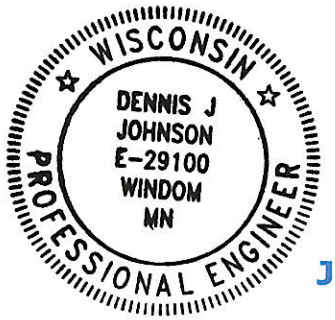
I hereby certify that this engineering document was prepared by me or under my direct personal supervision and that I am a duly licensed Professional Engineer under the Laws of the State of Wisconsin

Date: 7/22/2025
Dennis J. Johnson, P.E.
Reg.No.E-29100



JEG File #0169-01

Prepared for:

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Prepared by:

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CONSTRUCTION QUALITY ASSURANCE PLAN

GRUBER LIVESTOCK SOUTH LLC

MARIETTA TOWNSHIP

CRAWFORD COUNTY

NE 1/4 OF NW 1/4
SECTION 23
T-8-N R-4-W

July 2025

JOHNSON ENGINEERING GROUP

GRUBER LIVESTOCK SOUTH LLC

CRAWFORD COUNTY, MARIETTA TOWNSHIP, WISCONSIN

SECTION 23 – NE1/4 OF NW1/4

T-8-N R-4-W

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1. PROJECT PARTICIPANTS

Owner Contact

Gruber Livestock South LLC
236 Lincolnshire Lane
Bolingbrook, IL 60440
Contact: Mary Hrycyk
Phone: (630)-673-3245
Email: mhrycyk1@yahoo.com

Project Site Location

Crawford County, Wisconsin
Marietta TWP (T8N R4W)
NE1/4 NW1/4, Section 23

County Animal Waste Contact

David Troester
LCD County Conservationist
Crawford County Land Conservation Department
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Prairie du Chien, WI 53821
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Johnson Engineering Group, LLC Contacts

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2. PURPOSE

The purpose of providing this Construction Quality Assurance Plan is to identify specific construction features which should be documented to support conformance to the plans and specifications.

The Contractor is responsible for means and methods to accomplish construction in accordance with the plans and specifications. Construction observation by the Engineer is not intended to be an exhaustive check or a detailed inspection of the Contractor's work but rather to allow the Engineer to become generally familiar with the work in progress and to determine, in general, if the work is proceeding in accordance with the engineering plans.

3. RESPONSIBILITIES OF PARTIES

The purpose of this section is to identify key parties, their responsibilities, and authorities for the project.

Owner

The Owner is responsible for selecting and authorizing the Contractor of choice to install the structures of the proposed plan. The Owner is responsible for awarding the project, coordinating project communications, scheduling, and work for the project. Furthermore, unless otherwise delegated to the Contractor, Owner is responsible for having underground utilities located by calling the Diggers Hotline. Resolution of construction quality assurance issues shall be brought to the attention of the Owner and the Owner shall require the Contractor to install the structures in accordance with the approved plans and specifications. Contractors are responsible to the Owner.

Owner is responsible to coordinate construction observation with Engineer.

Contractor

The Contractor(s) are to install structures as per the approved plans and specifications. A contractor may hires sub-contractor to complete the work with the Owner's permission, but is responsible for their workmanship and compliance with the approved plans and specifications. No changes to the plans and specifications shall be made or accepted unless submitted in writing and approved by the Engineer.

Engineer

The Engineer is responsible for the project design and specifications. If modifications to the project are needed, the Engineer shall discuss with the Owner to determine a resolution. If evidence indicates the project is not constructed in accordance with the approved plans and specifications or approved modifications the Engineer shall not certify the construction as being in accordance with the plans.

Construction Observation Personnel

Construction observations shall be performed by Johnson Engineering Group, LLC personnel under the direction of the project's Engineer and direction from the Owner. Construction Observation Personnel are responsible for documenting structures being installed in accordance with the approved plans and specifications and, in some cases, may be responsible for providing soil, concrete, and liner material testing as required by the plans and specifications. Items requiring observation are detailed in the Observation and Verification section of this Construction Quality Assurance Plan.

Construction Observation Personnel shall notify the Owner, Engineer, and Contractor of deficiencies that are observed. The Contractor must correct these deficiencies to the satisfaction of the Construction Observation Personnel for the construction to be certified by the Engineer upon project completion.

Testing Firm

Unless performed by the Engineer or Construction Observation Personnel under the supervision of the Engineer, a Testing Firm(s) is responsible for providing soil, concrete, and liner material testing as required by the plans and specifications. The Testing Firm shall be retained by the Owner or Contractor based on the awarding of the project. The Testing Firm shall be an independent entity not associated with the Owner, Engineer, or Contractor. Test results shall be supplied to the Owner and Engineer for review. Deficiencies shall be discussed between the Engineer and Owner and a resolution brought to the Contractor.

4. QUALIFICATIONS FOR CONSTRUCTION OBSERVER

Construction Observation Personnel shall be under the supervision of Dennis J. Johnson, P.E., unless otherwise specified by the Owner. Engineer personnel should obtain readily available construction material manufacturing tags, take photographs of materials listed, and collect data from Contractors. The purpose of providing documentation of these materials is to show the facility was installed according to the approved plan design. Johnson Engineering Group, LLC staff expected to be assigned for construction documentation activities at the project are:

- Dennis Johnson, PE
- Michael Johnson, EIT
- Matthew Johnson

5. DOCUMENTATION

Construction Observation Personnel should obtain readily available construction material manufacturers tags, take photographs of materials listed, and collect data from Contractors or Testing Firms.

The purpose of providing documentation of these materials is to show the project was installed according to the approved plans and specifications.

Construction Observation Personnel shall prepare field reports summarizing observations made during each site visit. Such field reports shall contain the following at a minimum:

- Project name, date, weather conditions, and time on site.
- Personnel on site and work being completed.
- Items observed, deficiencies, and resolutions.
- Communications with Owner, Contractor, or Testing Firm.

Once construction is complete, a record documentation report and drawings shall be submitted, by a Professional Engineer, to verify that the system was installed substantially, in accordance with the plans, specifications, and applicable standards. This certification report shall include as-built plans red-lined showing any changes or alterations made throughout construction. This is required by the Dunn County ordinance and must be submitted to the Land and Water Conservation Department office prior to use of the facility.

6. PRE-CONSTRUCTION MEETING

A meeting shall be scheduled before construction to discuss construction scheduling, plan details, construction specifications, and known site limitations. The meeting should include the following:

	Name	Invited	Attended	Not Attended
Owner				
DNR				
County LCD				
Engineer	Dennis Johnson			
Excavator				
Concrete Contractor				
Building Contractor				
Testing Firm				
Other				

Items of discussion should include:

- ☐ Roles and responsibilities of parties
- ☐ Construction observation requirements and notification
- ☐ Continuous inspection during placement of concrete around embedded waterstop
- ☐ Testing requirements
- ☐ Modifications and alternatives procedures
- ☐ Review plans and specifications
- ☐ Locate and observe benchmark
- ☐ Determine who and how construction staking will take place
- ☐ Project schedule
- ☐ Coordination of work
- ☐ Procedure for certification of construction
- ☐ Discuss construction observation and which party is responsible for what structure(s)

Other items discussed:

7. OBSERVATION & CONSTRUCTION VERIFICATION

Items to be observed and documented include the following:

Grading/Drainage

- ☐ Document post construction surface drainage for conformance to the plan.
- ☐ Document stormwater pipe sizes, dimensions, and elevations for conformance to the plans.

Concrete Waste Storage Facility

Excavation

- ☐ Document separation to bedrock or saturation if needed.
- ☐ Document sub-base material and thickness (P_{200} and PI) for conformance to the plans.
- ☐ Document elevations and dimensions of the Waste Storage Facility.
- ☐ Document backfill material is in accordance with the plans and specifications.

Concrete

- ☐ Document concrete mix meets specifications (Contractor to supply at least seven days prior to concrete being placed).
- ☐ Concrete Contractor is to provide at least two days' notice prior to concrete being placed.
- ☐ Concrete shall be tested for slump, air, temperature, and strength as required by specifications and drawings.
- ☐ Batch tickets shall be provided for concrete delivered to the site and provide information as required by specifications.
- ☐ Document control joint location and dimensions for conformance with the plans.
- ☐ Document concrete dimensions of slabs, footings, walls, etc. for conformance with plans.
- ☐ Document concrete placement is in accordance with specifications.
- ☐ Document concrete curing is in accordance with specifications.
- ☐ Document form removal and backfilling is in accordance with plans and specifications.

Reinforcing Steel

- ☐ Document reinforcing steel size, grade, and that is free of loose rust, oil, or other debris.
- ☐ Document reinforcing steel placement, spacing, splice lengths, and clearances.

Waterstop

- ☐ Document waterstop size, material type, and factory joints.
- ☐ Document waterstop placement, splices, and clearances.
- ☐ Document waterstop is secured per manufacturer recommendation (No cold sticking is allowed).
- ☐ Document waterstop is free of concrete, dirt, mud or other debris prior to concrete placement.
- ☐ Document concrete around waterstop is vibrated.
- ☐ Continuous inspection during placement of concrete around embedded waterstop.

Safety and Markers

- ☐ Document safety fence is installed.
- ☐ Document warning signs are installed.
- ☐ Document maximum operating level markers are installed.

8. MATERIAL ALTERNATIVES

Contractors wishing to use materials that differ from the approved plans and specifications shall supply a written request of the alternative with material information to the Engineer for approval prior to its use. The request must describe the alternative material and its intended location or installation of use. Approval shall be submitted at least one week prior to use or installation. The Engineer shall review and comment on the approval of the material information within one week of request. Some alternatives may not be allowed.

9. NRCS WISCONSIN CONSTRUCTION SPECIFICATIONS

Applicable NRCS Wisconsin Construction Specifications include:

- 002 Excavation
- 003 Earthfill
- 004 Concrete
- 004 Embedded or Expansive Waterstop
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APPENDIX A –

NRCS WISCONSIN CONSTRUCTION SPECIFICATIONS

Construction Specification
002 Excavation

SCOPE

The work shall consist of the excavation of all materials necessary for the construction of the work.

USE OF EXCAVATED MATERIALS

To the extent that they are needed, all suitable materials removed from the specified excavations shall be used in the construction of the required earthfill. The suitability of materials for specific purposes will be determined by the Technician. The Contractor shall not waste or otherwise dispose of suitable excavated materials.

DISPOSAL OF WASTE MATERIALS

All surplus or unsuitable excavated materials will be designated as waste and shall be disposed of at the locations shown on the drawings or as approved by the Technician. Waste materials shall not be placed in wetlands or regulated floodplains.

Material placed in designated waste disposal areas shall be left in a sightly condition and sloped to provide positive drainage. Compaction of the waste materials will not be required unless specified by the construction plans.

Waste material excavated from channels may be deposited in leveled spoilbanks or areas adjacent to the channel work (if permissible). The shape and slopes of the spoilbanks shall be indicated on the drawings or as approved by the Technician. Spoil piles shall be located a minimum of 12 feet from the top of the channel side slope.

Spoil piles or disposal areas shall be protected to minimize site erosion and the production of sediment. Protective measures may include but are not limited to diversions, seeding, mulching, sediment basins, and silt fences.

SPECIAL REQUIREMENTS FOR STRUCTURE AND TRENCH EXCAVATION

The required dimensions and side slopes of all structure and trench excavations shall be as shown on the drawings.

Excavation beyond the limits of the specified lines and grades shall be corrected by filling the resulting voids with approved compacted materials.

Excavation for the installation of pipes shall follow the practices contained in the Occupational Safety and Health Administration (OSHA) Subpart P, Excavation, of 29 CFR 1926.650, .651 and

.652.

Side slopes shall be excavated or braced to safeguard the work and workers. When bracing or supporting is required, the width of the excavation shall be adjusted to allow for the space occupied by the sheeting, bracing, or other supporting installations. The Contractor shall furnish, place, and subsequently remove such supporting installations.

REMOVAL OF WATER

The Contractor shall construct and maintain all necessary cofferdams, channels, flumes, pumping equipment, and/or other temporary diversion and protective work for dewatering the various parts of the work. Foundations, cutoff trenches, and other parts of the work shall be maintained free from water as required for constructing each part of the work. After having served their purpose, all cofferdams and other temporary protective works shall be removed or leveled to give a sightly appearance and so as not to interfere in any way with the operation, usefulness, or stability of the permanent structure.

BORROW EXCAVATION

When the quantities of suitable materials obtained from specified excavations are insufficient to construct the specified fill portions of the permanent works, additional materials shall be obtained from the designated borrow areas.

When shown on the drawings, sediment basins, terraces, diversions, or other measures shall be constructed to protect the borrow areas from erosion and retain sediment within the borrow area.

The upper six (6) inches of soil shall be stripped from all borrow areas. This stripping shall be performed immediately prior to use of the borrow material to reduce the time the area is exposed to erosion. For large borrow areas, only a portion of the area should be stripped at a time. This material shall be redistributed over the area from which it came after borrow excavation is completed.

The extent of excavation and the selection of materials from the borrow area shall be as directed by the Technician. On completion of excavation, all borrow areas shall be left in a sightly condition. All borrow areas shall be graded to blend with existing topography and sloped to prevent ponding and provide positive drainage.

Construction Specification
003 Earthfill

SCOPE

The work consists of the construction of embankments, other earthfills, and earth backfills required by the drawings and specifications. This specification does not apply to the earthfill required for waste storage facilities.

Earthfill is composed of natural earth materials that can be placed and compacted by construction equipment operated in a conventional manner.

Earth backfill is composed of natural earth material placed and compacted in confined spaces or adjacent to structures (including pipes) by hand tamping, manually directed power tampers or vibrating plates, or their equivalent.

MATERIALS

All fill materials shall be obtained from required excavations and designated borrow areas. The selection, blending, routing, and disposition of materials in the various fills shall be subject to approval by the Technician.

Fill materials shall contain no sod, brush, roots, frozen soil, or other perishable materials. Stones larger than two-thirds of the uncompacted layer thickness or as otherwise specified in the gradation requirements in the plans or specifications shall be removed from the materials prior to compaction of the fill.

FOUNDATION PREPARATION

The foundation area shall be cleared of trees, stumps, roots, brush, rubbish, and stones having a maximum dimension greater than six (6) inches. Foundations shall be stripped to remove vegetation and other unsuitable materials or to the depth shown on the drawings, whichever is greater. Topsoil shall be stripped from the foundation area and stockpiled for use as a top dressing for vegetation establishment unless otherwise shown on the drawings.

Earth foundations shall be graded to remove surface irregularities and slopes steeper than 1:1.

The foundation surfaces shall be scarified parallel to the centerline of the fill to a minimum depth of 2 inches. The surface materials of the foundation shall be compacted and bonded with the first layer of earthfill. The moisture content of the scarified materials shall be maintained as specified for the earthfill.

Earth abutment surfaces shall be free of loose, uncompacted earth in excess of 2 inches in depth normal to the slope and shall be at such a moisture content that the earthfill can be compacted against them to produce a good bond between the earthfill and the abutments.

Rock foundation and abutment surfaces shall be cleared of all loose material by hand or other effective means and shall be free of standing water when earthfill is placed upon them. Occasional rock outcrops in earth foundations for earthfill, except in dams and other structures designed to restrain the movement of water, shall not require special treatment if they do not interfere with compaction of the foundation and initial layers of the earthfill or the bond between the foundation and the fill.

Foundation and abutment surfaces shall be no steeper than one horizontal to one vertical unless otherwise specified. Test pits or other cavities shall be filled with compacted earthfill conforming to the specifications for the earthfill to be placed upon the foundation.

PLACEMENT

Earthfill shall not be placed until the required excavation and foundation preparation is completed and inspected and approved by the Technician. Earthfill shall not be placed upon a frozen surface nor shall snow, ice, or frozen material be incorporated in the earthfill matrix.

Earthfill shall be placed in approximately horizontal layers beginning at the lowest elevation of the foundation. The thickness of each layer of fill prior to compaction shall be as indicated on the drawings.

In the absence of this information on the drawings, follow the guidance in Table 1. Materials placed by dumping in piles or windrows shall be spread uniformly to not more than the specified layer thickness prior to compaction.

Adjacent to structures, earthfill shall be placed in 4-inch lifts (prior to compaction) in a manner adequate to prevent damage to the structure and to allow the structure to gradually and uniformly assume the backfill loads. The height of the earthfill shall be increased at approximately the same rate on all sides of the structure.

Placement of earthfill adjacent to concrete structures may begin after the concrete has cured for the minimum time specified in the Concrete specification.

Earthfill in dams, levees, and other structures designed to restrain the movement of water shall be placed to meet the following additional requirements:

1. The distribution of materials throughout each zone shall be essentially uniform, and the earthfill shall be free from lenses, pockets, streaks, or layers of material differing substantially in texture, moisture content, or gradation from the surrounding material. Zone earthfills shall be constructed concurrently unless otherwise specified.
2. The embankment top shall be maintained approximately level during construction with three exceptions: 1) A crown or cross-slope of about 2 percent shall be maintained to ensure effective drainage, 2) or as otherwise specified for drainfill, 3) or as otherwise specified for sectional (or phase) construction as described in (5) below.
3. Dam embankments shall be constructed in continuous layers from abutment to abutment, except where openings to facilitate construction or to allow passage of stream flow during construction are specified.
4. If the surface of any layer becomes too hard and smooth to achieve a suitable bond with the succeeding layer, it shall be scarified parallel to the axis of the earthfill to a depth of not less than 2 inches before the next layer is placed.
5. When sectional (or phase) construction of embankments is authorized, the work shall be accomplished in the following manner:
    - Each section of the embankment that is constructed in the first phase shall be so placed that a slope not steeper than 3 feet horizontal to 1 foot vertical is maintained at the end of the embankment section adjacent to the gap in construction or closure section.
    - Prior to placement of the closure sections, the surfaces of completed earthfills and excavations that will be in contact with the closure shall be stripped of all loose material, scarified, moistened, and recompacted as necessary when the new earthfill is placed against it. This ensures a good bond with the new earthfill and obtains the specified moisture content and density at the contact of the inplace and new earthfills.

CONTROL OF MOISTURE CONTENT

During placement and compaction of earthfill or earth backfill, the moisture content shall be as specified on the drawings or supplemental specifications. If this information is not included on the drawings or supplemental specifications, the earthfill or earth backfill shall have a moisture content sufficient to insure the required compaction. When kneaded in the hand, the soil will form a ball which does not readily separate and will not extrude out of the hand when squeezed tightly. The adequacy of the moisture content will be determined by the Technician.

Earthfill material or the top surface of the preceding layer of compacted earthfill that becomes too dry to permit suitable bond shall either be removed or scarified and wetted by sprinkling to an acceptable moisture content prior to placement of the next layer of earthfill. Uniform moisture distribution shall be obtained by disking prior to compaction.

Earthfill material that is too wet when deposited or the top surface of the preceding layer of compacted earthfill becomes too wet shall be either removed or allowed to dry to an acceptable moisture content before compaction or placing additional layers of earthfill.

COMPACTION

The Contractor shall furnish and operate the types and kinds of equipment necessary to compact the earthfill materials.

Unless otherwise specified on the plans or supplemental specifications, compaction requirements for each layer of earthfill material are as shown in Table 1 or by an approved equivalent method. The Technician shall determine the adequacy of compaction. Equipment passes in addition to those shown in Table 1 may be required.

Each pass shall consist of at least one complete coverage by the wheel, track, or roller over the entire surface of the earthfill layer in a direction parallel to the main axis of the earthfill.

Earth backfill—Earth backfill adjacent to structures shall be compacted to a density equivalent to that of the surrounding in-place earth material or to the adjacent required earthfill or earth backfill requirements. Compaction shall be accomplished by hand tamping or manually directed power tampers, plate vibrators, walk-behind, miniature, or self-propelled rollers. Unless otherwise specified heavy equipment including backhoe mounted power tampers or vibrating compactors and manually directed vibrating rollers shall not be operated within 3 feet of any structure. Towed or self-propelled vibrating rollers shall not be operated within 5 feet of any structure. Compaction by means of drop weights operating from a crane or hoist is not permitted.

The passage of heavy equipment will not be allowed:

- Over cast-in-place conduits within 14-days after placement of the concrete.
- Over cradled or bedded precast conduits within 7 days after placement of the concrete cradle or bedding.
- Over any type of conduit until the backfill has been placed above the top surface of the structure to a height equal to one-half the clear span width of the structure or pipe or 3 feet, whichever is greater, except as may be specified on the drawings.

Compacting of earth backfill adjacent to structures shall not be started until the concrete has attained the specified strength or has attained the curing period as specified in Wisconsin Construction Specification 4-Concrete.

REWORKING OR REMOVAL AND REPLACEMENT OF DEFECTIVE EARTHFILL

Earthfill placed at densities lower than the specified minimum density or at moisture contents outside the specified acceptable range of moisture content or otherwise not conforming to the requirements of the specifications shall be reworked to meet the requirements or removed and replaced by acceptable earthfill. The replacement earthfill and the foundation, abutment, and earthfill surfaces upon which it is placed shall conform to all requirements of this specification for foundation preparation, approval, placement, moisture control, and compaction.

Table 1. Equipment Compaction Requirements

Equipment Type	Applicable Soils1	Maximum Fill Height2 (feet)	Layer Thickness3 (inches)	Minimum Passes
Sheepsfoot roller (10,000 lb. min. operating weight)	ML, MH, CL, CH or SM, SC, GM, GC with >20% fines	None	9	1
Vibratory tamping roller (9,000 lb. min. operating weight)	SM, SC, GM, GC	None	9	2

Equipment Type		Applicable Soils1	Maximum Fill Height2 (feet)	Layer Thickness3 (inches)	Minimum Passes
Rubber-tired scraper or articulated haul truck (fully loaded)		GM, GC, SM, SC, ML, MH, CL, CH	None	9	1
Rubber-tired front end loader (fully loaded)		GM, GC, SM, SC, ML, MH, CL, CH	20	6	1
Track-type crawler (standard tracks)	30,000 lb. min.	GM, GC, SM, SC, ML, CL	10**	6	2
		SP, SW, GP, GW	6**	12	4
		CL, ML, SC, SM	15##	3	2
	less than 30,000 lb.	GM, GC, GP, GW, SM, SC, SP, SW, ML, CL	6**	6	2
Farm tractor (2,400 lb. min.)		GM, GC, SM, SC, ML, MH, CL, CH	15	6	2
Smooth steel drum vibratory roller (10,000 lb. min.)		SP, SW, GP, GW	None**	12	2

[1]Unified Soil Classification System.

[2] Measured from the top of the fill to the lowest point along the centerline of the fill.

[3] Prior to Compaction.

** The fill shall not have a permanent body of water stored against it.

This method may only be used for embankments that will not have the potential for a permanent body of water stored against it that is greater than 1/4 acre in surface area or more than 6 feet deep.

Construction Specification
004 Concrete

A. Scope

The work shall consist of furnishing, forming, placing, consolidating, finishing, and curing concrete with Portland and Portland-Limestone cement, and the furnishing and placing of reinforcement or other appurtenances as required on the construction drawings. All materials, test procedures, and admixtures shall meet the requirements of the latest edition of the applicable ASTM designation.

Failure to meet any requirements contained in this specification may be cause for rejection of the concrete or delay of placement.

B. Definitions

The following definitions are provided for the purpose of this specification.

1. *Batch delivery ticket* refers to the form showing the total weights of all the ingredients used to mix the contents of the rotating drum mixer (total weights of all ingredients on the load) and other job pertinent information.
2. *Consolidating* refers to the process of reducing the volume of entrapped air in a fresh cementitious mixture, usually accomplished by inputting mechanical energy.
3. *Construction joints* are those joints where two successive placements of concrete meet, through which reinforcement is continuous and bond is required between the two pours.
4. *Control joints* often called Contraction joints are joints used in unreinforced and lightly reinforced slabs-on-ground to minimize random cracking and create straight-line weakened-planes in concrete. Control joints “control” the cracking location by inducing cracks at predetermined locations. The locations can be formed or saw cut.
5. *Finishing* refers to the process of treating surfaces of fresh or recently placed concrete or mortar to produce desired appearance and service.
6. *Firm* refers to the condition of the subgrade where it is not significantly displaced or deformed by foot traffic during construction and is able to properly support reinforcement chairs.
7. *Flatwork* refers to concrete slabs poured on slopes flatter than 5:1 (Horizontal:Vertical).
8. *Form release agent* refers to commercially manufactured formwork release agents that prevent formwork absorption of moisture, prevent bond with concrete, and do not stain the concrete surfaces.
9. *Formed surfaces* are those that require a temporary structure or mold for the support of concrete while it is setting and gaining sufficient strength to be self-supporting, such as walls or poured-in-place tank lids.
10. *Hand tamping* refers to the operation of consolidating freshly placed concrete by hand-held implements.
11. *Honeycomb* refers to voids left in concrete due to failure of the mortar to effectively fill the spaces among coarse aggregate particles.
12. *Jitterbug* refers to a grate tamper for pushing coarse aggregate slightly below the surface of a slab to facilitate finishing.
13. *Liquid-containment concrete* refers to concrete applications using specific placement and finishing techniques, and design features to minimize the loss of liquids.
14. *Manufacturer* refers to the producer/supplier of the ready-mixed concrete.

15. *Mesh roller* refers to a finishing tool consisting of a rolling drum attached to a handle, of which the surface of the drum is made of mesh, sometimes used for rolling over the surface of fresh concrete to embed coarse aggregate.
16. *Rock pocket* refers to a porous, mortar-deficient portion of hardened concrete consisting primarily of coarse aggregate and open voids; caused by leakage of mortar from the form, separation (segregation) during placement, or insufficient consolidation.
17. *Sloped slabs* refers to concrete slabs poured on slopes of 5:1 (Horizontal:Vertical) or steeper.
18. *Technician* refers to an individual trained in specific technical processes, and may include an engineer, government agency representative, private sector technical service provider, qualified independent third-party quality assurance inspector, or a similar person that is primarily responsible for the project quality assurance.
19. *Ternary mix* is a mixture using three cementitious materials, such as Portland cement, fly ash, and ground granulated blast-furnace slag (slag).
20. *Top bars* are horizontal reinforcements placed such that more than 12 inches of fresh concrete is cast below the reinforcing bar (such as horizontal wall bars).
21. *Vibration* refers to mechanical energetic agitation of freshly mixed concrete during placement by mechanical devices, either pneumatic or electric, that create vibratory impulses of moderately high frequency to assist in consolidating the concrete.
    a. Internal vibration employs one or more vibrating elements that can be inserted into the fresh concrete at selected locations.
    b. Surface vibration employs a portable horizontal platform on which a vibrating element is mounted.
22. *Water-cement ratio (w/c)* is the ratio of the weight of free water (excluding that absorbed by the aggregates) to the weight of Portland cement in a concrete mix expressed as a decimal.
23. *Water-cementitious material ratio (w/cm)* is the ratio of the weight of free water (excluding that absorbed by the aggregates) to the weight of cementitious material (fly ash, Portland cement, and slag) in a concrete mix expressed as a decimal.

C. Materials

The Contractor shall provide test data, independent laboratory reports, or other evidence from the concrete manufacturer showing that all materials meet the requirements of this specification. All materials proposed for use shall be approved by the Technician.

1. Type I, II, or III Portland cement shall conform to ASTM C 150.
2. Type IS Portland blast-furnace slag cement, Type IP Portland-pozzolan cement, or Type IL Portland-limestone cement shall conform with ASTM C595. Portland-limestone cement shall have a limestone content more than 5% but less than or equal to 15% by mass of blended cement as designated by Type IL(5) to Type IL(10). Moderate sulfate resistance when desired shall be specified by the suffix Type IL (MS). High sulfate resistance when desired shall be specified by the suffix Type IL(HS).
3. Fine aggregate shall conform to ASTM C 33 and be composed of clean, uncoated grains of material. Refer to the fine aggregate gradation table in Section D of this specification.
4. Coarse aggregates shall be gravel or crushed stone conforming to ASTM C 33 and be clean, hard, durable, and free from clay or coating of any character. Refer to the coarse aggregate gradation table in Section D of this specification.
5. Water shall be clean and free from injurious amounts of oil, salt, acid, alkali, organic matter, or other deleterious substances.
6. Air entraining agent shall conform to ASTM C 260.
7. Pozzolan (fly ash) shall conform to ASTM C 618, Class C or F. The loss of ignition shall not exceed 3 percent for Class C and F $\pm$1 percent for lot-to-lot variations.

8. Natural pozzolan shall conform to the requirements of ASTM C618, Class N including the optional requirements of uniformity and effectiveness in controlling alkali silica reactivity.
9. Ground granulated blast furnace (GGBF) slag as a partial substitute for cement shall conform to ASTM C 989.
10. Chemical admixtures shall be used in strict compliance with the manufacturer's recommendations, conform to ASTM C 494, and may be the following types:
    a. Type A - Water-reducing admixtures.
    b. Type B - Retarding admixtures.
    c. Type C - Accelerating admixtures.
    d. Type D - Water-reducing and retarding admixtures.
    e. Type E - Water-reducing and accelerating admixtures.
    f. Type F - Water-reducing, high range admixtures (superplasticizers).
    g. Type G - Water-reducing, high range, and retarding admixtures (superplasticizers).
    h. Type S - Specific performance admixtures
        - If Type C or E is used, the manufacturer shall provide the Technician a product data sheet verifying that the product is a non-chloride accelerator.
        - If Type S is used the manufacturer shall provide the Technician a report stating the specific performance characteristic(s) of the admixture and data to substantiate the performance characteristic(s).
        - Calcium chloride or admixtures containing chloride ions other than from impurities in admixture ingredients shall not be used.
11. Deformed reinforcing bars shall be free from loose rust, oil, grease, paint, or other deleterious matter. Steel bars for concrete reinforcement shall meet the requirements of ASTM A 615. The steel shall be deformed Grade 40 or Grade 60 billet-steel bars as noted on the plans.
12. Deformed welded wire reinforcement (WWR) shall conform to the requirements of ASTM A 1064 and shall be furnished in flat sheets and shall be size D4 or larger as indicated on the plans. This material may only be used for non-structural elements such as slabs on grade. Spacing of welded intersections shall not exceed 16 inches.
13. Curing compound shall be a liquid membrane-forming compound suitable for spraying on the concrete surface. The curing compound shall meet the requirements of ASTM C 309, Type 2 (white pigmented).
14. Glass Fiber Reinforced Polymer (GFRP) bars shall be free from soil, grease, paint, or other deleterious matter. GFRP bars for concrete reinforcement shall conform to ASTM D7957.

D. Design of the Concrete Mix

No less than seven (7) days prior to the start of concrete placement the Contractor is responsible for submitting documentation of the proposed design mix to the Technician. The Contractor is responsible for providing a mix with the minimum required 28-day compressive strength in the construction plan and meet the following:

1. The water-cement (w/c) or the water-cementitious material (w/cm) ratio shall not exceed 0.45 for all concrete construction.
2. The water cement (w/c) or the water-cementitious material (w/cm) ratio shall not exceed 0.42 for all concrete being designed using ACI 350 - Code Requirements for Environmental Engineering Concrete Structures. This concrete shall also have 28-day compressive strength of 4,500 psi.
3. The cementitious material required shall be a minimum of 564 pounds per cubic yard of concrete.
    a. The cementitious material may include a maximum of 25 percent (by weight) of fly ash or a maximum of 30 percent (by weight) of ground granulated blast-furnace (GGBF) slag. The remaining cementitious materials shall be Portland cement.

b. Mixes containing both fly ash and GGBF slag shall not exceed 30 percent in combination (ternary mix) and no more than 25 percent shall be fly ash. The remaining cementitious materials shall be Portland cement.

4. The air content (by volume) shall be 6 percent of the volume of the concrete.
5. The maximum (not to exceed) slump, with the use of water reducers, shall be 5 inches ± 0.25 inches.
6. The maximum (not to exceed) slump, with the use of superplasticizers, shall be 8 inches ± 0.25 inches.
7. The fine aggregate saturated surface dry weight shall be 30-45 percent of the total saturated surface dry weight of the combined coarse and fine aggregates. The well-graded fine aggregate shall conform to the following ASTM C 33 or Wisconsin DOT gradation requirements shown below:

Fine Aggregate Gradation

Sieve Size	Percent Passing By Weight	
	ASTM C 33	WI DOT
⅜" (9.5 mm)	100	100
No. 4 (4.75 mm)	95-100	90-100
No. 8 (2.36 mm)	80-100	---
No. 16 (1.18 mm)	50-85	45-85
No. 30 (600 µm)	25-60	---
No. 50 (300 µm)	5-30	5-30
No. 100 (150 µm)	0-10	0-10
No. 200 (75 µm)	0-5	0-3.5

8. The well graded coarse aggregate shall conform to the following ASTM C 33 gradation requirements for size number 67 aggregate shown below:

Coarse Aggregate Gradation

Sieve Size	Percent Passing By Weight
1" (25.0 mm)	100
¾" (19.0 mm)	90-100
⅜" (9.5 mm)	20-55
No. 4 (4.75 mm)	0-10
No. 8 (2.36 mm)	0-5
No. 200 (µm)	0-1.5

E. Mixing

1. Ready-mixed concrete shall be in accordance with ASTM C 94 for ordering (OPTION C, Minimum Cement Content), batching, mixing, and transporting.
2. Batching Tolerances (maximum w/c or w/cm ratio shall not exceed 0.45):
    a. Cementitious Material: The weight of the cementitious material shall be within plus or minus 1 percent (± 1%) of the required weight of the cementitious material.
    b. Admixtures: The admixtures shall be within plus or minus 3 percent (± 3%) of the required weight or volume for each specific admixture.
    c. Mixing Water: The water added to the batch, including free water on the aggregates, shall be measured by weight or volume to an accuracy of 1 percent of the required total mixing water. Added ice shall be measured by weight.
    d. Aggregate: The weight of the fine and coarse aggregate shall be within plus or minus 2 percent (± 2%) of the required weight.
    e. Air: The air content (by volume) shall be 6 ± 1.5 percent of the volume of the concrete at the location and time of placement.
3. Concrete shall be uniform and thoroughly mixed when delivered to the forms.
4. The water-cement (w/c) ratio or water-cementitious material (w/cm) shall not exceed 0.45 at any time, including the addition of water at the site.
5. The concrete shall be batched and mixed such that the temperature of the concrete at time of placement shall not be less than 55 degrees Fahrenheit or, at no time during its production or transportation more than 90 degrees Fahrenheit.

F. Batch Delivery Ticket Information

1. The Contractor shall obtain from the manufacturer a batch delivery ticket for each load of concrete before unloading at the site. Any concrete load delivered without a batch delivery ticket containing all the following information shall not be allowed to be discharged in any part of the construction project covered under this specification.
2. The following minimum information shall be included on the batch delivery ticket.
    a. Job-pertinent information
        i. Name of concrete manufacturer and batch plant
        ii. Name of purchaser and job location
        iii. Date of delivery
        iv. Truck number
        v. Amount of concrete delivered
        vi. Time loaded or time of first mixing of cement and aggregates
    b. Ingredients used to mix the batch
        i. Mixing water added as free water
        ii. Percent moisture, or weight of water contained on the aggregates
        iii. Percent absorption, or weight of water absorbed by the aggregates
        iv. Type and amount of cementitious materials
        v. Type and amount of admixtures
        vi. Weights of fine and coarse aggregates
    c. The Contractor is responsible for adding the following information:
        i. Volume of water added by the receiver of the concrete
        ii. Time the concrete arrived at the site
        iii. Time the concrete was completely unloaded

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

G. Placement of Subgrade, Forms, and Reinforcing Steel

1. Subgrade
   a. The site shall be graded to the dimensions and elevations as specified in the construction plans.
      - All surfaces shall be firm and damp prior to placing concrete.
      - Concrete shall not be placed on mud, dried earth, uncompacted fill, frozen subgrade, or in standing water.
        - The use of plastic sheeting beneath the concrete is not permitted except for a designed vapor barrier in an enclosed building.
2. Forms
   a. The forms, associated bracing, and stakes shall be substantial, unyielding, and constructed so that the finished concrete will conform to the specified dimensions and contours.
      - Forms shall be mortar tight.
      - Forms shall be coated with a form release agent before being set into place.
      - Form release agent shall not come in contact with the steel reinforcement, waterstop, or with hardened concrete against which fresh concrete is to be placed.
      - For structures which are to be store liquids, form ties shall be used that permit their removal to a depth of at least ½ inch.
      - Concrete joints shall be placed at locations and be of the type shown on the construction drawings.
3. Reinforcing Steel and GFRP Bars
   Reinforcement shall be accurately placed as shown on the drawings and secured in position in a manner that will prevent its displacement during the placement of concrete.
   a. Tolerances - The following tolerances will be allowed in the placement of reinforcement:
      - Where 1½ inches clear distance is shown between reinforcing steel and forms, or embedded objects, allowable clear distance is 1⅛ to 1½ inches.
      - Where 2 inches clear distance is shown between reinforcing steel and forms, allowable clear distance is 1⅝ to 2 inches.
      - Where 3 inches clear distance is shown between reinforcing steel and earth or forms, allowable clear distance is 2½ to 3 inches. Over-excavation backfilled with concrete shall not be considered as clear distance.
      - The maximum variation from the reinforcing steel spacing shown, shall be 1/12 of the spacing, without a reduction in the amount of reinforcing steel specified.
      - The ends of all reinforcing steel shall be covered with at least 1½ inches of concrete, with an allowable minimum distance of 1⅛ inches.
   b. Reinforcement Support - Holding steel reinforcement in position with temporary supports is not permitted. Tack welding of bars is not permitted.
      - Steel chairs, hangers, spacers; coated steel chairs, hangers, spacers; or plastic chairs, hangers, spacers may be used as supports. Short sections of GFRP bars inserted into the ground may be used as supports if they demonstrate an ability to stay rigid and upright, and hold the grid in a fixed position, under foot traffic and concrete placement.
      - Precast concrete chairs may be used as supports providing the chairs are manufactured from concrete equal in compressive strength to the concrete being placed.
      - Reinforcement shall be supported at a minimum as follows:
        - Deformed reinforcing bars for flatwork and sloped slabs shall be supported by a

minimum of 1 support chair every 4 feet in each direction. Reinforcement shall not deflect or sag between supports. Deformed reinforcing bars shall be tied at every other rebar intersection or as approved by the Technician.

- Deformed welded wire reinforcement (WWR) shall be supported no further than as indicated in the table below.
- When two layers of deformed reinforcing bars or deformed welded wire reinforcement are used for wall footings, flatwork and sloped slabs, the bottom layer may be supported by precast concrete chairs. The upper layer must be supported by metal chairs, metal spacers, plastic spacers, or rebar with legs tied to the lower mat and supporting the upper layer of reinforcing bars.

WWR Support

Welded Wire Reinforced Size[1]	Welded Wire Spacing	Maximum Support Spacing in Each Direction[2], feet
D9 or larger	12 inches or more	4 to 6 feet
D5 to D8	12 inches or more	3 to 4 feet
D9 or larger	Less than 12 inches	3 to 4 feet
D4 to D8	Less than 12 inches	2 to 3 feet

Notes:
(1) "D" is the standard designation for deformed wire.
(2) Support spacing shall be adequate to support all loads, including construction personnel and equipment. If excessive deflections occur, closer support spacing is required.

c. When GFRP bars are used, they require adequate stiffness (diameter) or chair support to prevent deflection into the base material under the weight of poured concrete. Bars need to maintain a specified vertical location within + ½ inch.

d. Flatwork reinforcement may be driven on prior to placement of supports if both of the following conditions are met:
   - The subgrade is firm so that minimal displacement is made by equipment. If significant displacement occurs, the steel shall be removed, the subgrade regraded and compacted before steel and concrete placement.
   - The reinforcing steel is not deformed by the equipment. If the steel is deformed, it shall be replaced before concrete placement.

e. Steel tying to protruding steel from a previous pour or form construction for new concrete that will be in contact with previously poured concrete shall not be started until the previously poured concrete has cured a minimum of 12 hours.

f. Reinforcement Splice Lengths and Bend diameters:
   - Deformed reinforcing bars
     - Bend diameter: 6 bar diameters for #3 through #8 bar sizes and 8 bar diameters for larger bars. Reinforcing bars shall not be heated to facilitate bending.
     - Splice Length for Steel Bars: The minimum splice lengths in the table below are for concrete designed with a 28-day compressive strength of 3,500 psi. (NRCS standard wall designs) Other higher concrete design strengths and reinforcement grades require different splice lengths (typically shorter) in accordance with ACI 318.
     - Splice Lengths for GFRP Bars: The minimum splice length shall be specified by manufacturer.
     - Deformed reinforcing bars shall not be spliced by welding. All lap splices shall be adequately tied together to firmly hold the reinforcement in position to maintain the proper splice length.

Minimum Splice Lengths [Note 1]

	Grade 40	Grade 60
#3 through #6 bars		
Top bars	27 bar diameters	41 bar diameters
all other bars	21 bar diameters	32 bar diameters
#7 and larger bars		
Top bars	34 bar diameters	51 bar diameters
all other bars	26 bar diameters	40 bar diameters

[Note 1]: Splice lengths shall be the greater of that indicated in the Table or 12-inches.

- Deformed welded wire reinforcement (WWR) - Splice length shall be in accordance with the requirements of ACI 318-08 or ACI 318-11 Part 12.18. Deformed welded wire reinforcement shall not be spliced by welding. All lap splices shall be tied to firmly hold the reinforcement in position to maintain the proper splice length.

H. Delivering, Placing, Consolidating, and Finishing Concrete

1. The Contractor shall notify the Technician of the proposed method of placement, consolidation, and finishing of the concrete at least seven (7) days prior to the start of concrete placement. The Contractor shall furnish the Technician a record of daily data including:
   a. Ambient temperature
   b. Relative humidity
   c. Wind velocity
2. General
   a. Prior to placement of concrete, the forms and subgrade shall be free of chips, sawdust, debris, water, ice, snow, extraneous oil, mortar, or other harmful substances or coatings. Any oil on the reinforcing steel or other surfaces required to be bonded to the concrete shall be removed. Concrete shall not be placed until the subgrade, forms, waterstop, and steel reinforcement have been inspected and accepted by the Technician. Any deficiencies shall be corrected before the concrete is delivered for placement. Forms, reinforcing steel, and subgrade shall be moistened prior to placing concrete. All reinforcement bars stored at the worksite shall be stored according to manufacturer recommendations. The bars shall also be stored above the ground surface on skids or other supports, kept clean and dry. GFRB shall be stored out of direct sunlight and away from temperatures high enough to soften the polymer.
3. Delivery
   a. Concrete shall be delivered to the site and discharged into the forms within 1½ hours after the introduction of the mixing water to the cement and aggregates, or when a superplasticizer is used, the manufacturer's recommended time limit for discharge after addition shall apply. The 1½ hour time may be extended if the concrete is of a slump that it can be placed, consolidated, and finished without the addition of water to the batch. Upon arrival at the job site, addition of water will be allowed to adjust the slump, provided such addition does not exceed the water-cement (w/c) ratio or water-cementitious material ratio (w/cm). Final placement of the batch shall begin immediately after mixing of the added water is completed.
   b. Additional superplasticizer shall not be added to the concrete mix after discharge of the concrete at the job site has commenced.
4. Placement
   a. The slump of the placed concrete shall not exceed the maximum slump of 5 inches ± 0.25 inches with the use of water reducers.
   b. The slump of the placed concrete shall not exceed the maximum slump of 8 inches ± 0.25

inches with the use of superplacticizers.

c. Concrete shall be deposited as closely as possible to its final position. Concrete shall be worked into the corners and angles of the forms and around all reinforcement and embedded items in a manner to prevent segregation of aggregates. All placement shall be done in a manner that prevents incorporation of subgrade material into the concrete.

d. Methods for placing concrete on sloped slabs shall only include chutes, pumps, conveyors, wheelbarrows, or similar means of directly depositing concrete as near as possible to its final position. Placement of concrete by other methods where concrete is deposited upslope and flows to its final position downslope (commonly called “lava flow”, “glacial pours”, etc.) shall not be permitted.

e. Concrete shall not be dropped more than 6 feet vertically unless suitable equipment is used to prevent segregation. Concrete containing superplasticizer shall not be dropped more than 12 feet vertically and shall not be placed in lifts exceeding 6 feet in depth. Non-superplasticized concrete shall be placed in forms in horizontal layers not more than 24 inches deep. Each layer shall be thoroughly consolidated before the next is placed, at a rate such that previously placed concrete has not yet set when the next layer of concrete is placed upon it.

5. Consolidation

a. All concrete required to be consolidated with internal type mechanical vibrator shall be capable of transmitting vibration to the concrete at frequencies not less than 8,000 impulses per minute, unless otherwise specified or approved before placement.

- Vibration shall compact the concrete and bring it into intimate contact with the forms, reinforcing steel, and other embedded items while removing voids and pockets of entrapped air. The location, insertion, duration, and removal of the vibrators shall be such that maximum consolidation of the concrete is achieved without causing segregation of the mortar and coarse aggregate or causing water or cement paste to flush to the surface.
- Vibration shall be supplemented by spading, rodding, and hand tamping as necessary to ensure smooth and dense concrete along the form surface, in corners, and around embedded items. The contractor shall provide a sufficient number of vibrators to properly consolidate the concrete immediately after it is placed. Placement rate will be restricted if an inadequate number of vibrators are available.
- The use of vibrators to transport concrete in the forms, slabs or conveying equipment will not be permitted.

b. Formed Surfaces

- All concrete walls shall be vibrated.
- Immediately after the concrete is placed in the forms, it shall be consolidated by internal vibration or hand tamping as necessary to insure dense concrete. Vibration shall be applied to the freshly deposited concrete by rapidly inserting the vibrator and slowly, in an up and down motion, removing the vibrator at points uniformly spaced at not more than 1.5 times the radius of the area visibly effected by vibration. Generally, this is at 5 to 10 seconds per foot on 14-inch spacings or less. The area visibly effected by the vibrator shall overlap the adjacent, just vibrated area. The vibrator shall extend vertically into the previously placed layer of fresh concrete by at least 6 inches at all points. Concrete supplied with superplasticizer shall be placed with a minimum amount of vibrating and finishing effort. Vibration shall not be applied directly to the reinforcement steel or the forms, nor to concrete which has hardened to the degree that it does not become plastic when vibrated. Each pour shall be consolidated to insure a monolithic bond with the preceding pour.

c. Slabs and footings

- Immediately after the concrete is placed, it shall be consolidated by hand or mechanical methods as necessary to insure dense concrete.

- Surface vibrators may be used to consolidate slabs 8 inches and less in thickness. In thin slabs the internal vibrator(s) should be sloped toward the horizontal to allow operations in a fully embedded position, but shall not contact the subgrade.
- Slabs and footings more than 8 inches thick shall be consolidated with internal vibration and may be augmented through use of a surface vibrator.

- Surface vibrators include vibrating screeds, plate or grid vibratory tampers, or vibratory roller screeds. (Mesh rollers, jitterbugs, and grate tampers are finishing tools and not consolidation tools.) When the concrete slab is to be consolidated using surface vibration methods, the contractor shall detail how this work is to be performed in writing to the technician for review and approval. This report must be submitted no less than 7 calendar days before placing concrete by this method. It includes equipment selection and specifications.

6. Finishing
   a. All screed support devices shall be removed from the concrete or driven down flush with the subgrade prior to finishing.
   b. All formed concrete surfaces shall be true and even, and shall be free of depressions, holes, projections, bulges, or other defects in the specified surface finish or alignment. All surface defects shall be repaired as stated in the “Form Removal” section of this specification.
   c. All flatwork and sloped slabs shall be worked to a uniform grade, maintaining the specified thickness. Concrete shall be worked to minimize segregation and in a manner that does not adversely affect the structural integrity, durability, or function of the structure. Surfaces shall be free from rock pockets, or honeycomb areas or other harmful irregularities or defects.
   d. Water shall not be sprinkled or added to the surface of the concrete to facilitate finishing. An additional finish shall be applied if specified in the construction plans.
   e. The proposed finished texture (broom, float, mesh roller, trowel, non-slip, etc.) of the concrete surface shall be approved by the Technician.
   f. Evaporation reducer may be used during the finishing operation if approved by the Technician. Curing of the concrete is still required as per Section K, Curing.
   g. If a protective concrete coating is specified on the drawings, the coating manufacturer’s recommendations for curing and surface preparation shall be followed.
7. Contraction (Control) Joints
   a. Control joints shall be the type and locations shown on the drawings.
   b. Saw-cutting should be performed before concrete starts to cool, as soon as the concrete surface is firm enough not to be torn or damaged by the blade, and before random drying-shrinkage cracks can form in the concrete slab.
   c. A 5 ft long cut should be attempted and evaluated for spalling or raveling before the contractor cuts the entire section of the slab. The saw-cutting can be done shortly after final set, but timing of the sawing is critical so not to pull up coarse aggregate. If aggregate is pulled up, delay the saw-cutting.
   d. Saw-cut joints shall be one-third the slab thickness and spacing specified on the drawings.
   e. New, clean saws fitted with an abrasive or diamond blades are recommended, using one of the following three types of saws: conventional wet-cut, conventional dry-cut, or early-entry dry-cut.
   f. Care should be taken to make sure the early-entry saw does not ride up over hard or large coarse aggregate and the joints shall be free of mortar and concrete.

I. Construction Joints

1. If the concrete sets during placement to the degree that it will not flow and merge with the succeeding pour when tamped or vibrated, the Contractor shall discontinue placing concrete and install a formed construction joint. The Contractor shall be prepared to install unplanned construction joints in the event that there is an interruption of the pour, equipment breakdown, or

other problem which makes it necessary to stop placement of concrete at locations other than those previously planned. The reinforcement shall pass through the joint, unless otherwise indicated on the construction plan. Prior to the succeeding pour, the joint surface shall be cleaned to remove all unsatisfactory concrete, laitance, coatings, stains, or debris by one of the following methods:

a. The joint surface shall be cleaned to expose the fine aggregate and sound surface mortar, but not so deep as to undercut the edges of coarse aggregate. Cleaning shall be by wire brush, sandblasting, or high pressure air-water cutting after the concrete has gained sufficient strength to prevent displacement of the coarse aggregate. The joint surface shall be washed to remove all loose material after cutting.

b. According to methods specified by the person approving the construction plans.

2. The surfaces of all construction joints shall be wetted and standing water removed immediately prior to placement of the new concrete. The new concrete shall be placed directly on the cleaned and washed surface. New concrete shall not be placed until the hardened concrete has cured at least 12 hours. The newly placed concrete shall be consolidated to achieve a good bond with the previously hardened concrete.

J. Form Removal and Concrete Repair

1. Form Removal

a. Forms shall be removed without damage to the concrete. Supports shall be removed in a manner that permits the concrete to take the stresses due to its own weight uniformly and gradually. The minimum period from completion of the concrete placement to the removal of the forms shall be based on either strength tests or cumulative times.

- The strength of the in-place concrete is determined by testing concrete cylinders specifically cast for this purpose and cured adjacent to the member in accordance with the ASTM C 31 methods for determining removal time.
- Unless otherwise specified, forms supporting the weight of the concrete member may be removed after the concrete strength is 70 percent of that specified for the 28-day compressive strength.
- Form removal for concrete tank walls between 10 and 20 feet high is allowed after a curing period of at least 16 hours if approved by the design engineer. Form removal time must be supported by a site-specific, compression cylinder that is cast, field cured, and tested to verify strength attainment of at least 600 psi.
- The total accumulated time, not necessarily continuous, that the air adjacent to the concrete is above 50 degrees Fahrenheit will be determined by the Contractor and accepted by the Technician. The forms may be removed after the total accumulated time shown in the following table:

Form Removal

Forms		Time
Sides of slabs or beams without waterstop		12 hours
Sides of slabs or beams with waterstop		16 hours
Underside of slabs or beams	Clear Span < 10 feet	4 days
	10-20 feet	7 days
	> 20 feet	14 days
Sides of Walls or columns	Height of forms < 10 feet	12 hours
	10- 20 feet	24 hours
	>20 feet	72 hours

b. For structures which are not required to store liquid, form ties shall be removed flush with or below the concrete surface. For structures which are to be store liquid, form ties shall be

removed to a minimum depth of ½ inch. All cavities or depressions resulting from form tie removal shall be patched in accordance with J.(2)(d).

c. Forms shall be removed and the concrete inspected by the Technician before walls are backfilled. Concrete loading shall be in accordance with Section N, Loading New Reinforced Concrete Structures.

2. Repair of Surface Defects (other than tie holes)

a. Immediately after removal of the forms, concrete which is honeycombed, damaged or otherwise defective as identified by the Technician shall be repaired or replaced by the Contractor. All repairs of surface defects shall be completed prior to the application of curing compound. Repair of surface defects such as honeycombed or otherwise defective concrete shall be made using bonding grout and site mixed Portland cement mortar or other products specifically intended to repair surface defects that are applied in accordance with the manufacturer's recommendations.

b. Bonding grout and site mixed Portland cement mortar:

- Outline the honeycombed or otherwise defective concrete with a ½ to ¾ inch deep saw cut and remove such concrete down to sound concrete. When chipping is necessary, leave chipped edges perpendicular to the surface or slightly undercut. Do not feather edges.
- Dampen the area to be patched plus another 6 inches around the patch area perimeter.
- Prepare bonding grout by mixing approximately one part Portland cement and one part fine sand with water to the consistency of thick cream.
- Thoroughly brush the bonding grout into the surface. When the bond coat begins to lose water sheen, apply repair mortar. Repair mortar is made by mixing 1 part Portland cement to 2½ parts fine sand (approximately finer than the No. 16 sieve size) by damp loose volume. The mortar shall be at a stiff consistency with no more mixing water than is necessary for handling and placing. Mix the repair mortar and manipulate the mortar frequently with a trowel without adding water.
- Thoroughly consolidate the mortar into place and strike off, leaving the patch slightly higher than the surrounding surface to compensate for shrinkage. Leave the patch undisturbed for 1 hour before finishing. The repair shall be cured as specified Section K, Curing.

c. Repair materials other than site mixed Portland cement:

- Portland cement mortar modified with a latex bonding agent conforming to ASTM C 1059, Type II.
- Epoxy mortars and epoxy compounds that are moisture-insensitive during application and after curing and that embody an epoxy binder conforming to ASTM C 881. The type, grade, and class shall be appropriate for the application as specified in ASTM C 881.
- Nonshrink Portland cement grout conforming to ASTM C 1107.
- Packaged dry concrete repair materials conforming to ASTM C 928.
- Other products specifically intended to repair surface defects that are applied and cured in accordance with the manufacturer's recommendations.

d. Repair of Form Tie Holes

- Liquid Containment Concrete Structures – Repair tie holes immediately after formwork removal and prior to the application of curing compound. All cavities or depressions resulting from form tie removal shall be patched with commercially available patching products or site mixed Portland cement repair mortar.
  - Site-mixed Portland cement repair mortar
    - Repair mortar is made by mixing 1-part cement to 2.5-parts fine sand (approximately finer than the No. 16 sieve size) by damp loose volume. Mortar shall be at a stiff consistency with no more mixing water than is necessary for handling and placing. Mix the repair mortar and manipulate the mortar frequently with a trowel without adding water. Clean and dampen tie holes before applying the mortar. Cure in accordance with Section K, Curing.
  - Repair materials other than site mixed Portland cement:
    - All those materials listed in J.2.(c).
    - Other products specifically intended to fill form tie holes for liquid containment applications that are applied and cured in accordance with the manufacturer's recommendations.

K. Curing

1. Concrete shall be cured for a period of at least 7 consecutive days (curing period) after it is placed, except as stated in Section M. Exposed concrete surfaces shall be kept continually wet during the entire curing period or until curing compound is applied.
2. Curing compound shall be applied at the rate and with the proper equipment recommended by the manufacturer. It shall form a uniform, continuous, adherent film that shall not check, crack, or peel and shall be free from pinholes or other imperfections.
3. Curing compound shall not be used at construction joints or other areas that are to be bonded to additional concrete. Surfaces subjected to heavy rainfall or running water within 3 hours after the application of curing compound, or surfaces damaged by subsequent construction operations during the curing period, shall be recoated in the same manner as the original application.
4. Concrete in feed storage areas shall be allowed to cure or be protected from contact with stored feed for a minimum of 28 days.

L. Concrete Placement in Hot Weather

1. Hot weather conditions exist at the time of proposed placement when:
   a. The rate of evaporation greater than 0.10 lb. /sq. ft. /hr. OR
   b. Two or more of the following factors are exceeded:
      - Ambient temperature is greater than 80 degrees Fahrenheit
      - Relative humidity is less than 60 percent
      - Wind velocity (average) is greater than 10 mph
2. Concrete surfaces shall not be allowed to dry after placement and during the curing period.
3. Measures to reduce surface moisture loss and rate of cement hydration must be taken to immediately protect and cure the concrete due to rapid drying conditions.
   a. Plan placement to early morning, late afternoon or evening.
   b. Use a set-retarding admixture meeting the requirements in Section C when the time between the introduction of the mixing water to the cement and aggregates and discharge exceeds 45 minutes. The 45 minute time may be extended if the concrete is of a slump that it can be placed, consolidated, and finished without the addition of water to the batch.
   c. Use a fog spray to raise the relative humidity of the ambient air.
   d. Moist cure the concrete surface as soon as the surfaces are finished and continue for at least 24 hours.

e. Use a monomolecular film, or evaporation retarder in accordance with the manufacturers printed instructions.

4. Concrete placement shall be suspended when:
   a. The rate of evaporation is greater than 0.25 lb./sq. ft./hr. OR
   b. When all of the following factors, as measured at the time of concrete placement are exceeded:
      - The ambient temperature is greater than 80 degrees Fahrenheit,
      - Relative humidity is less than 40 percent, and
      - Wind velocity (average) is greater than 15 mph

      $E = (Tc^{2.5} - R * Ta^{2.5}) (1+0.4V) \times 10^{-6}$

      where: E = evaporation rate, lb. /sq. ft. /hr.

      Tc = concrete temperature, °F

      Ta = air temperature, °F

      R = percent relative humidity /100 (decimal form 20% = 0.20)

      V = wind velocity, mph

5. Wind speeds at reporting station are taken above the ground surface, so V = average reported wind speeds x 0.66).

M. Concreting in Cold Weather

1. The following provisions shall apply when the minimum air temperature at the local job site is less than 35 degrees Fahrenheit (the forecasted temperature, which shall be verified with a maximum/minimum thermometer at the start of the morning job shift).
   a. No concrete shall be placed without the required thermometers at the job site.
   b. The Contractor shall furnish the Technician a record of daily temperature data including:
      - Outside air maximum and minimum temperatures at the local job site, and
      - Temperatures, of the air adjacent to the surface of the concrete, at several points along the concrete surface for all concrete curing periods.
   c. When the cement is initially added to the mix, the temperature of the mixing water shall not exceed 100 degrees Fahrenheit nor shall the temperature of the aggregate exceed 100 degrees Fahrenheit.
   d. The temperature of the concrete at the time of placement shall be not less than 55 degrees Fahrenheit or at no time during its production or transport more than 90 degrees Fahrenheit.
   e. Placed concrete may be protected by covering, housing, insulating or heating concrete structures.
   f. The minimum air temperature adjacent to the surface of the concrete shall be maintained above 40 degrees Fahrenheit for a period of at least 7 accumulated days. These 7 days must occur during the first 10 days after the concrete is placed. At no time, during the first 10 days after concrete is placed, shall the minimum air temperature adjacent to the surface of the concrete be less than 32 degrees Fahrenheit unless Type III cement or an approved accelerating admixture is used (see Item (g) below).
   g. The curing period may be reduced from 7 cumulative days to 3 consecutive days when Type III cement or an approved accelerating admixture is used. The accelerating admixture shall be used at the proportions recommended by the manufacturer. The minimum air temperature adjacent to the surface of the concrete shall be maintained above 40 degrees Fahrenheit for the 3 day curing period.
   h. Combustion heaters shall have exhaust flue gases vented out of the concrete protection enclosure. The heat from heaters and ducts shall be directed in such a manner as to not overheat or dry the concrete in localized areas or to dry the exposed concrete surface.

i. At the end of the curing period, the concrete shall be allowed to cool gradually. The maximum temperature decrease at the concrete surface in a 24-hour period shall not exceed 40 degrees.

N. Loading New Reinforced Concrete Structures

1. Backfill material shall be the type indicated on the drawings and shall be free of large stones or debris.
2. Compaction within 3 feet of the new structure wall will be by means of small manually directed tamping or vibrating equipment.
3. Days before backfilling:
   a. The age of concrete shall be at least 14 days prior to backfilling for vertical or near-vertical walls with earth loading on one side only and prior to backfilling for conduits and spillway risers with inside forms removed.
   b. The age of concrete shall be at least 7 days before any load (including backfill) is applied for walls backfilled on both sides simultaneously and prior to backfilling conduits and spillway risers with inside forms and bracing in-place.
   c. Loads may be applied to new concrete less than the specified days (7 or 14) after placement when the design strength has been attained and verified through compressive strength testing on cylinders that have been cured on-site under field conditions.

O. Inspection and Testing

1. The inspection and testing details of this section shall apply when specific concrete tests are required in the construction drawings or quality assurance plan. This testing does not relieve the Contractor of the responsibility to perform the work according to this specification. The Technician shall have free access to the work site and batching to obtain samples.
2. When testing is conducted, the following methods shall be used:

Testing

Type of Test	Test Method (ASTM Designation)
Sampling	C 172
Slump	C 143
Air Content	C 231 or C 173
Making and Curing Specimens in the Field	C 31
Obtaining and Testing Drilled Cores	C 42
Compressive Strength	C 39
Density (Unit Weight)	C 138
Temperature	C 1064

3. The contractor is responsible for determining who is responsible for testing, and providing results to all parties.
4. Compressive strength of the concrete shall be considered satisfactory if test results equal or exceed the 28-day design strength. For each ASTM C 39 strength test, three test specimens shall be made and cured onsite for 24 hours. The test result shall be the average of the compressive strength tests of any two of the three test specimens. If one test specimen shows evidence of improper sampling, molding, or testing, it shall be discarded and the remaining specimens tested. The strengths of the remaining two specimens shall be averaged, and the result shall then be considered the compressive strength of the concrete. If more than one specimen shows such defects, the test is not valid and the remaining specimen shall be discarded.
5. If test results are invalid due to specimen defects, or the in-place concrete that is in question was not sampled, the in-place concrete may be sampled by coring in accordance with ASTM C 42. For

core tests, at least three representative cores shall be taken from each area of the concrete in question. If one or more of the cores shows signs of being damaged before testing, it shall be replaced by a new one.

Specific Site Requirements

Construction Specification
004 Embedded or Expansive Waterstop

SCOPE

The work shall consist of furnishing, welding, placing and installation of embedded waterstop base seal waterstop, or expansive waterstop as required on the construction drawings. All material shall meet the requirements of the latest edition of the applicable ASTM designation.

QUALITY CONTROL AND QUALITY ASSURANCE DURING CONCRETE PLACEMENT

The contractor shall provide the technician a construction quality control plan at the pre- construction conference.

The plan shall detail the requirements for waterstop installation, including as a minimum:

- Waterstop placement and welding methods that will be utilized during construction,
- Name, contact information and responsibilities of a quality control (QC) individual providing continuous quality control during concrete placement around the embedded waterstop to ensure proper placement and consolidation.
    - The quality control person may be an employee of the contractor or the owner of the project, without other duties during concrete placement.
- Name, contact information and responsibilities of an individual performing continuous quality assurance (QA) during concrete placement around the embedded waterstop to ensure proper placement and consolidation.
    - The quality assurance individual shall be a person under the direction and control of the individual responsible for approving the as-built construction plan.

      OR
    - A qualified consultant hired by the owner to assure and document the installation complies with the manufacturer's recommendations and procedures and this specification. The third party consultant shall provide documentation to the owner and the Technician.

MATERIALS

The Contractor shall provide evidence from the manufacturer showing that the waterstop materials meet the requirements of this specification. All materials proposed for use shall be approved by the Technician.

Preformed expansion joint filler shall be commercially available products made of sponge rubber, closed cell foam, or boards containing bituminous materials. The joint filler shall have a minimum thickness of ½ inch and a width equal to the full cross sectional width of the concrete at the joint.

Embedded waterstops shall be made of polyvinyl chloride (PVC), thermoplastic elastomeric rubber (TPE-R), or polyethylene (PE or VLDPE). The minimum width of waterstop shall be 6 inches, or the width and material shown on an NRCS approved Wisconsin Standard Drawing. The waterstop web thickness shall be a minimum of 3/8 inches throughout the entire cross section of the waterstop. The maximum bulb size shall not exceed 1 inch. Waterstops shall be the type intended for placement entirely within the concrete cross section, or as shown on an NRCS approved Wisconsin Standard Drawing or other drawings as approved by the NRCS State Conservation Engineer. Waterstops shall have ribbed or "dumb-bell" type anchor flanges and a hollow tubular center bulb. Split flange waterstops are prohibited.

Base seal waterstops shall be made of polyvinyl chloride (PVC), thermoplastic elastomeric rubber (TPE-R), or polyethylene (PE or VLDPE). The minimum width of waterstop shall be 9 inches. This waterstop shape is limited to NRCS approved Wisconsin Standard drawings for feed storage facilities and pre-engineered waste storage structures approved by the Wisconsin State Conservation Engineer (SCE).

Expansive waterstops shall consist of preformed strips or mastic (caulk) made of hydrophilic materials that expand when subjected to moisture and shall not contain bentonite. Use shall be limited to non-movement joints (fixed joints).

WELDING OF WATERSTOP

Manufacturer's fabricated waterstop intersections shall be provided.

Only straight butt joint splices are allowed for field fabrication. Splices in waterstops shall be welded as recommended by the manufacturer. The specific splicing iron and the temperature of the iron shall be in accordance with the manufacturer's instructions for the type of waterstop being spliced.

Manufacturer-certified contractors may fabricate waterstop intersections in a controlled environment with the proper manufacturer's equipment. Prior to the time of delivery of the fabricated intersections, documentation of certification must be presented to the Technician.

PLACEMENT AND INSTALLATION OF WATERSTOP

Embedded Waterstop

Joints with embedded waterstops shall not be placed horizontally across sloped slabs.

Embedded waterstops shall be located as shown on the drawings and secured in position so that displacement does not occur during concrete placement.

Vertical applications (footing to wall joints and wall to wall joints) shall be secured to reinforcement using wire or "hog ring" type fasteners or factory installed grommets at the outermost rib at the spacing as recommended by the waterstop manufacturer (usually 12 inches on center). Hog rings shall be factory installed, if the manufacturer has that option available. Each waterstop shall be placed and secured with the hollow bulb aligned in the center of the planned joint.

Split forms should firmly hold the waterstop in place to prevent misalignment of the waterstop during concrete placement. A tight fit between the waterstop and the form is also necessary to prevent excessive leakage of concrete paste, which could lead to honeycombing of the concrete.

Waterstop clearance shall be a minimum of 1½ inches from reinforcement and one half the waterstop's width to the face of the concrete (3 inches for 6 inch wide waterstop).

Internal vibration is required along the entire length of all joints that contain embedded waterstops for both formed surfaces and slabs and shall be performed in the presence of the QC and QA individuals.

Continuous placement of concrete through a waterstop joint is not allowed, except for control joints in formed walls where preformed joint control formers are used in conjunction with the waterstops, or in control joints as shown on an NRCS approved Wisconsin Standard Drawings or other drawings as approved by the NRCS SCE.

Expansive Waterstop

Expansive waterstop shall be placed at the locations shown on the drawings in accordance with the manufacturer's instructions.

Preformed strips may require adhesive or other forms of mechanical fastening to existing concrete based on the manufacturer's instructions. The adhesive for preformed expansive waterstop and the mastic for caulk type expansive waterstop shall be allowed to cure for the duration as indicated by the manufacturer prior to placing concrete over the waterstop.

Mastic (caulk) type expansive waterstops shall be placed to the bead size as recommended by the manufacturer based on the amount of concrete cover provided.

Colder temperatures will require longer curing periods prior to concrete placement. Do not allow the expansive waterstop to become wet prior to placing concrete over the waterstop.

REPAIR PROTOCOL

Waterstop which does not comply with this specification, damaged or otherwise defective shall be repaired or replaced by the Contractor in accordance with the manufacturer's recommendations or a repair plan developed by the contractor and approved by the Technician. All repairs shall be completed prior to additional work on the waterstop joint.

Construction Specification
026 Topsoiling

SCOPE

The work consists of furnishing and spreading topsoil to specified depths at locations shown on the drawings. This specification does not apply to any other earthfill.

MATERIALS

Topsoil shall consist of naturally occurring friable surface soil reasonably free of grass, roots, weeds, sticks, rocks, other unsuitable material, herbicides, or other compounds whose presence would prevent establishment of grass and/or legume sod cover.

Topsoil shall be obtained from soil surfaces containing USDA soil textural classifications of loam, sandy loam, silt loam, silty clay loam, sandy clay loam, or clay loam soils shown on the drawings or approved by the Technician.

Topsoil shall:

- be salvaged from designated areas that will be disturbed by construction activities or be furnished from an offsite source designated by the Contractor. The Technician shall be granted access to the source for inspection and acceptance of the topsoil before delivery to the site.
- meet the following requirements (when testing is required):
  - 100% passing the ¾-inch sieve.
  - minimum 95% passing the #10 sieve.
  - minimum 25% passing the #200 sieve.
  - 3% - 15% organic material.
  - non-positive herbicide carryover (UW Extension Publication A3819, Herbicide Persistence and Carryover).

TESTING

The Technician will determine the need for testing the topsoil for gradation, percent organic matter content, and herbicide carryover effect. The testing will be at the expense of the Contractor.

FOUNDATION PREPARATION AND PLACEMENT

The surfaces designated to receive a topsoil application shall be cleared of all objectionable materials including trees, stumps, roots, brush, rubbish, and stones having a maximum dimension greater than 6 inches. The surfaces shall be lightly scarified just before the spreading operation. Topsoil shall not be placed until the required excavation, fill and preparation of the surfaces is complete and approved by the Technician.

Spreading shall not be conducted when the ground or topsoil is frozen, excessively wet, or otherwise in a condition detrimental to uniform spreading operations. Snow, ice, or frozen material shall not be incorporated in the topsoil.

Topsoil shall be placed in approximately horizontal layers no greater than 8 inches thick.

Placement of topsoil adjacent to concrete structures may begin after the concrete has cured for the minimum time specified. Heavy equipment shall not be operated within 2 feet of any structure.

Following the spreading operation, the topsoil surface shall be left reasonably smooth and without ruts or surface irregularities that could contribute to concentrated waterflow downslope.

MOISTURE CONTENT

Topsoil shall have a moisture content sufficient to insure the spreading of the material to the required thickness. When kneaded in the hand the soil will form a ball which does not readily separate and will not extrude out of the hand when squeezed tightly. The adequacy of the moisture content will be determined by the Technician.

COMPACTION

The Contractor shall furnish and operate the types and kinds of equipment necessary to compact the topsoil material when specified. The Technician shall determine if adequate compaction is being achieved.

Adequate compaction is defined as a firm surface able to support the growth of vegetation. Methods for compaction may include back-blading or a single pass from a rubber tire, track, or roller. A pass shall consist of complete coverage by the rubber tire, track, or roller over the entire surface of the topsoil. Care must be taken to avoid excessive compaction of topsoil.

Adjacent to structures or in confined areas, compaction of topsoil shall be accomplished by means of manually directed power tampers of plate vibrators or hand tamping, unless otherwise specified.

Where compacted earthfill is designated to be topsoiled, the topsoil shall be placed concurrently with the earthfill and shall be bonded to the compacted fill with the compaction equipment.

Construction Specification
044 Corrugated Polyethylene Tubing

SCOPE

The work shall consist of furnishing and installing corrugated polyethylene tubing with the necessary fittings and appurtenances as shown on the drawings and as outlined in this specification.

MATERIALS

Corrugated polyethylene tubing and fittings shall conform to the material requirements for the appropriate tubing size as shown in the following specifications:

- ASTM F 667/667M: 3 to 24 inch diameter pipe
- ASTM F3390-20: Standard Specification for 3 through 24 in. Lined Flexible Corrugated Polyethylene Pipe for Land Drainage Applications
- ASTM F 894: 10 to 120 inch diameter profile wall pipe
- AASHTO M 252: 3 to 10 inch diameter pipe
- AASHTO M 294: 12 to 36 inch diameter pipe

The tubing shall be appropriately marked with the ASTM or AASHTO designation.

When perforations are specified, the water inlet area shall be a minimum of 1 square inch per lineal foot of tubing. The inlets shall either be circular perforations or slots equally spaced along the length and circumference of the tubing. Unless otherwise specified, circular perforations shall not exceed 3/16 inch in diameter, and slot perforations shall not be more than 1/8 inch wide.

Geotextile filter socks, when required, shall meet the material requirements specified by the manufacturer for the intended use of the tubing.

Granular bedding material, when specified, shall conform to the requirements specified on the drawings.

HANDLING AND STORAGE

Tubing shall be delivered to the job site and handled by means that provide adequate support to the tubing and do not subject it to undue stresses or damage. When handling and placing corrugated polyethylene tubing, care shall be taken to prevent impact blows, abrasion damage, and gouging or cutting (by metal edges and/or surface or rocks). The manufacturer's special handling requirements shall be strictly observed. Special care shall be taken to avoid impact when the pipe must be handled at a temperature of 40 degrees Fahrenheit or less.

EXCAVATION

Unless otherwise specified or approved, excavation for and subsequent installation of each tubing line shall begin at the outlet end and progress upgrade. The trench or excavation for the tubing shall be constructed to the lines, depths, cross sections, and grade shown on the drawings.

Trench shields, shoring and bracing, or other suitable methods necessary to safeguard the workers shall be furnished, placed, and subsequently removed by the contractor.

BEDDING THE TUBING

Tubing shall not be laid on a rock foundation. In the event that boulders, rock or ledge rock, or other cemented materials that prevent satisfactory bedding are encountered at the required grade, the trench shall be excavated to a depth of at least 6 inches below the grade and backfilled to the required grade with a sand-gravel mixture or other approved material.

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

When a granular filter or envelope is specified, the filter or envelope material shall be placed in the bottom of the trench just before the tubing is laid. The tubing shall then be laid and the filter and envelope material placed to a depth over the top of the tubing of not less than that shown on the drawings.

When a granular filter or envelope is not specified, the bottom of the earthen trench shall be shaped to form a semicircular, trapezoidal, or 90-degree “V” groove in its center. This groove shall provide support for not less than a fourth of the outside circumference of the tubing. After the tubing is placed in the excavated groove, it shall be capped with friable material from the sides of the trench.

The friable material shall be placed around the tubing, completely filling the trench to a depth of at least 3 inches over the top of the tubing. For material to be suitable, it must not contain hard clods, rocks, frozen soil, or fine material that will cause a silting hazard to the drain. Tubing placed during any day shall be blinded (place required soil material around and over pipe) and temporarily capped before construction activities are completed for that day.

PLACEMENT AND JOINT CONNECTIONS

All tubing shall be installed to the grade shown on the drawings. After the tubing is placed in the trench and blinded, sufficient time shall be allowed for the tubing to adapt to the soil temperature before backfilling.

Maximum allowable stretch of the tubing is 5 percent. Special precautions must be implemented on hot, bright days to ensure that the stretch limit is not exceeded and excessive deflection does not occur as a result of installation procedures, including backfill operations.

Perforated pipe shall be laid with the perforations down and oriented symmetrically about the vertical centerline. Perforations shall be clear of any obstructions when the tubing is laid.

Lateral connections shall be made with manufactured junctions comparable in strength with the specified tubing.

The pipe ends and the couplings shall be free of foreign material when assembled. During the placement of the tubing, each open end shall be closed off with a suitable cover or plug at the end of the workday until work resumes.

All split fittings shall be securely fastened with nylon cord or plastic zip ties before any backfill is placed.

All buried ends of the tubing shall be supplied with end caps unless otherwise shown on the drawings.

BACKFILLING

The backfilling of the trench shall be as shown on the drawings and completed as rapidly as is consistent with the soil conditions. Automatic backfilling machines may be used. Backfill shall be placed so that displacement or deflection of the tubing will not occur. Backfill shall extend above the ground surface to allow for settlement and be well rounded and centered over the trench.

Construction Specification
204 Earthfill for Waste Storage Facilities

SCOPE

The work shall consist of all operations necessary to place the earthfill or soil liner required by the drawings or directed by the Technician.

MATERIALS

All fill materials shall be obtained from required excavations and designated borrow areas. The selection, blending, routing, and disposition of materials shall be subject to approval by the Technician.

Fill materials shall contain no sod, brush, roots, frozen soil, or other perishable materials. Stones larger than two-thirds of the uncompacted layer thickness shall be removed from the materials prior to compaction. Additional soil properties are shown on the drawings.

Sand and gravel fill required below concrete footings and floor slabs as indicated on any Wisconsin Standard Drawings shall consist of either in place or imported granular soils. These granular soils shall contain no rocks greater than 4” in maximum dimension and be reasonably well graded such that the surface is firm once wetted and compacted. The material shall have no more than 15%, by weight, passing the Number 200 sieve size.

Foundry sand shall be ferrous foundry sand with minimal concentrations of hazardous constituents, cores and other over-sized materials crushed or removed, and contain at least 5% bentonite.

GENERAL

Construction operations shall be carried out in such a manner and sequence that erosion and air and water pollution will be minimized. The completed job shall present a professional appearance and shall conform to the lines, grades, and elevations as shown on the drawings or as staked in the field. All operations shall be carried out in a safe and skillful manner. Safety and health regulations shall be observed and appropriate safety measures used by the contractor.

measures used by the contractor.

FOUNDATION PREPARATION

The foundation area shall be cleared of trees, stumps, roots, brush, rubbish, frozen soil, and stones having a maximum dimension greater than 6 inches. Foundations shall be stripped to remove vegetation and other unsuitable materials to a minimum depth of 6 inches or to a greater depth if so shown on the drawings. Topsoil shall be stripped from the foundation area and stockpiled for use as a top dressing for vegetation establishment unless otherwise shown on the drawings.

The moisture content of the scarified foundation materials shall be maintained as specified for the earthfill in Section 7. The surface materials of the foundation shall be compacted and bonded with the first layer of earthfill as specified for subsequent layers of earthfill.

EXCAVATION

The required excavations shall conform to the lines, grades, and elevations as shown on the drawings. Excavation beyond specified limits shall be corrected by filling with approved compacted materials.

The required dimensions and side slopes of all structure and trench excavations shall be as shown on the drawings. Trenches deeper than 4 feet shall have side slopes above the 4-foot depth excavated at 0.5:1 or flatter depending on the materials being excavated or the trench shall be braced to safeguard the work and workers. When backfilling pipe trenches in the waste storage facility embankment, the trench slopes shall be cut back to 1:1 from 12 inches above the top of the pipe. The backfill material and compaction shall be equivalent to the surrounding embankment.

To the extent that they are needed, all suitable materials removed from the specified excavations shall be used in the construction of the required earthfill or soil liner. The suitability of materials for specific purposes will be determined by the Technician.

All surplus or unsuitable excavated materials shall be disposed of at the locations shown on the drawings or as approved by the Technician. Surplus materials shall not be placed in wetlands.

BORROW AREAS

When the quantities of suitable materials obtained from specified excavations are insufficient to construct the specified fill portions of the permanent works, additional materials shall be obtained from the designated borrow areas. The borrow area shall be stripped to remove vegetation or other unsuitable materials to a minimum depth of 6 inches or to the depth shown on the drawings. This stripping shall be performed immediately prior to use of the borrow material to reduce the time the area is exposed to erosion. For large borrow areas, only a portion of the area should be stripped at a time.

FILL MOISTURE CONTENT

Fill materials shall have a moisture content sufficient to insure the required compaction. When kneaded in the hand, the soil will form a ball which does not readily separate and will not extrude out of the hand when squeezed tightly. The adequacy of the moisture content will be determined by the Technician.

If the top surface of compacted fill is too dry to permit suitable bond, it shall either be removed or scarified and wetted by sprinkling to an acceptable moisture content prior to placement of the next layer of fill. The applied water must be allowed time to be absorbed by the fill or disked into the dry layer.

Fill material that is too wet shall be allowed to dry to an acceptable moisture content before placement. If the top surface of compacted fill is too wet, it shall be either removed or allowed to dry to an acceptable moisture content before compaction or placing additional layers of fill.

FILL PLACEMENT

Fill shall not be placed until the required excavation and preparation of the underlying foundation is completed and approved by the Technician. Fill shall be placed beginning at the lowest elevation of the foundation. No fill shall be placed on a frozen surface.

If the surface of any layer becomes too hard and smooth for proper bond with the succeeding layer, it shall be scarified parallel to the axis of the fill to a depth of not less than 2 inches before the next layer is placed.

Available topsoil shall be placed on the top and the exposed outside slopes of the waste storage facility embankment, the borrow areas, and any other area where the topsoil was removed during construction and where vegetation will be established.

The pre-compacted thickness of each layer of fill and compaction requirements shall be as stated below unless otherwise specified in the construction plans. Materials placed by dumping in piles or windrows shall be spread uniformly to not more than the specified layer thickness prior to compaction. The Technician shall determine if adequate compaction is being achieved and may require more than the minimum specified passes of the compaction equipment.

1. Embankments. The fill shall be placed in horizontal layers extending the entire length and width of the embankment. Unless otherwise specified in the construction plans, compaction requirements shall be as shown in Table 1. Each layer shall be compacted by a minimum of one pass over the entire surface of the fill by the compaction equipment.
2. Adjacent to Structures and Pipes. Adjacent to structures or pipes, earthfill shall be placed in 4-inch lifts (prior to compaction) in a manner adequate to prevent damage to the structure and to allow the structure or pipe to gradually and uniformly assume the backfill loads. Compaction shall be accomplished by means of manually directed power tampers or plate vibrators or hand tamping unless otherwise specified. Heavy equipment shall not be operated within 2 feet of any structure or pipe. Compaction by means of drop weights operating from a crane or hoist of any type will not be permitted.

All intrusions into or penetrations of a clay or other soil liner will be backfilled with equivalent material and compacted to maintain its integrity. Pipe trenches into a storage facility will be backfilled with the same soils and compaction required for the storage facility for the distance shown on the drawings.

3. Soil Liners. A soil liner shall be installed as designated on the drawings. This work shall consist of constructing a low permeability earthliner for the inside slopes and the bottom of the earthen basin to the thickness shown on the drawings. It also includes the soil liner material placed in conjunction with other liner materials to form a composite liner as shown on the drawings. Only soils approved by the Technician will be used.

   The soil liner fill shall be placed in layers with a maximum thickness of 6 inches prior to compaction. The liner material shall be disked or worked in such a manner as to obtain a maximum clod size of 4 inches prior to compaction. Each layer of liners that do not require a specified density shall be compacted by a minimum of one pass over the entire surface of the fill by a:

   - Rubber-tired front end loader (fully-loaded); or
   - Scraper (fully-loaded); or
   - Articulated haul truck (fully-loaded); or
   - Sheepsfoot; or Tamping roller

   Smooth drum rollers are not suitable for compaction of fine-grained liners.

   Operation of the compaction equipment will be continuous over the entire area during fill operations. Any liner area disturbed by subsequent construction operations will be scarified and recompacted as specified.

4. Small Areas of Unsuitable Materials. Lenses or pockets of soil not meeting the criteria requirements in the applicable NRCS Standard or shown on the drawings, shall be removed and replaced with specified materials. The extent of removal and the quality of replacement materials will be as shown on the drawings or approved by the Technician. Excavated slopes shall be 1:1 or flatter. Replacement soil material placement, layer thickness, and compaction will be as stated for soil liners. Manually directed power tampers may be used for compaction and the soil shall be placed in 4-inch lifts prior to compaction.

Table 1 - Embankment Compaction Requirements

Equipment Type	Applicable Soils[1]	Maximum Fill Height[2] (feet)	Layer Thickness[3] (Inches)
Sheepsfoot or tamping roller 10,000 lb. min. operating weight	ML, MH, CL, CH, SM, SC, GM, GC	None	9
Vibratory tamping roller 9,000 lb. min. operating weight	SM, SC, GM, GC	None	6
Smooth steel drum vibratory roller 10,000 lb. min.	SP, SW, GP GW	20	6
Rubber-tired scraper or articulated haul truck (fully loaded)	ML, MH, CL, CH SM, SC, GM, GC	None	9
Rubber-tired front end loader (fully loaded)	ML, MH, CL, CH SM, SC, GM, GC	20	6

Equipment Type	Applicable Soils[1]	Maximum Fill Height[2] (feet)	Layer Thickness[3] (Inches)
Track-type crawler standard tracks 30,000 lb. min.	SM, SC, GM, GC, ML, CL, SP, SW, GP, GW	10	6
Farm tractor 2,400 lb. min.	ML, MH, CL, CH, SM, SC, GM, GC	15	6

[1] Unified Soil Classification System.

[2] Measured from the top of the fill to the lowest point along the centerline of the fill.

[3] Prior to compaction.