the proper procedures for mixing and applying the BFM. Strictly comply with the Manufacturer's mixing recommendations and installation instructions. Use approved hydraulic seeding/mulching machines with fan-type nozzle (50-degree tip) for BFM applications. Apply BFM from opposing directions to the soil surface in successive layers, reducing the "shadow effect" to achieve maximum coverage of all exposed soil. Do not apply the BFM immediately before, during or after rainfall. Allow the BFM a minimum of 24 hours to dry after installation. Do not exceed maximum slope length of 100 feet when slope gradients are steeper than 4H:1V. Install BFMs at a general application rate of 3500 pounds per acre.

Inspection and Maintenance

- Check areas protected by BFM for dislocation or failure every 7 calendar days and within 24-hours after each storm that produces ½-inch or more of rain.
- Reapply BFM to disturbed areas that require continued erosion control.
- Maintain equipment to provide uniform application rates. Rinse all BFM mixing and application equipment thoroughly with water to avoid formation of residues and discharge rinse water appropriately.
- Degradation of BFM is expected to occur as a result of mechanical degradation, chemical and biological hydrolysis, sunlight, salt, and temperature.

- Reapply BFM in accordance with the Manufacturer's instructions when treated soils are disturbed or turbidity or water quality shows the need for an additional application

BFM Application

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Slope areas have eroded due to concentrated flows.	• Make sure the upper end of the slope has a berm constructed to eliminate concentrated flows from flowing down the slope. • Slope length may be to long and concentrated flows are occurring. Use sediment tubes or other practices to provide slope breaks. • Re-apply BFM to the eroded areas once the concentration problem has been resolved.
Rain event is impending.	BFM requires a cure time. Do not apply the BFM immediately before, during or after rainfall. Allow the BFM a minimum of 24 hours to dry after installation.
BFM has degraded.	BFM has longevity of soil protection up to 6-months. Reapply BFM in accordance with the Manufacturer instructions. Reapplication is not required unless BFM treated soils are disturbed or turbidity or water quality shows the need for an additional application.

Permanent Seeding

Plan Symbol

PS

Description

Controlling runoff and preventing erosion by establishing a perennial vegetative cover with seed.

When and Where to Use It

A major consideration in the selection of the type of permanent grass to establish is the intended use of the land. Land use is separated in to two categories, high-maintenance and low-maintenance.

High-maintenance

High maintenance areas are mowed frequently, lime or fertilized on a regular basis, and require maintenance to an aesthetic standard. Land uses with high maintenance grasses include homes, industrial parks, schools, churches, and recreational areas such as parks, athletic fields, and golf courses.

Low-maintenance

Low maintenance areas are mowed infrequently, if at all, and lime and fertilizer may not be applied on a regular schedule. These areas are not subject to intense use and do not require a uniform appearance. The vegetation must be able to survive with little maintenance over long periods of time. Grass and legume mixtures are favored in these areas because legumes are capable of fixing nitrogen in the soil for their own use and the use of the grasses around them. Land uses requiring low-maintenance grasses include steep slopes, stream and channel banks, road banks, and commercial and industrial areas with limited access.

Seed Selection

The use of native species is preferred when selecting vegetation. Base plant seed selection on geographical location, the type of soil, the season of the year in which the planting is to be done, and the needs and desires of the permanent land user. Failure to carefully follow agronomic recommendations results in an inadequate stand of permanent vegetation that provides little or no erosion control.

Installation

Topsoil

Apply topsoil if the surface soil of the seedbed is not adequate for plant growth.

Tillage

If the area has been recently plowed, no tillage is required other than raking or surface roughening to break any crust that has formed leaving a textured surface. Disk the soil for optimal germination when the soil is compacted less than 6-inches. If the soil is compacted more than 6-inches, sub-soiled and disk the area.

Soil Testing

Soil testing is available through Clemson University Cooperative Extension Service.

Lime

Unless a specific soil test indicates otherwise, apply 1½ tons of ground course textured agricultural limestone per acre (70 lbs./1000 ft^2).

Fertilizer

Apply a minimum of 1000 pounds per acre of a complete 10-10-10 fertilizer (23 pounds per 1000 square feet) or equivalent during permanent seeding of grasses unless a soil test indicates a different requirement. Incorporate fertilizer and lime (if used) into the top 4-6 inches of the soil by disking or other means where conditions allow. Do not mix the lime and the fertilizer prior to the field application.

Seeding

Loosen the surface of the soil just before broadcasting the seed. Evenly apply seed by the most convenient method available for the type of seed applied and the location of the seeding. Typical application methods include but are not limited to cyclone seeders, rotary spreaders, drop spreaders, broadcast spreaders, hand spreaders, cultipacker seeder, and hydro-seeders. Cover applied seed by raking or dragging a chain or brush mat, and then lightly firm the area with a roller or cultipacker. Do not roll seed that is applied with a hydro-seeder and hydro-mulch.

Mulching

Cover all permanent seeded areas with mulch immediately upon completion of the seeding application to retain soil moisture and reduce erosion during establishment of vegetation. Apply the mulch evenly in such a manner that it provides a minimum of 75% coverage. Typical mulch applications include straw, wood fiber, hydromulches, BFM and FGM. Use hydromulches with a minimum blend of 70% wood fibers.

The most commonly accepted mulch used in conjunction with permanent seeding is small grain straw. Select straw that is dry and free from mold damage and noxious weeds. The straw may need to be anchored with netting or asphalt emulsions to prevent it from being blown or washed away. Apply straw mulch by hand or machine at the rate 2 tons per acre (90 pounds per 1000 square feet). Frequent inspections are necessary to check that conditions for growth are good.

Irrigation

Keep permanent seeded areas adequately moist, especially late in the specific growing season. Irrigate the seeded area if normal rainfall is not adequate for the germination and growth of seedlings. Water seeded areas at controlled rates that are less than the rate at which the soil can absorb water to prevent runoff. Runoff of irrigation water wastes water and can cause erosion.

Re-seeding

Inspect permanently seeded areas for failure, make necessary repairs and re-seed or overseed within the same growing season if possible. If the grass cover is sparse or patchy, re-evaluate the choice of grass and quantities of lime and fertilizer applied. Final stabilization by permanent seeding of the site requires that it be covered by a 70% coverage rate.

Inspection and Maintenance

- Inspect seeded areas for failure and make necessary repairs and re-seed immediately. Conduct a follow-up survey after one year and replace failed plants where necessary.
- If vegetative cover is inadequate to prevent rill erosion, overseed and fertilize in accordance with soil test results.
- If a stand of permanent vegetation has less than 40 percent cover, re-evaluate choice of plant materials and quantities of lime and fertilizer.
- Re-establish the stand following seed bed preparation and seeding recommendations, omitting lime and fertilizer in the absence of soil test results.
- If the season prevents re-sowing, mulch is an effective temporary cover.
- Final stabilization of the site requires a 70 percent overall coverage rate. This does not mean that 30 percent of the site can remain bare. The coverage is defined as looking at a square yard of coverage, in which 70 percent of that square yard is covered with vegetation.

Permanent Seeding

Permanent Seeding

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Areas have eroded.	Reseed or replace eroded areas.
Vegetation cover is inadequate and rill erosion is occurring.	Overseed and fertilize in accordance with soil test results.
Stand of permanent vegetation has less than 40% cover.	Re-evaluate choice of plant materials and quantities of lime and fertilizer.
Vegetation show signs of wilting before noon.	Water vegetation by wetting soil to a depth of 4-inches.

Sodding

Plan Symbol

SO

Description

Sodding is transplanting vegetative sections of plant materials to promptly stabilize areas that are subject to erosion. Use commercial sod which is a cultured product utilizing specific grass species.

When and Where to Use It

Sodding is appropriate for any graded or cleared area that may erode, and where a permanent, long-lived plant cover is immediately needed. Examples of where sodding is used are yards, buffer zones, streambanks, dikes, swales, slopes, outlets, level spreaders, and filter strips.

Installation

In general, do not use sod on slopes greater than 2H:1V or 3H:1V if it is to be mowed. If sod is placed on steep slopes, lay it with staggered joints and/or staple the sod down.

Clear the soil surface of trash, debris, roots, branches and soil clods in excess of 2-inches length or diameter. Rake soil surface to break crust just before laying sod or irrigate soil lightly if the soil is dry. Do not install sod on hot, dry or frozen soil, gravel, compacted clay, or pesticide treated soils.

Harvest, deliver and install sod within a period of 36-hours. Store rolls of sod in shade during installation. Sod should be free of weeds and be of uniform thickness, about 1-inch, and should have a dense root mat for mechanical strength.

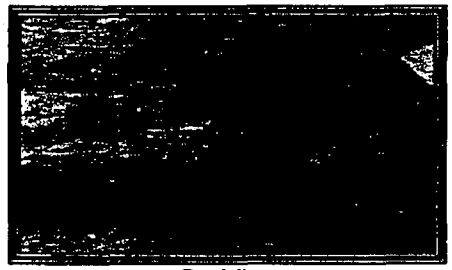
Lay strips of sod beginning at the lowest area to be sodded with the longest dimension of the strip perpendicular to the slope, and stagger in a brick-like pattern. Wedge strips securely in place. Square the ends of each strip to provide for a close, tight fit. Match angled ends correctly to prevent voids.

Roll or compact immediately after installation to ensure firm contact with the underlying topsoil.

Irrigate the sod until the soil is wet to a depth of 2-inches, and keep moist until grass takes root.

Inspection and Maintenance

- Watering may be necessary after planting and during periods of intense heat and/or lack of rain (drought). Keep soil moist to a depth of 2-inches until sod is fully rooted.
- Mow to a height of 2 to 3 inches after sod is well-rooted (2-3 weeks). Do not remove more than 1/3 of the shoot in any one mowing.
- Permanent, fine turf areas require yearly applications of fertilizer and lime.
- Inspect the sod frequently after it is first installed, especially after large storm events, until it has established a permanent cover.

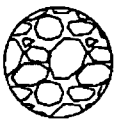


Sodding

Field Condition	Common Solutions
Drought	Keep soil moist to a depth of 2-inches until sod is fully rooted

Riprap

Plan Symbol



Description

Riprap is a permanent, erosion-resistant channel lining aggregate consisting of large, loose, angular stone with a filter fabric or granular underlining. The purpose of riprap is to:

- Protect the soil from the erosive force of concentrated runoff
- Slow runoff velocities while enhancing the potential for infiltration

The filter fabric or granular underlining prevents undermining of the riprap layer by the migration of soil particles under seepage forces through the riprap.

When and Where to Use It

The preferred method of slope and channel protection is the use of vegetation. If vegetation can not withstand the design flows, ECBs and TRMs are the preferred and suggested method of protection. When conditions are too severe for vegetation and TRMs, riprap may be used for erosion control and protection. Riprap is used, as appropriate, at storm drain outlets, on channel banks and/or bottoms, drop structures, at the toe of slopes, and in transitions from concrete channels to vegetated channels. Riprap sizes are designed by the diameter or by the weight of the stones. It is often misleading to think of riprap in terms of diameter, since the stones should be angular instead of spherical.

Installation

Place a lining of geotextile filter fabric or granular filter material between the riprap and the underlying soil surface to prevent soil movement into or through the riprap.

Inspection and Maintenance

- Once a riprap installation has been completed, it should require very little maintenance.
- It should, however, be inspected periodically to determine if high flows have caused scour beneath the riprap and filter fabric or dislodged any of the stone.
- Care must be taken to properly control sediment-laden construction runoff that may drain to the point of the new installation. If repairs are needed, they should be performed immediately.

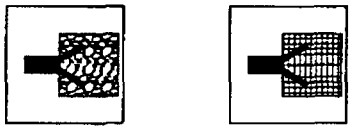
Riprap Lined Channel

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
High flows causing scour beneath riprap or filter fabric dislodging the stone.	Replace filter fabric and rearrange stone appropriately.
Riprap blocks channel, causing erosion along edges.	Make sure excavation is deep enough, rearrange riprap appropriately.
Piping or slumping occurs.	Make sure filter fabric was installed and make sure it isn't damaged.
Stones have moved and erosion of foundation has occurred.	Make sure riprap is properly graded.
Undercut riprap slope and slumping occurring.	Check to be sure that foundation toe is properly reinforced.
Stone displacement occurring.	Make sure fill slopes have been properly compacted, remove debris and make needed repairs.

Outlet Protection

Plan Symbol



Description

Outlet protection dissipates the energy of concentrated storm water flows reducing erosion or scouring at storm water outlets. In addition, outlet protection lowers the potential for downstream erosion. Outlet protection is achieved through a variety of techniques, including turf reinforcement mats (TRMs), riprap, concrete aprons, paved sections and other structural measures.

The techniques outlined in this section are not the only techniques that may be used for outlet protection design. This section shows one method for outlet protection design as an example of the variables that need to be considered in the design. Other methods utilized that are not discussed in this Handbook should include all graphs, charts, and calculations verifying that the protection will handle the peak flow velocity, flow depths, and shear stress.

Installation

- Do not protect pipe or channel outlets at the top of cut slopes or on slopes steeper than 10% with only outlet protection. This causes re-concentration of the flow resulting in increased velocities when the flow leaves the protection area.
- Follow specific standards for installation of the selected materials used for outlet protection.
- Follow all Manufacturer's installation procedures for TRMs and other manufactured products.

- A Manufacturer's Representative may be required to oversee all installation procedures and officially approve the installation of manufactured products used for outlet protection.

Inspection and Maintenance

- Periodically check all outlet protection, aprons, plunge pools, and structural outlets for damage. Immediately make all needed repairs to prevent further damage.
- If any evidence of erosion or scouring is apparent, modify the design as needed to provide long term protection (keeping in mind fish passage requirements if applicable).
- Inspect outlet structures after heavy rains to see if any erosion has taken place around or below the structure.

The table below provides general information for sizing rock and outlet aprons for various sized pipes.

Culvert Size (inches)	Average Rock Diameter (inches)	Apron Width at the narrow end (feet)	Apron Length for slow flow (feet)	Apron Length for high flow (feet)
8"	3"	2-3 ft	3-5 ft	5-7 ft
12"	5"	3-4 ft	4-6 ft	8-12 ft
18"	8"	4-6 ft	6-8 ft	12-18 ft
24"	10"	6-8 ft	8-12 ft	18-22 ft
30"	12"	8-10 ft	12-14 ft	22-28 ft
36"	14"	10-12 ft	14-16 ft	28-32 ft
42"	16"	12-14 ft	16-18 ft	32-38 ft
48"	20"	14-16 ft	18-25 ft	38-44 ft

Riprap Outlet Protection

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Riprap washes away.	Replace riprap with a larger diameter based on the pipe diameter and discharge velocity.
Apron is displaced.	Align apron with receiving water and keep it straight throughout its length. Repair damaged fabric and replace riprap that has washed away.
Scour occurs around apron or riprap.	Remove damaged TRM or riprap, fill in scoured areas, and repair damage to slopes channels or underlying filter fabric. Reinstall outlet protection.
Outlet erodes.	Stabilize TRM outlets with vegetation, replace eroded riprap; grout riprap.

Dust Control

Plan Symbol

DC

Description

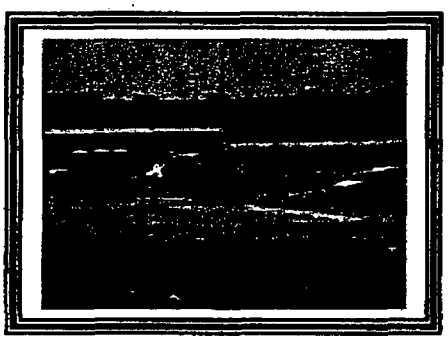
Wind erosion occurs when the surface soil is loose and dry, vegetation is sparse or absent, the wind is sufficiently strong, and when construction traffic disturbs the soil. Wind erodes soils and transports the sediment off site in the form of fugitive dust, where it may be washed into receiving water bodies by the next rainfall event. Fugitive dust is a nuisance for neighbors. It settles on automobiles, structures and windows and finds its way into homes. It also makes breathing difficult for those with respiratory problems and becomes a safety problem when it blinds motorists, equipment operators, and laborers.

When and Where to Use It

Utilize dust control methods whenever there are offsite impacts, especially during periods of drought. Implemented dust control until final stabilization is reached.

Inspection and Maintenance

- Add additional dust control or re-spray area as necessary to keep dust to a minimum.
- Spray exposed soil areas only with approved dust control agents as indicated by the SCDHEC Standard Specifications.



Dust Control with Water

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Excessive dust leaves the site.	Increase frequency of dust control application. Consider using a palliative or binder on inactive areas.
Vehicles kick up dust.	Water more frequently. Limit vehicle speeds. Stabilize the roadway.
Watering for dust control causes erosion.	Reduce water pressure on the water truck. Check watering equipment to ensure that it has a positive shutoff. Water less frequently.
Sprayed areas are ineffective at limiting dust.	Re-spray areas and ensure that the application rate is proper. Try another product or method if current dust control is not effective.

Polyacrylamides (PAMs)

Plan Symbol

PAM

Description

Anionic polyacrylamides (PAM) are non-toxic chemical materials used for controlling soil erosion and sedimentation on construction and agricultural sites.

When and Where to Use It

Anionic PAM is available in emulsions, powders, gel bars, or logs. Use other BMPs in combination with anionic PAM. The use of seed and mulch for additional erosion protection beyond the life of the anionic PAM is required. Repeat application is recommended if disturbance occurs to target areas. The following are additional recommendations:

- Use setbacks when applying anionic PAM near natural waterbodies.
- Consider that decreased performance can occur due to ultra-violet light and time after mixing when applying anionic PAM.
- In concentration channels, the effectiveness of anionic PAM for stabilization decreases.
- If seed is applied with anionic PAM, use mulch to protect seed.
- Never add water to PAM, PAM must be slowly added to water.
- NOT ALL POLYMERS ARE PAM.

Installation

The manufacturer's guidelines for application should be followed.

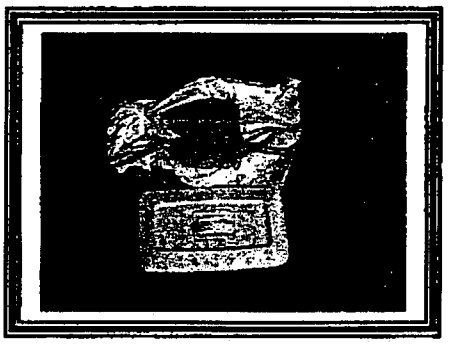
- Only use the anionic form of PAM. Cationic PAM is toxic and should NOT be used.
- PAM and PAM mixtures have to be environmentally harmless, harmless to fish, wildlife, and plants.
- Use pure form of anionic PAM with less than or equal 0.05 percent acrylamide monomer by weight, established by FDA and EPA.

- To maintain less than or equal 0.05 percent of acrylamide monomer, the maximum application rate of PAM, in pure form, should not exceed 200 pounds/acre/year. Do not over apply.
- Users of anionic PAM should obtain and follow all MSDS requirements and manufacturer's recommendations.
- Additives such as fertilizers, solubility promoters or inhibitors to PAM should be non-toxic.
- To prevent exceeding the acrylamide monomer limit in the event of a spill, the pure form of anionic PAM should not exceed 200 pounds/batch at 0.05 percent acrylamide monomer (AMD) or 400 pounds/batch at 0.025 percent AMD.

Inspection and Maintenance

- PAMs have been estimated to degrade approximately 10 percent per year. The effects are accelerated in highly exposed areas.
- If PAM treated soil is left undisturbed, reapplication may be necessary after 6-8 weeks.
- Further anionic PAM applications may be required for disturbed areas including highly silty and clayey soils, steep slopes, long grades, and high traffic or precipitation areas.
- All equipment should be maintained to provide the application rates recommended by the manufacturer.
- Rinse all equipment used to mix and apply anionic PAM thoroughly with water.

Liquid PAM



Solid/Block PAM

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Slope was improperly dressed before application.	Roughen slope and fill damaged areas.
Coverage is inadequate.	Follow recommended application rates. Reapply to thin areas.
Sprayed areas degrade or become ineffective.	Follow recommended application rates. Consider other or additional BMPs. Reapply as necessary.
Sprayed slope has spot failures.	Repair slopes, add jute netting and re-spray damaged areas.
Portions of the sprayed area have been disturbed.	Keep workers and equipment off sprayed areas. Repair and re-spray areas that have been damaged.
PAM is washed off slope.	Allow at least 24 hours for the materials to dry before a rain event. Follow manufacturer's recommendations. Reapply as necessary.
Excessive water flows across stabilized surface.	Use other BMPs to limit flow on stabilized area. Use other BMPs to reduce slope lengths. Do not use to stabilize slopes with swift moving concentrated flows.

Sediment Control

Uncontrolled runoff from construction sites is a water quality concern because of the devastating effects that sedimentation can have on local waterbodies, particularly small streams. Numerous studies have shown that the amount of sediment transported by storm water runoff from construction sites with no controls is significantly greater than from sites with controls. In addition to sediment, construction activities yield pollutants such as pesticides, petroleum products, construction chemicals, solvents, asphalts, and acids that can contaminate storm water runoff. During storms, construction sites may be the source of sediment-laden runoff, which can overwhelm a small stream channel's capacity, resulting in streambed scour, streambank erosion, and destruction of near stream vegetative cover. Where left uncontrolled, sediment-laden runoff has been shown to result in the loss of in-stream habitats for fish and other aquatic species, an increased difficulty in filtering drinking water, the loss of drinking water reservoir storage capacity, and negative impacts on the navigational capacity of waterways.

Polluted storm water runoff from construction sites often flows to MS4s and ultimately is discharged into local rivers and streams. Sediment is usually the main pollutant of concern. Sediment runoff rates from construction sites are typically 10 to 20 times greater than those of agricultural lands, and 1,000 to 2,000 times greater than those of forest lands. During a short period of time, construction sites can contribute more sediment to streams than can be deposited naturally during several decades. The resulting siltation, and the contribution of other pollutants from construction sites, can cause physical, chemical, and biological harm to our nation's waters. For example, excess sediment can quickly fill rivers and lakes, requiring dredging and destroying aquatic habitats.

There are numerous methods available to assist in the control of sediment. The following sediment control BMPs are discussed in this handbook:

- Temporary Sediment Basin
- Temporary Sediment Trap
- Silt Fence
- Rock Check Dams
- Sediment Tubes
- Stabilized Construction Entrances
- Inlet Protection
- Rock Sediment Dikes

Sediment Basin

Plan Symbol

Description

A Sediment Basin collects and traps sediment laden runoff from disturbed areas and slows down the flow so that soil particles fall from suspension and deposit in the basin. Drop inlet spillways, pipe spillways, rock fill outlets and weir spillways may be used for the design of the principal spillway.

When and Where to Use It

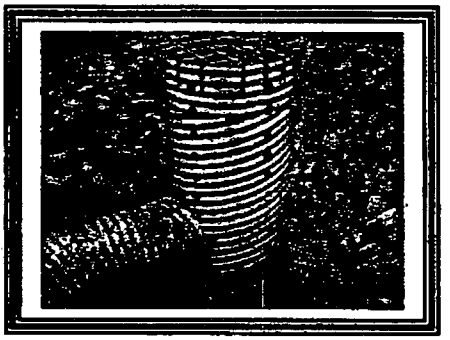
Temporary sediment basins are required on sites where 10 or more acres are disturbed and drain to a single point. A temporary sediment basin should not be built in wetlands, any active or live streams, ephemeral stream, or in Waters of State (defined to be all annual or perennial water bodies designated by a solid or dashed blue-line on USGS 7.5-minute quadrangle maps). Utilize temporary sediment basins until the contributing flow areas to the basin have undergone final stabilization.

Inspection and Maintenance

The key to a functional sediment basin is continual monitoring, regular maintenance and regular sediment removal. Attention to sediment accumulations within the pond is extremely important. Continually monitor sediment deposition in the basin.

- Remove sediment when it reaches 50 percent of storage volume or reaches the top of the designed cleanout stake where applicable.
- Remove all temporary sediment basins within 30 days after final site stabilization is achieved or after it is no longer needed.
- Remove trapped sediment from the site, or stabilize on site.
- Permanently stabilize disturbed areas resulting from the removal of the sediment basin

Sediment Basin



Sediment Basin Perforated Riser

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Outlet pipe is clogged with the debris.	Clean outlet pipe. Install a trash rack around pipe to hold back larger debris particles.
Spillway erodes due to high velocity flows.	Stabilize outlet with an ECB, TRM or riprap.
Side Slope eroding.	Stabilize slopes with vegetation, ECB, TRM, riprap or equivalent method.
Excessive accumulated sediment buildup.	Remove sediment to maintain the sediment storage capacity.
The upstream drainage area is too large.	Limit the contributing drainage area or expand basin. Ensure drainage area does not exceed recommended acreage. If the drainage area does exceed this limit, install diversion ditches and add additional BMPs to accommodate the diverted flow.

Sediment Trap

Plan Symbol

Description

A sediment trap is formed by excavating a pond or by placing an earthen embankment across a low area or drainage swale. The outlet should be a rock fill weir/spillway section, with the area below the weir acting as a filter for sediment and the upper area as the overflow spillway depth. The trap retains the runoff long enough to allow most of the silt to settle out. Design sediment traps to have an 80 percent design removal efficiency goal of the total suspended solids (TSS) in the inflow.

When and Where to Use It

Temporary sediment traps should not be placed in Waters of the State or USGS blue-line streams (unless approved by SCDHEC, State, or Federal authorities).

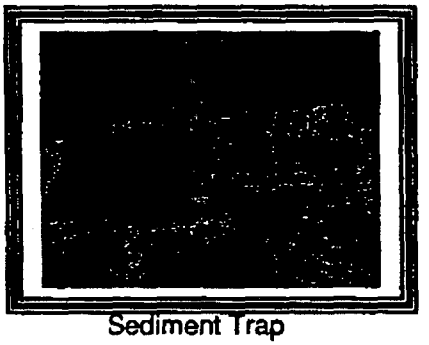
Installation

Install a non-woven geotextile filter fabric before installing the stone for the outlet structure. Allow the stone to extend downstream past the toe of the embankment. Mark the sediment cleanout level of trap with a stake in the field. Seed and mulch all disturbed areas.

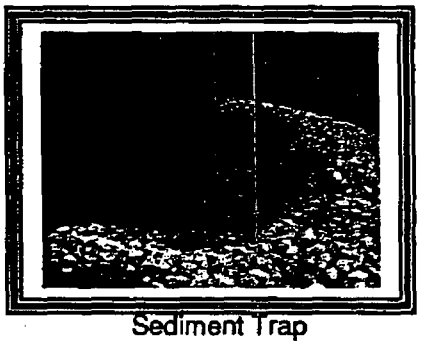
Inspection and Maintenance

The key to a functional sediment trap is continual monitoring, regular maintenance and regular sediment removal.

- Remove sediment when it reaches 50 percent of storage volume or top of cleanout stake.
- Inspect every 7 calendar days and within 24-hours after each rainfall event that produces ½-inches or more of precipitation.
- Remove within 30 days after final stabilization or after it is no longer needed.
- Remove trapped sediment from the site, or stabilized on site.
- Permanently stabilized disturbed areas resulting from trap removal.



Sediment Trap



Sediment Trap

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Outlet spillway is clogged with the debris.	Remove debris by lightly raking debris from upstream side of spillway. If debris is excessive, remove smaller filter stone on upstream side of spillway and replace with new clean stone.
Spillway erodes due to high velocity flows.	Stabilize outlet with larger riprap on downstream side of spillway.
Side Slope eroding.	Stabilize slopes with vegetation, ECB, TRM, riprap or equivalent method.
Excessive accumulated sediment buildup.	Remove sediment to maintain sediment storage capacity.
Drainage area is too large.	Limit contributing drainage area by installing diversion ditches and adding additional BMPs to accommodate diverted flow.

Silt Fence

Plan Symbol

Description

Silt fence is used as a temporary perimeter control around sites where there will be soil disturbance due to construction activities. Silt fence consists of geotextile fabric stretched across steel posts. The lower edge of the fence is vertically trenched into the ground and covered by compacted backfill.

When and Where to Use It

Silt fence is applicable in areas:

- Where the maximum sheet or overland flow path length to the fence is 100-feet.
- Where the maximum slope steepness (normal [perpendicular] to fence line) is 2H:1V.
- That do not receive concentrated flows greater than 0.5 cfs.
- ¼ acre drainage per 100

Do not place silt fence across channels or use it as a velocity control BMP.

Materials

Steel Posts

Use 48-inch long steel posts that meet the following minimum physical requirements:

- Composed of high strength steel with minimum yield strength of 50,000 psi.
- Have a standard "T" section with a nominal face width of 1.38-inches and nominal "T" length of 1.48-inches.
- Weigh 1.25 pounds per foot (± 8%).

- Have a soil stabilization plate with a minimum cross section area of 17-square inches attached to the steel posts.
- Painted with a water based baked enamel paint.

Use steel posts with a minimum length of 4-feet, weighing 1.25 pounds per linear foot (± 8%) with projections to aid in fastening the fabric. Except when heavy clay soils are present on site, steel posts will have a metal soil stabilization plate welded near the bottom such that when the post is driven to the proper depth, the plate will be below the ground level for added stability. The soil plates should have the following characteristics:

- Be composed of minimum 15 gauge steel.
- Have a minimum cross section area of 17-square inches.

Geotextile Filter Fabric

Filter fabric is:

- Composed of fibers consisting of long chain synthetic polymers composed of at least 85% by weight of polyolefins, polyesters, or polyamides.
- Formed into a network such that the filaments or yarns retain dimensional stability relative to each other.
- Free of any treatment or coating which might adversely alter its physical properties after installation.
- Free of defects or flaws that significantly affect its physical and/or filtering properties.
- Cut to a minimum width of 36 inches.

Use only fabric appearing on SCDOT Approval Sheet #34 meeting the requirements of the most current edition of the SCDOT Standard Specifications for Highway Construction.

Installation

Leave 10 feet between silt fence and creek or wetland.

Excavate a trench approximately 6-inches wide and 6-inches deep when placing fabric by hand. Place 12-inches of geotextile fabric into the 6-inch deep trench, extending the remaining 6-inches towards the upslope side of the trench. Backfill the trench with soil or gravel and compact.

Bury 12-inches of fabric into the ground when pneumatically installing silt fence with a slicing method.

Purchase fabric in continuous rolls and cut to the length of the barrier to avoid joints. When joints are necessary, wrap the fabric together at a support post with both ends fastened to the post, with a 6-inch minimum overlap.

Install steel posts to a minimum depth of 24-inches. Install steel posts a minimum of 1- to 2- inches above the fabric, with no more than 3-feet of the post above the ground. Space posts to maximum 6-feet centers.

Attach fabric to the steel posts using heavy-duty plastic ties that are evenly spaced and placed in a manner to prevent sagging or tearing of the fabric. In call cases, ties should be affixed in no less than 4 places.

Install the fabric a minimum of 24-inches above the ground. When necessary, the height of the fence above ground may be greater than 24-inches. In tidal areas, extra silt fence height may be required. The post height will be twice the exposed post height. Post spacing will remain the same and extra height fabric will be 4-, 5-, or 6-feet tall.

Locate silt fence checks every 100 feet maximum and at low points.

Install the fence perpendicular to the direction of flow and place the fence the proper distance from the toe of steep slopes to provide sediment storage and access for maintenance and cleanout.

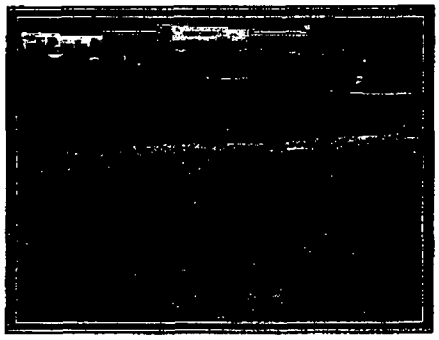
Height of Fill (ft)	Slope of Feet	Minimum silt fence offset from toe of slope (ft)	Minimum right of way offset from toe of slope (ft)
<6	2:1 4:1 6:1	2	3
6-10	2:1 4:1 6:1	12* 3	13* 4
>10	2:1 4:1 6:1	1* 4	13* 5

- These minimum offsets may be reduced when curb and gutter or some other feature reduces the flow of water down the slope. The smaller offsets of each group of height of fill can not be reduced.

Inspection and Maintenance

- Inspect every 7 calendar days and within 24-hours after each rainfall event that produces ½-inches or more of precipitation. Check for sediment buildup and fence integrity. Check where runoff has eroded a channel beneath the fence, or where the fence has sagged or collapsed by fence overtopping.
- If the fence fabric tears, begins to decompose, or in any way becomes ineffective, replace the section of fence immediately.
- Remove sediment accumulated along the fence when it reaches 1/3 the height of the fence, especially if heavy rains are expected.
- Remove trapped sediment from the site or stabilize it on site.
- Remove silt fence within 30 days after final stabilization is achieved or after temporary best management practices (BMPs) are no longer needed.
- Permanently stabilize disturbed areas resulting from fence removal.

Silt Fence



Silt Fence

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Excessive sediment accumulation.	Remove sediment. Apply hydraulic mulch or straw mulch or other BMPs upstream to reduce eroded sediment.
Bottom of fence is not properly keyed in.	Dig trench, place fabric, and backfill.
Length of slope draining to silt fence is too long.	Shorten slope length using diversion ditches, additional silt fence runs, or other BMPs.
Storage capacity is inadequate due to sediment buildup.	Remove accumulated sediment when it reaches 1/3 the height of the barrier.
There is a lack of sufficient ponding area.	Fence should be installed with at least a 5-foot setback from the toe of the slope where possible. Divert flow at top of slope with diversion ditches.
Erosion occurs around barrier ends.	Turn ends of barriers into the up-slope area every 100 feet.

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Silt fence is not installed along level contour.	Reinstall silt fence so that change in elevation does not exceed 1/3 the fabric height along the reach.
Slope draining to fence is too steep.	Shorten slope length using fiber rolls or equivalent. Increase setback of silt fence from the toe of slope.
Fence is installed in concentrated flow area.	Replace fence with proper BMP such as check dams, if appropriate.
Tie backs or j-hooks not installed or installed incorrectly.	Place Tie backs or j-hooks at a maximum separation of 100-feet.
Stakes are too far apart.	Add stakes a maximum of 6-feet apart.
Concentrated flows causing erosion.	Place cross barrier check dams behind the silt fence.

Rock Check Dam

Plan Symbol

Description

A rock check dam is a small, temporary or permanent rock fill dam constructed across a drainage ditch, swale, or channel to lower the speed of concentrated flows. Design rock check dams to have an 80 percent design removal efficiency goal of the total suspended solids (TSS) in the inflow.

When and Where to Use It

Install rock check dams in steeply sloped swales, or in swales where adequate vegetation can not be established. Use rock check dams in small open channels. Do not place check dams in Waters of the State or USGS blue-line streams (unless approved by SCDHEC, State, or Federal authorities).

Installation

Install the center section of the rock check lower than the edges.

Inspection and Maintenance

- Inspect every 7 calendar days and within 24-hours after each rainfall event that produces ½-inches or more of precipitation.
- Inspect for sediment and debris accumulation.
- Inspect rock check dam edges for erosion and repair promptly as required.
- Remove sediment when it reaches 1/3 the original check height.
- In the case of grass-lined ditches and swales, remove rock check dams when the grass has matured sufficiently to protect the ditch or swale unless the slope of the swale is greater than 4 percent.

- After construction is complete, remove stone if vegetation is used for permanent stabilization.
- Seed and mulch the area beneath the rock ditch checks immediately after dam removal.

Rock Check Dam

Rock Check Dam

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Too much sediment has accumulated.	Remove accumulated sediment to recover holding capacity.
There is insufficient ponding area.	Space check dams farther apart. Increase height of dam.
The check dam is higher than the drainage channel.	Lower check dam so that it is 6 inches lower than the channel side.
Check dams wash away.	Use larger stone for the body of the check dam. Decrease check dam spacing by adding more dams.
Wrong type of materials is used to construct check dam.	Use larger stones. Do not use straw bales or silt fence for checks.

Sediment Tubes

Plan Symbol

Description

Sediment tubes are elongated tubes of compacted geotextiles, curled excelsior wood, natural coconut fiber or hardwood mulch. Straw, pine needle, and leaf mulch-filled sediment tubes are not permitted.

When and Where to Use It

Install sediment tubes along contours, in drainage conveyance swales, and around inlets to help reduce the effects of soil erosion by energy dissipation and retaining sediment.

Materials

Sediment tubes for ditch checks and Type A Inlet Structure Filters exhibit the following properties:

- Produced by a Manufacturer experienced in sediment tube manufacturing.
- Composed of compacted geotextiles, curled excelsior wood, natural coconut fibers, hardwood mulch or a mix of these materials enclosed by a flexible netting material.
- Straw, straw fiber, straw bales, pine needles, and leaf mulch are not allowed under this specification.
- Utilizes outer netting that consists of seamless, high-density polyethylene photodegradable materials treated with ultraviolet stabilizers or a seamless, high-density polyethylene non-degradable materials.
- Diameter ranging from 18-inches to 24-inches.

- Curled excelsior wood, or natural coconut rolled erosion control products (RECPs) that are rolled up to create a sediment tube are **not** allowed under this specification.
- Select applicable Sediment Tubes from the SCDOT approved products list.

Installation

Proper site preparation is essential to ensure sediment tubes are in complete contact with the underlying soil or underlying surface. Remove all rocks, clods, vegetation or other obstructions so installed sediment tubes have direct contact with the underlying soil or surface.

Install sediment tubes by laying them flat on the ground. Construct a small trench to a depth that is 20% of the sediment tube diameter. Lay the sediment tube in the trench and compact the upstream sediment tube soil interface. Do not completely bury sediment tubes during installation. Review all project specifications for special installation requirements. Install sediment tubes so no gaps exist between the soil and the bottom of the sediment tube. Lap the ends of adjacent sediment tubes a minimum of 6-inches to prevent flow and sediment from passing through the field joint. Never stack sediment tubes on top of one another.

Avoid damage to sediment tubes during installation. Should the sediment tube become damaged during installation, place a stake on both sides of the damaged area terminating the tube segment and install a new tube segment. Perform field monitoring to verify that installation procedures do not damage sediment tubes. Replace all damaged sediment tubes damaged during installation as directed by the Inspector or Manufacturer's Representative at the contractor's expense.

Install sediment tubes in swales or drainage ditches perpendicular to the water flow and extend them up the side slopes a minimum of 1-foot above the design flow depth. Space sediment tubes according to the following table:

Slope	Maximum Sediment Tube Spacing
Less than 2%	150-feet
2%	100-feet
3%	75-feet
4%	50-feet
5%	40-feet
6%	30-feet
Greater than 6%	25-feet

Install sediment tubes using wooden stakes (2-inch x 2-inch) or steel posts (standard "U" or "T" sections with a minimum weight of 1.25 pounds per foot) a minimum of 48-inches in length placed on 2-foot centers. Intertwine the stakes with the outer mesh on the downstream side, and drive the stakes in the ground to a minimum depth of 24-inches leaving less than 12-inches of stake above the exposed sediment tube.

An acceptable alternative installation is driving stakes on 2-foot centers on each side of the sediment tube and connecting them with natural fiber twine or steel wire to inhibit the non-weighted sediment tube from moving vertically. Sediment tubes can also be secured by installing the stakes on 2-foot centers in a crossing manner ensuring direct soil contact at all times.

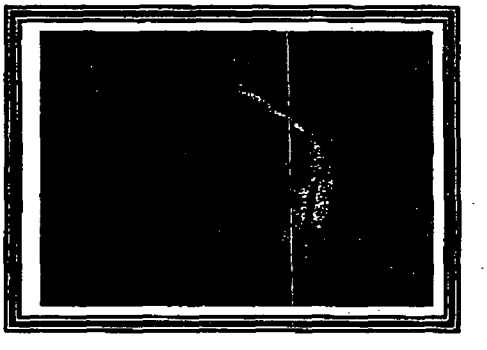
Select the sediment tube check length to minimize the number of sediment tubes needed to span the width of the drainage conveyance. If the required length (perpendicular to the water flow) is 15-feet, then one 15-foot sediment tube is preferred compared to two overlapping 10-foot sediment tubes.

Install sediment tubes for ditch checks over bare soil, mulched areas, or erosion control blankets. Keep sediment tubes for ditch checks in place until fully established vegetation and root systems have completely developed and can survive on their own.

Inspection and Maintenance

- Inspect sediment tubes after installation for gaps under the sediment tubes and for gaps between the joints of adjacent ends of sediment tubes.
- Inspect every 7-days and within 24-hours of a rainfall event of 0.5-inches or greater.
- Repair all rills, gullies, and undercutting near sediment tubes.
- Remove all sediment deposits that impair the filtration capability of sediment tubes when the sediment reaches 1/3 the height of the exposed sediment tube.
- Remove and/or replace installed sediment tubes as required to adapt to changing construction site conditions.
- Remove sediment tubes from the site when the functional longevity is exceeded as determined by the Engineer, Inspector or Manufacturer's Representative. Gather sediment tubes and dispose of them in regular means as non-hazardous, inert material.
- Prior to final stabilization, backfill all trenches, depressions and other ground disturbances caused by the removal of sediment tubes.

Sediment Tube Check Dam



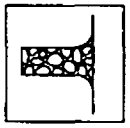
Sediment Tube Check Dam

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Too much sediment has accumulated.	Remove accumulated sediment to recover holding capacity. Remove accumulated sediment from the upstream side of the sediment tube when the sediment has reached a height of approximately one-half the original height of the tube (measured at the center).
There is insufficient ponding area.	Space sediment tubes farther apart or increase the sediment tube diameter.
Sediment tube washes away.	Use larger sediment tubes. Decrease post spacing, and add more posts. Install posts on both the upstream and downstream sides of the sediment tube. Decrease sediment tube spacing by adding more sediment tube check dams.
Other application used instead of sediment tubes	Do not use straw bales or silt fence as sediment tube check alternatives. In some situation rock check dams may be used as a sediment tube alternative.
Wrong type of materials or wrong type of sediment tube utilized.	Straw, pine needle and leaf mulch-filled sediment tubes are not permitted. Curled excelsior wood, or natural coconut rolled erosion control products (RECPs) that are rolled up to create a sediment tube are **not** permitted. Do not use straw bales or silt fence for checks.

Stabilized Construction Entrance

Plan Symbol



Description

A stabilized construction entrance is a temporary stone-stabilized pad located at all points of vehicular ingress and egress on a construction site to reduce the amount of mud, dirt, and rocks transported onto public roads by motor vehicles equipment and runoff.

When and Where to Use It

Use stabilized construction entrances whenever repetitive traffic will be leaving a construction site and moving directly onto a public road. Construction entrances provide an area where mud is removed from vehicle tires before entering a public road.

Installation

Remove all vegetation and any objectionable material from the foundation area.

Divert all surface runoff and drainage from stones to a sediment trap or basin.

Install a non-woven geotextile fabric prior to placing any stone.

Install a culvert pipe across the entrance when needed to provide positive drainage.

The entrance consists of 2 to 3 inch D_{50} aggregate with a minimum thickness of 6-inches.

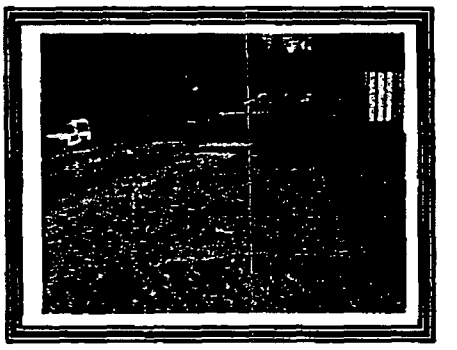
Minimum dimensions of the entrance are 24-feet wide by 100-feet long, and may be modified as necessary to accommodate site constraints.

Taper the edges of the entrance out towards the road to prevent tracking of mud at the edge of the entrance.

Inspection and Maintenance

- Inspect every 7 calendar days and within 24-hours after each rainfall event that produces ½-inches or more of precipitation, or after heavy use.
- Check for mud and sediment buildup and pad integrity.
- Make daily inspections during periods of wet weather. Maintenance is required more frequently in wet weather conditions. Reshape the stone pad as needed for drainage and runoff control.
- Wash or replace stones as needed.
- Wash or replace he stone in the entrance whenever the entrance fails to reduce mud being carried off site by vehicles. Frequent washing will extend the useful life of stone.
- Immediately remove mud and sediment tracked or washed onto public roads by brushing or sweeping.
- Only use flushing when the water is discharged to a sediment trap or basin.
- Repair any broken pavement immediately.
- Inspect and clean sediment traps immediately following each rainfall.
- Dispose of sediment in a suitable area in such a manner that it will not erode.
- Remove stabilized construction entrances as soon as they are no longer needed to provide access to the site. Bring the disturbed area to grade, and stabilize it using appropriate permanent stabilization methods.

Construction Entrance



Construction Entrance

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Access points require constant maintenance.	Select proper stabilization material or consider alternate methods for longevity, performance and site conditions.
Stone is tracked onto roadway.	Limit larger vehicles from construction exit or use larger diameter material.
Aggregate material is being incorporated into the soil.	Use geotextile fabric under base material.
Excessive sediment is tracked onto roadway.	Increase length of stabilized exit. Regularly maintain access area to remove sediment buildup.
Sediment-laden water is leaving the construction site.	Properly grade access points to prevent runoff from leaving site. Route runoff through a sediment-trapping device.
Sediment is being tracked from numerous locations.	Limit the number of access points and require their use. Stabilize designated access points.

Storm Drain Inlet Protection

Description

Storm drain inlet protection is achieved by placing a temporary filtering device around any inlet to trap sediment. This mechanism prevents sediment from entering inlet structures. Additionally, it serves to prevent the silting-in of inlets, storm drainage systems, or receiving channels.

There are six (6) types of inlet structure filters, including:

- Type A-Low Flow
- Type B-Medium Flow, Low Velocity
- Type C-Medium Flow, Medium Velocity
- Type D-High Flow, High Velocity
- Type E-Surface Course Curb Inlet
- Type F-Inlet Tubes

When and Where to Use It

Inlet protection may be installed prior to the construction of roads however, once the sub base is placed, a different type of inlet protection may be required. Inlet protection is required on all inlets that have outfalls that bypass sediment trapping structures and directly discharge off site. Use inlet protection as a last resort for sediment control when no other means are practical and do not use as the only means of protection.

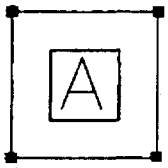
Inspection and Maintenance

- Inspect every 7 calendar days and within 24-hours after each storm that produces ½-inches or more of rain. Handle any damage or needed repairs immediately.
- Inspect after installation for gaps that may permit sediment to enter the storm drainage system.
- Remove accumulated sediment and debris from the surface and vicinity of Inlet Filters after each rain event or as directed by the Engineer, Inspector or Manufacturer's Representative.

- Remove sediment when it reaches approximately 1/3 the height of the Inlet Filter. If a sump is used, remove sediment when it fills approximately 1/3 the depth of the hole. Maintain the pool area, always providing adequate sediment storage volume for the next storm event.
- Remove, move, and/or replace as required to adapt to changing construction site conditions.
- Remove Inlet Filters from the site when the functional longevity is exceeded as determined by the Engineer, Inspector or Manufacturer's Representative.
- Dispose of Inlet Filters no longer in use at an appropriate recycling or solid waste facility.
- Prior to final stabilization, backfill and repair all trenches, depressions, and other ground disturbances caused by the removal of Inlet Filters.
- Remove all construction material and sediment and dispose of them properly. Grade the disturbed areas to the elevation of the inlet structure crest. Stabilize all bare areas immediately.

Type A - Filter Fabric Inlet Protection

Plan Symbol



Design filter fabric inlet protection to have an 80 percent design removal efficiency goal of the total suspended solids (TSS) in the inflow. The Design Aids located in the Silt Fence section of this Handbook may be used to properly design filter fabric inlet protection.

Materials

Use filter fabric that conforms to SCDOT standard specifications for highway construction (latest edition). Refer to the silt fence geotextile fabrics SCDOT Approval Sheet #34.

Use 48-inch long wood posts that meet the following requirements.

- 2-inch by 2-inch size.
- Heavy-duty wire staples at least 1½-inch long, spaced a maximum of 6-inches apart to attach the filter fabric to wooden stakes.

Use 48-inch long steel posts that meet the following minimum physical requirements:

- Be composed of high strength steel with minimum yield strength of 50,000 psi.
- Have a standard "T" section with a nominal face width of 1.38-inches and nominal "T" length of 1.48-inches.
- Weigh 1.25 pounds per foot (± 8%).
- Be painted with a water based baked enamel paint.

Installation

Excavate a trench 6-inches wide and 6-inches deep around the outside perimeter of the inlet.

Extend the filter fabric a minimum of 12-inches into the trench. Backfill the trench with soil or crushed stone and compact over the filter fabric unless the fabric is pneumatically installed.

Install the filter fabric to a minimum height of 18-inches and maximum height of 24-inches above grade. Space the posts around the perimeter of the inlet a maximum of 3-feet apart and drive them into the ground a minimum of 24-inches.

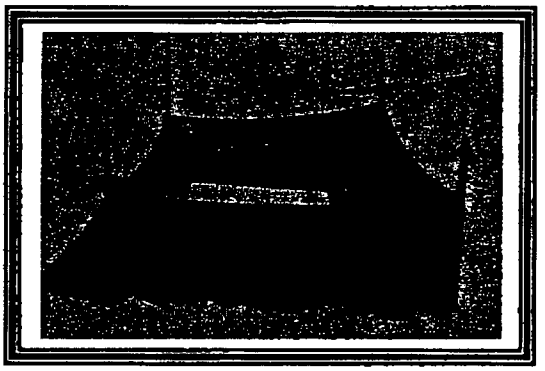
Cut the filter fabric from a continuous roll to the length of the protected area to avoid the use of joints. When joints are necessary, wrap filter fabric together only at a support post with both ends securely fastened to the post, with a minimum 6-inch overlap.

Attach fabric to wood posts using heavy-duty wire staples at least 1½-inch long, spaced a maximum of 6-inches apart.

Attach fabric to steel posts with heavy-duty plastic ties. Attach at least four (4) evenly spaced ties in a manner to prevent sagging or tearing of the fabric. In all cases, affix ties in no less than four (4) places.

Inspection and Maintenance

- Inspect every 7 calendar days and within 24-hours after each rainfall event that produces ½-inches or more of precipitation. Replace the fabric if it becomes clogged.
- Remove sediment when it reaches 1/3 the height of the fabric. Take care not to damage or undercut fabric when removing sediment.
- Remove sediment when it fills 1/3 the depth of the sump.
- Maintain the pool area, always providing adequate sediment storage volume for the next storm.
- Remove storm drain inlet protection only after the disturbed areas are permanently stabilized.
- Remove all construction material and sediment, and dispose of them properly.
- Grade disturbed areas to drop inlet structure crest. Stabilize bare areas with appropriate permanent stabilization methods.



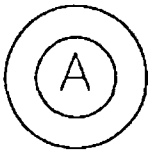
Filter Fabric Inlet Protection

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Excessive sediment is entering the inlet.	Ensure soil stabilization and sediment control devices are installed upstream of inlets. Ensure that the barriers around inlet are installed correctly. Filter fence needs to be keyed in so that water goes through filter fabric and not under it. Use a different type of inlet protection if concentrated flows are observed.
Filter fabric is clogged by sediment or other debris.	Replace filter fabric.
Sediment reaches 1/3 the height of the fabric.	Remove sediment.
Ponded water causes a traffic concern.	Use alternate BMPs upstream. Remove inlet protection if necessary.

Type A – Sediment Tube Inlet Protection

Plan Symbol



Materials

Sediment tubes for Type A Inlet Structure Filters exhibit the following:

- Be produced by a Manufacturer experienced in sediment tube manufacturing.
- Composed of compacted geotextiles, curled excelsior wood, natural coconut fibers, hardwood mulch or a mix of these materials enclosed by a flexible netting material.
- Straw, straw fiber, straw bales, pine needles, and leaf mulch are not allowed under this specification.
- Outer netting consists of seamless, high-density polyethylene photodegradable materials treated with ultraviolet stabilizers or a seamless, high-density polyethylene non-degradable materials.
- Diameter ranging from 18-inches to 24-inches.
- Curled excelsior wood, or natural coconut rolled erosion control products (RECPs) that are rolled up to create a sediment tube are **not** allowed under this specification.
- Select applicable Sediment Tubes from the SCDOT approved products list.

Use 48-inch long wood posts that meet the following requirements.

- 2-inch by 2-inch size.
- Heavy-duty wire staples at least 1½-inch long, spaced a maximum of 6-inches apart to attach the filter fabric to wooden stakes.

Use 48-inch long steel posts that meet the following requirements:

- Be composed of high strength steel with minimum yield strength of 50,000 psi.

- Have a standard "T" section with a nominal face width of 1.38-inches and nominal "T" length of 1.48-inches.
- Weigh 1.25 pounds per foot (± 8%).
- Be painted with a water based baked enamel paint.

Installation

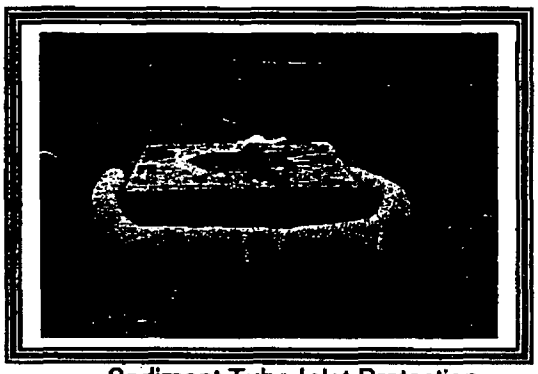
Remove all rocks, clods, vegetation or other obstructions so installed sediment tubes have direct contact with the underlying soil or surface.

Install sediment tubes by laying them flat on the ground. Construct a small trench to a depth that is 20% of the sediment tube diameter. Lay the sediment tube in the trench and compact the upstream sediment tube soil interface. Do not completely bury sediment tubes during installation. Lap the ends of adjacent sediment tubes a minimum of 6-inches to prevent flow and sediment from passing through the field joint. Never stack sediment tubes on top of one another.

Install sediment tubes using wooden stakes (2-inch x 2-inch) or steel posts (1.25 pounds per foot) a minimum of 48-inches in length placed on 2-foot centers. Intertwine the stakes with the outer mesh on the downstream side, and drive the stakes in the ground to a minimum depth of 24-inches leaving less than 12-inches of stake above exposed tube.

Inspection and Maintenance

- Inspect every 7 calendar days and within 24-hours after each rainfall event that produces ½-inches or more of precipitation.
- Inspect after installation for gaps under the tubes and for gaps between joints of adjacent ends of sediment tubes. Repair rills, gullies, and all undercutting near sediment tubes.
- Remove and/or replace as required to adapt to changing construction site conditions.
- Remove from the site when the functional longevity is exceeded as determined by Engineer, Inspector or Manufacturer's Representative
- Dispose of in regular means as non-hazardous, inert material.



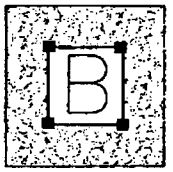
Sediment Tube Inlet Protection

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Too much sediment has accumulated.	Remove accumulated sediment to recover holding capacity. Remove accumulated sediment from the upstream side of the sediment tube when the sediment has reached a height of approximately one-third the original height of the tube (measured at the center).
Sediment tube washes away.	Use larger sediment tubes. Decrease post spacing, and add more posts. Install posts on both the upstream and downstream sides of the sediment tube.
Other application used instead of sediment tubes	Do not use straw bales as sediment tube alternatives.
Wrong type of materials or wrong type of sediment tube utilized.	Straw, pine needle and leaf mulch-filled sediment tubes are not permitted. Curled excelsior wood, or natural coconut rolled erosion control products (RECPs) that are rolled up to create a sediment tube are <u>not</u> permitted. Do not use straw bales.

Type B - Hardware Fabric and Stone Inlet Protection

Plan Symbol



Design hardware fabric and stone inlet protection to have an 80 percent design removal efficiency goal of the total suspended solids (TSS) in the inflow. The Design Aids located in the Rock Check Dam section of this Handbook may be used to properly design hardware fabric inlet protection.

Materials

Use hardware fabric or comparable wire mesh with maximum openings of 0.5-inches x 0.5-inches as the supporting material.

Use48-inch steel posts that meet the following minimum physical requirements:

- Be composed of high strength steel with minimum yield strength of 50,000 psi.
- Have a standard "T" section with a nominal face width of 1.38-inches and nominal "T" length of 1.48-inches.
- Weigh 1.25 pounds per foot (± 8%).
- Be painted with a water based baked enamel paint.

Use heavy-duty wire ties to attach the wire mesh material to the steel posts.

Place Aggregate No. 5 washed stone against the hardware fabric on all sides.

Installation

Excavate a trench 6-inches deep around the outside perimeter of the inlet.

Use hardware fabric or comparable wire mesh with maximum openings of 0.5-inches by 0.5-inches as the supporting material. Extended the fabric a minimum of 6-inches into the ground. Backfill the trench with soil or crushed stone and compact over the fabric.

Use steel posts with a minimum post length of 48-inches consisting of standard "T" sections with a weight of 1.25 pounds per foot (±8%). Install the wire mesh fabric above grade a minimum of 18-inches without exceeding 24-inches.

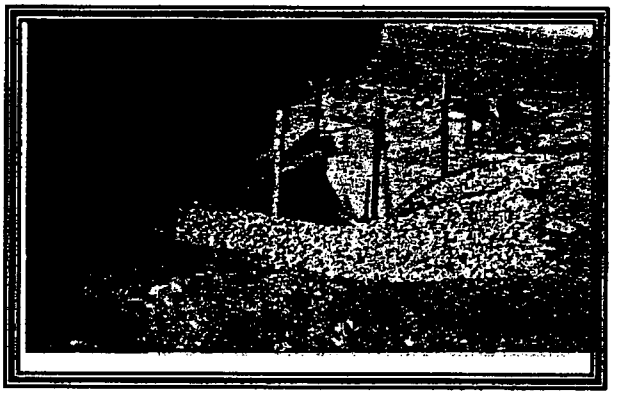
Space the steel posts a maximum of 3-feet apart around the perimeter of the inlet and drive them into the ground a minimum of 24-inches.

Use heavy-duty wire ties spaced a maximum of 6-inches apart to attach the wire mesh material to the steel posts.

Place Aggregate No. 5 washed stone to a minimum height of 12-inches, and a maximum height of 24-inches against the hardware fabric on all sides.

Inspection and Maintenance

- If the stone becomes clogged with sediment, pull the stones away from the inlet and clean or replace them.
- Since cleaning of gravel at a construction site may be difficult, an alternative approach would be to use the clogged stone as fill and put fresh stone around the inlet.



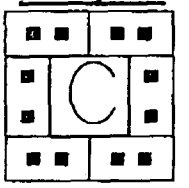
Hardware Fabric and Stone Inlet Protection

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Excessive sediment is entering the inlet.	Ensure that soil stabilization and sediment control devices are installed upstream of inlets. Ensure that the barriers around the inlet are installed correctly.
Sediment reaches 1/3 the height of the structure.	Remove sediment.
Stone filter material becomes clogged with sediment.	Pull stones away from inlet and clean them, or replace them with new stones.
Ponded water causes a traffic concern.	Use alternate BMPs upstream. Remove drain inlet protection if necessary.

Type C - Block and Gravel Inlet Protection

Plan Symbol



Block and gravel filters are used where heavy flows and higher velocities are expected and where an overflow capacity is necessary to prevent excessive ponding around the structure.

Materials

Use masonry blocks ranging from 8 to 12-inches wide.

Use hardware fabric or comparable wire mesh with maximum openings of ½-inches x ½-inches as the supporting material.

Use 1-inch D_{50} washed stone gravel.

Installation

Place the bottom row of the concrete blocks lengthwise on their side so that the open end faces outward, not upward.

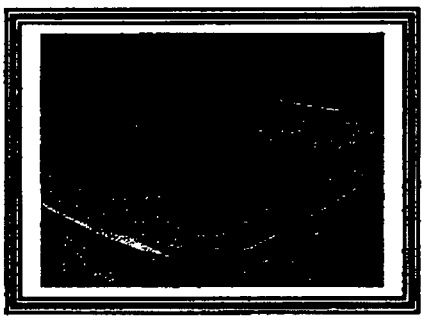
The height of the barrier is varied, depending upon design needs by stacking a combination of blocks that are 8- and 12-inches wide.

Place wire mesh over the outside vertical face of the concrete blocks to prevent stones from being washed through the holes in the blocks. Use hardware cloth or comparable wire mesh with ½-inch x ½-inch openings.

Install 1-inch D_{50} washed stone to a height equal to the elevation of the top of the blocks.

Inspection and Maintenance

- Inspect every 7 calendar days and within 24-hours after each storm that produces ½-inches or more of rain. Any needed repairs should be handled immediately.
- Remove sediment when it reaches 1/3 the height of the blocks. If a sump is used, remove sediment when it fills 1/3 the depth of the hole.
- If the stone filter becomes clogged with sediment, the stones must be pulled away from the inlet and cleaned or replaced. Since cleaning of gravel at a construction site may be difficult, an alternative approach would be to use the clogged stone as fill and put fresh stone around the inlet.
- Remove inlet protection structures after the disturbed areas are permanently stabilized. Remove all construction material and sediment, and dispose of them properly.
- Grade the disturbed area to the elevation of the drop inlet structure crest.
- Stabilize all bare areas immediately.



Block and Gravel Inlet Protection

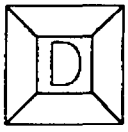
Block and Gravel Inlet Protection

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Excessive sediment is entering the inlet.	Ensure that soil stabilization and sediment control devices are installed upstream of inlets. Ensure that the block and gravel inlet protection is installed correctly.
Sediment reaches 1/3 the height of the blocks.	Remove sediment.
Stone filter material becomes clogged with sediment.	Pull stones away from inlet and clean them, or replace them with new stones.
Ponded water causes a traffic concern.	Use alternate BMPs upstream. Remove inlet protection if necessary.

Type D – Rigid Inlet Filters

Plan Symbol



There are two uses for rigid inlet filters: median applications (Type D1) and sump applications (Type D2). Type D1 filters have more overflow capacity and less filtration area than Type D2 to prevent ponding in medians. These filters are capable of protecting inlet structures not associated with curb inlets

Materials

Rigid inlet filters exhibit the following properties:

- Composed of a geotextile fabric connected to a rigid structure. The geotextile fabric is non-biodegradable and resistant to degradation by ultraviolet exposure and resistant to contaminants commonly encountered in storm water.
- Use a rigid structure composed of high molecular weight, high-density polyethylene copolymer with a UV inhibitor. Do not use structures that are not reusable and recyclable.
- Use a filter fabric constructed of 100% continuous polyester non-woven engineering fabric. The filter fabric is fabricated to provide a direct fit adjacent to the associated rigid structure.
- Rigid inlet filters have a two-stage design. The first stage conveys normal flows at a minimum clean water flow rate of 100 gallons per minute per square foot. The second stage conveys high flow rates, with a minimum apparent opening of 0.5-inch per square inch (No. 12 standard sieve opening).
- Type D1 inlet filters have a first stage minimum height of 9-inches and a maximum height of 12-inches in order to allow greater overflow capacity and prevent ponding in the median.
- Rigid inlet filters completely surround the inlet.

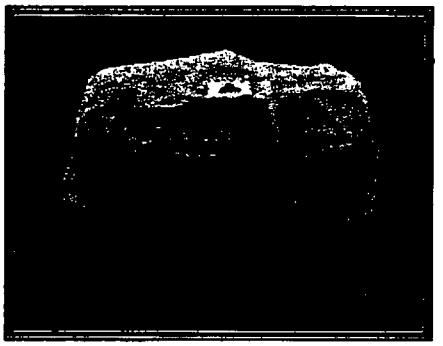
- Rigid inlet filters have lifting devices or structures to assist in the installation and to allow inspection of the storm water system.
- The filter fabric is capable of reducing effluent sediment concentrations by no less than 80% under typical sediment migration conditions.
- Select applicable Type D inlet filters from the SCDOT approved products list.

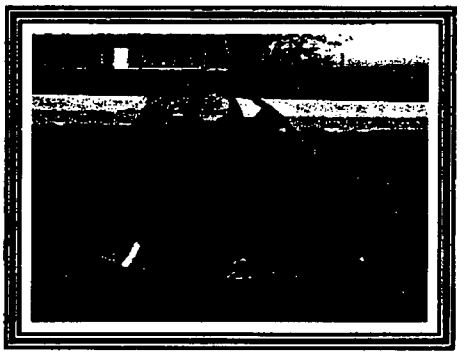
Installation

Install rigid inlet filters in accordance with the Manufacturer's written installation instructions. Properly install rigid inlet protection so the inlet is completely enclosed.

Inspection and Maintenance

- Inspect every 7 calendar days and within 24-hours after each storm that produces ½-inches or more of rain. Any needed repairs should be handled immediately.
- Inspect after installation to insure that no gaps exist that may permit sediment to enter the storm drain system.
- Remove and/or replace rigid inlet filters to adapt to changing construction site conditions.
- Clean the rigid inlet protection filter material when it becomes covered or clogged with deposited sediment.
- Replace the rigid inlet protection filter material as directed by the Engineer.





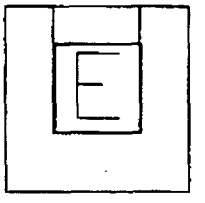
Rigid Inlet Filters

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Excessive sediment is entering the inlet.	Ensure that soil stabilization and sediment control devices are installed upstream of inlets. Ensure that the rigid inlet filters are installed correctly.
Sediment reaches 1/3 the height of the structure.	Remove sediment.
Rigid inlet filter material becomes clogged with sediment.	Pull rigid inlet filters from inlet and clean them, or replace rigid inlet filters with new filter material.
Ponded water causes a traffic concern.	Use alternate BMPs upstream. Remove rigid inlet filter if necessary.

Type E - Surface Course Curb Inlet Filters

Plan Symbol



Materials

Use surface course inlet filters that have a minimum height or diameter of 9-inches and have a minimum length that is 2-feet longer than the length of the curb opening. Surface course inlet filters are not designed to completely block the inlet opening.

Use surface course inlet filters constructed with a synthetic material that will allow storm water to freely flow through while trapping sediment and debris. Use a material that is non-biodegradable and resistant to degradation by ultraviolet exposure and resistant to contaminants commonly encountered in storm water. Straw, straw fiber, straw bales, pine needles, and leaf mulch are not permissible filter materials.

Surface course inlet filters have aggregate compartments for stone, sand or other weighted materials or mechanisms to hold the unit in place.

Use filter fabric that is capable of reducing effluent sediment concentrations by no less than 80% under typical sediment migration conditions.

Select Type E inlet filters from the SCDOT approved products list.

Installation

Surface course inlet filters are applicable for road Catch Basin after the road surface course is placed. Place surface course inlet filters where sediment may spill over sidewalks and curbs.

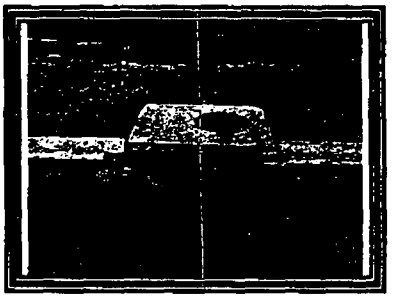
Install surface course inlet filters in front of curb inlet openings. The filter has a minimum height or diameter of 9-inches and has a minimum length that is 2-feet longer than the length of the curb opening to allow sufficient length to cover the inlet with at least 1-foot of clearance beyond the inlet on both ends.

Do not completely block the inlet opening with surface course inlet filters. Install surface course inlet filters in a manner to allow overflows to enter the catch basin.

Fill the aggregate compartment to a level (at least ½ full) that will keep the surface course inlet filter in place and create a seal between the surface course inlet filter and the road surface

Inspection and Maintenance

- Inspect every 7 calendar days and within 24-hours after each storm that produces ½-inches or more of rain. Any needed repairs should be handled immediately.
- Ponding is likely if sediment is not removed regularly.
- Inspect surface course curb inlet filters on a regular basis and immediately after major rain events.
- Clean the surface course curb inlet filter if a visual inspection shows silt and debris build up around the filter.



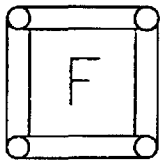
Surface Course Inlet Filters

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Excessive sediment is entering the inlet.	Ensure that soil stabilization and sediment control devices are installed upstream of inlets. Ensure that the surface course inlet filters are installed correctly.
Sediment reaches 1/3 the height of the structure.	Remove sediment.
Surface course inlet filter material becomes clogged with sediment.	Pull surface course filters from inlet and clean them, or replace surface course inlet filters with new filter material.
Ponded water causes a traffic concern.	Use alternate BMPs upstream. Remove surface course inlet filter if necessary.

Type F - Inlet Tubes

Plan Symbol



Inlet tubes are temporary filtering devices placed around inlet structures to trap sediment and keep silt, sediment and construction debris from entering pipe systems through open inlet structures. Additionally, inlet tubes prevent the silting-in of inlets, storm drainage systems and receiving channels.

Materials

Use inlet tubes that exhibit the following properties:

- Produced by a Manufacturer experienced in sediment tube manufacturing.
- Composed of compacted geotextiles, curled excelsior wood, natural coconut fibers or hardwood mulch or a mix of these materials enclosed by a flexible netting material.
- Do not use straw, straw fiber, straw bales, pine needles or leaf mulch under this specification.
- Utilize an outer netting that consists of seamless, high-density polyethylene photodegradable materials treated with ultraviolet stabilizers or a seamless, high-density polyethylene non-degradable materials.
- Curled wood excelsior fiber, or natural coconut fiber rolled erosion control products (RECP) rolled up to create an inlet tube devices are <u>not</u> allowed under this specification.

Weighted Inlet Tubes

Weighted inlet tubes are sediment tubes capable of staying in place without external stabilization measures and may have a weighted inner core or other weighted mechanism to keep them in place.

Materials

Weighted inlet tubes meet the minimum performance requirements shown in the table below.

Property	Test Method	Value
Diameter	Field Measured	6.0 inch to 12.0 inch
Mass per Unit Length	Field Measured	6 inch = 6lbs/ft minimum 12inch= 12lbs/ft minimum
Fiber Length	Field Measured	80% of the fiber materials at least 4-inches in length
Length per Tube	Field Measured	6 foot minimum
Netting Unit Weight	Certified	0.35 oz/ft minimum

Select Type F weighted inlet tubes from the SCDOT approved products list

Installation

Install weighted inlet tubes lying flat on the ground, with no gaps between the underlying surface and the inlet tube.

Never stack weighted inlet tubes on top of one another.

Do not completely block inlets with weighted inlet tubes.

Install weighted inlet tubes in such a manner that all overflow or overtopping water has the ability to enter the inlet unobstructed.

To avoid possible flooding, two or three concrete cinder blocks may be placed between the weighted inlet tubes and the inlet.

Non-Weighted Inlet Tubes

Non-weighted inlet tubes are defined as sediment tubes that require staking or other stabilization methods to keep them safely in place.

Materials

Non-weighted inlet tubes meet the minimum performance requirements shown in the table below.

Property	Test Method	Value
Diameter	Field Measured	6.0 inch to 12.0 inch
Mass per Unit Length	Field Measured	6 inch = 1.0lbs/ft minimum 12inch= 2.0 lbs/ft minimum
Fiber Length	Field Measured	80% of the fiber materials at least 4-inches in length
Length per Tube	Field Measured	6 foot minimum
Netting Unit Weight	Certified	0.35 oz/ft minimum

Select Type F non-weighted inlet tubes from the SCDOT approved products list.

Installation

Install non-weighted inlet tubes immediately after grading and construction of catch basin boxes. Maintain non-weighted inlet tubes during subgrade and base preparation until the base course is placed.

For weep hole inlet protection applications, both weighted and non-weighted inlet tubes are applicable. Install non-weighted inlet tubes in situations when stakes can be driven into the ground or subgrade to secure the tube.

Review all project specifications for special installation requirements.

Install non-weighted inlet tubes using 2-inch x 2-inch wooden stakes or steel posts consisting of standard "T" sections weighing 1.25 pounds per foot (±8%), 3-feet in length placed on 2-foot centers. Intertwine the stakes with the outer mesh on the downstream side of the inlet tube.

Drive stakes in the ground to a minimum depth of 1-foot leaving less than 1-foot of stake exposed above the non-weighted inlet tube.

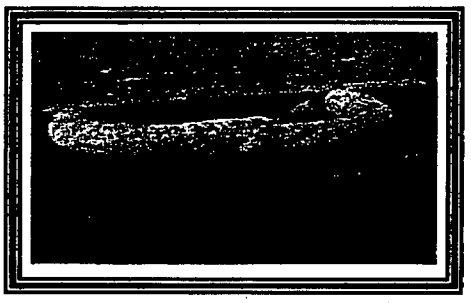
An acceptable alternative installation is driving stakes on 2-foot centers on each side of non-weighted inlet tubes and connecting them with natural fiber twine or steel wire to inhibit the non-weighted sediment tube from moving vertically.

Another acceptable alternative installation for non-weighted inlet tubes is installing stakes on 2-foot centers in a crossing manner maintaining direct soil contact at all times.

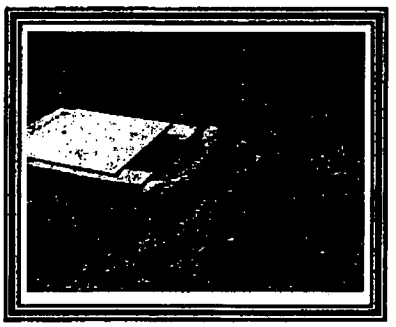
Install non-weighted inlet tubes so the top of the tube is below the top of the installed curb line to ensure that all overflow or overtopping water has the ability to enter the inlet unobstructed.

Inspection and Maintenance

- Inspect every 7 calendar days and within 24-hours after each storm that produces ½-inches or more of rain. Any needed repairs should be handled immediately.
- Inlet tubes may be temporarily moved during construction as needed.
- Replace inlet tubes damaged during installation as directed by the Inspector or Manufacturer's Representative at the contractor's expense.



Weighted Inlet Tube



Non-weighted Inlet Tube

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Excessive sediment is entering the inlet.	Ensure that soil stabilization and sediment control devices are installed upstream of inlets. Ensure that inlet tubes are installed correctly.
Sediment reaches 1/3 the height of the inlet tube.	Remove sediment.
Filter material becomes clogged with sediment.	Pull Inlet from inlet and clean them, or replace clogged inlet tubes with inlet tubes
Ponded water causes a traffic concern.	Use alternate BMPs upstream. Remove inlet tubes if necessary.

Rock Sediment Dikes

Plan Symbol

Description

Rock sediment dikes are semi-circular sediment control structures constructed across drainage ditches, swales, low areas or other areas that receive concentrated flow. A rock sediment dike consists of a half-circular shaped rock embankment with a sump area constructed for sediment storage. Design rock sediment dikes to have an 80 percent design removal efficiency goal of the total suspended solids (TSS).

When and Where to Use It

Rock sediment dikes are most effective in areas where sediment control is needed with minimal disturbance. Use as a sediment control structures for the outfalls of diversion swales, diversion dikes, in low areas or other areas where concentrated sediment laden flow is expected. Use rock sediment dikes for drainage less than 2.0 acres. Do not place rock sediment dikes in Waters of the State (unless approved by SCDHEC, State, or Federal authorities).

Installation

Install a non-woven geotextile fabric over the soil surface where the rock sediment dike is to be placed.

Construct the body of the rock sediment dike with minimum 9-inch D_{50} Riprap. Construct the upstream face with a 1-foot thick layer of ¾-inch to 1-inch D_{50} washed stone placed at a slope of 2H:1V.

Construct rock sediment dikes with a minimum top flow length of 3-feet (two-foot flow length through the riprap and one-foot flow length through the washed stone).

Place the rock by hand or mechanical placement (no dumping of rock to form the sediment dike) to achieve the proper dimensions.

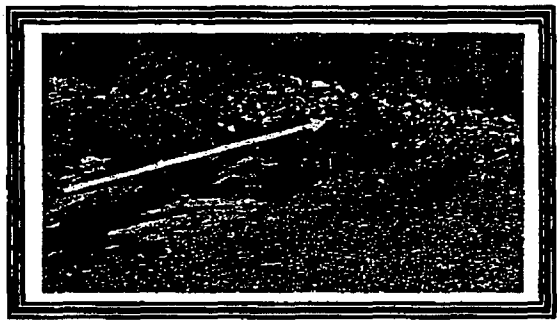
Install a sediment sump with a minimum depth of 2-feet on the upstream side of the structure to provide sediment storage. Install the upstream side of the sediment sump with a slope of 5H:1V to inhibit erosion of the sediment storage area.

Mark the sediment cleanout level of the sediment dike with a stake in the field.

Seed and mulch all disturbed areas.

Inspection and Maintenance

- The key to a functional rock sediment dike is continual monitoring, regular maintenance and regular sediment removal.
- Inspect every 7 calendar days and within 24-hours after each rainfall event that produces ½-inches or more of precipitation.
- Remove sediment when it reaches 50 percent of the sediment storage volume or the top of the cleanout stake. Removed sediment from the sump should be removed from, or stabilized on site.
- Remove rock sediment dikes within 30 days after final site stabilization is achieved or after they are no longer needed. Permanently stabilize disturbed areas resulting from the removal.



Rock Sediment Dike

Rock Sediment Dike

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Sediment reaches 50 percent of the sediment storage volume or the top of the cleanout stake.	Remove accumulated sediment to recover holding capacity.
Rock sediment dikes wash away.	Replace rock sediment dikes using larger stone.
Final site stabilization is achieved.	Remove rock sediment dikes from site within 30 days after stabilization, and permanently stabilize the areas that were disturbed by the dikes.

Runoff Control and Conveyance Measures

Storm water runoff is rainfall or snowmelt that runs off the ground or impervious surfaces (buildings, roads, parking lots, etc.) and drains into natural or manmade drainage ways. In some cases, it drains directly into streams, rivers, lakes, sounds or the ocean. In other cases, particularly urbanized areas, it drains into streets and manmade drainage systems consisting of inlets and underground pipes commonly referred to as "storm sewers." Storm water entering storm sewers does not usually receive any treatment before it enters streams, lakes and other surface waters.

Storm water runoff problems and impacts are most evident in areas where urbanization has occurred. Changes in land use have a major effect on both the quantity and quality of storm water runoff. Urbanization, if not properly planned and managed, can dramatically alter the natural hydrology of an area. Increased impervious cover decreases the amount of rainwater that can naturally infiltrate into the soil and increases the volume and rate of storm water runoff. These changes lead to more frequent and severe flooding and potential damage to public and private property. Under natural conditions, typically 10% of rainwater falling on a piece of property runs off the land surface into streams, rivers or lakes. The remainder either evaporates into the air or infiltrates into the soil replenishing groundwater supplies. Development of the site increases the percentage of impervious surfaces. As the percentage of impervious surfaces increases, the percentage of runoff increases since there is less vegetated area to soak up the rainwater.

The rate of runoff and streamflow after a storm event also shows dramatic increases under post versus predevelopment conditions. The higher and more rapid peak discharge of runoff and streamflow can overload the capacity of the stream or river, causing downstream flooding and streambank erosion. Local governments spend millions of

dollars each year rectifying damage to public and private property caused by uncontrolled storm water runoff. In heavily developed areas, damage to public and private property occurs during heavy rains. This damage includes road, culvert and water and sewer line washouts, flooded homes and yards, the deposition of sediment and debris on properties and roads, and damage to bridges. When streambanks erode they clog stream channels, culverts, and pipes with sediment contributing to flooding problems. Sediment is washed into ponds, lakes and other impoundments reducing their capacity to store water and requiring costly removal efforts. The increased volume and velocity of runoff and streamflow can also cause accelerated channel erosion and changes in streambed composition. This can destroy fish habitat and disrupt the natural ecology of the stream or river.

The following runoff control BMPs are discussed in this handbook:

- Pipe Slope Drains
- Runoff Diversion Measures
- Level Spreader
- Temporary Stream Crossing
- Subsurface Drains
- Construction De-watering

Pipe Slope Drains

Plan Symbol

Description

Pipe slope drains reduce the risk of erosion by discharging concentrated runoff from the top to the bottom of slopes. Pipe slope drains is temporary or permanent depending on installation and material used.

When and Where to Use It

Use pipe slope drains when it is necessary for water to flow down a slope without causing erosion, especially before a slope has been stabilized or before permanent drainage structures are installed. Install temporary pipe slope drains prior to construction of permanent drainage structures. Bury permanent slope drains beneath the ground surface. Stabilize the inlets and outlets of pipe slope drains with flared end sections, Erosion Control Blankets (ECBs), Turf Reinforcement Mats (TRMs) or riprap. Fully compact the soil around the pipe entrance to prevent bypassing and undercutting of the structure. Stabilize the discharge end of the pipe and along the bottom of any swales that lead to sediment trapping structures.

Installation

Secure and fasten slope drain sections together with gasket watertight fittings. Securely anchor slope drains to the soil with wooden stakes or steel posts.

Direct runoff to slope drains with diversion berms, swales, or dikes. The minimum depth of these dikes or berms should be 1.5-feet. The height of the berm around the pipe inlet should be a minimum of 1.5-feet high and at least 0.5-feet higher than the top of the pipe. The berm at the pipe inlet shall be compacted around the pipe.

The area around the inlet shall be properly stabilized with ECBs, TRMs, riprap or other applicable stabilization techniques.

The area below the outlet must be properly stabilized with ECBs, TRMs, riprap or other applicable stabilization techniques.

If the pipe slope drain is conveying sediment-laden water, direct all flows into the sediment trapping facility.

Permanent slope drains should be buried beneath the soil surface a minimum 1.5-feet.

Inspection and Maintenance

- Inspect pipe slope drain inlet and outlet points every 7 calendar days and within 24-hours after each rainfall event that produces ½-inches or more of precipitation.
- Inspect the inlet for undercutting, and water bypassing the point of entry. If there are problems, reinforce the headwall with compacted earth or sandbags.
- Inspect the outlet point for erosion and appropriate outlet protection.
- Remove temporary pipe slope drains within 30 days after final site stabilization is achieved or after the temporary BMP is no longer needed.
- Permanently stabilize disturbed soil areas resulting from slope drain removal.

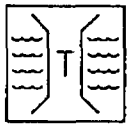
Pipe Slope Drains

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Pipe separates.	Reconnect pipe sections. Securely anchor and stabilize pipe into soil. Ensure that pipe connections are watertight.
Pipe outlet erodes.	Repair the damage and stabilize outlet with a flared end section, riprap, TRM or velocity dissipation device. If necessary, reduce flows being discharged.
Pipe becomes clogged.	Flush out pipe. Place a screen or grate at inlet to capture trash and large particles.
Erosion occurs around inlet.	Compact soil and stabilize area with flared end section, TRM or filter fabric and riprap. Re-grade around inlet to reduce the gradient angle.
Excessive sediment accumulates around inlet/outlet.	Remove accumulated sediment and stabilize upstream area.
Slope drain overtops.	Limit drainage area and flow velocity. Check pipe diameter to ensure proper size to accept flow. Add additional pipes to carry flows as necessary.

Temporary Stream Crossing

Plan Symbol



Description

A temporary stream crossing is a bridge or culvert across a stream or watercourse for short-term use by construction vehicles and heavy equipment. A stream crossing provides a means for construction vehicles to cross streams or watercourses without moving sediment to streams, damaging the stream bed or channel, or causing flooding. Prior to constructing a temporary stream crossing, the owner/person financially responsible for the project must submit an Application for Permit to construct across or along a stream to South Carolina Department of Health and Environmental Control (SCDHEC). Temporary stream crossings require authorization. Refer to the US Army Corps of Engineers and SCDHEC nationwide 401 and 404 regulations for information on permit requirements.

When and Where to Use It

When feasible, attempt to minimize or eliminate the need to cross streams. Temporary stream crossings are a direct source of pollution; therefore, every effort should be made to use an alternate method (e.g., longer detour), when feasible. When it becomes necessary to cross a stream, a well-planned approach minimizes damage to streambanks and reduces erosion. The design of temporary stream crossings requires knowledge of the design flows.

Installation

Install crossings prior to any other activities. Install and maintain pump-around diversions prior to any excavation and during the installation of the crossing. Place crossings in temporary construction easements only.

Minimize streambank clearing. Do not excavate rock bottom streambeds to install the crossing. Lay the culvert pipes on the streambed "as is" when applicable. Place as many pipes as possible within the low area of the stream. Place remaining pipes required to cross the stream on the existing stream bottom.

Install pipes with a maximum spacing of 12-inches between pipes. The minimum sized pipe culvert that may be used is 24-inches.

Install culverts with a length that extend the full width of the crossing, including side slopes.

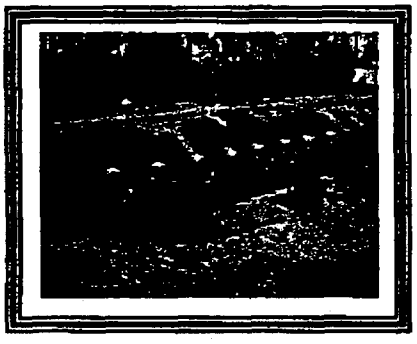
Use coarse aggregate of clean limestone riprap with a 6-inch D_{50} or greater to form the crossing. Install the stone cover over the culvert equal to ½ the diameter of the culvert or 12-inches, whichever is greater, but no greater than 18-inches.

Limit all fill materials associated with the roadway approach to a maximum height of 2-feet above the existing flood plain elevation.

Inspection and Maintenance

- Inspect crossings every 7 calendar days and within 24-hours after each rainfall event that produces ½-inches or more of precipitation. Check the structure integrity and for excessive sediment deposition and replace fill stone as needed.
- Clean mud and/or sediment from the roadway and prevent it from entering the stream.

- The structure shall be removed when it is no longer required to provide access to the construction area. During removal, leave stone and geotextile fabric for approaches in place. Place fill over the approaches as part of the streambank restoration operation. A temporary culvert crossing should be in place no longer than 24 months.



Temporary Stream Crossing

Temporary Stream Crossing

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Slopes of temporary earthen crossing erodes.	Place rock layer on slope sides. Stabilize roadway at crossing.
Sediment and debris block culvert inlet.	Remove sediment and debris as necessary to keep pipe open.
Pipe outlet causes erosion.	Stabilize outlet with riprap or flared end section.
Overtopping occurs.	Incorrect design. Redesign crossing and obtain approval (stamp) of registered civil and/or structural engineer.

Runoff Diversion Measures (Diversion berms/dikes and swales)

Plan Symbol

Description

Diversion dikes and berms (ridges of compacted soil) and diversion swales (excavated depressions) are used to divert upslope runoff from crossing areas where there is a high risk of erosion. Use runoff conveyance structures as temporary clean water diversions, temporary sediment laden diversions, or permanent clean water diversions. Use runoff control measures as either temporary or permanent storm water control structures.

When and Where to Use It

Runoff conveyance measures are installed around the perimeter of a construction sites before major disturbing activities takes place. When constructed along the upslope perimeter of a disturbed or high-risk area (though not necessarily all the way around it), clean water diversions prevent clear water runoff from flowing over unprotected down slope areas. Sediment laden diversions located on the downslope side of a disturbed or high-risk area prevent sediment-laden runoff from leaving the site before sediment is properly removed. For short slopes, runoff control measures at the top of the slope reduce the amount of runoff reaching the disturbed area. For longer slopes, several dikes or swales are placed across the slope at intervals. This practice reduces the amount of runoff that accumulates on the face of the slope and carries the runoff safely down the slope. In all cases, runoff is guided to sediment trapping area or a stabilized outfall before release.

Installation

Stabilized using vegetation, sod, and ECBs or TRMs before any major land disturbing activity takes place.

Install the top width of diversion dikes at least 2-feet wide. Install the bottom width at ground level at least 8-feet wide.

The minimum height for earthen dikes is 18-inches, with side slopes no steeper than 2H:1V.

Minimize construction traffic over diversion dikes and berms. However, for points where vehicles must cross the dike, the slope should be no steeper than 3H:1V and the mound should be constructed of gravel rather than soil.

Prior to swale excavation or dike building, clear and grub all trees, brush, stumps, and other objects in the path of the diversion structure.

Ensure the minimum constructed cross section meets all dimensions shown on the plans.

Immediately after construction establish vegetation by placing an Erosion Control Blanket on the diversion dikes and silt ditches.

Provide positive drainage to the upslope side of the dike so no erosion occurs at the outlet. Provide energy dissipation measures as necessary. Discharge sediment-laden runoff through a sediment trapping facility.

Inspection and Maintenance

- The runoff control measure should be inspected, every 7 calendar days and within 24-hours after each rainfall event that produces ½-inches or more of precipitation and repairs made as necessary.
- Damage caused by construction traffic or other activity must be repaired before the end of each working day.

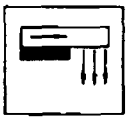
Diversion Berms

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Dikes wash out.	Re-grade, compact and stabilize the soil used to build earthen dikes.
Area behind dikes erode.	Stabilize the area. Use other BMPs to stabilize the uphill side of the dike.
Concentrated flow causes erosion.	Stabilize area and use check dams, ECBs, TRMs or riprap to prevent erosion.
Ditches and swales erode due to high velocity flows.	Stabilize and use check dams, ECBs, TRMs or riprap to prevent erosion.
Swales and ditches fill up with sediment.	Remove accumulated sediment from ditches and swales. Stabilize upstream contributing areas with appropriate erosion prevention BMPs.
Ditches and swales are overtaken by flows.	Determine the upstream contributing areas and size ditches and swales to handle anticipated flow velocities.
Outlet erodes.	Re-grade and stabilize outlet with ECBs, TRMs or riprap.

Level Spreader

Plan Symbol



Description

A level spreader is a permanent outlet for diversions consisting of an excavated channel constructed at zero grade across a slope converting concentrated runoff to sheet flow and releasing it onto stabilized areas. Sediment-laden waters **should not** be directed towards level spreaders.

When and Where to Use It

Construct level spreaders on undisturbed areas that are stabilized by existing vegetation and where concentrated flows are anticipated to occur. Level spreaders are used as a stable outlet for diversion channels if the runoff is relatively free of sediment. If properly constructed, level spreaders significantly reduce the velocity of concentrated storm water.

Installation

Ensure the lower lip is level. If there are any depressions in the lip, flow will tend to concentrate at these points and erosion will occur, resulting in failure of the outlet. Avoid the problem by using a grade board, a gravel lip or a TRM along the exit lip of the level spreader.

Extend the TRM 10-feet below the lip and bury it at least 6- inches within the spreader, and extend at least 12-inches beyond the lip on the outside of the spreader.

Install the grade of the channel transition for the last 20-feet before entering the level spreader less than or equal to 1 percent.

Install the crest of the overflow level (0 percent grade) to ensure uniform spreading of runoff.

Inspection and Maintenance

- Inspect every 7 days and within 24-hours after each rainfall event that produces ½-inches or more of precipitation to ensure that it is functioning correctly.
- The contractor should avoid the placement of any material on the structure or prevent construction traffic across the structure.
- Immediately repair damaged by construction traffic.

Level Spreader

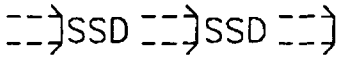
Level Spreader

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Spreader is damaged by construction traffic.	Repair immediately.
Water is channelizing and causing erosion.	Make sure level spreader lip was installed correctly, with a 0% grade to ensure a uniform distribution of flow, Repair immediately, as needed.
Too much sediment has accumulated.	Remove accumulated sediment to recover capacity. A sediment forebay may need to be constructed at the inlet of the level spreader.

Subsurface Drains

Plan Symbol



Description

A subsurface drain is a perforated pipe or conduit placed beneath the surface of the ground at a designed depth and grade.

When and Where to Use It

Subsurface drains are used to do the following:

- Drain areas by intercepting and conveying groundwater.
- Lower the water table.
- Drain or de-water storm water detention structures.
- Prevent sloping soils from becoming excessively wet and subject to slippage.

There are two types of subsurface drains: relief drains and interceptor drains.

- Relief drains are used to de-water an area where the water table is high. They are placed in a gridiron, herringbone, or random pattern.
- Interceptor drains are used to remove water where soils are excessively wet or subject to slippage. They are usually placed as single pipes instead of patterns.

Subsurface drains are suitable only in areas where the soil is deep enough for proper installation. They are not recommended where they pass under heavy vehicle crossings.

Installation

Install relief drains through the center of wet areas that drain in the same direction of the slope.

Install interceptor drains on the up-slope side of wet areas and install them across the slope to drain to the side of the slope.

Locate subsurface drains in areas where there are no trees within 50-feet of the drain.

Construct the installation trench on a continuous grade with no reverse grades or low spots.

Stabilize soft or yielding soils under the drain with gravel or suitable material.

Do not use deformed, warped, or otherwise unsuitable pipe.

Place filter material at least 3-inches of material on all sides of pipe.

Backfill trenches after pipe placement with no pipe remaining uncovered overnight or during a rainstorm. Place backfill material in the trench so that the pipe is not displaced or damaged. Use highly permeable open granular soil for backfill.

The outlet should consist of a 10-foot section of corrugated metal, cast iron, steel or schedule 40 PVC pipe without perforations. At least two-thirds of outlet pipe should be buried.

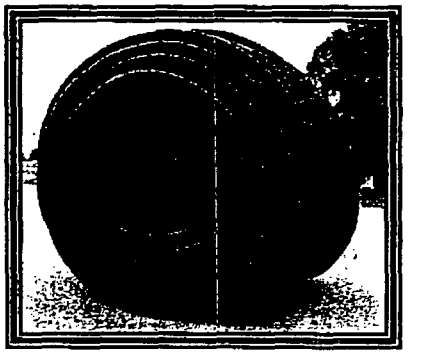
The outlet consists of a 10-foot section of corrugated metal, cast iron, steel or schedule 40 PVC pipe without perforations.

Inspection and Maintenance

- Inspect subsurface drains on a regular schedule and check for evidence of pipe breaks, clogging by sediment, debris or tree roots.
- Remove blockage immediately, replace any broken sections, and re-stabilize the surface. If the blockage is from tree roots, it may be necessary to relocate the drain.
- Check inlets and outlets for sediment or debris. Remove and dispose of these materials properly.

- Check the drainage line where heavy vehicles cross drains to ensure that pipes are not crushed or damaged.

Subsurface Drain



Subsurface Drain Pipe

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Discharge or treated water causes erosion.	Install outlet protection or velocity dissipation device.
Treatment unit fills with sediment.	Remove sediment when unit reaches 1/3 of its capacity to preserve settling efficiency.
Dewatering discharge flow is higher than expected.	Alter the treatment unit to handle increased flow.
Water spread on the construction site is not infiltrating fast enough and is entering the storm drain system or receiving water body.	Stop dewatering. Install a sediment treatment system and test discharge as necessary.

Construction De-Watering

Description

Construction de-watering involves removing storm water or ground water from bore pits, trenches, and other excavations on a construction site. Typically, this removal of water involves the pumping of the water to an appropriate receiving area. Direct pumping to lakes, rivers, and streams is illegal and must be avoided.

Criteria

Pump sediment-laden groundwater directly to:

- A sediment control structure (sediment basin, sediment trap manufactured de-watering device)
- An infiltration trench
- A buffer strip or zone.

Inspection and Maintenance

Pumping to a Sediment Control Structure:

It is recommended that sediment basins or temporary sediment traps receive sediment-laden water from bore pits and trenches. Ensure that the pumping of this water does not cause the sediment control structure to fail. In addition, ensure that erosion does not occur at the outlet of the hose from the pump due to high concentrated flows.

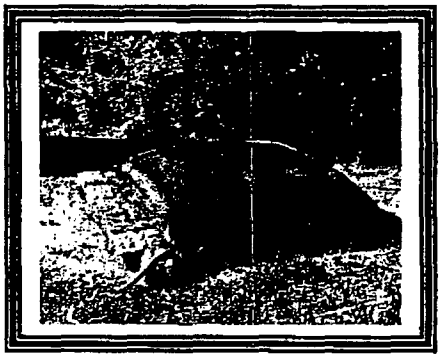
Pumping to an Infiltration Trench:

Ensure that erosion does not occur at the outlet of the hose from the pump due to high concentrated flows.

Pumping to a Vegetated Buffer Zone:

Ensure that erosion does not occur at the outlet of the hose from the pump due to high concentrated flows.

Construction Dewatering



Construction Dewatering

Preventive Measures and Troubleshooting Guide

Field Condition	Common Solutions
Discharge or treated water causes erosion.	Install outlet protection or velocity dissipation device.
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Dewatering discharge flow is higher than expected.	Alter the treatment unit to handle increased flow.
Water spread on the construction site is not infiltrating fast enough and is entering the storm drain system or receiving water body.	Stop dewatering. Install a sediment treatment system and test discharge as necessary.

Alternative Erosion Prevention and Sediment Control BMPs

To encourage the development and testing of innovative alternative EPSC BMPs, alternative management practices that are not included in the Handbook, Standard Specifications and Standard Drawings may be allowed upon review and approval. To use an alternative BMP, the design professional should submit substantial evidence that the proposed measure will perform at least equivalent to currently approved BMPs contained in the Handbook, Standard Specifications and Standard Drawings. Evidence may include, but is not limited to:

- Supporting hydraulic and trapping efficiency calculations.
- Peer-review by a panel of licensed professional engineers.
- Research results as reported in professional journals.
- Manufacturer literature.

To justify the efficiency of innovated EPSC BMPs, the owner may be required to monitor the trapping efficiency of the structure. If satisfactory results showing that trapping efficiencies of greater than 80 percent are obtained, the innovative BMP may be used and no other monitoring studies should be required. If monitoring shows that a certain BMP is not sufficient or if SCDHEC finds that a BMP fails or is inadequate to contain sediment, other upstream and downstream BMPs should be implemented to reach the required efficiency.

Post Construction Water Quality Control

Post-construction storm water management in areas undergoing new development or redevelopment is necessary because runoff from these areas significantly affects receiving waterbodies. There are two forms of substantial impacts of post-construction runoff. The first is an increase in the type and quantity of pollutants in storm water runoff. As runoff flows over areas altered by development, it picks up harmful sediment and chemicals such as oil and grease, pesticides, heavy metals, and nutrients. These pollutants become suspended in runoff and are carried to receiving waters, such as lakes, ponds, and streams. Once deposited, these pollutants enter the food chain through small aquatic life, eventually entering the tissues of fish and humans.

The second kind of post construction runoff impact is increasing the quantity of water delivered to the waterbody during storms. Increased impervious surfaces interrupt the natural cycle of gradual percolation of water through vegetation and soil. Instead, water is collected from surfaces such as asphalt and concrete and routed to drainage systems where large volumes of runoff quickly flow to the nearest receiving water. The affects of this process include streambank scouring and downstream flooding, which often lead to a loss of aquatic life and damage to property.

Non-Structural Low Impact Development Controls

Vegetated Conveyances
Stream Buffers
Disconnected Rooftop Drainage to Pervious Areas
Cluster Development
Grass Paving or Alternative Paving Surfaces
Natural Infiltration

Structural Controls

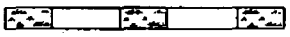
Wet Ponds
Dry Ponds
Storm Water Wetlands
Bioretention Areas
Sand Filters
Infiltration Trench
Enhanced Grassed Swales
Pre-Fabricated Control Devices
Vegetated Filter Strips (VFS)
Porous Pavement

Innovative Technologies

Non –Structural Low Impact Development Controls

Vegetated Conveyance Systems

Plan Symbol



Description

Vegetated conveyances are designed and installed as an alternative to curb and gutter and hard piping storm water conveyance systems. Open vegetated conveyances improve water quality by providing partial pollutant removal as water is filtered by the vegetation and by the opportunity to infiltrate into the soil. Open vegetated conveyances also are designed to reduce flow velocities when compared to hard piping systems.

When and Where to Use It

Open vegetated conveyance systems are incorporated into moderate to low density development sites where land is available and where the land surface is gently sloping (less than 5 percent). The soil must be able to withstand the design tractive forces and flow velocities of the open conveyance, or an applicable

Installation

Construct vegetated conveyances with trapezoidal or parabolic cross section with relatively flat side slopes (flatter than 3H:1V).

Install a flat bottom between 2 and 8 feet wide.

During construction, it is important to stabilize the channel before the turf has been established, either with a temporary grass cover or with the use of natural or synthetic erosion control products.

Inspection and Maintenance

- The useful life of a vegetated swale system is directly proportional to its maintenance frequency. If properly designed and regularly maintained, vegetated swales can last indefinitely.
- The maintenance objectives for vegetated swale systems include keeping up the hydraulic and removal efficiency of the channel and maintaining a dense, healthy grass cover.
- Maintenance includes periodic mowing (with grass never cut shorter than the design flow depth), weed control, watering during drought conditions, re-seeding of bare areas, and clearing of debris and blockages.
- Remove accumulated sediment manually to avoid the transport of resuspended sediments in periods of low flow and to prevent a damming effect from sand bars. Minimize the application of fertilizers and pesticides.
- Repair damaged areas within a channel.
- Inspect for a healthy thick grass cover. Re-seed as necessary.

Stream Buffers

Description

A stream buffer is an area along a shoreline, wetland or stream where development is restricted or prohibited. The primary function of the buffer is to physically protect and separate a stream, lake, or wetland from future disturbance or encroachment.

The general function of the buffer is to:

- Protect the overall stream quality by providing shade for the stream and provide wildlife habitat.
- Remove pollutants, sediments, bacteria, and excess nutrients from storm water runoff through infiltration and filtering.
- Help detain and slow down flow rates from developed areas.

- Provide a setback from the stream to prevent damage to structures or improved property due to flooding or changes in the stream channel.

When and Where to Use It

Effective water quality protection stream buffers consist of undisturbed natural vegetation including maintaining the original tree line along the stream or channel banks. Promptly stabilize disturbed buffers with a dense cover of strong rooted grasses, native plants, and native trees.

Buffer Maintenance

An effective buffer management plan includes establishment, management, and distinctions of allowable and unallowable uses in each Zone. Buffer boundaries are well defined and clearly marked during, and after construction is complete. Buffers designed to capture storm water runoff from urban areas require more maintenance if the first zone is designated as a bioretention or other engineered depression area.

Disconnected Rooftop Drainage to Pervious Areas

Description

Disconnected rooftop drainage reduces the runoff flow rates from developed areas. The disconnection involves directing storm water runoff from rooftops towards pervious areas where it is allowed to filter through vegetation and other landscaped material and infiltrate into the soil. Use erosion control devices such as splash blocks or level spreaders at the downspout discharge point to transfer the flow from concentrated flow to sheet flow.

Disconnected rooftop drainage has the following benefits:

- Increase the time of concentration by disconnecting runoff from any structural storm water drainage systems.

- Provide water quality benefits by allowing runoff to infiltrate into the soil. Downspouts from rooftops should discharge to gently sloping, well-vegetated areas, vegetated filter strips, or bio-retention areas.

When and Where to Use It

This practice is applicable and most beneficial in low-density residential or commercial developments having less than 50 percent impervious area. Disconnection is not applicable to large buildings where the volume of runoff from the rooftops will cause erosion or degradation to receiving vegetated areas.

Cluster Development

Description

Cluster development practices concentrate development away from environmentally sensitive areas such as streams, wetlands, and mature wooded areas. The clustering of development in one area reduces the amount of roadways, sidewalks, and drives required when compared to development sprawled over the entire land area.

Install clustering and conservation of natural area practices at least to some extent on all development sites not only to reduce the impacts to natural resources by minimizing disturbance and impervious areas, but also to maintain some of the natural beauty of the site.

Reducing the amount of disturbed area and impervious area reduces the amount of runoff volume treated for water quantity and water quality control. Concentrating development away from environmentally sensitive areas will also reduce the amount of time and expenses to get federal and state permits for impacting jurisdictional waters.

Concentrate development on the flattest part of the development parcel away from environmentally sensitive areas such as steep slopes, streams, and wetlands. This reduces the impacts to these areas, and reduces the amount of earth moving necessary for the development.

Natural Infiltration

Natural infiltration is a method in which an undisturbed land area covered with natural vegetation accepts runoff from new development and infiltrates the runoff into the soil.

When and Where to Use It

Use natural infiltration areas only where the soils are suitable. The area is typically in a forested condition with the land surface covered by leaves, pine needles, and other forest floor organic materials. Natural infiltration areas are designated for passive recreation only.

Structural Controls

Structural water quality control structures are recommended for use with a wide variety of land uses and development types. These controls have demonstrated the ability to effectively treat runoff volume to reduce the amounts of pollutants discharged to the downstream system. Structural storm water quality controls are classified into the following categories:

General Application Controls

General application structural controls are recommended for use in a wide variety of application situations. These structural controls have demonstrated the ability to effectively treat water quality volumes and are presumed to be capable of removing 80 percent of the total suspended solids (TSS) load typically found in urban post-development runoff.

Limited Application Controls

Limited application structural controls are those that are recommended only for limited use for special site or design conditions. Generally, these practices can not alone achieve 80 percent TSS removal goal and are intended for hotspots for specific land use constraints or conditions. Limited application controls may be used within a system of water quality controls and are very effective pre-treatment structures for the General Application Controls. Limited application structural controls should be designed and used only in development situations where regular maintenance is guaranteed.

Wet Storm Water Detention Ponds

Description

A wet or permanent pool detention pond is one of the most commonly used BMPs to meet water quality protection requirements. The advantages of permanent pool ponds have over other water quality treatment controls are:

- Ponds are durable and require less maintenance than other applicable water quality controls.
- Ponds required for water quantity control are easily modified to treat storm water runoff for water quality.
- Well designed ponds are effective in treating storm water runoff for water quality control.

Wet storm water detention ponds are classified as being:

- Wet Detention Pond. Wet ponds have a permanent (dead storage) pool of water equal to the water quality volume. Temporary storage (live storage) may be added above the permanent pool elevation for larger flows.
- Wet Extended Pond. A wet extended pond is a wet pond where the water quality volume is split evenly between the permanent pool and extended detention storage provided above the permanent pool. During storm events, water is stored above the permanent pool and released over 24-hours. The design has similar pollutant removal efficiencies as traditional wet ponds, but consumes less space.
- Micropool Extended Pond. The micropool extended pond is a variation of the wet extended detention pond where only a small "micropool" is maintained at the outlet to the pond. The outlet structure is designed to detain the water quality volume for 24-hours. The micropool prevents resuspension of previously settled sediments and prevents clogging of the low flow orifice.

When and Where to Use It

Permanent pool ponds improve storm water quality by detaining storm water runoff for an extended period of time to allow pollutants that are uspended in the runoff to settle out. During any given storm event, runoff enters wet ponds and replaces the "treated" water in the permanent pool that has been detained from the previous storm event. As runoff enters the pond, the velocity is significantly decreased, allowing suspended pollutants to settle out of the runoff. Many pollutant particles suspended in storm water runoff are very small in size, therefore the pond must be designed to provide adequate detention time to allow the smaller particles to settle out.

Inspection and Maintenance

Regular inspection and maintenance is critical to the effective operation of storm water ponds as designed. Maintenance responsibility for a pond and its buffer should be vested with a responsible authority by means of a legally binding and enforceable maintenance agreement that is executed as a condition of plan approval. The agreement may contain but is not limited to the following items:

- Mow side slopes of the pond monthly.
- Since decomposing vegetation captured in the wet pond can release pollutants, especially nutrients, it may be necessary to harvest dead vegetation annually. Otherwise the decaying vegetation can export pollutants out of the pond and also can cause nuisance conditions to occur.
- Clear debris from all inlet and outlet structures monthly.
- Repair all eroded or undercut areas as needed.
- Place a sediment marker in the forebay to determine when sediment removal is required.
- Monitor sediment accumulations in the main pond area and remove sediment when the permanent pool volume has been significantly filled and/or the pond becomes eutrophic.

Summary of Maintenance Requirements

Required Maintenance	Frequency
Clean and remove debris from inlet and outlet structures.	Monthly, or after large storm events
Mow side slopes.	Monthly, or as needed
Removal of invasive vegetation.	Semi-annual
Inspect for damage to control structure.	Annual
Inspect sediment accumulation in the facility and forebay.	Annual
Inspect for operational inlet and outlet structures.	Annual
Repair embankment, side slopes, undercut or eroded areas.	Annual, or as needed
Perform wetland plant management and harvesting.	Annual
Remove sediment from the forebay.	Per design cycle, as needed, after 50% of total forebay capacity is filled
Remove sediment accumulations in the main permanent pool.	5 to 10 year cycle, after 25% of the permanent pool volume is filled

Wet Pond

Wet Pond

Dry Storm Water Detention Ponds

Description

A dry (extended) detention pond provides temporary storage of storm water runoff. Dry ponds have an outlet structure that detains runoff inflows and promotes the settlement of pollutants. Unlike wet ponds, dry detention ponds do not have a permanent pool.

A dry pond is designed as a multistage facility that provides runoff storage and attenuation for both storm water quality and quantity. Design dry detention ponds as either single-stage or two-stage. Single-stage ponds are normally used strictly for flood control and are not recommended for water quality benefits. A two-stage pond contains a water quality volume in the lower stage, and has an upper stage for detention of larger storms for flood control.

The lower stages of a dry pond are controlled by outlets designed to detain the storm water runoff for the water quality volume for a minimum duration of 24-hours, which allow sediment particles and associated pollutants to settle out. Higher stages in the pond detain the peak rates of runoff from larger storms for flood and erosion control. Dry detention ponds are designed for complete drawdown of runoff and normally remain dry between storm events.

When and Where to Use It

Apply dry detention ponds to new or existing developments. Dry ponds are considered permanent, year-round control measures. Use dry detention ponds at sites where significant increases in runoff are expected from site development. Use dry detention ponds for residential, commercial, or industrial development sites.

Do not use dry ponds in areas with a high water table. A permanently wet bottom is a mosquito breeding ground.

While dry extended detention ponds are widely applicable, they have some limitations that may make other storm water management options preferable. Dry pond limitations include:

Possible nuisance due to mosquito breeding .

While wet ponds can increase property values, dry ponds may detract from the value of a home.

Dry detention ponds have only moderate pollutant removal when compared to other structural storm water practices, and have limited effectiveness in removing both particulate and soluble pollutants.

Inspection and Maintenance

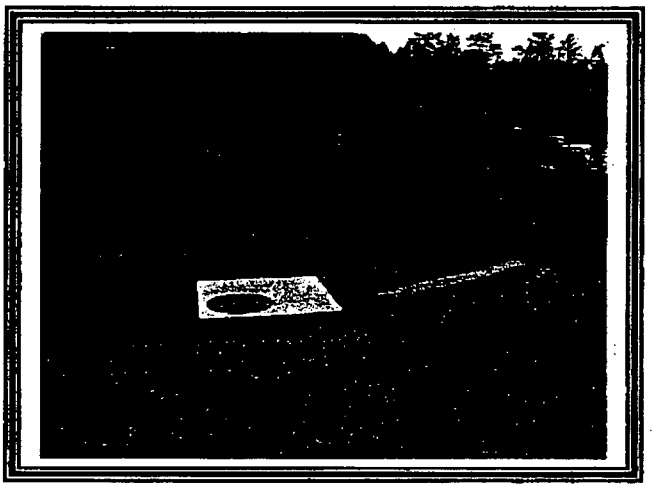
A Pond Maintenance Plan/Agreement is required before approval

Regular inspection and maintenance is critical to the effective operation of dry ponds as designed. Maintenance responsibility for a pond should be vested with a responsible authority by means of a legally binding and enforceable maintenance agreement that is executed as a condition of plan approval.

Conduct inspections semi-annually and after significant storm events to identify potential problems early. Direct maintenance efforts toward vegetation management and basic housekeeping practices such as removal of debris accumulations and vegetation management to ensure that the pond dewaters completely to prevent mosquito and other habitats.

Summary of Maintenance Requirements

Required Maintenance	Frequency
Note erosion of pond banks or bottom	Semi-Annual Inspection
Inspect for damage to the embankment Monitor for sediment accumulation in the facility and forebay. Ensure that inlet and outlet devices are free of debris and operational	Annual Inspection
Repair undercut or eroded areas Mow side slopes Pesticide/ Nutrient management Litter/ Debris Removal	Standard Maintenance
Seed or sod to restore dead or damaged ground cover.	Annual Maintenance (As needed)
Removal of sediment form the forebay	5 to 7 year Maintenance
Monitor sediment accumulations, and remove sediment when the pond volume has been reduced by 25%.	25 to 50 year Maintenance
Repair undercut or eroded areas Mow side slopes Pesticide/ Nutrient management Litter/ Debris Removal	Standard Maintenance



Dry Pond

Dry Pond

Underground Detention Facilities

Description

Detention tanks and vaults are underground structures used to attenuate peak storm water flows through detention or extended detention of storm water runoff. They are constructed out of concrete pipe (RCP), corrugated metal pipe (CMP), High Density Polyethylene Pipe (HDPE) or concrete vaults. The design and material selections considers the potential loading from vehicles on the vault or pipe.

When and Where to Use It

Due to the costs associated with underground detention systems for construction and maintenance, these systems are used when space is limited and there are no other practical alternatives.

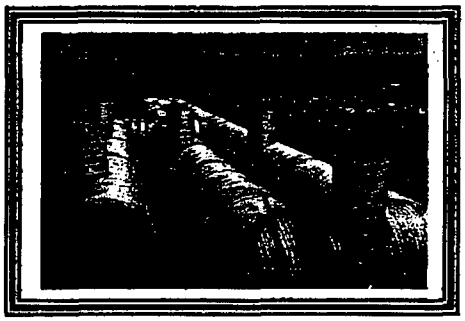
In the ultra-urban environment, costs for developable land may be high enough that these systems become a feasible alternative.

Relatively expensive to construct, use concrete vaults in areas where system replacement costs are high.

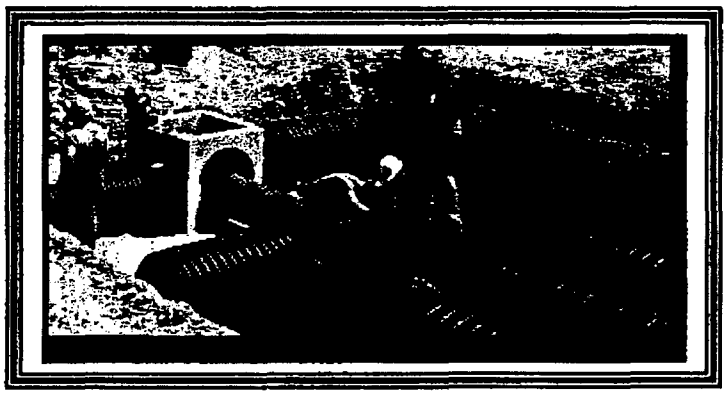
Less expensive, use CMP or HDPE systems to control significant volumes of runoff in parking lots, adjacent to rights-of-way, and in medians, where they is replaced or maintained if necessary.

Inspection and Maintenance

- Design the system for easy access for inspection and maintenance.
- Remove any trash/debris and sediment buildup in the underground vaults or tanks annually by pumping them out.
- Perform structural repairs to inlet and outlets as needed based on inspections.



Underground Detention



Underground Detention

Storm Water Wetlands

Description

Storm water wetlands remove pollutants primarily through physical filtration and settling, by biological processes of wetland plants, and bacteria in substrates. The storm water wetland is similar in design to the wet pond but has significant vegetation differences. The major difference in the wetland design is the creation of varying depth zones in the shallow marsh area of the wetland to support emergent wetland vegetation. Because consideration must be paid to creating various depth zones and establishing a plant community that can survive in the different zones, the design, construction, and maintenance of storm water wetlands is more complex than wet ponds. There are several different wetland applications including:

- Storm Water Wetland. Constructed shallow marsh system that is designed to treat both urban storm water runoff and control runoff volume. As storm water runoff flows through the wetland, pollutant removal is achieved through settling and uptake by marsh vegetation.
- Shallow Wetland. Most of the water quality treatment takes place in the shallow high marsh or low marsh depths. The only deep sections of the wetland are the forebay and the micropool at the outlet. A disadvantage of shallow wetlands is that a relatively large amount of land is required to store the desired water quality volume.
- Extended Detention Shallow Wetland. This design is similar to the shallow wetland, but part of the water quality treatment volume is provided as extended detention above the surface of the marsh and is released over a period of 24-hours. This application can treat a greater volume of storm water in a smaller space than the shallow wetland design. Plants that can tolerate both wet and dry periods are required in the extended detention area.

- Pond/Wetland System. The system consists of has two separate cells, a wet pond and a shallow marsh. The wet pond traps sediment and reduces runoff velocities before the runoff enters the shallow marsh. Primary water quality benefits are achieved in the shallow wetland. Less land is required for the pond/wetland system than the shallow wetland and the extended detention shallow wetland.
- Pocket Wetland. A pocket wetland is intended for smaller drainage areas of 5 to 10 acres, and requires excavation down to the water table for a reliable source of water to support the wetland vegetation.

Inspection and Maintenance

Regular inspection and maintenance is critical to the effective operation of storm water wetlands. Maintenance responsibility for the constructed storm water wetland should be vested with a responsible authority by means of a legally binding and enforceable maintenance agreement that is executed as a condition of plan approval.

- Maintenance requirements for constructed wetlands are particularly high while vegetation is being established. Monitoring during the first year is critical to the success of the wetland.
- Monitor wetlands after all storm events greater than 2-inches of rainfall during the first year to assess erosion, flow channelization and sediment accumulation. Inspection should be made at least once every six months during the first three years of establishment.
- Place a sediment cleanout stake in the forebay area to determine when sediment removal is required.
- Debris should be removed from the inlet and outlet structures monthly.
- Monitor wetland vegetation and replaced as necessary once every 6-months during the first three years of establishment.
- Annually inspect and maintain the depth of the zones within the wetland.
- Annually remove invasive vegetation.
- Repair all eroded or undercut areas as needed.

Summary of Maintenance Requirements

Required Maintenance	Frequency
Replace wetland vegetation to maintain at least 50% surface area coverage in wetland plants.	Once every 6-months during the first three years of establishment
Clean and remove debris from inlet and outlet structures.	Frequently (3 to 4 times/year)
Mow side slopes.	Frequently (3 to 4 times/year)
Monitor wetland vegetation and perform replacement planting as necessary.	Semi-annual (every 6-months)
Examine stability of the original depth zones.	Annual
Inspect for invasive vegetation, and remove where possible.	Annual
Inspect for damage to the embankment and inlet/outlet structures.	Annual, repair as necessary
Monitor for sediment accumulation in the facility and forebay.	Annual
Inspect for operational inlet and outlet structures.	Annual
Repair undercut or eroded areas.	As needed
Harvest wetland plants that have been "choked out" by sediment buildup.	Annual
Removal of sediment from the forebay.	Per design cycle, as needed, after 50% of total forebay capacity is filled
Remove sediment accumulations in the main permanent pool.	5 to 10 year cycle, after 25% of the permanent pool volume is filled

Planted Storm Water Wetland

Established Storm Water Wetland

Bioretention Areas

Description

Bioretention areas are designed to mimic natural forest ecosystems with a combination of soil filtration and plant uptake by utilizing a planting soil layer, mulch, plantings, and an underdrain system. Bioretention areas appear as landscaped or natural areas giving this BMP an appealing image. Storm water runoff enters the Bioretention area and is temporarily stored in a shallow pond on top of the mulch layer. The ponded water then slowly filters down through the planting soil mix and is absorbed by the plantings. As the excess water filters through the system it is temporarily stored and collected by an underdrain system that eventually discharges to a designed storm conveyance system.

When and Where to Use It

Bioretention areas are applicable for small sites where storm water runoff rates are low and typically are received into the Bioretention area as sheet flow. Bioretention drainage areas range from 1-2 acres and are well stabilized to prevent excessive debris and sediment from collecting in the Bioretention area. Because Bioretention areas are sensitive to fine sediments, they are not be placed on sites where the contributing area is not completely stabilized or is periodically being disturbed. Applicable sites include:

- Parking lots,
- Individual residential home sites, and
- Small commercial facilities.

Inspection and Maintenance

Regular inspection and maintenance is critical to the effective operation of Bioretention areas as designed. Maintenance responsibility of the Bioretention area should be vested with a responsible authority by means of a legally binding and enforceable maintenance agreement that is executed as a condition of plan approval.

The surface of the ponding area may become clogged with fine sediments over time. Core aeration or cultivating unvegetated areas may be required to ensure adequate filtration. Other required maintenance includes but is not limited to:

- Conduct pruning and weeding to maintain appearance as needed.
- Replace or replenish mulch as needed.
- Remove trash and debris as needed.

Bioretention Area with un-cut clean outs

Summary of Maintenance Requirements

Required Maintenance	Frequency
Pruning and weeding.	As needed
Remove trash and debris.	As needed
Inspect inflow points for clogging. Remove any sediment.	Semi-annual (every 6-months)
Repair eroded areas. Re-seed or sod as necessary.	Semi-annual (every 6-months)
Mulch void areas.	Semi-annual (every 6-months)
Inspect trees and shrubs to evaluate their health.	Semi-annual (every 6-months)
Remove and replace dead or severely diseased vegetation.	Semi-annual (every 6-months)
Removal of evasive vegetation.	Semi-annual (every 6-months)
Nutrient and pesticide management.	Annual, or as needed
Water vegetation, shrubs and trees.	Semi-annual (every 6-months)
Remove mulch, reapply new layer.	Annual
Test planting mix for pH.	Annual
Apply lime if pH < 5.2.	As needed
Add iron sulfate + sulfur if pH > 8.0.	As needed
Place fresh mulch over entire area.	As needed
Replace pea gravel diaphragm.	Every 2 to 3 years if needed

Infiltration Trenches

Description

Infiltration trenches are excavations typically filled with stone to create an underground reservoir for storm water runoff. The runoff volume gradually exfiltrates through the bottom and sides of the trench into the subsoil over a maximum period of 72 hours (three days), and eventually reaches the water table. By diverting storm water runoff into the soil, an infiltration trench not only treats the water quality volume, but it also preserves the natural water balance by recharging groundwater and preserving channel baseflow. Using natural filtering properties, infiltration trenches remove a wide variety of pollutants from the runoff through adsorption, precipitation, filtering, and bacterial and chemical degradation.

When and Where to Use It

Infiltration trenches are limited to areas with highly porous soils where the water table and or bedrock are located well below the trench bottom. They are only applicable for Hydrologic Soil Group A soils, or soils that have a minimum infiltration rate of 0.3-inches per hour. Infiltration trenches are not intended to trap sediment and are designed with a sediment forebay or other pre-treatment measure to prevent clogging in the gravel. Infiltration trenches are used for medium- to high- density residential, commercial, and institutional developments. They are most applicable for impervious areas where there are low levels of fine particulates in the runoff and the site is completely stabilized and the potential for possible sediment loads is very low. Do not use Infiltration trenches for manufacturing and industrial sites where there is potential for high concentrations of soluble pollutants and heavy metals. Infiltration trenches are designed to capture sheet flow from a drainage area or function as an off-line device. Due to the relatively narrow shape, infiltration trenches are adapted to many different types of sites and is utilized in retrofit situations. Unlike some water quality BMPs, infiltration trenches can easily fit into margin, perimeter or other unused areas of development sites.

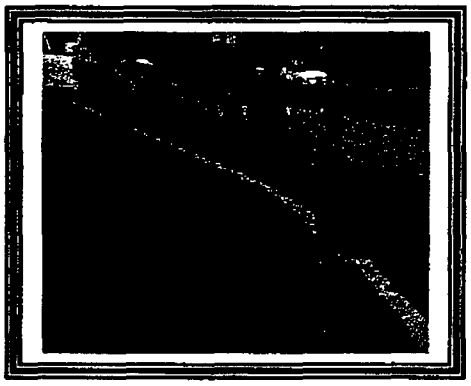
Inspection and Maintenance

Regular inspection and maintenance is critical to the effective operation of infiltration trenches as designed. Maintenance responsibility for the infiltration trench should be vested with a responsible authority by means of a legally binding and enforceable maintenance agreement that is executed as a condition of the Storm Water Management Permit approval. Typical maintenance responsibilities include:

- Keep a record of the average de-watering time of the infiltration trench to determine if maintenance is required.
- The top 6-inch layer of pea gravel and geotextile separating the pea gravel from the stone media serve as a sediment barrier and require replacement when full of sediment.
- Clear debris and trash from all inlet and outlet structures monthly.
- Check the observation well after three consecutive days of dry weather after a rainfall event. If complete de-watering is not observed within this period, there may be clogging within the trench requiring proper maintenance.
- Remove trees, shrubs, or invasive vegetation semi-annually.
- If complete failure is observed, perform total rehabilitation by excavating the trench walls to expose clean soil, and replacing the gravel, geotextiles, and topsoil.

Summary of Maintenance Requirements

Required Maintenance	Frequency
Ensure that the contributing area is stabilized with no active erosion.	Monthly
Grass filter strips should be mowed and grass clippings should be removed.	Monthly
Check observation wells after 72 hours of rainfall. Wells should be empty after this time period. If wells have standing water, the underdrain system or outlet may be clogged.	Semi-annual (every 6-months)
Remove evasive vegetation.	Semi-annual (every 6-months)
Inspect pretreatment structures for deposited sediment.	Semi-annual (every 6-months)
Replace pea gravel, topsoil and top surface filter fabric.	When clogging or surface standing water is observed
Perform total rehabilitation of infiltration trench.	Upon observed failure



Infiltration Trench

Enhanced Dry Swales

Description

Enhanced dry swales are conveyance channels engineered to capture, treat, and release the storm water quality runoff volume from a particular drainage area. Enhanced swales are different from normal drainage swales in that they have a designed structure implemented in them to enhance detention and storm water pollutant removal. Enhanced dry swale systems are designed primarily for storm water quality and have only a limited ability to provide storm water runoff volume control and downstream channel protection. Enhanced dry swales are vegetated channels designed to include a filter bed of prepared soil that overlays an underdrain system. Dry swales are sized to allow the entire water quality storage volume to be filtered or infiltrated through the swale bottom. Because these swales are predominantly dry, they are preferred in residential settings.

When and Where to Use It

Enhanced swales are applicable in moderate to large lot residential developments and industrial areas with low to moderate density where the impervious cover (parking lots and rooftops) of the contributing drainage areas is relatively small. Enhanced swales are also useful along rural roads and highways that have driveway entrances crossing the swale.

Inspection and Maintenance

Regular inspection and maintenance is critical to the effective operation of enhanced swales. Maintenance responsibility should be vested with a responsible authority by means of a legally binding and enforceable maintenance agreement that is executed as a condition of plan approval.

The surface of the filter bed may become clogged with fine sediments over time. Light core aeration is required to ensure adequate filtration. Other required maintenance includes but is not limited to:

- Mowing to maintain storage volume and appearance as needed.
- Remove trash and debris as needed.

Summary of Maintenance Requirements

Required Maintenance	Frequency
Mow grass to maintain design height and remove clippings.	As needed (frequent/seasonally)
Nutrient and pesticide management.	Annual, or as needed
Inspect side slopes for erosion and repair.	Annual, or as needed
Inspect channel bottom for erosion and repair.	Annual, or as needed
Remove trash and debris accumulated in forebay.	Annual
Inspect vegetation. Plant an alternative grass species if original cover is not established.	Annual (semi-annually first year)
Inspect for clogging and correct the problem.	Annual
Roto-till or cultivate the surface of the bed if swale does not draw down in 48 hours.	As needed
Remove sediment build-up within the bottom of the swale.	As needed, after 25% of the original design volume has filled

Enhanced Swales

Pre-Fabricated Control Devices

Description

The need for urban water quality BMPs that are very efficient and present less space constraints has produced the industry of innovated storm water BMP technology and products. These pre-manufactured products combine settling, filtration, and various biological processes into one controlled system. By combining these different processes, these BMPs are designed to focus on removing many different types and concentrations pollutants. Even where pre-fabricated control devices are not able to meet the 80 percent TSS removal goal alone, they can provide excellent pre-treatment in a series of water quality control BMPs or inlet to permanent pool detention basins or storm water wetlands.

Post construction pre-fabricated storm water quality BMPs are designed to filter and trap trash, floatable contaminates, sediment, oil and grease, and other pollutants. These BMPs are incorporated into storm water conveyance systems for pretreatment of storm water runoff. In some instances, pre-fabricated storm water quality BMPs serve as the only treatment mechanism before the runoff is discharged. Post construction pre-fabricated storm water quality BMPs are classified in to three separate categories:

1. Catch Basin Inserts
2. Separation Devices
3. Filtration Devices

When and Where to Use It

Pre-fabricated control devices may be used to treat runoff as long as they are designed to treat the first 1-inch of runoff and/or are proven to provide 80 percent TSS removal. Pre-fabricated control devices include the following beneficial attributes for water quality control over conventional water quality BMPs:

- Pre-fabricated control devices are placed almost anywhere on a site where they can receive concentrated flows from storm drainage pipes.

- Pre-fabricated control devises are safe to the public because storm water is treated within the unit and no surfaces are open to the environment, unlike the permanent pool detention pond or storm water wetland.
- Minimal on-site construction is required because pre-fabricated control devices are typically assembled before they reach the site.

Catch Basin Inserts

Catch Basin Inserts are defined as BMPs designed to be installed directly into storm drain catch basins to treat the runoff before it enters the primary conveyance system.

There are three basic Catch Basin Inserts available: tray, bag, and basket. These inlets typically are made of a stainless steel or a high strength corrugated plastic frame that supports a sedimentation chamber and filter media designed to absorb specific pollutants such as oil, grease hydrocarbons, and heavy metals. Catch Basin Inserts sometime include a high flow bypass mechanism to prevent scouring and re-suspension of previously trapped pollutants during larger rainfall events.

Pollutant removal efficiencies are variable and highly dependent on storm frequency, influent pollutant concentrations, rainfall intensity and other factors. Catch Basin Inserts exhibit the following properties:

- Utilize settling, separation, swirling, centrifugal force, and filtering techniques to remove pollutants from storm water runoff.
- Contain no moving components that require an external power source such as electricity, gas powered engines or generators.
- Have posted data from third party test results.

Separation Devices

Separation Devices are defined as BMPs designed and sized to capture and treat storm water runoff to prevent pollutants from being transported downstream. Separation Devices contain a sump for sediment deposition and a series of chambers, baffles, and weirs to trap trash, oil, grease and

other contaminants. These BMPs are designed as flow-through structures where the inflow rate into the structure is regulated. These structures are not designed to store the entire water quality volume. Separation Devices sometime include a high flow bypass mechanism to prevent scouring and re-suspension of previously trapped pollutants during larger rainfall events.

Pollutant removal efficiencies are variable and are highly dependent on storm size, influent pollutant concentrations, rainfall intensity, and other factors. Separation Devices exhibit the following properties:

- Utilize settling, separation, swirling, and centrifugal force techniques to remove pollutants from storm water runoff.
- Contain no moving components that require an external power source such as electricity, gas powered engines or generators.
- Have posted data from third party test results.

Filtration Devices

Filtration Devices are defined as BMPs designed and sized to capture and treat storm water runoff to prevent pollutants from being transported downstream. Filtration Devices are used in areas with impaired receiving waters where high pollutant removal efficiencies are required. Filtration Devices usually contain a sedimentation chamber and a filtering chamber. These devices may contain filter materials or vegetation to remove specific pollutants such as nitrogen, phosphorus, copper, lead, or zinc.

Pollutant removal efficiencies are variable and are highly dependent on storm size, influent pollutant concentrations, rainfall intensity and other factors. Filtration Devices shall exhibit the following properties:

- Utilize filtering techniques to remove pollutants from storm water runoff.
- Have posted data from third party test results.

Products

There are many pre-fabricated water quality structures on the market that may be used as water quality control BMPs.

Installation

Install in accordance with the Manufacturer's written installation instructions and in compliance with all OSHA, local, state, and federal codes and regulations. A Manufacturer's representative is required to certify the installation of all post construction pre-fabricated storm water quality BMPs.

Proper site stabilization is essential to ensure that post construction pre-fabricated storm water quality BMPs function as designed. These structures are not interned to trap eroded sediment from during construction operations. Post construction pre-fabricated storm water quality BMPs are the last storm water runoff structures installed on-site, or shall remain off-line until final stabilization is achieved.

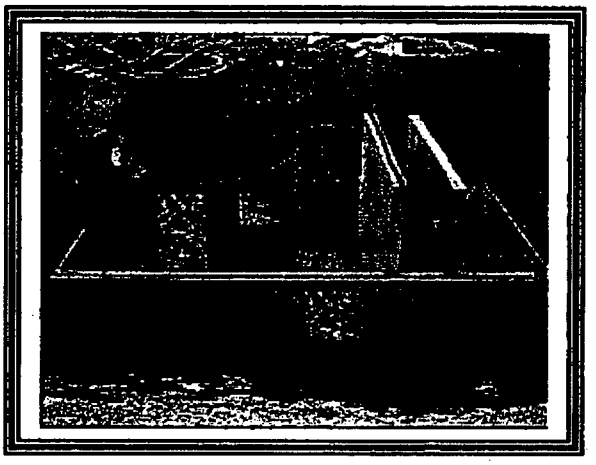
Inspection and Maintenance

- Inspect and maintain in accordance with the Manufacturer's written recommendations.
- The specific maintenance requirements and schedule prepared by the Manufacturer is signed by the owner/operator of the BMP.
- Require frequent inspection and maintenance to maximize pollutant removal.
- Maintain BMPs at least bi-annually to ensure that the BMPs are working properly.
- Keep a maintenance log to track routine inspections and maintenance. Lack of maintenance is the most common cause of failure for post construction pre-fabricated storm water quality BMPs.
- Remove accumulated sediment and other trapped pollutants when the BMP becomes full. Typical removal of pollutants requires the use of a Vactor truck.

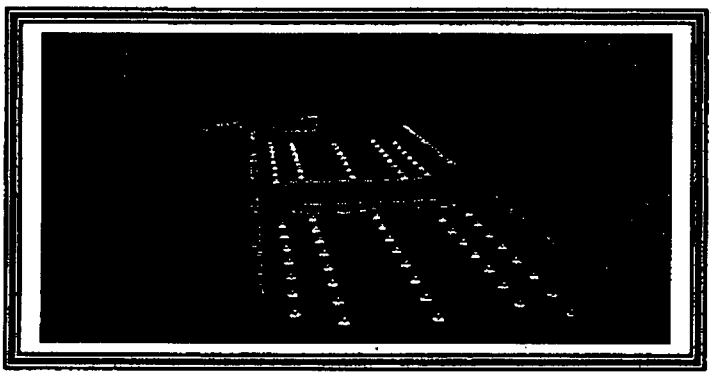
Summary of Maintenance Requirements

Required Maintenance	Frequency
Inspect separation and filtration units.	Regularly (quarterly)
Clean out sediment, oil and grease, and floatables. Manual removal of pollutants may be necessary.	As needed
Perform requirements obtained from manufacturer.	As needed
Inspections.	Frequency of inspection and maintenance is dependent on land use, accumulated solids climatological conditions, and design of pre-fabricated device

Catch Basin Insert



Separation Device



Filtration Device

Vegetated Filter Strips

Description

Vegetated Filter Strips (VFS) are zones of vegetation where pollutant-laden runoff is introduced as sheet flow. VFS may take the form of grass filters, grass filter strips, buffer strips, vegetated buffer zones, riparian vegetated buffer strips, and constructed filter strips.

When and Where to Use It

Applicable in areas where filters are needed to reduce pollutant impacts to adjacent properties and water bodies. VFS are used to remove pollutants from overland sheet flow but are not effective in removing sediment from concentrated flows. There are two main classifications of VFS:

- Constructed filter strips: Constructed and maintained to allow for overland flow through vegetation that consists of grass-like plants with densities approaching that of tall lawn grasses.
- Natural vegetative strips: Area where pollutant-laden flow is directed in an overland manner, including riparian vegetation around drainage channels. Vegetation ranges from grass-like plants to brush and trees with ground cover.

VFS remove pollutants primarily by three mechanisms:

1. Deposition of bedload material and its attached chemicals as a result of decreased flow velocities and transport capacity. This deposition takes place at the leading edge of the filter strip.
2. Trapping of suspended solids by the vegetation at the soil vegetation interface. When suspended solids settle to the bed, they are trapped by the vegetated litter at the soil surface instead of being re-suspended as would occur in a concentrated flow channel. When the litter becomes inundated with sediment, trapping no longer occurs by this mechanism.
3. Trapping of suspended materials by infiltrating water. This is the primary mechanism by which dispersed clay sized particles are trapped.

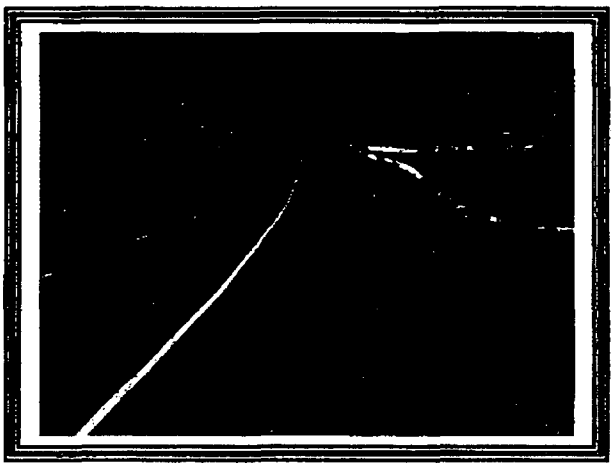
VFS effectiveness fluctuates considerably depending on vegetation type, vegetation height and density, season of the year, eroded particle characteristics, size of drainage area, and site topography.

Inspection and Maintenance

- Maintenance is very important for filter strips, particularly in terms of ensuring that flow does not short circuit the practice. They require similar maintenance to other vegetative practices.
- Inspect vegetation for rills and gullies annually and correct. Seed or sod bare areas.
- Inspect grass after installation to ensure it has established. If not replace with an alternative species.
- Inspect to ensure that grass has established annually. If not, replace with an alternative species.
- Mow grass to maintain a height of 3- to 4-inches.
- Remove sediment build-up from the bottom when it has accumulated to 25% of the original capacity.

Summary of Maintenance Requirements

Required Maintenance	Frequency
Mow grass to maintain design height.	Regularly (frequently)
Remove litter and debris.	Regularly (frequently)
Inspect for erosion, rills and gullies and repair.	Annual, or as needed
Repair sparse vegetation.	Annual, or as needed
Inspect to ensure that grass has established. If not, replace with an alternative species.	Annual, or as needed
Nutrient and pesticide management.	Annual, or as needed
Aeration of soil.	Annual, or as needed



Roadside Vegetated Filter Strip

Grass Pavement and Porous Pavement Surfaces

Description

Grass Paving

Grass paving technology allows for the reduction of paved areas by implementing grass paving in areas that are infrequently used such as fire lanes and overflow parking where applicable. A variety of grass paving materials are available on the market. Grass paving units are designed to carry vehicular loading and may be composed of different types of materials. The pavers are typically covered with sod to make the areas indistinguishable from other grassed areas. Grass pavers allow water quality benefits by allowing storm water to infiltrate into the underlying soils and by the filtering of storm water as it flows through the grass.

Grass pavers provide a more aesthetically pleasing site and reduce the impact of complete asphalt surfaces. Grass pavers should not be used for frequently traveled or parked in areas. Grass pavers reduce the runoff volume and extend the time of concentration for a particular site. Some pavers provide enough infiltration to be considered a pervious area.

Porous Paving

Porous pavement is a permeable pavement surface with an underlying stone reservoir to temporarily store surface runoff before it infiltrates into the subsoil. This porous surface replaces traditional pavement, allowing parking lot storm water to infiltrate directly and receive water quality treatment, and also reducing runoff from the sit

When and Where to Use It

Porous pavement options include porous asphalt, pervious concrete, and grass pavers. The ideal application for porous pavement is to treat low-traffic or overflow parking areas. Porous pavement also has highway applications where it is used as a surface material to reduce hydroplaning.

Porous pavements are a good option in ultra-urban areas because they consume no space since there is very little pervious area in these areas. Since porous pavement is an infiltration practice, do not apply it on storm water hot spots due to the potential for ground water contamination. The best application of porous pavement for retrofits is on individual sites where a parking lot is being resurfaced.

Inspection and Maintenance

- Porous pavement requires extensive maintenance compared with other practices.
- Avoid sealing or repaving with non-porous materials.
- Ensure that paving area is clean of debris, paving dewaters between storms, and that the area is clean of sediments monthly.
- Mow upland and adjacent areas, and seed bare areas as needed.
- Vacuum sweep frequently to keep the surface free of sediment as needed.
- Inspect the surface for deterioration or spalling annually.
- Perform high pressure hosing to free pores in the top layer from clogging as needed.

Porous Paving

Special Construction Operation BMPs

Pollution Prevention (P2) BMPs for water quality management during Special Construction Operations are discussed in this Field Manual in the indicated Sections:

- Vehicle and Equipment Washing
- Truck Washing
- Potable Water and Irrigation
- Illicit Connection/ Illegal Discharge Detection and Reporting
- Fertilizer Management
- Stockpile Management

Vehicle and Equipment Washing

On-site vehicle and equipment washing is discouraged. Clean all vehicles/equipment that regularly enters and leaves the construction site off-site. However, if vehicle or equipment cleaning operations must be performed on a construction site, use the BMPs presented below to minimize or eliminate the discharge of pollutants to storm drain systems or to watercourses.

BMPs

- Wash vehicles and equipment within a structure or building equipped with appropriate disposal facilities, if possible.
- When vehicle and equipment washing must occur onsite and outside, the outside cleaning area should have the following characteristics, and should be arranged with the Engineer or CRM:

  - Located away from storm drain inlets, drainage facilities, or watercourses;
  - Paved with concrete or asphalt and bermed to contain wash waters and to prevent run-on and runoff;
  - Configured with a sump to allow collection and disposal of wash water;
  - Wash waters should not be discharged to storm drains or watercourses; and,
  - Used only when necessary.

- Cleaning of vehicles and equipment with soap, solvents or steam should not occur on the project site unless wastes are fully contained and disposed of properly outside the highway right-of-way.
- The use of diesel for vehicle and equipment cleaning is prohibited.
- Vehicle and equipment wash water should be contained for percolation or evaporative drying away from storm drain inlets or watercourses and should not be discharged within the highway right-of-way. Apply sediment control BMPs if applicable.

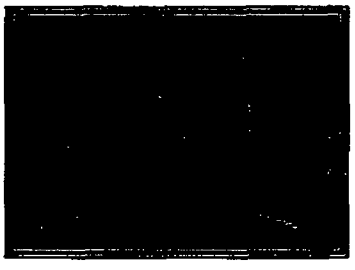
- When cleaning vehicles/equipment with water:

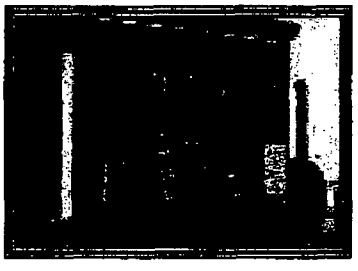
– Use as little water as possible. High pressure sprayers may use less water than a hose, and should be considered; and,
– Use positive shutoff valve to minimize water usage.

- Minimize the use of solvents. Do discharge thinners or solvents into Sanitary or storm sewer systems when cleaning large machine parts where discharge of water is required. Use alternative methods for cleaning larger equipment parts such as high pressure, high temperature water washes, or steam cleaning.
- Equipment washing detergents can be used and wash water discharged into the sanitary system if grit is removed from the solution first. The water discharged into the sewer system must not exceed discharge limits set by the local sewer authority.
- Small parts can be cleaned with degreasing solvents, which are reused after filtering or recycled. These solvents should not be discharged into any sewer.

Inspection and Maintenance

- Monitor employees and subcontractors throughout the duration of the construction project to ensure appropriate vehicle and equipment washing and cleaning practices are being implemented.
- Inspect wash water sump regularly and remove liquids and sediment as needed or as directed by the Engineer or CRM.





Vehicle & Equipment Washing

Concrete Truck Washout

Concrete trucks should not typically be washed on site. However, if this does need to occur the following BMPs should be used.

BMPs

- Do not dispose of truck washout water by dumping into a sanitary sewer, storm drain or onto soil or pavement that carries storm water runoff.
- The washout from a concrete truck should be disposed of into:

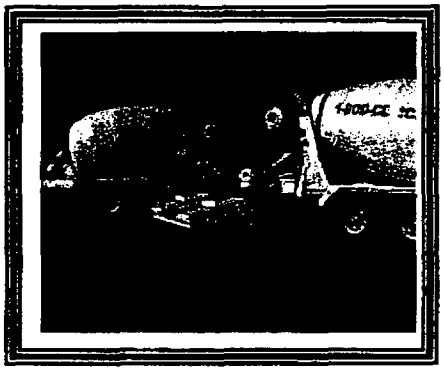
- A designated area that will later be backfilled: a slurry pit.
- An area where the concrete wash can harden, be broken up, and then disposed of as solid waste.
- A location which is not subject to surface water runoff, and more than 50-feet away from a storm drain, open ditch, or receiving water.

- Pump excess concrete in concrete pump bin back into concrete mixer truck.
- Concrete washout from concrete pumper bins can be washed into concrete pumper trucks and discharged into designated washout area or properly disposed offsite.

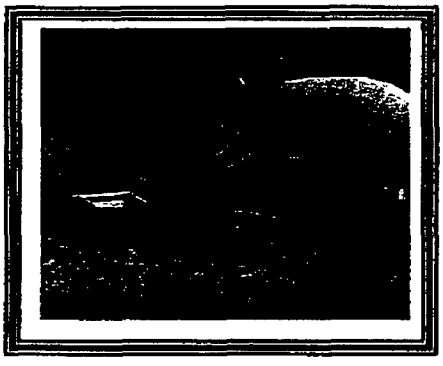
Inspection and Maintenance

- Monitor employees and subcontractors throughout the duration of the construction project to ensure appropriate practices are being implemented.

- Inspect washout sump regularly and remove liquids and sediment as needed.



Concrete Truck Washout



Concrete Truck Washout

Potable Water and Irrigation

Potable water/irrigation management consists of BMPs to manage the discharge of potential pollutants to storm drains or water courses generated during discharges from irrigation water lines, landscape irrigation, lawn or garden watering, planned and unplanned discharges from potable water sources, water line flushing, and hydrant flushing.

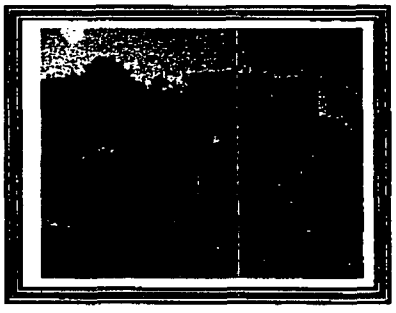
BMPs

- Inspect irrigated areas within the construction limits for excess watering. Adjust watering times and schedules to ensure that the appropriate amount of water is being used and to minimize runoff.
- Direct water from off-site sources around or through a construction site to minimizes contact with the construction site.
- Reuse water line flushing discharge for landscaping purposes.
- Shut off the water source to broken lines, sprinklers, or valves as soon as possible to prevent excess water flow.
- Protect downstream storm water drainage system and watercourses from water pumped or bailed from trenches excavated to repair water lines.

Inspection and Maintenance

- Repair broken water lines as soon as possible.
- Inspect irrigated areas regularly for signs of erosion and/or discharge.

Potable Water & Irrigation



Potable Water & Irrigation

Illicit Connection/ Illegal Discharge

The BMPs provided in this section are designed for construction contractors to recognize illicit connections or illegally dumped or discharged materials on a construction site. Illicit connection/illegal discharge detection and reporting is applicable anytime an illicit connection or discharge is discovered or illegally dumped material is found on the construction site and applies to all construction projects.

BMPs

- Inspect the construction site before beginning the job for evidence of illicit connections or illegal dumping or discharges.
- Inspect site regularly during project execution for evidence of illicit connections or illegal dumping or discharges.
- Observe site perimeter for evidence or potential of illicit discharges or illegally dumped material, which may enter the site.
- Solids – Look for debris, or rubbish piles. Solid waste dumping often occurs on roadways with light traffic loads or in areas not easily visible from the traveled way.
- Liquids – signs of illegal dumping or discharge can include:

– Visible signs of staining or unusual colors to the pavement or surrounding adjacent soils;
– Pungent odors coming from the drainage system;
– Discoloration or oily substances in the water or stains and residues detained within ditches, channels or drain boxes; and,
– Abnormal water flow during the dry weather season.

- Urban Areas – Evidence of illicit connections or illegal discharges is typically detected at storm drain outfall locations or at manholes. Signs of an illicit connection or illegal discharge can include:

– Abnormal water flow during the dry weather season;
– Unusual flows in subdrain systems used for dewatering;

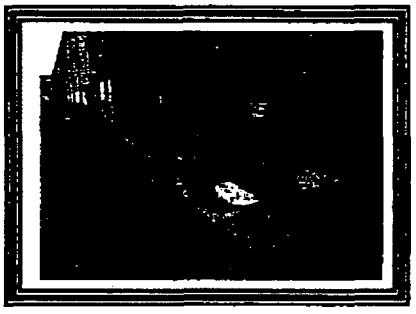
- Discoloration or oily substances in the water or stains and residues detained within ditches, channels or drain boxes; and,
- Excessive sediment deposits, particularly adjacent to or near active off-site construction projects.

- Rural Areas – Illicit connections or illegal discharges involving irrigation drainage ditches are detected by visual inspections. Signs of an illicit discharge can include:

- Abnormal water flow during the dry weather season;
- Non-standard junction structures; and,
- Broken concrete or other disturbances at or near junction structures.

Inspection and Maintenance

- Notify the Engineer or CRM of any illicit connections and illegal dumping or discharge incidents at the time of discovery.
- The contractor is not responsible for investigation and clean up of illicit or illegal dumping or discharges not generated by the contractor. SCDOT may direct contractors to clean up non-hazardous dumped or discharged material on the construction site.



Illicit Connections

Fertilizer Management

This section provides BMPs that will aid in reducing the contributions of pollutants from pesticides and fertilizers to storm water discharges. The term pesticide in this Manual refers to insecticides, fungicides, herbicides, nematicides, desiccants, defoliants, plant regulators, and disinfectants.

BMPs

Pesticide Applications

- Perform pesticide application with a licensed applicator.
- Follow instructions closely when applying pesticides around streams or ditches that may carry runoff. The proper application of a pesticide is described on the container label.
- Notify neighbors on properties adjacent to the one being sprayed prior to spraying.
- Place warning signals in areas recently sprayed or treated with the most dangerous pesticides.

Fertilizer Applications

- Fertilizers used in re-vegetating graded areas often cause inorganic nutrient pollution. Use proper soil-stabilization measures, sediment control, and storm water detention structures as effective means of keeping these materials out of waterways.
- Minimize nutrient pollution by working fertilizer and lime materials into the soil to depths of 4- to 6-inches and proper timing of the application.
- Hydro-seeding operations where seed, fertilizer and lime are applied in a one-step operation, are more conducive to nutrient pollution than conventional seedbed-preparation operations, where fertilizer and lime are tilled into the soil.
- Control can be achieved by applying the required quantity of fertilizer in more than one operation. For example, an area requiring an application of 500 pounds per acre or fertilizer could be dressed with about 125 pounds per acre at four separate times over the growing season.

- Use of fertilizer containing little or no phosphorous may be required by local authorities if development is near sensitive water bodies. In any event, use only the minimum amount of phosphorus needed, as determined by soil tests.
- Near sensitive surface waters, the addition of lime can affect the pH of runoff and receiving waters. Importation of topsoil is better than heavily liming and fertilizing exposed subsoil.

Storage and Handling

- Establish a locked, weather-resistant storage area for pesticides and fertilizer on the construction site.
- Container lids should be tightly closed.
- Keep pesticides in a cool, dry place. Many pesticides rapidly lose their effectiveness if stored in areas exposed to heat.
- In case of a leak, put original container into a larger container and label it properly.
- Keep a list of products in storage.
- Use plastic sheeting to line the storage area.
- Remind workers during pre-construction or safety meetings about proper storage and handling of materials.

Inspection and Maintenance

All storage sheds, dumpsters, or other storage facilities should be regularly monitored for leaks and repaired as necessary.

Fertilizer Management

Stockpile Management

The stockpile management BMPs described in this section are designed to reduce or eliminate air and storm water pollution from stockpiles of soil, and paving materials such as PCC rubble, AC, AC rubble, aggregate base, aggregate subbase or pre-mixed aggregate, asphalt binder (so-called "cold mix" asphalt) and pressure treated wood. These practices should be implemented at all construction sites that stockpile soil or these other materials.

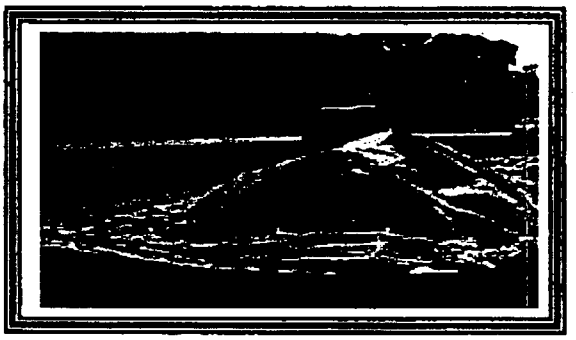
BMPs

General

- Protection of stockpiles is a year-round requirement.
- All active stockpiles should be covered, stabilized, or protected with a temporary linear sediment barrier prior to the onset of precipitation.
- All non-active stockpiles should be covered or protected with a temporary perimeter sediment barrier at all times.
- Cover stockpiles with plastic, mats, blankets, mulches, or sprayed with water or soil binders.
- Surround the base of a stockpile may with a row of fiber rolls, silt fence, or other sediment barrier.
- Keep the height of stockpiles low, and adjust the shape and orientation of the stockpiles to reduce the area of exposure to the prevailing wind.
- Locate stockpiles a minimum of 50-feet away from concentrated flows of storm water, drainage courses, and inlets.
- Bagged materials should be placed on pallets and under cover.
- Cold mix stockpiles should be placed on and covered with plastic or comparable material at all times.
- Treated wood (wood treated with copper, chromium and arsenic or ammonical, copper, zinc, and arsenate) should be covered with plastic or comparable material.

Inspection and Maintenance

Repair and/or replace perimeter controls and covers as needed, or as directed by the CRM to keep them functioning properly. Sediment should be removed when sediment accumulation reaches one-third (1/3) of the barrier height.



Stockpile Management

Stockpile Management

Waste Management BMPs

Waste Management BMPs for construction sites are discussed in this Field Manual in the indicated Sections:

- Solid Waste Management
- Liquid Waste Management
- Hazardous Waste Management
- Sanitary and Septic Waste Management
- Concrete Waste Management
- Spill Prevention, Control and Cleanup

Solid Waste Management

Solid waste management BMPs are designed to minimize or eliminate the discharge of pollutants to the drainage system or to watercourses as a result of the creation, stockpiling, or removal of construction site wastes. The BMPs presented below can be implemented on all construction projects that generate solid wastes. Solid wastes include but are not limited to:

- Construction wastes including brick, mortar, timber, steel and metal scraps, sawdust, pipe and electrical cuttings, non-hazardous equipment parts, Styrofoam and other materials used to transport and package construction materials.
- Highway planting wastes, including vegetative material, plant containers, and packaging materials.
- Litter, including food containers, beverage cans, coffee cups, paper bags, plastic wrappers, and smoking materials, including litter generated by the public.

BMPs

- Instruct employees and subcontractors on identification of solid waste and hazardous waste and proper disposal procedures, and encourage these procedures to be followed.
- Hold regular meetings to discuss and reinforce disposal procedures (incorporate into regular safety meetings).
- Wherever possible, minimize production of solid waste materials.
- Dumpsters of sufficient size and number should be provided to contain the solid waste generated by the project and properly serviced.
- Frequent garbage removal helps maintain clean construction sites and minimizes the exposure of waste to storm water.

- The site should be kept clean of litter debris.
- To prevent clogging of the storm drainage system, litter and debris removal from drainage system, drainage grates, trash racks, and ditch lines should be a priority.
- Trash receptacles should be provided in the contractor's yard, field trailer areas, and at locations where workers congregate for lunch and break periods. These containers should be handled and by trash hauling contractors. Only watertight dumpsters are acceptable for use on-site.
- Construction debris and litter from work areas within the construction limits of the project site should be collected and placed in watertight dumpsters at least weekly regardless of whether the litter was generated by the Contractor, the public, or others. Collected litter and debris should not be placed in or next to drain inlets, storm water drainage systems or watercourses.
- Solid waste storage areas should be located at least 50-feet from drainage facilities and watercourses and should not be located in areas prone to flooding or ponding.
- Dumpster washout on the project site is not allowed.
- Plan for additional containers during the demolition phase of construction.
- Plan for more frequent pickup during the demolition phase of construction.
- Construction waste should be stored in a designated area approved by the CRM and should be removed from the site every two weeks or directed by the Engineer or CRM.
- Segregate potentially hazardous waste from non-hazardous construction site waste.

- Make sure the toxic liquid wastes (e.g., used oils, solvents, and paints) and chemical (e.g., acids, pesticides, additives, curing compounds) are not disposed of in dumpsters designated for construction debris.
- For disposal of hazardous waste, see section on *Hazardous Waste Management.* Have hazardous waste hauled to an appropriate disposal and/or recycling facility.
- Salvage or recycle useful vegetation debris, packaging and/or surplus building materials when practical. For example, trees and shrubs from land clearing can be converted into wood chips, then used as mulch on graded areas. Wood pallets, cardboard boxes, and construction scraps can also be recycled.

Inspection and Maintenance

The Engineer or CRM should monitor onsite solid waste storage and disposal procedures.

Inspect site for litter and debris.

Solid Waste Management

Liquid Waste Management

Liquid waste management BMPs are designed to prevent or minimize the discharge of pollutants to the storm drain system or receiving waters as a result of the creation, collection, and disposal of non-hazardous liquid wastes. Liquid waste management BMPs are applicable to construction projects that generate any of the following non-hazardous byproducts, residuals, or wastes:

- Drilling slurries and drilling fluids;
- Grease-free and oil-free wastewater and rinse water;
- Dredgings; and,
- Other non-storm water liquid discharges not permitted by separate permits.

Disposal of some liquid wastes may be subject to specific laws and regulations, or to requirements of other permits secured for the construction project (e.g., other NPDES permits, Army Corps of Engineers permits, etc.).

This section does not apply to dewatering operations (see *Construction Dewatering*) or to permitted non-storm water discharges (see *Sections* various non-storm water discharges).

BMPs

General Practices

- The Engineer or CRM should oversee and enforce proper liquid waste management procedures and practices.
- Instruct employees and subcontractors how to safely differentiate between non-hazardous liquid waste and potential or known hazardous liquid waste.

- Instruct employees, subcontractors, and suppliers that it is unacceptable for any liquid waste to enter any storm drainage structure, waterway, or receiving water.

- Educate employees and subcontractors on liquid waste generating activities, and liquid waste storage and disposal procedures.

- Incorporate the discussion of proper disposal procedures into regular safety meetings.

- Apply the BMPs identified in *Vehicle and Equipment Washing*, for managing wash water and rinse water from vehicle and equipment cleaning operations.

Containing Liquid Wastes

- Drilling residue and drilling fluids should not be allowed to enter storm drains and watercourses and should be disposed of outside the highway right-of-way in conformance with the applicable SCDOT Standard Specification.

- If an appropriate location is available, as determined by the Engineer or CRM, drilling residue and drilling fluids may be dried by infiltration and evaporation in a containment facility constructed as described in *Concrete Waste Management* section.

- Liquid wastes generated as part of an operational procedure, such as water-laden dredged material and drilling mud, should be contained and not allowed to flow into drainage channels or receiving waters prior to treatment.

- Contain liquid wastes in a controlled area, such as a holding pit, sediment basin, roll-off bin, or portable tank.

- Containment devices must be structurally sound and leak free. Containment devices must be of sufficient quantity or volume to completely contain the liquid wastes generated.

- Take precautions to avoid spills or accidental releases of contained liquid wastes. Apply the education measures and spill response procedures outlined in the *Spill Prevention, Control and Cleanup* section.

- Do not locate containment areas or devices where accidental release of the contained liquid can threaten health or safety, or discharge to water bodies, channel, or storm drains.

Capturing Liquid Wastes

- Capture all liquid wastes running off a surface, which has the potential to affect the storm drainage system, such as wash water and rinse water from cleaning walls or pavement.

- Do not allow liquid wastes to flow or discharge uncontrolled. Use temporary dikes or berms to intercept flows and direct them to a containment area or device for capture.

- If the liquid waste is sediment laden, use a sediment trap (*see Section Temporary Sediment Dam*) for capturing and treating the liquid waste stream, or capture in a containment device and allow sediment to settle.

Disposing of Liquid Wastes

- Liquid wastes, such as from dredged material, may require testing and certification whether it is hazardous or not before a disposal method can be determined.

- For disposal of hazardous waste, see section on *Hazardous Waste Management.*

- If necessary, further treat liquid wastes prior to disposal. Treatment may include, though is not limited to, sedimentation, filtration, and chemical neutralization.

Inspection and Maintenance

- Spot check employees and subcontractors at least monthly throughout the job to ensure appropriate practices are being employed.
- Remove deposited solids in containment areas and capturing devices as needed, and at the completion of the task. Dispose of any solids as described in section on *Solid Waste Management.*
- Inspect containment areas and capturing devices frequently for damage, and repair as needed.

Liquid Waste Management

Hazardous Waste Management

The BMPs described in this section are designed to minimize or eliminate the discharge of pollutants from construction site hazardous wastes to the storm drain systems or to watercourses. These BMPs apply to all construction sites. Hazardous waste management practices are implemented on construction projects that generate waste from the use of:

- Petroleum products;
- Asphalt products;
- Concrete curing compounds;
- Pesticides;
- Acids;
- Paints;
- Stains;
- Solvents;
- Wood preservatives; and,
- Roofing tar.

Hazardous products may include one or more of the following words on the label: Caustic; Caution; Combustible; Corrosive; Danger; Explosive; Flammable; Poisonous; Volatile; or Warning.

Use of the BMPs described below, does not relieve SCDOT or their contractors from responsibility for compliance with all federal, state, and local laws regarding storage, handling, transportation, and disposal of hazardous wastes.

BMPs

Education

- Educate employees and subcontractors on hazardous waste storage and disposal procedures and on potential dangers to humans and the environment from hazardous wastes.

- Instruct employees and subcontractors in identification of hazardous waste.

- Hold regular meetings to discuss and reinforce hazardous waste management procedures (incorporate into regular safety meetings).

- The Engineer should oversee and enforce proper hazardous waste management procedures and practices.

Storage Procedures

- Buy and use only what is needed. Leftovers need to be stored, reused, given away, recycled, or disposed of safely. Look for nontoxic or less toxic options (check with materials specialists).

- Try to keep products in original containers and always keep them well-labeled. If the product must be transferred to smaller containers, use the proper size funnel and avoid spills.

- Labels can fall off with weathering. To prevent this, cover labels with transparent tape. To re-label, use a metal tag attached to the container or use a stencil and spray paint.

- Keep corrosive liquids away from flammable liquids.

- Wastes should be stored in sealed containers constructed of a suitable material and should be labeled as required federal regulations.

- All hazardous waste should be stored, transported, and disposed as required by federal regulations.

- Waste containers should be stored in temporary containment facilities that should comply with the following requirements:

- Temporary containment facility should be impervious to the materials stored there for a minimum contact time of 72-hours.
- Temporary containment facilities should be maintained free of accumulated rainwater and spills. In the event of spills or leaks accumulated rainwater and spills should be placed into drums after each rainfall. These liquids should be handled as a hazardous waste unless testing determines them to be non-hazardous. Non-hazardous liquids should be sent to an approved disposal site.
- Provide sufficient separation between stored containers to allow for spill cleanup and emergency response access.
- Incompatible materials, such as chlorine and ammonia, should not be stored in the same temporary containment facility.
- Temporary containment facilities should be covered during non-working days, and prior to rain events. Covered facilities may include use of plastic tarps for small facilities or constructed roofs with overhangs. A storage facility having a solid cover and sides is preferred to a temporary tarp. Storage facilities should be equipped with adequate ventilation.

- Drums should not be overfilled and wastes should not be mixed.

- Unless watertight, do store containers of dry waste on pallets.

- Paint brushes and equipment for water and oil based paints should be cleaned within a contained area and should not be allowed to contaminate site soils, watercourses or drainage systems. Waste paints, thinners, solvents, residues, and sludges that cannot be recycled or reused should be disposed of as hazardous waste.

- When thoroughly dry, latex paint and paint cans, used brushes, rags, absorbent materials, and drop cloths should be disposed of as solid waste with other construction debris.

- For water-based paint, clean brushes to the extent practical, and rinse to a drain leading to a sanitary sewer where permitted, or into a concrete washout pit.

- For oil-base paints, clean brushes to the extent practical and filter and reuse thinners and solvents.
- Ensure that adequate hazardous waste storage volume is available.
- Ensure that hazardous waste collection containers are conveniently located.
- Designate hazardous waste storage areas on site away from storm drains or watercourses and away from moving vehicles and equipment to prevent accidental spills.
- Minimize production or generation of hazardous materials and hazardous waste on the job site.
- Use containment berms in fueling and maintenance areas and where the potential for spills is high.
- Segregate potentially hazardous waste from non-hazardous construction site debris.
- Keep liquid or semi-liquid hazardous waste in appropriate containers (closed drums or similar) and under cover.
- Clearly label all hazardous waste containers with the waste being stored and the date of accumulation.
- Place hazardous waste containers in secondary containment.
- Do not allow potentially hazardous waste materials to accumulate on the ground.
- Do not mix wastes.

Disposal Procedures

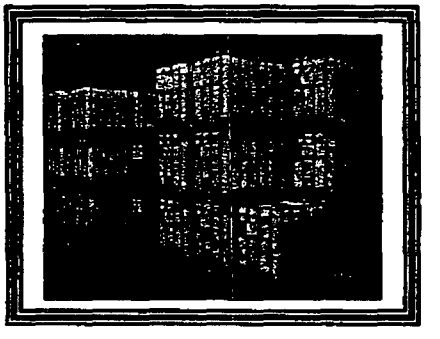
- Use all of the product before disposing of the container.
- Waste should be disposed of outside the highway right-of-way within 90 days of being generated, or as directed by the Engineer.
- Waste should be disposed of by a licensed hazardous waste transporter at an authorized and licensed disposal facility or recycling facility utilizing properly completed Uniform Hazardous Waste Manifest forms.
- A DHEC certified laboratory should sample waste and classify it to determine the appropriate disposal facility.
- Make sure that toxic liquid wastes (e.g., used oils, solvents, and paints) and chemicals (e.g., acids, pesticides, additives, curing compounds) are not disposed of in dumpsters designated for solid waste construction debris.
- Properly dispose of rainwater in secondary containment that may have mixed with hazardous waste.
- Recycle any useful material such as used oil or water-based paint when practical.

Inspection and Maintenance

- A foreman and/or construction supervisor should monitor on-site hazardous waste storage and disposal procedures.
- Waste storage areas should be kept clean, well organized, and equipped with ample clean-up supplies as appropriate for the materials being stored.
- Storage areas should be inspected in conformance with the provisions in the contract documents.

- Repair or replace perimeter controls, containment structures, covers, and liners as needed to maintain proper function.
- Clean hazardous spills should and report conformance with the applicable MSDS and the instructions posted at the project site.
- The National Response Center at (800) 424-8802, should be notified of spills of federal reportable quantities in conformance with the federal regulations.
- Copy of the hazardous waste manifests should be provided

Poor Hazardous Waste Management



Good Hazardous Waste Management

Sanitary/Septic Waste Management

The BMPs provided in this section may be used to minimize or eliminate the discharge of construction site sanitary/septic waste materials to the storm drain system or to watercourses. Sanitary/septic waste management BMPs are applicable on all construction sites that use temporary or portable sanitary/septic waste systems.

BMPs

Education

- Educate employees, subcontractors, and suppliers on sanitary/septic waste storage and disposal procedures and the potential dangers to humans and the environment from sanitary/septic wastes.
- Instruct employees, subcontractors, and suppliers in identification of sanitary/septic waste.
- Discuss and reinforce disposal procedures during regular safety meetings.

Storage and Disposal Procedures

- Temporary sanitary facilities should be located away from drainage facilities, watercourses, and from traffic circulation.
- Wastewater should not be discharged or buried within the highway right-of-way.
- Sanitary and septic systems that discharge directly into sanitary sewer systems, where permissible, should comply with the local health agency, city, county, and sewer district requirements.
- If using an on site disposal system, such as a septic system, comply with local health agency requirements.

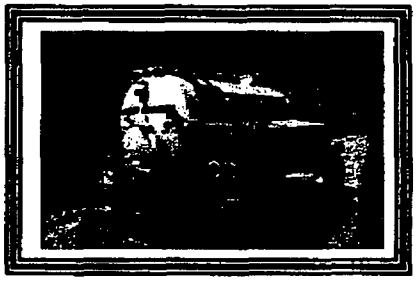
- Properly connect temporary sanitary facilities that discharge to the sanitary sewer system to avoid illicit discharges.

- Ensure that sanitary/septic facilities are maintained in good working order by a licensed service. Use only reputable, licensed sanitary/septic waste haulers.

Inspection and Maintenance

Monitor onsite sanitary/septic waste storage and disposal procedures at least weekly.

Sanitary and Septic Waste Management



Sanitary and Septic Waste Management

Concrete Waste Management

This section presents BMPs that are designed to minimize or eliminate the discharge of concrete waste materials to the storm drain systems or watercourses. Concrete waste management BMPs should be implemented on construction projects where:

- Concrete is used as a construction material or where concrete dust and debris result from demolition activities.
- Slurries containing Portland cement concrete (PCC) or asphalt concrete (AC) are generated, such as from saw cutting, coring, grinding, grooving, and hydro-concrete demolition. See also the section on *Paving and Grinding Operations.*
- Concrete trucks and other concrete-coated equipment are washed on site, when approved by the Engineer. See also *Vehicle and Equipment Washing* and *Concrete Truck Washout.*
- Mortar-mixing stations exist.

BMPs

Education

- Educate employees, subcontractors, and suppliers on the concrete waste management BMPs described in this section.

Concrete Slurry Wastes

- PCC and AC waste should not be allowed to enter storm drains or watercourses.
- PCC and AC slurry or hardened wastes should be collected and properly disposed of outside the highway right-of-way in conformance with Standard Specifications or placed in a temporary concrete washout facility.

- Install a sign adjacent to each temporary concrete washout facility to inform concrete equipment operators to utilize the proper facilities.

- A foreman and/or construction supervisor should monitor onsite concrete working tasks, such as saw cutting, coring, and grooving to ensure proper methods are implemented.

- Do not allow saw-cut PCC slurry to enter storm drains or watercourses. See also *Paving and Grinding Operations* and *Liquid Waste Management*. Residue from grinding operations should be picked up by means of a vacuum attachment to the grinding machine. Saw cutting residue should not be allowed to flow across the pavement, and should not be left on the surface of the pavement.

- Vacuum slurry residue and dispose in a temporary facility (as described in Onsite Temporary Concrete Washout Facility, Concrete Transit Truck Washout Procedures, below) and allow slurry to dry. Dispose of dry slurry residue in accordance with *Solid Waste Management*.

- Collect and dispose of residue from grooving and grinding operations in accordance with *Solid Waste Management*.

Onsite Temporary Concrete Washout Facility, Concrete Transit Truck Washout Procedures

- Temporary concrete washout facilities should be located a minimum of 50 feet from storm drain inlets, open drainage facilities, and watercourses, unless determined infeasible by the Engineer or CRM. Each facility should be located away from construction traffic or access areas to prevent disturbance or tracking.

- Install a sign adjacent to each washout facility to inform concrete equipment operators to utilize the proper facilities.

- Temporary concrete washout facilities should be constructed above grade or below grade at the option of the Contractor. Temporary concrete washout facilities should be constructed and maintained in sufficient quantity and size to contain all liquid and concrete waste generated by washout operations.

- Temporary washout facilities should have a temporary pit or bermed areas of sufficient volume to completely contain all liquid and waste concrete materials generated during washout procedures.

- Perform washout of concrete mixer trucks in designated areas only. Washout may be collected in an impermeable bag for disposal. See also *Concrete Truck Washout.*

- Once concrete wastes are washed into the designated area and allowed to harden, the concrete should be broken up, removed, and disposed of per *Solid Waste Management.*

Inspection and Maintenance

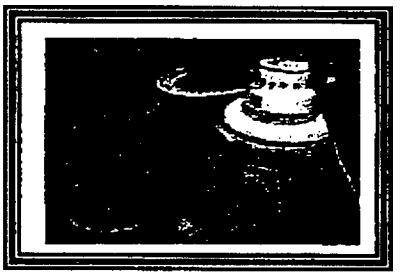
- The Engineer or CRM should monitor on site concrete waste storage and disposal procedures at least weekly.

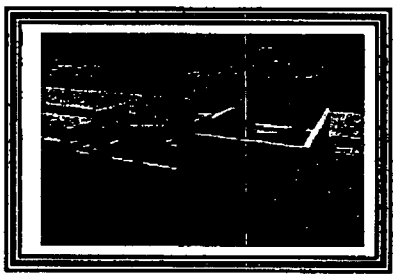
- The Engineer or CRM should monitor concrete working tasks, such as saw cutting, coring, grinding and grooving daily to ensure proper methods are employed.

- Temporary concrete washout facilities should be maintained to provide adequate holding capacity with a minimum freeboard of 4-inches for above grade facilities and 12-inches for below grade facilities. Maintaining temporary concrete washout facilities should include removing and disposing of hardened concrete and returning the facilities to a functional condition.

- Existing facilities should be cleaned, or new facilities should be constructed and ready for use once the washout is 75% full.

- Temporary concrete washout facilities should be inspected for damage (i.e., tears in PVC liner, missing sandbags, etc.). Damaged facilities should be repaired immediately.





Concrete Waste Management

Spill Prevention Control and Cleanup (SPCC)

The BMPs described below should be implemented to prevent and control spills in a manner that minimizes or prevents the discharge of spilled material to the drainage system or watercourses. They apply to all construction projects and should be utilized anytime chemicals and/or hazardous substances are stored on site. Substances may include, but are not limited to:

- Soil stabilizers/binders
- Dust palliatives
- Herbicides
- Growth inhibitors
- Fertilizers
- Deicing/anti-icing chemicals
- Fuels
- Lubricants, and
- Other petroleum distillates

To the extent that the work can be accomplished safely, spills of oil, petroleum products, substances listed under 40 CFR parts 110, 117, and 302, and sanitary and septic wastes should be contained and cleaned up immediately.

Develop and implement a SPCC Plan as part of the SWPPP if appropriate for the construction site involved. The SPCC Plan will identify persons responsible for implementing the plan if a spill of a dangerous or hazardous waste should occur.

If a spill, regardless of size, of a hazardous substance could reach surface waters, DHEC must be notified. When reporting a spill, the following information must be provided:

- Reporting party;
- Material released;

- Concentration of material;
- Contact phone number(s);
- Resource damages (e.g., dead fish);
- Location;
- Responsible party;
- Quantity of spill; and,
- Cleanup status.

Procedures and practices presented in this BMP are general. The site Contractor should identify appropriate practices for the specific materials used or stored on-site.

BMPs

Education

- Educate employees and subcontractors on what a "significant spill" is for each material they use, and what is appropriate response for "significant" and "insignificant" spills.

- Educate employees and subcontractors on potential dangers to humans and the environment from spills and leaks.

- Hold regular meetings to discuss and reinforce appropriate disposal procedures (incorporate into regular safety meetings).

- Provide specific cleanup instructions for different products handled on-site.

- Assign a person to be in charge of cleanup assistance.

- Prepare spill containment and cleanup lists that are easy to find and use.

- Post a summary of the cleanup plan at appropriate locations.

Cleanup and Storage Procedures

- If a spill occurs, demobilize it as soon as possible.
- If there is a chance that the spill could enter a storm drain or sewer, plug the inlet and turn off or divert any incoming water.
- Cover the spill with absorbent material such kitty litter or sawdust. Do not use straw. Dispose of the used absorbent per manufacturer's instructions. If the spill is flammable, dispose of as directed by the local fire marshal.
- Keep the area well ventilated.
- Minor Spills – Minor spills typically involve small quantities of oil, gasoline, paint, etc., which can be controlled by the first responder at the discovery of the spill. Use absorbent materials on small spills rather than hosing down or burying the spill.
- Semi-Significant Spills – Semi-significant spills still can be controlled by the first responder along with the aid of other personnel such as laborers and the foreman, etc. This response may require the cessation of all other activities.
- Contain spills immediately:

– If the spill occurs on paved or impermeable surfaces, clean up using "dry" methods (absorbent materials, cat litter and/or rags). Contain the spill by encircling with absorbent materials and do not let the spill spread widely.
– If the spill occurs in dirt areas, immediately contain the spill by constructing an earthen dike.
– If the spill occurs during rain, to the extent that it doesn't compromise clean up activities, cover spill with tarps or other material to prevent contaminating runoff.

- Significant/Hazardous Spills – For significant or hazardous spills that cannot be controlled by personnel in the immediate vicinity, the services of a spills contractor or a Haz-Mat team should be obtained immediately. Construction personnel should not attempt to clean up the spill until the appropriate and qualified staff has arrived at the job site.

- Spills should not be buried or washed with water.

- Used clean up materials, contaminated materials, and recovered spill material that are no longer suitable for the intended purpose should be stored and disposed of properly.

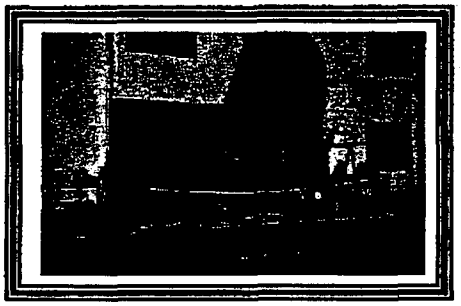
- Water used for cleaning and decontamination should not be allowed to enter storm drains or watercourses and should be collected and disposed of as described in *Liquid Waste Management.*

- Proper storage, clean-up and spill reporting instructions for hazardous materials stored or used on the project site should be posted at all times in an open, conspicuous and accessible location.

- Waste storage areas should be kept clean, well organized and equipped with ample clean-up supplies as appropriate for the materials being stored. Perimeter controls, containment structures, covers and liners should be repaired or replaced as needed to maintain proper function.

Inspection and Maintenance

- Verify weekly, that spill control clean up materials are located near material storage, unloading and use areas.
- Update SPCC plans and stock appropriate clean-up materials whenever changes occur in the types of chemicals used or stored onsite.



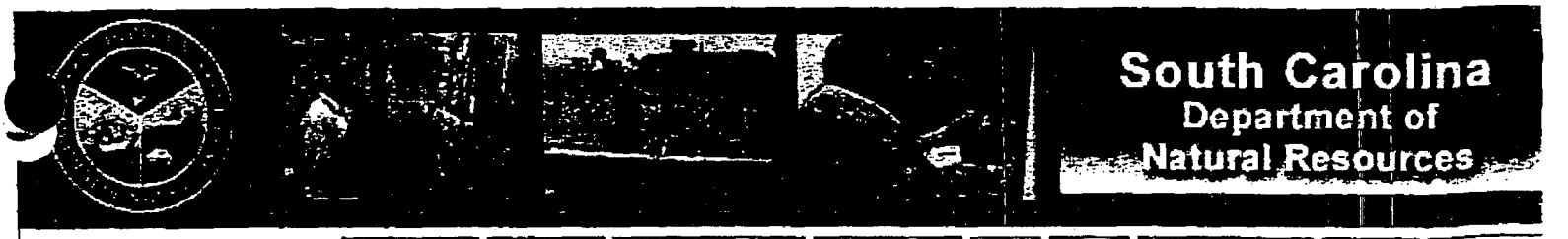
Spill Prevention, Control and Cleanup

Spill Cleanup Kit

8.0 Standard Details

No.	Description
EC-01	Tracking
EC-02	Stair Step Grading
EC-03	Slope Grooving
SC-01	Sediment Basin
SC-02	Sediment Trap
SC-03	Silt Fence
SC-04	Rock Ditch Check
SC-05	Sediment Tube
SC-06	Stabilized Construction Entrance
SC-07	Type A – Filter Fabric Inlet Protection
SC-07	Type A – Sediment Tube Inlet Protection
SC-08	Type B – Wire Mesh and Stone Inlet Protection
SC-09	Type C – Block and Gravel Drop Inlet Protection
SC-10	Type E – Surface Course Curb Inlet Filters
SC-10	Type E – Surface Course Curb Inlet Filters
SC-11	Type F – Inlet Tubes
SC-12	Rock Sediment Dike
SC-12	Rock Sediment Dike (page 2)
SC-12	Rock Sediment Dike (Page 3)
RC-01	Pipe Slope Drain
RC-02	Diversion Dike or Berm

No.	Description
RC-03	Diversion Swale
RC-04	Level Spreader
RC-05	Temporary Stream Low Water Crossing
RC-06	Subsurface Drain Layout
WQ-01	Stream Buffer
WQ-02	Wet Detention Pond
WQ-02A	Extended Detention Shallow Wetland
WQ-02B	Micropool Extended Detention Pond
WQ-03	Dry Ponds
WQ-04A	Shallow Wetland
WQ-04B	Wet Extended Detention Pond
WQ-04C	Pond/Wetland System
WQ-04D	Pocket Wetland
WQ-05	Typical Bioretention Area
WQ-06	Infiltration Trench
WQ-07	Enhanced Dry Swale
WQ-08	Vegetated Filter Strip



Regulations

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South Carolina Rare, Threatened, & Endangered Species Inventory County Selection From List

Please click on a county of interest to view its species data, or click here to list all species found in South Carolina.

Counties A - C	Counties D - L	Counties M - Y
Abbeville	Darlington	Lexington
Aiken	Dillion	Marion
Allendale	Dorchester	Malboro
Anderson	Edgefield	McCormick
Bamberg	Fairfield	Newberry
Barnwell	Florence	Oconee
Beaufort	Georgetown	Orangeburg
Berkeley	Greenville	Pickens
Calhoun	Greenwood	Richland
Charleston	Hampton	Saluda
Chereokee	Horry	Spartanburg
Chester	Jasper	Sumter
Chesterfield	Kershaw	Union
Clarendon	Lancaster	Williamsburg
Colleton	Laurens	York
	Lee	

South Carolina Rare, Threatened, & Endangered Species Inventory KEY

Return to species data...

STATUS - legal status:

FE -
Federal Endangered

FT -
Federal Threatened

PE -
Proposed for Federal listing as Endangered

PT -
Proposed for Federal listing as Threatened

C -
Candidate for Federal listing

NC -
Of Concern, National (unofficial - plants only)

RC -
Of Concern, Regional (unofficial - plants only)

SE -
State Endangered (official state list - animals only)

ST -
State Threatened (official state list - animals only)

SC -
Of Concern, State

SX -
State Extirpated

South Carolina Rare, Threatened, & Endangered Species Inventory
Species Found In Aiken County
Data Last Updated January 17th, 2006.

SCIENTIFIC NAME	COMMON NAME	GLOBAL RANK	STATE RANK	LEGAL STATUS
ACIPENSER BREVIROSTRUM	SHORTNOSE STURGEON	G3	S3	FE/SE
AESCULUS PARVIFLORA	SMALL-FLOWERED BUCKEYE	G2G3	S1	RC
AGALINIS LINIFOLIA	FLAX LEAF FALSE-FOXGLOVE	G4?	S?	SC
ALLIUM CUTHBERTII	STRIPED GARLIC	G3	S?	SC
AMBYSTOMA TIGRINUM TIGRINUM	EASTERN TIGER SALAMANDER	G5T5	S2S3	SC
ARISTIDA CONDENSATA	PIEDMONT THREE-AWNED GRASS	G4?	S?	SC
ASTRAGALUS VILLOSUS	A MILK-VETCH	G4	S?	SC
ATRYTONE AROGOS	AROGOS SKIPPER	G3G4	S?	SC
BOTRYCHIUM LUNARIOIDES	WINTER GRAPE-FERN	G4?	S?	SC
CALAMOVILFA BREVIPILIS	PINE-BARRENS REED-GRASS	G4	S?	NC
CAREX CHEROKEENSIS	CHEROKEE SEDGE	G4G5	SR	SC
CAREX COLLINSII	COLLINS' SEDGE	G4	S1	SC
CAREX ELLIOTTII	ELLIOTT'S SEDGE	G4?	S?	SC
CAREX FOLLICULATA	LONG SEDGE	G4G5	S1	SC
CAREX SOCIALIS	SOCIAL SEDGE	G4	S?	SC
CAROLINA BAY		G?	S?	SC
CLADRASTIS KENTUKEA	YELLOWWOOD	G4	S1	RC
CLEMMYS GUTTATA	SPOTTED TURTLE	G5	S5	ST
COLONIAL WATERBIRD		G?	S?	SC
CONDYLURA CRISTATA	STAR-NOSED MOLE	G5	S3?	SC
COREOPSIS ROSEA	ROSE COREOPSIS	G3	S2	RC
CORYNORHINUS RAFINESQUII	RAFINESQUE'S BIG-EARED BAT	G3G4	S2?	SE
CROTON ELLIOTTII	ELLIOTT'S CROTON	G2G3	S?	SC
CYSTOPTERIS PROTRUSA	LOWLAND BRITTLE FERN	G5	S?	SC
DELPHINIUM CAROLINIANUM	CAROLINA LARKSPUR	G5	S?	SC

DIRCA PALUSTRIS	EASTERN LEATHERWOOD	G4	S?	SC
ECHINACEA LAEVIGATA	SMOOTH CONEFLOWER	G2	S1	FE/
ECHINODORUS PARVULUS	DWARF BURHEAD	G3Q	S2	SC
ELEOCHARIS ROBBINSII	ROBBINS SPIKERUSH	G4G5	S?	SC
ENEMION BITERNATUM	FALSE RUE-ANEMONE	G5	S1	RC
EUONYMUS ATROPURPUREUS	WAHOO	G5	S1	SC
FORESTIERA LIGUSTRINA	UPLAND SWAMP PRIVET	G4G5	S1	SC
GAURA BIENNIS	BIENNIAL GAURA	G5	S?	SC
GOPHERUS POLYPHEMUS	GOPHER TORTOISE	G3	S1	SE
HALESIA PARVIFLORA	SMALL-FLOWERED SILVERBELL-TREE	G?	S?	SC
HALIAEETUS LEUCOCEPHALUS	BALD EAGLE	G4	S2	FT/SE
HETERODON SIMUS	SOUTHERN HOGNOSE SNAKE	G2	S?	SC
HYLA AVIVOCA	BIRD-VOICED TREEFROG	G5	S5	SC
HYMENOCALLIS CORONARIA	SHOALS SPIDER-LILY	G2Q	S2	NC
ILEX AMELANCHIER	SARVIS HOLLY	G4	S3	SC
IPOMOPSIS RUBRA	RED STANDING-CYPRESS	G4G5	S?	SC
JUNIPERUS COMMUNIS	GROUND JUNIPER	G5	S?	SC
KALMIA CUNEATA	WHITE-WICKY	G3	S1	NC
LASIURUS CINEREUS	HOARY BAT	G5	S?	SC
LINDERA SUBCORIACEA	BOG SPICEBUSH	G2	S?	R
LUDWIGIA SPATHULATA	SPATULATE SEEDBOX	G3G4	S?	SC
MACBRIDEA CAROLINIANA	CAROLINA BIRD-IN-A-NEST	G2G3	S?	SC
MAGNOLIA CORDATA	PIEDMONT CUCUMBER TREE	G?Q	S?	SC
MAGNOLIA PYRAMIDATA	PYRAMID MAGNOLIA	G4	S1	RC
MICRURUS FULVIUS	EASTERN CORAL SNAKE	G5	S2	SC
MYRIOPHYLLUM LAXUM	PIEDMONT WATER-MILFOIL	G3	S2	RC
NEOTOMA FLORIDANA	EASTERN WOODRAT	G5	S3S4	SC
NEOTOMA FLORIDANA FLORIDANA	EASTERN WOODRAT	G5T5	S3S4	SC
NERODIA FLORIDANA	FLORIDA GREEN WATER SNAKE	G5	S2	SC
NESTRONIA UMBELLULA	NESTRONIA	G4	S2	SC
NOLINA GEORGIANA	GEORGIA BEARGRASS	G3G5	S?	SC
PARONYCHIA AMERICANA	AMERICAN NAILWORT	G3?	S?	SC
PICOIDES BOREALIS	RED-COCKADED WOODPECKER	G3	S2	FE/SE
PITUOPHIS MELANOLEUCUS	PINE OR GOPHER SNAKE	G4	S3S4	SC
PITYOPSIS PINIFOLIA	PINE-LEAVED GOLDEN ASTER	G4	S?	SC
PLATANTHERA LACERA	GREEN-FRINGE ORCHIS	G5	S1	
PTILIMNIUM NODOSUM	HARPERELLA	G2	S1	FE/SE
RANA CAPITO	GOPHER FROG	G3	S1	SE
RHODODENDRON FLAMMEUM	PIEDMONT AZALEA	G3	S2	SC
RHYNCHOSPORA INUNDATA	DROWNED HORNEDRUSH	G3G4	S?	SC
RORIPPA SESSILIFLORA	STALKLESS YELLOWCRESS	G5	S?	SC

RUELLIA CAROLINIENSIS SSP CILIOSA	A PETUNIA	G5T3T4	S?	SC
SAGITTARIA ISOETIFORMIS	SLENDER ARROW-HEAD	G4?	S2	SC
SARRACENIA RUBRA	SWEET PITCHER-PLANT	G3	S4	SC
SCIRPUS ETUBERCULATUS	CANBY BULRUSH	G3G4	S?	SC
SCIURUS NIGER	EASTERN FOX SQUIRREL	G5	S4	SC
SEMINATRIX PYGAEA	BLACK SWAMP SNAKE	G5	S?	SC
SOLIDAGO AURICULATA	EARED GOLDENROD	G4	S?	SC
SPILOGALE PUTORIUS	EASTERN SPOTTED SKUNK	G5	S4	SC
SPOROBOLUS PINETORUM	CAROLINA DROPSEED	G3	SR	SC
STYLISMA PICKERINGII VAR PICKERINGII	PICKERING'S MORNING-GLORY	G4T2T3	S1	SC
SYNGONANTHUS FLAVIDULUS	YELLOW PIPEWORT	G5	S1	RC
TREPOCARPUS AETHUSAE	AETHUSA-LIKE TREPOCARPUS	G4G5	S?	SC
TRILLIUM DISCOLOR	FADED TRILLIUM	G3	S?	SC
TRILLIUM LANCIFOLIUM	NARROW-LEAVED TRILLIUM	G3	S1	NC
TRILLIUM PUSILLUM VAR PUSILLUM	LEAST TRILLIUM	G3T2	S1	NC
TRILLIUM RELIQUUM	RELICT TRILLIUM	G2	S1	FE/SE
URSUS AMERICANUS	BLACK BEAR	G5	S3?	SC
XYRIS BREVIFOLIA	SHORT-LEAVED YELLOW-EYED GRASS	G4G5	S?	SC

For detailed location information about rare & endangered species, please contact Julie Holling .

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South Carolina Department of Natural Resources - Phone Numbers
Rembert C. Dennis Building, 1000 Assembly Street, Columbia, SC 29201

South Carolina Rare, Threatened, & Endangered Species Inventory
Species Found In Edgefield County
Data Last Updated January 17th, 2006.

SCIENTIFIC NAME	COMMON NAME	GLOBAL RANK	STATE RANK	LEGAL STATUS
ACCIPITER COOPERII	COOPER'S HAWK	G5	S3?	SC
ALASMIDONTA VARICOSA	BROOK FLOATER	G3	S?	SC
AMORPHA GLABRA	SMOOTH INDIGOBUSH	G4?	S?	SC
ARISTIDA CONDENSATA	PIEDMONT THREE-AWNED GRASS	G4?	S?	SC
ASTER GEORGIANUS	GEORGIA ASTER	G2G3	S?	SC
CAREX AMPHIBOLA	NARROWLEAF SEDGE	G5	S?	SC
CAREX GRACILESCENS	SLENDER SEDGE	G5?	S?	SC
COREOPSIS ROSEA	ROSE COREOPSIS	G3	S2	RC
DELPHINIUM CAROLINIANUM	CAROLINA LARKSPUR	G5	S?	SC
ELEOCHARIS ROBBINSII	ROBBINS SPIKERUSH	G4G5	S?	SC
ELLIPTIO LANCEOLATA	YELLOW LANCE	G2G3	S?	SC
ETHEOSTOMA HOPKINSI	CHRISTMAS DARTER	G4G5	S4	SC
FORESTIERA LIGUSTRINA	UPLAND SWAMP PRIVET	G4G5	S1	SC
HALIAEETUS LEUCOCEPHALUS	BALD EAGLE	G4	S2	FT/SE
HYMENOCALLIS CORONARIA	SHOALS SPIDER-LILY	G2Q	S2	NC
ISOETES PIEDMONTANA	PIEDMONT QUILLWORT	G3	S2	SC
JUGLANS CINEREA	BUTTERNUT	G3G4	S?	SC
LAMPSILIS CARIOSA	YELLOW LAMPMUSSEL	G3G4	S?	SC
LASMIGONA DECORATA	CAROLINA HEELSPLITTER	G1	S1	FE/SE
LITHOSPERMUM TUBEROSUM	TUBEROUS GROMWELL	G4	S1	SC
MACBRIDEA CAROLINIANA	CAROLINA BIRD-IN-A-NEST	G2G3	S?	SC
MINUARTIA UNIFLORA	ONE-FLOWER STITCHWORT	G4	S?	SC
OENOTHERA LINIFOLIA	THREAD-LEAF SUNDROPS	G5	S?	SC
OPHIOGLOSSUM VULGATUM	ADDER'S-TONGUE	G5	S?	SC
OUTCROP		G?	S?	SC

PANAX QUINQUEFOLIUS	AMERICAN GINSENG	G3G4	S2S3	RC
PARONYCHIA AMERICANA	AMERICAN NAILWORT	G3?	S?	SC
PHILADELPHUS HIRSUTUS	STREAMBANK MOCK-ORANGE	G5	S1	SC
PLETHODON WEBSTERI	WEBSTER'S SALAMANDER	G3	S2	SE
PYGANODON CATARACTA	EASTERN FLOATER	G5	S?	SC
QUERCUS OGLETHORPENSIS	OGLETHORPE'S OAK	G3	S3	SC
QUERCUS SINUATA	DURAND'S WHITE OAK	G5	S1	SC
SCHOENOLIRION CROCEUM	YELLOW SUNNYBELL	G4	S1	SC
SCUTELLARIA PARVULA	SMALL SKULLCAP	G4	S?	SC
SEDUM PUSILLUM	GRANITE ROCK STONECROP	G3	S2	NC
SOLIDAGO AURICULATA	EARED GOLDENROD	G4	S?	SC
SPILOGALE PUTORIUS	EASTERN SPOTTED SKUNK	G5	S4	SC
STROPHITUS UNDULATUS	SQUAWFOOT	G5	S?	SC
SYLVILAGUS AQUATICUS	SWAMP RABBIT	G5	S2S3	SC
TRILLIUM DISCOLOR	FADED TRILLIUM	G3	S?	SC
TRILLIUM LANCIFOLIUM	NARROW-LEAVED TRILLIUM	G3	S1	NC
TRILLIUM RELIQUUM	RELICT TRILLIUM	G2	S1	FE/SE
VILLOSA DELUMBIS	EASTERN CREEKSHELL	G4	S?	SC
VILLOSA VIBEX	SOUTHERN RAINBOW	G4Q	S?	SC

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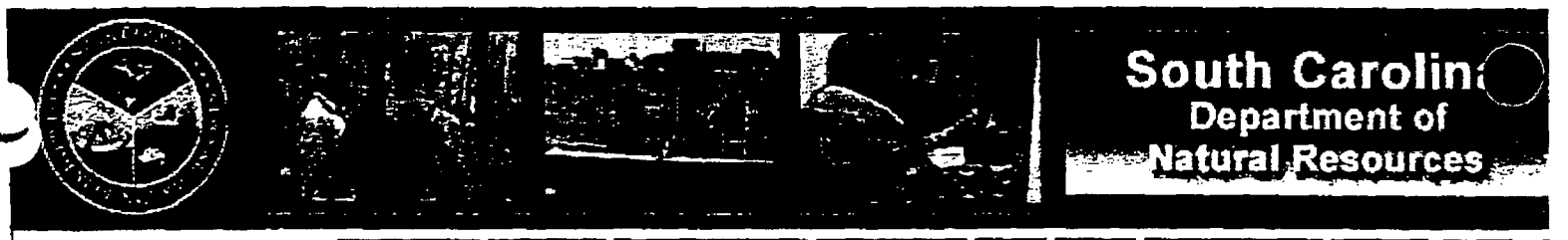
South Carolina Department of Natural Resources - Phone Numbers
Rembert C. Dennis Building, 1000 Assembly Street, Columbia, SC 29201

South Carolina Rare, Threatened, & Endangered Species Inventory
Species Found In Fairfield County
Data Last Updated January 17th, 2006.

SCIENTIFIC NAME	COMMON NAME	GLOBAL RANK	STATE RANK	LEGAL STATUS
ASTER GEORGIANUS	GEORGIA ASTER	G2G3	S?	SC
CAREX OLIGOCARPA	EASTERN FEW-FRUIT SEDGE	G4	S?	SC
COLONIAL WATERBIRD		G?	S?	SC
DIRCA PALUSTRIS	EASTERN LEATHERWOOD	G4	S?	SC
DODECATHEON MEADIA	SHOOTING-STAR	G5	S?	SC
ETHEOSTOMA COLLIS	CAROLINA DARTER	G3	S?	SC
FRASERA CAROLINIENSIS	COLUMBO	G5	S1	RC
HALIAEETUS LEUCOCEPHALUS	BALD EAGLE	G4	S2	FT/SE
ISOETES PIEDMONTANA	PIEDMONT QUILLWORT	G3	S2	SC
MINUARTIA UNIFLORA	ONE-FLOWER STITCHWORT	G4	S?	SC
OPHIOGLOSSUM VULGATUM	ADDER'S-TONGUE	G5	S?	SC
OSMORHIZA CLAYTONII	HAIRY SWEET-CICELY	G5	S?	SC
PHILADELPHUS HIRSUTUS	STREAMBANK MOCK-ORANGE	G5	S1	SC
PYGANODON CATARACTA	EASTERN FLOATER	G5	S?	SC
RHODODENDRON EASTMANII	MAY WHITE	G2	S2	SC
SCIURUS NIGER	EASTERN FOX SQUIRREL	G5	S4	SC
SCUTELLARIA PARVULA	SMALL SKULLCAP	G4	S?	SC
SEDUM PUSILLUM	GRANITE ROCK STONECROP	G3	S2	NC
VILLOSA DELUMBIS	EASTERN CREEKSHELL	G4	S?	SC

For detailed location information about rare & endangered species, please contact Julie Holling .

South Carolina Department of Natural Resources - Phone Numbers
Rembert C. Dennis Building, 1000 Assembly Street, Columbia, SC 29201



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South Carolina Rare, Threatened, & Endangered Species Inventory
Species Found In Newberry County
Data Last Updated January 17th, 2006.

SCIENTIFIC NAME	COMMON NAME	GLOBAL RANK	STATE RANK	LEGAL STATUS
COLONIAL WATERBIRD		G?	S?	SC
DIRCA PALUSTRIS	EASTERN LEATHERWOOD	G4	S?	SC
DISTOCAMBARUS YOUNGINERI	A CRAYFISH	G1	S1	SC
ELLIPTIO LANCEOLATA	YELLOW LANCE	G2G3	S?	SC
EUPATORIUM FISTULOSUM	HOLLOW JOE-PYE WEED	G5?	S?	SC
FRASERA CAROLINIENSIS	COLUMBO	G5	S1	RC
HALIAEETUS LEUCOCEPHALUS	BALD EAGLE	G4	S2	FT/SE
HETERANTHERA RENIFORMIS	KIDNEYLEAF MUD-PLANTAIN	G5	S?	SC
JUGLANS CINEREA	BUTTERNUT	G3G4	S?	SC
LIPARIS LILIIFOLIA	LARGE TWAYBLADE	G5	S?	SC
MAGNOLIA PYRAMIDATA	PYRAMID MAGNOLIA	G4	S1	RC
MONOTROPSIS ODORATA	SWEET PINESAP	G3	S1	RC
MYCTERIA AMERICANA	WOOD STORK	G4	S1S2	FE/SE
PHILADELPHUS HIRSUTUS	STREAMBANK MOCK-ORANGE	G5	S1	SC
RHODODENDRON EASTMANII	MAY WHITE	G2	S2	SC
URSUS AMERICANUS	BLACK BEAR	G5	S3?	SC
VIOLA PUBESCENS VAR LEIOCARPON	YELLOW VIOLET	G5T5	S?	SC

For detailed location information about rare & endangered species, please contact Julie Holling .

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South Carolina Department of Natural Resources - Phone Numbers
Rembert C. Dennis Building, 1000 Assembly Street, Columbia, SC 29201

South Carolina Rare, Threatened, & Endangered Species Inventory
Species Found In Saluda County
Data Last Updated January 17th, 2006.

SCIENTIFIC NAME	COMMON NAME	GLOBAL RANK	STATE RANK	LEGAL STATUS
AMPHIANTHUS PUSILLUS	POOL SPRITE	G2	S1	FT/ST
ASTER GEORGIANUS	GEORGIA ASTER	G2G3	S?	SC
CAROLINA BAY		G?	S?	SC
COREOPSIS ROSEA	ROSE COREOPSIS	G3	S2	RC
CUSCUTA CEPHALANTHI	DODDER; LOVE-VINE	G5	S?	SC
DODECATHEON MEADIA	SHOOTING-STAR	G5	S?	SC
ECHINODORUS PARVULUS	DWARF BURHEAD	G3Q	S2	SC
ELEOCHARIS ROBBINSII	ROBBINS SPIKERUSH	G4G5	S?	SC
ELLIPTIO LANCEOLATA	YELLOW LANCE	G2G3	S?	SC
ETHEOSTOMA HOPKINSI	CHRISTMAS DARTER	G4G5	S4	SC
HALIAEETUS LEUCOCEPHALUS	BALD EAGLE	G4	S2	FT/SE
HETERODON SIMUS	SOUTHERN HOGNOSE SNAKE	G2	S?	SC
HYPERICUM ADPRESSUM	CREEPING ST. JOHN'S-WORT	G2G3	S1	RC
ISOETES PIEDMONTANA	PIEDMONT QUILLWORT	G3	S2	SC
LAMPSILIS SPLENDIDA	RAYED PINK FATMUCKET	G3	S?	SC
LUDWIGIA SPATHULATA	SPATULATE SEEDBOX	G3G4	S?	SC
MINUARTIA UNIFLORA	ONE-FLOWER STITCHWORT	G4	S?	SC
OENOTHERA LINIFOLIA	THREAD-LEAF SUNDROPS	G5	S?	SC
OPHIOGLOSSUM VULGATUM	ADDER'S-TONGUE	G5	S?	SC
OSMORHIZA CLAYTONII	HAIRY SWEET-CICELY	G5	S?	SC
OUTCROP		G?	S?	SC
PLATANTHERA LACERA	GREEN-FRINGE ORCHIS	G5	S1	SC
PLETHODON WEBSTERI	WEBSTER'S SALAMANDER	G3	S2	SE
PTILIMNIUM NODOSUM	HARPERELLA	G2	S1	FE/SE
PYGANODON CATARACTA	EASTERN FLOATER	G5	S?	SC

QUERCUS OGLETHORPENSIS	OGLETHORPE'S OAK	G3	S3	SC
SAGITTARIA ISOETIFORMIS	SLENDER ARROW-HEAD	G4?	S2	SC
SCUTELLARIA PARVULA	SMALL SKULLCAP	G4	S?	SC
SEDUM PUSILLUM	GRANITE ROCK STONECROP	G3	S2	NC
STROPHITUS UNDULATUS	SQUAWFOOT	G5	S?	SC
TOXOLASMA PULLUS	SAVANNAH LILLIPUT	G2	S1S3	SC
UTTERBACKIA IMBECILLIS	PAPER PONDSHELL	G5	S?	SC
VILLOSA DELUMBIS	EASTERN CREEKSHELL	G4	S?	SC
VIOLA PUBESCENS VAR LEIOCARPON	YELLOW VIOLET	G5T5	S?	SC

For detailed location information about rare & endangered species, please contact Julie Holling .

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South Carolina Department of Natural Resources - Phone Numbers
Rembert C. Dennis Building, 1000 Assembly Street, Columbia, SC 29201

South Carolina Rare, Threatened, & Endangered Species Inventory
Species Found In Richland County
Data Last Updated January 17th, 2006.

SCIENTIFIC NAME	COMMON NAME	GLOBAL RANK	STATE RANK	LEGAL STATUS
AGALINIS TENELLA		G4Q	S?	SC
ANDROPOGON PERANGUSTATUS	NARROW LEAVED BLUESTEM	G5T3T4	S1	SC
ARISTIDA CONDENSATA	PIEDMONT THREE-AWNED GRASS	G4?	S?	SC
ASTER ELLIOTTII	ELLIOTT'S ASTER	G3G4	S?	SC
ASTRAGALUS MICHAUXII	SANDHILLS MILKVETCH	G3	S?	SC
BALDUINA ATROPURPUREA	PURPLE BALDUINA	G2G3	S?	SC
BOTRYCHIUM LUNARIOIDES	WINTER GRAPE-FERN	G4?	S?	SC
CALAMOVILFA BREVIPILIS	PINE-BARRENS REED-GRASS	G4	S?	NC
CAREX CHEROKEENSIS	CHEROKEE SEDGE	G4G5	SR	SC
CAREX COLLINSII	COLLINS' SEDGE	G4	S1	SC
CAREX CRUS-CORVI	RAVENFOOT SEDGE	G5	S?	SC
CAREX ELLIOTTII	ELLIOTT'S SEDGE	G4?	S?	SC
CAREX SOCIALIS	SOCIAL SEDGE	G4	S?	SC
CAROLINA BAY		G?	S?	SC
CAYAPONIA BOYKINII	CAYAPONIA	G4	S?	SC
COLLINSONIA SEROTINA	SOUTHERN HORSE-BALM	G3G4	S?	SC
COLONIAL WATERBIRD		G?	S?	SC
CONDYLURA CRISTATA	STAR-NOSED MOLE	G5	S3?	SC
COREOPSIS GLADIATA	SOUTHEASTERN TICKSEED	G3G5	S?	SC
CORYNORHINUS RAFINESQUII	RAFINESQUE'S BIG-EARED BAT	G3G4	S2?	SE
DRYOPTERIS CARTHUSIANA	SPINULOSE SHIELD FERN	G5	S?	SC
ECHINACEA LAEVIGATA	SMOOTH CONEFLOWER	G2	S1	FE/SE
ELEOCHARIS ROBBINSII	ROBBINS SPIKERUSH	G4G5	S?	SC
ELIMIA CATENARIA	GRAVEL ELIMIA	G4	S?	SC
ETHEOSTOMA COLLIS	CAROLINA DARTER	G3	S?	SC

FUNDULUS DIAPHANUS	BANDED KILLIFISH	G5	S1	SC
HALIAEETUS LEUCOCEPHALUS	BALD EAGLE	G4	S2	FT/
HETERODON SIMUS	SOUTHERN HOGNOSE SNAKE	G2	S?	SC
HYLA ANDERSONII	PINE BARRENS TREEFROG	G4	S2S3	ST
HYMENOCALLIS CORONARIA	SHOALS SPIDER-LILY	G2Q	S2	NC
HYPERICUM ADPRESSUM	CREEPING ST. JOHN'S-WORT	G2G3	S1	RC
HYPERICUM NITIDUM	CAROLINA ST. JOHN'S-WORT	G4	S?	SC
ILEX AMELANCHIER	SARVIS HOLLY	G4	S3	SC
IPOMOPSIS RUBRA	RED STANDING-CYPRESS	G4G5	S?	SC
JUNCUS ABORTIVUS	PINEBARREN RUSH	G4G5	S?	SC
LECHEA TORREYI	PIEDMONT PINWEED	G4G5	S?	SC
LIATRIS MICROCEPHALA	SMALL-HEAD GAYFEATHER	G3G4	S?	SC
LINDERA SUBCORIACEA	BOG SPICEBUSH	G2	S?	RC
LOBELIA SP 1	LOBELIA	G?	S?	SC
LUDWIGIA SPATHULATA	SPATULATE SEEDBOX	G3G4	S?	SC
LYCOPUS COKERI	CAROLINA BUGLEWEED	G3	S?	SC
LYSIMACHIA ASPERULIFOLIA	ROUGH-LEAVED LOOSESTRIFE	G3	S1	FE/
MACBRIDEA CAROLINIANA	CAROLINA BIRD-IN-A-NEST	G2G3	S?	SC
MAGNOLIA MACROPHYLLA	BIGLEAF MAGNOLIA	G5	S?	SC
MAGNOLIA PYRAMIDATA	PYRAMID MAGNOLIA	G4	S1	RC
MYRIOPHYLLUM LAXUM	PIEDMONT WATER-MILFOIL	G3	S2	RC
NESTRONIA UMBELLULA	NESTRONIA	G4	S2	SC
NOTROPIS CHILITICUS	REDLIP SHINER	G4	S1?	SC
OPHIOGLOSSUM VULGATUM	ADDER'S-TONGUE	G5	S?	SC
OXYPOLIS CANBYI	CANBY'S DROPWORT	G2	S1	FE/SE
PASPALUM BIFIDUM	BEAD-GRASS	G5	S?	SC
PICOIDES BOREALIS	RED-COCKADED WOODPECKER	G3	S2	FE/SE
PITYOPSIS PINIFOLIA	PINE-LEAVED GOLDEN ASTER	G4	S?	SC
PLAGIOCHILA SULLIVANTII		G2	S?	SC
POTAMOGETON CONFERVOIDES	ALGAE-LIKE PONDWEED	G4	S1	SC
PRUNUS ALABAMENSIS	ALABAMA BLACK CHERRY	G4	S?	SC
PSILOTUM NUDUM	WHISK FERN	G5	S1S2	SC
PTEROGLOSSASPIS ECRISTATA	CRESTLESS PLUME ORCHID	G2	S2	SC
RHEXIA ARISTOSA	AWNED MEADOWBEAUTY	G3	S2	SC
RHINICHTHYS ATRATULUS	BLACKNOSE DACE	G5	S1	SC
RHODODENDRON EASTMANII	MAY WHITE	G2	S2	SC
RHYNCHOSPORA INUNDATA	DROWNED HORNEDRUSH	G3G4	S?	SC
RHYNCHOSPORA MACRA	BEAK RUSH	G3	S?	SC

RHYNCHOSPORA OLIGANTHA	FEW-FLOWERED BEAKED-RUSH	G4	S?	SC
RHYNCHOSPORA PALLIDA	PALE BEAKRUSH	G3	S?	SC
RHYNCHOSPORA STENOPHYLLA	CHAPMAN BEAKRUSH	G4	S?	SC
SARRACENIA RUBRA	SWEET PITCHER-PLANT	G3	S4	SC
SCIRPUS ETUBERCULATUS	CANBY BULRUSH	G3G4	S?	SC
SCIURUS NIGER	EASTERN FOX SQUIRREL	G5	S4	SC
SPILOGALE PUTORIUS	EASTERN SPOTTED SKUNK	G5	S4	SC
STROPHITUS UNDULATUS	SQUAWFOOT	G5	S?	SC
SYLVILAGUS AQUATICUS	SWAMP RABBIT	G5	S2S3	SC
TOFIELDIA GLABRA	WHITE FALSE-ASPHODEL	G3	S?	SC
TREPOCARPUS AETHUSAE	AETHUSA-LIKE TREPOCARPUS	G4G5	S?	SC
TRIDENS CHAPMANII	CHAPMAN'S REDTOP	G?	S?	SC
TYTO ALBA	BARN-OWL	G5	S4	SC
URSUS AMERICANUS	BLACK BEAR	G5	S3?	SC
URTICA CHAMAEDRYOIDES	WEAK NETTLE	G4G5	S?	SC
VACCINIUM CRASSIFOLIUM SSP SEMPERVIRENS	RAYNER'S BLUEBERRY	G4G5T1	S1	NC
VILLOSA DELUMBIS	EASTERN CREEKSHELL	G4	S?	SC
WAREA CUNEIFOLIA	NUTTALL WAREA	G4	S?	SC

For detailed location information about rare & endangered species, please contact Julie Holling .

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South Carolina Department of Natural Resources - Phone Numbers
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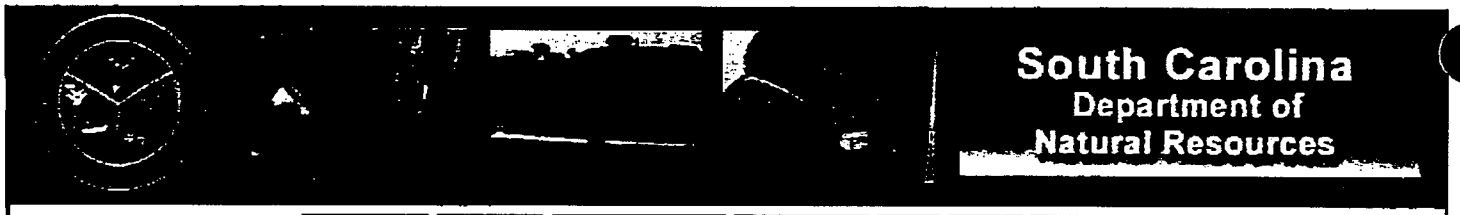

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South Carolina Rare, Threatened, & Endangered Species Inventory
Species Found In Fairfield County
Data Last Updated January 17th, 2006.

SCIENTIFIC NAME	COMMON NAME	GLOBAL RANK	STATE RANK	LEGAL STATUS
ASTER GEORGIANUS	GEORGIA ASTER	G2G3	S?	SC
CAREX OLIGOCARPA	EASTERN FEW-FRUIT SEDGE	G4	S?	SC
COLONIAL WATERBIRD		G?	S?	SC
DIRCA PALUSTRIS	EASTERN LEATHERWOOD	G4	S?	SC
DODECATHEON MEADIA	SHOOTING-STAR	G5	S?	SC
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
FRASERA CAROLINIENSIS	COLUMBO	G5	S1	RC
HALIAEETUS LEUCOCEPHALUS	BALD EAGLE	G4	S2	FT/SE
ISOETES PIEDMONTANA	PIEDMONT QUILLWORT	G3	S2	SC
MINUARTIA UNIFLORA	ONE-FLOWER STITCHWORT	G4	S?	SC
OPHIOGLOSSUM VULGATUM	ADDER'S-TONGUE	G5	S?	SC
OSMORHIZA CLAYTONII	HAIRY SWEET-CICELY	G5	S?	SC
PHILADELPHUS HIRSUTUS	STREAMBANK MOCK-ORANGE	G5	S1	SC
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
RHODODENDRON EASTMANII	MAY WHITE	G2	S2	SC
SCIURUS NIGER	EASTERN FOX SQUIRREL	G5	S4	SC
SCUTELLARIA PARVULA	SMALL SKULLCAP	G4	S?	SC
SEDUM PUSILLUM	GRANITE ROCK STONECROP	G3	S2	NC
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

For detailed location information about rare & endangered species, please contact Julie Holling .

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South Carolina Rare, Threatened, & Endangered Species Inventory
Species Found In Newberry County
Data Last Updated January 17th, 2006.

SCIENTIFIC NAME	COMMON NAME	GLOBAL RANK	STATE RANK	LEGAL STATUS
COLONIAL WATERBIRD		G?	S?	SC
DIRCA PALUSTRIS	EASTERN LEATHERWOOD	G4	S?	SC
DISTOCAMBARUS YOUNGINERI	A CRAYFISH	G1	S1	SC
ELLIPTIO LANCEOLATA	YELLOW LANCE	G2G3	S?	SC
EUPATORIUM FISTULOSUM	HOLLOW JOE-PYE WEED	G5?	S?	SC
FRASERA CAROLINIENSIS	COLUMBO	G5	S1	RC
HALIAEETUS LEUCOCEPHALUS	BALD EAGLE	G4	S2	FT/SE
HETERANTHERA RENIFORMIS	KIDNEYLEAF MUD-PLANTAIN	G5	S?	SC
JUGLANS CINEREA	BUTTERNUT	G3G4	S?	SC
LIPARIS LILIIFOLIA	LARGE TWAYBLADE	G5	S?	SC
MAGNOLIA PYRAMIDATA	PYRAMID MAGNOLIA	G4	S1	RC
MONOTROPSIS ODORATA	SWEET PINESAP	G3	S1	RC
MYCTERIA AMERICANA	WOOD STORK	G4	S1S2	FE/SE
PHILADELPHUS HIRSUTUS	STREAMBANK MOCK-ORANGE	G5	S1	SC
RHODODENDRON EASTMANII	MAY WHITE	G2	S2	SC
URSUS AMERICANUS	BLACK BEAR	G5	S3?	SC
VIOLA PUBESCENS VAR LEIOCARPON	YELLOW VIOLET	G5T5	S?	SC

For detailed location information about rare & endangered species, please contact Julie Holling .

[County Selection | DNR Heritage Preserves Home Page | SCDNR Home Page]

South Carolina Rare, Threatened, & Endangered Species Inventory
Species Found In Richland County
Data Last Updated January 17th, 2006.

SCIENTIFIC NAME	COMMON NAME	GLOBAL RANK	STATE RANK	LEGAL STATUS
AGALINIS TENELLA		G4Q	S?	SC
ANDROPOGON PERANGUSTATUS	NARROW LEAVED BLUESTEM	G5T3T4	S1	SC
ARISTIDA CONDENSATA	PIEDMONT THREE-AWNED GRASS	G4?	S?	SC
ASTER ELLIOTTII	ELLIOTT'S ASTER	G3G4	S?	SC
ASTRAGALUS MICHAUXII	SANDHILLS MILKVETCH	G3	S?	SC
BALDUINA ATROPURPUREA	PURPLE BALDUINA	G2G3	S?	SC
BOTRYCHIUM LUNARIOIDES	WINTER GRAPE-FERN	G4?	S?	SC
CALAMOVILFA BREVIPILIS	PINE-BARRENS REED-GRASS	G4	S?	NC
CAREX CHEROKEENSIS	CHEROKEE SEDGE	G4G5	SR	SC
CAREX COLLINSII	COLLINS' SEDGE	G4	S1	SC
CAREX CRUS-CORVI	RAVENFOOT SEDGE	G5	S?	SC
CAREX ELLIOTTII	ELLIOTT'S SEDGE	G4?	S?	SC
CAREX SOCIALIS	SOCIAL SEDGE	G4	S?	SC
CAROLINA BAY		G?	S?	SC
CAYAPONIA BOYKINII	CAYAPONIA	G4	S?	SC
COLLINSONIA SEROTINA	SOUTHERN HORSE-BALM	G3G4	S?	SC
COLONIAL WATERBIRD		G?	S?	SC
CONDYLURA CRISTATA	STAR-NOSED MOLE	G5	S3?	SC
COREOPSIS GLADIATA	SOUTHEASTERN TICKSEED	G3G5	S?	SC
CORYNORHINUS RAFINESQUII	RAFINESQUE'S BIG-EARED BAT	G3G4	S2?	SE
DRYOPTERIS CARTHUSIANA	SPINULOSE SHIELD FERN	G5	S?	SC
ECHINACEA [redacted]				
ELEOCHARIS ROBBINSII	ROBBINS SPIKERUSH	G4G5	S?	SC
ELIMIA CATENARIA	GRAVEL ELIMIA	G4	S?	SC
ETHEOSTOMA COLLIS	CAROLINA DARTER	G3	S?	SC
FUNDULUS DIAPHANUS	BANDED KILLIFISH	G5	S1	SC
HALIA[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
HETERODON SIMUS	SOUTHERN HOGNOSE SNAKE	G2	S?	SC

HYLA ANDERSONII	PINE BARRENS TREEFROG	G4	S2S3	ST
HYMENOCALLIS CORONARIA	SHOALS SPIDER-LILY	G2Q	S2	NC
HYPERICUM ADPRESSUM	CREEPING ST. JOHN'S-WORT	G2G3	S1	RC
HYPERICUM NITIDUM	CAROLINA ST. JOHN'S-WORT	G4	S?	SC
ILEX AMELANCHIER	SARVIS HOLLY	G4	S3	SC
IPOMOPSIS RUBRA	RED STANDING-CYPRESS	G4G5	S?	SC
JUNCUS ABORTIVUS	PINEBARREN RUSH	G4G5	S?	SC
LECHEA TORREYI	PIEDMONT PINWEED	G4G5	S?	SC
LIATRIS MICROCEPHALA	SMALL-HEAD GAYFEATHER	G3G4	S?	SC
LINDERA SUBCORIACEA	BOG SPICEBUSH	G2	S?	RC
LOBELIA SP 1	LOBELIA	G?	S?	SC
LUDWIGIA SPATHULATA	SPATULATE SEEDBOX	G3G4	S?	SC
LYCOPUS COKERI	CAROLINA BUGLEWEED	G3	S?	SC
[redacted]	[redacted] LOOSESTRIFE	[redacted]	[redacted]	[redacted]
MACBRIDEA CAROLINIANA	CAROLINA BIRD-IN-A-NEST	G2G3	S?	SC
MAGNOLIA MACROPHYLLA	BIGLEAF MAGNOLIA	G5	S?	SC
MAGNOLIA PYRAMIDATA	PYRAMID MAGNOLIA	G4	S1	RC
MYRIOPHYLLUM LAXUM	PIEDMONT WATER-MILFOIL	G3	S2	RC
NESTRONIA UMBELLULA	NESTRONIA	G4	S2	SC
NOTROPIS CHILITICUS	REDLIP SHINER	G4	S1?	SC
OPHIOGLOSSUM VULGATUM	ADDER'S-TONGUE	G5	S?	SC
[redacted]				
PASPALUM BIFIDUM	BEAD-GRASS	G5	S?	SC
PICOIDES BOREALIS	[redacted] WOODPECKER	[redacted]	[redacted]	[redacted]
[redacted]	PINE-LEAVED GOLDEN ASTER	G4	S?	SC
PLAGIOCHILA SULLIVANTII		G2	S?	SC
POTAMOGETON CONFERVOIDES	ALGAE-LIKE PONDWEED	G4	S1	SC
PRUNUS ALABAMENSIS	ALABAMA BLACK CHERRY	G4	S?	SC
PSILOTUM NUDUM	WHISK FERN	G5	S1S2	SC
PTEROGLOSSASPIS ECRISTATA	CRESTLESS PLUME ORCHID	G2	S2	SC
RHEXIA ARISTOSA	AWNED MEADOWBEAUTY	G3	S2	SC
RHINICHTHYS ATRATULUS	BLACKNOSE DACE	G5	S1	SC
RHODODENDRON EASTMANII	MAY WHITE	G2	S2	SC
RHYNCHOSPORA INUNDATA	DROWNED HORNEDRUSH	G3G4	S?	SC
RHYNCHOSPORA MACRA	BEAK RUSH	G3	S?	SC
RHYNCHOSPORA OLIGANTHA	FEW-FLOWERED BEAKED-RUSH	G4	S?	SC
RHYNCHOSPORA PALLIDA	PALE BEAKRUSH	G3	S?	SC
RHYNCHOSPORA STENOPHYLLA	CHAPMAN BEAKRUSH	G4	S?	SC
SARRACENIA RUBRA	SWEET PITCHER-PLANT	G3	S4	SC
SCIRPUS ETUBERCULATUS	CANBY BULRUSH	G3G4	S?	SC
SCIURUS NIGER	EASTERN FOX SQUIRREL	G5	S4	SC

SPILOGALE PUTORIUS	EASTERN SPOTTED SKUNK	G5	S4	SC
STROPHITUS UNDULATUS	SQUAWFOOT	G5	S?	SC
SYLVILAGUS AQUATICUS	SWAMP RABBIT	G5	S2S3	SC
TOFIELDIA GLABRA	WHITE FALSE-ASPHODEL	G3	S?	SC
TREPOCARPUS AETHUSAE	AETHUSA-LIKE TREPOCARPUS	G4G5	S?	SC
TRIDENS CHAPMANII	CHAPMAN'S REDTOP	G?	S?	SC
TYTO ALBA	BARN-OWL	G5	S4	SC
URSUS AMERICANUS	BLACK BEAR	G5	S3?	SC
URTICA CHAMAEDRYOIDES	WEAK NETTLE	G4G5	S?	SC
VACCINIUM CRASSIFOLIUM SSP SEMPERVIRENS	RAYNER'S BLUEBERRY	G4G5T1	S1	NC
VILLOSA DELUMBIS	EASTERN CREEKSHELL	G4	S?	SC
WAREA CUNEIFOLIA	NUTTALL WAREA	G4	S?	SC

For detailed location information about rare & endangered species, please contact Julie Holling .

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Sec 4.3 Ref 11
Note. Referenced in section 4.1

SOUTH CAROLINA ELECTRIC & GAS COMPANY

COLUMBIA, SC

TRANSMISSION LINE AND SUBSTATION SITING PROCESSES:

A DISCUSSION OF THE SCOPE OF WORK ASSOCIATED WITH EACH STEP IN THE PROCESSES

January 2000

1.0 SCE&G LINE SITING PROCESS

Sec 4.3 Ref 12

SOUTH CAROLINA ELECTRIC & GAS- STANDARD OPERATING PROCEDURE

"WETLANDS"
ISSUED June 9, 2004

A. These guidelines prescribe acceptable methods for complying with State and Federal Wetland Regulations while constructing and maintaining any and all buildings/facilities in the SCE&G System, including but not limited to electric and gas transmission, and/or distribution facilities, and associated rights of way, and rights-of-way crossings.

B. **Planning and New Construction:**

1. Avoidance of wetlands should be considered during the construction planning stages as much as possible. Trained individuals should survey planned electric and gas line corridors, or any other new facility locations for wetlands. Potential/suspected wetland areas should be delineated, marked in the field, and verified by the U. S. Army Corps of Engineers (ACOE). This should occur prior to any land-disturbing activity that would pose the potential to disturb or cast materials into the potential/suspected wetland areas. The wetland locations will be surveyed, following regulatory verification. The verified wetland areas will be identified and depicted on the resulting survey map/plat. No work may proceed in these wetland areas until the proper permits are obtained from the ACOE and DHEC. All permit conditions must be carefully adhered to.
2. Should a new development be involved, the developer shall be requested to provide evidence of proper delineation (USACOE-verified) and marking of wetlands, or in the absence of such, be requested to sign a wetlands delineation consent form, authorizing SCE&G to delineate and secure Corps verification for all areas identified by SCE&G as affected by its activities and potentially impacting wetlands. (Form attached.)

C. **Clearing of New Facility and Maintenance of Existing Facility Rights-of-way:**

1. Clearing normally will be done manually with chain saws, bush axes, etc. Exception: Rotary cutters and mowers may be used if limited to areas where the ground is firm enough to support the equipment's weight.
2. Rubber tired vehicles may be employed in routine use in wetland areas, if they are equipped with high floatation tires or wide tracks to distribute the vehicle's weight, to minimize rutting and/or compaction of the wetland area. When equipment with high flotation tires or wide tracks is not available, or practical, clearing and maintenance of new/existing rights-of-way within jurisdictional wetlands must be done in a manner that otherwise minimizes rutting. The use of bulldozers, backhoes, or any equipment with attachments such as sheer blades, rakes, discs, etc. that cut, turn up, or break up the soil, is prohibited. **Excessive rutting in a wetland is prohibited.** Excessive rutting occurs when the substrate is disturbed by mechanized equipment to the point that hinders the normal

wetland drainage. For example, ruts caused by mechanized equipment that are not likely to restore themselves quickly to prior conditions without further action by man, is considered excessive rutting. **Should excessive rutting occur in spite of efforts to avoid it, the rutted areas should be returned to original contours following the job completion.**

3. **Grubbing (mechanized land clearing) within wetlands areas is not allowed.** Stumps are to be left at or near ground level. Vegetative root systems are to be left intact. Trees and shrubs must be felled away from stream banks. Vegetative trimming within wetlands must be done in a manner that minimizes soil disturbance and minimizes changes in ground contours. Vegetative cuttings must not be allowed to fall and remain in streams if doing so impedes natural water flow.
4. **Accumulated Wood Chips** from maintenance or clearing activities must not be placed in wetland areas. Wood chips may be spread in upland areas only, away from any streams or low-lying areas.
5. **Herbicides** must be used only in accordance with label instructions, and may only be applied in wetland areas if so labeled.

D. Maintenance of Lines and associated structures:

1. Should a problem occur with an electric or gas line, requiring the use of mechanized equipment to accomplish repair, heavy equipment is to remain in upland areas as much as possible. When not possible, the use of mats or other means of protecting the soils, such as using cut timber for corduroy access to distribute equipment weight, must be employed to minimize damage to the wetlands. These mats or corduroy must be removed at job completion. Excessive rutting in a wetland is prohibited. **Should excessive rutting result, all reasonable efforts will be made to return the soil to its pre-disturbance grade following the job completion.**
2. If excavating or filling is needed for repairs and the excavation or filling will impact a wetland, it will be necessary to apply for a permit prior to making such repairs. **Any fill in wetland areas is illegal unless prior permitting has taken place.** Emergency situations will be dealt with on a case-by-case basis. In special cases, repairs can be completed and a notification or after the fact permit acquired.

E. Guidelines for Contractors:

1. Contracts for right-of-way maintenance, electric or gas line construction, or any new facility construction must contain line items addressing the appropriate wetland guidelines.

WETLANDS DETERMINATION AUTHORIZATION

Development/Project: _____

Developer: _____

To enable SCE&G to move forward with the installation of infrastructure to serve the Development/Project with gas and/or electricity, Developer, through the signature of its authorized representative below, gives its consent for SCE&G, at SCE&G's expense, to have all property within the Development that will be impacted by the installation of its utility facilities, surveyed by a qualified wetlands surveyor(s) and for the resulting delineation of any jurisdictional wetlands to be confirmed by the appropriate regulatory agency(ies).

Authorized Representative: _____
(Print or type)

_____
(Signature)

Sec 4.3 Ref 13

South Carolina Forestry Commission Best Management Practices

Streamside Management Zones

Primary SMZ for Perennial and Intermittent Streams
Secondary SMZ for Perennial and Intermittent Streams
Ephemeral Streams
Trout Waters

An effort has been made to italicize technical words or phrases and clearly define them in the glossary.

CEG-316

Land adjacent to perennial, intermittent, and ephemeral streams and ponds or lakes requires special attention during forestry operations. These Streamside Management Zones (SMZs) are critical areas where NPS pollutants can enter the aquatic system .

- *Perennial streams* are identified by well-defined banks and *natural channels*, and have continuously flowing water most years.
- *Intermittent streams* also have well-defined banks and natural channels, but typically have flowing water from a headwater source for only a portion of the year.
- *Ephemeral streams* generally do not have well-defined channels, and flow only in response to localized precipitation.

Identifying the type of stream is important in prescribing the level of streamside protection. Usually a landowner or manager will be most familiar with a stream's flow characteristics and can make the determination. However, in some situations the landowner or manager may be uncertain or have little knowledge of a stream's flow characteristics. For example, braided streams with multiple interconnected channels can be difficult to identify. In these situations a *licensed forester* or other *qualified professional* should be consulted.

The SMZ is divided into two parts: the primary and the secondary. The primary SMZ is 40 feet wide on each side of the stream, except for designated *trout waters* with slopes greater than 5% where the primary SMZ is 80 feet. The width of the secondary SMZ depends on the average percent slope perpendicular to the stream. Minimum required widths of secondary SMZs under various conditions are listed in **Figure 2**.

Forest management activities are restricted within both the primary and secondary SMZs. These restrictions are listed below.

PRIMARY SMZ
Perennial and Intermittent Streams

BMPs

- On perennial streams, select individual trees for harvest, making sure to leave a minimum of 50 square feet of

overstory *basal area* per acre evenly spaced throughout the zone. Leave all trees if less than 50 square feet of overstory basal area per acre exists. The intent is to maintain sufficient overstory and understory cover to provide shade, maintain bank stability, and protect water quality.
- On intermittent streams, permanent residual tree cover is not required as long as other vegetation and organic debris are left to protect the forest floor and stream banks.
- Fell trees away from the stream except where safety is a concern.
- Remove trees in a manner that minimizes disturbance of the forest floor, exposure of *mineral soil*, or degradation of stream bank stability. Under dry ground conditions, *directional felling* and removal of trees with mechanical equipment may be utilized.
- Hand plant or direct seed where *artificial regeneration* is desired.
- Remove tops or other *logging debris* dropped into stream channel.

- Handle and store toxic and hazardous material such as fuels, lubricants, and solvents outside of the SMZ.

Avoid

- Logging debris in the stream.
- Mechanical *site preparation* or machine planting.
- Portable sawmills or *log decks*.
- *Broadcast* application of any *pesticide*
- Road construction except where necessary for stream crossing.

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SECONDARY SMZ
Perennial and Intermittent Streams

BMPs

- Use all types of *silvicultural* harvest systems.
- Use *site preparation* practices that do not significantly disturb surface soil.
- Hand or machine plant or direct seed.
- Carefully use wheeled or tracked vehicles.
- Handle and store toxic and hazardous materials such as fuels, lubricants, and solvents outside of the SMZ.

Avoid

- Portable sawmills and *log decks*.
- Road construction, except where necessary for stream crossing.
- *Excessive rutting*, especially where ruts run perpendicular to a stream.
- Exposing more than 15% of the mineral soil.

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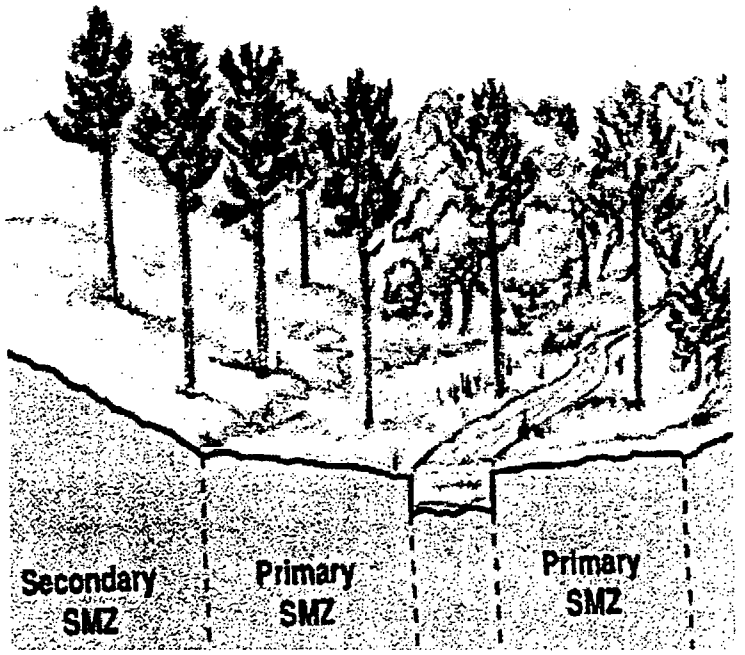

Percent Slope Perpendicular to Stream	Width of SMZ on each side (feet)		
	Primary		Secondary
Less than 5%	40	**Trout** 40	0
5% - 20%	40	80	40
21% - 40%	40	80	80
Greater than 40%	40	80	120

Figure 2. Recommended primary and secondary Streamside Management Zone (SMZ) widths for perennial and intermittent streams.

Ephemeral Streams

Ephemeral streams generally flow in the upper reaches of a *watershed* following precipitation. Although well-defined channels may be present in unique situations, ephemeral streams (commonly referred to as drains) rarely carry enough runoff to displace soil, but they may displace the *litter* on top of the soil. They do flow directly into *intermittent* and *perennial streams*. Therefore, the forest floor in ephemeral areas should be protected so that *sediment* can be filtered out before runoff enters the watercourse. Handle and store toxic and hazardous material such as fuel, lubricants, and solvents outside the ephemeral area.

Avoid

- Portable sawmills and *log decks* within the drain.
- *Skidding* logs during wet conditions within the drain except at infrequent planned crossings.
- *Site preparation* practices that significantly disturb the soil within the ephemeral area.
- Applying *pesticides* or fertilizers if surface water is present.
- Altering the flow of the runoff.
- Road construction except where necessary for crossings.
- Emptying road runoff directly into drains.

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Trout Waters

Trout require cool, clear streams. They, and the aquatic insects they feed on, are especially sensitive to increased sedimentation. Since South Carolina is near the southern limit of the trout's range, water temperature is also a critical factor. It is therefore important to take special precautions to minimize sedimentation and to maintain a shade cover to prevent excessive warming of the water.

Additional BMPs

- Increase the width of the primary SMZ from 40 feet to 80 feet on slopes over 5%.
- Drain water from roads and skid roads onto ridges and side slopes. Drainage structures should not divert water directly into streams.
- Revegetate exposed soils within the SMZ following road construction as soon as possible to take advantage of the loose soil conditions for seeding.
- Use mulch, gravel, and/or rock if needed to help stabilize fills where roads and skid roads cross streams.

Trout Waters in South Carolina

Water Body	County	Description
Cox Camp Creek	Greenville	The entire creek tributary to the Middle Saluda River
East Fork Chattooga River	Oconee	That portion of the river from its confluence with Indian Camp Branch to the Chattooga River
Emory Creek	Pickens	The creek from the northern boundary of Table Rock Resort property to its confluence with the Oolenoy River
Lake Jocassee	Oconee	The entire lake
Matthews Creek	Greenville	From the end of State land in the Mountain Bridge Area to its confluence with the South Saluda River
Saluda River (main stem)	Lexington/Richland	That portion from the Lake Murray Dam to the confluence with the Broad River
Savannah River	Abbeville	From Lake Hartwell Dam to the head waters of Lake Russell
Swaford Creek	Oconee	The entire creek tributary to East Fork Chattooga River
Whetstone Creek	Oconee	The entire creek tributary to the Chattooga River
Willis Creek	Pickens	The creek from the northern boundary of Table Rock Resort property to its confluence with the Oolenoy River

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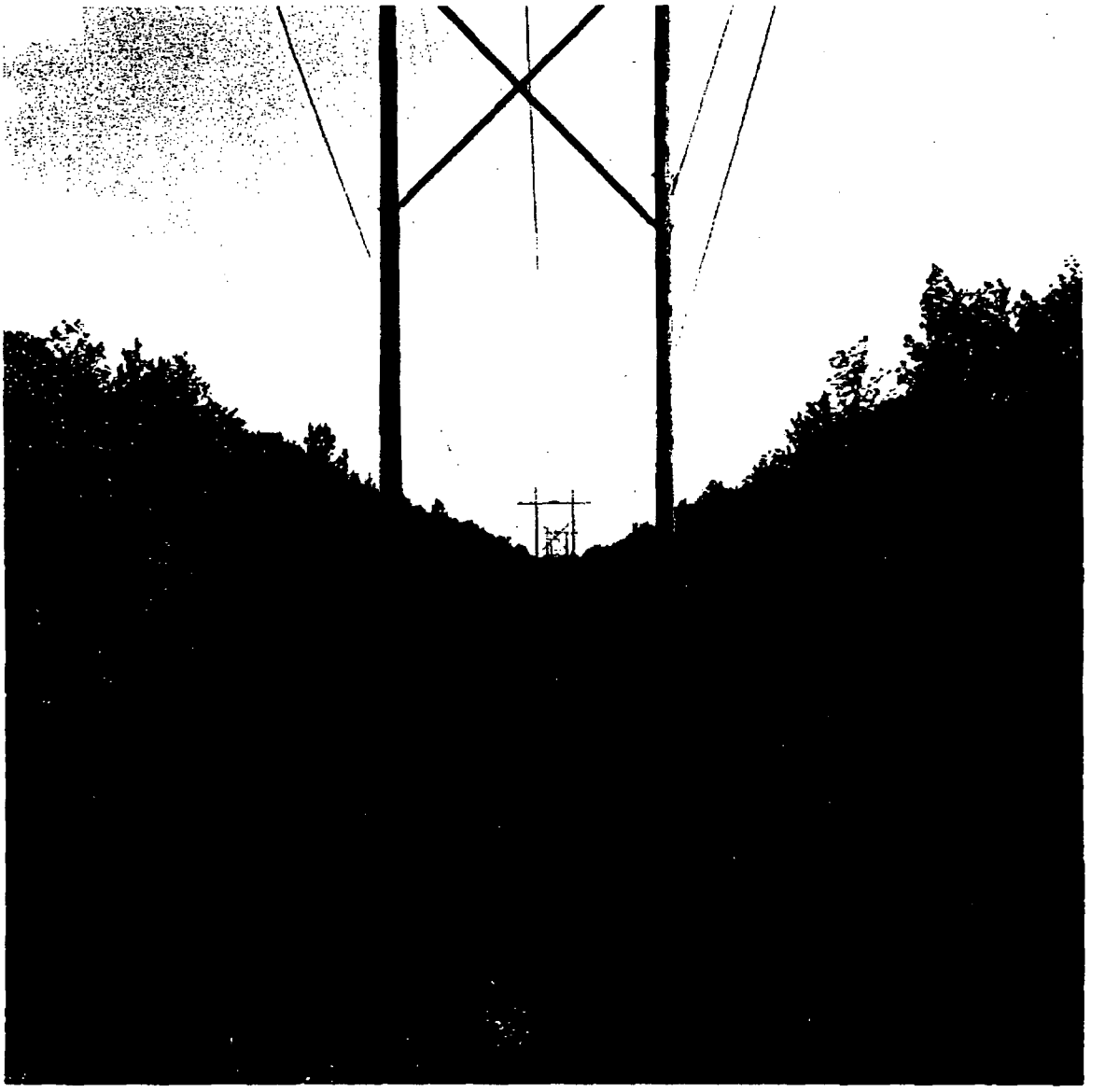
Rec 4.3 Ref 14

SANTEE COOPER
TRANSMISSION VEGETATION MANAGEMENT PROGRAM



Prepared by: Kenneth R. Sott
Date: February 17, 2006

Objectives

To provide an integrated Transmission Vegetation Maintenance Program (TVMP) that protects transmission system availability, provides safety to the public, promotes a positive public image, and complies with NERC Standard FAC-003-1.

To insure that the following key components that make up Santee Cooper's Transmission Vegetation Management Program are systematically reviewed and implemented appropriately.

- Consistent vegetation maintenance cycles
- Routine rights-of-way vegetation inspections
- Effective maintenance reporting tools
- Scheduling flexibility
- Utilization of best management vegetation practices
- Respect for individual property rights

Introduction

Santee Cooper is responsible for maintaining approximately 35,000 brush acres and trees on the periphery of the right-of-way on over 3,900 miles of transmission rights-of-way. The Santee Cooper transmission system is located throughout the state, except in the extreme northwest section, which creates a number of vegetation maintenance problems due to the differing topography, soil types and climates found throughout the state. In order to maintain an effective vegetation maintenance program, it is important to consider these problems and provide an integrated, proactive approach that is cyclic in nature.

Currently, the transmission system (figure 1) is divided into three (3) transmission areas (Southern Transmission Area – Green, Central Transmission Area – Peach, and the Northern Transmission Area – Purple) from a line maintenance perspective. From a vegetation management view point, this is very important since line personnel are very knowledgeable of the changing vegetation conditions in their respective areas. Their routine right-of-way inspections and associated feedback provide a quality check that ensures established vegetation maintenance cycles continue to be effective. Further, they routinely recognize and report critical vegetation problems (e.g., dead & leaning trees) that were not present during scheduled vegetation maintenance activities.

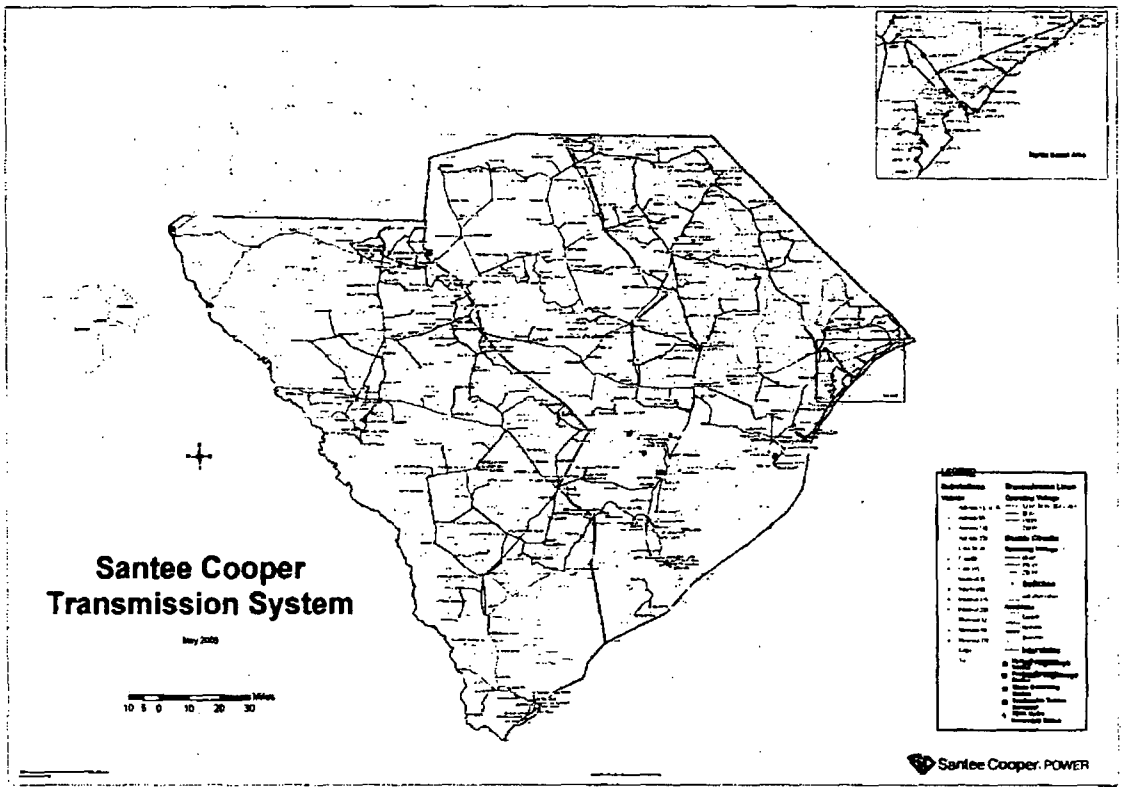


Figure 1

Organization

The *Right-of-Way Management* section (see Appendix A) is responsible for the scheduling and completion of all vegetation related issues located within and along transmission rights-of-way. This section is divided into three units which are responsible for a variety of right-of-way vegetation maintenance activities. Each unit is supported by individuals with varying degrees of professional work experience (e.g., clearing equipment operation, rights-of-way management, contract service administration, herbicide application, etc.) & educational backgrounds/certifications (forestry, arboriculture, wetland delineation, biology, etc.).

Mechanical Reclearing is the largest of the three units with respect to the number of company personnel and is responsible for the mechanical reclearing of selected transmission rights-of-way. This unit is made up of a Supervisor, two (2) crew leaders, and ten (10) equipment operators. A second unit, *Vegetation Management* is responsible for all herbicide related vegetation maintenance, scheduling of reported vegetation maintenance problems, and administering a wildlife habitat enhancement program that complements other vegetation management activities. This unit is made up of a Supervisor, Vegetation Management, Sr. Right-of-Way Specialist, Technical Assistant, Administrative Associate, and one (1) Equipment Operator. A third unit, *Contract Services*, is responsible for all tree related maintenance throughout the transmission system. This unit is made up of a Supervisor, Contract Services and a Right-of-Way Forester.

The overall supervision and direction of this section is the responsibility of the Superintendent, Right-of-Way Management.

Right-of-Way Vegetation Maintenance Standards

Ground Floor Maintenance

1) Right-of-way vegetation maintenance is scheduled, on average, every 3 years to effectively maintain the different vegetation species and associated growth potentials found throughout the transmission system. Mechanical reclearing equipment and/or herbicides are the primary tools that are used to achieve effective maintenance.

    a. Exceptions: Rights-of-way that have low site quality and/or treated with herbicides may produce a slow growing woody vegetation component as well as a herbaceous plant community that competes with new woody plants. In this situation, maintenance cycles can be extended in order to accommodate higher priority vegetation maintenance items and/or inclement weather situations where scheduled maintenance activities may damage (e.g., rutting) rights-of-way.

2) Easements, GIS data base, and Plan & Profiles are reviewed prior to maintenance activities to understand right-of-way widths and maintenance restrictions/provisions. Any atypical restrictions/provisions are provided to the appropriate maintenance personnel prior to beginning vegetation maintenance work.

3) All woody vegetation, capable of growing into transmission conductors and growing within the bounds of the right-of-way, will be maintained by the appropriate maintenance personnel. To ensure this, maintenance personnel routinely measure and flag the edges of the right-of-way to delineate the boundaries of the right-of-way.

   a. Exceptions: large diameter trees that can not be safely maintained by reclearing personnel will be maintained by professional tree maintenance personnel. Where easement restrictions/provisions exclude tree removals, maintenance personnel insure that sufficient clearances are gained through sound trimming practices (ANSI 300A) so reliability is not compromised prior to the next maintenance cycle.

4) Post maintenance clearances will vary depending on the design (i.e., the established height of the conductor in relation to the ground) of the line. However, a minimum of 15' clearance (Clearance 1 - R1.2.1 of Standard FAC-003-1) will be established between the conductor and remaining ground floor vegetation. Prior to the next scheduled maintenance cycle, no ground floor vegetation will be allowed to grow closer to conductors than the minimum clearances (Clearance 2 - R1.2.2 of Standard FAC-003-1) set forth in the Institute of Electrical and Electronics Engineering (IEEE) Standard 516-2003, section 4.2.2.3.

   a. Exceptions: Landowner conflicts may require certain maintenance items (e.g., removal/trimming of established trees) to be scheduled at a later date. In this event, minimal clearances (IEEE Standard 516-2003) will be established until the conflict is resolved. To ensure the follow-up maintenance is not over looked, a work request will be generated and assigned to the appropriate maintenance unit.

   b. Exceptions: Landscape and ornamental plantings (e.g., wax myrtle, crape myrtles, etc.) that have a maximum height growth potential that will bring them no closer that 15' from the conductor and/or slow growing species that can be effectively pruned to 15' from conductor and will not violate IEEE Standard 516-2003 prior to the next maintenance cycle may be left.

5) Daily progress sheets will be completed by the appropriate maintenance unit detailing when and where maintenance took place. This will include the current line name, location (structure/pole numbers) where maintenance was completed, and any atypical maintenance items that could not be completed and require alternative maintenance scheduling. Copies of the progress sheets will be forwarded to the Right-of-Way Management secretary so vegetation

maintenance information can be inputted into a GIS data base and hard copy progress sheets filed in a central location. Also, the Right-of-Way Management planner is to be notified of completed work, via e-mail, so work requests can be closed out.

6) Vegetation maintenance items that could not be completed by ground floor maintenance personnel will be forwarded to the planner via work request creation information forms so a work requests can be created for the appropriate maintenance activity. This may include the use of tree professionals and aerial reach devices where maintenance items are out of reach for normal ground maintenance personnel.

7) Maintenance production (e.g., acreage and brush miles) is reconciled annually for existing rights-of-way while new rights-of-way acreage is added to the total. This information is used to support future maintenance resources and insure that the three (3) year maintenance cycle is not compromised by new responsibilities.

Periphery of Right-of-Way

1) Contract services are used exclusively to maintain trees and tree limbs growing along the 3,900 miles of forested areas growing adjacent to transmission rights-of-way. Typically, a three (3) year maintenance contract is awarded to an established tree maintenance care company to ensure that scheduled tree maintenance work is completed within established time frames. Also, an annual aerial side trimming contract is also awarded to help supplement other long term contract services.

2) Established maintenance cycles are in place to deal with tree limbs that extend into rights-of-way. These maintenance cycles vary in length between 1 – 7 years depending on the width of the right-of-way and location & design of the transmission line within the right-of-way.

3) Easements are researched for maintenance restrictions/provisions and landowners contacted prior to tree maintenance activities, if necessary.

    a. Exception: Majority of landowner contacts are made when live trees are maintained outside of the right-of-way and/or growing in a maintained area within the right-of-way. Trimming of tree limbs along the along the right-of-way does not normally merit a landowner contact.

4) Maintenance reports, generated from the work management system, are run every Monday to ensure that new tree maintenance items are provided to the appropriate tree maintenance personnel to be completed. Typically, these are items (e.g., dead tree, leaning tree, etc.) generated from line patrols and/or during normal ground floor maintenance activities. To ensure that these items are completed per the vegetation maintenance template time frames, a dedicated patrol crew(s) is assigned solely to this task.

5) Daily progress information is recorded and then forwarded to an Administrative Associate who has the responsibility of inputting this information into a GIS data base as well as filing of the hard copy information in a central location. Also, completed work request information is forwarded to the Right-of-Way Management planner so they can be closed out in the work management system.

6) Post maintenance clearances will vary depending on the location of the outside conductor in relation to the edge of the right-of-way with a minimum clearance (Clearance 1 - R1.2.1 of Standard FAC-003-1) not less than 15'. Prior to the next scheduled maintenance cycle, limbs will be allowed to grow no closer to conductors than the minimum clearances (Clearance 2 - R1.2.2 of Standard FAC-003-1) set forth in IEEE Standard 516-2003.

    a. Exceptions: Landowner conflicts may require certain maintenance items (e.g., removal/trimming of established trees) to be scheduled at a later date. In this event, minimum clearances set forth in IEEE Standard 516-2003 will be established until the conflict is resolved.

    b. Exceptions: Lines designed to be off-set and/or stacked on rights-of-way may not allow maintenance personnel to achieve a 15' minimum clearance. In this case, limbs will be removed to the edge of the right-of-way with the clearance not being less than the minimum clearances set forth in IEEE Standard 516-2003.

Rights-of-Way Inspection

Electrical line personnel routinely inspect all transmission rights-of-way twice a year (spring & fall) by air patrol and once a year by ground. Along with electrical facility inspections, line personnel incorporate a right-of-way vegetation inspection that produces records of any vegetation related problems that could compromise system reliability. To aid in the identification and prioritization of

found vegetation related problems, line personnel utilize a vegetation maintenance template (i.e., a working template that describes various vegetation condition categories along with a recommended maintenance completion time frame – Appendix B). Additionally, right-of-way vegetation maintenance personnel utilize the same template to report items outside of their respective maintenance capabilities that are found during their scheduled maintenance activities. This provides an additional inspection source that has the potential of identifying new maintenance problems that developed after lineman have completed their patrols.

Vegetation Maintenance Reporting & Scheduling

Vegetation maintenance problems identified by linemen and vegetation maintenance personnel are recorded onto a patrol or daily progress sheet that represents a specific line section. Information included on these sheets include a description (e.g., dead tree) of the problem, location of the problem with respect to transmission structure/pole numbers, and a priority code that sets a recommended time frame in which the problem is to be mitigated. Completed sheets are then forwarded to the appropriate transmission planner who will in turn create individual maintenance work requests using a work management system.

Once the individual work requests have been created in the work management system, a Right-of-Way Maintenance planner utilizes the work request information to schedule the work as well as assign the work to the appropriate vegetation maintenance unit. Maintenance personnel are then able to access maintenance reports that provide a specific work request number, description of the maintenance problem, and a recommended completion date. After maintenance is completed, maintenance personnel provide a completion date so the planner can close out the work request.

Schedules for normal rotational vegetation maintenance (e.g., mowing, spraying, side trimming, etc.) are developed by the respective maintenance units in Right-of-Way Management. Work requests are then generated from these schedules and are available via a company reporting system (Brio).

In the event a maintenance problem (e.g., leaning tree close to conductor) is considered an immediate threat to the line, personnel will contact the Right-of-Way Maintenance planner, by phone, upon identifying the problem. In turn, the appropriate maintenance personnel will be dispatched to mitigate the problem. If required, line personnel will be contacted to obtain the proper line clearance(s) (e.g., hot line tag) to ensure the safety of maintenance personnel.

Annual Work Plan

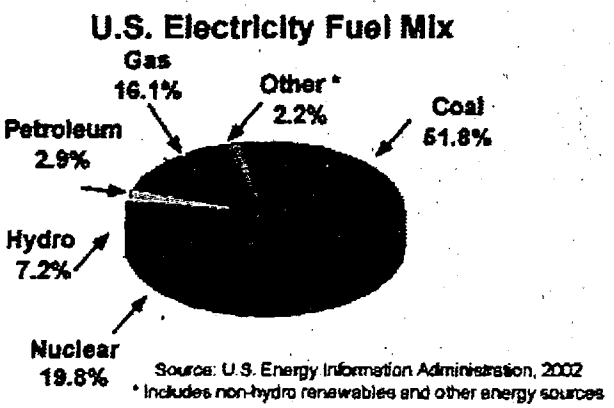
Based on established vegetation maintenance cycles, selected rights-of-way are placed on an annual maintenance schedule that is developed in late December for the upcoming year. Schedules will be available no later than January 15th and can be viewed on the Right-of-Way Management web site (access instructions below) and/or as an attachment (see Appendix C) to this document. Maintenance completion dates for specific line sections will be available on the Right-of-Way Management web site and will updated on a monthly basis.

Electronic Access to Right-of-Way Maintenance Schedules

- Using iPort, select "Departments" Tab
- Select "Transmission Operations" under the "Operations" listing
- Select the "Right-of-Way" Tab
- Under the "Right-of-Way Schedule Yr" list, select the maintenance operation you require a schedule for

Fuel Diversity

History has taught us that it is risky to develop an over-reliance on any one energy source. In fact, a balanced energy portfolio has been the key to providing America with a growing supply of affordable electricity for the past 30 years.



Fuel diversity helps to protect consumers against the threat of supply disruptions or price volatility. With America's demand for electricity expected to grow 40% by 2020, meeting the nation's growing demand for reliable, affordable electricity will require the continued utilization of all domestic energy resources. And that includes coal, which is the primary source of the electricity that powers America's homes and businesses.

- Currently, more than half of the electricity consumed by U.S. homes and businesses (51.8%) comes from coal.
- Other fuels used to generate electricity include nuclear (19.8%), natural gas (16.1%), hydroelectric facilities

Sec 4.3 Ref 15

Mayo Creek Aquatic Survey

V.C. Summer Units 2 and 3
Combined Construction/Operating License Project

Prepared for:
South Carolina Electric & Gas Company

Prepared by:
Tetra Tech NUS
Aiken, South Carolina

June 2007

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1.0 INTRODUCTION

In February 2006, SCE&G and Santee Cooper announced that they had selected a preferred site and a preferred reactor design for two new nuclear units. The new units would be built on the existing V.C. Summer Nuclear Station site near Jenkinsville, South Carolina. By mid-2006, SCE&G made the determination that new nuclear units 2 and 3 and important support facilities (e.g., cooling towers) would be placed approximately one mile south of existing Unit 1, in an area dominated by young planted pines and older mixed pine-hardwood stands. Because land clearing and earth moving associated with construction of new facilities could potentially degrade water quality in the Mayo Creek watershed, SCE&G commissioned Tetra Tech NUS to conduct studies of fish and mussels in Mayo Creek and its tributaries. The goal of the studies was to establish baseline conditions in Mayo Creek for purposes of impact assessment and to identify any special-status aquatic species that might be present.

2.0 THE SITE AND VICINITY

Mayo Creek (Figure 1) is the only stream in the project area that offers substantial year-round flow and habitat adequate to support reasonably diverse assemblages of benthic organisms and fish. Several other unnamed drainages that appear on U.S. Geological Survey (USGS) topographic maps as streams flowing into Parr Reservoir immediately north and south of the project site are either intermittent streams (known locally as "wet weather" streams) or small perennial streams that may be only inches wide in late summer.

In some places, these small streams are dammed by snags and leafpack, creating pools that may be 6-8 feet wide after heavy rains. Based on a July 2006 reconnaissance conducted by SCE&G and Tetra Tech NUS biologists, these pools serve as refuges for fish, crayfish, and aquatic insects during droughts and low-water periods. The importance of these "pool refugia" to fish and aquatic insects in intermittent streams is well known (Labbe and Fausch 2000; Magoulick 2000). Pools with relatively stable hydrology (water levels) in intermittent streams are associated with successful reproduction, population growth, and immigration of fish, whereas pools with more variable hydrology (drying completely or nearly so) tend to be characterized by population declines and emigration (Magoulick and Kobza 2003; Love 2004).

Mayo Creek is approximately three miles long and drains an area of about four square miles (Figure 1). It rises a half-mile southeast of the VCSNS Unit 1 generating facilities, flows south for approximately one mile then curves to the southwest before emptying into the Broad River at Hampton Island, just below the Parr Shoals dam. For much of its length, it flows through a mixed hardwood forest, and is almost completed shaded by a well-developed tree canopy. The tree canopy (shade) apparently moderates water temperatures in summer, which ranged from 23 to 25°C (74 to 76°F) on July 20, 2006 when stream levels were relatively low and ambient temperatures approached 100°F. Fish are found in all stream reaches, but are most numerous in

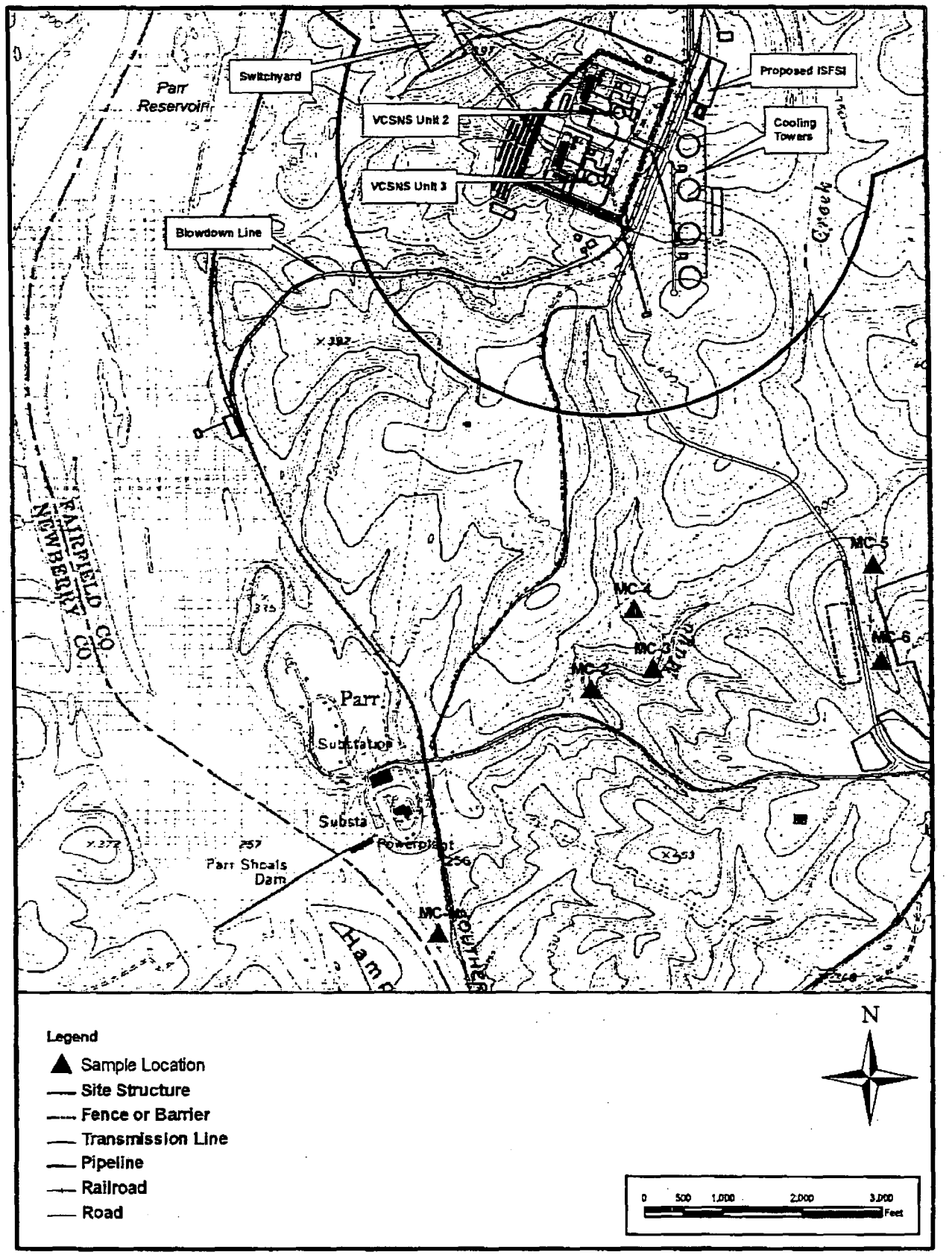

Figure 1. Fish Survey Sampling Locations

middle reaches that contain a mix of substrate and habitat types. The lower portion of Mayo Creek, immediately above its confluence with the Broad River, is noticeably wider and deeper than the rest of the stream, because of back-flow from the Broad River. The stream bottom here has a thick covering of silt, and habitat for fish and invertebrates is marginal at best.

Although the Mayo Creek drainage is almost completely undeveloped and there has been no logging in its floodplain, there has been significant logging activity in the watershed. Some sediment is presumed to have entered the stream with stormwater runoff from logging areas. For reasons that are unclear and are apparently related to characteristics of the watershed and the stream's morphology, it is subject to flash floods after heavy rains. These floods have eroded and undercut the stream's banks along much of its length and covered the stream bottom in many places with a heavy layer of silt.

Surveys of Mayo Creek fish and mussels were conducted in July and November 2006. Supplemental fish sampling was conducted in April 2007 to collect baseline information on a Mayo Creek tributary that could be affected by construction of an access road. The Mayo Creek aquatic surveys were designed to gather baseline information on the stream's biotic communities, supporting the assessment of construction impacts in the COL Environmental Report. The surveys were also intended to identify any special-status species that might be present, so that protection of any such species could be factored into project planning. Mayo Creek was selected for surveys because it is the only substantial stream in the project area, and the only one likely to contain significant numbers of fish and macrobenthos. Other streams in the project area are assumed to support smaller, less diverse benthic and fish communities that are a subset of the Mayo Creek communities, with species predominating that are able to tolerate high levels of turbidity and high summer water temperatures.

3.0 METHODS

Sampling Locations

Tetra Tech NUS and SCE&G biologists conducted a reconnaissance of project area streams and drainages in early July 2006. The goal of the reconnaissance was to identify sampling locations downstream of proposed construction sites that would yield representative baseline data on aquatic biota. This reconnaissance suggested that the small streams draining areas immediately north, west, and south of the proposed construction area were too small to effectively sample in summer: none was more than 2 feet wide or more than a few inches deep. The decision was made to focus sampling efforts on the middle reaches of Mayo Creek, downstream of the point where the west branch of the creek joins the mainstem. This portion of the stream appeared to offer year-round flows that would make electrofishing, the preferred sampling method, possible. Portions of Mayo Creek above this confluence had substantially less flow and were less accessible.

Three sampling transects (MC-1, MC-2, and MC-3) were initially established on the mainstem of Mayo Creek and sampled in July 2006 (see Figure 1). Transect MC-1, intended to serve as an indicator of fish movement between Mayo Creek and the Broad River, was abandoned after the July sampling round because so few fish were present and because its soft, silt-laden bottom made sampling difficult. In November 2006, an additional sampling station (MC-4) was established on an upstream tributary of Mayo Creek to validate the assumption that tributary fish assemblages represent a subset of mainstem fish assemblages. SCE&G determined in early 2007 that it would be necessary to build an access road from the existing Parr Road to the proposed site of Units 2 and 3. Because the construction of this road appeared to have potential for impacting a small, north-flowing tributary of Mayo Creek, this tributary was sampled in April 2007 with minnow traps, at new sampling stations designated MC-5 and MC-6. Sampling sites are described in Table 1.

Table 1. Descriptions of Mayo Creek Sampling Sites

Transect	Length (ft)	Average Width	Average Depth	Substrate	Notes
Transect MC-1	189	19 ft. 2 in.	1.5 ft.	Silty	Well-developed canopy; fully shaded; undercut banks, heavy silt load (turbid)
Transect MC-2	205	8 ft. 6 in.	8 inches	Boulder, rubble, cobble, gravel, or sand, depending on stream gradient/location	Well-developed canopy, almost completely shaded; alternating riffle-run-pool habitats.
Transect MC-3	166	6 ft.	6 inches	Boulder, rubble, cobble, gravel, sand, or silt, depending on stream gradient/location	Well-developed canopy, almost completely shaded; alternating riffle-run-pool habitats.
Station MC-4	N/A	3 ft.	1.0 ft.	Sand, leaves, litter	Pool in small tributary
Station MC-5	N/A	6 ft.	12 in.	Sand, litter	Pool in small tributary
Station MC-6	N/A	6 ft.	16 in	Sand, litter	Pool in small tributary

Biologist retrieves minnow trap at Station MC-5.

Water Quality

Water quality measurements were taken at each transect/station on the first day of each sampling round. In July, temperature, dissolved oxygen, conductivity, turbidity, and pH measurements were taken with a Horiba Model U-10 water quality instrument. Although the instrument was calibrated in advance of fieldwork, all field turbidity readings in July were zero, suggesting a probe malfunction. In November, temperature, dissolved oxygen, and conductivity measurements were taken with a YSI Model 85 water quality instrument. An Orion portable pH meter was used in November.

Fish Sampling and Handling

Transects MC-1, MC-2, and MC-3 were sampled using a Smith-Root Model LR-24 backpack electrofisher with settings intended to produce maximum amperage, as conductivity was relatively low. Current strength varied little, and was generally around 0.15-0.2 amp. Two netters followed the operator of the backpack unit as he moved upstream, collecting stunned fish. Standard galvanized minnow traps were set up- and downstream of the three electrofishing transects after the completion of electrofishing and retrieved approximately 24 hours later. Tributary streams (Sampling Stations MC-4, MC-5, and MC-6) were sampled using wire

minnow traps exclusively; these streams were either too small or too steep-sided to effectively and safely electrofish. Table 2 shows how the various transects and stations were sampled.

All fish collected, regardless of sampling method, were placed in a 10 percent buffered formalin solution and returned to the Aiken Office of Tetra Tech NUS to be measured, weighed, and identified to species. Although field identification and processing of fish would have been preferable, and would not have required sacrificing fish, concerns about possible mis-identification of small specimens and potentially rare species argued against it.

Fish were identified by an experienced Tetra Tech NUS fishery biologist, but identities of more obscure species and small (< 75 mm TL) catastomids were confirmed by either Dean Fletcher or Fred C. Rohde. Dean Fletcher is Research Coordinator of the Fish Ecology Program at the Savannah River Ecology Laboratory and co-author of *Fishes of the Middle Savannah River Basin*. Fred Rohde, a Fisheries Scientist with North Carolina Division of Marine Resources, is senior author of *Freshwater Fishes of the Carolinas, Virginia, Maryland, and Delaware*, and co-author of *Freshwater Fishes of South Carolina* (in preparation).

Table 2. Sampling Locations and Sampling Methods.

	July 2006		November 2006		April 2007
	Electrofishing	Minnow Traps	Electrofishing	Minnow Traps	Minnow Traps
MC-1	√	√			
MC-2	√	√	√	√	
MC-3	√	√	√	√	
MC-4				√	
MC-5					√
MC-6					√

Although quantitative surveys of freshwater mussels were not conducted, field personnel were instructed to be alert to the presence of bivalves, whether mussels or (Asiatic) clams. No live clams or mussels and no dead shells were observed in any of the stream reaches. No dead shells or midden piles were observed on stream banks. Mussels are common in portions of the Broad River (Bettinger, Crane, and Bulak 2003), but conditions in Mayo Creek appear to be unsuitable for these organisms. Because Mayo Creek is shallow and the bottom is visible in most locations and because representative segments (gravel bottom, sandy bottom, silty bottom) of the stream were searched and no mussels were found, there is no reason to believe that freshwater mussels are present in deeper pools or less-accessible areas of the creek.

4.0 RESULTS AND DISCUSSION

Water Quality

Water temperatures in Mayo Creek ranged from 23.6°C to 24.6°C (74°F to 76°F) in July and 12.5°C to 13.0°C (54°F to 55°F) in November. Temperatures in late summer appear to be moderated by the well-developed tree canopy, which shades most portions of the stream. Temperature and dissolved oxygen showed the expected inverse relationship, with dissolved oxygen concentrations at all stations higher in fall than summer. In July 2006, when air temperatures exceeded 36°C/97°F and stream temperatures reached almost 25°C/77°F, dissolved oxygen concentrations in all three mainstem reaches were higher than 5.0 mg/L. Most southeastern states use 5.0 mg/L (daily average) and 4.0 mg/L (instantaneous minimum) as criteria in establishing water quality standards for protection of aquatic life in warmwater streams (EPA 2007). In November, dissolved oxygen concentrations were somewhat higher, 8.5 to 8.8 mg/L. Mayo Creek's conductivity, which ranged from 110 to 117 millisiemens/cm, would place the stream in the lowest quartile (< 180 millisiemens/cm) of U.S. rivers (Potapova and Charles 2003) but was slightly higher than other streams in the Broad River drainage (Cooney et al. 2006). Measurements of pH in Mayo Creek generally ranged between 6.0 and 6.6, whereas pH measurements at other streams in the Broad River drainage in water year 2005 (last year for which USGS data are available) ranged between 6.6 – 7.6 (Tyger River) and 6.3 -7.7 (Enoree River) (Cooney et al. 2006).

Fish Populations

A total of 495 fish representing 14 species were collected during the 2006 Mayo Creek study (Table 3). Collections were dominated by Cyprinids (minnows) and Lepomids (sunfish); 92.2 percent of all fish collected were members of these two families. Bluehead chub (37.2 percent of total), yellowfin shiner (18.2 percent of total), sandbar shiner (16.4 percent), redbreast (9.7 percent), and creek chub (8.1 percent) were the species most often collected. Cyprinids (5 species) made up 80.7 percent of all fish collected.

Table 3. Summary of 2006 Mayo Creek Fish Collections

Common Name	Scientific Name	Total Number[a]	Relative Abundance (%)
Bluehead Chub	*Nocomis leptocephalus*	184	37.2
Yellowfin Shiner	*Notropis lutipinnis*	90	18.2
Sandbar Shiner	*Notropis scepticus*	81	16.4
Redbreast sunfish	*Lepomis auritus*	48	9.7
Creek Chub	*Semotilus atromaculatus*	40	8.1
Brassy jumprock	*Scartomyzon sp.*	19	3.8

Table 3. Summary of 2006 Mayo Creek Fish Collections (continued)

Common Name	Scientific Name	Total Number[a]	Relative Abundance (%)
Tesselated Darter	*Etheostoma olmstedi*	9	1.8
Seagreen Darter	*Etheostoma thalassinum*	8	1.6
Bluegill	*Lepomis machrochirus*	7	1.4
Greenfin Shiner	*Cyprinella chloristia*	4	0.8
Largemouth Bass	*Micropterus salmoides*	2	0.4
Margined Madtom	*Noturus insignis*	1	0.2
Piedmont Darter	*Percina crassa*	1	0.2
Flat Bullhead	*Ameirus platycephalus*	1	0.2
		495	100

a. includes electrofishing and minnow trap collections

Measures of abundance and species richness (Table 4) were markedly higher at Transects 2 and 3, a portion of the stream with a well-developed canopy, good water quality, a mix of aquatic habitats, and substantial year-round flow. Other transects/stations tended to be characterized by heavier silt, sediment, and debris loads, less optimal water quality, and/or extreme low flows in summer and early fall. Transects MC-2 and MC-3 had lower water temperatures and higher concentrations of dissolved oxygen than Transect MC-1 in July 2006, presumably reflecting a better-developed canopy (more completely shaded) and lower levels of solids, which absorb solar energy and raise water temperatures. There may also be cool seeps and springs in this stretch of the creek that buffer the stream's water temperatures. Stations MC-4, MC-5, and MC-6 were established on small tributaries of Mayo Creek. These small tributaries are subject to sudden changes in temperature and flow, and may turn from tiny (several inches wide) rills into debris-filled torrents after heavy rains.

Table 4. Number of Fish Collected in 2006-2007 by Sampling Location

	MC-1[a]	MC-2[b]	MC-3[b]	MC-4[c]	MC-5[d]	MC-6[d]
Bluegill	1	1	5			
Bluehead chub		92	88	4		
Brassy jumprock		12	7			
Creek chub		9	20	11	3	14
Flat bullhead			1			
Greenfin shiner		4				
Largemouth bass		1	1			

Table 4. Number of Fish Collected in 2006-2007 by Sampling Location (continued)

	MC-1[a]	MC-2[b]	MC-3[b]	MC-4[c]	MC-5[d]	MC-6[d]
Margined madtom		1				
Piedmont darter			1			
Redbreast sunfish	13	11	10	14		
Sandbar shiner		45	36			
Seagreen darter		5	3			
Tesselated darter		5	4			
Yellowfin shiner		54	36			
Number of Fish	14	240	212	29	3	14
Number of Species	2	12	12	3	1	1

a. July 2006 only

b. July and November 2006

c. November 2006 only

d. April 2007 only

All fish sampling gear are selective to some degree; however, electrofishing has proven to be the least selective and most effective single method for collecting stream fishes (EPA 1999). Pulsed DC (direct current) electrofishing is the method of choice to obtain a representative sample of the fish in wadeable streams, and was the method employed at V.C. Summer Nuclear Station. Because the goal of the sampling was to develop a list of species present and their relative abundance, rather than population estimates, "single-pass" sampling was employed rather than multiple-pass sampling.

Electrofishing success was dramatically higher at MC-2 and MC-3 than MC-1, reflecting substantially higher abundance of fish in these stream reaches (Table 5). Catch-per-unit effort was higher in the fall than in the summer, but statistical tests were not applied to the data to determine if differences were significant. These differences could have been the result of fish being more evenly distributed in the fall, fish being less active (water temperatures ranged from 12.5 to 13.0°C in November), or even netting efficiency (there were changes in field personnel between July and November).

Table 5. Electrofishing Catch-Per-Unit-Effort (CPUE) in 2006.

Sampling Location	July 2006			November 2006		
	Total Number of Fish	CPUE (fish/ min)	CPUE (fish/ hour)	Total Number of Fish	CPUE (fish/ min)	CPUE (fish/ hour)
MC-1	2	0.204	12.2	Not Sampled	N/A	N/A
MC-2	83	6.975	418.5	145	12.29	737.3
MC-3	66	5.789	347.4	92	8.364	501.8

Only two fish were collected at MC-1 in July 2006, which was the primary reason this transect was abandoned. A handful of species dominated electrofishing collections at MC-2 and MC-3, bluehead chub, yellowfin shiner, and sandbar shiner being the species with highest CPUE (Tables 6 and 7). Bluehead chub are found in a variety of habitats across the southeastern U.S. They were found at 42 of the 45 sites in the Broad River drainage sampled by SCDNR in 2003-2004 (Bettinger, Crane, and Bulak 2006). Yellowfin shiners have more restrictive habitat requirements, typically being found in clear-water streams in forested areas, but were also common in collections. Yellowfin shiners were found at 39 of 45 Broad River drainage sites sampled by SCDNR in 2003-2004 (Bettinger, Crane, and Bulak 2006). Sandbar shiners, which are often associated with clear, sandy-bottomed streams, were also numerous at both MC-2 and MC-3. They were found at 27 of 45 sites in the Broad River drainage sampled by SCDNR (Bettinger, Crane, and Bulak 2006).

Table 6. Electrofishing Catch by Species in July 2006.

	Total Number of Fish			Catch-Per-Unit-Effort		
	MC-1	MC-2	MC-3	MC-1	MC-2	MC-3
Bluehead Chub	0	36	15	---	181.5	78.9
Yellowfin Shiner	0	17	8	---	85.7	42.1
Sandbar Shiner	0	17	28	---	85.7	147.4
Redbreast sunfish	1	1	3	6.1	5.0	15.8
Creek Chub	0	1	2	---	5.0	10.5
Brassy jumprock	0	3	3	---	15.1	15.8
Tesselated Darter	0	4	3	---	20.2	15.8
Seagreen Darter	0	3	1	---	15.1	5.3
Bluegill	1	0	2	6.1	---	10.5
Largemouth Bass	0	0	1	---	---	5.3
Margined Madtom	0	1	0	---	5.0	---

Table 7. Electrofishing Catch by Species in November 2006.

	Total Number of Fish		Catch-Per-Unit-Effort	
	MC-2	MC-3	MC-2	MC-3
Bluehead Chub	50	49	254.2	267.3
Yellowfin Shiner	37	27	188.1	147.3
Sandbar Shiner	28	5	142.4	27.3
Redbreast sunfish	8	2	40.7	10.9
Creek Chub	5	1	25.4	5.5
Brassy jumprock	9	4	45.8	21.8
Tesselated Darter	1	1	5.1	5.5
Seagreen Darter	2	0	10.2	---
Greenfin shiner	4	2	20.3	10.9
Largemouth Bass	1	0	5.1	---
Piedmont darter	0	1	---	5.5

Three species were collected in minnow traps at sampling station MC-4: creek chub (11 fish), bluehead chub (4 fish), and redbreast sunfish (14 fish). The number and relative abundance of redbreast at this station were surprisingly high, given that the stream was only 2-3 feet wide when sampled and clogged with fallen leaves. All of the redbreast collected were small (49-90 mm TL) and probably moved into this small tributary when stream levels were higher and were trapped when waters receded.

Only one species (17 individuals), the creek chub, was found in the unnamed, north-flowing Mayo Creek tributary sampled (Stations MC-5 and MC-6) with minnow traps in April 2007. When sampling was conducted, there was a modest flow in some portions of this tributary, and no water (see photograph that follows) in others, making it difficult to sample. Minnow traps were placed in the four deepest pools available, and retrieved the following day. Two of the four pools contained traps with fish; these pools were designated sampling stations MC-5 and MC-6 and marked with day-glo plastic flagging, should additional sampling be conducted.

Unnamed Mayo Creek tributary stream sampled in April 2007, showing dry streambed.

The fish community structure of Mayo Creek bears a striking resemblance to those of other small Piedmont streams in Georgia and South Carolina. Yellowfin shiners (35.7 percent of total) and bluehead chubs (24.3 percent of total) dominated collections from four of five habitat types in Moore Creek, a third-order lower Piedmont stream in central Georgia (Parmley and Gaddis 2001). Cyprinids comprised 70 percent of all fish collected from Moore Creek. Three Cyprinids (bluehead chub, yellowfin shiner, creek chub) were numerically dominant in samples from two (Newberry County) South Carolina Piedmont streams in both dry (2000) and wet years (2003), but creek chubs were relatively more abundant in the wet ("post-drought") year (Keaton et al. 2005). Keaton et al. hypothesized that turbidity associated with higher rainfall and higher streamflows in 2003 drove bluehead chubs and yellowfin shiners upstream into less-turbid tributaries. They also hypothesized that deeper water created conditions more favorable to the creek chub, a large (up to 12 inches long), "aggressive," omnivorous minnow species that can feed on smaller minnows.

Most of the fish species collected in Mayo Creek and its tributaries are common species that are typically associated with streams and rivers in the Piedmont of the Carolinas and Georgia. Appendix A contains life history information on each of the species collected. Most fish species collected are common-to-abundant in the Broad River drainage (Bettinger, Crane, and Bulak 2006). No fish species listed by the state of South Carolina or the United States Fish & Wildlife

Service (SCDNR 2006; USFWS 2006) was collected. No fish species designated a "species of concern" by the state of South Carolina or USFWS (SCDNR 2006; USFWS 2006) was collected. Species of concern are not protected by law, but are considered by state and federal agencies in conservation planning and during project reviews.

The South Carolina Department of Natural Resources (SCDNR) has been engaged in a state-wide assessment of fisheries resources since 2002, part of a larger effort (termed the "Comprehensive Wildlife Conservation Strategy") intended to benefit the state's fish and wildlife. As part of this effort, fishes of wadeable streams in the Broad River drainage were inventoried in 2003 and 2004 (Bettinger, Crane, and Bulak 2006). Forty-five sites were sampled, yielding more than 20,000 fish specimens that represented 8 families and 45 species. Eleven of these species were assigned moderate, high, or highest "conservation priorities," meaning these species, although not protected by law, are given special attention in agency conservation planning and project reviews. Three of the species collected from Mayo Creek have been designated species of conservation concern by SCDNR: greenfin shiner (Moderate), flat bullhead (Moderate), and Piedmont darter (High).

5.0 SUMMARY

Surveys of Mayo Creek and two of its tributaries revealed a surprisingly diverse assemblage of fishes (14 species) dominated numerically by Cyprinids (minnows). Five minnow species comprised almost 81 percent of all fish collected. Three centrarchid (sunfish) species and three percid (darter) species were also present, but tended to be less abundant. Smaller numbers of catastomids (suckers; one species) and ictalurids (catfish; two species) were also present. No state- or federally-listed fish species were collected. No species designated "species of concern" by the state of South Carolina or USFWS were collected. Several uncommon fish species were collected, but none has been afforded state or federal protection.

Several species of freshwater mussel and the non-native clam *Corbicula* are found in the lower Broad River (Bettinger, Crane, and Bulak 2003) into which Mayo Creek flows. However, it appears that conditions in Mayo Creek and its tributaries are not conducive to survival and/or propagation of bivalves. Although systematic surveys of mussels and clams were not conducted, biologists were instructed to note their presence and collect specimens if any were discovered. No live specimens and no shells were observed in any of the streams surveyed

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APPENDIX A

SPECIES DESCRIPTIONS

Cyprinidae (carps and minnows)

Greenfin shiner. Medium-sized (to 72 mm SL) minnow found above Fall Line in Upper Piedmont of South Carolina and North Carolina (Lee et al. 1980; Bettinger undated). Endemic to Santee Drainage, which includes three major river systems in South Carolina --- the Wateree, the Broad, and the Saluda. Greenfin shiners are found in creeks and small rivers with cool, clear water (Bettinger undated). In these habitats, prefers the slower areas and margins of pools and runs with clean sand and rocky substrates. North Carolina Department of Environment and Natural Resources' Division of Water Quality classifies the species as an insectivore and rates its pollution tolerance as "intermediate" (NCDWQ 1999).

Bluehead chub. Common, thick-bodied (up to 214 mm SL) minnow found in Piedmont and mountain streams from South Branch of Potomac River in Virginia to Altamaha River, Georgia (Lee et al. 1980). Found in a variety of habitats from cool, high-gradient and clear streams to warm, lower-gradient, turbid streams. Substrates in these streams can range from bedrock to silt. North Carolina Department of Environment and Natural Resources' Division of Water Quality classifies the species as an omnivore and rates its pollution tolerance as "intermediate" (NCDWQ 1999).

Yellowfin shiner. Small to medium-sized (60 mm SL max) minnow found in Santee River drainage (SC), Savannah River drainage (SC-Ga), and Altamaha River drainage (Ga) (Lee et al 1980). Generally found in small, clear headwater streams; where found, often abundant. North Carolina Department of Environment and Natural Resources' Division of Water Quality classifies the species as a "specialized insectivore" and rates its pollution tolerance as "intermediate" (NCDWQ 1999).

Sandbar shiner. Medium-sized (50-75 mm SL) minnow found in Blue Ridge foothill and Piedmont streams, from Cape Fear drainage (N.C.) to Savannah drainage (S.C. and Georgia) (Lee et al. 1980). Typically inhabits pools of small-to-medium size streams with sandy substrates. North Carolina Department of Environment and Natural Resources' Division of Water Quality classifies the species as a "specialized insectivore" and rates its pollution tolerance as "intermediate" (NCDWQ 1999).

Creek chub. Large (to 305 mm TL) minnow found in ponds, creeks, and rivers throughout the eastern and Midwestern U.S. and, less commonly, in Great Plains and Prairie Provinces of Canada (Lee et al. 1980). Found in streams and river across the Piedmont of North and South

Carolina. Most abundant in small streams and brooks; less abundant in shallows of lakes and impoundments. North Carolina Department of Environment and Natural Resources' Division of Water Quality classifies the species as an insectivore and rates it as "tolerant" of pollution (NCDWQ 1999). Lee et al. (1980) and most other authorities describe it as a sight-feeding omnivore that eats algae, insects, and even small fish.

Catastomidae (suckers)

Brassy jumprock. This as yet-undescribed species was created when the taxonomy of the genus *Moxostoma* was re-examined by Dr. Robert Jenkins in 1990s (Rohde 1998). Formerly known as the "smallfin redhorse" (*Moxostoma robustum*), this species was placed in the genus *Scartomyzon,* while the newly-named robust redhorse inherited the Latin name *Moxostoma robustum*. Found from the Cape Fear River drainage in North Carolina to the Altamaha River drainage in Georgia in medium-sized streams to large rivers with varied substrates ((Marcy et al. 2005). North Carolina Department of Environment and Natural Resources' Division of Water Quality classifies the brassy jumprock as an insectivore and rates its pollution tolerance as "intermediate" (NCDWQ 1999).

Ictaluridae (freshwater catfishes)

Margined madtom. Small catfish (47-90 mm SL) that ranges from New Hampshire to Georgia. Found chiefly in clearwater streams with moderate current. More abundant in riffle areas with gravel-rubble substrates. North Carolina Department of Environment and Natural Resources' Division of Water Quality classifies the species as an insectivore and rates its pollution tolerance as "intermediate" (NCDWQ 1999).

Flat bullhead. Medium-sized catfish (179-286 mm TL) found in Piedmont and Coastal Plain streams from southern Virginia to Georgia (Lee et al. 1980). Within these streams, adults occur mostly in low-flow areas with silty, muddy, or sandy bottoms while young tend to inhabit areas with higher flow and clearer water. North Carolina Department of Environment and Natural Resources' Division of Water Quality classifies the species as an insectivore and rates it as "tolerant" of pollution (NCDWQ 1999).

Centrarchidae (sunfishes)

Redbreast sunfish. Common sunfish that is found in Coastal Plain and Piedmont streams and rivers from Canada to Florida (Lee et al. 1980; Jenkins and Burkhead 1994). Found most often in pools and backwaters of these streams and rivers in water that may be clear to turbid. Also found in ponds, oxbow lakes, and large impoundments. North Carolina Department of Environment and Natural Resources' Division of Water Quality classifies the species as an insectivore and rates it as "tolerant" of pollution (NCDWQ 1999).

Bluegill. Common sunfish that is found in streams, rivers, ponds, lakes, and impoundments across the eastern and midwestern U.S. Found in all southeastern waters except high-gradient trout streams in Appalachians (Jenkins and Burkhead 1994; Marcy et al. 2005). North Carolina Department of Environment and Natural Resources' Division of Water Quality classifies the bluegill as an insectivore and rates its pollution tolerance as "intermediate" (NCDWQ 1999).

Largemouth bass. Popular sport fish that is found throughout the U.S. and has been introduced to Central America, South America, and parts of Europe. Inhabits streams, rivers, ponds, and impoundments throughout its range, but is most often associated with the weedy shallows of ponds and impoundments. More tolerant of turbidity than other black basses and less tied to flowing water (Marcy et al. 2005). North Carolina Department of Environment and Natural Resources' Division of Water Quality classifies this aggressive predator as a piscivore and rates its pollution tolerance as "intermediate" (NCDWQ 1999). Although largely piscivorous, largemouth bass also eat insects, crayfish, frogs, snakes, mice, baby birds and "almost any other animal of appropriate size that has fallen in or is swimming in the water" (Marcy et al. 2005).

Percidae (perches/darters)

Tesselated darter. One of the most widely-distributed North American darters, found from Quebec to Georgia (Lee et al. 1980). Common in streams and larger, low-gradient rivers under a variety of temperature and water-clarity conditions (Jenkins and Burkhead 1994). Also found in brackish water in estuaries. Typically found in pools and calmer areas; avoids riffles. Found on substrates ranging from mud to clean gravel to rubble (Jenkins and Burkhead 1994). North Carolina Department of Environment and Natural Resources' Division of Water Quality classifies the species as a "specialized insectivore" and rates its pollution tolerance as "intermediate" (NCDWQ 1999).

Seagreen darter. Restricted to the Santee Drainage of North and South Carolina (Lee et al. 1980). Within the Santee Drainage it is found in all the major river systems --- Saluda, Broad, Catawba, Congaree, and Wateree (Lee et al. 1980; Hayes and Bettinger undated). More common in Blue Ridge foothills and upper Piedmont streams over rubble, cobble and bedrock; less common in lower Piedmont and upper Coastal Plain. North Carolina Department of Environment and Natural Resources' Division of Water Quality classifies the species as a "specialized insectivore" and rates it as "intolerant" of pollution (NCDWQ 1999).

Piedmont darter. The Piedmont darter is found primarily in North and South Carolina in the Cape Fear, Pee Dee, and Santee drainages (Lee et al. 1980). There are a few populations in south-central Virginia, just north of the North Carolina state line (Jenkins and Burkhead 1994). The species prefers moderate-gradient creeks, streams, and rivers. It is commonly associated with rubble and gravel riffles and runs. North Carolina Department of Environment and Natural

Resources' Division of Water Quality classifies the species as a "specialized insectivore" and rates it as "intolerant" of pollution (NCDWQ 1999).

Sec 4.3 Ref 16

Trip Report

V.C. Summer Nuclear Station, April 5-6, 2007

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As part of biology-related activities associated with a COL application being prepared by Tetra Tech NUS, Inc. for South Carolina Electric & Gas (SCE&G), we visited V.C. Summer Nuclear Station (VCSNS) on April 5 and April 6, 2007. Our objectives were to (1) characterize natural habitats in property that has been recently purchased by SCE&G and at other COL-related locations, (2) search for rare plant and animal species, and (3) collect fish from an unnamed stream on the recently purchased property. This report briefly provides the results of the site visit.

The area visited corresponds roughly to what is shown in yellow on Figure 2.4-2 of the Environmental Report being prepared for the SCE&G COL application. No rare or unusual habitats were discovered. Several American Colombo (*Frasera caroliniensis*) plants were noted in the narrow bottomland area along the south bank of Mayo Creek, just west of where the unnamed stream (discussed below) empties into Mayo Creek. American Colombo is not federally- or state-listed as threatened or endangered, but is somewhat rare in South Carolina. SCE&G is aware of and routinely monitors two other American Columbo populations at VCSNS.

The unnamed intermittent stream mentioned above originates in a ravine just north of Parr Road and flows northward where it empties into Mayo Creek slightly east of where the proposed access road is currently sited. Minnow traps were placed in pools along the length of the stream on April 5 and removed approximately 24 hours later. The only fish species collected was the creek chub (*Semotilus atromaculatus*).

Habitat within a few hundred yards of the stream consisted of hardwood forest comprised largely of tree species such as yellow poplar, dogwood, sweetgum, American holly, redbud, white oak, red maple, mockernut hickory, and black cherry. Russian olive, an introduced shrub, was a common understory species in this area and in much of other areas searched on April 5 and April 6.

The habitat along Mayo Creek is hardwood forest consisting of the same tree species mentioned above as well as by various oaks, blackgum, and black willow. Planted and native loblolly pines dominate the ridge west of the unnamed stream. In addition, loblolly pines (either native or planted) dominate most of the area searched on April 5 and 6. Mixed pine-hardwood forest occurs in large ecotonal areas between the pine and hardwood forests.

The proposed blowdown line would enter Parr Reservoir within a narrow (30-40 feet wide) marshy wetland dominated by *Juncus*, *Sagittaria*, and water pennywort. One juvenile bald eagle was observed perched in a tree along the rail line in this area. The bald eagle (federally-listed as threatened and state-listed as endangered) was the only threatened or endangered species observed during the site visit.

The site of the proposed waste water treatment plant, located near an arm of Monticello Reservoir, was also visited. A narrow forested area between an existing recreational ball field and the reservoir consists largely of loblolly pine and sweetgum, with scattered Eastern redcedar. This area appears to have little or no potential for harboring rare plants or animals.

Results of the April 5 and 6 site visit will be incorporated into the Environmental Report being prepared for the SCE&G COL application. In addition, a survey for Georgia aster, a federal candidate for listing, is planned for late summer or early fall when this species is in bloom.

Rec 4.3 Ref 17

Referenced in Chapter 1

U.S. NRC 1999, *Environmental Standard Review Plans for Environmental Reviews for Nuclear Power Plants*, NUREG-1555, Washington, D.C., October 1999.