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TECHNICAL SPECIFICATIONS

Contractor shall refer to the following documents for Technical Specifications, unless otherwise noted in the contract documents:

City of Buckeye Water Engineering Design Standards – June 2020

MAG Uniform Standard Specifications and Details for Public Works Construction – 2022 Revision to the 2020 Edition (Incorporated by Reference)

Division 09 – Finishes

09 91 00 Piping and Equipment Painting

Division 26 – Electrical

26 00 10 Electrical General Provisions
26 01 10 Raceways
26 01 20 Wire and Cable
26 01 94 Distribution Panelboards
26 01 97 Enclosed Circuit Breakers
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26 09 10 Instrumentation
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Division 33 – Utilities

33 14 14 High Density Polyethylene (HDPE) Pipe

Division 40 – Process Interconnections

40 05 67 Flow Control Valve
40 75 21 Chlorine Analyzer
40 91 16 Electromagnetic Meters

Appendix A – Geotechnical Report

MAG Standard Specifications List

All specifications applicable to construction for this project are identified as follows:

Applicable specifications listed below can be found on MAG's website at the address below:

https://azmag.gov/Portals/0/Documents/MagContent/2022_MAG_Uniform_Standard_Specifications_for_Public_Works_Construction_SPECS_FINAL.pdf

Part 300 – Streets and Related Work

Part 600 – Water, Sewer, Storm Drain and Irrigation

Part 700 – Materials

END OF SECTION

SECTION 09 91 00
PIPING AND EQUIPMENT PAINTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Furnish all labor, materials, tools and equipment required for painting of piping and equipment which are to receive finish as indicated in the paint schedule. This section applies to mechanical piping, valves, fittings, and electrical equipment.

B. Related Specification Sections include but are not limited to:
   1. City of Buckeye Water Engineering Design Standards.
   2. MAG Uniform Standard Specifications and Details for Public Works Construction.
   3. Division 40 – Process Interconnections.

1.2 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment
   1. Work associated with this Item is included in the total lump sum price for the control valve assembly and/or the connection to existing tank.

1.3 REFERENCES

A. Definitions
   1. For purposes of this painting specification, the following areas and spaces are not considered finished, occupied areas and there will be no painting therein except for doors and frames and as may be specifically scheduled in article paint schedule.
      a. Mechanical chases
      b. Spaces above suspended ceilings
      c. Under-floor crawl spaces

B. Reference Standards
   1. Reference standards cited in this Section refer to the current reference standard published at the time of the latest revision date logged at the end of this Section unless a date is specifically cited.
   2. American Society for Testing and Materials (ASTM):
      a. ASTM D 16 – Standard Terminology for Paint, Related Coatings, Materials, and Applications.
      b. ASTM D 4258 – Standard Practice for Surface Cleaning Concrete for Coating.
      c. ASTM D 4262 – Standard Test Method for pH of Chemically Cleaned or Etched Concrete Surfaces.
      d. ASTM D 4263 - Standard Test Method for Indicating Moisture in Concrete by The Plastic Sheet Method.
   3. NACE (National Association of Corrosion Engineers) - Industrial maintenance Painting.

4. NPCA (National Paint and Coatings Association) Guide to U.S. Government Paint Specifications.
5. PDCA (Painting and Decorating Contractors of America) - Painting - Architectural Specifications Manual.
6. SSPC (Steel Structures Painting Council) - Steel Structures Painting Manual.

1.4 ADMINISTRATIVE REQUIREMENTS [NOT USED]

1.5 SUBMITTALS

A. Submittals shall be in accordance with City of Buckeye Water Engineering Design Standards.

B. All submittals shall be approved by the City prior to delivery.

1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS

A. Product Data
   1. For each paint system used herein, furnish a Paint System Data Sheet (PSDS), Technical Data Sheets, and paint colors available (where applicable) for each product used in the paint system, except for products applied by equipment manufacturers.
   2. The Contractor shall also provide copies of the paint system submittals to the coating applicator.
   3. Indiscriminate submittal of manufacturer's literature only is not acceptable.

B. Shop Drawings
   1. Submit two 8 1/2” x 11” samples of each paint color. Samples shall be on heavy cardboard and shall be made with the actual mixed paints to be used on the project

C. Certificates
   1. Where ANSI/NSF Standard 60 and 61 approval is required, submit ANSI/NSF certification letter for each coating in the system indicating product application limits on size of tank or piping, dry film thickness, number of coats, specific product tested, colors certified, and approved additives.

D. Source Quality Control Submittals
   1. Applicator’s Experience
      a. List of references substantiating the requirements as specified.
   2. Factory Applied Coatings
      a. Manufacturer's certification stating factory applied coating systems meets or exceeds requirements specified herein.
   3. If the manufacturer of finish coating differs from that of shop primer, provide both manufacturers’ written confirmation that materials are compatible.

1.7 CLOSEOUT SUBMITTALS

A. Record Documentation
   1. Close-out Schedule

B. Upon completion of work, furnish a full schedule of paint types and colors actually used and formulas for each to the City.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Materials

1. Upon completion of the work, deliver to project site 2 gallons of each type and color of paint applied to interior and exterior surfaces. Provide formula for custom match colors.

1.9 QUALITY ASSURANCE

A. Qualifications

1. Manufacturers
   a. The paint manufacturer shall provide a representative to visit the jobsite at intervals during surface preparation and painting as may be required for product application quality assurance, and to determine compliance with manufacturer's instructions and the Contract Documents, and as may be necessary to resolve field problems attributable to, or associated with, the manufacturer's products furnished under this Contract.
2. Applicators
   a. Minimum of 5 years practical experience in application of specified products. Submit a list of recent projects and names of references for those projects. The Engineer will waive the requirement for 5 years' experience, when at the discretion of the Engineer, the applicators' experience and capabilities meet the intent of the experience requirement.

B. Product Labels

1. Include manufacturer's name, type of paint, stock number, color and label analysis on label of containers.

C. Single Source Responsibility

1. Provide primers and other undercoat paint produced by same manufacturer as final coats. Use only thinners approved by paint manufacturer and use only within recommended limits.

D. Do not paint over code-required labels, such as Underwriters' Laboratories and Factory Mutual, or equipment identification, performance rating, name or nomenclature plates. Delivery, storage, and handling

E. Inspection

1. Inspect and provide substrate surfaces prepared in accordance with the Contract Documents and the printed directions and recommendations of paint manufacturer whose product is to be applied.
2. Provide Engineer minimum 3 days advance notice prior to start of surface preparation work or coating application work.
3. Inspection by the Engineer, or the waiver of inspection of any particular portion of the Work, shall not be construed to relieve the Contractor of responsibility to perform the Work in accordance with the Contract Documents.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements

1. Deliver paint materials in sealed original labeled containers bearing manufacturers name, type of paint, brand name, color designation and instructions for mixing.
2. Provide adequate storage facilities at minimum ambient temperature of 45° F to a maximum of 90° F in well-ventilated area.
3. Where precoated items are to be shipped to the jobsite, protect coating from damage. Batten coated items to prevent abrasion.
4. Use nonmetallic or padded slings and straps in handling.
5. Items will be rejected for excessive damage.

B. Storage and Handling Requirements
1. Store paints in a suitable protected area that is heated or cooled as required to maintain temperatures within the range recommended by the paint manufacturer.

1.11 SITE CONDITIONS

A. Environmental Requirements
1. Comply with manufacturer's recommendations as to environmental conditions under which coatings and systems can be applied.
2. Do not apply finish in areas where dust is being generated.
3. Do not perform abrasive blast cleaning whenever the relative humidity exceeds 85 percent or whenever surface temperature is less than 5 degrees F above the dew point of the ambient air.
4. Surface preparation power tools and blast equipment shall contain dust collection equipment that will prevent discharge of dust particles into the atmosphere when surface preparation work is located within enclosures or confined areas with electrical equipment, motors, instrumentation, or other equipment that may be damaged by airborne dust and particles.

1.12 WARRANTY

A. Manufacturer Warranty
1. The Contractor and coating manufacturer shall jointly and severally warrant to the City and guarantee the Work under this Section against defective workmanship and materials for a period of 2 years commencing on the date of final acceptance of the Work.
2. A warranty inspection shall be conducted 1 month prior to expiration of the warranty period. Any defective Work discovered at this date shall be corrected by the Contractor in accordance with the Contract Documents at no additional cost to the City. Other corrective measures may be required during the 2 year warranty period.

PART 2 - PRODUCTS

2.1 CITY-FURNISHED PRODUCTS [NOT USED]

2.2 MATERIALS

A. Manufacturers
1. Manufacturer List

a. Sherwin Williams
b. Or approved equal
c. Other coating manufacturers will only be considered if the product complies with an unlimited recoat window.

B. Description
1. Regulatory Requirements
a. Products shall meet federal, state, and local requirements limiting the emission of volatile organic compounds.
b. Coatings shall be free of lead and lead compounds.

C. Materials
1. General
a. Whenever a material is identified by reference to manufacturer's or vendors' names, trade names, catalog number or the like, it is so identified for the purpose of establishing a standard, and material of other manufacturers or vendors which will perform adequately the duties imposed by the general design will be considered acceptable provided the material proposed is substituted in accordance with the General Provisions. It shall not be purchased or installed by the Contractor without the Engineer’s written approval.
b. Materials Including Primer and Finish Coats shall be produced by same paint manufacturer.
c. Thinners, Cleaners, Driers, and Other Additives may be used as recommended by paint manufacturer of the particular coating. Where coatings are required to meet ANSI/NSF Standard 60 and 61, addition of thinners, driers, and other paint additives not approved under the ANSI/NSF certification letter will not be permitted without written approval from the Engineer.
2. Products
a. Moisture Cured Zinc Primer – Single component, moisture cured urethane based, 12 lbs. metallic zinc content per gallon minimum, unlimited recoat period.
b. Moisture Cured Urethane – Single component, moisture cured urethane intermediate and top coat, suitable for high humidity and condensation, unlimited recoat period.
c. Polyamide Epoxy, High Solids – Polyamide or polyamine cured epoxy suitable for immersion or buried service.
3. Colors
a. Paint color shall be Desert Tan or,
1) Provide as selected by the City or Engineer. Colors will be selected by the City from standard manufacturer’s color samples.
2) The Contractor shall submit for approval samples of each color and finish, with the name of the manufacturer made in accordance with paragraph 1.6 B. Approved samples will form a standard for acceptance or rejection of completed work as to color and finish. Most colors will be the inter-mixes and let downs. Mix paints as required to obtain the color scheduled.

D. Paint Schedule
1. The products listed below represent top of the line products of each manufacturer. These products are not presented as being equivalent, as there are too many variables to match each product across the board.

2. Above Ground Valves, Pipes, and Fittings (Non-Submerged)
   a. Surface Preparation
      1) SSPC-SP1 and SSPC-SP10
   b. Painting System
      1) 1st Coat
         a) 5.0 – 10.0 dry mils of Sherwin-Williams Macropoxy 646 fast cure epoxy @ the rate of 115 sq.ft./gal.
      2) 2nd Coat
         a) 3.0 – 5.0 dry mils of Sherwin-Williams Hi-Solids Polyurethane @ the rate of 208 sq.ft./gal.

2.3 ACCESSORIES [NOT USED]

2.4 SOURCE QUALITY CONTROL [NOT USED]

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION

A. Inspection
   1. Thoroughly examine surfaces scheduled to be painted prior to commencement of work.
   2. The application of finishes shall be held to denote the acceptance of surfaces and conditions by the painter and he will be responsible for producing results reasonably to be expected under the specifications. Rooms shall be swept out before application of paint, and no sweeping shall be done in or adjacent to places where the paint has not had sufficient time to dry dust-free.
   3. Check each coat for the correct milage. Do not make measurement before a minimum of 8 hours after application of the coating

B. Inspection Test Equipment
   1. Provide a magnetic type or electronic dry film thickness gauge to test coating thickness specified in mils, as manufactured by:
      a. Nordson Corp., Anaheim, CA, Mikrotest.
      b. DeFelsko Corp., Anaheim, CA, PosiTector.
      c. Or equal.
   2. Provide an electrical holiday detector, low voltage, wet sponge type to test finish coatings less than 20 mils in thickness, except zinc primer, high-build elastomeric coatings, and galvanizing, for holidays and discontinuities as manufactured by:
      a. Tinker and Rasor, San Gabriel, CA, Model M-1.
      b. Or equal.

3.3 PREPARATION

A. Preparation of Surfaces
   1. All metal surfaces to be painted shall be sound, clean and free of mill scale, rust, dust, dirt, oil, grease, moisture or any other foreign matter which might, in any way, lessen the life or usefulness of the coating.

2. All metal surfaces shall be washed with mineral spirits to remove any dirt or grease, before applying materials. Where rust or scale is present, it shall be wire brushed, or sandpapered clean before painting. Shop coats of paint that become marred shall be cleaned and touched up.
3. Metal shall also be smooth and free from blisters, rough corners, pits, dents, or other imperfections before painting. Pits and dents shall be filled and the metal ground smooth where required.
4. When called for in the specifications or recommended by the paint manufacturer, the latest revisions of the following surface preparation specifications of the Steel Structures Painting Council shall apply:
   a. Solvent Cleaning (SSPC-SP1): Removal of oil, grease, soil and other contaminants by use of solvents, emulsions, cleaning compounds, steam cleaning or similar materials and methods which involve a solvent or cleaning action.
   b. Hand Tool Cleaning (SSPC-SP2): Removal of loose rust, loose mill scale and other detrimental foreign matter to degree specified by hand chipping, scraping, sanding and wire brushing.
   c. Power Tool Cleaning (SSPC-SP3): Removal of loose rust, loose mill scale and other detrimental foreign matter to degree specified by power wire brushing, power impact tools or power sanders.
   d. White Metal Blast Cleaning (SSPC-SP5): Blast cleaning to a gray-white uniform metallic color until each element of surface area is free of all visible residues.
   e. Commercial Blast cleaning (SSPC-SP6): Blast cleaning until at least two-thirds of each element of surface area is free of all visible residues from each square inch.
   f. Brush-Off blast Cleaning (SSPC-SP7): Blast cleaning to remove loose rust, loose mill scale and other detrimental foreign matter to degree specified.
   g. Near White Blast Cleaning (SSPC-SP10): Blast cleaning to nearly white metal cleanliness, until at least 95 percent of each element of surface area is free of all visible residues from each square inch.
5. When called for in the specifications or recommended by the paint manufacturer, the latest revisions of the following surface preparation specifications of the National Association of Pipe Fabricators shall apply:
   a. NAPF 500-03-01 “Solvent Cleaning”
   b. NAPF 500-03-02 “Hand Tool Cleaning”
   c. NAPF 500-03-03 “Power Tool Cleaning”
   d. NAPF 500-03-04 “Abrasive Blast Cleaning of Ductile Iron Pipe”
   e. NAPF 500-03-05 “Abrasive Blast Cleaning of Cast Ductile Iron Fittings”
6. All surface preparation of new equipment and surfaces shall be assumed to be on a SSPC Grade A steel surface condition, unless specifically noted otherwise.
7. Where OSHA or EPA regulations preclude standard abrasive blast cleaning, wet or vacu-blast methods may be required. Coating manufacturers' recommendations for wet blast additives and first coat application shall apply.
8. Hand tool clean areas that cannot be cleaned by power tool cleaning.

B. Welds and Adjacent Areas
   1. Prepared such that there is:
      a. No undercutting or reverse ridges on the weld bead.

b. No weld spatter on or adjacent to the weld or any other area to be painted.
c. No sharp peaks or ridges along the weld bead.

2. Grind embedded pieces of electrode or wire flush with the adjacent surface of the weld bead.

C. Blast Cleaning Requirements

1. Select type and size of abrasive to produce a surface profile that meets the coating manufacturer's recommendations for the particular coating to be applied or not less than 20 percent of the specified coating thickness, whichever is more stringent.
2. Meet applicable federal, state, and local air pollution control regulations for blast cleaning and disposition of spent aggregate and debris.
3. Do not reuse abrasive, unless abrasive is a recyclable abrasive.

D. Dehumidification

1. Where weather conditions or Project requirements dictate, Contractor shall provide and operate dehumidification equipment to maintain environmental conditions suitable for abrasive blasting and coating application as specified.
2. Contractor shall provide dehumidification equipment sized to maintain dew point temperature 5 degrees F or more below surface temperature of metal surfaces to be cleaned and painted.
3. Cleaned metal surfaces shall be prevented from flash rusting throughout the Project duration, condensation or icing shall be prevented throughout surface preparation and coating application.
4. Equipment size and power requirements shall be designed and operated by personnel trained in the operation and setup of dehumidification equipment based on Project requirements and anticipated weather conditions.
5. If required, dehumidification equipment shall operate 24 hours per day and continuously throughout surface preparation and coating application.
6. Daily maintenance requirements of the equipment shall be documented in writing and posted near the equipment for review by the Engineer.
7. Reblasting of flash rusted metal surfaces or removal of damaged coatings, as a result of equipment malfunction, shutdown, or other events that result in the loss of environmental control, will be at the sole expense of the Contractor.

E. Ventilation and Illumination

1. Adequate illumination shall be provided while work is in progress. Whenever required by the inspector, the Contractor shall provide additional illumination and necessary supports to cover all areas to be inspected. The level of illumination for inspection purposes shall be determined by the inspector.
2. Ventilation shall be used to control potential dust and hazardous conditions within confined areas. Ventilation flow rates shall be in accordance with OSHA regulations and as required to reduce air contamination to nonhazardous conditions.

F. Protection of Surfaces Not to be Painted

1. Remove, mask, or otherwise protect hardware, lighting fixtures, switchplates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not intended to be painted.

2. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces.
3. Protect working parts of mechanical and electrical equipment from damage during surface preparation and painting process.
4. Mask openings in motors to prevent paint and other materials from entering the motors.

G. Paint Mixing

1. Multiple-component coatings
   a. Prepare using all of the contents of the container for each component as packaged by the paint manufacturer.
   b. No partial batches will be permitted.
   c. Do not use multiple-component coatings that have been mixed beyond their pot lives.
   d. Provide small quantity kits for touchup painting and for painting other small areas.
   e. Mix only components specified and furnished by the paint manufacturer.
   f. Do not intermix additional components for reasons of color or otherwise, even within the same generic type of coating.
2. Keep paint materials sealed when not in use.
3. Where more than one coat of a material is applied within a given system, alternate color to provide a visual reference that the required number of coats have been applied.
4. Paints and similar materials shall be mixed in vessels of adequate capacity. All paints shall be thoroughly stirred before being taken from the containers, shall be kept stirred while using, and all ready-mixed paints shall be applied exactly from the manufacturer without addition of any kind of a drier or thinner, except as provided in manufacturer’s directions or upon specific authorization.
5. Mixing, thinning and application of the coating materials shall be in exact accordance with the manufacturer’s recommendations

3.4 APPLICATION

A. General

1. All work shall be done by skilled mechanics. All materials shall be evenly spread and smoothly flowed on without sags or runs, and all coats shall be thoroughly dry per the manufacturer data sheet before applying succeeding coats.
2. Apply coatings in accordance with the paint manufacturer's recommendations. Sand between coats with fine sandpaper to produce an even, smooth finish.
3. No exterior painting shall be done in rainy, damp, or frosty weather per the manufacturer data sheet or until the surface is thoroughly dry. No interior painting or finishing shall be permitted until the building has thoroughly dried out by natural or artificial heat.
4. Inspection: Schedule with Engineer in advance for cleaned surfaces and all coats prior to the succeeding coat.
5. Units to be bolted together and/or to structures shall be painted prior to assembly or installation.
6. Shop Primed or Factory Finished Surfaces

a. Inspection: Coordinate with Engineer in advance for shop primed or factory-finished items to be delivered to the Site for compliance with the Specifications.
b. Power sand areas of chipped, peeled, or abraded coating, feathering the edges. Follow with a spot primer using specified primer.
c. For two-package or converted coatings, consult the coatings manufacturer for specific procedures as relates to top coating of products.
d. Prior to application of finish coats, clean shop primed surfaces of dirt, oil, and grease, and apply a mist coat of specified primer, 1.0 mil dry film thickness.
e. After welding, prepare and prime holdback areas as required for the specified paint system. Apply primer in accordance with manufacturer's instructions.

7. Manufacturer Applied Paint Systems
   a. Repair abraded areas on factory-finished items in accordance with the equipment manufacturer's directions.
   b. Carefully blend repaired areas into the original finish.

B. Film Thickness
   1. Applied coating system film thickness per coat shall be applied at the specified coating thickness or the manufacturer’s recommended minimum thickness, whichever is greater.
   2. Maximum film build per coat shall not exceed the coating manufacturer's recommendations.
   3. Surfaces that are subject to immersion, condensing environments, or where specifically specified shall be stripe coated on all angles, edges, corners, threads, welds, and similar type surfaces. Stripe coat shall be an extra coat of the intermediate or topcoat material. The stripe coat shall be a separate coat of paint from coats specified under the coating system. Stripe coats shall be alternated in color similar to a full coat.

C. Mechanical and Electrical Equipment
   1. Refer to mechanical and electrical sections with respect to color coding identification banding of equipment, ducting, piping and conduit.
   2. Remove grilles, covers, and access panels for mechanical and electrical systems from location and paint separately.
   3. Finish paint primed equipment to color selected.
   4. Prime and paint exposed insulated and bare pipes, conduits, boxes, insulated and bare ducts, hangers, brackets, collars and supports, except where items are plated or covered with a pre-finished coating.
   5. Replace identification markings on mechanical or electrical equipment when painted over or spattered.
   6. Paint both sides and edges of plywood backboards for electrical equipment before installing backboards and mounting equipment on them

D. Hardware
   1. Remove all hardware and electric plates and thoroughly protect same before painting, as the Contractor will be held responsible for any paint spots or staining and will be required to replace same, if damaged by painting or staining.

3.5 REPAIR

A. Damaged Coatings, Pinholes, and Holidays
   1. Feather edges and repair in accordance with the recommendations of the paint manufacturer.
   2. Apply finish coats, including touchup and damage-repair coats in a manner that will present a uniform texture and color-matched appearance.

B. Unsatisfactory Application
   1. If the item has an improper finish color, or insufficient film thickness, clean and topcoat surface with specified paint material to obtain the specified color and coverage. Obtain specific surface preparation information from the coating manufacturer. Hand or power sand visible areas of chipped, peeled, or abraded paint and feather the edges. Follow with primer and finish coat in accordance with the Specifications. Depending on the extent of repair and its appearance, a finish sanding and topcoat may be required.
   2. Evidence of runs, bridges, shiners, laps, or other imperfections shall be cause for rejection.

C. Repair defects in coating system per written recommendations of coating manufacturer.

3.6 RE-INSTALLATION

A. Touch-Up
   1. On completion, carefully touch up all holidays, marred and damaged spots, and work over all surfaces that have been repaired by other trades.

3.7 SITE QUALITY CONTROL [NOT USED]

3.8 SYSTEM STARTUP [NOT USED]

3.9 ADJUSTING [NOT USED]

3.10 CLEANING

A. General
   1. Place cloths and waste that might constitute a fire hazard in closed metal containers or destroy at the end of each day.
   2. Upon completion of the Work, remove staging, scaffolding, and containers from the Site.
   3. Completely remove paint spots, oil, or stains upon adjacent surfaces and floors and leave entire job clean.

B. Damages due to over spray on buildings, vehicles, trees, or other surfaces not specified to be painted would be the responsibility of the Contractor.

3.11 CLOSEOUT ACTIVITIES [NOT USED]

3.12 PROTECTION

A. Regulatory Requirements

1. Protect workers and comply with applicable federal, state, and local air pollution and environmental regulations for surface preparation, blast cleaning, disposition of spent aggregate and debris, coating application and dust prevention including, but not limited to the following Acts, Regulations, Standards, and Guidelines.
   a. Clean Air Act.
   b. National Ambient Air Quality Standard.
   c. Resource Conservation and Recovery Act (RCRA).
2. Comply with applicable federal, state, and local regulations for confined space entry.
3. Provide and operate equipment that meets explosion proof requirements.
4. Perform painting in accordance with recommendations of the following:
   a. Paint manufacturer's instructions.
   b. NACE contained in the publication, Manual for Painter Safety.

3.13 MAINTENANCE [NOT USED]

3.14 ATTACHMENTS [NOT USED]

END OF SECTION

SECTION 26 00 10

GENERAL PROVISIONS

PART 1 – GENERAL

1.1 GENERAL CONDITIONS

A. The General Conditions and Requirements, Special Provisions, are hereby made a part of this Section.

B. The Electrical Drawings and Specifications under this Section shall be made a part of the Contract Documents. The Drawings and Specifications of other sections of this contract, as well as supplements issued thereto, information to bidders and pertinent documents issued by the Owner's Representative are a part of these Drawings and Specifications and shall be complied with in every respect. All the above documents will be on file at the office of the Owner's representative and shall be examined by all the bidders. Failure to examine all documents shall not relieve the responsibility or be used as a basis for additional compensation.

C. Furnish all work, labor, tools, superintendence, material, equipment and operations necessary to provide for a complete and workable electrical system as defined by the Contract Documents. A licensed journeyman shall be on site at all times while electrical work is being performed and a licensed master electrician shall be in charge of the work. Submit license for master electrician and all journeymen.

D. Be responsible for visiting the site and checking the existing conditions. Ascertain the conditions to be met for installing the work and adjust bid accordingly. This project shall include electrical work as shown on the Location Map.

E. It is the intent of the Contract Documents that upon completion of the electrical work, the entire system shall be in a finished, workable condition.

F. All work that may be called for in the Specifications but not shown on the Drawings, or, all work that may be shown on the Drawings but not called for in the Specifications, shall be performed by the Contractor as if described in both. Should work be required which is not set forth in either document, but which work is nevertheless required for fulfilling of the intent thereof, then the Contractor shall perform all work as fully as if it were specifically set forth in the Contract Documents.

G. The definition of terms used throughout the Contract Documents shall be as specified by the following agencies:

1. Underwriters Laboratories
2. National Electrical Manufacturers Association
3. American National Standards Institute
4. Insulated Power Cable Engineers Association
5. National Electrical Code
6. National Fire Protection Association

H. The use of the terms "as (or where) indicated", "as (or where) shown", "as (or where) specified", or "as (or where) scheduled" shall be taken to mean that the reference is made to the Contract Documents, either on the Drawings or in the Specifications, or both documents.

I. The use of the words "furnish", "provide", or "install" shall be taken to mean that the item or facility is to be both furnished and installed under Division 26, unless stated to the contrary that the item or facility is to be either furnished under another Division or under another Contract, furnished under this Division and installed under another Division or under another Contract, or furnished and installed under another Division or under another Contract.

1.2 PERMITS AND CODES

A. Secure all permits, licenses, and inspection as required by all authorities having jurisdiction. Give all notices and comply with all laws, ordinances, rules, regulations and contract requirements bearing on the work.

B. The minimum requirements of the electrical system installation shall conform to the latest edition of the National Electrical Code, as well as state and local codes.

C. Codes and ordinances having jurisdiction and specified codes shall serve as minimum requirements, but, if the Contract Documents indicate requirements which are in excess of those minimum requirements, then the requirements of the Contract Documents shall be followed. Should there be any conflicts between the Contract Documents and codes, or any ordinances, report these with bid.

PART 2 - PRODUCTS

2.1 STANDARDS

A. All materials and equipment shall conform to the requirements of the Contract Documents. They shall be new, free from defects, and they shall conform to the following standards where these organizations have set standards:

1. Underwriters Laboratories (UL)
2. National Electrical Manufacturer's Association (NEMA)
3. American National Standards Association (ANSI)
4. Insulated Cable Engineers Association (ICEA)

B. All material and equipment of the same class shall be supplied by the same manufacturer, unless specified to the contrary.

C. All products shall bear UL labels where standards have been set for listing. All other products shall be UL labeled. Motor control centers, switchboards, and switchgear shall have UL labels. Custom panels, modified motor starters, control panels, and instrument panels and the like shall be manufactured by a fabricator approved as a UL508A shop and shall bear a UL 508A or UL Industrial Control Panel label.

D. When the Contractor provides a product for this project he shall be bound by the terms and conditions of the Contract Documents and he shall agree to warrant and to be liable for the merchantability and fitness of his product to the applications to which his product is applied under the Contract Documents.

2.2 SHOP DRAWINGS AND SUBMITTALS

A. Shop drawings and submittals shall comply with general conditions and as specified herein.

B. Shop drawings shall be taken to mean detailed drawings with dimensions, schedules, weights, capacities, installation details and pertinent information that will be needed to describe the material or equipment in detail.

C. Submittals shall be taken to mean catalog cuts, general descriptive information, catalog numbers and manufacturer's name.

D. Submit for review all shop drawings and submittals as hereinbefore called for.

E. Review of submittals or shop drawings shall not remove the responsibility for furnishing materials or equipment or proper dimensions, quantity and quality, nor will such review remove the responsibility for error in the shop drawings or submittals.

F. Failure to process submittals or shop drawings on any item and/or items specified shall make the Contractor responsible for the suitability for the item and/or items, even though the item and/or items installed appear to comply with the Contract Documents.

G. Assume all costs and liabilities which may result from the ordering of any material or equipment prior to the review of the shop drawings or submittals, and no work shall be done until the shop drawings or submittals have been reviewed. In case of correction or rejection, resubmit until such time as they are accepted by the Owner's Representative, and such procedures will not be cause for delay.

H. Submittals and shop drawings shall be compiled from the manufacturer's latest product data. Should there be any conflicts between this data and the Contract Documents, report this information for each submittal and/or shop drawing.

I. Shop drawings and submittals will be returned and unchecked if the specific items proposed are not clearly marked, or if the General Contractor's approval stamp is omitted.

J. When requested, furnish samples of materials for acceptance review. If a sample has been reviewed and accepted, then that item of material or equipment installed on the job shall be equal to the sample; if it is found that the installed item is not equal, then replace all such items with the accepted sample equivalent.

2.3 ACCEPTANCE AND SUBSTITUTIONS

A. All manufacturers named are a basis as a standard of quality and substitutions of any equal product will be considered for acceptance. The judgment of equality of product substitution shall be made by the Engineer.

B. Substitutions after award of Contract shall be made only within sixty (60) days after the notice to proceed. Furnish all required supporting data. The submittal of substitutions for review shall not be cause for time extensions.

C. Where substitutions are offered, the substituted product shall meet the product performance as set forth in the specified manufacturer's current catalog literature, as well as meeting the details of the Contract Documents.

D. The details on the drawings and the requirements of the Specifications are based on the first listed material or equipment. If any other than the first listed material or equipment is furnished, then assume responsibility for the correct function, operation, and accommodation of the substituted item. In the event of misfits or changes in work required, either in this section or other sections of the Contract, or in both, bear all costs in connection with all changes arising out of the use of other than the first listed item specified.

E. Substitutions of products under other sections may occur. Make necessary adjustments and additions to work under Division 26 to accommodate those substitutions. Such adjustments and additions shall be performed in compliance with Division 26 Specifications at no additional charge.

F. Energy efficiency of each item of power consuming equipment shall be considered one of the standards for evaluation.

PART 3 - EXECUTION

3.1 CUTTING AND PATCHING

A. Cutting and patching required under this section shall be done in a neat workmanlike manner. Cutting lines shall be uniform and smooth.

B. Use concrete saws for large cuts in concrete and use core drills for small round cuts in concrete.

C. Where openings are cut through masonry walls, provide lintel or other structural support to protect the remaining masonry. Adequate support shall be provided during the cutting operation to prevent damage to masonry.

D. Where large openings are cut through metal surfaces, attach metal angle around the opening.

E. Patch concrete openings that are to be filled with nonshrinking cementing compound. Finish concrete patching shall be troweled smooth and shall be uniform with surrounding surfaces.

3.2 WATERPROOFING

A. Provide waterproof flashing for each penetration of exterior walls and roofs.

3.3 CONSTRUCTION REQUIREMENTS

A. Except where specifically noted or shown, the locations and elevations of equipment are approximate and are subject to small revisions as may prove necessary or desirable at the time the work is installed. Locations changed substantially from that shown on the drawings shall be confirmed with the Engineer in advance of construction.

B. Where equipment is being furnished under another Division, request from Engineer an accepted drawing that will show exact dimensions of required locations or connections. Install the required facilities to the exact requirements of the accepted drawings.

C. All work shall be done in the best and most workmanlike manner by qualified, careful electricians who are skilled in their trade. The standards of work required throughout shall be of the first class only.

D. Unless shown in detail, the Drawings are diagrammatic and do not necessarily give exact details as to elevations and routing of raceways, nor do they show all offsets and fittings; nevertheless, install the raceway system to conform to the structural and mechanical conditions of the construction.

E. Holes for raceway penetration into sheet metal cabinets and boxes shall be accurately made with an approved tool. Cutting openings with a torch or other device that produces a jagged, rough cut will not be acceptable.

F. Cabling inside equipment shall be carefully routed, trained and laced. Cables so placed that they obstruct equipment devices will not be acceptable.

G. Equipment shall be set level and plumb. Supporting devices installed shall be set and so braced that equipment is held in a rigid, tight-fitting manner.

3.4 EQUIPMENT PROTECTION

A. Provide suitable protection for all equipment, work and property against damage during construction.

B. Assume full responsibility for material and equipment stored at the site.

C. Conduit openings shall be closed with caps or plugs during installation and made watertight. All outlet boxes and cabinets shall be kept free of concrete, plaster, dirt and debris.

D. Equipment shall be covered and tightly sealed against entrance of dust, dirt and moisture.

E. All dry-type transformers prior to energization shall be protected against moisture and dirt absorption by a suitable covering. Also, maintain heat inside the covering by means of 100 watt minimum lamps.

F. Interiors of and motor control centers shall be kept clean and dry prior to energization. Maintain heat inside each unit with one (1) 100 watt lamp located at bottom of each vertical section or energize section space heaters.

3.5 COOPERATION WITH WORK UNDER OTHER DIVISIONS

A. Cooperate with all other trades so as to facilitate the general progress of their work. Allow all other trades every reasonable opportunity for the installation of their work and the storage of their materials.

B. The work under this section shall follow the general building construction closely. Set all pipe sleeves, inserts, etc., and see that openings for chases, pipes, etc.., are provided before concrete is placed or masonry installed.

C. Work with other trades in determining exact locations of outlets, conduits, fixtures, and pieces of equipment to avoid interference with lines as required to maintain proper installation of other work.

D. Make such progress in work that will not delay the work of other trades. Schedule the work so that completion dates as established by the Engineer are met. Furnish sufficient labor or work overtime to accomplish these requirements if directed to do so.

3.6 INSTALLATION OF WORK UNDER ANOTHER DIVISION

A. Verify the electrical capacities of all motors and electrical equipment furnished under other sections, or furnished by the Owner, and request wiring information from the Engineer if wiring requirements are different from that specified under this Section. Do not make rough-ins until equipment verification has been received.

B. Install all motors, controllers, terminal boxes, pilot devices, and miscellaneous items of electrical equipment that are not integrally mounted with the equipment furnished under other divisions. All such equipment shall be securely mounted and adequately supported in a neat and workmanlike manner.

3.7 CLEAN-UP

A. Remove all temporary labels, dirt, paint, grease and stains from all exposed equipment. Upon completion of work, clean equipment and the entire installation so as to present a first class job suitable for occupancy. No loose parts or scraps of equipment shall be left on the premises.

B. Equipment paint scars shall be repaired with paint kits supplied by the equipment manufacturer or with an approved paint.

C. Clean interiors of each item of electrical equipment. At completion of work all equipment interiors shall be free from dust, dirt and debris.

3.8 TESTS

A. Test all systems furnished under Division 26 and repair or replace all defective work. Make all necessary adjustments to the systems and instruct the Owner's personnel in the proper operation of the system.

B. Make all circuit breaker and protective relay adjustments and settings.

C. Make the following minimum tests and checks prior to energizing the electrical equipment:

1. Check all wire and cable terminations for tightness.
2. Test all wiring as specified in Section 26 01 20.
3. Test grounding system as specified in Section 26 04 50.
4. Set all transformer taps as required to obtain the proper secondary voltage.
5. Carefully check all interlocking, control and instrument wiring for each system to ascertain that the system will function properly as indicated by schematics, wiring diagrams, or as specified herein.
6. Mechanical inspection of all low voltage circuit breakers, disconnect switches, motor starters, control equipment, etc. for proper operation.
7. Provide all instruments and equipment required for the above tests.

3.9 RECORD DRAWINGS

A. At the start and during the progress of the job, keep one separate set of blue-line prints for making construction notes and mark-ups.

B. Show conduit routing and wiring runs as constructed and identify each.

C. Record all deviations from the Contract Documents.

D. Submit set of marked-up drawings for review. The final payment will not be made until the review is complete.

3.10 OPERATIONS AND MAINTENANCE MANUALS

A. Compile an Operations and Maintenance Manual on each item of equipment. These manuals shall include detailed instructions and maintenance as well as spare parts lists.

B. Submit copies for review as hereinbefore specified.

C. Preliminary Operations and Maintenance Manuals shall be included with the initial shipments.

END OF SECTION

SECTION 26 01 10
RACEWAYS

PART 1 - GENERAL

1.1 SCOPE

A. This section shall include raceways, enclosures, supporting devices ancillary fittings and appurtenances. Furnish and install the complete raceway systems as shown on the Drawings and as specified herein.

B. Raceway is a broad-scope term that shall be defined by the National Electrical Code under Article 100.

1.2 APPLICATIONS

A. Except as otherwise shown on the Drawings, or otherwise specified, all underground and in-slab conduit raceways shall be made with schedule 40 PVC. Bends to grade shall be made with plastic coated rigid galvanized steel conduit.

B. Except as otherwise shown on the Drawings, or otherwise specified, all outdoor exposed power, control, and instrumentation, signal, and communication conduit shall be rigid steel conduit, except where areas are denoted as corrosive or NEMA 4X. The inside of the chlorine storage building shall be a NEMA 4X corrosive area. In those area furnish plastic coated rigid steel conduit, fittings, and boxes.

1.3 SUBMITTALS AND SHOP DRAWINGS

A. Process catalog submittals for the following:

1. Plastic Jacketed Rigid Steel Conduit
2. Rigid Non-Metallic Conduit
3. Liquid-tight Flexible Conduit
4. Liquid-tight Fittings
5. Conduit Bushings
6. Conduit Bodies
7. Conduit Sealing Fittings
8. Expansion-Deflection Fittings
9. Expansion Fittings
10. Cast Metal Boxes
11. NEMA 4X J-Boxes
12. Tape Products
13. Wiring Devices
14. Supporting Devices
15. Labels
16. Grounding Devices
17. Foam Sealant

18. Conduit End Bell Fittings

PART 2 - PRODUCTS

2.1 RACEWAYS

A. Rigid metallic aluminum conduit shall be manufactured of 6063 alloy, T-1 temper, with no more than 0.02% copper content. All conduit couplings shall be threaded aluminum. All such conduit shall be listed with UL and comply with UL-6 and ANSI C80.5. Aluminum conduit shall be Easco, Indalex or equal.

B. Rigid metallic steel conduit shall be hot-dip galvanized inside and outside and over threads. All such conduit shall comply with U.L. Standard UL-6, Federal Specification WWC-581-D, ANSI C90.1, and NEMA RN1-1980. Furnish Wheatland, Allied or equal.

C. Plastic coated rigid steel conduit shall consist of rigid steel body that complies with above specifications for rigid metallic steel conduit, plus conduit shall have 40 mil thick heat-fused PVC over outside and 2 mil coat of fully catalyzed phenolic inside. The inside coat shall have the chemical resistance of the outer coating and shall not dissolve in lacquer thinner. All couplings shall be equipped with PVC sleeves that extend one pipe diameter or 2", whichever is less, beyond the end of the coupling. All plastic coated conduit shall conform to NEMA Standard #RNI-1974 (Type A) and such conduit shall be Robroy "Plastibond Red", or equal.

D. Non-metallic rigid conduit shall be Schedule 40 PVC. Such conduit shall be UL listed for 90 degrees C and shall conform to NEMA TC-2 and UL-651 standards. Furnish Carlon, Cantex, or equal. Furnish manufacturer's approved solvent for joining couplings.

E. Liquid-tight flexible conduit shall consist of hot-dipped galvanized, flexible interlocking steel core with thermoplastic cover, integral copper ground wire (through 1-1/4" trade size) and shall be Anaconda Sealtite or equal.

2.2 CONDUIT FITTINGS

A. NEMA 4 locknuts for rigid metallic conduit shall consist of galvanized steel body with neoprene sealing ring. Furnish Crouse-Hinds, T&B, or equal.

B. NEMA 1 locknuts for rigid metallic conduits shall be galvanized steel for use with galvanized steel conduit and hardened aluminum for use with aluminum conduit.

C. Conduit field-applied hubs for sheet metal enclosures shall be aluminum body with recessed neoprene sealing ring, threaded NPT insert, and shall be, T&B 370 AL series, or equal products by OZ/Gedney.

D. Conduit hubs for non-metallic enclosures shall be fiberglass polyester reinforced with galvanized steel core, complete with locknut and grounding bushing. All such hubs shall be Crouse-Hinds Type NHU, or equal.

E. Rigid metallic conduit chase nipples, split couplings, slip fittings, unions, reducers, and enlargers, shall be hot-dip or mechanically galvanized malleable iron.

F. Rigid metallic conduit short els and long els shall be hot-dip galvanized malleable iron with NPT threaded hubs and male ends. Throats shall be smooth and free from burrs. All such fittings shall be OZ/Gedney Type "9" Series, Appleton, or equal.

G. Rigid metallic conduit split couplings shall have threaded body with split tightening shelves with neoprene sandwich. Furnish malleable iron mechanically galvanized body. Such fittings shall be OZ type "SSP", or equal.

H. Rigid metallic conduit grounding bushings shall be aluminum body with threaded hub, bakelite insulated throat, and tin-plated copper ground lug. Furnish OZ/Gedney type ABLG, or equal.

I. Liquid-tight flexible conduit fittings shall be hot-dip galvanized steel body with internal locking ring and ground cone plus external ground wire fitting. Furnish straight or angle connectors as required. All such connectors shall be OZ/Gedney 4Q series, or equal.

J. Rigid metallic conduit expansion/deflection fittings shall consist of galvanized malleable iron hubs with heat-fused epoxy coating, flexible neoprene joining sleeve banded to hubs with stainless steel bands, and with internal bonding jumper and guide cones. Furnish Crouse-Hinds type "XDHF" or equal.

K. Rigid metallic conduit expansion fittings shall consist of metallic barrel joined to hubs at each end. One hub shall be threaded to barrel and other hub shall have slip fit to allow up to four (4") inches of conduit lateral movement. Provide external bonding jumper for each expansion joint. Furnish Crouse-Hinds type "XJ", OZ Type "AX", or equal.

L. Conduit waterstops for sealing inside of conduit runs shall consist of aluminum pressure discs with sandwiched neoprene seal and with 316 stainless steel hardware. Furnish OZ/Gedney type "CS" series products, as indicated.

2.3 CONDUIT BODIES AND BOXES

A. Conduit bodies such as "C", "LB", "T" and the like pulling fittings shall be zinc coated with malleable iron or aluminum (material shall match conduit). Covers for damp and/or wet location use shall be gasketed cast metal with "wedge-nut" clamps. Covers for dry locations shall be cast aluminum and hardware shall be 316 stainless steel. All covers shall be equipped with clamp type clevises. Furnish Crouse-Hinds Form 7, or Appleton Form "FM7" products.

B. Conduit bodies for use in corrosive areas shall be as specified above but shall have 40 mil plastic coated PVC jacket and 2 mil interior coating as specified for plastic coated rigid steel conduit. Furnish Robroy Plasti-bond Red fittings or equal.

C. Conduit bodies such as "GUA", "GUAT", "GUAL", and the like pulling/splicing fittings shall be cast aluminum with threaded cast aluminum covers. All such conduit bodies shall be Killark "GE" series, or equal products by Crouse-Hinds or Appleton.

D. Cast metal outlet boxes, pullboxes, and junction boxes whose volume is smaller than 100 cubic inches, and cast metal device boxes, shall be sand-cast, copper-free aluminum or zinc coated sand-cast malleable iron. All boxes shall have threaded hubs. Furnish Crouse-Hinds "FD" style condulets, Appleton "FD" style Unilets, or equal.

Covers for cast metal boxes shall be gasketed cast metal covers with 316 stainless steel screws and shall be suitable for use in wet or damp locations.

2.4 PULL AND JUNCTION BOXES

A. Pullboxes and junction boxes whose volume is less than 100 cubic inches shall be furnished as specified hereinbefore except where sheet metal types are shown, in which case, furnish

such sheet metal enclosures in NEMA 4X 316 stainless steel construction with gasketed covers of same material.

B. Pullboxes and junction boxes whose volume is 100 cubic inches and greater shall be NEMA 4X 316 grade stainless steel type with gasketed stainless steel covers. Provide print pocket and interior back panel for mounting of terminal strips where terminal strips are called for on the drawings. Sheet metal boxes shall be as manufactured by Hoffman or equal.

C. Covers for sheetmetal pullboxes and junction boxes over 100 cubic inches (and for smaller sized where shown) shall have hinged doors. All hardware shall be 316 stainless steel.

D. Cast metal junction boxes shall be cast aluminum type with gasketed, cast metal covers and with stainless steel cover screws.

2.5 LABELS

A. Buried conduit marking tape for marking path of secondary buried conduits shall be four (4") inch nominal width strip of polyethylene with highly visible, repetitive marking "BURIED CONDUIT" or similar language, repeated along its length.

B. Voltage warning labels for cabinets shall be waterproof vinyl strips with adhesive back and shall have "DANGER (VOLTAGE) - DISCONNECT ALL SOURCES OF POWER BEFORE ENTERING". Letters shall be highly visible red color on white background.

2.6 SUPPORTING DEVICES

A. Mounting hardware, nuts, bolts, lockwashers, and washers, shall be Grade 304 stainless steel.

B. Unless otherwise indicated, channel framing and supporting devices shall be manufactured of ASTM 6063, TO6 grade aluminum; 1-5/8" wide x 3-1/4" deep (double opening type). Clamp nuts for use with channels shall be grade 316 stainless steel.

C. Where indicated, furnish grade 316 stainless steel slotted channel members 1-5/8" wide x 1-5/8" deep or 1 5/8" x 3 1/4" deep, double-faced type. All hardware and conduit clamps shall be grade 316 stainless steel.

D. Conduit clamp supports for terminating conduits onto cable trays shall be mechanically galvanized malleable iron with adjustable angle clamp. Fittings shall be provided with 316 stainless steel hardware. Furnish OZ/Gedney type CTC products.

E. All such channel members and fittments shall be B-Line, Unistrut or equal.

F. Conduit straps, and associated nuts, lockwashers and bolts for use with channels shall be 316 stainless steel with 316 stainless steel hardware. Furnish B-Line products or equal.

G. After-set concrete inserts (drilled expansion shields "D.E.S.") shall consist of two types. For anchors to accommodate 5/16" diameter bolts and smaller, provide HILTI "HDI" series 304 stainless steel anchors. For anchors to accommodate 3/8" diameter and larger bolts, provide HILTI "HVA" series with 316 stainless steel threaded inserts.

H. Hanger rod shall be 3/8" minimum diameter Type 316 stainless steel all-thread.

I. One hole conduit clamps shall be two piece nest-back or clamp-back type constructed of cast malleable iron or cast copper-free aluminum. The material shall match the conduit. Furnish Crouse-Hinds series 500 clamp and series CB spacer, T&B series 1270/1280 clamp + series 1350 spacer (add suffix "al" for aluminum items for T&B parts), OZ\Gedney 14G clamp +

series 141G spacer + 141NG nestback (if required), or equal. Finish for malleable iron items shall be hot dip galvanized.

J. Conduit beam clamps shall be hot-dip galvanized malleable iron and shall be as follows:

TYPE	MANUFACTURER
Right Angle	OZ/Gedney Type "UBCG", or equal.
Parallel	OZ/Gedney Type "UPCG", or equal.
Edge	OZ/Gedney Type "UECG", or equal.

K. Hanger rod beam clamps shall be clamp type with hardened steel, bolt, Steel City "500" Series, Crouse-Hinds series "500", or equal. Furnish swivel stud for each rod make- up.

L. Conduit "J" hangers shall consist of steel straddle with detachable bolt. Finish shall be electro-galvanized. Furnish Kindorf type "C-149", Unistrut "J-1200" Series, or equal.

M. Conduit "U" bolts shall be hot-dip galvanized steel with 316 stainless steel hex-head bolts.

N. Equipment stands for supporting devices such as control stations, device boxes and the like, shall consist of a welded structural steel c-channel and plate steel floor plate as detailed on the drawings. Equipment stands shall be hot-dipped galvanized after fabrication.

2.7 MISCELLANEOUS MATERIAL

A. Double bushings for insulating wiring through sheet metal panels shall consist of mating male and female threaded phenolic bushings. Phenolic insulation shall be high-impact thermosetting plastic rated 150 degrees C. Furnish OZ Type "ABB", or equal.

B. Conduit pull-cords for use in empty raceways shall be glass-fiber reinforced tape with foot-marked identification along its length. Furnish Thomas, Greenlee, or equal products.

C. Conduit thread coating compound shall be conductive, non-galling, and corrosion-inhibiting. Furnish Crouse- Hinds Type "STL", Appleton Type "ST", or equal.

D. Plastic compound for field-coating of ferrous material products shall be PVC in liquid form that sets-up semi- hard upon curing. Furnish Rob Roy "Rob Kote", Sedco "Patch Coat", or equal.

E. Zinc spray for coating galvanized steel threads shall be Research Laboratory type "LPS", Mobil "Zinc-Spray" or equal conductive zinc-rich spray enamel product.

F. Foam sealant for waterproofing uses shall be "AV280 Hydrofoam" by Avanti Internarional of Webster, Texas or equal.

PART 3 - EXECUTION

3.1 RACEWAYS

A. Install the conduit system to provide the facility with the utmost degree of reliability and maintenance free operation. The conduit system shall have the appearance of having been installed by competent workmen. Kinked conduit, conduit inadequately supported or carelessly installed, do not give such reliability and maintenance free operation and will not be accepted.

B. Raceways shall be installed for all wiring runs, except as otherwise indicated.

C. Conduit sizes, where not indicated, shall be N.E.C. code-sized to accommodate the number and diameter of wires to be pulled into the conduit. Unless otherwise indicated, 3/4" trade-size shall be minimum size conduit.

D. Unless otherwise noted, conduit runs shall be installed exposed. Such runs shall be made parallel to the lines of the structure. Conduit shall be installed such that it does not create a tripping hazard or an obstruction for headroom.

E. All runs of rigid conduit shall be threaded, and all male threads shall be coated with non-galling thread compound prior to assembly.

F. Plastic coated metallic conduit lengths shall be joined with threaded metallic coupling that shall be each equipped with a 40 mil thickness sleeve that shall extend over the threads of the joined conduit. Each joint shall be watertight.

G. Field-cut threads in runs of plastic coated metallic conduit shall be cut with a special die that has rear reamed out oversize so as to slip over plastic coating. Do not attempt to cut threads on plastic coated conduit with regular dies, whereby plastic coating is skinned back to allow the incorrect die to be used. Coat all field-cut threads with cold-galvanizing spray, use two coats to provide 1-mil minimum coating thickness.

H. Conduit runs made in concrete pours or surface-mounted runs that are attached to the structure shall be equipped with an expansion/deflection fitting where they cross an expansion joint, or at every 100 feet.

I. Unless otherwise shown, conduit penetrations through floors located below enclosures, shall be made each with couplings set flush with the outside faces of the concrete pour. Each pair of couplings shall be joined with a threaded spool piece. Use coated aluminum or galvanized steel couplings.

J. Rigid metallic conduit runs shall have their couplings and connections made with screwed fittings and shall be made up wrench-tight. Check all threaded conduit joints prior to wire pull. Coat all male threads with Crouse-Hinds "STL" or equal, conductive lubricant prior to joining.

K. All conduit runs shall be watertight over their lengths of run, except where drain fittings are indicated. In which cases, install specified drain fittings.

L. Plastic jacketed flexible steel conduit shall be used to connect wiring to motors, limit switches, bearing thermostats, and other devices that may have to be removed for servicing. Unless otherwise indicated, maximum lengths of flex shall be three (3') feet.

M. Where plastic jacketed flex is installed, make up terminal ends with liquid-tight flex connectors. In wet locations, install sealing gaskets on each threaded male connector. Each flex connector shall be made-up tightly so that the minimum pull-out resistance is at least 150 lbs. Install external spirally-wrapped ground wire around each run of liquid-tight flex and bond each end to specified grounding-type fittings.

N. Empty conduits shall have pull-ropes installed. Identify each terminus as to location of other end and trade size of conduit. Use blank plastic waterproof write-on label and write information on each label with waterproof ink. Pull a mandrel through each conduit to check and clear blockage before installing pull-rope. Owner’s representative shall witness test. Provide documentation that all conduits are clear and ready for future use. Cap exposed ends of empty conduit with threaded plugs.

O. Conduit runs into boxes, cabinets and enclosures shall be set in a neat manner. Vertical runs shall be set plumb. Conduits set cocked or out of plumb will not be acceptable.

P. Conduit entrances into equipment shall be carefully planned. Cutting away of enclosure structure, torching out sill or braces, and removal of enclosure structural members, will not be acceptable.

Q. Use approved hole cutting tools for entrances into sheet metal enclosure. Use of cutting torch or incorrect tools will not be acceptable. Holes shall be cleanly cut and they shall be free from burrs, jagged edges, and torn metal.

R. All raceways shall be swabbed clean after installation. There shall be no debris left inside. All interior surfaces shall be smooth and free from burrs and defects that would injure wire insulation.

3.2 CONDUIT BODIES AND BOXES

A. Conduit bodies such as "LB", "T", "GUAT", etc., shall be installed in exposed runs of conduit wherever indicated and where required to overcome obstructions and to provide pulling access to wiring. Covers for such fittings shall be accessible and unobstructed by the adjacent construction. GUA series pulling bodies rather than LB fittings and the like, shall be used for splicing purposes as well as pulling access.

B. Covers for all conduit bodies shall be installed with gasketed cast metal type where located in damp or wet locations.

C. All conduit boxes installed whose inside volume is less than 100 cubic inches shall be cast metal type with gasketed cast metal cover, unless otherwise indicated.

D. All conduit boxes whose inside volume exceeds 100 cubic inches shall be sheet metal type except where gasketed cast metal type, stainless steel or fiberglass reinforced polyester are indicated.

3.3 RACEWAY SUPPORT

A. All raceway systems shall be adequately and safely supported. Loose, sloppy and inadequately supported raceways will not be acceptable. Supports shall be installed at intervals not greater than those set forth by the NEC, unless shorter intervals are otherwise indicated, or unless conditions require shorter intervals of supports.

B. Multiple runs of surface mounted conduit on concrete or masonry surfaces shall be supported off the surface by means of aluminum channels. Attach each slotted channel support to concrete surface by means of two (2) 1/4" diameter stainless steel bolts into drilled expansion shields.

C. Single runs of surface mounted conduit on concrete or masonry surfaces shall be supported with hot-dipped malleable iron conduit clamps and nest-back spacers. Furnish plastic coated malleable iron conduit clamps and nest backs where corrosive areas are called out.

D. Conduit runs that are installed along metallic structures shall be supported by means of hot-dipped galvanized beam clamps as specified herein.

3.4 LABELING

A. In addition to labeling requirements as specified throughout this and other Sections, install wiring and raceway labeling as follows:

1. Apply write-on identification to empty conduits to identify each conduit as to terminus of other end and also to identify trade size of conduit.
2. Where active conduits terminate into bottoms of motor control centers, install label on each conduit terminus and show number and size of wiring and function of circuitry and trade size of conduit.

END OF SECTION

No specifications on this page for formatting purposes.

SECTION 26 01 20
WIRE AND CABLE

PART 1 - GENERAL

1.1. SCOPE
A. This section shall include wire and cable, terminating devices, splice kits, labeling, and appurtenances.

1.2. STANDARDS
A. ASTM
B. UL 1277 Electrical Power and Control Tray Cables
C. UL 1685 Flame Exposure Test for Tray Cables
D. ICEA T-29-520 Vertical Cable Tray Flame Test
E. IEEE 1202 Flame Testing of Cables for use in Cable Tray

1.3. SUBMITTALS AND SHOP DRAWINGS
A. Process catalog submittals for the following:
1. Power and control cable
2. Instrument cable
3. Conductor Connectors
4. Tape Products
5. Labels

PART 2 - PRODUCTS

2.1 WIRE AND CABLE
A. All conductors shall be soft-drawn annealed copper, Class B stranding that meets ASTM B-8. Copper conductors shall be uncoated, except as otherwise specified.
B. Single conductor cable for power, control, and branch circuits shall have cross-linked polyethylene insulation, rated for 600 volts. Cable shall be NEC type XHHW-2. All such cable shall be rated for wet or dry use. Cable insulation shall be color coded with factory pigmented colors below size #6 awg. Color coding shall be as specified under Part 3 of this section. Cable shall be as manufactured by Southwire or equal.
C. Instrument cable for analog circuits, shall be # 16 awg, twisted shielded pairs or triads with PVC insulation and overall jacket. Cable assembly shall be rated for 600 volts, wet or dry locations. Furnish Okonite "Okoseal-N Type P-OS" or approved equal.
D. Single conductor cable for 24 volt dc control shall be minimum size #16. Furnish MTW type insulation for panel wiring and XHHW-2 insulation for field wiring in conduits.
E. Single conductor cable 1/0 and above for use in cable trays shall be rated for CT (cable tray) use. Insulation shall be cross-linked polyethylene, XHHW-2. Furnish Southwire XHHW/TC or approved equal.
F. Multi-conductor power cable for use in cable trays shall be 600 volt and rated for CT use. Cable assembly shall be three or four conductor with ground conductor. Insulation of each

conductor shall be cross-linked polyethylene, XHHW. Ground shall be bare. Cable assembly shall have an overall PVC jacket. Furnish Southwire type TC or approved equal.

G. Multi-conductor control cable for use in cable trays shall be 600 volt and rated for CT use. Insulation of each conductor shall be cross-linked polyethylene, XHHW. Cable assembly shall have an overall PVC jacket. Furnish Southwire type TC Control Cable or approved equal.

H. Multi-conductor instrumentation cable for use in cable trays shall be 600 volt rated and rated for CT use. Cable assembly shall consist of shielded pairs or triads with overall shield and Nylon jacket. Conductor insulation shall be flame retardant PVC. Furnish Okonite Company "Okoseal-N Type SP-OS or approved equal.

I. Multiconductor cable for connection of the output of VFDs to motors shall be 90 deg C rated, 2000 volt copper conductors with RHW insulation, copper tap shield and groiund conductors. Furnish Service Wire Company "ServiceDrive" or equal cable.

J. Ground mat and associated upcomers and grounding conductors shall be tin-plated stranded copper.

K. Cable for RS485 applications shall be Belden #9841.

L. Telephone cable for underground shall be solid conductor 22 awg and shall meet REA Specification PE-39. Furnish HWC series N08022-XX in pair numbers as indicated on the drawings.

M. Telephone cable for inside of buildings shall be unshielded, twisted pair, solid conductor 24 awg and shall be in pairs as indicated on the drawings. Furnish Belden model 9562 (two pair), 9566 (six pair), 9570 (ten pair), or 9585 (twenty five pair).

N. Fiber optic cable shall be 6 fiber count cables. Cable shall be 62.5 um multimode and shall be suitable for installation in conduit. Furnish Corning FREEDM One Riser Cables.

2.2 CONNECTORS

A. Mechanical connectors for 600V class wiring shall be tin-plated copper alloy bolted pressure type with bronze tin-plated hardware. Furnish connectors as follows:

TYPE	MANUFACTURER & TYPE
Single conductor to flat-plate connector	Blackburn LH
Multiple conductor to flat-plate connector	Blackburn L2H, L3H, L4H
Split-bolt connector	Blackburn HPS
Two-bolt parallel connector with spacer	Blackburn 2BPW
Cross Connector	Blackburn XT
Splice Connector	Blackburn S
Flush ground connector	OZ Type "VG"

B. Insulated spring wire connectors, "wire-nuts", for small building wire taps and splices shall be plated spring steel with thermoplastic jacket and pre-filled sealant. Connector shall be rated for 600 volts, 75 degrees C continuous. Furnish King Technology, or equal.

C. Connectors for control conductor connections to screw terminals shall be crimp-type with vinyl insulated barrel and tin-plated copper ring-tongue style connector. Furnish T&B "Sta-Kon", 3M "Scotchlok", or equal.

D. Terminal strips for miscellaneous field terminations of control and instrumentation circuits shall consist of 12 point box lug terminals with marking surface. Terminal assembly shall accept #18 to #12 awg and shall be rated 600 volts. Furnish Allen-Bradley #1492-HJ812 terminal blocks.

2.3 INSULATING PRODUCTS

A. Tape products shall be furnished as hereinafter specified and shall be Plymouth, Okonite, 3M, or equal.

B. General purpose electrical tape shall be 7 mil thick stretchable vinyl plastic, pressure adhesive type, "Slipknot Grey", 3M Scotch 33+, or equal.

C. Insulating void-filling tape and high voltage bedding tape shall be stretchable ethylene propylene rubber with high-tack and fast fusing surfaces. Tape shall be rated for 90 degrees C continuous, 130 degrees C overload, and shall be moisture-proof. Void filling tape shall be "Plysafe", 3M Scotch 23, or equal.

D. High temperature protective tape shall be rated 180^{O}C continuous indoor/outdoor, stretchable, self-bonding silicone rubber. High temperature tape shall be Plysil #3455, 3M Scotch 70, or equal.

E. Insulation putty filler-tape shall be Plymouth #32074, 3M Scotchfill, or equal.

F. Arc and fireproofing tape shall be Plymouth #3318, 3M Scotch #70 or equal.

2.4 LABELS

A. Colored banding tape shall be 5 mil stretchable vinyl with permanent solid color. Colors shall be as hereinafter specified. Tape shall be Plymouth "Slipknot 45", 3M Scotch #35, or equal.

B. Numbered wire marking labels shall be PVC sleeve-type markers, T&B, Brady or equal. Markers using adhesive are not acceptable.

C. Cable identification ties shall be weather resistant polyester with blank write-on space, T&B, Brady or equal.

2.5 MISCELLANEOUS MATERIAL

A. Cable grips shall be 316 SS grip-type wire mesh with machined metal support. Furnish Kellems, Appleton, or equal products.

B. Wire pulling compound shall be non-injurious to insulation and to conduit and shall be lubricating, non- crumbling, and non-combustible. Furnish Gedney "Wire- Quick", Ideal "Yellow" or equal.

C. Fiber Optic Patch Panels shall be 12 fiber with SC connectors. Furnish Corning SPH-01P units. Furnish two patch panels per RTU enclosure. One shall be for the 6 fiber cable ring and the other shall be for interconnection of fiber optic cables for the video surveillance system cameras.

D. Patch cables shall be factory terminated and tested in lengths as needed with SC or ST connectors as required. Furnish Industrial Networking Solutions or equal products.

E. Conduits for concrete encased ductbanks that are supported by piers shall be fiberglass conduits manufactured by Champion.

PART 3 - EXECUTION

3.1 POWER AND CONTROL CABLE

A. Power and control conductors shall be sized as shown and where no size is indicated, the conductor size shall be #12 awg for power circuits #14 awg for 120 vac control circuits, and #16 awg for instrumentation circuits.

B. Equipment grounding conductors shall be installed with type XHHW insulated stranded copper conductors and the insulation color shall be green in sizes up to and including #10 awg.

C. Color coding shall be as follows. Non-factory color coded cables shall be marked with specified color tape. Use the following colors:

CONDUCTOR	120/208V SYSTEMS	480V SYSTEMS
Phase A or L1	Black	Brown
Phase B or L2	Red	Orange
Phase C	Blue	Yellow
Neutral	White	N/A
Ground	Green	Green

D. Branch circuits may be spliced for receptacle, lighting and small appliance load inside appropriate junction boxes. Feeders, branch circuit, power wiring, control wiring, and signal wiring shall be installed without splice.

E. Except as otherwise specified, taps and splices with #10 AWG and smaller, shall be made with insulated spring wire connectors. Such connectors in damp or wet locations shall be waterproofed by filling interstices around wires with silicone rubber and further insulating with an envelope of stretched piece of EPR tape around each wire. Then, apply one-half lapped layer of electrical tape over all.

F. Motor connections made with #10 AWG and smaller wire shall be made up with set-screwed copper lugs with threaded-on insulating jacket. After make-up of each connector, install two (2) layers half-lapped, of high temperature tape over connector barrel and down one (1") inch over wires.

G. Taps, splices, and connections in #8 AWG and larger wires shall be made with copper alloy bolted pressure connectors. Each such connector shall be insulated by means of applying insulation putty over sharp edges so as to present a smooth bonding surface. Next, apply at least four (4) layers, half-lapped each layer of EPR tape. Then, make final wrapping of at least three (3) layers, half-lapped each layer of electrical tape.

H. Control wiring connections to stud type and screw type terminals shall be made with ring-tongue type crimp connectors. Label each terminal jacket with wire marking label at each connection.

I. Each wire connection shall be made up tightly so that resistance of connection is as low as equivalent length of associated conductor resistance.

J. Numbered marking labels shall be installed to identify circuit numbers from panelboards. Install labels on each wire in each panelboard, junction, pullbox and device connection.

K. Label each wiring run with write-on waterproof labels inside motor control center. Install write-on label ties around wire group at conduit entrance and write-on label the wire size, conduit size and service.

L. Install PVC sleeve type numbered marking on each control wire termination at each terminal strip and at each device. Do this in motor control center, terminal cabinets, safety switches, remote controllers, pilot operators, and instrumentation equipment. Number selected shall correspond to number on terminal strip.

M. All wiring inside equipment enclosures shall be neatly trained and laced with nylon tie-wraps.

N. Tie wrap cables in tray.

3.2 INSTRUMENTATION WIRING

A. All 4-20mA analog pairs shall have shields grounded at the instrumentation panel and insulated on the field end unless otherwise required by instrument supplier. Single point grounding shall be maintained.

3.3 GROUND WIRING

A. Each item of equipment shall be adequately and thoroughly grounded. Comply with Article 250 of N.E.C., except where higher standards of grounding have been specified. In addition to requirements as specified under Section 26 04 50, install grounding for general wiring systems as follows.

B. Equipment grounding conductors (EGC) shall be installed in each run of power and control conduits. These wires shall be green colored in sizes #6 AWG and smaller and green banded in larger sizes. Ground wires shall be type XHHW-2 insulated copper wires.

C. EGC runs into equipment shall be grounded to equipment bus where available, or to equipment ground lugs.

D. Where grounding type bushings are installed, bond EGC thereto, and furthermore, ground each bushing lug to equipment ground bus or ground lug, or ground rod.

E. In each motor terminal box, install equipment ground lug and connect EGC thereto. Bond pump frame to motor frame. Bond motor and pump to grounded electrode conductor.

F. Run continuous ground in tray, bond to each section and to all switchgear, panels, and transformers.

3.4 LABELING

A. In addition to labeling requirements as specified throughout this Section, install wiring and raceway labeling as follows:

1. Apply numbered wire marking labels to control wiring terminations for each termination in each item of equipment. Use PVC sleeve type labels.
2. Apply numbered wire marking labels to power and control wiring terminations in motor control centers, panelboards, and at outlets, to identify circuit numbers. Use PVC sleeve type labels.
3. Apply numbered wire marking labels to each signal wire termination in each instrument junction box, and in each item of equipment served by instrumentation circuits. Use PVC sleeve type labels.
4. Apply write-on identification labels to wiring sets in each motor control center, and in each pullbox and junction box. Show wire size, conduit size, and line and load information. Use waterproof plastic write-on labels with nylon tie-wraps.

3.5 TESTING

A. Each run of 600V class power and control wiring shall be tested prior to connection of line and load. Make tests with 1000V dc hand-crank or motor driven ohmmeter. Each run of wiring shall be tested phase-to-phase and/or phase-to-neutral, and phase-to-ground. Test

results for each test shall be equal to or greater than 25,000,000 ohms with 1000V dc applied. All tests shall be made in the presence of the Owners representative or Engineer.

B. Test all runs of signal wiring with 250V dc megger. Insulation values shall meet or exceed 1,000,000 ohms per 100 feet (cable to shield).

C. Should any cable or circuit fail to meet the above tests, replace wire and retest.

3.6 FIBEROPTIC CABLE INSTALLATION

A. The fiberoptic cable shall be installed and terminated per the manufacturer's installation guidelines for the particular cable. No splices shall be made in manholes without prior approval.

B. Connectors shall be compatible with the fiberoptic equipment specified in Section 4.1.18.04. Terminations shall be made by qualified technicians trained in the termination of fiberoptic cables. Specified testing shall be performed after all terminations are made.

C. All cables and termination hardware shall be 100% tested for defects in installation and to verify cabling system performance under installed conditions according to the requirements of ANSI/TIA/EIA-568-B (B.1, B.2, B.3) and any additional requirements with respect to the extended product and/or application assurance warranties. All pairs of each installed cable shall be verified prior to system acceptance. Any defect in the cabling system installation including but not limited to cable, connectors, feed through couplers, patch panels, and connector blocks shall be repaired or replaced in order to ensure 100% useable conductors in all cables installed.

D. All cables shall be tested in accordance with this document, the ANSI/TIA/EIA standards and best industry practice. If any of these are in conflict, the Contractor shall bring any discrepancies to the attention of the project engineer/designer for clarification and resolution.

END OF SECTION

SECTION 26 01 94
DISTRIBUTION PANELBOARDS

PART 1 - GENERAL

1.1 SCOPE
A. This specification covers the requirements for 480 volt distribution panelboards.

B. This specification defines minimum requirements, characteristic guidelines and features required.

1.2 STANDARDS
A. A. All panelboards shall be designed, manufactured and tested in accordance with the latest applicable standards of UL and NEMA. Panelboards shall be UL listed.

1.3 SUBMITTALS
A. Submit outline and dimensional drawings and catalog literature to Engineer for review.

PART 2 - PRODUCTS

2.1 GENERAL
A Ratings shall be as indicated on the drawings.

B Circuit Breakers shall be rated 14,000 amps rms symmetrical interrupting capacity.

C Panelboards shall have integrated 480 volt SPD rated for 200 kA. Provide alarm contacts, event counter, and indicator lights.

2.2 CONSTRUCTION
A. All buses shall be tin-plated copper.

B. Enclosures shall be painted steel.

C. NEMA 4 for installation outdoors.

2.3 MANUFACTURER
A. Panelboards shall be Square D type I-Line or equal.

PART 3 – EXECUTION

3.1 INSTALLATION
A. Install panelboards as scheduled and in locations shown on the drawings. Provide grounding as specified per 26 04 50 and per NEC.

PART 4 - PAYMENT

4.1 PAYMENT
A. Payment for electrical shall be made on a unit price basis as shown in the Bid Schedule and shall constitute full payment for these items.

END OF SECTION

SECTION 26 01 97
ENCLOSED CIRCUIT BREAKERS

PART 1 GENERAL

1.1 SCOPE
A. This specification covers the requirements for 480 volt enclosed circuit breakers.

B. This specification defines minimum requirements, characteristic guidelines and features required.

1.2 STANDARDS
A. All enclosed circuuit breakers shall be designed, manufactured and tested in accordance with the latest applicable standards of UL and NEMA. Enclosed circuit breakers shall be UL listed.

1.3 SUBMITTALS
A. Submit outline and dimensional drawings and catalog literature to Engineer for review.

PART 2 PRODUCTS

2.1 GENERAL
A. Ratings shall be as indicated on the drawings.

B. Circuit Breakers shall be rated 18,000 amps rms symmetrical interrupting capacity at 480 volts.

2.2 CONSTRUCTION
A. Enclosures shall be painted steel.

B. NEMA 12 for installation indoors.

C. Enclosed circuit breakers for use as service entrance mains shall have solid neutral accessory.

D. Trip unit for 600 amp frame shall be solid state with LSIG (long time, short time, instantaneous, and ground fault) functions. Provide sensor rating as indicated on the drawings. Trip unit shall be capable of having settings made without programmer. Trip unit for 250 amp frame and below shall have LI thermal magnetic trip unit.

E. Circuit breaker shall have auxiliary contacts. Provide terminals for powering electronic trip unit versions at 24 volts dc for programming.

2.3 MANUFACTURER
A. Enclosed circuit breakers shall be Square D “L” frame with Micrologic 3.3S trip unit or equal for 600 amp frame breakers and Square D Q frame for 250 amp frame circuit breakers.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install enclosed circuit breakers as scheduled and in locations shown on the drawings. Provide grounding as specified per 26 04 50 and per NEC.

B. Make breaker trip unit settings as directed by Engineer.

END OF SECTION

SECTION 26 04 50

GROUNDING

PART 1 - GENERAL

1.1 SCOPE

A. Furnish and install complete grounding systems in accordance with Article 250 of the National Electrical Code as shown on the Drawings and as specified herein.

B. Provide ground mat grounding electrode system as shown on the drawings and as specified herein.

1.2 SUBMITTALS

A. Submit manufacturers' catalog sheets with catalog numbers marked for the items furnished, which shall include:

1. Ground well casings
2. Ground rods
3. Terminal lugs and clamps
4. Exothermal welding materials
5. Ground cable
6. Ground connection hardware

PART 2 - PRODUCTS

2.1 GROUNDING ELECTRODES

A. All ground mat grounding electrodes and grounding electrode conductors shall consist of tin plated stranded copper.

B. All ground rods shall be copper clad steel products, 3/4" diameter x 10 foot long, unless otherwise indicated. Ground rods shall be Blackburn #6258, or equal. Provide heavy duty ground rod clamps, exothermic welds where concealed or below grade. Equal to Blackburn #GG58 where vertical connections are installed and #GUV where U-bolt connectors are installed to serve horizontal connections.

2.2 GROUNDING DEVICES

A. Connectors shall be furnished as specified under Section 26 01 20.

B. Conduit grounding bushings shall be furnished as specified under Section 26 01 10.

C. Equipment grounding conductors shall be furnished as specified under Section 26 01 20.

D. Flush cast metal grounding plates shall consist of bronze body with flat plate on top and bolted clamp connector on bottom. Furnish OZ type "VG", or equal flush connectors. Each such connector shall be furnished with silicon bronze connector bolts for installation of top-mounted grounding connectors.

E. Exothermal welding kits shall be "Cadweld" products as manufactured by Erico. Molds, cartridges, powder, and accessories shall be as recommended by the manufacturer.

2.3 GROUND TEST WELLS

A. Ground test wells shall be furnished each ground rod for the purpose of field testing the ground mat system.

B. Ground test wells shall each consist of ground rod with connector attached to a #4 upcomer from the ground mat and contained within an access well with labeled top.

C. Ground test well enclosures shall be Brooks product #3RT series, or equal. Enclosures shall be 10 1/4" diameter and shall include cast iron cover with integrally cut "GROUND TEST WELL" in top of cover.

PART 3 - EXECUTION

3.1 GROUND MATS AND GROUND WELLS

A. Install ground mat around the perimeter of structures, electrical equipment racks, the generator pad and where indicated on the drawings. Use #4/0 AWG tin-plated copper stranded conductor for the ground mat. Install upcomer with indicated wire sizes of tin plated copper conductors. Exothermally weld all connections.

B. Unless other larger sizes are indicated on the drawings, install #2 upcomers from ground mat to PLC, and other equipment indicated on the drawings. Install "VG" flush floor connector to serve each upcomers and run #2 stingers from top side of each "VG" to ground bus in equipment. Bond VG to rebar in concrete.

C. Install ground rods in test wells where indicated on the drawings.

3.2 TRANSFORMER

A. Bond transformer neutral to cabinet.

B. Install grounding electrode conductor from each transformer neutral to system ground and to local electrodes as shown. Run #2 ground wire to ground mat.

3.3 WIRING SYSTEMS GROUNDING

A. All equipment enclosures, motor and transformer frames, metallic conduit systems and exposed structural steel systems shall be grounded.

B. Equipment grounding conductors shall be run with all wiring. Sizes of equipment grounding conductors shall be based on Article 250 of the N.E.C. except where larger sizes may be shown. Bond each equipment grounding conductor to the equipment grounds at each end of each run. Run 4/0 ground full length of tray, bond to each section and every enclosure where conductors originate or terminate. Protect grounded equipment conductor in conduit where it leaves the tray.

C. Liquid tight flexible metal conduit in sizes 1" and larger shall be equipped with external bonding jumpers. Use liquid tight connectors integrally equipped with suitable grounding lugs.

D. Where conduits enter into equipment free of the metal enclosure, install grounding bushing on each conduit and bond bushing lug to equipment ground bus.

E. Where conduits enter equipment enclosures, equip each penetration inside with grounding bushing. Install bonding jumper from each grounding bushing to ground bus.

F. Equipment enclosures that do not come furnished with a ground bus, install ground lug in each enclosure that shall be bonded to the metal cabinet or backpan of the enclosure.

G. Separately derived systems shall be each grounded as shown and shall comply with Article 250 of the NEC except where higher standards are shown.

3.4 TESTING

A. All exothermic weld connections shall successfully resist moderate hammer blows. Any connection which fails such test or if upon inspection, weld indicates a porous or deformed connection, the weld shall be remade.

B. All exothermic welds shall encompass 100 percent of the ends of the materials being welded. Welds which do not meet this requirement shall be remade.

C. Test the ground resistance of the system. All test equipment shall be furnished by Contractor and be approved by Engineer. Test equipment shall be as manufactured by Biddle or approved equal. Dry season resistance of the system shall not exceed five ohms. If such resistance cannot be obtained with the system as shown, provide additional grounding as directed by Engineer.

END OF SECTION

No specifications on this page for formatting purposes.

SECTION 26 09 10
INSTRUMENTATION

PART 1 - GENERAL

1.01 SCOPE

A. This section covers the instruments, instrumentation enclosures and miscellaneous devices.

B. Auxiliary and accessory devices necessary for system operation or performance, such as relays, din connectors, or terminals to interface with other Sections of these Specifications, shall be included.

1.02 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of products of this type, and whose products have been in satisfactory use in similar service for not less than 5 years.

B. Installer: Qualified with at least 5 years of successful installation experience on projects with work similar to that required for this project.

C. NEC Compliance: Comply with the National Electrical Code, NFPA 70, as applicable to wiring and other electrical construction of the unit.

D. UL Compliance: Provide components with UL listing and labeling for applicable UL categories.

E. Provide complete unit and installation to conform with NFPA-90A.

1.03 SUBMITTALS

A. Submittals shall be in accordance with the requirements outlined in Section 01 33 23 Submittals.

B. Submit catalog literature, specification material and installation and operation manual for each instrument and device specified herein.

C. Submit outline and dimensional drawings and wiring diagrams to ENGINEER for review.

D. Submit shop drawings for instrument panels shall include wiring schematics and dimensional outlines. Shop drawings shall include ISA loop drawings on all loops. Loop drawings shall include all device terminal numbers and wire numbers. Shop drawings shall include all pin-out wiring for RS-232 and RS-485 and similar type connectors.

1.04 SYSTEM RESPONSIBILITY

A. The CONTRACTOR shall assume complete "SYSTEM RESPONSIBILITY" for the instrumentation system. "System Responsibility" shall mean that the CONTRACTOR is responsible for the overall operation, satisfactory performance, and integration of the individual components into the whole system so that the entire system functions in whole and in its parts as intended by the Contract Documents. Coordinate integration and testing of instrumentation system with programmer of RTU and Computer HMI System.

PART 2 PRODUCTS

2.01 SURGE SUPPRESSORS

A. Surge suppressors for protecting 120vac circuits shall meet UL 1449, UL 1283, NEMA LS-1 1992, and ANSI/IEEE C62.41 and C62.45. Load current rating shall be 20 amps at 120vac.

B. Surge suppressors shall be series connected and shall have a surge current capacity of 45,000 amps.

C. 120VAC Surge suppressor shall be Phoenix Contact model 2906489 or approved equal.

2.02 INSTRUMENT AND PLC ENCLOSURES

A. Indoor enclosures instrumentation equipment shall be hinged door type and shall have interior mounting sub panel. Enclosures shall be Hoffman or equal. Enclosure shall be sized to house the specified equipment, but shall not be less than the size indicated on the PLANS.

B. Enclosure rating for air-conditioned and ventilated locations in pump stations shall be NEMA 12. Enclosure rating for outdoor or damp locations such as the Raw Water Island shall be NEMA 4X and shall be constructed of 316 stainless steel painted white.

2.03 MISCELLANEOUS

A. Terminal strips for connection of field wiring shall be DIN rail mounted channel mounted terminals suitable for connecting #22 to #12 wire sizes. Furnish ABB model 011512017 with 35mm Aluminum DIN rail mounting channel. Terminal strips shall have factory terminal markers.

B. Isolation relays shall be 24vdc SPDT with base. Furnish Idec model RV8H-L-D24.

C. Furnish and install a 24V DC 20 Amp Power Supply for the equipment as shown on the drawings. The 24V DC PSU shall be Phoenix Contact #2938620.

D. Furnish and install a 24V DC 20 Amp Uninterruptable Power Supply (UPS) for the equipment as shown on the drawings. The 24V DC UPS shall be Phoenix Contact #2320238.

E. Furnish and install a 24V DC 12-Amp Hour Battery Module. The Battery Module shall be Phoenix Contact #2320322.

F. Signal Splitters shall be 24vdc powered with 4-20mA inputs & (2) 4-20mA outputs. Signal Splitters shall be Acromag model #633T-0100 or approved equal.

G. 4-20mA Surge Suppressors shall be provided where required and as indicated on the drawings. 4-20mA surge suppressors shall be Phoenix Contact #2839538 or approved equal.

2.04 MAGNETIC FLOWMETER

A. Magnetic Flowmeter shall be Endress+Hauser – Promag P 500 as specified in section 40 91 16 Electromagnetic Meters.

2.05 FLOW CONTROL VALVE

A. Flow Control Valve controller shall be Cla-Val VC-22D as specified in section 40 05 67 Flow Control Valve.

2.06 CHLORINE ANALYZER

A. Chlorine Analyzer shall be ProMinent – DACb as specified in section 40 75 21 Chlorine Analyzer.

PART 3 EXECUTION

3.01 INSTALLATION GENERAL

A. Permanently mount the instruments, and all required appurtenances in accordance with manufacturer's requirements. All work shall be done in accordance with industry standards, the NEC, ISA recommendations and in a workmanship like manner.

B. All surge suppression devices shall be grounded with minimum #14 ground wire.

3.02 OPERATIONS AND MAINTENANCE MANUALS

A. Six (6) weeks prior to the completion of the project, compile an Operations and Maintenance Manual on the instrumentation equipment. The manual shall meet the requirements outlined in Section 01 78 23 Operations And Maintenance Data.

END OF SECTION

No specifications on this page for formatting purposes.

SECTION 26 09 30
SCADA

PART 1 - GENERAL

1.01 SCOPE

A. This section covers existing PLC equipment and programming, network components, testing and verification. Work shall include all necessary materials, equipment, labor, and services.

1.02 QUALITY ASSURANCE

A. Comply with Section 26 09 10, Part 1.02
Allow in bid for VerTek as system integrators for programming the water treatment plant RTU and associated HMI system. Contact Doug Sells 802-878-8822.

1.03 RELATED WORK

Section 26 09 10, Instrumentation

Section 40 05 67, Flow Control Valve

Section 40 75 21, Chlorine Analyzer

Section 40 91 16, Electromagnetic Meters

1.04 SUBMITTALS AND SHOP DRAWINGS

A. Submit catalog information on:
1. Enclosures
2. Power Supplies
3. PLC Equipment
4. Terminals and accessories

B. Submit shop drawings on PLC equipment and wiring.

PART 2 - PRODUCTS

2.01 EXISTING WATER TREATMENT PLANT PROGRAMMABLE LOGIC CONTROLLER "ATP PLC"

A. PLC's if required, shall be matched to existing "ATP PLC" model number or approved equivalent.

B. PLC power supply shall match existing model number or approved equivalent. Contractor shall verify existing power supply has sufficient capacity for proposed scope of work.

C. PLC shall have expansion I/O modules as required to accommodate the I/O scheduled on the drawings. PLC expansion I/O modules shall match existing model number or approved equivalent.

D. Digital input modules shall match existing model number or approved equivalent.

E. Discrete output modules shall match existing model number or approved equivalent.

F. Analog input modules shall match existing model number or approved equivalent.

G. Analog output modules shall match existing model number or approved equivalent.

2.02 POWER SUPPLIES AND BATTERIES

A. See 24vdc PSU requirements – Instrumentation Section 26 09 10.2.03.C

B. See UPS requirements – Instrumentation Section 26 09 10.2.03.D

C. See Battery requirements – Instrumentation Section 26 09 10.2.03.E

PART 3 - EXECUTION

3.01 GENERAL

Reservoir 1 tank level dictates operation of flow control valve FCV-100. Operator to select Reservoir 1 tank level that initiates fill operation. Flow control parameter in GPM is sent to FCV-100 from SCADA operator to begin tank fill after tank level set point has been reached. FCV-100 will operate based on input from VC-22D set program and input from flow meter FM-100. FM-100 pulse and 4-20mA signals will be sent to PLC "ATP PLC" Arsenic Treatment Plant PLC. Flow meter signals to be recorded as total flow. Flow meter to aide in fill calibration PID control of FCV-100.

CL sensor will send a 4-20mA signal back to PLC independent of other systems. This process is independent and only for monitoring free CL levels.

END OF SECTION

SECTION 33 14 14
HIGH DENSITY POLYETHYLENE (HDPE) PIPE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. HDPE Pipe 4-inch through 60-inch for water distribution.

B. Deviations from this City of Denton Standard Specification:
   1. None.

C. Related Specification Sections include but are not limited to:
   1. City of Buckeye Water Engineering Design Standards.
   2. MAG Uniform Standard Specifications and Details for Public Works Construction.

1.2 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment
   1. HDPE Pressure Pipe
      a. Measurement
         1) Measured horizontally along the ground surface from center line to center line of fitting, manhole, or appurtenance of HDPE Pressure Pipe installed.
      b. Payment
         1) 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 per linear foot for “HDPE Pressure Pipe” installed for:
            a) Various sizes.
            b) Various types of backfill.
      c. The price bid shall include:
         1) Furnishing and installing HDPE Pipe as specified by the Drawings
         2) Utility Markers/Locators
         3) Pavement Removal
         4) Excavation
         5) Hauling
         6) Disposal of excess material
         7) Furnishing, placement, and compaction of embedment
         8) Furnishing, placement, and compaction of backfill
         9) Clay Dams
         10) Fusion of joints
         11) HDPE fittings
         12) Ductile Iron Fittings with Restraint (if required)
         13) Bolts and nuts
         14) Clean-up
         15) Cleaning
         16) Disinfection (for potable)
         17) Testing

1.3 REFERENCES

A. Abbreviations and Acronyms
   1. HDPE – High Density Polyethylene

B. Reference Standards
   1. Reference standards cited in this Section refer to the current reference standard published at the time of the latest revision date logged at the end of this Section unless a date is specifically cited.
   2. ASTM International (ASTM):
      a. D3035, Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.
      b. D3350, Standard Specification for Polyethylene Plastic Pipe and Fittings Materials.
      c. F2620, Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings.
      d. F1290, Standard Practice for Electrofusion Joining Polyolefin Pipe and Fittings.
      e. D3261, Standard Specifications for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
      f. F714, Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter.
      g. F2164: Standard Practice for Field Leak Testing of Polyethylene (PE) Pressure Pipeline Systems Using Hydrostatic Pressure.
   3. American Water Works Association (AWWA):
      a. C901, Polyethylene (PE) Pressure Pipe and Tubing, 3/4-inch through 3-inch, for Water Service.
      b. C906, Polyethylene (PE) Pressure Pipe and Fittings, 4-inch through 63-inch, for Water Distribution.
      c. M55, PE Pipe Design and Installation.
   4. NSF International (NSF) (for use in potable applications):
      a. 61, Drinking Water System Components – Health Effects.
      b. 372, Drinking Water System Components – Lead Content.

1.4 ADMINISTRATIVE REQUIREMENTS [NOT USED]

1.5 SUBMITTALS

A. Submittals shall be in accordance with the City of Buckeye Water Engineering Design Standards.

B. All submittals shall be approved by the City prior to delivery.

1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS

A. Qualifications
   1. Submit manufacturer and butt fusion welder qualifications in accordance with Article 1.9 and the following:
      a. Documentation that each Fusion Technician has met requirements for joining proficiency for each type of fusion joint performed by the Fusion Technician under this specification.

b. Documentation of conformance with this Section and applicable standards, including written documentation regarding any intended variance from this Section and applicable standards. This will include fusion joint warranty information and recommended project specific fusion parameters, including criteria logged and recorded by data logger.

2. The following AS-RECORDED DATA is required from the Contractor and/or Fusion Provider:
   a. Fusion reports for each fusion joint performed on the project, including joints that were rejected. Submittals of the Fusion Technician's joint reports are required as requested by the Owner or Engineer. Specific requirements of the Fusion Technician's joint report shall include:
      1) Pipe or fitting size and DR or pressure class rating
      2) Fusion equipment size and identification
      3) Fusion Technician Identification
      4) Job Identification Number
      5) Fusion Number
      6) Fusion joining parameters
      7) Ambient Temperature

B. Product Data
   1. Manufacturer
   2. Nominal pipe diameter
   3. Pressure Rating
   4. Standard Dimension ratio (DR)
   5. Cell classification
   6. Laying lengths

C. Certificates
   1. Furnish an affidavit certifying all HDPE pipe has been tested and is in accordance with this Section and all ASTM and AWWA standards as listed herein.

1.7 CLOSEOUT SUBMITTALS [NOT USED]

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE

A. Qualifications
   1. Manufacturers
      a. Finished pipe shall be the product of 1 manufacturer for each size, unless otherwise specified by the City.
         1) Change orders, specials, and field changes may be provided by a different manufacturer upon City approval.
      b. Pipe manufacturing operations shall be performed under the control of the manufacturer.
      c. Certified copies of test reports required with each delivery, stating all pipe is in accordance with ASTM F714, ASTM D3350, ASTM D3035 as applicable.
   2. Butt-Fusion Welding
      a. Butt-fusion welding of pipe sections shall be performed by a fusion technician certified by the pipe manufacturer. Manufacturer's recommended practices shall be followed.

b. Each Fusion Technician performing butt fusion, saddle fusion, or electrofusion joints shall be qualified to make butt fusion joints in accordance with ASTM F2620/1290. Qualification shall have occurred not more than 12 months before performing fusion joining on site in accordance with this Section. Qualification shall be a documented demonstration of proficiency by making joints in accordance with ASTM F2620/1290 that are proved to be satisfactory by destructive testing in accordance with ASTM F2620/1290.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Storage and Handling Requirements
   1. Store and handle in accordance with the guidelines as stated in AWWA M55.

1.11 FIELD CONDITIONS [NOT USED]

1.12 WARRANTY [NOT USED]

PART 2 - PRODUCTS

2.1 CITY-FURNISHED PRODUCTS [NOT USED]

2.2 MATERIALS

A. Manufacturers
   1. HDPE Pipe and Fittings
      a. Performance Pipe
      b. JM Eagle
      c. Pipeline Plastics
      d. ISCO Pipe
      e. WL Plastics
   2. Substitution requests for manufacturers or models not indicated above shall be processed in accordance with the General Provisions.

B. HDPE Pipe
   1. Pipe and Fittings
      a. As a minimum the following pipe classes apply. The Drawings or the pressure and deflection design criteria may require a higher wall thickness, but in no case should the pipe classes be less than the following:

Type of Use	Min Pipe Class
Potable Distribution	DR-11

      b. Material
         1) Extra High Molecular Weight, High Density Polyethylene PE 4710, Cell Class PE445474C with colored striping the entire length of pipe in accordance with AWWA C901 or AWWA C906.
            a) Striping shall be Cell Class PE445474E.
            b) Cell Classifications are to be in accordance with ASTM D3350.
         2) Homogeneous throughout and free of:
            a) Abrasion, cutting, or gouging of the outside surface extending to more than 10 percent of the wall thickness in depth

b) Cracks
c) Kinking
d) Flattening
e) Holes
f) Blisters
g) Other defects

c. All pipe shall be color coded for the intended service. The color coding shall be permanently co-extruded stripes on the pipe outside surface as part of the pipe's manufacturing process. Painting HDPE pipe to accomplish color coding is not permitted. Color coding shall be as follows:
   1) Water – blue
   2) Reuse – purple
d. Pipe with gashes, nicks, abrasions, or any such physical damage which may have occurred during storage and/or handling, which are larger/deeper than 10 percent of the wall thickness, shall not be used and shall be removed from the construction site.
e. Pipe and fittings shall be uniform in color, opacity, density, and other physical properties.
f. Pipe Markings
   1) In accordance with ASTM D3350
   2) Minimum pipe markings shall be as follows:
      a) Intervals uniformly at 6-inch
      b) Manufacturer's Name or Trademark and production record
      c) Nominal pipe size
      d) ASTM or Dimension Ratio (DR) designation
      e) Cell classification
      f) Seal of testing agency that verified the suitability of the pipe
g. Dimension Classification
   1) All uses may be Iron Pipe Size (IPS).

2. Connections
   a. Use only manufactured fittings in accordance with ASTM D3261
   b. HDPE fabricated fittings shall have pressure class ratings not less than the pressure class rating of the pipe to which they are joined.
      1) For pressure applications, a minimum pressure rating of 200 psi is required for all fittings.
3. Tracer Wire/Detectable Metallic Tape in accordance with City of Buckeye Water Engineering Design Standards.
4. Polyethylene Repair Clamp
   a. Smith-Blair Full Circle Clamp Style 228, 263, or approved equal.

2.3 ACCESSORIES [NOT USED]

2.4 SOURCE QUALITY CONTROL [NOT USED]

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION [NOT USED]

3.3 PREPARATION [NOT USED]

3.4 INSTALLATION

A. General
   1. Install pipe, fittings, specials, and appurtenances in accordance with this Section and the pipe manufacturer's recommendations.
   2. Lay pipe to the lines and grades as indicated in the Drawings.
   3. Excavate, embed, and backfill trenches in accordance with COB Standard Detail 31380.

B. Pipe Handling
   1. Haul and distribute pipe and fittings at the project site.
   2. Handle piping with care to avoid damage.
      a. Inspect each joint of pipe and reject or repair any damaged pipe prior to lowering into the trench.
      b. Use only nylon ropes, slings, or other lifting devices that will not damage the surface of the pipe for handling the pipe.
   3. At the close of each operating day:
      a. Keep the pipe clean and free of debris, dirt, animals, and trash – during and after the laying operation.
      b. Effectively seal the open end of the pipe using a gasketed night cap.

C. Pipe Joining
   1. Join pipe in accordance with ASTM F2620.
   2. Operators must be certified by the manufacturer to use the fusion equipment.
   3. Follow the time and temperature recommendations of the manufacturer.
   4. Joints shall be stronger than the pipe itself, be properly aligned, and contain no gaps or voids.
   5. Each fusion joint shall be recorded and logged by an electronic monitoring device (data logger) connected to the fusion machine that shall register and/or record the parameters required by the manufacturer and these specifications. Data not logged by the data logger shall be logged manually and be included in the Fusion Technician's joint report.

D. Tracer Wire/Detectable Metallic Tape Installation in accordance with City of Buckeye Water Engineering Design Standards..

3.5 REPAIR

A. Repair any damaged pipe, fittings, specials, and appurtenances in accordance with this Section and the pipe manufacturer's recommendations. Faulty fusion joints must be removed and remade.

3.6 RE-INSTALLATION [NOT USED]

3.7 FIELD QUALITY CONTROL

A. Potable Water Mains
   1. Hydrostatic testing:
      a. Hydrostatically test the mains in accordance with MAG 611.

3.8 SYSTEM STARTUP [NOT USED]

3.9 ADJUSTING [NOT USED]

3.10 CLEANING

A. Potable Water Mains
   1. Cleaning, disinfection, and bacteriological testing of water mains:
      a. Clean, flush, pig, disinfect, and bacteriological test the mains in accordance with Section 33 01 10.

3.11 CLOSEOUT ACTIVITIES [NOT USED]

3.12 PROTECTION [NOT USED]

3.13 MAINTENANCE [NOT USED]

3.14 ATTACHMENTS [NOT USED]

END OF SECTION

SECTION 40 05 67
FLOW CONTROL VALVE

PART I - GENERAL

1.1. SUMMARY

A. Section Includes:

1. Electronic flow control valve that can operate in Modulating service to provide flow control, base on loop control and meter signal. Furnish all materials, equipment, and labor and incidentals necessary to provide, install and put into operation one flow control valve as specified herein and shown on the drawings.

B. Related Specifications include, but are not necessarily limited to:

1. City of Buckeye Water Engineering Design Standards.
2. MAG Uniform Standard Specifications and Details for Public Works Construction.
3. Division 09 – Finishes
4. Division 26 – Electrical
5. Division 40 – Process Interconnections

1.2 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment

1. Work associated with this Item is included in the total lump sum price for the control valve assembly.

1.3 REFERENCES:

American Society for Testing and Materials (ASTM).

ASTM A48	Standard Specification for Gray Iron Castings.
ASTM A126	Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
ASTM A436	Standard Specification for Austenitic Gray Iron Castings.
ASTM A536	Standard Specification for Ductile Iron Casings.

1.4 SYSTEM DESCRIPTION:

A. The arrangement shown on the drawings is based upon the best information available to the Engineer at the time of design and is not intended to show exact dimensions to any specific equipment unless otherwise shown or specified. Therefore, it may be anticipated that the structural supports, foundations, and connected piping shown may have to be changed in order to accommodate the equipment furnished. No additional payment will be made for such changes. All necessary calculations and drawings for any related redesign shall be submitted to the Engineer for his approval prior to beginning the work.

B. The valve shall be designed to operate with the following working conditions without damage to the valve.

Upstream Pressure Range*	70 psi – 115 psi

Downstream Pressure	0 psi
Normal Flow Range	0 – 600 gpm
Maximum Flow Rate	1500 gpm

* Valve shall include a pressure sustaining feature which will ensure a minimum upstream pressure at all times. Contractor shall coordinate and verify with the City and Engineer on the minimum pressure prior to the valve being manufactured.

C. The flow control valve shall operate satisfactorily over the complete operating range shown. The equipment to be provided under this section shall be suitable for installation and operation at elevations for about 667 feet above sea level inside a vault structure. Outside ambient temperatures range between 10 and 130 degrees F, and reported water temperatures vary between 50 and 105 degrees F. Relative humidity is expected to range between 5 and 100 percent. The valve shall be capable of being submerged periodically.

1.5 QUALITY ASSURANCE:

A. The valve shall be the product of a manufacturer regularly engaged in the manufacture of hydraulic valves having similar service and size. The valves covered by the specifications are intended to be standard equipment of that has proven ability. Only the following manufacturers and models are acceptable.

Manufacturer

Cla-Val Model 131-BW BCNPSY KOX D/S CL 150FL with VC-22D Electronic Valve Controller

B. All other valves will be considered a substitution, and will be required to submit in writing as specified in the General Provisions. The Engineer shall be the sole judge of the acceptability of any substitution requested. If the substitution request is found to be unacceptable by the Engineer then the contractor shall provide the listed equipment at no additional expense to the City. The Contractor shall be responsible for any delays as a result of a substitution request.

C. The listing above does not imply that the pump or the manufacturer's standard product is acceptable. The successful manufacturer will be required to conform to all specifications.

D. Unit Responsibility and Coordination:

The Contractor shall cause all equipment specified under this section to be furnished by the valve manufacturer who shall be responsible for the adequacy and compatibility of all unit components including but not limited to the valve, actuator and extension stems. Any component of each complete unit not provided by the valve manufacturer shall be designed, fabricated, tested, and installed by factory-authorized representatives experienced in the design and manufacture of the equipment. This requirement, however, shall not be construed as relieving the Contractor of the overall responsibility for this portion of the work.

1.6 SUBMITTALS:

A. Submittals required after award of contract and prior to shipping:

1. Technical bulletins and brochures on flow control valve.

2. Certification of compliance with specifications.

B. Submittals required prior to final walk through:

1. Operation and Maintenance Manual.

1.7 SPARE PARTS AND TOOLS:

A. None required.

1.8 SHIPPING INSTRUCTIONS:

A. All parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed and the units and equipment are ready for operation.

B. All equipment and parts must be properly protected against any damage during a prolonged period at the site.

C. The finished surfaces of all exposed flanges shall be protected by wooden blank flanges, strongly built and securely bolted thereto.

D. Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.

E. Storage and Protection: Take special care to prevent plastic and similar brittle items from being directly exposed to the sun, or exposed to extremes in temperature, preventing any deformation.

1.9 WARRANTY:

F. The equipment shall be warranted to be free from defects in workmanship, design and materials. If any part of the equipment should fail during the warranty period, it shall be replaced and the unit(s) restored to service at no expense to the City. Warranty shall be for a period of two (2) years and begin on the Date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MAIN VALVE:

A. The valve shall be hydraulically operated, single diaphragm-actuated, globe pattern. The valve shall consist of three major components: the body with seat installed, the cover with bearing installed, and the diaphragm assembly. No separate chambers shall be allowed between the main valve cover and body. Valve body and cover shall be of cast material. No fabrication or welding shall be used in the manufacturing process.

B. The valve shall contain a resilient, synthetic rubber disc with a rectangular cross-section contained on three and one-half sides by a disc retainer and forming a tight seal against a single removable seat insert. No o-ring type discs (circular, square, or quad type) shall be permitted as the seating surface. The disc guide shall be of the contoured type to permit smooth transition of flow and shall hold the disc firmly in place. The disc retainer shall be of a sturdy one-piece design capable of withstanding opening and closing shocks. No hour-glass shaped disc retainers shall be permitted and no V-type or slotted type disc guides shall be used.

C. The diaphragm assembly containing a non-magnetic 303 stainless steel stem; of sufficient diameter to withstand high hydraulic pressures shall be fully guided at both ends by a bearing in the valve cover and an integral bearing in the valve seat. The seat shall be a solid, one-piece design and shall have a minimum of a five-degree taper on the seating surface for a positive, drip-tight shut off. No center guides shall be permitted. The stem shall be drilled and tapped in the cover end to receive and affix such accessories as may be deemed necessary. The diaphragm assembly shall be the only moving part and shall form a sealed chamber in the upper portion the valve, separating operating pressure from line pressure.

D. The flexible, non-wicking, FDA approved diaphragm shall consist of nylon fabric bonded with synthetic rubber compatible with the operating fluid. The diaphragm shall not be used as the seating surface.

E. The main valve seat and the stem bearing in the valve cover shall be removable. The valve seat in 8” and larger size valves shall be retained by flat head machine screws for ease of maintenance. Cover bearing, disc retainer, and seat shall be made of the same material. All necessary repairs and/or modifications other than replacement of the main valve body shall be possible without removing the valve from the pipeline. Packing glands and/or stuffing boxes shall not be permitted and components including cast material shall be of North American manufacture.

F. The valve manufacturer shall warrant the valve to be free of defects in material and workmanship for a period of three years from date of shipment, provided the valve is installed and used in accordance with all applicable instructions. Electrical components shall have a one-year warranty.

G. The valve manufacturer shall be able to supply a complete line of equipment from 1 1/4" through 48" sizes and a complete selection of complimentary equipment. The valve manufacturer shall also provide a computerized cavitation chart which shows flow rate, differential pressure, percentage of valve opening, Cv factor, system velocity, and if there will be cavitation damage.

2.2 MATERIAL SPECIFICATION:

Valve size: 6”

Main Valve Body and Cover: Ductile Iron / ASTM A-536

Main Valve Trim: Stainless steel with anti-cavitation

Stem: 303 Stainless Steel

End Detail: ANSI B16.42 150 LB. FLG.

Pressure Rating: 250 PSI

Temperature Range: -40 to +180 Degrees F

Rubber Material: Buna "N"

Coating: Epoxy coated by baked on resin fusion method process 5-7 mils thick internal & external

Desired Options: See model number listed above

2.3 PILOT CONTROL SYSTEM:

A. Valve Controls consist of solenoids and VC-22D electronic controller to provide the interface between a remote computer system and a hydraulic control valve to provide remote electronic control operation of the valve. The electronic controller shall be supplied with pre-programmed valve application templates used to setup and

configure the controller to match the desired function of the valve in the piping system.

B. The controller display shall be a color TFT screen to graphically display valve application with integral real-time system information.

C. A panel mount enclosure shall be provided to house the controller for environmental protection. An anodized aluminum mounting bracket suitable for mounting on pipe or wall shall be supplied as standard. The controller shall feature a multi-PID loop control with local or remote set point input. The controller shall include six (6) configurable analog inputs; six (6) dry contact digital inputs; six (6) 4-20mA analog outputs; and two (2) solid-state relays.

D. The controller shall have a configurable set point ramping to protect against system surges and shall also include a configurable flow totalizer. High speed logging data (1000Hz) shall be downloadable to a portable memory device such as a USB drive. Security codes shall be provided to protect against unauthorized changes.

E. The electronic controller shall be capable of data retransmission to SCADA or similar control systems and shall be capable of generating and sending signal loss warnings and other configurable control actions. Alarm outputs shall be provided as standard rather than an optional feature.

F. Each VC-22D controller enclosure and supporting AC/DC power supply conversion box enclosure shall include their own individual universal bracket(s), allowing for versatility of installation. If require, clips for mounting to DIN rail shall be supplied by Contractor.

G. Sufficient clearance around controller enclosure should be made for adequate access/wiring. Considerations should be made to comply with all the various local codes, standards and best practices.

H. Utilizing electronic digital control, solenoid pilots equipped onto the control valve(s) are actuated by electrical signals received from the Electronic Valve Controller which enables remote computer control over the diaphragm valve operations. The solenoids either add or relieve line pressure from the cover chamber of the diaphragm valve, causing it to open or close as directed by the Electronic Valve Controller. Each solenoid is controlled by a solid-state relay with zero switching voltage. The total cycle time between each pulse shall be programmable.

I. In either digital or analog control, the Electronic Valve Controller shall accept an analog 4-20mA feedback signal. Upon receiving the remote set-point command from the computer system or local command from the operator, the Electronic Valve Controller shall provide a digital signal or 4-20 mA analog signal to the appropriate pilot(s) and maintain the desired set-point value. When the feedback signal is within a programmable dead band zone, the appropriate electronic pilot(s) on the control valve will not activate; control valve will maintain position. When the feedback signal deviates from or approaches the set-point, the appropriate electronic pilot(s) will be activated, smoothly modulating the valve to its set-point. Preinstalled valve application templates allow the Electronic Valve Controller to be configured to perform a wide range of control valve functions, such as: pressure management, pressure reducing, pressure sustaining, rate of flow control, level control or valve position.

J. Cla-Val EPC Power Converter shall be supplied, and is a self-contained device used

to convert an AC power source to 24VDC to operate the Cla-Val Model VC-22D Electronic Valve Controller.

K. The EPC Power Converter also converts the 24VDC solenoid outputs from the VC-22D controller to 120 VAC; to operate control valves that are equipped with the AC solenoids.

1. EPC Power Converter enclosure is panel mount.
2. Each power converter box enclosure shall be provided standard with a mounting bracket.
3. MATERIALS
4. Enclosure
5. Enclosure Material Flame retardant UL rated PC/ABS plastic
6. Enclosure Connections (12) ½" Cable Glands with Plugs
7. Enclosure Dimensions 6.50" (165 mm) H x 4.375" (111 mm) W x 3.250" (83 mm) D
8. Enclosure Weight 2 lbs. (.91 kg)
9. Environmental panel mount, 2 meter for 48 hours
10. Mounting Bracket Anodized Aluminum
11. Internal Power Supply
12. Input Voltage Range 90-264VAC 47-440Hz or 100-375VDC
13. Relays (2) Solid State
14. Safety Agency Certification UL/CSA/CE marking
15. Output Ratings
16. Output Voltage 24V
17. Maximum Current 1A
18. Power 40W
19. Recommend External Fuse 3.15A Slow Blow Type
20. The Power Converter shall be the CLA-VAL Company Model No. EPC, as manufactured by Cla-Val Co., Newport Beach, CA 92659-0325.

L. Valve shall have a solenoid that shall be utilized to close the valve completely upon a signal from a remote point or local tank level control. A manual operator shall be installed on the solenoid. The pilot assembly shall include a fixed orifice assembly, opening and closing speed control needle valves and pilot system strainer.

2.4 MATERIAL SPECIFICATION FOR PILOT CONTROL:

1. Body & Cover: Cast Bronze ASTM B62
2. Pressure Rating: 300 PSI
3. Trim: 303 SS
4. Rubber Material: Buna "N"
5. Tubing and Fittings: Bronze & Copper
6. Operating Fluids: Potable Water
7. Voltage: 120/60 Volt AC
8. Adjustment Range: 20-105 PSI
9. Enclosure Type: Panel mount

10. Desired Options: Manual Operator

PART 3 - EXECUTION

3.1 INSTALLATION:

A. All pump control valves shall be installed in accordance with the instructions of the manufacturer and as shown on the drawings.

B. Installation and adjustment shall be checked and approved by a manufacturer's factory representative. After acceptance, the representative shall address a letter to the Engineer outlining all installation and start up procedures. The letter shall include a statement that the valves are installed per the manufacturer's recommendations. The manufacturer or his qualified representative shall conduct training session for the City's personnel in the operation and maintenance of the valves.

C. The valve manufacturer shall provide a factory representative to calibrate the valve and verify operation during start up.

END OF SECTION

No specifications on this page for formatting purposes.

SECTION 40 75 21
CHLORINE ANALYZER

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes
   1. Furnish labor, materials, equipment and incidentals necessary to install a chlorine analyzer for continuous measurement of free or total chlorine as specified herein.

B. Related Specification Sections include but are not necessarily limited to
   1. City of Buckeye Water Engineering Design Standards.
   2. MAG Uniform Standard Specifications and Details for Public Works Construction.
   3. Division 09 – Finishes
   4. Division 26 – Electrical
   5. Division 40 – Process Interconnections

1.2 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment
   1. Work associated with this Item is included in the total lump sum price for the control valve assembly.

1.3 REFERENCES

A. Reference Standards
   1. Reference standards cited in this specification refer to the current reference standard published at the time of the latest revision date logged at the end of this specification, unless a date is specifically cited.
   2. American National Standards Institute (ANSI).
   3. American Society for Quality Control (ASQC).
   4. American Society of Mechanical Engineers (ASME).
   5. American Society for Testing Materials (ASTM).
   6. American Water Works Association (AWWA).
   7. The Chlorine Institute (CI).
   8. Institute of Electrical and Electronics Engineers (IEEE).
   9. International Standards Organization (ISO).
   10. National Electrical Code (NEC).
   11. National Electrical Manufacturers Association (NEMA).
   12. National Fire Code (NFC).
   13. National Institute of Occupational Safety & Health (NIOSH).
   14. Occupational Safety and Health Administration (OSHA).
   15. Standard Fire Code (SFC).
   16. Uniform Fire Code (UFC).

17. Arizona Department of Environmental Quality (ADEQ) Regulations.

1.4 ADMINISTRATIVE REQUIREMENTS [NONE]

1.5 SUBMITTALS

A. Submittals shall be in accordance with the City of Buckeye Water Engineering Design Standards.

B. All submittals shall be approved by the City prior to delivery.

1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS

A. Product Data
   1. Sufficient information to show that the equipment meets this specification.
   2. Electrical wiring diagrams as required for the installation.
   3. Diagram and plan for providing SCADA monitoring
   4. Equipment Mounting
   5. Manufacturer's literature, illustrations and specification sheets defining materials of construction, dimensions and weights.
   6. Operation and maintenance manual.

1.7 CLOSEOUT SUBMITTALS [NOT USED]

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE

A. The equipment and material to be furnished under this Contract shall be tested at the factory prior to delivery and shall be free from defects.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Storage and Handling Requirements
   1. Secure and maintain a location to store the material in accordance with the manufacturer's recommendations.

1.11 SITE CONDITIONS [NOT USED]

1.12 WARRANTY [NOT USED]

PART 2 - PRODUCTS

2.1 CITY-FURNISHED PRODUCTS [NOT USED]

2.2 MATERIALS

A. Manufacturers
   1. Manufacturer List
      a. ProMinent – DACb Free Chlorine Residual Analyzer/Controller
   2. Substitution requests for manufacturers or models not indicated above shall be submitted in writing as specified in the General Provisions.

B. General
   1. The method of measuring total chlorine will be with a three-electrode amperometric sensor immersed into an electrolytic medium with a membrane, selective to chlorine, separating it from the sample.

C. Performance / Design Criteria
   1. Measurement range: 0 to 20 ppm chlorine for total chlorine
   2. Total Chlorine:
      a. Low Limit Of Detection (LOD): 30 ppb (0.03 ppm) or better
      b. Limit Of Quantitation (LOQ): 90 ppb (0.09 ppm) or better
      c. Repeatability/precision: 30 ppb or 3%, whichever is greater
      d. Response time: ~100 s for 90% change (T_{90})
      e. Interference: Chlorine Dioxide, Ozone, and chalk deposits
   3. Drift: <10% with regular calibration
   4. Specificity/Selectivity: Non-specific to a certain chlorine form, responds to any chlorine species and other oxidizers as noted in the interference section
   5. Calibration method: One-point (zero or slope) calibration.
   6. Verification procedure: One-point process calibration (slope) against a standard reference method.

D. Environmental Requirements
   1. Operational Criteria
      a. Operating ambient temperature: 10 – 130 °F
      b. Relative humidity: 5 – 100%, non-condensing
   2. Sample Requirements
      a. Maximum back pressure the chlorine sensor can manage without failure:
         1) 0.5 bar, no pressure impulses and/or vibrations
      b. Water temperature: 33 – 115 °F
      c. Temperature compensation range: 5 to 45 °C (41 to 113 °F)
      d. Flow: 0 – 600 gpm - normal, 1500 gpm - maximum
   3. Storage Requirements
      a. Electrolyte: 15 to 25°C (59 to 77°F)
      b. Chlorine sensors: 0 to 50°C (32 to 122°F) dry without electrolyte
      c. Panel: -20 to 60°C (-4 to 149°F)

E. Manufactured Unit
   1. Chlorine Analyzer shall include:
      a. Three-Electrode Amperometric Chlorine sensor
      b. Chlorine sensor flow cell with integrated flow sensor
      c. pH flow cell with grab sample port
      d. Digital gateway for communication between probes and controller
      e. Stainless steel panel

F. Equipment
   1. Controller
      a. Include three 4-20mA outputs and four relays
      b. Enclosure must be wall mounted and rated NEMA 4X
      c. Display shall be graphic dot matrix LCD with LED backlighting, display size of 1.89 x 2.67 inches and resolution of 240 x 160 pixels
   2. Amperometric Cell shall consist of:

a. Gold cathode
b. Stainless Steel counter electrode
c. Silver/silver chloride reference electrode
d. pH buffered electrolyte
e. Sensor membrane to filter chlorine species selectively and to provide interface between the electrochemical cell and the sample

3. Wetted materials as follows:
   a. Chlorine Measuring Cell: PVC
   b. Chlorine Sensor Body: PVC
   c. Chlorine Sensor Flow Cell: Acrylic
   d. pH Sensor Flow Cell: PVC
4. The sensor interface to the controller is through a digital gateway.
5. The chlorine sensor automatically compensates for temperature utilizing an embedded temperature sensor.
6. The electrolyte provides internal, buffered pH compensation in the range of 4-9 pH units.
7. The sensor includes proprietary Cal Watch self-diagnostic technology.
8. The panel assembly includes a flow cell that integrates a flow meter and control valve.

G. Components
   1. Standard Equipment
      a. Stainless Steel Mounting Panel
      b. Chlorine Sensor with Membrane and Electrolyte
      c. Chlorine Sensor flow cell
      d. Flow meter with control valve
      e. Digital gateway to SC controller with cable
      f. User Manual
   2. Dimensions
      a. Controller
         1) 9.84”W x 8.66”H x 4.80”D
      b. Backboard
         1) 30”W x 24”H
   3. Weight
      a. Controller: 3 lbs.
      b. Complete backboard panel with pH sensor: approximately 20 lbs.

2.3 ACCESSORIES

A. ProMinent – DACb Free Chlorine Residual Analyzer/Controller and wall mount hardware

B. CL 10 stainless steel panel mounting hardware, determined by manufacturer or Contractor

C. pH sensor

D. Sample conditioning kit with pressure regulator

E. Pressure reducing valve – set to a maximum 65 psi

2.4 SOURCE QUALITY CONTROL [NOT USED]

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION [NOT USED]

3.3 PREPARATION [NOT USED]

3.4 INSTALLATION

A. Chlorine analyzer shall be installed in accordance with the instructions of the manufacturer. Installation and adjustment shall be checked and approved by a manufacturer's factory representative.

B. ProMinent – DACb Free Chlorine Residual Analyzer/Controller and panel shall be mounted in accordance with manufacturer recommendations or as determined by Contractor.

C. Provide electrical and SCADA connections as detailed in Division 26.

3.5 REPAIR [NOT USED]

3.6 RE-INSTALLATION [NOT USED]

3.7 SITE QUALITY CONTROL [NOT USED]

3.8 SYSTEM STARTUP

A. The chlorine analyzer equipment manufacturer shall furnish the services of a qualified field engineer to check installation, start-up and instruct operating personnel in the proper operation and maintenance of the equipment.

3.9 ADJUSTING [NOT USED]

3.10 CLEANING [NOT USED]

3.11 CLOSEOUT ACTIVITIES [NOT USED]

3.12 PROTECTION [NOT USED]

3.13 MAINTENANCE [NOT USED]

3.14 ATTACHMENTS [NOT USED]

END OF SECTION

No specifications on this page for formatting purposes.

SECTION 40 91 16

ELECTROMAGNETIC METERS

PART 1 - GENERAL

1.1 SUMMARY

A. Electromagnetic flow meters for permanent installations both above and below ground. The meters shall utilize bipolar pulse DC coil excitation to measure voltage induced by the flow of conductive liquid through a magnetic flux. The voltage shall be linearly proportional to flow velocity from 0.033 to 33 feet per second.

B. Related Specifications include, but are not necessarily limited to:

1. City of Buckeye Water Engineering Design Standards.
2. MAG Uniform Standard Specifications and Details for Public Works Construction.
3. Division 09 – Finishes
4. Division 26 – Electrical
5. Division 40 – Process Interconnections

1.2 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment

1. Work associated with this Item is included in the total lump sum price for the control valve assembly.

1.2 SUBMITTALS

A. Furnish complete Product Data, Shop Drawings, Test Reports, Operating Manuals, Record Drawings, Manufacturer’s certifications, Manufacturer’s Field Reports

B. Product Data:

1. Dimensional Drawings.
2. Materials of Construction:
    a. Sensor.
    b. Liner
    c. Electrodes
    d. Process Connection.
3. Measurement accuracy.
4. Range and range ability.
5. Enclosure Rating.
6. Classification Rating.
7. Power:
    a. Voltage.

b. Wattage.

8. Output options.

1.3 QUALITY ASSURANCE

A. Manufacture instruments in facilities certified to the quality standards of ISO Standard 9001 - Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation, and Servicing.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store all instruments in a dedicated structure with space conditioning to meet the recommended storage requirements provided by the Manufacturer.

B. Any instruments that are not stored in strict conformance with the Manufacturer's recommendation shall be replaced.

1.5 PROJECT OR SITE CONDITIONS

A. Provide instruments suitable for the installed site conditions including, but not limited to, material compatibility, site altitude, process and ambient temperature, and humidity conditions.

1.6 CALIBRATION AND WARRANTY

A. The meter shall have standard one year warranty from date of shipment. If the meter is commissioned by a factory certified technician, the warranty is extended to three years from the date of shipment.

1.7 MAINTENANCE

A. Provide all parts or materials necessary for maintenance and calibration purposes throughout the warranty period. Deliver all of these supplies before project substantial completion.

1.8 LIFECYCLE MANAGEMENT

A. Instrument documentation, like original calibration certificates, manuals and product status information shall be accessible via a web enabled system with a license. The instrument specific information shall be accessed via serial number. When services are provided by an authorized service provider, the service information (ex. subsequent field calibrations) shall be archived and accessible via this web enabled system.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. One of the following:

1. Endress+Hauser - Promag P 500

2.2 MANUFACTURED UNITS

A. The flow meter shall be a flanged sensor (by application and instrument schedule) and transmitter mounted separately (remote) from the sensor.

1. The flow meter shall be microprocessor based and possess a method in which to store the sensor calibration and transmitter setup information in non-volatile memory. The electronics shall be interchangeable for meters sizes 1/2" – 24"

2. The sensor shall be the proper size to measure the design flow rate of the piping and measure bi-directional flow as a standard.
3. The sensor shall consist of a stainless steel flow tube with ANSI B16.5 carbon steel or stainless steel flanges. The flanges shall carry Class 150 or Class 300 pressure ratings as specified.
4. The system shall simultaneously produce multiple process variables (ex. volume flow and conductivity) while in operation.
5. The sensor liner and electrode material shall be chosen to be compatible with the process fluid. All fluids require a minimum conductivity of 5 µS/cm.
6. The sensor tube shall be lined with PFA or PTFE as specified based upon the size of the flow meter and the process media conditions.
7. The sensor shall house two measuring electrodes, a grounding electrode, and one for physical empty pipe detection. The electrodes shall be made of 316L SS, Alloy C22, Tantalum, Titanium, or Platinum as specified.
8. The external sensor housing shall enclose the coil assemblies and internal wiring. The materials shall be designed and constructed to prevent moisture ingress and promote corrosion resistance.
9. The electrode circuit shall have a minimum impedance of 10^{12} Ohms to overcome moderate coating buildup.
10. The system shall include an electrical circuit for cleaning electrodes from magnetite buildup as specified.
11. The sensor shall be rated for NEMA 4X as standard.
12. The system shall be a remote design insensitive to external vibrations and immune from external piping forces due to robust design.

B. The transmitter shall be a three-stage microprocessor controller mounted remotely as specified in the instrument schedule. The transmitter shall operate on AC (100 to 240V) or DC (24 V) via a dedicated or universal power supply as specified. The transmitter housing will carry a NEMA 4X rating and shall be constructed to prevent moisture ingress, promote corrosion resistance, and be impervious to saline environments.

1. The measurement signals from the sensor shall be conducted as specified to the transmitter:
    i. As a digital signal up to 1,000 feet.
    ii. As an analog signal up to 650 feet.
2. The transmitter shall allow local or remote programming that can be operated via an optical display or WLAN connection without opening the compartment.
3. The transmitter display shall indicate simultaneous flow rate and total flow with three Totalizers (eg. forward, reverse and net total) and user-selectable engineering units, readout of diagnostic remedy messages, and support at least 19 standard languages.

4. The transmitter shall safeguard against entering of invalid data for the particular meter size and all programming parameters shall be access-code protected and retained in the embedded HistoROM.

5. The transmitter primary output shall be specified, as:

   4-20mA HART, or

   Modbus RS485, or

   PROFIBUS PA, or

   FOUNDATION Fieldbus, or

   EtherNet/IP, or

   PROFINET

   And up to (3) secondary configurable analog I/O slots (freely programmable to 4-20mA in/output, 0-10 kHz pulse/frequency, or status input)

6. The transmitter output(s) shall be integral to the electromagnetic flowmeter transmitter electronics; using an external third party signal converter is unacceptable.

7. The transmitter output selected must be supported by Add-on Instructions (AOI), faceplates, device drivers, instructions and pre-engineered code.

8. The transmitter shall internally retain all setup parameters, calibration parameters and accumulated measurements in non-volatile memory in the event of power failure.

9. The transmitter shall be protected against voltage spikes from the power source with internal transient protection.

10. The transmitter and sensor must support an onboard, ISO traceable means of attested in-situ verification utilizing redundant references to validate measurement quality over the lifespan.

11. The transmitter shall provide access to service and monitoring parameters designed to identify transient or permanent process influences.

12. The transmitter shall support commissioning and maintenance options via a service interface for operation via an internal web server, accessible via a standard RJ-45 cable.

13. The transmitter shall include a wireless local area network (WLAN) option built into the device display with a five meter operating range. The WLAN shall permit unique SSID programming, four encryption levels and activation/deactivation of the function at the owner preference.

C. Remote configuration shall be capable of being performed thorough the programmable automation controller with common off the shelf tools, software, interfaces or gateways. Generic profiles or special tools and hardware will not be acceptable.

2.3 ACCESSORIES

A. Stainless steel tag - labeled to match the contract documents.

B. Provide grounding rings, as per manufacturer's recommendations, if required.

C. Provide sun shield for outdoor installations as required per the instrument schedule.

2.4 SOURCE QUALITY CONTROL & CALIBRATION

A. Electromagnetic flow meters shall be factory calibrated on an ISO 17025 accredited test stand with certified accuracy traceable to NIST per "General Requirements for the Competence of Testing and Calibration Laboratories"

B. Evidence of accreditation must originate from a national verification agency such as A2LA.

C. Each meter shall ship with a certificate of a 2-point calibration report exceeding stated standard accuracy of 0.5% or 0.2% of rate as specified.

D. A real-time computer generated printout of the actual calibration data points shall indicate apparent and actual flows. The flow calibration data shall be confirmed by the manufacturer and shipped with the meters to the project site.

E. The manufacturer shall provide complete documentation covering the traceability of all calibration instruments.

F. The manufacturer shall provide ISA data sheet ISA-TR20.00.01 as latest revision of form 20F2321. The manufacturer shall complete the form with all known data and model codes and dash out the inapplicable fields. Incomplete data sheets submitted will result in a rejected submittal.

2.5 SAFETY

A. All electrical equipment shall meet the requirements of ANSI/NFPA 70, National Electric Code latest addition.

B. All devices shall be certified for use in hazardous areas, independent of the output protocol selected.

C. At a minimum, the device shall allow installation in a Class I, Division 2, Group A to D as a non-incendive design.

D. All devices shall be suitable for use as non-incendive devices when used with appropriate non-incendive associated equipment.

E. Electrical equipment housing shall conform to NEMA 4X classification.

F. Non-intrinsically safe electrical equipment shall be approved by a Nationally Recognized Testing Laboratory (NRTL) such as cCSAus, FM, or UL for the specified electrical area classification.

G. Device failure modes, self-monitoring characteristics and remedy diagnosis shall follow NAMUR standards NE 43 and NE 107.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the complete set of plans, the process fluids, pressures, and temperatures and furnish instruments that are compatible with installed process condition.

B. Examine the installation location for the instrument and verify that the instrument will work properly when installed.

3.2 INSTALLATION

A. As shown on installation details and mechanical Drawings.

B. As recommended by the manufacturer's installation and operation manual.

C. Specific attention should be given to the following technical requirements:

1. Verify ground rings (if required) have been installed according to the manufacturer's recommendations.

2. Reduced inlet installations must be accompanied by manufacturer's documented evidence of third party testing and data collection in comparison to a traceable standard.

3.3 FIELD QUALITY CONTROL

A. Each instrument shall be tested before commissioning and the ENGINEER shall witness the interface capability in the PLC control system and associated registers.

1. Each instrument shall provide direct programming capability through the PLC

2. Each instrument shall provide direct control of totalizer reset functions through PLC

3. Each instrument shall be supported with a device profile permitting direct integration in the PLC

B. The ENGINEER shall witness all instrument verifications in the field.

C. Manufacturers Field Services are available for start-up and commissioning by a Factory field service representative or a manufacturer's authorized service provider (ASP) – the warranty against manufacturing defects is three years.

1. Manufacturer representative shall verify installation of all installed flow tubes and transmitters.

2. Manufacturer representative shall notify the ENGINEER in writing of any problems or discrepancies and proposed solutions.

3. Manufacturer representative shall perform field verification at the time of installation for long-term analysis of device linearity, repeatability and electronics health. A comparative report shall be generated for each meter tested.

4. Manufacturer representative shall generate a configuration report for each meter.

3.4 ADJUSTING

A. Verify factory setup of all instruments in accordance with the Manufacturer's instructions.

3.5 PROTECTION

A. All instruments shall be fully protected after installation and before commissioning. Replace any instruments damaged before commissioning:

1. The ENGINEER shall be the sole party responsible for determining the corrective measures.

END OF SECTION

Appendix A
Geotechnical Report

No specifications on this page for formatting purposes.

Geotechnical Evaluation

Reach Line Connection

Broadway Road: 239th Avenue to Rainbow Road

Buckeye, Arizona

Kimley-Horn

7740 North 16th Street, Suite 300 | Phoenix, Arizona 85020

June 8, 2022 | Project No. 607106001

Geotechnical | Environmental | Construction Inspection & Testing | Forensic Engineering & Expert Witness

Geophysics | Engineering Geology | Laboratory Testing | Industrial Hygiene | Occupational Safety | Air Quality | GIS

Ninyo & Moore

Geotechnical & Environmental Sciences Consultants

Ninyo & Moore
Geotechnical & Environmental Sciences Consultants

CELEBRATING 35 YEARS

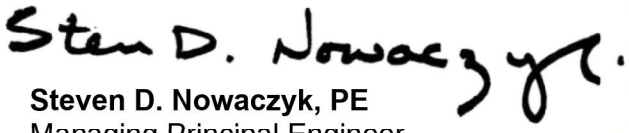
Geotechnical Evaluation
Reach Line Connection
Broadway Road: 239th Avenue to Rainbow Road
Buckeye, Arizona

Mr. Robert Lyons, PE
Kimley-Horn
7740 North 16th Street, Suite 300 | Phoenix, Arizona 85020

June 8, 2022 | Project No. 607106001

Kenneth Rush, III, PE
Senior Engineer

KR/SDN/tlp



Steven D. Nowaczyk, PE
Managing Principal Engineer

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APPENDICES

1 INTRODUCTION

In accordance with our proposal dated September 30, 2021 and your authorization, we have performed a geotechnical evaluation for the proposed Reach Line Connection project in Buckeye, Arizona. The purpose of our evaluation was to assess the subsurface conditions for the project alignment in order to provide geotechnical recommendations for design and construction. This report presents the results of our evaluation and our geotechnical conclusions and recommendations regarding the proposed construction.

2 SCOPE OF SERVICES

The scope of services for this study included the following to date:

- Reviewing available geologic literature and aerial photographs of the project site.
- Conducting a visual geologic reconnaissance of the project site.
- Obtaining City of Buckeye permission to conduct our field work.
- Conducting a site visit to mark out the proposed boring locations.
- Notifying Arizona 811 of the boring locations prior to drilling.
- Arranging for appropriate traffic control services at our boring locations during our field work activities.
- Drilling, logging and sampling nine borings to a depth of 10 feet each below ground surface (bgs) using hollow-stem auger (HSA) drilling techniques. The boring logs are presented in Appendix A.
- Performing laboratory tests on selected samples obtained from the borings to evaluate in-situ moisture content and dry density, gradation, Atterberg limits, maximum density, consolidation, swell, and corrosivity characteristics (including pH, minimum electrical resistivity, soluble sulfates, and chlorides). The results of the laboratory testing are presented on the boring logs and/or in Appendix B.
- Preparing this report that presents our findings, conclusions, and recommendations regarding the design and construction of the project.

Our scope of services did not include environmental consulting services such as hazardous waste sampling or analytical testing at the site. A detailed scope of services and estimated fee for such services can be provided upon request.

3 SITE DESCRIPTION

The project site is located along the Broadway Road alignment, from roughly 239th Avenue to Rainbow Road in Buckeye, Arizona (Figure 1). At the time of our work, Broadway Road had one lane in each direction with a southbound turn lane at its intersection of Broadway Road and Watson Road. The roadway surface consisted of asphalt concrete (AC) pavement with unpaved shoulders.

According to the Valencia, Arizona-Maricopa Co., 7.5-Minute United States Geological Survey (USGS) Topographic Quadrangle Maps (2021), the project site slopes from the northwest down to the southeast. Based on this map, the site elevation ranges from about 970 to 955 relative to mean sea level (MSL).

4 AERIAL PHOTOGRAPH REVIEW

Aerial photographs dated 1949 through 2021 from the Maricopa County website, National Environmental Title Research website and Google Earth were reviewed for this project. A summary of the observations noted for each aerial photograph is presented in Table 1:

Table 1 – Summary of Aerial Photograph Review

Photograph Date(s)	Site	Adjacent Properties	
1949, 1953	Broadway Road alignment.	North:	Agricultural Land. Cemetery at Broadway and 231st Avenue. Residential development.
		South:	Agricultural Land. Residential development.
		East:	Agricultural Land. Residential development.
		West:	Agricultural Land.
1976, 1986, 1996, 1998, 2000-2018	Broadway and Watson Roads paved. In 2008, paved shoulder between Broadway and Watson Roads and southbound turn lane constructed at intersection of Broadway Road and Watson Road.	North:	Agricultural Land. Cemetery at Broadway and 231st Avenue. Residential development. Basin at Broadway and Rainbow Road (1986). Basin at northwest corner of Broadway and Watson Road (2004).
		South:	Agricultural Land. Continued residential development.
		East:	Agricultural Land. Rainbow Road paved. Residential development.
		West:	Agricultural Land.
2019, 2020	Construction for the Jackie A. Meck Water Campus near Broadway Road and 239th Avenue.	North:	Agricultural Land. Cemetery at Broadway and 231st Avenue. Residential development. Basins.
		South:	Agricultural Land. Residential development.
		East:	Agricultural Land. Rainbow Road paved. Residential development.
		West:	Agricultural Land.

5 PROJECT DESCRIPTION

Based on our discussions with your firm, the project generally includes the design and construction of a new 16-inch waterline along Broadway Road, from about Rainbow Road to the 239th Avenue alignment in Buckeye, Arizona; a distance of about 7,900 linear feet. The waterline will typically extend less than 10 feet deep and will be installed using transitional cut-and-cover techniques.

6 SUBSURFACE EXPLORATION AND LABORATORY TESTING

On April 5, 2022, Ninyo & Moore conducted a subsurface exploration at the site in order to observe the subsurface conditions and to collect soil samples for laboratory testing. Our exploration consisted of drilling, logging, and sampling nine small-diameter borings, denoted as shown below in Table 2. The approximate Latitude and Longitude coordinates are provided in Table 2. Elevations were estimated from USGS. Additionally, the approximate locations of our explorations are presented on Figure 2.

Table 2 – Test Borings

Boring Designation	Approximate Project Station(1)	Approximate Project Offset(1)	Elevation (feet)	Exploration Depth (feet)	Project Location/Alignment
B-1	16+75	20' Left	969	10	Begin new pipeline/Broadway Road
B-2	27+15	23' Left	967	10	Broadway Road
B-3	37+70	25' Left	965	10	Broadway/Watson Roads
B-4	46+80	16' Left	964	10	Broadway Road
B-5	56+10	15' Left	962	10	Broadway Road
B-6	63+45	15' Left	960	10	Broadway Road
B-7	70+00	17' Left	959	10	Broadway Road
B-8	79+30	18' Left	957	10	Broadway Road
B-9	88+75	25' Left	956	10	Broadway/Rainbow Roads

Notes:
[1]Project Stationing based on preliminary plans prepared by KHA.
[2]Vertical Datum – NAVD88.

The borings were advanced using a CME-75 truck-mounted drill rig equipped with HSA drilling equipment. They extended to a depth of approximately 10 feet each bgs. Bulk and relatively undisturbed soil samples were collected at selected intervals. Detailed descriptions of the soils encountered are presented on the boring logs in Appendix A.

Ninyo & Moore personnel logged the borings in general accordance with the Unified Soil Classification System and ASTM International (ASTM) D2488 by observing cuttings and drive samples. Detailed descriptions of the drive sample method used and corresponding ASTM procedure are presented on the cover page of Appendix A. Collected ring samples were trimmed in the field, wrapped in plastic bags, and placed in cylindrical plastic containers to retain in-place moisture conditions. Similarly, the Standard Penetration Test split-spoon samples were placed in re-sealable bags to help preserve their natural moisture. Bulk samples were also collected from the HSA cuttings and placed in large plastic bags. The selected intervals at which the bulk soil samples were collected are provided on the boring logs in Appendix A.

The soil samples collected from our drilling activities were transported to the Ninyo & Moore laboratory in Phoenix for geotechnical laboratory testing. The testing included in-situ moisture content and dry density, gradation, Atterberg limits, maximum density, consolidation, swell, and corrosivity characteristics (including pH, minimum electrical resistivity, soluble sulfates, and chlorides). The results of the in-situ moisture content and dry density testing are presented on the boring logs in Appendix A. A description of each laboratory test method, ASTM standards and the remainder of the test results are presented in Appendix B.

7 GEOLOGIC AND SUBSURFACE CONDITIONS

The geology and subsurface conditions at the site are described in the following sections.

7.1 Geologic Setting

The project site is located in the Sonoran Desert Section of the Basin and Range physiographic province, which is typified by broad alluvial valleys separated by steep, discontinuous, sub-parallel mountain ranges. The mountain ranges generally trend north-south and northwest-southeast. The basin floors consist of alluvium with thickness extending to several thousands of feet.

The basins and surrounding mountains were formed approximately 10 to 13 million years ago during the mid to late-Tertiary. Extensional tectonics resulted in the formation of horsts (mountains) and grabens (basins) with vertical displacement along high-angle normal faults. Intermittent volcanic activity also occurred during this time. The surrounding basins filled with

alluvium from the erosion of the surrounding mountains as well as from deposition from rivers. Coarser-grained alluvial material was deposited at the margins of the basins near the mountains.

The surficial geology of the site is described as Holocene-age (less than 10,000 years) and Middle to Late Pleistocene-age (10,000 to 790,000 years) alluvial fan and river deposits. The site soils are generally described as deposits of silt, sand, and gravel with varying amounts of clay layers. Stage I to II (scattered specks to partial grain coating) calcic horizons were described in the Holocene-age soils, while Stage II to IV (cemented layer) calcic horizons were described in the Pleistocene-age material. The soil units are mapped as Rillito sandy loam, Maripo sandy loam, Perryville sandy loam, Brios sandy loam and Laveen loam. Loam is an agricultural soil classification that refers to a soil comprised of a mixture of clay, silt, and sand. Descriptions of the soils encountered during our subsurface exploration are presented in Section 7.2.

7.2 Subsurface Conditions

Our knowledge of the subsurface conditions at the project site is based on the results of our explorations and our understanding of the general geology of the area. The boring logs contains our field test results, as well as our interpretation of the conditions anticipated to exist between actual samples retrieved. Therefore, the boring logs contains both factual and interpretive information. Lines delineating subsurface strata on the boring logs are intended to group soils having similar engineering properties and characteristics. They should be considered approximate, as the actual transition between soil types may be gradual. Note that relative densities of coarse-grained soils and non-elastic silts (non-plastic in this report) include very loose, loose, medium dense, dense and very dense. Consistency of elastic silts and clays include very soft, soft, firm, stiff, very stiff, and hard. Detailed stratigraphic information as well as a key to the soil symbols and terms used on the boring logs are provided in Appendix A.

7.2.1 Fill

Undocumented fill soils (plausibly placed as part of the past roadway construction) were encountered at the surface in borings B-3, B-7, B-8 and B-9 and extended up to 5 feet deep. The fill generally consisted of loose to medium dense, clayey sand with varying amounts of gravel (SC) and stiff sandy lean clay (CL) in our borings.

7.2.2 Alluvium

Underlying the fill described above or at the surface of the remaining borings, we encountered native, late and middle Pleistocene-age alluvium in our borings, that generally consisted of heterogeneous interlayered deposits of medium dense to very dense clayey sands (SC) and

very stiff to hard sandy lean and fat clays (CL, CH) to the termination depths. Scattered caliche nodules and trace to few gravel were observed within this soil layer.

7.3 Groundwater

Groundwater was not encountered in any of our borings. Based on well data provided by the Arizona Department of Water Resources within 1 mile of the site, the depth to the regional groundwater table is approximately 60 feet bgs or deeper. Groundwater levels may fluctuate due to the close proximity to the Gila River, adjacent ditches and canals, seasonal variations, irrigation, groundwater withdrawal or injection, and other factors.

7.4 Surface Water

Based on the information presented on the Federal Emergency Management Agency Online Map Viewer, the site lies within flood zone X, which is described as an area with 0.2 percent or more chance of flooding each year, in the form of sheet flow with average depths of less than 1 foot. As such, surface water flows and/or shallower groundwater levels may be encountered within the project limits during rain events, and may need to be mitigated during construction.

8 GEOLOGIC HAZARDS

The following sections describe potential geologic hazards at the site, including land subsidence and earth fissures, and faulting and seismicity.

8.1 Land Subsidence and Earth Fissures

Groundwater depletion, due to groundwater pumping, has caused land subsidence and earth fissures in numerous alluvial basins in Arizona. It has been estimated that subsidence has affected more than 3,000 square miles and has caused damage to a variety of engineered structures and agricultural land (Schumann and Genualdi, 1986). From 1948 to 1983, excessive groundwater withdrawal has been documented in several alluvial valleys where groundwater levels have been reportedly lowered by up to 500 feet. With such large depletions of groundwater, the alluvium has undergone consolidation resulting in large areas of land subsidence.

Ninyo & Moore reviewed land subsidence maps and available Synthetic Aperture Radar Interferometry (InSAR) imagery from the ADWR website. InSAR is an application used to measure the rate of ground subsidence by measure subtle changes in the ground surface elevation versus time. To monitor elevation changes, elevation data points are collected at separate passes during satellite orbits and the change in elevation is depicted on an interferogram image.

According to the information from ADWR, the project site lies within the West Valley Land Subsidence feature in the western Phoenix Metropolitan Area in Maricopa County. Land subsidence around the project site was evaluated between May 2010 and May 2022 and up to 6 cm (2.4 inch) of land subsidence was measured. Historic subsidence may have also occurred prior to ADWR's 2010 measurements.

In Arizona, earth fissures are generally associated with land subsidence and pose an ongoing geologic hazard. Earth fissures generally form near the margins of geomorphic basins where significant amounts of groundwater depletion have occurred. Reportedly, earth fissures have also formed due to tensional stress caused by differential subsidence of the unconsolidated alluvial materials over buried bedrock ridges and irregular bedrock surfaces (Schumann and Genualdi, 1986).

Based on our field reconnaissance and our review of the referenced material, there are no known earth fissures within the project site. Based on our research, the closest earth fissure to the site located approximately 9 miles northeast of the project site. Continued groundwater withdrawal near the site may result in further subsidence and the formation of new fissures or the extension of existing fissures.

8.2 Faulting and Seismicity

The site lies within the Sonoran zone, which is a relatively stable tectonic region located in southwestern Arizona, southeastern California, southern Nevada, and northern Mexico (Euge et al., 1992). This zone is characterized by sparse seismicity and few Quaternary faults. Based on our field observations, review of pertinent geologic data, and analysis of aerial photographs, Quaternary faults are not located on or adjacent to the property. The closest Quaternary fault to the site is the Carefree fault zone, located approximately 27 miles to the north of the site (Pearthree, 1998). Approximately 2 meters of displacement has occurred along this fault within middle Pleistocene deposits (<750,000 years), but the upper Pleistocene and Holocene deposits (<250,000 years) are not displaced. Seismic design considerations are presented in Section 10.2.

8.3 Expansive Soils

Expansive soils typically contain significant clay fractions, and the expansive characteristics of these clay fractions depend upon a number of factors, which include clay mineralogy, degree of compaction (density) for reworked soils, moisture content, etc. Very low to low expansive potential soils are defined as having a percent swell (by ASTM D4546) of 1 percent or less. In addition,

expansive soils tend to have a more adverse effect on lightly loaded construction elements (e.g., exterior flatwork, floor slabs, etc.) than on more heavily loaded foundations. Samples for swell test were tested for one dimensional expansion in accordance with the applicable portions of ASTM D4546 applying a surcharge of 144 psf. The swell test results indicate 1.1 percent swell. The presence of expensive soils at this site is considered low to moderate.

8.4 Collapsible Soils

Collapsible soils generally consist of loose soils that exhibit a sudden decrease in volume upon inundation with water or excessive loading. The “collapse” of the soils is attributed to clay or cemented bonds between individual particles losing strength or dissolving when in contact with water resulting in filling of voids. Collapsible soils can have an adverse effect on foundations, floor slabs, pavements, and walls due to the response in the settlement. Blow count resistance and collapse potential data collected in our explorations were analyzed. Based on our experience with regional soils and collapse data results, the collapse potential is low for this site.

9 CONCLUSIONS

Based on the results of our subsurface evaluation, laboratory testing, and data analysis, it is our opinion that the proposed construction is feasible from a geotechnical standpoint. Geotechnical considerations include the following:

- In general, the near-surface soils are considered to be rippable with heavy-duty excavation equipment. However; gravel and scattered caliche nodules were encountered in our borings, which may be more difficult to excavate and/or will slow the rate of excavation.
- Pipeline trenches may capture surface or subsurface flows because the bedding material may be more pervious than the adjacent native soils.
- An earthwork (shrinkage) factor of approximately 5 to 15 percent if the on-site soils are re-used as fill.
- Imported soils and soils generated from on-site excavation activities that exhibit a low to low-moderate expansion potential can generally be used as engineered fill, provided the oversized or heavily cemented materials are either broken down or wasted. On the basis of our evaluation, many of the on-site soils will be suitable for re-use as engineered fill, with special considerations when placed below settlement sensitive project features.
- Groundwater was not encountered in our borings. Groundwater may rise due to proximity to adjacent ditches and canals, seasonal variations, irrigation and other factors. Groundwater is not expected to be a construction restraint; however, surface flows may be encountered depending on the construction schedule.
- The subgrade soils at the sites are corrosive to ferrous metals and the sulfate content of the soils presents a negligible sulfate exposure to concrete.

- The site lies within the West Valley land subsidence feature. No active faults or fissures, or other geologic hazards are reported underlying or immediately adjacent to the site.

10 RECOMMENDATIONS

The following sections present our geotechnical recommendations for the proposed construction. If the proposed construction is changed from that discussed in this report, Ninyo & Moore should be contacted for additional recommendations.

10.1 Earthwork

The following sections provide our earthwork recommendations for this project. In general, the earthwork specifications contained in the Maricopa Association of Governments (MAG), *Uniform Standard Specifications and Details for Public Works Construction,* and/or any City of Buckeye amendments, are expected to apply, except as noted.

10.1.1 Excavation Characteristics

Our evaluation of the excavation characteristics of the on-site materials is based on the results of our exploratory borings, our site observations, and our experience with similar materials. In our opinion, excavation of the near-surface on-site materials can generally be accomplished with heavy-duty earthmoving equipment in good operating condition. However, scattered gravel and caliche nodules were observed in our borings, and may be more difficult to excavate and/or slow the rate of excavation depending on the actual degree of cementation encountered during construction.

If the proposed construction extends deeper than the extent of our test borings in any part of this project, Ninyo & Moore should be contacted for additional consultation and possible further evaluation of the subsurface materials.

Due to the heterogeneous nature of the site, and the limited access for our borings, soils different than that encountered in our borings should be anticipated during construction.

10.1.2 Temporary Slope Stability

The side slopes of new excavations and trenches should be stabilized in order to allow access and minimize damage to adjacent structures resulting from vertical or lateral movement of the soil. The side slopes may be stabilized by sloping back the sides and/or by using bracing. However, the side slopes may be difficult to stabilize in areas where loose, low cohesion, granular soils exist on site. These soils could have a potential for caving and

sloughing during excavation, especially if the soils are wet or saturated. Additionally, vibrations caused by nearby traffic or construction equipment could accelerate sloughing.

Excavations that are 20 feet deep or less could be constructed using a sloped excavation in accordance with Occupational Safety and Health Administration ([OSHA], 2011) Standards, based on the soil types encountered. Soils with low cohesion were encountered during our field exploration. Due to the presence of these soils, we recommend that the OSHA soil *"Type C"* be used for the subject site. Based on OSHA standards, this corresponds to a temporary side slope of 1.5:1 (horizontal to vertical) or flatter for soils, in sloped excavations that are less than 20 feet. Upon making the excavations, soil classification, and excavation performance should be evaluated in the field by the geotechnical consultant in accordance with the OSHA regulations. These cut slope recommendations assume that no groundwater is present and no surcharge loading will be located adjacent to the top of the cut.

Temporary excavations that encounter surface or groundwater seepage may need shoring and/or stabilization by placing sandbags or gravel along the base of the seepage zone. Excavations encountering seepage should be evaluated on a case-by-case basis. Slope stability of trenches deeper than 20 feet, though not anticipated, should be evaluated by the contractor's engineer based on alignment-specific soil properties and settlement-sensitive features.

10.1.3 Temporary Shoring

Temporary shoring may be desired in areas where wider excavations cannot be conducted, such as near roadways and adjacent to structures or utilities. Temporary earth retention systems may include braced systems, such as trench boxes or shields with internal supports or cantilevered systems (e.g., soldier piles and lagging); however, the risk of excessive lateral deflection may render a cantilevered shoring system inappropriate for the project.

Shored or braced trench and pit excavations may be designed using the parameters presented on Figures 3A, 3B, and 3C, depending on the soil conditions and type of shoring or bracing used. The recommended design earth pressures are based on the assumptions that the shoring system will be constructed without raising the ground surface elevation behind the shoring system and that there are no stockpiles of soil and/or construction materials, or other loads, such as existing tanks, that act above a 1:1 (horizontal to vertical) plane extending up and back from the dredge line. For earth retention systems subjected to the above-mentioned surcharge loads, the contractor should include the effect of these loads on the design lateral earth pressures. In addition, due to the presence of low cohesion soils

encountered in our borings, the excavations may not stand open long enough to install the trench boxes. The contractor should be prepared to deal with these soil conditions and plan accordingly. Once installed, some sloughing is possible at the ends of the trench box; therefore, any loose material should be removed prior to backfilling of the trench. We recommend that an experienced structural engineer design the shoring system. The shoring parameters presented in this report should be considered as guidelines.

We anticipate that settlement of the ground surface will occur behind shoring systems during excavation. The amount of settlement will depend on the type of shoring system used, the contractor's workmanship, and soil conditions. We recommend that roadways, utilities, and other structures in the vicinity of the planned excavation be evaluated with regard to foundation support and tolerance to settlement. To reduce the potential for distress to these structures, we recommend that the shoring system be designed to limit the ground settlement behind it to 1/2-inch or less. Possible causes of settlement that should be addressed include settlement during excavation, construction vibrations, de-watering (if needed), and removal of the shoring system.

The contractor should retain a qualified and experienced engineer to design the shoring system. The contractor should evaluate the adequacy of the shoring parameters presented in this report, and make the appropriate modifications for their design. We recommend that the contractor take appropriate measures to protect the workers. OSHA requirements pertaining to workers' safety should be observed.

10.1.4 Protection of Existing Structures/Utilities

Lateral movement of a shored excavation will depend on the type and relative stiffness of the system used and other factors beyond the scope of this study. The shoring designer should perform a deflection analysis for the proposed shoring system. A survey of existing utilities, tanks, and structures, if any, adjacent to those portions of the proposed excavation that will be shored should also be performed prior to construction. The purpose of the analysis and survey would be to evaluate the ability of existing structures, pipelines, or conduits to withstand anticipated horizontal and vertical movements associated with a shored excavation. If movements exceed the tolerance of existing project features (utilities, roadways, structures, etc.), alternative shoring systems employing the at-rest earth pressure, tie-backs, dead-man anchors, or cross bracing may be needed to reduce deflections to acceptable levels. The contractor should anticipate repairing cracks in perimeter walls adjacent to shored portions of the excavation due to anticipated lateral

displacements of the shoring system. Horizontal and vertical movements of the shoring system should be monitored by a surveyor and the results reviewed by the project Geotechnical Engineer.

10.1.5 Bottom Stability

The proposed excavations are not anticipated to encounter significant groundwater (with the possible exception of surface run-off or perched zones) during construction. Therefore, trench bottom stability problems during construction are generally not anticipated at this site. However, if excavations are located near drainage ditches, or near a known wash, arroyo, or drainage area that is open during a heavy rain event, or near any leaking utilities, the trench material(s) might become saturated and unstable and a dewatering system may be needed for these conditions. Should this occur, further remedial measures may be needed.

10.1.6 Construction Dewatering

Stream flow, surface run-off, and perched groundwater will vary seasonally depending on rainfall in the site vicinity. Excavations that do encounter surface run-off (if any) could be dewatered by pumping the water out from the bottom and away from the excavation. However, heavily saturated units or perched groundwater zones, if encountered, may call for more aggressive means of dewatering and consultation with a qualified expert. Discharge of water from the excavations to natural drainage channels may entail securing a special permit.

10.1.7 Engineered Fill and Reuse of On-site Soils

On-site and imported soils that exhibit relatively low to low-moderate plasticity indices are generally suitable for re-use as engineered fill for this project. Relatively low to low-moderate plasticity indices are defined as a plasticity index ([PI] ASTM D4318) value of 15 or less. The Atterberg limits tests performed on selected samples indicated that the samples tested ranged in PI values from 10 to 24. Additionally, swell testing performed on selected samples indicated 1.1 percent swell. As such, it is our opinion that some of the on-site soils will not be suitable for re-use as engineered fill if supporting settlement-sensitive features or within 3-feet of the new pavement surfaces. However, on-site soils with PI values up to 25 may be used as engineered fill within the trench backfill zone situated 1-foot above the pipe invert level and 3-feet below the new pavement surface. Additional field sampling and laboratory testing may be conducted by the contractor either prior to or during construction to better understand the limits of suitable and unsuitable materials.

Suitable fill should also not include organic material, construction debris, or other non-soil fill materials. Rock particles and clay lumps should not be larger than 4 inches in dimension. Unsuitable fill material should be disposed of off-site or in non-structural areas.

Trench and pit backfill zone shown in Figures 4A and 4B, as discussed in this report, refers to the zone above the pipe zone/bedding backfill material in the pipeline trench. For backfill locations situated below settlement sensitive features; such as pavement, slab on grade, and/or flatwork areas; the upper zone shown in Figure 4A shall consist of aggregate base course (ABC) in accordance with MAG section 702 and 601. Additionally, the upper 2 feet of engineered fill within the trench zone shall be moisture-conditioned from optimum to 3 percent above optimum. For backfill locations situated outside settlement sensitive features such as pavement, slab on grade, flatwork areas (shown in Figure 4B) the engineered fill shall be moisture-conditioned from 3 percent below to 3 percent above optimum

For the bedding/pipe-zone shown in Figures 4A and 4B, we recommend that new pipeline be supported on 4 inches, or 1/12 of the outside diameter of the pipe, whichever is more of granular material that has particle sizes no more than 1-1/2-inches in diameter, and has 3 to 12 percent passing the No. 200 sieve such as ABC in accordance with MAG section 702. The bedding/pipe-zone backfill should extend 1 foot above the pipe crown.

Generated excavation materials that contain this oversize fraction shall not be used as backfill unless the material meets the criteria given above and/or the oversize fraction has been processed and removed from the material. Imported backfill material, if utilized, should meet the criteria for imported fill as presented in this report. An earthwork (shrinkage) factor of 5 to 15 percent for the on-site soils is estimated.

10.1.8 Fill Placement and Compaction

Prior to the placement of any new fill or other construction, the exposed surface should be carefully evaluated by the geotechnical consultant for the presence of soft, loose or wet native soils. Based on this evaluation, remediation may be needed. This remediation, if needed, should be addressed by the geotechnical consultant during the earthwork operations. Drying or overexcavation of some materials may be appropriate.

ABC material beneath the settlement sensitive features noted in this report should be compacted to a relative compaction of 100 percent as evaluated by ASTM D698 at moisture content generally near optimum. In the bedding/pipe-zone, care should be taken not to allow voids to form beneath the pipe (i.e., the pipe haunches should be supported) to avoid damaging the pipeline. This may involve fill placement by hand or small compaction

equipment. The bedding/pipe zone should be placed in horizontal lifts no more than approximately 8 inches in loose thickness and compacted by appropriate mechanical methods to a relative compaction of 95 percent (as evaluated by ASTM D698) and at a moisture content slightly above the laboratory optimum.

Trench backfill zone should be mechanically compacted to a relative compaction of 95 percent as evaluated by ASTM D698. Lift thickness for backfill will be dependent upon the type of compaction equipment utilized, but should generally be placed in lifts not exceeding 8 inches in loose thickness. Due to the clayey nature of the some of the site-soils, compaction may be difficult to achieve in some areas. Special care should be exercised to avoid damaging the pipe or other structures during the compaction of the backfill. Compaction should be accomplished in a manner that inhibits surface water infiltration as well as conveyance of subsurface moisture due to the intersection of natural drainages along the alignment.

We recommend that new pavements and exterior flatwork, if any, also be supported on an engineered subgrade. If outside the trench backfill footprint, this zone of engineered subgrade should be measured from the bottom of the aggregate base layer and should extend to a depth of 1 foot. The zone should be backfilled with engineered fill that is moisture-conditioned to a moisture content above optimum, and compacted to 95 percent (ASTM D698).

Backfilling should be accomplished by mechanical methods; compaction by flooding or jetting should not be permitted. In addition, particle sizes should not exceed 4 inches in diameter.

Following the overexcavation described above, and prior to the placement of engineered fill, the resulting exposed surface should be carefully evaluated by Ninyo & Moore. Based on this evaluation, additional remediation may be needed. This could include additional scarification of the exposed surface. This additional remediation, if needed, should be addressed by the geotechnical consultant during the earthwork operations.

10.1.9 Imported Fill Material

Imported fill, if utilized, should consist of granular material with a very low or low expansion potential as discussed in this report. Import material in contact with ferrous metals should preferably have low corrosion potential (minimum electrical resistivity more than 2,000 ohm-cm, chloride content less than 25 parts per million [ppm]). In lieu of this, corrosion protection techniques (e.g., cathodic protection, pipe wrapping, etc.) can be implemented.

Imported material in contact with concrete should have a soluble sulfate content of less than 0.1 percent. The geotechnical consultant should evaluate such materials and details of their placement prior to importation. A corrosion specialist should be consulted for recommendations.

10.1.10 Modulus of Soil Reaction (E')

The modulus of soil reaction (E´) is used to characterize the stiffness of soil backfill placed on the sides of buried pipelines for the purpose of evaluating deflection caused by the weight of the backfill over the pipe. For granular backfill soils for pipes, we recommend using an E´ value of 1,500 pounds per square inch (psi). Based on MAG guidelines, the definition of "granular backfill" material is material which the sum of the PI and the percent of material passing a No. 200 sieve does not exceed 23. For granular backfill with less than 50 percent passing the No. 40 sieve and 12 percent or less passing the No. 200 sieve, an E´ value of 2,000 psi may be used.

E' for native materials will vary with material type and stiffness of the trench sidewalls. Approximate values of E' for the materials encountered in our borings are presented in Table 3 below:

Table 3 – Modulus of Soil Reaction (E') for Native Soils

Trench Wall Soil Classification (USCS)	Approximate E' (psi)		
	Loose/Firm	Medium Dense/ Stiff	Dense – Very Dense/ Stiff-Hard
Sandy Clay (CH, CL)	200	500	1500
Clayey Sand (SC)	400	700	2500

10.1.11 Controlled Low Strength Material

It is our opinion that the backfill zones may be filled with either engineered fill as described above or CLSM. CLSM consists of a fluid, workable mixture of aggregate, Portland cement, and water. The use of CLSM has some advantages:

- A narrower backfill zone can be used, thereby minimizing the quantity of soil to be excavated and possibly reducing disturbance to the near-by structures.
- Relatively higher E' values may be used (E'= 3,000 psi).
- The support given to the connecting pipes is generally better.

- Because little compaction is needed to place CLSM, there is less risk of damaging the connecting pipes.
- CLSM can be batched to flow into irregularities in the trench bottom and walls.

The CLSM design mix should be in accordance with current MAG or Standard Specifications for Public Works Construction standards. Additional mix design information can be provided upon request. The CLSM should meet MAG standards performance and acceptance criteria.

Buoyant or uplift forces on the piping should be considered when using CLSM and prudent construction techniques may result in multiple pours to avoid inducing excessive uplift forces. Sufficient time should be provided to allow the CLSM to cure before placing additional lifts of CLSM or trench backfill.

10.2 Seismic Design Considerations

Design of the proposed improvements should be performed in accordance with the requirements of the governing jurisdictions and applicable building codes. Table 4 presents the seismic design parameters for the site in accordance with International Building Code (IBC) guidelines and adjusted maximum considered earthquake spectral response acceleration parameters evaluated using the USGS ground motion calculator (web-based).

Table 4 – IBC Seismic Design Criteria

Site Coefficients and Spectral Response Acceleration Parameters	Values
Class	D
Coefficient, F_a	1.6
Coefficient, F_v	2.4
Mapped Spectral Response Acceleration at 0.2-second Period, S_s	0.169 g
Mapped Spectral Response Acceleration at 1.0-second Period, S_1	0.077 g
Spectral Response Acceleration at 0.2-second Period Adjusted for Site Class, S_{MS}	0. 27 g
Spectral Response Acceleration at 1.0-second Period Adjusted for Site Class, S_{M1}	0.184 g
Design Spectral Response Acceleration at 0.2-second Period, S_{DS}	0.18 g
Design Spectral Response Acceleration at 1.0-second Period, S_{D1}	0.122 g
MCE_G peak ground acceleration, PGA	0.074 g
Site modified peak ground acceleration, PGA_M	0.118 g

10.3 Corrosion

The corrosion potential of the on-site materials was analyzed to evaluate its potential effect on the ferrous metals used for this project. Corrosion potential was evaluated using the results of laboratory testing on a sample obtained during our subsurface evaluation that was considered representative of soils along the project alignment.

Laboratory testing consisted of pH, minimum electrical resistivity, and chloride and soluble sulfate contents. The pH and minimum electrical resistivity tests were performed in general accordance with Arizona Test 236c, while sulfate and chloride content tests were performed in accordance with Arizona Test Method 733 and 736, respectively. The results of the corrosivity tests are presented in Appendix B.

The soil pH value of the tested samples was 7.7to 7.9, which is considered to be alkaline. The minimum electrical resistivity values were 308 to 1,112 ohm-cm, which is considered to be corrosive to ferrous materials. The chloride content was 615 and 1192 ppm on the samples tested, which is also considered to be corrosive to ferrous metals. The soluble sulfate content of the soil sample was 0.007 to 0.045 percent by weight, which is considered to represent negligible to severe sulfate exposure for concrete.

The results of the laboratory testing indicate that the on-site soils are corrosive to ferrous metals. These soils generally present a negligible sulfate exposure for concrete. Therefore, special consideration may be given to the use of heavy-gauge, corrosion-protected, underground steel pipe. As an alternative, plastic pipe, reinforced concrete pipe, or corrosion protection techniques may be considered. We recommend that topsoil, organic soils, and mixtures of sand and clay not be placed adjacent to buried metallic utilities. Rather, we suggest a relatively clean sand and/or gravel, or CLSM, be placed around buried metal piping. Also, buried utilities of different metallic construction should be electrically isolated from each other to minimize galvanic corrosion problems. In addition, new piping should be electrically isolated from old piping so that the old metal will not increase the corrosion rate of the new metal. A corrosion specialist should be consulted for further recommendations.

10.4 Concrete

Laboratory chemical tests performed on on-site soil samples indicated sulfate contents of 0.007 to 0.045 percent by dry weight of soil. Based on American Concrete Institute criteria, the on-site soils should be considered to present a negligible exposure for concrete.

Notwithstanding the sulfate test results and due to the limited number of chemical tests performed, as well as our experience with similar soil conditions and regional practice, we recommend that "Type II" cement be used for the construction of concrete structures at this site. Due to potential uncertainties as to the use of reclaimed irrigation water, or topsoil that may contain higher sulfate contents, pozzolan or admixtures designed to increase sulfate resistance may be considered.

The structural engineer should ultimately select the concrete design strength based on the project specific loading conditions. Higher strength concrete may be selected for increased durability and resistance to slab curling and shrinkage cracking.

10.5 Site Drainage

Surface drainage should be provided to divert water away from structures and off of paved/flatwork surfaces. Surface water should also not be permitted to drain towards the structures or to pond on or below pavement areas. Positive drainage is defined as a slope of 2 percent or more for a distance of 5 feet or more away from the structures. We recommend a slope of 5 percent for a distance of 10 feet away from the pump station.

10.6 Pre-Construction Conference

We recommend that a pre-construction conference be held. Representatives of the owner, the civil engineer, the geotechnical consultant, and the contractor should be in attendance to discuss the project plans and schedule. Our office should be notified if the project description included herein is incorrect or if the project characteristics are significantly changed.

10.7 Construction Observation and Testing

During construction operations, we recommend that a qualified geotechnical consultant perform observation and testing services for the project. These services should be performed to evaluate exposed subgrade conditions, including the extent and depth of overexcavation, to evaluate the suitability of proposed borrow materials for use as fill and to observe placement and test compaction of fill soils. If another geotechnical consultant is selected to perform observation and testing services for the project, we request that the selected consultant provide a letter to the owner, with a copy to Ninyo & Moore, indicating that they fully understand our recommendations and they are in full agreement with the recommendations contained in this report. Qualified subcontractors utilizing appropriate techniques and construction materials should perform construction of the proposed improvements.

11 LIMITATIONS

The field evaluation, laboratory testing, and geotechnical analyses presented in this geotechnical report have been conducted in general accordance with current practice and the standard of care exercised by geotechnical consultants performing similar tasks in the project area. No warranty, expressed or implied, is made regarding the conclusions, recommendations, and opinions presented in this report. There is no evaluation detailed enough to reveal every subsurface condition. Variations may exist and conditions not observed or described in this report may be encountered during construction. Uncertainties relative to subsurface conditions can be reduced through additional subsurface exploration. Additional subsurface evaluation will be performed upon request. Please also note that our evaluation was limited to assessment of the geotechnical aspects of the project, and did not include evaluation of structural issues, environmental concerns, or the presence of hazardous materials.

This document is intended to be used only in its entirety. No portion of the document, by itself, is designed to completely represent any aspect of the project described herein. Ninyo & Moore should be contacted if the reader requires additional information or has questions regarding the content, interpretations presented, or completeness of this document.

Our conclusions, recommendations, and opinions are based on an analysis of the observed site conditions. If geotechnical conditions different from those described in this report are encountered, our office should be notified and additional recommendations, if warranted, will be provided upon request. It should be understood that the conditions of a site could change with time as a result of natural processes or the activities of man at the subject site or nearby sites. In addition, changes to the applicable laws, regulations, codes, and standards of practice may occur due to government action or the broadening of knowledge. The findings of this report may, therefore, be invalidated over time, in part or in whole, by changes over which Ninyo & Moore has no control.

This report is intended exclusively for use by the client. Any use or reuse of the findings, conclusions, and/or recommendations of this report by parties other than the client is undertaken at said parties' sole risk.

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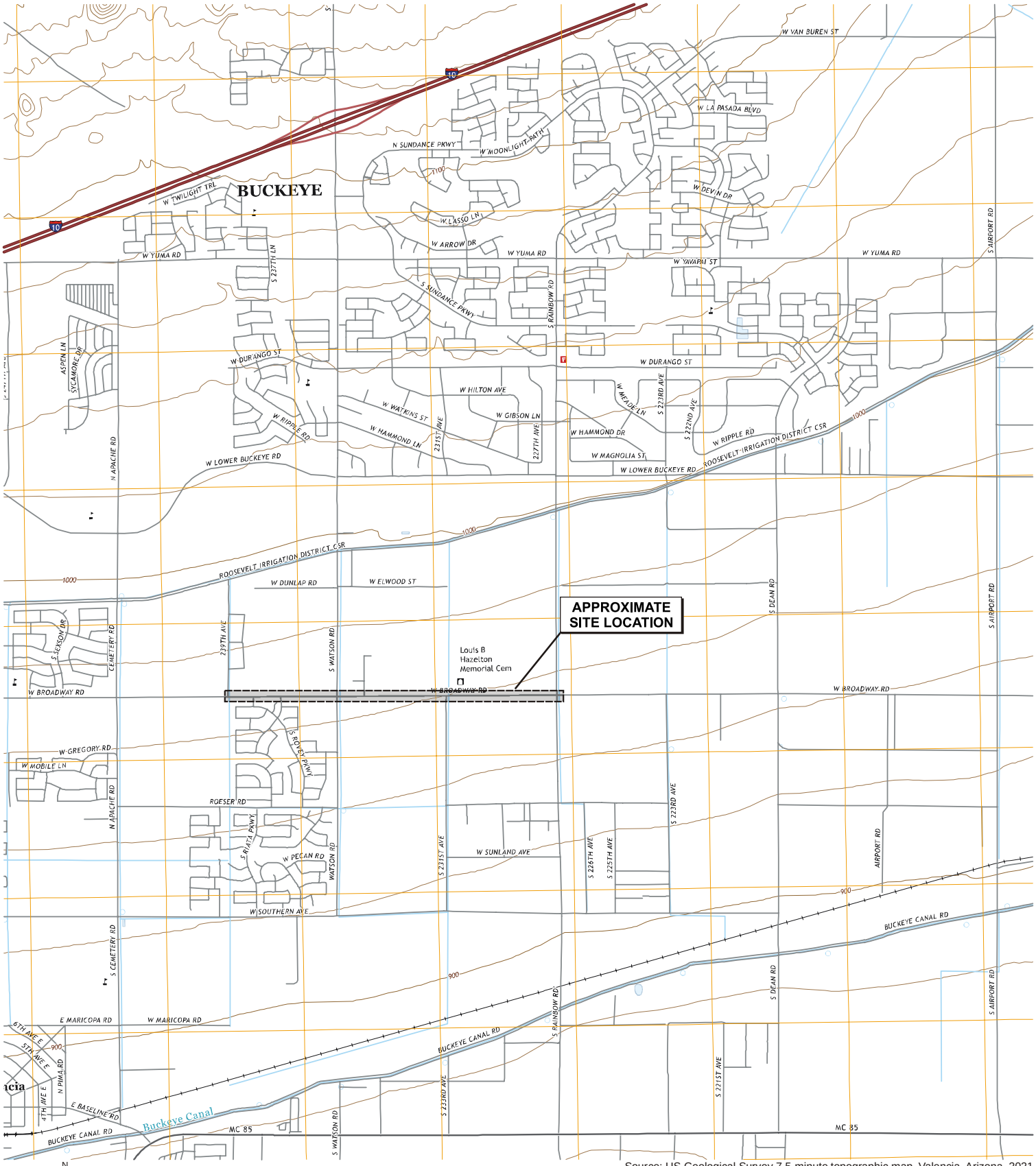
FIGURES



Source: US Geological Survey 7.5-minute topographic map, Valencia, Arizona, 2021.

NOTE: DIMENSIONS, DIRECTIONS AND LOCATIONS ARE APPROXIMATE.

FIGURE 1

SITE LOCATION

REACH LINE CONNECTION
BUCKEYE, ARIZONA

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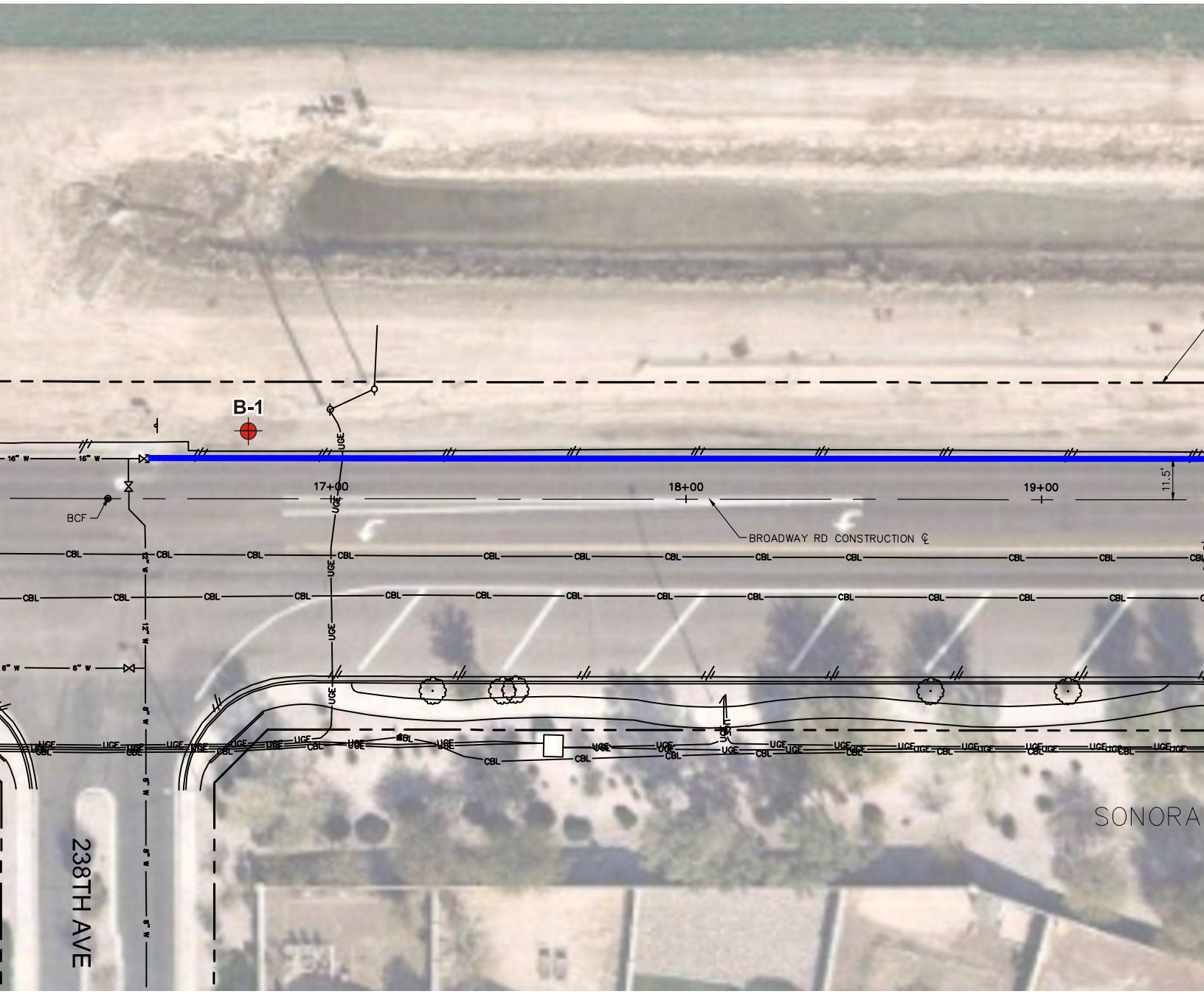
Ninyo & Moore
Geotechnical & Environmental Sciences Consultants

bsm file no: 7106vmap0522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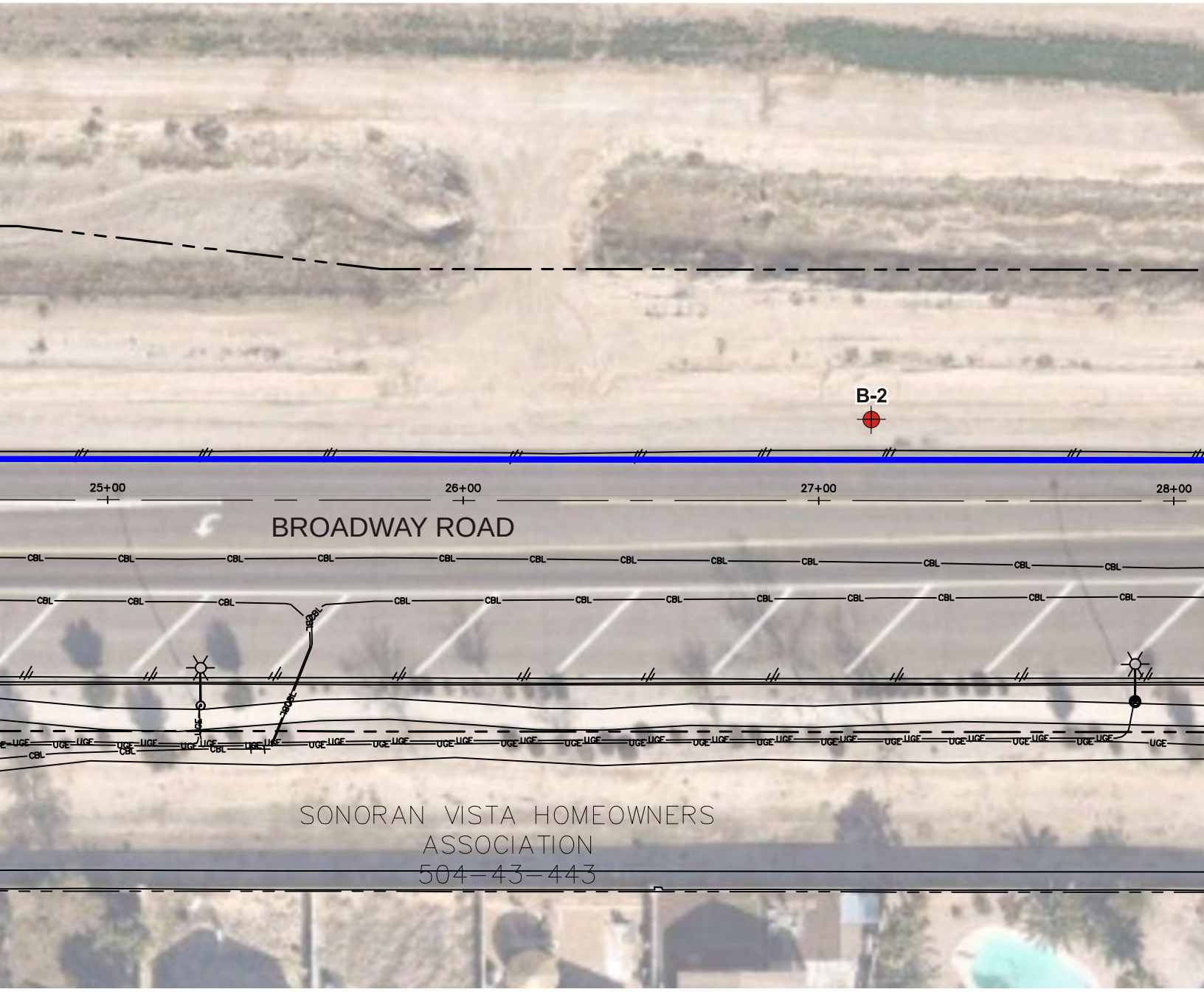
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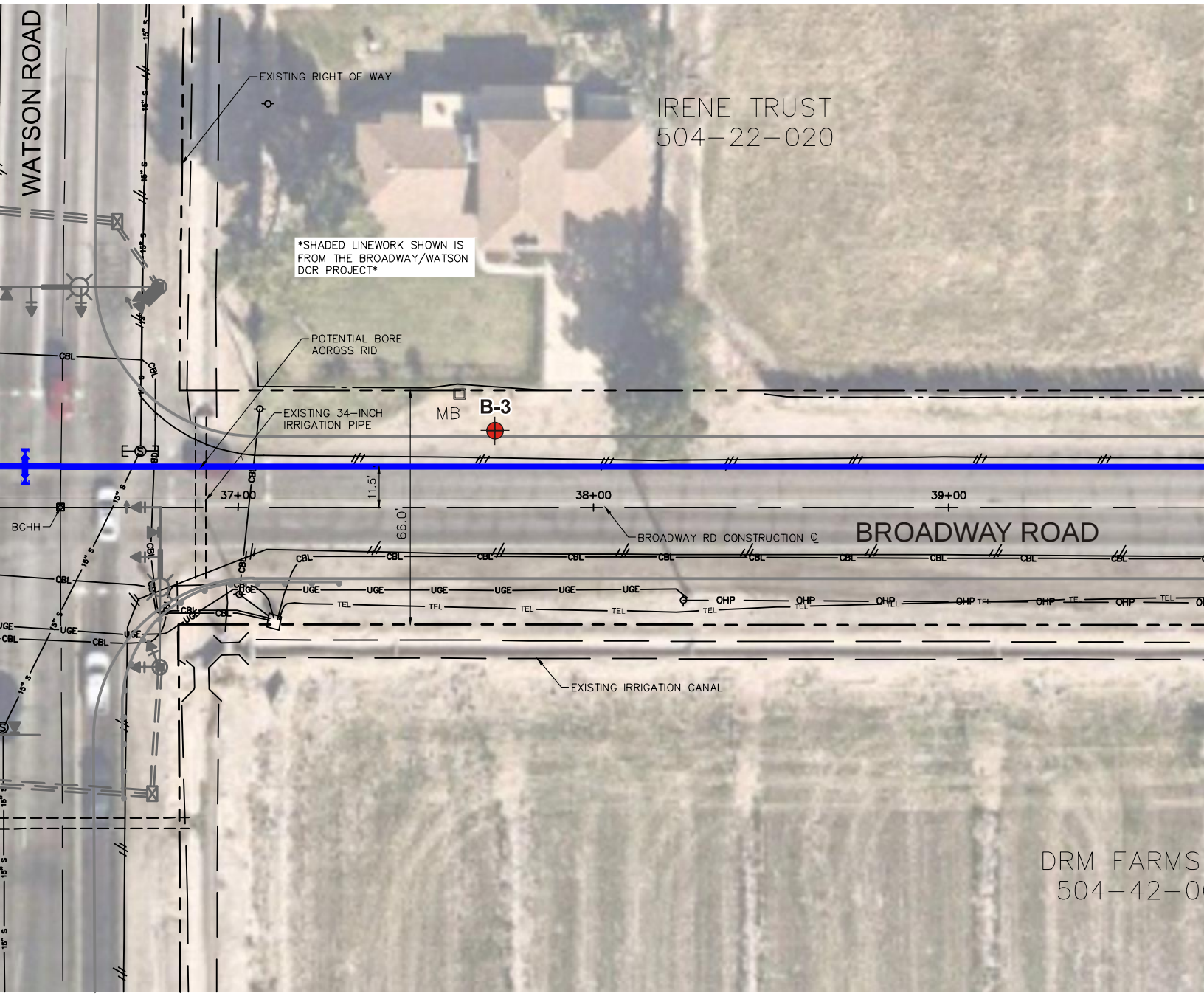
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IRENE TRUST
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EXISTING 34-INCH IRRIGATION PIPE
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11.5'
66.0'
37+00
38+00
39+00
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BROADWAY ROAD
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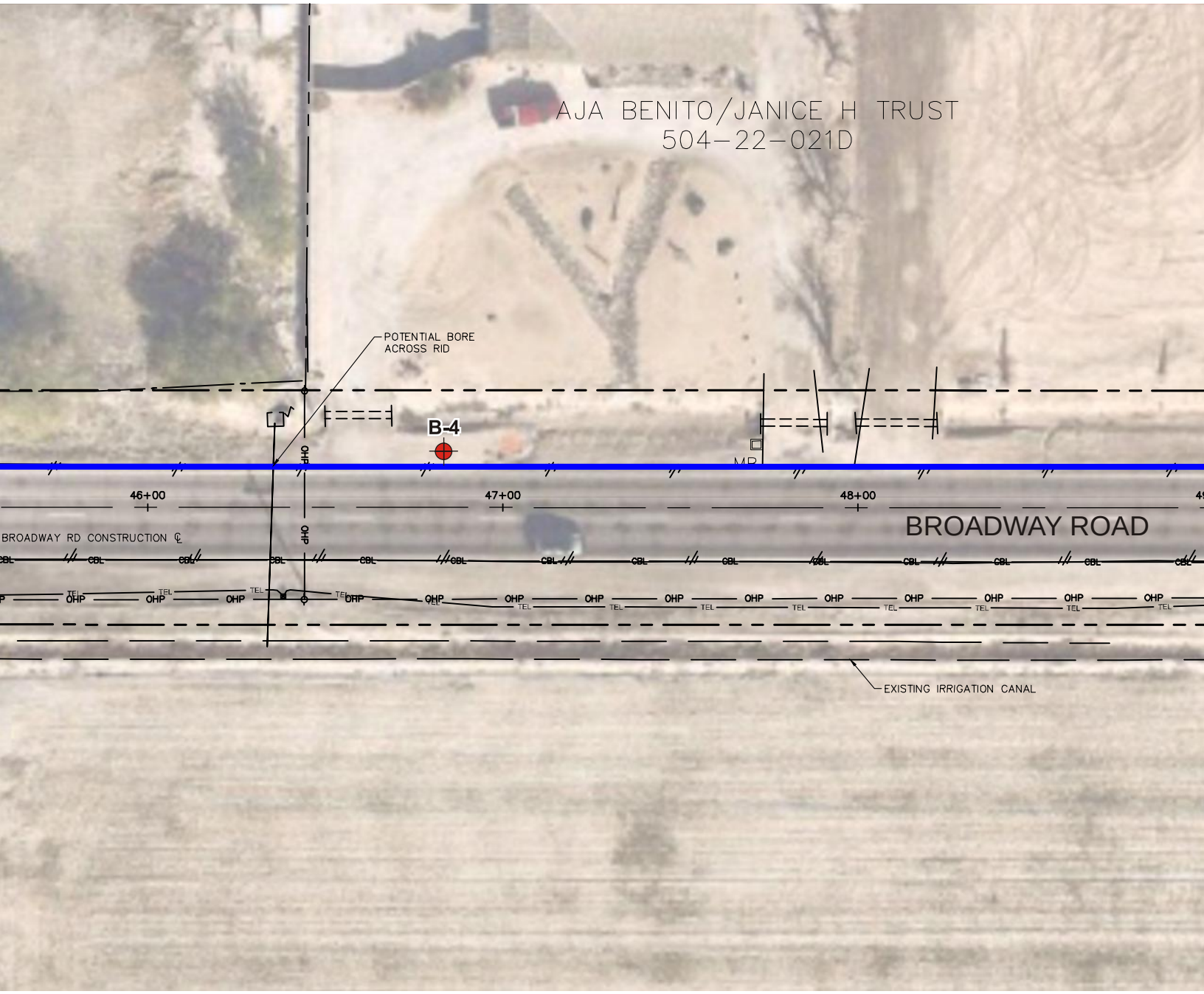
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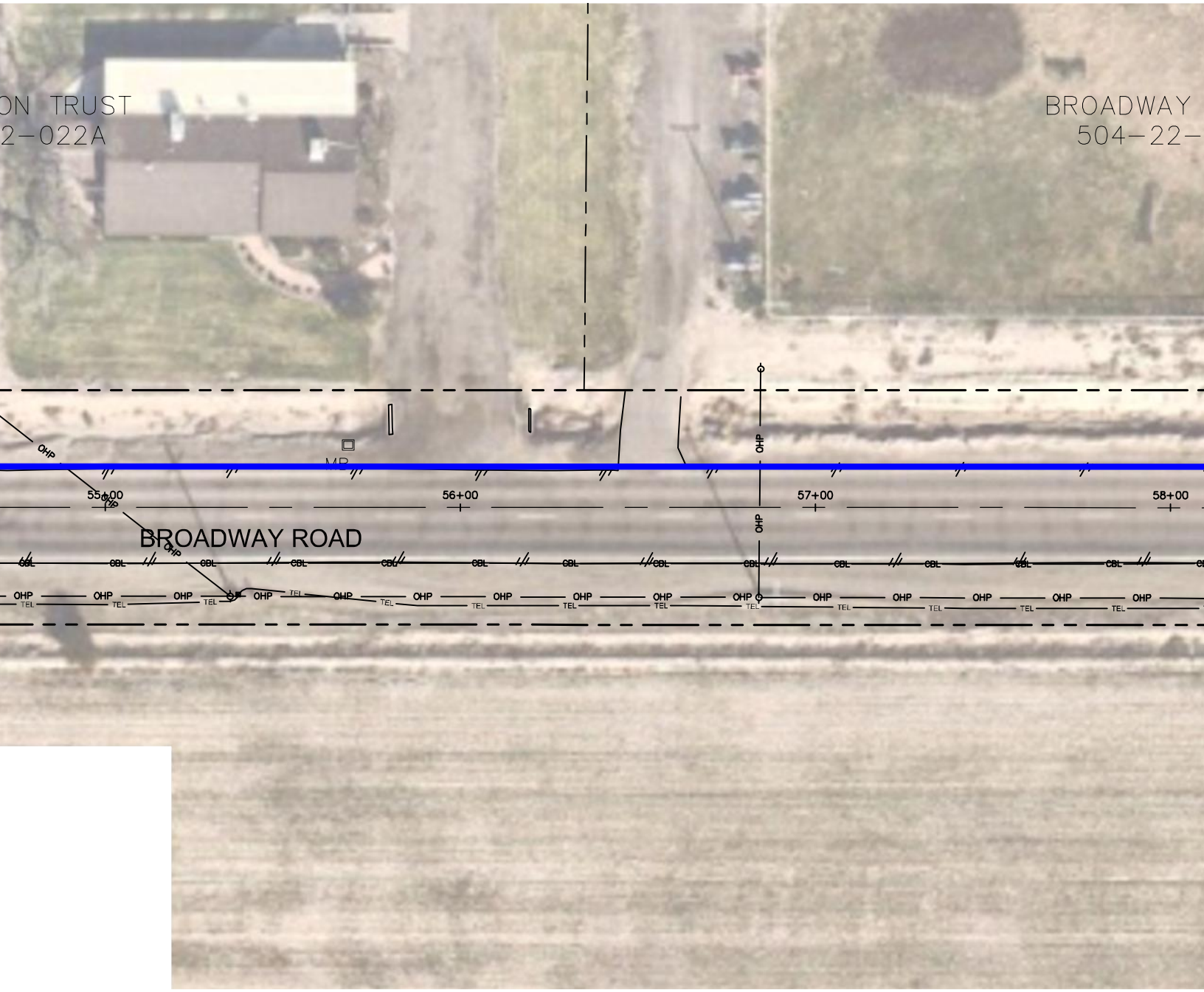
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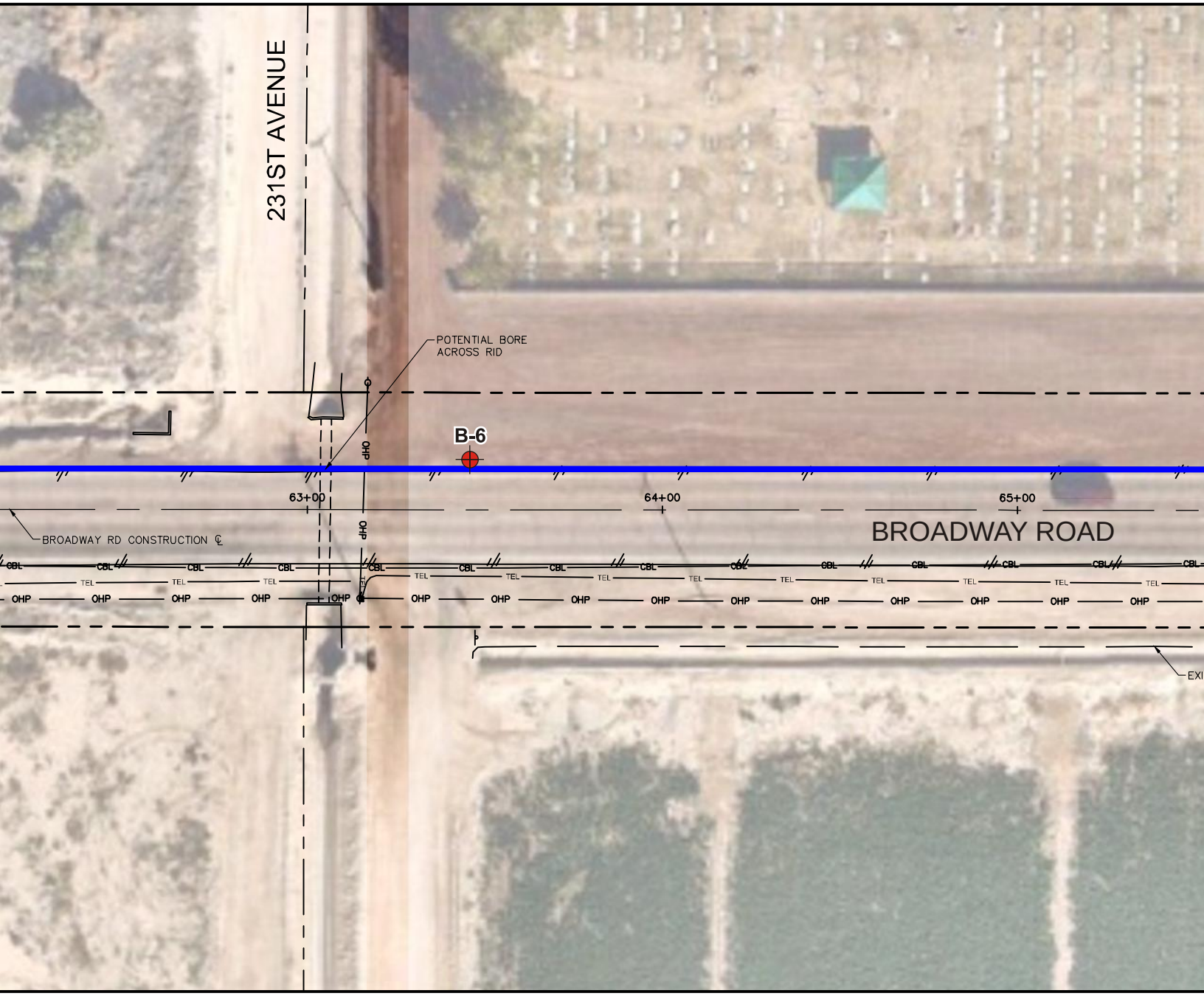
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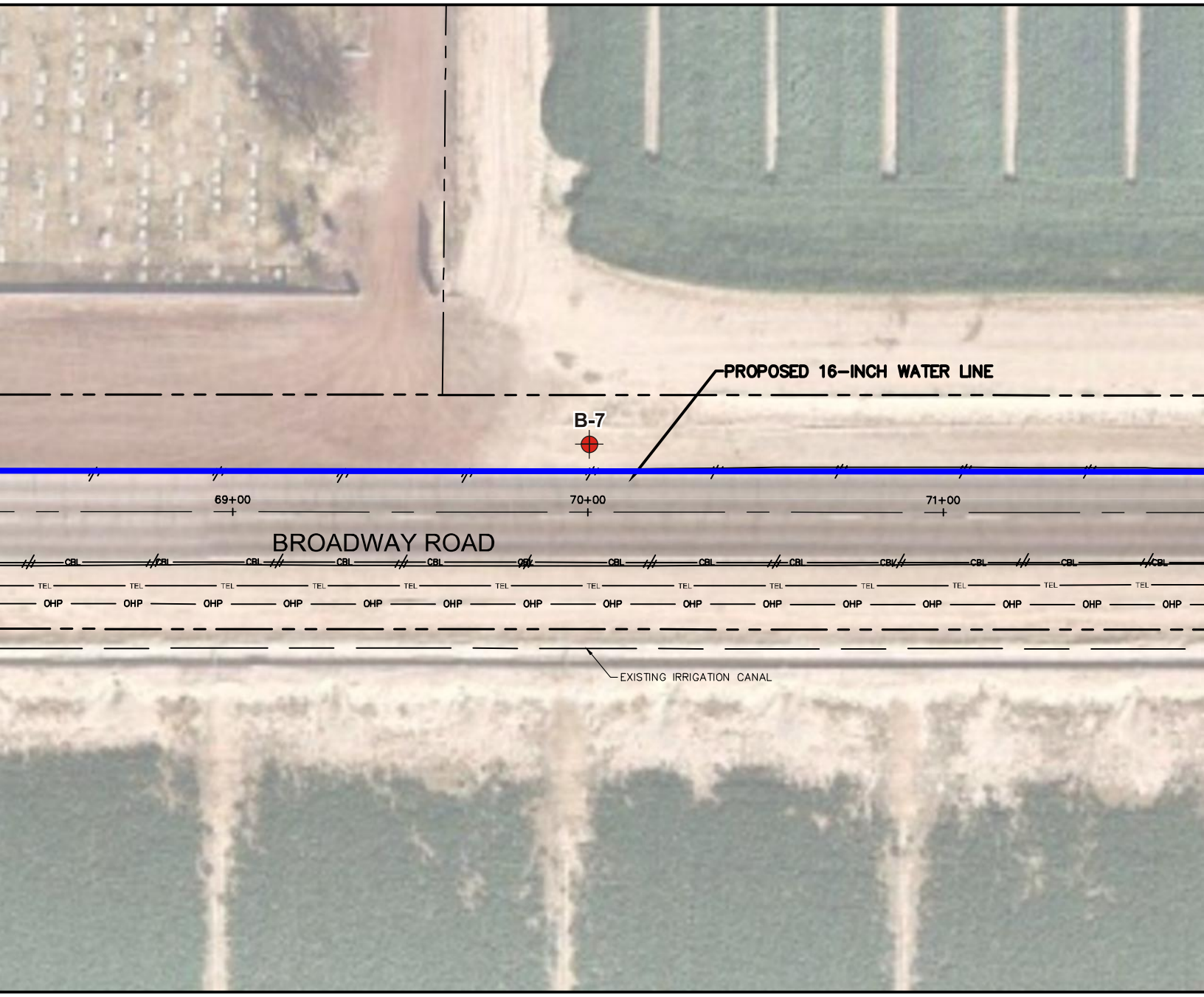
PROPOSED 16-INCH WATER LINE
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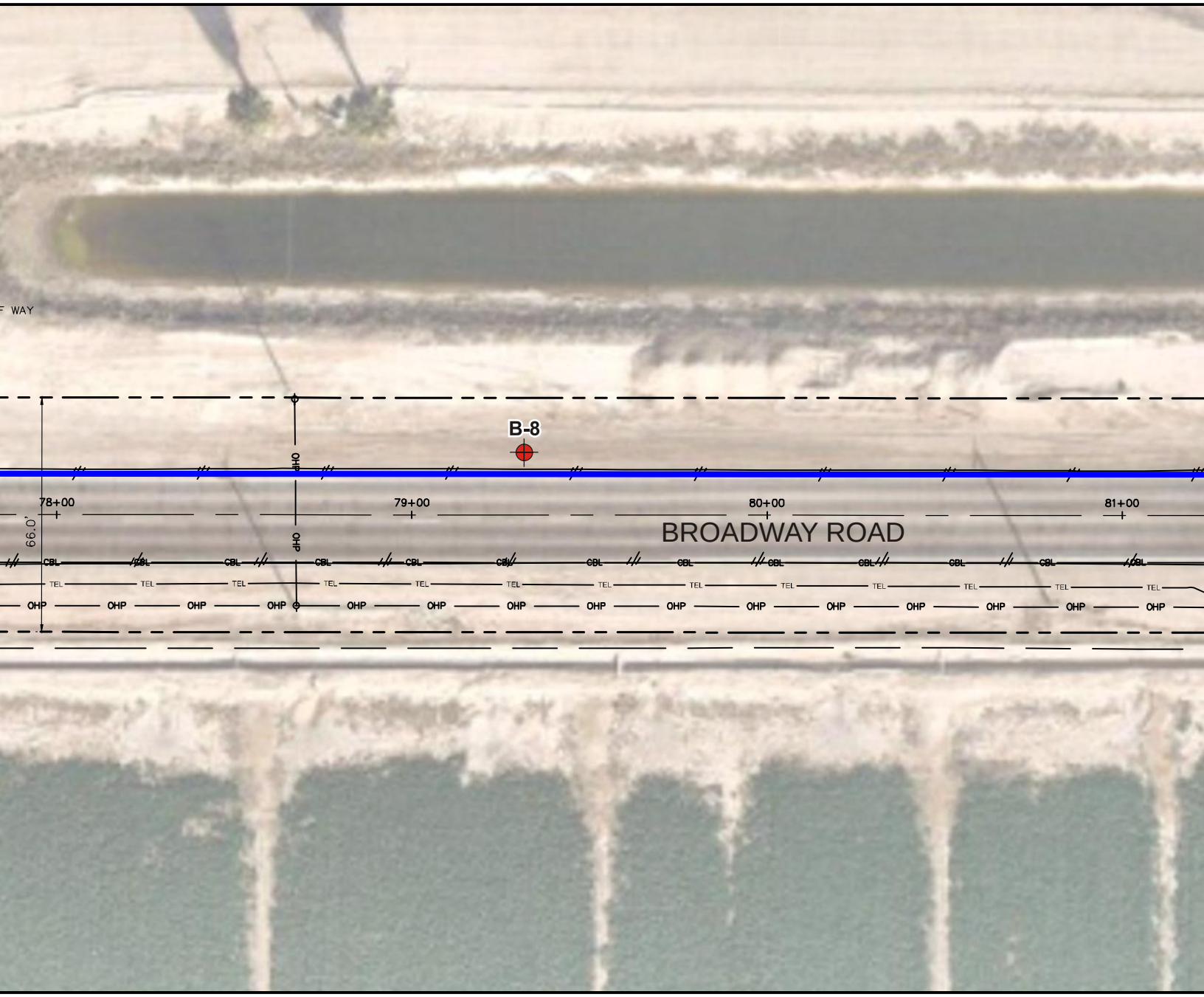
EXISTING IRRIGATION CANAL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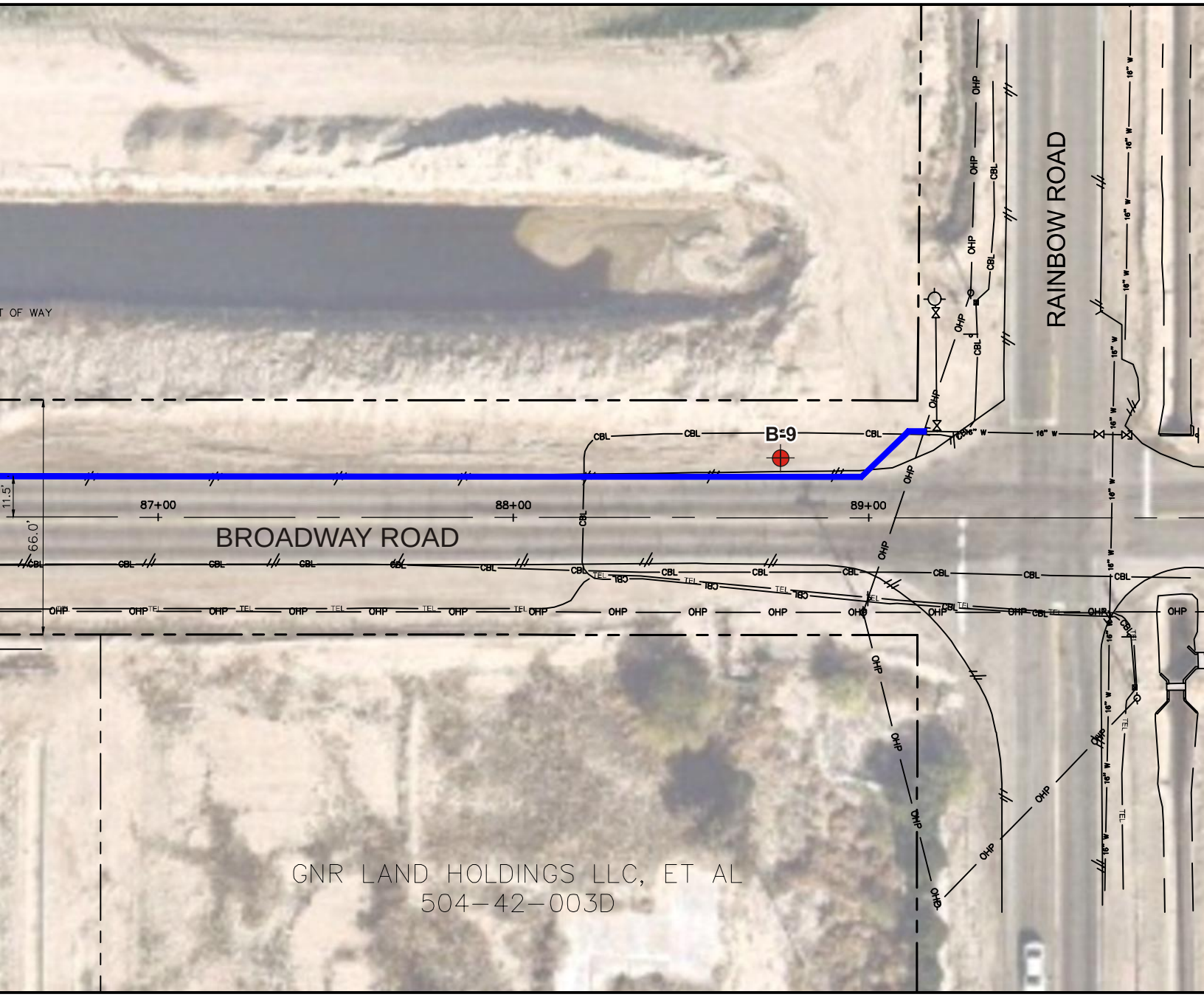
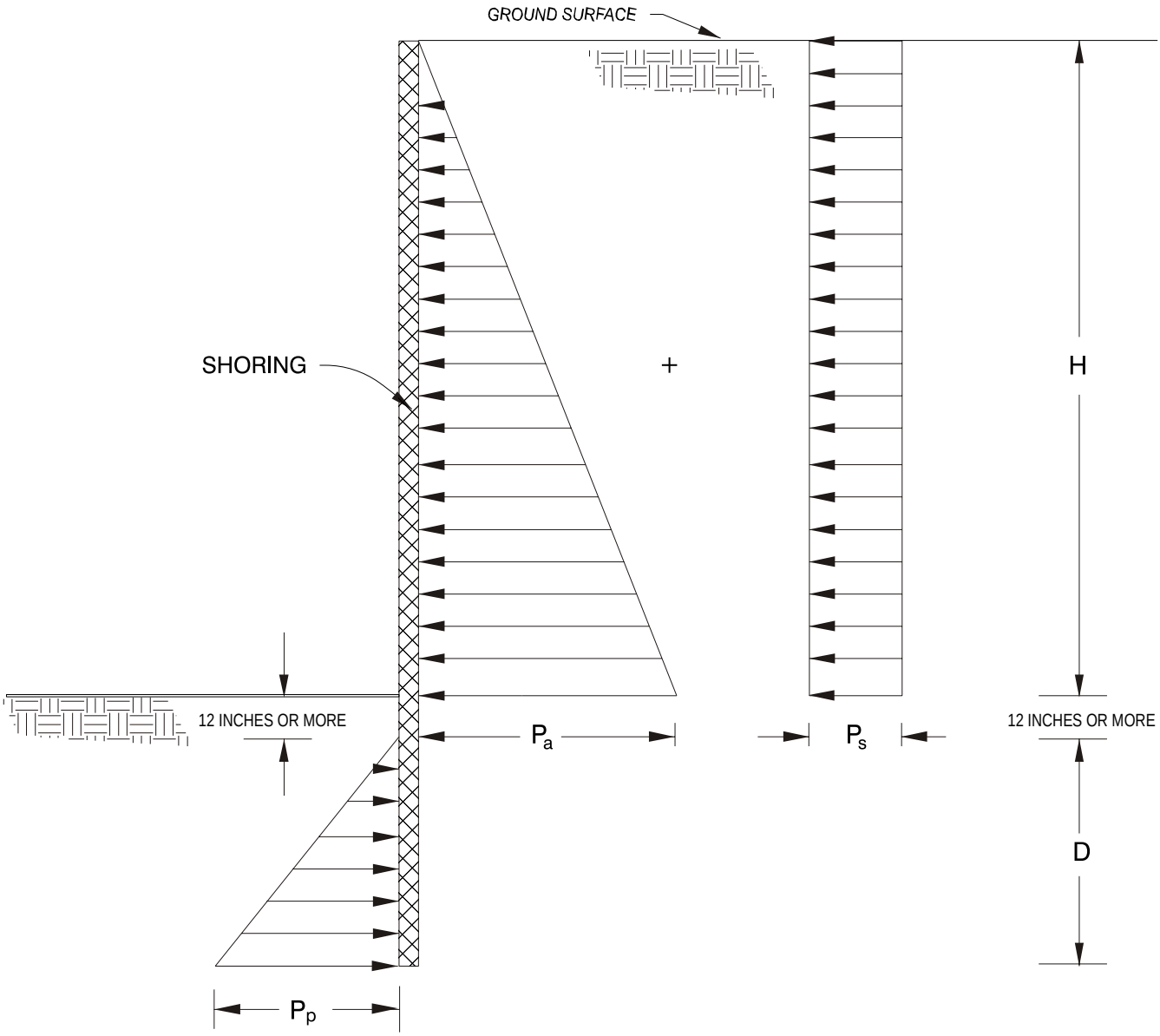
CBL
TEL


RAINBOW ROAD
BROADWAY ROAD
B-9
87+00
88+00
89+00
66.0'
11.5'
GNR LAND HOLDINGS LLC, ET AL
504-42-003D



NOTES:

1. ACTIVE LATERAL EARTH PRESSURE, P_a
   P_a = 45H psf
2. CONSTRUCTION TRAFFIC INDUCED SURCHARGE PRESSURE, P_s
   P_s = 120 psf
3. PASSIVE LATERAL EARTH PRESSURE, P_p
   P_p = 345D psf
4. ASSUMES GROUNDWATER IS NOT PRESENT
5. H AND D ARE IN FEET

NOT TO SCALE

FIGURE 3A

LATERAL EARTH PRESSURES FOR TEMPORARY CANTILEVERED SHORING

REACH LINE CONNECTION
BUCKEYE, ARIZONA

Ninyo & Moore
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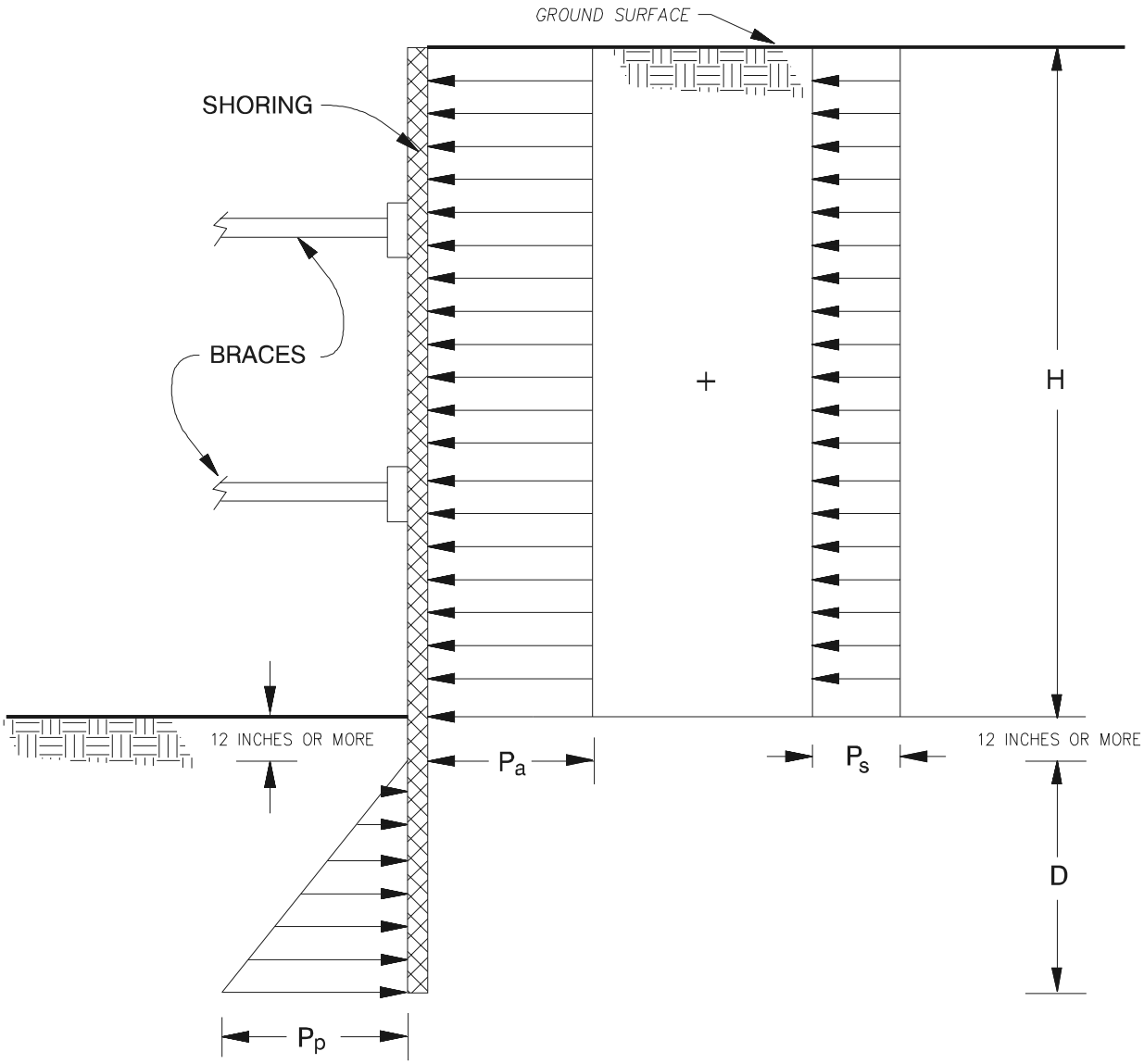
607106001 | 6/22

bsm file no: 7106lep0522a



NOTES:

1. APPARENT LATERAL EARTH PRESSURE, P_a
   P_a = 29 H psf
2. CONSTRUCTION TRAFFIC INDUCED SURCHARGE PRESSURE, P_s
   P_s = 120 psf
3. PASSIVE LATERAL EARTH PRESSURE, P_p
   P_p = 345 D psf
4. ASSUMES GROUNDWATER IS NOT PRESENT
5. SURCHARGES FROM EXCAVATED SOIL OR CONSTRUCTION MATERIALS ARE NOT INCLUDED
6. H AND D ARE IN FEET

FIGURE 3B

LATERAL EARTH PRESSURES FOR TEMPORARY BRACED EXCAVATION (GRANULAR SOIL)

REACH LINE CONNECTION
BUCKEYE, ARIZONA

607106001 | 6/22

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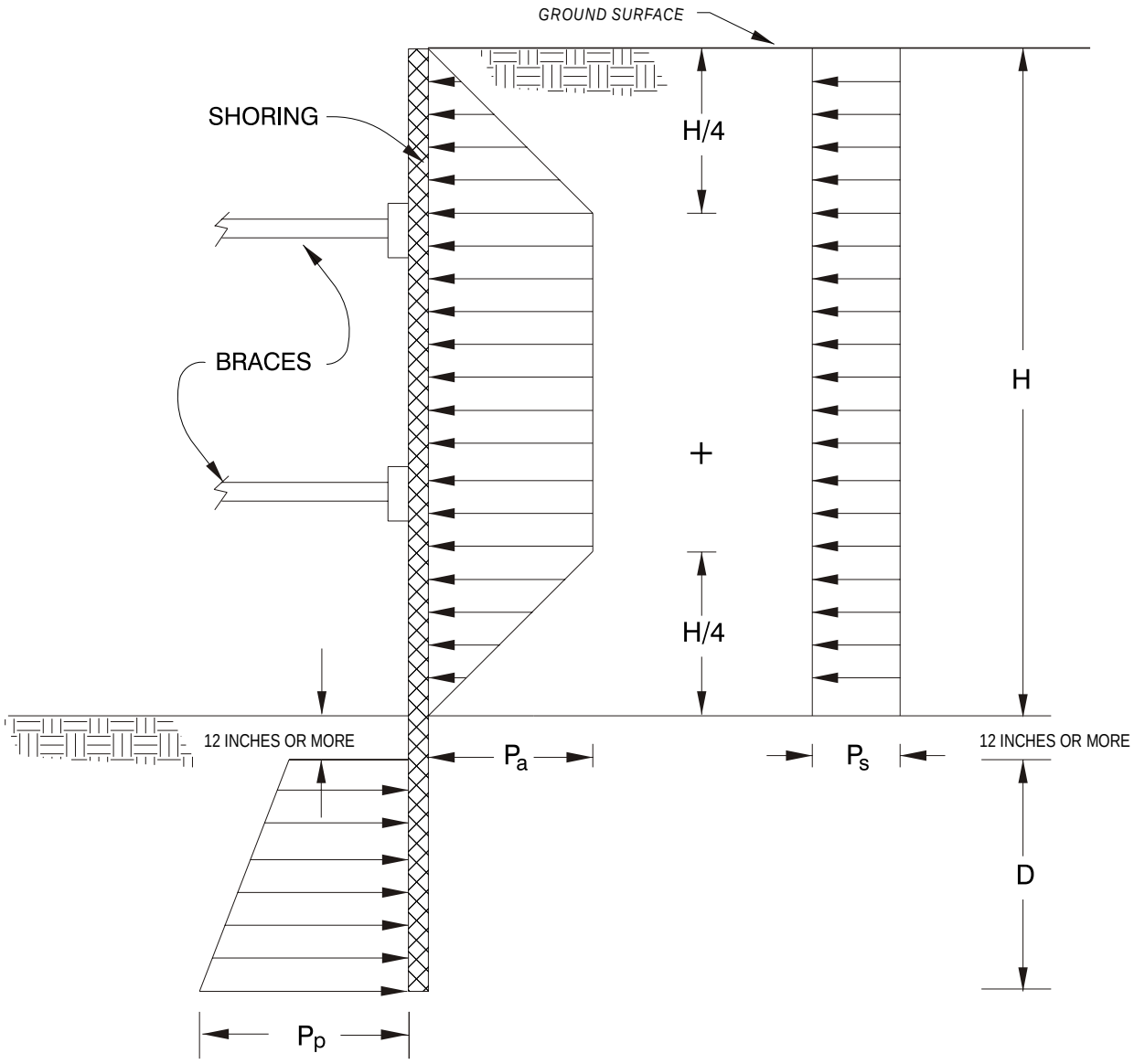
Geotechnical & Environmental Sciences Consultants

kg file no: 7106lep0522b



NOTES:

1. APPARENT LATERAL EARTH PRESSURE, P_a
   P_a = 48H psf
2. CONSTRUCTION TRAFFIC INDUCED SURCHARGE PRESSURE, P_s
   P_s = 120 psf
3. PASSIVE LATERAL EARTH PRESSURE, P_p
   P_p = 280D psf
4. ASSUMES GROUNDWATER IS NOT PRESENT
5. SURCHARGES FROM EXCAVATED SOIL OR CONSTRUCTION MATERIALS ARE NOT INCLUDED
6. H AND D ARE IN FEET

NOT TO SCALE

FIGURE 3C

LATERAL EARTH PRESSURES FOR TEMPORARY BRACED EXCAVATION (COHESIVE SOIL)

REACH LINE CONNECTION
BUCKEYE, ARIZONA

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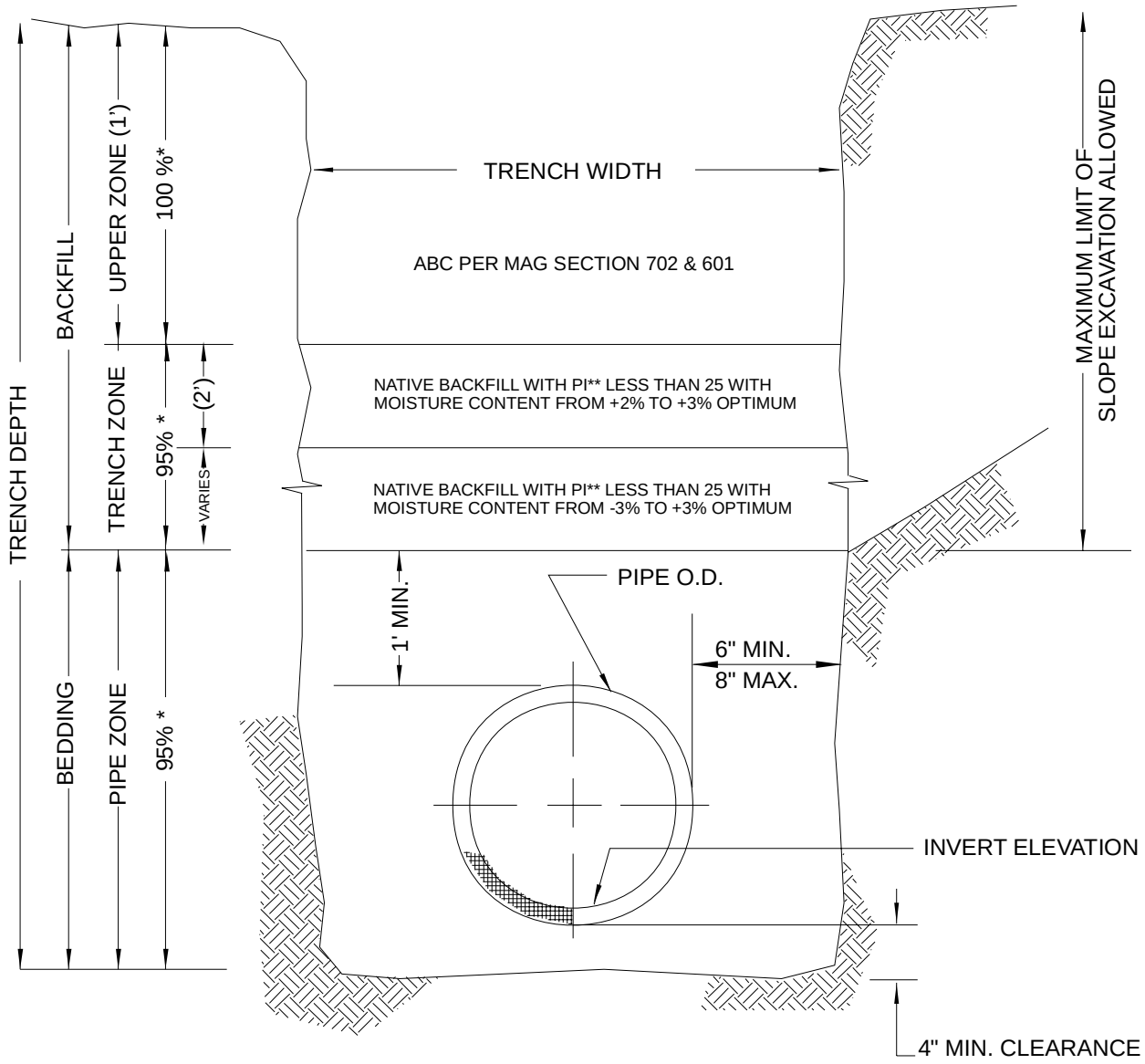
kg file no: 7106lep0522c



BELOW PAVEMENT, SLAB,
AND/OR FLATWORK

NOTE

* Indicates minimum relative compaction (see report for details).

** PI= Plastic Index.

Upper zone required for pavement areas only.

Diagram not drawn to scale.

FIGURE 4A

PIPE BEDDING GUIDELINES (BELOW PAVEMNT LOCATIONS)

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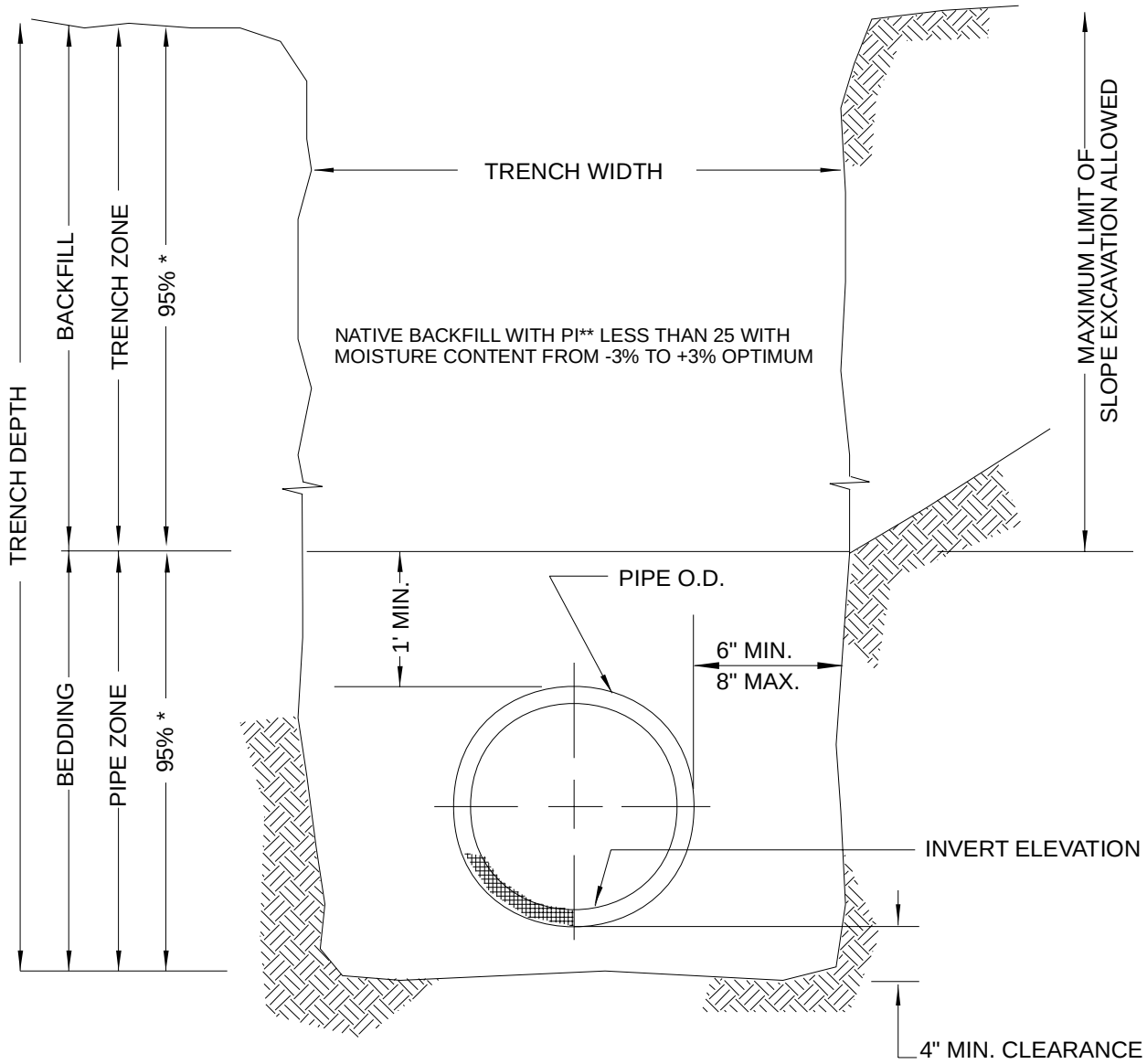
REACH LINE CONNECTION
BUCKEYE, ARIZONA

607106001 | 6/22

kg file no: 7106dtl0522a



OUTSIDE OF
PAVEMENT, SLAB,
AND/OR FLATWORK

NOTE

* Indicates minimum relative compaction (see report for details).

** PI= Plastic Index.

Upper zone required for pavement areas only.

Diagram not drawn to scale.

FIGURE 4B

PIPE BEDDING GUIDELINES (OUTSIDE OF PAVEMNT LOCATIONS)

REACH LINE CONNECTION
BUCKEYE, ARIZONA

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Geotechnical & Environmental Sciences Consultants

kg file no: 7106dtl0522b

APPENDIX A

Boring Logs

APPENDIX A

BORING LOGS

Field Procedure for the Collection of Disturbed Samples
Disturbed soil samples were obtained in the field using the following methods.

Bulk Samples
Bulk samples of representative earth materials were obtained from the explorations. The samples were bagged and transported to the laboratory for testing.

The Standard Penetration Test (SPT) Samples
Disturbed drive samples of earth materials were obtained by means of a Standard Penetration Test (SPT) sampler. The sampler is composed of a split barrel with an external diameter of 2 inches and an unlined internal diameter of $1^{3}/_{8}$ inches. The samples were driven up to 18 inches into the ground with a 140-pound hammer falling freely from a height of 30 inches in general accordance with ASTM D1586. The blow counts were recorded for every 6 inches of penetration; the blow counts reported on the log are those for the last 12 inches of penetration. Soil samples were observed and removed from the samples, bagged, sealed, and transported to the laboratory for testing.

Field Procedure for the Collection of Relatively Undisturbed Samples
Relatively undisturbed soil samples were obtained in the field using the following method.

The Modified Split-Barrel Drive Sampler
The sampler, with an external diameter of 3 inches, was lined with 1-inch-long, thin brass rings with inside diameters of approximately 2.4 inches. The sample barrel was driven into the ground with a 140-pound hammer falling freely from a height of 30 inches in general accordance with ASTM D3550. The approximate length of the fall, the weight of the hammer or bar, and the number of blows per foot of driving are presented on the boring logs as an index to the relative resistance of the materials sampled. The samples were removed from the sample barrel in the brass rings, sealed, and transported to the laboratory for testing.

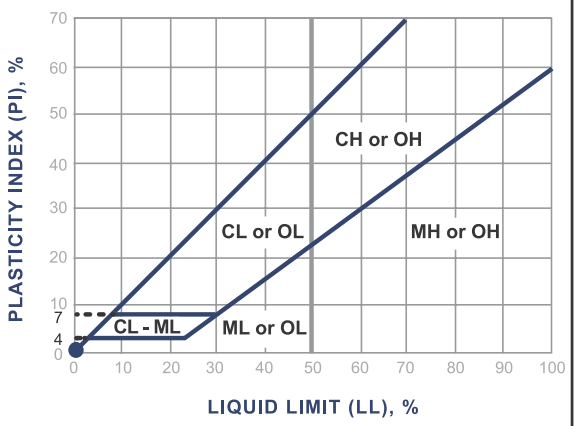
Soil Classification Chart Per ASTM D 2488

Primary Divisions			Secondary Divisions	
			Group Symbol	Group Name
COARSE-GRAINED SOILS more than 50% retained on No. 4 sieve	**GRAVEL** more than 50% of coarse fraction retained on No. 4 sieve	CLEAN GRAVEL less than 5% fines	GW	well-graded GRAVEL
			GP	poorly graded GRAVEL
		GRAVEL with DUAL CLASSIFICATIONS 5% to 12% fines	GW-GM	well-graded GRAVEL with silt
			GP-GM	poorly graded GRAVEL with silt
			GW-GC	well-graded GRAVEL with clay
			GP-GC	poorly graded GRAVEL with
		GRAVEL with FINES more than 12% fines	GM	silty GRAVEL
			GC	clayey GRAVEL
			GC-GM	silty, clayey GRAVEL
	SAND 50% or more of coarse fraction passes No. 4 sieve	CLEAN SAND less than 5% fines	SW	well-graded SAND
			SP	poorly graded SAND
		SAND with DUAL CLASSIFICATIONS 5% to 12% fines	SW-SM	well-graded SAND with silt
			SP-SM	poorly graded SAND with silt
			SW-SC	well-graded SAND with clay
			SP-SC	poorly graded SAND with clay
		SAND with FINES more than 12% fines	SM	silty SAND
			SC	clayey SAND
			SC-SM	silty, clayey SAND
FINE-GRAINED SOILS 50% or more passes No. 200 sieve	**SILT and CLAY** liquid limit less than 50%	INORGANIC	CL	lean CLAY
			ML	SILT
			CL-ML	silty CLAY
		ORGANIC	OL (PI > 4)	organic CLAY
			OL (PI < 4)	organic SILT
	SILT and CLAY liquid limit 50% or more	INORGANIC	CH	fat CLAY
			MH	elastic SILT
		ORGANIC	OH (plots on or above "A"-line)	organic CLAY
			OH (plots below "A"-line)	organic SILT
	Highly Organic Soils		PT	Peat

Grain Size

Description		Sieve Size	Grain Size	Approximate Size
Boulders		> 12"	> 12"	Larger than basketball-sized
Cobbles		3 - 12"	3 - 12"	Fist-sized to basketball-sized
Gravel	Coarse	3/4 - 3"	3/4 - 3"	Thumb-sized to fist-sized
	Fine	#4 - 3/4"	0.19 - 0.75"	Pea-sized to thumb-sized
Sand	Coarse	#10 - #4	0.079 - 0.19"	Rock-salt-sized to pea-sized
	Medium	#40 - #10	0.017 - 0.079"	Sugar-sized to rock-salt-sized
	Fine	#200 - #40	0.0029 - 0.017"	Flour-sized to sugar-sized
Fines		Passing #200	< 0.0029"	Flour-sized and smaller

Plasticity Chart



Apparent Density - Coarse-Grained Soil

Apparent Density	Spooling Cable or Cathead		Automatic Trip Hammer	
	SPT (blows/foot)	Modified Split Barrel (blows/foot)	SPT (blows/foot)	Modified Split Barrel (blows/foot)
Very Loose	≤ 4	≤ 8	≤ 3	≤ 5
Loose	5 - 10	9 - 21	4 - 7	6 - 14
Medium Dense	11 - 30	22 - 63	8 - 20	15 - 42
Dense	31 - 50	64 - 105	21 - 33	43 - 70
Very Dense	> 50	> 105	> 33	> 70

Consistency - Fine-Grained Soil

Consis-tency	Spooling Cable or Cathead		Automatic Trip Hammer	
	SPT (blows/foot)	Modified Split Barrel (blows/foot)	SPT (blows/foot)	Modified Split Barrel (blows/foot)
Very Soft	< 2	< 3	< 1	< 2
Soft	2 - 4	3 - 5	1 - 3	2 - 3
Firm	5 - 8	6 - 10	4 - 5	4 - 6
Stiff	9 - 15	11 - 20	6 - 10	7 - 13
Very Stiff	16 - 30	21 - 39	11 - 20	14 - 26
Hard	> 30	> 39	> 20	> 26

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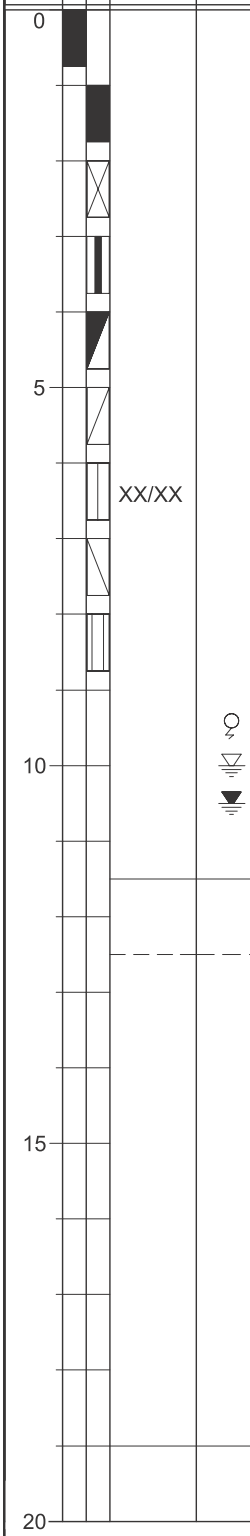
USCS METHOD OF SOIL CLASSIFICATION

BORING LOG EXPLANATION SHEET



Bulk sample.

Modified split-barrel drive sampler.

No recovery with modified split-barrel drive sampler.

Sample retained by others.

Standard Penetration Test (SPT).

No recovery with a SPT.

Shelby tube sample. Distance pushed in inches/length of sample recovered in inches.

No recovery with Shelby tube sampler.

Continuous Push Sample.

Seepage.

Groundwater encountered during drilling.

Groundwater measured after drilling.

SM

MAJOR MATERIAL TYPE (SOIL):
Solid line denotes unit change.

CL

Dashed line denotes material change.

Attitudes: Strike/Dip
b: Bedding
c: Contact
j: Joint
f: Fracture
F: Fault
cs: Clay Seam
s: Shear
bss: Basal Slide Surface
sf: Shear Fracture
sz: Shear Zone
sbs: Shear Bedding Surface

The total depth line is a solid line that is drawn at the bottom of the boring.

DATE DRILLED 4/5/22 BORING NO. B-1

GROUND ELEVATION 969' ± (MSL) SHEET 1 OF 1

METHOD OF DRILLING CME-75, 8" Diameter Hollow-Stem Auger (Wildcat)

DRIVE WEIGHT 140 lbs. (Automatic Trip Hammer) DROP 30"

SAMPLED BY DM LOGGED BY DM REVIEWED BY SDN

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0						SC	ALLUVIUM: Brown, dry, medium dense, clayey SAND; trace gravel.
		18	6.1	100.9			
		58					Very dense; few fine to coarse gravel.
5						CH	Brown, dry, hard, sandy fat CLAY; trace gravel.
		55	7.3	108.7			
		24					
10							Total Depth = 10 feet. Groundwater not encountered during drilling. Backfilled on 4/5/22 shortly after completion of drilling. Notes: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report. The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.
15							
20							

DATE DRILLED 4/5/22 BORING NO. B-2

GROUND ELEVATION 967' ± (MSL) SHEET 1 OF 1

METHOD OF DRILLING CME-75, 8" Diameter Hollow-Stem Auger (Wildcat)

DRIVE WEIGHT 140 lbs. (Automatic Trip Hammer) DROP 30"

SAMPLED BY DM LOGGED BY DM REVIEWED BY SDN

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0						SC	ALLUVIUM: Brown, dry, medium dense, clayey SAND; trace fine gravel.
		11					
						CH	Brown, dry, very stiff, sandy fat CLAY; trace gravel.
		23	6.1	113.7			Scattered caliche nodules.
5							
		24					Hard.
		24					Very stiff; few fine to coarse gravel.
10							Total Depth = 10 feet. Groundwater not encountered during drilling. Backfilled on 4/5/22 shortly after completion of drilling.
							Notes: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report. The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.
15							
20							

DATE DRILLED 4/5/22 BORING NO. B-3

GROUND ELEVATION 965' ± (MSL) SHEET 1 OF 1

METHOD OF DRILLING CME-75, 8" Diameter Hollow-Stem Auger (Wildcat)

DRIVE WEIGHT 140 lbs. (Automatic Trip Hammer) DROP 30"

SAMPLED BY DM LOGGED BY DM REVIEWED BY SDN

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0						SC	FILL: Brown, dry, loose, clayey SAND; trace fine gravel.
		14	8.0	109.5			
		9					Medium dense.
5						CH	ALLUVIUM: Brown, dry, very stiff, sandy fat CLAY; trace gravel.
		20	9.8	109.6			
		15					Scattered caliche nodules.
10							Total Depth = 10 feet. Groundwater not encountered during drilling. Backfilled on 4/5/22 shortly after completion of drilling. Notes: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report. The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.
15							
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DATE DRILLED 4/5/22 BORING NO. B-4

GROUND ELEVATION 964' ± (MSL) SHEET 1 OF 1

METHOD OF DRILLING CME-75, 8" Diameter Hollow-Stem Auger (Wildcat)

DRIVE WEIGHT 140 lbs. (Automatic Trip Hammer) DROP 30"

SAMPLED BY DM LOGGED BY DM REVIEWED BY SDN

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0						CL	ALLUVIUM: Brown, dry, very stiff, sandy lean CLAY; trace gravel.
		11					
		28	10.4	103.8			Hard.
5						CH	Brown, dry, very stiff, sandy fat CLAY; trace fine gravel.
		18					
		34	12.9	106.7			
10							Total Depth = 10 feet. Groundwater not encountered during drilling. Backfilled on 4/5/22 shortly after completion of drilling.
							Notes: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.
							The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.
15							
20							

DATE DRILLED 4/5/22 BORING NO. B-5

GROUND ELEVATION 962' ± (MSL) SHEET 1 OF 1

METHOD OF DRILLING CME-75, 8" Diameter Hollow-Stem Auger (Wildcat)

DRIVE WEIGHT 140 lbs. (Automatic Trip Hammer) DROP 30"

SAMPLED BY DM LOGGED BY DM REVIEWED BY SDN

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0						CL	ALLUVIUM: Brown, dry, very stiff, sandy lean CLAY; trace gravel.
		21	7.9	113.6			
		15					
5							
		49	13.2	108.0			Hard.
		24					Scattered caliche nodules.
10							Total Depth = 10 feet. Groundwater not encountered during drilling. Backfilled on 4/5/22 shortly after completion of drilling. Notes: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report. The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.
15							
20							

DATE DRILLED 4/5/22 BORING NO. B-6

GROUND ELEVATION 960' ± (MSL) SHEET 1 OF 1

METHOD OF DRILLING CME-75, 8" Diameter Hollow-Stem Auger (Wildcat)

DRIVE WEIGHT 140 lbs. (Automatic Trip Hammer) DROP 30"

SAMPLED BY DM LOGGED BY DM REVIEWED BY SDN

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0						CL	ALLUVIUM: Brown, dry, very stiff, sandy lean CLAY; trace gravel.
		14					
		34	14.3	101.6			Hard.
5							
		23					
		20	11.8	96.7			Very stiff.
10							Total Depth = 10 feet. Groundwater not encountered during drilling. Backfilled on 4/5/22 shortly after completion of drilling. Notes: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report. The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.
15							
20							

DATE DRILLED 4/5/22 BORING NO. B-7

GROUND ELEVATION 959' ± (MSL) SHEET 1 OF 1

METHOD OF DRILLING CME-75, 8" Diameter Hollow-Stem Auger (Wildcat)

DRIVE WEIGHT 140 lbs. (Automatic Trip Hammer) DROP 30"

SAMPLED BY DM LOGGED BY DM REVIEWED BY SDN

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0						SC	FILL: Brown, dry, loose, clayey SAND; trace fine gravel.
	Driven	13	3.7	114.6			
	Driven	7				CL	Brown, dry, stiff, sandy lean CLAY; trace gravel; scattered caliche nodules.
5						CL	ALLUVIUM: Brown, dry, very stiff, sandy lean CLAY; trace gravel.
	Driven	23	14.0	94.8			
	Driven	15					Scattered caliche nodules.
10							Total Depth = 10 feet. Groundwater not encountered during drilling. Backfilled on 4/5/22 shortly after completion of drilling. Notes: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report. The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.
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DATE DRILLED 4/5/22 BORING NO. B-8

GROUND ELEVATION 957' ± (MSL) SHEET 1 OF 1

METHOD OF DRILLING CME-75, 8" Diameter Hollow-Stem Auger (Wildcat)

DRIVE WEIGHT 140 lbs. (Automatic Trip Hammer) DROP 30"

SAMPLED BY DM LOGGED BY DM REVIEWED BY SDN

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0						SC	FILL: Brown, dry, medium dense, clayey SAND; few gravel.
		12					No recovery.
		40					No recovery.
5						SC	ALLUVIUM: Brown, dry to moist, medium dense, clayey SAND; trace gravel.
		10					
		39	14.0	92.3			Scattered caliche nodules.
10							Total Depth = 10 feet. Groundwater not encountered during drilling. Backfilled on 4/5/22 shortly after completion of drilling. Notes: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report. The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.
15							
20							

DATE DRILLED 4/5/22 BORING NO. B-9

GROUND ELEVATION 956' ± (MSL) SHEET 1 OF 1

METHOD OF DRILLING CME-75, 8" Diameter Hollow-Stem Auger (Wildcat)

DRIVE WEIGHT 140 lbs. (Automatic Trip Hammer) DROP 30"

SAMPLED BY DM LOGGED BY DM REVIEWED BY SDN

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0						SC	FILL: Brown, dry, loose, clayey SAND; trace fine gravel.
	Driven	12	9.4	102.8			
	Driven	13					Medium dense.
5						SC	ALLUVIUM: Brown, dry, medium dense, clayey SAND; scattered caliche nodules.
	Driven	36	8.7	110.9			
	Driven	25					Dense.
10							Total Depth = 10 feet. Groundwater not encountered during drilling. Backfilled on 4/5/22 shortly after completion of drilling. Notes: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report. The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.
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APPENDIX B

Laboratory Testing

APPENDIX B

LABORATORY TESTING

Classification
Soils were visually and texturally classified in accordance with the Unified Soil Classification System (USCS) in general accordance with ASTM D2488. Soil classifications are indicated on the logs of the exploratory borings in Appendix A.

In-Place Moisture and Density Tests
The moisture content and dry density of relatively undisturbed samples obtained from the explorations were evaluated in general accordance with ASTM D2937. The test results are presented on the logs of the explorations in Appendix A.

Gradation Analysis
Gradation analysis tests were performed on selected representative soil samples in general accordance with ASTM D422. The grain-size distribution curves are shown on Figures B-1 through B-6. These test results were utilized in evaluating the soil classifications in accordance with the USCS.

Atterberg Limits
Tests were performed on selected representative fine-grained soil samples to evaluate the liquid limit, plastic limit, and plasticity index in general accordance with ASTM D4318. These test results were utilized to evaluate the soil classification in accordance with the USCS. The test results and classifications are shown on Figure B-7.

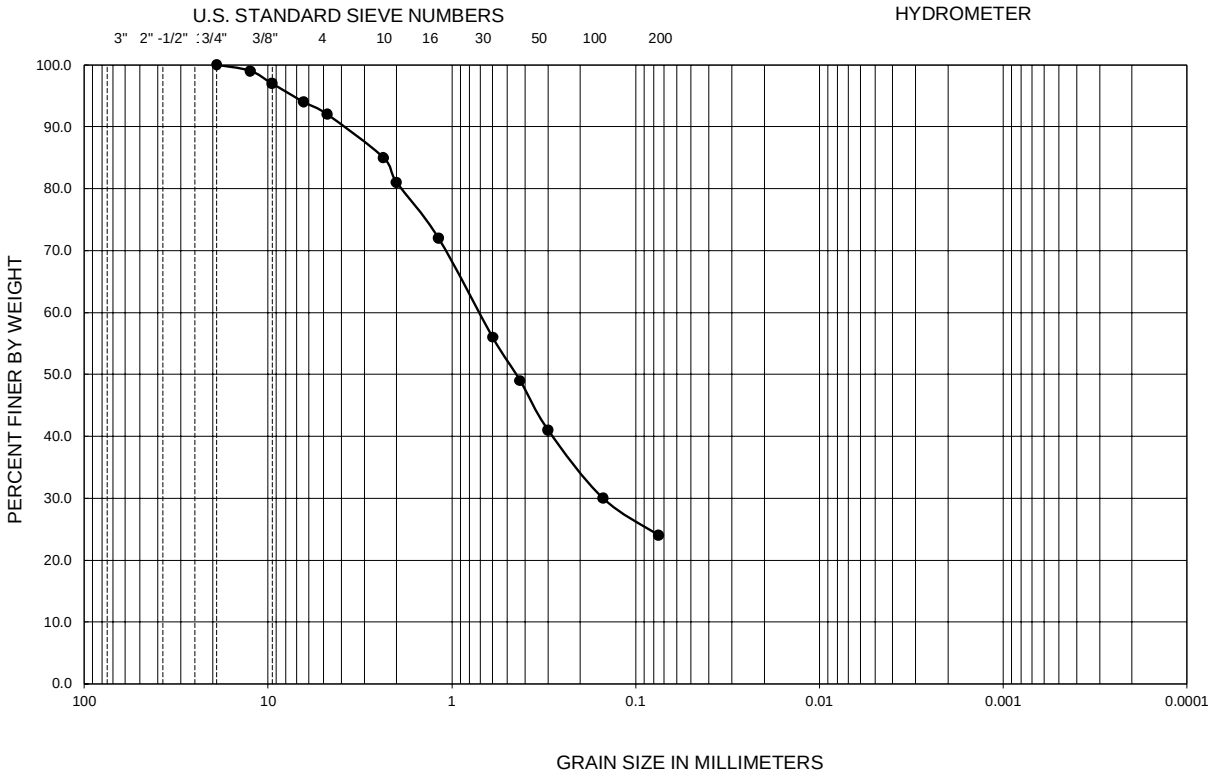
Proctor Density Tests
The maximum dry density and optimum moisture content of selected representative soil samples were evaluated using the Standard Proctor method in general accordance with ASTM D 698. The results of these tests are summarized on Figure B-8.

Consolidation Tests (response-to-wetting)
Consolidation tests were performed in general accordance with ASTM D4546 on relatively undisturbed soil samples. The samples were inundated during testing at approximate overburden pressures to represent adverse field conditions. The percent of consolidation was recorded as a ratio of the amount of vertical compression to the original height of the sample. The results of the tests are summarized on Figures B-9 through B-11.

Swell Potential Tests
The swell potential of selected materials was evaluated in general accordance with ASTM D4546, Method B. Relatively undisturbed specimens were loaded with a specified surcharge before inundation with tap water. Readings of volumetric swell were recorded until completion of primary swell. The results of the tests are presented on Figure B-12.

Soil Corrosivity Tests
Soil pH and minimum resistivity tests were performed on a representative sample in general accordance with Arizona Test 236C. The chloride content of the selected sample was evaluated in general accordance with Arizona Test 736. The sulfate content of the selected sample was evaluated in general accordance with Arizona Test 733. The test results are presented on Figure B-13.

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY



Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (percent)	USCS
●	B-3	3.5-5.0	28	18	10	--	0.150	0.70	--	--	24.0	SC

PERFORMED IN GENERAL ACCORDANCE WITH ASTM C136 / D422

FIGURE B-1

GRADATION TEST RESULTS

REACH LINE CONNECTION

BUCKEYE, ARIZONA

Ninyo & Moore

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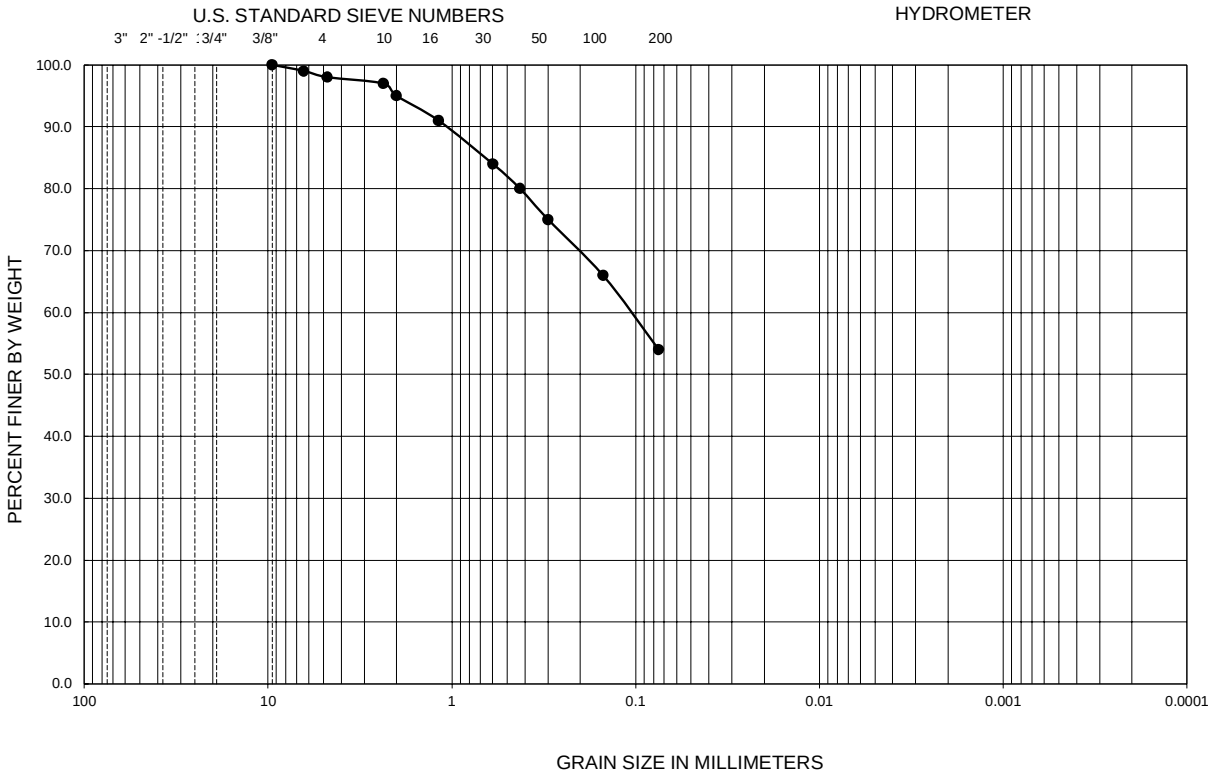
GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY



Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (percent)	USCS
●	B-4	6.0-7.5	51	28	23	--	--	0.11	--	--	54.0	CH

PERFORMED IN GENERAL ACCORDANCE WITH ASTM C136 / D422

FIGURE B-2

GRADATION TEST RESULTS

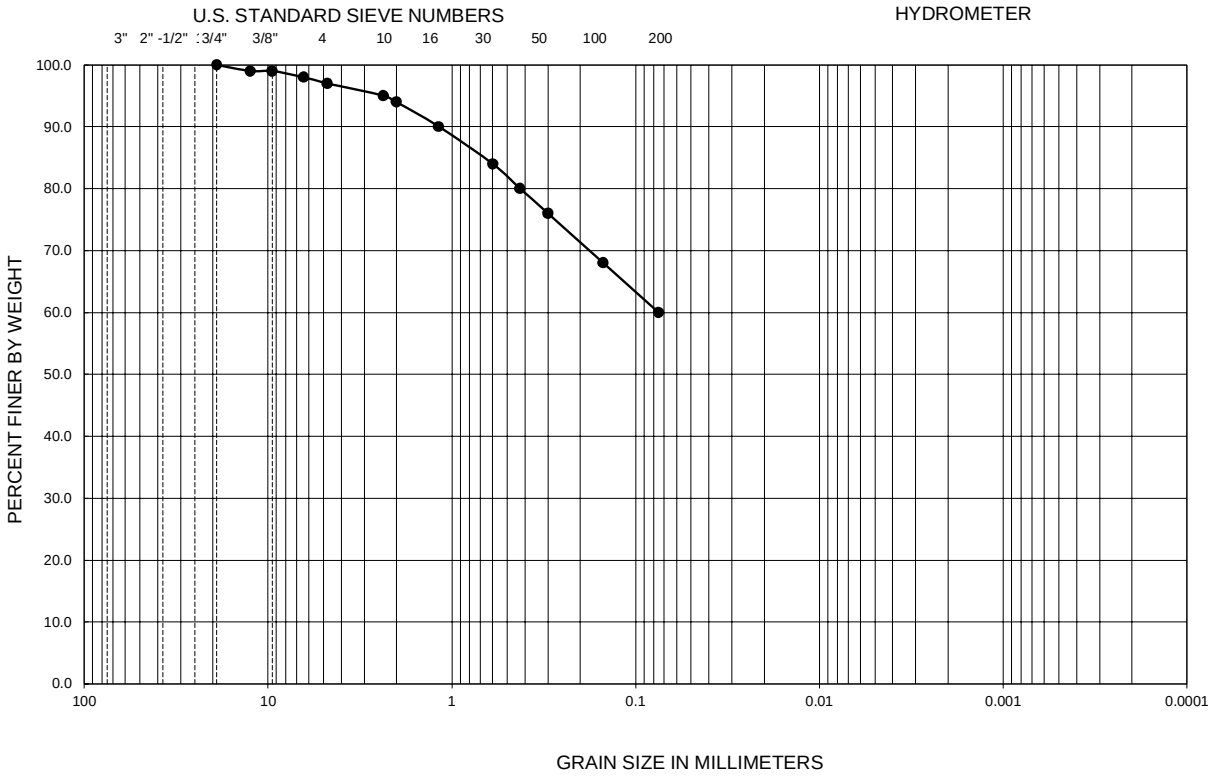
REACH LINE CONNECTION

BUCKEYE, ARIZONA

Ninyo & Moore

Geotechnical & Environmental Sciences Consultants

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY



Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (percent)	USCS
●	B-6	1.0-2.5	39	22	17	--	--	0.07	--	--	60.0	CL

PERFORMED IN GENERAL ACCORDANCE WITH ASTM C136 / D422

FIGURE B-3

GRADATION TEST RESULTS

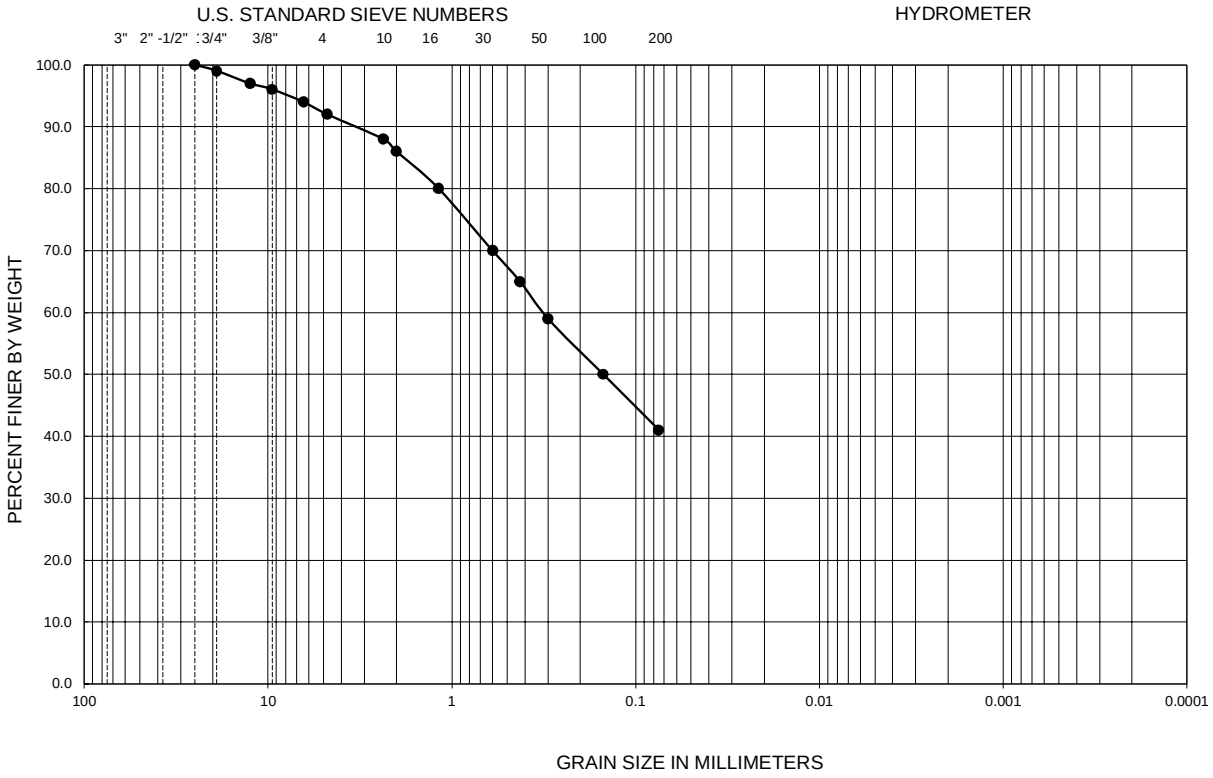
REACH LINE CONNECTION

BUCKEYE, ARIZONA

Ninyo & Moore

Geotechnical & Environmental Sciences Consultants

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY



Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (percent)	USCS
●	B-8	0.0-5.0	28	17	11	--	--	0.32	--	--	41.0	SC

PERFORMED IN GENERAL ACCORDANCE WITH ASTM C136 / D422

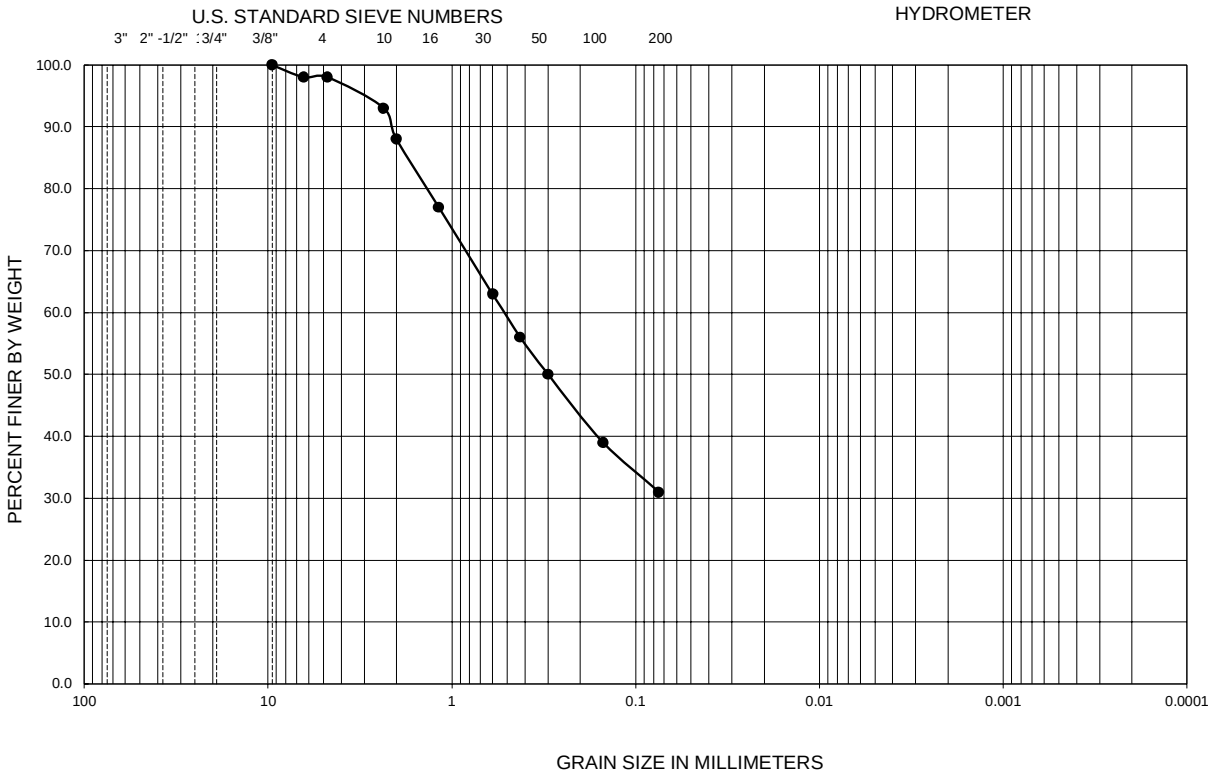
FIGURE B-4

GRADATION TEST RESULTS

REACH LINE CONNECTION

BUCKEYE, ARIZONA

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY



Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (percent)	USCS
●	B-9	3.5-5.0	46	22	24	--	--	0.51	--	--	31.0	SC

PERFORMED IN GENERAL ACCORDANCE WITH ASTM C136 / D422

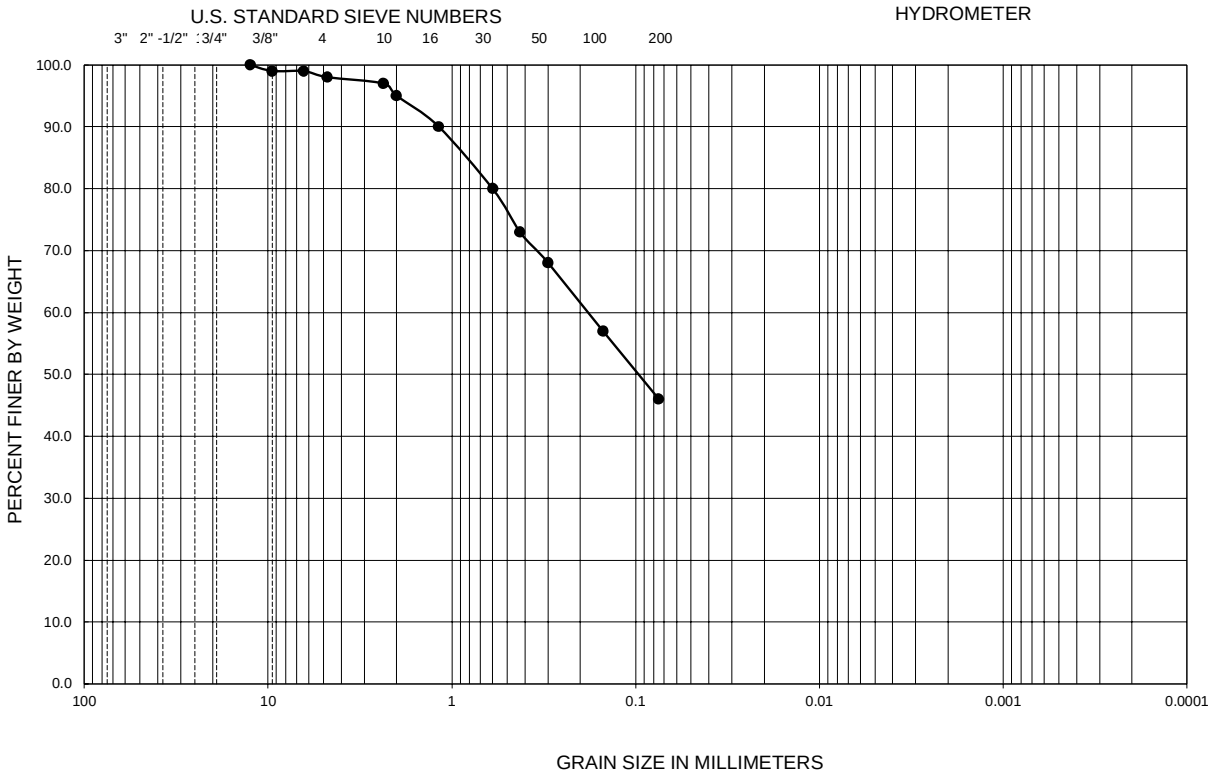
FIGURE B-5

GRADATION TEST RESULTS

REACH LINE CONNECTION

BUCKEYE, ARIZONA

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY



Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (percent)	USCS
●	B-9	8.5-10.0	35	19	16	--	--	0.18	--	--	46.0	SC

PERFORMED IN GENERAL ACCORDANCE WITH ASTM C136 / D422

FIGURE B-6

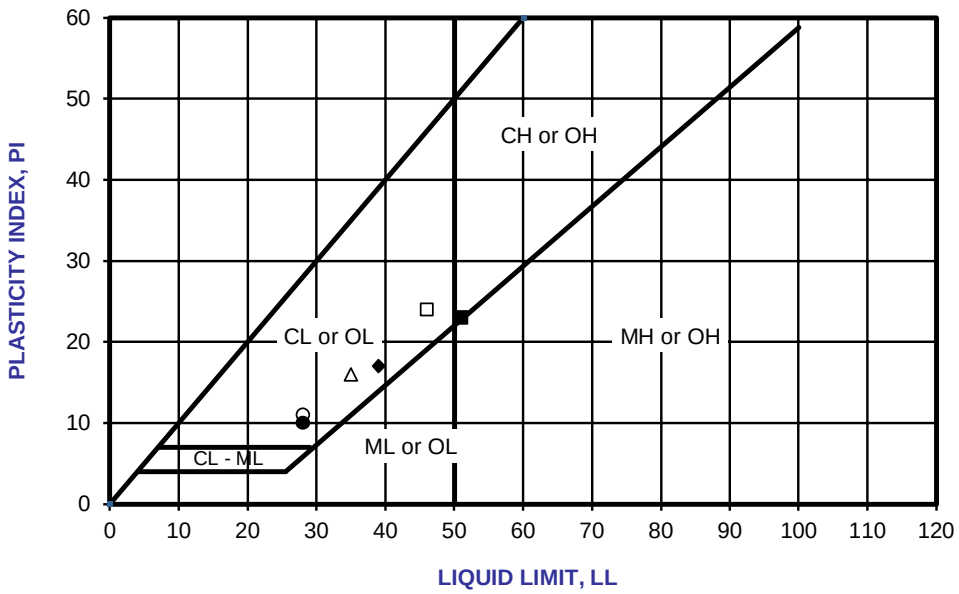
GRADATION TEST RESULTS

REACH LINE CONNECTION

BUCKEYE, ARIZONA

SYMBOL	LOCATION	DEPTH (ft)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	USCS CLASSIFICATION (Fraction Finer Than No. 40 Sieve)	USCS
●	B-3	3.5-5.0	28	18	10	CL	SC
■	B-4	6.0-7.5	51	28	23	CH	CH
◆	B-6	1.0-2.5	39	22	17	CL	CL
○	B-8	0.0-5.0	28	17	11	CL	SC
□	B-9	3.5-5.0	46	22	24	CL	SC
△	B-9	8.5-10.0	35	19	16	CL	SC

NP - INDICATES NON-PLASTIC



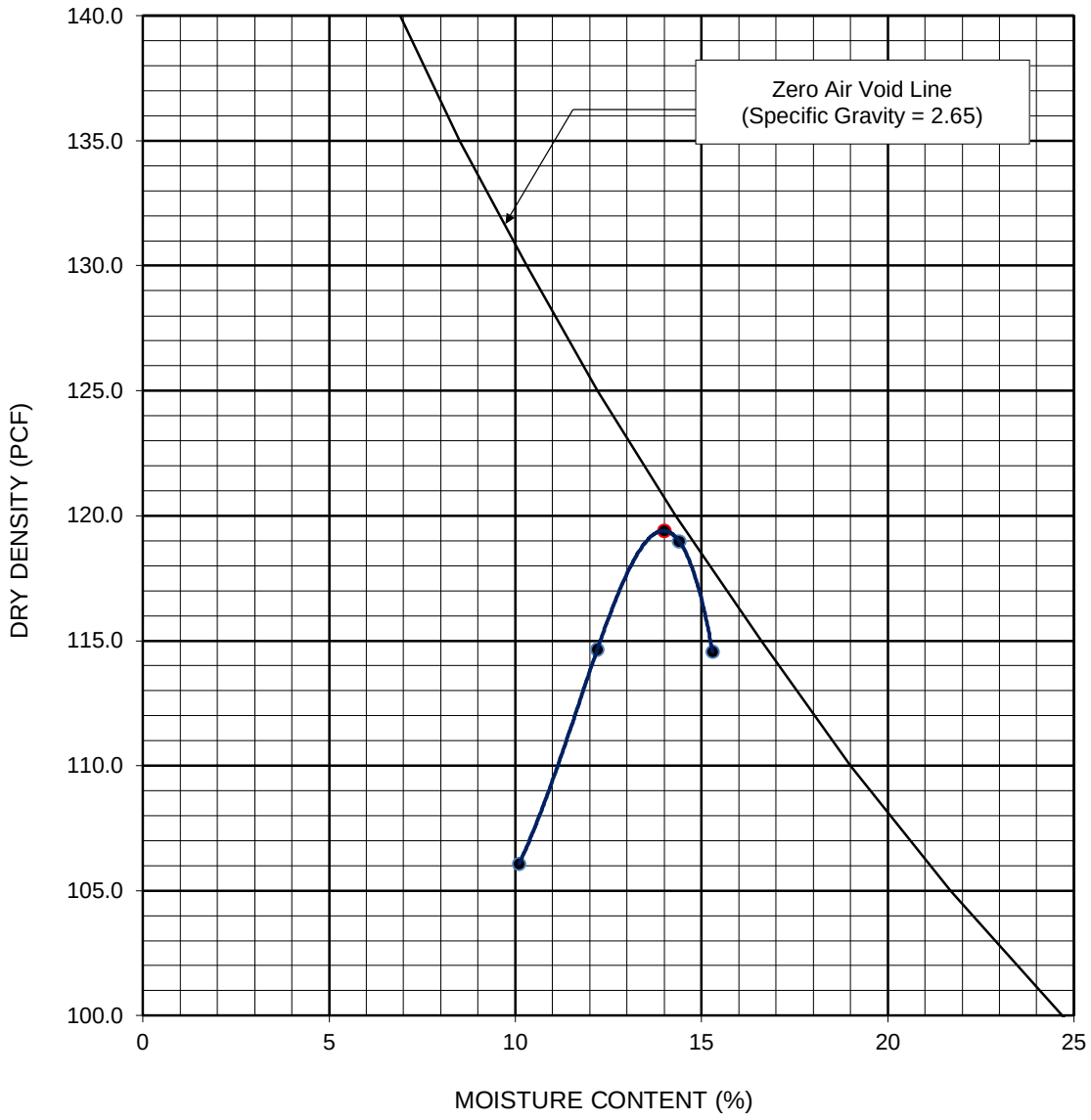
PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 4318

FIGURE B-7

ATTERBERG TEST RESULTS

REACH LINE CONNECTION

BUCKEYE, ARIZONA



Sample Location	Depth (ft)	Soil Description	Maximum Dry Density (pcf)	Optimum Moisture Content (percent)
B-6	0.0-5.0	CL	119.4	14.0
Dry Density and Moisture Content Values Corrected for Oversize (ASTM D 4718)			N/A	N/A

PERFORMED IN GENERAL ACCORDANCE WITH ☐ ASTM D 1557 ☑ ASTM D 698 METHOD ☑ A ☐ B ☐ C

FIGURE B-8

MAXIMUM DENSITY RESULTS

REACH LINE CONNECTION

BUCKEYE, ARIZONA

607106001 | 6/22

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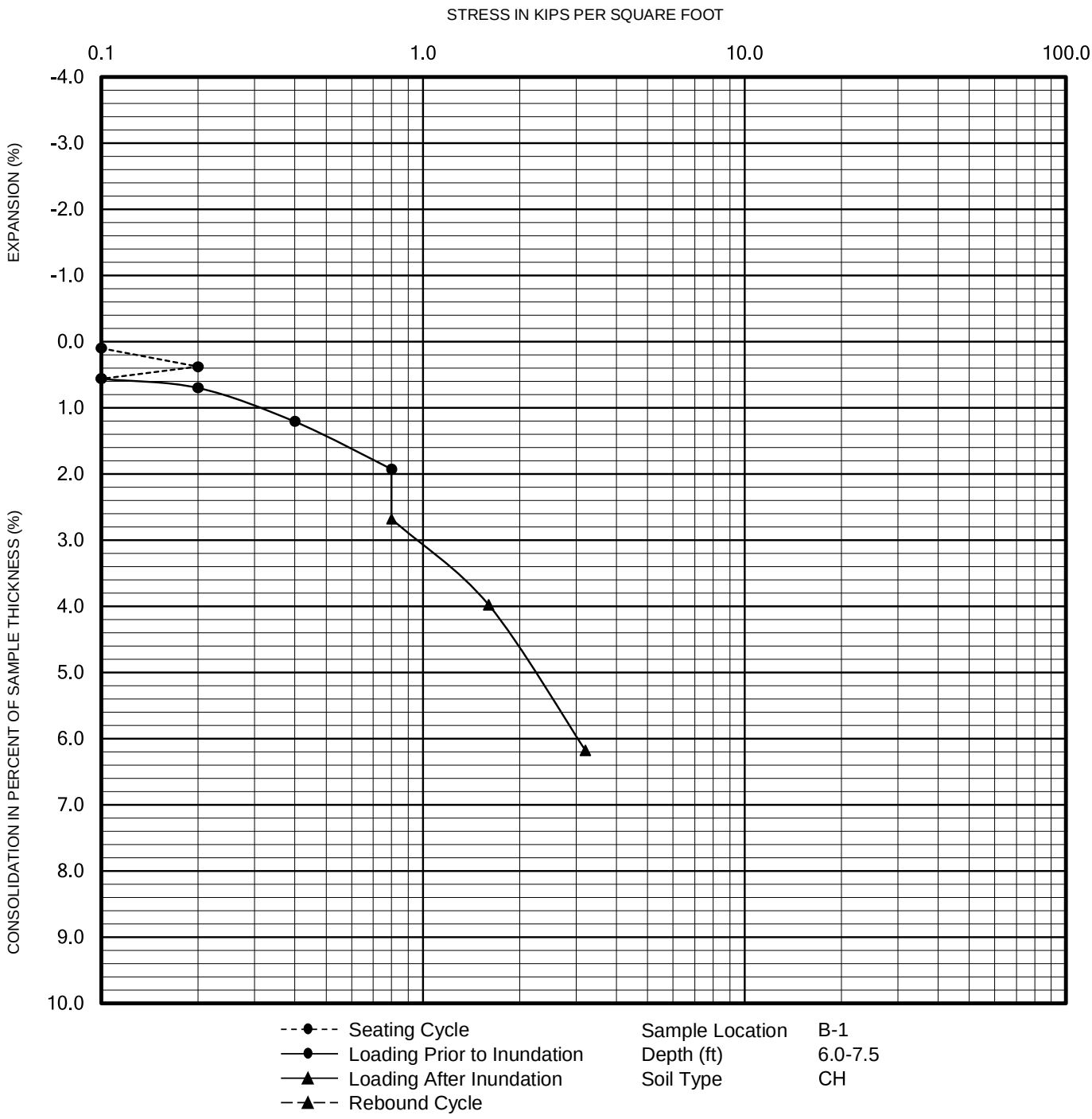

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 2435

FIGURE B-9

CONSOLIDATION TEST RESULTS

REACH LINE CONNECTION

BUCKEYE, ARIZONA

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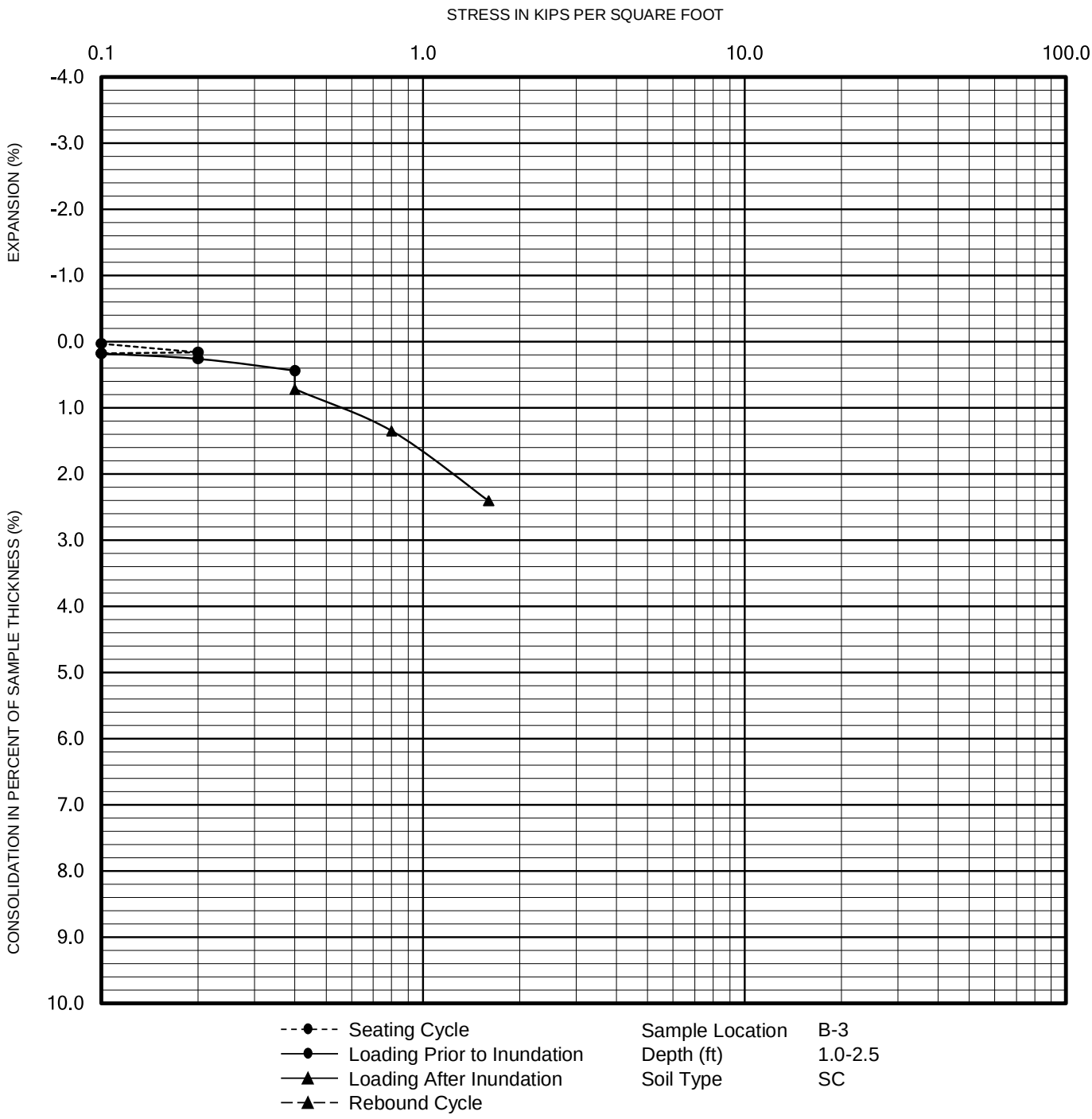

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 2435

FIGURE B-10

CONSOLIDATION TEST RESULTS

REACH LINE CONNECTION

BUCKEYE, ARIZONA

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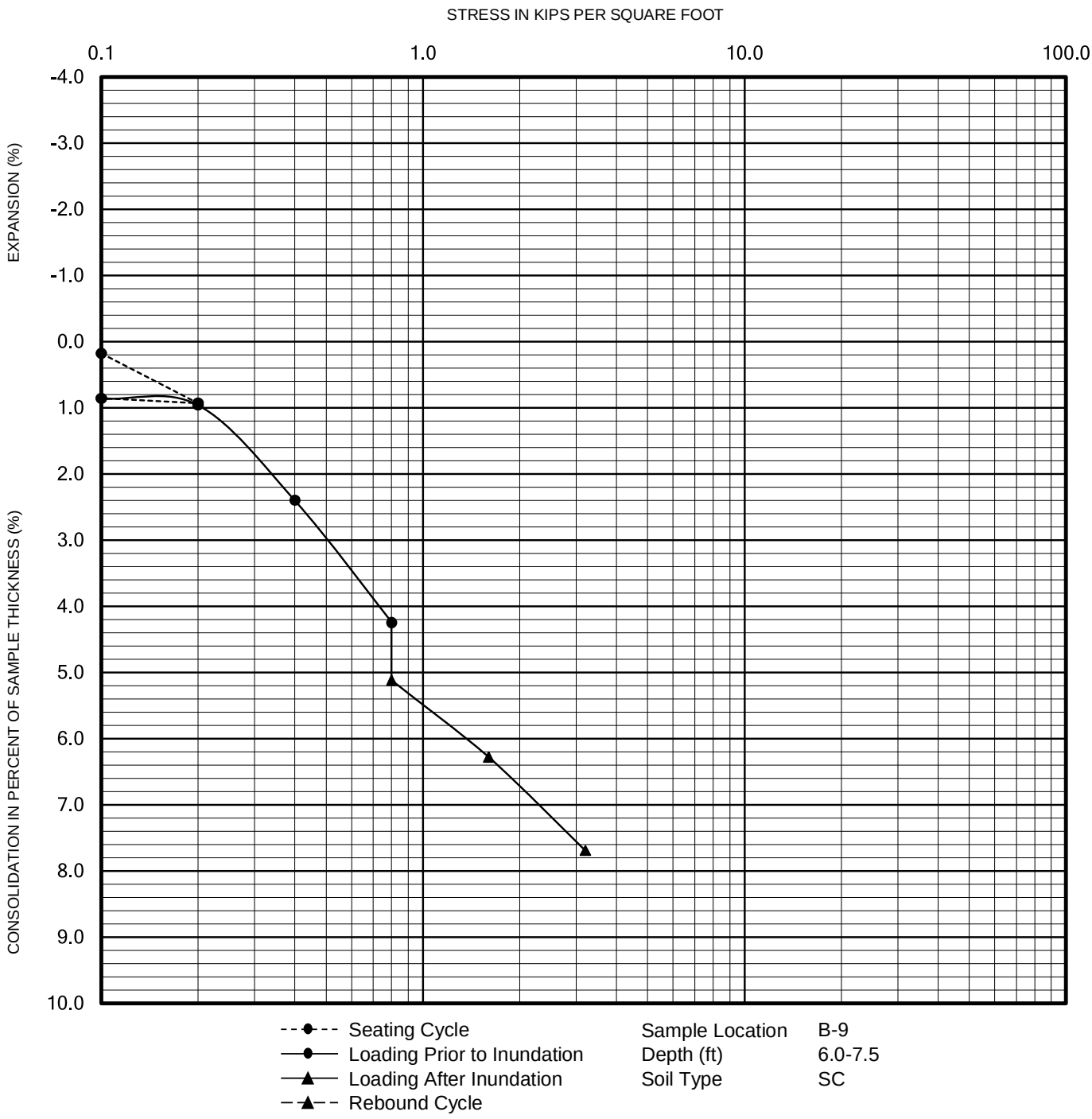

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 2435

FIGURE B-11

CONSOLIDATION TEST RESULTS

REACH LINE CONNECTION

BUCKEYE, ARIZONA

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SAMPLE LOCATION	SAMPLE DEPTH (ft)	U.S.C.S	SWELL (%)
B-6	0.0-5.0	CL	1.1

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 4546

SWELL TEST RESULTS

REACH LINE CONNECTION

BUCKEYE, ARIZONA

SAMPLE LOCATION	SAMPLE DEPTH (ft)	pH [1]	RESISTIVITY [1] (Ohm-cm)	SULFATE CONTENT [2] (ppm)	(%)	CHLORIDE CONTENT [3] (ppm)
B-2	0.0-5.0	7.7	308	453	0.045	1192
B-4	0.0-5.0	7.4	335	224	0.022	770
B-9	0.0-5.0	7.9	1,112	71	0.007	615

[1] PERFORMED IN GENERAL ACCORDANCE WITH ARIZONA TEST METHOD 236c
[2] PERFORMED IN GENERAL ACCORDANCE WITH ARIZONA TEST METHOD 733
[3] PERFORMED IN GENERAL ACCORDANCE WITH ARIZONA TEST METHOD 736

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