CONSTRUCTION SPECIFICATIONS

FOR

WINN970905B (SHATEK) WETLAND
WINNESHIEK COUNTY, IOWA

July 9th, 2026

	I hereby certify that this engineering document was prepared by me or under my direct personal supervision and that I am a duly licensed Professional Engineer under the laws of the State of Iowa.
	Signature Date Printed or typed name Anthony J. Harbaugh License Number 26394 My License Renewal Date is: December 31, 2027 Pages, Sheets, or Divisions covered by this Seal: All

PREPARED BY:

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ARCHITECTURE + ENGINEERING

PROJECT #2240006350

NATURAL RESOURCES CONSERVATION SERVICE
CONSTRUCTION SPECIFICATIONS

For

WINN970905B (Shatek) WETLAND
Winneshiek County, Iowa

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These specifications are part of the construction plans. The work shall be performed in accordance with the drawings and specifications unless otherwise approved, in writing, by the Division and Engineer. For items of work requiring inspection, it is the responsibility of the contractor to keep the Engineer and Division informed of the progress of work so that timely inspections may be performed. Work installed without inspection will not be certified as meeting NRCS standards.

Construction Specification
000 IA CS-00-1 Site Preparation

1. SCOPE

Site preparation work shall consist of clearing, grubbing, stripping, refuse removal, bank sloping and structure removal on the site as necessary to rid the site of all undesirable materials on or near the surface and prepare the site for the structure. All woody growth within the construction area shall be cleared and all stumps and roots one inch in diameter or larger shall be grubbed from the site. In addition, all areas within 25 feet of the footprint of the structure shall be cleared and grubbed except as directed by NRCS. The work shall also consist of the removal and disposal of structures (including fences) that must be removed to perform other items of work.

For wetland restoration, enhancement, or creation projects, the wetland area shall be disturbed as little as possible and existing naturally vegetated spillway areas shall not be disturbed.

2. FOUNDATION PREPARATION

The construction areas shall be stripped a minimum of 6 inches to remove all unsuitable materials such as organic matter, grasses, weeds, sod, debris, and stones larger than 6 inches in diameter.

In an earth embankment foundation area, all channel banks and sharp breaks shall be sloped to no steeper than 1.5 horizontal to 1 vertical.

The foundation area shall be thoroughly scarified before placement of fill material. The surface shall have moisture added or shall be compacted if necessary so that the first layer of fill material can be compacted and bonded to the foundation.

3. STRIPPED MATERIAL DISPOSAL

Suitable soil material shall be stockpiled for use as topsoil. The other stripped materials shall be buried, removed from the site, or disposed of as directed by the owner or NRCS. Whenever possible, material shall not be disposed of in the pool area created by the structure.

Stockpiled materials around a construction site should be placed so as not to hinder subsequent construction operations.

4. DISPOSAL OF REFUSE MATERIALS

Waste materials from clearing and structure removal shall be burned or buried at locations approved by the owner. Buried materials shall be covered with a minimum of 2 feet of earthfill. Whenever possible, material shall not be disposed of in any pool area created by the structure.

All refuse shall be disposed of in a manner which complies with all local and state regulations.

5. SALVAGE

Items to be salvaged shall be as shown on the drawings. Structures and fencing materials that are designated to be salvaged shall be carefully removed and neatly placed in the specified storage areas.

6. SPECIFIC SITE REQUIREMENTS

A. Measurement and Payment

Compensation for any work item described in the contract documents but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and bid items to which they are made subsidiary are identified in Items of Work and Construction Details section of this specification.
For items of work which lump sum prices are established in the contract, the quantity of work will not be measured for payment. Payment for each item will be made at the contract lump sum price and will constitute full compensation for completion of the work.

For items of work for which specific unit prices are established in the contract, the payment will be made based on the approved quantity measured by the engineer or weight tickets. Payment will constitute full compensation of the work completed as defined by each work item.

B. Items of Work and Construction Details

"Site Stripping and Preparation":

1. Bid Item No. 1

This item will consist of work to remove and dispose of existing material to remove vegetation on areas to be excavated or filled outside of borrow area footprint. Total depth of vegetative stripping and topsoil stripping shall equal a combined depth of 12", with the estimated cubic yards and area of topsoil removal as shown in the plans. The topsoil replacement quantity shall be paid separately.

This item will also include any tree and brush removal along with any fences. These shall be considered incidental to site stripping.

This item will be paid out as a lump sum.

"Site Stripping and Preparation, Borrow Area":

3. Bid Item No. 2

This item will consist of work to remove and dispose of existing material to remove vegetation within designated borrow area. Total depth of vegetative stripping and topsoil stripping shall equal a combined depth of 6", with the estimated cubic yards and area of topsoil removal as shown in the plans. The topsoil replacement quantity shall be paid separately.

Borrow areas should be stripped on an as-needed basis, coordinate with engineer.

This item will also include any tree and brush removal along with any fences. These shall be considered incidental to site stripping.

This item will be paid out as a lump sum.

“Crop Damage”:

3. Bid Item No. 3

This item consists of crop damage that results from construction activities. It is recommended contractor remove corn residue rather than knock it down.

Payment for crop damage will be made to the nearest 0.1 acre as measured by the Engineer or their representative. The unit rate for crop damage will be determined by the Division near the completion of construction and added to the contract with a Change Order. Payment will be made to contractor who will pay landowner.

Construction Specification
000 IA CS-005 Pollution Control 2011

1. SCOPE

The work shall consist of installing measures or performing work to control erosion and minimize the production of sediment and other pollutants to water and air during construction operations.

2. MATERIALS

All materials furnished shall meet the requirements shown on the drawings or in the specifications.

3. EROSION AND SEDIMENT CONTROL MEASURES AND WORKS

The measures and works shall include, but are not limited to, the following:

Staging of Earthwork Activities: The excavation and moving of soil materials shall be scheduled so that areas unprotected from erosion will be minimized. These areas will be unprotected for the shortest time feasible.

Seeding: Structures and disturbed areas shall be seeded as soon as possible after construction is completed.

Temporary seedings may be used as an alternative to other stabilization measures as approved by NRCS.

Mulching: Construction areas that have been disturbed but have no construction activity scheduled for 21 days or more shall have erosion protection measures applied by the 14th day. This erosion protection may be mulching or other approved temporary measures. Construction areas shall not be left open during a winter shutdown period and shall be protected by mulching.

All seeding and mulching shall be completed in accordance with the seeding plan and Iowa Construction Specification IA-6, Seeding and Mulching for Protective Cover.

The following works may be temporary. If they are installed as a temporary measure, they shall be removed and the area restored to its original state when they are no longer needed or when permanent measures are installed.

Diversions: Diversions may be required to divert clean runoff water away from work areas and to collect runoff from work areas for treatment and safe disposition.

Stream Crossings: Culverts or bridges may be required where construction equipment must cross streams.

Sediment Basins: Sediment basins may be required to settle and filter out sediment from eroding areas to protect properties and streams below the construction site.

Sediment Filters: Straw bale filters, geotextile sediment fences, or other equivalent methods may be used to trap sediment from areas of limited runoff. Sediment filters shall be properly anchored to prevent erosion under them.

Waterways: Waterways may be required for the safe removal of runoff from fields, diversions, and other structures or measures

4. CHEMICAL POLLUTION

The Contractor shall provide watertight tanks or barrels or construct a sump sealed with plastic sheets to be used to dispose of chemical pollutants, such as drained lubricating or transmission oils, greases, soaps, concrete mixer wash water, asphalt, etc., produced as a by-product of the construction work.

At the completion of the construction work, sumps shall be removed and the area restored without causing pollution.

Sanitary facilities such as chemical toilets or septic tanks shall not be placed adjacent to live streams, wells, or springs. They shall be located at a distance sufficient to prevent contamination of any water sources. At the completion of construction work, facilities shall be disposed of without causing pollution.

5. AIR POLLUTION

The burning of brush or trash or disposal of other materials shall adhere to local and state regulations.

Fire prevention measures shall be taken to prevent the start or the spreading of wild fires, which result from project work. Fire breaks or guards shall be constructed at locations shown on the drawings.

All public access or haul roads used by the contractor during construction of the project shall be sprinkled or otherwise treated to fully suppress dust. All dust control methods shall insure safe operations at all times. If chemical dust suppressants are used, the material shall be a commercially available product specifically designed for dust suppression and the application shall follow manufacturer's requirements and recommendations. A copy of the product data sheet and manufacturer's recommended application procedures shall be provided to the Engineer five working days before use.

6. MAINTENANCE, REMOVAL, AND RESTORATION

All pollution control measures and works shall be adequately maintained in a functional condition as long as needed during the construction operation. All temporary measures shall be removed and the site restored to as near original conditions as practical.

7. SPECIFIC SITE REQUIREMENTS

A. Measurement and Payment

Compensation for any work item described in the contract documents but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and bid items to which they are made subsidiary are identified in Items of Work and Construction Details section of this specification.

For items of work which lump sum prices are established in the contract, the quantity of work will not be measured for payment. Payment for each item will be made at the contract lump sum price and will constitute full compensation for completion of the work.

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B. Items of Work and Construction Details

1. Subsidiary Item - Pollution Control

This item shall consist of applying and performing all construction activities in a manner that will minimize water pollution, air pollution and soil erosion.

No separate payment will be made for Pollution Control. Compensation for this item will be other items as appropriate.

"Pollution Control, Silt Fence":

1. Bid Item No. 33

This item includes procurement and installation of silt fence ditch checks as shown on the plans and as detailed. Silt fence installation shall be in accordance with SUDAS 9040.

Construction Specification
000 IA-6 Seeding and Mulching for Protective Cover

1. SCOPE

The work shall consist of seeding, mulching, and fertilizing all disturbed areas and other areas as indicated on the drawings or otherwise designated.

2. SEEDBED PREPARATION AND APPLICATION

The entire area to be seeded shall be reasonably smooth and all washes and gullies shall be filled to conform to the desired cross-section before actual seedbed preparation is begun. At this stage of the operation, the required fertilizer and lime shall be applied uniformly and incorporated into the top 3 inches of the soil with suitable tillage equipment. The seedbed preparation operation shall be suspended when the soil is too wet or too dry. The seedbed shall be loosened to a depth of at least three inches.

On side slopes steeper than 2-1/2 horizontal to1 vertical, the 3 inch minimum depth of seedbed preparation is not required, but the soil shall be worked enough to insure sufficient loose soil to provide adequate seed cover.

Unless otherwise specified, the seeding operation shall be performed immediately after preparation of the seedbed. The seed shall be drilled or broadcast by equipment that will insure uniform distribution of the seed.

3. MATERIALS

The seeding, fertilizing, and mulching requirements are as specified on Form IA-CPA-4.

Straw from cereal grains or hay will be used as mulching material. It shall be relatively free of weeds.

4. MULCH APPLICATION

The required mulching shall be performed as soon as possible after seeding unless otherwise specified. The mulch shall be applied uniformly over the area. The type and rate shall be as specified. When mulching is required, all areas seeded during any one day shall be mulched within 24 hours. The mulch may be spread by any means that results in a uniform cover.

The mulch shall be anchored. Anchoring of the mulch may be performed by a mulch anchoring tool or regular farm disk weighted and set nearly straight, by installation of mulch netting, or by other methods approved by NRCS.

5. SPECIFIC SITE REQUIREMENTS

A. Measurement and Payment

Compensation for any work item described in the contract documents but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and bid items to which they are made subsidiary are identified in Items of Work and Construction Details section of this specification.

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B. Items of Work and Construction Details

"Structure & Channel Seeding":

1. Bid Item No. 4

This item will consist of seeding the dike except the upstream side slope below the weir elevation, auxiliary spillway, the tile outlet channel side slopes and any other disturbed areas noted on the plans or as determined by engineer.

All seed must be clean and weed free. Seeding rates are expressed in bulk pounds per acre. Seed quality shall not drop below 70% Pure Live Seed (PLS) where PLS = (percent germination plus percent dormant seed) times percent purity.

Seeding rates are as follows:

Smooth Brome grass	25 pounds/acre

Seed shall be applied with a drill and placed at ¼ to ½ inch deep.

Fertilizer shall be applied on the entire seeding area at the following rate:

Nitrogen (N)	30 pound/acre
Phosphorus (P_2O_5)	30 pounds/acre
Potassium (K_2O)	40 pounds/acre

Straw mulch shall be applied at a rate of 2 tons per acre on all areas receiving structure and channel seeding.

Seeding shall be completed during the following seeding periods:

Spring	March 1 to May 15
Summer	August 1 to September 15
Fall	November 15 to Freeze-up

If construction is completed during any other time of the year, the seeding shall be performed at the next seeding period.

If seeding is completed during the spring seeding period, a companion crop of oats shall be seeded at a rate of 1-1/2 bushels per acre.

Measurement will be based on the areas successfully seeded to the nearest 0.1 acre.

“Buffer Seeding”:

2. Bid Item No. 5

This item will consist of seeding the areas designated on the plans as buffer seeding and include borrow areas, disturbed areas not seeded as part of structural seeding, and other areas within the easement. Buffer seeding is not required in area below normal pool elevation established by the weir elevation.

Some areas of the site may have existing CRP vegetation or steep slopes with existing vegetation. Local NRCS personnel will determine if these areas will be included as part of the buffer seeding areas for this project or will be left as is. This may affect the bid quantity and Contractor will verify with Engineer the number of acres that will require buffer seeding.

All seed must be clean and weed free. Seeding rates are expressed in pounds of pure live seed per acre. All seed must be yellow-tagged Iowa ecotype unless approved otherwise by IDALS-DSCWQ.

Seeding mixture shall include a minimum of 5 native grasses and 10 native forbs. The mixture shall provide a minimum of 30 grass seeds per square foot and 10 forbs seeds per square foot. Number of seeds will be based on Iowa Conservation Practice 327 “Native Species for Wildlife”. Contractor’s proposed seed mix shall be submitted to Engineer and local NRCS office for approval at least 2 weeks before seed is to be applied.

Seeding shall be completed during the following seeding periods:

Spring	April 1 to June 30
Fall	November 15 to Freeze-up

The seed bed shall be properly prepared prior to seeding:

(a) Any weed control measures shall be completed prior to seeding. If spraying is used, then a span of two weeks shall be allowed between spraying and seeding.

(b) If the land was in soybeans, no additional tillage is required. If the land was in corn or other vegetation, areas to be seeded shall be disked to thoroughly loosen and pulverize the soil to a depth of 3 inches. This may require multiple passes of equipment. If the land was used for pasture and has a smooth surface, the preparation in non-disturbed areas to be seeded shall include mowing any vegetation taller than 12 inches and applying an appropriate herbicide at the labeled rates to emergent growth 2 to 4 weeks after mowing. After the vegetation has died, the area shall be disked thoroughly loosen and pulverize the soil depth of 3 inches. If emergent growth occurs prior to seeding, the areas shall receive a second application of herbicide. Seeding shall not occur until the existing vegetation has died (about 1 week).

(c) If deeper disking is used at the site, a lighter disk or spring harrow shall be used to remove deep furrows.

(d) After disking operations and prior to seed application, the seedbed shall be firmed with a cultipacker or similar piece of equipment.

(e) No lime or fertilizer is to be applied.

Sow seed with contour using a grassland or rangeland drill set for the specified seeding rates. The drill shall be equipped with double coulter furrow openers. The drill shall be subject to acceptance by Engineer. Overlap each successive seeding pass to ensure complete coverage.

Plant seed not more than 1/4 inch deep; some seed may be seen on the surface after seeding.

Broadcasting by centrifugal-type or hydroseeder broadcasters, or by hand shall be allowed in areas not accessible to drills or other equipment. Once broadcast, the seed must be covered with soil to a depth no greater than 1/4 inch by means of hand rakes or other approved methods.

Upon completion of the seeding operation, cultipack the seedbed to provide a positive seed-soil contact. If the drill seeder is equipped with an approved cultipacker or press wheels, separate operations shall not be necessary. The type of cultipacker/seeder to be used shall be subject to acceptance by Engineer.

No mulch shall be required.

Measurement will be based on the area successfully seeded and measured to the nearest 0.1 acre.

3. Subsidiary Item - Weed Control

Weed control may be needed in portions of this site depending upon the start date of the contract, the initiation of grading, and the seeding dates.

Weed control will be added to the contract with a change order to be negotiated between Contractor and Division based on conditions observed and the type of weed control used and will be paid only once. If delays require additional weed control, this will be paid for at Contractor's own expense.

Weed control may include placement of a cover crop such as oats or rye, spraying with appropriate chemicals, or disking. If thistles are present, only spraying is allowed for weed control and shall include appropriate chemicals designed to control thistles.

NATURAL RESOURCES CONSERVATION SERVICE
CONSTRUCTION SPECIFICATION

Construction Specification 8—Mobilization and Demobilization

1. SCOPE

The work consists of the mobilization and demobilization of the contractor's forces and equipment necessary for performing the work required under the contract. It does not include mobilization and demobilization for specific items of work for which payment is provided elsewhere in the contract. Mobilization will not be considered as work in fulfilling the contract requirements for commencement of work.

2. EQUIPMENT AND MATERIAL

Mobilization shall include all activities and associated costs for transportation of contractor's personnel, equipment, and operating supplies to the site; establishment of offices, buildings, and other necessary general facilities for the contractor's operations at the site; premiums paid for performance and payment bonds including coinsurance and reinsurance agreements as applicable; and other items specified in section 4 of this specification.

Demobilization shall include all activities and costs for transportation of personnel, equipment, and supplies not required or included in the contract from the site; including the disassembly, removal, and site cleanup of offices, buildings, and other facilities assembled on the site specifically for this contract.

This work includes mobilization and demobilization required by the contract at the time of award. If additional mobilization and demobilization activities and costs are required during the performance of the contract as a result of changed, deleted, or added items of work for which the contractor is entitled to an adjustment in contract price, compensation for such costs will be included in the price adjustment for the item or items of work changed or added.

3. PAYMENT

Payment will be made as the work proceeds, after presentation of paid invoices or documentation of direct costs by the contractor showing specific mobilization and demobilization costs and supporting evidence of the charges of suppliers, subcontractors, and others. When the total of such payments is less than the lump sum contract price, the balance remaining will be included in the final contract payment. Payment of the lump sum contract price for mobilization and demobilization will constitute full compensation for completion of the work.

Payment will not be made under this item for the purchase costs of materials having a residual value, the purchase costs of materials to be incorporated in the project, or the purchase costs of operating supplies.

4. ITEMS OF WORK AND CONSTRUCTION DETAILS

A. Measurement and Payment

Compensation for any work item described in the contract documents but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and bid items to which they are made subsidiary are identified in Items of Work and Construction Details section of this specification.

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B. Items of Work and Construction Details

"Mobilization & Demobilization":

1. Bid Item No. 6

This item shall consist of mobilizing and demobilizing personnel and equipment in preparation to perform the work within the scope of this contract.

Any work that is necessary to provide access to the site including, but not limited to, grading, temporary culverts, and clearing will be included in this item. When construction is completed access areas will be restored, as close as practical, to its original condition.

Any fence removed for access and /or to provide work area shall be replaced with same or like materials as approved by the engineer.

The Contractor shall exercise caution to minimize the amount of damage caused by the grading and clearing operations.

Portable toilets shall be provided at the construction site and used for the sanitary facilities.

This item shall not include transportation of personnel, equipment and operating supplies within the work limits areas of this contract.

Payment will constitute full compensation for related subsidiary item, Pollution Control.

Payment will be made as the work proceeds and will paid out on the percent of the project complete as the work progresses. Payment of the lump sum contract price for mobilization and demobilization will constitute full compensation for the completion of the work.

Contractor is to contact "Iowa One Call" for utility locations a minimum of two (2) days prior to any excavation/construction. The ticket number must be provided to Engineer.

2. Subsidiary Item - Sign Installation

This item shall include all labor, materials, equipment and Iowa One Call notifications to install sign provided by Iowa Department of Agriculture and Land Stewardship, as shown on the plans or on next page.

NATURAL RESOURCES CONSERVATION SERVICE
CONSTRUCTION SPECIFICATION

IA-9 SUBSURFACE DRAIN INVESTIGATION, REMOVAL, AND REPAIR

1. SCOPE

The work shall consist of investigation, location, repair, and/or removal of subsurface drains (tile) near new or existing animal waste storage facilities or in wetland restoration, enhancement, or creation project areas, or other situations where subsurface drains may be present.

2. INVESTIGATION AND LOCATION

An inspection trench at least 10 inches wide shall be dug at the location shown on the drawings or as directed by the engineer or his representative. The trench shall be at least 6 feet deep measured from the original ground line, unless otherwise shown on the plans. The Engineer or his representative shall examine the trench and excavated material to identify tile lines.

Size, material, operating condition and direction of flow of each conduit shall be documented. Location and flow line elevation of each conduit shall be surveyed with horizontal and vertical control based on benchmarks shown on the plans.

The inspection trench shall be documented by surveying the natural ground and trench bottom location and elevations at the beginning, end, and every 50 feet for trenches longer than 50 feet.

Backfilling shall not be started without approval of the Engineer. See Section 5 for backfill specifications.

Trench shields, shoring and bracing, or other methods necessary to safeguard the workers and work, and to prevent damage to the existing improvements shall be furnished, placed, and subsequently removed by the contractor.

3. TILE REPAIR

Unless designated for removal, replace damaged conduit with new conduit having equal or greater capacity using material specified in Section 6 or 7. When replacing short sections of clay or concrete tile with single-wall corrugated polyethylene pipe, use the next larger nominal size.

Make connections with manufactured fittings and tight joints. Where joints have gaps that would allow soil to enter, cover the joint with a permanent type material such as coal tar pitch treated roofing paper, fiber glass sheet or mat, or plastic sheet.

If the investigation trench has been excavated below the existing drain grade, backfill the trench with gravel or well-pulverized soil in layers not over four (4) inches thick and tamp by hand or manually directed power tamper to provide a firm foundation for the conduit at the existing grade. Do not backfill with any soil containing broken tile fragments.

Using selected soil free of hard clods, rocks, or frozen soil, hand tamp the backfill material around the haunch of the pipe in layers not over four (4) inches thick to provide support. Hold the conduit in place mechanically while

placing excavated material around and over the conduit to ensure proper alignment and grade is maintained. Complete the backfill operation according to Section 5.

4. TILE REMOVAL

Remove conduits as shown on the plans or directed by the Engineer or his representative, including envelope filter material or other flow enhancing material when present.

Cap or plug the open ends of the disconnected conduit to prevent soil entry when the conduit will continue to function downstream, or otherwise shown on the plans. For a minimum distance of two feet around each sealed conduit end, backfill in layers not over four (4) inches thick and tamp by hand or manually directed power tamper to a density equal to or greater than the surrounding undisturbed soil. Do not backfill with any soil containing broken tile fragments, large stones, frozen material, or large dry clods.

Where tile are located beneath an existing animal waste facility, remove the tile or fill the entire length of tile with concrete or Portland cement grout as shown on the plans. When tile removal is specified, the owner shall contact the Iowa Department of Natural Resources (IDNR) for permission to remove the drainage tile under the structure. The structure shall be emptied of waste or lowered to a point below the tile prior to its removal. The structure must be retested for percolation and the results submitted to IDNR and approval received prior to reusing the structure.

If shown on the plans or directed by the engineer, reroute upstream drain lines so the capacity of the upstream drainage system is maintained. Install conduit in accordance with Iowa Construction Specification IA-46, Tile Drains for Land Drainage.

5. BACKFILL

Compact soil around disturbed tile as specified in Section 3 (Tile Repair) and Section 4 (Tile Removal). Keep the backfill within 5 feet of the conduit free from large stones, frozen material, and large dry clods. Unless otherwise shown on the plans, backfill the remainder of the trench as follows:

For trenches located under or near structures, backfill in 12-inch layers and compact each layer to a density equal to or greater than the surrounding undisturbed soil.

For other locations, backfill the remainder of each trench with the excavated soil material which shall extend above the ground surface and be well rounded over the trench.

6. MATERIALS

Unless otherwise shown on the plans, conduit and fittings used for repair shall conform to the specifications listed in Table 1. Perforated pipe shall have a water inlet area of at least 1 square inch per foot, provided by perforations spaced uniformly along the long axis of the pipe. The perforations shall be circular or slots. Circular perforations shall not exceed 3/16 inch in diameter. Slots shall not be more than 1/8 inch wide.

Table 1. Acceptable pipe for subsurface drain repair

Kind of Pipe[#]	Specification
Corrugated Polyethylene (PE) Pipe and Fittings, 3 to 6 inch	ASTM F 405
Corrugated Polyethylene (PE) Pipe and Fittings, 3 to 24 inch	ASTM F 667
Corrugated Profile Wall (Dual Wall) Polyethylene (PE) pipe, 2 to 60 inch	ASTM F 2648[$]
Corrugated Profile Wall (Dual Wall) Polyethylene (PE) pipe, 12 to 60 inch	ASTM F 2306[$]
Polyvinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80 and 120	ASTM D 1785
PVC Pressure-Rated Pipe (SDR Series)	ASTM D 2241
Clay drain tile	ASTM C 4
Concrete drain tile	ASTM C 412

[#]Pipe sizes are nominal and the ranges are inclusive

[$]Pipe conforming to AASHTO M 252 (3 to 10 inch), or AASHTO M 294 (12 to 60 inch) is acceptable.

7. SPECIFIC SITE REQUIREMENTS

A. Measurement and Payment

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B. Items of Work and Construction Details

"Drain Tile Investigation and Removal":

1. Bid Item No. 7

This item will consist of the excavation necessary to locate and remove all tile under the embankment and to locate and determine the tie-in locations for the tile locations shown on the plans. This item shall also include backfilling of the trenches.

This item does not include the additional excavation required to excavate the embankment core trench, if included in the project. Excavation of the core trench is covered under Specification IA-21, Excavation.

The extent of the tile investigation shall be as shown on the drawings. If extra work is required to locate additional tile not shown on the drawings, the Contractor can request additional compensation, but it must be first approved by the Division.

The investigation should reveal where the tile crosses the embankment footprint or where it is located if it does not cross the embankment footprint

Payment for Drainage Tile Investigation and removal shall be made as noted in the plans.

Construction Specification
000 IA-11 Removal of Water

1. SCOPE

The work shall consist of the removal of surface water and ground water as needed to perform the required construction in accordance with the plans and specifications.

2. DIVERTING SURFACE WATER

The Contractor shall build, maintain and operate all cofferdams, channels, diversions, flumes, sumps, and other temporary protective works needed to divert surface water away from the construction site while construction is in progress.

3. DEWATERING THE CONSTRUCTION SITE

Foundations, cutoff trenches, borrow areas and other parts of the construction site shall be dewatered as needed for proper execution of the construction work. The Contractor shall furnish, install, operate and maintain all works and equipment needed to perform the dewatering.

4. EROSION AND POLLUTION CONTROL

Removal of water from the construction site, including the borrow areas shall be accomplished in such a manner that erosion and the transmission of sediment and other pollutants are minimized.

5. REMOVAL OF TEMPORARY WORKS

After temporary works have served their purposes and before the Contractor leaves the site, they shall be removed.

6. SPECIFIC SITE REQUIREMENTS

A. Measurement and Payment

Compensation for any work item described in the contract documents but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and bid items to which they are made subsidiary are identified in Items of Work and Construction Details section of this specification.

For items of work which lump sum prices are established in the contract, the quantity of work will not be measured for payment. Payment for each item will be made at the contract lump sum price and will constitute full compensation for completion of the work.

For items of work for which specific unit prices are established in the contract, the payment will be made based on the approved quantity measured by the engineer or weight tickets. Payment will constitute full compensation of the work completed as defined by each work item.

B. Items of Work and Construction Details

1. Subsidiary Item - Dewatering

This item shall include all costs to divert, pump, dam or other means to dewater the site as needed to complete construction activities.

No separate payment will be made for Removal of Water. Compensation for this item shall be made subsidiary to other bid items requiring removal of water in order to complete.

Construction Specification
000 IA-13 Sheet Piling

1. SCOPE

The work shall consist of furnishing and driving the specified sheet piling at the location shown on the drawings.

2. MATERIALS

Sheet piling shall conform to the requirements of ASTM A328 (Steel Sheet Piling), A572 (High- Strength Low-Alloy Columbium-Vanadium Structural Steel), or A690 (High-Strength Low-Alloy steel H-Piles and Sheet Piling for Use in Marine Environments). The sheet piling provided shall meet the required cross-section, section modulus, thickness, and steel grade shown on the drawings. Fabrication of sheet piles from shorter lengths of pile stock is not permitted.

3. DRIVING SHEET PILE

The piling shall be driven in a manner so as to insure perfect interlocking throughout the entire length of each pile. The piles shall be held in proper alignment during driving by means of suitable temporary guide structures which shall be removed when they have served their purpose.

Piling shall be driven to the full depth shown on the drawings unless otherwise approved by the engineer.

4. CUTTING OFF PILES

The contractor shall cut the piling off at the specified elevations. Piling length shall be sufficient to permit removal of all materials damaged by driving.

5. DEFECTIVE PILING

Any piling damaged in driving, driven out of its proper location, driven below the specified cut off elevation, or inaccurately cut off shall be pulled and replaced or re-driven. Any piling ruptured in the interlock or otherwise damaged during driving shall be pulled and replaced.

6. SPECIFIC SITE REQUIREMENTS

A. Measurement and Payment

Compensation for any work item described in the contract documents but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and bid items to which they are made subsidiary are identified in Items of Work and Construction Details section of this specification.

For items of work which lump sum prices are established in the contract, the quantity of work will not be measured for payment. Payment for each item will be made at the contract lump sum price and will constitute full compensation for completion of the work.

For items of work for which specific unit prices are established in the contract, the payment will be made based on the approved quantity measured by the engineer or weight tickets. Payment will constitute full compensation of the work completed as defined by each work item.

B. Items of Work and Construction Details

"Steel Sheet Piling":

1. Bid Item No. 8

Payment will be made based on the submitted unit price based on the area of sheet pile walls, acceptably placed, computed to the nearest square foot within the neat lines shown on the drawings. Payment will be made at the contract unit price for each type, kind and weight of piling. Such payment will constitute full payment for all labor, materials, equipment and all other items necessary and incidental to the completion of the work.

This item shall consist of furnishing and installing the steel sheet piling shown on the drawings. This item shall include field cutting the side slopes of the sheet piling to the specified slope shown on the drawings along with any damaged portion from driving.

The sheet piling will be installed starting from the center of the weir section and progressing away from centerline.

Sheet piling shall have the requirements specified in the plans.

The sheet pile minimum requirements have been determined for in-place stresses. The Contractor is responsible for making sure the sheet pile provided can be adequately placed without excessive damage based on expected stresses experienced during placement.

2. Subsidiary Item - Steel c-channel

Furnishing and Installation the steel c-channel (See IA-81), including bolts, nuts, washers and steel channel.

All holes shall be field drilled. Torch, plasma cutting or other methods resulting in imperfect holes will not be permitted.

Construction Specification
000 IA-21 Excavation

1. SCOPE

The work shall consist of the excavation required by the drawings and specifications and disposal of the excavated materials. The cutoff trench and any other required excavations shall be dug to the lines and grades shown on the drawings or as staked in the field. Structure or trench excavations will conform to all safety requirements of OSHA.

2. USE OF EXCAVATED MATERIALS

Suitable materials from the specified excavations shall be used in the construction of required permanent earth fill. The suitability of materials for specific purposes shall be determined by the NRCS Inspector.

3. DISPOSAL OF WASTE MATERIAL

All surplus or waste material shall be disposed of in areas shown on the drawings or as approved by the NRCS Inspector. The waste material shall be smoothed and sloped to provide drainage.

4. STRUCTURE AND TRENCH EXCAVATION

Structure or trench excavations will conform to all safety requirements of OSHA.

5. BORROW EXCAVATION

When the quantities of suitable materials obtained from specified excavations are insufficient to construct the specified fills, additional materials shall be obtained from the designated borrow areas as shown on the drawings or as approved by NRCS and the landowner. On wetland projects, borrow shall not be taken from the wetland area within 10 feet of the embankment or as shown on the drawings.

Borrow areas shall be excavated and grading completed in a manner to eliminate steep or unstable side slopes or hazardous or unsightly conditions.

6. OVER-EXCAVATION

Excavation beyond the specified lines and grades shall be corrected by filling the resulting voids with compacted earthfill, except that if the earth is to become the subgrade for riprap, sand or gravel bedding or drainfill, the voids shall be filled with material conforming to the specifications for the riprap, bedding or drainfill, as appropriate.

7. SPECIFIC SITE REQUIREMENTS

A. Measurement and Payment

Compensation for any work item described in the contract documents but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and bid items to which they are made subsidiary are identified in Items of Work and Construction Details section of this specification.

For items of work which lump sum prices are established in the contract, the quantity of work will not be measured for payment. Payment for each item will be made at the contract lump sum price and will constitute full compensation for completion of the work.

For items of work for which specific unit prices are established in the contract, the payment will be made based on the approved quantity measured by the engineer or weight tickets. Payment will constitute full compensation of the work completed as defined by each work item.

The volume of excavation as provided in the bid quantities has been determined from the topographic information shown on the Drawings using a computer program. Payment will be made based on the planned quantities provided unless additional excavation is directed by the Engineer. Excavation resulting from the contractor's improper construction operations, as determined by the Engineer, is not included for measurement and payment.

B. Items of Work and Construction Details

"Excavation (General (P))":

1. Bid Item No. 9

This item will consist of excavation and grading of material needed for the core trench as shown in the plans:

Excavations required for the placement of toe drain, tile exploration, new tile installation, riprap placement, are not included in this bid quantity and will not be measured for payment. The cost of excavation for these items are incidental and should be included as part of their corresponding bid items.

This item does not include the excavation for site stripping or topsoil, which is covered under Specification IA-CS-001. "Site Preparation".

This item includes the hauling of excavated material to be used as earthfill or spoil.

See Specification IA-CS-023 for compaction method.

Payment will be based on plan quantity. If unsuitable material is found at the bottom of the core trench, the over excavation shall be measured and paid in a change order.

Payment will constitute full compensation for the following related Subsidiary items: Pollution Control; Removal of Water; and Structure Excavation.

“Excavation (Waste)”:

2. Bid Item No. 10

This item includes excavation, hauling, and placement of all unsuitable material found within the wetland pool grading limits as required to reach "finish grade". Excavation of material within the pool grading limits that is suitable for general, general dam, dam core, or liner earthfill shall be used for those purposes and shall be considered incidental to those items. Over-excavation of unsuitable materials to implement a liner shall be incidental to liner item(s). Notify the engineer if sand seams or other unfavorable subsurface conditions are encountered. Excess or unsuitable material shall be placed to restore borrow areas to existing grades--especially if outside of the easement--and as directed by the engineer.

Excavations required for the placement of toe drain, tile exploration, new tile installation, riprap placement, are not included in this bid quantity and will not be measured for payment. The cost of excavation for these items are incidental and should be included as part of their corresponding bid items.

This item does not include the excavation for site stripping or topsoil, which is covered under Specification IA-CS-001. “Site Preparation”.

This item includes the hauling of excavated material that is unsuitable to be used as earthfill and is to be used to backfill the borrow area(s).

See Specification IA-CS-023 for compaction method.

Payment will constitute full compensation for the following related Subsidiary items: Pollution Control; Removal of Water; and Structure Excavation.

3. Subsidiary Item - Borrow Excavation

This item will consist of excavation of the borrow area for placement of cohesive material in the embankment core and compacted clay liner, if included and as shown in the plans. The cost for excavation and transporting of borrow shall be included in corresponding bid Items listed in Specification IA-CS-023 “Earthfill”.

Borrow from any other area will not be allowed unless directed and approved by the Engineer.

The topsoil from the borrow area shall be removed to a minimum depth of 6" and stockpiled. When the borrow operations have been completed, grades shall be returned to that indicated on the plans and the topsoil shall be uniformly spread over the entire borrow area to a depth of 6".

No separate payment will be made for strip or respread of topsoil over borrow area.

4. Subsidiary Item - Structure Excavation

This item shall consist of the excavation necessary to install the steel sheet pile, riprap, corrugated metal pipe (CMP) conduit, CMP tile outlets and water control structure in the locations and as shown on the drawings.

No separate payment will be made for Structure Excavation. Compensation for this item will be included in payment with the corresponding bid items for CMP conduit; CMP water control structure; steel sheet pile; and riprap.

Construction Specification
000 IA-23 Earthfill

1. SCOPE

The work shall consist of the construction of earth fills required by the drawings and specifications. The completed work shall conform to the lines, grades, and elevations shown on the drawings or as staked in the field.

2. MATERIALS

All fill materials shall be obtained from required excavations and designated borrow areas. Fill materials shall contain no sod, brush, roots or other bio-degradable materials. Rocks larger than 6 inches in diameter shall be removed prior to compaction of the fill.

3. FOUNDATION PREPARATION

Foundations for earthfill shall be stripped a minimum of 6 inches to remove vegetation and other unsuitable materials. Foundation surfaces shall be scarified to a minimum depth of 2 inches prior to placing fill material.

Foundation and abutment surfaces shall not be sloped steeper than 1.5 horizontal to 1 vertical unless otherwise shown on the drawings.

4. PLACEMENT

Fill shall not be placed until the required excavation and foundation preparation have been completed and the foundation has been inspected and approved by NRCS. Fill shall not be placed upon a frozen surface, nor shall snow, ice, or frozen material be incorporated in the fill.

Adjacent to structures or pipes, fill shall be placed in a manner which will prevent damage. The height of the fill adjacent to structures or pipes shall be increased at approximately the same rate on all sides.

The materials used throughout the earth fill shall be essentially uniform. Selective placement shall be as shown on the drawings or approved by NRCS.

If the surface of any layer becomes too hard and smooth for proper bond with the succeeding layer, it shall be scarified to a minimum depth of 2 inches before the next layer is placed.

The top surfaces of embankments shall be maintained approximately level during construction, except that a cross-slope of approximately 2% shall be maintained to ensure effective drainage.

When moving fill material from the borrow area(s) to the embankment by use of bulldozers only, the following steps shall be followed:

- Immediately after the borrow material is pushed to the embankment, it shall be spread in horizontal lifts placed parallel to the centerline of the embankment.
- Compactive effort will then be applied by operating equipment parallel to the centerline of the fill or embankment.
- Lift thicknesses shall be in strict compliance with Clause 6, below.

Sectional fills are not allowed unless they are shown on the construction drawings.

5. CONTROL OF MOISTURE CONTENT

The moisture content of the fill material shall be adequate for obtaining the required compaction. Material that is too wet shall be dried to meet this requirement, and material that is too dry shall have water added and mixed until the requirement is met.

The moisture content of the fill material shall be such that a ball formed with the hands does not crack or separate when struck sharply with a pencil and will easily ribbon out between the thumb and finger.

Earth foundations under and adjacent to concrete structures shall be prevented from drying and cracking before concrete and backfill are placed.

The application of water to the fill materials shall be accomplished at the borrow areas insofar as possible.

6. COMPACTION

Earth fill shall be compacted by one of the following methods as specified on the plans or in Section 8, Special Specifications. If no method is specified, compaction will be in accordance with Method 1.

- Method 1 - Earthfill shall be placed so that the wheels or tracks of the loaded hauling equipment, traveling in a direction parallel to the centerline of fill, pass over the entire surface of each layer being placed. Low ground pressure vehicles shall not be used for this purpose.
- Method 2 - Two (2) complete passes of a tamping-type roller will be made over each layer. The roller shall be capable of exerting a minimum force of two hundred (200) pounds per square inch.
- Method 3 - Minimum density shall be 90% of the maximum density as determined by ASTM D 698 and as shown on the plans.

The maximum thickness of a lift of fill before compaction shall be 9 inches, unless otherwise indicated on the drawings.

Fill adjacent to structures, pipe conduits, and appurtenances shall be placed in layers not more than 4 inches thick and compacted to a density equivalent to that of the surrounding fill. Methods used to obtain compaction for fine or coarse grained materials are as follows:

- For fine grained materials, hand tamping or manually directed power tampers may be used. Hand compaction only shall be used to compact the earthfill under the bottom half of circular pipes. Manually directed power tampers shall not be used in tight spaces where applying full compactive effort will result in direct contact of the tamper plate with the pipe. Care should be taken so that compaction around the spillway pipe does not cause uplift of the pipe resulting in a void beneath the pipe.
- For coarse grained materials (sands and gravels), vibratory plate compactors shall be used for obtaining compaction. However, hand tamping shall be used to compact the material under the bottom half of circular pipes.

In all cases, follow manufacturer instructions for the specific compaction equipment being used. Heavy equipment shall not be operated within 2 feet of any structure or pipe.

Compacting of fill adjacent to concrete structures shall not be started until the concrete is 7 days old.

7. ISLANDS, MOUNDS, AND LOAFING AREAS ON WETLAND RESTORATION, ENHANCEMENT, OR CREATION PROJECTS

Islands shall be randomly located within the wetland area at locations shown on the drawings or as staked in the field. The orientation of island shorelines shall be random with attention given to prevailing

winds to limit wave damage. In general, the side of the island with the longest dimension shall be parallel to the prevailing wind direction. Side slopes of islands shall be as shown on the drawings, but in no case shall be steeper than 6 horizontal to 1 vertical. Island shapes shall be irregular.

Loafing areas shall be constructed in the areas shown on the drawings or as staked in the field and shall be graded to drain runoff water. The elevation of at least one loafing area should be above the maximum water level whenever possible.

Excavated material not suitable for embankments, wetland dikes, or islands can be used to create mounds or blended into surrounding topography to create a natural appearance. Spoil material shall not be spread on existing wetland areas.

Organic soils shall not be used to construct islands, loafing areas, dikes, or embankments.

8. SPECIFIC SITE REQUIREMENTS

A. Measurement and Payment

For items of work which specific unit prices are established in the contract, the volume of earthfill will be computed to the nearest cubic yard by the method of average cross-sectional end areas. No deduction in volume will be made for embedded items, such as, conduits inlet structures and their appurtenances. The pay limits for computation shall be as shown on the drawings with the further provisions that earthfill voids resulting from over excavation of the foundation, outside specified lines and grades, will be included in the measurement for payment only under the following conditions:

- Where such over excavation is directed by the engineer to remove unsuitable material, and
- Where the unsuitable condition is not a result of the contractor's improper construction operations as determined by the engineer.

Earthfill beyond the specified lines and grades to backfill excavation required for compliance with OSHA requirements will be considered subsidiary to the earthfill bid item(s).

Payment for each type and compaction class of earthfill and earth backfill is made at the contract unit price for that type and compaction class of earthfill. Such payment will constitute full compensation for all labor, material, equipment, and all other items necessary and incidental to the performance of the work.

Compensation for any item of work described in the contract, but not listed in the bid schedule is included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in this specific section.

B. Items of Work and Construction Details

Items of work to be performed in conformance with this specification and the construction details therefore are:

“Earthfill (General (P))”:

1. Bid Item No. 11

This item shall consist of the earthfill necessary to construct the submerged berms and additional fill to be placed over the tile to provide adequate cover. Cohesive material found during general grading and compacted liner removal can be used for these areas. Sand and gravel found on site shall not be used for this earthfill.

Compaction shall be Method 1.

Rocks larger than 6" shall be removed prior to compaction.

Payment for these items shall be based on plan quantity unless additional length or location of tile varies from what is shown on the plans. The plan quantity is based on neat lines and does not account for any shrinkage.

Payment will constitute full compensation for the following related Subsidiary items: Pollution Control, Removal of Water, and Backfill Required Excavation.

“Earthfill (General Dam (P))”:

2. Bid Item No. 12

This item will consist of earthfill placement and compaction necessary to construct the portion of the embankment that is not considered part of the embankment core. Cohesive material found during general grading and compacted liner removal can be used for this area. Sand and gravel found on site shall not be used for fill for these items

Compaction shall be Method 1.

Rocks larger than 6" shall be removed prior to compaction.

Payment for this item shall be based on plan quantity. The plan quantity is based on neat lines and does not account for any shrinkage.

Payment will constitute full compensation for the following related Subsidiary items: Pollution Control, Removal of Water, and Backfill Required Excavation.

“Earthfill (Dam Core (P))”:

3. Bid Item No. 13

This item will consist of earthfill placement and compaction necessary to construct the portion of the embankment designated the embankment core, including the core trench. Cohesive material taken from the designated borrow area should be used for this area. Sand and gravel found on site shall not be used for fill for these items.

Compaction shall be Method 2.

Rocks larger than 6" shall be removed prior to compaction.

Payment for this item shall be based on plan quantity. The plan quantity does include a shrinkage value of 25%.

Payment will constitute full compensation for the following related Subsidiary items: Pollution Control, Removal of Water, and Backfill Required Excavation.

"Earthfill (18" Clay Liner, Wetland Bottom, Two 9" Lifts (P))":

4. Bid Item No. 14

This item includes scarification and loosening of an 18-inch liner in two lifts in all excavated areas within the wetland pool. Remove an additional 9-inch of soil, scarify and re-compact 9-inch below, replace 9-inch and recompact, moisture conditioning, and compaction of the wetland bottom to form a seal. The contractor shall remove rocks larger than 6 inches. Compaction shall be method 2. Notify engineer immediately if sandy soils are encountered. Item will be paid based on plan quantity.

"Earthfill (Scarify and Recompact 9" Layer of Wetland Bottom (P))":

5. Bid Item No. 15

This item includes scarification and loosening of a 9-inch surface layer of soil on the wetland pool bottom, moisture conditioning, and compaction of the wetland bottom to form a seal. Contractor shall remove rocks larger than 6 inches. Compaction shall be method 2. Notify engineer immediately if sandy soils are encountered. Item will be paid based on plan quantity.

"Earthfill (Removal Of 9" Of Material, Disposal, Replacement with Suitable Fill, And Compaction)":

6. Bid Item No. 16

This item includes the removal of a 9" layer of unsuitable material from the wetland bottom, disposal of the unsuitable material, and replacement of 9" of suitable material on the wetland bottom. Compact with suitable material on the wetland bottom to form a seal.

7. Subsidiary Item - Backfill Required Excavation

This item shall consist of backfilling the areas excavated to install the other components related to the project such as piping or structures and to locate and remove the tile lines.

Compaction adjacent to the structures shall be as indicated above. All other compaction shall be Method 1 or equivalent.

No separate payment will be made for Backfill of Structure Excavation. Compensation for this item will be included in payment for Corrugated Metal Pipe; CMP Drawdown Structure; Riser Inlet Structure, Tile Investigation and Removal and Dual Wall HDPE.

Construction Specification
000 IA-26 Topsoiling

1. SCOPE

The work shall consist of salvaging topsoil from borrow areas or required excavations and spreading it on the exposed disturbed areas.

2. QUALITY OF TOPSOIL

Topsoil shall consist of friable surface soil reasonably free of grass, roots, weeds, sticks, stones, or other foreign materials.

3. EXCAVATION

After the site has been cleared and grubbed, the topsoil shall be removed from borrow areas and required excavation areas to the depth as shown on the drawings. Topsoil shall be stockpiled at locations approved by NRCS.

4. SPREADING

Spreading shall not be done when the ground or topsoil is frozen, excessively wet, or otherwise in a condition detrimental to the work. Surfaces designated to be covered shall be lightly scarified just prior to the spreading operation. Where compacted fills are designated to be covered by topsoil, the topsoil shall be placed concurrently with the fill and shall be bonded to the compacted fill with the equipment.

Topsoil shall be placed to the minimum depth shown on the drawings. After the spreading operation is completed, the surface shall be finished to a reasonably smooth surface.

5. SPECIFIC SITE REQUIREMENTS

A. Measurement and Payment

Compensation for any work item described in the contract documents but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and bid items to which they are made subsidiary are identified in Items of Work and Construction Details section of this specification.

For items of work which lump sum prices are established in the contract, the quantity of work will not be measured for payment. Payment for each item will be made at the contract lump sum price and will constitute full compensation for completion of the work.

For items of work for which specific unit prices are established in the contract, the payment will be made based on the approved quantity measured by the engineer or weight tickets. Payment will constitute full compensation of the work completed as defined by each work item.

B. Items of Work and Construction Details

“Topsoil Placement (P)”

1. Bid Item No. 17

This item will consist of spreading salvaged and stockpiled topsoil as the surface layer of all excavations and earthfills that will be seeded. Topsoil shall be placed as final lift.

Areas to receive a minimum of 12-inch layer of topsoil include the embankment. All other disturbed areas shall receive a minimum of 6-inch layer of topsoil.

All salvaged topsoil shall be respread on-site unless otherwise directed by the engineer

Measurement and payment for Topsoiling shall be on a plan quantity. Plan quantity listed in the proposal will be used to measure and pay for the bid.

Grading areas with less than 6 inches of cut will not require topsoil respreading unless required by engineer.

Payment will constitute full compensation for the following related subsidiary items: Site Preparation and Pollution Control.

Construction Specification
000 IA-31 Concrete

1. SCOPE

The work shall consist of furnishing, forming, placing, finishing, and curing Portland cement concrete including steel reinforcement.

2. MATERIALS

Portland Cement shall conform to ASTM C 150 and shall be Type I or Type II.

Fine Aggregates shall conform to ASTM C 33 and shall be composed of clean, uncoated grains of material.

Coarse Aggregates shall be gravel or crushed stone conforming to ASTM C 33 and shall be clean, hard, durable and free from clay or coating of any character. The maximum size of coarse aggregate shall be 1 1/2 inches or as shown on the drawings.

Water shall be clean and free from injurious amounts of oil, acid, salt, alkali, organic matter, or other deleterious substances.

Air entraining agent shall conform to ASTM C 260.

Fly ash may be used as a partial substitution for Portland cement and shall be in strict compliance with ASTM C 618, Class F or C. The loss by ignition shall not exceed 4.0 percent.

Blast-furnace slag may be used as a partial substitution for Portland cement and shall be in conformance with ASTM C 989 for ground granulated blast-furnace slag (GGBF slag).

Water-reducing admixtures shall conform to ASTM C 494 and may be the following types:

1. Type A - Water-reducing admixture
2. Type D - Water-reducing and retarding admixture
3. Type F - Water-reducing, high range admixture (superplasticizer).
4. Type G - water-reducing, high range, and retarding admixture (superplasticizer).

Type D or G admixture may be used when the air temperature is over 80 degrees F. at the time of mixing and/or placement.

Calcium Chloride or other antifreeze compounds or accelerators will not be allowed.

Preformed expansion joint filler shall be a commercially available product made of bituminous, sponge rubber or closed cell foam materials with a minimum thickness of 1/2 inch.

Reinforcing steel shall be free from loose rust, oil, grease, paint, or other deleterious matter. Reinforcing steel shall conform to one or more of the following:

1. Reinforcing Bars - ASTM A 615 or A 996, Grade 40 or greater, deformed.
2. Welded Wire Fabric - ASTM A 185 or A 497.

Waterstops shall be either metallic or nonmetallic. Metallic waterstops shall be fabricated from sheets of copper or galvanized steel. Nonmetallic waterstops shall be made of natural or synthetic rubber or vinyl chloride polymer or copolymer. Rubber, polymer and copolymer waterstops shall have ribbed or bulb-type

anchor flanges and a hollow tubular center bulb, unless otherwise shown on the drawings. All waterstops shall be of the sizes shown on the drawings.

Curing compound shall be a liquid membrane-forming compound suitable for spraying on the concrete surface. The curing compound shall meet the requirements of ASTM C 309 Type 2 (white pigmented).

3. CONCRETE DESIGN MIX

The contractor will be responsible for the determining the design mix proportions in accordance with the requirements included in this paragraph and shall provide a copy of the mix to the NRCS Engineer at Natural Resources Conservation Service least 3 days prior to placing any concrete. The concrete mix shall be of such proportions as to provide a minimum strength of 3500 p.s.i. in 28 days, unless otherwise shown on the drawings. The air content shall be 4 to 8 percent of the volume of the concrete at the time of placement. The slump shall be 2 to 5 inches except when superplasticizer is used. The slump shall be 3 inches or less prior to the addition of superplasticizer admixture and shall not exceed 7 1/2 inches following addition and mixing. The fine aggregate shall be 30-50 percent of the total combined aggregate based on oven dry weights. The contractor shall provide tests to verify that the design mix meets the requirements. In lieu of this, one of the following mix proportions per cubic yard may be used:

Mix Number	Minimum Cement, Pounds	Fly Ash, Pounds	GGBF Slag, Pounds	Maximum **Water, Gallons
1	564	0	0	33
2	470	45-90	0	31-34
3	517	129	0	31*
4	366	114	91	31*
5	259	103	155	31*

** Total of available aggregate moisture, mixing water added at the plant and mixing water added at the job site (one gallon equals 8.33 pounds).
* Requires water reducing admixture.

4. MIXTURES AND MIXING

Ready-mixed concrete shall be batched, mixed and transported in accordance with ASTM C 94. Concrete shall be uniform and thoroughly mixed when delivered to the forms. No mixing water in excess of the amount shown for the design mix or in an amount that would cause the maximum slump to be exceeded shall be added to the concrete during mixing, hauling or after arrival at the point of delivery. The concrete shall be batched and mixed so that the temperature of the concrete at the time of placing shall be between 50 and 90 degrees F.

5. BATCH TICKET

The contractor shall obtain from the supplier a delivery ticket for each batch of concrete before unloading at the site. The following information shall be included on the ticket: name of concrete supplier, job name or location, date, truck number, amount of concrete, time loaded or time of first mixing cement, aggregate, and mixing water added at the plant, type and amount of cement, type and amount of admixtures, oven dry weights of fine and coarse aggregate, and moisture content(%) or weight of water contained in the aggregates.

The following information shall be added to the batch ticket on site: mixing water added on site, time concrete arrived on site and time concrete was unloaded.

Upon completion of the concrete placement, copies of all batch tickets shall be provided to NRCS.

6. REINFORCING STEEL

Before reinforcement is placed, the surfaces of the bars or mesh shall be cleaned to remove any loose, flaky rust, mill scale, oil, grease, or other foreign substances. After placement, the reinforcement shall be maintained in a clean condition until it is completely embedded in the concrete.

Reinforcing bars shall be cut and bent according to ACI Standard 315.

Tack welding of bars shall not be permitted. Reinforcement shall be accurately placed as shown on the drawings and secured in position in a manner that will prevent its displacement during placement of concrete. Metal chairs, metal hangers, metal spacers or concrete chairs shall be used to support reinforcement. Precast concrete chairs shall be manufactured from concrete equal in quality to the concrete being placed. Precast concrete chairs shall be moist at the time concrete is placed

Splices of reinforcing bars shall be made only at the locations shown on the drawings, unless otherwise approved by the NRCS Engineer. All reinforcing splices and placement shall be in accordance with ACI 318 and as shown on the drawings.

After placement of the reinforcement, concrete shall not be placed until the reinforcement has been inspected and approved by NRCS.

7. PREPARATION OF FORMS AND SUBGRADE

Prior to placement of concrete, the forms and subgrade shall be free of woodchips, sawdust, debris, water, ice, snow, extraneous oil, mortar, or other harmful substances or coatings. Any oil on the reinforcing steel or other surfaces required to be bonded to the concrete shall be removed. All surfaces shall be firm and damp prior to placing concrete. Placement of concrete on mud, dried earth, uncompacted fill, or frozen subgrade will not be permitted.

The forms and associated false-work shall be substantial and unyielding and shall be constructed so that the finished concrete will conform to the specified dimensions and elevations. Forms will be mortar tight. Forms with torn surfaces, worn edges, dents or other defects will not be used. Forms shall be coated with a nonstaining form release agent before being set into place. Excess form coating material shall not stand in puddles in the forms or come in contact with the steel reinforcement or hardened concrete against which fresh concrete is to be placed.

Form accessories to be partially or wholly embedded in the concrete, such as ties and hangers, shall be of a commercially manufactured type. Non fabricated wire shall not be used. Form ties shall be constructed so that the ends or end fasteners can be removed without causing spalling at the surface of the concrete.

Metal form ties used within the forms on structures with a total volume of concrete exceeding fifteen cubic yards shall be equipped with cones or other devices that permit their removal to a depth of at least one inch without damage to the concrete. The holes resulting from cones and other devices shall be patched in accordance with Section 9.

Form ties except those specifically covered by the preceding paragraph shall be broken off flush with the formed surface. Any surface areas which have been spalled or otherwise damaged shall be repaired in accordance with Section 9.

Steel tying and form construction adjacent to new concrete shall not be started until concrete has cured at least 12 hours.

Concrete joints shall be of the type and at the locations shown on the drawings. Splices in metal waterstops shall be brazed, welded or overlapped and bolted.

Splices in nonmetallic waterstops shall be cemented or joined as recommended by the manufacturer.

8. PLACING CONCRETE

Concrete shall not be placed until the subgrade, forms, and steel reinforcement have been inspected and approved by the NRCS Inspector. Any deficiencies are to be corrected before the concrete is delivered for placement.

Concrete shall be delivered to the site and discharged into the forms within 1 1/2 hours after the introduction of the cement to the aggregates. When a superplasticizer is used, the concrete shall be discharged within the manufacturer's recommended time limit for discharge after addition of the admixture. In hot weather or under conditions contributing to quick setup of the concrete, discharge of the concrete shall be accomplished in 45 minutes unless a set-retarding admixture is used, in which case the manufacturer's recommended time limit will apply.

Addition of water at the job site may be done at the beginning of placement of each load of concrete in order to obtain allowable slump, provided that the maximum water content and water/cement ratio in the design mix is not exceeded. Addition of water will not be permitted after placement of the load has started.

The concrete shall be deposited as closely as possible to its final position in the forms and shall be worked into corners and around reinforcement and other embedded items in a manner which prevents segregation. Formed concrete shall be deposited in layers 24 inches or less in depth and shall be continuously deposited so that no concrete will be deposited on concrete which has hardened sufficiently to cause the formation of "cold joints". Concrete containing superplasticizer shall be placed in lifts not exceeding 5 feet in depth. If the surface layer of concrete sets during placement to the degree that it will not flow and merge with the succeeding layer when tamped or vibrated, the contractor shall discontinue placing concrete and install a construction joint. Construction joints shall be completed as shown on the drawings or by one of the following methods:

1. The joint shall be constructed using a 6 inch wide by 1/4 inch steel plate. The surfaces of the construction joint shall be prepared by washing and scrubbing with a wire brush or wire broom to expose coarse aggregate. The steel plate shall be embedded 3" in the concrete.
2. The joint surface shall be cleaned to expose coarse aggregate by sandblasting or air-water cutting after the concrete has gained sufficient strength to prevent displacement of the coarse aggregate or cement fines. The surface of the concrete shall not be cut so deep as to undercut the coarse aggregate. The joint shall be washed to remove all loose material after cutting.

The surfaces of all construction joints shall be kept continuously moist for at least 1 hour prior to placement of the new concrete. The new concrete shall be placed directly on the cleaned and washed surface. New concrete shall not be placed until the hardened concrete has cured at least 12 hours.

Concrete shall not be dropped more than 5 feet vertically unless suitable equipment is used to prevent segregation. Concrete containing superplasticizer shall not be dropped more than 12 feet vertically.

Immediately after the concrete is placed in the forms, it shall be consolidated by vibration, spading or hand tamping as necessary to insure smooth surfaces and dense concrete. Care should be taken not to over-vibrate concrete containing superplasticizer. Vibration shall not be supplied directly to the reinforcing steel, the forms or concrete which has hardened to the degree that it does not insure a monolithic bond with the preceding layer, The use of vibrators to transport concrete in the forms or conveying equipment will not be permitted.

9. FORM REMOVAL AND FINISHING

Forms shall be left in place for at least 24 hours after placing concrete. Forms shall be removed in such a way as to prevent damage to the concrete. Supports shall be removed in a manner that will permit concrete to take the stresses due to its own weight uniformly and gradually.

Immediately after removal of the forms, concrete which is honey combed, damaged or otherwise defective shall be repaired or replaced. All cavities or depressions resulting from form tie removal shall be patched with a non-shrink grout, mortar mix or epoxy-type sealer. Non-shrink grout consists of 1 part cement and 2-1/2 parts sand that will pass a No. 16 sieve. Only enough water shall be added to produce a filling which is at the point of becoming rubbery when the material is solidly packed.

All repaired and patched areas shall be cured as required in Section 10.

10. CURING

Concrete shall be cured for a period of not less than 7 consecutive days by one of the following approved methods:

1. Membrane Curing: Concrete shall be cured with white pigmented curing compound. The compound shall be sprayed on moist concrete as soon as free water has disappeared, but shall not be applied to any surface until patching, repairs and finishing of that surface are completed. Curing compound shall not be applied to surfaces requiring bond to subsequently placed concrete, such as construction joints, shear plates, reinforcing steel, and other embedded items. Surfaces subjected to heavy rainfall or running water within 3 hours after curing compound has been applied or surfaces damaged by subsequent construction operations during the curing period, shall be reapplied in the same manner as the original application.
2. Moist Curing: Concrete shall be cured by maintaining all surfaces continuously wet for the entire curing period.
3. Cover: Adequately cover an exposed structure with burlap mats, or other material and continually soak with water.

11. BACKFILLING

Backfilling may begin when the curing period has ended. Backfill against the structure will be placed in no more than 4-inch layers and compacted by hand tamping or with manually directed power tampers or plate vibrators. Layers compacted in this manner shall extend not less than 2 feet from any part of the concrete structure.

12. HOT AND COLD WEATHER CONCRETING

When the atmospheric temperature may be expected to drop below 40° F. at the time concrete is delivered to the work site, during placement, or at any time during curing period, concrete shall be mixed, placed and protected in accordance with ACI Standard 306, “Recommended Practice for Cold Weather Concreting.”

When climatic or other conditions are such that the temperature of the concrete may reasonably be expected to exceed 90o F. at the time of delivery to the work site, during placement or during the first 24 hours after placement, concrete shall be mixed, placed and protected in accordance with ACI Standard 305, “Recommended Practice for Hot Weather Concreting.”

13. SPECIFIC SITE REQUIREMENTS

A. Measurement and Payment

Compensation for any work item described in the contract documents but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and bid items to which they are made subsidiary are identified in Items of Work and Construction Details section of this specification.

For items of work which lump sum prices are established in the contract, the quantity of work will not be measured for payment. Payment for each item will be made at the contract lump sum price and will constitute full compensation for completion of the work.

For items of work for which specific unit prices are established in the contract, the payment will be made based on the approved quantity measured by the engineer or weight tickets. Payment will constitute full compensation of the work completed as defined by each work item.

B. Items of Work and Construction Details

1. Subsidiary Item - Concrete

This item shall consist of all necessary concrete, reinforcing steel, formwork, materials, and labor to place poured concrete and reinforced concrete as shown in the drawings including, but not limited to, the Water Control Structure and concrete collars around pipe connections.

No separate payment will be made for Concrete. Compensation for this item will be included in the payment for the Water Control Structure and Tile Installation.

However, concrete structures that meet the Iowa Statewide Urban Design and Specifications (SUDAS), will be paid as discussed below.

"24" Aluminized CMP Drawdown Riser, 12 GA"

1. Bid Item No. 23

The work shall consist of constructing the concrete base for the drawdown riser as shown and detailed in the plans.

In general, the concrete structures shall meet the requirements of SUDAS 6010, unless otherwise stated in the drawings.

"48" CMP Water Control Structure"

2. Bid Item No. 24

The work shall consist of constructing the concrete base for the water control structure as shown and detailed in the plans.

In general, the concrete structures shall meet the requirements of SUDAS 6010, unless otherwise stated in the drawings.

NATURAL RESOURCES CONSERVATION SERVICE
CONSTRUCTION SPECIFICATION

IA-46 TILE DRAINS FOR LAND DRAINAGE

1. SCOPE

The work shall consist of furnishing and installing drainage tubing and tile and the necessary fittings and appurtenances.

2. MATERIALS

Concrete drain tile shall conform to the requirements of ASTM C 412 and clay drain tile shall conform to the requirements of ASTM C 4.

Corrugated polyethylene (PE) pipe (tubing) and fittings shall conform to ASTM F 405 (3" to 6") or F 667 (3" to 24"), as appropriate. Corrugated profile wall (dual wall) polyethylene (PE) pipe shall meet or exceed the requirements of ASTM F 2648 (2" to 60") or ASTM F 2306 (12" to 60"). Pipe conforming to AASHTO M 252 (3" to 10") or AASHTO M 294 (12" to 60") is acceptable. Perforated tubing shall have a water inlet area of at least 1 square inch per foot, provided by perforations spaced uniformly along the long axis of the tubing. The perforations shall be circular or slots. Circular perforations shall not exceed 3/16 inch in diameter. Slots shall not be more than 1/8 inch wide.

3. EXCAVATION

Unless otherwise specified, excavation for and subsequent installation of each drain line shall begin at the outlet end and progress upstream.

The trench or excavation for the tile shall be constructed to the line, depths, cross sections, and grade shown on the drawings or as directed by the NRCS Inspector. The trench bottom shall be smooth and free of exposed rock. If rock is encountered in the trench bottom, over-excavate the trench and place at least 6 inches of compacted earth or sand bedding in the trench to bring it up to the conduit grade.

If not otherwise shown on the drawings, trench width at the top of the conduit shall be the minimum required to permit installation and provide bedding conditions suitable to support the load on the conduit, but with not less than three (3) inches of clearance on each side of the conduit. Maximum trench width shall be the conduit diameter plus 12 inches measured at the top of the conduit, unless approved bedding is installed.

Trench shields, shoring and bracing, or other methods, necessary to safeguard the workers and work, and to prevent damage to the existing improvements shall be furnished, placed, and subsequently removed by the contractor.

Plow installation is allowed. Minimum trench width shall be two (2) inches wider than the conduit on each side. Grade control and bedding conditions shall be closely inspected during plow installation. Boulders, cobbles, or cemented soil scan cause the plow to jump or lose grade. These hardpoints can also puncture or dimple and deform the pipe.

4. PREPARING THE BEDDING

Unless otherwise specified, no filter or envelope is required. In stable soils the bottom of the trench shall be shaped to form a semicircular, trapezoidal, or 90 degree "V" groove in its center. The groove shall be shaped to fit the size of tile. The 90-degree "V" groove shall not be used on conduits greater than 6 inches in diameter.

If the bottom of the trench does not provide a sufficiently stable or firm foundation for the drain tile, a sand-gravel mix or other approved materials shall be used to stabilize the bottom of the trench.

5. FILTER OR ENVELOPE MATERIAL

When a filter is specified, the shape of the bottom of the trench, gradation and the thickness of the filter or envelope material to be placed around the tile will be as shown on the drawings. The envelope or filter material shall be placed in the bottom of the trench just prior to the laying of the tile. The tile shall then be laid and the envelope or filter material placed over the tile.

6. PLACEMENT AND JOINT CONNECTIONS

All drains shall be laid to grade.

Joints between lateral drain tile shall vary with soil type as follows:

a. Peat and muck - 1/4 inch preferred, 3/8 inch maximum
b. Clay - 1/8 inch preferred, 1/4 inch maximum
c. Silt and loam - 1/16 inch preferred, 1/8 inch maximum
d. Sand - tightest possible fit.

Joint between main drain tile which serve only to collect and transport drainage water from lateral tile lines should be the tightest fit possible.

Where the joint width exceeds the maximum above, the joint shall be covered with a permanent type material such as coal tar pitch treated roofing paper, fiber glass sheet or mat, or plastic sheet.

After placement and blinding of plastic tubing, but prior to backfilling, sufficient time shall elapse to allow the tubing to reach the ambient temperature of the trench. All split fittings shall be securely tied with nylon cord before backfill is placed. When corrugated plastic tubing is used, no more than 5% stretch will be allowed.

7. CONNECTIONS

Lateral connections will be made with manufactured appurtenances (wyes, tees, etc.) comparable in strength and durability with the specified tile or tubing unless otherwise shown on the drawings.

Existing tile lines not shown on the drawings but encountered during installation shall be bridged across the trench or connected into the new line, as directed by NRCS.

Connections with the outlet pipe shall be made watertight.

8. OUTLETS

A continuous section of non-perforated conduit at least 20 feet long shall be used at the outlet. At least two-thirds of the outlet pipe shall be buried in the ditch bank, and the cantilever section must extend to the toe of the ditch side slope or the side slope protected from erosion. Acceptable materials for use at the outlet include the following:

a. Corrugated metal pipe, galvanized or aluminum, 16 gauge minimum;
b. Smooth steel pipe with a minimum wall thickness of 3/16 inch;
c. Smooth plastic pipe, polyvinyl chloride (PVC), with a SDR of 26 or less or schedule 40 or heavier; or
d. Corrugated profile wall (dual wall) polyethylene pipe (PE).

All plastic (PVC) and polyethylene pipe (PE) outlets shall include ultra-violet stabilizer. PVC or PE pipe outlets shall not be used where burning vegetation on the outlet ditch bank is likely to create a fire hazard.

The outlet shall be equipped with a flap-gate type rodent guard.

9. BLINDING

After the tubing or tile is placed in the excavated groove, friable material from the sides of the trench shall be placed around the tubing, completely filling the trench to a depth of not less than three inches over the top of the tubing. For material to be suitable it must not contain hard clods, rocks, frozen soil, or fine material which will cause a silting hazard to the drain. Tubing placed during any one day shall be blinded by the end of the day's work.

10. BACKFILLING

The backfilling of the trench shall be completed as rapidly as consistent with the soil conditions. Automatic backfilling machines may be used. Backfill shall extend above the ground surface and be well rounded over the trench.

Unless otherwise shown on the plans, in mineral soils, the minimum cover over subsurface drains shall be 2.4 feet. In organic soils, the minimum depth of cover after initial subsidence shall be 3.0 feet.

11. SPECIAL SPECIFICATIONS

A. Measurement and Payment

Compensation for any work item described in the contract documents but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and bid items to which they are made subsidiary are identified in Items of Work and Construction Details section of this specification.

For items of work which lump sum prices are established in the contract, the quantity of work will not be measured for payment. Payment for each item will be made at the contract lump sum price and will constitute full compensation for completion of the work.

For items of work for which specific unit prices are established in the contract, the payment will be made based on the approved quantity measured by the engineer or weight tickets. Payment will constitute full compensation of the work completed as defined by each work item.

B. Items of Work and Construction Details

"4" Corrugated Profile Wall (Single Wall, Non-Perforated) Polyethylene Pipe":

1. Bid Item No. 18

This item will consist of furnishing and installing 4" non-perforated corrugated profile wall (single wall) Polyethylene pipe used as a drain tile as shown on the drawings.

Measurement and payment for the corrugated profile wall (single wall) Polyethylene pipe shall be on an installed linear foot basis, and shall include all necessary fittings and adapters.

Payment will also include all subsidiary items required for installation such as trench excavations, backfill, site preparation, and removal of water, and concrete collar at joint. Additional fill required to provide adequate cover as needed is included in Earthfill, General.

“4” Corrugated Profile Wall (Dual Wall, Non-Perforated) Polyethylene Pipe”:

2. Bid Item No. 19

This item will consist of furnishing and installing 4” non-perforated corrugated profile wall (Dual wall) Polyethylene pipe used as a drain tile as shown on the drawings.

Measurement and payment for the corrugated profile wall (Dual wall) Polyethylene pipe shall be on an installed linear foot basis, and shall include all necessary fittings and adapters.

Payment will also include all subsidiary items required for installation such as trench excavations, backfill, site preparation, and removal of water, and concrete collar at joint. Additional fill required to provide adequate cover as needed is included in Earthfill, General.

“6” Corrugated Profile Wall (Dual Wall, Non-Perforated) Polyethylene Pipe”:

3. Bid Item No. 20

This item will consist of furnishing and installing 6” non-perforated corrugated profile wall (Dual wall) Polyethylene pipe used as a drain tile as shown on the drawings.

Measurement and payment for the corrugated profile wall (Dual wall) Polyethylene pipe shall be on an installed linear foot basis, and shall include all necessary fittings and adapters.

Payment will also include all subsidiary items required for installation such as trench excavations, backfill, site preparation, and removal of water, and concrete collar at joint. Additional fill required to provide adequate cover as needed is included in Earthfill, General.

“Toe Drain - 6" Corrugated Profile Wall (Dual Wall, Perforated) Polyethylene Pipe”:

4. Bid Item No. 21

This item will consist of furnishing and installing 6” perforated corrugated profile wall (Dual wall) Polyethylene pipe used as a toe drain as shown on the drawings.

Measurement and payment for the corrugated profile wall (Dual wall) Polyethylene pipe shall be on an installed linear foot basis, and shall include all necessary fittings and adapters.

Payment will also include all subsidiary items required for installation such as trench excavations, porous backfill, site preparation, and removal of water, and concrete collar at joint. Additional fill required to provide adequate cover as needed is included in Earthfill, General.

“8” Corrugated Profile Wall (Dual Wall, Non-Perforated) Polyethylene Pipe”:

5. Bid Item No. 22

This item will consist of furnishing and installing 8” non-perforated corrugated profile wall (Dual wall) Polyethylene pipe used as a drain tile as shown on the drawings.

Measurement and payment for the corrugated profile wall (Dual wall) Polyethylene pipe shall be on an installed linear foot basis, and shall include all necessary fittings and adapters.

Payment will also include all subsidiary items required for installation such as trench excavations, backfill, site preparation, and removal of water, and concrete collar at joint. Additional fill required to provide adequate cover as needed is included in Earthfill, General.

Construction Specification
000 IA-51 Corrugated Metal Pipe Conduits

1. SCOPE

The work shall consist of furnishing and placing circular, arched or elliptical corrugated metal pipe and the necessary fittings.

2. MATERIALS

Metallic-coated steel corrugated pipe and fittings shall be zinc-coated or aluminized, Type 2, and shall conform to the requirements of ASTM A 760 and A 929 for the specified type and size of pipe. Aluminum corrugated pipe shall conform to the requirements of ASTM B 745 for the specified type and size of pipe. All pipe is subject to the following additional requirements:

1. When polymer coating is specified, pipe, coupling bands and anti-seep collars shall be coated in accordance with ASTM A 762. All riveted joints shall be caulked as described in paragraph B.
2. Pipe with annular corrugations shall be furnished with caulked seams. Riveted pipe joints shall be caulked with a bituminous mastic material during fabrication to provide a watertight joint. All circumferential and longitudinal seams shall be caulked before riveting. This shall be accomplished by applying a uniform bead of the mastic compound to the inner lap surface before riveting such that when the rivets are in place, all voids are filled and a coating of mastic is between the lap surfaces. The inner surface of coupling bands shall be asphalt coated in the field prior to installation. A neoprene gasket having a minimum thickness of 3/8 inch and a minimum width of 7 inches may be used in lieu of mastic coated coupling bands.
3. Welded or lock seams in helical corrugated pipe are considered to be watertight.
4. When close riveted pipe is specified: (1) the pipe shall be fabricated so that the rivet spacing in the circumferential seams shall not exceed 3 inches, except that 12 rivets will be sufficient to secure the circumferential seams in 12-inch pipe, and (2) in those portions of the longitudinal seams that will be covered by the coupling bands, the rivets shall have finished flat heads or the rivets and holes shall be omitted and the seams shall be connected by welding to provide a minimum of obstruction to the seating off the coupling bands.
5. Double riveting or double spot welding of pipe less than 42 inches in diameter may be required. If specified, the riveting or welding shall be done in the manner specified for pipe 42 inches or greater in diameter.

3. COUPLING BANDS

Coupling bands shall meet the requirements of the table below or have detailed drawings submitted for approval by the State Conservation Engineer. Coupling bands shall be of the same minimum thickness (gage) as the pipe being connected.

4. FABRICATION

Fabrication of all appurtenances shall be done as shown on the drawings. All appurtenances shall be made of metallic-coated steel when corrugated steel pipe is used and aluminum when used with aluminum pipe. Dissimilar metals shall not be installed in contact with each other.

Description of Coupling Band	Maximum Fill Height, Ft.	Maximum Pipe Diam., In.
24-inch wide coupling band with four 1/2-inch Diam. galvanized rods with tank lugs for annular or helical corrugated metal pipe. Bands shall have a minimum lap of 3 inches.	All	All
Hugger band from Armco Steel Corp. for helical corrugated metal pipe with reformed ends; and for annular corrugated pipe. Bands include O-ring gaskets and two 1/2-inch Diam.	35	48
Hugger band without rods and lugs but	20	24
Angles riveted or welded to a coupling band and drawn tight with bolts. Bands shall be a minimum of 7 corrugations wide and have a minimum lap of 2 inches.	35	15
Flanged couplings for helical corrugated 25 12 pipe welded to the ends of the pipe and field assembled by a minimum of 3/8-inch Diam. bolts. A joint sealer shall be placed between the flanges to ensure water tightness	25	12
1/ Use is limited to sites where soft foundation and conduit elongation is not anticipated.		

5. REPAIR OF DAMAGED COATINGS

The Contractor shall place the pipe without damaging the pipe or coatings. The pipe shall be transported and handled in a manner to prevent damage to the pipe or coating. Breaks, scuffs, or other damage to the various coatings shall be repaired as follows:

1. Metallic Coating - by thoroughly wire brushing the damaged area and cleaning with solvent, and then painting two coats of one of the following paints:
   a. Zinc Dust - Zinc Oxide Primer conforming to ASTM D 79 and D 520.
   b. Single package, moisture cured urethane prime in silver metallic color.
   c. Zinc-rich cold galvanized compound, brush, or aerosol applications.
2. Polymer Coating - apply two coats of polymer material similar to and compatible with the durability, adhesion and appearance of the original polymer coating. The repair coating shall be a minimum thickness of 0.010 (10 mils) after drying and shall bond securely to the pipe.

6. LAYING AND BEDDING THE PIPE

The pipe shall be laid to the line and grade shown on the drawings and shall be firmly and uniformly bedded throughout its entire length. Details of the bedding are as shown on the drawings.

The pipe shall be laid with the outside laps of circumferential joints pointing upstream and with longitudinal laps on the sides at approximately the vertical mid-height of the pipe. Field welding of corrugated galvanized steel pipe will not be permitted. The pipe sections shall be joined with coupling bands.

7. BACKFILLING

Special care shall be taken during backfill operations not to disturb the grade and alignment.

The pipe shall be tied down or loaded sufficiently during backfilling around the sides to prevent its being lifted from the bedding.

Backfill material shall have sufficient moisture so that optimum compaction can be obtained. Backfill around the pipe shall be placed in layers not more than 4 inches thick before compaction.

Each layer of backfill shall be compacted with power tampers, hand tampers, or plate vibrators to the same density requirements as specified for the adjacent embankment. Backfill over and around the pipe shall be brought up uniformly on all sides. The passage of earth moving equipment will not be allowed over the pipe until backfill has been placed above the top of the pipe surface to a depth of two (2) feet.

8. SPECIFIC SITE REQUIREMENTS

A. Measurement and Payment

Compensation for any work item described in the contract documents but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and bid items to which they are made subsidiary are identified in Items of Work and Construction Details section of this specification.

For items of work which lump sum prices are established in the contract, the quantity of work will not be measured for payment. Payment for each item will be made at the contract lump sum price and will constitute full compensation for completion of the work.

For items of work for which specific unit prices are established in the contract, the payment will be made based on the approved quantity measured by the engineer or weight tickets. Payment will constitute full compensation of the work completed as defined by each work item.

B. Items of Work and Construction Details

"**24" Aluminized CMP Drawdown Riser, 12 GA":**

1. Bid Item No. 23

This item includes costs for the material and installation of 24-inch aluminized CMP drawdown structure riser pipe, trash rack, and base a detailed. Riser shall be 12 GA aluminized CMP with 2 2/3" x ½" corrugations.

"**48" CMP Water Control Structure":**

2. Bid Item No. 24

This item will consist of providing and installing the water control structure, stop logs, and concrete base as shown on the drawings.

Provide detailed shop drawings of the water control structure and all appurtenances. Contractor shall furnish two metal lifting rods with hook end and handles capable of lifting supplied stop logs while standing on the surface above the drawdown structure. The length of the lifting rod shall allow for storage in the drawdown structure while allowing for reaching the lower stop log. Structure shall be CRCS 12GA aluminized CMP with 2 2/3" x ½" corrugations.

Measurement and payment for water control structure shall be on a lump sum basis. Subsidiary items include concrete base, excavation and backfill, and control of water.

"18" CMP Wetland Drawdown Outlet Pipe. 14GA":

3. Bid Item No. 25

This item will consist of providing and installing the CMP drawdown outlet pipe as shown on the drawings.

The corrugated metal outlet pipe shall be 14 gauge, closed riveted caulk seam (CRCS) round pipe with 2-2/3" and 1/2" annular corrugation and shall conform to ASTM A760. Pipe shall be Aluminized.

Installation shall include anti-seep collars or filter diaphragm and filter diaphragm outlet as shown on the drawings.

Measurement and payment shall be on an installed linear foot basis.

Subsidiary items include water-tight coupling bands, anti-seep collars or drainage diaphragm, rodent guard, excavation and backfill, and control of water.

"18" Aluminized CMP Flared End Section":

1. Bid Item No. 26

This item will consist of furnishing and installation of the flared end section and reinforced concrete footings as shown on the plans for the drawdown pipe outlet.

Payment will constitute full compensation for this lump sum bid item and related subsidiary items.

"8" CMP Tile Outlets (20 LF Each)":

2. Bid Item No. 27

This item will consist of furnishing and installing the 8" CMP pipe and fittings shown on the plans for tile outlets, including animal guard at outlet end of pipe.

The corrugated metal pipe shall be 16-gauge minimum, aluminum coated with annular or helical corrugations.

Connect dissimilar pipes with manufactured adapters or couplings if available. A concrete collar shall be used as shown on the plans. Connections shall be watertight.

Installation shall be so at least two-thirds of the outlet pipe shall be buried in the ditch bank, and the cantilever section must extend to the toe of the ditch side slope or the side slope protected from erosion.

Measurement and payment shall be on an installed foot basis will constitute full compensation for this bid item and related subsidiary items.

Payment will constitute full compensation for the following related items: Pollution Control, Removal of Water, Animal Guard, Riprap, and Geotechnical Fabric.

"10" CMP Tile Outlets (20 LF Each)":

3. Bid Item No. 28

This item will consist of furnishing and installing the 10" CMP pipe and fittings shown on the plans for tile outlets, including animal guard at outlet end of pipe.

The corrugated metal pipe shall be 16-gauge minimum, aluminum coated with annular or helical corrugations.

Connect dissimilar pipes with manufactured adapters or couplings if available. A concrete collar shall be used as shown on the plans. Connections shall be watertight.

Installation shall be so at least two-thirds of the outlet pipe shall be buried in the ditch bank, and the cantilever section must extend to the toe of the ditch side slope or the side slope protected from erosion.

Measurement and payment shall be on an installed foot basis will constitute full compensation for this bid item and related subsidiary items.

Payment will constitute full compensation for the following related items: Pollution Control, Removal of Water, Animal Guard, Riprap, and Geotechnical Fabric.

1. Subsidiary Item - CMP Animal Guard

This item will consist of furnishing and installing the CMP animal guard, for each size tile such as AgriDrain RG series or IDALS approved equal.

No separate payment will be made for the CMP animal guard. Compensation for this item shall be included in the payment for CRCS and CMP tile outlet pipes.

2. Subsidiary Item - Corrugated Metal Water-tight Coupling Bands

This item will consist of furnishing and installing the corrugated metal coupling bands for connections of all pipe sections and structure stubouts.

No separate payment will be made for the CMP coupling bands. Compensation for this item shall be included in the payment for CRCS metal outlet pipe.

Construction Specification
000 IA-61 Loose Rock Riprap

1. SCOPE

The work shall consist of the construction of loose rock riprap revetments, structures and blankets, including filter layers or bedding where specified.

2. MATERIALS

Rock for loose rock riprap, filter layers or bedding shall come from sources approved by NRCS. The rock shall be excavated, selected and handled as necessary to meet the quality and grading requirements of this specification and the construction drawings.

Individual rock fragments shall be dense, sound and free from cracks, seams and other defects conducive to accelerated weathering. The rock fragments shall be angular to sub rounded in shape. The least dimension of an individual rock fragment shall not be less than 1/3 the greatest dimension of the fragment unless otherwise specified on the construction drawings.

3. SUBGRADE PREPARATION

The subgrade surfaces on which the riprap or bedding is to be placed shall be cut or filled and graded to the lines and grades shown on the drawings. When fill to subgrade lines is required, it shall consist of approved materials and shall be compacted to a density equal to the adjacent existing soil material.

Rock materials shall not be placed until the foundation preparation is completed and the subgrade surfaces have been inspected and approved by NRCS.

4. EQUIPMENT-PLACED ROCK RIPRAP

Rock shall be placed by equipment on the surfaces and to the depths specified. The riprap shall be constructed to the full thickness in one operation and in such a manner as to avoid serious displacement of the underlying materials. The rock shall be delivered and placed in a manner that will ensure that the riprap in place shall be reasonably homogeneous with the larger rocks uniformly distributed and firmly in contact, one to another, with the smaller rocks and spalls filling the voids between the larger rocks. Placement of rock shall begin at the bottom of the slope or downstream end of the structure.

Riprap shall be placed in a manner to prevent damage to structures. Hand placing will be required to the extent necessary to prevent damage to adjacent structures.

5. HAND-PLACED RIPRAP

Rock shall be placed by hand on the surfaces and to the depths specified. It shall be securely bedded with the larger rocks firmly in contact, one to another. Spaces between the larger rocks shall be filled with smaller rocks and spalls. Smaller rocks shall not be grouped as a substitute for larger rock. Flat slab rock shall be laid on edge unless otherwise specified. Placement of rock shall begin at the bottom of the slope or downstream end of the structure.

6. FILTER LAYERS OR BEDDING

When the drawings specify filter layers or bedding beneath riprap, the filter or bedding material shall be spread uniformly on the prepared subgrade surfaces to the depth specified. Compaction of filter layers or

bedding will not be required, but the surface of such layers shall be finished reasonably free of mounds, dips or windrows.

7. SPECIFIC SITE REQUIREMENTS

A. Measurement and Payment

Compensation for any work item described in the contract documents but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and bid items to which they are made subsidiary are identified in Items of Work and Construction Details section of this specification.

For items of work which lump sum prices are established in the contract, the quantity of work will not be measured for payment. Payment for each item will be made at the contract lump sum price and will constitute full compensation for completion of the work.

For items of work for which specific unit prices are established in the contract, the payment will be made based on the approved quantity measured by the engineer or weight tickets. Payment will constitute full compensation of the work completed as defined by each work item.

B. Items of Work and Construction Details

"Rip Rap":

1. Bid Item No. 29

This item shall consist of furnishing and placing the rock riprap in the locations as shown on the drawings.

Rock shall be Class E Revetment Stone as defined by Iowa Department of Transportation (DOT). Quantity determination is based on a unit on a unit weight of 110 pounds per cubic foot.

Weigh tickets shall be provided to the Engineer for all rock.

All riprap shall be screened by running the stone over a grizzly or plate screen with a minimum opening of 8 inches. This operation shall be done at the quarry. The portion of the stone that is removed by the screening operation will not be acceptable for use as riprap.

Payment will be based on actual tonnage delivered to the site based on weight tickets to the nearest 0.1 ton, subject to the approval of the engineer.

Payment will constitute full compensation for the following related subsidiary items: Pollution Control, Removal of Water, Structure Excavation and Geotextile Fabric.

“Macadam Stone”:

2. Bid Item No. 30

This item shall consist of furnishing and placing the macadam stone in the locations as shown on the drawings.

Rock shall be Macadam Stone as defined by Iowa Department of Transportation (DOT). Quantity determination is based on a unit on a unit weight of 135 pounds per cubic foot.

Weigh tickets shall be provided to the Engineer for all rock.

Payment will be based on actual tonnage delivered to the site based on weight tickets to the nearest 0.1 ton, subject to the approval of the engineer.

“2” Clean Stone”:

3. Bid Item No. 31

This item shall consist of installing erosion stone at the locations shown in the drawings.

Erosion stone must meet the Iowa DOT Specifications 4130 to be considered acceptable. Quantity determination is based on a unit on a unit weight of 130 pounds per cubic foot.

Weigh tickets shall be provided to the Engineer for all rock.

Erosion stone gradation should be with a nominal size of 6 inches, with 100% passing the 9 inch screen and 100% being retained by the 3 inch screen.

Payment will be based on actual tonnage delivered to the site based on weight tickets, to the nearest 0.1 ton, subject to the approval of the engineer.

4. Subsidiary Item - Geotextile Fabric

Geotextile Fabric, IA-95

Construction Specification
000 IA-62 Concrete Grout for Riprap

1. SCOPE

The work shall consist of furnishing, transporting, and placing concrete grout in the construction of grouted rock riprap sections as shown on the drawings.

2. MATERIALS

Cement shall be Type I or Type II Portland cement conforming to ASTM C 150. Fly ash shall be in strict compliance with ASTM C 618, Class F or C. It may be used as a partial substitution for Portland cement for amounts not to exceed 20 percent of the total amount of cementitious material in the grout. The loss by ignition shall not exceed 4.0 percent. Fine aggregate shall conform to ASTM C 33 and shall be composed of clean, uncoated grains of material. Water shall be clean and free of harmful chemicals. Air entraining admixtures shall conform to ASTM C 260.

3. GROUT MIX

The grout mix shall be as follows:

1.	Cement:	10 sacks or 940 pounds per cubic yard
2.	Fine concrete aggregate:	2,100 pounds per cubic yard
3.	Water:	45 gallons per cubic yard or enough to provide a thick creamy consistency
4.	Air content:	6 to 10 percent.

When ready-mixed grout is furnished, the contractor shall furnish to NRCS a delivery ticket showing the time of loading and the quantities of materials used for each load of grout mix.

No mixing water in excess of the amount called for in the grout mix shall be added during mixing, hauling or after arrival of the mix at the delivery point.

4. CONVEYING AND PLACING

Grout mix shall be delivered to the site and placed within 1 1/2 hours after the introduction of the cement to the aggregates. In hot weather or under conditions contributing to quick setup of the grout mix, discharge of the concrete shall be accomplished in 45 minutes unless a set-retarding admixture is used, in which case the manufacturer's recommended time limit will apply.

Grout mix shall not be dropped more than 5 feet vertically unless suitable equipment is used to prevent segregation.

The grout mix shall not be placed until the rock riprap has been inspected and approved.

Rock to be grouted shall be kept wet for at least 2 hours immediately prior to grouting. Grout shall not be placed in standing or flowing water.

The grout shall be consolidated by spading or mechanical vibration. The grout shall not be forced to flow laterally to its final location.

The average rate of grout application shall be 5.4 cubic feet per square yard of riprap (0.6 cubic feet per square foot).

5. CURING CONCRETE

Concrete shall be cured for 7 days by either:

1. Applying white pigmented curing compound at a rate of 1 gallon per 150 square feet or as recommended by the manufacturer.
2. Water soak exposed surface for the entire 7 days.
3. Cover with burlap, mats or other material and maintain in a moist condition.
4. Cover with four (4) mil plastic sheeting while concrete is still wet.

Grout mix shall not be placed when daily minimum temperatures are expected to be lower than 40 degrees F unless facilities are provided to maintain the temperature of the materials at 50 to 90 degrees F during the placement and curing period. Grout may not be placed on frozen surfaces. When freezing conditions are expected, rock shall be heated to 50 to 90 degrees F for at least 24 hours prior to placing grout.

6. SPECIFIC SITE REQUIREMENTS

A. Measurement and Payment

Compensation for any work item described in the contract documents but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and bid items to which they are made subsidiary are identified in Items of Work and Construction Details section of this specification.

For items of work which lump sum prices are established in the contract, the quantity of work will not be measured for payment. Payment for each item will be made at the contract lump sum price and will constitute full compensation for completion of the work.

For items of work for which specific unit prices are established in the contract, the payment will be made based on the approved quantity measured by the engineer or weight tickets. Payment will constitute full compensation of the work completed as defined by each work item.

B. Items of Work and Construction Details

“Concrete Grout”:

1. Bid Item No. 32

This item shall consist of furnishing and placing concrete grout on those portions of the riprap shown on the drawings.

The grout shall be consolidated into the voids with the use of a concrete vibrator. The average rate of grout application shall be adjusted to ensure that the voids are properly filled through the entire riprap depth. A smooth surface is not to be created by the grouting operation.

Grout shall be placed in contact with the downstream sheet pile over the full depth of riprap. There shall be no voids against the sheet pile. Grout against sheet pile upstream shall be smooth.

Grouting operation shall not be performed except in the presence of the Engineer or Engineer's Representative.

Grout unused or wasted, including any partial batch remaining at the completion of the operation, will be estimated and deducted by the Engineer from the volume for payment.

Payment will constitute full compensation for the following related subsidiary items: Pollution Control; and Removal of Water.

Construction Specification
000 IA-81 Metal Fabrication and Installation

1. SCOPE

The work shall consist of furnishing, fabricating, and installing metalwork including metal parts of composite structures.

2. MATERIALS

Steel shall be of structural quality. Finished surfaces shall be smooth and true to assure proper fit. Bolts, nuts, washers, rods, rivets, etc., shall be of a material equal to the steel being fastened.

3. PROTECTIVE COATINGS

Protective coatings will consist of either galvanizing or painting and shall be applied by the fabricator.

Galvanizing shall consist of a zinc coating by the hot dip process, except that bolts, nuts, and washers may have a electrodeposited zinc coating.

Paint System for this specification shall consist of the application of one coat of Epoxy Polyamide Primer (lead and chromate free) and one or more coats of Epoxy Polyamide (intermediate or finish), lead free. When finished, it will have a minimum dry film thickness of 8.0 mils.

4. FABRICATION

Materials shall be carefully fabricated as shown on the drawings. The fabrication shall be smooth and true to assure proper fit. Galvanized items shall not be cut, welded, or drilled after the zinc coating is applied.

5. ERECTION

The metal shall be erected true and plumb, closely conforming to the drawings.

6. SPECIFIC SITE REQUIREMENTS

A. Measurement and Payment

Compensation for any work item described in the contract documents but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and bid items to which they are made subsidiary are identified in Items of Work and Construction Details section of this specification.

For items of work which lump sum prices are established in the contract, the quantity of work will not be measured for payment. Payment for each item will be made at the contract lump sum price and will constitute full compensation for completion of the work.

For items of work for which specific unit prices are established in the contract, the payment will be made based on the approved quantity measured by the engineer or weight tickets. Payment will constitute full compensation of the work completed as defined by each work item.

B. Items of Work and Construction Details

1. Subsidiary Item - Steel

This item will consist of furnishings and installing the steel channel pieces used to form the crest of the sheet pile weir (waler), reinforcing, and steel used for fabrication of the stoplog channel, and steel grating used in covering the water control structure.

Bolts, nuts and washers required for installation shall be included and considered incidental.

No separate payment will be made for steel. Payment for this item will be considered subsidiary to Steel Sheet Pile and the Water Control Structure.

Construction Specification
000 IA-95 Geotextile

1. SCOPE

This work shall consist of furnishing all materials, equipment, and labor necessary for the installation of geotextile.

2. MATERIAL QUALITY

Geotextile shall be manufactured from synthetic long chain or continuous polymeric filaments or yarns, having a composition of at least 95 percent, by weight, of polypropylene, polyester or polyvinylidene chloride. The geotextile shall be formed into a stable network of filaments or yarns that retain their relative position to each other, are inert to commonly encountered chemicals and are resistant to ultraviolet light, heat, hydrocarbons, mildew, rodents and insects. Unless otherwise specified, the class and type of geotextile shall be as shown on the drawings and shall meet the requirements for materials that follow:

1. Woven Geotextile shall conform to the physical properties listed in Table 1. The woven geotextile shall be manufactured from monofilament yarns that are woven into a uniform pattern with distinct and measurable openings. The geotextile shall be manufactured so that the yarns will retain their relative position with regard to each other. The yarns shall contain stabilizers and/or inhibitors to enhance their resistance to ultraviolet light or heat exposure. The edges of the material shall be salvaged or otherwise finished to prevent the outer yarn from unraveling.
2. Nonwoven Geotextile shall conform to the physical properties listed in Table 2. Nonwoven geotextile shall be manufactured from randomly oriented fibers that have been mechanically bonded together by the needle-punched process. In addition, one side may be slightly heat bonded. Thermally bonded, nonwoven geotextile, in addition to mechanically bonded, nonwoven geotextile, may be used for Road Stabilization. The filaments shall contain stabilizers and/or inhibitors to enhance their resistance to ultraviolet light or heat exposure.
3. The geotextile shall be shipped in rolls wrapped with a protective covering to keep out mud, dirt, dust, debris and direct sunlight. Each roll of geotextile shall be clearly marked to identify the brand, type and production run.

3. STORAGE

Prior to use, the geotextile shall be stored in a clean dry place, out of direct sunlight, not subject to extremes of either hot or cold, and with the manufacturer's protective cover in place. Receiving, storage, and handling at the job site shall be in accordance with the requirements in ASTM D 4873.

4. SURFACE PREPARATION

The surface on which the geotextile is to be placed shall be graded to the neat lines and grades as shown on the drawings. The surface shall be reasonably smooth and free of loose rock and clods, holes, depressions, projections, muddy conditions and standing or flowing water (unless otherwise shown on the drawings).

5. PLACEMENT

Prior to placement of the geotextile, the soil surface will be inspected for quality assurance of design and construction. The geotextile shall be placed on the approved prepared surface at the locations and in accordance with the details shown on the drawings. The geotextile shall be unrolled along the placement area and loosely laid (not stretched) in such a manner that it will conform to the surface irregularities

when material is placed on or against it. The geotextile may be folded and overlapped to permit proper placement in the designated area.

The geotextile shall be joined by overlapping a minimum of 18 inches (unless otherwise specified), and secured against the underlying foundation material. Securing pins, approved and provided by the geotextile manufacturer, shall be placed along the edge of the panel or roll material to adequately hold it in place during installation. Pins shall be steel or fiberglass formed as a “U”, “L”, or “T” shape or contain “ears” to prevent total penetration. Steel washers shall be provided on all but the “U” shaped pins. The upstream or up-slope geotextile shall overlap the abutting down-slope geotextile. At vertical laps, securing Natural Resources Conservation Service pins shall be inserted through both layers along a line through approximately the midpoint of the overlap. At horizontal laps and across slope laps, securing pins shall be inserted through the bottom layer only. Securing pins shall be placed along a line approximately 2 inches in from edge of the of the placed geotextile at intervals not to exceed 12 feet unless otherwise specified. Additional pins shall be installed as necessary and where appropriate, to prevent any undue slippage or movement of the geotextile. The use of securing pins will be held to the minimum necessary. Pins are to be left in place unless otherwise specified.

Should the geotextile be torn or punctured, or the overlaps disturbed, as evidenced by visible geotextile damage, subgrade pumping, intrusion, or grade distortion, the backfill around the damaged or displaced area shall be removed and restored to the original approved condition. The repair shall consist of a patch of the same type of geotextile being used, overlaying the existing geotextile. The patch shall extend a minimum of 2 feet from the edge of any damaged area.

The geotextile shall not be placed until it can be anchored and protected with the specified covering within 48 hours or protected from exposure to ultraviolet light. Geotextile shall be placed in accordance with the following applicable specification according to the use indicated in drawings:

Slope protection – Class I or II as indicated in Tables 1 and 2.

The geotextile shall not be placed until it can be anchored and protected with the specified covering within 48 hours or protected from exposure to ultraviolet light. Rock shall not be pushed or rolled over the geotextile.

Class I, unprotected – limit height for dropping stone onto bare geotextile to 3 feet.

Class II, protected – require the use of 6 inches a clean pit-run gravel over the geotextile to cushion the stone and limit the height of drop to 3 feet.

On slopes with strong seepage flow, the geotextile must be in intimate contact with the soil to prevent erosion of the soil surface. Use 6 inches of a clean pit-run gravel over the geotextile to hold it in place and minimize voids under the riprap. Embedment of the geotextile in a trench to form a cutoff at regular intervals down the slope will prevent erosion under the fabric. Place cutoffs more closely together in highly erodible soils and wider apart in more stable soils

Subsurface drains – Class III as indicated in Tables 1 and 2.

The geotextile shall not be placed until drainfill or other material can be used to provide cover within the same working day. Drainfill material shall be placed in a manner that prevents damage to the geotextile. In no case shall material be dropped on uncovered geotextile from a height of more than 5 feet.

Road stabilization – Class IV as indicated in Tables 1 and 2.

The geotextile shall be unrolled in a direction parallel to the roadway centerline in a loose manner permitting conformation to the surface irregularities when the roadway fill material is placed on its surface. In no case shall material be dropped on uncovered geotextile from a height of more than 5 feet. Unless otherwise specified, the minimum overlap of geotextile panels joined without sewing shall be 24 inches.

The geotextile may be temporarily secured with pins recommended or provided by the manufacturer, but they shall be removed before the permanent covering material is placed.

Table 1. Requirements for Woven Geotextiles[1/]

Property	Test Method	Class I	Class II	Class III	Class IV
Grab tensile strength (pounds)	ASTM D4632	247 minimum	180 minimum	180 minimum	315 minimum
Elongation at failure (%)	ASTM D4632	< 50	< 50	< 50	< 50
Trapezoidal tear strength (pounds)	ASTM D4533	90 minimum	67 minimum	67 minimum	112 minimum
Puncture strength (pounds)	ASTM D6241	495 minimum	371 minimum	371 minimum	618 minimum
Ultraviolet light (% retained strength)	ASTM D4355	50 minimum	50 minimum	50 minimum	70 minimum
Permittivity (sec^{-1})	ASTM D4491	as specified			
Apparent opening size (AOS)[2/]	ASTM D4751	as specified			
Percent open area (POA)(%)	USACE [3/]CWO-02215-86	as specified			

[1/] All values are minimum average roll values (MARV) in the weakest principal direction, unless otherwise noted.

[2/] Maximum average roll value.

[3/] Note: CWO is a USACE reference.

Table 2. Requirements for Nonwoven Geotextiles[1/]

Property	Test Method	Class I[2/]	Class II[2/]	Class III[2/]	Class IV[2/]
Grab tensile strength (pounds)	ASTM D4632 grab test	202 minimum	157 minimum	112 minimum	202 minimum
Elongation at failure (%)	ASTM D4632	50 minimum	50 minimum	50 minimum	50 minimum
Trapezoidal tear strength (pounds)	ASTM D4533	79 minimum	56 minimum	40 minimum	79 minimum
Puncture strength (pounds)	ASTM D6241	433 minimum	309 minimum	223 minimum	433 minimum
Ultraviolet light (% retained strength)	ASTM D4355	50 minimum	50 minimum	50 minimum	50 minimum
Permittivity (sec^{-1})	ASTM D4491	0.7 minimum or as specified			
Apparent opening size (AOS)[3/]	ASTM D4751	0.22 minimum or as specified			

[1/] All values are minimum average roll values (MARV) in the weakest principal direction, unless otherwise noted.

[2/] Needle punched geotextiles may be used for all classes. Heat-bonded or resin-bonded geotextiles may be used for class IV only.

[3/] Maximum average roll value.

6. SPECIFIC SITE REQUIREMENTS

A. Measurement and Payment

Compensation for any work item described in the contract documents but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and bid items to which they are made subsidiary are identified in Items of Work and Construction Details section of this specification.

For items of work which lump sum prices are established in the contract, the quantity of work will not be measured for payment. Payment for each item will be made at the contract lump sum price and will constitute full compensation for completion of the work.

For items of work for which specific unit prices are established in the contract, the payment will be made based on the approved quantity measured by the engineer or weight tickets. Payment will constitute full compensation of the work completed as defined by each work item.

B. Items of Work and Construction Details

1. Subsidiary Item - Geotextile

This item shall consist of furnishing and placing geotextile on all surfaces that contact the rock riprap as shown on the drawings and at concrete aprons.

Geotextiles shall conform to the requirements of IDOT Engineering Fabric for embankment erosion control.

The geotextile shall be placed with the long dimension parallel to the channel.

No separate payment will be made for geotextile. Compensation of this item will be included in the payment for the related bid item, Riprap.

INTENDED USE OF FENCE

Fences are constructed as barriers to control the movement of animals and people, including vehicles. Fences may be designed or installed for permanent or temporary use.

The type and class of livestock as well as the degree of control needed will have a specific influence in the type of fence selected to perform its intended function. The number and spacing of fence wires, the spacing of vertical stays (for woven wire fence), and the height of the fence as well as the need for an electric component to the system should all be considered in the planning process.

Permanent fencing is intended to be in place for long periods of time with minimum maintenance requirements; therefore, it should be built with durable materials and constructed to endure a longer life span. Permanent fences are most often used for exterior of grazing systems, property boundaries, or where animals or humans are prohibited.

Temporary or moveable fences are designed to be in place for short periods of time. Temporary fences are best used as subdivision fences for frequent movement or control of animals and where the exact location of the fence may not be the same from time to time. This fencing offers maximum flexibility in rotational stocking systems for subdividing pastures to enhance grazing efficiency, livestock movement, and afford temporary stream and riparian protection.

Fence Type or Style

Specifications for wire for all fence types are listed in Table 3 – Wire Specifications of this document.

Barbed wire fence is commonly used as a multi strand permanent fencing material for perimeter fences, land use boundaries, exclusion, and livestock containment and isolation areas as well as interior cross fencing to facilitate grazing management. Barbed wire fencing is generally not recommended for horses, sheep, goats, hogs, poultry, and ratites.

Woven wire fences consist of a series of horizontal (line) wires and vertical (stay) wires and are offered in two main types including “hinge joint” and “continuous stay fixed knot.” All woven wire fences will meet ASTM A116 Woven Wire Fence requirements.

In a hinge joint woven wire fence the vertical stays wrap around the line wires. In a continuous stay fixed knot fence the vertical stay wires are fixed with another separate wire to the line wire. Both come in various designs (line and stay spacing), tensile strength grades and metallic coating types and grades. High tensile continuous stay fixed knot woven wire may be used for all animals as specified by manufacturer.

Net and mesh wire fences are used as permanent fences for both perimeter and subdivision fences. Wire spacing and height varies depending on the type of livestock or animals being controlled. Follow manufacturer’s recommendation for wire spacing and height based on the goal of the fence.

High tensile smooth wire fence is commonly used as a multi-strand permanent fence for both perimeter and subdivision purposes. It can be used to control almost all animals when properly spaced. Smooth wire may be steel, aluminum or vinyl coated. It can be electrified or non-electrified. Consider using wire with a tensile strength of 200,000 psi for non-electric.

Electric fences may be permanent or temporary. The electrical power source can be from electrical current (110 v or 220 v) or battery. Batteries may be re-charged by solar or electrical power. Livestock must be trained to respect electric fence. Follow guidance from the manufacturer of the electric fence charger to train livestock to electric fence when introducing livestock to electric fence.

Board fences are usually wood or composite material used for permanent and subdivision purposes. Board fence is used primarily where aesthetics or animal safety is of concern and most often used around horses or working facilities.

Other fence types may include chain link, pipe, vinyl, galvanized panel, guard rail, and cable fences. These are commonly used around homesteads and in corrals. They may be used to restrict access to unsafe or prohibited areas.

Heavy use feed area containment fencing is used to control access into and out of feed areas to minimize damage to soil and pasture around these permanent feed sites. This fencing is usually constructed of board, pipe, cable, or high tensile smooth wire built to sustain heavy use by high numbers of livestock around a confined feed area.

Non-conventional fencing includes variations of alternative fence systems that may be acceptable when installed according to manufacturer's recommendations and pre-approved by the grazing/livestock specialist for the area or the Area Resource Conservationist (ARC). Alternative fence systems are often applicable for horses and other animals having special needs.

MATERIALS SPECIFICATIONS

Acceptable fencing criteria for various fencing needs may be selected from Tables 1 and 2, which lists the minimum acceptable fence for livestock species and when people are to be excluded. Table 1 is for permanent fence wire, while table 2 is for temporary fence wire.

The materials used in the construction of a chosen fence type must be of high quality and meet the size, strength, durability, and lifespan requirements found in this specification including Tables 3 - 9.

- Table 3 has minimum wire specifications for different fence types.
- Table 4 includes information for line posts for different fence types along with installation depth requirements.
- Table 5 has specifications for H-brace posts including diameter or posts and depth requirements.
- Table 6 includes brace rail specifications for H-brace or diagonal floating brace.
- Table 7 has requirements for single post braces, which are only allowed for one or two wire high tensile electric fence.
- Table 8 includes maximum distance between anchor posts for different wires.
- Table 9 has specifications for fence components including: energizers, lightning protection (for energizer), electric insulators, underground insulated wire, grounding rods, staples, fasteners, and gates.

Do not notch posts for stabilizing horizontal brace rails as this will increase the chance of wood rot.

All permanent steel posts or pipe used as line posts, brace posts, or rails must be painted or galvanized. If using steel pipe for posts, the top of the pipe must be securely capped. Caps need to be galvanized or painted. Caps must be securely fastened, preferably by welding (paint after) or an adhesive for metals.

Variations of what is presented in this document may be approved if alternatives will meet or exceed current specifications. Sufficient documentation must be presented to the Iowa NRCS State Resource Conservationist.

CONSTRUCTION SPECIFICATIONS

Fence-Line Clearing

Prior to construction, the fence line shall be cleared of any obstruction that would hinder fence placement and operation. Clearing along stream banks will be held to a minimum except as required for stream crossings. The soil surface along the fence line shall be relatively smooth such that placement of the bottom wire does not exceed the specified maximum wire spacing from the soil surface.

Setting end, corner, gate, and brace posts

End, corner, gate, and brace post requirements are outlined in Table 5. Brace rails are outlined in Table 6. End posts requirements for 1 and 2 strand permanent high tensile electric fence are outlined in Table 7.

End, corner, gate, and brace post shall be set and maintained in a position perpendicular to ground level. For end, corner, and gate posts; set posts leaning slightly (1-2" off perpendicular) away from direction of wire tension. On slopes less than 11%, vertical can be substituted for perpendicular.

Posts set with a driver have about 9 times the holding strength of handset posts. If handset, holes will be at least 6" larger than the diameter of the posts and all backfilled material will be thoroughly tamped in layers no thicker than 4 inches. Fill the post hole to the ground surface or mound above the ground if additional soil is available. Steel pipe posts must be set in concrete or driven. See Tables 5 and 7 for requirements.

Concrete backfill is not necessary when posts are driven or handset with proper tamping; however, if used it shall be rodded into place in layers not thicker than 12 inches and shall completely fill the post hole to the ground surface. No stress shall be applied to posts set in concrete for 24 hours. Let concrete set posts cure for 24 hours before assembling brace or attaching wires.

Line Posts

Specifications of line posts are found in Table 4. The maximum spacing of line posts for permanent fences is found in Table 1 and will be the same for all types of posts. **Post spacing may be reduced depending on terrain and pressure from livestock.** Installation shall ensure that adequate fence height is maintained based on its purpose.

Note: Landscaping timbers shall not be used for any post or brace component of a fence system.

Installing Curves

Installing curves in high tensile, woven wire, and barbed wire fences is permissible if the change in direction from one post to the next does not exceed 20 degrees. Posts on curves shall be 5-inch minimum nominal diameter for changes up to 14 degrees and 6-inch minimum nominal diameter for changes up to 20 degrees. Posts on curves should be driven 48 inches deep with 4 inches of lean to the outside of the curve and spaced no closer than 4 feet apart. (In an 8-foot-long section, 14 degrees is approximately 24 inches off straight line and 20 degrees is approx. 35 inches off the straight line).

Line Posts – Stream Crossing

Anchor posts are required on both sides of a stream crossing. For crossings less than 16 feet wide, standard line posts set on both sides will be adequate. For crossings wider than 16 feet, or when non-electrified flood gate is used, a single H-brace assembly or other brace shall be used.

Where needed, flood gates will be attached below bottom wire and will be designed to allow water and debris to pass and still control livestock. Some type of hinged or breakaway floodgate works best.

Posts that are set in low areas or gullies may need to be weighted or anchored to prevent lifting.

Stays or battens between line posts

Stays or wire spacers or battens may be used to maintain desired wire spacing between line posts; note that specifications for post spacing differs with and without stays (Table 1). Stays shall be secured sufficiently to remain in position along wire line.

Offset Brackets

Offset brackets made of galvanized high tensile spring wire with an insulator of high-density polyethylene with ultraviolet stabilizer or porcelain can be attached to standard barbed wire fence or woven wire fence to provide transmission line and /or to protect a standard fence. Other corrosion resistant offset brackets with insulators that attach directly to the fence posts can also be used.

Place offset brackets up to 60 feet apart and attach to wires of standard fence next to post. If control of animals is desired, place offset brackets at 2/3 the height of the animals to be controlled. Make sure no wires of the old fence come in contact of the electric fence wire, as a short will occur. Use offset brackets that hold the electric wire at least 4 inches from the non-electrified fence material.

Post Bracing

Bracing of anchor (pull) posts is required at all corners, gates, fence ends and at definite slope and alignment changes in the fence line. The type of fence, number of fence wires, and length of span will determine the type, size and spacing of bracing required to support a fence. See table 8.

The purpose of bracing is to withstand the forces of the fence load and transfer them to the surrounding soil. They come in several configurations depending on the purpose and number of posts utilized. The minimum length of brace rails is at least 2 times the height of the fence above ground they are supporting.

See Tables 5 and 6 for selection criteria and design specifications of single and double brace assemblies.

Corner braces are required at all points where the fence alignment has a change of 20 degrees or more from one post to the next. (In an 8-foot-long section, 20 degrees is approx. 35 inches off the straight line).

End braces are required where fence ends and on both sides of gate openings and has pull from only one direction.

In–line pull post assemblies are in straight sections of the fence line and where there are sudden changes in elevations, such as at the bottom and top of slopes. Tie off all wires at in-line pull assemblies and start new wires for the next fence section. Posts that are set in low areas or gullies may need to be weighted or anchored to prevent lifting out.

Single post braces may be used with 2 strand or less high tensile electrical wire fence (Table 7).

Brace Rails

Refer to Table 6 for Brace Rail Criteria and Specifications.

- Placement of the horizontal brace rail will be below the top wire of the fence or fence fabric. At a minimum, the brace will be 3 feet above ground.
- The horizontal brace rail will be between 6 feet and 12 feet long.
- The length of the horizontal brace shall be at least 2 times the height of the fence fabric it is supporting. When brace rails are 2½ times the fence height, single H braces may replace double H braces, refer to the appropriate Fence IR drawings.
- The longer the brace rail the stronger the brace. **A single H brace with a 10’ brace rail is strong enough to take the place of a double 8’ H brace.**
- The brace post and anchor posts should be fastened to the compression brace using galvanized brace pins (1/2” X 10” and 1/2” X 4”) (drilled through vertical post and into end of horizontal brace, 2 inches deep).
- Do not notch vertical posts (wood) for stabilizing horizontal brace support. This will increase chance of wood rot and deterioration.

Diagonal Floating Brace Assembly

The diagonal floating brace assembly can be substituted at corner, gate and end post H brace assemblies and in-line pull assemblies. The brace post specifications for diagonal floating brace assemblies are consistent with the specifications in Table 5.

The diagonal floating brace rail specification is found in Table 6. The brace member for the diagonal floating brace shall be installed below the top wire and be at least 2.5 times the length of the height of the top wire.

Brace blocks for the diagonal floating brace shall have a minimum of 225 square inches of top surface area and can be made of a flat rock, solid concrete block, or a paving stone.

Note: Landscaping timbers shall not be used for any post or brace component of a fence system.

Adjoining Fences
A fence adjoining an existing fence must terminate in a brace assembly as required per the fence brace specifications in Table 5, 6, and 7. The anchor post must be a new post when adjoining an existing fence.

Tension of Brace Wires

For brace wires use two complete loops of
12½ gauge HT wire or one loop of 9-gauge soft wire, or a single 3/16" galvanized cable with cable lock.

For horizontal braces, brace wire will be double wrapped and stapled to brace post at a height of just above the brace member and to the anchor (pull) post at a point approximately 2-3 inches above the ground level.

Brace wire will be tightened using a wire tightener, strainer, or tensioner. Another suitable method is to use a twist stick of 18-24" approximately midway along brace wire to provide moderate tension and to remain in place.

INSTALLATION OF WIRE

Barbed and woven wire will be stretched to sufficient tension prior to being fastened to posts. Temperature variations must be considered (wire will tighten in cold weather and expand in hot weather). See wire specification requirements in Table 3.

Tensioning the wire

Woven Wire - In warm weather, wire shall be stretched until 1/3 of the height of the "tension curve" is removed. In cold weather, remove ½ of the tension curve. *Fixed-Knot High Tensile Woven Wire*- The tension crimp should be ½ the size of an un-tensioned crimp.

Barbed Wire - In warm weather, a 100 ft stretch of wire should sag no more than 4 inches in the middle (prior to attaching to posts) and no more than 2 inches in cold weather.

High Tensile Wire – For non-electric, tension should be 250 lbs. for cattle, bison, and horses and 300 lbs. for goats and sheep. For electrified high tensile wire, the tension should be sufficient to maintain the proper average height and spacing of the fence wires.

Tension springs

In-line wire spring-tensioners are designed to indicate lbs. of tension on the line, assuming placement within the line is appropriate. On most fences the use of one tensioner per pull will provide sufficient indication of the tension on adjacent wires.

Springs offer only 3-6 inches of elasticity therefore are of little benefit when something like a tree falls on the wire.

Staples and fasteners

Staples should be installed into post to allow free slippage of wire.

Staples shall be driven diagonally across the grain of the wood and at a slight downward angle (except in dips of landscape) and shall not be driven so tightly as to bind the wire against the post.

Electrically charged smooth wires must be attached to conductive posts with an appropriate ceramic, UV resistant HDPE (High Density Polyethylene) or HDPP (High Density Polypropylene) or tube type plastic reinforced insulators.

For steel line posts, the fencing shall be fastened with either 2 turns of 14-gauge galvanized steel wire or the manufacturer's special wire clips. For all other types of posts, attach as specified by manufacturer.

Tie-off of wire or insulators: High tensile wire is tied off using the "thread through method" (a half hitch and 3 wraps) or with compression sleeves or a wire joiner. A length of high tensile wire is fastened around the groove of the insulator then looped around the post and stapled on opposite side of post. An alternative is the tubular plastic reinforced insulator to prevent cracking of the plastic and grounding of the wire. All insulators must be rated for use with high tensile fence.

Wire attachment to posts

Attaching Fence Wire to Anchor (Pull) Post: For **Barbed wire** fences, wires will be attached to anchor (pull) post by one complete wrap around the post, double stapled (wood posts) or wired (steel posts) and ends tightly wrapped around stretched wire five times. Compression sleeves or wire joiners may be used to connect ends of brace wire.

For **Woven or Mesh wire**, determine amount of wire needed to fully wrap around post once then remove enough vertical stays to provide that length. The wire ends are then attached as described in previous paragraph.

For **High Tensile** wire, the line wires are attached to each anchor post by wrapping the post and securing with a half hitch with 3 wraps, or using appropriate double crimp sleeves or wire joiners.

Fixed-knot woven wire fence shall be stapled to wood anchor post or fastened to steel post at every horizontal wire using manufacturer's special wire clips.

High Tensile wire that pulls through corners or bends may be suspended from the inside of posts in corners and bends using ceramic or appropriate UV resistant HDPE or HDPP donut type plastic high strain insulators. The tubular plastic reinforced high strain insulators can wrap around the outside of bends and corner posts.

Barbed wire shall be attached at each post with 1½ inch staples driven to allow slippage. The top wire shall be at least 2 inches below the top of posts on wood posts and at least 1 inch below the top on steel posts. Wire shall be spaced no more than 12 inches apart and often closer depending on livestock controlled.

Woven wire fencing shall be attached at a minimum to alternate horizontal strands. Staples shall allow slippage.

Post side wire placement: the wire shall be placed on the livestock side of line posts except for curves and bends where it shall be placed on the outside of the posts. HT electric wire may be suspended from the inside of posts in corners and bends using ceramic or appropriate UV resistant HDPE or HDPP plastic donut type insulators. The tubular plastic reinforced high strain insulator can be used on the outside of corners, curves, or bends.

Wire Splicing

There are four basic ways to splice wire:

1. Figure 8 knot



2. Western Union splice



3. Square knot/Reef knot



4. Crimping sleeves or wire joiner (per manufacturer recommendation)

Barbed wire and woven wire shall be spliced by means of a western union splice or by suitable compression sleeves or wire joiner applied with a tool designed for the purpose.

All wires on electrical fence are recommended to have positive electrical charge

It is suggested that all wires on electrical fences be electrified to provide the maximum electrical conductivity and animal deterrent as earth grounding is generally sufficient. If heavy vegetation grows over the bottom wire, it should be fitted to allow it to be switched to a ground wire when needed.

If a hot/ground system is used, all ground wires need grounded. The best grounding will happen when the ground wire is connected to the energizer. In addition, install grounding rods with the grounding/return system. A minimum of three grounding rods are required for each section of grounded wire not connected to the energizer.

Gates

Gates weighing less than 100 lbs may be hung from single end post properly installed. Metal or wood gates more than 6 ft. wide shall best be attached to the pull post of an H-brace or diagonal floating brace.

All gates must be substantial enough to withstand expected pressures from livestock and wildlife.

Electrified perimeter fence gates may consist of a pair of 12½ gauge straight or coiled wires installed to be non-electrified when opened.

Gates between electrical subdivision fences may be composed of polywire, polyrope, polytape or coiled spring connected to insulated handles.

A 12½ gauge overhead or insulated underground transmission line will be used to carry electricity across all gate openings (including electrified gates) to charge the remainder of the fence when the gate is not connected.

Fencing Over Streams and Ditches

Non-electric flood gates should be hinged such that gate will swing with the rising water during storm events. Hanging gates should terminate approximately 6 inches above average normal water level.

An electrified flood gate may be used to minimize debris problems on stream crossings. The electrified flood gate is constructed by stretching an electrified wire across the drainage above high-water flow level. Attach, with compression sleeves, hanging galvanized chains or wire to the electrified wire at a spacing of 6 inches for goats, hogs, and sheep or 12 inches for cattle and horses.

It is advisable to connect the gate to electric fence with double insulated cable through a cut-off switch and flood gate controller. More information is available in Electric Fencing for Serious Graziers by Missouri NRCS.

Stream Bank Protection

Place permanent fencing at least 10 feet from the top of the stream bank and allow for more area in meanders and in areas with bank erosion to minimize corner bracing. Permanent fencing setback distance from drainage ditches should be enough to allow sufficient room for vegetation management and fence maintenance.

Safety

Barbed wire should not be electrified because of safety hazard.

Fence installation can result in painful and serious injury. Wear heavy gauntlet leather gloves to protect hands and wrists, and boots or high-top shoes to protect legs and ankles. Tough, close-fitting clothing will reduce risks of catching on wire. Wear safety glasses to protect eyes from injury. When stretching woven, fixed-knot, or barbed wire, stand on the opposite side of the post from the wire and stretcher unit.

It is dangerous to use a tractor or other vehicle to stretch wire fencing because of potential breaking of the wire resulting in serious injury from the recoil of the clamp bar, chain, or wire. Keep chains and wire stretching clamps in good condition.

Carry staples, nails, or other fasteners in a metal container or in an apron and not in trouser pockets. Do not hold fasteners in mouth which is a common but extremely dangerous habit.

If handling preservative treated posts, do not rub your hands or gloves on your skin. Minimize the inhalation of sawdust.

Electrical fences should be clearly labeled or identified with the appropriate warning signs.

Considerations and helpful hints in construction

1. It is recommended to consult a professional fencing contractor in the planning phase of any fence system.
2. Woven wire for sheep and goats should have vertical stay wires wide enough (9” to 12”) or narrow enough (≤4”) to minimize catching their heads. Otherwise use an electric offset wire to keep animals away from woven wire that might “entangle” them. Offset wires must be at least four inches from the woven wire fence.
3. Never use household electrical wire for any part of an electrified fence. Splicing wires of different metals often results in oxidation and corrosion which causes short circuits and poor conductivity.
4. A digital voltmeter is essential to monitoring and maintaining electrical power fences.
5. Avoid placing electrical fences parallel with telephone as interference may affect call quality.
6. Avoid placing any fences parallel to commercial power lines since static fields can be created and energize the fence. Use grounding on non-electrified fence wires if static electricity is a concern.
7. It is recommended that fences be located 20 feet or more from streams with a maintenance gate to allow for emergency access to water. This distance can also lessen fence maintenance by reducing flood damage.
8. Temporary fencing may be used to protect streambanks while utilizing forage adjacent to the stream.

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Table 1. Permanent Fence Selection Criteria

Fence design and construction must meet the minimum requirements for controlling specific animal types.

Animal Type to Control	Fence Type	Approximate Spacing inches above ground level woven wire fences start 2-4" above the ground	Line Posts and Stay Spacing (Maximum spacing)		
			Posts w/o stays	Posts with stays	Stay Spacing
		Inches	Feet		
Cattle	Barbed 3-wire	18, 28, 38	16½	33	11
Cattle	Barbed 4-wire	14 to 44 evenly spaced	16½	33	11
Cattle	Barbed 5-wire	10 to 46 evenly spaced	16½	33	11
Cattle*	Non-Electric 8-wire high tensile smooth	6 to 48 or higher, spacing can vary	16½	30	15
Cattle	Electric 1-wire high tensile smooth	26-32	100	NA	NA
Cattle	Electric 2-wire high tensile smooth (both hot)	20, 32	100	150	50
Cattle	Electric 3-wire high tensile smooth (min. 2 hot)	18, 30, 42,	50	150	50
Cattle	Electric 4-wire high tensile smooth (min. 2 hot)	12 to 42 evenly spaced	30	90	30
Cattle	Electric 5-wire high tensile smooth (min. 2 hot)	12 to 44 evenly spaced	30	90	30
Cattle	Woven wire (hinge joint) plus one or more HT or barbed top wires	46" min, 6" max between top wires	16½	NA	NA
Cattle	HT woven wire (hinged joint) plus one or more HT or barbed top wires	46" min, 6" max between top wires	16½	NA	NA
Cattle	HT Woven wire (fixed knot)	46" min	16½	NA	NA
Cattle	Wood or Composition 4 board (6" wide)	6, 6, 8, 10 between boards	8	NA	NA
Goats & Sheep#	Electric 3-wire high tensile smooth (all hot)	8, 18, 30	50	150	50
Goats & Sheep#	Electric 4-wire high tensile smooth (all hot)	6 to 36 evenly spaced	50	150	50
Goats & Sheep#	Electric 5-wire high tensile smooth (all hot)	6, 12, 18, 28, 38	30	90	30
Goats & Sheep	Woven wire plus one HTE offset inside	47" min, one HTE offset (optional) set at 2/3 animal ht.	16½	NA	NA
Goats & Sheep	Woven wire plus one or more HT or Barbed top wires to 48"	36 min, 6" max between top wires	16½	NA	NA
Goats & Sheep	HT fixed knot woven wire plus one or more HT or Barbed top wires to 48"	36 min, 6" max between top wires	16½	NA	NA
Horses°	Electric 2-wire high tensile smooth (both hot)	28, 38	100	150	50
Horses°	Electric 3-wire high tensile smooth (min 2 hot)	28, 38, 48	50	150	50
Horses°	Electric 4-wire high tensile smooth (min 2 hot)	18 – 54 evenly spaced, minimum 2 hot	50	150	50
Horses	Woven wire w/1 wire HT on top	48 + HT at 54	16½	NA	NA
Horses	HT woven wire (fixed knot)	60	16½	NA	NA
Horses	Mesh "No climb" 2"x4" spacing	48 + HT at 54"	16½	NA	NA
Horses	Wood or Composition boards (6" wide)	18 min. 12 max. between boards	8	NA	NA
Hogs	Electric 2-wire high tensile smooth (both hot)	6-10, & 16-18	20	30	15
Hogs	Electric 6-wire high tensile smooth (min 2 hot)	6, 12(+), 18(+), 26, 34, 42	20	30	15
Hogs	Woven wire 32" w/ barbed wire	32 + 1 barb above, and one barbed 2" off ground and 2" below woven wire	16½	NA	NA
Hogs	Woven wire 32" w/ 1 HT electric inside	32 + 1barbed or HTE 6" above and one HTE wire 8" off ground, 8" inside of fence.	16½	NA	NA
Hogs	HT woven wire (fixed knot) 32" w/ 1 barb or HTE	35" + 1 HTE offset like above	16½	NA	NA
Deer^	HT woven wire (fixed knot) 96" tall	96"	16½	NA	NA
Deer^	Electric 7-wire High tensile smooth wire slanted	see diagram of slant measurements	30	90	30
Deer^	Electric 9-wire High tensile smooth wire	8, to 72 evenly spaced	30	90	30
Deer^	Electric 12-wire High tensile smooth wire	6, to 72 evenly spaced	30	90	30
Deer^	Electric 15-wire High tensile smooth wire	2, to 96 evenly spaced	30	90	30
Buffalo	Electric 4-wire high tensile smooth	16 to 42 evenly spaced	100	150	50
Buffalo	Electric 5-wire high tensile smooth	16 to 48 evenly spaced	30	90	30
Buffalo	Electric 6-wire high tensile smooth	12 to 52 evenly spaced	30	90	30
Buffalo	HT woven wire (fixed knot)	48	16.5	NA	NA
Buffalo	HT woven wire (fixed knot)	60	16.5	NA	NA

Continued on next page.

Table 1. Permanent Fence Selection Criteria

Fence design and construction must meet the minimum requirements for controlling specific animal types.

Animal Type to Control	Fence Type	Approximate Spacing inches above ground level woven wire fences start 2-4" above the ground	Line Posts and Stay Spacing (Maximum spacing)		
			Posts w/o stays	Posts with stays	Stay Spacing
Chickens/turkey	Woven wire 2"x4" 1 wire HT or barb above	72	16½	NA	NA
Emu and ostrich	Woven wire 6"x6" 1 wire HT or barb above	72	16½	NA	NA
Chickens/turkey	HT Woven wire 2"x4" 1 wire HT or barb above	72	16½	NA	NA
Emu and ostrich	HT Woven wire 6"x6" 1 wire HT or barb above	72	16½	NA	NA
People^	Chain link	60	8	NA	NA
People^	Electric 5-wire	12 to 60 evenly spaced	30	90	30
People^	Woven wire 47 inch plus 1 or 2 barbed wires or HT electric	47 min. HT or barb at 6 spacing to 48. HT may be electrified	16½	NA	NA

Use the information in this table as a guide to determine the number of strands and spacing requirements. Adjustments may be made based on manufacturer's recommendations and landowner preference for containment with NRCS approval.

* Heavy use feed area containment fencing should be built of a suitable material (usually HT smooth wire, pipe, cable, guardrail, or board) and post spacing to endure heavy use around permanent feed areas.

Goats or sheep must be trained to electric fencing then high tensile electric fencing is probably not a good option for the livestock operation.

º Consideration for visibility should be taken when using high tensile fence for horses. Poly coated or vinyl encased wire or rail can be used following manufacturer recommendations for installation.

^ Exclusion fence only

Table 2. Temporary Fence Selection Criteria

Fence design and construction must meet the minimum requirements for controlling specific animal types.

Animal Type to Control	Fence Type[1] (all wires hot)	Typical Spacing Above Ground Level	Line Posts (maximum spacing)
		Inches	**Feet**
Cattle	Electric 1-wire Polywire or Polytape or galvanized steel braided wire	26-36	100
Cattle	Electric 2-wire Polywire or Polytape or galvanized steel braided wire	20, 32	100
Goats/Sheep	Electric 4-wire Polywire or Polytape	8, 16, 24, 32,	60
Goats/Sheep	Electric Net Fencing[3]	0, (minimum 35 inches tall)	built in[4]
Horses	Electric 1-wire Polytape	34	25
Horses	Electric 2-wire Polytape	28, 40	25
Hogs	Electric 2-wire Polywire or Polytape or galvanized steel braded wire	8, 18	40
	Electric Net Fencing[3]	0, (35 inches tall)	built in[4]
Poultry	Electric Net Fencing[3]	0, (minimum 42 inches tall)	built in[4]

[1] Livestock must be trained to respect electric fencing prior to using temporary fence products for complete containment.

[2]Two wires may be needed to prevent young calves from going beneath the fence.

[3]Use electric netting specifically designed for the type of livestock being controlled; it is not suggested for small animals with horns (consider spacing of vertical stays and horizontal lines and fence height).

[4]Line posts are typically built into the rolls of netting near 12.5 feet spacing.

Based on the type of livestock, use the information in this table as a guide to determine the number of strands and spacing for different types of temporary fencing products. Adjustments may be made based on manufacturer's recommendations and landowner's preference and ability to control the livestock. Polywire and Polytape are not intended to be used as permanent or semi-permanent containment fencing. 14-gauge wire may be used for seasonal temporary fence such as when livestock are grazing crop fields after harvest.

Table 3. Wire Specifications

Wire Type	Minimum Wire Size	Minimum Wire Coating/Composition	Wire Strength and Other Considerations	
Barbed, Standard Double Strand (must meet ASTM A121)	12½ gauge (ga.) with 4-point barbs spaced on 5" centers or 2-point barbs on 4" centers	Class 3 zinc coating per ASTM A641-	950 lbs	
Barbed, High-Tensile Double Strand (Gaucho Wire) (must meet ASTM A121)	15½ ga. 4-point barbs or 2-point barbs or 4" centers	Class 3 zinc coating per ASTM-A641	170,000 psi or 950 lbs.	
High Tensile Smooth single strand (must meet ASTM A854)	12½ ga.	Class 3 zinc coating per ASTM-A641	130,000 psi or 1300 lbs.	
High Tensile Vinyl Coated or Polymer Encased Wire	12½ ga.	UV resistant polymer	1,300 lbs per wire or 4,000 lbs per rail	
Galvanized Steel	1.7 mm	Class IV	160 lbs	Can be used for 1 or 2 wire temporary fences
Standard Woven Wire "hinged joint" or continuous stay "fixed knot" (must meet ASTM A116)	Top & Bottom wires: 12½ gauge min. Intermediate wires: 14½ ga.	Class 3 zinc coating per ASTM A641	Horizontal and vertical spacing should be appropriate for animal types. Design numbers of woven fence are related to the characteristics of the fence fabric. For example: 1047-12-12½ has 10 line wires is 47" high has 12" stay wire spacing and is 12½ gauge.	
High Tensile Woven Wire (must meet ASTM A116)	Top & Bottom wires: 12½ gauge min. Intermediate wires: 14½ ga.	Class 3 zinc coating per ASTM A641	175,000 psi on line wires	
Mesh Wire; such as Horse-No-Climb	Top & Bottom wires: 10 gauge Intermediate & Stay Wires: 12½ gauge	Class 3 zinc coating per ASTM A641	At least 48" high, less than or equal to 2-inch x 4-inch mesh spacing.	
Polywire or "Twine" Type	Minimum of 9 strands of aluminum, stainless steel or mixed metal wires	Wires interwoven with polyethylene or polypropylene fiber.	Polywire (twine-type), as compared to polytape is more durable under frequent movement. Polytape is best used where high visibility is needed. Do not use on fences more than 1 mile in length (low-conductivity). Life expectancy is 3-5 years if moved frequently.	
Polytape or Tape-Type	Minimum ½ inch wide and 5 strands of stainless steel or mixed metal wire filaments			
Aluminum	12½ gauge	Aluminum	May be used as one of the wires in a multi-wire fence or as single wire subdivision fence. May be used as lead out cable from Power Energizer to fence.	
Steel wire and hardware used to construct a permanent fence will be new and galvanized material. Not all materials are for permanent or containment fencing, reference Table 1 to ensure the fence material selected is appropriate for the type of fence and the livestock to control.				

Table 4. Line Post Type, Size and Depth Specifications

Fence Type	Post Type	Minimum Diameter/ Weight	Minimum Depth*
Barbed Wire Woven Wire Smooth High Tensile wire non-electrified	Pressure treated wood (Material Spec 585)	3”	24”
	black locust, Osage orange, or red cedar (>50% heartwood)	2½”	
	Steel T posts[1] Steel U posts[1] Steel L posts[1]	1⅜” x 1⅜” x ⅛” thick 2” x 1¼” x 3/32” thick 2” x 2” x ¼” thick All 1¼ lbs. per foot, exclusive of anchor plates	20”
	Steel pipe, galvanized[1,5]	2” outside diameter	20”
Smooth High Tensile wire electrified	Pressure treated wood (Material Spec 585)	3”	24”
	Black locust, Osage orange, or red cedar (>50% heartwood) bb	2½”	
	Steel T posts[1] Steel U posts[1] Steel L posts[1]	1⅜” x 1⅜” x ⅛” thick 2” x 1¼” x 3/32” thick 2” x 2” x ¼” thick All 1¼lbs. per foot, exclusive of anchor plates	16”
	Fiberglass[2,4]	⅝”	16”
	HDPE[3,4]	1⅓” (per manufacturer recommendations)	12”
	Composite[3,4]	1⅛” (per manufacturer recommendations)	16”
	PVC T posts[3,4]	1½”	12”
	Steel pipe, galvanized[1,5]	2” outside diameter	20”
Stays (Battens, Droppers, or Spacers)	Wire stays Composite Fiberglass Steel T post w insulators Wood PVC	12 ga. galvanized for barbed wire 1” ½” Listed above 1½”X1½” 1”	Stays are not always designed to touch the soil surface, but should be sufficient to maintain wire spacing
Temporary Electric Fences	Fiberglass, composite, plastic, PVC, steel rod	⅜”	4”

[1]All steel posts shall be new and painted or galvanized. Steel T posts are not recommended on electric fences without using high quality insulators.
[2]Fiberglass posts should be coated to prevent splintering and cracking.
[3] All HDPE, PVC and composite material must be UV protected.
[4]Fiberglass, composite, PVC and HDPE posts are not to be used in bends, curves or at places in the fence with abrupt changes in elevation.
[5]The top of all steel pipe posts must be securely capped.
*Minimum depth unless specified by manufacturer. If top fence wire is greater than 60 inches minimum depth increases, consult NRCS technical specialist during design for approval prior to construction.

Table 5. H-Brace Pull Post (corner, gate, pull, and end) Specifications

Brace Post Type	Minimum Top Diameter	Depth Anchoring[1]	Other
Pressure treated pine (Material Spec 585) or other wood of suitable strength: red cedar (>50% heartwood), black locust.	6" top diameter (corners, ends, pull posts and gates) 5" top diameter all other wooden brace posts	42" in ground 42" in ground	Minimum post lengths should allow for required buried depth and fence height plus at least 2 inches of post above top wire. Posts will have appropriate treatment to prevent rust and deterioration. The assembly strength of a corner post set 2.5' deep is approximately half compared to a post set at 3.5' deep. A single post brace assembly can be used as bracing for ≤2 HT smooth electric wires. See Table 7.
Steel round pipe – braced[2,3]	2" nominal pipe (2⅜" O.D.); 5 lbs/ft. (Schedule 80)	48" set in 12 in diameter hole with concrete	
	2½" nominal pipe (2⅞" O.D.); 7½ lbs/ft. (Schedule 80)	60" driven	
Steel, angle iron – braced[2]	2½" x 2½" x ¼"	36" set in 12 in diameter hole with concrete	

[1]If top fence wire is greater than 60 inches depth anchoring increases, consult NRCS technical specialist during design for approval prior to construction.
[2]All steel posts shall be new and painted or galvanized.
[3]The top of all steel pipe posts must be securely capped.

Table 6. Brace Rail Specifications for H-Brace or Diagonal[1] Floating Brace

Brace Member Type	Minimum Diameter/ Weight	Typical Length	Other
Pressure treated pine (Material Spec 585) or other wood of suitable strength; red cedar (>50% heartwood), black locust.	4 inches	8-10 feet	Posts will be straight and free of splintering. Posts will have appropriate treatment for rust and deterioration. The wider this brace the stronger the brace. A 10-12' single H brace may replace a standard double 8' H brace.
Galvanized steel pipe[2]	2" nominal pipe (2⅜" O.D.); 5 lbs/ft. (Schedule 80)	8-10 feet	
Steel, angle iron[2]	2½" x 2½" x ¼"	8-10 feet	

[1]Length of the diagonal floating brace rail must be at least 2½ times the height of the top wire.
[2]All steel pipe shall be new and painted or galvanized.

Table 7. Single Post Brace[1] Specifications for 1-2 strands high tensile electric fence only			
Brace Post Type	**Minimum Top Diameter**	**Minimum Depth Anchoring**	**Other**
Steel round pipe or tubular steel[2,3] (galvanized)	2½" outside diameter schedule 40	24" set in 12" diameter hole with concrete	For single wire fences, concrete not needed if posts are driven 3 feet deep
Steel angle iron[2]	2½" x 2½" x ¼"		
Steel[2,3]	4" outside diameter	Depth equal to or greater than height of top wire above ground.	Concrete not needed
Pressure treated pine (Material Spec 585) or other wood of suitable strength; red cedar (>50% heartwood), black locust.	6 inch (post must be driven)		The strength of a corner post set 2½' deep is approximately half as much as for one set 3½' deep.
[1]Single posts as braces should lean approximately 4 inches away from the direction of pull. [2]All steel posts shall be new and painted or galvanized. [3]The top of all steep pipe posts must be securely capped.			

Table 8. Maximum Brace Assembly Spacing (on straight and level pulls)*			
Fence Type	**Distance Between Anchor (pull) Posts (ft.)**	**End / Corner Brace Types**	**Inline Brace Type**
Barbed Wire	0 - 660	Single H or Diagonal Brace Assembly	NA
	660 – 1,320	Double H or Diagonal Brace Assembly[1]	NA
	>1,320	Double H or Diagonal Brace Assembly[1]	Double H-10 ft or Diagonal Brace Assembly
Posts with brace assemblies should not exceed 1,320 feet for standard barbed wire in long sections of fence.			
Smooth HT wire non-electrified or Smooth HT wire - electrified	0 – 1,320	Single H or Diagonal Brace Assembly[2]	NA
	1,320 – 2,640	Double H or Diagonal Brace Assembly[1&2]	NA
	>2,640	Double H or Diagonal Brace Assembly[1&2]	Double H-10 ft or Diagonal Brace Assembly
Posts with brace assemblies should not exceed 2,640 feet for HT smooth wire fences in long sections of fence.			
Standard Woven (net) wire (Hinge Joint)	0 - 330	Single H or Diagonal Brace Assembly	N/A
	330 - 660	Double H or Diagonal Brace Assembly[1]	N/A
	>660	Double H or Diagonal Brace Assembly[1]	Double H-10 ft or Diagonal Brace Assembly
Posts with brace assemblies should not exceed 660 feet for standard WW fences in long sections of fence.			
High Tensile Fixed Knot Woven Wire (Continuous Stay)[3]	0 – 1,320	Double H or Diagonal Brace Assembly[1]	N/A
	>1,320	Double H or Diagonal Brace Assembly[1]	Double H-10 ft or Diagonal Brace Assembly
Posts with brace assemblies should not exceed 1,320 feet for High-Tensile Fixed Knot Woven Wire fences in long sections of fence.			
*The maximum distance between anchor posts of a brace assembly will often be shorter than what is listed in this table due to abrupt changes in topography or fence direction that will require closer brace assembly spacing.			
*All wires must be tied off at in-line pull assemblies and new wires started for the next fence section.			
*Use this information as a guide to determine bracing requirements for the type of fence being constructed. Minor adjustments may be made based on topography and the number or height of fence wires installed with NRCS approval.			

[1]Single H brace with a 10’ – 12’ brace rail can take the place of the standard double 8’ H brace.
[2]Single post brace assembly of suitable diameter can be used for fences with 1-2 strands HT electric wires, see Table 7.
[3]Build HT fixed knot WW fence according to recommendations of the fencing manufacturer.

Table 9. Specifications of other Fence Components	
Component	**Description/Specification**
Electrical Energizers or "Chargers"	• Energizers for permanent electric fencing must be U.L. or CSA approved and manufactured for the purpose of agricultural fencing. • Energizers must ○ be high power ○ be low impedance ○ can produce at least 5,000 volt peak output ○ produce a short pulse less than 300 milliamps (mAmps) in intensity ○ finished within 0.0003 of a second, and ○ pulse at a rate of 35-65 pulses per minute. • It is recommended that the energizer have a fence charge meter • Only one charger is allowed per fence • It is recommended the unit include: ○ high impact self-insulating weather resist case ○ snap-in circuit panel ○ safety pace fuse ○ lightning arrester ○ have full power input and reduced power output • May be solar, 110 or 220 volt, or 12 volt battery units • Solar chargers are required for all battery powered energizers with output of 4 joules or more • OUTPUT Joule rating should be based on: ○ size of fence system ○ type of fence being electrified ○ high enough to provide a minimum shock at the farthest point in the fence. • To control most livestock, it is recommended to maintain fence line voltage ≥ 3,000 volts. Use higher voltage for sheep, goats, and predator control.
Lightning Protection (for energizer)	A properly grounded lightning arrester and a "lightning choke" shall be installed to protect the energizer from lightning strikes. A voltage spike protector is also recommended.
Electrical Insulators	Insulators shall be made of high-quality glazed porcelain or UV resistant HDPE or HDPP plastic manufactured for durability under high tensile strain. UV resistant tubular plastic insulators that wrap around end and corner posts must have a reinforced strip to prevent cracking and grounding under high tensile strain. Galvanized 12½-gauge wire may be used on fiberglass and other non-conductive posts to secure wire to post.
Wire connecting energizer to fence or beneath gate or road	Underground cable (insulated wire) is often used where wires are buried under gates and as leads from the energizer to the fence. Underground cable should be 12½-gauge galvanized or soft steel wire with bonded, high density, ultra-violet stabilized polyethylene or polypropylene or polypropylene insulation. Never use household or underground electrical copper wire with fence energizers. Where underground insulated wire is buried under gates or roads, it is strongly recommended to run the wire through a non-metal conduit (with watertight connections) to decrease the incidence of short circuiting over time.
Ground rod and installation	Ground rods should be 6 to 8 feet long x ½"- 5/8" galvanized steel rod set minimum 10 feet apart and driven to no more than 6" above the ground. The number of ground rods needed is based on a minimum of 3 feet of ground rod per joule of energizer output capacity. All energizers must be grounded sufficiently to test less than 300 Ohms on the last ground rod when the fence is "grounded" 300 feet from energizer. Galvanized ground rods for the fence must be driven into the ground a minimum of 6 feet. If this is impossible, alternative methods of grounding include putting rods in trenches surrounded with Epson Salt or Bentonite. Placing ground rods in damp areas will improve effectiveness. Follow manufacturer's recommendations for grounding the system.
Staples or Fasteners	Staples used to fasten wire to wood post shall be 9-gauge Class 3 galvanized barbed with a minimum length of 1½ inches. For steel line posts, the fencing shall be fastened with 14-gauge galvanized steel wire or the post manufacturer's special wire clips. For all other types of posts, attach as specified by manufacturer.
Gates	Only new materials may be used for gates, and they must be made of suitable material and coated to be durable enough to last 10 years with suitable maintenance. All non-electrified gates must be substantial enough to withstand expected pressures from livestock and wildlife. Gates between electrical subdivision fences may be of polywire, polyrope or coiled spring connected to spring loaded handles.

1. SPECIFIC SITE REQUIREMENTS

A. Measurement and Payment

Compensation for any work item described in the contract documents but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and bid items to which they are made subsidiary are identified in Items of Work and Construction Details section of this specification.

For items of work which lump sum prices are established in the contract, the quantity of work will not be measured for payment. Payment for each item will be made at the contract lump sum price and will constitute full compensation for completion of the work.

For items of work for which specific unit prices are established in the contract, the payment will be made based on the approved quantity measured by the engineer or weight tickets. Payment will constitute full compensation of the work completed as defined by each work item.

B. Items of Work and Construction Details

"Barb-Wired Fence Removal":

1. Bid Item No. 34

This item shall consist of all materials, labor, and equipment required for the proper removal of the existing barbed wire fence.

"Barb-Wired Fence with Gates Installation**":**

2. Bid Item No. 35

This item shall consist of all materials, labor, and equipment required for the proper installation of the barbed wire fence and gates as shown on the plans and described in this document.

Fence shall be installed with five-strand barbed wire fence with the top wire being hot/electric. Gates shall be 16' wide pipe gates.