

ATTACHMENT B: TECHNICAL SPECIFICATIONS
FOR
LANDA PARK LAKE DAM IMPROVEMENTS

CITY OF NEW BRAUNFELS

July 2024

ISSUED FOR CONSTRUCTION



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02 41 00 DEMOLITION

1.00 GENERAL

1.01 WORK INCLUDED

- A. Furnish labor, materials, equipment and incidentals necessary for every type of required demolition.
- B. Furnish equipment of every type required to demolish and transport construction debris away from the Site.

1.02 STANDARDS

- A. Work shall be performed in accordance with the codes and ordinances of the agency having authority over the City of New Braunfels.

1.03 DELIVERY AND STORAGE

- A. Stockpile construction debris at the Site only as long as necessary to haul to a disposal site. Stack materials neatly and handle in an orderly manner until removed from the Site.

1.04 JOB CONDITIONS

- A. Contractor shall visit the Site and determine the extent of demolition required and the Site conditions that might affect its proposal. Include costs of covering all aspects of the demolition as part of the proposal.
- B. The Drawings shall be carefully reviewed to determine the extent of necessary demolition and to identify elements of the existing construction which are to remain in place. Report any discrepancies to Owner and Engineer before disturbing existing conditions. Property lines and limits of demolition shall be accurately located prior to beginning site demolition. Start of demolition activities shall represent confirmation by Contractor that existing conditions are as presented in the Contract Documents. Demolition outside the limits indicated on the Drawings, or outside the property lines shall not be performed.
- C. Material removed during demolition, and any equipment not otherwise designated to remain the property of the Owner, shall become the property of the Contractor, and shall be promptly removed from the Site.

2.00 PRODUCTS

2.01 MATERIALS

- A. New materials and equipment for patching and extending work shall meet the requirements of the individual Sections in these Contract Documents. For materials not addressed in these documents, materials used shall meet or exceed the dimensions and quality of the existing work.

3.00 EXECUTION

3.01 SITE CLEARING

- A. Perform site clearing to the limits indicated on the Drawings. Scrape the Site, removing brush, trees, weeds and trash. Haul debris away from the Site to an approved site as it accumulates.
- B. Grub out tree and brush roots within the limits of the actuator platform and auxiliary spillway riprap area. Remove rock out-croppings and boulders from any area within the limits of grading or structures. Remove roots and backfill any excavation resulting from tree removal with suitable soil for final grading plan.
- C. Trees not located within the construction limits, or otherwise indicated for removal, shall remain in place. Visit the Site with the Engineer or Owner and identify those trees that are to remain. Mark all other trees with yellow paint to indicate removal. Protect remaining trees during construction. Wrap the tree trunks with 2 x 4 timbers if construction equipment must operate in close proximity to them.
- D. Only designated trees shall be removed. In the event that trees other than those designated are erroneously removed or damaged to the point of distress, install replacement trees of equal size and number to compensate for those destroyed, at no additional cost to the Owner.
- E. Provide dust control as needed or requested by the Owner.

3.02 REMOVAL OF STRUCTURES

- A. Removal of Steel Sluice Gates: Meet with Owner and identify any material to be salvaged. Protect such material from damage using protective demolition methods. Remove steel structural members by unbolting, cutting welds, or cutting rivet heads and punching shanks through holes. Do not use flame-cutting unless approved by the Engineer.
- B. Removal of Timber Structures:
 - 1. Protect existing timber structures designated by Owner as salvageable. Remove using protective measures which prevent damage. Disconnect wood members at joints by removing fasteners. Do not cut into smaller sections, unless approved by the Engineer.

3.03 BACKFILLING

- A. Backfill cavities resulting from demolition. Fill cavities occurring within the limits of buildings, structures, or pavements in accordance with the requirements of other Sections of the Specifications. Backfill and compact cavities outside the construction limits to the same density as the surrounding earth. No testing is required for backfill outside the limits of new construction.

3.04 CLEANING AND REPAIR

- A. Clean and repair existing materials and equipment which remain or are to be reused.
- B. Lights: Use mild detergent to clean all exterior and interior surfaces. Rinse with clean water and wipe dry. Replace lamps and broken electrical parts impacted by the demolition processes.

END OF SECTION

03 11 00 CONCRETE FORMING

1.00 GENERAL

1.01 WORK INCLUDED

- A. Furnish material and labor to form, tie, brace and support wet concrete, reinforcing steel and embedded items until the concrete has developed sufficient strength to remove forms.

1.02 QUALITY ASSURANCE

- A. Design Criteria: Forms shall be designed for the pressure exerted by a liquid weighing 150 pounds per cubic foot. The rate of placing the concrete, the temperature of the concrete, and all other pertinent factors shall be taken into consideration when determining the depth of the equivalent liquid. An additional design live load of 50 pounds per square foot shall be used on horizontal surfaces.
- B. Alignment Control:
 - 1. True alignment of walls and other vertical surfaces having straight lines or rectangular shapes shall be controlled and checked by the following procedures:
 - a. Forming shall be arranged with provisions for adjusting the horizontal alignment of a form, after the form has been filled with concrete to grade, using wedges, turn buckles, or other adjustment methods. Establish a transit line or other reference so that adjustments can be made to an established line while the concrete in the top of the form is still plastic.
 - b. Adjusting facilities shall be at intervals which permit adjustments to a straight line. Concrete shall not be placed until adequate adjusting facilities are in place.
- C. Tolerances: Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

1.03 SUBMITTALS

- A. Submittals include:
 - 1. Shop Drawings:
 - a. Manufacturers' literature for "approved equal" products.
 - 2. Record Data.
 - a. Manufacturers' literature for specified products.

1.04 STANDARDS

- A. The applicable provisions of the following standards shall apply as if written here in their entirety:
 - 1. American Concrete Institute (ACI) Specifications:

ACI 117	Specifications for Tolerances for Concrete Construction and Materials
ACI 301	Specifications for Structural Concrete

2. American Institute of Steel Construction (AISC) Publication:
 - a. AISC Manual of Steel Construction.
3. American Iron and Steel Institute (AISI) Publication:
 - a. AISI Cold Formed Steel Design Manual.
4. American Plywood Association (APA) Standards:
 - a. APA Design/Construction Guide: Concrete Forming.

1.05 DELIVERY AND STORAGE

- A. Lumber for forms shall be stacked neatly on platforms raised above ground.

1.06 JOB CONDITIONS

- A. The Contractor shall notify the Engineer upon completion of various portions of the work required for placing concrete so that compliance with the plans and specifications may be monitored. The Engineer will authorize the Contractor to proceed with the placement after this has been completed and corrections, if required, have been made.
- B. In hot weather, both sides of the face forms may be required to be treated with oil to prevent warping and to secure tight joints.

2.00 PRODUCTS

2.01 MATERIALS

- A. Lumber: Properly seasoned and of good quality; free from loose or unsound knots, knot holes, twists, shakes, decay, splits, and other imperfections which would affect its strength or impair the finished surface of the concrete.
 1. Refer to Section 03 30 00 "Cast-In-Place Concrete" for finish requirements.
- B. Fiber Board Form Lining: Hardboard finished smooth on one side; minimum thickness of 3/16 inch thoroughly wet with water at least 12 hours before using.
- C. Plywood Form Lining: Conforming to APA HDO; exterior exposure waterproof adhesive, 3/8 inch thick.
- D. Form Oil: Light, clear oil; shall not discolor or injuriously affect the concrete surface, subsequent coatings, or delay or impair curing operations.

2.02 FABRICATIONS

- A. Lumber: Lumber for facing or sheathing shall be surfaced on at least one side and two edges, and sized to uniform thickness. Lumber of nominal 1-inch thickness or plywood of 3/4-inch thickness shall be permitted for general use on structures, if backed by a sufficient number of studs and wales.

B. Special Form Lumber:

1. Molding for chamfer strips or other uses shall be made of redwood, cypress, or pine materials of a grade that will not split when nailed, and which can be maintained to a true line without warping. The form shall be mill cut and dressed on all faces. Fillet forms at sharp corners, both inside and outside and at edges, with triangular chamfer strips at all non-contiguous edges exposed to view. Thoroughly oil chamfer strips before installation on forms.
2. All moldings, panel work, and bevel strips shall be straight and true with neatly mitered joints, and designed so that the finished work shall be true, sharp and clean cut.

C. Forms:

1. Forms shall be built mortar tight and of material sufficient in strength to prevent bulging between supports.
2. Reused forms or form lumber shall be maintained clean and in good condition as to accuracy, shape, strength, rigidity, tightness, and smoothness of surface.
3. All forms shall be so constructed as to permit removal without damage to the concrete. Exercise special care in framing forms for copings, offsets, railing and ornamental work, so that there will be no damage to the concrete when the forms are removed.

D. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation.

E. Metal Forms:

1. The specifications for "Forms" regarding design, mortar tightness, filleted corners, beveled projections, bracing, alignment, removal, re use, oiling, and wetting shall apply equally to metal forms.
2. The metal used for forms shall be of such thickness that the forms will remain true to shape. Bolt and rivet heads on the facing sides shall be countersunk. Clamps, pins, or other connecting devices shall be designed to hold the forms rigidly together and to allow removal without injury to the concrete.
3. Metal forms which do not present a smooth surface or line up properly shall not be used. Exercise special care to keep metal free from rust, grease, or other foreign material that discolors the concrete.

F. Form Linings:

1. Timber forms for exposed concrete surfaces which are to be given a rubbed finish shall be face-lined with an approved type of form lining material.
2. If plywood is used for form lining, it shall be made with waterproof adhesive and have a minimum thickness of 3/4 inch. It shall preferably be oiled at the mill and then re-oiled or lacquered on the job before using.
3. If fiber board is used, apply water to the screen side on the board. Stack the boards screen side to screen side. Use the smooth hard face as the contact surface of the form. Such surfaces may be formed with 3/4-inch thick plywood made with waterproof adhesive if backed with adequate studs and wales. The greatest strength of the outer

plies should be at right angles to the studding. In this case, form lining will not be required.

4. Carefully align edges and faces of adjacent panels and fill the joints between panels with patching plaster or cold water putty to prevent leakage. Lightly sand with No. 0 sandpaper to make the joints smooth.
 5. Forms which are reused shall have all unused form tie holes filled and smoothed as specified above.
- G. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
- H. Form Ties:
1. Metal form ties shall be used to hold forms in place and to provide easy metal removal. The use of wire for ties shall not be permitted.
 2. Leave no metal or other material within 1-1/2 inches of the surface, when removing form tie assemblies which are used inside the forms to hold the forms in correct alignment. The assembly shall provide cone-shaped depressions in the concrete surface at least 1 inch in diameter and 1-1/2 inches deep to allow filling and patching. Such devices, when removed, shall leave a smooth depression in the concrete surface without undue injury to the surface from chipping or spalling.
 3. Burning off rods, bolts, or ties shall not be permitted.
 4. Metal ties shall be held in place by devices attached to wales. Each device shall be capable of developing the strength of the tie.
 5. Metal and wooden spreaders which are separate from the forms shall be wired to top of form and shall be entirely removed as the concrete is placed.
 6. In the construction of water bearing walls, the portion of a single rod tie that is to remain in the concrete shall be provided with a tightly fitted washer at midpoint to control seepage. Multi-rod ties do not require washers. The use of form ties which are tapered or encased in paper or other material to allow the removal of complete tie, and which leave a hole through the concrete structure, shall not be permitted.
- I. Falsework:
1. Falsework shall be designed and constructed so that no excessive settlement or deformation occurs. Falsework shall provide necessary rigidity.
 2. Timber used in falsework centering shall be sound, in good condition and free from defects which impair its strength.
 3. Steel members shall be of adequate strength and shape for the intended purpose.
 4. Timber piling used in falsework may be of any wood species which satisfactorily withstands driving and which adequately supports the superimposed load.
 5. When sills or timber grillages are used to support falsework columns, unless founded on solid rock, shale or other hard materials, place them in excavated pits. Backfill to

prevent the softening of the supporting material from form drip or from rains that may occur during the construction process. Sills or grillages shall be of ample size to support the superimposed load without settlement.

6. Falsework not founded on a satisfactory spread footing shall be supported on piling, which shall be driven to a bearing capacity to support the superimposed load without settlement.

3.00 EXECUTION

3.01 PREPARATION

- A. Before placing concrete, ensure that embedded items are correctly, firmly and securely fastened into place. Embedded items shall be thoroughly clean and free of oil and other foreign material. Anchor bolts shall be set to the correct location, alignment and elevation by the use of suitable anchor bolt templates.

3.02 INSTALLATION

- A. Pre-Placement:
 1. During the elapsed time between building the forms and placing the concrete, maintain the forms to eliminate warping and shrinking.
 2. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:
 - a. For concrete surfaces exposed to view: Class A, 1/8 inch.
 - b. For concrete surfaces to receive a rubbed finish: Class A, 1/8 inch.
 3. Construct forms tight enough to prevent loss of concrete mortar.
 4. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical. Kerf wood inserts for forming keyways, reglets, recesses, and the like, for easy removal.
 5. Do not use rust-stained steel form-facing material.
 6. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
 7. Treat the facing of forms with suitable form oil before concrete is placed. Apply oil before the reinforcement is placed. Wet form surfaces which will come in contact with the concrete immediately before the concrete is placed.
 8. At the time of placing concrete, the forms shall be clean and entirely free from all chips, dirt, sawdust, and other extraneous matter at the time. Forms for slab, beam and girder construction shall not have tie wire cuttings, nails or any other matter which would mar the appearance of the finished construction. Clean forms and keep them free of foreign matter during concrete placement.

B. Placement:

1. Set and maintain forms to the lines designated, until the concrete is sufficiently hardened to permit form removal. If, at any stage of the work, the forms show signs of bulging or sagging, immediately remove that portion of the concrete causing this condition. If necessary, reset the forms and securely brace against further movement.
2. Provide adequate cleanout openings where access to the bottom of the forms is not otherwise readily attainable.
3. Chamfer exterior corners and edges of permanently exposed concrete.
4. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
5. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement. Carefully and accurately place and support reinforcement in concrete structures.

C. Removal: Remove forms so that the underlying concrete surface is not marred or damaged in any way. Forms shall not be removed until the concrete has attained sufficient strength to safely carry the dead load, but in no case less than the number of curing days set forth in the following table:

Forms	Curing Days
Forms for concrete of minor structural load carrying importance	1 day
Forms for walls, columns, sides of drilled shafts, massive structural components and other members not resisting a bending moment during curing	1 day
Forms and falsework under slabs, beams and girders where deflections due to dead load moment may exist (for spans < or = 10 feet)	7 days
Forms and falsework under slabs, beams and girders where deflections due to dead load moment may exist (for spans > 10 feet and < or = 20 feet)	14 days
Forms and falsework under slabs, beams and girders where deflections due to dead load moment may exist (for spans > 20 feet)	21 days

D. Reuse:

1. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.
2. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Owner's Representative.

END OF SECTION

03 21 00 REINFORCING STEEL

1.00 GENERAL

1.01 WORK INCLUDED

- A. Furnish labor and reinforcing materials required to cut, bend, tie, splice, place and support the reinforcement in the material grades, sizes, quantities, and locations specified.

1.02 QUALITY ASSURANCE

A. Tolerances:

1. Reinforcing shall be placed where specified, with the following maximum tolerances, plus or minus:
 - a. Concrete Cover: 1/4 inch.
 - b. Reinforcing Bar Spacing: 1/4 inch in 12 inches.

1.03 SUBMITTALS

- A. Submittals shall be in accordance with Section 01 33 00 "Document Management" and shall include:
1. Shop Drawings:
 - a. Reinforcing bar layout drawing with bar lists clearly marked and referenced to the Drawings. Include:
 - 1). Material, grade, bar schedules, stirrup spacing, bent bar diagrams, arrangement, and supports of concrete reinforcing.
 - 2). Additional reinforcing required for openings through concrete structures.
 2. Record Data: Manufacturers' literature for specified products.
 3. Certified Test Reports:
 - a. Certification of steel quality, size, grade and manufacturer's origin.

1.04 STANDARDS

- A. The applicable provisions of the following standards shall apply as if written here in their entirety:

1. ASTM International (ASTM) Standards:

ASTM A1064	Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM A615	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

2. American Concrete Institute (ACI) Publications:

ACI 301	Specification for Structural Concrete
ACI SP-66	ACI Detailing Manual

ACI 318	Building Code Requirements for Structural Concrete
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3. Concrete Reinforcing Steel Institute (CRSI) Publications:

CRSI	Manual of Standard Practice
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1.05 DELIVERY AND STORAGE

- A. Store reinforcement above the surface of the ground upon platform skids or other supports. Protect from mechanical and chemical injury and surface deterioration caused by exposure to conditions producing rust. When placed in the Work, reinforcement shall be free from dirt, scale, dust, paint, oil and other foreign material. Tag and store reinforcement for ease of correlation with Shop Drawings.

1.06 JOB CONDITIONS

- A. Proposed deviations from reinforcing indicated on the Drawings or Specifications shall be approved in writing by the Engineer prior to fabrication.
- B. Lap lengths shall be of the length shown on the Drawings or noted in lap and embedment table and shall be in compliance with ACI 318.
- C. Specified cover for reinforcing shall be maintained throughout construction. Bars shall be cut to lengths necessary to allow for proper clearances. Cover of concrete shall be measured from face of forms to outside face of reinforcement.
- D. Stirrups shall be hooked.

2.00 PRODUCTS

2.01 MATERIALS

- A. Steel Reinforcing Bars: Billet-Steel bars for concrete reinforcement conforming to ASTM A615; Grade 60, deformed, with minimum yield strength of 60,000 psi.
- B. Welded Wire Reinforcement: Cold-drawn steel wire conforming to ASTM A1064; flat sheets fabricated in accordance with ASTM A1064.
- C. Joint Dowel Bars: Plain-steel bars, ASTM A615/A615M, Grade 60. Cut bars true to length with ends square and free of burrs.
- D. Supports (Chairs): Bar supports shall be of the proper type for the intended use.
 - 1. Exposed Surface: CRSI Class 2 – Moderate Protection.
 - 2. Unexposed Surface: CRSI Class 3 – No Protection.
- E. Spacers: Precast mortar blocks with a 28-day compressive strength that is greater than the specified concrete strength in which the blocks are being placed. Additionally:
 - 1. Cure a minimum of 4 days.
 - 2. Blocks shall be in the form of a frustum positioned such that its size increases away from the formed surface. The surface placed adjacent to the forms shall not exceed 2-1/2 x 2-1/2 inches or 3 inches in diameter.

3. Blocks shall be accurately cast to the thickness required and the surface to be placed adjacent to the forms shall be a true plane free of surface imperfections.
 4. Wires ties for securing reinforcement shall be embedded in the block.
- F. Mechanical Splices:
1. Mechanical splices shall develop at least 125 percent of the reinforcement yield strength.
 2. Cadweld splices as manufactured by Erico Products, Inc.
- G. Zinc Repair Material: ASTM A780, zinc-based solder, paint containing zinc dust, or sprayed zinc.

3.00 EXECUTION

3.01 FABRICATION

- A. Reinforcing bars shall be bent cold by machine to shapes indicated on the Drawings; true to shapes indicated; irregularities in bending shall be cause for rejection. Unless otherwise noted, all hook and bend details and tolerances shall conform to the requirements of ACI SP-66 and ACI 318.
1. Fabricate reinforcement to provide lapped connections, bends and transitions in reinforcement as required for continuity of the typical reinforcement specified on the Drawings.
 2. Unless otherwise detailed, intersecting wall and/or beam reinforcement shall extend to the far face and terminate in a standard hook. Reinforcement at the outside face of corners shall be continuous or provide lap splices at each side of the corner.

3.02 PREPARATION

- A. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials.
- B. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcement.

3.03 INSTALLATION

- A. General: Place the reinforcement carefully and accurately in the concrete structures. Rigidly tie and support the reinforcement. Welding of any type of reinforcement shall not be permitted.
- B. Splices:
1. Splice reinforcement only as indicated on the Drawings or as approved by the Engineer prior to fabrication. Splices shall preferably occur at points of minimum stress.
 2. Lap Splice: Lengths shall be as indicated on the Drawings. Rigidly wire the bars at all splices. Overlap sheets of wire fabric sufficiently to maintain a uniform strength and securely fasten.

3. Mechanical Splice: Cadweld splices or approved equal, installed in accordance with the manufacturer's instructions and recommendations. The splice device shall develop at least 125 percent of the specified yield strength of the reinforcement.
4. Welding of reinforcing steel splices shall not be permitted.

C. Placement:

1. Place reinforcement, as indicated on the Drawings with the specified tolerances. Hold securely in place during the placing of the concrete. The minimum clear distance between bars shall be per ACI 318 unless noted otherwise. Always pass vertical stirrups around the main tension members and securely attach thereto. Wire reinforcing together at a sufficient number of intersections to produce a sound, sturdy mat or cage of reinforcement that will maintain the reinforcement in correct positions when the concrete is placed.
2. Hold the reinforcing steel in concrete slabs firmly in place with wire supports or "chairs." Sizing and spacing of the chairs shall be sufficient to properly support the steel, and shall be in accordance with CRSI Publications "Manual of Standard Practice in."
3. Space the reinforcing steel in concrete walls the proper distance from the face of the forms, as indicated on the Drawings:
 - a. For wall surfaces exposed to view, use chairs.
 - b. For wall surfaces not exposed to view, use chairs or precast mortar blocks.
4. Where reinforcing conflicts with location of anchor bolts, inserts, etc., submit prompt notifications so that revisions can be made before concrete is placed. No cutting of reinforcing shall be permitted without the prior approval of the Engineer.
5. Welded wire shall be fabricated flat sheets, in longest practical lengths. Lap joints one mesh. Do not locate end laps over beams of continuous structures or midway between supporting beams. Offset end laps of adjacent widths to prevent continuous lap. Fasten ends and sides of welded wire fabric at 48 inches O.C. with tie wire.
6. Reinforcing shall extend through construction joints.
7. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

3.04 FIELD QUALITY CONTROL

- A. Concrete shall not be placed until the Engineer has observed the final placing of the reinforcing steel and has given permission to place concrete.

END OF SECTION

03 30 00 CAST-IN-PLACE CONCRETE

1.00 GENERAL

1.01 SUMMARY

- A. Furnish labor, materials, mixing and transporting equipment and incidentals necessary to proportion, mix, transport, place, consolidate, finish, and cure concrete in the structure.

1.02 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and silica fume; subject to compliance with requirements.
- B. Mass Concrete: Any concrete placement with a minimum dimension greater than 3 feet shall be considered mass concrete.

1.03 SUBMITTALS

- A. Submittals shall be in accordance with City of New Braunfels specifications and shall include:
 - 1. Shop Drawings:
 - a. Mix Design: For each mix design, provide documentation using field test data or trial mixture data in accordance with ACI 301, which includes average strength documentation using either field strength test data or trial mixtures.
 - b. Submit a schedule to the Owner's representative which shows the sequence of concrete placements.
 - c. Procedures for placement through water if required.
 - d. If joints are not detailed on the Drawings, construction joint details and locations shall be submitted to the Engineer for approval.
 - e. Submit a thermal control plan for each mass concrete placement per ACI 301.
 - 1). Thermal control plan shall be signed and sealed by a Professional Engineer licensed in state where the Project is located.
 - 2). Thermal control plan should identify target temperatures or tolerances that will provide a buffer against exceeding specified maximum temperatures. Trial placements, mock-ups, thermal models and the thermal control plan will be evaluated using the target temperatures identified in the thermal control plan.
 - 3). Perform trial placement and/or computer simulation of thermal control plan as verification of intended procedures and equipment. Trial placement shall be similar in nature to intended use and is independent of final production work.
 - 4). Approval of the thermal control plan should be considered conditional based on the ability to control temperatures in the structure. Failure to consistently control temperature within predicted limits shall be reason for subsequent rejection of the thermal control plan. Failure to meet specified limits for

elements of the final structure will trigger remedial requirements, which may include removal and replacement.

2. Certified Test Reports:

- a. Materials used in the mix design and which will be used during production of concrete for the Project.
- b. Water: Verification that all potable mix water and curing water sources do not exceed the non-potable water limits listed in ASTM C1602 Table 2.
- c. Aggregate, conforming to ASTM C33, including the test reports for soundness and abrasion resistance.
- d. Aggregate:
 - 1). Verification that aggregate is not “potentially reactive” per ASTM C1260.
 - 2). Or a cement chemical analysis indicating that the total alkali content is acceptable per Paragraph 2.02.A.
- e. 7-day and 28-day compressive strength tests results.
- f. Daily mass concrete thermal monitoring records.
- g. If the sum total of chlorides in mix water and aggregates exceeds 80 percent of the specified limit for hardened concrete, then prior to use of concrete, test mix design to verify acceptable chloride ion concentrations in accordance with ASTM C1218.

3. Record Data:

- a. Manufacturer’s literature on specified materials.
- b. Documentation indicating conformance with ASTM C94 requirements.
 - 1). Concrete delivery tickets in accordance ASTM C94.
- c. Documentation of supplier's National Ready Mixed Concrete Association certification.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed concrete work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- B. Manufacturer Qualifications:
 - 1. A firm experienced in manufacturing ready-mixed concrete products complying with ASTM C94 requirements for production facilities and equipment.
 - 2. Manufacturer must be certified according to the National Ready Mixed Concrete Association’s Certification of Ready Mixed Concrete Production Facilities.
- C. Testing Agency Qualifications:
 - 1. An independent testing agency, acceptable to authorities having jurisdiction and the Engineer, qualified according to ASTM C1077 and ASTM E329 to conduct the testing indicated.

- D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, each aggregate from one source, and each admixture from the same manufacturer.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver cement in bulk or bags which are plainly marked with the brand and manufacturer's name. Immediately upon receipt, store cement in a dry, weather-tight, and properly ventilated structure which excludes moisture. Storage facilities shall permit easy access for inspection and identification. Cement not stored in accordance with the requirements shall not be used.
- B. Sufficient cement shall be in storage to complete placement of concrete started. In order that cement may not become unduly aged after delivery, maintain records of delivery dates. Use cement which has been stored at the Site for 60 days or more before using cement of lesser age. No cement shall be used which is lumped, caked, stored more than 90 days, or whose temperature exceeds 170 F.

1.06 STANDARDS

- A. Mixing, sampling, placing, curing and testing of concrete, and the materials used shall be in compliance with the latest revisions of the following standards, unless otherwise noted in the Contract Documents. The Contractor shall maintain one copy of each of the applicable standards at the construction field office.

1. ASTM International (ASTM) Standards:

ASTM Standards	
ASTM C31	Standard Practice for of Making and Curing Concrete Test Specimens in the Field
ASTM C33	Standard Specification for Concrete Aggregates
ASTM C39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C42	Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C94	Standard Specification of Ready Mixed Concrete
ASTM C109	Standard Test Method for Compressive Strength of Hydraulic Cement Mortars
ASTM C125	Standard Terminology Relating to Concrete and Concrete Aggregates
ASTM C138	Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
ASTM C143	Standard Test Method for Slump of Hydraulic Cement Concrete
ASTM C150	Standard Specification for Portland Cement
ASTM C171	Standard Specification for Sheet Materials for Curing Concrete
ASTM C172	Standard Practice for Sampling Freshly Mixed Concrete

ASTM Standards	
ASTM C173	Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C191	Standard Test Method for Time of Setting of Hydraulic Cement by Vicat Needle
ASTM C192	Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
ASTM C231	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260	Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C290	Standard Specification for Elastomeric Joint Sealants
ASTM C309	Standard Specification for Liquid Membrane Forming Compounds for Curing Concrete
ASTM C494	Standard Specification for Chemical Admixtures for Concrete
ASTM C579	Standard Test Methods for Compressive Strength of Chemical Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes
ASTM C580	Standard Test Method for Flexural Strength and Modulus of Elasticity of Chemical Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes
ASTM C595	Standard Specification for Blended Hydraulic Cements
ASTM C618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C827	Standard Test Method for Change in Height at Early Stages of Cylindrical Specimens of Cementitious Mixtures
ASTM C845	Standard Specification for Expansive Hydraulic Cement
ASTM C881	Standard Specification for Epoxy Resin Base Bonding Systems for Concrete
ASTM C1116	Standard Specification for Fiber-Reinforced Concrete
ASTM C1157	Standard Performance Specification for Hydraulic Cement
ASTM C1218	Standard Test Method for Water-Soluble Chloride in Mortar and Concrete
ASTM C1240	Standard Specification for Silica Fume used in Cementitious Mixtures
ASTM C1260	Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1602	Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
ASTM D1751	Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D1752	Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction

ASTM Standards	
ASTM D2240	Standard Test Method for Rubber Property Durometer Hardness
ASTM E96	Standard Test Methods for Water Vapor Transmission of Materials

2. American Concrete Institute (ACI) Standards:

ACI Standards	
ACI 211.1	Standard Practice for Selecting Proportions for Normal, Heavy-weight, and Mass Concrete
ACI 301	Specification for Structural Concrete
ACI 305.1	Specification for Hot Weather Concreting
ACI 306.1	Standard Specification for Cold Weather Concreting
ACI 308.1	Specification for Curing Concrete
ACI 318	Building Code Requirements for Structural Concrete

3. Concrete Plant Manufacturers Bureau (CPMB) Standards:

a. Concrete Plant Standards.

2.00 PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
2. Products: Subject to compliance with requirements, provide one of the products specified.
3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
4. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 CONCRETE MATERIALS

- A. Cementitious Material; General: If the fine and/or coarse aggregates test "Potentially Reactive", in accordance with ASTM C1260, then a low alkali cementitious material shall be used. A low alkali cementitious material shall be such that, the Sodium Oxide Equivalent ($N_{a_2O_{eq}}$) shall not exceed 0.6 percent of the total cementitious material content.

B. Cement; Provide one of the following:

1. Type I or I/II Portland cement, conforming to ASTM C150.
2. Type IL blended hydraulic cement, conforming to ASTM C595.
3. Type GU hydraulic cement, conforming to ASTM C1157.

C. Supplementary Cementitious Materials (SCM):

1. Fly Ash/Pozzolans: Conforming to ASTM C618, Class F fly ash; used in all classes of concrete. If fly ash is not available then provide a straight cement mix.

D. Coarse Aggregate:

1. Crushed stone or gravel conforming to ASTM C33, in the gradation size specified.
 - a. Class: Negligible weathering region, but not less than 1N.
2. For gradation size number 57, the maximum aggregate size of 1 inch is:

Sieve Size	Percent Retained	Percent Passing
1-1/2"	0	100
1"	0-5	95-100
1/2"	40-75	25-60
No. 4	90-100	0-10
No. 8	95-100	0-5

E. Fine Aggregate:

1. Washed and screened natural sands or sands manufactured by crushing stones; conforming to ASTM C33. The gradation in ASTM C33 for air entrained concrete is:

Sieve Size	Percent Retained	Percent Passing
3/8"	0	100
#4	0-5	95-100
#8	0-20	80-100
#16	15-50	50-85
#30	40-75	25-60
#50	70-90	10-30

2. Fine aggregate shall have not more than 45 percent retained between any two consecutive sieves. Its fineness modulus, as defined in ASTM C125, shall be not less than 2.3 nor more than 3.1.

F. Water: Potable and complying with ASTM C1602.

2.03 ADMIXTURES

- A. Measure and dose admixtures in accordance with manufacturer's recommendations.
- B. Air Entraining Admixture: Conforming to ASTM C260.

- C. Set Retarding Admixtures: Conforming to ASTM C494; Types B and D.
- D. Water Reducing Admixtures, High Range (HRWR): High Range Water Reducer shall comply with ASTM C494, Type F or G. HRWR shall be added to the concrete mix at the concrete batch plant. HRWR may not be added at placement site except to redose a batch and only after approval of the HRWR manufacturer. The high range water reducing admixture shall be able to maintain the plasticity range without significant loss of slump or rise in concrete temperature for 2 hours. Other admixtures may only be used with the HRWR if approved by the HRWR manufacturer. A representative of the HRWR manufacturer shall be present during any large placement, placement of slabs, or during times of unusual circumstance which may require changes to the product formulation.
 - 1. Manufacturers:
 - a. GCP Applied Technologies.
 - b. Master Builders Solutions US LLC.
 - c. Sika Corporation.

2.04 WATERSTOPS

- A. Flexible PVC Waterstops: CE CRD-C 572, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes. Unless indicated otherwise, provide the following configurations.
 - 1. Construction Joints:
 - a. Profile: Ribbed without center bulb.
 - b. Width: 6 inches.
 - c. Minimum thickness: 3/8 inch.
 - 2. Expansion Joint:
 - a. Profile: Ribbed with center bulb.
 - b. Width: 9 inches.
 - c. Minimum thickness: 3/8 inch.
 - 3. Manufacturers:
 - a. Sika Greenstreak and Sika Westec Barrier Technologies.
 - b. W.R. Meadows, Inc.
 - c. Paul Murphy Plastics Co.
 - d. Progress Unlimited Inc.
 - e. DCA Construction Products, LLC: Durajoint Waterstop.
 - f. Vinylex Corporation.
- B. Self-Expanding Strip Waterstops (Hydrophilic): Self-expanding strip waterstops shall be used only where specifically indicated. Manufactured rectangular or trapezoidal strip, sodium bentonite or other hydrophilic material for adhesive bonding to concrete.

1. Products:
 - a. De Neff Swellseal Joint; GCP Applied Technologies.
 - b. Adeka Ultra Seal; Mitsubishi International Corporation.
 - c. Sika Hydrotite; Sika Corporation – U.S.

2.05 CURING MATERIALS

- A. Water: Potable and complying with ASTM C1602.
- B. Absorbent Material: AASHTO M182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz. per sq. yd. dry.
- C. Sheet Curing Material: Conforming to ASTM C171.
 1. Waterproof paper.
 2. Polyethylene film.
 3. White burlap - polyethylene film.
- D. Membrane Curing Compounds: Membrane curing compound conforming to ASTM C309; applied according to the manufacturer's recommendations. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 1, Class B, 18 to 22 percent solids.
 1. Products:
 - a. Diamond Clear VOX; Euclid Chemical Co.
 - b. Lambco Glazecote 30; Lambert Corporation.
 - c. Dress & Seal; Laticrete International, Inc.
 - d. Vocomp-20; W.R. Meadows, Inc.
 - e. Cure & Seal 250E; Nox-Crete Products Group, Kinsman Corporation.
 - f. Starseal 0800; Vexcon Chemicals, Inc.
 - g. Approved equal.
- E. Finishing Aid: Spraying material designed to form a monomolecular film on fresh concrete that reduces the rate of evaporation of surface moisture prior to finishing. This material is not a curing compound. Concrete must be cured as specified.
 1. MasterKure ER 50; Master Builders Solutions US LLC.
 2. Approved equal.

2.06 RELATED MATERIALS

- A. Expansion and Isolation Joint Filler:
 1. Water retaining structures: ASTM D1752, Type I or II.
 2. Thickness as indicated on the Drawings.

- B. Expansion and Isolation Joint Sealant:
 - 1. Water retaining structures: ASTM C920, Type M, Grade P or NS as applicable, Class 35, Use I (ASTM C127, Class 2), UV resistance.
 - 2. Backing material for sealant shall be a rod of diameter and composition recommended by the sealant manufacturer.
- C. Bonding Agent: Water-based epoxy modified, with integral corrosion inhibitor. Install according to the manufacturer's recommendations.
 - 1. Sika Armatec 110 EpoCem; Sika Corporation.
 - 2. MasterEmaco P 124; Master Builders Solutions US LLC.
 - 3. Approved equal.
- D. Bonding Agent: Epoxy bonding system shall conform to ASTM C881. Install according to the manufacturer's recommendations.
 - 1. Sikadur 32, Hi-Mod LPL; Sika Corporation.
 - 2. Master Emaco ADH 326; Master Builders Solutions US LLC.
 - 3. Approved equal.
- E. Non-Shrink Grout:
 - 1. Non-Shrink Non-Metallic Grout: Pre-mixed, non-staining, non-shrink grout; minimum 28-day compressive strength of 5000 psi.
 - a. Do not use for vibrating equipment.
 - b. Products:
 - 1). MasterFlow 100; Master Builders Solutions US LLC.
 - 2). Five Star Grout; Five Star Products, Inc.
 - 3). SikaGrout 212; Sika Corporation.
- F. Zinc Rich Primer: Aluminum surfaces which contact or are embedded in concrete shall be coated with zinc rich primer. Primer shall be:
 - 1. Tneme-Zinc; Tnemec Company, Inc.
 - 2. MasterProtect P 8100AP; Master Builders Solutions US LLC.
 - 3. Approved equal.

2.07 REPAIR MATERIALS

- A. Structural Concrete Repair Material: Low-shrink, non-slump, non-metallic, quick setting patching mortar; as approved by the manufacturer for each application and applied accordance with the manufacturer's recommendations.
 - 1. Products:
 - a. Five Star Structural Concrete; Five Star Products, Inc.
 - b. SikaTop 123; Sika Corporation.

- c. SikaTop 122; Sika Corporation.
- d. MasterEmaco N 425; Master Builders Solutions US LLC.
- e. Approved equal.

2.08 CONCRETE MIXTURES

A. Design Criteria:

1. Provide a mix design for each concrete application indicated. This may necessitate multiple mix designs for each class of concrete depending on HRWR, entrained air, and other requirements.
2. All Concrete shall be normal weight concrete composed of cement, fine aggregate, coarse aggregate, admixtures, and water, as specified.
3. ACI 211.1 shall be the basis for selecting the proportions for concrete made with aggregates of normal and high density and of workability suitable for usual cast in place structures.
4. The workability of any mix shall be as required for the specific placing conditions and the method of placement. The concrete shall have the ability to be worked readily into corners and around reinforcing steel without the segregation of materials or the collection of free water on the surface. Compliance with specified slump limitations shall not necessarily designate a satisfactory mix.
5. In no case shall the amount of coarse material produce harshness in placing or honeycombing in the structure, when forms are removed. The maximum amount of coarse aggregate (dry loose volume) per cubic foot of finished concrete shall not exceed 0.82 cubic feet.
6. In calculating water-cement ratio: The water content shall include the amount of water batched or to be added later, plus the free water in the aggregate, and minus the water content at SSD conditions.
7. No allowance shall be made for the evaporation of water after batching. If additional water is required to obtain the desired slump, a compensating amount of cement shall also be added. In no case shall the maximum water cement ratio exceed the specified maximum or that of the approved mix design.
8. Air Entrainment: Provide the percent air entrainment in each concrete mix design as recommended by ACI 318:
 - a. Exposure Class: F1, unless otherwise specified/restricted.
9. Maximum water-soluble chloride ion content in concrete, by percent weight of concrete, shall not exceed ACI 318 Exposure Class C1.
10. When job conditions dictate, water-reducing and set-controlling admixtures may be used. Only specified admixtures shall be used. Admixtures shall be batched at the batch plant.

11. High Range Water Reducer (HRWR): HRWR may be permitted to be used in mix designs if approved by the engineer.
12. If fly ash is to be used in place of cement, no more than 25 percent of the cement may be replaced.
13. Concrete shall be capable of developing two-thirds of the required 28-day compressive strength in 7 days.
14. Shrinkage Limits: Concrete used in the embankment toe wall along the existing pool wall shall have a shrinkage limit of 0.04 percent at 28 days in accordance with ASTM C157.

B. Concrete Classifications:

Class	Min. 28-Day Compressive Strength (psi)	Max. Size Aggregate (inches)	Max. Water: Cementitious Materials Ratio	Slump +/-1 (inches)
C	4000	1.0, Size No. 57	0.45	4 (8*)
* Slump shown is with HRWR.				

C. Concrete Usage:

Class	Usage
Class C Use	Walls, columns, beams, drilled shafts

D. Required Average Compressive Strength:

1. All concrete is required to have an average compressive strength greater than the specified strength. The required average compressive strength shall be established according to the requirements of ACI 301.
2. Standard Deviation: Calculate a standard deviation and establish the required average compressive strength (f_{cr}') in accordance with ACI 301. If field test records are not available, select the required average strength from ACI 301.

E. Documentation of Required Average Compressive Strength:

1. Documentation indicating the proposed concrete proportions will produce an average compressive strength equal to or greater than f_{cr}' . Documentation shall consist of field strength records or trial mixture.
2. Field Strength Test Records: Document field strength test records according to ACI 301, which is partially restated here:
 - a. If field test data are available and represent a single group of at least 10 consecutive strength tests for one mixture, using the same materials, under the same conditions, and encompassing a period of not less than 45 days, verify that the average of the field test results equals or exceeds f_{cr}' .
 - b. If the field test data represent two groups of strength tests for two mixtures, plot the average strength of each group versus the water-cementitious materials ratio of the corresponding mixture proportions and interpolate between them to establish the required mixture proportions for f_{cr}' .

3. Trial Mixtures:

- a. Establish trial mixture proportions according to ACI 301, which is partially restated here:
 - 1). Make at least three trial mixtures complying with performance and design requirements. Each trial mixture shall have a different cementitious material content. Select water-cementitious materials ratios that will produce a range of compressive strengths encompassing f_{cr}' .
 - 2). Submit a plot of a curve showing the relationship between water-cementitious materials ratio and compressive strength.
 - 3). Establish mixture proportions so that the maximum water-cementitious materials ratio is not exceeded when the slump is at the maximum specified.
- b. Trial mixtures shall be designed, sampled, and tested by an independent testing laboratory, retained and paid by the Contractor and approved by the Owner.
- c. Provide 7-day and 28-day strengths test results.

4. Revisions to concrete mixtures:

- a. When less than 15 compressive strength tests results for a given class of concrete are available from the current Project:
 - 1). If any of the following criteria are met, take immediate steps to increase average compressive strength of the concrete.
 - a). A 7-day compressive strength test result multiplied by 1.5 falls below the required 28-day compressive strength.
 - b). A 28-day compressive strength test result is deemed not satisfactory.
- b. When at least 15 compressive strength test results for a given class of concrete become available from the current Project:
 - 1). Calculate the actual average compressive strength, standard deviation and required average compressive strength using the previous 15 consecutive strength tests. Submit results in graphical form with each 28-day test result for that class of concrete.
 - 2). If any of the following criteria are met, take immediate steps to increase average compressive strength of the concrete.
 - a). A 28-day compressive strength test result is deemed not satisfactory.
 - b). The average compressive strength falls below the required average compressive strength.
- c. When revisions to the mix design are required, notify the Engineer in writing of the corrective actions taken.

2.09 OFF-SITE BATCH PLANT

- A. Batch plants shall be an established concrete batching facility meeting the requirements of the Concrete Plant Standards of the Concrete Plant Manufacturers Bureau.

2.10 CONCRETE MIXING

- A. Mixers may be stationary, truck, or paving mixers of approved design. They shall be capable of combining the materials into a uniform mixture and of discharging without mixture segregation. Stationary and paving mixers shall be provided with an acceptable device to lock the discharge mechanism until the required mixing time has elapsed. The mixers or mixing plant shall include a device for automatically counting the total number of batches of concrete mixed. The mixers shall be operated at the drum or mixing blade speed designated by the manufacturer on the name plate.
- B. The mixing time for stationary mixers shall be based upon the mixer's ability to produce uniform concrete throughout the batch and from batch to batch. For guidance purposes, the manufacturer's recommendations, or 1 minute for 1 cubic yard plus 1/4 minute for each additional cubic yard may be used. Final mixing time shall be based on mixer performance. Mixers shall not be charged in excess of the capacity specified by the manufacturer.
- C. When a stationary mixer is used for partial mixing of the concrete (shrink mixed), the stationary mixing time may be reduced to the minimum necessary to intermingle the ingredients (about 30 seconds).
- D. When a truck mixer is used, either for complete mixing (transit-mixed) or to finish the partial mixing in a stationary mixer and in the absence of uniformity test data, each batch of concrete shall be mixed not less than 70 nor more than 100 revolutions of the drum, at the rate of rotation designated by the manufacturer of the equipment as mixing speed. If the batch is at least 1/2 cubic yard less than the rated capacity, in the absence of uniformity test data, the number of revolutions at mixing speed may be reduced to no less than 50. Additional mixing shall be performed at the speed designated by the manufacturer of the equipment as agitating speed. When necessary for proper control of the concrete, mixing of transit-mixed concrete shall not be permitted until the truck mixer is at the Site of the concrete placement. Truck mixers shall be equipped with accurate revolution counters.

3.00 EXECUTION

3.01 PREPARATION

- A. Notify the Owner's representative upon completion of various portions of the work required for placing concrete, so that inspection may be made as early as possible. Keep the Owner's representative informed of the anticipated concrete placing schedules.
- B. All items, including lines and grades, forms, waterstops, reinforcing, inserts, piping, electrical, plumbing and the Contractor's concreting materials and equipment shall be in compliance with the Contract Documents before proceeding.
- C. Do not place any concrete until formwork and the placing reinforcement in that unit is complete. Place no concrete before the completion of all adjacent operations which might prove detrimental to the concrete.
- D. Brilliantly light the Site so that all operations are plainly visible when concrete mixing, placing, and finishing, continues after daylight. Whenever possible, concrete finishing shall be completed in daylight hours.

- E. When placing concrete, the forms shall be clean and entirely free from all chips, dirt, sawdust and other extraneous matter. Forms for the new pool wall shall not have tie wire cuttings, nails, or any other matter which would mar the appearance of the finished construction. Clean forms and keep them free of any foreign matter during concrete placing.
- F. The concrete shall be mixed in quantities required for immediate use. Any concrete which is not in place within the time limits specified shall not be used. Concrete shall not be re-tempered.
- G. Concrete shall not be placed if impending weather conditions would impair the quality of the finished Work.
- H. Unless otherwise provided, the following requirements shall govern the time sequence on which construction operations shall be carried.
 - 1. Forms for walls shall not be erected on concrete footings until the concrete in the footing has cured for at least 2 curing days. Concrete may be placed in a wall or column as soon as the forms and reinforcing steel placements are approved.
 - 2. Steel beams or forms and falsework for superstructures shall not be erected on ground-supported concrete substructures until the substructure concrete has cured for at least 4 curing days.

3.02 EMBEDDED ITEMS

- A. Where post-installed anchors are not specified on the Drawings, place and secure anchorage devices and other embedded items required for adjoining Work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 1. Install anchor bolts and dowels, accurately located, to elevations required.

3.03 JOINTS

- A. Expansion Joints and Devices:
 - 1. Workmanship: Exercise careful workmanship in joint construction to separate the concrete sections by an open joint or by the joint materials, and make the joints true to the outline indicated.
 - 2. Expansion Joints: Construct expansion joints and devices to provide expansion and contraction. Construct joints which are to be left open or filled with poured joint material with forms which are adaptable for loosening or early removal. In order to avoid jamming by the expansion action of the concrete and the consequent likelihood of injuring adjacent concrete, remove or loosen these forms as soon as possible after the concrete has initially set. Make provisions for loosening the forms to permit free concrete expansion without requiring full removal.
 - 3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

B. Construction Joints:

1. Construction joints are formed by placing plastic concrete in direct contact with concrete which has attained its initial set. When concrete is specified as monolithic, the term shall be interpreted as the manner and sequence of concrete placement so that construction joints do not occur.
2. Additional horizontal and vertical construction joints, when submitted and approved by the Engineer, may have an impact on reinforcing details. Revise reinforcing details to reflect additional joints.
3. Unless otherwise provided, construction joints shall be square and normal to the forms. Provide bulkheads in the forms for all joints except horizontal joints.
4. Clean horizontal construction joints for receiving the succeeding lift using air water cutting. The surface shall be exposed sound, clean aggregate with a 1/4 inch amplitude. After cutting, wash the surface until there is no trace of cloudiness in the wash water.
5. In areas where air water cutting cannot be satisfactorily accomplished, or in areas where it is undesirable to disturb the surface of the concrete before it has hardened, prepare the surface for receiving the next lift by wet sand blasting to immediately remove all laitance and unsound concrete prior to placing of the next lift. Thoroughly wash the surface of the concrete after sand blasting to remove all loose material.
6. Provide construction joints with concrete keyways, reinforcing steel dowels, and waterstops where indicated on the Drawings. The method of forming keys in keyed joints shall permit the easy removal of forms without chipping, breaking, or damaging the concrete.
7. Construction joint layout unless otherwise indicated on the Drawings:
 - a. Maximum horizontal spacing of construction joints shall be 45 feet.

- C. Hardened Concrete: Where new concrete or grout is to be placed in contact with existing or recently hardened concrete, texture the existing or recently hardened surface by chipping or other means so that an irregular surface having a height variance of not less than 1/4 inch is created. The existing or recently hardened concrete shall then be coated with a bonding agent and new concrete or grout placed.

3.04 WATERSTOPS

- A. PVC/TPER/PE Waterstops: Install in construction joints as indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of Work.
1. At formed surfaces, a split form shall be used. The split form shall have a tight fit which prevents misalignment and concrete leakage.
 2. The embedded flange of the waterstop must be secured prior to concrete placement. The flange shall be secured at 12 inches on-center by factory installed hog rings or grommets at the outermost rib. Never place nails or screws through the body of the waterstop.

3. All fittings and changes in direction shall be factory fabricated. Only straight butt splices shall be made in the field. Field splices shall be according to the manufacturer's written instructions and as follows:
 - a. Cut adjoining ends square to form matching edges.
 - b. Uniformly melt the ends at 380 F using a thermostatically controlled, Teflon coated splicing iron.
 - c. When a 1/8-inch diameter melt bead develops on each waterstop end, remove the splicing iron and firmly press the two ends together in proper alignment. Hold until the material has fused and cooled. Allow the splice to cool naturally; do not quench.

B. Self-Expanding Strip Waterstops:

1. Install in construction joints and at other locations indicated, according to manufacturer's written instructions, bonding or mechanically fastening and firmly pressing into place.
 - a. Waterstop shall be bonded to the substrate using a continuous bead of swelling sealant or adhesive as recommended by the manufacturer.
 - 1). ADEKA Ultra Seal P-201.
 - 2). Approved Equal.
2. Install in longest lengths practicable.
3. Protect from moisture, oil, dirt, and sunlight prior to the placement of concrete. Coordinate with manufacturer for additional requirements.

3.05 CONCRETE PLACEMENT

A. Mass Concrete:

1. Temperature and temperature difference within concrete shall be monitored and controlled from the time the concrete is placed until time internal temperature has cooled from its maximum so the difference between average daily ambient and internal temperatures at the time of protection removal is less than specified temperature difference limit between the center and surface concrete.
 - a. The maximum temperature in concrete after placement shall not exceed 160 degrees F. Concrete that does not meet this requirement is subject to removal and replacement at Owner's discretion.
 - b. The maximum temperature difference between the center and surface of placement shall not exceed 35 degrees F.
2. Temperatures shall be monitored using temperature sensors within the concrete.
 - a. Provide two sensors (one primary and one spare) at the center and two sensors (one primary and one spare) at the edge of the mass concrete placement and an additional sensor for monitoring ambient on-site temperature.
 - b. Coordinate sensor location with thermal control plan and the Owner's Representative.

3. Provide all means necessary to control concrete temperature to meet specified limits.]

B. Cold Weather:

1. If air temperature has fallen to or is expected to fall below 40 F during the protection period (a minimum of 48 hours but not less than that required by ACI 306.1), then cold weather concreting shall be performed in accordance with ACI 306.1.
2. In cases where the temperature drops below 40 F after the concreting operations have been started, sufficient canvas and framework or other type of housing shall be furnished to enclose and protect the structure, in accordance with the requirements of ACI 306.1. Sufficient heating apparatus to provide heat shall be supplied, and heating source and protection from combustion gas shall be in accordance with ACI 306.1. The concrete shall be protected when placed under all weather conditions. Should concrete placed under such conditions prove unsatisfactory, remove and replace the concrete at no cost to the Owner.
3. When the air temperature is above 30 F:
 - a. The minimum concrete temperature at the time of mixing shall be 60 F unless other requirements of ACI 306.1 are met, which may allow for a lower mix temperature.
 - b. The minimum concrete temperature at the time of placement and during the protection period shall be 55 F unless other requirements of ACI 306.1 are met, which may allow for a lower temperature.
4. The means used to heat a concrete mix shall be in accordance with ACI 306.1.
5. Salts, chemicals, or other foreign materials shall not be mixed with the concrete to preventing freezing. Calcium chloride is not permitted.

C. Hot Weather:

1. Hot weather is defined as any combination of high air temperature, low relative humidity, and wind velocity that impairs the quality of the concrete. Hot weather concreting shall be in accordance with ACI 305.1. Concrete shall be placed in the forms without the addition of any more water than that required by the design (slump). No excess water shall be added on the concrete surface for finishing. Control of initial set of the concrete and extending the time for finishing operations may be accomplished with the use of approved water reducing and set retarding admixture, as specified.
2. Maximum time intervals between the addition of mixing water and/or cement to the batch, and the placing of concrete in the forms shall not exceed the following (excluding HRWR admixture use):

Concrete Temperature	Maximum Time from Water Batch to Placement
Non-Agitated Concrete	
Up to 80 F	30 Minutes
Over 80 F	15 Minutes
Agitated Concrete	
Up to 75 F	90 Minutes

Concrete Temperature	Maximum Time from Water Batch to Placement
75 F to 89 F	60 Minutes

- a. The use of an approved set-retarding admixture will permit the extension of the above time maximums by 30 minutes, for agitated concrete only.
 - b. The use of an approved high range water reducing (HRWR) or hydration-controlling admixture will allow placement time extensions as determined by the manufacturer.
 3. The maximum temperature of fresh concrete at time of discharge shall not exceed 95 F. The temperatures of the mixing water shall be reduced by the use of chilled water or ice.
 4. The maximum temperature of fresh concrete with high range water reducing admixture shall not exceed 100 F at time of discharge.
 5. On days when the predicted high temperature is 90 F or higher, the initial curing of test specimens shall be according to ASTM C31 except that the means of maintaining moisture and temperature shall be limited to the following options:
 - a. Immersion of molded specimens with plastic lids in water saturated with calcium hydroxide.
 - b. Suitable moisture loss control combined with a temperature-controlled environment.
 - c. Other methods as approved by the Engineer.
 6. Under extreme heat, wind, or humidity conditions, concreting operations may be suspended if the quality of the concrete being placed is not acceptable.
- D. Handling and Transporting:
1. Delivery tickets shall be required for each batch and shall be in accordance with ASTM C94. Each delivery ticket must show plainly the amount of water, in gallons that can be added to the mixer truck at the Site without exceeding the maximum water cement ratio approved for that mix design. Amount of water added must be in proportion to contents of truck.
 2. Arrange and use chutes, troughs, or pipes as aids in placing concrete so that the ingredients of the concrete are not segregated. They shall be steel or steel lined. When steep slopes are necessary, equip the chutes with baffles or make in short lengths that reverse the direction of movement. Extend open troughs and chutes, if necessary, inside the forms or through holes left in the forms. Terminate the ends of these chutes in vertical downspouts.
 3. Keep chutes, troughs, and pipes clean and free from coatings of hardened concrete by thoroughly flushing with water before and after placement. Discharge water used for flushing away from the concrete in place.
 4. Use pumping equipment that has sufficient capacity so that:
 - a. Discharge of pump concrete does not result in segregation.

- b. Modification of accepted concrete mixture is not required.

E. Depositing:

1. The method and manner of placing shall prevent segregation or separation of the aggregate or the displacement of the reinforcement. Use drop chutes or tremies as necessary.
2. Free Fall: Concrete shall not be allowed to free fall more than 10 feet when HRWR admixture is used or 5 feet without the use of HRWR. Free falling concrete shall avoid striking reinforcing during placement. Placement of concrete for heights exceeding the free fall limit shall be placed using a tremie.
 - a. Concrete shall not be allowed to free fall through water. Place as indicated below.
3. Prevent the splattering of forms and reinforcing bars if the splattered concrete will dry or harden before incorporation into the mass.
4. Fill each part of the forms by directly depositing concrete as near its final position as possible. Work the concrete under and around the reinforcement bars. Depositing large quantities at one point in the forms, then running or working it along the forms shall not be permitted.
 - a. Place required sections in one continuous operation to avoid additional cold joints. Each layer shall be fluid and concrete shall not have taken initial set when a new layer is placed upon it. Not more than 1 hour shall elapse between the placing of successive concrete layers in any portion of the structures included in continuous placement.
5. Place in continuous horizontal layers with a depth of from 1 to 3 feet. If excessive bleeding causes water to form on the surface of the concrete in tall forms, revise mix design to reduce the bleeding.
6. For slopes greater than 2 percent, start concrete placement at low end and proceed upslope.
7. After the concrete has taken initial set, the forms shall not be jarred. No force or load shall be placed upon projecting reinforcement.

F. Consolidating:

1. Compact each layer of concrete and flush the mortar to the surface of the forms by continuous-working mechanical vibrators. Apply the vibrator to the concrete immediately after deposit. Move vibrator throughout the layer of the newly placed concrete, several inches into the plastic layer below. Thoroughly work the concrete around the reinforcement, embedded fixtures and into the corners and angles of the forms until it is well-compacted.
2. Mechanical vibrators shall not be operated so that they penetrate or disturb previously placed layers which are partially set or hardened. They shall not be used to aid the flow of concrete laterally. The vibration shall be of sufficient duration to completely compact and embed reinforcement and fixtures, but not to an extent causing segregation.
3. Keep vibrators constantly moving in the concrete and apply vertically at points uniformly spaced, not farther apart than the radius over which the vibrator is visibly

effective. The vibrator shall not be held in one location longer than required to produce a liquified appearance on the surface.

4. When submerged in concrete, internal vibrators shall maintain a frequency of not less than 6000 impulses per minute for heads with diameters greater than 5 inches and 10,000 impulses for smaller vibrator heads. The vibration intensity (amplitude) shall be sufficient to produce satisfactory consolidation.
 - a. Vibrator head shall be sufficiently small to allow placement between reinforcing steel.
 - b. Provide at least one standby vibrator.
 - c. Check vibrators intended for regular service or standby service prior to concreting operations.

G. Placement in Water:

1. Deposit concrete in water only when dry conditions cannot be obtained. The forms, cofferdams, or caissons shall be sufficiently tight to prevent any water flowing through the space where concrete is to be deposited. Pumping of water shall not be permitted while the concrete is being placed, nor until it has set for at least 36 hours.
2. Carefully place the concrete using a tremie, closed bottom dumping bucket, or another approved method which does not permit the concrete to fall through the water without protection. The concrete shall not be disturbed after being deposited. Regulate depositing to maintain horizontal surfaces.
3. When a tremie is used, it shall consist of a tube constructed in sections having water-tight connections. The means of supporting the tremie shall permit the movement of the discharge end over the entire top surface of the work, and shall allow the tremie to be rapidly lowered to retard the flow. The number of times it is necessary to shift the location of the tremie shall be held to a minimum for any continuous placement of concrete. During the placing of concrete, keep the tremie tube full to the bottom of the hopper. When a batch is dumped into the hopper, slightly raise the tremie, but not out of the concrete at the bottom, until the batch discharges to the level of the bottom of the hopper. Stop the flow by lowering the tremie. Continue placing operations until the work is completed.
4. When concrete is placed by means of the bottom dump bucket, the bucket shall have a capacity of not less than 1/2 cubic yard. Lower the bucket gradually and carefully until it rests upon the concrete already placed. Raise it very slowly during the discharge travel to maintain still water at the point of discharge and to avoid agitating the mixture.
5. Use a sump or other approved method to channel displaced fluid and concrete away from the shaft excavation. Recover slurry and dispose of it as approved. Do not discharge displaced fluids into or in close proximity to streams or other bodies of water.

H. Placement in Walls:

1. Immediately before placing concrete, thoroughly dampen the subgrade to receive concrete to prevent moisture absorption from the concrete.
2. As soon as concrete placing is complete for a wall section of sufficient width to permit finishing operations, level the concrete, strike off, tamp and screed. The screed shall be

of a design adaptable to the use intended, shall have provision for vertical adjustment and shall be sufficiently rigid to hold true to shape during use.

3. The initial strike off shall leave the concrete surface at an elevation slightly above grade so that, when consolidation and finishing operations are completed, the surface of the top of wall is at grade elevation.
4. Continue tamping and screeding operations until the concrete is properly consolidated and free of surface voids. Bring the surface to a smooth, true alignment using longitudinal screeding, floating, belting, and/or other methods.
5. When used, templates shall be of a design which permits early removal so satisfactory finishing at and adjacent to the template is achieved.
6. While the concrete is still plastic, straighten the surface as required to achieve specified flatness requirements. Remove high spots and fill depressions with fresh concrete and re-float. Continue to check during the final finishing operation, until the surface is true to grade and free of depressions, high spots, voids, or rough spots.

3.06 FINISHING FORMED SURFACES

- A. Forms for walls shall be removed as specified in Section 03 11 00 "Concrete Forming." Patch, repair, finish, and clean concrete after form removal. Finish concrete not more than 7 days after form removal. Cure concrete as finishing progresses.
- B. Air voids, for all types of finishes, are defects and shall be removed by rubbing or patching.
- C. Smooth Finish: The form facing material shall produce a smooth, uniform texture on the concrete. Patch tie holes. Repair defects larger than 3/4 inch wide or 1/2 inch deep. Remove projections flush with the adjacent surface.

3.07 FINISHING SLABS AND TOPS OF WALLS

- A. General: Screed, restraigten, and finish concrete surfaces. Do not wet concrete surfaces.
- B. Finish tops of walls and levelled lifeguard platforms and apply as indicated on the Drawings and the following schedule of finishes:

Type of Finish	Location
Broom Finish	Top of toe walls along pool.
Grout-Cleaned Rubbed Finish	Demo'd surface of levelled lifeguard platforms.

1. Float Finish: Finish surfaces using a float to a true, even plane with no coarse aggregate visible. In the initial floating, while the concrete is plastic, use sufficient pressure on the float to bring excess moisture to the surface for removal. Apply a final "light float" finish to the surface as the concrete hardens. The surface shall have a uniform granular texture and shall meet the straightness requirements.
2. Grout-Cleaned Rubbed Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix 1 part cement to 1-1/2 parts fine sand with a 1:1 mixture of bonding admixture and water. Add white cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Scrub

grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.

3. Broom Finish: Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with the Engineer before application.

3.08 MISCELLANEOUS CONCRETE ITEMS

A. Normal Shrinkage Grouting:

1. Prior to grout application, thoroughly clean the surface of all foreign matter. Roughen concrete surface to CSP 4 and wet as required for a saturate surface dry condition (SSD). Set forms in place; tight and securely anchored to prevent the loss of grout.
2. The necessary materials and tools shall be on hand before starting grouting operations.
3. After preparing surface and immediately prior to grouting, provide scrub coat of grout material. Do not allow scrub coat to dry prior to placing grout.
4. After mixing, quickly and continuously place the grout to avoid overworking, segregation and breaking down of the initial set. Mix and place the grout where indicated on the Drawings. Cure grout using wet curing method for concrete. Grout shall receive a trowel finish, unless otherwise noted.

B. Non-Shrink Grout:

1. Obtain field technical assistance from the grout manufacturer, as required, to ensure that grout mixing and installation comply with the manufacturer's recommendations and procedures.
2. Roughen concrete surface as required by the manufacturer, but not less than CSP 4. Saturate the surface to achieve an SSD condition. Baseplates shall be free of oil, grease, laitance and other foreign substances.
 - a. Epoxy Grout: Surface shall be dry as recommended by the manufacturer.
3. Place grout according to the manufacturer's directions so that spaces and cavities below the bottom of the baseplates are completely filled. Provide forms where structural components of the baseplates do not confine the grout. Trowel finish the non-shrink grout where the edge of the grout is exposed to view and after the grout has reached its initial set. Cut off the exposed edges of the grout at a 45-degree angle to the baseplate, bedplate, member, or piece of equipment.
4. Wet cure a minimum of 3 days, but not less than that recommended by the manufacturer.
 - a. Epoxy Grout: Dry curing is acceptable if recommended by the manufacturer.
5. Use epoxy non-shrink grout under all machinery, pumps, equipment, and where chemicals are present that would abate cementitious non-shrink grouts.

3.09 CONCRETE CURING AND PROTECTION

- A. General: Begin curing of concrete immediately after completion of finishing activities for unformed concrete and immediately after removal of forms from formed concrete. Apply

curing method without staining, marring, or damaging concrete surfaces. Where pedestrian traffic is unavoidable, provide suitable walkways to protect the curing material and the concrete surface from damage. Unless a particular curing method is specified, select the appropriate curing method from the curing options indicated.

B. Length of Curing Period:

1. Curing Day: A day on which the ambient temperature is above 50 deg. F for at least 18 hours.
2. Curing Period: 7 consecutive curing days.
3. Extended Curing Period: When curing day requirements are not met, then extend the curing period by one day for each day not in compliance. Extend curing up a maximum total of 14 consecutive days.

C. Wet Curing with Absorbent Material:

1. Cover concrete surfaces with absorbent material and hold it in contact with concrete surface. Provide a minimum 8-inch lap of adjacent material section edges.
2. Apply water to absorbent material and saturate. Maintain saturated condition for curing period – do not allow absorbent material to dry.
3. Do not use wet curing if curing water will be subject to freezing during the curing period.

D. Sheet Curing: Cover concrete surfaces with sheets and hold in contact with concrete surface. Apply in accordance with manufacturer recommendations, which includes placement, patching holes, and tape joints per manufacturer recommendations.

E. Membrane Curing:

1. Cover the surface of the concrete with a continuous, uniform film. Application shall be in accordance with manufacturer recommendations. Prevent overspray as necessary to meet project requirements.
2. Do not allow foot traffic on surface in accordance with manufacturer recommendations.
3. Repair film if damaged within the curing period.
4. Unless preapproved, do not use membrane curing on surfaces that:
 - a. Receive concrete topping, terrazzo, paint, floor hardener, or other finish.
 - b. Are specified to have a rubbed finish.

F. Protection: During and after curing period, protect concrete surfaces from damage, marring, or staining by construction activities.

3.10 CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Repair and patch defective areas when approved by Engineer. Remove and replace concrete that cannot be repaired and patched to Engineer's approval.
- B. After the tie rods are broken back or removed, thoroughly clean the holes to remove grease and loose particles. Patch holes with structural concrete repair material or non-shrink grout. After the holes are completely filled, strike off flush excess mortar and finish the surface to render the filled hole inconspicuous.

- C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
1. If the surface of the concrete is bulged, uneven, or shows honeycombing or form marks, which in the Engineer's opinion cannot be repaired satisfactorily, remove and replace the entire section.
 2. Patch honeycomb and minor defects in all concrete surfaces with structural concrete repair material. Cut back each defective area with a pneumatic chipping tool as deep as the defect extends, but in no case less than 1/2 inch. Prepare the existing concrete and apply repair material according to the manufacturer's recommendations. Finish the surface of the patches to match finish on surrounding concrete.
 3. Immediately after form removal, cut out honeycombs, rock pockets, and voids to expose solid concrete but not less than 1-inch in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with repair material before bonding agent has dried.
 4. Repair defects on surfaces exposed to view by blending white cement and standard cement so that, when dry, patching mortar will match surrounding color. Patch a test area at an inconspicuous location to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
- D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
1. Repair finished surfaces containing defects. Surface defects include spalls, pop outs, honeycombs, rock pockets, crazing and cracks in excess of 0.01-inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
 2. After concrete has cured at least 14 days, correct high areas by grinding.
 3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
 4. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mix as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
 5. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

- E. Perform structural repairs of concrete, subject to Engineer's approval, using epoxy adhesive and patching mortar.
- F. Repair materials and installation not specified above may be used, subject to Engineer's approval.

3.11 FIELD QUALITY CONTROL

A. Testing:

1. General:

- a. Tests shall be required throughout the Work to monitor the quality of concrete. Samples shall be taken in accordance with ASTM C172.
- b. Engineer may waive these requirements on concrete placements of 10 cubic yards or less. However, evidence shall be furnished showing a design mix which meets the Specifications.
- c. Unless noted otherwise, testing of the materials, ready mix, transit mix, or central plant concrete will be by an independent testing agency. The independent testing agency will be approved by the Owner and paid by the Contractor. A summary of all tests performed will be available. No concrete shall be placed without a representative present at either the plant or at the Site.
- d. Unless the Owner's laboratory is on the Site, provide housing for the curing and storage of test specimens and equipment.

2. Slump Test: Slump tests, in accordance with ASTM C143, shall be used to indicate the workability and consistency of the concrete mix from batch to batch. Generally, a slump test shall be made at the start of operations each day, at regular intervals throughout a working day, and at any time when the appearance of the concrete suggests a change in uniformity.

3. Air Content Test: Tests for the concrete's air content shall be made in accordance with ASTM C231 or ASTM C173, at the point of delivery of concrete, prior to placing in forms. The test shall be made frequently to monitor a proper air content uniform from batch to batch.

4. Temperature Test: Test for the concrete's temperature in accordance with ASTM C1064 and as follows: the temperature of the concrete to be placed shall be taken with a thermometer immediately before placement, with the point of measurement being in the chute or bucket. Temperature test shall be performed for each truck. Record temperatures on batch ticket.

5. Density: Determine the concrete density for normal weight concrete in accordance with ASTM C138. Density shall be measured at the same frequency as measuring air content.

6. Compression Test:

- a. Compression test specimens shall be 6-by-12-inch concrete cylinders made and cured in accordance with ASTM C31. If the maximum aggregate size is no larger than 1 inch, 4-by-8-inch concrete cylinders are acceptable. No fewer than two 6-by-12-inch or three 4-by-8-inch specimens shall be made for each test Sample. Samples shall be taken at a minimum of every 50 cubic yards of concrete for each

class placed. At least one set of test specimens per day shall be made for each class of concrete used that day. Initial cure of specimens shall be in a temperature and moisture controlled environment as specified in ASTM C31. Initial cure shall be in an enclosure such that the temperature is uniform and can be monitored. The temperature range of initial curing shall be recorded using a maximum-minimum thermometer. See "Hot Weather" section of this specification for additional requirements. Final cure of specimens shall be under laboratory conditions specified in ASTM C31. Additional concrete cylinders may be required for curing on the job under actual job curing conditions. These Samples could be required when:

- 1). There is a possibility of the air temperature surrounding the concrete falling below 40 F, or rising above 90 F.
 - 2). The curing procedure may need to be improved and/or lengthened.
 - 3). It is necessary to determine when the structure may be put into service.
- b. Compression strength tests shall be made on the laboratory-cured and job-cured concrete cylinders at 7 and 28 days, in accordance with ASTM C39. The value of each test result shall be the average compressive strength of all of the cylinders in the test Sample. All cylinders within a test Sample shall be taken at the same time from the same batch of concrete. For the 28-day cylinders, the strength level shall be satisfactory if the averages of all sets of three consecutive strength test results exceed the required design compressive strength, and no individual strength test result falls below the required compressive strength by more than 500 psi. The method of initial curing and maximum and minimum initial curing temperatures shall be included on concrete compression test reports.
7. High Early Strength Concrete Test: When Type "III" High Early Strength Portland cement is used instead of Type "I" Portland cement, the minimum allowable 28-day strength for Type "I" Portland cement concrete shall be at 7 days. The ages at time of test for Type "III" shall be 3 days and 7 days, instead of 7 days and 28 days, respectively, for Type "I."
8. Failure to Meet Requirements:
- a. Should the 28-day strengths shown by the test specimens fall below the required values, additional curing shall be performed on those portions of the structures represented by the test specimens at the Contractor's expense. Test cores shall be obtained and tested in accordance with ASTM C42. If additional curing does not give the strength required, the Owner reserves the right to require strengthening, replacement of those substandard portions of the structure, or additional testing, at the Contractor's expense.
 - b. Upon receipt of the Contractor's written request, substandard concrete work may be reexamined in place by nondestructive testing methods or core Samples, in accordance with ACI 301. The services of an independent testing laboratory shall be retained and all expenses paid without compensation from the Owner. Laboratory results shall be evaluated by the Engineer, who shall make the final decision on acceptability of the concrete in question. Core Sample holes shall be repaired.
- B. The Owner may withhold payment for any section of concrete which does not meet the requirements of the Specifications. Withheld payment shall be based upon the unit prices established for concrete and reinforcing steel. Payment shall be withheld until the

unacceptable concrete has been refinished, removed and replaced or otherwise brought into conformance with the Specifications.

- C. PVC/TPER/PE Waterstops: Waterstops shall be observed by the Owner's representative prior to concrete placement. Unacceptable splicing defects include:
1. Misalignment of center bulb, ribs, and end bulbs greater than 1/16 inch.
 2. Bond failure at joint deeper than 1/16 inch.
 3. Misalignment which reduces waterstop cross-section more than 15 percent.
 4. Bubble or visible porosity in the weld.
 5. Visible signs of splice separation when a cooled splice is bent by hand at a sharp angle.
 6. Charred or burnt material.

Concrete Mix Design

Project Name: _____
FNI Project Number: _____
Project Location: _____
Owner: _____
General Contractor: _____
Mix Number / Class: _____

A. Mix Design:

Cement = _____ lb/yd³
Fly Ash = _____ lb/yd³
Other Cementitious Material:
_____ = _____ lb/yd³
Fine Aggregate = _____ lb/yd³
Coarse Aggregate = _____ lb/yd³
Water = _____ lb/yd³
Water Reducing Admixture = _____ oz/yd³
High Range Water Reducer = _____ oz/yd³
Air Entraining Admixture = _____ oz/yd³
Other Admixture:
_____ = _____ oz/yd³
Slump = _____ inches
Gross Weight = _____ lb/yd³
Air Content = _____ percent
Water/Cement Ratio = _____

B. Materials:

	Source	ASTM	Type	Remarks
Cement				
Fly Ash				
Other Cementitious Material: _____				
Fine Aggregate				
Coarse Aggregate				
Water				
Water Reducer				
High Range Water Reducer				
Air Entraining				

	Source	ASTM	Type	Remarks
Other Admixture: _____				

C. Determination of Average Strength Required (f_{cr}'):

1. Test Records Available:

A. Summary of Test Records (Provide Supporting Documentation):

Test Group No.	No. of Consecutive Tests	Specified Strength (psi)	Standard Deviation (psi)
Average Standard Deviation:			

B. Standard Deviation Modification Factor (ACI 301, Table 4.2.3.3.(a)2): ____.

C. Standard Deviation Used: ____.

D. Average Compressive Strength Required: ____.

2. Test Records Not Available:

A. Average Compressive Strength Required (ACI 301, Table 4.2.3.1, if required): ____.

D. Documentation of Required Average Compressive Strength (Check One):

1. Field Strength:

a. Field Strength Test Records (ACI 301, Table 4.2.3.3.a): _____. *Complete Attachment A.

2. Trial Mixtures:

a. Trial Mixtures (ACI 301, Table 4.2.3.1, if required): _____. *Complete Attachment B.

I, _____ certify that the above information is correct and all gradations, cement certifications, and test results are located at our place of business for review by the Engineer.

Name: _____ Date: _____

Title: _____

Company: _____

Address: _____

Attachment A

**Documentation of Required Average Strength – Field Strength Records
(ACI 301, 4.2.3.4.a or 4.2.3.4.b)**

A. Summary of Test Records (Provide Supporting Documentation):

Test Record No.	No. of Tests in Record	Duration of Record (days)	Water-Cementitious Materials Ratio	Average Strength (psi)

B. Interpolation used? _____.

1. Provide an interpolation calculation or plot of strength versus proportions.

C. Submit the following data for each mix:

1. Brand, type, and amount of cement.
2. Brand, type, and amount of each admixture.
3. Source of each material used.
4. Amount of water.
5. Proportions of each aggregate material per cubic yard.
6. Gross weight per cubic yard.
7. Measured slump.
8. Measured air content.
9. Results of consecutive strength tests.

END OF ATTACHEMENT A

Attachment B

Documentation of Required Average Strength – Trial Mixtures (ACI 301, 4.2.3.4.c)

A. Summary of Test Record(s):

Trial Mix No.	7-Day Tests		28-Day Tests		Water-Cementitious Materials Ratio	Slump (in)	Air Content (percent)	Temperature (F)
	No. of Test Cylinders	Strength (psi)	No. of Test Cylinders	Strength (psi)				

B. Maximum water-cementitious materials ratio _____.

1. Provide an interpolation calculation or plot of strength versus water-cementitious materials ratio.

C. Submit the following data for each mix:

1. Brand, type, and amount of cement.
2. Brand, type, and amount of each admixture.
3. Amount of water used in trial mixes.
4. Proportions of each aggregate material per cubic yard.
5. Gross weight per cubic yard.
6. Measured slump.
7. Measured air content.
8. Compressive strength developed at 7 days and 28 days, from not less than three test cylinders cast for each 7-day and 28-day test.

END OF ATTACHMENT B

END OF SECTION

31 11 00.13 CLEARING AND GRUBBING

1.00 GENERAL

1.01 WORK INCLUDED

- A. Furnish labor, materials, equipment, and incidentals necessary to clear, grub, and dispose of cleared and grubbed materials. Maintain tools and other equipment necessary to complete specified Work.

1.02 JOB CONDITIONS

- A. Debris, trash, or rubbish resulting from clearing and grubbing shall become property of the Contractor. It shall be promptly disposed of in compliance with the applicable ordinances.

2.00 PRODUCTS (NOT APPLICABLE)

3.00 EXECUTION

3.01 CLEARING

- A. Thoroughly clear (1) to the limits of the area to be occupied by the Rock Rip Rap, (2) areas of new sodding in the upper auxiliary spillway, and (3) the limits of the existing ACB concrete crest along the dam. Clearing shall consist of the felling, cutting up, and the satisfactory disposal of trees and other vegetation, together with the down timber, snags, brush, rubbish, and debris occurring within the area to be cleared. Cut off trees, other vegetation, stumps, roots, and brush in the area flush with or slightly below the original ground surface. Trees and brush outside the limits of the indicated areas to be cleared, but within the immediate vicinity of the Work that interfere with or retard the progress of construction operations, may be removed upon receipt of the approval of the Engineer.
- B. Remove and dispose of the existing Turf Reinforced Matting (TRM) and all appurtenances and attachments in the auxiliary spillway in the area to be occupied by the Rock Rip Rap.

3.02 GRUBBING

- A. Thoroughly grub the areas to be occupied by the Rock Rip Rap. Grubbing shall consist of the removal and disposal of stumps and roots larger than 1 inch in diameter to the depth indicated, matted roots, abandoned structures, abandoned concrete foundations, concrete floor slabs, and any other debris or rubble. Any grubbing that may cause damage to the surveyed trees identified in the Drawings shall be coordinated with the City.
- B. Completely remove timber, logs, roots, brush, rotten wood, and other refuse from the Owner's property. Disposal of materials in streams shall not be permitted and no materials shall be piled in stream channels or in areas where it might be washed away by floods. Timber within the area to be cleared shall become the property of the Contractor, and the Contractor may cut, trim, hew, saw, or otherwise dress felled timber within the limits of the Owner's property, provided timber and waste material is disposed of in a satisfactory manner. Materials shall be removed from the Site daily unless permission is granted by the Engineer to store the materials for longer periods.

END OF SECTION

31 23 19.01 CARE OF WATER DURING CONSTRUCTION

1.00 GENERAL

1.01 WORK INCLUDED

- A. Furnish labor, materials, equipment and incidentals necessary to operate pumps, piping and other facilities to assist in the removal of surface water, stormwater runoff, and ground water, and provide protection of the work site from water of any source. Build and maintain the necessary temporary dewatering systems, berms, diversions, impounding works, channels and ditches to protect the work site from lake levels and spillway discharges, streamflow, and stormwater runoff. Remove the temporary works, equipment, and materials after completion in accordance with this Section and the applicable Drawings.

1.02 SUBMITTALS

- A. Submittals shall be in accordance with the City of New Braunfels specifications and shall include:
 - 1. Plans and procedures for handling flood flows, stormwater runoff, and pool inlet dewatering systems for approval by the Engineer. Modifications to these plans shall also be submitted for approval by the Engineer. If the Project contains separate phases that require different steps in the diversion of streamflow or spillway discharges, then the submitted plans must clearly distinguish the differences in each phase. Plans for each phase in the sequence may be submitted separately.
- B. Approval of submittals does not relieve the Contractor of full responsibility and liability for care of water during construction.

2.00 PRODUCTS (NOT APPLICABLE)

3.00 EXECUTION

3.01 FLOOD FLOWS AND OTHER SURFACE WATER

- A. The Contractor shall understand that Landa Lake Dam was designed and constructed to store surface water up to the top of the dam that is approximately EL. 621.5, and to safely pass high flow events. Contractor shall conduct his means and methods as necessary to complete the work associated with the contract documents. It is the contractor's responsibility to keep abreast of the weather conditions at all times.
- B. The springfed pool level at Landa Lake Dam is controlled by two sluice gates at the pool inlet and one sluice gate at the downstream end of the pool. The Contractor may drain the pool for construction care of water and leave the downstream sluice gate open to pass nuisance flows during construction. Draining of the pool and further operation of the downstream sluice gate shall be coordinated with the Owner.
- C. The Contractor is responsible for handling and diverting any incidental flood flows, stormwater runoff, stream flows, or any other water, including groundwater encountered during the progress of the work. Build, maintain, and operate cofferdams, channels, flumes, sumps, berms, ditches, and other temporary works as needed to pass divert stream flow or

stormwater runoff water through or around the construction site and away from construction work while it is in progress. The handling of stormwater runoff should be coordinated with the erosion control plan. Unless otherwise approved by the Owner, a diversion must discharge into the same natural watercourse in which its headworks are located. Construct permanent Work in areas free from water. Full responsibility for the successful dewatering of the work areas rests with the Contractor. Remove protective works, after they have served their purpose, in a manner satisfactory to the Owner or its representative.

3.02 DEWATERING EXCAVATED AND OTHER FOUNDATION AREAS

- A. Contractor is responsible for dewatering foundations for all areas during construction of the Project, including areas of required backfills. Lower the water table as needed to keep work areas free of standing water or excessively muddy conditions as needed for proper performance of the construction work. Furnish, prepare, and maintain drains, sumps, casings, well points, and other equipment needed to dewater areas for required construction work. Any dewatering method that causes a loss of fines from foundation areas shall not be permitted. Keep available standby equipment to ensure the proper and continuous operation of the dewatering system. Provide continuous monitoring (24 hours per day) of the dewatering system to ensure continuous operation.
- B. Construction modifications in the dewatering system may be required by the Engineer to provide adequate performance. In the event of failure of the system, flooding of the excavation may be ordered by the Engineer until the system is operative.

3.03 POOL INLET DEWATERING INSTALLATION

- A. The Contractor is responsible for the design of the dewatering system at the springfed pool inlet as required to replace the sluice gates. The dewatering system must have a minimum top EL. of 621.5 and be contained within the concrete-lined channel. No component of the dewatering system shall be installed upstream of the channel within Landa Park Lake.

3.04 EVACUATION OF SITE DURING INCREASED FLOWS AND FLOODING CONDITIONS

- A. Protect and remove all equipment, materials, and personnel during increased flow conditions resulting from reservoir control operations, or any other increased flow condition. Any damage or loss of equipment and materials shall be at the Contractor's sole expense. The Owner shall not be liable for any damages or costs associated with Contractor's failure to adequately protect the work areas or to move equipment, personnel, and materials.

3.06 ESTIMATE LAKE LEVEL INFORMATION

- B. The estimated lake levels at the dam site are:

Storm Event	Lake Water Surface Elevation
Normal Pool	EL. 620.4
2-year "Low Flow"	EL. 622.4

END OF SECTION

31 37 00 ROCK RIPRAP

1.00 GENERAL

1.01 WORK INCLUDED

- A. Furnish labor, materials, equipment, tools and incidentals necessary to produce and place the rock riprap and geotextile material.

1.02 SUBMITTALS

- A. Submittals shall be in accordance with City of New Braunfels specifications.
- B. Certified Test Reports: soundness (ASTM C88), gradation (ASTM C136/ASTM D5519), and unit weight (ASTM C127).

1.03 STANDARDS

- A. Sampling and testing of material shall comply with the latest revision of the following except where specifically modified:
 - 1. ASTM International (ASTM):

ASTM C88	Standard Specification for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium sulfate
ASTM C127	Standard Specification for Specific Gravity and Absorption of Coarse Aggregates
ASTM C136	Standard Specification for Sieve Analysis of Fine and Coarse Aggregates
ASTM D5519	Standard Test Methods for Particle Size Analysis of Natural and Man-Made Riprap Materials

1.04 DELIVERY AND STORAGE; ROCK RIPRAP STOCKPILE

- A. Rock Riprap temporarily stockpiled for construction purposes shall be located in an area approved by the Owner. Rock riprap materials shall not be located so as to block or restrict equipment and vehicle access to existing structures or impact flow of spillways, drainageways, or creeks.

2.00 PRODUCTS

2.01 MATERIALS

- A. Rock Riprap:
 - 1. Stone for rock riprap shall be durable and of a suitable quality for permanence in the structure and in the climate which it is to be used. The stone shall be free from cracks, seams, and other defects which would tend to increase unduly its deterioration from natural causes and shall be reasonably well graded between the prescribed limits as shown in the Drawings.

2. Except as otherwise specified, the rock fragments shall be angular to subrounded. The least dimension of an individual stone fragment shall be not less than one-third the greatest dimension of the stone.
3. Rock riprap shall have a minimum unit weight of 150 pounds per solid cubic foot based upon the bulk specific gravity (saturated surface dry) when tested in accordance with ASTM C127. A minimum of one bulk specific gravity (saturated surface dry) shall be performed on rock riprap material delivered to the Site.
4. Rock riprap shall have a loss of less than 18 percent after five cycles when tested for soundness in magnesium sulfate in accordance with ASTM C88. A minimum of one soundness-in-magnesium sulfate test shall be performed on rock riprap material delivered to the Site.
5. Rock Riprap gradation shall be as shown on the Drawings. Acceptance of rock riprap material shall be based upon in-place gradations.

2.02 MANUFACTURED PRODUCTS

- A. Geotextile Fabric: Geotextile fabric shall be Typar manufactured by DuPont, Supra manufactured by Phillips Fibers Corporations, Bidim manufactured by Monsanto, or other approved equal. The weight of the material shall be at least 6 ounces per square yard. The material shall be nonwoven geotextile that is needle punched and made of 100 percent polypropylene fibers. Fabric shall have an AOS of 80 (US Standard Sieve Size) (ASTM D4751).

3.00 EXECUTION

3.01 FOUNDATION PREPARATION

- A. Trim and dress areas on which rock riprap are to be placed to conform to cross-sections shown on the Drawings within an allowable tolerance of plus or minus 2 inches from the slope lines and grades shown on the Drawings. Where such areas are below the allowable minus tolerance limit, bring areas to grade with compacted fill similar to the adjacent material.

3.02 GEOTEXTILE FABRIC

- A. Store and place fabric as specified by the manufacturer. Place the geotextile fabric after the foundation is prepared.
- B. Place fabric with the length running up and down the slope unless otherwise approved. The geotextile shall be placed so that placement of the overlying materials will not excessively stretch or tear the fabric. Anchoring of the terminal ends of the geotextile shall be accomplished through the use of key trenches or aprons at the crest and the toe of the slope.
- C. Make a minimum 24-inch lap on all joints. Secure fabric with nails or pins. Use nails at least 2 inches long with washers or U-shaped pins with legs at least 9 inches long. Space nails or pins at a maximum of 10 feet in each direction and 5 feet along the seams. Alternative anchor spacing may be used when approved.

- D. Construction vehicles will not be allowed to traffic directly on the fabric. Damaged geotextile shall be repaired with geotextile patch placed over the damaged area and extended 3 feet beyond the perimeter of the tear or damage.

3.03 ROCK RIPRAP PLACEMENT

- A. Place stone for rock riprap on the geotextile in such manner as to produce a reasonably well-graded mass of rock with the minimum practicable percentage of voids, and construct within the specified tolerance to the lines and grades shown on the Drawings or staked in the field. A tolerance of plus 6 or minus 0 inches from the slope lines and grades shown on the Drawings shall be allowed in the finished surface of the rock riprap. Place rock riprap to its full course thickness at one operation and in such a manner as to avoid displacing the geotextile material. Distribute the larger stones evenly and conform the entire mass of stones in their final position to the specified gradation.
- B. The finished rock riprap shall be free from objectionable pockets of small stones and clusters of larger stones. Place rock riprap loads along horizontal rows and progress up the slope. Place each load against previously placed rock riprap. Placing rock riprap by dumping from top of slope, dumping into chutes, or by similar methods likely to cause segregation of the various sizes shall not be permitted. The desired distribution of the various sizes of stones throughout the mass shall be obtained by methods of placement which produces the specified results. Rearrange individual stones by mechanical equipment or by hand to the extent necessary to obtain a reasonably well graded distribution of stone sizes. Maintain the rock riprap protection until accepted and replace any material displaced by any cause to the lines and grades shown on the Drawings.
- C. Rock riprap shall be placed in a manner to prevent damage to structures. Hand placing is required as necessary to prevent damage to any new and existing structures.

3.04 EROSION PROTECTION

- A. In the event rain is forecasted and a section of the auxiliary spillway is exposed during rock riprap replacement work, Contractor shall cover the exposed section of the spillway with geotextile fabric or plastic tarps to prevent erosion of the embankment material.

3.05 FIELD QUALITY CONTROL TESTING

- A. Contractor shall be responsible for providing all testing to demonstrate compliance with the requirements of the Contract Documents. Particle size analysis shall be performed in accordance with ASTM D5519, Test Method A or B. The analysis shall be performed at the work site on a test pile of representative rock. The mass of the test pile shall be at least 20 times the mass of the largest rock in the pile. The results of the test shall be compared to the gradation required for the Project prior to beginning placement. Test pile results that do not meet the construction specifications shall be cause for the rock to be rejected. The test pile that meets contract requirements shall be left on the job site as a sample for visual comparison. The test pile shall be used as part of the last rock riprap to be placed..
- B. In-place verification of the stone size shall be performed for every 100 CY of rock riprap placed. Determine the in-place size of the stone by taking linear transects along the rock riprap and measuring the intermediate axis of the stone at select intervals. Place a tape measure along the rock riprap and determine the intermediate axis size of the stone at 2-

foot intervals. Measure a minimum of 100 stones, either in a single transect or in multiple transects, then follow ASTM D5519 Test Procedure Part B to determine the gradation. Contractor shall bear all costs, including additional testing, of the correction of materials which fail to meet the requirements of the Contract Documents.

END OF SECTION

35 73 13.13 EXCAVATION

1.00 GENERAL

1.01 WORK INCLUDED

- A. Furnish labor, materials, equipment, and incidentals necessary to perform operations in connection with removing, hauling, and disposing of materials at the locations indicated.
- B. The locations of the excavations, excavation limit lines, borrow areas, and waste disposal areas are generally as shown on the Drawings. All excavation shall be subsidiary to the placement of the Rock Riprap in the auxiliary spillway as shown in the Drawings.

1.02 QUALITY ASSURANCE

A. Classification:

- 1. General: Classifications of excavation shall include material of whatever nature encountered, including clays, sands, gravels, conglomeritic boulders, weathered clay shales, shales, and rock. The Engineer shall, in accordance with the specifications, determine the classification of required excavations. Required excavation shall be considered to fall within one of the following classifications: stripping excavation, general required excavation, or borrow excavation.
- 2. Stripping Excavation: Stripping excavation shall consist of excavation, down to a designated depth as required to remove all turf reinforced matting, topsoil, rubbish, vegetation not removed by clearing and grubbing operations, and other unsatisfactory material from the foundation areas of the auxiliary spillway. Stripping operations shall be limited to the area within the lines indicated for required excavation and the foundation areas of the auxiliary spillway. Engineer may require excavation to a greater depth than the designated depth as indicated on the Drawings. Compensation for stripping excavation greater than the designated depth shall be made as general required excavation. Continuous drainage of stripped areas shall be maintained to prevent ponding of water or formation of swampy areas. Stripped soil may be stockpiled in an approved location for future use as topsoil if clear of debris. Otherwise, stripped soils shall be wasted in an approved area.
- 3. General Required Excavation: General required excavation shall consist of the material required to be excavated for the permanent work which is not classified or subsidiary to another class of excavation or other work. General required excavation shall include material of whatever nature encountered including clays, sands, gravels, caliche, conglomeritic boulders, and weathered clay shales and shales, and rock, if encountered in required excavations.

B. Definitions: For the purpose of these classifications, the following definitions shall apply:

- 1. Heavy Ripping Equipment: A rear-mounted, heavy duty, single-tooth, ripping attachment mounted on a track-type tractor having a power rating of at least 300 net horsepower (at the flywheel).
- 2. Wheel Tractor-Scraper: A self-loading (not elevating) and unloading scraper having a struck bowl capacity of more than 12 cubic yards.

3. Pusher Tractor: A track type tractor having a power rating of at least 300 net horsepower (at the flywheel) equipped with appropriate attachments.

2.00 PRODUCTS (NOT APPLICABLE)

3.00 EXECUTION

3.01 PREPARATION

- A. Perform excavation of materials by the use of any excavating and hauling equipment adaptable to the work and by any method generally accepted for this type of work.

3.02 REMOVAL

A. General:

1. Excavate to the lines and grades indicated or as directed by the Engineer. Any and all excess excavation for the convenience of the Contractor or over-excavation performed by the Contractor for any purpose or reason, except when ordered by the Engineer, and whether or not due to the fault of the Contractor, will be at the expense of the Contractor. Where required to complete the work, refill the excess excavation and over excavation with materials furnished, placed, and compacted at the Contractor's expense, using procedures and materials specified herein. No excavation shall occur within the limits Landa Park Lake or below the normal waterline of the Comal River 'Old Channel'.
2. Perform excavation for the auxiliary spillway in the dry. No excavation shall be made in frozen material without the approval of the Engineer. No additional allowance above the unit prices bid per cubic yard for the respective classification of excavation shall be made on account of any material being wet or frozen or on account of any surface or ground water condition.
3. Excavations shall be to the full dimensions indicated, or as directed by the Engineer. Finish excavations to the prescribed lines and grades. Individual sharp points of undisturbed material may extend within the prescribed lines not more than 6 inches except in areas that are excavated as for the auxiliary spillway, for which no extension of points into the prescribed lines and grades is acceptable.
4. Following completion of the excavation and prior to placement of the auxiliary spillway Rock Rip Rap upon the prepared foundation surface, the Engineer shall approve the foundation surface. Proof rolling may be required before approval. The foundation material shall meet the moisture and density requirements of the fill material to be placed upon it at the time the material is being placed. If the foundation material which, in the opinion of the Engineer, is unsuitable for use as the foundation, perform additional excavation and backfill as directed. Such additional directed excavation and backfill shall be paid for in accordance with the appropriate bid items or agreed upon prices. Following approval of the foundation surface, assume full responsibility for maintaining the foundation surface and remove or re-compact the weathered or unsatisfactory foundation material and replace with compacted fill or lean concrete, at the Contractor's expense. Following approval of the foundation, diligently prosecute the working of placing the appropriate embankment or structural material on the

prepared foundation. Do not excavate or maintain the side slopes any steeper than 3 horizontal to 1 vertical (3:1) unless otherwise indicated on the Drawings.

5. Maintenance of side slopes is the Contractor's responsibility.
- B. No blasting is allowed.

END OF SECTION

40 05 50 FABRICATED GATES

1.00 GENERAL

1.01 WORK INCLUDED

- A. Furnish labor, materials, equipment and incidentals necessary to fabricate, test and install slide gates as shown on the Drawings with operators, gate stems, frames, gate guides, wall thimbles and other related appurtenances.

1.02 QUALITY ASSURANCE

- A. Acceptable Manufacturers:
 - 1. Whipps.
 - 2. Rodney Hunt.
 - 3. Fontaine.
 - 4. Golden Harvest.
 - 5. RW Gate.
- B. The fully assembled gates shall be shop inspected, tested for operation and leakage, and adjusted before shipping. Manufacturer shall provide test certificates to show that they meet the leakage rate required in this Section. Factory hydrostatic testing shall be conducted to the maximum design head 8-feet. There shall be no assembling or adjusting on the Site other than for the lifting mechanism

1.03 SUBMITTALS

- A. Submittals shall be in accordance with City of New Braunfels specifications and shall include at least the following:
 - 1. Shop Drawings:
 - a. Certified shop and installation drawings showing all materials, details of construction, dimensions and anchor bolt locations. General arrangement drawings and catalog cut sheets are not acceptable for use as shop and installation drawings.
 - b. Submit a list of not less than 10 operating installations in the United States with similar size gates as scheduled, as evidence of meeting the experience requirement. Include project reference contact information.
 - 2. Record Data:
 - a. Descriptive literature, bulletins and/or catalogs of the equipment.
 - b. Prior to shipment of gates, submit certified affidavit of compliance stating that the gates for this Contract were manufactured, inspected, and tested in accordance with all applicable AWWA and ASTM Standards.
 - c. Shop test reports, including test results from operation and shop leakage tests on all gates. Leakage tests shall be performed with water in the unseating head condition. Feeler gauge testing is not acceptable in lieu of testing with water.

3. Operation and Maintenance Manuals.

1.04 STANDARDS

- A. The applicable provisions of the following standard shall apply as if written here in its entirety unless expressly contradicted in the text of this specification:
 1. American Water Works Association (AWWA): AWWA C561-21, Fabricated Stainless-Steel Slide Gates (latest revision).
 2. ASTM International (ASTM).
 3. American Welding Society (AWS).

1.05 EXPERIENCE REQUIREMENTS

- A. The equipment Supplier shall have at least 10 years of experience in the design, application and supply of stainless steel fabricated gates in water service. The equipment supplier shall submit a list of not less than 10 operating installations in the United States with similar size gate as scheduled, as evidence of meeting the experience requirement. Installation list shall be submitted with the Shop Drawings.

1.06 GUARANTEE AND WARRANTY

- A. Gate Manufacturer shall warrant the equipment furnished under this specification for a minimum period of 5 years against defects in materials and workmanship, and operational failure.
- B. In the event of a defect in material or workmanship or equipment design of any part or parts of the equipment during the first 5 years of service, provided that the equipment has been operated and maintained in accordance with good practice, the Gate Manufacturer shall furnish, deliver and install a replacement for the defective part or parts at its own expense.
- C. The first 5 years of service shall be interpreted as the 60-month period following the installation, adjusting, and acceptance tests of all gates, operators, motors and appurtenances.

2.00 PRODUCTS

2.01 MATERIALS

- A. Materials in fabricated gates and appurtenances shall conform to the requirements of the applicable specifications listed below for the alloy, grade, type, or class of material and the condition and finish appropriate to the structural and operational requirements:
 1. Carbon Steel Bars: ASTM A108 or ASTM A575.
 2. Structural Steel Shapes, Plates, and Bars: ASTM A36.
 3. Stainless Steel: ASTM A167, ASTM A276 or ASTM A582, Type 302, 303, 304 or 304L, 316 or 316L.
 4. Bronze Bar, Rods, Shapes: ASTM B21 or ASTM B98.

5. Cast Bronze: ASTM B584.
6. Rubber for Gaskets and Seals: ASTM D2000.
7. UHMW Polyethylene: ASTM D4020.
8. Fasteners, screws, and washers: Type 304 or 316 Stainless Steel.
9. Nuts: ASTM B98 Alloy 651, 655 Silicon Bronze

2.02 GATE DEFINITIONS

- A. Slide gates are defined as fabricated gates with bottom and side seals. Slide gates are typically used for open channel isolation and diversion. The top of slide gates are typically above the maximum water surface elevation. Slide gates are not suitable for submerged orifice applications.

2.03 FABRICATED GATES

A. General:

1. Gates shall be as specified herein and have the characteristics and dimensions shown on the Contract Documents and schedule. Any discrepancies shall be brought to the attention of the Engineer.
2. Leakage for fabricated gates shall not exceed 0.1 gpm/ft of wetted seal perimeter in seating and unseating head conditions.
3. The gate seal design shall meet the latest applicable AWWA standards.
4. All structural components of the frame and slide shall be constructed of fabricated stainless steel having a minimum thickness of 1/4 inch and shall have adequate strength to prevent distortion during normal handling, during installation and while in service.
5. All welding shall be performed by welders with AWS or ASME Section IX certification and be completed in the manufacturing facility. No welding is allowed in the field during installation.
6. Fabricated components shall be passivated in accordance with ASTM A380 to remove weld burn and discoloration for uniform finish. If sandblasting or glass bead blasting is utilized, the entire frame and slide shall be blasted for a uniform finish.
7. Materials:

Components	Materials
Frame Assembly and Retainers	304L stainless steel.
Slide and Stiffeners	304L stainless steel.
Stem	304L stainless steel.
Fasteners, Nuts and Bolts	316 stainless steel
Invert Seal (Upward Opening Gates Only)	EPDM or Neoprene
Seat/Seals and Facing	UHMWPE.
Lift Nuts	Bronze

Components	Materials
Pedestal and Wall Brackets	Stainless steel

B. Frames:

1. Frame shall be formed or extruded construction consisting of guides and invert members. Suitable reinforcements will be provided to resist all operating loads. The mounting and bolting flange of the frame to the wall shall be separate and independent from the seating and sealing plane of the slide.
2. The structural portion of the frame that incorporates the seat/seals shall be formed into a one-piece shape for rigidity. Gussets shall be provided on the guides to transfer the load from unseating head conditions to the wall. Guide member designs where water loads are transferred through the assembly bolts are not acceptable.
3. The portion of the wall mounted guide, where the anchor bolt penetrates, shall have a minimum thickness of 1/2-inch. Guide extensions shall be formed plate C-channel or Z-channel members and shall have a minimum weight of 6 lb/ft. Angles are not acceptable as guide extensions. Alternatively, the manufacturer may supply frames with a flange-back design utilizing fully welded gusset plate stiffeners, minimum 1/4-inch thickness in order to limit the frame deflection to lesser of $1/360 \times L$ or 1/16 inch.
4. On self-contained gates, a yoke shall be provided across the top of the frame. The yoke shall be formed by two C-channel shaped structural members affixed to the top of the side frame members to provide a one-piece rigid assembly. The yoke shall be designed to allow removal of the slide. The maximum deflection of the yoke shall be $1/360$ of the gate's span or 1/16 inch, whichever is less.
5. A rigid stainless steel invert member shall be provided across the bottom of the opening. The invert member shall be of the flushbottom type on upward opening gates. Flushbottom seal shall incorporate an embedded frame channel gate for new construction or an existing channel gate mount for existing channels.
6. The frame shall be capable of withstanding lateral forces as appropriate in this configuration as well as during the extraction of the slide with lifting cables at angles of up to 10 degrees.

C. Slides and Guides:

1. The slide and reinforcing stiffeners shall be constructed of stainless steel plate. All structural components shall have a minimum thickness of 1/4 inch.
2. The gate slide deflection shall not exceed $1/360$ th of gate width at maximum design head or 1/16 inch, whichever is less.
3. Reinforcing stiffeners shall be welded to the slide and mounted horizontally. Vertical stiffeners shall be welded on the outside of the horizontal stiffeners for additional reinforcement if needed.
4. The stem connector shall be constructed of two angles or plates. The stem connector shall be welded to the slide. A minimum of two bolts shall connect the stem to the stem connector.

5. The gate guides shall be designed for maximum rigidity, having a weight of not less than 7 pounds per foot for wall mounted frames. The guides shall be of sufficient length to properly support two-thirds of the height of the slide when the gate is fully open. On self-contained gates, where the guides extend above the operating floor, they shall be strong enough so that no further reinforcing shall be required.
6. Each gate frame shall be fabricated with two integrated lifting lugs or eyes capable of supporting the entire weight of the gate assembly. The location of the lifting points shall be determined by the manufacturer for lifting from above.
7. Seat facings shall be machined to a smooth finish to ensure proper watertight contact.

D. Gate Stem and Lift:

1. Stems shall be of suitable length with minimum 1.0-inch diameter, and ample strength for the intended service. The operating stem shall be rising. The stem diameter shall be capable of withstanding twice the rated output of the operator at 40 pounds crank or hand wheel pull and shall be capable of moving the gate slide with the specified seating and unseating head against the gate.
2. The stem shall be furnished in sections of sufficient length to completely open the gate as necessary and to permit reasonable ease transportation and in installation. Couplings shall be stainless steel and shall be bored and bolted or pinned. Stem threads shall be machine rolled or machine-cut full depth ACME threads. The threads shall be smooth and of uniform lead and cross-section, such that the nut can travel the full length without binding or excessive friction. The stem shall be provided with two bolt holes for connection to the stem connector on the slide or the stem shall be threaded for connection to the stem block or thrust nut on the gate slide. The entire stem shall be of solid stainless steel material and the threaded portion of the stem shall have a rolled or machine cut full depth, full depth ACME threads with a 16-microinch finish or better. Stem extension pipes are not acceptable unless specifically required by the Contract Documents and approved prior to installation by the Engineer.
3. Stem guides shall be fabricated from stainless steel with UHMWPE bushed collars and adjustable in two directions. Stem guide spacing shall be as recommended by the manufacturer, but in no case shall it exceed slenderness ratio l/r ratio of 200.
4. An adjustable bronze, or stainless steel stop collar shall be provided to limit both upward and downward travel of the fabricated gate. The stop collar shall be internally threaded and provided with a stainless steel set screw. Removable upstops and downstops can also be provided on the slide and frame.
5. Provision shall be made to prevent stem rotation within the thrust nut at the connection with the gate slide.

E. Seals:

1. All gates shall be equipped with self-adjusting UHMW polyethylene side and bottom seat/seals to restrict leakage and to prevent metal to metal contact between the frame and slide.
2. The seat/seals shall extend the full height of the frame and guides to accommodate the height of the slide when the slide is in the fully closed or fully opened position.

3. The seal system shall be durable and shall be designed to accommodate high velocities and frequent cycling without loosening or suffering damage.
 4. Wall mounted upward opening gates shall be provided with a resilient seal to seal the bottom portion of the gate. The seal shall be attached to the invert member or the bottom of the slide and it shall be held in place with stainless steel attachment hardware.
 5. All seals must be bolted or otherwise mechanically fastened to the frame or slide. All seals must be field replaceable without the need to remove the gate frame from the wall or without the need to remove grout. Arrangement with seals that are force fit or held in place with adhesives are unacceptable.
 6. The seals shall be mounted so as not to obstruct the gate opening.
 7. The seal system shall be factory tested to confirm negligible wear (less than 0.02 inches) and proper sealing.
- F. Manual Operators: Gates shall be operated by a manual horizontal handwheel. The operator shall be mounted on the yoke of the gate.
1. The gate manufacturer shall select the proper gear ratio to ensure that the gate can be operated with no more than a 40-pound effort when the gate is in the closed position and experiencing the maximum operating head.
 2. An arrow with the word "OPEN" shall be permanently attached or cast onto the operator to indicate the direction or rotation to open the gate.
 3. Manufacturer shall provide the appropriate operator handwheel at 36 inches above operating platform unless noted otherwise in the schedule or the Drawings.
 4. Handwheel operators shall be fully enclosed and shall have a cast aluminum, stainless steel or ductile iron housing.
 - a. Handwheel operators shall be provided with a threaded cast bronze lift nut to engage the operating stem.
 - b. Handwheel operators shall be equipped with roller bearings above and below the operating nut.
 - c. Positive mechanical seals shall be provided above and below the operating nut to exclude moisture and dirt and prevent leakage of lubricant out of the hoist.
 - d. The handwheel shall be removable and shall have a minimum diameter of 14 inches.
 - e. Operators shall not include stem covers.

3.00 EXECUTION

3.01 INSTALLATION

- A. Fabricated gates shall be installed in accordance with the recommendations of the gate manufacturer. Guide frames for fabricated gates shall be as shown on the schedule. The bottom of the fabricated gate structure shall be embedded flush bottom, unless otherwise indicated.

- B. Install the gates in a manner that will prevent leakage around the frame and will prevent binding of the slide during operation. Keep surfaces where metal and the concrete placed come in contact free from oil, grease, loose mill scale, loose paint, surface rust, and other debris or objectionable coatings. Secure anchor bolts, thimbles and spigot frames in true position in the forms and hold in alignment during the placement of the concrete. Finish surfaces to provide a smooth and uniform contact surface where concrete and rubber seals come in contact and where frames or plates are installed. When a gate or stop log frame is installed against concrete, the Contractor shall either install using double-nuts and a nominal 1-inch grout pad or a minimum 3/8-inch thick 1/2-inch EPDM mounting gasket or 1/2-inch non-shrink grout shall be placed between the gate and the concrete
- C. Carefully align gate stems, stem guides and gate lifts so the stem is parallel to the guide bars or angles on the gate frame after installation.

3.02 FIELD QUALITY CONTROL

- A. Prior to final acceptance by the Owner, the slide gates shall be tested in the presence of the Engineer. A seating head and/or unseating head, at the Engineer's request, corresponding to the maximum water level shall be placed on the slide gate and the gate examined for leakage. The maximum allowable leakage for fabricated gates shall be per Paragraphs 2.03.A.2 Manufacturer shall provide test certificates to show that they meet the leakage rate required in this Section. The slide gate shall be opened from the fully closed position under maximum seating head, and closed from the fully open position under average flow conditions to verify that the gate lift is operational and in satisfactory working order.

3.03 CLEAN AND ADJUST

- A. After installation, clean, lubricate, and otherwise service the gate and lift in accordance with the manufacturer's instructions.

END OF SECTION

Item 162

Sodding for Erosion Control



1. DESCRIPTION

Provide and install grass sod as shown on the plans or as directed.

2. MATERIALS

Use live, growing grass sod of the type specified on the plans. Use grass sod with a healthy root system and dense matted roots throughout the soil of the sod for a minimum thickness of 1 in. Do not use sod from areas where the grass is thinned out. Keep sod material moist from the time it is dug until it is planted. Grass sod with dried roots is unacceptable.

- 2.1. **Block Sod.** Use block, rolled, or solid sod free from noxious weeds, Johnson grass, other grasses, or any matter deleterious to the growth and subsistence of the sod.
- 2.2. **Mulch Sod.** Use mulch sod from an approved source, free from noxious weeds, Johnson grass, other grasses, or any matter deleterious to the growth and subsistence of the sod.
- 2.3. **Fertilizer.** Furnish fertilizer in accordance with Article 166.2., "Materials."
- 2.4. **Water.** Furnish water in accordance with Article 168.2., "Materials."
- 2.5. **Mulch.** Use straw mulch consisting of oat, wheat, or rice straw or hay mulch of either Bermudagrass or prairie grasses. Use straw or hay mulch free of Johnson grass and other noxious and foreign materials. Keep the mulch dry and do not use molded or rotted material.
- 2.6. **Tacking Methods.** Use a tacking agent applied in accordance with the manufacturer's recommendations or a crimping method on all straw or hay mulch operations. Use tacking agents as approved or as specified on the plans.

3. CONSTRUCTION

Cultivate the area to a depth of 4 in. before placing the sod. Plant the sod specified and mulch, if required, after the area has been completed to lines and grades as shown on the plans. Apply fertilizer uniformly over the entire area in accordance with Article 166.3., "Construction," and water in accordance with Article 168.3., "Construction." Plant between the average date of the last freeze in the Spring and 6 weeks before the average date for the first freeze in the Fall according to the Texas Almanac for the project area.

- 3.1. **Sodding Types.**
 - 3.1.1. **Spot Sodding.** Use only Bermudagrass sod. Create furrows parallel to the roadway, approximately 5 in. deep and on 18-in. centers. Sod a continuous row not less than 3 in. wide in the 2 furrows adjacent to the roadway. Place 3-in. squares of sod on 15-in. centers in the remaining furrows. Place sod so that the root system will be completely covered by the soil. Firm all sides of the sod with the soil without covering the sod with soil.
 - 3.1.2. **Block Sodding.** Place sod over the prepared area. Roll or tamp the sodded area to form a thoroughly compacted, solid mat filling all voids in the sodded area with additional sod. Trim and remove all visible netting and backing materials. Keep sod along edges of curbs, driveways, walkways, etc., trimmed until acceptance.

- 3.1.3. **Mulch Sodding.** Mow sod source to no shorter than 4 in., rake and remove cuttings. Disk the sod in 2 directions, cutting the sod to a minimum of 4 in. Excavate the sod material to a depth of no more than 6 in. Keep excavated material moist or it will be rejected. Distribute the mulch sod uniformly over the area to a depth of 6 in. loose, unless otherwise shown on the plans, and roll with a light roller or other suitable equipment.
- Add or reshape the mulch sod to meet the requirements of Section 162.3.2., "Finishing."
- 3.2. **Finishing.** Smooth and shape the area after planting to conform to the desired cross-sections. Spread any excess soil uniformly over adjacent areas or dispose of the excess soil as directed.
- 3.3. **Straw or Hay Mulch.** Apply straw or hay mulch for "Spot Sodding" and "Mulch Sodding" uniformly over the area as shown on the plans. Apply straw mulch at 2 to 2-1/2 tons per acre. Apply hay mulch at 1-1/2 to 2 tons per acre. Use a tacking method over the mulched area.

4. MEASUREMENT

"Spot Sodding," "Block Sodding," and "Straw or Hay Mulch" will be measured by the square yard in its final position. "Mulch Sodding" will be measured by the square yard in its final position or by the cubic yard in vehicles as delivered to the planting site.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "Spot Sodding," "Block Sodding," "Straw or Hay Mulch," or "Mulch Sodding." This price is full compensation for securing a source, excavation, loading, hauling, placing, rolling, finishing, furnishing materials, equipment, labor, tools, supplies, and incidentals. Fertilizer will not be paid for directly but will be subsidiary to this Item.

Unless otherwise specified on the plans, water, except for that used for maintaining and preparing the sod before planting, will be measured and paid for in accordance with Item 168, "Vegetative Watering