Pre-Construction Checklist

_____ A pre-construction meeting between the farmer, contractors, suppliers, and inspected personnel recommended. The following checklist may be used to ensure critical items are addressed.

_____ Nutrient Management Plan is available to landowner and approved by certified planner.

_____ Design reviewed and approved by CD, landowner and designer/engineer.

_____ Farmer has a copy of Waste Management Plan and has had an explanation of its content. Farmer understand their role in accomplishing plan.

_____ Farmer and contractors have a copy of:

- _____ Contract Drawings
- _____ Installation sequence and E&S Plan.
- _____ Construction specifications
- _____ Contractor certification upon job completion.
- _____ Other pertinent plans and designs.

_____ Reviewed construction plans with contractor and farmer.

_____ Went over site and problem areas with contractor and farmer.

_____ Laid out facilities.

The contractor and the farmer agree with the above checklist. Construction will start on

Farmer's Signature _____

Contractor's Signature _____

Technician's Signature _____

Contractor's Notification List

The following is a list of key steps in the construction of the project. You are required to notify the Conservation District (CD) at least 24 hours before proceeding with each of the following construction phases. Failure to do so may result in the CD being unable to adequately check construction and verify that the installation meets the standards and specifications for the project.

NOTIFY CD 24 HOURS BEFORE:

Construction Phase:

1. Starting construction
2. Completion of foundation excavation
3. Starting placement of sub-base materials
4. Placement and backfilling of any pipes
5. Placement of floor concrete
6. Placement of concrete walls
7. Backfilling of concrete walls
8. Delivery and setting of trusses
9. Starting timber framing
10. Placement of Access Road and Animal Walkways
11. Final grading
12. Apply seeding to all disturbed area
13. Project completion

The responsibility for notification will be reviewed and individual responsibilities will be assigned at the pre-construction conference.

Prior to the purchase of any materials, certification of their compliance to the specification shall be provided. Certification can be in the form of a signed statement that materials conform or from the markings on the materials themselves. Material literature supplied by the manufacturer usually satisfies the certification requirement. The documentation for material certification shall be provided to the quality assurance representative.

General Notes
Eric Stevens
Luzerne County, Pennsylvania

1. Prepare site, supply and install all components of the Ag Waste Management System to the dimensions, elevations, and locations shown on the drawings. The components of the system include the following:
    a. Roofed Manure Storage Structure
    b. Roof over Heavy Use Area
    c. Heavy Use Area Concrete
    d. Underground Outlets
    e. All excavation and backfilling required to install all components
    f. Seed, lime, fertilize and mulch all disturbed areas
    g. All labor, equipment, tools and other items necessary and incidental to the work.
2. A copy of the specifications and drawings shall be on site during all phases of construction.
3. It is the responsibility of the contractor to implement all measures necessary to protect work-in progress from environmental conditions such as temperature extremes, surface and ground water etc.
4. All critical work that is indicated in the additional conditions shall be done Monday – Friday between the hours of 7:00 am and 3:00 pm unless cleared by the assigned inspector.
5. ONE CALL – It is the responsibility of the **Excavating Contractor** to comply with the provisions of the Pennsylvania One-Call Act (Utility Act) to check for underground utilities before performing any excavation work.
6. Refer to the Contractor's Notification list for the required notification of CD during construction.
7. Refer to and comply with all requirements on the cover sheet of this design.
8. OSHA regulations shall be followed at all times.
9. A pre-construction conference between the landowner, CD, contractors and applicable suppliers is required seven (7) days prior to starting work.
10. The contractor is responsible for the security of the job until the work has been certified by the deign engineer.
11. In the event rock is encountered during excavation, stop excavation and notify CD. CD must be notified in order to determine if or how the rock would be removed.
12. In the event unstable soils or seeps are encountered during excavation, stop excavation and notify CD personnel. CD must be notified in order to determine the quantity of the best method for removing the soil or water, to provide for stable sub-base to build on.

GUIDELINES FOR COLD WEATHER CONCRETING

This document is to be used as a supplement to the current PA Fact Sheet #2—Cold Weather Concreting—ACI 306R-16. This document is intended to provide additional guidance, for cold weather concreting procedures, in the Northeast Counties that receive engineering guidance from the NRCS Bloomsburg Technical Office. This document is only to be used for Heavy Use Area and Stacking Structure type of construction. This document does not apply to "liquid" storage structures (Tanks or Paint Tray Style Storages). Cold weather concreting on "liquid" structures is discouraged and shall be discussed with the NRCS engineering staff in Bloomsburg in detail prior to planning construction.

Cold Weather Concreting shall be discussed at the preconstruction meeting, no matter what time of year the meeting is held and discussed again 2 weeks prior to concrete placement. The landowner shall be involved in these conversations to help make a decision if it is worth the extra expense and effort to provide the added level of protection during cold weather concrete procedures or wait until milder weather.

Roles & Responsibilities:

It is the contractor's responsibility to submit a "Cold Weather Concrete Plan" to the assigned primary inspector for the given project. This plan shall be provided to the inspector at least 2 weeks prior to the concrete placement. The concrete mix design shall also be submitted to the inspector at this time. The primary inspector shall review the submitted Cold Weather Concrete Plan and also the Concrete Design Mix. If revisions to the Cold Weather Plan are required, then the contractor will do so. If changes to the design mix are required, the contractor shall work with the concrete plant to make the needed changes. The revised documents shall be resubmitted to the inspector for further review. Concrete cannot be ordered and construction cannot begin until the inspector approves all submitted documents.

Design Mix:

Concrete with a slump lower than normal (less than 4") is particularly desirable in cold weather for flatwork; bleeding of water is minimized and set occurs earlier. Bleed water, during cold weather, could affect the concrete surface strength. It is assumed that concrete with at least 600 #/cu.yd of cement content is being used for cold weather placement.

Conditions of Subgrade & Reinforcement:

Concrete shall not be placed on "frosty" or frozen subgrade material or reinforcement. The subgrade and reinforcement shall be covered with insulating material for a few days before the concrete placement. In some cases, external heat must be applied. Steel forms for walls, especially, shall be heated by some means prior to concrete placement. There shall not be any snow or ice on the forms prior to placement of concrete. Tops of wall forms shall be covered to prohibit snow and ice from occupying space intended for concrete. Snow and ice at the bottom of the forms will also expose the freshly placed concrete to low temperatures.

Protecting Concrete During Cold Weather:

TABLE 1 shall be used to determine if the Contractor's Cold Weather Concrete Plan is sufficient for the forecasted weather conditions. The table shows what thermal resistance value (R-Value) is required at expected low air temperatures, for any of the first 3 days of the curing period; However, Concrete shall be protected for a minimum of 7 days. It is assumed that the ground (subgrade) temperature is well above freezing.

TABLE 1A -5" SLAB THICKNESS

EXPECTED LOW TEMP FOR 1ST 3 DAYS OF CURING (DEGREES)	REQUIRED R-VALUE (hr-sqft-F/Btu)	REQUIRED SAWDUST (INCHES)	REQUIRED STRAW (INCHES)
40	4	2	3
35	7	3	4.5
30	8	4	5.5
25	9	4.5	6.5
20	11	5	7
<20	ADDITIONAL HEAT REQUIRED ENCLOSURE REQUIRED CONSULT WITH DESIGN ENGINEER		

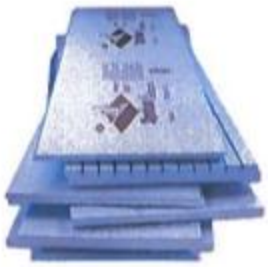
TABLE 1B -8" WALL THICKNESS

EXPECTED LOW TEMP FOR 1ST 3 DAYS OF CURING (DEGREES)	REQUIRED R-VALUE (hr-sqft-F/Btu)
40	3
35	4
30	5
25	6
20	7
<20	ADDITIONAL HEAT REQUIRED ENCLOSURE REQUIRED CONSULT WITH DESIGN ENGINEER

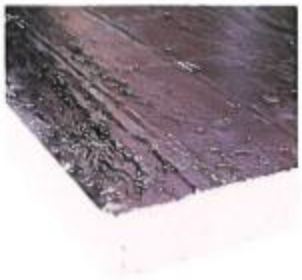
Insulating Materials:

A. Blankets: Concrete "Blankets" typically have an R-Value between 2 & 8; R value of blankets need confirmed prior to use.
B. Polystyrene foam or Polyurethane sheets; R value needs verified according to manufacturer data sheets.

EXPANDED POLYSTYRENE FOAM (EPS)
(Similar to the foam used for for packing "peanuts")
R=3.6 to 4.0 per inch of thickness



EXTRUDED POLYSTYRENE FOAM (XPS)
(Blue board or pink board)
R=4.5-5.0 per inch of thickness



POLYISOCYANURATE / POLYURETHANE BOARD
(Foil Faced)
R=7.0-8.0 per inch of thickness

C. Sawdust: Typical R-Value is 2.22 per 1" thickness
D. Straw or Hay: Typical R-Value is 1.5 per 1" thickness.

Straw, Hay, and Sawdust (Materials) need to be dry. Any moisture in the materials beyond normal may result in it freezing and providing a lesser degree of protection. If using these materials for flatwork protection; a layer of plastic shall be installed on the concrete surface prior to the material. After the required thickness of the material is placed, it needs covered with another layer of plastic or a tarp and weighted down to prevent it from blowing off. Do not install the initial layer of plastic until the concrete has set enough; otherwise the plastic will stick to the concrete.

Corners and edges are particularly vulnerable during cold weather. Therefore, the thickness of insulation for these parts shall be about 3X the thickness that is required for slabs or walls. It is recommended to extend the protection a minimum of 2' beyond the edges of footing and slabs.

Concrete placed for footings or slabs shall be covered, with the needed protection, as soon as the concrete can be walked on. Concrete placed in wall forms shall be covered, with the needed protection, immediately after concrete placement. Insulation shall be kept in close contact with the concrete form surface to be effective.

Protection Period:

All concrete (Footings, Slabs, and Walls) shall be protected for no less than 7 days for proper curing purposes. Wall forms shall remain in place for a minimum of 7 days as well. Curing compound does not need to be used during cold weather concreting, due to the insulating material being left on for a minimum of 7 days. Many curing compound manufacturers do not recommend that this product be used at cold temperatures. The use of non-chloride "accelerators" are welcome as an added measure of early set and strength gain. The use of accelerators will not decrease the protection period; 7 days is still the minimum protection period.

At the end of the protection period, concrete should be cooled gradually to reduce the risk of "thermal shock". Gradual cooling reduces the risk of cracking. This can be accomplished by allowing the insulating material to remain in place until the concrete has essentially reached equilibrium with the outside air temperature.

Consult with the design engineer for the allowable time of "loading" the concrete structures. Depending on the weather conditions; the curing time before backfilling, driving on slabs with skid steers, or allowing animal traffic may vary.

Fact Sheet

COLD WEATHER CONCRETING
(ACI-306R-88 Summary)

USDA
Natural Resources
Conservation Service

-Definition of Cold Weather (1.1)

As per ACI-306R report, cold weather is defined as: a period for more than 3 consecutive days the average daily air temperature is less than 40^0 F, and the air temperature is not greater the 50^0 F for more than half (12hrs.) of any of the 3 days. *"The average daily air temperature is the average of the highest and the lowest temperatures occurring during the period from midnight to midnight."*

-Objectives (1.3)

The objectives for cold weather concreting are to;

- prevent damage to concrete from early stage freezing. As concrete gains maturity the mixing water combines with the cement during hydration decreasing the degree of saturation below the critical level. The critical level is the degree of saturation where a single cycle of freezing could cause damage to the concrete.
- assure that the concrete develops essential strength for safe removal of forms and safe loading of the structure during construction and after.
- limit rapid changes of temperature before the concrete has obtained sufficient strength to withstand induced thermal stresses.
- provide protection that warrant normal strength development and the intended serviceability of the structure.

"Short-term construction economy should not be obtained at the expense of long-term durability."

-Principles (1.4)

Concrete that has attained a compressive strength of at least 500-psi will not be damaged by exposure to a single freezing cycle. Concrete that is protected will obtain its potential strength despite subsequent exposure to cold weather. Except within heated enclosures little or no external supply of moisture is required. Calcium chloride should not be used to accelerate setting because of increased chances of corrosion to re-enforcing metal.

-Economy (1.5)

The owner must decide whether the extra costs in cold weather concreting are more profitable or cost effective than waiting for milder weather. Neglect of protection against freezing in the early stages can cause immediate destruction or weakening of the concrete.

-Planning (2.1)

Plans to prevent early freezing of fresh concrete and maintaining temperatures above the recommended minimums should be made well before freezing temperatures are expected to occur. The necessary equipment and materials should be at the work site before cold weather is likely to occur, not after the fresh concrete begins to approach the freezing point.

-Protection during fall and spring (2.2)

During Fall and Spring when temperatures are not defined as cold weather, all concrete surfaces should be protected from freezing, for at least the first 24-hours after placement, when heavy frost or freezing is forecast at the job site.

-Concrete temperature (2.3)

The concrete temperature at the time of placement should not be lower than the values given in Table 3.1, also the concrete temperature should be maintained at the recommended placement temperature for the required protection period.

Air Temperature	Concrete Temperature
Minimum concrete temperature as placed and maintained	
ALL	**55 F**
Minimum concrete temperature as mixed for indicated air temperature	
Above 30F	60F
0-30F	65F

Table 3.1- Recommended concrete temperatures

-Preparation before concreting (4.1, 4.3, 4.4)

Preparation for concreting primarily consists of insuring that all surfaces that will be in contact with the freshly poured concrete are at temperatures that will not cause freezing or prolonged setting. All snow, ice and frost must be removed prior to placement of the concrete. Concrete will not be placed on frozen subgrade. The subgrade can be thawed, sometimes, by covering it with insulating material for a few days prior to concrete placement.

-Protection to prevent early-age freezing (5.1)

Prevention of early-age freezing must be provided immediately after concrete placement. Arrangements for covering, housing or heating of newly placed concrete should be made before placement. Protective materials must be on-site ready for installation to prevent corners and edges from freezing. In cold weather, the temperature of newly placed concrete should be kept as close to the values given in Table 3.1 and the corners and edges are more vulnerable to freezing and are more difficult to maintain at the optimal temperature.

-Length of protection period (5.3)

The length of the required protection period depends on the type and amount of cement used and whether an accelerator is used. The length of protection may be reduced by: (1) using Type III cement; (2) using an accelerating admixture **(non-chloride)**; or (3) using 100 lb/yd^3 of cement in excess of the design cement content. Table 5.3 gives the minimum length of protection, in days at the temperatures given in Line 1 of Table 3.1.

Line	Service category	Type I or II cement	Type III or 100lb/yd^3 of additional cement
1	No load not exposed	2	1
2	No load, exposed	3	2
3	Partial load, exposed	6	4

Table 5.3- Length of protection period for concrete placed during cold weather (Days)

-Stripping forms (5.4)

The protection afforded by forms may require that the forms remain in-place for the full length of the protection period recommended in Table 5.3. The minimum time before stripping the forms is best determined by past experiences and current job conditions. If the newly placed concrete is in a heated enclosure, form removal and exposure to low daily temperatures may cause damage to corners and edges. Also, in the case of structures subjected to hydrostatic pressure, hasty removal of forms may dislodge the form ties creating water channels.

-Temperature drop after removal of protection (5.5)

Concrete should be cooled gradually to reduce differential strains between the interior and exterior of the structure. This can be accomplished by slowly reducing the applied heat or by leaving the insulation materials until the concrete has reached equilibrium with ambient temperatures.

-Form removal requirements (6.10)

Recommendations made are based on job conditions that meet the following requirements:

- Concrete internal temperature is at least 50 F after placement.
- Facilities are available to maintain the concrete temperature at 50 F throughout the structure.
- Reshores are left in place as long as necessary to safeguard all members of the structure.
- The concrete is made of Type I or II Portland cement.
- Proper curing is used to avoid drying in heated enclosures.

-Materials and methods of protection (7.2)

In some cases the use of natural heat of hydration may only require the use of insulating material. In extreme cases, it may be necessary to us enclosure and heating units to maintain the required temperature.

The heat of hydration is mostly generated during the first 3 days. The heat may be retained on unformed surfaces using insulating blankets and by using insulated forms. The insulation must be kept in close contact with the concrete or the form surface. Suitable protection from wind, moisture and heat loss are required. Corners and edges are particularly vulnerable, therefore the thickness of the insulation should be about three times the thickness used for walls or slabs. Commonly used insulating materials follow, definitions are listed in Chapter 7 ACI-306R:

- Polystyrene foam sheets
- Urethane foam
- Foamed vinyl blankets
- Mineral wool or cellulose fibers
- Straw
- Blanket or batt insulation

The heat of hydration will gradually decrease with age. It may be necessary to use enclosures and heating units to maintain the required temperature for the required protection period. Enclosures conserve heat, keep out cold air, and if secured properly block the wind. They can be made with any suitable material such as wood, canvas or plastic sheet. Enclosures must capable of withstanding wind and snow loads and be reasonably air tight. Sufficient space between the concrete and the enclosure to allow circulation of warmed air. If combustion heaters are used, venting is required to prevent reactions between exhaust gasses and exposed concrete surfaces that will result in a weak concrete surface. Also, heaters and vents should be placed so as not to cause overheating or drying of concrete. The operation of combustion heaters should be supervised continuously and fire fighting equipment should be available at the job site at all times. **Warning, exhaust gasses poses a serious health threat in an enclosed structure. Never enter without properly venting before hand.**

-NOTE:

This fact sheet does not include all information set forth in the ACI-306. Consult the latest edition for further details. A complete catalog of all ACI publications is available from:

American Concrete Institute
Box 19150, Redford Station
Detroit, Michigan 48219

Natural Resources Conservation Service
Practice Specification
Access Road (Code 560)

1. SCOPE

The work shall consist of construction of the Access Road at the location, and to the dimensions and grades, shown on the drawings and as staked in the field.

2. SITE PREPARATION

All trees, stumps, roots, brush, weeds, and other objectionable material shall be removed from the work area and disposed of as directed.

All unsuitable material shall be removed from the roadbed area prior to placing fill or surfacing materials.

The roadbed shall be graded to the required elevations. All areas which require filling will be scarified prior to placement of fill. All fill shall be compacted according to the specified method with the appropriate equipment or to the specified density.

3. SURFACING

Aggregate for the subbase shall be clean and free from deleterious substances.

GEOTEXTILE shall meet the requirements as outlined in NRCS Design Note 24 and NRCS Material Specification 592 or as otherwise stated in Section 6.

Gradation shall be such that a stable base will be formed. Placement of the surface course shall be in accordance with sound highway construction practices.

4. SEEDING

All disturbed areas shall be revegetated as designated on the drawings.

5. EROSION CONTROL

Construction operations shall be carried out in such a manner that erosion and air and water pollution will be minimized. State and local laws concerning pollution abatement must be followed.

6. ADDITIONAL CONDITIONS WHICH APPLY TO THIS PROJECT ARE:

Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

ACCESS ROAD

CODE 560

(ft)

DEFINITION

An access road is an established route for equipment and vehicles.

PURPOSE

This practice is used to accomplish one or more of the following purposes:

- To provide a fixed route for vehicular travel for resource activities involving the management of conservation forestry operations, livestock, agriculture, wildlife habitat, and other conservation enterprises

CONDITIONS WHERE PRACTICE APPLIES

This practice applies where access is needed from a private or public road or highway to a land use enterprise or conservation measure, or where access is needed in a planned land use area.

Access roads range from single-purpose, seasonal-use roads, designed for low speed and rough driving conditions, to all-purpose, all-weather roads. Single-purpose roads provide access to areas such as forest fire lines, forest management activities, remote recreation areas, or for maintenance of facilities.

This practice does not apply to temporary or infrequently used trails used for logging. Use NRCS Conservation Practice Standard (CPS) Forest Trails and Landings (Code 655) to meet this need. Trails and walkways used for animals, pedestrians, or off-road vehicles are addressed in NRCS CPS Trails and Walkways (Code 575).

CRITERIA

General Criteria Applicable to All Purposes

Design the access road to serve the enterprise or planned use with the expected vehicular or equipment traffic. Factors in the design include the type of vehicle or equipment and the speed, loads, soils, climate, turning radius, and other conditions under which vehicles and equipment are expected to operate.

Location

Locate the access road to serve the purpose intended, to facilitate the control and disposal of surface and subsurface water, to control or reduce erosion, and to make the best use of topographic features. Design the layout of the road to follow natural contours and slopes to minimize disturbance of drainage patterns. Locate the access road where it can be maintained and where water management problems are not created. To reduce potential pollution, position the road as far as possible from water bodies and watercourses. To the extent possible, do not impede overland flow.

Alignment
Adapt the gradient and horizontal alignment to the intensity of use, the mode of travel, the type of equipment and load weights, and the level of development.

Grades normally should not exceed 10 percent except for short lengths. A maximum grade of 15 percent should only be exceeded, if necessary, for special uses such as field access roads or fire protection roads.

Width
The minimum width of the roadbed for an all-purpose road is 14 feet for one-way traffic and 20 feet for two-way traffic. The roadbed width includes a tread-width of 10 feet for one-way traffic or 16 feet for two-way traffic and 2 feet of shoulder width on each side. Increase the two-way traffic width by a minimum of 4 feet for trailer traffic. Single-purpose roads will have a minimum width of 10 feet with greater widths at curves and turnouts. Use vegetation or other measures to protect the shoulders from erosion.

Use turnouts on single lane roads where vehicles travel in both directions on a limited basis. Design the turnout to accommodate the anticipated vehicle use.

Provide a turnaround at the end of dead end roads. Size the turnaround for the anticipated vehicle type that will be using the road.

Provide parking space as needed to keep vehicles from parking on the shoulder or other undesirable locations.

Side slopes
Design all cuts and fills to have stable slopes that are a minimum of 2 horizontal to 1 vertical. For short lengths, rock areas, or very steep hillsides, steeper slopes may be permitted if soil conditions warrant and special stabilization measures are installed. Where possible, design slopes to a minimum of 4 horizontal to 1 vertical to improve establishment and maintenance of turf.

Where possible, avoid areas with geological conditions and soils that are subject to slides. When the area cannot be avoided, treat the area to prevent slides.

Drainage
The type of drainage structures used will depend on the intended use and runoff conditions. Provide a culvert, bridge, ford, or surface cross drain for water management at every natural drainageway. The capacity and design of the drainage feature must be consistent with sound engineering principles and must be adequate for the class of vehicle, road type, land use in the watershed, and intensity of use.

When a culvert or bridge is installed in a drainageway, it must have a minimum capacity that is sufficient to convey the design storm runoff without causing erosion or road overtopping. Table 1 lists minimum design storm frequencies for various road types.

Table 1: Minimum design storm frequencies

Road Intensity and Usage	Storm Frequency
Intermittent; single-purpose or farm use	2 year - 24 Hour
Frequent; farm headquarters, livestock access, isolated recreation areas	10 year - 24 Hour
High intensity; residential or public access	25 year - 24 Hour

For public access roads, design storm frequencies must also meet local standards.

Use NRCS CPSs Stream Crossing (Code 578), or Aquatic Organism Passage (Code 396) when aquatic species are present, to design stream crossings.

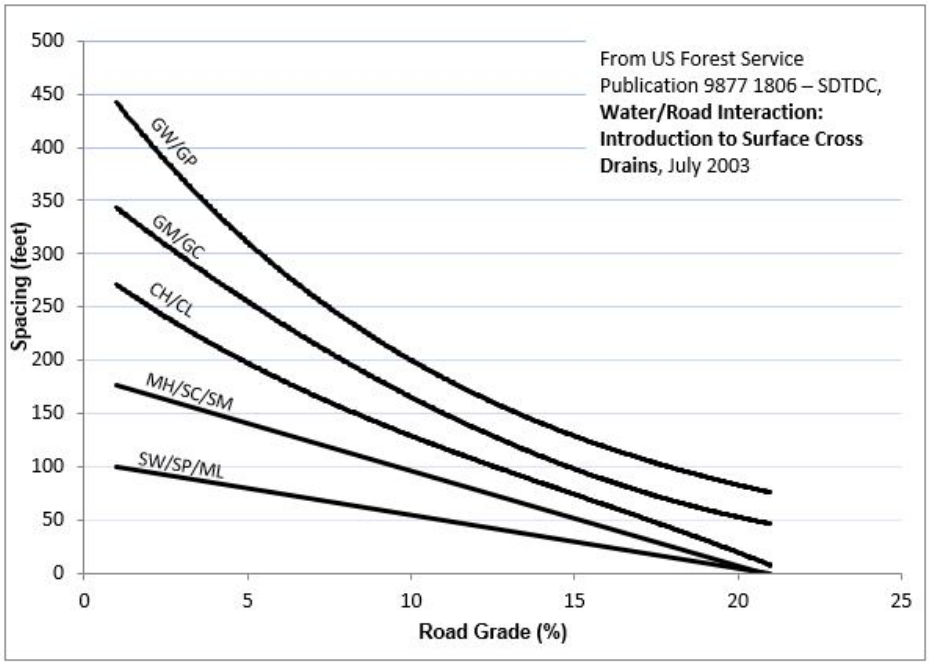
An erosion-resistant low point or overflow area may be constructed across the access road to supplement the culvert capacity on nonpublic-use roads.

Surface cross drains, such as broad-based or rolling dips, may be used to control and direct water flow off the road surface on low-intensity-use forest, ranch, or similar roads. Protect the outlets of drainage measures to limit erosion. On steep grades where water could run down the road, use a broad-based dip or other similar feature to divert runoff. The surface cross drain must be constructed of materials that are compatible with the use and maintenance of the road surface. The discharge area for a surface cross drain must be well-vegetated or have other erosion resistant materials (see fig. 1). Reduce separation distances as needed to account for local hydrologic conditions.

Design a minimum cross slope to direct precipitation off the roadway. Cross slopes should range from 1.5 to 2 percent for paved surfaces and 2 to 6 percent for unpaved surfaces. Unobstructed flow into the ditches must be maintained to prevent flows from causing roadside erosion.

Provide ditches, as needed, to move water away from the road. Maintain unobstructed flow into the ditches to prevent flows from causing roadside erosion. The capacity of a roadside ditch must be adequate to carry the drainage from the road surface. Design ditch channels to have stable grades and side slopes. Provide a stable outlet for the ditch. Protection may include riprap or other similar materials. Use NRCS CPSs Structure for Water Control (Code 587), Lined Waterway or Outlet (Code 468), or Grade Stabilization Structure (Code 410), if needed.

Figure 1. Recommended spacing of surface cross drains based on soil types



Surfacing

Install a wearing course or surface treatment on the access road if required by traffic needs, soil, climate, erosion control, particulate matter emission control, or other site condition. If none of these factors apply, no special treatment of the surface is required.

When a treatment is used, the type of treatment will depend on local conditions, available materials, and the existing road base. On roads made of soils with weak bearing capacity, such as silts, organics, and clays, or where it is necessary to separate the surfacing material from the foundation material, place a geotextile material specifically designed for road stabilization applications under the surface treatment. Use the criteria in NRCS CPS Heavy Use Area Protection (Code 561) to design the surface treatment. Do not use toxic and acid-forming materials to build the road.

If dust control is needed, use NRCS CPS Dust Control on Unpaved Roads and Surfaces (Code 373).

Safety
Provide passing lanes, turnouts, guardrails, signs, and other facilities as needed for safe traffic flow. Design an intersection to a public highway to meet applicable Federal, State, and local criteria.

Erosion control
Use the criteria in NRCS CPS Critical Area Planting (Code 342) or the NRCS State-approved seeding specification to vegetate road banks and disturbed areas as soon as soil and climatic conditions are favorable. If permanent vegetation cannot be established in a timely manner, use appropriate temporary measures to control erosion. If the use of vegetation is precluded and protection against erosion is needed, use the criteria in NRCS CPS Mulching (Code 484) to provide surface protection.

During and after construction, use erosion and sediment control measures to minimize offsite damages.

CONSIDERATIONS

Consider visual resources and environmental values during planning and design of the road system.

Consider locating roads outside of the active floodplain to reduce bank erosion potential and the effects on stream hydrology.

Limiting the number of vehicles and vehicle speed will reduce the potential for generation of particulate matter and decrease safety and air quality concerns.

Consider using additional conservation practices, such as NRCS CPSs Dust Control on Unpaved Roads and Surfaces (Code 373) or Windbreak/Shelterbelt Establishment (Code 380), to reduce the potential for generation and transport of particulate matter emissions.

During adverse weather, some roads may become unsafe or may be damaged by use. Consider restricting access to the road at that time.

When revegetation is needed, consider revegetating using species or diverse mixes that are native or adapted to the site and have multiple benefits. In addition, where appropriate, consider a diverse mixture of forbs and wildflowers to support pollinator and other wildlife habitat.

Consideration should be given to—

- Effects on downstream flows, wetlands, or aquifers that would affect other water uses or users.
- Effects on wildlife habitats that would be associated with the practice.
- Utilizing buffers where possible to protect surface water.
- Short-term and construction-related effects of this practice.

PLANS AND SPECIFICATIONS

Provide plans and specifications that describe the requirements for applying the practice to achieve its intended purpose. As a minimum, include—

- A plan view of the proposed road that shows water features, known utilities, and other features that affect the design.
- Road width and length with profile and typical cross section(s) including turnouts, parking, and turnarounds.
- Design road grades or maximum grades when applicable.
- Soils investigation. Include location of soil borings and plot of the soil/geologic boring showing the Unified Soil Classification System, as needed.
- Type and thickness of surface treatment including any subbase preparation.
- Grading plan.

- Cut and fill slopes where applicable.
- Planned drainage features.
- Location, size, type, length, and invert elevations of all required water control structures.
- Vegetative requirements that include vegetation materials to be used, establishment rates, and season of planting.
- Erosion and sediment control measures, as needed.
- Safety features.
- Construction and material specifications.

OPERATION AND MAINTENANCE

Prepare a written operation and maintenance plan for the access road. As a minimum, include the following activities:

- Inspect culverts, roadside ditches, water bars, and outlets after each major runoff event and restore flow capacity as needed. Ensure proper cross section is available and outlets are stable.
- Maintain vegetated areas in adequate cover to meet the intended purpose(s).
- Fill low areas in travel treads and regrade, as needed, to maintain road cross section. Repair or replace surfacing materials as needed.
- Selection of chemical treatment(s) for surface treatment or snow/ice removal, as needed. Select the chemicals used for surface treatment or snow and ice removal to minimize adverse effects on stabilizing vegetation.
- Selection of dust control measures, as needed.

REFERENCES

American Association of State Highway and Transportation Officials. 2011. A Policy on Geometric Design of Highways and Streets, 6th Edition. Washington, D.C.

American Association of State Highway and Transportation Officials. 2001. Guidelines for Geometric Design of Very Low-Volume Local Roads (ADT $\leq$ 400). Washington, D.C.

Swift, L.W., Jr. 1988. Forest Access Roads: Design, Maintenance, and Soil Loss. *In*: W.T. Swank and D.A. Crossley, Jr. (ed.) Ecological Studies, Vol. 66: Forest Hydrology and Ecology at Coweeta. New York: Springer-Verlag: 313-324.

USDA Forest Service. 2003. Water/Road Interaction: Introduction to Surface Cross Drains, Publication 9877 1806 – SDTDC. Washington, D.C.

Weaver, W.E., E.M. Weppner, and D.K. Hagans. 2015. Handbook for Forest, Ranch & Rural Roads: A Guide for Planning, Designing, Constructing, Reconstructing, Upgrading, Maintaining and Closing Wildland Roads (Rev. 1st ed). Mendocino County Resource Conservation District. Ukiah, CA. https://www.pacificwatershed.com/sites/default/files/RoadsEnglishBOOKapril2015b.pdf

Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

FENCE

CODE 382

(ft)

DEFINITION

A constructed barrier to animals or people.

PURPOSE

This practice is used to accomplish the following purpose:

- Provide a means to control the movement of animals, people, and vehicles to accomplish specific conservation objectives.

CONDITIONS WHERE PRACTICE APPLIES

Apply this practice on any area where management of animal or human movement is needed.

CRITERIA

General Criteria Applicable to All Purposes

Plan, design, and construct this practice to comply with all Federal, State, and local regulations. The landowner must obtain all necessary permissions from regulatory agencies or document that no permits are required. The landowner and/or contractor is responsible for locating all buried utilities in the project area, including drainage tile and other structural measures.

Ensure all fencing materials installed are durable and of high quality, and the type and design of the fence installed meets the management objectives and site challenges. Use permanent, portable, or temporary fences based on management objectives.

Position fences to facilitate changes in management strategies, access requirements, or otherwise meet conservation objectives. The fence design and installation must include height, size, spacing, type of materials, and location of features such as gates and cattle guards.

The fence design and materials must have a life expectancy appropriate for the management system and resource objectives. Base the durability of materials in the design and location of fences on topography, environment, purpose, and management objectives. Specialized bracing, designs, and materials may be necessary to cross features such as gulliesand streams.

Design, locate, and install fences to minimize impacts on local wildlife as appropriate.

Provide for proper disposal of materials when fence construction requires the removal of existing fencing materials to prevent harm to animals, people, or equipment.

Additional criteria for fencing associated with grazing management

Improve resource management by locating fences to separate areas with differences in forage seasons of growth and palatability, use, topography, or production potential.

Pasture/paddock divisions shall be consistent with grazing needs as projected by a grazing management plan developed under Pennsylvania Conservation Practice Standard 528.

Permanent fencing for grazing livestock should allow flexibility for implementation of the grazing management plan and management activities such as nutrient application, pest control, forage harvest, and other associated practices.

Additional criteria for fencing associated with Waste Storage Facilities (WSF), Waste Transfer (WT), and Heavy Use Areas (HUA)

All WSF, some WT systems, and HUA with drops of greater than 3.5 feet shall be fenced to exclude children and animals from accidental entry. The minimum safety fence height shall be 4.5 feet. When a WSF, WT, or HUA walls extend out of the ground, a combination of exterior wall and shorter fence resulting in a total height of 4.5 feet is acceptable. Fencing is optional when exterior wall heights exceed 4.5 feet.

Limit openings to 4” when installing horizontal fence around the perimeter of a WSF, WT, or HUA. When using woven wire, the spacing can be up to 6” within the grid pattern.

CONSIDERATIONS

Consider soil properties, soil moisture conditions, and erosion concerns.

Consider livestock management and adaptive grazing strategies, trailing, access to water facilities, and wildlife deterrence or passage.

Consider animal and human safety concerns by enhancing visibility of fences through design materials, fence markers, signage or fladry systems (line of rope mounted along the top of a fence, from which are suspended strips of fabric or colored flags that will flap in a breeze).

Consider using natural barriers where appropriate and design and locate fences to ease access for construction, maintenance, and landscape aesthetics.Fences across gullies or streams may require special bracing, designs or approaches.

Establish cleared rights-of-way to facilitate fence construction and maintenance where applicable. Avoid clearing of vegetation during the nesting and brood rearing seasons for migratory and ground nesting birds.

Consider type and class of livestock and degree of control needed to perform intended function. The number and spacing of wires, spacing of vertical stays (for woven wire fence), and height of fence as well as need for an electric component should be considered during the planning process. When using electric fences to control livestock, a training area should be planned to condition livestock to fences.

Fence construction requiring the removal of existing unusable fence should provide for proper disposal of scrap materials to prevent harm to animals, people and equipment.

Consider the following safety guidelines when constructing electric fences:

1. Do not erect wires or ground wires near overhead power lines, telephone wires, or radio antennas.

It is illegal to cause interference.

2. Install energizers inside a building when possible. Energizers need not be attached to a power pole. All power supply lines should comply with local electrical codes.
3. All energizers must be connected to a separate grounding system. Never attach an energizer to other farm related grounding devices (e.g. electric panels, ground rods, lightning rods on buildings, houses, barns, etc).
4. Fence charger ground rods need to be at least 50 feet away from grounding rods that are not part of the fencing system.
5. Only one energizer should be installed onto a fence line.
6. Where there is public access to the fence, both interior and exterior, warning signs should be placed at a minimum of 300 feet apart.
7. Warn all children that electric fencing is being used and let neighbors know where and how to shut off the current.
8. Install lightening arrestors and chokes to protect fence.

PLANS AND SPECIFICATIONS

Prepare plans and specifications that describe the requirements for applying the practice according to the requirements of this standard. As a minimum, include—

- Plan view or map showing layout of fence and location of gates.
- Details for fence installation showing post spacing, bracing, and gate installation.
- Material quantities and requirements.

OPERATION AND MAINTENANCE

Regular inspection of permanent, temporary, and portable fences is a part of an ongoing maintenance program that ensures proper function of the fence for the lifespan of the practice. As a minimum, include the folowing in the operation and maintenance plan:

- Conduct inspections of fences after storms and other disturbance events
- Repair or replacement of loose or broken material, gates, and other forms of ingress and egress
- Removal of trees and limbs
- Repair or replacement of water gaps as necessary
- Repair of eroded areas as necessary
- Repair or replacement of markers or other safety and control features as required
- Maintain fladry or signage as necessary

REFERENCES

ASTM STANDARD 116. www.astm.org/Standards/A116.htm

Bell, H.M. 1973. Rangeland Management for Livestock Production. University of Oklahoma Press. Norman, OK.

Heady, H.F. and R.D. Child. 2002. Rangeland Ecology and Management, Third Edition. Routledge, NY.

Holechek, J.L., R.D. Pieper, and C.H. Herbel. 2001. Range Management: Principles and Practices. Prentice Hall, NJ.

Jakes, A.F., P.F. Jones, L.C. Paige, R.G. Seidler, M.P. Juijser. 2018. A Fence Runs Through It: A Call for Greater Attention to the Influence of Fences on Wildlife and Ecosystems. Biological Conservation, vol. 227, pp. 310–318. doi:10.1016/j.biocon.2018.09.026.

Fence Brace Assemblies, Circular 792, Institute of Food and Agricultural Sciences, Rev. 1992.

Gallagher, W.M. 2005. *Gallagher Power Fence Systems Manual. 12th Edition.* New Zealand.

Kencove Farm Fence Inc. *Kencove Farm Fence Supplies 2022. www.kencove.com*

Knapp, J.W. 1980. *How to Build Fences with Max-Ten 200 High-Tensile Fence Wire*. USSC Pittsburgh, PA.

National Engineering Handbook, 2009, Part 3 Std. Material *Spec 585 Wood Preservatives and Treatment*

Paige, C. 2012. A Landowner's Guide to Fences and Wildlife: Practical Tips to Make Your Fences Wildlife Friendly. Wyoming Land Trust. Pinedale, WY.

Sherry, J. 2020. IB: 20-10-A. Installing Turbo Fladry: An Informal Guide, Issue Brief. The Natural Resources Defense Council, NY.

Stoddard, L.A., A.D. Smith, and T.W. Box. 1975. Range Management. McGraw-Hill Book Company.

USDA NRCS. 2003. National Range and Pasture Handbook (Title 190). Washington, D.C. https://directives.sc.egov.usda.gov/

USDA NRCS. 2005. Electric Fencing for Serious Graziers. Columbia, MO.

United States Department of Interior, Bureau of Land Management and United States Department of Agriculture, Forest Service. 1988. Fences. Missoula Technology and Development Center.

Vallentine, J.F. 1989. Range Development and Improvement, Third Edition. Brigham Young University Press. Provo, UT.

Worley, J.W. 2015. Fences for the Farm, Circular 774. University of Georgia Extension. Athens, GA.

Natural Resources Conservation Service
Practice Specification
Heavy Use Area Protection (Code 561)

1. SCOPE

The work shall consist of furnishing materials and installing all components of the paved surface treatment areas for heavy use area protection as outlined in this specification and the drawings.

2. MATERIALS

All materials used shall conform to the quality and grade noted on the plans, set forth in Section 6, or as otherwise listed below:
PORTLAND CEMENT shall be Type I, IA, II, or IIA and conform to ASTM-C150, unless otherwise set forth in Section 6. If Type I or II is used, an air-entrainment agent shall be used.

CONCRETE AGGREGATE shall meet the requirements and gradation specified in ASTM-C33. Coarse aggregate shall meet the gradation for size numbers 57 or 67.

WATER used in mixing or curing concrete shall be clean and free from injurious amounts of oil, acid, salt, organic matter or other deleterious substances.

REINFORCEMENT BARS shall be grade 40 or higher, and shall conform to ASTM-A615, A616, or A617.Welded wire fabric reinforcement shall conform to ASTM-A185 or A497. Reinforcement shall be free from loose rust, oil, grease, curing compound, paint or other deleterious coatings.

CONCRETE ADMIXTURES shall conform to ASTM-C260 for air-entrainment, and ASTM- C494, type A,D, F or G, for water-reduction and set-retardation, and type C or E for non- corrosive accelerators.

POZZOLAN shall conform to ASTM-C618.

COAL COMBUSTION BYPRODUCTS (CCB) shall have a chemical analysis that provides adequate cementing and safety (toxicity) for the purpose intended.

CURING COMPOUND shall meet the requirements of ASTM-C309, Type 2, Class A or B, or as otherwise required in Section 6.

MASONRY COMPONENTS shall meet the requirements of ASTM-C90 & C270 and be placed in accordance with ACI - 530.

PRECAST CONCRETE units shall comply with ACI-525 and 533.

PREFORMED EXPANSION JOINT FILLER shall conform to the requirements of ASTM-D1752, Type I, II, or III, unless bituminous type is specified, in which case it shall conform to ASTM-D994 or D1751.

JOINT SEALERS shall conform to the requirements for ASTM-C920, Federal Specification SS-S-210A, or Federal Specification TT-S-227, as appropriate for the specific application.

WATERSTOPS. Vinyl-chloride polymer types shall be tested in accordance with Federal Test Method Standard No. 601 and shall show no sign of web failure due to brittleness at a temperature of -35 degrees Fahrenheit. Colloidal (bentonite) waterstops shall be at least 75 percent bentonite in accordance with Federal Specification SS-S-210A. Non-colloidal waterstops shall only be used if approved by the Engineer.

AGGREGATES. Aggregates shall meet the requirements of Pennsylvania Dirt and Gravel Road Program(DSA), PennDOT Pub. 408, Section 703, for the gradations specified in the drawings or Section 6, or as otherwise set forth in Section 6.

BITUMINOUS CONCRETE. Bituminous concrete shall meet the requirements of PennDOT Pub. 408,Sections 401, 420 and 421, for the course(s) specified in the drawing or Section 6, or as otherwise set forth in Section 6.

WOOD shall be graded and stamped by an agency accredited by the American Lumber Standards Committee as meeting the required species, grade, and moisture content. In the absence of such a stamp, the Contractor or material supplier shall provide written certification that the wood products meet the designated quality criteria.

PRESSURE TREATED WOOD PRODUCTS shall be Douglas Fir, Southern Yellow Pine, or as otherwise specified on the drawings or in Section 6. They shall be treated with preservatives in accordance with the American Wood Preservers Association (AWPA) Standard C16, “Wood Used on Farms, Pressure Treatment.” Each piece shall bear the AWPA stamp of quality. In the absence of such a stamp, the Contractor or material supplier shall provide written certification that the pressure treated wood meets the designated quality criteria.

FASTENERS for roofs and covers shall be stainless steel and/or galvanized in accordance with ASTM A153, and/or A653 Class G185, and Type 304 or 316, or otherwise protected from corrosion due to contact with moisture, manure and associated gasses. All fasteners, connectors, and any other metal contacting ACZA, ACQ or CA treated wood shall be stainless steel, in accordance with Supplement A below.

GEOTEXTILES. Geotextiles shall meet the requirements of PennDOT Pub. 408, Sections 212 and 735,for the Type and Class specified in the drawings or Section 6, or as otherwise set forth in Section 6.

ORGANIC SURFACES. Materials such as tanbark and saw dust shall be free of contaminants and rot.

3. FOUNDATION PREPARATION

Clear all trees, brush, fences, manure, and rubbish within the area to be protected, including any appurtenances, and borrow areas. All material removed by clearing and excavation operations shall be disposed of as directed by the Owner or his/her Representative. Sufficient topsoil is to be stockpiled in a convenient location for use on disturbed areas to facilitate seeding.

Set all base course material on undisturbed soil or non-yielding compacted material. Geosynthetics may be used, if approved by the Engineer, to further separate and/or stabilize the foundation. Over-excavation must be corrected as noted on the drawings or as directed by the Engineer or his/her designated Representative.
Surface and subsurface drainage systems shall be installed and operating adequately to remove water from the foundation to allow for proper placement of base and surface materials.

Drain fill upon which concrete is to be placed shall be covered with a geosynthetic that has an AOS between 20 and 100, inclusive.

4. BASE COURSE

The base course shall be placed on the area to the grades and thicknesses shown on the plans. The base material shall be as set forth in Section 6 and/or as shown on the drawings. The material shall be wetted and compacted by rollers or other construction equipment approved by the Engineer.

5. SURFACE TREATMENTS

A. Portland Cement Concrete

CONCRETE MIX

Unless otherwise specified in Section 6, concrete shall be proportioned to provide a minimum compressive strength at 28 days of 4,000 psi. The Contractor shall be responsible for the design of the mix and certification of the necessary strength, in accordance with ACI 301. Acceptance and certification of design mixes by PennDOT within the past year may be accepted in lieu of additional testing.

REINFORCING STEEL PLACEMENT

Reinforcement shall be accurately placed and secured in position in a manner that will prevent its displacement during the placement of concrete.
Steel shall be supported by precast concrete bricks (not clay bricks), metal or plastic chairs, or hard fieldstone. Except for dowel rods, placing steel reinforcement into concrete already in place shall not be permitted.

The following tolerances will be allowed in the placement of reinforcing bars shown on the drawings:

1. Maximum reduction in cover: from exposed surfaces -1/4 inch from earth surfaces -1/2 inch

2. Maximum variation from indicated spacing: 1/12th of indicated spacing

Splices of reinforcing bars shall be made only at the locations shown on the drawings, unless otherwise approved by the Engineer. Unless otherwise required, welded wire fabric shall be spliced by overlapping sections at least one full mesh dimension plus too inches. All reinforcement splices shall be in accordance with ACI 318.

Reinforcing steel shall not be welded unless approved by the Designer.

The ends of all reinforcing steel shall be covered with at least 1-1/2 inches of concrete.

MIXING AND HANDLING CONCRETE

In general, concrete shall be transported and placed in accordance with ACI-304, of which some specific interpretations are set forth below.

For concrete mixed at the site, the mixing time after all cement, aggregates and water are in the mixer drum shall be at least 1-1/2 minutes. Concrete shall be conveyed from the mixer as rapidly as practical by methods that will prevent segregation of the aggregates or loss of mortar. Concrete shall be placed within1-1/2 hours after the introduction of cement to the aggregate unless an approved set- retarding admixture is used in the mix. During periods of hot weather, it may be necessary to reduce this time.

For each load of concrete delivered to the site, a batch ticket shall be provided to the Owner or Technician by the Supplier. As a minimum, this ticket shall show the design strength, time out, admixtures (if any), and amount of water that may be added (if any) on site and still be within the design mix limits.

The Contractor shall test slump and air entrainment as necessary to ensure that the concrete meets the requirements of this specification. The slump shall be three to six inches (without superplasticizers) and the air content shall be five to seven percent of the volume of the concrete. Admixtures such as superplasticizers, water-reducers and set-retarders may be used provided they are approved by the Engineer prior to concrete placement and are used in accordance with the manufacturer’s recommendations. Superplasticizers (ASTM C494, Type F or G) may be added to concrete that has a 2- to 4- inch slump before the addition, and that is not warmer than 95o F. The slump shall not exceed 7½ inches with the addition of superplasticizer.

Concrete shall be uniform and thoroughly mixed when delivered to the job site. Variations in slump of more than one inch within a batch will be considered evidence of inadequate mixing and shall be corrected or rejected. No water in excess of the amount called for by the job design mix shall be added to the concrete.

Immediately after placement, concrete shall be consolidated by spading and vibrating, or spading and hand tamping. It shall be worked into corners and around all reinforcement and embedded items in a manner which prevents segregation. Excessive vibration which results in segregation of materials will not be allowed. Vibration must not be used to make concrete flow in forms, slabs, or conveying equipment.

If the surface of a layer in place will develop its initial set, i.e., will not flow and merge with the succeeding layer when vibrated, a construction joint shall be made. Construction joints shall be made by cleaning the hardened concrete surface to exposed aggregate by sandblasting, air/water jetting, or hand scrubbing with wire brush, and keeping the concrete surface moist for at least one hour prior to placement of new concrete.

Concrete surfaces do not require extensive finishing work; however, the surface shall be smooth and even, with no depressions that would result in surface water ponding. Careful screeding (striking-off) and/or wood float finishing shall be required. Any additional desired finishing of the surface (such as roughening for improved traction) shall be accomplished after an initial stiffening of the concrete has taken place. These requirements will be stated in Section 6 or on the drawings. Exposed edges should be chamfered, either with form molding or molding tools.

The addition of dry cement or water to the surface of screeded concrete to expedite finishing is not allowed. If concrete placing is discontinued prior to completion of the entire structure, the unfinished end of the concrete shall be formed to create a proper construction or expansion/contraction joint.

EXPANSION/CONTRACTION JOINTS

When required in Section 6 or on the drawings, expansion/contraction joints shall contain a six-inch, Type B, vinyl waterstop with a minimum web thickness of 1/8-inch, or an approved joint sealer.

FORM REMOVAL AND CONCRETE REPAIR

Forms for walls and columns shall not be removed for at least 24 hours after placing the concrete. When forms are removed in less than seven days, the exposed concrete shall be sprayed with a curing compound or be kept wet continuously for the remainder of the curing period. Forms which support beams or covers shall not be removed for at least seven days, or 14 days if they are to support forms or shoring.

Forms shall be removed in such a way as to prevent damage to the concrete. Forms shall be removed before walls are backfilled. Columns shall be at least seven days old before any structural loads are applied.

Concrete that is damaged or otherwise defective shall be removed and replaced, or where feasible, repaired. The Engineer will determine the required extent of

removal, replacement, or repair. The plan for accomplishing the repair must be approved by the Engineer prior to beginning the repair work. Where minor areas of the concrete surface are “honeycombed,” damaged or otherwise defective, the area maybe cleaned, wetted, and then filled with a dry-pack mortar. Dry-pack mortar shall consist of one part Portland cement and three parts sand with just enough water to produce a workable paste.

CONCRETING IN COLD WEATHER

Concreting in cold weather shall be performed in accordance with ACI-306R-88. In addition, the contractor shall provide a written plan at least 24 hours in advance of placing concrete in cold weather and shall have the necessary equipment and materials on the job site before the placement begins.

CONCRETING IN HOT WEATHER

Concreting in hot weather shall be performed in accordance with ACI 305, of which some specific interpretations are set forth below.

The supplier shall apply effective means to maintain the temperature of concrete below 90 degrees) Fahrenheit during mixing and conveying. Exposed surfaces shall be continuously moistened by means of fog spray or otherwise protected from drying during the time between placement and finishing, and during curing. Concrete with a temperature above 90 degrees Fahrenheit shall not be placed.

CURING

In general, concrete shall be cured in accordance with ACI-308. Specifically, it shall be prevented from drying for at least seven days after it is placed. Exposed surfaces shall be kept continuously moist during this period by covering with moistened canvas, burlap, straw, sand, or other approved material unless they are sprayed with a curing compound.

Concrete, except at construction joints, may be coated with a curing compound in lieu of continuous application of moisture. The compound shall be sprayed on moist concrete surfaces 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 allowed on any rebars.

Curing compound shall be applied in a uniform layer over all surfaces requiring protection at a rate of not less than one gallon per 150 square feet of surface. Surfaces subjected to heavy rainfall or running water within three hours after the curing compound has been applied, or otherwise damaged, shall be resprayed. Any construction activity which disturbs the curing material shall be avoided. If the curing material is subsequently disturbed, it shall be reapplied immediately.

B. Bituminous Concrete

Bituminous concrete shall be installed in accordance with PennDOT Pub. 408, Sections 305, 320, & 400,as appropriate, and/or as otherwise set forth in Section 6.

C. Compacted Stone Aggregate
Compacted stone aggregate surfaces shall consist of the material specified in the drawing or Section 6. The material shall be moist and uniformly placed on the prepared base. The loose material shall be place to an adequate thickness so that when compacted the finished thickness is as specified. The stone aggregate shall be compacted with a vibratory smooth wheeled roller or other approved equipment to form a dense, smooth surface.

D. Other Materials and Structures
Surface treatments, such as saw dust, coal combustion byproducts, soil cement, etc., shall be placed asset forth in Section 6, and to the grades and thicknesses shown on the drawings.

6. ADDITIONAL CONDITIONS WHICH APPLY TO THIS PROJECT ARE:

Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

HEAVY USE AREA PROTECTION

CODE 561

(sf)

DEFINITION

Stabilization or protection of an intensively used area.

PURPOSE

This practice is used to accomplish one or more of the following purposes:

- Reduce soil erosion
- Provide a stable, noneroding surface for areas frequently used by animals, people, or vehicles
- Protect or improve water quality

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to all land uses where a frequently or intensively used area requires relocation or treatment to address one or more resource concerns.

CRITERIA

General Criteria Applicable to All Purposes

All planned work must comply with Federal, State, Tribal, and local laws and permit regulations.

Design load

Base the design load on the type and frequency of traffic (vehicular, animal, or human) anticipated on the heavy use area.

Foundation

Evaluate the site foundation to ensure that the presumptive bearing capacity of the soil meets the intended design load and frequency of use for the normal climate conditions. Prepare the foundation by removal and disposal of materials that are not adequate to support the design loads.

Use a base course of gravel, crushed stone, other suitable material, geotextile, or a combination of materials on all sites that need increased load-bearing strength, drainage, separation of material, and soil reinforcement. GEOTEXTILE shall meet the requirements as outlined in NRCS Design Note 24 and NRCS Material Specification 592.

Surface treatment

Select a surface treatment that is stable and appropriate to the purpose of the heavy use area. Use concrete, bituminous concrete pavement, cementitious materials, mulches, aggregates, geotextiles, or a combination of materials to prevent punching or rutting failure (causing significant erosion or precluding performance of its intended purpose) in a heavy use area. Surface treatments must meet the following requirements according to the material used.

Concrete

Design concrete structures and slabs-on-ground in accordance with NRCS National Engineering Manual (NEM) (Title 210), Part 536, “Structural Engineering.”

Bituminous concrete pavement

Refer to the American Association of State Highway and Transportation Officials (AASHTO) “Guide for Design of Pavement Structures” or the applicable State highway department’s specification for design criteria for bituminous concrete paving.

In lieu of a site-specific design for areas that will be subject to light use, pave with a minimum of 4 inches of compacted bituminous concrete over a subgrade of at least 4 inches of well-compacted gravel. Use bituminous concrete mixtures commonly used for road paving in the area.

Other cementitious materials

Cementitious materials such as soil cement, agricultural lime, roller-compacted concrete, and coal combustion byproducts (flue gas desulphurization sludge and fly ash) can be used to provide a durable, stable surfacing material. Based on the properties of the surface material, develop a site-specific mix design with compressive strengths necessary for the expected use and loading on the heavy use area. Select materials that are nontoxic and that have chemical properties that are compatible with the intended use.

Aggregate

Design aggregate surfaces for expected wear and intended use. In lieu of a site-specific design for areas that will be subject to light nonvehicular use, install a minimum combined thickness for aggregate surfacing and base course of 6 inches for animals and 4 inches for other applications.

For other applications, use NRCS Technical Note (Title 210), Agricultural and Biological Engineering, Agricultural Engineering Technical Note 4, “Earth and Aggregate Surfacing Design Guide,” or other appropriate methodology to design aggregate thickness.

Mulches

Use a minimum layer thickness of 6 inches for materials such as limestone screenings, cinders, tanbark, bark mulch, brick chips, or shredded rubber. Mulches are not recommended for livestock or vehicular applications.

Vegetation

Use vegetative measures only on areas where traffic can be managed so the vegetative cover can be maintained. Select grass species or other plant materials that are wear resistant, have fast recovery from heavy use, and are suitable to the site. Establish the vegetation in accordance with the criteria in NRCS Conservation Practice Standard (CPS) Critical Area Planting (Code 342) or the appropriate State reference.

For heavy use areas managed as vegetated lots, provide an adequate number of lots in the system to allow the vegetation to be sustained by moving the animals. Establish a rotation that ensures the vegetated lot will be used only when vegetation has had time to recover between animal activities.

Other

Other materials can be used for surface treatment if they will serve the intended purpose and design life.

Structures

When a roof is needed to address the resource concern, use PA367, *Roofs and Covers.* For non-waste applications (roofs for shade, i.e.), design structures according to the accepted engineering practice.

Drainage

Include provisions in the design for surface and subsurface drainage, as needed. Design positive grade in the planned direction of flow. Fill low areas that may contribute to subgrade instability or ground water contamination.

Diversion of clean water
To the extent possible, prevent surface water and runoff from roofs from entering the heavy use area. Refer to NRCS CPSs Diversion (Code 362), Underground Outlet (Code 620), Roofs and Covers (Code 367), Roof Runoff Structure (Code 558), or other appropriate CPSs for drainage control.

Stabilization and erosion control
Stabilize all areas disturbed by construction as soon as possible after construction. Refer to the criteria in NRCS CPS Critical Area Planting (Code 342) for establishment of vegetation. If vegetation is not appropriate for the site, use the criteria in NRCS CPS Mulching (Code 484) to stabilize the disturbed area.

Water quality
If there is the potential for ground water contamination from the heavy use area, select another site or provide an impervious surface to reduce infiltration of pollutants.

For heavy use areas with surface water quality concerns, relocate the site or make provisions to collect, store, treat, or utilize contaminated surface runoff from the heavy use area. Include provisions to address runoff without causing erosion or water quality impairment. Use NRCS CPSs Waste Transfer (Code 634), Vegetated Treatment Area (Code 635), Waste Storage Facility (Code 313), Critical Area Planting (Code 342), Fence (Code 382), Prescribed Grazing (Code 528), Filter Strip (Code 393), Access Control (Code 472), etc. as supporting practices, when needed.

Recreation
Address accessibility requirements for new construction and when existing facilities are being altered. The Americans with Disabilities Act of 1990 (ADA) requires recreation areas that are used by the public to be accessible to people with disabilities.

Paved Surface Treatment Areas
Paved treated areas include asphalt, concrete, other cementitious materials, aggregates, or other similar inorganic materials. These are permanent sites or sites that are used on a reoccurring or regular basis throughout the year or used from year to year.

Provisions shall be made to collect, store, utilize and/or treat manure accumulations and contaminated runoff in accordance with other NRCS conservation practice standards. Manure must be collected on a regular basis. Runoff shall be directed to a PA313, *Waste Storage Facility,* or a PA635, *Vegetated Treatment Area* or a PA656, *Constructed Wetland* and other companion practices, when needed to meet the criteria and intended purpose of the heavy use area protection. The exception shall be runoff collection and treatment for Equine Heavy Use Areas.

The use of non-cementitious surface treatment shall be limited to low intensity animal use applications. If open, clean aggregate surfaces are used; provide at least one foot of compacted soil between the open, clean aggregate and bedrock or the seasonal high-water table.

Where needed the treated area shall extend an appropriate distance from facilities such as portable hay rings, water troughs, feeders, feeding troughs, mineral boxes and other facilities where livestock concentrations cause resource concerns.

Additional Criteria for Temporary Concentrated Livestock Areas on Pastures
Criteria can be found in PA528, *Prescribed Grazing*.

Additional Criteria for Equine Heavy Use Areas
These areas are designed specifically for horse usage and must be built and managed to meet all of the following conditions:

- Treated area must be stoned with appropriate aggregate. A base zone, binder zone, and top layer of aggregate or other material suitable for equine. Slope pad 1% to 5%. Sites with poor subbase require a geotextile.

- The treated area must be fenced separately from the pasture. Fence meets PA382, *Fence Standard.*
- Requires manure solids and/waste feed to be removed weekly.
- The treated area sized for maximum equine access group. See sizing guidelines found in Section III of the FOTG, Concentrated Livestock Area Guidance, “Exhibit 5”.
- Divert all upslope runoff.
- Runoff shall be sheet flow across lower edge or be collected and redistributed to a vegetated buffer.
- Vegetated buffers can be partially or fully in a pasture. Maintain at least 3 inches of vegetation in the buffer area at all times of the year. Buffers shall extend downslope 2x the upslope length of the treated area for up to 150’. The minimum buffer length shall be 35’ in low-risk locations or 50’ when sloping towards surface water or a sensitive area.
- Slope of vegetated buffer 1 to 15%.

CONSIDERATIONS

Heavy use areas can have a significant impact on adjoining land uses. These impacts can be environmental, visual, and cultural. Select a treatment that is compatible with adjoining areas. Consider such things as proximity to neighbors and the land use where the stabilization will take place.

Vegetated heavy use areas may need additional materials such as geogrids or other reinforcing techniques or planned periods of rest and recovery to ensure that vegetative stabilization will succeed.

Consider the safety of the users during the design. Avoid slippery surfaces, sharp corners, or surfaces and structures that might entrap users. For heavy use areas used by animals, avoid the use of angular aggregates that might injure livestock. When concrete is used for livestock imprint or texture concrete to provide traction in wet or freezing conditions.

Paving or otherwise reducing the permeability of the heavily used area can reduce infiltration and increase surface runoff. Depending on the size of the heavy use area, this can have an impact on the water budget of the surrounding area. Consider the effects to ground and surface water.

Consider the effects on improved animal health from the installation of heavy use area protection on muddy sites. Mud transmits bacterial and fungal diseases and provides a breeding ground for flies. Hoof suction makes it difficult for cattle to move around in muddy areas. In addition, mud negates the insulation value of hair coat and the animals must use more energy to keep warm. As temperatures fall, animal bunching may occur, which can reduce or eliminate vegetative cover and lead to erosion and water quality concerns.

To reduce the negative water quality impact of heavy use areas, consider locating them as far as possible from water bodies or water courses. In some cases, this may require relocating the heavily used area rather than just armoring an area that is already in use.

To the extent possible, maintain a 2-foot separation distance between the bottom of the surface material and the seasonal high water table or bedrock.

To reduce the potential for air quality problems from particulate matter associated with a heavy use area, consider the use of NRCS CPSs Windbreak/Shelterbelt Establishment (Code 380), Herbaceous Wind Barriers (Code 603), Dust Control from Animal Activity on Open Lot Surfaces (Code 375), or Dust Control on Unpaved Roads and Surfaces (Code 373) to control dust from heavy use areas.

Consider ways to reduce the size of the heavy use area as much as possible. This may require changes in how the livestock are managed but in the long run may result in less maintenance and a more efficient operation.

Consider a concrete or other durable surface for areas that require frequent scraping.

PLANS AND SPECIFICATIONS

Prepare plans and specifications that describe the requirements for installing the practice according to this standard. As a minimum, include—

- A plan view showing the location and extent of the practice. Include the location and distances to adjacent features and known utilities.
- Typical sections showing the type and required thickness of paving or stabilization materials.
- A grading plan, as needed.
- Where appropriate, plans for required structural details.
- Methods and materials used to stabilize areas disturbed by construction.
- Construction specifications with site-specific installation requirements.
- Vegetative establishment specifications, as applicable.

OPERATION AND MAINTENANCE

Prepare an operation and maintenance (O&M) plan and review it with the operator prior to practice installation. The minimum requirements to be addressed in the O&M plan are—

- Periodic inspections—annually and immediately following significant rainfall events.
- Prompt repair or replacement of damaged components, especially surfaces that are subjected to wear or erosion.
- Regular removal and management of manure, as needed, for livestock heavy use areas.
- Application of organic material for manure stacking, as applicable.
- Restricted uses, as needed, to protect the stand and to allow vegetative recovery for vegetated heavy use areas. Include frequency of vegetative removal.

REFERENCES

American Concrete Institute. 2010. Guide to Design of Slabs-on-Ground. ACI 360R-10. Farmington Hills, MI.

American Concrete Institute. 2008. Guide for the Design and Construction of Concrete Parking Lots. ACI 330R-08. Farmington Hills, MI.

American Concrete Institute. 2006. Code Requirements for Environmental Concrete Structures. ACI 350-06, Appendix H, Slabs on Soil. Farmington Hills, MI.

American Association of State Highway and Transportation Officials. 1993. AASHTO Guide for Design of Pavement Structures. Washington, D.C.

Korcak, R.F. 1998. Agricultural Uses of Coal Combustion Byproducts. *In* R.J. Wright, et al. (eds.). Agricultural Uses of Municipal, Animal, and Industrial Byproducts. USDA-ARS, Conservation Research Report 44, pp. 103-119.

USDA NRCS. 1991. Technical Note (Title 210) Design Engineering, Design Note 24, Guide for the Use of Geotextiles. Washington, D.C. https://directives.sc.egov.usda.gov/

USDA NRCS. 2017. Technical Note (Title 210) Agricultural and Biological Engineering, Agricultural Engineering Technical Note 4, Earth and Aggregate Surfacing Design Guide. Washington, D.C. https://directives.sc.egov.usda.gov/

USDA NRCS. 2017. National Engineering Manual (Title 210), Part 536, Structural Engineering. Washington D.C https://directives.sc.egov.usda.gov/

Natural Resources Conservation Service
Practice Specification
Livestock Pipeline (Code 516)

1. SCOPE

The work shall consist of furnishing materials and installing all components of a pipeline, as outlined in this specification and the drawings.

2. MATERIALS

All materials used shall conform to the quality and grade noted on the plans, set forth in Section 5, or as otherwise listed below:

PIPE

If the plastic pipe is stored on site, it should be protected from sunlight.

Pipe and fittings shall meet the requirements of one of the following types and standards, or as described in NRCS NEH Part 636 Chapter 52, or as otherwise set forth in Section 5 or on the drawings.

1. Steel Pipe. AWWA standard C200; ASTM standards A53, A134, A135 and A139, A858, and A865.
2. Ductile Iron. AWWA standard C600; and ASTM standard A746.
3. Aluminum (Tubing). ASTM standards B210, B241, and B313; ANSI standards H35.1 and H35.2.
4. Corrugated Metal. ASTM standards A760 and B745; AASHTO standards M36, M196, and M245. Pipe bands or couplers shall meet the requirements of the applicable pipe specification, except that channel bands (for use with flanged pipe), smooth or flat bands, nor dimple bands shall be allowed.
5. Polyvinyl chloride (PVC). ASTM standards D1784, D1785, D2241, D2466, F794, D2774; AASHTO standard M304; AWWA standards C900 or C905; and ASABE/ANSI standard S376.
6. Acrylonitrile-butadiene-styrene (ABS). ASTM standards D1527, D2282, and D3965.
7. Polyethylene (PE; commonly referred to as PE or HDPE, the primary difference being product density). ASTM standards D3350, F714, D2104, D2239, D2447, D2513, D2737, D3035, F405, F667, F771, F894, and D2774; AASHTO standard M294; AWWA standards C901 and C906; and ASABE/ANSI standard S376.

Pipe shall be marked as directed by the applicable reference standard(s) but shall have at a minimum: nominal pipe size, pipe material, dimensioning system (IPS, NPS, Sch, etc.), thickness (pressure rating or substitute designation from which the pressure rating can be obtained), and manufacture’s name or trademark.

Unless otherwise set forth in Section 5, pipe and fittings shall have a protective coating applied and shall conform to one of the following specifications, as applicable:

AWWA C104, AWWA C116, AWWA C203, AWWA C203, AWWA C209, AWWA C210, AWWA C213, AWWA C214, AWWA C218, ASTM A53, ASTM A123/A 123M, or ASTM A153/A

All joints and connections shall be constructed to withstand the design working pressure for the pipeline without leakage and shall leave the inside of the pipeline free of any obstruction which could reduce the pipe capacity below design requirements.

All fittings, such as couplers, reducers, bends, tees and endives shall be made of material that is recommended for use with the type of pipe specified and shall be installed in accordance with the recommendations of the pipe manufacturer.

Joints and connections for steel pipe shall meet the following requirements:

- Field joints shall be installed according to the manufacturer's recommendations. On buried pipelines, high-resistance joints between pipe lengths shall be electrically bridged with a welded, brazed, or soldered copper wire. If coated pipe is field welded, care shall be taken to avoid burning the protective coating. After joints are welded, they shall be covered with a coating equal in quality to that specified for the pipe and hardware.

Plastic pressure pipe fittings shall conform to the following ASTM specifications, as

applicable: D 2464, D 2466, D 2467, D 2468, D 2609, D 2672, D 2683, D 3139, or D 3261

Solvents for solvent-welded plastic pipe joints shall conform to the following ASTM specifications, as applicable: D 2235, D 2564, or D 2855

Rubber gaskets for pipe joints shall conform to the requirements of ASTM F477.

VALVES AND OTHER APPURTENANCES

The pipeline valves and appurtenances shall be of the size, type, material and pressure rating as shown on the drawings. If not specified in the design, pressure ratings shall equal or exceed that of the pipe.

Pressure relief valves shall be stamped with the pressure at which the valve starts to open. Adjustable valves shall be sealed or otherwise altered to ensure that the setting marked on the valve is not changed.

All other appurtenances, such as valve housings, shall be made of non-corrosive material and shall be according to manufacturer's recommendations, Section 5 and/or the drawings.

CONCRETE

Concrete used for thrust blocks shall have a minimum compressive strength, at 28 days, of 3000 psi. If the supplier cannot show evidence that a mix will meet strength requirements, a mix with a maximum net water content of seven gallons per bag (94 lbs.) of cement, and a minimum cement content of five and a half (5.5) bags per cubic yard of concrete, may be used

3. PIPE INSTALLATION

Pipelines shall be placed so that they are protected against hazards imposed by traffic, livestock, farm operations, freezing temperatures, or soil cracking. Other means of protection must be provided if the depth required for protection is impracticable because of shallow soils over rock or for other reasons. Abrupt changes in grade must be avoided to prevent rupture of the pipe. All special pipe installation requirements of the pipe manufacturer shall be followed.

Upon pipeline completion, pipeline shall be flushed to ensure that air vents properly operate, and airlocks do not occur.

ABOVE GROUND INSTALLATIONS

For suspension installations the pipe supports (saddle, rack, stand, hanger, etc.) shall meet design specifications and manufacturer or industry recommendations. Unless otherwise specified on the drawings, pipe shall (1) be supported a minimum of one foot above the ground, (2) have two layers of felt strips placed between the pipe and the support, and (3) have graphite lubricant placed between the pipe and the felt strip. Treated wood shall be used for timber supports.

Unless otherwise specified on the drawings, above ground pipelines with restrained joints (e.g., welded steel or banded CMP) shall have: (1) expansion couplers installed at a spacing not to exceed 400 feet, (2) a maximum distance between a coupler and a fixed or anchored location of 200 feet, and (3) couplers that provide for a minimum of 4 inches of travel distance.

For installations designed for laying the pipe across naturally occurring terrain, the pipe shall be firmly and uniformly bedded throughout its entire length. For corrugated metal pipe the bedding shall facilitate pipe installation so that at least the bottom 25% of the pipe circumference shall be in contact with the pipe.

Unless otherwise specified on the design, bedding material shall be imported if the ground surface will result in point loads or unacceptable abrasion on the pipe (e.g., bedrock or rock outcrops). Blocking or mounding shall not be used to bring the pipe up to final grade. Unless otherwise specified on the drawings, supports/saddles specifications as described above shall be followed.

The pipe shall not be handled in a manner to cause damage to the pipe and its coating. The pipe shall not be rolled or dragged on the ground. The pipe shall be placed onto above ground supports by the use of canvas slings or padded cables. Individual joints of pipe shall be inspected, and any damaged pipe shall be removed and replaced.

UNDERGROUND INSTALLATIONS

a. Trench Construction

Trench depth and depth of cover shall be as specified on the drawings.

Trench width at any point below the top of the pipe should be only wide enough to permit the pipe to be easily placed and joined and to allow the initial backfill to be safely and properly placed and compacted. The minimum trench width is dependent on backfill

placing and compacting equipment, but for typical manual installation clearance on either side of the pipe shall be 9 inches unless the trench is precision excavated with a semicircular bottom that closely fits the pipe. In that case, the minimum clearance on either side of the pipe shall be 6 inches. The maximum trench width shall be no greater than the minimum required by backfill placing and compacting equipment, but for typical manual installation shall be 30 inches greater than the outside diameter of the pipe (i.e., maximum clearance between the pipe and trench wall shall be 15 inches).

Trenches more than 5 feet deep shall be shored, sloped, or benched to provide safe and stable trench walls. Unless otherwise specified on the drawings, trenches shall be constructed according to Figures 1 through 5; or as provided in OSHA Construction Safety Regulations, Subpart P, Excavations, Appendix B – Sloping and Benching.

Where rock, hardpan, cobbles or other hard material which might prevent the pipe from being uniformly supported is encountered in the bottom of the trench, the trench shall be undercut a minimum of four inches below final grade. The trench shall then be brought back to grade with appropriate backfill material placed and compacted to provide proper bedding.

More than one pipe may be placed in a common trench. In such cases with typical manual installation the minimum and maximum clearances shall apply, and the minimum distance between pipes shall be 12 inches to facilitate safe and proper backfill installation.

b. Bedding

The pipe shall be firmly and uniformly bedded throughout its entire length. Bedding material, if necessary, shall be placed and spread in uniform layers and in such a manner as to fill the trench so there are no unfilled spaces (air pockets) below the pipe. For pipe with bell joints, holes shall be dug in the bedding at the bells to permit the body of the pipe to be in contact with the bedding along its entire length. Blocking or mounding shall not be used to bring the pipe up to final grade.

The pipe shall not be dropped into the trench or handled in a manner to cause damage. PVC pipe shall not be handled when the temperature is less than 20°F or greater than 100°F. PE pipe shall not be handled when the temperature is less than 10°F or greater than 110°F. The pipe shall be allowed to come within a few degrees of the temperature it will have after it is completely backfilled before placing fill other than that needed for shading or before connecting the pipe to other facilities. Individual joints of pipe shall be inspected, and any damaged pipe shall be removed and replaced.

Thrust blocks shall be formed against a solid trench wall. They shall be of the minimum size and materials as specified on the drawings.

The thrust block cavity shall be in undisturbed soil or previously placed compacted backfill that yields an acceptable allowable bearing pressure. The cavity shall be formed with soil or wood to hold the freshly placed concrete without displacement until an initial set has occurred.

When excavation beyond the designated trench widths and depths, as shown on the drawings or specified in Section 5 of this specification, occurs at locations where installation of concrete thrust blocks is required, the contractor shall install an alternative thrust block provision.

The concrete thrust block shall have a thickness, length, and depth as shown on the drawings or specified in Section 5. Backfill shall be placed on all sides of the thrust block and to the sides of the excavation.

c. Backfill

Initial Backfill. Unless otherwise specified in the design solid wall pipe 18 inches nominal diameter or less the initial backfill material may be fine grained soil. This may be the on-site trench excavated materials as long as any unsuitable materials are removed; it must be free of rocks, gravels, frozen materials larger than 1 inch or earth clods greater than 2 inch in diameter. Unless otherwise specified in the design, for solid wall pipe greater than 18 inches nominal diameter and corrugated, ribbed, or profile wall pipe, the initial backfill material shall be angular 1 to ¼ inch size crush stone with a maximum of 10 percent cohesive fines or sand and gravels (Soil types GW, GP, SW, and SP) with a maximum particle size of 1 inch containing a maximum of 12 percent of non-cohesive fines. Sands shall have a maximum of 45 percent passing the # 40 sieve.

Unless otherwise specified in the design, initial backfill shall be placed in lifts no greater than 8 inches deep before being compacted. For typical manual installation, each lift shall be worked to eliminate any unfilled spaces and compacted with appropriate tamping equipment and significant effort. When backfilling is done by mechanical means the initial fill shall first be worked to eliminate any voids.

The initial backfill materials shall be placed in a manner so as not to displace, deform or damage the pipe.

When water packing is used, the pipe shall be filled with water. The initial backfill, before wetting, shall be of sufficient depth to ensure complete coverage of the pipe with backfill after consolidation has taken place. Water packing shall be accomplished by adding water to diked reaches of the trench in such quantity as to thoroughly saturate the initial backfill. After the backfill is saturated, the fill shall be consolidated by rodding or with a vibrator. The wetted fill shall be allowed to dry until firm before completing the final backfill. The pipeline shall remain full of water until after the final backfill is placed.

Final Backfill. The final backfill material shall be free of rocks, frozen clods or other debris larger than 1inch in diameter within 6 inches of the pipe and 6 inches in particle size for the remaining portion of the final backfill unless otherwise specified in the design. The material shall be placed and spread in approximately uniform layers so there are no unfilled spaces in the backfill. Rolling equipment shall not be used until a minimum of 18 inches of compacted backfill material has been placed over the top of the pipe

Final backfill shall result in a finished trench surface that is smooth, slightly rounded so that the trench surface is higher than the surrounding ground, free of rocks greater in

size than the surrounding surface and has a clean and finished appearance.

Plastic pipelines may be placed by plow-in equipment if soils are suitable and rocks and boulders will not damage the pipe.

All disturbed areas shall be revegetated according to the recommendations for permanent seeding as stated in Conservation Practice Standard PA342, Critical Area Planting and/or the Pennsylvania Agronomy Guide.

4. BASIS OF ACCEPTANCE

The acceptability of the pipeline shall be determined by inspections to check compliance with all the provisions of this standard and specifications including the design of the line, the pipe, and pipe marking, the appurtenances, and the minimum installation requirements.

The pipeline shall be pressure tested for leaks. Before pressure testing, the joints of the assembled pipeline shall be allowed to set as recommended by the manufacturer and all concrete thrust blocks shall be in place and allowed to cure for a minimum of 3 days.

Pipeline shall be pressure tested by one of the following methods:

1. Before backfilling, fill the pipe with water and test at the design working head or at a minimum head of 10 ft., whichever is greater. All leaks must be repaired, and the test must be repeated before backfilling.
2. Pressure test at the working pressure for 2 hours. The allowable leakage shall not be greater than one gallon per diameter inch per mile. If the test exceeds this rate, the defect must be repaired until retests show that the leakage is within the allowable limits, but all visible leaks must be repaired.

If water is not available to complete a test, the installer shall provide a guarantee stating they will return and fix leaks that are found when the pipe is initially filled with water.

All materials shall conform to these minimum requirements and to the tests prescribed in the applicable ASTM Specification. If requested by the engineer, a qualified testing laboratory must certify with supporting test results that the pipe meets the requirements specified in this specification. The seal of approval of a recognized laboratory on pipe bearing the ASTM or AWWA designations may be accepted for this certification.

The installing contractor shall certify that the materials and installation comply with the requirements of these specifications. He shall furnish a written guarantee against defective workmanship and materials to cover a period of not less than one year. The installing contractor shall furnish a copy of the certification and guarantee, which will be made a part of the supporting records of the pipeline.

5. ADDITIONAL CONDITIONS WHICH APPLY TO THIS PROJECT ARE:

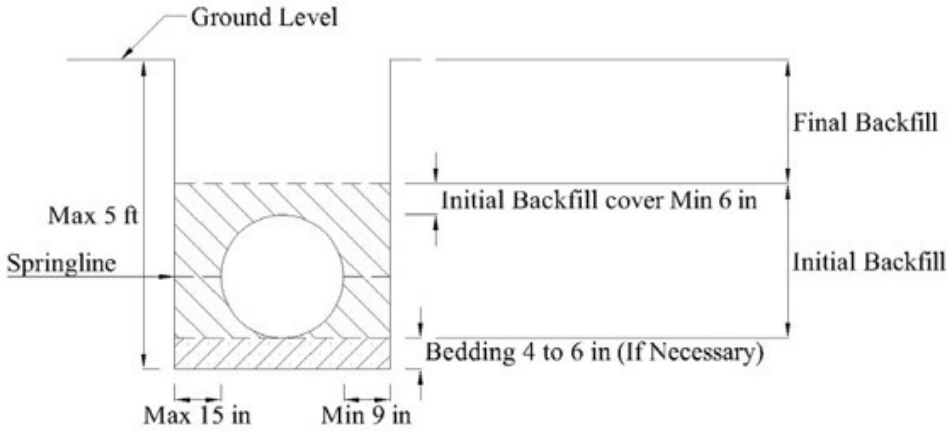


Figure 1. *Typical Trench with flat bottom, Manual Installation of Backfill*

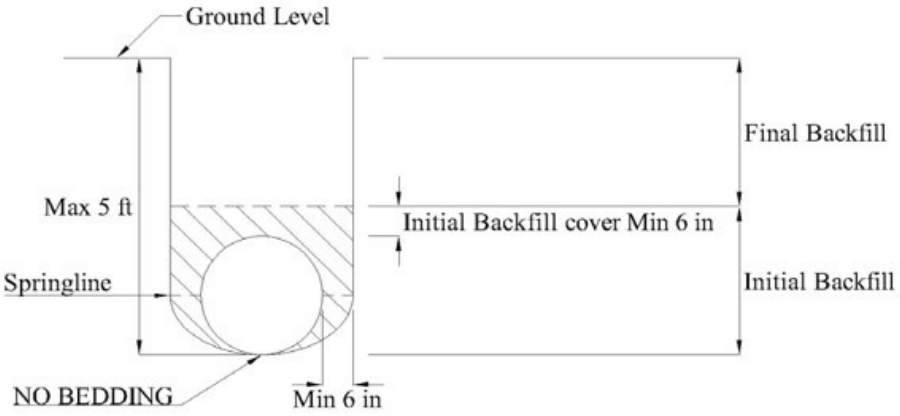


Figure 2*. Typical Trench with semi-circular bottom, Manual Installation of Backfill*

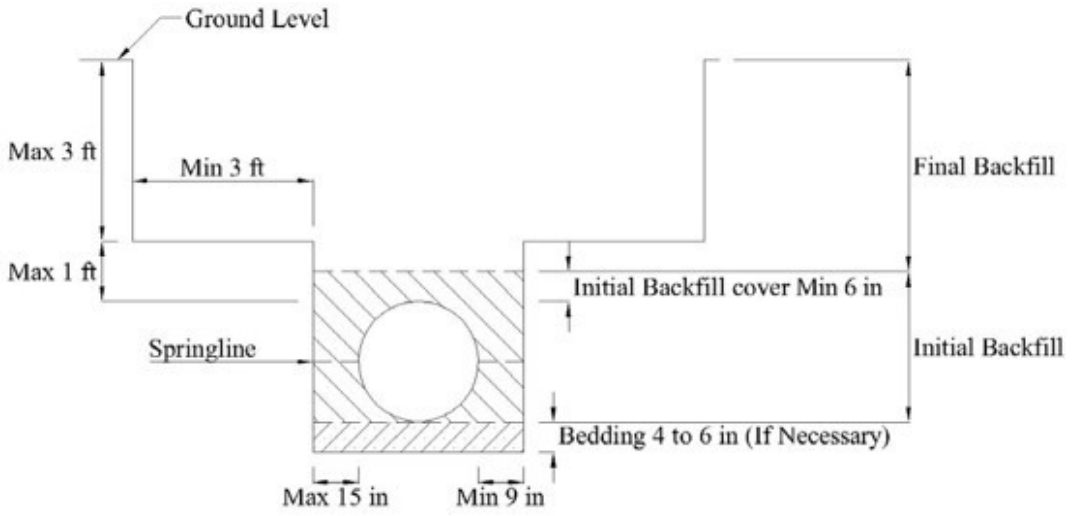


Figure 3. ***Trench Depth 5 to 10 feet: Benching System.***

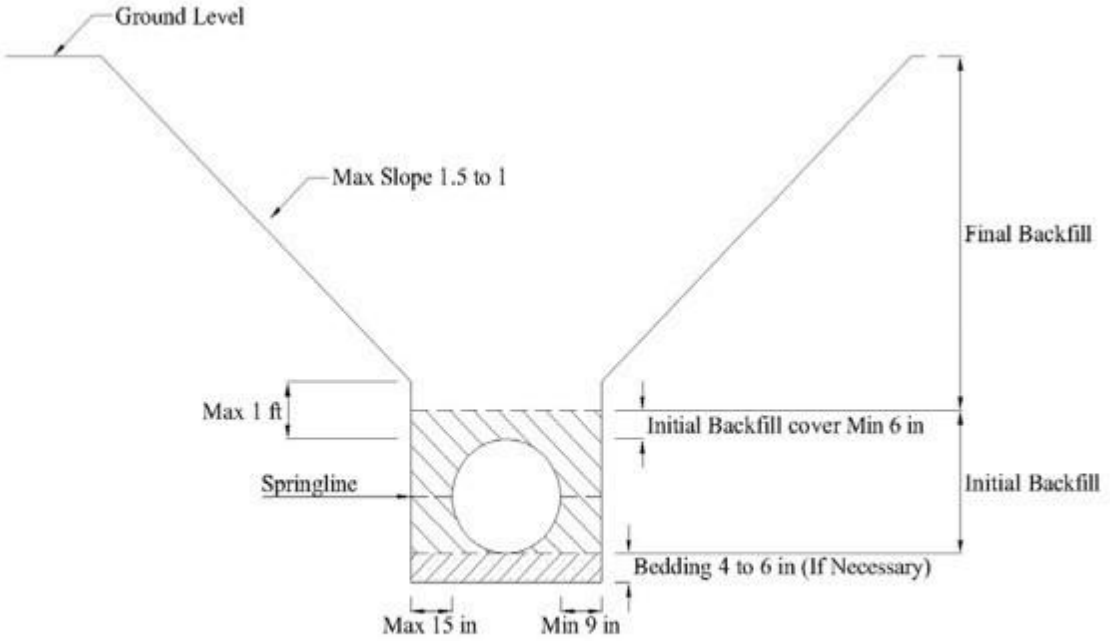


Figure 4. ***Trench Depth 5 to 10 feet: Vertically-sided lower portion with sloped upper portion***

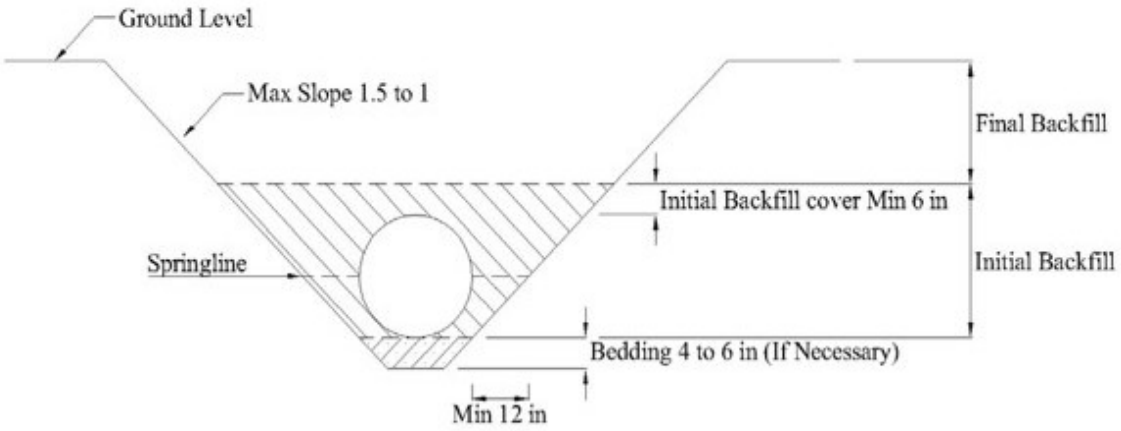


Figure 5. Trench Depth 5 to 12 feet: Sloped walls

Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

LIVESTOCK PIPELINE

CODE 516

(ft)

DEFINITION

A pipeline and appurtenances installed to convey water for livestock or wildlife.

PURPOSE

This practice is used to accomplish one or more of the following purposes:

- Convey water to points of use for livestock or wildlife
- Reduce energy use

CONDITIONS WHERE PRACTICE APPLIES

This standard applies to the conveyance of water through a closed conduit, from a source of supply to a watering facility, for use by livestock or wildlife.

This practice does not apply to the use of pipelines for irrigation. Use NRCS Conservation Practice Standard (CPS) Irrigation Pipeline (Code 430) for that purpose.

CRITERIA

General Criteria Applicable to All Purposes

Plan, design, and construct this practice to comply with all Federal, State, and local regulations. The landowner must obtain all necessary permissions from regulatory agencies, or document that no permits are required. The landowner and/or contractor is responsible for locating all buried utilities in the project area, including drainage tile and other structural measures.

Design the pipeline to provide sufficient volume, quality, and rate of delivery for practical and feasible use by livestock or wildlife.

Place pipelines only in or on soils with environmental conditions suitable for the type of material selected.

Capacity

Provide the capacity necessary to meet the seasonal high daily water requirements for the number and species of animals to be supplied.

Include reasonable water losses during conveyance and use in the capacity requirement calculations.

Friction and other losses

For design purposes, base head loss for hydraulic grade line computations using one of the following equations: Hazen-Williams, Darcy-Weisbach, or Manning's. Base equation selection on the given flow conditions and the pipe materials used. In computations for hydraulic grade line, include head losses (also called minor losses) from change in velocity and direction of flow due to inlet type, valves, bends,

enlargements, or contractions, as appropriate. For closed, pressurized systems, maintain the hydraulic grade line for all pipelines above the top of the pipeline at all locations for all flows, unless specifically designed for negative internal pressures.

Pipe design
Design pipelines to meet all service requirements such that internal pressure, including hydraulic transients or static pressure at any point, is less than the pressure rating of the pipe.

Design flexible conduits such as plastic and metal pipe using NRCS National Engineering Handbook (NEH) (Title 210), Part 636, Chapter 52, “Structural Design of Flexible Conduits,” and the following criteria.

Plastic pipe
When operating at design capacity, limit the full-pipe flow velocity to 5 feet per second in pipelines with valves or other flow control appurtenances placed within the pipeline or at the downstream end. As a safety factor against transient pressures (surge or water hammer), limit the working pressure at any point to 72 percent of the pressure rating of the pipe at the planned operating temperature. If either of these limits must be exceeded, provide special design consideration to the flow conditions, and take measures to adequately protect the pipeline against transient pressures.

Metal pipe
Determine the specified maximum allowable pressure using the hoop stress formula, limiting the allowable tensile stress to 50 percent of the yield-point stress for the material selected. Design stresses for commonly used metal pipes are shown in 210-NEH-636-52. Steel pipe shall meet the requirements of AWWA Specification C-200.

Support of pipe
Where needed, provide support for pipelines installed aboveground to provide stability against external and internal forces. Design pipe support using 210-NEH-636-52.

Joints and connections
Design and construct all connections to withstand the pipeline working pressure without leakage, and leave the inside of the pipeline free of any obstruction that would reduce capacity.

Obtain permissible joint deflection from the manufacturer for the type of joint and pipe material used. Place expansion joints adjacent to and downhill from anchors or thrust blocks in sloping metal pipelines.

Install expansion joints as needed in pipelines with welded pipe joints to limit pipeline stresses to the allowable values.

Base the allowable longitudinal bending for the pipeline on type of material and the pressure rating, and in accordance with industry standards or as described in 210-NEH-636-52.

Design joints for suspended pipelines for pipe loading, including the water in the pipe, wind, ice, and the effects of thermal expansion and contraction.

Joints and connections for metal pipes should be of similar materials whenever possible. If dissimilar materials are used, protect the joints or connections against galvanic corrosion.

Depth of cover
Install buried pipe at sufficient depth below the ground surface to provide protection from hazards imposed by traffic loads, farming operations, freezing temperatures, or soil cracking, as applicable.

Pipelines will have sufficient strength to withstand all external loads on the pipe for the given installation conditions. Use live loads appropriate for the anticipated traffic conditions.

Where it is not possible to achieve sufficient cover or sufficient strength with the pipeline alone, use a carrier (encasement) pipe or other mechanical measures to provide the pipeline system with adequate strength to withstand all anticipated loading conditions.

Pressure reduction
Incorporate pressure-reducing valves or breaker tanks to protect the pipeline in circumstances such as pressure gain exceeding pressure loss by a significant amount, excessive static pressures, or excessive flow rates.

Valves and other appurtenances
Pressure ratings of valves and other appurtenances will equal or exceed the design working pressure. When lever-operated valves are used, perform an analysis to evaluate potential transient pressures, assuming rapid valve closure.

Check valves and backflow prevention
Install a backflow prevention device or air-gap between pump discharge and the pipeline if detrimental backflow may occur. If an air-gap is used, the air-gap must be at least twice the inside diameter of the supply pipe or valve opening, or 1 inch, whichever is greater.

Use approved backflow prevention devices on all pipelines where back flow may contaminate the source water supply or ground water.

Pressure relief valves
Install a pressure relief valve between the pump discharge and the pipeline if excessive pressure can build up when all valves are closed. If needed to protect the pipeline against malfunction or failure of pressure-reducing valves, install pressure relief valves downstream of pressure-reducing valves.

Set pressure relief valves to open at a pressure as low as practical, but no greater than 5 pounds per square inch above the design working pressure rating or maximum allowable pressure of the pipe. The valves shall have sufficient flow capacity to reduce the excessive pressures in the pipeline. Mark the pressure at which the valves start to open on each pressure relief valve. Seal adjustable pressure relief valves or otherwise alter to prevent changing the adjustment from that marked on the valve.

In lieu of a detailed transient pressure analysis, the minimum size of pressure relief valve will be one-fourth inch nominal valve size per inch of the nominal pipeline diameter.

Air vents
Provide for entry and removal of air along the pipeline, as needed to prevent air locking, hydraulic transients, or pipe collapse. Include provisions for air release and vacuum relief, as needed to protect the pipeline. Design the pipeline to remain below the hydraulic grade line during operation. If parts of the pipeline will be located above the hydraulic gradient, periodic use of an air pump may be required.

Surge tanks and air chambers
Where surge tanks or air chambers are required for control of hydraulic transients or water column separation, they will be of adequate size to ensure the water volume needs of the pipeline are met without the tank/chamber being emptied, and the required flow rate into the pipeline for the calculated pressure drop is met.

Outlets and water level control
Appurtenances to deliver water from the pipe to the watering facility will have adequate capacity to deliver the required flow. Where water is supplied continuously to the watering facility, use automatic water level controls (such as float valves) to control the flow of water and to prevent unnecessary overflows.

Design outlets and water level controls to withstand or be protected from damage by livestock, wildlife, freezing, and ice damage. Design outlets to minimize erosion, physical damage, or deterioration due to exposure.

Thrust control
Abrupt changes in pipeline grade, horizontal alignment, or size reductions may require an anchor or thrust blocks to absorb pipeline axial thrust. Thrust control is typically needed at the end of the pipeline and at in-line control valves. Follow the pipe manufacturer's recommendations for thrust control. In absence of manufacturer's data, design thrust blocks using 210-NEH-636-52.

Thermal effects
For plastic pipe, thermal effects must be properly factored into system design. Values and procedures for pressure rating reduction will follow information described in 210-NEH-636-52.

Physical protection
Galvanize steel pipe installed above ground, or protect with a suitable protective paint coating.

Plastic pipe installed aboveground will be resistant to ultraviolet light throughout the intended life of the pipe, or measures must be taken to protect the pipe from damage due to ultraviolet light.

Protect all pipes from hazards presented by traffic loads, farm operations, freezing temperatures, fire, thermal expansion, and contraction. Take reasonable measures to protect the pipe from potential vandalism.

All metal-to-metal fittings, such as risers, bends, tees, and reducers, should be of similar metals. If dissimilar metals are used, the fittings shall be protected against galvanic corrosion (e.g., separate dissimilar metals with rubber or plastic insulator).

When cathodic protection is required, joints and connecting bands shall be electrically bridged to ensure continuous flow of current. A dielectric connection shall be placed between the pump and the pipeline and between pipes with different coatings.

The total current required, kind and number of anodes needed, and life expectancy for the cathodic protection shall be designed in accordance with NRCS Design Note 12, *Control of Underground Corrosion.*

Filling
Provide a means of filling the pipeline that will prevent entrapment of air or excessive transient pressures.

Filling velocities greater than 1 foot per second in a closed-to-the-atmosphere pipe system (i.e., all outlets closed), requires special evaluation and provisions to remove entrapped air and prevent excessive transient pressures.

If filling at a low flow rate is not possible, open the system to the atmosphere (outlets open) prior to pressurizing. Design the system for air removal and excessive transient pressures that may develop at higher filling rates.

Flushing
If the sediment load in the water is significant, design the pipeline with adequate velocity to ensure that sediment is moved through and flushed out of the pipeline.

If provisions are needed for flushing sediment or other foreign material, install a suitable valve at the distant end or low point of the pipeline.

Draining
Make provisions for the complete removal of water from the pipeline by gravity or other means when—

- Freezing temperatures are a hazard.
- Draining is required by the pipe manufacturer.
- Draining of the pipeline is otherwise specified.

The water drained from pipelines must not cause water quality, soil erosion, or safety problems upon release.

Safe discharge of water
Make provisions for water being discharged from valves, especially air valves and pressure relief valves. Locate these valves such that flows are directed away from system operators, livestock, electrical equipment, or other control valves.

Vegetation
Reestablish vegetation or otherwise stabilize disturbed areas as soon as practical after construction. Seedbed preparation, seeding, fertilizing, and mulching will meet applicable criteria in NRCS CPS Critical Area Planting (Code 342).

Safety
Pipeline systems may present a safety hazard to people during installation and operation. Ensure safe conditions by—

- Addressing trench safety in design and during construction.
- Providing protection for people from high pressure water blowing from pressure relief, air release, and other valves.
- Determining the existence or nonexistence of underground utilities prior to construction.

Additional Criteria for Reducing Energy Use
Provide analysis to demonstrate reduction of energy use from practice implementation.

Reduction of energy use is calculated as average annual or seasonal energy reduction compared to previous operating conditions.

CONSIDERATIONS

Economics
Consider economics in pipeline design by—

- Selecting pipe sizes based on lifetime energy requirements, versus initial costs of materials.
- Selecting pipe material based upon the expected service life of practice.
- Considering hydropower applications as alternatives to the use of pressure reducing valves or reduced pipe diameters to induce friction loss.

Other Resources
Consider potential impacts to other resources including the visual design of pipelines and appurtenances, especially in areas of high public visibility.

PLANS AND SPECIFICATIONS

Prepare plans and specifications for livestock pipelines that describe the requirements for applying the practice according to this standard. As a minimum, the plans and specifications will include—

- A plan view of the layout of the pipeline.
- Profile view of the pipeline.
- Pipe sizes, materials, and coatings (if applicable).
- Pipe joint requirements.
- Vents, valves, etc.
- Pipe support requirements, as applicable.
- Site-specific construction specifications that describe in writing the installation of the pipeline.

Include requirements for pressure testing of the pipeline.

- Depth of cover and backfill requirements, as applicable.
- Vegetative establishment requirements, as applicable.

OPERATION AND MAINTENANCE

Develop an operation and maintenance (O&M) plan for each livestock pipeline system installed. The plan should document needed actions to ensure that practices perform adequately throughout their expected life. As applicable, include—

- Recommended operating proceduires to prevent excessive water hammer, etc.
- Valve operation to prevent pipe or appurtenance damage.
- Appurtenance or pipe maintenance.
- Monitoring of cathodic protection systems.
- Draining procedures.
- Maintaining erosion protection at outlets.
- Checking for debris, minerals, algae, and other materials which may restrict system flow.

Develop a filling procedure that details allowable flow rates and appurtenance operation at the various phases of the filling process to assure safe filling of the pipeline. Flow measuring devices, such as flow meters or other means (e.g., number of turns of a gate valve), should be used to determine the rate of flow into the pipeline system. Provide this information to the operator and incorporate it into the O&M plan as appropriate.

REFERENCES

USDA NRCS. 2008. National Engineering Handbook (Title 210), Part 636, Chapter 52, Structural Design of Flexible Conduits. Washington, D.C. https://directives.sc.egov.usda.gov

United States Department of Agriculture

Natural Resources Conservation Service
Practice Specification
Pumping Plant (Code 533)

1. SCOPE

The work shall consist of furnishing materials and installing all components of the pumping facility, as outlined in this specification and the drawings.

2. MATERIALS

All materials used shall conform to the size, type, etc. noted on the plans, set forth in Section 6, or as otherwise listed below:

1. PUMP:

   The pump shall meet the required capacity, pressure, and head requirements, as specified in Section 6 or on the drawings. Pumps shall be compatible and resistant to the type of water or manure being conveyed.

   The contractor shall be responsible for assessing the consistency, nature, quality and quantity of the substance to be pumped, and provide the appropriate equipment. The contractor shall provide in writing, or by performance tables provided by the manufacturer, the pumps performance characteristics (discharge, head, and pressure) and the relationship to or requirements of the following:

   a. Operating power requirements
   b. Estimated service life
   c. Maintenance requirements
   d. Efficiency

2. PIPE:

   Suction and Discharge pipe shall be chosen so that the type and class of pipe exceeds the systems pressure requirement. The operating pressure shall be specified in Section 6 or on the drawings, or as determined by the pump manufacturer. If the pipe is an integral part of another related planned practice or distribution system, the pipe type and class shall meet or exceed the requirements of the pipe installed in that planned system.

   Fittings shall be rated equal to the pipe being specified.

   The pipe and fittings, where applicable, shall be marked by the manufacturer as described in the applicable ASTM specification.

   Used pipe or seconds shall not be used. Pipe shall be approved by the engineer prior to installation.

3. CONTROLS:

   All check valves and directional control valves, gauges, quick disconnects, and automatic controls shall be durable and constructed with a rust resistant, non-corrosive, material able to withstand the type of water, or manure being pumped.

4. SUCTION AND DISCHARGE BAYS:

   Suction and discharge bays shall be designed to conform to the hydraulic characteristics of the pump. They shall be to the dimension and capacity as specified in Section 6 or on the drawings.

   Precast concrete units shall be in conformance with PennDOT specifications for such units and/or comply with ACI-525 and 533. All concrete units shall have a 28-day compressive strength of 4000psi., or greater, and all reinforcement bars shall be of grade 60 steel or higher, unless otherwise specified in Section 6 or on the drawings.

   Portland cement shall be Type I, IA, II, or IIA and conform to ASTM-C150, unless otherwise set forth in Section 6. If Type I or II is used, an air-entrainment agent shall be used.

   Concrete Aggregate shall meet the requirements and gradation specified in ASTM-C33. Coarse aggregate shall meet the gradation for size numbers 57 or 67.

   Reinforcement bars shall conform to ASTM-A615, A616, or A617. Welded wire fabric reinforcement shall conform to ASTM-A185 or A497. Reinforcement shall be free from loose rust, oil, grease, curing compound, paint or other deleterious coatings.

   All rock structures shall be of rock that is durable and resistant to weathering. The rock shall be of the type specified in Section 6 and shall be obtained from a source listed in the most current edition of PennDOT Bulletin #14. The gradation of the rock shall comply with the requirements set forth by the National Crushed Stone Association.

5. HOUSING AND ACCESSORIES:

   Trash racks, housings, and other devices shall be installed as shown on the drawings provided to and concurred in by NRCS. All materials furnished and installed shall conform to the quality and grade noted on the drawings. A site-specific set of construction drawings shall be at the site during construction.

   Wood shall be graded and stamped by an agency accredited by the American Lumber Standards Committee as meeting the required species, grade, and moisture content. All exposed or buried lumber shall be pressure treated. Pressure treated wood products shall be Douglas Fir, Southern Yellow Pine, or as otherwise specified in Section 6 or on the drawings. They shall be treated with preservatives in accordance with the American Wood Preservers Association (AWPA) Standard C16 for “wood used on Farms, Pressure Treatment”. Non-CCA preservative pressure treated lumber shall be used where aquatic life is a concern.

   Roofing material shall be corrugated 29 gage galvanized steel. Equivalent or better material maybe approved by the Engineer.

   Sheet piling shall be of steel or vinyl type. The piling must be of the thickness and grade specified in Section 6, and as recommended by the manufacturer for the intended use. Suitable methods of installing and anchoring the piling shall be as listed in Section 6, and as recommended by the manufacturer.

3. SITE PREPARATION

All trees, brush, fences, and other debris shall be cleared so as not to interfere with construction or proper functioning of the Pumping Plant system. All material removed by the clearing and grubbing operation shall be disposed of as directed by the Owner or his/her Representative.

4. SAFETY

All positive responses from the Pennsylvania One Call System should be shown on the drawings and the Pennsylvania One Call serial number and date noted on the plans. It is the Contractor's or Landowner's responsibility to contact the affected utility for marking at the time of construction.

The Contractor must comply with OSHA requirements Part 1926, subpart P, for protection of workers entering trenches.

5. INSTALLATION

Pipelines shall be placed so that they are protected against hazards imposed by traffic, farm operation, freezing temperatures, or soil cracking. Other means of protection must be provided if the depth required for protection is impractical because of shallow soils over rock or for other reasons.

Trenches for pipeline shall be free of rocks and other sharp-edged materials. The pipe shall be carefully placed to prevent damage.

Before backfilling, the pipeline shall be pressure tested. To pressure test the pipe, fill the pipe with water and test at the design working head and pressure. All leaks must be repaired, and the test must be repeated before backfilling.

All backfilling shall be completed before the line is placed in service. The initial backfill shall be of selected material that is free of rocks or sharp-edged materials that can damage the pipe.

Deformation or displacement of the pipe must not occur during backfilling.

All seeding shall be in accordance with the Critical Area Planting Standard and Specifications (PA342).

6. ADDITIONAL CONDITIONS WHICH APPLY TO THIS PROJECT ARE:

Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

PUMPING PLANT

CODE 533

(no)

DEFINITION

A facility that delivers water or wastewater at a designed pressure and flow rate.

PURPOSE

This practice is used to accomplish one or more of the following purposes:

- Deliver water for improved plant condition, livestock, or wetlands
- Remove excessive subsurface or surface water
- Provide efficient use of water on irrigated land
- Transfer of livestock waste or liquid byproducts as part of a wastewater transfer system
- Reduce energy use

CONDITIONS WHERE PRACTICE APPLIES

This practice applies where conservation objectives require the addition of energy to—

- Pressurize and transfer water from a surface or underground source to irrigated land, wetlands, livestock watering facilities, or reservoirs.
- Transfer water for fire protection, or transfer of manure, wastewater or liquid byproducts.
- Remove surface runoff or excess subsurface water.

The pumping plant includes one or more pumps and associated power units, plumbing, and appurtenances, and may include pressure tanks, onsite fuel or energy source, and protective structures.

For a combustion system replacement, repowering, or retrofit associated with a pumping plant (e.g., pumping plant power unit) for an air quality or energy purpose, use NRCS Conservation Practice Standard (CPS) Combustion System Improvement (Code 372).

CRITERIA

General Criteria Applicable to All Purposes

Plan, design, and construct all pumping plants to comply with all Federal, State, Tribal, and local laws and regulations.

Pump requirements

Select pumps to meet design flow rate, range of operating pressures, and pump-type requirements of the application. Document how the proposed pump meets the requirements using manufacturer-supplied pump curves and other technical data.

Select pump materials based on the physical and chemical qualities of the material being pumped, the operating environment, and manufacturer's recommendations.

Power (drive) units
Select pump drive units based on the availability and cost of power, operating conditions, need for automation, and other site-specific objectives. Match drive units to the pump requirements so the pumping plant can operate efficiently and effectively within the planned range of conditions. Size the pump drive unit to meet the horsepower requirements of the pump, including efficiency, service factor, and environmental conditions.

Electric drive units may include line power, photovoltaic panels, and wind- or water-powered turbines. Install electrical system to meet the requirements of the National Electrical Code. Other drive units may include power take-off (PTO), diesel, gasoline or distillate, or propane running engines. Ensure that diesel power units meet U.S.Environmental Protection Agency Tier 3 or higher engine technology.

Meet applicable design criteria in NRCS or industry standards for renewable energy power units and install units in accordance with manufacturer's recommendations.

Photovoltaic panels
Size the photovoltaic array based on average data for the location and the time of year pumping occurs, according to manufacturer's recommendations. Ensure that the photovoltaic array provides the power necessary to operate the pump at the design flow rate, with the appropriate service factor considering a minimum panel degradation of 10 years. Typically, panels are expected to degrade not more than 1 percent each year. Orient fixed arrays to meet maximum efficiency. Base panel tilt angle on the location latitude and time of year for power requirements. Mount panels securely to resist movement by environmental factors.

Windmills
Size pumping units according to pumping lifts and capacities, as specified by the manufacturer. Base the diameter of the mill on the stroke length and the average wind speed. Size towers to the mill diameter, and to provide proper wind exposure, with adequate height for efficient and safe operation. Locate towers away from obstructions that will block wind movement.

Water-powered pumps (hydraulic rams)
Size pumping units according to flow rate, lift, fall, and efficiency. Return bypass water to the stream or storage facility, without erosion or impairment to water quality.

PTO-driven pumps
Size pump according to delivery rate required at outlet. Match pump size to the available operating equipment in addition to the pump demand.

Variable frequency drives
Prior to installation, it is the landowner's responsibility to inform the electric power provider of the proposed variable frequency drive (VFD) installation. Ensure that the power provider's standards are met regarding potential harmonics (e.g., the Institute of Electrical and Electronics Engineers (IEEE) Standard 519) and other interference issues.

Protect VFDs against overheating. Provide a VFD control panel that has a readout display of flow rate or pressure.

Suction and discharge pipes
Design suction and discharge pipes to prevent cavitation. Account for suction lift, net positive suction head, pipe diameter and length, minor losses, temperature, and altitude. Base the size of suction and discharge pipes on hydraulic analysis, operating costs, and compatibility with other system components.

Include appurtenances such as gate valves, check valves, relief valves, pressure-reducing valves, pressure gauges, pressure tanks, pipe connections, and other protective devices to meet the requirements of the application.

When operating at design capacity, limit the full-pipe flow velocity to 5 feet per second in pipelines with valves or other flow control appurtenances placed within the pipeline or at the downstream end. As a safety factor against transient pressures (surge or water hammer), limit the working pressure at any point to 72 percent of the pressure rating of the pipe at the planned operating temperature. If either of these limits must be exceeded, provide special design consideration to the flow conditions, and take measures to adequately protect the pipeline against transient pressures (surge or water hammer).

Install screens, filters, trash racks, or other devices as needed to prevent the intake of sand, gravel, debris, or other objectionable material into the pump. Design intake screens according to applicable Federal and State guidelines to avoid entrainment or trapping of aquatic organisms.

If chemicals or fertilizers are included in a delivery system using a water source, include backflow prevention devices according to Federal, State, and local laws to prevent contamination of water sources connected to the pumping plant.

Buildings and accessories

Mount floating pumps on floating structures as designed by the manufacturer. Support submersible pumps by a column pipe sufficient to support the pump and static and dynamic loads or provide additional support by stainless steel cable. For all other pumps securely mount on a solid foundation such as pilings or concrete. Design the foundation to safely support the loads imposed by the pumping plant and appurtenances. Use sheet piling or other measures as required, to prevent piping beneath the structure foundation.

Where enclosures, shelters, covers, or other structures are necessary to protect the pumping plant, include provisions for adequate ventilation and accessibility for equipment maintenance, repairs, or removal.

Design suction bays or sumps to prevent the introduction of air into the intake pipe and to eliminate rotating currents.

Design the discharge bay or the connection to the distribution system to meet all hydraulic and structural requirements.

Safety

Design structures and equipment to provide adequate safety features to protect operators, workers, and the public from potential injury. Require drive shaft covers on all exposed rotating shafts.

Construct barriers if needed to protect humans and livestock from the pump or drive unit.

If the project includes excavation, the landowner or contractor is responsible for locating all buried utilities in the project area, including drainage tile and other structural measures.

Additional Criteria for Providing the Efficient Use of Water on Irrigated Land

Include provisions for the connection of flow and pressure measurement devices in the pumping plant system design.

Additional Criteria for the Reduction of Energy Use

Meet or exceed the Nebraska Pumping Plant Performance Criteria for fossil fuel or electrical grid power sources and pumping plant installations, if applicable. Refer to NRCS National Engineering Handbook (NEH) (Title 210), Part 652, Chapter 12, “Energy Use and Conservation,” Table 12–2.

Alternatively, estimate reduced energy use that results directly from the application of this practice. Calculate the estimated annual difference in energy use on an after-practice minus before-practice basis under the same operating conditions. Use a documented assessment methodology as approved by NRCS.

Additional Criteria for Pumping Waste and Waste Byproducts

Size pumps utilized for the transfer of wastewater or manure based on the required system pressure and flow rate determined by the waste management plan. Select the pump type based on the consistency of the material being pumped and the manufacturer's recommendations. See NRCS CPS Waste Transfer (Code 634) for additional criteria.

CONSIDERATIONS

When planning this practice, the following considerations are recommended:

- The removal of surface water by a pumping plant can affect downstream flows or aquifer recharge volumes. Consider potential long-term impacts downstream of the pumping plant.
- If using a pumping plant to remove surface or ground water flowing into a wetland, consider the potential impacts on existing wetland hydrology.
- The operation and maintenance of a pumping plant can involve the use of fuels and lubricants that when spilled may adversely affect surface or ground water quality. Consider measures to protect the environment from potential spills. In some cases, secondary containment of spilled fuel may be required by Federal and State laws or regulations.
- Pumping plants are often constructed in flood-prone areas or can be subject to other unexpected natural events. Consider how the pumping plant may be protected from extreme natural events and the consequences of damage or failure.
- Consider having the visual appearance of pumping plant enclosures or housing compatible with the surrounding environment.
- Consider including protective sensors to detect low or stopped flow, or pressures that are too high or too low.
- Powered pumps can create noise that reaches nuisance levels to the surrounding environment. Consider selecting energy sources compatible with sensitive areas.
- Consider mobile photovoltaic panels for livestock watering facilities to facilitate use in rotational grazing systems.
- Consider photovoltaic panels that track the sun.
- To reduce energy imported on a farm, consider developing and using on-farm solar, wind, or other renewable energy resource for the pump power unit.

PLANS AND SPECIFICATIONS

Prepare plans and specifications for constructing a pumping plant that describe the requirements for properly installing the practice to achieve its intended purpose. As a minimum, the plans and specifications must include—

- A plan view showing the location of the pumping plant in relationship to other structures, water source, pressure tank, pipeline, end use, or natural features.
- Detailed drawings of the pumping plant and appurtenances, such as piping, inlet and outlet connections, mounting, foundations, and other structural components.
- Proposed pump manufacturer-supplied pump curves and data.
- Written specifications that describe the site-specific details of installation.

OPERATION AND MAINTENANCE

Prepare an operation and maintenance plan specific to the pumping plant being installed for use by the owner and responsible operator with specific instructions for operating and maintaining facilities to ensure the pumping plant functions properly as designed. As a minimum, address in the plan—

- Inspection of the pumping plant annually and after significant storm events to identify repair and maintenance needs.
- Inspection or testing of all pumping plant components and appurtenances.
- Proper startup and shutdown procedures for the operation of the pumping plant.
- Routine maintenance of all mechanical components (power unit, pump, drive train, etc.) in accordance with the manufacturer's recommendations, including lubrication of parts.
- Procedures to protect the system from damage due to freezing temperatures.
- Ensuring that tractors driving PTO pumps are secured or blocked as necessary to prevent movement prior to running them.
- When applicable, procedures to frequently check the power unit, fuel storage facilities, hydraulic lines, and fuel lines for leaks and repair as needed.
- Periodic checks and removal of debris as necessary from trash racks and structures to assure adequate flow capacity reaching the pumping plant intake.
- Periodic removal of sediment in suction bays to maintain design capacity and efficiency.
- Inspection and maintenance of anti-siphon and blowback devices, if applicable.
- For photovoltaic panels, that are used year-round, change the tilt angle seasonally as recommended by the manufacturer.
- Routine testing and inspection of all automated components of the pumping plant to assure the proper functioning as designed.
- Inspection and maintenance of secondary containment facilities, if applicable.
- Periodic inspection of all safety features to ensure proper placement and function.
- Disconnecting electrical service and verifying the absence of stray electrical current prior to retrofitting any electrically powered equipment.
- Maintaining records, including manufacturer installation and operation and maintenance guide along with records of when equipment is serviced, work performed, and by whom.
- When applicable, periodically cleaning the solar array of snow, ice, dust, and film to maintain efficiency.

REFERENCES

MidWest Plan Service. 1993. Livestock Waste Facilities Handbook (MWPS-18), Chapter 8, Pumps. Ames, IA.

USDA NRCS. 2010. Oregon Technical Note No. 28, Design of Small Photovoltaic (PV) Solar-Powered Water Pump Systems. Portland, OR.

Irrigation Association. 2015. Pumps and Pumping Systems. Fairfax, VA.

USDA NRCS. 1997. National Engineering Handbook (Title 210), Part 652, Irrigation Guide, Chapter 12, Energy Use and Conservation. Washington, D.C. https://directives.sc.egov.usda.gov/

USDA NRCS. 2016. National Engineering Handbook (Title 210), Part 623, Chapter 8, Irrigation Pumping Plants. Washington, D.C. https://directives.sc.egov.usda.gov/

Natural Resources Conservation Service
Practice Specification
Roof Runoff Structure (Code 558)

1. SCOPE

The work shall consist of furnishing, fabricating, and installing all components of the roof runoff structure(s) as outlined in this specification and as shown on the drawings.

2. MATERIALS

GUTTERS, DOWNSPOUTS, AND SUPPORTS shall be made of aluminum, galvanized steel, wood, or plastic, and the size and type set forth in Section 4, or as shown on the drawings. Aluminum gutters and downspouts shall have a nominal thickness of at least 0.027 and 0.020 in (0.07 and 0.05 cm), respectively. Galvanized steel gutters and downspouts shall be at least 28 gauge. Wood gutters shall be redwood, cedar, cypress, or pressure-treated, and shall be clear and free of knots. Plastics shall contain ultraviolet stabilizers. Supports shall have sufficient strength to withstand anticipated water, snow, and ice loads. The type of supports for manufactured gutters and downspouts shall be determined by the manufacturer's requirements, given the type of installation and type of gutter or downspout.

DRAIN FILL for subsurface drains and driplines shall meet the size and quality requirements of PennDOT Publication 408, Section 704, Type A, Coarse Aggregate, with gradation as shown in Section 4 or in the drawings.

DRAIN PIPE for subsurface drains and drip lines shall be perforated corrugated polyethylene (PE) pipe and fittings meeting the requirements of ASTM F405 or ASTM F667.

APPURTENANCES, such as storage tanks, guard pipe, flush diverters, etc., if required, shall be of the materials set forth in Section 4 and/or the drawings.

3. INSTALLATION

Gutters and drainpipes shall be installed at the locations and grades shown on the drawings. Gutter supports shall have maximum spacing of 48 in (120 cm) for galvanized steel and 24 in (60 cm) for aluminum or plastic. Joints shall be made watertight with the use of mastics or by welding. Dissimilar metals shall not be in contact with each other. Wood gutters shall be mounted on fascia boards using furring blocks that are a maximum of 24 in (60 cm) apart.

Gutters shall be hung so that the outer edge of the gutter is below the projection of the roof line as shown on the drawings. Roof edges shall be nearly level. Replacement or repair of structure members may be necessary to provide a nearly level and uniform roof edge.

Downspouts shall be securely fastened at the top and bottom, with intermediate supports that are a maximum of 10 ft (3 m) apart.

Drain pipe shall be installed in accordance with ASTM F449.

Drain fill shall be placed in the drip drain trench in such a manner so as not to be contaminated with adjacent soil. Geotextile may be used to envelop the bottom and sides of the drain fill to accomplish this. Geotextile shall have properties equal to or exceeding the requirements of NRCS Design Note 24.

Outlets shall be located as shown on the drawings. Where downspouts empty directly onto the ground surface there shall be an elbow to direct the flow away from the building and splash blocks or other protection to prevent erosion. Downspouts shall not outlet into foundation drains.

4. ADDITIONAL CONDITIONS WHICH APPLY TO THIS PROJECT ARE:

Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

ROOF RUNOFF STRUCTURE

CODE 558

(no)

DEFINITION

A structure or system of structures to collect, control, and convey precipitation runoff from a roof.

PURPOSE

This practice may be applied to achieve one or more of the following purposes:

- Protect surface water quality by excluding roof runoff from contaminated areas
- Prevent erosion from roof runoff
- Increase infiltration of roof runoff
- Capture roof runoff for onfarm use

CONDITIONS WHERE PRACTICE APPLIES

Where roof runoff from precipitation needs to be—

- Diverted away from a contaminated area.
- Collected and conveyed to a stable outlet or infiltration area.
- Collected and captured for other uses such as evaporative cooling systems, livestock water, or irrigation.

CRITERIA

General Criteria Applicable to All Purposes

Plan, design, and construct the roof runoff structure to comply with all Federal, State, and local laws and regulations. Notify landowner and/or contractor of their responsibility to locate all buried utilities in the project area, including drainage tile and other structural measures. The landowner is also required to obtain all necessary permits for project installation prior to construction.

Evaluate the condition of the existing roof structure prior to installation of a gutter. Install new fascia boards as needed to support gutters and downspouts for the practice life span. Mount gutters on plumb fascia boards. If the building does not have a fascia board, mount to the rafter ends, adding any necessary appurtenances to ensure the gutters are securely attached and positioned to collect runoff from the roof.

Ensure that the gutter support system will withstand the anticipated loading from precipitation including loads from snow and ice, where applicable. Where snow and ice are expected, install roof gutters below the projection of the roof line. If this is not possible with the existing roof, install rigid supports or wraparound straps. If structural supports are missing or insufficient, design the required supports for the gutter.

Protect the downspouts, laterals, and cross-pipe pipelines from damage by livestock or equipment with heavy-walled pipe, fencing, or other protective measures to exclude livestock and equipment.

Gutter design capacity
To exclude roof runoff from manure contamination, design roof runoff structures to convey the peak flow from a 25-year, 5-minute rainfall event. (Refer to NRCS National Engineering Handbook (Title 210), Part 651, Agricultural Waste Management Field Handbook, Chapter 10, Appendix 10B.)

For other applications, design roof runoff structures to convey the peak flow from a 10-year, 5-minute rainfall event.

Downspout
Design downspouts, collector pipes, lateral downspouts, or cross-pipes with a capacity that equals or exceeds the designed roof gutter flow rate. If downspouts drain directly onto the ground, use an elbow and energy dissipation device at the outlet to provide erosion protection and direct water away from the foundation of the structure by ensuring that ground slopes away from the building.

Ground gutter
If roof gutters are not feasible, ground gutters may be used in some instances. Ground gutters may not be practical for livestock housing where the purpose is to exclude roof runoff from contaminated areas.

Use ground gutters only on buildings with eaves that extend 12 inches or more horizontally from the building. Where runoff from the roof eave drops onto the ground surface, provide a gutter with the same capacity as required for roof gutters. Ground gutters must convey runoff away from the building to a stable outlet without erosion.

Ground gutters can be rock-lined channels, rock-filled trenches with subsurface drains, or concrete channels.

Outlet
Roof runoff can empty into a subsurface drain, underground outlet, a storage tank, a dry well, or onto an energy dissipation device as described above in section “Downspout.”

Size outlets to handle the design flow from the gutter system. Provide accessible cleanouts for subsurface drains, underground outlets, and storage tanks that are used as outlets.

Use NRCS Conservation Practice Standard (CPS) Subsurface Drain (Code 606) to design subsurface drains if necessary to dewater ground gutters or infiltration ditches.

Use NRCS CPS Underground Outlet (Code 620) to design underground outlets to convey roof runoff to a stable outlet. In cold climates, ensure underground outlets are deep enough to avoid freezing or include a method to bypass the outlet without damage to the downspout.

Materials
Roof gutters and downspouts may be made of aluminum, galvanized steel, plastic, or wood. Aluminum gutters must have a minimum nominal thickness of 0.027 inches. Aluminum downspouts of 3 inches by 4 inches must have a minimum nominal thickness of 0.019 inches. Aluminum downspouts larger than 3 inches by 4 inches must have a minimum nominal thickness of 0.024 inches. Galvanized steel gutters and downspouts must be a minimum of 28 gauge. Plastics must contain ultraviolet stabilizers. Wood gutters must be made of rot-resistant wood free of knots.

To prevent corrosion, avoid contact between components of dissimilar metals.

To improve infiltration for rock-filled trenches and dry wells, use poorly graded gravel.

Where traffic, climatic, or other conditions necessitate the use of reinforced concrete for channels, pads, and slabs, refer to NRCS National Engineering Manual (NEM) (Title 210), Part 536, Section 536.20, “Design Criteria for Reinforced Concrete,” for design and installation of reinforced concrete.

Where nonreinforced concrete is acceptable, refer to NRCS 210-NEM-536, Section 536.22, “Design Criteria for Concrete Slabs-on-Ground,” for design and installation of nonreinforced concrete.

Additional Criteria to Increase Infiltration

Increase runoff infiltration by directing flow to existing vegetation or infiltration features (e.g., lawns, mass planting areas, existing natural areas, infiltration trenches, dry wells, rain gardens, or natural areas). Ensure these areas have the capacity to infiltrate the runoff without flowing directly to surface or ground water, causing excessive erosion, or adversely affecting the desired plant species.

Additional Criteria to Capture Water for Other Uses

Roof runoff can be contaminated with environmental pollutants that have settled on the roof between runoff events. This may make the captured runoff unsuitable for uses such as drinking water for livestock without treatment. The operator is responsible for ensuring that the quality of the runoff is suitable for the intended purpose.

If runoff water is to be stored, determine the tank size based on the planned use of the captured water. Select tank materials that have adequate strength and durability to hold water for the intended purpose and length of time required. Use materials that will not degrade the quality of the stored water for its intended use. Include a drain to allow maintenance of the tank and to protect from damage from freezing.

Install the storage tank on a firm, level foundation that will not settle differentially. Examples of suitable foundation materials are bedrock, concrete, compacted gravel, and stable well-compacted soils. Where necessary, prepare the foundation by removal and disposal of materials that are not adequate to support the design loads. Anchor or brace aboveground tanks as needed to prevent overturning or sliding by wind and animals.

Use NRCS design procedures or manufacturer’s guidelines to ensure that buried tanks will withstand all earth and vehicle loads anticipated for the site.

Include provisions for access to the tank for maintenance and repairs. However, ensure that access points will limit unintended or unauthorized access.

Design tanks connected directly to gutters and downspouts to bypass runoff events that exceed the design capacity of the tank. Include provisions to convey overflows to a stable outlet without excessive erosion.

CONSIDERATIONS

Gutter size can be decreased by increasing the number of downspouts. When designing a gutter and downspout system consider the balance between gutter size and the spacing and sizing of downspouts to optimize the design.

If roof runoff will be used for livestock drinking water or other applications where reliable water quality is desired, the runoff should be treated before being consumed by livestock or otherwise used. This might include bypassing the first flush of runoff which often contains the majority of pollutants. Depending on the use of the runoff, additional actions may be necessary, such as settling and filtration to remove suspended particles and treatment of pathogens with ultraviolet light or chlorination. See International Code Council, CSA/ICC 805-2018, “Rainwater Harvesting Systems,” for information on water quality treatment options for different end uses of the collected water.

When underground outlets are used, consider either a strainer at the head of the downspout, or a clean-out port on the riser pipe.

For cold climates, ensure the underground outlet is deep enough to avoid freezing or include a method to bypass the outlet without damage to the downspout.

Discharging roof runoff outlets near wells and sinkholes or directly into drainage ditches, streams, or ponds can be a point source of pollution. Consider the use of vegetative filter areas, such as raingardens, at outlets to minimize the pollution potential from roof runoff.

Consider the use of wraparound straps in lieu of rigid supports on steep roofs where the outer edge of the gutter cannot be placed below the projected roof line.

On roofs subject to snow and ice slides, consider additional supports even if the gutter is installed below the projected roof line.

PLANS AND SPECIFICATIONS

Provide plans and specifications that describe the requirements for applying this practice to achieve its intended purpose. As a minimum, include—

- A plan view showing the layout of gutters, downspouts, and outlets.
- Details of gutter installation, including necessary cross sections and slope of gutters.
- Details on the protection of downspouts from damage.
- Details on outlets, storage tanks, or infiltration areas as appropriate.
- Any other site-specific detail drawings necessary for the installation of the practice.
- Requirements for stabilization of any areas disturbed by the installation of the practice.
- Construction specifications describing the installation of the practice, materials, and quantities.

OPERATION AND MAINTENANCE

Prepare an operation and maintenance plan and review it with the operator. Describe the actions that must be taken to ensure that the facility functions properly for its design life. As a minimum, include—

- A schedule for regularly checking the gutters and downspouts for removal of any accumulated debris, damage from weather events, livestock, and equipment. Additional checks should be made after significant weather events (rain, snow, ice, extended cold periods, or high winds).
- Ensuring that the outlets are freely operating and not causing erosion.
- Ensuring roof runoff structures are clean, operating properly, and overflows are not causing erosion.
- Promptly repairing or replacing any damaged components.

REFERENCES

International Code Council. 2018. CSA/ICC 805-2018 Rainwater Harvesting Systems. ICC, Washington, D.C. https://codes.iccsafe.org/content/CSAB8052018P1

Rose, W. 1990. Gutters and Downspouts for the Home. Small Homes Council-Building Research Council. University of Illinois, Urbana-Champaign, IL. http://hdl.handle.net/2142/54649

USDA NRCS. 2021. National Engineering Handbook (Title 210), Part 650, Chapter 2, Estimating Runoff Volume and Peak Discharge. Washington, D.C. https://directives.sc.egov.usda.gov

USDA NRCS. 2009. National Engineering Handbook (Title 210), Part 651, Agricultural Waste Management Field Handbook, Chapter 10, Agricultural Waste Management System Component Design. Washington, D.C. https://directives.sc.egov.usda.gov

USDA NRCS. 2014. National Engineering Handbook (Title 210), Part 642, Construction Specification 32, Structure Concrete. Washington, D.C. https://directives.sc.egov.usda.gov

USDA NRCS. 2017. National Engineering Manual (Title 210), Part 536, Section 536.20, Design Criteria for Reinforced Concrete Structures. Washington, D.C. https://directives.sc.egov.usda.gov

Practice Specification
Roofs and Covers (Code 367)

1. SCOPE

The work shall consist of furnishing materials and installing all components of the roof or cover, as outlined in this specification and the drawings.

Construction work covered by this specification shall not be performed between December 1 and the following March 15 unless the site conditions and/or the construction methods to be used have been reviewed and approved by the Engineer or his/her designated Representative.

2. MATERIALS

All materials used shall conform to the quality and grade noted on the drawings, set forth in Section 8, or as otherwise listed below:

PORTLAND CEMENT shall be Type I, IA, II or IIA and conform to ASTM-C150, unless otherwise set forth in Section 8. If Type I or II is used, an air-entrainment agent shall be used.

CONCRETE AGGREGATE shall meet the requirements and gradation specified in ASTM-C33. Coarse aggregate shall meet the gradation for size numbers 57 or 67.

WATER used in mixing or curing concrete shall be clean and free from injurious amounts of oil, acid, salt, organic matter or other deleterious substances.

REINFORCEMENT BARS shall be grade 40 or higher, and shall conform to ASTM- A615, A616, or A617. Welded wire fabric reinforcement shall conform to ASTM-A185 or A497. Reinforcement shall be free from loose rust, oil, grease, curing compound, paint or other deleterious coatings.

CONCRETE ADMIXTURES shall conform to ASTM-C260 for air-entrainment, and ASTM-C494, type A, D, F or G, for water- reduction and set-retardation, and type C or E for non-corrosive accelerators.

POZZOLAN shall conform to ASTM-C618, Class F, except loss of ignition shall not exceed 3.0 percent.

CURING COMPOUND shall meet the requirements of ASTM-C309, Type 2, Class A or B or as otherwise required in Section 8.

MASONRY COMPONENTS shall meet the requirements of ASTM-C90 & C270, and placed in accordance with ACI-530.

PRECAST CONCRETE units shall comply with ACI-525 and 533.

PREFORMED EXPANSION JOINT FILLER shall conform to the requirements of ASTM- D1752, Type I, II, or III, unless bituminous type is specified, in which case it shall conform to ASTM-D994 or D1751.

JOINT SEALERS shall conform to the requirements for ASTM-C920, Federal Specification SS-S-210A, or Federal Specification TT-S-227, as appropriate for the specific application.

WATERSTOPS. Vinyl-chloride polymer types shall be tested in accordance with Federal Test Method Standard No. 601, and shall show no sign of web failure due to brittleness at a temperature of -35 degrees Fahrenheit. Colloidal (bentonite) waterstops shall be at least 75 percent bentonite in accordance with Federal Specification SS- S-210A. Non-colloidal waterstops shall only be used if approved by the Engineer.

METALS shall conform to the following standards:

Structural steel - ASTM-A36

Carbon steel - ASTM-A283, grade C or D; or A611, grade D; or A570, grade C or D

Aluminum alloy - ASTM-B308, B429, B221, B210, B211, or B209

Bolts - ASTM-A307; zinc coating shall conform to ASTM-A153, B633 (cond. SC3), A165 (type TS).

Screws - wrought iron or medium steel Split or tooth-ring connectors - hot-rolled, low carbon steel conforming to ASTM- A711, grade 1015

WOOD shall be graded and stamped by an agency accredited by the American Lumber Standards Committee as meeting the required species, grade, and moisture content. In the absence of such a stamp, the Contractor or material supplier shall provide written certification that the wood products meet the designated quality criteria.

MANUFACTURED TRUSSES shall be certified as having been designed and built to Truss Plate Institute standards.

PRESSURE TREATED WOOD PRODUCTS shall be Douglas Fir, Southern Yellow Pine, or as otherwise specified on the drawings or in Section 8. They shall be treated with preservatives in accordance with the American Wood Preservers Association (AWPA) Standard C16, “Wood Used on Farms, Pressure Treatment.” Each piece shall bear the AWPA stamp of quality. In the absence of such a stamp, the Contractor or material supplier shall provide written certification that the pressure treated wood meets the designated quality criteria.

FASTENERS for roofs and covers shall be stainless steel and/or galvanized in accordance with ASTM A153, and/or A653 Class G185, and Type 304 or 316, or otherwise protected from corrosion due to contact with moisture, manure and associated gasses. All fasteners, connectors, and any other metal contacting ACZA, ACQ or CA treated wood shall be stainless steel, in accordance with Supplement A below.

GEOMEMBRANES shall comply with the requirements of Construction Specification PA521A-PE/PP, as applicable.

3. FOUNDATION PREPARATION AND CONDITIONS

All trees, brush, fences, and rubbish shall be cleared within the area of the structure, including any appurtenances, and borrow areas. All material removed by clearing and excavation operations shall be disposed of as directed by the Owner or his/her Representative. Sufficient topsoil shall be stockpiled in a convenient location for spreading on disturbed areas. All structures shall be set on undisturbed soil or non-yielding compacted material. Over excavation must be corrected as noted on the drawings or as directed by the Engineer or his/her designated Representative.

In addition to uniformity, the existing subgrade material must have sufficient strength to support the structure and its associated loads. Organic soil or soils with high percentages of clays and silts shall be removed. A base course (a layer of granular material placed on the subgrade prior to placement of concrete) may be used to improve the stability of the foundation. In addition, geosynthetics may be used, if approved by the Engineer, to further separate and/or stabilize the foundation.

Surface and subsurface drainage systems shall be installed and operating adequately to remove water from the foundation to allow for proper structure placement.

Drainfill upon which concrete is to be placed shall be covered with a geosynthetic that has an AOS between 20 and 100, inclusive.

Concrete shall not be placed until the subgrade, forms and steel reinforcements have been inspected and approved by the Engineer or his/her designated Representative. Notification shall be given far enough in advance to provide time for the inspection.

Prior to placement of concrete, the forms and subgrade shall be free of chips, sawdust, debris, standing water, ice, snow, extraneous oil, mortar or other harmful substances or coatings.

Earth surfaces against which concrete is to be placed shall be firm and damp. Placement of concrete on mud, dried earth or uncompacted fill or frozen subgrade will not be permitted.

4. CAST-IN-PLACE CONCRETE STRUCTURES

a. Concrete Forms

Forms shall be of wood, plywood, steel, or other approved material and shall be mortar tight. The forms and associated falsework shall be substantial and unyielding and shall be constructed so that the finished concrete will conform to the specified dimensions and contours.

Form surfaces shall be smooth and essentially free of holes, dents, sags, or other irregularities. Forms shall be coated with form oil before being set into place. Care shall be taken to prevent form oil from coming in contact with steel reinforcement.

b. Concrete Mix

Concrete for structures shall have a 28-day compressive strength of at least 4000 psi, unless otherwise specified on the drawings or in Section 8. The Contractor shall be responsible for the design of the mix and certification of the necessary compressive strength. Current certification of the design mix by Penn DOT may be accepted in lieu of additional testing.

The slump shall be 3 to 6 inches (without superplasticizers, if any); the air content by volume shall be five to seven percent of the volume of the concrete. Admixtures such as superplasticizers, water-reducers and set-retarders may be used provided they are approved by the Engineer prior to concrete placement and are used in accordance with the manufacturer's recommendations. Superplasticizers (ASTM C494, Type F or G) may be added to concrete that has a 2 to 4 inch slump before the addition, and that is not warmer than 95°F. The slump shall not exceed 7½ inches with the addition of superplasticizer.

c. Mixing and Handling Concrete

In general, concrete shall be transported, placed, and consolidated in accordance with ACI-304, of which some specific interpretations are set forth below.

The supplier shall provide a batch ticket to the Owner or Technician with each load of concrete delivered to the site. The batch ticket shall state the class of concrete, any admixtures used, time out, and the amount of water that can be added at the site and still be within the design mix limits. Concrete shall be uniform and thoroughly mixed when delivered to the job site. The Contractor shall test slump and air entrainment as necessary to insure that the concrete meets the requirements of this specification. Variations in slump of more than one inch within a batch will be considered evidence of inadequate mixing and shall be corrected or rejected. No water in excess of the amount called for by the job design mix shall be added to the concrete.

For concrete mixed at the site, the mixing time after all cement, aggregates and water are in the mixer drum shall be at least 1-1/2 minutes.

Concrete shall be conveyed from the mixer to the forms as rapidly as practical by methods that will prevent segregation of the aggregates or loss of mortar. Concrete shall be placed in the forms within 1-1/2 hours after the introduction of cement to the aggregate unless an approved set-retarding admixture is used in the mix. During periods of hot weather, it may be necessary to reduce this time.

Concrete shall not be dropped more than 5 feet vertically unless special equipment is used to prevent segregation.

Superplasticized concrete shall not be dropped more than 12 feet unless special equipment is used to prevent segregation.

Slab concrete shall be placed at the design thickness in one layer. Formed walls shall be placed in layers not more than 24-inches high, unless superplasticizer is used, in which case the maximum layer shall be 5 feet. Each layer shall be consolidated to insure a good bond with the preceding layer.

Immediately after placement, concrete shall be consolidated by spading and vibrating, or by spading and hand tamping. It shall be worked into corners and angles of the forms and around all reinforcement and embedded items in a manner that prevents segregation or in the formation of "honeycomb." Excessive vibration that results in segregation of materials will not be allowed. Vibration must not be used to make concrete flow in forms, slabs, or conveying equipment.

If the surface of a layer in place will develop its initial set, i.e., will not flow and merge with the succeeding layer when vibrated, a construction joint shall be made. Construction joints shall be made by cleaning the hardened concrete surface to exposed aggregate by sandblasting, air/water jetting, or hand scrubbing with wire brush, and keeping the concrete surface moist for at least one hour prior to placement of new concrete. Concrete surfaces do not require extensive finishing work; however, the surface shall be smooth and even with concrete paste worked to the surface to fill all voids. The concrete surface must be watertight. Careful screeding (striking-off) and/or wood float finishing shall be required, unless otherwise shown on the drawings. Exposed edges shall be chamfered, either with form molding or molding tools.

The addition of dry cement or water to the surface of screeded concrete to expedite finishing is not allowed.

d. Reinforcing Steel Placement

Reinforcement shall be accurately placed and secured in position in a manner that will prevent its displacement during the placement of concrete. In forms, this shall be accomplished by tying temperature and shrinkage steel or special tie bars (not stress steel) to the form “snap ties” or by other methods of tying. In slabs, steel shall be supported by precast concrete bricks (not clay bricks), or metal or plastic chairs. Except for dowel rods, placing steel reinforcement into concrete already in place shall not be permitted.

The following tolerances will be allowed in the placement of reinforcing bars shown on the drawings:

1. Maximum reduction in cover:
    - from formed and exposed surfaces - 1/4 inch
    - from earth surfaces - 1/2 inch
2. Maximum variation from indicated spacing - 1/12th of indicated spacing

Splices of reinforcing bars shall be made only at the locations shown on the drawings, unless otherwise approved by the Engineer. Unless otherwise required, welded wire fabric shall be spliced by overlapping sections at least one full mesh dimension plus two inches. All reinforcement splices shall be in accordance with ACI 318.

Reinforcing steel shall not be welded, unless approved by the Designer. The ends of all reinforcing steel shall be covered with at least 1-1/2 inches of concrete.

e. Curing

Concrete shall be prevented from drying for at least seven days after it is placed. Exposed surfaces shall be kept continuously moist during this period by covering with moistened canvas, burlap, straw, sand or other approved material unless they are sprayed with a curing compound. Wooden forms left in place during the curing period shall be kept wet.

Concrete, except at construction joints, may be coated with a curing compound in lieu of continuous application of moisture. The compound shall be sprayed on moist concrete surfaces 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. Concrete shall be wet cured or remain in forms until immediately before patching, repairs, or finishing is performed. Curing compound shall not be allowed on any rebars.

Curing compound shall be applied in a uniform layer over all surfaces requiring protection at a rate of not less than one gallon per 150 square feet of surface. Surfaces subjected to heavy rainfall or running water within three hours after the curing compound has been applied, or otherwise damaged, shall be resprayed.

Any construction activity which disturbs the curing material shall be avoided during the curing period. If the curing material is subsequently disturbed, it shall be reapplied immediately.

Steel tying or form construction adjacent to new concrete shall not be started until the concrete has cured at least 24 hours. Vehicles, overlying structures, or other heavy loads shall not be placed on new concrete

slabs for at least three days, unless the concrete strength can be shown to be adequate to support such loads.

f. Form Removal and Concrete Repair

Forms for walls and columns shall not be removed for at least 24 hours after placing the concrete. When forms are removed in less than seven days, the exposed concrete shall be sprayed with a curing compound or be kept wet continuously for the remainder of the curing period. Forms which support beams or covers shall not be removed for at least seven days, or 14 days if they are to support forms or shoring.

Forms shall be removed in such a way as to prevent damage to the concrete. Forms shall be removed before walls are backfilled. Columns shall be at least seven days old before any structural loads are applied.

Where minor areas of the concrete surface are “honeycombed,” damaged or otherwise defective, the area shall be cleaned, wetted and then filled with a dry-pack mortar. Dry- pack mortar shall consist of one part Portland cement and three parts sand with just enough water to produce a workable paste.

g. Concreting in Cold Weather

Concreting in cold weather shall be performed in accordance with ACI-306R-88. In addition, the contractor shall provide a written plan at least 24 hours in advance of placing concrete in cold weather, and shall have the necessary equipment and materials on the job site before the placement begins.

h. Concreting in Hot Weather

Concreting in hot weather shall be performed in accordance with ACI 305, of which some specific interpretations are set forth below. The supplier shall applyeffective means to maintain the temperature of concrete below 90 degrees Fahrenheit during mixing and conveying. Exposed surfaces shall be continuously moistened by means of fog spray or otherwise protected from drying during the time between placement and finishing and during curing. Concrete with a temperature above 90 degrees Fahrenheit shall not be placed.

i. Backfilling New Concrete Walls

Backfilling and compaction of fill adjacent to new concrete walls shall not begin in less than 14 days after placement of the concrete, except that walls that can be backfilled on both sides simultaneously may be done so within seven days.

Heavy equipment shall not be allowed within three feet of a new concrete wall. Provide compaction near the wall by means of hand tamping or small, manually-directed equipment.

5. WOOD STRUCTURES

All framing shall be true and exact. Timber and lumber shall be accurately cut and assembled to a close fit and shall have even bearing over the entire contact surfaces. Nails and spikes shall be driven with just sufficient force to set the heads flush with the wood surface. Deep hammer marks in the wood shall be considered evidence of poor workmanship and may be sufficient cause for rejection of the work.

Holes for lag screws shall be bored with a bit not larger than the body of the screw at the base of the thread. Holes for bolts shall be bored with a bit no more than 1/16” larger than the bolt diameter to achieve a snug fit without forcibly driving the bolt.

Washers shall be used in contact with all bolt heads and nuts that would otherwise be in contact with wood.

All joints shall be fastened with the number, type, and size of fasteners specified, at the locations or spacing specified.

If field cuts of pressure-treated wood expose untreated interior wood, the untreated surfaces shall be covered with two coats of a liquid preservative, as approved by the Engineer.

Roof trusses shall be handled, installed and braced according to the Truss Plate Institute's HIB-91, "Handling, Installing and Bracing MPC Wood Trusses."

Wood structures shall be backfilled within the limits shown on the drawings by placing material in uniform lifts not to exceed nine inches. Compaction within three feet of walls shall be accomplished by means of hand tamping or small manually-directed equipment.

6. GEOMEMBRANE STRUCTURES

Semi-rigid and flexible covers which utilize geomembranes shall be installed as required by the manufacturer, and as otherwise set forth in Section 8 and Construction Specification PA521A-PE/PP.

7. STRUCTURES INSTALLED ACCORDING TO STANDARD DETAIL DRAWINGS PREPARED BY OTHERS

Commercially available structures shall be installed as shown on the drawings provided to and concurred in by NRCS. All materials furnished and installed shall conform to the quality and grade noted on the drawings. A site specific set of construction drawings shall be at the site during construction.

Modification of the structure outside limits shown on the drawings shall not be made without prior review and approval by the Engineer with appropriate approval authority. The Supplier or Contractor who submitted the original standard detail drawings shall be responsible for making any changes. Sufficient design documentation to allow an adequate review of the proposed modification shall accompany any request for a change.

Within thirty (30) days of the completion of construction of the structure, the Contractor or Supplier shall furnish written certification to the Engineer that all aspects of the installation are in conformance with the requirements of the drawings and specifications.

8. ADDITIONAL CONDITIONS WHICH APPLY TO THIS PROJECT ARE:

Supplement A – "Guidelines for Selecting Corrosion-Resistant Fasteners for Use with Preservative-Treated Wood"

Based on a review of technical information posted by the major U. S. preservative manufacturers and selected fastener and connector manufacturers, the following guidelines summarize the current state-of-practice regarding the selection of metal fasteners and connectors for use with ACQ and copper azole (CA) preservative-treated wood:

AWPA Use Category and Description	**Appropriate Fastener/Connector Types**
UC 3A or B – Exterior Construction, Above Ground UC 4A – Ground Contact or Fresh Water, Non-critical components	Fasteners Hot-Dipped (HD) Galvanized per ASTM A153 or Stainless Steel (SS), Type 304 or 316 Connectors HD Galvanized per ASTM A653, Class G185 or Stainless steel, Type 304 or 316
UC 4B - Ground Contact or Fresh Water, Critical components or difficult to replace	Stainless steel, Type 304 or 316

Other Preservatives:

1. For CCA-treated wood, HD galvanized fasteners and connectors as specified above are recommended. CCA is less corrosive than ACQ and CA.
2. For ACZA-treated wood, SS fasteners and connectors as specified above are recommended. ACZA contains ammonia and is significantly more corrosive than ACQ and CA.
3. For other preservatives, the more stringent of the preservative manufacturer's recommendations and the fastener/connector manufacturer's recommendations should be followed.

Notes regarding NRCS-type structures:

1. Use Category UC 3A and B include railings, decking, bracing, and slats on composter bins.
2. Use Category UC 4A includes posts such as those used in composter bins.
3. Use Category UC 4B includes structural building poles and permanent wood foundations.

Specific Site Requirements

Reset

Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

ROOFS AND COVERS

CODE 367

(no)

DEFINITION

A rigid, semirigid, or flexible manufactured membrane, composite material, or roof structure placed over a waste management facility, agrichemical handling facility, or an on-farm secondary containment facility.

PURPOSE

Use this practice to accomplish one or more of the following purposes–

- Protect clean water by excluding precipitation from potential contaminants.
- Improve waste management and utilization to protect nearby surface water quality.
- Reduce emissions of ammonia, odorous sulfur compounds, greenhouse gases, volatile organic compounds, and particulate matter to improve air quality.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies where—

- Precipitation should be excluded from the following areas: animal feeding and management areas, on-farm secondary containment facilities, facilities for waste storage, animal mortality, composting, waste transfer or waste treatment, and agrichemical handling.
- Biotreatment of emissions using a porous cover on a wastewater storage facility is needed to improve air quality, limit odors, and moderate the net effect of greenhouse gas emissions.
- A cover is needed to exclude precipitation from a waste management facility. Auxiliary elements of the cover will also capture and manage biogas emissions, improve air quality, limit odors, and reduce the net effect of greenhouse gas emissions.
- Biogas capture for energy production is a component of an existing or planned waste management system. Biogas capture and utilization will also improve air quality, limit odors, and reduce the net effect of greenhouse gas emissions.

This practice does not apply to NRCS Conservation Practice Standard (CPS) High Tunnel System (Code 325).

CRITERIA

General Criteria Applicable to All Purposes

Laws and Regulations

Plan, design, and construct the roof and covers to meet all Federal, State, Tribal, and local laws and regulations.

Materials
Select the type, thickness and material properties of the roof or cover and any supporting members after accounting for all loads and stresses due to operational, environmental, and climatic conditions.

Design
Design roofs and covers to withstand all anticipated loads in accordance with the requirements in Title 210, National Engineering Manual, Part 536, “Structural Design” (210-NEM-536) including all anticipated loads in the structural design for facility components that serve as part of the foundation or support for a roof or cover. See the sections below, on Additional Criteria for Rigid and Semi-rigid Roofs and Covers, and Additional Criteria for Flexible Covers.

Refer to NRCS CPS Waste Storage Facility (Code 313) or NRCS CPS Agrichemical Handling Facility (Code 309) for structural design criteria of the foundations associated with these respective practices. Account for all items that will influence the performance of the roof or cover, including strength, durability, serviceability, material properties and construction quality in the current editions of the following material references, as well as other references as appropriate as noted in Title 210, National Engineering Manual, Part 536, “Structural Design” (210-NEM-536):

- Steel. Manual of Steel Construction, AISC, American Institute of Steel Construction.
- Timber. National Design Specifications for Wood Construction, American Wood Council.
- Concrete Appropriate ACI Standard (see 210-NEM-536), American Concrete Institute.
- HDPE/LLDPE Geomembrane. HDPE and LLDPE Geomembrane Installation Specification, International Association of Geosynthetic Installers.

Access
Provide suitable access for normal operation and maintenance of a facility which is enclosed as the result of a roof or cover.

Venting
For an enclosed roof structure located over animals, manure storage, or petroleum product storage, provide ridge or end vent openings of at least 2 inches per 10-foot-width of building. This prevents buildup of moisture and gases in the attic area.

For enclosed buildings, provide mechanical (exhaust fans) or natural (adequate openings) ventilation in order to maintain a safe working environment when human entry is intended. Refer to American Society of Agricultural and Biological Engineers’ (ASABE’s) document, *ASABE S607, Ventilating Manure Storages to Reduce Entry Risk* for design standards.

Safety
Provide safety features, including fences and warning signs, as appropriate, to prevent undue hazards from biogases and drowning. Refer to ASABE’s document, *ASAE EP470.1, Manure Storage Safety* for guidance.

Design covers and grating over openings such that livestock and humans cannot accidentally displace them and fall into the facility.

Equip openings in covered tank with grills or secure covers for safety, and for odor and vector control.

Include provisions in the design to prevent the unintentional conveyance of biogas to any facilities connected to the installed roof or cover.

Additional Criteria for Rigid and Semirigid Roofs and Covers -
Design rigid and semirigid roofs and covers to withstand all anticipated loads including, but not limited to, internal and external loads, uplift pressure, concentrated surface and impact loads and load combinations in compliance with this standard. Design roofs, covers and associated support systems to resist all applicable loads including wind, snow, and seismic loads as specified in the current version of American

Society of Civil Engineers (ASCE), Standard ASCE 7, *Minimum Design Loads for Buildings and Other Structures*. In lieu of compliance with ASCE 7, use the applicable provisions of the current International Building Code (IBC) to develop design loads and load combinations.

Design covers intended for vehicle, equipment and/or livestock traffic to withstand anticipated dead and live loads. The minimum live load design values for covers are contained in ASABE ASAE EP378.4, *Floor and Suspended Loads on Agricultural Structures Due to Use*, and ASAE EP393.3, *Manure Storages*. For tank wagons having more than a 2,000-gallon capacity, use the actual axle load for design.

Follow criteria outlined in NRCS CPS Roof Runoff Structure (Code 558) for structural practices to collect, control and convey roof runoff away from the contaminated area. Divert any outside surface water from entering the roofed area.

Treated Wood

Use preservative-treated wood when wood members are exposed to animal waste or elements that deteriorate wood. Preservative-treated wood must meet the applicable American Wood Protection Association (AWPA) Standards or have an evaluation service report (ESR) prepared by an organization recognized by the International Code Council (ICC). Treated wood in contact with animal wastes or as critical components that are difficult to replace, shall meet AWPA UC4B or equivalent for heavy-duty ground contact.

Aluminum fasteners, connectors, or cladding must not be used in direct contact with treated wood unless specifically allowed by the preservative manufacturer. Use hot-dipped galvanized or stainless steel bolts, washers, nuts, nails, and other hardware which meet American Society for Testing and Materials (ASTM) specifications A153 for fasteners and ASTM A653 coating designation G185 for sheet metal connectors, or ASTM A240 for Type 304 or 316 stainless steel, except as noted below. Fasteners and connectors of other materials may be used if specifically allowed by the preservative manufacturer. All fasteners, connectors, and any other metal in contact with Alkaline Copper Quaternary (ACQ), micronized copper quaternary (MCQ), Copper Azole (CA), Micronized Copper Azole (MCA), or Dispersed Copper Azole (μCA-C) treated wood shall be stainless steel if the conditions for AWPA Use Category UC4B apply, if in direct contact with manure, or if constant, repetitive, or where long periods of wet conditions may occur. All fasteners, connectors, and any other metal in contact with wood treated with Ammoniacal Copper Zinc Arsenate (ACZA) or any other preservative containing ammonia must be stainless steel.

Repair

Allow use of sectional replacement repair for rigid or semirigid roof and cover material.

Additional Criteria for Flexible Covers -

For fabrication of flexible membrane inflated and floating covers, use only membrane materials which have been certified by the manufacturer as suitable for the intended application.

Design flexible membrane cover systems to resist snow, wind, and wind uplift loads as appropriate. Design shall also include a system to properly tension the liner and to hold it down during up to a 105-mph wind.

Design floating covers to fluctuate with rising and falling liquid levels to properly manage the waste storage facility.

Include floatation materials on floating membrane covers as necessary for proper cover performance, and operation and maintenance tasks.

Design impermeable floating covers with a biogas collection, transfer, and control system to provide protection for the cover and convey biogas to a flare, release, or control point. Design shall include methods to address moisture, sedimentation, and flame trap. Such systems shall also include method(s) to collect and remove rainfall and snowmelt, and emergency release vents for excessive gas buildup. Manure to be under such covers shall be processed to reduce solids and remove sand, unless otherwise

approved by the State Conservation Engineer. All systems shall have a method to circulate/agitate and unload the waste material.

Design biogas handling systems with the capacity to handle the large range in gas production that can occur as a result of changing ambient temperatures and substrate conditions.

Design inflated covers to be—

- Equipped with a warning system to notify operator of blower failure for mechanically forced air systems.
- Provided with a support system to limit cover collapse.

Use table 1 to select the minimum thickness for flexible geomembrane cover materials.

Table 1. Flexible geomembrane cover materials.

Type for	**Minimum Thickness Criteria**	
Purpose	***Contain Biogas***	***Divert Clean Water***
HDPE	40 mil	30 mil
LLDPE	40 mil	30 mil
LLDPE-R	36 mil	24 mil
PVC	40 mil	30 mil
EPDM	45 mil	45 mil
FPP	40 mil	30 mil
FPP-R	36 mil	23 mil
PE-R	NR	23 mil

1 mil = 1/1000 of an inch

HDPE – High Density Polyethylene Geomembrane

LLDPE – Linear Low Density Polyethylene Geomembrane

LLDPE-R – Reinforced Linear Low Density Polyethylene Geomembrane,

PVC – Polyvinyl Chloride Geomembrane

EPDM – Ethylene Propylene Diene Terpolymer Geomembrane

FPP – Flexible Polypropylene Geomembrane

FPP-R – Reinforced Flexible Polypropylene Geomembrane PE-R – Reinforced, Slit –Film, Woven Polyethylene Geomembrane

NR – Not Recommended

Repair.
Use only flexible cover material which is readily repairable. Repair may be made by solvent, adhesive, thermoplastic welding, or other methods according to manufacturer's recommendation.

Additional Criteria for Biogas Control/Utilization-

Biogas Emissions
The cover system will provide for bio-reduction and treated release of gaseous emissions, contain and manage release of gaseous emissions, or capture and control or utilization of biogas, as appropriate.

- Permeable Cover for Bio-reduction and Treated Release. Select a cover fabricated of a permeable composite membrane designed to promote biological treatment of gaseous emissions which pass through the membrane for treated release to the atmosphere.
- Impermeable Cover for Precipitation Exclusion and Biogas Capture. Design the impermeable cover system on the stored manure and organic wastes with auxiliary elements to manage any biogas produced by capturing biogas emissions and transferring biogas to the point of discharge without mixing with air. For storage cover systems which collect biogas, provide for the safe handling, transfer, and flaring or utilization of the biogas.

Equipment and material exposed to biogas must be resistant to corrosion and suitable for use within a potentially explosive environment. Materials, controls, motors and their installation must conform to the National Electrical Code (NEC). Motors must be rated explosion proof and properly sealed.

Design aboveground pipe for biogas transfer with fittings for expansion and contraction effects.

Use steel or plastic materials for aboveground biogas transfer pipe intended for pressurized biogas systems. Steel pipe must meet the requirements of American Water Works Association (AWWA) Specification C-200, or ASTM A53; or AWWA C-220 or ASTM A312 for stainless steel. Plastic pipe must be HDPE meeting AWWA Specification C-906 or ASTM D-3350. PVC is only acceptable for aboveground biogas transfer when pipe meets ASTM D2241 or D1785, is ultraviolet light inhibited and pipe material is modified for high impact strength.

Anchorage. Design the cover anchorage system to withstand internal gas pressures, corrosive environment, wind loads, air tightness (as necessary), and other forces as appropriate to the cover system.

Pressure. For covers associated with biogas production, include provisions for fail safe pressure relief when interior pressures exceed design operating pressures. Do not exceed manufacturer's recommended maximum pressure.

Precipitation. Design features to direct precipitation on impermeable covers to collection points for removal by pumping or by controlled release to suitable grassed or otherwise stabilized areas for discharge or infiltration.

Biogas Capture
Design the cover materials and all appurtenances such as weights and floats, to capture and convey biogas to the gas collection system. Provide for the following:

1. Air Exclusion - Design the cover system and appurtenances, including perimeter soil slopes above the water line, for in-ground liquid waste storage, to exclude the entrance of air under all operating conditions.
2. Gas Collection, Control, and Utilization - The collection, control, and utilization of biogas must meet appropriate criteria in NRCS CPS Anaerobic Digester (Code 366).

Biogas Safety
As a minimum for all roofs and covers that contain or control biogas, post the following warning signs:

- "Warning Flammable Gas."
- "No Smoking."
- And when human entry is possible: "Do Not Enter – Hazardous Gases."

Where biogas is captured, design the gas collection, transfer and control/utilization system in accordance with standard engineering practice for safely handling a flammable gas including safety criteria noted in NRCS CPS Anaerobic Digester (Code 366).

CONSIDERATIONS

Consider an increased level of designed treatment for sites with high priority areas for source water protection or that are upstream of community drinking water withdrawal sites. Also consider increased levels of treatment in watersheds where water quality impairments for nutrients or pathogens have been shown to have impacted the designated use of downstream waterbodies.

To further improve water quality, consider eliminating or reducing feedlot areas when placing livestock under roof.

Screening with vegetative plantings, landforms, or other measures may be implemented for aesthetic purposes.

Maintain storage capacity and functionality of covered liquid waste storage by minimizing solids accumulation. Consider the use of manure management practices such as solid/liquid separation, NRCS CPS Waste Separation (Code 632).

On USDA certified organic and transitioning-organic operations, all wood treatments should comply with the National Organic Program (NOP) regulations.

For organic applications, consider using special construction material such as qualifying lumber as documented by an evaluation service recognized by the International Code Council (ICC). Other application considerations may also need to be made to address organic issues.

For areas where energy production is an option, consider adding energy recovery or production to the gas handling system. Energy recovery or production can offset air emissions from fossil fuel combustion.

Consider storage of biogas when installing flexible covers over waste storage facilities or waste treatment lagoons to attenuate gas supply for end use or treated release.

Waste facility covers which capture biogas may change nutrient volatilization of the stored manure. Consider the effect this may have on the nutrient management plan.

Waste facility covers which capture biogas may increase the odor nuisance during agitation, pump out, and land application. Consider the effect these activities may have on the surrounding areas and waste management options.

Consider requiring the roof or cover manufacturer and/or installer to provide maintenance instructions and certify that the roof or cover is properly installed.

Consider providing ventilation in addition to the 2 inches per 10-foot width of building for increased animal comfort.

PLANS AND SPECIFICATIONS

Prepare plans and specifications that describe the requirements for applying this practice to meet its intended purpose.

As a minimum, the plans and specifications will provide the following:

- Include information about the location and sequence of the phases of construction.
- Specify layout and location of agricultural waste storage and handling facility, or agrichemical handling facility.
- Include roof or cover footprint, any waste collection points and all planned access features.
- Grading plan showing excavation and fill. Include appropriate drainage features and revegetation plan as needed.
- Materials and structural details of the roof or cover including all necessary appurtenances as

appropriate for the complete system.

- For flexible geomembrane cover systems with biogas utilization, include a listing of associated biogas collection and transfer equipment, and necessary appurtenances.
- Specify that the manufacturer or installer of the geomembrane cover system must certify the installation of the cover. Require the same manufacturer or installer to provide the project owner with maintenance instructions for the cover material.
- Biosecurity measures during installation.
- Warning and safety signage placement.

OPERATION AND MAINTENANCE

Prepare an operation and maintenance (O&M) plan and review the plan with the landowner or operator responsible for the application of this practice. Provide specific instructions for proper operation and maintenance of each component of this practice and detail the level of inspection and repairs needed to maintain the effectiveness and useful life of the practice.

- For covers fabricated of a permeable composite membrane designed to promote biological treatment of gaseous emissions, maintain the cover media for the life of the practice to ensure proper biofilter operation.
- Address biosecurity concerns in all aspects of operation and maintenance.
- For enclosed waste facilities, exercise caution and care during cover removal or access. If opening of the cover is required for facility management, include provisions to prevent exposure of workers to hazardous gases.
- If personnel are or may be required to enter an enclosed waste facility, include safety provisions recommended by the National Institute for Occupational Safety and Health (NIOSH) for working in confined spaces including, but not limited to, using a positive-pressure self-contained breathing apparatus, safety line, and standby personnel.
- Develop an emergency action plan for covered systems associated with biogas production. Include instructions as to limits of cover performance and emergency procedures if control equipment fails. Provide contact(s) and phone numbers of person(s) to contact for the event of an emergency.

REFERENCES

American Concrete Institute (ACI). *Building Code Requirements for Structural Concrete, ACI 318*. ACI Committee 318. ACI, Farmington Hills, MI.

American Institute of Steel Construction. *Steel Construction Manual*, 15th Edition. AISC, Chicago, IL.

American Society of Agricultural and Biological Engineers. *Floor and Suspended Loads on Agricultural Structures Due to Use, ASAE EP378.4*. ASABE, St. Joseph, MI.

American Society of Agricultural and Biological Engineers. *Manure Storage Safety, ASAE EP470.1*. ASABE, St. Joseph, MI.

American Society of Agricultural and Biological Engineers. *Manure Storages, ASAE EP393.3*. ASABE, St. Joseph, MI.

American Society of Agricultural and Biological Engineers. *Ventilating Manure Storages to Reduce Entry Risk*, *ASAE S607*, ASABE, St. Joseph, MI.

American Society of Civil Engineers. *Minimum Design Loads for Buildings and Other Structures, ASCE/SEI 7-22*. ASCE, Reston, VA.

American Wood Council (AWC). 2018. *National Design Specifications for Wood Construction*. AWC, Washington, DC.

American Wood Protection Association. 2021. *AWPA Book of Standards.* AWPA, Birmingham, AL.

ASTM A53/A53M-20. 2020. *Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.* ASTM International, West Conshohocken, PA, A53/A53M-20.

ASTM A153/A153M-16a. 2016. *Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.* ASTM International, West Conshohocken, PA, A153/A153M-16a.

ASTM A240/A240M-22. 2022. *Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.* ASTM International, West Conshohocken, PA, A240/A240M-22.

ASTM A312/A312M-22. 2022. *Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.* ASTM International, West Conshohocken, PA, ASTM A312/A312M-22.

ASTM A653/A653M-20. 2020. *Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process*. ASTM International, West Conshohocken, PA, A653/A653M-20.

ASTM D1785-21A. 2021. Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120. ASTM International, West Conshohocken, PA, D1785-21A.

ASTM D2241-20. 2020. *Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)*. ASTM International, West Conshohocken, PA, D2241-20.

ASTM D3350-21. 2021. *Standard Specification for Polyethylene Plastics Pipe and Fittings Materials*. ASTM International, West Conshohocken, PA, D3350-21.

AWWA C200-17. *Steel Water Pipe, 6 in. (150 mm) and larger*. Denver, CO.

AWWA C220-17. *Stainless-Steel Pipe, 1/2 in. (13 mm) and Larger*. Denver, CO.

AWWA C906-21. *Polyethylene (PE) Pressure Pipe and Fittings, 4 in. through 65 in. (100 mm through 1,650 mm), for Waterworks*. Denver, CO.

International Association of Geosynthetic Installers. *HDPE and LLDPE Geomembrane Installation Specification*. IAGI, St. Paul, MN.

International Building Code. 2021. International Code Council (ICC). ICC, Whittier, CA.

International Code Council Evaluation Service. International Code Council (ICC). ICC, Whittier, CA.

National Fire Protection Association (NFPA) 70, National Electrical Code (NEC).

Natural Ventilating Systems for Livestock Housing. *1989*. *Midwest Plan Service,MWPS-33.*

USDA National Organic Program, Organic Regulations, Title 7 Code of Federal Regulations, Part 205.

USDA NRCS. 2017. Title 210, NEM, Part 536, Structural Engineering. Washington, D.C.

USDA Office of the Chief Economist. 2014. Technical Bulletin 1939, Quantifying Greenhouse Gas Fluxes in Agriculture and Forestry: Methods for Entity-Scale Inventory, Washington, DC., July.

Natural Resources Conservation Service
Practice Specification
Trails and Walkways (Code 575)

1. SCOPE

The work shall consist of furnishing materials and installing all components of the trails and walkways as outlined in this specification and the drawings.

2. MATERIALS

All materials used shall conform to the quality and grade noted on the plans, set forth in Section 8, or as otherwise listed below:

WEARING SURFACE, BINDER COURSE, and BASE COARSE aggregate shall meet the requirements and gradation specified in Section 8 or on the drawings.

GEOTEXTILE shall meet the requirements as outlined in NRCS Design Note 24 and NRCS Material Specification 592.

PIPE shall meet the requirements specified in Section 8 or on the drawings.

PRESSURE TREATED WOOD PRODUCTS shall be Douglas Fir, Southern Yellow Pine, or as otherwise specified on the drawings or in Section 8. They shall be treated with preservatives in accordance with the American Wood Preservers Association (AWPA) Standard C16, “Wood Used on Farms, Pressure Treatment.” Each piece shall bear the AWPA stamp of quality. In the absence of such a stamp, the Contractor or material supplier shall provide written certification that the pressure treated wood meets the designated quality criteria.

FASTENERS for wood structures shall be stainless steel, galvanized, or otherwise protected from corrosion due to contact with moisture and soil.

3. FOUNDATION PREPARATION

All trees, brush, fences, manure, and rubbish shall be cleared within the trail or walkway area, including any associated drainage control features and borrow areas. All stumps and roots larger than two-inch diameter shall be removed down to the subgrade elevation. All material removed by clearing operations shall be disposed of as directed by the Owner or his/her Representative.

Topsoil shall be stripped and stockpiled in a convenient location for use on disturbed areas to facilitate seeding.

Soil shall be excavated and if suitable can be used as fill as shown on the drawings to establish a uniform, stablesubgrade. Wet soil, mud, and topsoil shall not be used as fill. The fill material shall be compacted as specified in Section 8 or on the drawings.

Borrow material shall be taken from the designated borrow area as needed after excavation of the trail or walkway is complete. The borrow area shall be final graded to drain freely and blend into the surrounding undisturbed area.

Excess excavated material shall be disposed of in the designated spoil area, which shall be graded to blend into the surrounding undisturbed area. Geotextile or base course material shall be installed on undisturbed soil or non-yielding compacted material. Over-excavation must be corrected as noted on the drawings, or as directed by the Engineer or his/her designated Representative.

4. DRAINAGE STRUCTURES

Culverts, subsurface drains, and swales shall be installed as shown on the drawings. Surface and subsurface drainage structures shall be adequately removing water from the foundation to allow for proper placement of base and surface materials.

5. GEOTEXTILE

Where specified in Section 8 or on the drawings, geotextile shall be installed on the prepared subgrade. The geotextile shall be placed, overlapped and anchored as recommended by the manufacturer, unless otherwise specified in Section 8 or on the drawings.

Vehicles and heavy equipment shall not be operated directly on top of the geotextile. Base course or surface material shall be placed on the geotextile ahead of the construction equipment.

6. E&S CONTROL

E&S control measures shall be as set forth in the E&S Plan, and as otherwise detailed in the drawings.

Vegetation shall be established as set forth in Construction Specification PA 342, and/or as set forth in Section 8 and the drawings.

7. SURFACING

Where specified in Section 8 or on the drawings, the base and binder course shall be placed on the trail or walkway to the specified grades and thickness. The material shall be wetted and compacted by rollers or other construction equipment approved by the Engineer.

Surface material shall be placed to the grades and thicknesses set forth in Section 8 or on the drawings. The material shall be compacted by rollers or other construction equipment approved by the Engineer. The finished surface shall be smooth and free of projecting stones.

Vegetation shall be established in accordance with Construction Specification PA342.

The surface material within 3’ of surface water control devices and other structures (pipes, drop inlets, etc.) shall becompacted using manually directed tamping equipment.

8. ADDITIONAL CONDITIONS WHICH APPLY TO THIS PROJECT ARE:

Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

TRAILS AND WALKWAYS

CODE 575

(ft)

DEFINITION

A constructed path with a vegetated, earthen, gravel, paved, or other hard surface to facilitate the movement of animals, people, or off-road vehicles.

PURPOSE

This practice is used to accomplish one or more of the following purposes:

- Provide or improve animal access to forage, water, working/handling facilities, or shelter
- Protect ecologically sensitive, erosive, or potentially erosive sites
- Provide pedestrian or off-road vehicle access for agricultural, construction, or maintenance operations
- Provide trails or walkways for recreational activities or access to recreation sites

CONDITIONS WHERE PRACTICE APPLIES

This practice applies on all lands where management of animal, human, or off-road vehicle movement is needed. It does not apply to roads constructed for movement of equipment or vehicles. Use NRCS Conservation Practice Standard (CPS) Access Road (Code 560) for the construction of roads.

CRITERIA

General Criteria Applicable to All Purposes

Plan, design, and construct the trail or walkway to comply with all Federal, State, and local laws and regulations. Notify landowner and/or contractor of their responsibility to locate all buried utilities in the project area, including drainage tile and other structural measures. The landowner is required to obtain all necessary permits for project installation prior to construction.

Design the trail or walkway to accommodate the planned use and site constraints. Include measures to minimize erosion and adverse onsite and offsite impacts to areas such as riparian zones, stream channels, streambanks, and wildlife habitat (e.g., fragmentation or restriction of wildlife movement).

Clearing

Design clearing widths and heights to accommodate the safe use of the trail or walkway. Use NRCS Technical Note (TN) (Title 210), Landscape Architecture (LAN) 4, “Trail and Walkway Design Aid” for guidance, as needed.

Grades

Design trail or walkway grades to safely accommodate the planned use and to reduce the potential for erosion.Design the cross-slope (the surface perpendicular to the direction of travel) or crown of the trail or walkway to allow water to drain off without creating erosion.

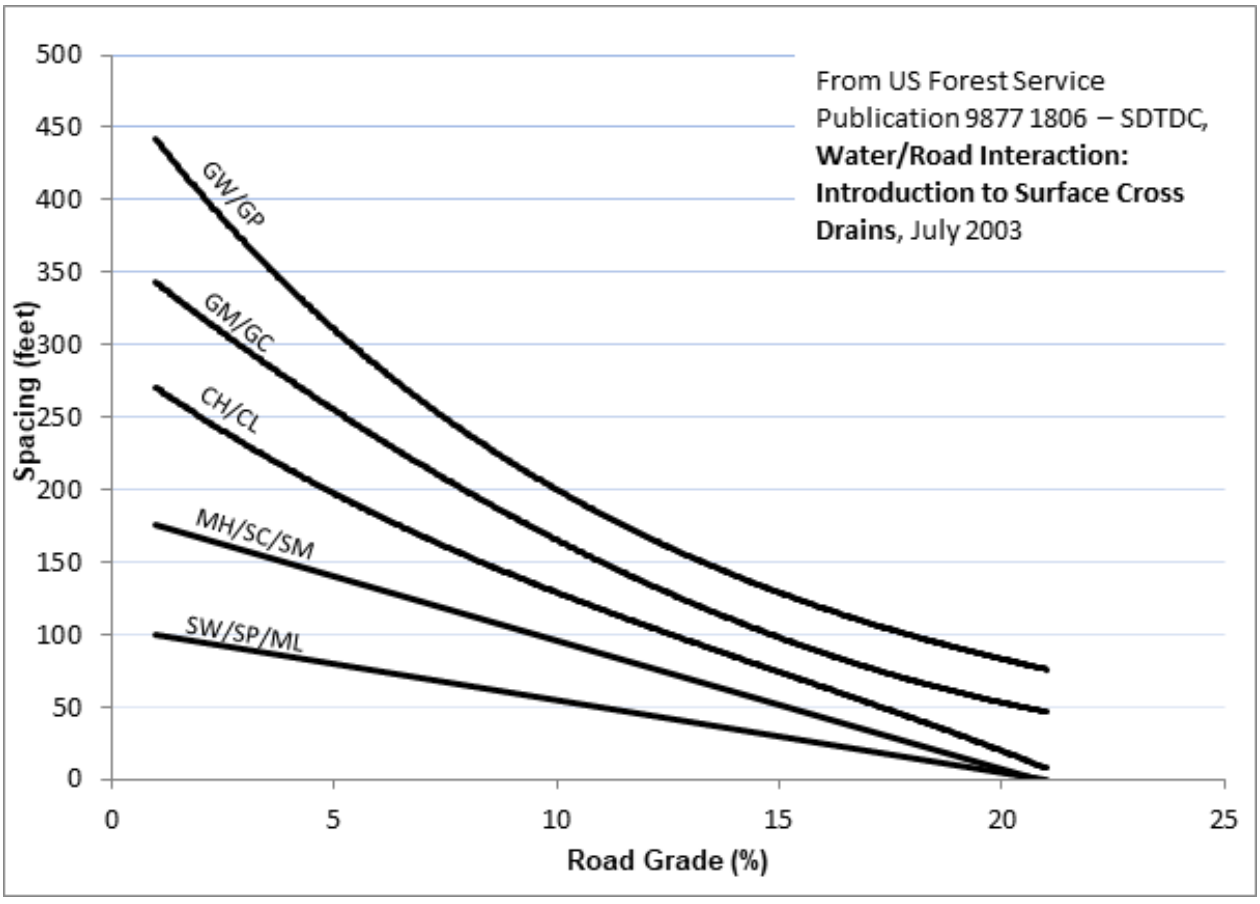
Side slopes
Design all cuts and fills to have stable slopes that are no steeper than 2 horizontal to 1 vertical. For short lengths, rock areas, or very steep hillsides, steeper slopes may be permitted if soil conditions allow and special stabilization measures are installed.

Where possible, avoid areas with geological conditions and soils that are subject to slides. When the area cannot be avoided, treat the area to prevent slides.

Turns
Design turning radii based on the intended use of the trail or walkway.

Water control
Divert concentrated water flows away from the trail or walkway by installing surface or subsurface drainage measures, such as NRCS CPSs Subsurface Drain (Code 606) or Diversion (Code 362), as needed. Surface cross drains, such as broad-based or rolling dips, may be used to control and direct water flow off the trail or walkway surface. Space drains according to soil type as shown in figure 1. Protect the outlets of drainage measures to limit erosion.

Figure 1. Minimum spacing for surface cross drains for trails or walkways with exposed soil, by soil type (Unified Classification System).



Avoid traversing wet soil areas whenever possible. If unavoidable, provide an all-weather surface or elevate the walkway above ponded water or wet soil areas.

Avoid locating the trail or walkway where runoff will flow directly from the trail or walkway into a stream or body of water. To the extent possible, place the trail or walkway along the contour and avoid placement perpendicular to the contour. Slope the trail away from waterways and expand the vegetative buffer zone to adequately mitigate nutrients entering waterways if the trail is used for livestock.

Where a trail or walkway crosses a stream, use NRCS CPS Stream Crossing (Code 578). If a drainage feature is typically dry, use NRCS CPS Structure for Water Control (Code 587) to design structures to safely carry runoff under the trail or walkway. At a minimum, design drainage culverts to carry the flow from the 2-year, 24-hour storm event. Use a larger storm event to design the drainage culvert where watershed conditions or anticipated usage warrant a larger structure.

Bridges and elevated walkways
Design bridges in accordance with NRCS CPS Stream Crossing (Code 578). Design elevated walkways in a manner that is consistent with sound engineering principles and adequate for the use and type of walkway. For elevated walkways, use the maximum loading anticipated during normal use plus a safety factor of at least 1.5. For elevated walkways that will only be used for pedestrian traffic, use the American Association of State Highway and Transportation Officials (AASHTO) “Guide Specifications for Design of Pedestrian Bridges” for design, or State building codes, whichever is more restrictive.

Design bridges and elevated walkways that will be used for horses or other large livestock for a uniformly applied load of not less than 200 pounds per square foot.

Surfacing
A trail can have a vegetated or unvegetated surface if the soil surface will support the intended use.

If a trail is planted to vegetative cover select vegetation that can withstand the intended use. Establish the vegetation in accordance with the criteria in NRCS CPS Critical Area Planting (Code 342). Protect it from traffic until it is fully established and capable of withstanding the expected use.

Where a hardened surface is needed, refer to NRCS CPS Heavy Use Area Protection (Code 561) for design criteria. Select a surface material for the walkway that is appropriate for the intended use and frequency. If concrete or bituminous material is used for the surface of the trail or walkway, texture the surface to avoid slippage during inclement conditions.

When selecting the surface material for a walkway used by animals, do not use sharp aggregates that might injure livestock or other wildlife.

Erosion control
Include provisions to control water and wind erosion during construction. Where possible, establish vegetation on disturbed areas as soon as practicable. Use the criteria in NRCS CPS Critical Area Planting (Code 342) or the NRCS State-approved seeding specification. Use vegetation adapted to the site. Give preference to native plant species where compatible with land use and existing plant species, including plants/species that provide pollinator habitat and forage.

If soil, shade, or climatic conditions prevent establishment of vegetation, use the criteria in NRCS CPS Mulching (Code 484) for erosion control.

Safety and use control
Incorporate use control and the safety of the users into the design of the trail or walkway. Where needed, install directional and warning signs, handrails, gates, fencing, and other safety devices. Refer to NRCS CPS Fence (Code 382) for fencing criteria. Provide protection from slides and falling rocks, as needed.

Additional Criteria Applicable to Provide or Improve Animal Access to Forage, Water, Working/Handling Facilities, or Shelter

When a trail or walkway is needed to facilitate animal distribution and movement or to allow better pasture utilization, use NRCS CPS Prescribed Grazing (Code 528) to plan the grazing system. Construct the trail or walkway wide enough to accommodate the movement of the animals and access by the operator for management and maintenance. Keep widths to the minimum necessary for the efficient movement of animals and equipment to reduce opportunities for animal loafing on the trail or walkway.

When needed to facilitate movement of animals through a series of paddocks or pastures, design gate openings and trails or walkways for efficient flow of animals.

Where fencing is needed to keep animals confined to the trail or walkway, use NRCS CPS Fence (Code 382).

Additional Criteria Applicable to Pedestrian or Off-Road Vehicle Access for Agricultural, Construction, or Maintenance Operations, or Recreation

Base the design requirements on the type and class of trail or walkway described in NRCS 210-TN-LAN-04, "Trail and Walkway Design Aid." When a trail or walkway will have multiple uses, design for the most restrictive criteria. When needed, use NRCS CPS Access Control (Code 472) to provide temporary or permanent exclusion from an area.

Width

Design the trail or walkway width to safely accommodate the intended use. The minimum width is determined by the type and class of trail. See the tables in appendix A in NRCS 210-TN-LAN-04 for design parameters.

Accessibility for recreation

The Americans with Disabilities Act of 1990 (ADA) requires outdoor recreation access routes and some hiker/pedestrian trails to be accessible to people with disabilities. Address accessibility requirements for new construction and when existing facilities are being altered. Compliance with the ADA outdoor recreation guidelines is not required where—

- Compliance would cause harm to cultural, historic, religious, or significant natural features.
- Compliance would substantially alter the nature of the setting.
- Compliance would require construction methods or materials that are prohibited by Federal, State, or local regulations.
- Compliance would not be feasible due to terrain or the prevailing construction practices.

Make an accessibility evaluation to determine the required level of accessibility for a trail/walkway design. Refer to NRCS 210-TN-LAN-04 for accessible trail design procedures.

CONSIDERATIONS

General Considerations

When planning this practice, consider the following, as applicable:

- The effect on areas of special scenic value, endangered species, wetlands, streambanks, floodways, and cultural resources.
- The location of the trail or walkway and its effect on water quality.
- Saving and maintaining key trees and other vegetation that have scenic value, provide shade, reduce erosion and runoff, provide habitat for fish, wildlife, and pollinators, or add to the visual quality of the area. Some selective cutting or trimming of trees or other vegetation may be necessary to provide and maintain scenic vistas at overlooks. At overlooks, keep tree removal or trimming to the minimum needed to provide an unobstructed view of the most salient features present.
- Contributions to food safety by channeling animals away from sensitive sites where pathogen transfer might occur.
- In areas that are vulnerable to wind erosion, or have frequent dry, loose surfaces that can easily create mechanically-generated particulate matter (i.e., dust), use of a surfacing material with a coarse texture for a walkway requiring non-vegetated surface treatment. Coarser materials will have larger particle sizes that are less easily entrained in the air and will minimize the potential for dust formation.

- An unvegetated trail can be a prime source of dust emissions resulting in a particulate matter resource concern. Utilize additional conservation practices, such as NRCS CPS Dust Control on Unpaved Roads and Surfaces (Code 373), to reduce the potential for generation and transport of particulate matter emissions, if warranted.

Additional Considerations to Provide or Improve Animal Access to Forage, Water, Working/Handling Facilities, or Shelter

To facilitate maintenance of a walkway, consider putting the fence outside of the surface material.

Additional Considerations for Pedestrian and Off-Road Vehicle Access

A trail or walkway for agricultural access generally should not exceed a 15-percent grade, although short sections of 50 feet or less may be up to 50 percent(26^0). . Break long, steep grades with the use of switchbacks. The grades of general-use pedestrian and equestrian trails or walkways should generally not exceed 10 percent. Grades for other uses may be steeper, such as cross-country skiing, which may be as steep as 50 percent for difficult trails. Hiking trails may be as steep as 20 percent.

If switchbacks are used, consider placing switchbacks where there are obstructions (e.g., rocks or dense vegetation) on the inside of the turns so the pedestrians and animals have a difficult time trying to cut across the switchbacks.

For a recreational trail that starts from a roadway, adequate parking for users may need to be provided as part of the design.

A trail or walkway for agricultural purposes may need to incorporate staging areas where equipment, supplies, or harvested crops can be stockpiled.

PLANS AND SPECIFICATIONS

Provide plans and specifications that describe the requirements for applying the practice to achieve its intended purpose. As a minimum, include—

- A plan view showing the location of the trail or walkway.
- Typical cross-sections for each reach of the trail or walkway showing the width, typical side slopes, and any surfacing needed.
- Profile for each reach.
- Details of water control structures and other appurtenances.
- Erosion protection measures.
- Material quantities.
- Construction specifications that describe in writing the details necessary for construction.
- Fencing, as needed.
- Safety features, as needed.
- Expected application types and amounts of dust suppressants, if needed.

OPERATION AND MAINTENANCE

Prepare a written operation and maintenance plan for each site. As a minimum include—

- A schedule for inspections at least annually and after significant runoff events. The inspections must include drainage structures, trail or walkway surfaces, vegetation, fencing, bridges and elevated walkways, and safety features, as appropriate.
    - For bridges and elevated walkways that are open or accessible to the public, conduct inspections in accordance with AASHTO “Guide Manual for Bridge Element Inspection.”

- Maintenance activities:
  - Removal of sediment from water control features.
  - Repair of eroded areas or damaged surface materials.
  - Grading and shaping of the trail or walkway to maintain design grades and dimensions.
  - Application of dust control measures, as needed. Include types, amounts, and frequency of application of dust suppressants.
  - Repair of safety or control features, as required.
  - Reseeding of areas where vegetation has been damaged or destroyed.
  - Periodic removal and management of manure accumulations, as needed.

For multiple adjacent vegetated animal trails, include a rotation plan to allow for recovery of vegetation and for improvement of traffic-supporting conditions.

REFERENCES

These references were current at the time the CPS was developed. Use more recent editions, if available.

American Association of State Highway and Transportation Officials. 2017. AASHTO Load and Resistance Factor Rating Bridge Design Specifications, 8th Edition. Washington, D.C.

American Association of State Highway and Transportation Officials. 2019. Guide Manual for Bridge Element Inspection, 2nd edition. Washington, D.C.

American Association of State Highway and Transportation Officials. 2002. Standard Specifications for Highway Bridges, 17th Edition. Washington, D.C.

American Association of State Highway and Transportation Officials. 2009. Guide Specification for Design of Pedestrian Bridges, 2nd Edition. Washington, D.C.

Pennsylvania Department of Highways, PennDOT 408 Construction Specification, Harrisburg, Pa.

USDA Forest Service. 2007. Trail Construction and Maintenance Notebook. Washington, D.C.

USDA Forest Service. 2008. Trails Management Handbook. Washington, D.C.

USDA NRCS. 2003. National Range and Pasture Handbook (Title 190), Revision 1. Washington, D.C. https://directives.sc.egov.usda.gov/

USDA NRCS. 2009. Technical Note (TN) (Title 210), Landscape Architecture (LAN) 4, Trail and Walkway Design Aid. Washington, D.C. https://directives.sc.egov.usda.gov/

U.S. Department of Interior National Park Service. 1998. Handbook for Trail Design, Construction and Maintenance. Washington, D.C.

Wood, G. 2007. Recreational Horse Trails in Rural and Wildland Areas: Design, Construction and Maintenance. Clemson University. Clemson, SC.

Practice Specification
Underground Outlet (Code 620)

1. SCOPE

The specification covers the fabrication, installation, and construction of underground outlets.

2. MATERIALS

The materials required for the underground outlet shall be as shown on the drawings or as otherwise required in Section 9.

a. DRAINFILL AGGREGATE shall meet the requirements of Penn DOT, Publication 408, Section 703, fine and coarse aggregate. The size and gradation shall be as specified in the additional conditions of this specification or on the drawings.

Table 1 – Drain pipe requirements

Type	Specification
Concrete drain tile	ASTM-C-412
Concrete pipe for irrigation or drainage	ASTM-C-118
Concrete pipe or tile, determining physical properties of	ASTM-C-497
Concrete sewer, storm drain and culvert pipe	ASTM-C-14
Reinforced concrete culvert, storm drain and sewer pipe	ASTM-C-76
Perforated concrete pipe	ASTM-C-444
Portland cement	ASTM-C-150
Pipe, bituminized fiber & fitting	Fed Spec SS-P-1540
Styrene rubber (SR) plastic drain pipe & fitting	ASTM-D-2852
Polyvinyl chloride (PVC), SHD 40, 80, 120	ASTM-D-1785
Polyvinyl chloride (PVC) sewer pipe & fitting	ASTM-D-2729
Polyvinyl chloride (PVC), SDR 35, 26	ASTM-D-3034
	type PSM
Corrugated polyethylene tubing & fitting (3-6 inch)	ASTM-F-405
Corrugated polyethylene tubing & fitting (8-24 inch)	ASTM-F-667
Corrugated polyethylene tubing	ASTM F2648
Corrugated polyethylene tubing (3-10”)	AASHTO M252
Corrugated polyethylene tubing (12-60”)	AASHTO M294
Pipe, corrugated (steel, polymer coated)	ASTM-A-762
Pipe, corrugated (steel, zinc coated)	ASTM-A-760

b. PIPE shall meet the requirements of Table 1, and as set forth in Section 9 and/or on the drawings. All pipes shall be clearly marked with the appropriate specification designation. If plastic pipe is stored on site for a length of time, it should be protected from sunlight. At the time of installation, it should be kept as cool as possible to minimize elongation of the pipe during installation.

c. GEOTEXTILE shall meet the requirements as outlined in NRCS Design Note 24 and NRCS Material Specification 592.

d. CONCRETE and related materials shall meet the requirements set forth in Construction Specification PA313S, Waste Storage Facility (Structure), and/or as set forth in Section 9.

All materials shall be carefully inspected prior to installation. Clay and concrete tile shall be checked for damage by freezing. Plastic pipe and tubing shall be protected from hazards causing deformation. Any damaged or imperfect pipe or tubing shall not be installed. Any pipe or tubing which is damaged during installation shall be removed and replaced.

3. SITE PREPERATION

All trees, brush, fences and rubbish shall be cleared within the area that the subsurface drain will be installed. All material removed by the clearing and grubbing operation shall be disposed of as directed by the Owner or his/her Representative.

4. INSPECTION AND MATERIAL HANDLING

Material for underground outlets shall be carefully inspected before the drains are installed. If applicable, clay and concrete tile shall be checked for damage from freezing and thawing before it is installed. Bituminized fiber and plastic pipe and tubing shall be protected from hazard causing deformation or warping.

Plastic pipe and tubing with physical imperfections shall not be installed. Any damaged section shall be removed and replaced. All material shall be satisfactory for its intended use and shall meet applicable specifications and requirements.

5. SAFETY

All positive “design” responses from the Pennsylvania One Call System shall be noted on the plans. It is the Contractor’s or Landowner’s responsibility to notify One Call of pending construction and to contact the affected utility for marking at the time of construction.

The Contractor must comply with OSHA requirements Part 1926, subpart P, for protection of workers entering trench.

6. EXCAVATION

Construction operations shall follow the erosion and sediment control plan.

Unless otherwise specified, excavation for each underground outlet shall begin at the outlet end and progress upstream. The trench shall be excavated to the grades and cross sections shown on the drawings. The trench width above the conduit may increase as necessary for safe installation or for the convenience of the Contractor. Trench shields, shoring, or bracing are required whenever workers will be in a trench deeper than four feet, or as otherwise required be OSHA Regulations.

7. INSTALLATION

BEDDING. In stable soils, the conduit shall be firmly and uniformly bedded throughout its entire length as required on the drawings or Section 9. Where the underground outlet foundation is in unstable soils, the bedding shall be as shown on the drawings or as otherwise required by the Engineer. Where the conduit is to be laid in rock, or rock is exposed at the trench bottom, the rock shall be removed at least two inches below the invert grade to allow for compacted bedding under the conduit.

PLACEMENT. Debris inside of pipes and tubing shall be removed prior to installation. The conduit ends shall be protected during placement. Similarly, all appurtenances, including trash guards and animal guards, shall be protected during installation to avoid damage. All underground outlets shall be laid to line and grade, and immediately covered with an approved blinding, envelope, or the required depth of filter material. No reversals in grade of the conduit are permitted, and in very hot climates no more than five percent stretch is allowed. Special precautions must be taken in hot weather to observe this stretch limit.

Flexible conduits, such as plastic pipe or tubing and bituminized fiber pipe, shall be installed, according to the requirements in ASTM-F-449, “Standard Recommended Practice for Subsurface Installation of Corrugated Thermoplastic Tubing for Agricultural Drainage or Water Table Control.”

Earth backfill material shall be placed in the trench in a manner to ensure that the conduit does not become displaced and so that the filter and bedding material, after backfilling, meet the requirements of the plans and specifications.

8. BACKFILL

Initial backfill shall be of selected material that is free of rocks or other sharp-edged material that could damage the pipe. Earth backfill shall be placed in the trench in such a manner that the conduit is not displaced, and that the filter and bedding materials are not contaminated or displaced. Unless otherwise specified, where the underground outlet is laid under roads or at other designated locations, the backfill shall be placed in successive layers of not more than six inches, and each lift compacted before the subsequent layer. Backfill shall extend above the adjacent ground to allow for settlement, and be well rounded over the trench.

Work areas shall be restored to their pre- construction condition or as otherwise required in the plans or Section 9.

9. ADDITIONAL CONDITIONS WHICH APPLY TO THIS PROJECT ARE:

United States Department of Agriculture

Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

UNDERGROUND OUTLET

CODE 620

(ft)

DEFINITION

A conduit or system of conduits installed beneath the ground surface to convey surface water to a suitable outlet.

PURPOSE

This practice is used to accomplish one or more of the following purposes:

- Prevent concentrated flow erosion.
- Manage flooding and ponding.
- Maintain water quality.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies where—

- Removal of surface water is necessary.
- An outlet is needed for a terrace, diversion, water and sediment control basin, or similar practices.
- Removal of stormwater collected by roof runoff structures or similar practices is necessary.
- A surface outlet is impractical because of stability problems, topography, climatic conditions, land use, or equipment traffic.

CRITERIA

General Criteria Applicable to All Purposes

Plan, design, and construct the underground outlet to meet all Federal, State, Tribal, and local regulations.

Capacity

Base the design capacity of the underground outlet on the requirements of the structure or practice it serves. An underground outlet can function as the only outlet for a structure or in

conjunction with other types of outlets.

Design the outlet so the water storage time does not exceed the inundation tolerance of the planned crops, vegetation, or works of improvement.

Design the underground outlet to account for anticipated water surface conditions at the outlet during design flow.

Flood routing techniques may be used to determine the relationship between flooding duration, underground release rate, and basin storage volume.
Underground outlets can be designed for either pressure or gravity flow. Design all pipes and joints in pressure systems to withstand the design pressure, including surges and vacuum. For gravity flow systems, use a flow-restricting device such as an orifice or weir to limit flow into the conduit or choose conduit sizes that are large enough to prevent pressure flow. Design the orifice to be compatible with the inlet. Size the orifice based on the inundation time and potential crop residue. Gravity flow systems must maintain a positive grade throughout the conduit length towards the outlet.

If necessary, use pressure relief wells to allow excess flow to escape the conduit and flow over the ground surface. Use pressure relief wells only where there is a stable outlet for the discharge from the relief well. Cover pressure relief wells with a grate or other appropriate covering to prevent injury to animals and entry of debris.

Inlet
An inlet can be a collection box, blind inlet (gravel), perforated riser, perforated conduit, or other appropriate device. Design components of underground outlets, including inlet collection boxes and conduit junction boxes, with sufficient size to facilitate maintenance and cleaning operations.

Open inlets must have a trash guard. Design the inlet so any trash or debris entering the inlet will pass through the flow-restricting device and conduit without plugging.

Perforated riser inlets must be durable, structurally sound, and resistant to damage by rodents or other animals. Perforations must be smooth, free of burrs, and have adequate capacity to prevent the riser from restricting flow in the underground outlet.

Blind inlets may be used where the installation of an open or above ground structure is impractical. Design the blind inlet to prevent soil particle movement into the conduit.

Conduit
The minimum allowable diameter of conduits is 4 inches. Conduit joints must be hydraulically smooth and consistent with the manufacturer’s recommendation for the conduit material and installation.

Design the underground outlet to ensure that maximum allowable loads on the conduit are not exceeded for the type and size of conduit. Assess the depth of cover requirements to prevent damage to the underground outlet from traffic, tillage operations, and frost action. Design perforated components of underground outlets to prevent soil particle movement into the underground outlet. In absence of manufacturer’s data, use NRCS Conservation Practice Standard (CPS) Subsurface Drain (Code 606) criteria for filters, design loading, placement, and bedding requirements.

Provide thrust blocking or anchoring where needed to prevent undesired movement of the conduit. Evaluate placement, bedding, and backfill requirements for the conduit to ensure integrity of the installation. In absence of manufacturer’s data, design thrust blocks in

accordance with NRCS Title 210, National Engineering Handbook, Part 636, Chapter 52, "Structural Design of Flexible Conduits."

Minimum velocity and grade
In areas where sedimentation of fine sands and silts is not a hazard, design the minimum grade based on site conditions and a velocity of not less than 0.8 feet per second. If a sedimentation potential exists, either use a velocity of not less than 1.4 feet per second to establish the minimum grade or include provisions for preventing sedimentation. Use filters, collect and periodically remove sediment from installed traps, or periodically clean the lines with high-pressure jetting systems or cleaning solutions to address sedimentation. Prior to using high-pressure jetting systems, verify that the jetting system will not damage the pipe or the pipe embedment.

Maximum velocity
Limit the design velocities in perforated, high-density polyethylene (HDPE) pipe under open channel flow to 12 feet per second or the manufacturer's recommended limit. Limit design velocities for nonperforated

pipe to manufacturer's recommended limits applicable to the pipe diameter, material and joint type, and site condition.

Materials
Underground outlet materials include flexible conduits of plastic, metal, or other materials of acceptable quality. Materials must meet applicable site-specific design requirements for leakage, external loading, and internal pressure including vacuum conditions.

All conduits must meet or exceed the minimum requirements of the appropriate specifications published by the American Society for Testing and Materials (ASTM), American Association of State Highway Transportation Officials (AASHTO), or the American Water Works Association (AWWA).

Underground outlet conduits may be continuous tubing, tile, or pipe sections and may be perforated or nonperforated. Ensure any couplers joining pipe sections are compatible with the pipe and will withstand all required loads.

Use fire-resistant materials for underground outlet components if fire is an expected hazard. All plastics must be UV resistant or protected from exposure to sunlight.

Outlet
Stabilize the outlet and protect it against erosion and undermining for the range of design flow conditions.

An underground outlet may discharge into a structure that is designed to accommodate the additional inflow.

For discharge to streams or channels, locate the outlet invert above the elevation of normal flow and at least 1 foot above the channel bottom.

Specify a continuous section of pipe for the outlet section, without open joints or perforations, and with stiffness necessary to withstand expected loads, including those caused by ice. Use table 1 for the minimum length for the outlet section of the conduit.

Table 1. Minimum Length of Outlet Pipe Sections

Pipe Diameter (inches)	Minimum Section Length (feet)
8 and smaller	10
10 to 12	12
15 to 18	16
Larger than 18	20

A shorter section of closed conduit may be used if a headwall is used at the outlet of the conduit. The use and installation of outlet pipe must conform to the following requirements:

- Bury at least two-thirds of the rigid outlet pipe section in the ditch bank and project the cantilever section past the toe of the ditch side slope; or protect the side slope from erosion below the outlet pipe.
- If ice or floating debris may damage the outlet pipe, protect the pipe by recessing the cantilevered part of the pipe to protect it from the current of flow in the ditch or channel.
- Headwalls used for subsurface drain outlets must be adequate in strength and design to avoid washouts and other failures.

Specify animal guards on all outlets to prevent the entry of rodents or other animals. Design animal guards to allow passage of debris while blocking the entry of animals large enough to restrict the flow in the conduit.

Animal guards are not required on pipe 12” in diameter and greater.

Use a vertical outlet to discharge water to the ground surface where topography does not allow adequate conduit cover using a horizontal outlet, or where it is practical to discharge over a vegetated filter strip.
Design the vertical outlet to allow the system to drain during periods when not in use which may include perforations and placement in an envelope of coarsely graded aggregate.

Pressure relief wells and vertical outlets, if not properly identified, can present a safety hazard for people or animals and may be damaged by field equipment. Identify pressure relief wells and vertical outlet locations with a high visibility marker.

Stabilization
Reshape and regrade all disturbed areas so they blend with the surrounding land features and conditions. For areas that will not be farmed, refer to NRCS CPS Critical Area Planting (Code 342) for establishment of vegetation criteria. Establish permanent vegetation on all non-crop disturbed areas as soon as possible after construction.

CONSIDERATIONS

Consider climate change impact on determining an outlet’s capacity.

Consider maintaining adequate cover over the conduit based on expected loads, depth of tillage equipment, and manufacturer’s requirements. At least 2 feet of cover is recommended over all conduits unless special design elements are provided.

Consider impacts on downstream source water due to erosion and sediment load and impacts on important fish and wildlife habitats such as streams, creeks, riparian areas, groundwater, and wetlands.

Consider the effects of the underground outlet on the hydrology of adjacent lands, especially potential or delineated wetlands and existing wetland easements. Where wetlands may be affected, advise the cooperator that current USDA wetland policy will apply.

Seasonal water sources can be beneficial for migratory waterfowl and other wildlife. Consider the use of a water control structure at the inlet of an underground outlet to provide water for wildlife during non- cropping periods. Use NRCS CPS Shallow Water Development and Management (Code 646) to manage seasonal water sources for wildlife and NRCS CPS Structure for Water Control (Code 587) for the structure.

Underground outlets may provide a direct conduit to receiving waters for contaminated runoff. Install underground outlets and the accompanying structures or practices as part of a conservation system that addresses issues such as nutrient and pest management, residue management, and filter areas. Consider providing an increased level of designed treatment for sites with high priority areas for source water protection or are upstream of community drinking water withdrawal sites.

The construction of an underground outlet in a riparian corridor can have an adverse effect on the visual resources of the corridor. Consider the visual quality of the riparian area when designing the underground outlet.

Consider potential effects of soil physical and chemical properties on areas where a conduit or system of conduits are installed to convey surface water. Refer to soil survey data as a preliminary planning tool for assessment of areas. Consult the Web Soil Survey to obtain soil properties and qualities information.

When revegetation is needed, consider using species or diverse mixes that are native or adapted to the site and have multiple benefits. In addition, where appropriate, consider a diverse mixture of forbs and wildflowers to support pollinator and other wildlife habitat. if project is for USDA certified-organic and transitioning-to-organic operations, all materials need to comply with the USDA National Organic Program (NOP) Standards, including all seeds, planting stock, fertilizers, and other production inputs.

PLANS AND SPECIFICATIONS

Prepare plans and specifications for underground outlets that describe the requirements for applying this practice according to this standard. The plans and specifications for an underground outlet may be incorporated into the plans and specifications for the structure or practice it serves. As a minimum include—

- A plan view of the layout of the underground outlet.
- Typical cross sections and bedding requirements for the underground outlet.
- Profile of the underground outlet.
- Details of the inlet, pipe, and outlet.
- Seeding requirements if needed.

Prepare construction specifications describing site-specific installation requirements of the

underground outlet.

OPERATION AND MAINTENANCE

Prepare an operation and maintenance plan for the operator. The minimum requirements to be addressed in a written operation and maintenance plan are—

- Periodic inspections, especially immediately following significant runoff events, to keep inlets, trash guards, and collection boxes and structures clean and free of materials that can reduce flow.
- Prompt repair or replacement of damaged components.
- Repair or replacement of inlets damaged by farm equipment.
- Repair of leaks and broken or crushed lines to ensure proper functioning of the conduit.
- Periodic inspection of the outlet and animal guards to ensure proper functioning.
- Repair eroded areas at the pipe outlet.
- Maintenance of adequate backfill over the conduit.
- Maintenance of the permeability of surface materials of blind inlets by periodic scouring or removal and replacement of the surface soil layer.

REFERENCES

USDA NRCS. 2021. National Engineering Handbook (Title 210), Part 650, Chapter 6, Structures. Washington, D.C. https://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=46256.wba

USDA NRCS. 2021. National Engineering Handbook (Title 210), Part 650, Chapter 8, Terraces. Washington, D.C. https://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=46257.wba

USDA NRCS. 2021. National Engineering Handbook (Title 210), Part 650, Chapter 14, Water Management (Drainage). Washington, D.C. https://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=46289.wba

USDA NRCS. 2005. National Engineering Handbook (Title 210), Part 636, Chapter 52, Structural Design of Flexible Conduits. Washington, D.C. https://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=17760.wba

USDA NRCS. 2019. Web Soil Survey. Accessed January 19, 2022. https://websoilsurvey.sc.egov.usda.gov/.

Natural Resources Conservation Service
Practice Specification
Water Well (Code 642)

1. SCOPE

The work shall consist of furnishing materials and installing all components of the water well as outlined in this specification and the drawings.

2. MATERIALS

Casings: Casings shall be of steel, iron, stainless steel, copper alloys, plastic, fiberglass, or concrete of sufficient strength and durability consistent with the intended use of the water and the maximum anticipated differential head between the inside and outside of the casing. Unless otherwise set forth in Section 5 of this specification:

- Plastic casings made of acrylonitrile- butadiene-styrene (ABS), polyvinyl chloride (PVC), or styrene-rubber (SR) shall conform to material, dimensional and quality requirements specified in ASTM F 480.
- Filament-wound fiberglass casings (glass-fiber-reinforced-thermosetting- resin pipe, RTRP) may be used if material meets requirements specified in ASTM D 2996. Tests for long-term cyclic pressure strength, long-term static pressure strength, and short-term rupture strength as required in ASTM D 2996 are not needed because the pipe is to be used for well casing. Joints shall meet requirements specified in section 3.8, ASTM F 480.
- Fiberglass pressure pipe (also called reinforced polymer mortar pipe, RPMP, or fiberglass pipe with aggregate) shall meet or exceed requirements specified in ASTM D 3517.

Other casing materials shall be certified by the manufacturer or a registered Professional Engineer as being of adequate strength.

Joints: Well casing joints shall have adequate strength to carry the load due to the casing length and still be watertight or shall be mechanically supported during installation to maintain joint integrity. Such mechanically supported casings shall terminate on firm material that can adequately support the casing weight.

Screen: Well screens shall be constructed of commercially manufactured screen sections, well points, or field-perforated sections.
Perforation by any method is allowable provided the following provisions can be met:

- For uniform size aquifer material, screen openings are smaller than the average diameter of aquifer material.
- For non-uniform aquifer material, screen openings are smaller than 60 percent of the aquifer material.
- Screen openings, for filter/gravel pack must exclude at least 85 percent of the filter pack material.

- Size the length and open area of the screen to keep entrance velocity or shear stress below the threshold for erosion of filter pack particles and transport into the well.
- Casing must not be functionally weakened or deformed.

Gravel Pack: If gravel pack is used, it shall have the gradation and thickness specified in Section 5, or as shown on the drawings.

If acceptable *filter materials are unavailable*, use a commercially manufactured, pre-packed well screen. A pre-packed well screen consists of inner and outer screens that contain the engineered filter material. The material must meet the following quality criteria:

- Less than five percent fines (the proportion that passes the number 200 sieve);
- Predominantly rounded, dense, siliceous materials.
- No angular particles, such as crushed rock, or flat particles, such as mica.
- No earthy or soft materials, such as clay, shale, silt, gypsum, or anhydrite.
- No organic matter, no other impurities, or metallic substances.
- No material soluble in hydrochloric acid, such as limestone.

3. EQUIPMENT

The installer shall provide and operate all equipment necessary to install the well in a safe manner. The operator shall have a Water Well Driller's License and a Drilling Rig Permit, issued by the PA Geological Survey, for the equipment used on the site.

4. INSTALLATION

Drilled, jetted, bored, and driven wells shall be sufficiently round, straight, and of adequate diameter, to permit satisfactory installation of inlet, well casing, filter pack, and annular seal, and passage of tremie pipe (including couplings), if used. Hard rock formations or physically stable geologic materials may not require casing except for the uppermost 10 feet. However, casing shall be installed to seal out undesirable surface or shallow groundwater, and to support the side of the hole through unstable earth materials.

If drilling encounters erodible, friable, or otherwise unstable material, install watertight, grouted casing throughout, with the exception of the intake portions.

Provide a watertight seal in the annulus of all well casing. Acceptable sealants include mortar containing expansive hydraulic cement (ASTM C 845), bentonite-based grout, bentonite chips and pellets, sand- cement grout, neat cement, or concrete. The length of the grout seal shall be no less than 10 feet, and not less than the minimum specified in state or locally applicable construction codes.

If one or more zones are encountered that produce water of unacceptable quality, use grout or packers to prevent comingling of waters or cross-contamination of aquifers. Provide a packer, or similar retaining device, or a sealant between the casing and the less pervious material overlying the aquifer of artesian wells. Provide a similar

positive seal to separate water bearing zones where co- mingling of waters is undesirable.

For artesian conditions, seal the confining geologic units directly above and below the aquifer in such a manner as to retain its confining pressure.

Casing shall extend from above the ground surface down through unstable earth materials to an elevation of at least 2 feet into stable material or to the top of the screen.

If casing extends to the bottom of the drill hole, install a watertight end cap or grout seal to prevent entry of geologic material into the well from the bottom.

When the design requires telescoped screen assemblies, install one or more sand-tight seals between the top of the telescoped screen assembly and the casing. Upon completion, provide a suitably threaded, flanged, or welded cap or compression seal to prevent entry of contaminants into the well.

Well Development: After completion of well construction, ensure that the well is developed. Well development is required regardless of whether the well is finished in unconsolidated materials or hard rock aquifers. Use one or more development techniques to effectively loosen and remove silt, fine sand, drill cuttings, drilling muds, or additives deposited by the drilling operation on the uncased borehole face and in adjacent portions of the aquifer. For screened zones, the development technique must collapse sand bridges and remove fines outside the screen. Following the development process, remove accumulated sediment at the bottom of the well bore by bailing or pumping.

Pump the well at approximately 120 percent of the anticipated normal production rate until suspended sediment and associated turbidity clears. Do not use the permanent pump to conduct any well development work.

Unless otherwise set forth in Section 5, wells to be completed without a filter pack in unconsolidated granular aquifers shall be developed following guidance provided in ASTM D 5521, *Standard Guide for Development of Ground-Water Monitoring Wells in Granular Aquifers.*

The method shall be selected based on geologic character of the aquifer, type of drilling rig, and type of screen.

Aquifer Development: For massive, unfractured rock formations unresponsive to well development procedures, the use of aquifer stimulation techniques may be used to improve well efficiency and capacity, if permitted in Section 5 of this specification.

Techniques may include dry ice, acidizing, explosives, or hydrofracturing, depending on the composition and structure of the formation, and as specified in Section 5.

Access Port: An access port with a minimum diameter of 0.5 inch shall be installed to allow for unobstructed measurement of depth of the water surface, or for a pressure gage for measuring shut-in pressure of a flowing well. Access ports and pressure gages or other openings in the cover shall be sealed or capped to prevent entrance of surface water or foreign material into the well. Removable caps are acceptable as access ports.

Wellhead Protection: Surface runoff and drainage that might reach the wellhead from areas used by livestock or other contaminant sources shall be diverted away from the well.

The ground surface around the well shall be graded away from the well for a distance of at least five feet in all directions. Low points where water can puddle on the surface shall be eliminated.

If the well water is intended for human consumption, the casing shall be surrounded at the ground surface by a 4-inch-thick concrete slab extending at least 2 feet in all directions.

If the top of the well casing is subject to flooding from surface water, either of two methods shall be used to prevent floodwater from entering the well: (1) the well cap shall be water tight and equipped with a vent that extends two feet above the 100-year flood level, or (2) the well casing shall be extended to two feet above the 100-year flood level.

Disinfection: Wells shall be disinfected immediately following their construction or repair to neutralize any contamination from equipment, material, or surface drainage introduced during construction. The disinfection process shall comply with all local or state requirements.

Prior to final chemical disinfection, remove foreign substances, such as grease, soil, sediment, joint dope, and scum from the well and near the wellhead. Clean all pump parts before placing them into the well.

Disinfect the well using a chlorine compound at a concentration of no less than 50 mg/L (100 ppm) available chlorine in solution to treat the entire well.

Water Quality Testing: Sampling and testing shall comply with all applicable federal, state, and local requirements. These requirements vary according to the water quality parameters associated with the intended use(s) of the water. Test well water according to the *Construction Specification for Groundwater Testing (PA355)*.

Well Performance Testing. After completion of well construction and the water level is stable, conduct a pump test to determine specific capacity and dynamic water level. Wait no less than 24 hrs. after well development is completed and the water level has stabilized, to conduct a pumping test for determining specific capacity and dynamic water levels. Refer to NRCS 210-NEH-631 and 210-NEH, Part 650, Chapter 12, Section 650.1203, “Wells” for guidance on conducting, recording, and analyzing pumping tests. Discharge water a minimum of 300 feet from the well and in such a way that reduces erosion to the land surface and prevents potential artificial recharge during the test. Record the length of test and pumping rate.

Documentation: The well driller shall provide to the landowner and the PA-DCNR Topographic and Geological Survey copies of the water well completion report.

5. ADDITIONAL CONDITIONS WHICH APPLY TO THIS PROJECT ARE:

Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

WATER WELL

CODE 642

(no)

DEFINITION

A hole drilled, dug, driven, bored, jetted, or otherwise constructed into an aquifer for agricultural water supply.

PURPOSE

This practice is used to accomplish one or more of the following purposes:

- Address the need for adequate livestock water quality and quantity
- Provide water for terrestrial wildlife
- Provide irrigation water

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to all types of agricultural land where the quality and quantity of underground water is appropriate for the intended purpose.

This practice does not apply to—

- Wells constructed for domestic or public water supply.
- Monitoring wells, NRCS Conservation Practice Standard (CPS) Monitoring Well (Code 353), injection wells, temporary test wells, or piezometers.
- Pumps, surface supply lines, storage facilities, and related appurtenances.

CRITERIA

General Criteria Applicable to All Purposes

Law and regulations

The investigation, design, and installation of an agricultural water supply well must comply with all applicable governmental regulations, laws, permits, licenses, and registrations according to NRCS Title 450, General Manual (GM), Part 405, Subpart A, "Compliance with Laws and Regulations." Where applicable laws and regulations do not exist, follow industry standards, such as—

- A proposed well must comply with criteria in the current version of American Water Works Association (AWWA), A100-15, "Water Well Standard."
- A proposed irrigation well must comply with criteria in the current version of American Society of Agricultural and Biological Engineers (ASABE or ASAE) EP400.3, "Designing and Constructing Irrigation Wells."
- The well design and installation must comply with criteria in the current version of National Ground Water Association (NGWA) 01, "Water Well Construction Standard."

Roles and responsibilities
Licensed water well driller is responsible for drilling and installing the water well, according to State regulations.

The landowner is responsible for obtaining all necessary permits, rights, or approvals according to NRCS 450-GM-405 and applicable laws, rules, and regulations.

The landowner and/or licensed contractor are responsible for locating all buried utilities in the project area, including drainage tiles and other structural measures.

Site suitability
Use reliable local experience, and review all relevant geologic maps, reports, and well records maintained by State and Federal agencies to evaluate ground water quantity and quality. When local hydrogeologic data are limited or conditions are complex and uncertain, conduct onsite evaluation to provide professional recommendations regarding site suitability.

Locate the well according to the Occupational Safety and Health Administration (OSHA) Standard 1926.1408 (h), “Power line safety (up to 350 kV)–equipment operations” to comply with setback distances from overhead or underground utility lines or other safety hazards.

Locate the well away and upgradient from potential surface and subsurface contamination or pollution and areas subject to flooding, according to State regulations. In determining hydraulic gradient, consider both pumped and static water levels.

Laterally locate the well to comply with applicable conservation practice standards and State-specific water well setback zones and prohibitions. Locate the well at least 100 feet from potential sources of surface and subsurface pollution.

Clear the site of all trees, brush, and obstructions. Locate the drill rig, related equipment, and the well on relatively flat, reasonably dry, working surface for a safe and effective working environment.

Wellhead protection
Divert all surface runoff, precipitation, and drainage away from the wellhead. Compact, mound, and slope earth material away from the wellhead.

Protect the wellhead and associated appurtenances from contamination or damage by wildlife, livestock, farm machinery, vehicle parking, or other harmful human activity.

The top of the casing shall be equipped with a cap or well seal to prevent rainfall or insects from entering the well. If the top of the well casing is subject to flooding from surface water, the cap shall be water tight and equipped with a vent that extends two feet above the 10-year flood level. As an alternative, the well casing may be extended two feet above the 100-year flood level.

Grouting and sealing the casing
When drilling into hard rock formations or physically stable geologic materials, install a minimum of 10 feet of casing.

For erodible, friable, or otherwise unstable materials, install watertight grouted casing.

Install a watertight seal in the annulus of all well casing. Acceptable sealants include mortar containing expansive hydraulic cement, bentonite-based grout, bentonite chips and pellets, sand-cement grout, neat cement, or concrete.

Use sealant, packers, or similar retaining device to isolate one or more aquifers or zones that produce poor ground water quality to prevent commingling or cross-contamination. Provide a similar positive seal to separate water-bearing zones where comingling is not desired.

For artesian wells (flowing and nonflowing), grout the casing and geologic units directly above and below the aquifer to retain its confining pressure.

Casing shall extend from above the ground surface down through unstable earth materials to an elevation of at least 2 feet into stable material or to the top of the screen.

When casing extends to the borehole bottom, install a watertight end cap or grout seal to prevent entry of geologic material. For designs requiring telescoped screen assemblies, install one or more sand-tight seals between the top of the telescoped screen assembly and the casing.

After well completion, provide a suitably threaded, flanged, welded cap, or compression seal to prevent entry of contaminants into the well.

Casing materials
Acceptable materials for casing include steel, iron, stainless steel, copper alloys, plastic, fiberglass, concrete, or other material of equivalent strength, which have sufficient chemical resistance to the ground water for the design life of the well. To prevent galvanic corrosion, do not join dissimilar metals. Select a casing diameter to permit satisfactory installation and efficient operation of a submersible pump, if used. Typically, the casing diameter should be a minimum of 2 inches larger than the maximum outside diameter of the pump and pump column.

Select casing material that can withstand all anticipated static and dynamic pressures imposed on the casing while maintaining a watertight seal during installation, well development, and use throughout the design life of the well. When needed, mechanically support casing during installation to maintain joint integrity. Refer to NRCS National Engineering Handbook (NEH) (Title 210), Part 631, “Geology,” for guidance in determining proper differential head limitations for approved casing materials.

Screen and Filter Pack
Screen slot size and filter pack (artificial or natural) must conform to the characteristics listed in ASTM D5092, “Standard Practice for Design and Installation of Groundwater Monitoring Wells” and ASTM D6725, “Standard Practice for Direct Push Installation of Prepacked Screen Monitoring Wells in Unconsolidated Aquifers.” Use only manufactured well screen that consists of corrosion-resistant material.

Install a well screen and filter pack (artificial or natural) if any of the following conditions exist:

- Presence of a poorly graded, fine sand aquifer or heaving or caving sands;
- Presence of a highly variable aquifer, such as alternating sand and clay layers;
- Presence of a poorly cemented sandstone or other loosely compacted material;
- Requirement for maximum yield from a low-yielding aquifer;
- Hole drilled by reverse circulation.

Refer to ASTM D5092 for filter pack quality criteria and filter pack and well screen slot size compatibility with formation rock and soil.

Use a prepacked well screen for horizontal, vertical, or angled wells. Use an artificial filter pack if natural filter pack is unavailable.

Screen and filter pack installation
Position the well screen according to the depth of the water-bearing zone(s) below the ground surface and thickness of the water-bearing zone penetrated by the drill hole. Install a conventional filter pack from the bottom up and place in a manner that avoids segregation and bridging of particles. Install filter pack according to NRCS 210-NEH-631, and ASTM D5092.

When bentonite seals are allowed, hydrate bentonite to facilitate expansion and fill voids. Hydrate bentonite according to manufacturer’s recommendations.

For a screened well cased to the well bottom, install several extra feet of blank screen or casing at the bottom of the well to accommodate sediment that passes through the well screens and settles to the bottom of the well.

Access port
Install an access port with a minimum diameter of 0.5 inch to allow for unobstructed measurement of depth of the water surface, or for the installation of a pressure gage for measuring shut-in pressure of a flowing well.

Seal or cap access ports, pressure gages, and all other openings in the well cover to prevent entry of unwanted materials and to discourage tampering. A removable cap is acceptable for an access port.

Well development
After completing well construction, but before conducting well performance (aquifer) tests, develop the well to remove fines, drill cuttings, mud, drilling fluids, and additives. Well development is required for all water wells. Pump the well at approximately 120 percent of the anticipated normal production rate until water discharge is clear. Do not use the permanent pump to conduct any well development work. Refer to ASTM 5521 “Standard Guide for Development of Groundwater Monitoring Wells in Granular Aquifers” for well development procedure.

Water quality testing
Conduct a water quality test of the well water using parameters that pertain to well performance and the suitability of the water for its intended usage. If local water quality conditions are unknown or questionable, test the well water using parameters that pertain to well performance or the suitability of the water for its intended usage. Test well water according to NRCS CPS Groundwater Testing (Code 355).

Disinfection
Prior to chemical disinfection, remove foreign substances, such as grease, soil, sediment, joint dope, and scum from the well and near the wellhead. Clean all pump parts before placing them into the well. Disinfect the well using a chlorine compound at a concentration of a minimum 50 mg/L (50 ppm).

Well performance (aquifer) testing
Design the well so at maximum drawdown, the water surface does not drop to the top of the highest screen or pump intake. Wait no less than 24 hrs after well development is completed and the water level has stabilized, to conduct a pumping test for determining specific capacity and dynamic water levels. Refer to NRCS 210-NEH-631 and 210-NEH, Part 650, Chapter 12, Section 650.1203, “Wells” for guidance on conducting, recording, and analyzing pumping tests.

Discharge water a minimum of 300 feet from the well and in such a way that reduces erosion to the land surface and prevents potential artificial recharge during the test.

Take all measurements from the top of well casing.

CONSIDERATIONS

Consider the following when planning and designing a water well:

- Evaluating the potential for adverse interference with existing nearby production wells when planning and designing the water well
- Health impacts of nitrates in groundwater used for livestock consumption. In areas of nitrogen fertilizer use, consider checking with the local Health Department for excess nitrogen levels in ground water
- Health impacts of ground water mineral content used for irrigation or animal watering. Minerals contained in ground water, such as selenium, sodium, sulfate, and others have the potential to negatively impact soil, plant and animal health
- For (aquifer) testing, consider the potential for ground water overdraft and the long-term, safe

aquifer yield

- Wells intended for human consumption are required to meet different criteria, for example surround the well casing at the ground surface with a 4-inch-thick concrete slab extended at least 2-feet in all directions from the outside of the casing for additional contamination prevention. Slope the slab away from the well.

PLANS AND SPECIFICATIONS

Develop plans and specifications that clearly describe requirements for applying the practice to achieve its intended purposes. If not already specified in the documentation required by the State regulatory authority, record the following information in the installation record:

- Well purpose and required yield.
- Location of water well by Global Positioning System (GPS) coordinates or in a sufficiently detailed narrative description to readily locate the well.
- Name of well owner.
- Type of casing material or schedule, and whether new or used.
- Height of casing extending aboveground surface.
- Static water level measured from top edge of casing or from ground surface.
- Well diameter, total well depth, and screened depth/interval.
- Notification of whether aquifer is artesian or non-artesian. If well is flowing artesian, provide flow rate and pressure.
- Screen slot size and filter gradation (if used).
- Drilling method and bore hole diameter.
- Well development methods used.
- Results of pump test, drawdown, pumping rate, specific capacity, and well efficiency.
- Driller's log for water-bearing and dry holes.
- If water quality was tested, record the parameters and test results, date of sampling, name of person who took sample, and name of laboratory that conducted tests.
- Schematic drawing of well construction showing well diameter and depth, casing and liner diameters, fill, bentonite, or grouting surface elevation, and top of well head elevation.
- Disinfection method and solution used, and date the well is disinfected.
- Copy of the driller's "PA DCNR Water Well Completion Report" including documentation of the pumping test results for actual well yield in gallons/minute (GPM) shall be submitted to PA DCNR, the owner, and for project certification.

OPERATION AND MAINTENANCE

Prepare a site-specific plan for operation and maintenance of the water well. The owner is responsible for keeping and maintaining well construction records with the maintenance plan. The owner must ensure periodic inspection of the well for proper functioning and water quality.

Do not store or mix agricultural chemicals, such as fertilizers and pesticides, or rinse containers within a 100-foot radius of the wellhead.

Regular inspection must include conditions that affect well performance, based upon the well's intended use. As a minimum, these conditions include—

- Declines in discharge, static level, maximum pumping level, and pressure (for artesian wells) that are outside acceptable limits for the well design.
- Appearance of sediment that may damage the well, pump, or appurtenances.
- Changes in water quality including odor, color, taste, and chemistry.

- Presence of algae or iron bacteria.

For wells that have blank casing installed below the screen, periodically bail or flush the well to remove excessive, accumulated sediment.

In the maintenance record, include statements describing identified problems, corrective action taken and date, and specific capacity of well before and after corrective action. The owner must remedy unacceptable conditions in a timely manner.

In the event the well becomes unserviceable, it may be decommissioned according to NRCS Conservation Practice Standard Well Decommissioning (Code 351).

REFERENCES

American National Standards Institute National Groundwater Association (ANSI/NGWA-01-14). 2014. Water Well Construction.

American National Standards Institute/American Society of Agricultural Engineers (ANSI/ASAE). 2017. American National Standard EP400.3, Designing and Constructing Irrigation Wells.

American National Standards Institute/American Water Well Association (ANSI/AWWA). 2015. American National Standard, A100, Standard for Water Wells. American National Standard/American Water Well Association, Denver, CO. AWWA catalog no: 41100-2015, http://www.awwa.org.

ASTM D5521. 2018. Standard Guide for Development of Groundwater Monitoring Wells in Granular Aquifers. ASTM International, West Conshohocken, PA. DOI: 10.1520/D5521_D5521M-18, http://www.astm.org.

ASTM D5092. 2016. Standard Practice for Design and Installation of Groundwater Monitoring Wells. ASTM International, West Conshohocken, PA. DOI: 10.1520/D5092-D5092M-16, http://www.astm.org.

ASTM D6725. 2016.Standard Practice for Direct Push Installation of Prepacked Screen Monitoring Wells in Unconsolidated Aquifers. ASTM International, West Conshohocken, PA. DOI: 10.1520/D6725-D6725M-16, http://www.astm.org.

Occupational Safety and Health Administration. 2012. Power Line Safety (up to 350 KV) - equipment operations. Safety and Health Regulations for Construction Standard - 1926.1408, Subpart CC. Retrieved from https://www.osha.gov/laws-regs/regulations/standardnumber/1926/1926.1408.

USDA NRCS. 2010. National Engineering Handbook (Title 210), Part 631..
https://directives.sc.egov.usda.gov/

USDA NRCS. 2012. National Engineering Handbook (Title 210), Part 651, Chapter 1,Laws, Regulations, Policy, and Water Quality Criteria. https://directives.sc.egov.usda.gov/

USDA NRCS. 2012. National Engineering Handbook (Title 210), Part 650, Chapter 12, Section 650.1203, Chapter 12, Wells. https://directives.sc.egov.usda.gov/