SECTION 01 45 33
SPECIAL INSPECTION, OBSERVATION, AND TESTING

PART 1 GENERAL

1.01 SUMMARY

A. This section covers requirements for Special Inspection, Observation, and Testing required in accordance with Chapter 17 of the **[A: 2006] [B: 2009] [C: 2012] [D: 2015]** IBC and is in addition to and supplements requirements included in Statement of Special Inspections shown **[E: on Drawings] [F: in supplement located at end of this section]**.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Society of Civil Engineers (ASCE): 7, Minimum Design Loads for Buildings and Other Structures.
2. International Code Council (ICC):
   a. International Building Code (IBC).
   b. Evaluation Service (ICC-ES) Reports and Legacy Reports.

1.03 DEFINITIONS

A. Agencies and Personnel:

1. Agency Having Jurisdiction (AHJ): Permitting building agency; may be a federal, state, local, or other regional department, or individual including building official, fire chief, fire marshal, chief of a fire prevention bureau, labor department, or health department, electrical inspector; or others having statutory authority. AHJ may be Owner when authorized to be self-permitting by governmental permitting agency or when no governmental agency has authority.
2. Approved Agency: An established and recognized agency regularly engaged in conducting tests or furnishing inspection services, when such agency has been approved.
3. Registered Design Professional in Responsible Charge: An individual who is registered or licensed to practice their respective design profession as defined by statutory requirements of professional registration laws of state or jurisdiction in which Project is to be constructed.
4. Special Inspector: Qualified person employed by **[A: Owner] [B: Owner's Registered Design Professional]** who will demonstrate competence to the satisfaction of AHJ for inspection of a particular type of construction or operation requiring Special Inspection.

B. Statement of Special Inspections: Detailed written procedure contained **[A: on Drawings] [B: in supplement located at end of this section]** establishing systems and components subject to Special Inspection, Observation, and Testing during construction, type and frequency of testing, extent and duration of Special Inspection, and reports to be completed and distributed by Special Inspector.

C. Special Inspection:

1. Special Inspection: Inspection required of materials, installation, fabrication, erection, or placement of components and connections requiring special expertise to ensure compliance with approved Contract Documents and referenced standards.
2. Special Inspection, Continuous: Full-time observation of work requiring Special Inspection by an approved Special Inspector who is present in area where the Work is being performed.
3. Special Inspection, Periodic: Part-time or intermittent observation of the Work requiring Special Inspection by an approved Special Inspector who is present in area where the Work has been or is being performed, and at completion of the Work.

D. Structural Systems and Components:

1. Diaphragm: Component of structural lateral load resisting system consisting of roof, floor, or other membrane or bracing system acting to transfer lateral forces to vertical resisting elements of structure.
2. Drag Strut or Collector: Component of structural lateral load resisting system consisting of diaphragm or shear wall element that collects and transfers diaphragm shear forces to vertical force-resisting elements or distributes forces within diaphragm or shear wall.
3. Seismic-Force-Resisting System: That part of structural lateral load resisting system that has been considered in the design to provide required resistance to seismic forces identified on Drawings.
4. Shear Wall: Component of structural lateral load resisting system consisting of a wall designed to resist lateral forces parallel to plane of the wall. Unless noted otherwise on Drawings, load-bearing walls with direct in-plane connections to roof and floors shall be considered to be shear walls.
5. Wind Force Resisting System: That part of the structural system that has been considered in the design to provide required resistance to wind forces identified on Drawings.

E. Nonstructural Components:

1. Architectural Component Supports: Structural members or assemblies of members which transmit loads and forces from architectural systems

or components to structure, including braces, frames, struts, and attachments.

2. Electrical Component Supports: Structural members or assemblies which transmit loads and forces from electrical equipment to structure, including braces, frames, legs, pedestals, and tethers, as well as elements forged or cast as part of component for anchorage.
3. Mechanical **[A: and Plumbing]** Component Supports: Structural members or assemblies which transmit loads and forces from mechanical **[B: or plumbing]** equipment to structure, including braces, frames, skirts, legs, saddles, pedestals, snubbers, and tethers, as well as elements forged or cast as part of component for anchorage.

F. Professional Observation:

1. Does not include or waive responsibility for required Special Inspection or inspections by building official.
2. Requirements are indicated on Statement of Special Inspections provided **[A: on Drawings] [B: in supplement located at the end of this section]**.
3. Geotechnical Observation: Visual observation of selected subgrade bearing surfaces and installation of deep foundation elements by a registered design professional for general conformance to Contract Documents.
4. Structural Observation: Visual observation of structural system(s) by a registered design professional for general conformance to Contract Documents.
5. **[C: __ Observation: Visual observation of selected [D: __ system] by registered design professional for general conformance to Contract Documents.]**

1.04 SUBMITTALS

A. Informational Submittals:

1. **[A: Contractor's Statement of Responsibility: Form shall be completed by entity responsible for construction of [B: main wind-force-resisting system,] [C: and] [D: main seismic-force-resisting system,] [E: wind-resisting component,] [F: and] [G: seismic-resisting component] listed in Statement of Special Inspections. Refer to Article Supplements located at end of section.]**
2. **[H: Fabricator's Certificate of Compliance: Form shall be completed by entity responsible for shop fabrication of structural load-bearing members and assemblies. Refer to Article Supplements located at end of section.]**

1.05 STATEMENT OF SPECIAL INSPECTIONS REQUIREMENTS

A. Designated Systems for Inspection:

1. Seismic-force-resisting systems designated under IBC Section 1705 and subject to Special Inspection under Section **[A: 1707] [B: 1705]**: **[C: See Drawings for basic lateral load resisting systems for each structure and other designated seismic systems.] [D: None required.]**
2. Wind-force-resisting systems designated under IBC Section 1705: **[E: See Drawings for basic lateral load resisting systems for each structure and other designated wind-resisting components.] [F: None required.]**
3. Architectural, **[G: Plumbing,]** Mechanical, and Electrical Components subject to Special Inspection under IBC Section **[H: 1707] [I: 1705.11.5, 1705.11.6, and 1705.12] [J: 1705.12.5 and 1705.12.6]** for Seismic Resistance: **[K: None required.] [L: As listed in Section 01 45 36, Equipment Seismic Certification.] [M: Together with the additional components listed below:]**
   a. **[N: .]**

B. Statement of Special Inspections:

1. As included in **[A: Drawings] [B: supplement located at the end of this section]** and in support of building permit application, Project-specific requirements were prepared by Registered Design Professional in Responsible Charge. The following identifies elements of inspection, observation, and testing program to be followed in construction of the Work:
   a. Designated **[C: seismic systems and main seismic force] [D: and] [E: wind-force]**-resisting systems and components that are subject to Special Inspection **[F: and Structural Observation]** for lateral load resistance.
   b. Special Inspection and testing required by IBC Section **[G: 1704 and Section 1708] [H: 1705]** and other applicable sections and referenced standards therein.
   c. Type and frequency of Special Inspection required.
   d. Type and frequency of testing required.
   e. Required frequency and distribution of testing and Special Inspection reports to be distributed by Special Inspector to Engineer, Contractor, building official, and Owner.
   f. Geotechnical Observation to be Performed: **[I: Required frequency and distribution of Geotechnical Observation reports by registered design professional to Contractor, building official, and Owner.] [J: Not required for this Project.]**

g. Structural Observations to be Performed: **[K: Required frequency and distribution of Structural Observation reports by registered design professional to Contractor, building official, and Owner.] [L: Not required for this Project.]**

h. **[M: __ Observations to be Performed: Required frequency and distribution of [N:] observation reports by registered design professional to Contractor, building official, and Owner.]**

C. Special Inspection and associated testing of shop fabrication and field construction will be performed by an approved accredited independent agency or by Authority Having Jurisdiction's (AHJ) approved, qualified inspection staff. **[A: Owner] [B: Owner's Registered Design Professional In Responsible Charge]** will secure and pay for services of agency to perform Special Inspection and associated testing.

D. Code required Special Inspection with associated testing **[A: and Professional Observation]**, as provided in Statement of Special Inspections **[B: on Drawings] [C: in supplement located at the end of this section]** and further provided in this section, is for benefit of Owner and does not:

1. Relieve Contractor of responsibility for providing adequate quality control measures.
2. Relieve Contractor of responsibility for damage to or loss of material before acceptance.
3. Constitute or imply acceptance.
4. Affect continuing rights of Owner after acceptance of completed Work.

E. The presence or absence of code required Special Inspector **[A: and Professional Observer]** does not relieve Contractor from Contract requirements.

F. Contractor is responsible for additional costs associated with Special Inspection and Testing **[A: and Observation]** when Work is not ready at time identified by Contractor and Special Inspectors **[B: and Professional Observer]** are onsite, but not able to provide contracted services.

G. Contractor is responsible for associated costs for additional Special Inspection and Testing **[A: and Professional Observation]** by Special Inspectors **[B: and Professional Observers]** required because of rejection of materials of in place Work that cannot be made compliant to Contract Document without additional inspections **[C: and observation]** and testing.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Requirements of the Statement of Special Inspections are provided by the Owner. All other testing and inspections, unless noted otherwise, are provided by Contractor.

B. Provide access to shop or Site for Special Inspection and Testing **[A: and Professional Observation]** requirements.

C. Notify Engineer in advance of required Special Inspection **[A: and Professional Observation]** no later than 48 hours prior to date of Special Inspection **[B: and Professional Observation]**.

D. Provide access for Special Inspector to construction documents.

E. Retain special inspection records on-site to be readily available for review.

F. Cooperate with Special Inspector and provide safe access to the Work to be inspected.

G. Submit Fabricator's Certificates of Compliance for approved fabricators.

H. Provide reasonable auxiliary services as requested by the Special Inspector. Auxiliary services required include, but not limited to:

1. Providing access to the Work and furnishing incidental labor and facilities necessary to facilitate inspections and tests to assist the Special Inspector in performing test/inspections.
2. Providing storage space for the Special Inspector’s exclusive use, such as for storing and curing concrete test samples and delivery of samples to testing laboratories.
3. Providing the Special Inspector with access to all approved submittals.
4. Providing security and protection of samples and test equipment at the Project Site.
5. Provide samples of materials to be tested in required quantities.

I. **[A: When required by Registered Design Professional in Responsible Charge, provide access for [B: plumbing,] mechanical and electrical component inspections for those items requiring certification.]**

J. Materials and systems shall be inspected during placement where Continuous Special Inspection is required.

K. Where Periodic Special Inspection is indicated in the Statement of Special Inspections:

1. Schedule inspections for either during or at completion of their placement or a combination or both.
2. Schedule periodically inspected Work (either inspected during or after its placement) so that corrections can be completed and re-inspected before Work is inaccessible.
3. Sampling a portion of the Work is not allowed. Schedules shall provide for inspection of all Work requiring periodic inspection.

3.02 SUPPLEMENTS

A. The supplements listed below, following "End of Section," are a part of this specification:

1. Contractor's Statement of Responsibility.
2. Fabricator's Certificate of Compliance.
3. **[A: Statement of Special Inspections.]**

END OF SECTION

CONTRACTOR'S STATEMENT OF RESPONSIBILITY

_____
(Project)

[A:] _____
(Name of Contracting Company)

_____
(Business Address)

(_____) _____ (_____) _____
(Telephone) (Fax)

I, (We) hereby certify that I am (we are) aware of the Special Inspection and Testing **[A: and Professional Observation] [B: and component certification]** requirements contained in Contract Documents for this Project for **[C: wind] [D: and] [E: seismic]** force-resisting systems **[F: , and for components including architectural, mechanical, and electrical components,]** as listed in Statement of Special Inspections **[G: on Drawings] [H: in supplement located at the end of this section]** and Section 01 45 36, Equipment Seismic Certification, and that:

1. I, (We) aware of the systems and the requirements of the special inspection and acknowledge our responsibility in the implementation of the Statement of Special Inspections for the construction of the following systems:

Facility	Specification	Lateral Force-Resisting System
33-Treated Water Pump Reservoir	**[I:]**	Flat-bottom, ground-supported, self-anchored, steel tank.
35-Treated Water Pump Station		Ordinary steel moment frames (main frames) and ordinary steel concentrically braced frames (sidewall bracing).

2. **[J: and I, (We) are responsible for construction of the following components:**

Facility	Component
09–Electrical Site Work	**Standby Engine Generators**
09–Electrical Site Work	**Switchgear**
09–Electrical Site Work	**Secondary Unit Substation**

Facility	Component
31–Pump Station	**Fire Protection Equipment**
44–Operations Building	**Lab HVAC Distribution Systems for Hazardous Materials**
44–Operations Building	**Lab Piping Distribution Systems for Hazardous Materials]**

3. Control of this Work will be exercised to obtain conformance with Contract Documents approved by building official.

4. Procedures within the Contractor's organization to be used for exercising control of the Work, method and frequency of reporting, and distribution of reports required under Statement of Special Inspections for Project are attached to this statement.

5. I, (We) will provide 48-hour notification to Engineer and approved inspection agency as required for structural tests and Special Inspection for Project.

6. The following person is hereby identified as exercising control over requirements of this section for the Work designated above:

   Name: _____

   Qualifications: _____

   _____

   _____

   (Print name and official title of person signing this form)

   Signed by: _____

   Date: _____

   Project Name: _____

FABRICATOR'S CERTIFICATE OF COMPLIANCE

Each approved fabricator that is exempt from Special Inspection of shop fabrication and implementation procedures per section **[A: 1704.2 of 2009 IBC] [B: 1704.2.5 of 2012 IBC] [C: 1704.2.5 of 2015 IBC]** must submit Fabricator's Certificate of Compliance at the completion of fabrication.

_____
(Project)

_____
(Fabricator's Name)

_____
(Business Address)

_____
(Certification or Approval Agency)

_____
(Certification Number)

_____
(Date of Last Audit or Approval)

Description of structural members and assemblies that have been fabricated:

_____

_____

_____

_____

_____

I hereby certify that items described above were fabricated in strict accordance with approved construction documents.

_____
(Name and Title) type or print

_____
(Signature and Date)

Attach copies of fabricator's certification or building code evaluation service report and fabricator's quality control manual.

STATEMENT OF SPECIAL INSPECTIONS

GENERAL NOTES

1. THE STATEMENT OF SPECIAL INSPECTIONS PROVIDE PROJECT COMPLIANCE WITH THE PROVISIONS OF THE **[A: 2006] [B: 2009] [C: 2012] [D: 2015]** INTERNATIONAL BUILDING CODE (IBC) CHAPTER 17 FOR SPECIAL INSPECTION, STRUCTURAL OBSERVATION, AND TESTING FOR WIND AND SEISMIC RESISTANCE AS APPLICABLE. EXCEPT WHERE OTHERWISE NOTED, THIS INSPECTION IS OWNER FURNISHED.
2. STANDARD SPECIAL INSPECTION REQUIREMENTS FOR NONSTRUCTURAL COMPONENTS ARE CONTAINED IN TABLE 1.
3. STANDARD SPECIAL INSPECTION REQUIREMENTS FOR STRUCTURAL COMPONENTS, REGARDLESS OF WIND OR SEISMIC DESIGN CATEGORIES, ARE CONTAINED IN TABLE 2. STANDARD TESTING REQUIREMENTS FOR STRUCTURAL COMPONENTS ARE CONTAINED IN TABLE 3.
4. PROJECT SPECIFIC REQUIREMENTS FOR STRUCTURES ASSIGNED TO SEISMIC DESIGN CATEGORIES C, D, E, OR F ARE CONTAINED IN TABLE 4. ADDITIONAL TESTING REQUIREMENTS FOR STRUCTURAL RESISTANCE ARE CONTAINED IN TABLE 6.
5. PROJECT SPECIFIC REQUIREMENTS FOR STRUCTURES SUBJECT TO BASIC WIND SPEEDS [(V_{asd})] IN EXCESS OF 110 MPH ARE CONTAINED IN TABLE 5.
6. FOR ADDITIONAL REQUIREMENTS, REFER TO SPECIFICATION SECTION 01 45 33, SPECIAL INSPECTION, OBSERVATION, AND TESTING. THESE INCLUDE:
   A. CONTRACTOR'S REQUIREMENTS TO PROVIDE ACCESS TO THE WORK FOR REQUIRED INSPECTIONS, AND TO PROVIDE NOTICE OF REQUIRED INSPECTIONS AND STRUCTURAL OBSERVATION.
   B. CONTRACTOR'S STATEMENT OF RESPONSIBILITY FOR WORK TO BE PERFORMED ON SYSTEMS DESIGNATED UNDER THE STATEMENT OF SPECIAL INSPECTIONS FOR WIND OR SEISMIC RESISTANCE.
   C. DEFINITIONS AND TERMINOLOGY USED IN THIS STATEMENT OF SPECIAL INSPECTIONS.

SPECIAL INSPECTION

1. SPECIAL INSPECTION WILL BE IN ACCORDANCE WITH IBC SECTIONS 1704 **[A: AND 1705]** TOGETHER WITH LOCAL AND STATE AMENDMENTS. REFER TO THE FOLLOWING TABLES FOR PROJECT SPECIFIC INSPECTION TYPES AND FREQUENCIES.
2. SPECIAL INSPECTIONS WILL BE PROVIDED BY A CERTIFIED OR QUALIFIED INSPECTOR AND ASSOCIATED TESTING WILL BE PERFORMED BY AN APPROVED ACCREDITED INDEPENDENT AGENCY. THE **[B: OWNER] [C: OWNER'S REGISTERED DESIGN PROFESSIONAL IN RESPONSIBLE CHARGE]** WILL SECURE AND PAY FOR THE SERVICES OF THE AGENCY TO

PERFORM ALL SPECIAL INSPECTION AND ASSOCIATED TESTS. INSPECTORS FOR EACH SYSTEM AND MATERIAL WILL BE INTERNATIONAL CODE COUNCIL (ICC) CERTIFIED OR OTHERWISE APPROVED BY THE BUILDING OFFICIAL.

3. THE SPECIAL INSPECTOR WILL OBSERVE THE INDICATED WORK FOR COMPLIANCE WITH THE APPROVED CONTRACT DOCUMENTS AND SUBMIT RECORDS OF INSPECTION. ALL DISCREPANCIES WILL BE BROUGHT TO THE IMMEDIATE ATTENTION OF THE CONTRACTOR FOR CORRECTION.
4. SPECIAL INSPECTION AND ASSOCIATED TESTING REPORTS WILL BE SUBMITTED TO THE ENGINEER, CONTRACTOR, BUILDING OFFICIAL, AND OWNER WITHIN ONE WEEK OF INSPECTION OR WITHIN ONE WEEK OF TEST COMPLETION. INSPECTIONS FOR WHICH REPORTING WILL BE REQUIRED ARE NOTED IN THE FOLLOWING TABLES.
5. AT THE CONCLUSION OF CONSTRUCTION, A FINAL REPORT DOCUMENTING REQUIRED SPECIAL INSPECTIONS AND CORRECTION OF PREVIOUSLY NOTED DISCREPANCIES WILL BE SUBMITTED.

GEOTECHNICAL OBSERVATION

1. ALL FOUNDATION BEARING SURFACES SHALL BE INSPECTED BY GEOTECHNICAL ENGINEER PRIOR TO PLACEMENT OF REINFORCING STEEL. ADDITIONAL SPECIAL INSPECTION REQUIREMENTS ARE LISTED IN TABLE 1.
2. GEOTECHNICAL TESTING REQUIREMENTS ARE LISTED IN TABLE 3.

STRUCTURAL OBSERVATION

1. STRUCTURAL OBSERVATION WILL BE IN ACCORDANCE WITH IBC SECTION **[A: 1709] [B: 1710] [C: 1704.5] [D: 1704.6]** TOGETHER WITH LOCAL AND STATE AMENDMENTS.
2. ONSITE STRUCTURAL OBSERVATION WILL BE PERFORMED FOR EACH IDENTIFIED SEISMIC FORCE- OR WIND FORCE-RESISTING SYSTEM, INCLUDING FOUNDATIONS AND CONNECTIONS. REFER TO THE **[E: GENERAL STRUCTURAL NOTES, DRAWING] [F: INDIVIDUAL STRUCTURAL DRAWINGS]** FOR THE BASIC SEISMIC AND WIND FORCE-RESISTING SYSTEMS FOR THE STRUCTURES INCLUDED IN THE WORK.
3. STRUCTURAL OBSERVATION WILL BE PERFORMED BY A REGISTERED PROJECT DESIGN PROFESSIONAL FOR GENERAL CONFORMANCE TO THE APPROVED CONSTRUCTION DOCUMENTS. STRUCTURAL OBSERVATION DOES NOT INCLUDE OR WAIVE THE RESPONSIBILITY FOR ANY REQUIRED SPECIAL INSPECTIONS OR INSPECTIONS BY THE BUILDING OFFICIAL.
4. STRUCTURAL OBSERVATION REPORTS, NOTING ANY DEFICIENCIES IN OBSERVED CONSTRUCTION, WILL BE DELIVERED TO THE CONTRACTOR, BUILDING OFFICIAL, AND OWNER FOLLOWING EACH OBSERVATION. THE

CONTRACTOR WILL BE NOTIFIED ONSITE OR BY PHONE OR E-MAIL WITHIN 24 HOURS UPON FINDING DEFICIENCIES.

5. AT THE CONCLUSION OF CONSTRUCTION, A WRITTEN STATEMENT WILL BE PROVIDED TO VERIFY THAT THE STRUCTURAL OBSERVATION SITE VISITS WERE MADE AND WHETHER THERE REMAIN ANY STRUCTURAL DEFICIENCIES THAT HAVE NOT BEEN RESOLVED.
6. STRUCTURAL OBSERVATION WILL INCLUDE VISUAL OBSERVATION OF THE STRUCTURAL SYSTEM AT SIGNIFICANT CONSTRUCTION STAGES AND AT COMPLETION OF THE STRUCTURAL SYSTEM FOR EACH STRUCTURE CONTAINED IN THE WORK. THE CONTRACTOR SHALL SCHEDULE AND FACILITATE STRUCTURAL OBSERVATION, INCLUDING THE ELEMENTS DESCRIBED IN THE STRUCTURAL OBSERVATION TABLES (ATTACHED).

SPECIAL INSPECTIONS FOR WIND RESISTANCE

1. **[A: SPECIAL INSPECTIONS REQUIREMENTS FOR WIND RESISTANCE IN ACCORDANCE WITH IBC SECTION [B: 1705.4] [C: 1705.4 AND 1706] [D: 1705.10] [E: 2015] ARE NOT APPLICABLE TO THIS PROJECT.]**
2. SPECIAL INSPECTIONS REQUIREMENTS FOR WIND RESISTANCE WILL BE IN ACCORDANCE WITH IBC SECTION **[F: 1705.4] [G: 1705.4 AND 1706] [H: 1705.10] [I: 1705.11]** TOGETHER WITH LOCAL AND STATE AMENDMENTS.
3. SPECIAL INSPECTIONS REQUIREMENTS SHALL APPLY TO THE FOLLOWING:
   A. WIND FORCE-RESISTING SYSTEMS IN STRUCTURES IN WIND EXPOSURE CATEGORY B, WHERE THE 3-SECOND-GUST BASIC WIND SPEED **[J: (V asd)]** IS 120 MILES PER HOUR OR GREATER.
   B. WIND FORCE-RESISTING SYSTEMS IN STRUCTURES IN WIND EXPOSURE CATEGORIES C OR D, WHERE THE 3-SECOND-GUST BASIC WIND SPEED **[K: (V asd)]** IS 110 MILES PER HOUR OR GREATER.

      REFER TO **[L: GENERAL STRUCTURAL NOTES, DRAWING _____,] [M: INDIVIDUAL STRUCTURE DRAWINGS]** FOR BASIC WIND SPEED AND WIND EXPOSURE CATEGORY.
4. WIND FORCE-RESISTING SYSTEMS TO RECEIVE SPECIAL INSPECTION FOR WIND RESISTANCE SHALL INCLUDE THE COMPONENTS LISTED IN TABLE 5.
5. MAIN SYSTEMS REQUIRED TO BE COVERED UNDER PROJECT SPECIAL INSPECTION REQUIREMENTS INCLUDE THE FOLLOWING TOGETHER WITH THEIR CONNECTIONS. REFER TO SECTION 01 45 33, SPECIAL INSPECTION, OBSERVATION AND TESTING.
   A. **[N: FACILITY ___ - ___.]**

SPECIAL INSPECTIONS FOR SEISMIC RESISTANCE

1. **[A: SPECIAL INSPECTIONS REQUIREMENTS FOR SEISMIC RESISTANCE IN ACCORDANCE WITH IBC SECTION [B: 1705.3, 1707 AND 1708] [C: 1705.11**

AND 1705.12] [D: 1705.12 AND 1705.13] ARE NOT APPLICABLE TO THIS PROJECT.]

2. SPECIAL INSPECTIONS REQUIREMENTS FOR SEISMIC RESISTANCE WILL BE IN ACCORDANCE WITH IBC SECTION **[E: 1705.2, 1707 AND 1708] [F: 1705.11 AND 1705.12] [G: 1705.11 AND 1705.12] [H: 1705.12 AND 1705.13]** TOGETHER WITH LOCAL AND STATE AMENDMENTS. REFER TO **[I: GENERAL STRUCTURAL NOTES, DRAWING _____,] [J: INDIVIDUAL STRUCTURE DRAWINGS]** FOR BASIC SEISMIC-FORCE-RESISTING SYSTEMS FOR EACH STRUCTURE AND DESIGNATED SEISMIC DESIGN CATEGORY.
3. SPECIAL INSPECTIONS REQUIREMENTS FOR SEISMIC RESISTANCE SHALL APPLY TO THE SYSTEMS AND COMPONENTS LISTED IN TABLE 4.
4. MAIN SYSTEMS REQUIRED TO BE COVERED UNDER PROJECT SPECIAL INSPECTION REQUIREMENTS INCLUDE THE FOLLOWING TOGETHER WITH THEIR CONNECTIONS. REFER TO SECTION 01 45 33, SPECIAL INSPECTION, OBSERVATION AND TESTING.

   A. **[K: FACILITY ___ - ___.]**

Statement of Special Inspections Prepared by:

Preparer's Seal

_____
Type or Print Name

_____
Signature

_____
Date

SECTION 01 78 23
OPERATION AND MAINTENANCE DATA

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Detailed information for the preparation, submission, and Engineer's review of Operations and Maintenance (O&M) Data, as required by individual Specification sections.

1.02 DEFINITIONS

A. Preliminary Data: Initial and subsequent submissions for Engineer's review.

B. Final Data: Engineer-accepted data, submitted as specified herein.

C. Maintenance Operation: As used on Maintenance Summary Form is defined to mean any routine operation required to ensure satisfactory performance and longevity of equipment. Examples of typical maintenance operations are lubrication, belt tensioning, adjustment of pump packing glands, and routine adjustments.

1.03 SEQUENCING AND SCHEDULING

A. Equipment and System Data:

1. Preliminary Data:
   a. Do not submit until Shop Drawing for equipment or system has been reviewed and approved by Engineer.
   b. Submit prior to shipment date.
2. Final Data: **[A: Submit Instructional Manual Formatted data not less than 30 days prior to [B: installation of equipment or system [C: equipment or system field functional testing].] [D: Submit Compilation Formatted and Electronic Media Formatted data prior to Substantial Completion of Project.]**

B. Materials and Finishes Data:

1. Preliminary Data: Submit **[A: at least 15 days prior to request for final inspection] [B:]**.
2. Final Data: Submit within 10 days after final inspection.

1.04 DATA FORMAT

A. Prepare preliminary **[A: and final]** data in the form of an instructional manual. **[B: Prepare final data [C: in data compilation format.] [D: on electronic media.]**

B. Instructional Manual Format:

1. Binder: Commercial quality, permanent, three-ring or three-post binders with durable plastic cover.
2. Size: 8-1/2 inches by 11 inches, minimum.
3. Cover: Identify manual with typed or printed title "OPERATION AND MAINTENANCE DATA" and list:
   a. Project title.
   b. Designate applicable system, equipment, material, or finish.
   c. Identity of separate structure as applicable.
   d. Identify volume number if more than one volume.
   e. **[A: Identity of general subject matter covered in manual.] [B: Identity of equipment number and Specification section.]**
4. Spine:
   a. Project title.
   b. Identify volume number if more than one volume.
5. Title Page:
   a. Contractor name, address, and telephone number.
   b. Subcontractor, Supplier, installer, or maintenance contractor's name, address, and telephone number, as appropriate.
      1) Identify area of responsibility of each.
      2) Provide name and telephone number of local source of supply for parts and replacement.
6. Table of Contents:
   a. Neatly typewritten and arranged in systematic order with consecutive page numbers.
   b. Identify each product by product name and other identifying numbers or symbols as set forth in Contract Documents.
7. Paper: 20-pound minimum, white for typed pages.
8. Text: Manufacturer's printed data, or neatly typewritten.
9. Three-hole punch data for binding and composition; arrange printing so that punched holes do not obliterate data.
10. Material shall be suitable for reproduction, with quality equal to original. Photocopying of material will be acceptable, except for material containing photographs.

C. **[A: Data Compilation Format:**

1. **Compile all Engineer-accepted preliminary O&M data into a hard-copy, hard-bound set.**

2. **Each set shall consist of the following:**
    a. **Binder: Commercial quality, permanent, three-ring or three-post binders with durable plastic cover.**
    b. **Cover: Identify each volume with typed or printed title "OPERATION AND MAINTENANCE DATA, VOLUME NO. ___ OF ___", and list:**
        1) **Project title.**
        2) **Contractor's name, address, and telephone number.**
        3) **If entire volume covers equipment or system provided by one Supplier include the following:**
            a) **Identity of general subject matter covered in manual.**
            b) **Identity of equipment number and Specification section.**
    c. **Provide each volume with title page and typed table of contents with consecutive page numbers. Place contents of entire set, identified by volume number, in each binder.**
    d. **Table of contents neatly typewritten, arranged in a systematic order:**
        1) **Include list of each product, indexed to content of each volume.**
        2) **Designate system or equipment for which it is intended.**
        3) **Identify each product by product name and other identifying numbers or symbols as set forth in Contract Documents.**
    e. **Section Dividers:**
        1) **Heavy, 80 pound cover weight, tabbed with numbered plastic index tabs.**
        2) **Fly-Leaf:**
            a) **For each separate product, or each piece of operating equipment, with typed description of product and major component parts of equipment.**
            b) **List with Each Product:**
                (1) **Name, address, and telephone number of Subcontractor, Supplier, installer, and maintenance contractor, as appropriate.**
                (2) **Identify area of responsibility of each.**
                (3) **Provide local source of supply for parts and replacement.**
            c) **Identity of separate structure as applicable.**
    f. **Assemble and bind material, as much as possible, in same order as specified in the Contract Documents.]**

D. **[A: Electronic Media Format:**

1. **[B: Portable Document Format (PDF):**

a. **After all preliminary data has been found to be acceptable to Engineer, submit Operation and Maintenance data in PDF format on CD.**
b. **Files to be exact duplicates of Engineer-accepted preliminary data. Arrange by specification number and name.**
c. **Files to be fully functional and viewable in most recent version of Adobe Acrobat.]**

2. **[C: Manufacturers' standard electronic format.]**

1.05 SUBMITTALS

A. Informational:

1. Data Outline: Submit **[A: two] [B:]** copies of a detailed outline of proposed organization and contents of Final Data prior to preparation of Preliminary Data.
2. Preliminary Data:
   a. Submit **[C: two] [D: three]** copies for Engineer's review.
   b. If data meets conditions of the Contract:
      1) One copy will be returned to Contractor.
      2) One copy will be forwarded to Resident Project Representative.
      3) **[E: One copy will be retained in Engineer's file.]**
   c. If data does not meet conditions of the Contract:
      1) All copies will be returned to Contractor with Engineer's comments (on separate document) for revision.
      2) Engineer's comments will be retained in Engineer's file.
      3) Resubmit **[F: two] [G:]** copies revised in accordance with Engineer's comments.
3. Final Data: Submit **[H: two] [I:]** copies in format specified herein.

1.06 DATA FOR EQUIPMENT AND SYSTEMS

A. Content For Each Unit (or Common Units) and System:

1. Product Data:
   a. Include only those sheets that are pertinent to specific product.
   b. Clearly annotate each sheet to:
      1) Identify specific product or part installed.
      2) Identify data applicable to installation.
      3) Delete references to inapplicable information.
   c. Function, normal operating characteristics, and limiting conditions.
   d. Performance curves, engineering data, nameplate data, and tests.
   e. Complete nomenclature and commercial number of replaceable parts.

f. Original manufacturer's parts list, illustrations, detailed assembly drawings showing each part with part numbers and sequentially numbered parts list, and diagrams required for maintenance.
g. Spare parts ordering instructions.
h. Where applicable, identify installed spares and other provisions for future work (e.g., reserved panel space, unused components, wiring, terminals).

2. As-installed, color-coded piping diagrams.
3. Charts of valve tag numbers, with the location and function of each valve.
4. Drawings: Supplement product data with Drawings as necessary to clearly illustrate:
   a. Format:
      1) Provide reinforced, punched, binder tab; bind in with text.
      2) Reduced to 8-1/2 inches by 11 inches, or 11 inches by 17 inches folded to 8-1/2 inches by 11 inches.
      3) Where reduction is impractical, fold and place in 8-1/2-inch by 11-inch envelopes bound in text.
      4) Identify Specification section and product on Drawings and envelopes.
   b. Relations of component parts of equipment and systems.
   c. Control and flow diagrams.
   d. Coordinate drawings with Project record documents to assure correct illustration of completed installation.
5. Instructions and Procedures: Within text, as required to supplement product data.
   a. Format:
      1) Organize in consistent format under separate heading for each different procedure.
      2) Provide logical sequence of instructions for each procedure.
      3) Provide information sheet for Owner's personnel, including:
         a) Proper procedures in event of failure.
         b) Instances that might affect validity of guarantee or Bond.
   b. Installation Instructions: Including alignment, adjusting, calibrating, and checking.
   c. Operating Procedures:
      1) Startup, break-in, routine, and normal operating instructions.
      2) Test procedures and results of factory tests where required.
      3) Regulation, control, stopping, and emergency instructions.
      4) Description of operation sequence by control manufacturer.
      5) Shutdown instructions for both short and extended duration.
      6) Summer and winter operating instructions, as applicable.
      7) Safety precautions.
      8) Special operating instructions.
   d. Maintenance and Overhaul Procedures:

1) Routine maintenance.
2) Guide to troubleshooting.
3) Disassembly, removal, repair, reinstallation, and re-assembly.

6. Guarantee, Bond, and Service Agreement: In accordance with Section 01 77 00, Closeout Procedures.

B. Content for Each Electric or Electronic Item or System:

1. Description of Unit and Component Parts:
   a. Function, normal operating characteristics, and limiting conditions.
   b. Performance curves, engineering data, nameplate data, and tests.
   c. Complete nomenclature and commercial number of replaceable parts.
   d. Interconnection wiring diagrams, including control and lighting systems.
2. Circuit Directories of Panelboards:
3. Electrical service.
4. Control requirements and interfaces.
5. Communication requirements and interfaces.
6. List of electrical relay settings, and control and alarm contact settings.
7. Electrical interconnection wiring diagram, including as applicable, single-line, three-line, schematic and internal wiring, and external interconnection wiring.
8. As-installed control diagrams by control manufacturer.
9. Operating Procedures:
   a. Routine and normal operating instructions.
   b. Startup and shutdown sequences, normal and emergency.
   c. Safety precautions.
   d. Special operating instructions.
10. Maintenance Procedures:
    a. Routine maintenance.
    b. Guide to troubleshooting.
    c. Adjustment and checking.
    d. List of relay settings, control and alarm contact settings.
11. Manufacturer’s printed operating and maintenance instructions.
12. List of original manufacturer’s spare parts, manufacturer’s current prices, and recommended quantities to be maintained in storage.

C. Maintenance Summary:

1. Compile individual Maintenance Summary for each applicable equipment item, respective unit or system, and for components or sub-units.
2. Format:

a. Use Maintenance Summary Form bound with this section or electronic facsimile of such.
b. Each Maintenance Summary may take as many pages as required.
c. Use only 8-1/2-inch by 11-inch size paper.
d. Complete using typewriter or electronic printing.

3. Include detailed lubrication instructions and diagrams showing points to be greased or oiled; recommend type, grade, and temperature range of lubricants and frequency of lubrication.
4. Recommended Spare Parts:
   a. Data to be consistent with manufacturer's Bill of Materials/Parts List furnished in O&M manuals.
   b. "Unit" is the unit of measure for ordering the part.
   c. "Quantity" is the number of units recommended.
   d. "Unit Cost" is the current purchase price.

1.07 DATA FOR MATERIALS AND FINISHES

A. Content for Architectural Products, Applied Materials, and Finishes:

1. Manufacturer's data, giving full information on products:
   a. Catalog number, size, and composition.
   b. Color and texture designations.
   c. Information required for reordering special-manufactured products.
2. Instructions for Care and Maintenance:
   a. Manufacturer's recommendation for types of cleaning agents and methods.
   b. Cautions against cleaning agents and methods that are detrimental to product.
   c. Recommended schedule for cleaning and maintenance.

B. Content for Moisture Protection and Weather Exposed Products:

1. Manufacturer's data, giving full information on products:
   a. Applicable standards.
   b. Chemical composition.
   c. Details of installation.
2. Instructions for inspection, maintenance, and repair.

1.08 SUPPLEMENTS

A. The supplements listed below, following "End of Section", are part of this Specification.

1. Forms: Maintenance Summary Form.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

MAINTENANCE SUMMARY FORM

PROJECT:_____ CONTRACT NO.:_____

1. EQUIPMENT ITEM_____

2. MANUFACTURER _____

3. EQUIPMENT/TAG NUMBER(S) _____

4. WEIGHT OF INDIVIDUAL COMPONENTS (OVER 100 POUNDS)_____

5. NAMEPLATE DATA (hp, voltage, speed, etc.) _____

6. MANUFACTURER'S LOCAL REPRESENTATIVE _____

   a. Name_____ Telephone No. _____

   b. Address _____

7. MAINTENANCE REQUIREMENTS

Maintenance Operation Comments	**Frequency**	**Lubricant (If Applicable)**
List briefly each maintenance operation required and refer to specific information in manufacturer's standard maintenance manual, if applicable. (Reference to manufacturer's catalog or sales literature is not acceptable.)	List required frequency of each maintenance operation.	Refer by symbol to lubricant required.

8. LUBRICANT LIST

Reference Symbol	Shell	Exxon Mobile	Chevron Texaco	BP Amoco	Or Equal
List symbols used in No. 7 above.	List equivalent lubricants, as distributed by each manufacturer for the specific use recommended.				

9. RECOMMENDED SPARE PARTS FOR OWNER'S INVENTORY.

Part No.	Description	Unit	Quantity	Unit Cost
Note: Identify parts provided by this Contract with two asterisks.				

SECTION 01 91 14
EQUIPMENT TESTING AND FACILITY STARTUP

PART 1 GENERAL

1.01 DEFINITIONS

A. Facility: Entire Project, or an agreed-upon portion, including all of its unit processes.

B. Functional Test: Test or tests in presence of Engineer and Owner to demonstrate that installed equipment meets manufacturer's installation, calibration, and adjustment requirements and other requirements as specified.

C. Performance Test: Test or tests performed after any required functional test in presence of Engineer and Owner to demonstrate and confirm individual equipment meets performance requirements specified in individual sections.

D. Unit Process: As used in this section, a unit process is a portion of the facility that performs a specific process function, such as **[A:] [B:]** and **[C:]**.

E. Facility Performance Demonstration:

1. A demonstration, conducted by Contractor, with assistance of Owner, to demonstrate and document the performance of the entire operating facility, both manually and automatically (if required), based on criteria developed in conjunction with Owner and as accepted by Engineer.
2. Such demonstration is for the purposes of (i) verifying to Owner entire facility performs as a whole, and (ii) documenting performance characteristics of completed facility for Owner's records. Neither the demonstration nor the evaluation is intended in any way to make performance of a unit process or entire facility the responsibility of Contractor, unless such performance is otherwise specified.

1.02 SUBMITTALS

A. Informational Submittals:

1. Facility Startup and Performance Demonstration Plan.
2. Functional and performance test results.
3. Completed Unit Process Startup Form for each unit process.
4. Completed Facility Performance Demonstration/Certification Form.

1.03 FACILITY STARTUP AND PERFORMANCE DEMONSTRATION PLAN

A. Develop a written plan, in conjunction with Owner's operations personnel; to include the following:

1. Step-by-step instructions for startup of each unit process and the complete facility.
2. Unit Process Startup Form (sample attached), to minimally include the following:
    a. Description of the unit process, including equipment numbers/nomenclature of each item of equipment and all included devices.
    b. Detailed procedure for startup of the unit process, including valves to be opened/closed, order of equipment startup, etc.
    c. Startup requirements for each unit process, including water, power, chemicals, etc.
    d. Space for evaluation comments.
3. Facility Performance Demonstration/Certification Form (sample attached), to minimally include the following:
    a. Description of unit processes included in the facility startup.
    b. Sequence of unit process startup to achieve facility startup.
    c. Description of computerized operations, if any, included in the facility.
    d. Contractor certification facility is capable of performing its intended function(s), including fully automatic operation.
    e. Signature spaces for Contractor and Engineer.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Facility Startup Meetings: Schedule, in accordance with requirements of Section 01 31 19, Project Meetings, to discuss test schedule, test methods, materials, chemicals and liquids required, facilities operations interface, and Owner involvement.

B. Contractor's Testing and Startup Representative:

1. Designate and furnish one or more personnel to coordinate and expedite testing and facility startup.
2. Representative(s) shall be present during startup meetings and shall be available at all times during testing and startup.

C. Provide temporary valves, gauges, piping, test equipment and other materials and equipment required for testing and startup.

D. Provide Subcontractor and equipment manufacturers' staff adequate to prevent delays. Schedule ongoing work so as not to interfere with or delay testing and startup.

E. Owner will:

1. Provide water, power, chemicals, and other items as required for startup, unless otherwise indicated.
2. Operate process units and facility with support of Contractor.
3. Provide labor and materials as required for laboratory analyses.
4. **[A: Furnish assistance of manufacturer's representative(s) for Owner-furnished products, as specified in Section 01 64 00, Owner-Furnished Products.]**
5. **[B: Make available spare parts, special tools, and operation and maintenance information for Owner-furnished products.]**

3.02 EQUIPMENT TESTING

A. Preparation:

1. Complete installation before testing.
2. Furnish qualified manufacturers' representatives, when required by individual Specification sections.
3. Obtain and submit from equipment manufacturer's representative Manufacturer's Certificate of Proper Installation Form, in accordance with Section 01 43 33, Manufacturers' Field Services, when required by individual Specification sections.
4. Equipment Test Report Form: Provide written test report for each item of equipment to be tested, to include the minimum information:
   a. Owner/Project Name.
   b. Equipment or item tested.
   c. Date and time of test.
   d. Type of test performed (Functional or Performance).
   e. Test method.
   f. Test conditions.
   g. Test results.
   h. Signature spaces for Contractor and Engineer as witness.
5. Cleaning and Checking: Prior to beginning functional testing:
   a. Calibrate testing equipment in accordance with manufacturer's instructions.
   b. Inspect and clean equipment, devices, connected piping, and structures to ensure they are free of foreign material.

c. Lubricate equipment in accordance with manufacturer's instructions.
d. Turn rotating equipment by hand when possible to confirm that equipment is not bound.
e. Open and close valves by hand and operate other devices to check for binding, interference, or improper functioning.
f. Check power supply to electric-powered equipment for correct voltage.
g. Adjust clearances and torque.
h. Test piping for leaks.

6. Ready-to-test determination will be by **[A: Engineer] [B:]** based at least on the following:
   a. Acceptable Operation and Maintenance Data.
   b. Notification by Contractor of equipment readiness for testing.
   c. Receipt of Manufacturer's Certificate of Proper Installation, if so specified.
   d. Adequate completion of work adjacent to, or interfacing with, equipment to be tested **[C: , including items to be furnished by Owner]**.
   e. Availability and acceptability of manufacturer's representative, when specified, to assist in testing of respective equipment.
   f. Satisfactory fulfillment of other specified manufacturer's responsibilities.
   g. Equipment and electrical tagging complete.
   h. Delivery of all spare parts and special tools.

B. Functional Testing:

1. Conduct as specified in individual Specification sections.
2. Notify Owner and Engineer in writing at least 10 days prior to scheduled date of testing.
3. Prepare Equipment Test Report summarizing test method and results.
4. When, in Engineer's opinion, equipment meets functional requirements specified, such equipment will be accepted for purposes of advancing to performance testing phase, if so required by individual Specification sections. Such acceptance will be evidenced by Engineer/Owner's signature as witness on Equipment Test Report.

C. Performance Testing:

1. Conduct as specified in individual Specification sections.
2. Notify Engineer and Owner in writing at least 10 days prior to scheduled date of test.
3. Performance testing shall not commence until equipment has been accepted by Engineer as having satisfied functional test requirements specified.

4. Type of fluid, gas, or solid for testing shall be as specified.
5. Unless otherwise indicated, furnish labor, materials, and supplies for conducting the test and taking samples and performance measurements.
6. Prepare Equipment Test Report summarizing test method and results.
7. When, in Engineer's opinion, equipment meets performance requirements specified, such equipment will be accepted as to conforming to Contract requirements. Such acceptance will be evidenced by Engineer's signature on Equipment Test Report.

3.03 STARTUP OF UNIT PROCESSES

A. Prior to unit process startup, equipment within unit process shall be accepted by Engineer as having met functional and performance testing requirements specified.

B. Startup sequencing of unit processes shall **[A: be as chosen by Contractor to meet schedule requirements.] [B: be in the following order:]**

1. **[C: .]**
2. **[D: .]**

C. Make adjustments, repairs, and corrections necessary to complete unit process startup.

D. Startup shall be considered complete when, in opinion of Engineer, unit process has operated in manner intended for **[A: 5] [B:]** continuous days without significant interruption. This period is in addition to functional or performance test periods specified elsewhere.

E. Significant Interruption: May include any of the following events:

1. Failure of Contractor to provide and maintain qualified onsite startup personnel as scheduled.
2. Failure to meet specified functional operation for more than **[A: 2] [B:]** consecutive hours.
3. Failure of any critical equipment or unit process that is not satisfactorily corrected within **[C: 5] [D:]** hours after failure.
4. Failure of any noncritical equipment or unit process that is not satisfactorily corrected within **[E: 8] [F:]** hours after failure.
5. As determined by Engineer.

F. A significant interruption will require startup then in progress to be stopped. After corrections are made, startup test period to start from beginning again.

3.04 FACILITY PERFORMANCE DEMONSTRATION

A. When, in the opinion of Engineer, startup of all unit processes has been achieved, sequence each unit process to the point that facility is operational.

B. Demonstrate proper operation of required interfaces within and between individual unit processes.

C. After facility is operating, complete performance testing of equipment and systems not previously tested.

D. Document, as defined in Facility Startup and Performance Demonstration Plan, the performance of the facility **[A: including its computer system] [B: , until all unit processes are operable and under control of computer system]**.

E. Certify, on the Facility Performance Demonstration/Certification Form, that facility is capable of performing its intended function(s), including fully automatic **[A: and computerized]** operation.

3.05 SUPPLEMENTS

A. Supplements listed below, following “End of Section,” are a part of this Specification:

1. Unit Process Startup Form.
2. Facility Performance Demonstration/Certification Form.

END OF SECTION

UNIT PROCESS STARTUP FORM

OWNER: _____ **PROJECT:** _____

Unit Process Description: (Include description and equipment number of all equipment and devices):

Startup Procedure (Describe procedure for sequential startup and evaluation, including valves to be opened/closed, order of equipment startup, etc.):

Startup Requirements (Water, power, chemicals, etc.): _____

Evaluation Comments: _____

FACILITY PERFORMANCE DEMONSTRATION/CERTIFICATION FORM

OWNER:_____ **PROJECT:**_____

Unit Processes Description (List unit processes involved in facility startup):

_____

_____

_____

_____

Unit Processes Startup Sequence (Describe sequence for startup, including computerized operations, if any):

_____

_____

_____

_____

_____

Contractor Certification that Facility is capable of performing its intended function(s), including fully automatic operation:

Contractor: _____ **Date:** _____**, 20____**

Engineer: _____ **Date:** _____**, 20____**

(Authorized Signature)

SECTION 03 40 00
PRECAST CONCRETE

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Concrete Institute (ACI): 304R, Guide for Measuring, Mixing, Transporting, and Placing Concrete.
2. ASTM International (ASTM):
   a. A36, Standard Specification for Structural Steel.
   b. A416, Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete.
   c. C31, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
3. Precast/Prestressed Concrete Institute (PCI):
   a. MNL-117, Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products.
   b. MNL-120, Design Handbook for Precast and Prestressed Concrete, Third Edition.

1.02 SUBMITTALS

A. Action Submittals:

1. Retardant for Exposed Aggregate Finish:
   a. Technical data.
   b. Instructions for product application.
2. Bond Breaker for Tilt-Up Walls:
   a. Technical data.
   b. Evidence of successful use in this type of application.
   c. Instructions for product mixing/application.
3. Sealer for Exterior Surfaces: Product data with mixing/application instructions.
4. Form Liners: Manufacturer’s literature and product data.
5. Calculations and Technical Data: Proposed details and design calculations for stresses in all critical sections of precast members for all loading conditions including transportation, handling, and erection.
   a. Tilt-Up Panel Walls: Show type and location of inserts, extra reinforcement for handling, and other pertinent data for proposed tilt-up construction.

B. Informational Submittals:

1. For Precasting Manufacturers Not Listed in Article Quality Assurance:
   a. Experience record on production of precast concrete as shown, with information on precasting plant, that will indicate capability to satisfactorily perform the Work.
   b. Evidence of current PCI plant certification.
   c. Complete list of architectural panelwork accomplished in past 2 years, including:
      1) Type of structure.
      2) Name of owner.
      3) Address of completed work.
2. Certificate of Compliance: Certify admixtures and concrete do not contain calcium chloride.
3. Test Reports:
   a. For precast manufacturer's concrete test cylinders.
   b. Inspection of installed panels.

1.03 QUALITY ASSURANCE

A. Qualifications of Precasting Manufacturers:

1. Precast Concrete and Precast Prestressed Concrete: Product of manufacturer with 3 years' experience producing precast concrete products of quality specified.
2. Precast Plant: PCI certified plant with current certification.
3. Precasting Manufacturers with Apparent Capability to Meet These Specifications:
   a. **[A: .]**
   b. **[B: .]**
   c. **[C: .]**
4. Calculations stamped by an engineer registered in the same state as the Project.

B. Samples for Exposed Aggregate Finish:

1. Before starting tilt-up panels, provide two Sample concrete panels for each aggregate finish required, 4 feet square and 3 inches thick for Engineer's approval.
2. Vary amounts of retardant to be used.
3. Approved Finish: Constitutes standard of quality required in completed Work.

C. Mockup Panels for Architectural Precast Panels:

1. Review Sample in Engineer's office as a guide in preparation of mockup panels.
2. Construct:

a. One full-size mockup panel for each different type of color or finish as shown to be used and installed in their respective places after approval of final precast Shop Drawings and calculations.
b. In accordance with details shown using materials, forming systems, reinforcing details, cast-in inserts, and mix proportions, and as specified and approved.

3. Finish:
a. Uniform in appearance and similar in all respects to Samples on display in Engineer's office.
b. Constitutes standard of quality required in completed Work.

4. If mockup panel does not represent quality required, construct additional mockup panels until approved by Engineer.
5. Protect and maintain approved mockup panels at location selected by Engineer or until Engineer approves installation in their respective locations in the Project.

PART 2 PRODUCTS

2.01 MATERIALS

A. Formwork:

1. One-piece, full length and without seams.
2. As specified in Section 03 10 00, Concrete Forming and Accessories.

B. Reinforcing Steel: As specified in Section 03 21 00, Reinforcing Steel.

C. Cement: As specified in Section 03 30 00, Cast-in-Place Concrete.

D. Pretensioning Strands: Seven-wire, uncoated, stress relieved, ASTM A416, Grade 270.

E. Aggregates: As specified in Section 03 30 00, Cast-in-Place Concrete, for 3/4-inch maximum size. Furnish of consistent quality, gradation, and color for precast architectural panels to produce uniformity of appearance in all panels.

F. Admixtures: As specified in Section 03 30 00, Cast-in-Place Concrete.

G. Embedded Items:

1. ASTM A36 steel.
2. Anchor Studs: Headed anchor studs (HAS), deformed bar anchors (DBA), or threaded studs as manufactured by Nelson Stud Welding Co., Lorain, OH.
3. Furnish inserts for lifting tilt-up walls, bolting stiffeners, attaching braces, and as otherwise required.

H. Grout: Nonshrink, nonmetallic Type II grout as specified in Section 03 62 00, Nonshrink Grouting.

I. Retardant for Exposed Aggregate Finish Manufacturers:

1. Sika Chemical Corp.; Rugasol.
2. Burke Co.; Exposed Aggregate Compound.

J. Sealer for Exterior Surfaces:

1. Silane Sealer: One-component penetrating sealer, hydrophilic (isopropyl alcohol as a carrier) with 40 percent active ingredients.
2. Manufacturers:
   a. Master Builders Co.
   b. Euclid Chemical Co.

K. Bond Breaker for Tilt-up Walls: Nonstaining, effective as a parting compound, will not leave film, quick drying, nontacky, rainproof, and provides reasonable abrasion resistance.

1. Manufacturers:
   a. Cresset Chemical Co.
   b. The Burke Co.

L. Precast Prestressed Concrete Members: **[A: girders,] [B: single tees,] [C: double tees,] [D: voided slabs,] [E: ,] [F:]** feet wide by **[G:]** feet deep.

2.02 CONCRETE MIX

A. As specified in Section 03 30 00, Cast-in-Place Concrete.

B. Design Strength: **[A: 5,000] [B:]** psi at 28 days.

C. Water/Cement Ratio: 0.38 maximum.

D. For colored precast concrete, coordinate ingredients and procedures to achieve uniformity of color.

2.03 DESIGN REQUIREMENTS

A. Precast Architectural Wall Panels:

1. Crack Control: PCI MNL-120.
2. Stresses: Limit tensile stress in the panels, from all handling and installation loads, to that less than that which would cause cracking on the exposed face.

3. Impact Design: Minimum 50 percent of member weight.
4. Tensile Stresses: Do not exceed those recommended in Chapter 5 of above referenced manual for a safety factor of 1.5 in critical sections under all loading conditions.
5. Design and reinforce to withstand handling and erection loads.

B. Structural Precast and Prestressed Members, Except for Architectural Panels:

1. Meet applicable sections of PCI MNL-120.
2. Design for spans and superimposed live and dead loads shown plus dead loads of members.

C. Prestressed Members:

1. Calculated tension at full service loads shall not exceed six times the square root of design strength except that in wet or corrosive service conditions and in **[A: ,]** the calculated tension due to live load and dead load shall not exceed zero.
2. Limit long-term camber growth to span length divided by 360.

D. Tilt-Up Wall Panels:

1. Furnish design for pickup and bracing attachments and location thereof required to lift panels.
2. Pickup point locations where shown are intended only as a guide.
3. Meet design requirements specified for Precast Architectural Wall Panels.

2.04 FABRICATION

A. General:

1. Comply with PCI MNL-117.
2. Reinforcing Steel and Pretensioning Strands:
   a. Place in position before concrete is cast.
   b. Keep clean and free from form oil or other substances harmful to bond.
3. Pretensioning Force, if Used: Determine by elongation and by gauge pressure.
   a. Method: Meet requirements of Prestressed Concrete Institute.
4. Forms: Produce smooth surfaces.
5. Concrete: Deposit, vibrate, finish, and cure in accordance with recommended practices of ACI 304R. Steam curing is permitted.
6. Release Strength for Pretensioning Method: Minimum 4,000 psi, unless otherwise approved.

7. Coordinate dimensions, determine type, quantity, size, and location of, and furnish necessary embedded items in precast concrete. Coordinate location of embedded items in cast-in-place concrete necessary to connect precast items.

B. Surface Finish for Precast Structural Units: Furnish concrete finish, as specified in Section 03 30 00, Cast-in-Place Concrete, to additional concrete field placed on precast units.

1. Other Surfaces: Smooth screeded finishes, unless otherwise shown.

C. Surface Finish for Precast Architectural Panels or Tilt-Up Walls:

1. Exposed Surfaces in Building Interior: As shown.
2. Panel Interior Surface: **[A: As shown.] [B: Steel trowel, Type S-1, as specified in Section 03 30 00, Cast-in-Place Concrete.]**
3. Meet standard of quality represented by approved mockup panel.
4. Furnish panels from same manufacturer.

D. Sealer:

1. Apply to **[A: exterior surfaces of architectural panels,] [B: ,]** at **[C: precast plantsite,] [D: at Site,] [E: after sandblasting panels,]** in accordance with manufacturer's instructions.
2. Protect surface until installed in the Work.
3. Repair damage as approved by manufacturer.

2.05 SOURCE QUALITY CONTROL

A. Prepare minimum three standard concrete test cylinders for each 50 cubic yards or fraction thereof of concrete placed in the precast work in accordance with ASTM C31.

B. Test and record concrete strengths.

PART 3 EXECUTION

3.01 ERECTION

A. Verify that anchorage inserts are in correct locations.

B. Handle and erect precast concrete with care as recommended by manufacturer.

C. Erect precast units plumb, straight, level, square, and in proper alignment.

D. Fasten units securely in place and brace to maintain position, stability, and alignment until permanently connected and structure is complete and stable.

E. Field Cutting: Not allowed without prior approval of Engineer.

3.02 TILT-UP PANEL WALLS

A. General: Plan operation so no equipment for raising slabs is placed on concrete floors.

B. Casting Slab:

1. Use finished concrete floor.
2. Cast tilt-up panels on this slab, unless otherwise approved.
3. Do not cast panels on warped surfaces, across construction joints, or surfaces pitched to drain outlets.
4. Bond Breaker: Apply in accordance with manufacturer's recommendations.

C. Casting Slab:

1. Finished Slab: True and level plane with smooth trowel finish.
2. Bond Breaker: Apply in accordance with manufacturer's recommendations as approved.

D. Reglets: Install in forms in straight lines in accordance with manufacturer's recommendations.

E. Exposed Aggregate Finish:

1. Retardant Application:
   a. Shake uniformly over freshly placed concrete surface immediately following finishing process and before all surface water has disappeared.
   b. Rate: To effect a depth of 1/8 inch or more exposure of aggregate, as approved.
   c. In accordance with manufacturer's recommendations.
2. Curing: Cover with wet burlap or other acceptable covering and maintain in a moist state.
3. Hose or brush off retarded concrete surface to expose clean aggregate.
4. After retarded concrete has been removed, cure panels in the manner specified in Section **[A: 03 39 00, Concrete Curing] [B:]**.
5. Where sides of panels are to be exposed aggregate, paint forms with two coats of retardant before placing concrete.
6. Finish: To match Sample approved by Engineer.

F. Lifting and Setting Panels in Position:

1. Caution: Walls or panels are not stable in themselves against lateral loads, such as wind until construction is complete. Provide bracing as required.
2. Do not move panels until concrete has obtained the design field strength required by design calculation for handling stresses, including impact. Field strength shall be determined by test cylinders.
3. Pickup Lines: Provide equal lifting force at panel pickup points, applied simultaneously and acting at right angles to panel.
4. Excessive Stresses or Shock Loading: Prevent when lifting panel from casting surface, consider form suction and impact using Part 5 of PCI MNL-120 Design Handbook.
5. Lifting Equipment: Of size and capacity to prevent damage to panel.
6. Set panels on carefully leveled shims.
7. Position, plumb and align true to line, and brace securely.
8. Bottom Joint Space: Fill with nonshrink nonmetallic grout as shown and as specified in Section 03 62 00, Nonshrink Grouting, as soon as panels are placed and braced.
9. Insert Holes: Fill with nonshrink nonmetallic grout.
10. Holes in Exposed Surfaces: Patch to match adjacent surfaces.
11. Make welded connections.

G. Cast-In-Place Pilasters and Closing Sections: As specified in Section 03 30 00, Cast-in-Place Concrete.

3.03 PATCHING

A. Mix and place patching mixture to match color and texture of surrounding concrete and to minimize shrinkage.

B. Demonstrate patching method and obtain acceptance and approval.

3.04 CLEANING

A. After installation, clean soiled precast concrete surfaces with detergent and water, using fiber brush and sponge.

B. Use acid solution only to clean particularly stubborn stains after more conservative methods have been tried unsuccessfully.

C. Use extreme care to prevent damage to precast concrete surfaces and to adjacent materials.

D. Rinse thoroughly with clean water immediately after using cleaner.

3.05 FIELD QUALITY CONTROL

A. Inspection:

1. With Engineer, inspect precast architectural wall panels for chips, cracks, discoloration, and other damage.
2. Compare every panel to approved mockup panel and finish sample panel.
3. Record location and condition of damaged or nonmatching panels.

B. Resolution:

1. Repair damage to satisfaction of Engineer and Owner.
2. Remove panels with damage or repairs not acceptable to Engineer.
3. Install new acceptable panels in place of those removed.
4. Perform reinspection and obtain acceptance by Engineer.

3.06 PROTECTION

A. Protect precast units from chipping, spalling, cracking, or other damage to the units after delivery to Site.

B. After erection, protect units from damage.

END OF SECTION

SECTION 03 63 00
CONCRETE DOWELING

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. American National Standards Institute (ANSI).
2. ASTM International (ASTM):
   a. C881/C881M, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
   b. E488, Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements.
3. International Code Council (ICC):
   a. **[A: 2009] [B: 2006] [C: 2003]** International Building Code (IBC).
   b. Evaluation Services Reports.
4. **[D: NSF International (NSF): 61, Drinking Water System Components – Health Effects.]**

1.02 DEFINITIONS

A. ICC Evaluation Services Report: Published by ICC for products provided by concrete adhesive anchor manufacturers.

B. Special Inspection: As defined in the ICC IBC and indicated on the Statement of Special Inspection (Plan) **[A: on the Drawings] [B: in Supplement located at end of Section 01 45 33, Special Inspection, Observation, and Testing]**.

1.03 SUBMITTALS

A. Action Submittals:

1. Product Data: Manufacturer’s catalog information.
2. **[A: Samples: Two random Samples of each batch of products delivered to Site, for independent testing.]**

B. Informational Submittals:

1. Manufacturer’s instructions for preparation, placement, drilling of holes, installation of anchors and adhesive, and handling of cartridges, nozzles, and equipment.
2. **[B: Manufacturer’s written letter of certification identifying installer’s qualifications to install products.]**

3. ICC Evaluation Services Report: Specific to proposed doweling system manufacturer.
4. **[A: Field Test Reports: Reports documenting ratio checks made for metering and mixing devices where a batch process is used for mixing adhesive.]**

1.04 QUALITY ASSURANCE

A. Qualifications:

1. **[A: Manufacturer: At least three similar projects with same products within last 3 years.]**
2. **[B: Installer: Trained and certified by manufacturer.]**

B. **[A: Regulatory Requirements: Adhesive shall be certified as meeting NSF 61 for use in potable water structures.]**

1.05 DELIVERY, STORAGE, AND HANDLING

A. Container Markings: Include manufacturer's name, product name, batch number, **[A: mix ratio by volume]**, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.

B. Store adhesive components in accordance with manufacturer's written instructions.

C. Dispose of when:

1. Shelf life has expired.
2. Stored other than per manufacturer's instructions.

PART 2 PRODUCTS

2.01 MATERIALS

A. Adhesive:

1. Approved by an ICC Evaluation Services Report for conformance to **[A: 2009] [B: 2006] [C: 2003]** IBC requirements for doweling of steel reinforcing bars in cracked concrete.
2. Suitable for long-term loads as well as for wind and seismic loads.
3. Meet requirements of ASTM C881/C881M.
4. Two-component, insensitive to moisture, designed to be used in adverse freeze/thaw environments.
5. Disposable, Self-Contained Cartridge System:
   a. Capable of dispensing both components in proper mixing ratio.
   b. Fit into manually or pneumatically operated caulking gun.

6. **[D: Mixed Adhesive: Nonsag, light paste consistency with ability to remain in a 1-inch diameter overhead drilled hole without runout.]**
7. **[E: Cure Temperature, Pot Life, and Workability: Compatible for intended use and anticipated environmental conditions.]**
8. **[F: Potable Water Structures: Adhesive shall be acceptable for use by NSF 61.]**
9. Manufacturers and Products:
    a. Hilti, Inc., Tulsa, OK; HIT-RE 500-SD (ESR-2322) or HIT-HY 200 (ESR-3187) Adhesive Anchors.
    b. Powers Fasteners, Brewster, NY; Power PURE110+ Epoxy Adhesive Anchor System (ESR-3298).
    c. Simpson Strong-Tie Co., Inc., Pleasanton, CA; SET-XP Epoxy Adhesive Anchors (ESR-2508).

B. Mixing Nozzles:

1. Disposable, manufactured in several sizes to accommodate size of reinforcing dowels.
2. **[A: Nonremovable internal static mixer required to ensure proper blending of components.]**

C. Reinforcing Dowels:

1. As specified in Section 03 21 00, Steel Reinforcement.
2. **[A: Smooth Epoxy-Coated Expansion Joint Dowels: As specified in Section 03 15 00, Concrete Accessories.]**

PART 3 EXECUTION

3.01 INSTALLATION

A. Drilling Equipment:

1. Drilling Hammers for Dowel Holes:
    a. Electric or pneumatic rotary type with medium or light impact.
    b. Hollow drills with flushing air systems are preferred.
2. Where edge distances are less than 2 inches, use lighter impact equipment to prevent microcracking and concrete spalling during drilling process.

B. Hole Diameter: Use drill bit diameter meeting ICC Evaluation Services Report requirements and as recommended by manufacturer.

C. Obstructions in Drill Path: When existing steel reinforcement is encountered during drilling, obtain Engineer approval for proposed fix.

D. Doweling:

1. Install per details shown on Drawings and in accordance with adhesive manufacturer's instructions.
2. When using epoxy anchors, dowels may be prebent prior to installation to 15 degrees to align with other bars. Do not heat dowels to bend.
3. Bent Bar Dowels: Where edge distances are critical, and intersection with steel reinforcement is likely, drill hole at 10-degree angle or less and use prebent reinforcing bars.
4. **[A: If bars have fused epoxy coating and coating is damaged, recoat damaged area with epoxy.]**

E. Adhesive:

1. Install in accordance with written manufacturer's instructions.
2. Dispense components through specially designed static mixing nozzle that thoroughly mixes components and places mixed adhesive at base of predrilled hole.
3. **[A: Dispensing, Metering, and Mixing Adhesive Components: Use portable, automatic metering and mixing device or machine capable of maintaining prescribed mix ratio within deviation of 5 percent or less, by volume.]**

3.02 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. **[A: Proof Loading:**

1. **To be performed where continuous inspection of concrete dowels is required.**
2. **Testing will be performed by Owner's Independent Testing Agency.**
3. **Proof loading to be performed only after adhesive has achieved proper cure per manufacturer's requirements.**
4. **Testing will be conducted on minimum of [B: 10] [C:] percent of installed dowels, with a minimum of [D: two] [E:] tension tests. A minimum of two cartridges per box or packaging unit will be tested.**
5. **Testing will be conducted in accordance with ASTM E488 and as follows:**
   a. **Performance of a static tension test of each test dowel.**
   b. **Test apparatus reaction base will not interfere with bond failure of dowel, but will preclude a concrete pullout cone failure.**
   c. **Each test dowel will be tested at a proof load equal to the lesser of 80 percent of the yield strength of the dowel bar or 50 percent of calculated ultimate load based on adhesive bond strength.**

d. **Test load to be maintained for a minimum of 30 seconds without visible signs of movement of dowel or drop in gauge reading.**

6. **Failure of dowel bar or failure within base concrete will cause dowel to be rejected. For each rejected dowel, two additional dowels will be tested. Replace rejected dowels as approved by Engineer.]**

B. **[A: Testing of Automatic Metering and Mixing Devices:**

1. **Test for Proper Ratio:**
   a. **Retain small amount of dispensed adhesive for inspection after each time pump is refilled.**
   b. **Check samples for color change.**
   c. **Should change in color occur, follow manufacturer's service instructions to obtain proper operation.**
2. **Frequency of Tests: Make full ratio check after each 100 gallons of adhesive is dispensed or if color of mixed adhesive becomes noticeably darker or lighter.**
3. **Ratio Check Procedure:**
   a. **Disconnect dispensing head behind ON/OFF valve.**
   b. **Place volume containers of required proportions under "B" and "A" component hose ends.**
   c. **Actuate pump.**
   d. **Both cups should fill in an equal time to proper volume, thereby verifying proportion ratio by volume.**
   e. **Document timing and results of each ratio check procedure.]**

C. Owner-Furnished Quality Assurance, in accordance with IBC Chapter 17 requirements, is provided in the Statement of Special Inspection (Plan) **[A: on Drawings] [B: in Supplement located at end of Section 01 45 33, Special Inspection, Observation, and Testing]**. Contractor responsibilities and related information on special inspection and testing are included in Section 01 45 33, Special Inspection, Observation, and Testing.

1. Special inspection will be performed by the Special Inspector in accordance with ICC ESR requirements and as specified in Section 01 45 33, Special Inspection, Observation, and Testing.
2. Continuous inspection required where noted **[C: on Drawings] [D: in Supplement located at end of Section 01 45 33, Special Inspection, Observation, and Testing] [E: herein]** and where concrete dowels are installed in overhead applications.
3. Periodic inspection required where continuous inspection is not specified.

4. Special Inspector will observe installation in accordance with requirements of the ICC Evaluation Services Report and will submit report including the following:
   a. Product Description: Product name, rod diameter, and length.
   b. Drill bit compliance.
   c. Hole diameter, diameter, and depth and cleanliness.
   d. Adhesive expiration date.
5. Verification of dowel installation in accordance with manufacturer's published instructions

D. Contractor-Furnished Quality Control: Inspection and testing as required in Section 01 45 16.13, Contractor Quality Control.

END OF SECTION

SECTION 31 23 19.01
DEWATERING

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals:

1. Water control plan.
2. Well permits.
3. Discharge permits.
4. Water Level Elevations Observed in Observation Wells: Submit same day measured.
5. Settlement Benchmark Elevations: Submit weekly record.
6. Inflow Measurements: Submit weekly record.

1.02 WATER CONTROL PLAN

A. As a minimum, include:

1. Descriptions of proposed groundwater and surface water control facilities including, but not limited to, equipment; methods; standby equipment and power supply, **[A: means of measuring inflow to excavations,]** pollution control facilities, discharge locations to be utilized, and provisions for immediate temporary water supply as required by this section.
2. Drawings showing locations, dimensions, and relationships of elements of each system.
3. Design calculations demonstrating adequacy of proposed dewatering systems and components.

B. If system is modified during installation or operation revise or amend and resubmit Water Control Plan.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. **[A: :]** Continuously control water during course of construction, including weekends and holidays and during periods of work stoppages, and provide adequate backup systems to maintain control of water.

B. **[A: For Other Portions of Project:]** Remove and control water during periods when necessary to properly accomplish Work.

3.02 SURFACE WATER CONTROL

A. See Section 01 50 00, Temporary Facilities and Controls, Article Temporary Controls.

B. Remove surface runoff controls when no longer needed.

3.03 DEWATERING SYSTEMS

A. Provide, operate, and maintain dewatering systems of sufficient size and capacity to permit excavation and subsequent construction in dry and to lower and maintain groundwater level a minimum of **[A: 2] [B: 5] [C:]** feet below the lowest point of excavation. Continuously maintain excavations free of water, regardless of source, and until backfilled to final grade.

B. For **[A: ,]** dewatering systems shall include wells or well points, and other equipment and appurtenances installed outside **[B: structural limits] [C: limits of excavations]** and sufficiently below lowest point of excavation, or to maintain specified groundwater elevation.

C. Design and Operate Dewatering Systems:

1. To prevent loss of ground as water is removed.
2. To avoid inducing settlement or damage to existing facilities, completed Work, or adjacent property.
3. To relieve artesian pressures and resultant uplift of excavation bottom.

D. Provide sufficient redundancy in each system to keep excavation free of water in event of component failure.

E. Provide 100 percent emergency power backup with automatic startup and switchover in event of electrical power failure.

F. Provide supplemental ditches and sumps only as necessary to collect water from local seeps. Do not use ditches and sumps as primary means of dewatering.

3.04 MONITORING WELLS

A. Monitoring Groundwater Levels: Install and monitor observation wells at **[A:]** locations **[B: shown] [C: selected by Engineer]**. Measure water levels observed in each observation well at **[D: least weekly] [E: frequency stated in Contractor's Dewatering Plan]** and whenever system or component failures are discovered **[F: and whenever any event, including but not limited to flood, storms, changes in water surface elevation of nearby water bodies, may have caused a change in the groundwater elevation]**.

B. After groundwater level observation wells are no longer needed for monitoring groundwater levels, abandon observation wells, as **[A: required by regulations] [B: specified in Section [C:]]**.

1. Contractor-installed observation wells.
2. Existing observation wells with following exceptions:
   a. **[D: .]**

3.05 SETTLEMENT

A. Monitoring Dewatering-Induced Settlement: Establish monuments for monitoring settlement at **[A:]** locations **[B: shown] [C: selected by Engineer]**. Monitor vertical movement of each settlement monument, relative to remote benchmark selected by Engineer, at **[D: least weekly] [E: frequency stated in Contractor's Dewatering Plan]**.

3.06 MONITORING FLOWS

A. Monitor volume of water pumped per calendar day from excavations, as Work progresses. Also monitor volume of water introduced each day into excavations for performance of Work. Monitor flows using measuring devices acceptable to Engineer.

3.07 DISPOSAL OF WATER

A. Obtain discharge permit for water disposal from authorities having jurisdiction.

B. Treat water collected by dewatering operations, as required by regulatory agencies, prior to discharge.

C. Discharge water as required by discharge permit and in manner that will not cause erosion or flooding, or otherwise damage existing facilities, completed Work, or adjacent property.

D. Remove solids from treatment facilities and perform other maintenance of treatment facilities as necessary to maintain their efficiency.

3.08 PROTECTION OF PROPERTY

A. Make assessment of potential for dewatering induced settlement. Provide and operate devices or systems, including but not limited to reinjection wells, infiltration trenches and cutoff walls, necessary to prevent damage to existing facilities, completed Work, and adjacent property.

B. Securely support existing facilities, completed Work, and adjacent property vulnerable to settlement due to dewatering operations. Support shall include, but not be limited to, bracing, underpinning, or compaction grouting.

3.09 REMEDIATION OF GROUNDWATER DEPLETION

A. If dewatering reduces quantity or quality of water produced by existing wells, temporarily supply water to affected well owners from other sources. Furnish water of a quality and quantity equal to or exceeding the quality and quantity available to well owner prior to beginning the Work or as satisfactory to each well owner.

END OF SECTION

SECTION 31 62 16
STEEL PILES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Concrete Institute (ACI): 318/318R, Building Code Requirements for Structural Concrete and Commentary.
2. American Petroleum Institute (API): Spec 5L, Specification for Line Pipe.
3. American Water Works Association (AWWA): C200, Steel Water Pipe—6 in. (50 mm) and Larger.
4. American Welding Society (AWS): D1.1, Structural Welding Code—Steel.
5. ASTM International (ASTM):
   a. A36, Standard Specification for Carbon Structural Steel.
   b. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   c. A139, Standard Specification for Electric-Fusion (ARC)-Welded Steel Pipe (NPS 4 and Over).
   d. A252, Standard Specification for Welded and Seamless Steel Pipe Piles.
   e. A572, Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
   f. A1011/A1011M, Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.

1.02 DEFINITIONS

A. Design Position: The location of the centroid of the pile at cutoff elevation (x, y, and z coordinates) as shown.

B. Dynamic Monitoring: Monitoring performed with Case-Goble Pile Driving Analyzer (PDA). Gauges are attached to pile approximately 3 feet below pile head and connected with cable to monitoring station on ground away from pile. Gauges consist of two accelerometers and two strain transducers.

C. Elevations: Referenced to **[A: mean lower low water (MLLW)] [B:]**.

D. Fixed Leads: Leads that are pinned to crane boom at top and equipped with hydraulic spotter at bottom capable of spotting pile to its correct position and

maintaining alignment during driving. Degree of rigidity and strength acceptable will be subject to review of Engineer.

E. Impact Stress: Stress transferred to pile head at impact from driving train, as determined from measurements using Pile Driving Analyzer.

F. Obstruction: Sudden and significant increase of penetration resistance and deviation of pile out of tolerance resulting from encountering a subsurface or physical condition.

G. Practical Refusal: Penetration resistance of at least 120 blows per foot for 3 continuous feet, 200 blows per foot for 1 foot, or 50 blows per inch for 2 consecutive inches, whichever comes first, and to continue driving pile would be impractical. These criteria apply only for hammer sizes and operation as specified.

H. Rated Hammer Energy:

1. Diesel Hammers: Product of rated stroke times ram weight.
2. Air Hammers: Rated energy from manufacturer’s literature.

I. Restriking: Positioning driving train and driving already installed pile after some nominal waiting period (as specified) after initial installation. This definition applies to redriving piles selected by Engineer for determining appropriate driving criteria requirements or for checking pile integrity. Restriking may require mobilizing crane and driving train from one pile to another location at opposite ends of structure(s).

J. Set: Pile penetration in inches per blow.

K. Sweep: Deviation from straightness measured along two perpendicular faces of pile while not subject to bending forces.

L. Swinging Leads: Pile driving leads that are not pinned at the top and do not have a hydraulic spotter to position the leads.

M. Termination Penetration Resistance: Penetration resistance (blow count) at which driving may be terminated, as established by Engineer.

N. Transferred Hammer Energy: Energy transferred to pile head from driving train impact, as determined from measurements using Pile Driving Analyzer.

1.03 SUBMITTALS

A. Action Submittals:

1. Splice Design Details and Calculations:

a. AWS D1.1 Appendix E; include documentation establishing each welder is currently qualified in the proposed welding procedure.
b. Premanufactured Splices: Manufacturer's recommendations for installation.

B. Informational Submittals:

1. Production pile driving schedule and sequence.
2. Piling Installer Qualifications.
3. Welder Qualifications and Certifications: Source and Site welding.
4. Manufacturer's Certification of Compliance: Manufactured Products.
5. **[A: Certified Test Results: Concrete mix design [B: , including certified minimum 28-day compressive strength].]**
6. Certification of Calibration:
   a. Pressure gauge for measuring air pressure (for air hammers) or chamber pressure (for closed end diesel hammers). Include correction data for hose losses if air pressure gauge is located away from hammer. Include a chart for closed end diesel hammers that equates bounce chamber pressure to either equivalent stroke or energy.
   b. Flowmeter and pressure gauge used for measuring flow rates and water pressures at jetting pump.
7. Proposed method(s) to align and maintain pile alignment, including type of leads to be used with details on methods and equipment to be used to measure alignment.
8. Manufacturer's Specifications of Products, and Maintenance Manuals, for pile hammer and auxiliary equipment.
9. Complete Pile Hammer Data Sheet, attached as Supplement to this Specification. Refer to Part 3, Article Supplements.
10. Daily Log and Record: At end of each working day, submit two copies of each record for every pile constructed that day.

1.04 QUALIFICATIONS

A. Piling Installer: Minimum of 5 years of past successful experience on ten projects of steel pile installation.

B. Source and Site Welders: Current qualification in proposed welding procedure(s) in accordance with AWS D1.1.

1.05 STORAGE AND HANDLING

A. Do not subject piles to damage by impact bending stresses in transporting to and storing piles onsite.

B. Store and handle piles such that corrosion protection coatings will not be damaged.

1.06 SEQUENCING AND SCHEDULING

A. Complete foundation excavation, construction of cofferdams or earth support systems prior to start of pile driving activity.

B. Production Pile Driving: Begin after successful completion of testing as specified in Section **[A: 31 09 18, Static Pile Testing] [B: and] [C: 31 09 17, Dynamic Pile Testing] [D:]**.

PART 2 PRODUCTS

2.01 PILES

A. H-Piles **[A: , Including Test Piles:]** Minimum nominal size and ASTM Standard and Grade shown.

B. Pipe Piles **[A: , Including Test Piles]**: Minimum size and wall thickness shown manufactured to **[B: ASTM A139, Grade B, with minimum specified yield of 35,000 psi] [C: AWWA C200; pipe made to ASTM A53, Grade B, Type E or S, or pipe fabricated from steelplate sheet or coils manufactured to ASTM A36, ASTM A1011/A1011M, and ASTM A572, with minimum specified yield of 35,000 psi] [D: API 5L, Grade B, with minimum specified yield of 35,000 psi]**.

[E: ASTM A252, Grade 2, as modified herein:

1. **[F: .]]**

C. **[A:]** test piles will be driven at production pile locations as indicated on the Drawings for **[B: each]** designated facility. Test piles, if found acceptable to Engineer, will be left in place as part of the foundations system of the permanent facility.

2.02 PILE SPLICES

A. Meet requirements of AWS D1.1, and provide equal stress strain behavior in bending, tension, compression, and torsion as unspliced segments of pile.

B. Premanufactured: Engineer’s prior approval required.

2.03 CONCRETE

A. As specified in **[A: Section 03 30 00, Cast-in-Place Concrete,] [B: ,]** except:

1. Compressive Strength: **[C: 3,000 psi] [D:]** minimum at 28 days.
2. Slump: 6 to 8 inches immediately prior to being placed.

B. Evaluation and Acceptance of Concrete: In accordance with ACI Standard Building Code Requirements for Reinforced Concrete (ACI 318/318R), Section 4.8, Evaluation and Acceptance of Concrete, and **[A: as specified in Section 03 30 00, Cast-in-Place Concrete, except]** as follows:

1. Investigation of low strength test results, ACI Section 4.84, will not apply.
2. If concrete does not meet above requirements, provide additional piling to ensure structural design load-carrying capacity.
   a. Engineer will determine number of extra piles required and will base this determination on actual 28-day compressive strength attained, location and required load-carrying capacity of piles in question, and calculated load-carrying capacity of piling based on following equation:

      Maximum Axial Load-Carrying Capacity = $0.35 F_Y A_S + 0.33 f'_C A_C$

      Where:

      F_Y = yield stress of steel, and $0.35 F_Y$ is not to exceed 12.6 ksi for pipe piles

      A_S = Cross-sectional area of steel in pile (minimum cross-sectional area for piles with varying cross-section)

      f'_C = actual 28-day compressive strength of concrete

      A_C = cross-sectional area of concrete in pile

   b. Costs associated with furnishing and installing additional piles due to low strength concrete, including required modifications to pile cap, shall be borne by Contractor.

2.04 END PLATES

A. Furnish with each pipe pile.

B. Size: **[A: 3/4] [B:]** inch thick and diameter equal to outside diameter of pile, plus 0.5 inch.

C. ASTM A36 grade steel.

D. Mill Tolerance: Manufacturer’s standard.

2.05 PILE TOE PROTECTION

A. Cast Alloy Steel Cutting Type: Inside flanged, and designed to fit integrally to the pile.

1. Manufacturers:
   a. Associated Pile and Fitting Corp., (APF).
   b. Dougherty Foundation Products, Inc., (DFP).

B. Cast Alloy Steel Type:

1. Manufacturers and Models:
   a. Associated Pile and Fitting Corp., (APF); HP 77750.
   b. Dougherty Foundation Products, Inc., (DFP); HP 777.

C. Rock Point Shoes:

1. Manufacturer and Model: AB Scanpile; HR 550.

2.06 CORROSION PROTECTION

A. As specified **[A: in Section 09 90 00, Painting and Coating] [B:]**.

PART 3 EXECUTION

3.01 PILE DRIVING EQUIPMENT

A. Pile Driving Hammer and Driving System:

1. Air or diesel hammers capable of continuous operation at all fuel and/or trip valve settings, and not overstress or otherwise cause damage to pile during installation.
2. Size and type to consistently deliver an effective dynamic energy sufficient to drive pile to required ultimate pile capacity and minimum toe elevation.
3. Compressor/Boiler Capacity: Furnish with at least 10 percent greater than manufacturer’s minimum requirement.
4. Air Hammer Calibrated Pressure Gauge: Furnish and position on hammer side of all valves, no more than 100 feet of hose away from hammer inlet and located for easy observation.
5. Closed-End Diesel Hammer Calibrated Pressure Gauge: Furnish and position near ground level for easy observation.
6. Minimum Hammer Rated Energy:
   a. Air Hammers: **[A: .]**
   b. Diesel Hammers: **[B: .]**

B. Hammer Cushion/Capblock: Manufactured from stable and predictable material.

1. Manufacturer and Type:
   a. Metex Corp; Aluminum-Micarta, Force 10.
   b. Penn State Metal Fabricators; Aluminum and Conbest.

C. Helmet: Seat onto pile and bear evenly and concentrically with minimum play upon pile.

D. Pile Head: Free to rotate.

E. Pile Driving Leads:

1. Degree of rigidity and strength acceptable will be subject to the Engineer's review.
2. Fixed Leads: Provide with hydraulic spotter.
3. Swinging Leads:
   a. Driving Template: Capable of maintaining alignment and position of leads and pile during driving within tolerances specified herein.
   b. Of sufficient length so that lowering the leads during driving is not necessary.
4. Of sufficient length so use of follower is not necessary.
5. Straight and parallel, not deviating from straight line by more than 1/2 inch over 15-foot length.
6. Easily adjustable to permit axial driving without interruption if piles deviate from required alignment.

3.02 JETTING EQUIPMENT

A. Size: Sufficient to maintain flows and jet tip pressures necessary to accomplish the work.

B. Jets, Volume, and Pressure: Quantity sufficient to freely erode material adjacent to pile.

C. Pump Capacity: Sufficient to continuously deliver **[A: 75] [B:]** gallons per minute at **[C: 100] [D:]** pounds per square inch pressure at two jet nozzles.

3.03 PREPARATION

A. Make allowance for upheaval of excavation bottom due to driving.

B. Use templates or other suitable methods to ensure required degree of accuracy.

C. Do not drive piles within 200 feet of structural concrete less than 7 days old **[A: and of] [B:] [C: concrete masonry units installed within prior 3 days]**.

3.04 INSTALLATION

A. Notify Engineer **[A: 7] [B:]** days in advance of and perform driving in presence of Engineer.

B. Welding: Meet requirements of AWS D1.1.

C. End Plates: Drive each pile closed toe using end plate. Attach end plate by means of continuous fillet weld around pile circumference.

D. Toe Protection: Install toe protection according to manufacturer's recommendations and as shown.

E. Corrosion Protection:

1. Coat piles from cutoff elevation to Elevation **[A:]**. Ensure that piles are coated over elevations and/or distances as herein defined.
2. Repair damaged coating, including damage caused by welding, in accordance with Section 09 90 00, Painting and Coating.

F. Splicing:

1. Do not splice without Engineer present.
2. Number: Maximum of **[A: one] [B: two] [C: three]** splices per pile.
3. Spacing: Minimum 15 feet apart, unless otherwise approved by Engineer.
4. Preparation: Square ends of both pile sections to be joined.
   a. Tolerance: Pile ends shall not be out of square by more than 1/16 inch.
5. Pre-Manufactured Splices or Couplers: If used, install in accordance with manufacturer's recommendations.
6. Spliced Pile: Straight, deviation in pile alignment shall be less than 1 inch in 50 feet.

G. Pile Marking: At 1-foot intervals for purpose of recording driving resistance and depth of penetration of pile.

H. Pile Driving:

1. Perform in presence of Engineer.
2. Maintain hammer concentric with driving train in axial alignment on pile. Do not use hammer to limit deviation of pile during driving by

exerting lateral forces or striking at angle. Where pile orientation is essential, take special care to maintain orientation during driving.

3. Impact driving may be terminated when a minimum toe elevation of **[A:]** feet (MLLW) is reached and required ultimate capacity has been obtained.
   a. After Effective Date of Agreement and within **[B: 30] [C:]** days of receiving Contractor's Pile Hammer Data Sheet Submittal, Engineer will issue Termination Penetration Resistance criteria. If pile testing is required, the Termination Penetration Resistance criteria issued shall be considered preliminary and shall be revised by the Engineer after completion of the pile testing.
   b. Engineer will relate ultimate capacity to a penetration resistance (blow count) based on **[D: Wave Equation and Contractor's driving train, using information contained on Pile Hammer Data Sheet] [E:]**.
4. The following table relates manufacturer's rated energy to estimated penetration resistances required to obtain ultimate capacity.

Estimated Penetration Resistance Criteria Table	
Manufacturer's Rated Energy	**Estimated Penetration Resistance (Blow Count)**
[A:] ft-kips	**[B:]** blows/ft
[C:] ft-kips	**[D:]** blows/ft

5. Means or device suitable to indicate penetration of piles which is visible to Engineer at reasonable and safe distance from pile driver.
6. Drive piles continuously, and without voluntary interruption, to termination penetration resistance or to refusal driving resistance.
   a. Termination penetration resistance shall only apply after minimum toe elevation has been achieved.
   b. If refusal driving resistance is obtained above minimum toe elevation, preboring, jetting, or other methods acceptable to Engineer may be required to advance pile.
   c. Proceed with alternative installation method.
7. Specified rates of driving resistance shall not apply until set resulting from interruption in driving or change in hammer cushion has been overcome, as determined by Engineer.
8. Remove material forced up between piles above elevation shown for bottom of foundation pit.
9. Where jetting is required to advance pile, use following procedure:
   a. Jet pile to minimum toe elevation.
   b. Continued driving will be permitted during jetting.
   c. Terminate jetting and allow pile to set up for at least 30 minutes.

d. Impact drive pile to required penetration resistance.

10. Redrive piles that are raised during process of driving.
11. Pulling piles into alignment or position will not be permitted.
12. Drive piles for dock bents so that cap may be placed in its exact location without inducing stresses in pile.

I. Driving Tolerances:

1. Not more than 1 percent from vertical or 2 percent from batter shown.
2. Centroid of pile at cutoff elevation shall not vary from design position shown by more than **[A: 3] [B:]** inches after driving.

3.05 PILE CUTOFF

A. Cut square at required elevation with tools that will not damage area below cut surface.

3.06 PLACING CONCRETE IN PIPE PILES

A. Fill pipe piles with concrete.

B. Place as specified in Section **[A: 03 30 00, Cast-in-Place Concrete,] [B: ,]** except:

1. Do not place concrete in pile without prior approval of Engineer.
2. Prior to Placing Concrete:
   a. Confer with Engineer to determine if restriking is required.
   b. Inspect interior of each pile and, dewater and clean each pile of water and mud.
3. Concrete may drop freely for entire pile length provided contact with the sides of the pipe pile or reinforcing cage (if required) is avoided.
4. Only upper 10 feet of concrete in pile will require consolidation with mechanical vibrators.

3.07 PILE EXTRACTION

A. Extract selected piles after driving to determine condition of the pile toe and toe protection as requested by Engineer.

1. Remove from Site of work piles pulled and found to be damaged to such extent as would impair its usefulness in completed structure.
2. Drive new pile to replace damaged pile.
3. Modify toe protection as directed.
4. Redrive excavated piles found to be in sound and satisfactory condition.
5. If pile is pulled and cannot be redriven as same location, backfill hole with pea gravel and provide replacement pile(s) at locations determined by Engineer.

3.08 FIELD QUALITY CONTROL

A. Dynamic Monitoring: Plan, coordinate, and accomplish in accordance with Section **[A: 31 09 17, Dynamic Pile Testing] [B:]**.

B. Pile Load Testing: Plan, coordinate, and accomplish pile load testing in accordance with Section **[A: 31 09 18, Static Pile Testing] [B:]**.

C. Daily Log and Record: Document for each pile showing as a minimum:

1. Pile identification/location.
2. Weather/groundwater conditions.
3. Date and time start and complete driving.
4. Respective depths of penetration.
5. Pile toe and cutoff elevations.
6. Driving resistance for each foot of driving over entire pile length.
7. Equipment used.
8. Installation method.
9. Final pile head position (x, y, z coordinates) after cut off indicating if pile is installed within the specified tolerances.
10. Nature and location of obstructions encountered.
11. Other pertinent pile driving behavior.

3.09 SUPPLEMENT

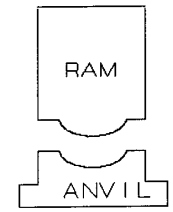
A. The supplement listed below, following “End of Section,” is a part of this Specification.

1. Hammer Data Sheet.

END OF SECTION

HAMMER DATA SHEET

Contract No.:	Structure Name and/or No.:
Project:	
Pile Driving CONTRACTOR or Subcontractor:	
County:	Piles Driven By:

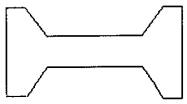


HAMMER

Manufacturer:	Model:
Type:	Serial No.
Rated Energy: @	Length of Stroke
Modifications:	

CAP BLOCK

Material:	
Thickness:	Area:
Modulus of Elasticity - E	(psi)
Coefficient of Restitution - e	

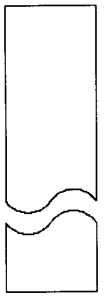


HELMET

ALL COMPONENTS	Weight:

CUSHION

Cushion Material:	
Thickness:	Area:
Modulus of Elasticity - E	(psi)
Coefficient of Restitution - e	



PILE

Pile Type:	Weight/ft
Length in Leads:	
Wall Thickness:	Taper:
Design Pile Capacity:	(Tons)
Description of Splice:	

Tip Treatment Description:

NOTE: If mandrel is used to drive pile, attach separate manufacturer's detail sheet(s), including weight and dimensions.

Submitted By:_____ Date:_____

SECTION 33 05 01.09
POLYVINYL CHLORIDE (PVC) PRESSURE PIPE AND FITTINGS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Water Works Association (AWWA):
   a. C110, Ductile-Iron and Gray-Iron Fittings.
   b. C153, Ductile-Iron Compact Fittings, for Water Service.
   c. C605, Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings.
   d. C900, Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 Inches Through 12 Inches (100 mm Through 300 mm), for Water Transmission and Distribution.
   e. C905, Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 Inches through 48 Inches (350 mm through 1,200 mm) for Water Transmission and Distribution.
   f. C907, Injection-Molded Polyvinyl Chloride (PVC) Pressure Fittings, 4 Inches through 12 Inches (100 mm Through 300 mm), for Water, Wastewater, and Reclaimed Water Service.
2. ASTM International (ASTM):
   a. D2241, Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
   b. D2321, Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
   c. D2466, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
   d. D2467, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
   e. D2672, Standard Specification for Joints for IPS PVC Pipe Using Solvent Cement.
   f. D2855, Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings.
   g. D3139, Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
3. NSF International (NSF).

1.02 SUBMITTALS

A. Action Submittals: **[A: Drawings showing pipe diameter, pipe class, dimension ratio (DR) and fitting details.] [B: .]**

B. Informational Submittals:

1. Manufacturer's Certificate of Compliance, in accordance with Section **[A: 01 61 00, Common Product Requirements.] [B: .]**
2. Hydrostatic Testing Plan: Submit at least 15 days prior to testing and at minimum, include the following:
   a. Testing dates.
   b. Piping systems and section(s) to be tested.
   c. Method of isolation.
   d. Method of conveying water from source to system being tested.
   e. Method of disposing of test water.
   f. Calculation of maximum allowable leakage for piping section(s) to be tested.
3. Certification of Calibration: Approved testing laboratory certificate if pressure gauge for hydrostatic test has been previously used. If pressure gauge is new, no certificate is required.
4. Test report documentation.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Solvent Cement: Store in accordance with ASTM D2855.

PART 2 PRODUCTS

2.01 MATERIALS

A. Pipe:

1. PVC, conforming to requirements of **[A: AWWA C900] [B: AWWA C905] [C: ASTM D2241]**.
2. **[D: SDR] [E: DR]** shall be **[F:] [G: as shown on Drawings]**.
3. Pipe to be used for potable water conveyance shall **[H: meet the requirements of NSF 61] [I: be manufactured from National Sanitation Foundation (NSF) approved compounds]**.

B. Joints:

1. **[A: Rubber gasketed.] [B: Solvent welded.] [C: As shown on Drawings.]**
2. Conform to **[D: AWWA C900] [E: AWWA C905] [F: ASTM D2672] [G: ASTM D3139]**.

C. Fittings: **[A: Ductile iron, conforming to AWWA C153 or AWWA C110.] [B: PVC conforming to AWWA C900, C905, or C907.] [C: PVC conforming to ASTM D2466 or ASTM D2467.] [D: PVC fittings as recommended by pipe manufacturer.] [E: Fabricated steel fittings with epoxy lining and coating.]**

D. Service Saddles:

1. Double strap type with minimum strap width of 2 inches.
2. Straps: Type 304 stainless steel.
3. Saddles: Ductile iron, **[A: epoxy-coated, 10 mils minimum thickness] [B: nylon fused coated, 10 mils minimum thickness] [C:]**.
4. Minimum Pressure Rating: **[D: psi]**.

E. **[A: Restrained Joints:**

1. **Provide pipe restraint, where indicated on Drawings, by system designed specifically for use with PVC pipe using wedges. Do not use systems with set screws, gripper rings, or gripper gaskets.**
2. **Minimum Pressure Rating: [B: psi.]]**

PART 3 EXECUTION

3.01 INSTALLATION

A. In accordance with **[A: AWWA C605] [B: ASTM D2321] [C: AWWA Manual 23]**.

B. Solvent cement used for joints as recommended by pipe manufacturer.

C. Joints:

1. Rubber Gasketed: In accordance with manufacturer’s written instructions.
2. Solvent Cemented: In accordance with ASTM D2855.
3. Restrained Joint Systems: In accordance with manufacturer’s written instructions.

D. Pipe Bending for Horizontal or Vertical Curves:

1. Bending of pipe barrels larger than 12 inches in diameter is not allowed.
2. Radius of curves shall not exceed 75 percent of manufacturer’s recommended values.
3. Use blocks or braces at pipe joints to ensure axial deflection in gasketed or mechanical joints does not exceed allowable deflection.

E. Maximum Joint Deflection **[A: at Mechanical Joint]**: 75 percent of manufacturer's recommended values.

F. **[A: No deflection is allowed at push-on joints.]**

3.02 INSPECTION AND HYDROSTATIC TESTING

A. General:

1. Notify Engineer in writing at least **[A: 5] [B:]** days in advance of testing. Perform testing in presence of Engineer.
2. Using water as test medium, all newly installed pipelines must successfully pass hydrostatic leakage test prior to acceptance.
3. Conduct field hydrostatic test on buried piping after trench has been completely backfilled and compacted. Testing may, as approved by Engineer, be done prior to placement of asphaltic concrete or roadway structural section.
4. Contractor may, if field conditions permit and as approved by Engineer, partially backfill trench and leave joints open for inspection and conduct an initial informal service leak test. Final field hydrostatic test shall not, however, be conducted until backfilling has been completed as specified above.
5. Supply of Temporary Water: In accordance with Section 01 50 00, Temporary Facilities and Controls.
6. Dispose of water used in testing in accordance with federal, state, and local requirements.
7. Install temporary thrust blocking or other restraint as necessary to prevent movement of pipe and protect adjacent piping or equipment. Make necessary taps in piping prior to testing.
8. Wait a minimum of **[C: 5] [D:]** days after concrete thrust blocking is installed to perform pressure tests. If high-early strength cement is used for thrust blocking, wait may be reduced to **[E: 2] [F:]** days.
9. Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.
10. New Piping Connected to Existing Piping:
    a. Isolate new piping with grooved-end pipe caps, blind flanges, or other means as acceptable to Engineer.
    b. Provide appropriate thrust blocking.

B. Hydrostatic Testing Procedure:

1. Furnish testing equipment, as approved by Engineer, which provides observable and accurate measurements of leakage under specified conditions.
2. Maximum Filling Velocity: **[A: 0.25 foot per second] [B:]** calculated based on full area of pipe.

3. Expel air from piping system during filling.
4. Test Pressure: **[C: 100] [D:]** psi above system operating pressure, **[E: but in no case less than] [F:]** psi as measured at **[G:]**.
5. Test Pressure: **[H: 125 percent] [I:]** of system operating pressure based on pressure as measured at **[J:]**.
6. Test Pressure: **[K:] [L: psi] [M: feet of head]** as measured at **[N: low point of pipeline] [O:]**.
7. Apply and maintain specified test pressure with hydraulic force pump. Valve off piping system when test pressure is reached.
8. Maintain hydrostatic test pressure continuously for **[P: 2] [Q:]** hours minimum, adding make-up water only as necessary to restore test pressure to within 5 psi of specified hydrostatic test pressure.
9. Determine actual leakage by measuring quantity of water necessary to maintain specified test pressure for duration of test.

C. Maximum Allowable Leakage:

$$L = \frac{ND(P)^{1/2}}{7400}$$

where:

L = Allowable leakage, in gallons per hour.
N = Number of joints in tested line.
D = Nominal diameter of pipe, in inches.
P = Average test pressure during leakage test, in pounds per square inch.

END OF SECTION

SECTION 33 05 01.10
HIGH-DENSITY POLYETHYLENE (HDPE) PRESSURE PIPE AND FITTINGS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. American Society of Mechanical Engineers (ASME):
   a. Boiler and Pressure Vessel Code, Section IX, Article XXI-XXIV.
   b. B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
   c. B18.2.1, Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series).
   d. B18.2.2, Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series).
2. American Water Works Association (AWWA):
   a. C906, Polyethylene (PE) Pressure Piping and Fittings, 4 in. through 65 in. for Waterworks.
   b. Manual M55, PE Pipe - Design and Installation.
3. ASTM International (ASTM):
   a. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications.
   b. A194/A194M, Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   c. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   d. A307, Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 psi Tensile Strength.
   e. A536, Standard Specification for Ductile Iron Castings.
   f. A563, Standard Specification for Carbon and Alloy Steel Nuts.
   g. D3035, Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.
   h. D3261, Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
   i. D3350, Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
   j. F714, Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter.

k. F2164, Standard Practice for Field Leak Testing of Polyethylene (PE) and Crosslinked Polyethylene (PEX) Pressure Piping Systems Using Hydrostatic Pressure.
l. F2620, Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings.

4. Code of Federal Regulations (CFR): Title 49 Part 192.285, Plastic Pipe: Qualifying Persons to Make Joints.
5. NSF International (NSF): 61, Drinking Water System Components - Health Effects.
6. Plastics Pipe Institute (PPI):
   a. Handbook of PE Pipe.
   b. Technical Note 38, Bolt Torque for Polyethylene Flanged Joints.
   c. TR-33, Generic Butt Fusion Joining Procedure for Field Joining of Polyethylene Pipe.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Catalog information confirming pipe, fittings, and other materials conform to requirements of this section.
   b. Drawings of specific connection details.
   c. **[A:]**

B. Informational Submittals:

1. Manufacturer’s Certificate of Compliance, in accordance with Section **[A: 01 61 00, Common Product Requirements] [B:]**.
2. Infrared temperature gun product data.
3. **[C: Certificates of qualification for persons to be fusing HDPE pipe.] [D: Experience, training record, and certificates of persons to be fusing HDPE pipe.]**
4. Information on manufacturer and model of machine to be used for fusion of HDPE pipe.
5. Testing Plan: Submit at least 15 days prior to testing and include the following as a minimum:
   a. Testing dates.
   b. Piping systems and section(s) to be tested.
   c. Method of isolation.
   d. Method of conveying water from source to system being tested.
6. Certifications of Calibration: Approved testing laboratory certificate if pressure gauge for hydrostatic test has been previously used. If pressure gauge is new, no certificate is required.
7. Test report documentation.

8. **[E: Installation Plan following the Plastic Pipe Institute, ASTM F2620, and manufacturer's recommendations. Plan shall include, but not be limited to the following major components:**
   a. **Pipe and fitting storage.**
   b. **Pipe and fitting handling equipment.**
   c. **Proposed means to maintain required temperatures for fusing.**
   d. **Proposed means to shield fusing area from wind, snow, blowing dust, and rain.**
   e. **Proposed means to maintain uniform pipe wall temperature prior to fusing.]**
   f. **[F: Temperature Control Plan: Plan shall include means to reduce temperature of pipe to limit stated in Part 3 of this specification.]**
9. **[G: Fusion parameters including recommended limits of criteria recorded by data logger.]**
10. **[H: Fusion report for each joint, including information listed under Article Field Quality Control. Submit joint reports within 24 hours after fusion.]**
11. Confirmation that thickness and design of stiffening inserts have been approved by pipe **[I: and coupling]** manufacturer and are suitable for use with pipe **[J: and coupling]**. Stiffener shall not buckle under a minimum interior pipe temperature of **[K:]** degrees F when pipe is empty.
12. **[L: Gasket manufacturer's table for recommended bolt torque and tightening pattern.]**
13. **[M:]**

1.03 QUALITY ASSURANCE

A. Qualifications:

1. Pipe Manufacturer: Listed with Plastic Pipe Institute.
2. Experienced in fabricating pipe of similar diameters and wall thickness required for the Work.
3. Successful fabrication of at least **[A:]** linear feet of **[B:]**-inch diameter or larger pipe within past 5-year period.
4. Persons fusing HDPE pipe shall **[C: have a current operator qualification training certificate and wallet card showing operator is qualified to operate machine to be used on the Project] [D: and] [E: have minimum of [F: 1] [G:] year(s) of experience with fusing HDPE pipe] [H: and] [I: have received minimum of 20 hours training for fusing HDPE pipe from pipe supplier or fusing equipment supplier]**.

B. **[A:]**

1.04 DELIVERY, STORAGE, AND HANDLING

A. Shipping: Do not cut, kink, or otherwise damage pipe during transportation.

B. Storage and Handling:

1. Pipe interiors are to be inspected and all debris removed prior to storage.
2. Limit stacking of pipe to a height that will not cause excessive deformation of bottom layers of pipes under anticipated temperature conditions.
3. Do not exceed the stacking heights stated in AWWA Manual M55.
4. Where necessary, because of ground conditions, store pipe on wooden sleepers, spaced suitably and of such widths as not to allow deformation of pipe at point of contact with sleeper or between supports.
5. Comply with the requirements of the approved Installation Plan.
6. Keep pipe shaded from direct sunlight prior to fusion and installation in trench.

1.05 CONNECTIONS TO EXISTING PIPE

A. Fusing to Existing Pipe: **[A: Comply with manufacturer's or distributor's recommendations based on Site conditions and PPI TR-33.] [B:]**

PART 2 PRODUCTS

2.01 MATERIALS

A. Pipe and Fittings:

1. Conform to requirements of **[A: AWWA C906] [B: ASTM F714] [C: ASTM D3035]**.
2. In compliance with NSF 61.
3. Resin:
   a. Potable Water Transmission and Distribution Systems: Polyethylene resin shall meet or exceed requirements of ASTM D3350 for PE 4710 material with cell classification of 445474C, or better. PE 4710 HDPE pipe and fittings shall be manufactured from bimodal resins. Pressure rating shall be based on hydrostatic design stress of **[D: 1,000] [E:]** psi at 73.4 degrees F.
   b. Non-Potable Water Transmission and Distribution Systems: Polyethylene resin shall meet or exceed requirements of ASTM D3350 for:
      1) **[F: PE 3608 material with cell classification of 345464C, or better. Pressure rating shall be based on hydrostatic design stress of 800 psi at 73.4 degrees F.]**

2) **[G: PE 4710 material manufactured from bimodal resin with cell classification of 445474C, or better. Pressure rating shall be based on hydrostatic design stress of 1,000 psi at 73.4 degrees F.]**

4. Pressure Rating: **[H:] [I: and nominal DR of _____]**.
5. Outside Diameter Basis: **[J: IPS] [K: DIPS]**.
6. Pipe lengths, fittings, and flanged connections to be joined by thermal butt-fusion shall be of a compatible resin mix for the fusion process.
7. Fittings:
   a. Polyethylene fittings shall have same or higher pressure rating as pipe.
   b. Sizes 12 Inches and Smaller: Molded and manufactured to requirements of ASTM D3261.
   c. Sizes Larger than 12 Inches: Thermal butt-fused fabricated.
   d. **[L: Unless noted otherwise, provide fittings with a factory fused 4-foot-long spool on each end to facilitate onsite fusion.]**

B. Backup Rings:

1. Convoluted for Flanged Connections:
   a. **[A: ASTM A240/A240M, Type 316 stainless steel.] [B: ASTM A536, ductile iron.]**
   b. Complete with one-piece, molded polyethylene flange adapters.
   c. Flanged Connections: Same or greater pressure rating as pipe.
2. Ductile Iron: **[C: Shop-primed with red oxide] [D: and] [E: shop-coated in accordance with requirements in Section 09 90 00, Painting] [F: shop-coated with two-part epoxy material in accordance with AWWA C550. Dry film thickness shall be 10 mils minimum].]**
3. Gaskets: Material, size, and thickness shall be as recommended by gasket manufacturer and in accordance with PPI Technical Note 38. Gasket manufacturer shall provide a table with recommended bolt torque and tightening pattern.

C. Joints: Thermal butt-fusion or electrofusion **[A: , except where connecting to unions, valves, and equipment with flanged or threaded connections that may require future disassembly. Use appropriate transition fitting or adapter for all joints that are not thermal butt-fused or electro-fused.]**

D. Bolts, Nuts, and Washers:

1. Bolt Materials: **[A: Type 304 stainless steel, ASTM A193/A193M, Grade B8 hex-head, carbide solution treated and strained hardened.] [B: Type 316 stainless steel, ASTM A193/A193M, Grade B8M hex-head, carbide solution treated and strained**

hardened.] [C: Carbon steel, ASTM A193/A193M, Grade B7 hex-head.]

2. Bolt Fabrication: In accordance with ASME B18.2.1
3. Nut Materials: **[D: Type 304 stainless steel, ASTM A194/A194M, Grade 8 hex-head.] [E: Type 316 stainless steel, ASTM A194/A194M, Grade 8 hex-head.] [F: Carbon steel, ASTM A194/A194M, Grade 7 hex-head.]**
4. Nut Fabrication: In accordance with ASME B18.2.2.
5. Washers: **[G: Type 304 stainless steel. Same material as bolts in accordance with ASME B18.21.1.] [H: Type 316 stainless steel. Same material as bolts in accordance with ASME B18.21.1.] [I: Carbon steel, ASTM F436, Type 3.]**
6. Thread Lubricant: Provide bolt manufacturer's recommended lubricant on bolt threads, nuts, nut face, and around bolt hole.
7. Corrosion Resistance: When used in submerged brine water applications, bolts, nuts, and washers shall be coated in polytetrafluoroethylene (PTFE) applied by fastener manufacturer.

E. Stiffening Inserts:

1. Stiffening inserts used to provide circumferential inside support of HDPE pipe ends shall be constructed of Type **[A: 304] [B: 316]** stainless steel per ASTM A240.
2. Thickness of metal stiffening inserts shall be as approved by pipe manufacturer **[C: and coupling manufacturer]** for the specific use.

F. Wall Anchor:

1. Material: Same as HDPE pipe.
2. Internal Diameter: Equal to adjacent pipe.
3. Shear Strength: Equal to or greater than tensile strength of adjacent pipe.
4. Fabrication: Butt fusion. Extrusion bead welding is not allowed.

G. Electrofusion Flex Restraint:

1. Material: HDPE.
2. Method of Attachment: Electrofusion.
3. Designed for restraining movement of HDPE pipe.
4. Manufacturers:
   a. Central Plastics Company.
   b. Industrial Pipe Fittings, IPF-Plasson.

H. Electrofusion Couplings:

1. Material: HDPE.
2. Method of Attachment: Electrofusion.

3. Designed for coupling HDPE pipe.
4. Manufacturers:
   a. Central Plastics Company.
   b. ISCO Industries.

I. Concrete Thrust Blocks: See Section 33 05 01, Conveyance Piping—General.

J. Products that restrain HDPE pipe with wedges or clamps are not acceptable.

2.02 SERVICE CONDITIONS

A. **[A: .]**

PART 3 EXECUTION

3.01 INSTALLATION

A. General:

1. Install polyethylene pipe in conformance with AWWA M55, PPI TR-33, ASTM F2620, and pipe manufacturer's recommendations.
2. **[A: Follow all requirements of approved Installation Plan where HDPE is to be installed in ambient temperatures less than 50 degrees F, in hot conditions or in windy conditions.]**
3. **[B: Protect and install pipe in accordance with the Temperature Control Plan when contraction of pipe length may cause damage to or pull out from structures.]**

B. Joining: Butt-fuse pipes and fittings in accordance with pipe manufacturer's recommendations. Depending on Site conditions, perform butt-fusion joining in or outside of excavated trench.

1. **[A: Remove and extract internal fusion bead from pipe.**
   a. **Verify complete internal fusion bead removal was performed. Accomplish by examination of extracted internal fusion bead or by means of closed-circuit television (CCTV) examination.**
   b. **Extracted Internal Fusion Bead:**
      1) **Appearance shall have same double roll back semblance as external fusion bead.**
      2) **Possess smooth root cut or pipe smoothness and shall be verified by means of closed-circuit television (CCTV) examination.**
   c. **Removal of internal bead may include pipe wall mass. However, wall mass that is removed shall not exceed 1/10th of pipe wall thickness.]**
2. If HDPE pipe surface temperature is above **[B:]** degrees F as measured with infrared temperature gun, allow pipe to cool prior to

making any connections to flanges, existing pipeline systems, or structures.

3. Connect HDPE pipe to auxiliary equipment such as valves, pumps, tanks, and other piping systems with flanged connections as follows:
   a. Polyethylene flange adapter, thermally butt-fused to end of pipe. Flange "stub ends" are not allowed.
   b. **[C: Convoluted backing flange, as specified.]**
   c. Bolt and nut of sufficient length to show a minimum of three complete threads when joint is made and tightened to manufacturer's standard.
   d. Follow requirements of PPI Technical Note 38 including mandatory 4-hour bolt re-torquing.
4. Special Precautions at Flanges: Support polyethylene pipe connected to heavy fittings, manholes, and rigid structures in such a manner that no subsequent relative movement between polyethylene pipe at flanged joint and rigid structures is possible.
5. Minimum Long-Term Field Bending Radius: Restricted to limits recommended by AWWA M55, Table 8-2.

C. Placement in Trench:

1. Handle joined pipeline in such a manner that pipe is not damaged by dragging it over sharp and cutting objects.
2. Position slings for handling pipeline away from butt-fused joints.
3. Remove sections of damaged pipe and replace it with undamaged pipe. Damaged pipe is defined as pipe with kinks or gouges exceeding 10 percent of pipe wall thickness.
4. Exercise care when lowering pipe into trench to prevent damage or twisting of pipe.
5. **[A: Buried Pipe: Snake pipe from one side of trench to other to allow for thermal and settling movements, and as recommended by pipe manufacturer.] [B: Above Ground Pipe: Follow manufacturers design requirements for snaking pipe to reduce end anchor loads.]**
6. At flanges, valves, and connections, excavate out trench bottom sufficiently to ensure clearance between undisturbed trench bottom and flange, valve, or connection.

3.02 FIELD QUALITY CONTROL

A. Joint Butt Fusion:

1. Measure and log each joint fusion by an electronic monitoring device (data logger) affixed to fusion machine. Data to be logged shall include the following and shall be capable of being retrieved electronically:
   a. Pipe size, dimensions, and wall thickness.
   b. Machine model and size.

c. Operator identification.
d. Job identification number.
e. Weld number.
f. Fusion, heating, and drag pressure settings.
g. Heater plate temperature.
h. Time stamp showing when weld was performed.
i. Heating and curing time of weld.
j. Curing temperature readings and time stamps of readings.
k. Error messages and warnings for out of range temperature or pressure settings.

2. In addition to logged items above, the following shall be logged or annotated on report:
   a. Location of joint being fused by pipeline station or by reference to pipe Shop Drawing.
   b. Ambient temperature, wind speed, precipitation, and humidity.
   c. If internal bead was removed.
   d. Environmental actions taken (such as, use of tarps, enclosures, and blankets).
   e. Type of HDPE and manufacturer.

B. Joint Weld Inspection:

1. Visually examine each joint in accordance with the guidelines in ASTM F2620. Remove and replace any joints not meeting the standard.
2. Mechanical Joint Testing:
   a. Pipe Wall Thickness 1-Inch or Less: Test joints in accordance with bend back testing provided in Appendix X4 of ASTM F2620.
   b. Pipe Wall Thickness Greater than 1-Inch: Test joints in accordance with the guided side bend testing in accordance with ASME BPVC, Section IX, Article XXI-XXIV.
   c. Specimens: Cut pipe 12 inches on each side of field made joint. Rejoin ends and proceed with Work.
   d. Test Frequency:
      1) First **[A: 1,000] [B:]** Linear Feet: **[C: Two] [D:]** joints selected at random by Engineer.
      2) Each Additional **[E: 5,000] [F:]** Linear Feet: **[G: One] [H:]** joint selected at random by Engineer.
      3) Each Test Failure: **[I: Two] [J:]** additional joints selected at random by Engineer.

C. Pipeline Hydrostatic Test:

1. General:
   a. Notify Engineer in writing **[A: 5] [B:]** days in advance of testing. Perform testing in presence of Engineer.

b. Furnish testing equipment and perform tests in manner satisfactory to Engineer. Testing equipment shall provide observable and accurate measurements of initial service leak and allowable make-up water volume under specified conditions.
c. Test newly installed pipelines.
d. Isolate new pipelines that are connected to existing pipelines.
e. Using water as test medium, pipes shall successfully pass a hydrostatic test prior to acceptance.
f. Conduct field hydrostatic test on buried piping after trench has been completely backfilled. Testing may, as approved by Engineer, be done prior to placement of asphaltic concrete or roadway structural section.
g. Contractor may, if field conditions permit and as determined by Engineer, partially backfill trench and leave joints open for inspection and conduct initial service leak test. Final field hydrostatic test shall not be conducted until backfilling has been completed as specified above.
h. Supply of temporary water shall be as stated in Section 01 50 00, Temporary Facilities and Controls.
i. Dispose of water used in testing in accordance with federal, state, and local requirements.

2. Preparation:
   a. Install temporary thrust blocking or other restraint as necessary to prevent movement of pipe and protect adjacent piping or equipment. Make necessary taps in piping prior to testing.
   b. Wait **[C: 5] [D:]** days minimum after concrete thrust blocking or designed thrust collars are installed to perform pressure tests. If high-early strength cement is used for thrust blocking, wait may be reduced to **[E: 2] [F:]** days.
   c. Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.
   d. New Piping Connected to Existing Piping: Isolate new piping with grooved-end pipe caps, blind flanges, or other means as acceptable to Engineer.
3. Procedure:
   a. Test pressure shall be **[G: 150 percent] [H:]** of system operating pressure based on pressure as measured at **[I: lowest point in pipeline] [J:]**.
   b. Test pressure shall be **[K: 100] [L:]** psi above system operating pressure, **[M: but in no case less than] [N:]** psi as measured at **[O:]**.
   c. Test pressure shall be **[P:] [Q: psi] [R: feet of head]** as measured at **[S: low point of pipeline] [T:]**.
   d. Maximum filling velocity shall not exceed **[U 0.25 feet per second] [V:]**, calculated based on full area of the pipe.
   e. Expel air from pipe system during filling.

f. Test procedure shall be in accordance with ASTM F2164.
   1) Initial Expansion Phase: Add water as required to maintain test pressure for 4 hours.
   2) Test Phase: Reduce pressure by 10 psi and start pressure test.
   3) Test is successful if pressure says within 5 percent of initial value for 1 hour.

g. If test is not completed because of leakage, equipment failure, or other reasons, depressurize test section and allow it to relax for at least 8 hours before retesting.

h. If there is leakage, repair defective pipe section and repeat hydrostatic test.

3.03 DISINFECTION

A. Conform to the requirements of Section 33 13 00, Disinfection of Water Utility Distribution Facilities.

B. Active chlorine concentration shall not exceed 10 percent.

3.04 MANUFACTURER'S SERVICES

A. Provide pipe manufacturer's representative at Site **[A: in accordance with Section 01 43 33, Manufacturers' Field Services,]** for assistance during pipe joining operations and pipe installation.

END OF SECTION

SECTION 33 41 01
[STORM DRAIN] [SANITARY SEWER] [AND] [DRAINAGE] PIPING

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section and any supplemental Data Sheets:

1. American Association of State Highway and Transportation Officials (AASHTO):
   a. M36M, Standard Specification for Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains.
   b. M190M, Standard Specification for Bituminous Coated Corrugated Metal Culvert Pipe and Pipe Arches.
   c. M196M, Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains.
2. American Water Works Association (AWWA):
   a. C104/A21.4, Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
   b. C105/A21.5, Polyethylene Encasement for Ductile-Iron Pipe Systems.
   c. C110/A21.10, Ductile-Iron and Gray-Iron Fittings, 3 in. Through 48 in. (75 mm Through 1200 mm) for Water and Other Liquids.
   d. C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   e. C151/A21.51, Ductile-Iron Pipe, Centrifugally Cast, for Water.
3. ASTM International (ASTM):
   a. A746, Standard Specification for Ductile Iron Gravity Sewer Pipe.
   b. C14, Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe.
   c. C76, Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
   d. C150, Standard Specification for Portland Cement.
   e. C311, Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland-Cement Concrete.
   f. C361, Standard Specification for Reinforced Concrete Low-Head Pressure Pipe.
   g. C425, Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings.
   h. C443, Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.

i. C497, Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile.
j. C507, Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe.
k. C595, Standard Specification for Blended Hydraulic Cements.
l. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.
m. C655, Standard Specification for Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe.
n. C700, Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated.
o. C1012, Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution.
p. D1248, Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.
q. D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
r. D2412, Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
s. D3034, Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
t. D3212, Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
u. F477, Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
v. F679, Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
w. F794, Standard Specification for Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter.
x. F894, Standard Specification for Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe.

1.02 SUBMITTALS

A. **[A: Informational Submittals: Manufacturer's Certification of Compliance.]**

PART 2 PRODUCTS

2.01 PIPE AND FITTINGS

A. As specified in the Data Sheets following "End of Section."

2.02 SERVICE AND DRAIN CONNECTIONS

A. Pipe and fittings for individual service connection shall be of one type of material throughout.

B. **[A: Vitrified clay] [B: Nonreinforced concrete] [C: Ductile iron] [D: Polyvinyl chloride] [E: Cast iron soil]** pipe.

C. Residential Service: **[A: 4] [B: 6]** inches.

D. Commercial Service, Including Motel and Apartments: 6 inches, unless shown otherwise.

2.03 SERVICE CONNECTION MARKERS

A. New 2 by 4 lumber **[A: construction] [B: utility]** grade or better.

PART 3 EXECUTION

3.01 INSTALLATION OF PIPE, FITTINGS, AND APPURTENANCES

A. General:

1. Pipe laying shall proceed upgrade with spigot ends pointing in direction of flow.
2. Excavate bell holes at each joint to permit correct assembly and inspection of entire joint.
3. Pipe invert may deviate from line or grade up to **[A: 1/2] [B:]** inch for line and **[C: 1/4] [D:]** inch for grade, provided that finished pipe line will present a uniform bore, and such variation does not result in a level or reverse sloping invert, or less than minimum slope shown.
4. Pipe bedding shall form continuous and uniform bearing and support for pipe barrel between joints. Pipe shall not rest directly on bell or pipe joint.
5. Prevent entry of foreign material into gasketed joints.
6. Plug or close off pipes that are stubbed off for manhole, concrete structure, or for connection by others, with temporary watertight plugs.

B. Ductile Iron Pipe Corrosion Protection:

1. Remove foreign material from the exterior of the pipe.
2. Wrap pipe with polyethylene encasement tube 2 feet longer than the pipe section prior to laying pipe section
3. After assembling the pipe joint, overlap encasement tube with adjacent tube and seal joints with securing tape.
4. Provide additional securing tape at 3-foot intervals along the pipe.

5. Repair rips, punctures, or other damage to the polyethylene with securing tape.
6. Fittings may be wrapped with a flat sheet or split tube provided all seams are securely taped.

C. Concrete Closure Collars: Only use concrete closure collars where shown or authorized by Engineer.

D. Service Connections:

1. Minimum Slope: **[A: 1/4 inch] [B:]** per foot.
2. Markers:
   a. Paint the top portion of the marker immediately after its installation with first-quality white, quick-drying enamel. **[C: After the paint has dried, use black, quick-drying enamel and neatly indicate the distance from the natural ground surface to the top of the service connection pipe in feet and inches.]**
   b. If marker is broken or knocked out of vertical alignment during backfilling operation, reopen trench and place marker in accordance with Sewer Service Connection Details shown on Drawings.
3. Disconnecting and Reconnecting Existing Service Connections:
   a. Locate the existing service connections prior to constructing the tee in the new sewerline.
   b. Disconnect existing service connections from existing sewers to be abandoned and reconnect them to the new sewers.

E. Square-End Underdrains: Cover top and sides of the joints with a strip of asphalt-saturated 30-pound roofing felt.

F. Perforated Underdrain: Lay with open joints and with perforations down.

3.02 PRESSURE TESTING

A. As specified in Section 40 80 01, Process Piping Leakage Testing.

3.03 REPAIR AND RETESTING

A. Sections of pipe not meeting the pressure test requirements shall **[A: be replaced] [B: or] [C: have individual joints tested and sealed]**.

B. Following repairs, sections shall be retested as specified.

3.04 SEWER CLEANING

A. Prior to final acceptance and final manhole-to-manhole inspection of the sewer system by Engineer, flush and clean all parts of the system. Remove all accumulated construction debris, rocks, gravel, sand, silt, and other foreign material from the sewer system at or near the closest downstream manhole. If necessary, use mechanical rodding or bucketing equipment.

B. Upon Engineer's final manhole-to-manhole inspection of the sewer system, if any foreign matter is still present in the system, reflush and clean the sections and portions of the lines as required.

3.05 SUPPLEMENTS

A. Data Sheets.

Number	Title
-.01	Corrugated Metal
-.02	Ductile Iron
-.03	Polyvinyl Chloride (PVC)
-.04	Nonreinforced Concrete
-.05	Reinforced Concrete
-.06	Vitrified Clay
-.07	Polyethylene (PE) Profile Wall
-.08	Corrugated Polyethylene

END OF SECTION

SECTION 33 41 01.05 REINFORCED CONCRETE	
Item	**Description**
Pipe	ASTM C76, Wall B, class as shown. Mark each joint with pipe class. Rotating packer or platform not allowed.
Cement	ASTM C150, Type II, or ASTM C150, Type I, with fly ash; maximum 12 percent Tricalcium Aluminate, or ASTM C595 Rev A, Type IP, with fly ash; Cement: ASTM C150. Minimum 564 pounds per cubic yard without fly ash. Minimum 479 pounds per cubic yard with fly ash.
Ratio: Water to Cementitious Materials	Not over 0.49.
Fly Ash	ASTM C618, Class C or Class F, Tables 1 and 2 modified as follows: Loss on Ignition: Maximum 3 percent Water Requirement: Maximum 100 percent of control Ratio Percent CaO/Fe_2O_3: Maximum 1.5 or test cement fly ash mix in accordance with ASTM C1012. Mix: Equal to or better than ASTM C150, Type II cement. 85 pounds per cubic yard minimum, 160 pounds per cubic yard maximum. Test: ASTM C311 and ASTM C618.
Joints	ASTM **[A: C443 Rev A.] [B: C361.]** Captive gasket in groove.
Rubber Gaskets	ASTM C443.
Tee Fittings	Reinforced concrete, rubber gasketed. Provide plug when service piping is not required.
Plugs	Removable. Removal shall provide a socket suitable for making a flexible jointed lateral connection or extension.
Circumferential Reinforcement	Not closer than 1 inch to inside surface of pipe. Area of outer circular reinforcing cage not less than 75 percent of inner cage.
Elliptical Reinforcement	Not allowed.

SECTION 33 41 01.05 REINFORCED CONCRETE	
Item	**Description**
Source Quality Control Testing	Load Bearing 0.01-inch Crack, Compressive Strength and Absorption: ASTM **[A: C76.] [B: C507.] [C: C655.]** Load Bearing Ultimate: ASTM **[D: C76.] [E: C507.] [F: C655.]** Permeability: ASTM C497. Voids: Longitudinally sawcut one pipe from each 100 lengths of pipe manufactured in half with saw that will not damage the concrete or reinforcing steel. Inspect for voids adjacent to circumferential bars. Voids will be considered continuous if a 1/16-inch diameter pin can be inserted 1/4 inch deep. If voids exist adjacent to more than 10 percent of the circumferential bars, two additional pipes shall be tested. If either of the two pipes fail, the entire 100 lengths will be rejected.

END OF SECTION

SECTION 33 46 00
SUBSURFACE DRAINAGE

PART 1 GENERAL

1.01 GENERAL

A. This section covers requirements for subsurface drainage piping, cleanouts, **[A: silt traps,] [B: pump station sumps,] [C: level checks]** used to control shallow groundwater elevations within the Project area.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Association of State Highway and Transportation Officials (AASHTO):
   a. M252, Standard Specification for Corrugated Polyethylene Drainage Pipe.
   b. M294, Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-mm Diameter.
2. ASTM International (ASTM):
   a. A48/A48M, Standard Specification for Gray Iron Castings.
   b. C387/C387M, Standard Specification for Packaged, Dry, Combined Materials for Mortar and Concrete.
   c. C478, Standard Specification for Precast Reinforced Concrete Manhole Sections.
   d. D75, Standard Practice for Sampling Aggregates.
   e. D422, Standard Test Method for Particle-Size Analysis of Soils.
   f. D1140, Standard Test Methods for Amount of Material in Soils Finer than No. 200 (75-µm) Sieve.
   g. F405, Standard Specification for Corrugated Polyethylene (PE) Pipe and Fittings.
   h. F449, Standard Practice for Subsurface Installation of Corrugated Polyethylene Pipe for Agricultural Drainage or Water Table Control.
   i. F667, Standard Specification for Large Diameter Corrugated Polyethylene Pipe and Fittings.
3. Natural Resources Conservation Service (NRCS): Conservation Practice Standard 606, Subsurface Drain.

1.03 DEFINITIONS

A. Cleanouts: Surface access ports used to access drain lines and constructed of solid corrugated piping.

B. Drain Lines: Buried perforated pipe providing collection and conveyance of drain water from saturated soils to Drainage Management Unit (DMU).

C. Drainage Management Unit (DMU): An area drained by continuous connected network of drain lines discharging to a single **[A: outfall] [B: pump station]**.

D. Granular Drain Material: Granular (sand or gravel) material used as an envelope around drain lines to provide pipe bedding, a permeable drainage zone, and stabilization of base soils to prevent migration of fines into drain lines.

E. Level Check: Inline water control structure used to control hydraulic grade line within subsurface drainage system by inserting or removing adjustable stoplogs.

F. Silt Trap: Manhole installed within drainage system to provide access for removing sediment collected within drain lines.

1.04 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Product Data:
      1) Drain line pipe and fittings.
      2) Drain line installation equipment.
      3) High-pressure water jet cleaning equipment.
      4) Drain line sock; include manufacturer's recommendation for length of time UV-resistant sock may be left exposed.
   b. Precast Base, Cone, and Top Slab Manhole Sections: Details of construction.
   c. Level Check Box, Stop Logs, Cover, and Pipe Boots: Details of construction.

B. Informational Submittals:

1. Granular Drain Material:
   a. Manufacturer's Certificate of Compliance, in accordance with Section **[A: 01 61 00, Common Product Requirements] [B:]**.
   b. Test results from approved commercial testing laboratory before delivering material to Site and at least 10 days before material is required for use.
2. Surveys:
   a. Survey plan to collect drain line grade QA/QC information, including methods and schedule.
   b. Field Survey:

1) Information consisting of stationing and ground surface elevation for each drain line prior to installation.
2) Information consisting of stationing and installed invert elevation of drain pipe for drain line grade QA/QC.

3. Final drain line inspection and cleaning certification of compliance.

1.05 QUALITY ASSURANCE

A. Granular Drain Material Source:

1. Sampling:
   a. Conduct sampling of granular drain material source under supervision of Engineer in accordance with ASTM D75.
   b. Samples shall be representative and be clearly marked to show source of the material.
   c. Testing:
      1) In accordance with ASTM D1140 to determine percentage of fines.
      2) In accordance with ASTM D422 to determine gradation of particles larger than No. 200 sieve.
   d. Acceptance:
      1) Based on inspection of source by Engineer.
      2) Certified test results.
   e. Provide additional sampling, testing, and certification for every 500 cubic yards of material and when there is a change in granular drain material.
   f. Upon Engineer’s request, supply supplemental samples of granular drain material to a testing laboratory designated by Owner during installation of drain lines. Owner will bear costs of testing.

1.06 DOCUMENTATION

A. Survey Plan:

1. Submit prior to beginning Work.
2. Update on a weekly basis through final drain line inspection and cleaning.

B. Surveying:

1. At least 10 days prior to installation, provide Engineer with the following information for each drain line:
   a. Field survey ground surface elevations at 250-foot increments.
   b. Calculated cut depth from ground surface to drain line invert elevation.

2. Provide surveyed drain line grades to Engineer no more than 5 days following installation of drain line section.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Drain Sock:

1. Free of tears or other damage. Replace damaged sock.
2. Protect polyethylene drain lines with geotextile sock from UV light while stored onsite, unless geotextile sock is certified UV resistant.
3. UV-resistant Sock Stored Onsite Uncovered:
   a. Mark date of first sunlight exposure for each roll at factory.
   b. Do not allow UV-resistant sock to remain uncovered for more time than recommended by manufacturer.

PART 2 PRODUCTS

2.01 DRAIN LINES

A. Drain lines shall be perforated, unless otherwise noted on Drawings.

B. Perforated Drain Lines:

1. Heavy-duty corrugated polyethylene pipe meeting NRCS Conservation Practice Specification 606.
2. Conforming to ASTM F405 for 3-inch to 6-inch diameter pipe.
3. Conforming to ASTM F667 for 8-inch to 15-inch diameter pipe.
4. Water Inlet:
   a. Area of at least 1 square inch per foot of length.
   b. Dimensions of water inlet area shall be measured on a straight specimen with no external forces applied. Make measurements with instruments accurate to 0.01 inch.
   c. Perforations:
      1) Locate at least one perforation in the middle of corrugation so there is a shoulder on each side of perforation.
      2) Pipe 4 Inches to 12 Inches in Diameter:
         a) Slotted perforations shall be no wider than 1/8 inch or no longer than 1-1/4 inches.
         b) Slotted perforations equally spaced along length and circumference of tubing in not less than three rows.
      3) Pipe 15 inches in Diameter: Circular perforations will be accepted.

C. Nonperforated Drain Lines:

1. Heavy-duty corrugated polyethylene pipe with smooth interior walls.
2. Conforming to AASHTO M252 for 3-inch to 10-inch pipe.

3. Conforming to AASHTO M294 for 12-inch to 15-inch pipe, Type S.

D. Drain Sock:

1. Provide geotextile fabric material (sock) surrounding perforated drain lines.
2. **[A: Specify fabric type, weight, and apparent opening size (AOS).]**
3. **[B: Manufacturer and Product: .]**

E. Drain Line Fittings:

1. Includes cleanouts, elbows, tees, branch connections, snap end caps, and reducing couplers.
2. Conforming to ASTM F405 and ASTM F667 as appropriate.
3. Cleanout snap end cap shall have a metal locating plate attached as shown in Drawings.
4. Diameter of cleanout fittings shall be as shown on Drawings.
5. Fittings installed as part of a continuous operation shall be clamp type rather than snap type. Fittings installed after pipe is in place may be either type.

2.02 GRANULAR DRAIN MATERIAL

A. In accordance with Section 31 23 23.15, Trench Backfill.

B. Composed of hard, durable, natural mineral particles free from organic matter, clay balls, soft particles, or other impurities or foreign matter.

C. Material shall conform to the following grading requirements:

Size or U.S. Standard Sieve	Percent Passing by Dry Weight
[A:]	**[B:]**
[C:]	**[D:]**
[E:]	**[F:]**
[G:]	**[H:]**
[I:]	**[J:]**
[K:]	**[L:]**

2.03 TRENCH BACKFILL

A. Above pipe zone shall be in accordance with Section 31 23 23.15, Trench Backfill.

B. Within pipe zone shall be in accordance with Section 31 23 23.15, Trench Backfill.

C. Native backfill free from organic matter and other impurities or foreign matter and free from rocks larger than 3 inches in diameter.

2.04 BASE ROCK

A. In accordance with Section 31 23 23.15, Trench Backfill.

B. Base rock shall be clean 3/4-inch minus crushed granular or crushed rock uniformly graded from coarse to fine and with sufficient fines for proper compaction.

2.05 SILT TRAPS **[A: AND PUMP STATION SUMPS]**

A. Provide manholes to serve as silt traps **[A: and pump station sumps]** in conformance with Section 33 05 13, Manholes.

B. Manhole dimensions shall be as shown in Drawings.

C. Precast Manhole Sections:

1. Conform to ASTM C478 with minimum **[A: 42] [B:]**-inch inside diameter.
2. Cone: **[C: Concentric] [D: Eccentric]** type with a wall thickness and reinforcement similar to manhole section, unless otherwise shown.
3. Tops and bottoms of sections shall be parallel.

D. Mortar:

1. Conform to ASTM C387/C387M or be proportioned one part Portland cement to two parts clean, well-graded sand which will pass a 1/8-inch screen.
2. Admixtures shall not exceed the following percentages by weight of cement:
   a. Hydrated Lime: 10 percent.
   b. Diatomaceous Earth or Other Inert Materials: 5 percent.
3. Consistency of mortar shall be such that it will adhere readily to pipe.
4. Mortar mixed for longer than 30 minutes shall not be used.

E. Manhole Frames and Covers:

1. Cast iron of size and style indicated and shown on Drawings.
2. Castings shall be tough, close-grained gray iron, sound, smooth, and clean, free from blisters, blowholes, shrinkage, cold shuts, and defects.
3. Castings shall conform to ASTM A48/A48M, Class **[A: 20] [B:]**.

4. Where ring and cover are in contact, casting shall be ground to a flat, true bearing surface.

2.06 LEVEL CHECK

A. Dimensions shall be as shown on Drawings.

B. Manufacturer and Product: Agri Drain Corporation, Adair, IA; Inline Water Level Control Structures with internal cross braces for sidewall support perpendicular to direction of flow.

C. Metal components, including corner braces, cross braces, screws, stoplog lifting hooks, covers, and anode bond straps shall be constructed with Type 316 stainless steel.

D. Metal components shall be cathodically protected in accordance with Section 26 42 00, Cathodic Protection, and as detailed in Drawings.

PART 3 EXECUTION

3.01 TRENCH EXCAVATION

A. Trenching Equipment:

1. Automatic laser-guided grade control.
2. Shoe (or boot) that allows granular fill to be placed uniformly around perforated drain lines in a continuous operation during installation.
3. Equipped with specially lengthened shield.
4. Capable of operating at sufficient speed to ensure drain lines can be laid and blinded with granular drain material before groundwater or soil-water slurry moves into trench and into direct contact with **[A: drain line] [B: geotextile sock]**.

B. In accordance with Section 31 23 16, Excavation.

C. Excavate to lines and grades shown on Drawings allowing required thickness of granular fill to be placed around drain lines as shown on Drawings.

D. Installation of Drain Lines below Water Table: Install with trenching machine specifically designed for fluid soil conditions.

3.02 DRAIN LINE INSTALLATION

A. General:

1. No portion of subsurface drainage system in each drainage management unit (DMU) shall be installed until the permanent or temporary

[A: outfall] [B: pump station] in that DMU is installed and operational.

2. Installation of drain lines shall proceed starting from the DMU **[C: outfall] [D: pump station]**.
3. **[E: Size temporary pumping and conveyance facilities to match rated DMU pump flows as specified in Section and to convey water to approved discharge locations as specified in Section .]**

B. Pipe Installation:

1. Handle and install in conformance with ASTM F449.
2. Lay drain lines and appurtenances to lines and grades shown on Drawings.
3. Take special precautions on hot days to ensure stretch limit is not exceeded and excessive deflection is not caused by premature backfilling.

C. Fitting Installation:

1. Standard connections shall be in conformance with ASTM F449.
2. For nonstandard connections, join drain lines using manufacturer's printed recommended methods to complete connection.
3. Drain lines that are exposed to make a connection after trench backfilling shall have 4 inches of granular drain material replaced around drain line and connection.
4. Wrap connections and fittings with geotextile sock.

3.03 GRANULAR DRAIN MATERIAL INSTALLATION

A. Place granular drain material around perforated drain lines as shown on Drawings.

B. Place granular drain material around perforated drain lines in a continuous operation during placement of drain lines.

C. Place granular drain material with spreader boxes or other equipment in a manner to minimize segregation.

3.04 TRENCH BACKFILL

A. Trench shall not be left open overnight; plug end of drain lines and backfill trench to prevent animals, sediment, or debris from entering pipe.

B. Perform in a manner that shall minimize settlement.

C. Backfill may be placed automatically by trencher.

D. Where backfill material is placed in drain line trenches mechanically, backfill material shall be pushed onto slope of backfill previously placed and allowed to slide down into trench. Backfill shall not be pushed into trench in such a way as to permit free fall of material until at least 2 feet of cover has been provided over the top of drain line.

E. Place in such a manner to prevent displacement of drain line and granular fill after backfilling.

F. Trench Compaction:

1. After initial backfilling to final grade, a rubber-tired tractor shall be driven a minimum of two passes with tires running parallel on top of trench to facilitate compaction.
2. Additional mechanical backfilling shall be done to leave trench with 4-inch to 6-inch elevated mound on trench.

G. Unless otherwise directed by Engineer, procedures for compaction of trench backfill material shall be accomplished by close of each day's work.

3.05 CLEANING ACCESS INSTALLATION

A. Install inline cleanouts, end-of-line caps, and silt traps **[A: and pump station sumps]** as shown on Drawings.

B. Install inline cleanout in drain lines longer than 1,000 feet and place cleanouts no further than 1,000 feet apart in drain lines longer than 2,000 feet. Silt traps may be substituted for inline cleanouts.

C. Install end-of-line caps at upstream end of drain lines.

3.06 SILT TRAP **[A: AND PUMP STATION SUMP]** INSTALLATION

A. Silt trap **[B: and pump station]** shall be installed in accordance with Section 33 05 13, Manholes.

B. Base Preparation:

1. Remove loose material from excavation.
2. Place base rock to a compacted depth of not less than 6 inches with top surface at proper elevation.
3. Place precast base section on compacted imported base material.
4. Properly locate, ensure firm bearing throughout, and plumb first section.

C. Placing Precast Manhole Sections:

1. Make joints between precast manhole sections of cement mortar.

2. Place mortar in groove of the lower section of pipe prior to placing next section.
3. Set sections plumb.
4. Fill joints between sections completely with mortar and trowel to a smooth finish.
5. Joints between precast sections shall be watertight.
6. Cut openings in precast manhole sections as required to accommodate inlet and discharge pipes.
7. Cut holes with care and patch with nonshrinking mortar. Bend reinforcement out from the hole insofar as possible so as to reinforce patching.

D. Manhole Inverts: Construct of concrete in accordance with Drawings. Finished inverts shall be free from sharp edges or rough sections and shall provide a smooth flow.

E. Manhole Frame and Cover: Install in bed of mortar so as to provide a tight, secure joint. Elevation of finished cover shall be as shown on Drawings.

3.07 LEVEL CHECK INSTALLATION

A. Preparation of Base: Remove loose material. Place base rock to a compacted depth of not less than 6 inches with top surface at proper elevation.

B. Install level check true and plumb before making watertight connections to drain line.

C. Backfill excavation around level check with trench backfill placed in 12-inch loose lifts to no greater than 85 percent relative compaction.

D. Internal stoplogs shall be easily removed and replaced as needed following installation and backfilling.

3.08 FIELD QUALITY CONTROL

A. Drain Line Grade:

1. Measure by excavating down to drain every 250 feet and at the beginning and end of each line.
2. Measure drain invert elevation with a survey method accurate to 0.01 foot vertical.
3. Measure for grade at the top of pipe.
4. Drain lines with grades less than 1 percent shall be placed to the design grade within a tolerance of plus or minus 0.1 foot of design invert elevation.
5. Grades of 1 percent or steeper shall be placed to the design grade within a tolerance of plus or minus 0.2 foot of design invert elevation.

6. No reversal in grade of the drain lines shall be permitted.

B. Drain Line Stretching:

1. Drain lines shall not be stretched more than 5 percent during installation.
2. Measure stretch by measuring the distance across a minimum of 10 corrugations and comparing to manufacturer's standard corrugation dimensions.

3.09 FINAL INSPECTION AND CLEANING

A. Preparation:

1. Do not begin jet washing until subsurface drainage work within a DMU is complete.
2. Stage the Work to provide adequate supply of water for jet washing to allow inspection and cleaning of each section of drain line in one continuous operation.
3. Access to drain lines shall be through drain line cleanouts, silt traps, or the **[A: outfall] [B: pump station sump]**.

B. High Pressure Jet Washing Equipment:

1. Suitable type and size to perform cleaning specified herein.
2. Cleaning nozzle capable of jet washing 6-inch diameter to 15-inch diameter drain lines in sections up to 1,000 feet long.
3. Capable of negotiating 4-inch diameter cleaning access point.
4. Jet mechanism shall have a forward-piercing jet with trailing side jets that propel mechanism forward.
5. Operating pressures at pump shall not exceed a maximum of 2,300 psi.
6. Operate in accordance with manufacturer's printed instructions, recommendations, and best practice of the trade.

C. Pass high-pressure water jet cleaner through entire length of each drain line no sooner than 10 calendar days after installation of drain line.

D. When drain lines must be jet washed in sections, upstream sections shall be jet washed before connecting section downstream.

E. If tailwater produced is not clear, run jet cleaner through drain line section up to two more passes.

F. Obstructions within drain lines, collapsed drain line sections, or sections outside allowable tolerances for grade that are identified during final inspection and cleaning shall be repaired and corrected to meet Specification.

G. Complete final drain line inspection and cleaning certification of compliance addressing the following items:

1. Dates of work, equipment, and personnel performing work.
2. Locations and descriptions of obstructions, collapsed sections, out-of-grade sections, and actions taken to repair problems.
3. Locations of sections where tailwater did not run clear after three passes.

H. After completing jet washing for a drain line, restore area to a neat and finished appearance.

END OF SECTION