SECTION FIVE

Irrigation Water Management Planning

Georgia's agriculture industry utilizes millions of gallons of water each year for irrigation purposes. Irrigated agriculture ranges from row crop farming to plant nurseries to orchards. Much of the concern with irrigation is with regard to efficiency, runoff and the capture and collection of runoff.

Many irrigation systems are inefficient and essentially waste water during the irrigating process. Irrigation efficiency may seem complicated; many producers may feel that their systems are simply too old to modify. In today's agricultural industry, producers have numerous opportunities to improve the efficiency of their system in a cost efficient way. Improved nozzles, metering, and computer software are all readily available to provide producers with a more efficient means of irrigating their cropland and monitoring plant water use.

Planning an irrigation schedule that best utilizes available water can reduce waste and runoff. Irrigation systems need to be routinely checked to ensure that water is being distributed uniformly and that there are no damaged pipes, sprinklers or nozzles. Irrigation meters provide producers with an accurate measurement of the amount of water that is applied to their crops and can also help identify pumping problems within their system. More information on the benefits of metering can be found in the UGA CES document, Water Meters as a Water Management Tool on Georgia Farms. An efficient system should range between 80 and 92% efficient. If a system is less than 80% efficient, producers should consider a system upgrade. There are several government sponsored irrigation system audit programs available and most system manufacturers can assist with an audit program.

Conservation practice components of Irrigation Water Management Planning section include:

Irrigation Tailwater Recovery System 447

Irrigation Water Management 449

Microirrigation 441

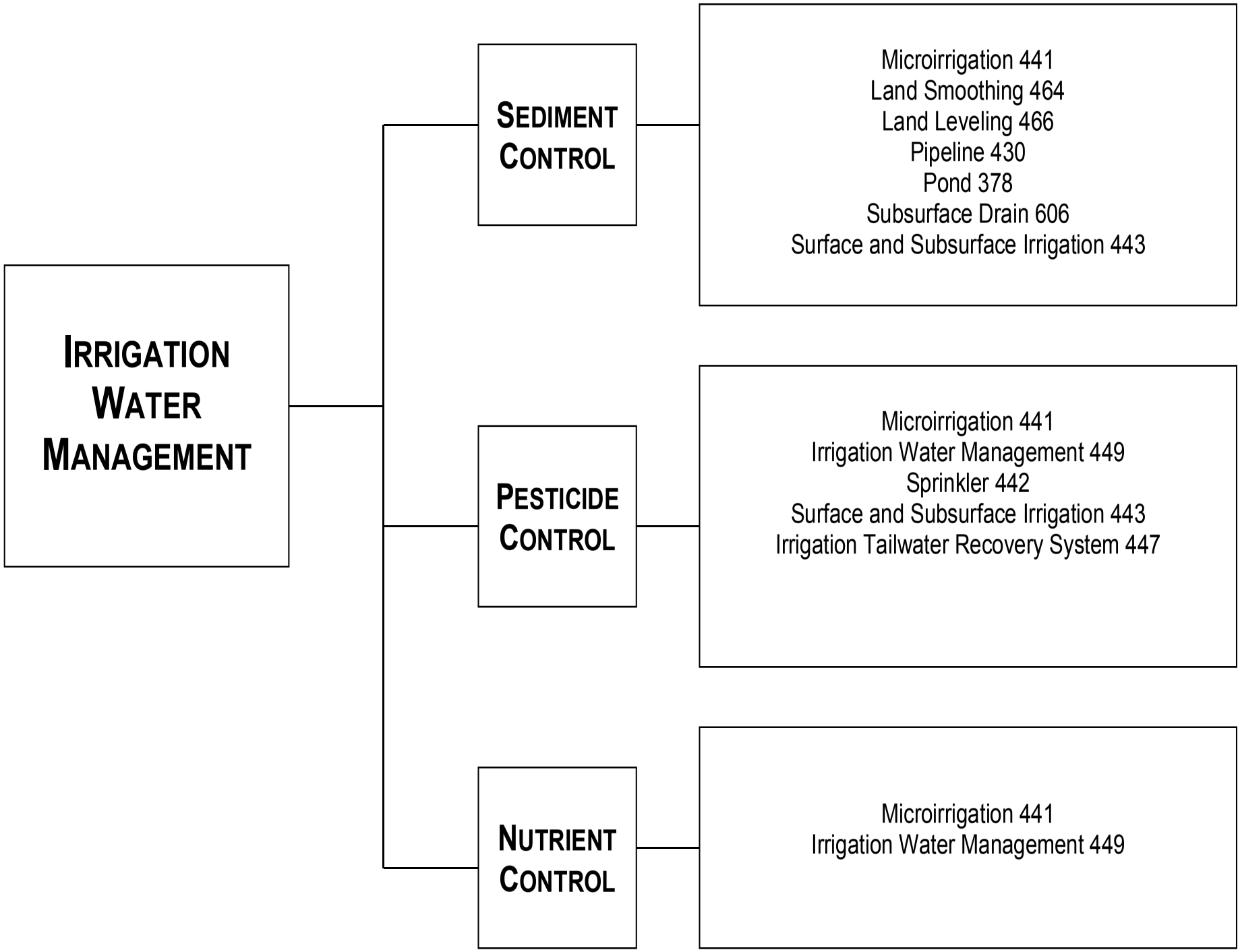
Pipeline 430

Pond 378

Sprinkler 442

Subsurface Drain 606

Surface & Subsurface Irrigation 443


IRRIGATION WATER MANAGEMENT
SEDIMENT CONTROL
Microirrigation 441
Land Smoothing 464
Land Leveling 466
Pipeline 430
Pond 378
Subsurface Drain 606
Surface and Subsurface Irrigation 443
PESTICIDE CONTROL
Microirrigation 441
Irrigation Water Management 449
Sprinkler 442
Surface and Subsurface Irrigation 443
Irrigation Tailwater Recovery System 447
NUTRIENT CONTROL
Microirrigation 441
Irrigation Water Management 449

IRRIGATION TAILWATER RECOVERY SYSTEMS (447) are designed to collect, store and transport tailwater for reuse in an irrigation system.

Water Quality Benefits

- Reduces runoff from fields
- Improves offsite water quality
- Traps sediment, sediment attached nutrients and chemicals from runoff water

When to Use

Tailwater recovery systems can be used with any irrigation system where runoff recovered from fields can be predicted, captured and reused.

How to Establish

Design storage facilities with adequate capacity to meet anticipated needs. Consider runoff volumes and rates, and anticipated application needs in determining storage facility size. Sumps, pits and storage facilities should be protected from erosion where applicable, and from storm events and sedimentation.

For more information, see *Additional Resources*.

Considerations and Costs

Consider any negative impacts on downstream flows and aquifer recharge volumes. Neighboring wetland hydrology may be altered by tailwater recovery and storage facilities.

Systems should be periodically inspected for damages; leaks and repairs should be made in a timely manner.

Contact your local conservation agent prior to beginning a tailwater recovery construction project in order to fully understand maintenance requirements.

Tailwater recovery systems are high in cost depending on size and material costs.

Effectiveness

In the greenhouse and container nursery industries, using a capture and reuse irrigation system has been found to reduce water use by 50% in studies.

Additional Resources

NRCS Conservation Practice Standard 447

IRRIGATION WATER MANAGEMENT (449) plans are designed to reduce irrigation water runoff by incorporating the rate, amount and timing of irrigation water into efficient water use planning.

A well designed and managed irrigation water management system can significantly reduce inefficient use

Water Quality Benefits

- Reduces soil erosion from irrigation
- Reduces nutrients and sediment in runoff
- Improves overall system efficiency
- Reduces leaching and deep percolation

When to Use

An irrigation water management (IWM) plan should be developed for all irrigated land and facilities.

How To Establish

Irrigation water management plans should address timing, capacity, application rates, and irrigation water collection and storage.

Numerous conservation practices are components of an irrigation water management plan. Irrigation water management should be a priority conservation concern. In developing an irrigation plan, consider all nutrients, chemicals and pesticides that may be applied. As part of these systems, planning may be needed to capture and store water for later use.

Costs and Considerations

Consider any impacts irrigation may have on wetlands, water related wildlife habitats, riparian areas, cultural resources and recreational opportunities. By controlling water application amounts, the potential for chemical and sediment transport in runoff can be significantly reduced.

Take care to manage nutrients, chemicals and pesticides, and to prevent transport into surface water and groundwater. Bordering irrigated land with grasses or legumes can reduce erosion.

Test water supplies prior to installing an irrigation system to ensure that the quantity and quality of water demanded can be achieved.

Costs associated with these practices include materials, installation, maintenance and repair. Inspect and repair all irrigation in a timely manner.

Irrigation systems can be moderate to high in cost.

Effectiveness

Irrigation management plans reduce the amount of water wasted and can also significantly reduce sediment, nutrients and insecticides entering water.

Additional Resources

NRCS Conservation Practice Standard 449

MICROIRRIGATION (441) is used as part of an irrigation system to efficiently apply water to the root zone of plants using low-pressure emitters.

Microirrigation allows for direct application of pesticides to individual plants

Water Quality Benefits

- Reduces soil erosion
- Improves water use efficiency
- Reduces sediment in runoff

When to Use

Microirrigation is ideal in areas where soil and topography can/needs to be irrigated and plants are compatible with microirrigation.

How to Establish

Design microirrigation systems to uniformly distribute water at an appropriate application rate. System capacity should account for losses due to evaporation, runoff, and percolation. Space emitters to adequately and uniformly provide water. Emitters can be drippers, microsprayers or misters.

For more information, see *Additional Resources.*

Considerations and Costs

Microirrigation is ideal for orchards, greenhouses, row crops, and residential and commercial landscapes. For small container nurseries with frequent container moving, microirrigation may not be ideal.

Microirrigation benefits include efficient water use, decreased foliar disease, and reduced opportunity for chemical loss and contamination. Microirrigation is also suited for chemigation.

Microsprayers work best with larger containers, as the flow rate may be too much for small plants. Multiple drippers may be needed for even water distribution. Drippers allow more plants to be irrigated at a time because of lower flow rates.

Test water supply prior to installation to ensure that both the quantity and quality of water demanded can be achieved. Microirrigation raises soil moisture levels which can reduce soil water storage capabilities, and can increase runoff. Plant growth rates and transpiration may decrease as a result of microirrigation.

Costs associated with this practice may include materials, installation and maintenance.

Microirrigation can be moderate in cost.

Effectiveness

Well-designed and managed microirrigation systems can potentially be 90-95% efficient. Converting field nurseries and container nurseries to microirrigation can provide an estimated 10% water savings. In studies, microirrigation has been found to be 74% efficient compared to conventional irrigation in vegetable production.

Additional Resources

NRCS Conservation Practice Standard 441

PIPELINES (430) are used to transport water for irrigation purposes.

Water Quality Benefits

- Allows for the transport of water for irrigation purposes without soil erosion or water loss resulting from evaporation or transpiration

When to Use

Pipelines can be installed when needed to transport water in a closed conduit from one point to another. Pipeline is used as a component of a irrigation system and is not a stand-alone conservation practice.

This practice standard is not applicable to surface gated pipes, sprinklers or microirrigation tubing.

How to Establish

Select pipeline materials that will withstand pressure, water surges and water hammer. Acceptable working pressure will be based on the type and diameter of pipe selected.

Valves or unions should be installed at low points in the pipe to allow for water drainage when necessary. Joints should be watertight, composed of a material that is compatible with pipe material and non-corrosive.

Depending on the type of piping material used, different specifications apply.

A check valve or back flow preventer may be needed to ensure the integrity of the system. If using pipeline as part of a chemigation system, a check valve should be installed.

Pipes should be protected from hazards such as traffic, farm operations, freezing temperatures, fire, thermal expansion and contraction.

Revegetate any disturbed areas as soon as possible to reduce erosion.

For more information, see *Additional Resources*.

Considerations and Costs

During installation, disturbed areas should be protected with erosion prevention structures. Consider visual impacts prior to installation.

Maintenance for pipelines includes periodically inspecting valves, pressure regulators, switches and other equipment for proper function. Filling rates should be monitored. Drain pipes during cold weather to prevent freezing and bursting.

Pipelines are moderate in cost depending on the size and length of the pipe.

Effectiveness

As part of an alternative water supply or a waste management system, pipelines indirectly reduce negative water quality impacts.

Additional Resources

NRCS Conservation Practice Standard 430

SPRINKLERS (442) are used to efficiently apply pressurized water through nozzles to irrigated areas.

Sprinklers can efficiently apply water to targeted areas

Water Quality Benefits

- Reduces excessive water loss
- Reduces erosion
- Reduces water quality impairments

When to use

Use sprinkler irrigation systems as part of an overall conservation plan. All sprinkler systems should have an irrigation water management (IWM) plan.

When wastewater is used for irrigation purposes, a nutrient management plan (NMP) must also be developed and maintained. See pages 2.3 and 2.28 for more information on NMPs.

How to Establish

Sprinkler systems should have adequate capacity to efficiently irrigate crops. Systems used to apply wastewater to crops require sufficiently sized nozzles to prevent clogging. Backflow and anti-siphon preventative measures should be incorporated into sprinkler systems.

For more information, see *Additional Resources*.

Considerations and Costs

Monitoring may be necessary at the center pivot to reduce excessive water application. Filtering may be needed to reduce clogging if the water source contains particulate matter, algae or other materials.

Other conservation practices can be utilized in a sprinkler system to prevent soil erosion and runoff; however, benefits gained from implementing other conservation practices are reduced over an irrigation system. Careful monitoring is necessary to ensure that conservation practices efficiently reduce erosion and runoff.

Sprinkler irrigation can impact the water budget, downstream flows and use, and can negatively impact downstream water quality. Users should consider water quality impacts from soil erosion and sediment transport.

Costs of sprinkler systems may include installation, maintenance and repair. Monitoring is needed to ensure the efficiency of a system.

Effectiveness

Sprinkler systems can be 50-95% efficient, depending on the type of the system, cultural practices and management.

Additional Resources

NRCS Conservation Practice Standard 442
NRCS National Engineering Handbook, Part 6

SUBSURFACE DRAINS (606) are underground drains used to collect and remove excess water.

Water Quality Benefits

- Regulates the water table and encourages vegetative growth
- Prevents water from entering wet and heavy use areas
- Regulates sub-irrigated or waste disposal areas
- Reduces runoff
- Increases soil infiltration
- Reduces sediment and attached pollutant transport into surface water

When to Use

Subsurface drains can be used in areas where it will be beneficial to lower the water table or control surface and groundwater.

Only use subsurface drains when required drainage has been installed and other conservation practices are not meeting the operational needs.

How to Establish

Before installing a subsurface drain, inspect the area to determine if the site is suited for a drain. Use the Georgia Drainage Guide to determine tile spacing and depth of placement.

To effectively control water, install drains at the proper depth, spacing and location based on site conditions, topography, groundwater conditions, crops, land use and outlets.

Cover depth is dependent on the type of soil: mineral soils (2 feet) and organic soils (2.5 feet).

Materials used in subsurface drains should meet strength and durability requirements for the site. Filters may be used around conduits to reduce surrounding soil movement into the conduit.

For more information, see *Additional Resources*.

Considerations and Costs

Consider water quality impacts such as sediment delivery, changes in nitrate delivery to downstream water users, changes in the delivery of dissolved substances into aquifers, downstream water temperature changes, and impacts on the visual quality of downstream water.

Subsurface drainage can encourage the transport of nitrate-nitrogen into surface water, and can promote mellower soil conditions and reduce compaction potential.

Using subsurface drains and wetlands together can reduce soluble pollutant loadings in surface waters. Most of the nitrate-nitrogen can be removed by wetlands during spring and summer.

Effectiveness

Subsurface drainage can potentially reduce total runoff by 29-65%, peak runoff by 15-30%, sediment loss by 16-65%, phosphorus loss by 45%, and soil bound nutrient loss by 30-50%.

Additional Resources

NRCS Conservation Practice Standard 606
Georgia Drainage Guide

SURFACE AND SUBSURFACE IRRIGATION SYSTEMS (443) are designed so that all necessary water control structures have been installed to efficiently distribute irrigation water.

Water Quality Benefits

- Efficiently uses water
- Reduces soil erosion
- Reduces water usage and lowers pumping costs

When to Use

These systems can be used to apply irrigation water and/or chemical and nutrient applications to areas of need.

How to Establish

All federal, state and local regulations should be met.

Land should be suitable for irrigation applications. Water supply should adequately meet quality and quantity demanded, and system capacity should be adequate to meet crop demands.

Irrigation systems should be designed to distribute water using sound application methods.

Locate head ditches and pipelines where irrigation water can be uniformly distributed without causing soil erosion.

For more information, see *Additional Resources*.

Considerations and Costs

Erosion control structures may be needed in areas with steeper slopes. For surface irrigation, seepage control measures may also be necessary.

Collection facilities for tailwater and excess runoff should be included as part of an irrigation system.

Consider impacts on surface and ground water quality before chemical and nutrient applications.

Also consider impacts on the water budget, volumes and rates of runoff, changes in plant growth and transpiration, downstream flows, surrounding habitats and the movement of sediment in runoff.

Costs associated with this practice may include installation, maintenance and repair. All equipment should be inspected periodically for damages and repaired in a timely manner.

Effectiveness

Subsurface irrigation can potentially reduce water usage by an estimated 25%.

Additional Resources

NRCS Conservation Practice Standard 443

SECTION SIX

Row Crop Management Planning

Row crop farming is a major agricultural sector in Middle and South Georgia. Cotton, peanuts, corn, wheat and soybeans are among the top crops grown in Georgia's fertile soils. Farmers spend a great deal of time planning and preparing land prior to each growing season. An estimated 70% of Georgia's farmland is considered to be prime farmland. Prime farmland has soil with the best combination of physical and chemical characteristics for producing food and fiber on a sustained basis with proper management. Soil is classified into capability classes based on limitations related to soil type and the need for conservation practices to reduce erosion potential. Prime farmland is separated into five classes with Class I soil having the least limitations to restrict use and Class IV having severe limitations that reduce planting choices and require careful management.

It is important to also consider the shape and slope of fields when designing a cropping system. It is better to adjust your cropping system to fit the land than to try to force the land to fit your system. By contour farming, you farm on or near the level across the slope rather than up and down the slope. Incorporating a ridged planting system along with contour farming can effectively reduce erosion and also improve infiltration. Numerous other conservation practices also work well to reduce erosion, increase water holding capacity, and improve soil tilth and organic matter on row cropped land.

As part of a row cropping operation, pesticides are frequently used to improve crop productivity by controlling insects, disease and weeds. In commercial nursery operations, pesticides are also used through drip irrigation and/or sprinkler systems. Pesticides can be a serious risk for humans and animals if improperly used. Many pesticides are broad spectrum and can be toxic to non-target species. The compounds that make up many pesticides can also be potential pollutants for surface and groundwater.

Integrated Pest Management (IPM) programs are used to reduce the use of and dependency on pesticides. Your local conservation agent can assist you in developing an IPM plan that best fits your operation. In addition, by reducing use, producers have the opportunity to reduce spending on pesticides. IPM provides producers with a plan that addresses application, container and excess chemical storage as well as safety. Planning in advance can promote a safer work environment for all employees as well as reduce injuries and illness from pesticide use.

It is important that any pesticide spill be properly contained and cleaned. Every operation that uses pesticides should have a spill kit with protective equipment listed on the label (safety glasses, gloves, proper clothing etc.), absorbent materials to contain the spill (cat litter, saw dust, sand, dirt), a scoop to gather contaminated absorbent material and a container to place the contaminated materials. Never hose down spills. Be sure to protect yourself and others while cleaning up a pesticide spill. Proper authorities should be notified immediately of spills on public roads or with large spills, leaks or pesticide fires.

Emergency information and emergency steps should be posted clearly for anyone that may come in contact with pesticides.

To prevent chemical mix-ups, be sure that all chemical containers are properly labeled and stored. Always keep chemicals out of the reach of children. Also keep all protective clothing located in the same area as chemicals are stored. After any pesticide application, be sure to rinse clothing prior to disposal. Follow all label directions for mixing, applying, storing and disposing of chemicals. According to the University of Georgia Pest Management website, nearly all pesticide accidents are the result of not following all of the directions, restrictions, and precautions on the label. If accidental exposure does occur, contact emergency personnel and follow label directions exactly. Do not induce vomiting unless the label indicates to do so. Seek medical attention if necessary.

Pesticides should never be transported inside of a passenger vehicle or with food, feed or other products that may come in contact with humans or animals. Pesticides should be properly labeled prior to transport. Pesticide storage should be located away from food or feed, and at least 100 feet from wells or other waterways. Store pesticides in a fire-resistant, well ventilated, well-lit, locked, and dry area that has a concrete floor. Pesticide storage areas should be protected from direct sunlight and should also be insulated.

Older pesticides can be recalled due to new discovery of environmental and human risk. It is not illegal to possess a cancelled or recalled pesticide. In order to use pesticides on the Restricted Use List, a person must be certified as a licensed applicator. Along with recalls, a re-collection program is often introduced to assist producers in disposing of recalled pesticides. Paying careful attention to announcements and working with extension agents to properly dispose of unwanted pesticides can save producers time, money and worry. Burying, burning or dumping any pesticide is illegal.

Pesticide containers can sometimes be disposed of in landfills with proper preparation. Producers should check with local landfills to see if they accept clean, empty pesticide containers. Plastic, metal or glass containers must first be pressure or triple washed and then must be punctured to prevent reuse. Paper bags should be shaken clean prior to landfill disposal.

The Georgia Department of Agriculture in cooperation with UGA Cooperative Extension Service, the Georgia Crop Production Alliance and the Georgia Farm Bureau has developed a pesticide disposal program known as Georgia Clean Day. Contact information can be found in Chapter 3 of this Manual.

Conservation practice components of Row Crop Management Planning section include:

Conservation Cover 327

Conservation Tillage (Residue Management)
No-Till 329
Mulch Till 345
Ridge Till 346

Contour Farming 330
Row Arrangement 557

Contour Strips
Buffer Strips 332
Stripcropping 585

Cover Crop 340

Crop Rotation 328

Diversion 362

Field Border 386

Field Stripcropping 586

Filter Strip 393

Grade Stabilization 410

Grassed Waterway 412

Integrated Pest Management 595

Nutrient Management 590

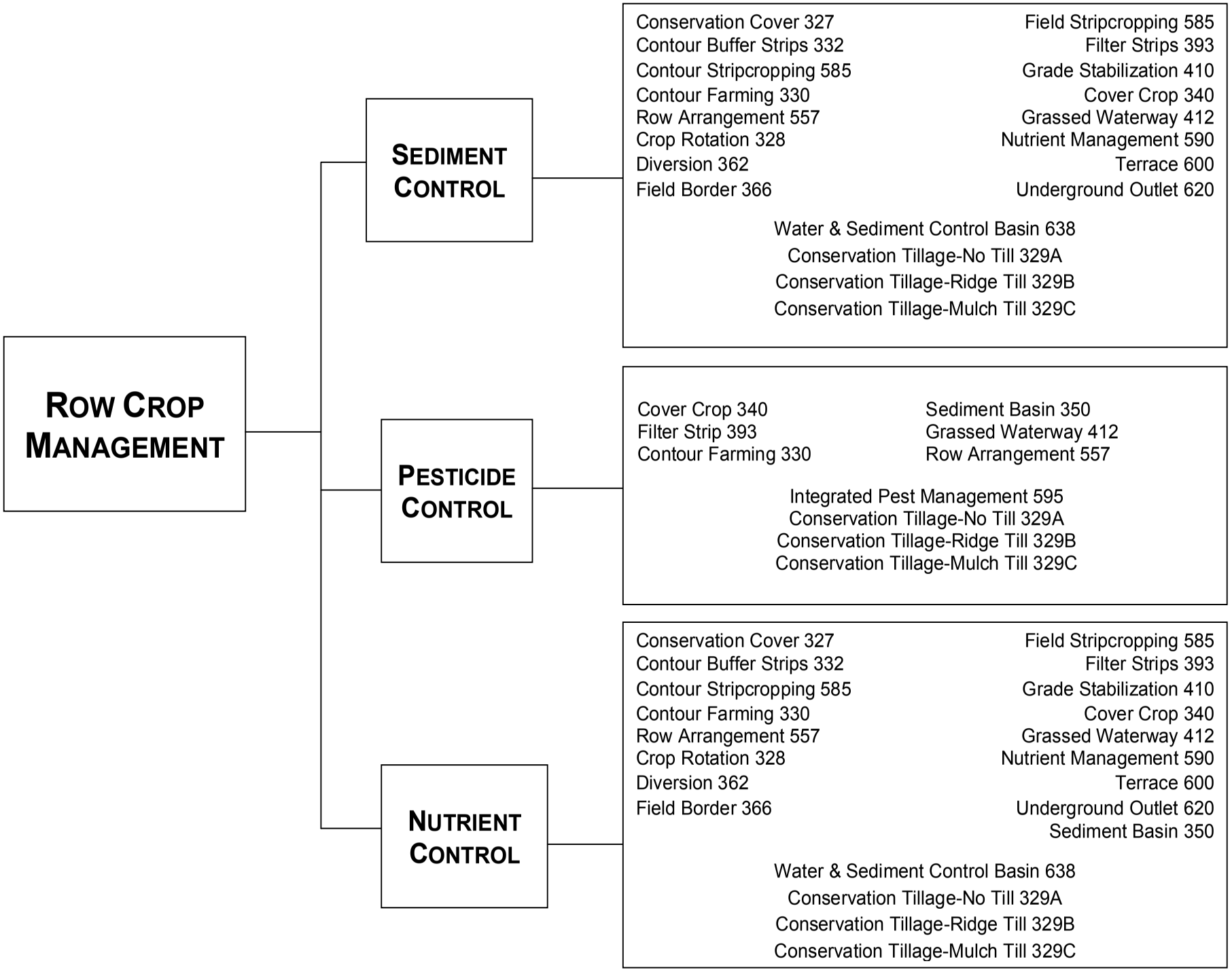
Scouting

Sediment Basin 350

Terrace 600

Water & Sediment Control Basin 638

Underground Outlet 620


ROW CROP MANAGEMENT
SEDIMENT CONTROL
Conservation Cover 327
Contour Buffer Strips 332
Contour Stripcropping 585
Contour Farming 330
Row Arrangement 557
Crop Rotation 328
Diversion 362
Field Border 366
Field Stripcropping 585
Filter Strips 393
Grade Stabilization 410
Cover Crop 340
Grassed Waterway 412
Nutrient Management 590
Terrace 600
Underground Outlet 620
Water & Sediment Control Basin 638
Conservation Tillage-No Till 329A
Conservation Tillage-Ridge Till 329B
Conservation Tillage-Mulch Till 329C
PESTICIDE CONTROL
Cover Crop 340
Filter Strip 393
Contour Farming 330
Sediment Basin 350
Grassed Waterway 412
Row Arrangement 557
Integrated Pest Management 595
Conservation Tillage-No Till 329A
Conservation Tillage-Ridge Till 329B
Conservation Tillage-Mulch Till 329C
NUTRIENT CONTROL
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Contour Buffer Strips 332
Contour Stripcropping 585
Contour Farming 330
Row Arrangement 557
Crop Rotation 328
Diversion 362
Field Border 366
Field Stripcropping 585
Filter Strips 393
Grade Stabilization 410
Cover Crop 340
Grassed Waterway 412
Nutrient Management 590
Terrace 600
Underground Outlet 620
Sediment Basin 350
Water & Sediment Control Basin 638
Conservation Tillage-No Till 329A
Conservation Tillage-Ridge Till 329B
Conservation Tillage-Mulch Till 329C

CONSERVATION COVER (327) is the establishment and maintenance of permanent vegetative cover to protect soil and water resources on retired agricultural land.

Water Quality Benefits

- Protects and improves water quality by reducing soil erosion
- Reduces sediment entering watering sources
- Increases soil infiltration

When to Use

Conservation cover is typically used when land is/has been retired from agricultural production or on land that requires permanent cover to decrease soil erosion and water quality degradation.

For a more temporary cover, please see Cover Crops on page 2.60.

How to Establish

Native plant species that are adapted to the site are recommended for conservation cover. Plant according to proper horticultural practices, planting methods and seeding rates to ensure establishment.

Chemical treatments are not recommended for this conservation practice.

For more information, see *Additional Resources*.

Considerations and Costs

Consider a rotating mowing schedule to encourage plant and wildlife diversity.

Costs associated with conservation cover include seed and plant materials as well as labor costs associated with preparing, planting and maintaining cover.

During primary nesting periods for grassland species (May 1-September 30 in Georgia), maintenance activities should be avoided.

During the growing season, mowing may be necessary to reduce competition.

Conservation cover is low in cost depending on plant material costs.

Effectiveness

Conservation cover can potentially reduce erosion and sedimentation up to 90%.

Additional Resources

NRCS Conservation Practice Standard 327

CONSERVATION TILLAGE (329, 345, 346), also known as residue management, reduces erosion, maintains and improves soil organic matter and conserves soil moisture by managing plant residue on the soil surface year-round. This includes no tillage (strip tillage), ridge tillage and mulch tillage.

Cotton growing in no-till

Water Quality Benefits

- Reduces erosion
- Reduces soil detachment
- Reduces sediment and sediment attached particles entering water sources
- Increases infiltration

Types of Conservation Tillage

Any tillage and planting system that maintains at least 30% residue cover on the soil surface after planting is considered conservation tillage.

No-Till/Strip Tillage (329)—Fields are seeded in narrow slots of tilled or residue free strips of previously untilled soil; soil is undisturbed from one planting to the next; nutrients are injected into the soil rather than broadcasted; planting is done in a narrow bed.

No-till is a one-pass planting and fertilizer operation in which soil and surface residues are minimally disturbed. No-till conserves water, reduces erosion, maintains organic matter content at a high level, and sustains economic productivity.

Mulch Tillage (345)—Leaving or spreading crop residue onto fields prior to or after planting to reduce erosion in fields where the entire surface is tilled prior to planting; or soil is tilled prior to planting and residue is left on soil as a mulch.

Ridge Tillage (346)—Fields are seeded in preformed ridges alternated with furrows protected by crop residue; soil is undisturbed from one planting to the next. Nutrients are injected into the soil rather than broadcasted; planting is on ridges of rows. Soil is left undisturbed from previous crop harvest until new crop is planted.

When to Use

Conservation tillage practices can be used on any agricultural operation.

How to Establish

Initially, plant crops that produce high residue for conservation tillage. For mulch tillage, spread residue after crop has been planted to reduce erosion. In some cases, re-mulching may be necessary in order to maintain adequate cover, especially when baling and heavy grazing may lower the mulch cover content.

When ridge tilling, it is necessary to maintain ridge height throughout the field.

For more information, see *Additional Resources*.

Considerations and Costs

Ridge tilling requires stable outlets with ridges to direct runoff to areas of concentrated flow. Conservation practices such as grassed waterways or water and sediment control basins can be used to

protect concentrated flow areas.

No-tillage may require more chemical inputs in order to control weeds.

Residue management is low to moderate in cost.

Effectiveness

No-till systems can potentially reduce herbicide runoff by up to 70% compared to conventional systems with dry weather.

Thirty percent cover can potentially reduce soil erosion by 50-60% compared to conventional tillage.

In a 5-year study conducted in the Piedmont region of Georgia, runoff from no-tilling was 22% less during cropping periods and 35% less during fallow periods compared to conservation tillage.

Additional Resources

NRCS Conservation Practice Standard 329
NRCS Conservation Practice Standard 345
NRCS Conservation Practice Standard 346

Immature corn growing in no-till

CONTOUR FARMING (330) is a system of tilling, planting and performing other farming operations on or near the contour of a field to reduce erosion and prevent runoff entering into water sources.

Onions growing in contoured rows

Water Quality Benefits

- Slows overland water flow
- Reduces runoff and sediment detachment
- Increases infiltration and captures sediment
- Allows more time for nutrient absorption to remove excess nutrients from runoff

When to Use

Contour farming works best on fields with a slope between 2-10%. Contour farming does not work well on rolling topography with irregular slope variations.

Row arrangement can also be used as part of a contour farming system to promote efficient water use and to control water flow and direction on sloping land.

How to Establish

Establish a key line around the area to be contour farmed as a base line for arranging rows. Key lines should have a slope of 2%. Key lines located near an outlet can be 3%. Either a natural or constructed outlet is necessary to capture water flowing from contour-farmed fields. Grassed waterways work well to control the rate of water flow into outlets and reduce gully erosion.

Ridges for crop rows are built by tilling on or near the contour of a field. These ridges slow water flow, increase infiltration rates and capture sediment in runoff.

Row arrangement should complement farm size and type as well as any equipment being used. Rows should be arranged to move excess water from fields into surface ditches.

For more information, see *Additional Resources*.

Considerations and Costs

Unless permanently established, key lines will have to be re-determined every year. Permanent key lines can be established using grass.

Additional costs associated with this practice may include establishing grassed waterways and constructing outlets for water flow. Crop row ridges should be monitored for washes that may increase runoff from fields.

Contour farming and row arrangement are both low in cost.

Effectiveness

Sediment runoff models indicate that contour farming can be 25-50% effective in reducing soil loss.

In studies, contour farming has reduced erosion rates by 5-30% in Georgia, depending on the slope of land and row ridge height.

Additional Resources

NRCS Conservation Practice Standard 330
NRCS Conservation Practice Standard 557

CONTOUR STRIPS (332 & 585) are used to reduce soil erosion, slow sediment transport and reduce runoff entering into water sources.

Contour strips slow surface water flow leaving fields and reduces erosion

Water Quality Benefits

- Reduces soil erosion from water and wind
- Reduces sediment transport into water sources
- Slows surface water flow and traps sediment

When to Use

There are several types of contour strip systems. Contour stripcropping is a planting system that alternates fallow strips with cropping strips of equal width. Contour buffer strips are permanent strips planted along a field contour and are most suitable on land with a slope of 4-8%.

How to Establish

For contour stripcropping, two or more strips of equal width should be as close to the contour of a field as possible. Stable outlets are needed to capture diverted surface runoff and reduce concentrated flow erosion. Grassed waterways, field borders, filter strips, water and sediment control basins and underground outlets are acceptable stable outlets.

Grade contour buffer strips to align as closely as possible with the contour. Strips should be a minimum of 15 feet wide at the narrowest point to control sheet and rill erosion. Grasses or grass-legume mixtures are ideal for contour buffer strips; to reduce sediment transport, plant sod-forming vegetation.

Considerations and Costs

When designing a stripcropping system, plan for equipment traffic and movement into design. Remove sediment build-up along strip edges periodically to maintain the efficiency of a stripcropping system.

Contour strips are typically used in contour farming. Conservation cover can be used in permanent contour strips. When planting permanent strips, be sure to use plants/crops resistant to herbicides used on harvested crops.

Costs associated with these practices may include site preparation, seed and fertilizer, maintenance and repair.

These practices are low in cost, depending on the width and length and type of vegetation established.

Effectiveness

Contour stripcropping can potentially reduce soil erosion by 50-60%; contour buffer strips can potentially reduce soil erosion 20-75%.

Additional Resources

NRCS Conservation Practice Standard 332
NRCS Conservation Practice Standard 585

COVER CROPS (340) such as close-growing grasses, legumes and forages are planted as a temporary cover to reduce soil erosion, capture and use excess nutrients, and improve soil quality.

Cover crops protect the soil and provide soil stability

Water Quality Benefits

- Reduces soil erosion
- Reduces nutrients and pesticides in runoff
- Reduces nitrogen leaching
- Promotes nutrient absorption and utilization

When to Use

Cover crops can be established where vegetative cover is needed to reduce erosion and to utilize excess nutrients from previous crops. Cover crops can be planted after low residue crops to reduce erosion.

Plants incorporate nitrogen into tissue as they grow and reduce nitrogen leaching into groundwater. Roots anchor soil, decrease erosion and minimize phosphorus losses.

For permanent cover, please see Conservation Cover on page 2.55.

How to Establish

Establish cover crops during critical erosion periods and prior to the leaf drop of preceding crops to allow time for establishment. Select plant species that best match the nutrient and pest management plans of an operation.

Delaying cover crop harvesting as much as possible will maximize plant biomass production.

For more information, see *Additional Resources*.

Considerations and Costs

Herbicides used on cover crops should be compatible with the next crop.

Plant cover crops to allow adequate time for establishment. Whenever possible, plant crops that can be used on-site for other purposes.

To utilize cover crops in a feeding system, select plants that are palatable to animals. If planted for nutrient uptake, select crop varieties that will use the maximum amount of nutrients.

Cover crops are low in cost depending on the type of vegetation established.

Effectiveness

Covers crops can potentially reduce erosion by 40-60% and herbicide residues by nearly 40%.

Additional Resources

NRCS Conservation Practice Standard 340

CROP ROTATION (328) is a system where cropping is performed in recurring sequence in order to reduce soil erosion and runoff entering water bodies.

Water Quality Benefits

- Decreases runoff and erosion
- Improves soil tilth and increases organic matter
- Breaks disease, insect and weed life cycles
- Improves nutrient utilization

When to Use

Crop rotation can be used on any land where crops are grown other than pasture land and hayland. Plan rotation to balance plant nutrients in soil using legumes. Select crops with deep rooting systems. Avoid crop species that will require equipment in the area during wet periods to promote infiltration and reduce compaction.

How to Establish

Select crops for rotation that compliment each other and improve overall soil composition. During the first year after establishment, fertilizer may be needed to encourage plant growth. Legumes require one planting season to before nitrogen fixation will begin.

For more information, see *Additional Resources*.

Considerations and Costs

Crop rotation requires more intensive management and planning. Select crops that will provide sufficient biomass to reduce erosion.

Legumes used in crop rotation provide nitrogen for the next crop. Follow legumes with crops that have high nutrient requirements.

Normal planting costs will apply. However, additional fertilizer costs may be necessary during the first year following planting.

For more information on different types of crop rotation, please contact your local conservation agent.

Crop rotation is low in cost.

Effectiveness

When properly managed, crop rotation can potentially reduce soil erosion by 40-50%.

Additional Resources

NRCS Conservation Practice Standard 328

DIVERSIONS (362) are permanently vegetated strips established across a slope to redirect water to areas of need.

A grassed diversion is planted to redirect water from a slope and also traps nutrients and sediment in runoff

Water Quality Benefits

- Diverts runoff water away from water sources
- Reduces sediment and nutrient transport
- Reduces gully erosion and flooding
- Increases infiltration

When to Use

Diversions can be used to control runoff water by installing a channel across the slope of a field.

How to Establish

Diversions protecting agricultural land should have a minimum capacity to maintain peak runoff from a 10-year frequency storm. Channels should be designed with stable slopes and minimum ridge top widths of 4 feet. For diversions with less than 10 acres of drainage area upland, ridge tops may be 3 feet wide.

Avoid installing diversions below high sediment producing areas. Diversions used to reduce or prohibit water from entering into wetlands can change a wetland's hydrology.

All diversions must have a safe and stable outlet with adequate capacity and convey runoff to a point where outflow will not cause damage. Diversions should also have an operation and maintenance plan.

For more information, see *Additional Resources.*

Considerations and Costs

Design diversions to accommodate equipment. Keep equipment and machinery out of the area until vegetation is established.

Maintenance may include repairing and replacing damaged components, maintaining capacity (ridge height and outlet elevations), clearing outlets and re-distributing sediment build-up, clearing trees and brush and maintaining vegetative cover.

Contact your local conservation agent prior to beginning a diversion construction project in order to fully understand maintenance requirements.

Diversions are low to moderate in cost, depending on materials, construction, size and maintenance costs.

Effectiveness

In cropland, diversions can potentially reduce soil erosion 30-60%.

Additional Resources

NRCS Conservation Practice Standard 362

FIELD BORDERS (386) are permanently vegetated borders established around fields and pastures to reduce soil erosion.

Field borders protect water quality by reducing erosion and filtering runoff

Water Quality Benefits

- Slows runoff leaving fields and pastures
- Reduces sediment and nutrients entering water sources
- Increases nutrient absorption
- Protects water quality and reduces soil erosion

When to Use

Field borders can be used around the edges of cropland and to connect other buffer practices within a field. When established alongside a water source, borders are called riparian buffers. See page 2.83 for more information on riparian herbaceous cover and page 2.81 for riparian forest buffers.

Field borders can also be used to eliminate sloping end rows, headlands, and other areas where concentrated water flows may occur.

How to Establish

Field borders should be at least 20 feet wide for traditional use and should accommodate equipment used for planting, fertilizing or harvesting crops. Select adapted species of permanent grasses, legumes and/or shrubs. A minimum of 80% year-round vegetation cover is ideal. When field borders are being established for wildlife purposes, a minimum width of 30 feet is required.

For more information, see *Additional Resources*.

Considerations and Costs

Costs associated with this practice may include site preparation, seed/planting materials, and fertilizer and maintenance costs. Maintenance costs may include sediment removal, shaping and reseeding border areas, weed treatment, and repairing damages from weather or equipment.

Select plant species that are tolerant to heavy traffic, sediment deposition and chemicals used in a cropping system. Narrow strips of stiff-stemmed upright grasses can increase trapping efficiency. Keep grass at least one foot tall when heavy erosion is expected.

Field borders are low in cost depending on the type of vegetation established.

Effectiveness

Field borders can remove up to 50-80% of nutrients and sediment, 50% of pesticides, 60% of pathogens, and 60-80% of nitrogen and phosphorus depending on the width, slope, cover and density of vegetative cover.

Additional Resources

NRCS Conservation Practice Standard 386

FIELD STRIPCROPPING (586) is a planting system in which crops are grown in alternating strips with grasses to reduce soil erosion and runoff.

A field stripcropping system is used to reduce erosion and runoff by anchoring soil between cropping rows

Water Quality Benefits

- Reduces erosion
- Slows and reduces runoff from fields
- Reduces nutrient and sediment transport into water sources

When to Use

Field stripcropping works on sloping cropland where contour stripcropping is not possible and on rolling topography.

How to Establish

This practice works best on cropland with a slope exceeding 15%. Strips should be the same width and run parallel to each other.

Select row grade and ridge height to reduce erosion as best as possible. All runoff from stripcropping should be directed to stable outlets.

Plant strips with a close growing vegetation strip and a clean-tilled crop/fallow strip alternating. Potential highly erosive strips should never be located adjacent to each other.

For more information, see *Additional Resources*.

Considerations and Costs

Consider planting strips of permanent vegetation or grass that can be used for grazing and hay production. It may be necessary and ideal to incorporate other erosion control practices to further reduce erosion and runoff.

Plan strips to accommodate traffic patterns and equipment that will be used on fields.

Costs associated with this practice may include site preparation, seed and fertilizer, and equipment and maintenance costs.

Maintenance associated with this practice may include mowing permanent strips and maintaining adequate cover to manage runoff.

Field stripcropping is low in cost depending on the length and width, and the type of vegetation established.

Effectiveness

Sediment runoff models indicate that field stripcropping can be 75% effective in reducing soil loss.

Additional Resources

NRCS Conservation Practice Standard 586

FILTER STRIPS (393) are strips of vegetation that are located between cropland, grazing land or disturbed areas and water sources to protect water quality.

Filter strips protect water quality by filtering runoff, removing sediment and nutrients

Water Quality Benefits

- Traps sediment, attached nutrients and pesticides
- Slows surface runoff
- Improves infiltration

When to Use

Use filter strips as part of a conservation plan where land-altering activities may increase environmental damage.

Filter strips are not planted along waterways. For this type of planting, see Riparian Herbaceous Cover (390) on page 2.83.

Filter strips are not designed to filter manure, wastewater or runoff from AFOs.

How to Establish

Filter strips can be planted in either a single planting species or in a mixture of grasses, legumes and/or forbs. Select plants with stiff stems and a high stem density near the ground surface.

Plant filter strips in adequate time before the irrigation season begins to allow for strong root establishment that can handle sediment deposits and runoff.

The minimum flow length of any filter strip is 20 feet. The appropriate flow length for a filter strip should be based on the width of the flood plain and the percent slope of the field. Your local conservation agent can help you determine the appropriate filter strip length and width for your site.

For more information, see *Additional Resources*.

Considerations and Costs

Filter strips should not be used as part of a cropping system. Choose strip locations that will reduce runoff, and increase infiltration and groundwater recharge. Select plants that are tolerant to herbicides used in nearby cropping systems.

Since larger soil/organic particles settle out more rapidly than smaller particles, longer strips may be necessary to remove finer particles. Wider strips and appropriate flow lengths improve the likelihood of a filter strip capturing particulates.

Costs associated with this practice include site preparation, seed/plant costs and maintenance. Periodically harvesting filter strips will promote vegetative growth.

Sediment build-up removal may be needed to maintain overall filter strip function. Weed control and fertilizer costs may also be associated with filter strips. In some cases, light grazing can be used to control growth.

During periods of heavy rain, filter strips can flood

and result in large loads of pollutants entering surface water.

Filter strips are moderate in cost depending the length and width of strips, and the type of vegetation established.

Effectiveness

Properly installed and maintained filter strips can potentially remove up to 50-80% of nutrients and sediment, 50% of pesticides, 60% of pathogens, and 60-80% of nitrogen and phosphorus in runoff depending on the width, slope, cover and density of the vegetative cover.

Additional Resources

NRCS Conservation Practice Standard 393
UGA Cooperative Extension Service

GRADE STABILIZATION STRUCTURES (410) work by allowing water to move to a lower elevation without causing soil erosion.

Water Quality Benefits
- Reduces erosive channel flow
- Reduces soil erosion

When to Use
Grade stabilization structures can be used in both natural and artificial channels to prevent gullies.

How to Establish
All federal, state and local regulations should be met.

Design grade stabilization structures for stability and function. Typically, structures are regulated by the height and capacity of water that the structure must sustain. Embankment dams, pond sized dams, full-flow open structures, island type structures, and side inlet drainage structures are all considered grade stabilization structures and have specifications. Please see NRCS Conservation Practice Standard 410 for more information.

Protective fencing, caution signs and/or lifesaving equipment may be required.

For more information, see *Additional Resources*.

Considerations and Costs
Consider visual impacts. It may be necessary to revegetate disturbed and surrounding areas in order to improve the effectiveness of a structure.

Costs associated with this practice may include site preparation, materials, structure establishment and maintenance.

Maintenance may include periodic inspections and repairs of the structure.

Contact your local conservation agent prior to beginning any grade stabilization projects in order to fully understand maintenance requirements.

Grade stabilization structures are moderate to high in cost depending on materials, size and construction.

Effectiveness
Grade stabilization structures have the potential to reduce suspended solids originating from unstable areas by 75-90%.

Additional Resources
NRCS Conservation Practice Standard 410

GRASSED WATERWAYS (412) are natural or constructed channels seeded with grass that are established within a field to slow the flow of water, re-direct excess water from fields, and to prevent soil and gully erosion.

Grassed waterways slow runoff and allow more time for nutrient absorption and sediment capture.

Water Quality Benefits

- Slows runoff
- Reduces gully erosion
- Captures sediment attached nutrients in runoff and reduces entry into water sources

When to Use

Grassed waterways should be used in areas where water conveyance capacity and vegetative protection can control erosion from concentrated runoff.

How to Establish

Grassed waterways should have the capacity to handle expected peak runoff from a 10-year, 24-hour storm. Grassed waterways should be constructed and vegetated at least 1 year prior to installing terraces and diversions. Typically, it is easier to establish vegetation from September to December. The minimum top width for agricultural waterways in Georgia is 25 feet, depending on structure design. A stable outlet is mandatory with this practice.

For more information, see *Additional Resources*.

Considerations and Costs

Before installing a grassed waterway, consider impacts on the surrounding environment. Grassed waterways work well with riparian buffers and filter strips.

Initial costs may include site preparation, materials and installation. Mulch, rock, straw, hay bales, dikes, filter fences or runoff diversions may be used to promote plant establishment. Stable outlets are needed to prevent gully formation.

Maintenance costs associated with this practice include maintaining waterway capacity, vegetative cover and outlet stability. Contact any local conservation agent prior to constructing a grassed waterway project in order to fully understand maintenance requirements.

Grassed waterways are moderate to high in cost depending on the length and width of the waterway and material costs.

Effectiveness

Grassed waterways have been found to reduce soil erosion by 60-80% from the flow area and herbicide runoff by 78% in studies.

Additional Resources

NRCS Conservation Practice Standard 412

INTEGRATED PEST MANAGEMENT (595) plans use environmentally sensitive practices to control weeds, insects and disease on fields and pastures and reduce potential negative effects on humans, and soil and water quality.

A pesticide field application

Water Quality Benefits

- Reduces pesticides/herbicides entering water sources
- Protects aquatic species and habitats from detrimental chemicals
- Reduces the degradation of water resources

When To Use

An integrated pest management (IPM) program should be developed whenever pests necessitate management.

How To Establish

Integrated pest management involves a review of past pest problems and then the development of a management program that plans for future pest control necessity.

IPM is a program that balances economics, efficiency and environmental risk. IPM combines prevention, avoidance, monitoring and suppression into one plan. IPM plans should be incorporated into irrigation water management plans where applicable to manage environmental risks and reduce water contamination. Plans should include a plan map and soil map, location of sensitive areas and setbacks, an environmental risk analysis, and an operation/maintenance plan.

Select pesticides with a lower half-life and a lower potential for leaving application sites through run-off and leaching.

For more information, see *Additional Resources*.

Considerations and Costs

In addition to developing a plan for chemical use, mitigation plans that address emergency and liability issues should be developed. Emergency plans should include procedures that address chemical exposure as well as provide emergency phone numbers.

IPM plans should be developed to comply with all federal, state and local regulations.

Follow all label requirements and post signs (where mandated) around sites where chemical applications will be or have been applied.

Take preventative measures to reduce pests prior to treatment. This may include using pest-free seeds and cleaning equipment between fields among other general management practices.

In addition to chemicals, costs may include soil testing, equipment and maintenance, and the upkeep and maintenance of nozzle tips, hoses and gauges.

Pest management records are essential in protecting users from liability issues. Clear, easy to understand records should be kept for at least 2 years. Check with federal, state and local regulations for additional requirements.

A buffer zone of 50-100 feet is recommended from wells and surface water for safety.

Pest management is low to moderate in cost.

Effectiveness

Using IPM has the potential to decrease pesticide use 40-50% within 5 years and 70-80% within 10 years without sacrificing crop yields or grower profits.

Additional Resources

NRCS Conservation Practice Standard 595
Georgia Pest Management Handbook

Proper chemical disposal is a minimum requirement for all CAFOs. Contact the Georgia Department of Agriculture for more information.

SCOUTING is the utilization of available research and thorough field investigation to determine when pests reach a sufficient threshold to require pesticide treatment.

By scouting, the necessity for pesticides can be significantly reduced.

Water Quality Benefits

- Reduces pesticide applications which decreases the opportunity for pesticide transport in runoff

When to Use

Scouting is an essential part of an integrated pest management plan for crop and orchard operations.

How to Establish

Scouting is the regular inspection of crops and orchards for insects and their damage in order to get an accurate estimate of the type of insects in a field and damage to fields. This is determined by inspecting a representative sample of plants or plant parts from each field.

The sample size of inspection should be based on the type of insects you are looking for. This sample size may change in response to insects found on the field. Scouting is a careful process in which either an entire plant or plant parts are inspected for insects, or evidence of insects or eggs that can result in infestation if not treated.

Peanut pests in Georgia may include Wireworms, Southern Corn Rootworms, Thrips, Lesser Corn Borers, Corn Earworms, Fall Armyworms, Spider Mites, Velvetbean Caterpillars and other insect species.

Cotton pests in Georgia may include Thrips, Aphids, Plant Bugs, Stink Bugs, Cotton Bollworms, Tobacco Budworms, Fall Armyworms, Beet Armyworms, Boll Weevils (currently in containment phase), European Corn Borers and other insect species.

Corn pests in Georgia may include Corn Earworm, Fall Armyworm, Beet Armyworm, European Corn Borer, Lesser Cornstalk Borers and other insect species.

Tobacco pests in Georgia may include Thrips, Tobacco Budworms, Fall Armyworms, Beet Armyworms and other insect species.

Soybean pests in Georgia may include Corn earworms, Beet Armyworms, Velvetbean Caterpillars, Lesser Corn Borers, Stink Bugs, Aphids and other insect species.

In addition to scouting cultivated crops, pecan and apple orchards and commercial vegetable fields are often scouted for pests. In North Georgia, apples are inspected for Codling Moths, Oriental Fruit Moths, and Tufted Apple Bud Moths. Pheromone traps have been developed for apple orchards that monitor adult populations and help growers determine when to treat for these pests. The ideal treatment time is the time frame between when larvae are hatched and then grow to caterpillars. This management system allows growers to be much more precise in their insecticide applications and lower costs.

Pheromone traps are available commercially that use synthesized scents from one sex of an insect to attract and trap either sex (Boll Weevils) or the opposite sex (most moths).

Another method of insect control is through the promotion of beneficial insects. Beneficial insects are either predators that prey on insect pests or parasites that live within the host insect. Beneficial insects include Bug-Eyed Bugs, Minute Pirate Bugs, Fire Ants, and Cotesia Wasps.

In order to reduce insecticide resistance, it is best to alternate the use of insecticide classes on different generations of insects during the season.

Considerations and Costs

Through scouting reports, producers can determine which insecticide applications are needed and appropriate application rates.

Scouting is low in cost, especially when compared to costs associated with frequent insecticide applications.

Effectiveness

Scouting can significantly reduce insecticides being transported in runoff.

Additional Resources

Georgia Cotton Producers Guide
University of Georgia Entomology Dept.

Pests can be detrimental to crops without proper management and treatment

SEDIMENT BASINS (350) capture and store debris or sediment in runoff leaving fields or pastures.

Water Quality Benefits

- Reduces sediment transport into water sources
- Reduces gullying
- Reduces nutrient and chemical transport

When to Use

Sediment basins can be used in areas with irregular slopes and where other erosion control measures have been installed and are not efficient in controlling sediment transport.

How to Establish

Sediment basin capacity should be at least 67 cubic yards per acre from the primary or emergency spillway. If sediment will be removed periodically, basin capacity can be reduced by the same proportion.

Disturbed areas should be re-vegetated as soon as possible to reduce erosion. If possible, use native species when re-vegetating.

Principle spillways and emergency spillways are required to protect the integrity of a sediment basin. Follow NRCS guidelines for installation. Design dams, spillways and drainage facilities according to NRCS standards.

Fencing will be needed to prevent animal access.

Permits are the responsibility of the owner to obtain. These include Georgia 401 Clean Water Certification, Section 404 of the Clean Water Act permits, and authorization from the Department of Natural Resources, Fish and Wildlife Division in addition to any local permits that may be necessary.

Water enters sediment basins through inlets. Sediment filters out while in the basin and then water exits via a stable outlet. Basins should be routinely cleaned out in order to ensure the integrity of the structure. Please see NRCS Conservation Practice Standard 350 for additional requirements.

For more information, see *Additional Resources*.

Considerations and Costs

Sediment basins designed to capture and store debris and sediment from fields are prohibited from waters of the U.S., which includes all intermittent or perennial streams or wetlands. Contact the U.S. Army Corps of Engineers for more information on appropriate sites for sediment basins.

Larger sediment basins can negatively impact downstream habitats by reducing peak discharge rates.

Costs associated with this practice may include planning and design, permitting, site preparation, installation, maintenance and repairs, and mitigation.

Basins require periodic cleaning to maintain capacity, depending on the amount of sediment entering the basin. Remove fill material in a way that protects the design of the basin. Sediment should be land applied to promote soil fertility and enhance topography. Sediment should never enter streams during sediment removal or disposal. Never redistribute sediment downstream from an embankment or adjacent to a stream or floodplain.

Contact your local conservation agent prior to beginning any sediment basin construction project in order to fully understand maintenance requirements.

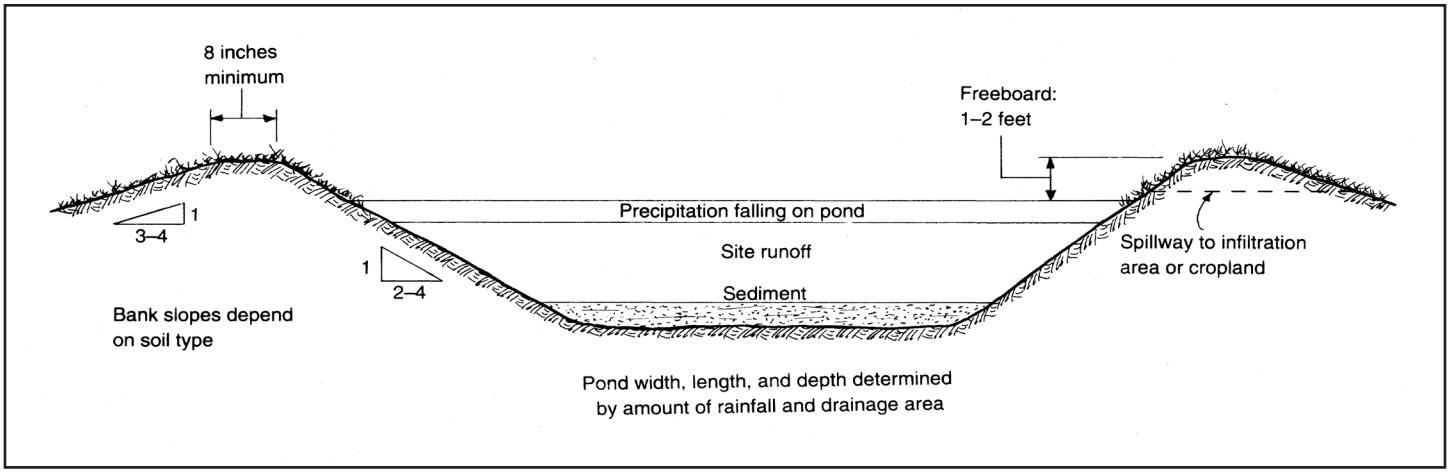
Sediment basins are moderate to high in cost depending on size, material costs and construction.

Effectiveness

Sediment basins can potentially remove 75-95% of sediment from water entering basins. Sediment basins are estimated to reduce insecticide and herbicide losses by 10%.

Additional Resources

NRCS Conservation Practice Standard 350
Manual for Erosion and Sediment Control in GA



Source: NRAES On-Farm Composting Handbook, 1992. Natural Resource, Agriculture and Engineering Service., NREAS-S4, 152 Riley Robb Hall, Cooperative Extension, Ithaca, NY 1483-5702

TERRACES (600) are built across field slopes to capture runoff water from fields and to safely convey it to stable outlets.

Terraces are used in numerous cropping systems to reduce erosion and protect soil resources

Water Quality Benefits

- Reduces soil erosion
- Conserves water resources
- Reduces nutrients and sediment entering water sources
- Reduces gully erosion
- Increases infiltration

When to Use

Terraces can be used where erosion is a problem or concern, water conservation is necessary, or where an agricultural operation can be improved by use.

How to Establish

Terraces should have a capacity to control runoff from a 10-year, 24-hour storm. Terraces should be proportional to the land slope and should have adequate outlets to contain water. Ridges should be a minimum of 2 feet wide.

For more information, see *Additional Resources*.

Considerations and Costs

Before installing terraces, consider impacts on the water budget, and water quality and quantity. Terraces may also impact downstream flow. Also consider effects of erosion, sediment movement, and pathogens on water quality. If improperly installed, terraces can cause gully erosion. Vegetation may be necessary to further reduce erosion.

Costs associated with this practice include site preparation, materials, installation and maintenance. Maintenance includes maintaining terrace capacity and keeping outlets clear of sediment build-up.

Terraces can effectively maintain and conserve soil moisture but can also negatively impact groundwater by significantly increasing infiltration rates.

Contact your local conservation agent prior to beginning a terracing project in order to fully understand maintenance requirements.

Terraces are low to moderate in cost.

Effectiveness

Level terraces have been found to reduce sediment by 85-95%, total nitrogen by 20%, and total phosphorus by 70% in studies.

Additional Resources

NRCS Conservation Practice Standard 600

WATER & SEDIMENT CONTROL BASINS (638) are used to temporarily capture runoff leaving agricultural fields, trap sediment, reduce soil erosion and improve water quality.

Water Quality Benefits

- Reduces watercourse and gully erosion
- Protects down gradient water bodies from runoff flow
- Improves downstream water quality

When to Use

Water and sediment control basins are typically placed above and below terraces but do not replace terraces. Basins are ideal for land with irregular topography.

How to Establish

Follow all federal, state and local regulations. These basins should be used in conjunction with other conservation practices.

Water and sediment control basins located both above and below terraces reduce excessive maintenance and operation problems. Plan spacing and location adapted to farm equipment operation. Re-vegetate disturbed areas not intended for cropping as soon as possible.

These basins should be no higher than 15 feet from the natural ground. Basin capacity should be large enough to control runoff from a 10-year, 24-hour frequency storm.

For more information, see *Additional Resources*.

Considerations and Costs

Water and sediment control basins are designed to be part of an overall erosion control program. They do not control erosion at the source. Consider impacts on streams and wetlands prior to installation. These basins may impact downstream flows and raise water temperature which can impact aquatic habitats.

Costs associated with this practice include site preparation, installation, and maintenance. Maintenance includes periodic monitoring of sediment levels and inlets, and repairing erosion problems on embankments.

Periodic cleaning may be needed to maintain capacity, depending on the amount of sediment entering the basin. Remove fill material in a way that protects the design of the basin. Sediment can be land applied to promote soil fertility and enhance topography but should never enter streams during sediment removal or disposal. Never redistribute sediment downstream from the embankment, or adjacent to a stream or floodplain.

Contact your local conservation agent prior to basin construction in order to fully understand maintenance requirements.

Water and sedimentation control basins are moderate in cost depending on size, materials and construction.

Effectiveness

Water and sediment control basins can potentially reduce suspended solids in runoff by 40-60%.

Additional Resources

NRCS Conservation Practice Standard 638

UNDERGROUND OUTLETS (620) are used to collect surface water and convey it to safe outlets.

Water Quality Benefits

- Reduces erosion
- Decreases sediment in runoff
- Decreases nutrient and chemical transport into water sources
- Reduces farm runoff entering streams and waterways
- Reduces gully erosion

When to Use

Underground outlets are used as part of a drainage system to remove excess surface water. Outlets remove water from terraces, diversions, subsurface drains, surface drains and other sources.

How to Establish

Underground outlets should have the capacity to manage the expected quantity of water from a system. Inlets should be of appropriate material and size to effectively transport water. Guards are necessary to prevent animal and rodent entry.

Water exiting underground outlets should not enter into a surface water body such as a pond, stream or wetland without first traveling through filtering practices such as settling ponds or filter strips.

For more information, see *Additional Resources*.

Considerations and Costs

Consider impacts on the water budget, downstream flow and use, wetlands and water related habitats. It is also important to consider negative water quality impacts resulting from agrichemicals in water from these systems. Effects on erosion and the movement of sediment, pathogens, and soluble and sediment-attached substances carried in runoff should also be considered in the design of a drainage system.

Costs associated with this practice include site preparation, materials, installation, and maintenance. Maintenance may include cleaning inlets, trash and collection guards, repairing leaks or broken lines, and general monitoring.

Underground outlets should not be used for grade stabilization. Underground outlets are smaller than grade stabilization structures. For more information on Grade Stabilization Structures, see page 2.67.

Underground outlets are moderate in cost depending on materials and construction costs.

Effectiveness

When properly installed and maintained, underground outlets can be beneficial in reducing sediment and nutrients in runoff.

Additional Resources

NRCS Conservation Practice Standard 620

SECTION SEVEN

Wetlands & Stream Protection Management Planning

Stream water quality and protection has become a major environmental concern in recent years. Agricultural operations are receiving more attention for their impacts on water quality than ever before. As a result, more farmers are working to protect streams, creeks, ponds, and other water sources from damage.

In addition, regulatory requirements for agricultural operations are increasing each year. It is becoming a common struggle for farmers to meet regulatory requirements while also maintaining a profitable operation. More effort is now being put into voluntary programs that offer cost-share assistance for protecting water sources from agricultural environmental damage.

The practices listed in this section all address stream protection and management to protect and conserve natural resources.

Conservation practices included in the Wetlands & Stream Protection Management Planning section include:

Channel Bed Stabilization 584

Riparian Forest Buffer 391

Riparian Herbaceous Cover 390

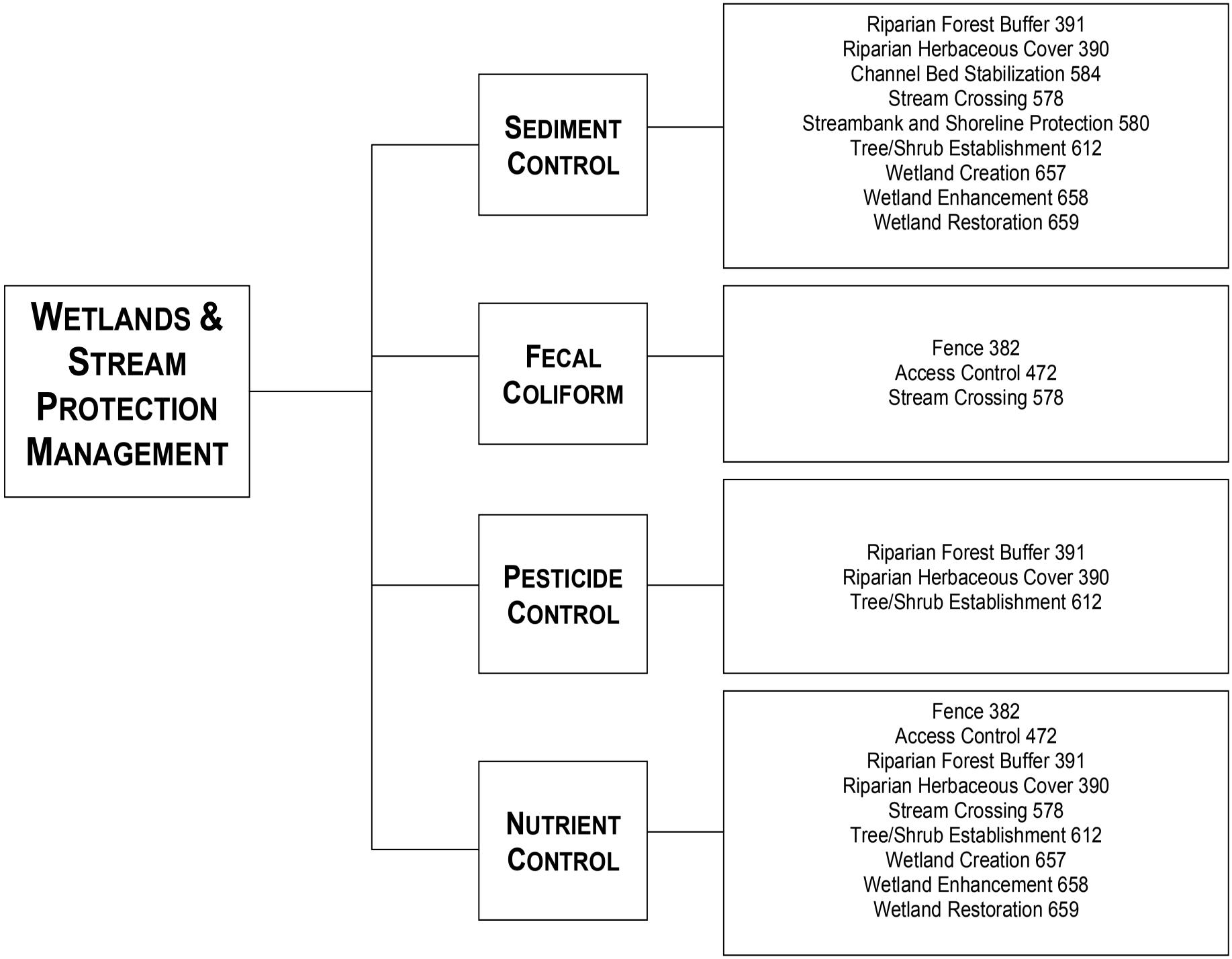
Streambank and Shoreline Protection 580

Tree/Shrub Establishment 612

Wetland Creation 658

Wetland Enhancement 659

Wetland Restoration 657


WETLANDS & STREAM PROTECTION MANAGEMENT
SEDIMENT CONTROL
Riparian Forest Buffer 391
Riparian Herbaceous Cover 390
Channel Bed Stabilization 584
Stream Crossing 578
Streambank and Shoreline Protection 580
Tree/Shrub Establishment 612
Wetland Creation 657
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FECAL COLIFORM
Fence 382
Access Control 472
Stream Crossing 578
PESTICIDE CONTROL
Riparian Forest Buffer 391
Riparian Herbaceous Cover 390
Tree/Shrub Establishment 612
NUTRIENT CONTROL
Fence 382
Access Control 472
Riparian Forest Buffer 391
Riparian Herbaceous Cover 390
Stream Crossing 578
Tree/Shrub Establishment 612
Wetland Creation 657
Wetland Enhancement 658
Wetland Restoration 659

CHANNEL BED STABILIZATION (584) includes actions that can be taken to stabilize or strengthen the bed or bottom of a channel.

Water Quality Benefits

- Reduces sedimentation
- Protects streambed integrity and aquatic habitats

When to Use

Channel bed stabilization is used to alter bed depth and adjust sediment transport when normal maintenance is not sufficient.

How to Establish

Stream channel stability is based on the materials that are part of the channel bottom and the ability to maintain stream peak flows, velocities and volumes.

Re-vegetating disturbed areas around a channel can reduce additional erosion.

In addition, effort should be taken to protect and ensure wildlife habitats and migration needs.

For more information, see *Additional Resources*.

Considerations and Costs

Channel stabilization may temporarily increase soil erosion. Producers should minimize these impacts as much as possible.

Producers should avoid channel clearing whenever possible to protect and maintain aquatic habitats.

A maintenance plan is needed for general operation, use and maintenance.

Contact your local conservation agent prior to beginning any stream channel stabilization project in order to fully understand maintenance requirements.

Channel stabilization is moderate to high in cost.

Effectiveness

Channel bed stabilization can, in the long run, significantly reduce soil erosion and sedimentation entering water.

Additional Resources

NRCS Conservation Practice Standard 584
NRCS Stream Corridor Restoration Manual

RIPARIAN FOREST BUFFERS (391) use trees or shrubs to reduce sediment, organic matter, nutrients and pesticides in surface runoff alongside watercourses.

Riparian forest buffers provide additional habitats for wildlife and promote water quality

Water Quality Benefits

- Reduces soil erosion
- Reduces sediment transport into water sources
- Reduces nutrient loadings in water sources
- Provides shade and lowers aquatic temperature

When to Use

Use forest buffers on areas adjacent to permanent or intermittent streams, lakes, ponds, wetlands and in areas with groundwater recharge capable of supporting woody vegetation.

When establishing new riparian areas between forestland and water bodies, follow streamside management zone (SMZ) guidelines in the Georgia Best Management Practices for Forestry Manual.

These areas can be used for very limited livestock grazing and hay harvesting.

How to Establish

Prepare site to support the type of forest buffer zone that will be established. Use native trees and shrubs that are noninvasive. Plants and trees need time to establish and should be planted when growth will be promoted. Fertilizer may be needed. In addition, livestock and equipment should be kept out of forest buffers until plants and trees are established.

For more information, see *Additional Resources*.

Considerations and Costs

Use Zone 2 buffers on sites that receive nutrient, sediment and animal waste applications where additional protection is needed to reduce soil erosion and water contamination.

Use Zone 3 buffers on sites adjacent to cropland and highly erodible areas to filter sediment, address concentrated flow erosion, and maintain sheet flow. For Zone 3 buffers, follow standards and specifications for filter strips.

Maintenance and labor costs may include sediment build-up removal and periodic inspections to ensure proper function.

Forest buffers are moderate in cost depending on the type of vegetation established.

Effectiveness

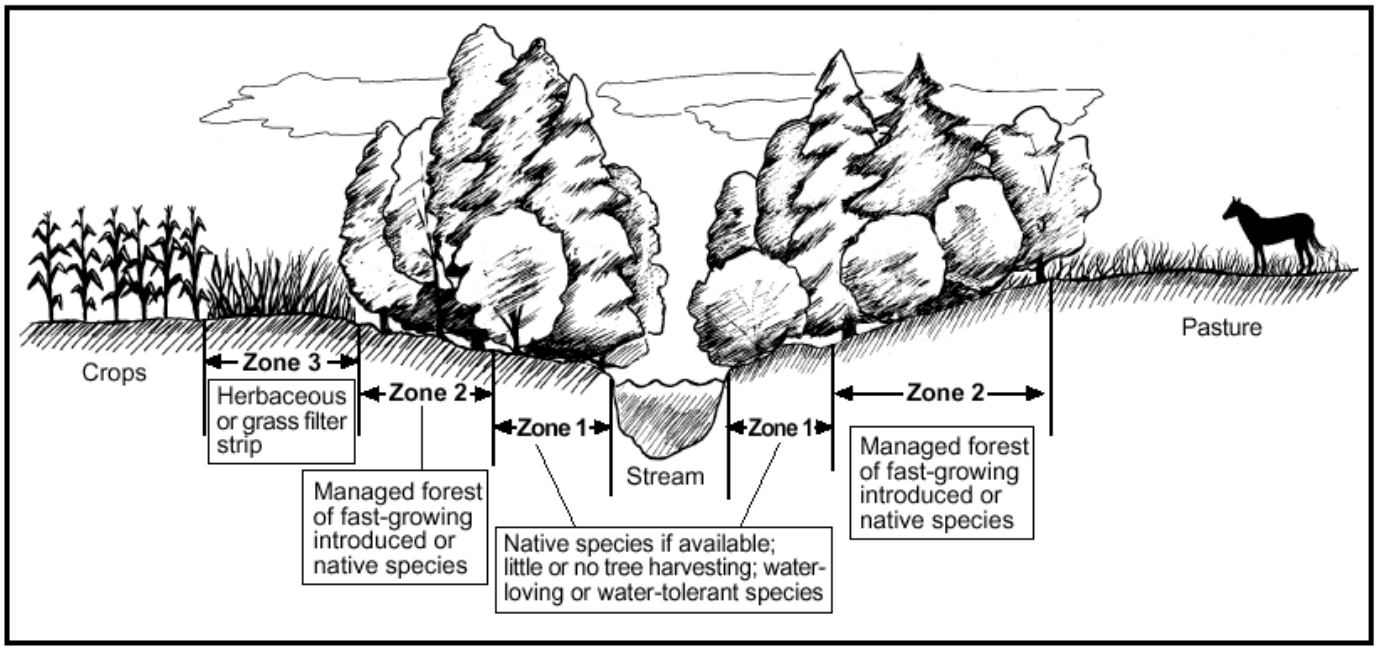
Riparian forest buffers removed 25-85% of nitrogen, 50-75% of phosphorus and 50-75% of sediment in runoff in addition to the acreage converted to forests in studies.

Restored Zone 3 buffers removed 60% of nitrogen and 65% of phosphorus entering from manure application sites to an adjacent water source in one Georgia research study. Grass buffers alone removed 45% of the nitrogen and 20% of the phosphorus from the same sites.

Additional Resources

NRCS Conservation Standard 391

Georgia's Best Management Practices for Forestry Manual



Zone 1 is the area closest to the water body course. Zone 2 is adjacent to and up-gradient from Zone 1 (a minimum of 15 feet). Zone 2 plantings intercept sediment, nutrients, pesticides and other pollutants in surface and subsurface water flows (a minimum of 20 feet). Zone 3 is established if periodic and excessive water flows, erosion and sediment from upslope fields or tracts are anticipated. Zone 3 is generally of herbaceous plants or grass and a diversion or terrace, if needed.

Source: NRCS Conservation Practice Job Sheet 391

Riparian Forest Buffers are called Stream Management Zones by the Georgia Forestry Commission. For more information, see the Georgia Best Management Practices for Forestry Manual

RIPARIAN HERBACEOUS COVER (390) uses grasses, grass-like plants and forbs to protect water quality, provide wildlife habitats and to stabilize streambanks and channels.

Riparian herbaceous cover protects water resources and enhances aquatic habitats

Water Quality Benefits

- Reduces soil erosion
- Reduces sediment transport into water sources
- Reduces nutrient loadings in water sources

When to Use

Riparian herbaceous cover is ideal where runoff can be a problem from pastures and cropland. Riparian cover is used between areas of agricultural land and water bodies. When establishing new riparian areas between forestland and water bodies, follow streamside management zone (SMZ) guidelines in the Georgia Best Management Practices for Forestry Manual.

Riparian Herbaceous Cover areas are not filter strips. Please see page 2.65 for information on filter strips.

How to Establish

The size of a riparian area varies according to use. Use native plant species whenever possible. Avoid harvesting or grazing these areas until plants are established. Then harvest or graze on a carefully monitored rotational schedule. Normal maintenance is required to ensure the function of a riparian herbaceous cover area. Herbaceous cover works best to provide soil stability when used in conjunction with planting shrubs and trees.

For more information, see *Additional Resources*.

Considerations and Costs

Costs associated with riparian herbaceous cover areas include site preparation, seed and plant materials and maintenance.

Herbaceous cover is low to moderate in cost depending on the type of vegetation established.

Effectiveness

Riparian herbaceous cover can potentially reduce nitrogen by 17-58%, phosphorus by 50-75%, and sediment by 50-75%. Riparian herbaceous cover effectiveness depends on maintaining sheet flow across the buffer and increasing infiltration and subsurface flow.

Additional Resources

NRCS Conservation Practice Standard 390
Georgia Best Management Practices for Forestry Manual

STREAMBANK AND SHORELINE PROTECTION (580) is the stabilization and protection of streams, constructed channels and shorelines in order to reduce erosion and water quality degradation.

A stream revetment was used to reduce and prevent streambank erosion along with revegetation

Water Quality Benefits

- Reduces erosion and loss of land
- Protects and maintains water flow and storage capacity
- Can be used to protect and improve stream corridors for wildlife and aquatic species
- Lowers total sediment and nutrient loads entering water bodies
- Provides shade and lowers aquatic temperature

When to Use

This practice can be applied to the streambanks of natural or constructed channels or shorelines that are susceptible to erosion. This type of practice is NOT applicable to ocean fronts or associated areas.

Prior to initiating work in any water body, including wetlands, contact the U.S. Army Corps of Engineers for additional requirements.

How to Establish

All federal, state and local regulations should be followed in the installation process.

Permits are the responsibility of the owner to obtain. These include Georgia 401 Clean Water Certification, Section 404 of the Clean Water Act permits, and authorization from the Department of Natural Resources, Fish and Wildlife Division in addition to any local permits that may be necessary.

Prior to installation, an assessment of the project area should be performed to identify unstable and erosive areas.

Install protective measures to protect streams from up-gradient runoff. The channel grade should be stable and based on a prior field assessment when permanent measures are installed.

Limit the removal of obstructions whenever possible as they provide ideal aquatic habitats. It may be necessary to clear channels when obstructions and/or debris (stumps, fallen trees, etc.) cause erosion or interrupt channel flow and function.

Use materials that cause minimal visual impacts, and maintain or compliment the existing landscape. Protective measures should have a minimal impact on the existing wildlife and habitat.

Disturbed areas should be re-vegetated as soon as possible with plant species that are native or adapted to the local ecosystem. Livestock should be excluded until plants are established, and then use appropriate grazing practices.

For more information, see *Additional Resources*.

Considerations and Costs

Additional protection may be necessary to protect surrounding habitats. Consider implementing other conservation practices to further protect water quality and reduce erosion.

Costs associated with this practice may include site preparation, materials, installation, maintenance, and the re-vegetation of surrounding areas.

Contact your local conservation agent prior to beginning a streambank or shoreline protection project in order to fully understand maintenance requirements.

Streambank and shoreline protection is moderate to high in cost depending on the size and length of the protection area.

Effectiveness

Streambank and shoreline protection can significantly reduce erosion and sediment entering water.

Additional Resources

NRCS Conservation Practice Standard 580
Georgia EPD

A streambank restoration project along the Etowah River

TREE/SHRUB ESTABLISHMENT (612) can be utilized for long-term erosion control by slowing runoff and allowing more time for nutrient absorption.

Water Quality Benefits

- Reduces erosion and runoff in the long-run
- Improves infiltration
- Reduces percolation in soil

When to Use

Trees and shrubs can be planted in areas where woody plants can be maintained.

How to Establish

Prepare site for plant/seedling installation. Plant tree seedlings, shrubs and seeds according to proper horticultural practices. Seedlings should ideally be planted between December 1 and March 15. The ideal planting time for deciduous shrubs is in late winter and is in early fall for evergreen shrubs.

Plant cuttings at least 4 to 6 inches above the ground and 14 to 16 inches below the ground. Planted areas need to be protected from livestock and wildlife until fully established. Depending on the site, it may be necessary to mulch, and to provide supplemental water or other treatments to promote plant establishment and growth.

When planting pines for wood production, 600-700 trees per acre is standard. 900-1,200 trees per acre is recommended on highly erodible lands.

For more information, see *Additional Resources*.

Considerations and Costs

Using locally adapted seed, seedlings or cuttings will encourage viability of plants. Space seeds, seedlings and cuttings appropriately. Consider future activities on the site prior to installation.

Costs associated with this practice may include materials, site preparation, installation, maintenance, protection and repair.

Tree and shrub establishment is low to moderate in cost depending on materials and installation costs.

Effectiveness

As an added benefit to reducing soil erosion, trees have been found to reduce dust particles from poultry houses by 50% in studies and can potentially reduce energy costs by providing shading. Species that work well include Leland Cypress, Red Cedar and White Pine.

Additional Resources

NRCS Conservation Practice 612

The Georgia Forestry Commission has an annual seedling sale for purchases of pine and hardwood seedlings. Visit the GFC website for more information.

WETLAND CREATION, ENHANCEMENT AND RESTORATION (657, 658, & 659) is the establishment, modification or restoration of a wetland to improve and protect water quality.

A restored wetland provides habitats for wildlife and can trap nutrients

Water Quality Benefits

- Reduces nutrient loadings
- Provides and protects native species habitats
- Can improve water quality associated with degraded wetlands
- Can reduce chemical contaminants

When to Use

Creating a wetland is ideal in areas where wetland conditions can be established and maintained by modifying drainage.

Enhancing existing wetlands can improve overall habitat and water quality, and may improve the many functions of a wetland. Restoring a wetland can provide habitats for wildlife.

Large wetland restoration projects can generate income when used to mitigate wetland losses elsewhere. Prior to any wetlands project, contact the U.S. Army Corps of Engineers for additional requirements.

How to Establish

All federal, state and local regulations should be followed. Landowners must obtain all required permits before beginning a restorative process.

Except where seasonal, wetlands require a permanent water source. Examine natural wetlands in the area as a guide for restoring a wetland. Vegetation established in wetlands should be adapted to the area as well as to wet conditions.

Permits are the responsibility of the owner to obtain. These include Georgia 401 Clean Water Certification, Section 404 of the Clean Water Act permits, and authorization from the Department of Natural Resources, Fish and Wildlife Division in addition to any local permits that may be necessary.

For more information, see *Additional Resources*.

Considerations and Costs

Consider any impacts of changes in the volume and rate of runoff, infiltration, evaporation, and transpiration on the water budget that may result from these practices. Producers should also consider any impacts on downstream flows and wildlife habitats prior to creating or modifying a wetland.

Costs associated with wetland creation include planning and design, site preparation, seed/plant materials, and other costs that result from altering water flows and establishing vegetative buffers.

Costs associated with enhancing and restoring wetlands may include drainage modification, additional plant materials, soil improvement costs, expansion costs, etc.

Contact your local conservation agent prior to beginning a wetlands project in order to fully understand maintenance requirements.

Wetland creation is moderately high to high in cost. Wetland enhancement is low in cost. Wetland restoration is moderate in cost.

Effectiveness

Restored wetland buffers with an up slope grass strip and down slope planted pines and hardwoods retained or removed 59% of nitrogen and 66% of phosphorus entering from adjacent manure application sites in studies.

Additional Resources

NRCS Conservation Practice Standard 657
NRCS Conservation Practice Standard 658
NRCS Conservation Practice Standard 659

Wetlands offer nesting sites for wood ducks and other wildlife

Fencing can be used to protect established wetlands and also to prohibit livestock access for restoration projects.