FINAL SPECIAL PROVISIONS

City of Flagstaff
Phoenix Avenue Waterline & Bridge Replacement

Prepared By:

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City of Flagstaff Project Number: WS3476/03-20008

INDEX TO THE SPECIAL PROVISIONS:

MAG UNIFORM STANDARD SPECIFICATIONS FOR PUBLIC WORKS CONSTRUCTION 2020 EDITION, CITY OF FLAGSTAFF REVISIONS OF MAG STANDARD SPECIFICATIONS FOR PUBLIC WORKS CONSTRUCTION AND CITY OF FLAGSTAFF ENGINEERING STANDARDS ARE HEREBY AMENDED TO INCLUDE THE FOLLOWING:

PART 100 - GENERAL CONDITIONS

SECTION 104: SCOPE OF WORK

104.1 WORK TO BE DONE:

104.1.1 GENERAL:

(Revise to include the following)

The City of Flagstaff Stormwater Section of the Water Services Division has identified the bridge culvert that conveys the Rio De Flag under Phoenix Ave (Structure No. 8709) is in need of replacement based on inspection by the ADOT Bridge Inspection Group. The inspection and an associated report identify the crossing is made up of three structural elements identified as the Beam, Bridge 1, and Bridge 2.

The two bridge sections which comprise the bridge culvert are owned by the City of Flagstaff and within the Phoenix Avenue Right-of-way. The identified Beam is under the wall of the Zani Store and is owned by the private property owner. The project's work is based around a mutually beneficial private-public partnership to repair/replace the deficient structures.

Existing 12" and 6" waterline mains in Phoenix Avenue between Mikes Pike and Beaver Street are being abandoned and replaced by a new 12" waterline which will cross below the Phoenix Avenue Bridge Culvert structure. The project work includes replacement/reconstruction of the structural system, new waterline construction, and associated roadway improvements. The work includes the following elements:

- New Bridge Culvert, per the structural design
- Reconstruction of the Zani Beam, per the structural design.
- New stormdrain pipes
- Coordination for relocation of franchise utilities
- New COF Fiber Optic conduits and Pull Boxes
- Waterline main replacement with associated water services
- Sewer manhole replacement
- New curbs
- New sidewalks
- Roadway asphalt paving

- Roadway mill and overlay
- Pavement Striping

The scope of work includes all material installation costs associated with construction of the items listed above.

Rio De Flag conveyance shall be maintained at all times during construction.

104.1.2 MAINTENANCE OF TRAFFIC:
(Revise to include the following)

The contractor shall furnish to the City a traffic control plan for the project that includes provisions for access to all adjacent private properties within the project area. The contractor may temporarily limit vehicular and pedestrian traffic to properties through advance written notice and coordination with the City's Project Representative and the property owners.

The Phoenix Avenue roadway and pedestrian facilities across the bridge culvert portion of the project area shall be shut down during the duration of the structural system replacement, including during non-working hours. This full-time shutdown area shall be limited to be from ten (10) feet east of the bridge eastern abutment wall to ten (10) feet west of the bridge western abutment wall. However, every effort must me be made to prioritize reopening of the Phoenix Avenue southern sidewalk for business access. Upon project award, the contractor shall provide the City a construction schedule and phasing plan which identifies the limits of the shutdown, the durations, and identifying the reopening time of the sidewalk. The contractor shall coordinate with the City the shutdown and re-opening schedule, including any phased or temporary re-openings. Temporary openings to the businesses may be required through the construction zone for deliveries and building maintenance.

The Contractor is responsible for securing the construction site and maintaining safe passage for pedestrian and bicycle traffic.

Special Access Requirements:

The Contractor shall maintain access to all side streets, access roads, and driveways at all times during their hours of operations. Access to all residential driveways shall be provided during all non-working hours. Where property has more than one driveway, no more than one access will be restricted or closed at one time. Should it be necessary to close access to private property or driveways, the closure must be for as short a time as possible and be restored at the end of the work shift.

Sanitation Pickup:

Trash pickup in and around the project area is scheduled every Tuesday and Wednesday. Recycle pickup in and around the project area is scheduled every Friday. When construction

activity interferes with pickup, the contractor shall provide for sanitation vehicle access to the affected properties or relocate the trash containers where access is acceptable. The Solid Waste Division of the Public Works Department contact is 213-2110.

Emergency Access:

Traffic control information shall be submitted to the City's Project Representative who will forward the information to the Fire Department and Police Department. All notices shall be submitted at least 72 hours in advance of the closures.

U.S. Postal Service Access:

The contractor shall be responsible for maintaining access for Postal Service within the project area at all times.

104.2.2 ALTERATION OF WORK:
(Revise to include the following)

During construction, should the footings of the existing, remaining culvert walls be uncovered or exposed, the contractor is to immediately notify the City Project Manager of the exposed condition and footing depth to allow the City to determine if further evaluation or construction is necessary to protect against scour.

SECTION 105: CONTROL OF WORK

105.2 PLANS AND SHOP DRAWINGS:
(Revise to include the following)

The Contractor shall be required to maintain an as-built "red-line" set of construction plans that fully describes work that deviated from the approved contract documents. The redline planset will be reviewed at each weekly meeting with the City's PM and the engineer to assure that all deviations from the plans are being noted. The redline planset needs to be legible and contain accurate information that will be used by the Contractor to prepare Record Drawings at the conclusion of the project. The redlines and Record Drawings will include at least the following information, and what is defined in the City of Flagstaff's most current As-Built Plans/Record Drawings Checklist:

- Ground surface elevations including channel flow lines and embankment edges
- Horizontal locations of channel flow lines and embankment edges
- Locations and elevations of headwalls
- Location and elevation of the bridge culvert inverts
- Size of the bride culvert, including any walls
- Location and elevations of the Zani Beam
- Dimensions of the Zani Beam
- Locations and elevations of the relocated or new utilities and appurtenances

- Inverts and horizontal locations of stormdrain pipes and their stubs
- Slope of the stormdrain pipes

The As-Built survey for the sealed Record Drawings shall include verifying all channel and structure locations and elevations in sufficient detail to verify conformance with the design drawings. The contractor shall submit the final As-Built/Record Drawing planset to the City's Project Manager at the conclusion of the project per the City of Flagstaff's most current As-Built Plans/Record Drawings Checklist and the City of Flagstaff Amendments to MAG Standard Specifications.

SECTION 107: LEGAL RELATIONS AND RESPONSIBILITY TO PUBLIC

107.2 PERMITS:
(Revise to include the following)

The contractor is responsible for acquiring a Public Improvement Permit, a Temporary Use Permit (for construction yard), and Floodplain Use Permit, but the City will cover all costs and will help with the permit paperwork. The contractor is responsible for obtaining a Floodplain Use Permit from the City of Flagstaff for work around, in, and over the Rio de Flag. The Floodplain Use Permit application will be prepared by Doug Slover, Stormwater Project Manager with the City's Water Services Division, and the contractor is to coordinate with him for filing for the permit.

107.9 PROTECTION AND RESTORATION OF PROPERTY AND LANDSCAPE:
(Revise to include the following)

Survey monuments and property corners shall be protected and not disturbed. All costs associated with protecting or re-establishing disturbed survey monuments and property corners shall be borne solely by the Contractor.

The Contractor is will have to propose a yard location.

107.9.1 EROSION PROTECTION AND SITE RESTORATION:
(revise to include the following)

The Contractor will be required prepare a Stormwater Polution Prevention Plan (SWPPP) manual and to submit a Notice of Intent (NOI), at the beginning of the project, and a Notice of Termination (NOT), at the end of the project, to be in compliance with the most current AZPDES General Permit. The Contractor shall use best management practices (BMP) in controlling stormwater runoff and shall install the SWPPP per the erosion control plans. A copy of the NOI and NOT shall be submitted to the City. All costs associated with the SWPPP manual, NOI, NOT and BMP's for stormwater runoff are the responsibility of the Contractor. The SWPPP will be paid as a lump sum.

107.11 CONTRACTOR'S RESPONSIBILITY FOR UTILITY PROPERTY AND SERVICE:
(Revise to include the following)

The Contractor shall protect existing water, sewer, gas, electric, fiber optic, telephone and cable service lines where the proposed work crosses individual service lines. Not all services lines are shown on the plans and it is the Contractor's responsibility to determine their location in the field. Protection or repair of existing service lines not in conflict with the work is considered incidental to the other work. In the event that there is a physical conflict between an existing service line and the proposed work, the Contractor shall immediately notify the City of the conflict. The City will make a determination as to how the conflict will be resolved. On City ROW projects, all City water and sewer issues are to go through the assigned Engineering Inspector, and they will coordinate with the City PM and/or Water Services (which now is both sewer and water).

Utility company contacts are listed below:

Arizona Public Service	Ryan Weisner	(928) 773-6414
CenturyLink	Manuel Hernandez	(928) 779-4935
SuddenLink	Sanford Yazzie	(928) 606-4521
Unisource	Martin Conboy	(928) 226-2269

SECTION 108: COMMENCEMENT, PROSECUTION AND PROGRESS

108.5 LIMITATIONS OF OPERATIONS:
(Revise to include the following)

Working hours shall be from 7 am – 5 pm. Rock excavation working hours shall be from 8 am – 5 pm.

PART 200 - EARTHWORK

SECTION 220: RIPRAP CONSTRUCTION

220.1 DESCRIPTION
The work for gabion riprap baskets shall consist of furnishing all materials, including filter or erosion control geosynthetic fabric, and anchoring stakes. The work shall be completed in accordance with the requirements ADOT Standard Specifications Section 913, 2008 edition, and these Special Provisions.

220.2 MATERIALS:
Standard specifications shall be revised to include the following for gabion baskets:

A) Metal Items:

At the contractor's option, either woven wire mesh or welded wire mesh (welded mesh) may be used. For each individual gabion, the same mesh style shall be used for the base, front, ends, back, diaphragms, and lid panels. Each gabion shall be divided into cells of equal length, no greater than 3 feet, by diaphragm panels.

Mesh: Individual wires of either mesh style (woven or welded) shall conform to the definitions and requirements of ASTM A641 for "carbon steel", zinc-coated wire. All zinc coated gabions shall conform to ASTM A975 Style 1 (zinc coated gabions) for woven gabions and ASTM A974 Style 1 for welded gabions, and shall meet the following requirements:

Characteristic	**Test Designation**	**Requirement**
Minimum Tensile Strength	ASTM A370	60,000 psi
Zinc Coating	ASTM A641	Class 3
Wire Size (Minimum) Wire Diameter (Minimum) Galvanizing	USA Steel Wire Gage ASTM A641 ASTM A641, Table 3 ASTM A641, Table 1 And ASTM A90	11 0.120 inch 0.116 inch 0.85 oz/sf
Wire Size (Minimum) Wire Diameter (Minimum) Galvanizing	USA Steel Wire Gage ASTM A641 ASTM A641, Table 3 ASTM A641, Table 1 And ASTM A90	9 0.148 inch 0.144 inch 0.90 oz/sf

Twisted-mesh wires shall form a uniform hexagonal pattern and shall be formed with a non-raveling twist. The area of hexagonal opening shall not exceed 3-1/4 inch. Twisted-mesh gabion panels shall be manufactured from 11-gage wires with 9-gage selvage wires.

Welded-mesh wires shall form a grid pattern. Welds shall be made by resistance welding. Welds and panels shall conform to ASTM A185, "Steel Welded Wire Fabric –Plain for Concrete," except weld shears shall be 600 pounds force for 11-gage wires and 800 pounds force for 9-gage wires.

Joints: Wires used to form joints shall conform to the definitions and requirements of ASTM A641 for "carbon steel", zinc-coated wire and shall meet the following requirements:

Characteristic	Test Designation	Requirement
Minimum Tensile Strength	ASTM A370	60,000 psi
Zinc Coating	ASTM A641	Class 3
Tie Wire Wire Size (Minimum) Wire Diameter (Minimum) Galvanizing	 USA Steel Wire Gage ASTM A641 ASTM A641, Table 3 ASTM A641, Table 1 And ASTM A90	 13.5 0.086 inch 0.083 inch 0.70 oz/sf
Spirals Wire Size (Minimum) Wire Diameter (Minimum) Galvanizing	 USA Steel Wire Gage ASTM A641 ASTM A641, Table 3 ASTM A641, Table 1 And ASTM A90	 9 0.148 inch 0.144 inch 0.90 oz/sf

Spiral binders shall have a 3-inch separation between continuous, successive loops. Overlapping fasteners (rings) may be used in lieu of, or to complement, lacing wire for basket assembly and installation. The spacing of the fasteners during all phases of assembly and installation shall be in accordance with spacing based pull apart resistance of 1,400 lb/ft for galvanized mesh when tested in accordance with ASTM A975 section 13.1.2, with a nominal spacing of 4 in., and not to exceed 6 in.

- Galvanized Fasteners: Diameter = 0.120 in. (3.05mm), according to ASTM A313/A313M-98, Type 302, Class I.
- Tensile Strength: 230,000 to 273,000 psi (1586-1882 MPa) in accordance with ASTM A764-95(2001).
- Proper Installation of Rings: A properly formed ring fastener shall have a nominal overlap of one (1) in. after closure.

Any internal cross tie connecting wires or preformed stiffeners shall be at least 13.5-gage. Each wire shall also meet the minimum requirements of the wire in this specification.

The contractor shall request acceptance of alternative fasteners. Alternative fasteners for woven and welded gabions must be tested in accordance with ASTM A975 Table 2 panel to panel connection. Contractor shall provide a copy of the tests made by a recognized laboratory 15 days prior to construction of gabions. The contractor's request shall describe how and where the proposed alternative fasteners will be used.

Random samples of alternative fasteners shall be submitted for testing at least 15 calendar days prior to construction of gabions. The contractor shall submit 12 formed and 12

unformed alternative fasteners. Formation of the 12 formed alternative fasteners shall be done at the job site by the contractor and shall be witnessed by the Engineer.

Gabions which have been constructed with unacceptable alternative fasteners shall be removed or reconstructed at no additional cost to the City at the discretion of the Engineer.

Certificates of Compliance conforming to the requirements of Subsection 106.05 of the ADOT Standard Specifications shall be submitted.

B) Soil Anchor Stakes:

Soil anchor stakes shall meet the requirements of Subsection 913-2.02 (F) of the ADOT Standard Specifications.

C) Gabion Baskets:

Gabion baskets are wire baskets that are filled on-site with hard, durable rock. A single gabion can be made of square or rectangular panels.

Acceptable individual gabion basket nominal dimensions of width, height, and length are as follows, and shall not vary more than 5 percent from the dimensions listed in these special provisions:

- Width = 3 feet
- Height = 1.5 feet
- Length = 9 feet and 12 feet

Woven wire baskets shall consist of a uniform hexagonal wire mesh woven in double twist pattern with openings of approximately 2-1/2 inches by 3-1/4 inches, fabricated in such a manner as to be non-raveling, and designed to provide the required flexibility and strength.

Welded wire baskets shall consist of wire spaced at 3 inches center to center.

Empty gabion baskets shall be manufactured individually, in the factory with base, front, ends, back, and diaphragms all connected together on one side minimum, lids may be assembled on the site. Gabion baskets shall be assembled such that the strength and flexibility along the joints are in accordance with ASTM A975 (woven gabion) and A974 (welded gabion) panels to panels connection.

D) Bedding Material:

Bedding material shall consist of granular material having a maximum dimension of two inches and shall be free of clay or organic material. The bedding material shall be compacted to 95%.

E) Filter Fabric:

Geotextile filter fabric shall meet the requirements of Subsection 913-2.05 of the ADOT Standard Specifications.

220.5 RIPRAP PLACEMENT:

Standard specifications shall be revised to include the following for gabion baskets:

A) General:

Areas on which the gabions are to be constructed shall be cleared, grubbed, and excavated or backfilled in accordance with the requirements of the appropriate sections of these Special Provisions and ADOT Specifications to produce a ground surface in reasonable conformance with the lines and grades shown on the plans or established by the Engineer.

B) Gabion Baskets:

The gabion bed shall be excavated to the width, line and grade as shown on the plans. The gabions shall be founded on this bed and laid to the lines and dimensions required. Excavation for toe shall be made to the neat lines of the toe.

Gabions shall be preassembled in the factory with sides, ends, and diaphragms all connected together, on side minimum where they can be assembled at the construction site into rectangular units of the specified sizes. Lids may be assembled on site. Gabions are to be of single unit construction; the base, ends and sides either to be woven into a single unit or one edge of these members connected to the base section of the unit.

Where the length of the gabion exceeds its horizontal width, the gabion is to be equally divided by diaphragms, of the same mesh and gauge as the body of the gabions, into cells whose length does not exceed the horizontal width. The gabion shall be furnished with the necessary diaphragms secured in proper position on the base section in such a manner that no additional tying at this juncture will be necessary. All perimeter edges of gabions are to be securely selvedged or bound so that the joints formed by tying the selvedges have the minimum connection strength.

Gabions shall be placed to conform to the specifications and dimensions shown on the project plans. Rock shall be placed in close contact in the unit so that maximum fill is obtained. The units may be filled by machine with sufficient handwork to accomplish requirements of this specification. Units shall be overfilled by 1.5 to 2 inches before closing the lid to compensate for settlement.

The exposed face or faces shall be hand-placed using selected rocks or prevent bulging or the gabion cell and to improve appearance.

Two connecting tie wires shall be placed between each lift in each cell. All connecting tie wires shall be looped around two mesh openings and the ends of the wires shall be securely

twisted to prevent loosening. Care shall be taken to protect the vertical panels and diaphragms from being bent during filling operations.

The last lift of stone in each cell shall be level with the top of the gabion in order to properly close the lid and provide an even surface for the next course.

All gabion units shall be tied together, each to its neighbor along all contacting edges in order to form a continuous connecting structure.

Empty gabions stacked on filled gabions shall be laced to the filled gabion at the front, side and back. Interlocking rings or overlapping rings may be used for assembly of individual gabions. There shall be a ring in each mesh opening along the joint in lieu of tie wire or spiral binders. The use of alternative joint fasteners shall be approved by the Engineer in writing.

C) Filter Fabric:

Filter fabric shall be placed on all areas to receive gabions, as shown on the project plans, prior to placement of the gabion. The surface to receive the filter fabric shall be free of obstructions, depressions, and debris. The fabric shall be loosely laid and not placed in a stretched condition.

The strips of filter fabric shall be placed to provide a minimum 24-inch overlap along each joint. On horizontal joints, the uphill strip shall overlap the downhill strip. On vertical joints the upstream strip shall overlap the downstream strip. The fabric shall be protected at all times during construction from extensive exposure to sunlight.

Placement of the gabions shall be done in such a manner as not to damage the fabric. If, in the opinion of the Engineer, the fabric is damaged or displaced during the placement of the gabion to the extent that it cannot function as intended, the contractor shall remove the rock and replace the filter fabric.

The filter fabric shall be attached to the bottom and side of the gabions that make up the outside perimeter of a finished bank protection unit. Typically, this attachment will be made horizontally along the top-of-bank and end-of-apron, and vertically along the upstream and downstream limits of each continuous unit of bank protection.

D) Testing:

When requested by the Engineer, gabions manufacturer shall provide a copy of all tests made by an approved laboratory for the following properties:

For woven gabions all tests for zinc coating, mesh tensile strength, panels to panels connection, and salt spray test when alternative fastener is used, shall be made in accordance with ASTM A975 Standard Specification for Double-Twisted Hexagonal Mesh Gabions and Revert Mattresses.

For welded gabions all tests for zinc coating, welds shear strength, and panels to panels connection shall be made in accordance with ASTM A974 Standard Specification for Welded Wire Fabric Gabions and Gabion Mattresses.

All tests shall not be older than 5 years.

E) Manufacturer Construction Drawings/Details:

Prior to fabrication of the baskets, the contractor shall submit manufacturer details, assembly instructions, and material data in accordance with the requirements of Subsection 105.03 of the ADOT Standard Specifications. The submittal(s) shall include complete fabrication and erection details for the frames including detailed dimensions and sizes of component parts.

F) Guarantee and Warrantee Provisions:

The Contractor shall guarantee the work against defective workmanship or materials for a period of 1 year from the date of its final acceptance under the contract, ordinary wear and tear and unusual abuse or neglect excepted.
Any omission on the part of the Engineer to condemn defective work or materials at the time of construction shall not be deemed an acceptance, and the Contractor will be required to correct defective work or materials at any time before final acceptance and within 1 year thereafter.

Should any defects develop within 1 year from the date of final acceptance due to faults in workmanship or materials, the Contractor shall, within 14 calendar days of receipt of written notice from the City, begin making the necessary repairs to the satisfaction of the Engineer. Such work shall include the repair or replacement of other work or materials damaged or affected by making the above repairs or corrective work, all at no additional cost to the City.

If defects develop which are determined by the Engineer to be an emergency, the Engineer shall notify the Contractor, via the most expeditious means, regarding the nature and condition of the defects. In turn, the Contractor shall immediately dispatch necessary forces to correct the defect or the emergency condition. If the Contractor, in his initial action, resolves the emergency condition but not the defect, a letter as discussed above will follow and normal procedures for corrections will be employed. If immediate or appropriate action, satisfactory to the Engineer, is not taken by the Contractor, or if the Contractor cannot be contacted, the Engineer will deploy necessary forces to correct and/or secure the deficiency. Costs of the Engineer's action shall be paid by the Contractor and/or his bonding agency. Should it later be determined that the defects requiring such emergency action are not the responsibility of the Contractor, the Contractor will be paid for all costs incurred as a result of these demands. Such action by the Engineer will not relieve the Contractor of the guarantees required by this section or elsewhere in the Contract Documents.

In case of work, materials, or equipment for which written warranties are required by the special provisions, the Contractor shall provide or secure from the appropriate Subcontractor or supplier such warranties addressed to and in favor of the City and deliver same to the Engineer prior to final acceptance of the work. Delivery of such warranties shall not relieve the Contractor from any obligation assumed under any other provisions of the contract.

The warrantees and guarantees provided in this subsection of the contract documents shall be in addition to and not in limitation of any other warrantees, guarantees or remedies required by law.

220.8 PAYMENT:
Payment for gabions will be made by the following.

Pay Item:	Pay Unit:
Gabion Baskets	Cubic Yard

PART 300 – STREETS AND RELATED WORK

SECTION 301 SUBGRADE PREPARATION

301.1 DESCRIPTION:

Compaction under all sidewalks shall be 95%.

SECTION 350 REMOVAL OF EXISTING IMPROVEMENTS

350.1 DESCRIPTION:

Work under this sections shall be in accordance with Section 350 of the MAG Standard Specifications. Removal and replacement of existing curb or asphalt not specifically called out shall be considered incidental to project construction and must be approved by the engineer and COF Project Manager. No separate or additional measurement or payment will be made for additional removal and replacement items unless provided in writing by the COF Project Manager.

PART 400 – RIGHT OF WAY AND TRAFFIC CONTROL

SECTION 401 TRAFFIC CONTROL

401.7 PAYMENT:
Traffic Control will be paid as a lump sum as shown on the bid schedule.

PART 600 – WATER, SEWER, STORM DRAIN AND IRRIGATION

SECTION 631 SUBGRADE PREPARATION

631.3 INSTALLATIONS:
(Revise to include the following)

New water service lines shall be installed to replace the existing water service lines. Construction includes replacement of all water services to COF Engineering Standards, including the service saddle at the main, corporation stop, pipe and curb stop to the meter and adjust the customers' service to the new outlet meter coupling elevation. The lines shall be extended to the new polymer meter box location and a new meter box shall be installed and shall connect to the existing meter. It the existing meter is not at the City's standard depth; the contract shall adjust the elevation of the meter. In cases where the meter box moves, the contractor shall salvage the existing meter and shift it to the proposed location. At each of these locations the contractor is required to connect to the existing water services on the private side of the meter. The Contractor shall coordinate with each property owner where private construction is required to verify the water line rerouting and to restore landscaping to its original condition.

City of Flagstaff utility tapping fees are the responsibility of the contractor. The contractor shall perform all work and coordinate payment directly with the City Utilities Department at City Hall. All costs for utility tap work and fees shall be included in the line item for installation of the new service, including but not limited to all labor and materials for complete installation. Repair associated within any abandoned or new tap shall be included in the contract bid item.

PART 800 – ROADSIDE DEVELOPMENT

SECTION 810 EROSION CONTROL AND POLLUTION PREVENTIONS

810.1 DESCRIPTION:
The work under this section shall be in accordance with Section 810 of the ADOT Standard Specifications and as modified herein. This section refers to all work as specified on the Erosion Control Plan. Completion of the SWPPP includes preparation of the SWPPP Manual, hydroseeding of disturbed areas, BMP maintenance, inspections, and NOI and NOT filings are all incidental to the SWPPP bid item. Additional BMPs may be required during construction and are to be included in the bid price.

The contractor is responsible for the SWPPP until the NOT has been filed with and accepted by ADEQ.

810.4 METHOD OF MEASUREMENT:
Measurement for the SWPPP shall be a lump sum and includes the elements as specified in 810.1, above.

810.5 BASIS OF PAYMENT:
Payment for the SWPPP is by Lump Sum.

Pay Item:	Pay Unit:
SWPPP	Lump Sum

APPENDIX A

Structural Special Provisions

SPECIAL PROVISIONS FOR PHOENIX AVENUE BRIDGE CULVERT REPLACEMENT (STRUCTURE NO. 8709) AND ZANI CONCRETE BEAM REPAIR

PROPOSED WORK

The proposed project is located in the City of Flagstaff, Arizona on the Phoenix Avenue crossing of the Rio de Flag Wash, about 50 feet west of the junction with Beaver Street. The existing two span reinforced concrete bridge culvert structure was built in 1929 and will be replaced with a new bridge culvert. The work includes demolition of the existing bridge, strengthening the existing Zani concrete beam, and constructing a new two span cast-on-place reinforced concrete bridge culvert, as shown on the project plans.

PROFESSIONAL SEALS

This book of specifications and related contract documents represents the efforts of the following:

- Cannon Consultants, LLC

A representative of the firm has affixed his/her seal below. The seal attests that those specifications that relate to the plan sheets appearing with his/her seal were prepared under his/her direction.

Cannon Consultants, LLC
Jerry A. Cannon, P.E., S.E., Bridge Engineer
Bridge Plans – Sheets B1 through B13
Sheets S1 & S2

MISCELLANEOUS CONTRACT REQUIREMENTS

PRE-CONSTRUCTION MEETING

A pre-construction meeting will be scheduled by the Owner. Attendance by the Contractor, the Bridge Engineer-of-Record, and the City of Flagstaff Project Manager and Inspector is required at the scheduled place and time.

TECHNICAL REQUIREMENTS:

All work shall conform to the 2008 Edition of the Arizona Department of Transportation Standard Specifications for Road and Bridge Construction, and current ADOT Stored Specifications, unless otherwise noted in these Special Provisions.

The average elevation of the project is about 6800 feet.

The project site is environmentally sensitive. City of Flagstaff has the right-of-way for the roadway and new bridge culvert structure. Contractor may use a portion of the existing roadway for contractor staging area as approved by the Engineer.

The City of Flagstaff has specified the following clarifications to these project Special Provisions:

1. Material submittal demonstrating and certifying compliance with the Contract Documents shall be made to City of Flagstaff as identified in the pre-construction conference.

2. Payment shall be by the Unit Price for the items of work listed on the Bid Schedule. If an item of miscellaneous work is not included it shall be deemed as having been included by the bidder in a related or similar bid item or within mobilization.

3. The table of "Approximate Quantities" shown on the Contract Plans is for information only. The use of this table in determining actual quantities or in estimating the work is wholly at the risk of the bidder.

ENVIRONMENTAL REQUIREMENTS:

The Contractor shall be responsible for compliance to the following mitigation measures during the construction of this project:

1. To prevent the introduction of invasive species, all earthmoving and hauling equipment shall be washed at the Contractor's storage facility prior to entering the construction site.

2. To prevent the spread of invasive species to uncontaminated areas, all earthmoving and hauling equipment shall be washed at a designated location prior to leaving the construction site.

3. No construction materials or debris shall be allowed to fall into the Rio de Flag Wash.

4. If suspected hazardous materials are encountered during construction, work shall cease at that location and the City of Flagstaff shall be contacted to arrange for proper assessment, treatment, or disposal of those materials.

5. If previously unidentified cultural resources are encountered during activity related to the construction of the project, the Contractor shall stop work immediately at that location and shall take all reasonable steps to secure the preservation of those resources. The Contractor will contact the City of Flagstaff immediately and make arrangements for proper treatment of those resources.

No measurement or direct payment will be made for compliance with environmental requirements. The cost will be considered as included in the cost of the contract items.

MISCELLANEOUS ITEMS:

- The Contractor shall make arrangements for temporary power during construction. No measurement or payment will be made for temporary power.

- No source of water is designated for construction of this project. The Contractor shall make arrangements for obtaining water for use during construction. No measurement or direct payment will be made for furnishing the water supply.

- The Contractor shall prevent contaminants from entering Rio de Flag Wash. The Contractor shall not place oily or greasy substances that originate from the Contractor's operations where they will later enter the wash. The Contractor shall prevent concrete or curing water for the concrete from entering the wash.

- **Equipment List/Schedule of Manpower/Construction Schedule:** The Contractor shall provide a list of equipment to be utilized on this project, a schedule of manpower to be utilized on this project, and a detailed construction schedule, for review and approval by the Owner prior to award.

- **Project Superintendent:** The Project Superintendent must be on-site at all times during performance of work and must attend the weekly construction meetings.

- **Guarantee:** All portions of the work under this contract shall be guaranteed for workmanship and materials for a period of two years from the date of final acceptance of the product by the owner.

- **Responsibility:** The Contractor shall be fully responsible for the project until the date of final acceptance.

- **Clean-Up:** The Contractor shall, at all times, keep the premises free from accumulation of waste materials and/or rubbish caused by his operations. At the completion of the work, the Contractor shall completely clean the premises, removing and disposing of all rubbish and debris, and cleaning all stains, spots, marks, dirt, smear, etc.

Weekly Meetings:

The Contractor shall provide meeting agenda and meeting minutes of the weekly construction meetings. All meetings will be held at the Phoenix Avenue Bridge site.

No measurement or payment will be made for weekly meetings, the cost being considered as included in the cost of contract items.

Concrete Testing:

Concrete testing, including concrete slump test, air content and compression strength tests, shall be made for each day's concrete placement and for every 10 CY of concrete and results submitted to the Engineer. All concrete tests will be paid for by the City of Flagstaff.

Pay Item:	**Pay Unit:**
106001: Quality Control	Lump Sum

Plan for Construction Activities:

Before starting work on the project, the Contractor shall submit a written plan for construction activities related to the Phoenix Avenue Bridge project. The plan shall describe how the Contractor will prevent material from falling into the Rio de Flag Channel, protection of existing adjacent buildings and accommodate the flow of water in the Rio de Flag Wash during construction, the location of Contractor storage and staging sites, a plan for construction activities and maintenance of traffic, protect cultural resources, insure the safety of the public and construction workers, and the removal of existing bridge structure. The plan shall consider for the need for cooperation and coordination with all parties involved in the project.

The Contractor shall submit the plan to the Engineer prior to the start of the construction, for the Engineer's review and approval, and obtain approval of the plan prior to the start of construction activities.

No measurement or direct payment will be made for the plan for construction activities related to the Phoenix Avenue Bridge project as described above, the cost being considered as included in the cost of contract items.

SECTION 202: ITEMS 2020034 – REMOVAL OF STRUCTURES AND OBSTRUCTIONS

202.1 Description of: of the ADOT Standard Specifications is modified to add:

The work under this section shall consist of removing and disposing of all vegetation, concrete, steel, debris and other material from the bridge construction area in accordance with ADOT Standard Specifications.

202-3.05 Removal of Bridge: of the ADOT Standard Specifications is modified to add:

Contractor Requirements:

The Contractor shall remove the existing concrete bridge culvert structure, as shown on the project plans. (See Section 202-3.05 of ADOT Standard Specifications.) The Contractor shall first install falsework under the existing Zani concrete beam that supports the adjacent concrete Zani channel deck slab, the existing Zani building masonry wall, etc., then saw cut the existing walls and the existing bridge culvert deck slab adjacent to the Zani concrete beam, removing the existing box culvert structure in such a manner so that the Zani building beam and masonry wall adjacent to the building are not damaged in any way. The Contractor shall dispose of the concrete and reinforcing steel and other steel members, hauling it to an approval disposal site. Any damage to the existing Zani building or adjacent buildings as a result of these removals shall be repaired to the satisfaction of the Engineer at no additional cost to the owner.

The Contractor shall make sure not to damage the existing reinforcing remaining steel and then using a hand held 30 pound maximum jackhammer to remove the existing walls and deck slab in a manner so as to not damage the remaining structure.

Submittals:

The Contractor shall prepare and submit, prior to start of construction, removal and demolition plans to the Bridge Engineer for review and approval. The Contractor shall include in that submittal shoring and falsework to support the existing Zani concrete beam and the protection of the adjacent buildings and walls, and how they plan to remove the existing concrete box culvert structure and protect adjacent buildings. The Contractor shall accomplish all work in such a manner so that no materials or debris enter the Rio de Flag Wash. Also, the Contractor shall include how they plan to accommodate water that may be flowing in the wash as this work is being done.

The falsework and temporary shoring shall be designed in accordance with Section 601-3.02 of the ADOT Standard Specifications for Road and Bridge Construction, 2008 Edition. The Contractor shall provide and submit design calculations and plans for the falsework and shoring design, signed and stamped by an Arizona professional engineer for review and approval of the Engineer.

The falsework shall be founded on solid footings that are safe against undermining during a storm event in the wash and capable of supporting loads imposed. The falsework and shoring shall be designed using working stress method of design.

The submittal shall include a detailed plan for removal saw cutting walls, deck slabs and the stabilization of the remaining beams and wall, dealing with water in the wash, and protection of the Rio de Flag Wash and adjacent structures, and disposal of materials.

Method of Measurement:

Removal of the existing concrete bridge structure and obstructions will be measured on a lump sum basis.

Basis of Payment:

The accepted quantities for the work, measured as provided above, will be paid for at the contract unit price which shall be full compensation for the item, complete in place, as defined and described above including removal of the existing bridge concrete culvert structure barrier railing, providing and removal of temporary shoring and falsework, saw cutting walls and deck slab, protection of adjacent buildings, designing and installation of falsework to support the Zani concrete beam, accommodating water flow in the wash, disposal of debris and materials, structural excavations and structure backfill, and miscellaneous related items as shown on the project plans, complete in place.

Pay Items:	**Pay Unit:**
2020034: Removal of Existing Concrete Bridge Structure	Lump Sum (LS)

SECTION 203: EARTHWORK

203-5 Structural Excavation and Structure Backfill

203-5.01 Description: of the Standard Specifications is revised to add:

The structure excavation shall include the excavation of the Rio de Flag Wash channel for the new bridge abutment walls, pier walls and the bridge wing walls, as shown on the project plans. This work shall include furnishing all equipment and labor in accordance with the details shown on the project plans and these Special Provisions. The work shall comply with the 2008 edition of the ADOT Standard Specifications for Roads and Bridges.

Construction Requirements:

The foundations for the bridge abutment walls, the pier wall, and the wing walls shall be keyed into bedrock, a minimum of 1'-0", and to bear on bedrock as shown on the project plans. The bottom foundations shown on the project plans is the estimated depth of bedrock based core borings by the geotechnical engineer that show the estimated depth to bedrock. After the foundation excavations are complete, and prior to placement of reinforcing steel, the exposed surface of rock shall be inspected and approved the the Geotechnical Engineer and the Bridge Engineer. It may be necessary to excavate the footing deeper than shown on the plans or to excavate to a more shallow depth than shown on the plans in order to bear on bedrock material.

Any voids encountered at the bottom of the concrete foundation excavation shall be filled with a sand/ cement grout mixture designed to develop a minimum 28 day compressive strength of 4000 psi with a slump of five to seven inches.

The spread footings for the bridge shall bear on bedrock in accordance with the project plans. The surface shall be relatively level using stepped footings where necessary. All weathered and fractured bedrock material shall be removed from the excavations.

The foundation excavation shall be inspected and approved by the Geotechnical Engineer and the Bridge Engineer prior to placement of reinforcing steel.

If the bedrock is found at a lower elevation than the estimate on the project plans, or if rock voids are found below the bottom of the footings, the soil shall be removed and replaced with Class S 4000 psi concrete as direction by the Engineer.

In cases where the bottom of the wall footings can be raised and are still embedded into bedrock 1'-0", and have a minimum 18 inch cover over the top of the footings, the wall heights and size of the footing can be decreased in accordance with the project plans. In all cases, if bedrock is located at elevations different than that shown on the project plans, the Contractor shall notify the Bridge Engineer so that adjustments can be made to the project plans.

Submittals:

The Contractor shall provide and submit to the Engineer for review and approval the temporary shorings and falsework needed to protect and not damage the adjacent buildings or Zani building, and shall conform to Section 610-3.02 of the ADOT Standard Specifications. The Contractor shall retain the services of an Arizona structural or civil engineer to design the shoring and falsework and prepare plans and details for this work. The Contractor shall submit those plans, details and structural calculations, stamped and signed by an Arizona professional engineer for review and approval of the Bridge Engineer prior to the start of that work.

The Contractor shall submit the bottom of footing elevations to the Bridge and Geotechnical Engineers for review and approval prior to placement of the reinforced steel. See Plan Sheet B1 for additional requirements.

203-5.02 Description: Geocomposite Materials

The geocomposite wall drains material shall conform to the following requirements of subsection 1014-1 and 1014-6. The geocomposite wall drains shall be installed on the soil side of the new abutment walls and the new wing walls as shown on the project plans.

The concrete surface of the structure against which the geocomposite drain is to be placed, shall be free of soil, debris and excessive irregularities that will prevent continuous contact between the concrete surface and the drain material. The geocomposite drain shall be installed with the single fabric surface in contact with the backfill material. When the core of the geo composite wall drain is not perforated during manufacture, perforations shall be made in the core where the wall drain will lay against a weep hole or other drainage outlet. When making these perforations, the fabric shall not be damaged in any way.

Unless otherwise specified, geocomposite wall drains shall be constructed in horizontal courses and in accordance with the details shown on the plans. To prevent infiltration of the backfill material, the geocomposite material shall be firmly secured to the face, top and sides of the wall by using adhesive or 1.5 – 2-inch long concrete nails, with approved washers or wood battens of not less than 4 square inches in area. The adhesive or alignment of the core shall not affect the drainage area or downward

flow within the core. The spacing of concrete nails shall be as directed by the Engineer, but shall not be more than 4 feet apart, both horizontally and vertically. When nails are utilized, there shall be at least 1 horizontal row of nails in each course of geocomposite.

Structural backfill operations shall be started as soon as possible after place the geocomposite material but in no case shall the geocomposite material be exposed to sunlight for more than fourteen (14) days after installation. Care shall be taken during the backfill operation not to damage the geotextile surface of the drain, and to avoid excessive settlement of the backfill material.

203-5.03 Description: Backfill Material

The structure backfill material shall conform to Section 203-5.03 (B) Backfill, of the ADOT Standard Specifications 2008 Edition and shall be compacted to 95 percent of the maximum dry density ASTM D-698, and shall conform to the following gradation (Arizona Test Method 201):

SIEVE SIZE	PERCENT PASSING
3 inch	100
¾ inch	60 – 100
No. 8	35 – 80
No. 200	0 – 12

The plasticity index shall not exceed 5 when tested in accordance with the requirement of AASHTO T90. The existing soil material at the site may be used as long as it conforms to the above gradation.

Measurement and Payment:

Structural excavation, structure backfill and geocomposite materials will be measured on a lump sum basis.

Basis of Payment:

The accepted quantities for the work, measured as provided above, will be paid for at the contract unit price which shall be full compensation for the item, complete in place, as defined and described above including structural excavation, structure backfill, geocomposite drain system, temporary shoring, falsework, and miscellaneous related items as shown on the project plans, complete in place.

Pay Items:	**Pay Unit:**
2030035: Structural Excavation and Structure Backfill	Lump Sum (LS)

ITEM 60100010: STRUCTURAL CONCRETE (F'c = 4500 psi)

ITEM 60100011: STRUCTURAL CONCRETE (F'c = 4000 psi)

The work under this section shall consist of furnishing all materials and construction structures, parts of structures and form, to the shapes and dimensions shown on the project plans, complete-in-place and in accordance with the requirements of the specifications. All work under this section shall conform to Section 601 Concrete Structures, Section 605 Steel Reinforcement and Section 1006 Portland Cement of the ADOT Standard Specifications for Road and Bridge Construction, 2008 Edition, except as herein noted in these Special Provisions and on the project plans.

Materials:

All concrete shall be ADOT Class S concrete with the following strengths:

F'c = 4000 psi @ 28 days – substructure walls and miscellaneous
F'c = 4500 psi @ 28 days – super structure bridge deck

All concrete shall be Type II Portland cement.

Reinforcing steel shall be epoxy coated and shall conform to ASTM A615 and shall be furnished as Grade 60. Reinforcing steel to be welded, where approved by the Engineer, shall conform to ASTM A706. The structural steel angles and sliding steel plate shall conform to ASTM A36 or equal, and shall be galvanized in accordance with ASTM A123.

Construction Requirements:

The concrete deck shall be cured in accordance with Section 1006-6.01 Curing Cast-in-Place of the ADOT Standard Specifications using a burlap cover with water cure for a minimum of 7 days. The finish of the bridge deck shall be in accordance with Section 601-3.05D Finishing Bridge Deck of the ADOT Standard Specifications.

The Contractor shall use Sikadur 32 Hi Mod or approved bonding agent, to bond fresh concrete to hardened concrete. The Sikadur 32 product shall be used in accordance with product manufacturer's requirements for bonding new concrete to hardened concrete.

The foundations for the bridge abutment walls, the pier wall, and the wing walls shall be keyed into bedrock, a minimum of 1'-0", and to bear on bedrock as shown on the project plans. The bottom foundations shown on the project plans is the estimated depth of bedrock based core borings by the geotechnical engineer that show the estimated depth to bedrock. After the foundation excavations are complete, and prior to placement of reinforcing steel, the exposed surface of rock shall be inspected and approved by the Geotechnical Engineer and the Bridge Engineer. It may be necessary to excavate the footing deeper than shown on the plans or to excavate to a more shallow depth than shown on the plans in order to bear on bedrock material. This additional work, or lesser work, will be negotiated for, or reduced, based on the unit price shown in the Bid Schedule.

Any voids encountered at the bottom of the concrete foundation excavation shall be filled with a sand/ cement grout mixture designed to develop a minimum 28 day compressive strength of 4000 psi with a slump of five to seven inches.

The removal of falsework and forms shall conform to Section 601-3.02(D) of the ADOT Standard Specifications and no falsework or forms shall be relieved of load and no forms shall be removed without approval of the Bridge Engineer.

The spread footings for the bridge shall bear on bedrock in accordance with the project plans. The surface shall be relatively level using stepped footings where necessary. All weathered and fractured bedrock material shall be removed from the excavations.

All foundation excavation shall be inspected and approved by the Geotechnical Engineer and the Bridge Engineer prior to placement of reinforcing steel.

If the bedrock is found at a lower elevation than the estimate on the project plans, or if rock voids are found below the bottom of the footings, the soil shall be removed and replaced with Class S 4000 psi concrete as directed by the Engineer.

In cases where the bottom of the wall footings can be raised and are still embedded into bedrock 1'-0", and have a minimum of an 18 inch cover over the top of the footings, the wall heights and size of the footing can be decreased in accordance with the project plans. In all cases, if bedrock is located at elevations different than that shown on the project plans, the Contractor shall notify the Bridge Engineer so that adjustments can be made to the project plans.

Cold Weather Concrete Requirements and Submittal:

Cold weather concreting shall comply and shall meet the requirements of Section 1006-5.03 Cold Weather Concreting of the ADOT Standard Specifications including tenting the structure and using space heaters, etc., to comply with the specifications. The Contractor shall submit a written outline of the proposed protection method submitted to the Engineer for approval prior to placement of concrete.

Submittals:

The Contractor shall submit concrete mix designs in accordance with the ADOT Standard Specifications. The Contractor shall submit shop drawings for all falsework and form designs and reinforcing steel and in accordance with Subsection 105.03 of the ADOT Standard Specifications.

The Contractor shall also submit the method of curing the concrete deck, methods for curing and forming for concrete deck for review and approval of the Bridge Engineer.

The falsework and forms shall be designed and constructed in accordance with Section 601-3.02(A) of the ADOT Standard Specifications for Road and Bridge Construction, 2008 Edition. The Contractor shall provide and submit design calculations and plans for the falsework design, using working stress method of design, signed and stamped by an Arizona professional engineer for review and approval of the Engineer.

The Contractor shall submit shop drawings and lists showing the bending of reinforcement bars, splice locations, and details, in accordance with ADOT Subsection 105.03, to the Engineer for review and approval prior to proceeding with the work. Approval of the submittal shall not relieve the Contractor of responsibility for the correctness of the shop drawings and lists.

The Contractor shall prepare shop drawings for the edge angles and sliding steel plate as shown on the project plans.

Method of Measurement:

The measurement of structural concrete shall be by the cubic yard in accordance with the dimensions shown on the project plans. No deduction will be made for the volume occupied by reinforcing steel, or other materials embedded or recessed in the concrete.

Basis of Payment:

The accepted quantities for this work, measured as provided above, will be paid for at the contract unit price per cubic yard, which shall be full compensation for furnishing all labor, materials, reinforcing steel, concrete, tools, equipment, structural excavation, structure backfill, cold weather concrete, keying wall footings into bedrock, edge angles and sliding cover plate, steel sleeves for utilities, the new concrete abutment and pier walls with footings that are used to connect the new bridge structure to the existing remaining culvert structure, and incidentals for doing all work involved in furnishing, placing, and curing concrete, design of falsework and shoring, and miscellaneous related items as shown on the project plans and complete-in-place.

Pay Items:		**Pay Unit:**
60100010:	Structural Concrete (f'c = 4500 psi) Class S	Cubic Yard (CY)
60100011:	Structural Concrete (f'c = 4000 psi) Class S	Cubic Yard (CY)

ITEM 6010012: CONCRETE WINGWALLS (F'c = 4000 psi)

Description:

The work under this section shall consist of furnishing all materials and construction wingwalls, parts of structures and form to the shapes and dimensions shown on the project plans, complete-in-place and in accordance with the requirements of the specifications. All work under this section shall conform to Section 601 Concrete Structures in Section 605 Steel Reinforcement and Section 1006 Portland Cement of the ADOT Standard Specifications for Road and Bridge Construction, 2008 Edition, except as herein notes in these Special Provisions and on the project plans.

Materials:

All concrete shall be ADOT Class S concrete with the following strengths:

F'c = 4000 psi @ 28 days – wingwalls

All concrete shall be Type II Portland cement.

Reinforcing steel shall be epoxy coated and shall conform to ASTM A615 and shall be furnished as Grade 60. Reinforcing steel to be welded, where approved by the Engineer, shall conform to ASTM A706.

Construction Requirements:

The concrete walls shall be cured by leaving the forms on the walls for a minimum of 7 days before removal. The walls shall have a Class II finish. The foundation for the wing walls shall bear on bedrock.

Cold Weather Concrete Requirements and Submittal:

Cold weather concreting shall comply and shall meet the requirements of Section 1006-5.03 Cold Weather Concreting of the ADOT Standard Specifications including tenting the structure and using space heaters, etc., to comply with the specifications. The Contractor shall submit a written outline of the proposed protection method submitted to the Engineer for approval prior to placement of the concrete. Concrete curing shall be by the forms in place method for a minimum of 7 days before forms are removed.

Submittals:

The Contractor shall submit concrete mix designs in accordance with the ADOT Standard Specifications. The Contractor shall submit shop drawings for all falsework form designs and reinforcing steel and in accordance with Subsection 105.03 of the ADOT Standard Specifications.

The falsework and form work shall be designed in accordance with Section 601-3.02 of the ADOT Standard Specifications for Road and Bridge Construction, 2008 Edition. The Contractor shall provide and submit design calculations and plans for the falsework design, signed and stamped by an Arizona professional engineer for review and approval of the Engineer.

The Contractor shall submit shop drawings and lists showing the bending of reinforcement bars, splice locations, and details, in accordance with ADOT Subsection 105.03, to the Engineer for review

and approval prior to proceeding with the work. Approval of the submittal shall not relieve the Contractor of responsibility for the correctness of the shop drawings and lists.

Method of Measurement:

The measurement of concrete retaining walls shall be by the square foot in accordance with the dimensions shown on the project plans from top of wall to bottom of wall times length of wall. No deduction will be made for the volume occupies by reinforcing steel or other materials embedded or recessed in the concrete.

Basis of Payment:

The accepted quantities for this work, measured as provided above, will be paid for at the concrete unit price per square foot which shall be full compensation for furnishing all labor, materials, reinforcing steel, tools, equipment, structural excavation and the structure backfill, and incidentals for doing all work involved in furnishing, placing, and curing concrete, design of falsework and forms, and transporting and erecting falsework forms, and miscellaneous related items as shown on the project plans, complete and in place.

Pay Items:	**Pay Unit:**
60100012: Concrete Wingwalls (f'c = 4000 psi)	Square Foot (SF)

ITEM 9240053: MISCELLANEOUS WORK (Epoxy Dowels)

Description:

The work under this item shall include providing epoxy coated dowels as shown on the project plans, Special Provisions, and ADOT Standard Specifications as modified herein.

Materials:

All reinforcing steel shall be ASTM A615, Grade 60, epoxy coated and ADOT approved epoxy grout into existing concrete walls or slabs.

Construction Requirements:

The Contractor shall provide and install the epoxy dowels as shown on the project plans. The Contractor shall drill holes for dowels ¼-inch larger diameter than dowels, clean holes of any dust or other contaminants, and epoxy grout dowels into existing concrete. The Contractor shall notify the Engineer as to when the work will be done so the Engineer can provide inspection of epoxy dowel installation work.

Submittals:

The Contractor shall provide shop drawings for the dowels and submit manufacturer's specifications and test performance data and procedures for installation of epoxy grout. The epoxy grout shall be selected from the ADOT Approved Product List for epoxy.

Method of Measurement:

The epoxy dowels will be measured by each dowel installed into the existing concrete.

Basis of Payment:

The accepted quantities for the epoxy dowels, as provided above, will be paid for at the contract price amount which price shall be full compensation for all work and materials described herein and as shown on the project plans. Payment shall include epoxy coated reinforced steel dowels, drilling and clean out of holes for the dowels, and epoxy grouting dowels into existing concrete as shown on the project plans, complete and in place.

Pay Item:	Pay Unit:
9240053: Miscellaneous Work (Epoxy Dowels)	Each (EA)

ITEM 9240054: MISCELLANEOUS WORK (Concrete Bridge Barrier Rail)

Description:

The work under this item shall include the construction of the concrete bridge barrier rail which shall consist of furnishing all materials and labor in accordance with the details shown on the project plans and in these Special Provisions and ADOT Standard Specifications as modified herein.

Materials:

Reinforcing steel shall conform to ASTM A615, Grade 60, and be epoxy coated. All concrete shall be Class S f'c = 4000 psi @ 28 days.

Construction Requirements:

The Contractor shall construct the reinforced concrete bridge barrier rail as shown on the project plans. The wall shall be a near replica of the barrier rail on the existing bridge with a Class II finish and to match the existing wall appearance.

Submittals:

The Contractor shall submit detailed shop drawings of the new concrete barrier wall showing reinforcing steel, and the rustication to match existing barrier rail.

Method of Measurement:

Concrete barrier rail will be measured per lineal foot.

Basis of Payment:

Payment for this item will be made at the unit price, which includes full compensation for all labor, equipment and materials needed to construct barrier as described herein including: reinforcing steel, recess rustication, concrete and miscellaneous related items as shown on the project plans and these Special Provisions, complete and in place.

Pay Item:	Pay Unit:
9240054: Concrete Bridge Barrier Rail	Lineal Foot (LF)

ITEM 9240055: MISCELLANEOUS WORK (Zani Concrete Beam Repair)

Description:

The work under this item shall include all labor and materials for the repair of the existing Zani concrete beam, including additional temporary falsework , shoring and form work for the Zani concrete beam, and the preparation of existing concrete beam, installation and providing externally bonded reinforcement concrete, protective encasement and reinforcing steel, in accordance with the

details shown on the project plans and in these Special Provisions and ADOT Standard Specifications as modified herein.

Materials:

Concrete shall be Class S, f'c = 4000 psi @ 28 days, and all reinforcing steel shall conform to ASTM A615, Grade 60, and be epoxy coated. Externally bonded FRP shall be provided by the Contractor to strengthen the Zani concrete beam.

Construction Requirements:

The Contractor shall provide additional falsework shoring as needed to support the Zani concrete beam while repairs are being made to the beam. The Contractor shall construct the new pier and abutment concrete walls that bear on bedrock material and are used to support the Zani concrete beam as shown on the project plans. The Contractor shall prepare the existing Zani concrete beam and then apply the externally bonded reinforcement (FRP) to the concrete beam. The preparation of the Zani concrete beam shall include removal of deteriorated concrete, removal of rust from the existing reinforced steel, application of concrete patch material to the beam, application of rust preventing a bonding agent, and application of externally bonded reinforcement (FRP) as recommended by the FRP structural engineer who will provide structural calculations and design for strengthening the Zani concrete beam. The Contractor shall provide protective concrete encasement around the beam and connecting the Zani concrete beam to the new walls in order to transfer the loads to the pier and abutment walls as shown on the project plans.

Some of the requirements for repair of the Zani concrete beam using the externally bonded reinforcing (FRP):

- Surface Preparation
  - ➡ Repairs to damaged and delaminated concrete by means of removal and replacement by hand patching using patching material
  - ➡ Surface preparation to the existing concrete substrate by abrasive blasting and/or dustless abrasive grinding
  - ➡ Surface preparation shall achieve a CSP 2 or 3 to ensure proper bond between surface and FRP
  - ➡ Left over dust to be removed with pneumatic air and wiped clean prior to installation
- FRP Preparation
  - ➡ Application of protective coating over top of the externally bonded reinforcement
  - ➡ Protection of externally bonded reinforcement during curing period

Submittals:

(1) The Contractor shall submit concrete patch material, reinforcing steel shop drawings, and FRP materials shop drawings.

(2) The Contractor shall submit the concrete patch materials from the ADOT Approved Material List. Externally bonded reinforcement, and structural calculations shall be stamped and signed by an Arizona professional structural engineer.

(3) Product Information and Technical Data: the Contractor shall provide technical data and product information for the externally bonded reinforcement (FRP), that it has been successfully used to

strengthen existing concrete members along with test data and test results for the material. This technical information is to be provided by a certified material testing organization including application, long term use of product, and strength and durability when subjected to temperature, etc. The Contractor shall provide documentation that ADOT has approved the use of the externally bonded reinforcement.

(4) Structural Design of Zani Beam Repair: the Contractor shall retain the services of an Arizona Structural Engineer to prepare structural calculations for the design of the existing Zani concrete beam repair. The design shall be for a two span concrete beam reinforced with externally bonded reinforcement (FRP) with the entire load on the beam being supported by the FRP as the only reinforcement. The existing steel in the Zani concrete beam nor the reinforcing steel in the concrete protective encasement shall not be used in the strengthening of the Zani concrete beam. The Contractor shall provide structural calculations in determining the load capacity with loads which include 12" masonry wall, roof and floor liveloads from the Zani building, concrete beam loads and existing concrete channel slab. The Contractor shall submit structural calculations and structural details to the Bridge Engineer of Record for review and approval. All structural calculations shall be performed using the allowable stress design method.

(5) The Contractor shall provide the following information for the externally bonded reinforcement (FRP):

(a) Product Evaluation Report
(b) required inspection schedule
(c) a list of certified inspectors for the product

Method of Measurement:

The Miscellaneous Work (Zani Concrete Beam Repair) shall be measured as a lump sum.

Basis of Payment:

The accepted quantities for miscellaneous work, as provided above, will be paid for at the contract lump sum amount which includes additional temporary falsework and shoring to support the Zani concrete beam during construction, as needed, removal of deteriorated concrete from the Zani concrete beam, removal of rust from existing reinforcing steel, surface preparation of concrete beam, providing and installation of the externally bonded reinforcement (FRP), supported by the new pier and abutment walls, reinforcing steel, concrete protective encasement for Zani concrete beam, structural calculations for a two span concrete beam, and details for externally bonded reinforcement (FRP) for the Zani concrete beam, and miscellaneous related items, complete and in place as specified in these Special Provisions, complete in place.

Pay Item:	**Pay Unit:**
9240055: Zani Concrete Beam Repair	Lump Sum (LS)

APPENDIX B

Geotechnical Report Addendum No. 1, dated 8-8-18, and

Geotechnical Report, dated 9-8-17

August 8, 2018

Douglas Slover
City of Flagstaff
211 W. Aspen Ave.
Flagstaff, AZ 86001

RE: Project No.: 171323SF
Phoenix Avenue Box Culvert
107 W Phoenix Avenue
Flagstaff, AZ
Addendum No. 1

Dear Mr. Slover:

At the request of structural engineer Jerry Cannon, P.E., Speedie & Associates has revisited the idea of the box culvert being supported on the underlying soils as opposed to the underlying basalt bedrock. Clarification has been requested regarding the statement in the original geotechnical investigation report that "subsoils at the site are not suitable for support of the proposed structure".

Initial concerns placing the foundations on the underlying soils were related to scour and the potential for the soils to become saturated. Based on the relatively shallow depth to bedrock, it was our opinion that extending the excavations a few feet to bear on a very stable medium, out-weighed the risk of placing foundations on soil that could be subject to inundation and/or scour. It is our understanding that there are concerns regarding extending the foundation excavations to bear on the underlying basalt could compromise the foundations of adjacent structures. Mr. Cannon has proposed that the foundations would bear at an elevation of approximately 6891 and that there would be a concrete cutoff wall in front of the structure foundations. The cut-off wall would extend to a depth of 6 feet below the bottom of the channel (elevation 6888.5). This footing bottom elevation roughly corresponds to a depth of 9 feet on our boring logs since the borings were conducted on the roadway surface. Although placing a cutoff wall 6 feet deep at the leading edge of the box culvert results in excavations that could encounter the underlying basalt, it reduces the foundation excavations necessary adjacent to the structures to a depth of only 30 inches. At that elevation, the SPT values were greater than 50 blows per foot and drilling and was described as 'hard'. The boring logs are attached to this addendum and have been revised to include surface elevations of the boring locations that were not made available at the time of the report. A revision to the strata encountered at 7.5 feet and 8.0 feet for Borings B-1 and B-2 respectively has also been made.

Although bearing on the underlying basalt provides superior support of the structure when compared to the underlying soil, we also understand the concern of compromising the adjacent structure(s). Based on this

Information, it would be acceptable to raise the foundations to bear on the dense/hard underlying soils at the proposed footing bottom elevation provided that the foundation supporting soils remain unsaturated.

The structure may be founded on shallow spread footings bearing on undisturbed native soil at a minimum depth of 30 inches below finished exterior grade. A recommended allowable bearing capacity of 4,000 psf can be utilized for design. This bearing capacity refers to the total of all loads, dead and live, and is a net pressure. It may be increased one-third for wind, seismic or other loads of short duration. All footing excavations should be level and cleaned of all loose or disturbed materials. The cut-off wall should be installed prior to the foundations and positive drainage away from the foundations must be maintained at all times during construction. If competent bedrock is encountered during excavation of the foundations or cut-off wall, this office should be contacted for revised recommendations that may result in a depth reduction and include pinning to the rock surface.

Estimated settlements under design loads are on the order of ½ to ¾ inch, virtually all of which will occur during construction. Post-construction differential settlements will be negligible, under existing moisture contents. Additional localized settlements of the same magnitude could occur if native supporting soils were to experience a significant increase in moisture content.

It should be noted that two different bearing media, basalt bedrock and soil, maybe encountered at foundation elevation. This may result in differential settlement. Bearing on two different strata may result in differential settlement in excess of 1½ inches if the native supporting soils become saturated as the bedrock will not experience any significant settlement under the design loads. If differential settlement of this magnitude cannot be tolerated, then the foundations should bear on one media, i.e. bedrock OR undisturbed native soil. This may result in deepening some of the foundation elements to encounter rock.

We recommend that a representative of Speedie & Associates observe the foundation portions of this project to ensure compliance to project specifications and the field applicability of subsurface conditions which are the basis of the recommendations presented in this addendum. All recommendations contained in the original report are still valid. This addendum should be attached to the original geotechnical investigation report and made a part thereof.

Please give us a call if you have any questions or if we can be of further assistance.

Respectfully submitted,
SPEEDIE & ASSOCIATES

Registered Geologist
CERTIFICATE NO
50535
CLAY WARD SPENCER
Date Signed 8/8/18
ARIZONA U.S.A.
Expires 03/31/19

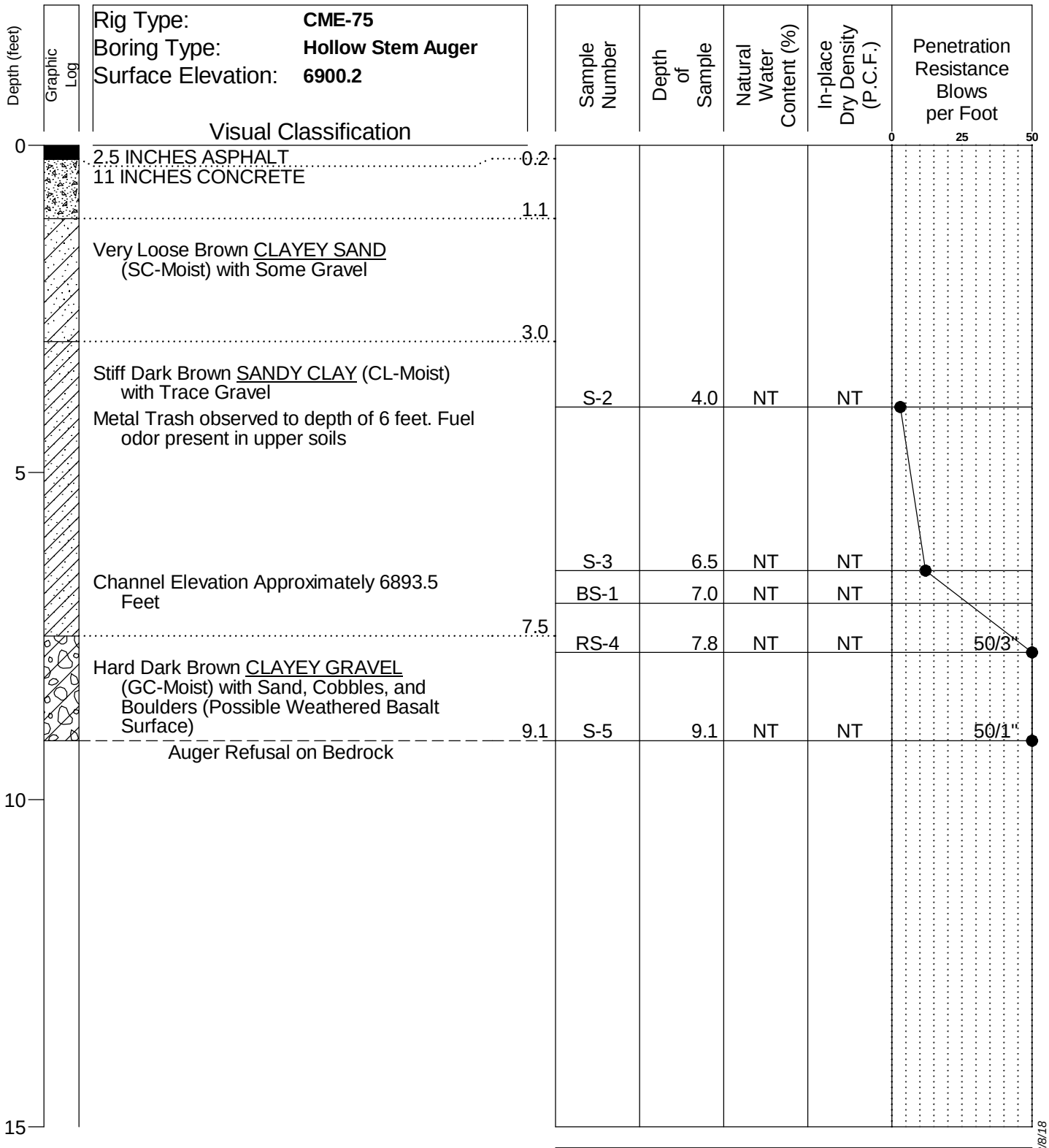
Clay W. Spencer, R.G.

Registered Professional Engineer (Civil)
CERTIFICATE NO.
14388
GREGG ALAN CREASER
Date Signed 8/8/18
ARIZONA, U.S.A.
Expires 06/30/20

Gregg A. Creaser, P.E.

Attachments: Revised Boring Logs

Cc: The WLB Group, Inc. – Brian Joerger, P.E.
Cannon Consultants, LLC – Jerry Cannon, P.E. -



Boring Date: **7-26-17**
Field Engineer/Technician: **J. DeGeyter**
Driller: **B. Anderson**
Contractor: **Resilient Drilling**

Water Level

Depth	Hour	Date
Free Water was Not Encountered		

NT = Not Tested

SPEEDIE AND ASSOCIATES

Log of Test Boring Number: **B- 1**

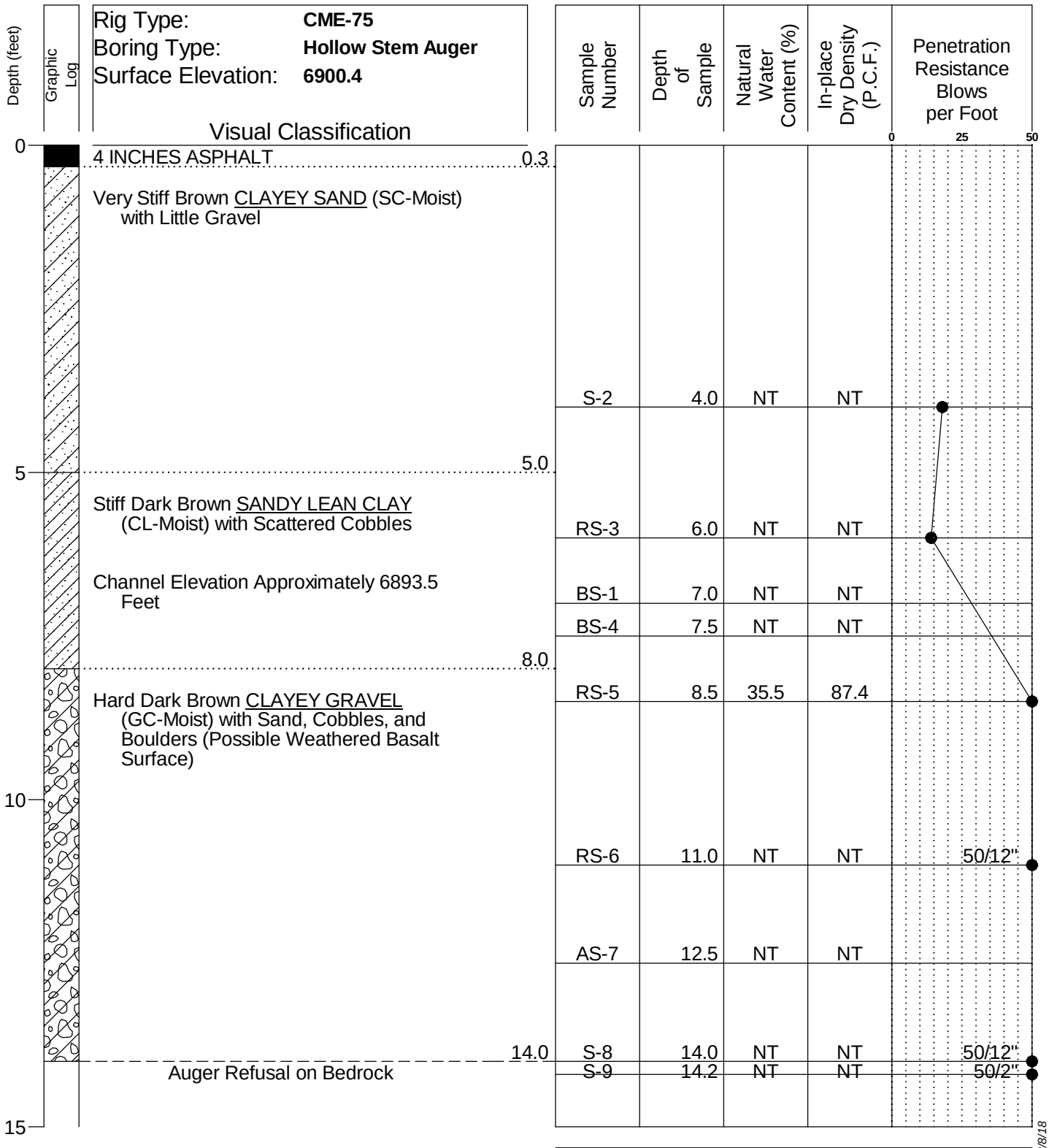
Phoenix Avenue Box Culvert

107 W. Phoenix Avenue

Flagstaff, Arizona

Project No.: **171323SF**

_SPEEDIE 171323SF.GPJ GENGEO.GDT 8/8/18



Boring Date: **7-26-17**
Field Engineer/Technician: **G. Chott**
Driller: **B. Anderson**
Contractor: **Resilient Drilling**

Water Level

Depth	Hour	Date
Free Water was Not Encountered		

NT = Not Tested

SPEEDIE AND ASSOCIATES

Log of Test Boring Number: **B- 2**

Phoenix Avenue Box Culvert

107 W. Phoenix Avenue

Flagstaff, Arizona

Project No.: **171323SF**

_SPEEDIE 171323SF.GPJ GENGEO.GDT 8/8/18

REPORT ON GEOTECHNICAL INVESTIGATION

DESIGNATION:	Phoenix Avenue Box Culvert Replacement
LOCATION:	107 W. Phoenix Avenue Flagstaff, AZ
CLIENT:	City of Flagstaff
PROJECT NO:	171323SF
DATE:	September 8, 2017

SPEEDIE AND ASSOCIATES
Geotechnical ▪ Environmental ▪ Materials Engineers

TABLE OF CONTENTS

Registered Professional Engineer (Civil)
CERTIFICATE NO.
14388
GREGG ALAN
CREASER
DATE SIGNED 9/8/17
ARIZONA, U.S.A.
Expires 06/30/2020

1.0 INTRODUCTION

This report presents the results of a subsoil investigation carried out at the site of proposed box culvert/bridge replacement at the Phoenix Avenue crossing of the Rio De Flag channel, in Flagstaff, Arizona.

Preliminary information indicates that construction will consist of replacement of the existing box culvert and associated infrastructure on Phoenix Avenue. Adjacent pavement is expected to be reconstructed. Anticipated traffic volumes and types of vehicles are unknown at this time, but are assumed to consist of moderate volumes of passenger vehicles, buses, and light duty trucks. No structural loading or proposed designs for the new box culvert/bridge were available at the time of this investigation.

If any significant changes are made in the scope of work or type of construction that was assumed in this report, we must review such revised conditions to confirm our findings if the conclusions and recommendations presented hereafter are to apply.

2.0 GENERAL SITE AND SOIL CONDITIONS

2.1 Site Conditions

The existing box culvert is located at 107 W. Phoenix Avenue. The box culvert is currently comprised of three structures: Bridge 1, Bridge 2, and "The Beam". Bridge 1 is currently used to support vehicular and pedestrian traffic and is located to the north side of Phoenix Avenue. Bridge 2 is directly adjacent on the south side and currently supports only pedestrian traffic as vehicular traffic has been barricaded to keep away from the severely deteriorated Beam that supports a structure currently housing the "Zani" retail store at the southern extent of the project. Current bearing conditions for the existing structures are unknown. The channel had standing water at the time of the investigation. Phoenix Avenue services primarily commercial/retail properties and is a bus route, located near the City of Flagstaff Downtown Bus Connection Center. Water, sanitary sewer, overhead electric, communications, and natural gas utilities run across or near the existing box culvert. The site is relatively flat and drainage is to the south and to the sides of the box culvert.

2.2 General Subsurface Conditions

The existing asphalt section ranges from 2.5 to 4.0 inches in thickness with no observed aggregate base below. The asphalt concrete at Boring B-1 was underlain by 11 inches of Portland Cement Concrete Pavement (PCCP). The asphalt in the area of the box culvert was observed to be in poor condition, with alligator and advanced block cracking throughout. The upper subgrade soils typically consist of Sandy Lean Clay/Clayey Sand, with subordinate amounts of gravel. Refusal on basalt bedrock was encountered in

Borings B-1 and B-2 at 9.1 and 14.0 feet, respectively. Occasional cobbles were observed in the soil profile. Standard Penetration Resistance Tests (SPT) values range from 3 to greater than 50 blows per foot (bpf) in the upper soils. The high blow counts occurred while driving samples through cobble layers and may not be representative of the surrounding soils. Based on visual and tactile observation, the upper soils were generally in a moist state at the time of investigation, typically above or near the plastic limit of the soil. The sample location labeled "CREEK", was located at the entrance to the eastern box culvert. The CREEK sample was obtained at the surface of the channel using a shovel. The current streambed at the box culvert was armored with a well graded gravel with silt and sand.

Laboratory testing indicates liquid limits ranging from 26 to 42 percent with plasticity indices ranging from non-plastic to 20 percent. Percent passing the #200 sieve ranged from 6 to 50 percent. It should be noted that the soil sample, BS-1, from boring B-1 exhibited a smell of fuel and during laboratory testing "oil" was observed in the sample. The odor was present in the soil samples and most notable at depths of 1 to 5 feet. Environmental analysis was not part of the scope of this investigation. Several miscellaneous metal trash pieces were encountered in Boring B-1 to depths of 6 feet.

While groundwater was not encountered at the time of our investigation it should be expected that excavations in the Rio De Flag drainage channel are likely to encounter seasonal groundwater. Measures will likely be needed to remove water from footing excavations during construction. Groundwater levels will depend on weather conditions preceding and during construction.

3.0 ANALYSIS AND RECOMMENDATIONS

3.1 Analysis

Analysis of the field and laboratory data indicates that **subsoils at the site are not suitable** for support of the proposed structure. Footings for the new box culvert/bridge should be extended in depth to the basalt bedrock underlying the existing subsoils. Additional rock investigation is recommended in accordance with AASHTO Bridge Design requirements ahead of foundation construction to establish final bearing elevations and to verify that adequate rock conditions are present within the zone of influence of the foundation element. Based on local experience at nearby sites, rock conditions in the area are highly variable and it is recommended that a minimum of 15 feet of rock coring be obtained to verify that adequate bearing conditions exist.

Gradation curves for the existing subsoils and current channel armor are presented in this report appendix for scour design analysis. However current foundation recommendations are to extend footings to rock, which would preclude the need for scour analysis of the existing soils.

As mentioned above, the soil sample, BS-1, from boring B-1 exhibited a smell of fuel and during laboratory testing "oil" was observed in the sample. The odor was present in the soil samples and most notable at depths of 1 to 5 feet. Environmental analysis was not part of the scope of this investigation. Several miscellaneous metal trash pieces were encountered in Boring B-1 to depths of 6 feet.

3.2 Site Preparation

The area for the new box culvert/bridge will require the complete removal of the existing structure, including adjacent asphalt surfaces and any aggregate base. Millings and aggregate base from the existing pavement may be reused in a subbase layer and as general fill if they meet the general intent of MAG/City of Flagstaff Standard Specifications and are selectively stockpiled. Subsoils should be excavated to expose the basalt bearing layer. Depending on the season of construction, groundwater and water in the drainage channel may be present and will require groundwater removal techniques during construction. Shoring and special construction considerations may be required during excavations.

Prior to placing structural backfill around the bridge structure, the grade should be scarified to a depth of 8 inches, moisture conditioned to optimum (±2 percent) and compacted to at least 95 percent of maximum dry density as determined by ASTM D-698. Pavement areas should be treated in a similar manner. Bedrock does not require scarification.

3.3 Foundation Design

If site preparation is carried out as set forth herein, the following recommended safe allowable bearing capacity can be utilized for design:

Table 3.3.1: Foundation Bearing Capacity

Structure	Foundation Type	Bearing Medium	Bearing Depth[1] (feet)	Allowable Bearing Capacity (ksf)
Box Culvert, Abutments	Spread Footings	Undisturbed, clean Basalt Bedrock	2.5	10[2, 3]

Notes:

1. Bearing depth refers to the minimum depth below the lowest finished exterior grade within 5 feet of the structure.
2. Presumptive bearing resistance (capacity) value based on AASHTO LRFD Bridge Design Specifications Table C10.6.2.6.1-1
3. **Additional rock investigation is recommended in accordance with AASHTO Bridge Design requirements ahead of foundation construction to establish final bearing elevation and to verify that adequate rock conditions are present within the zone of influence of the foundation element. A minimum of 15 feet of rock should be cored to verify rock conditions.**

This bearing capacity refers to the total of all loads, dead and live, and is a net pressure. They may be increased one-third for wind, seismic or other loads of short duration. All excavations should be level and cleaned of all loose or disturbed materials prior to concrete or precast placement.

Continuous wall footings and isolated rectangular footings should be designed with minimum widths of 16 and 24 inches respectively, regardless of the resultant bearing pressure.

Estimated settlements under design loads are on the order of negligible to ½ inch for structures bearing on basalt bedrock, virtually all of which will occur during construction. Post-construction differential settlements will be negligible, under existing and compacted moisture contents

Continuous footings and stem walls should be reinforced to distribute stresses arising from small differential movements, and long walls should be provided with control joints to accommodate these movements. Reinforcement and control joints are suggested to allow slight movement and prevent minor slab cracking.

3.4 Seismic Design Parameters

The project area is located in a seismic zone that is considered to have low to moderate historical seismicity. The USGS database shows that there is a 25-30% chance of a major earthquake, magnitude greater than 5.0, within 50km of Flagstaff, AZ within the next 50 years. The largest recorded earthquake within 50km of Flagstaff, AZ was a 4.7 magnitude in 2014. The most recent earthquake within 30 miles of Flagstaff, AZ was a 2.7 Magnitude in April, 2017. Liquefaction is not considered a concern due to the shallow depth to bedrock.

Although soil borings were not advanced to 100 feet, based on the nature of the subsoils encountered in the soil borings and geology in the area, Site Class Definition, Class B (Section 1613, 2012 IBC) may be used for design of the structures bearing on rock. In addition, the following seismic parameters may be used for design (based on 2008 USGS maps adopted by 2012 IBC):

Table 3.4.1 Seismic Parameters

MCE[1] spectral response acceleration for 0.2 second period, S_S:	0.358g
MCE[1] spectral response acceleration for 1.0 second period, S_1:	0.103g
Site coefficient, Fa:	1.0
Site coefficient, Fv:	1.0
MCE[1] spectral response acceleration adjusted for site class, S_{MS}:	0.358g
MCE[1] spectral response acceleration adjusted for site class, S_{M1}:	0.103g
5% Damped spectral response acceleration, S_{DS}:	0.239g
5% Damped spectral response acceleration, S_{D1}:	0.068g
NOTES: 1. MCE = maximum considered earthquake	

3.5 Lateral Pressures

The following ultimate lateral (equivalent fluid) pressure values may be utilized for the proposed construction assuming drained conditions. Increase to full saturated values for wall backfill that is not drained.

Active Pressures (wall allowed to rotate 0.2% of wall height for loose backfill)

Unrestrained Walls (Free Draining)	35 pcf
Unrestrained Walls (**Saturated Condition**)	75 pcf

At-Rest Pressures	
Restrained Walls (Free Draining)	60 pcf
Restrained Walls (**Saturated Condition**)	85 pcf
Passive Pressures	
Continuous Footings	200 pcf
Spread Footings or Drilled Piers	250 pcf
Coefficient of Friction *(With Passive Pressure)*	0.35
Coefficient of Friction *(Without Passive Pressure)*	0.45
Coefficient of Friction *(Clean Basalt Bedrock/Cobbles)*	0.65

All backfill must be compacted to not less than 95 percent (ASTM D-698) to mobilize these passive values at low strain. Expansive native soils should not be used as retaining wall backfill, except as a surface seal to limit infiltration of storm/irrigation water. The expansive pressures could greatly increase active pressures.

3.6 Fill and Backfill

Native soils, old aggregate base, and milled asphalt are suitable for use in roadway subgrade and utility trench backfill. In situ moisture contents may make the native soils difficult to work with if the moisture contents encountered are elevated. Oversized material (> 3 inches) should be removed or reduced in size.

Imported fill, if required, shall meet the following requirements:

Table 3.6.1 – Import Specifications

Specification	Common
Passing 3″/75mm	100%
Passing #200/.075mm	≤60%
Liquid Limit	<30%
Plasticity Index	<10%
Swell[1]	<1.5

Notes:
1. Swell potential when compacted to 95 percent of maximum dry density (ASTM D-698) at a moisture content of 2 percent below optimum, confined under a 100 psf surcharge, and inundated.

Imported common fill for use in site grading should be examined by a Soils Engineer to ensure that it is of low swell potential and free of organic or otherwise deleterious material.

Although "clean" cinders often times meet these fill specifications for placement of common fill, they may pose difficulties during construction. Due to their granular nature and lack of sufficient fines, "clean" cinders are a free draining material. As a result, they may be difficult to properly moisture condition and water may infiltrate the cinders and saturate the underlying soils. This could result in an unstable support for pavement. Excess water, as a result of moisture conditioning, is often observed at the interface between the fill and underlying less permeable material. "Clean" cinders also pose difficulties in trenching operations due to the inability to excavate neat trenches. With the lack of fines and cohesive soils, the clean cinders generally slough and vertical walls are hard to maintain.

Fill should be placed on subgrade which has been properly prepared and approved by a Soils Engineer. Fill must be wetted and thoroughly mixed to achieve optimum moisture content, ±2 percent. Granular fill (ASTM Classification GW, GP, SW, SP) can be placed on the dry side of optimum at the discretion of the geotechnical engineer on record. The clayey soils may be sensitive to excessive moisture content and may become unstable at elevated moisture contents. Accordingly, it may be necessary to compact soils on the dry side of optimum. The reduced moisture content under pavements should only be used upon approval of the engineer in the field.

Fill should be placed in horizontal lifts of 8-inch thickness (or as dictated by compaction equipment) and compacted to the percent of maximum dry density per ASTM D-698 as set forth below. **Frozen material shall not be placed, nor shall fill be placed upon frozen grade.**

A.	Bridge/Sidewalk Subgrade or Fill	95
B.	Pavement Subgrade or Fill	95
C.	Utility Trench Backfill	
	1. More than 2.0' below finish subgrade	95
	2. Within 2.0' of finish subgrade (non-granular)	95
	3. Within 2.0' of finish subgrade (granular)	100
D.	Aggregate Base Course	
	1. Below concrete slabs	95
	2. Below asphalt paving	100
E.	Landscape Areas	
	1. Miscellaneous fill	90
	2. Utility trench - more than 1.0' below finish grade	85
	3. Utility trench - within 1.0' of finish grade	90

3.7 Utilities Installation

In general, trench excavations for utilities should be able to be accomplished by conventional trenching equipment except where there is concrete pavement. Only occasional cobbles were encountered in the borings at varying depths. Although not encountered in our borings, it is possible that shallow bedrock, large boulders, or concentrated cobble layers may be present at other locations. Deeper trenches will likely encounter groundwater. Due to soft wet soils, trench walls may not stand near-vertically for the short periods of time required to install utilities. Trench walls may experience some premature sloughing due to the relatively low density and moist condition. As the trench walls dry out, additional sloughing should be anticipated. Appropriate lay back or shoring of the trenches should be provided to protect workers entering the trenches. Depending upon the time of season and precipitation, surface flows due to runoff may impact construction.

Backfill of trenches above the bedding/shading zone may be carried out with native excavated material provided material greater than 8 inches is broken down or removed. Material up to 8 inches is allowed provided it does not impact the ability to properly compact the backfill lifts. Removing 3 to 8 inch material may make proper compaction more readily attainable. Material used for backfill of trenches should be moisture-conditioned, placed in 8 inch lifts and mechanically compacted. Water settling is not recommended. Compaction requirements are summarized in the "Fill and Backfill" section of this report.

3.8 Permanent Cut/Fill Slope Limitations

Care should be taken during excavation not to endanger nearby existing structures, roadways, utilities, etc. Depending on proximity, existing structures (including utilities) may require shoring, bracing or underpinning to provide structural stability and protect personnel working in the excavation.

Generally, permanent cut or fill slopes should be no steeper than 2 horizontal to 1 vertical (2:1). Where particular conditions make it appropriate to vary from these slopes, these must be addressed on a case by case basis, either in this report or at special request directed to a representative of this office. Steeper cut slopes in stable rock may be possible (depending on geology), but are not very likely in soils. Determination of acceptable steeper slope ratios is predicated on a stability analysis of the specific geometry, determinations of soil and groundwater characteristics, structure setbacks, surcharge loads and slope stabilization.

In accordance with Building Code requirements, all occupied structures should be set back from the crest (top edge) of the slope such that the outer edge of the nearest foundation is no closer than a distance equal to at least one third (⅓) of the total height of the slope. See specific building code requirements for additional detail and/or placement of structures at the bottom (toe) of slopes.

Where fills are made on hillsides or slopes, the slope of the original ground upon which the fill is to be placed shall be plowed or scarified deeply or where the slope ratio of the original ground is steeper than 5 horizontal to 1 vertical (5:1), the bank shall be stepped or benched to remove all loose soils and to provide a level surface for placement of fill. Ground slopes which are flatter than 5 to 1 may require benching when considered necessary by a representative of this office. The benches should be cut wide enough to remove loose surface soils and allow proper compaction of fills. A minimum bench width of 8 feet is typically recommended for the first lift (toe) of any fill placed on a slope. This width may be reduced at the direction of the field engineer depending on the presence of loose soils, slope steepness, exposed rock and lift thickness. A keyway shall also be constructed at the toe of the slope. The key width shall be ½ times the height of the slope or at least 1½ times the width of the compaction equipment. The key bottom shall be sloped 2% toward the slope. The key shall be excavated into dense soil or rock formation to a minimum depth of 18 inches unless approved otherwise by the engineer.

Placement and obtaining compaction of fill adjacent to fill slopes may be very difficult. Depending on soil type and final slope configuration, it may be necessary to over-build the slope and cut back to the final configuration to obtain the required degree of compaction.

4.0 GENERAL

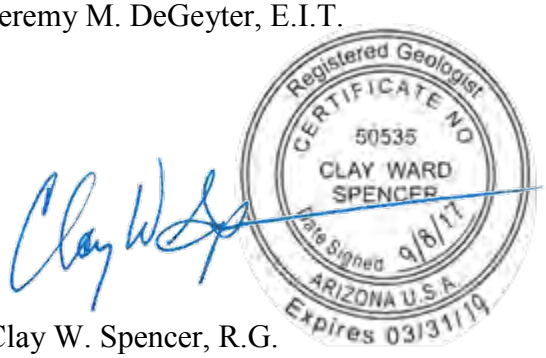
The scope of this investigation and report does not include regional considerations such as seismic activity and ground fissures resulting from subsidence due to groundwater withdrawal, nor any considerations of hazardous releases or toxic contamination of any type.

Our analysis of data and the recommendations presented herein are based on the assumption that soil conditions do not vary significantly from those found at specific sample locations. Our work has been performed in accordance with generally accepted engineering principles and practice; this warranty is in lieu of all other warranties expressed or implied.

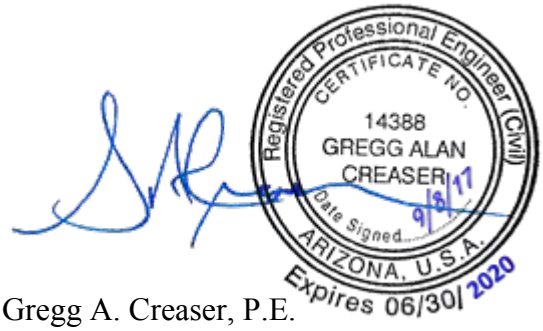
We recommend that a representative of the Geotechnical Engineer observe and test the earthwork and grading portions of this project to ensure compliance to project specifications and the field applicability of subsurface conditions which are the basis of the recommendations presented in this report. If any significant changes are made in the scope of work or type of construction that was assumed in this report, we must review such revised conditions to confirm our findings if the conclusions and recommendations presented herein are to apply.

Respectfully submitted,
SPEEDIE & ASSOCIATES, INC.

Jeremy M. DeGeyter, E.I.T.



Clay W. Spencer, R.G.



Gregg A. Creaser, P.E.

SPEEDIE AND ASSOCIATES
Geotechnical • Environmental • Materials Engineers

APPENDIX

FIELD AND LABORATORY INVESTIGATION

SOIL BORING LOCATION PLAN

SOIL LEGEND

LOG OF TEST BORINGS

TABULATION OF TEST DATA

HYDROMETER GRADATION RESULTS

STREAMBED GRADATION CURVE

CONSOLIDATION TESTS

MOISTURE-DENSITY RELATIONS

SWELL TEST DATA

SPEEDIE AND ASSOCIATES
Geotechnical • Environmental • Materials Engineers

FIELD AND LABORATORY INVESTIGATION

On July 26th, 2017, two structural soil borings were excavated at the approximate locations shown on the attached Soil Boring Location Plan. An additional sample of the streambed material was obtained, by hand, at the northern entrance of the box culvert. All exploration work was carried out under the full-time supervision of our staff engineer, who recorded subsurface conditions and obtained samples for laboratory testing. The borings were excavated with CME-75 drill rig utilizing 7-inch diameter hollow stem augers. Detailed information regarding the soil borings and samples obtained can be found on an individual Log of Test Boring prepared for each location.

Laboratory testing consisted of moisture content, dry density, grain-size distribution, and plasticity (Atterberg Limits) tests for classification and bridge abutment scour design parameters. Remolded swell tests were performed on samples compacted to densities and moisture contents expected during construction. Compression tests were performed on a selected ring samples in order to estimate settlements and determine effects of inundation. All field and laboratory data are presented in this appendix.

⊕ – APPROXIMATE SOIL BORING LOCATIONS

Drawing Courtesy of Google

SOIL BORING LOCATION PLAN

DR:JMD	CHK:CWS	REV:	DATE: 08-31-17	PROJECT NO. 171323SF

Phoenix Ave Box Culvert
107 W Phoenix Ave.
Flagstaff, Arizona

SPEEDIE AND ASSOCIATES
GEOTECHNICAL/ENVIRONMENTAL/MATERIALS ENGINEERS
4025 E. HUNTINGTON, SUITE 140 FLAGSTAFF, ARIZONA 86004

TMPLT_2000.CAD 10/23/00

SOIL LEGEND

SAMPLE DESIGNATION		DESCRIPTION	
	AS	**Auger Sample**	A grab sample taken directly from auger flights.
	BS	**Large Bulk Sample**	A grab sample taken from auger spoils or from bucket of backhoe.
	S	**Spoon Sample**	Standard Penetration Test (ASTM D-1586) Driving a 2.0 inch outside diameter split spoon sampler into undisturbed soil for three successive 6-inch increments by means of a 140 lb. weight free falling through a distance of 30 inches. The cumulative number of blows for the final 12 inches of penetration is the Standard Penetration Resistance.
	RS	**Ring Sample**	Driving a 3.0 inch outside diameter spoon equipped with a series of 2.42-inch inside diameter, 1-inch long brass rings, into undisturbed soil for one 12-inch increment by the same means of the Spoon Sample. The blows required for the 12 inches of penetration are recorded.
	LS	**Liner Sample**	Standard Penetration Test driving a 2.0-inch outside diameter split spoon equipped with two 3-inch long, 3/8-inch inside diameter brass liners, separated by a 1-inch long spacer, into undisturbed soil by the same means of the Spoon Sample.
	ST	**Shelby Tube**	A 3.0-inch outside diameter thin-walled tube continuously pushed into the undisturbed soil by a rapid motion, without impact or twisting (ASTM D-1587).
	--	**Continuous Penetration Resistance**	Driving a 2.0-inch outside diameter "Bullnose Penetrometer" continuously into undisturbed soil by the same means of the spoon sample. The blows for each successive 12-inch increment are recorded.

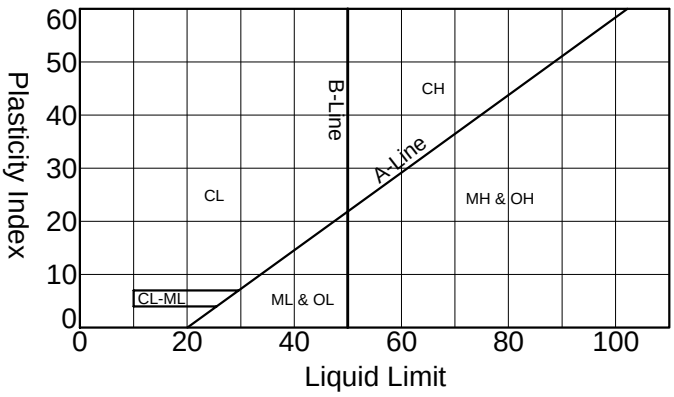
CONSISTENCY			RELATIVE DENSITY	
Clays & Silts	Blows/Foot	Strength (tons/sq ft)	Sands & Gravels	Blows/Foot
Very Soft	0 - 2	0 - 0.25	Very Loose	0 - 4
Soft	2 - 4	0.25 - 0.5	Loose	5 - 10
Firm	5 - 8	0.5 - 1.0	Medium Dense	11 - 30
Stiff	9 - 15	1 - 2	Dense	31 - 50
Very Stiff	16 - 30	2 - 4	Very Dense	> 50
Hard	> 30	> 4		

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS (MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE)	GRAVEL AND GRAVELLY SOILS (MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE)	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS (MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE)	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS (MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE)	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL OR MODIFIED SYMBOLS MAY BE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS OR TO PROVIDE A BETTER GRAPHICAL PRESENTATION OF THE SOIL

MATERIAL SIZE	PARTICLE SIZE			
	Lower Limit		Upper Limit	
	mm	Sieve Size ◆	mm	Sieve Size ◆
SANDS				
Fine	0.075	#200	0.42	#40
Medium	0.420	#40	2.00	#10
Coarse	2.000	#10	4.75	#4
GRAVELS				
Fine	4.75	#4	19	0.75" ×
Coarse	19	0.75" ×	75	3" ×
COBBLES	75	3" ×	300	12" ×
BOULDERS	300	12" ×	900	36" ×

◆U.S. Standard ×Clear Square Openings



Rig Type: **CME-75**
Boring Type: **Hollow Stem Auger**
Surface Elevation: **N/A**

Depth (feet)	Visual Classification	Sample Number	Depth of Sample	Natural Water Content (%)	In-place Dry Density (P.C.F.)	Penetration Resistance Blows per Foot (0 / 25 / 50)
0	2.5 INCHES ASPHALT 11 INCHES CONCRETE					
	0.2					
	Very Loose Brown CLAYEY SAND (SC-Moist) with Some Gravel					
	1.1					
	Stiff Dark Brown SANDY CLAY (CL-Moist) with Trace Gravel	S-2	4.0	NT	NT	
	Metal Trash observed to depth of 6 feet. Fuel odor present in upper soils					
5		S-3	6.5	NT	NT	
		BS-1	7.0	NT	NT	
	Hard Drilling at 7.5 Feet	RS-4	7.8	NT	NT	50/3"
	9.1	S-5	9.1	NT	NT	50/1"
	Auger Refusal on Bedrock					
10						
15						

Boring Date: **7-26-17**
Field Engineer/Technician: **J. DeGeyter**
Driller: **B. Anderson**
Contractor: **Resilient Drilling**

Water Level

Depth	Hour	Date
Free Water was Not Encountered		

NT = Not Tested

SPEEDIE AND ASSOCIATES

Log of Test Boring Number: **B- 1**

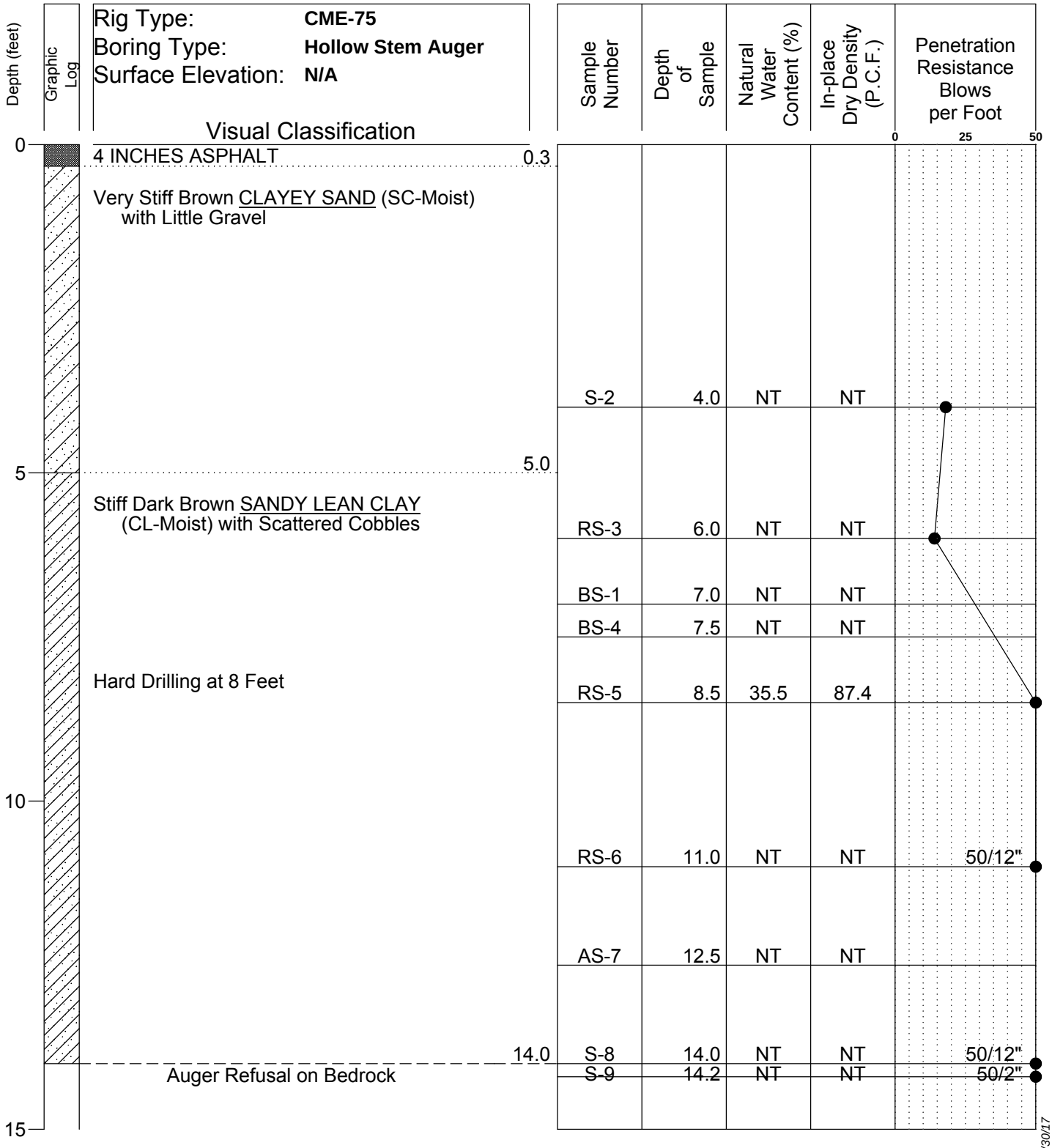
Phoenix Avenue Box Culvert

107 W. Phoenix Avenue

Flagstaff, Arizona

Project No.: **171323SF**

_SPEEDIE 171323SF.GPJ GENGEO.GDT 8/31/17



Boring Date: **7-26-17**
Field Engineer/Technician: **G. Chott**
Driller: **B. Anderson**
Contractor: **Resilient Drilling**

Water Level

Depth	Hour	Date
Free Water was Not Encountered		

NT = Not Tested

SPEEDIE AND ASSOCIATES

Log of Test Boring Number: **B- 2**

Phoenix Avenue Box Culvert

107 W. Phoenix Avenue

Flagstaff, Arizona

Project No.: **171323SF**

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TABULATION OF TEST DATA

SOIL BORING or TEST PIT NUMBER	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE INTERVAL (ft)	NATURAL WATER CONTENT (Percent of Dry Weight)	IN-PLACE DRY DENSITY (Pounds Per Cubic Foot)	PARTICLE SIZE DISTRIBUTION (Percent Finer)					ATTERBERG LIMITS			UNIFIED SOIL CLASSIFICATION	SPECIMEN DESCRIPTION
						#200 SIEVE	#40 SIEVE	#10 SIEVE	#4 SIEVE	3" SIEVE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX		
B- 1	BS-1	BULK	1.0 - 7.0	NT	NT	34.7	54	70	83	100	26	13	13	SC	CLAYEY SAND with GRAVEL
B- 2	BS-4	BULK	5.5 - 7.5	NT	NT	50.4	68	85	93	100	34	16	18	CL	SANDY LEAN CLAY
B- 2	RS-5	RING	7.5 - 8.5	35.5	87.4	15.5	22	33	43	100	42	22	20	GC	CLAYEY GRAVEL with SAND
CREEK	BS-1	BULK	0.0 - 1.0	NT	NT	6.1	12	22	40	100	NP	NP	NP	GW-GM	WELL-GRADED GRAVEL with SILT and SAND

Sieve analysis results do not include material greater than 3". Refer to the actual boring logs for the possibility of cobble and boulder sized materials.

NT=Not Tested

Phoenix Avenue Box Culvert
107 W. Phoenix Avenue
Flagstaff, Arizona
Project No. 171323SF

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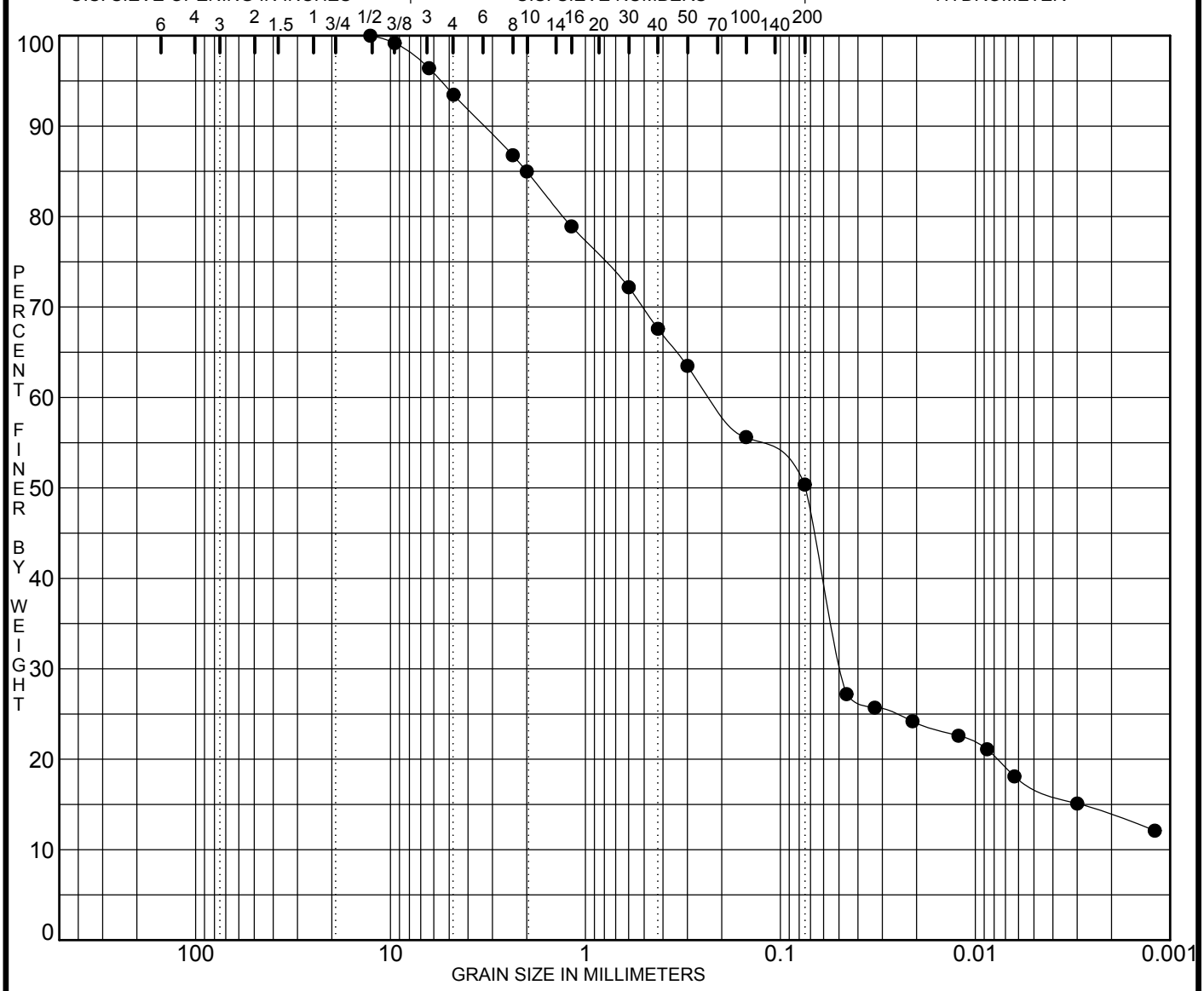

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	**B- 2**	**5.5**	**SANDY LEAN CLAY CL**		**34**	**16**	**19**		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B- 2**	**5.5**	**12.70**	**0.22**	**0.049**		**6.5**	**43.1**	**33.2**	**17.2**

PROJECT **Phoenix Avenue Box Culvert - 107 W. Phoenix Avenue**

JOB NO. **171323SF**

DATE **7/26/17**

GRADATION CURVES

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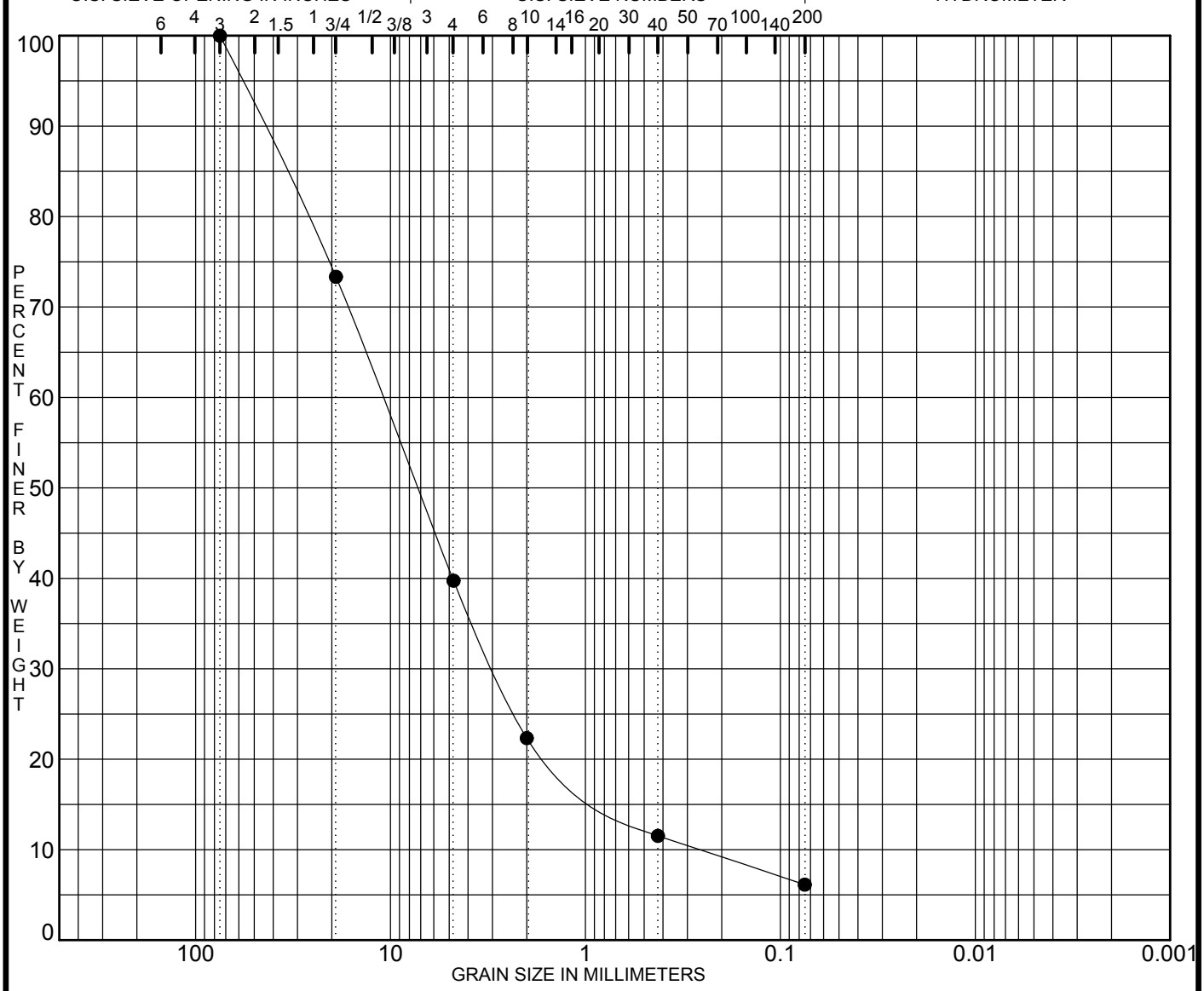

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
●	**CREEK 0.0**	**WELL-GRADED GRAVEL with SILT and SAND GW-GM**		**NP**	**NP**	**NP**	**3.00**	**42.2**

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**CREEK 0.0**	**75.00**	**10.98**	**2.928**	**0.2603**	**60.3**	**33.6**	**6.1**	

PROJECT **Phoenix Avenue Box Culvert - 107 W. Phoenix Avenue**

JOB NO. **171323SF**

DATE **7/26/17**

GRADATION CURVES

SPEEDIE AND ASSOCIATES

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CONSOLIDATION TEST

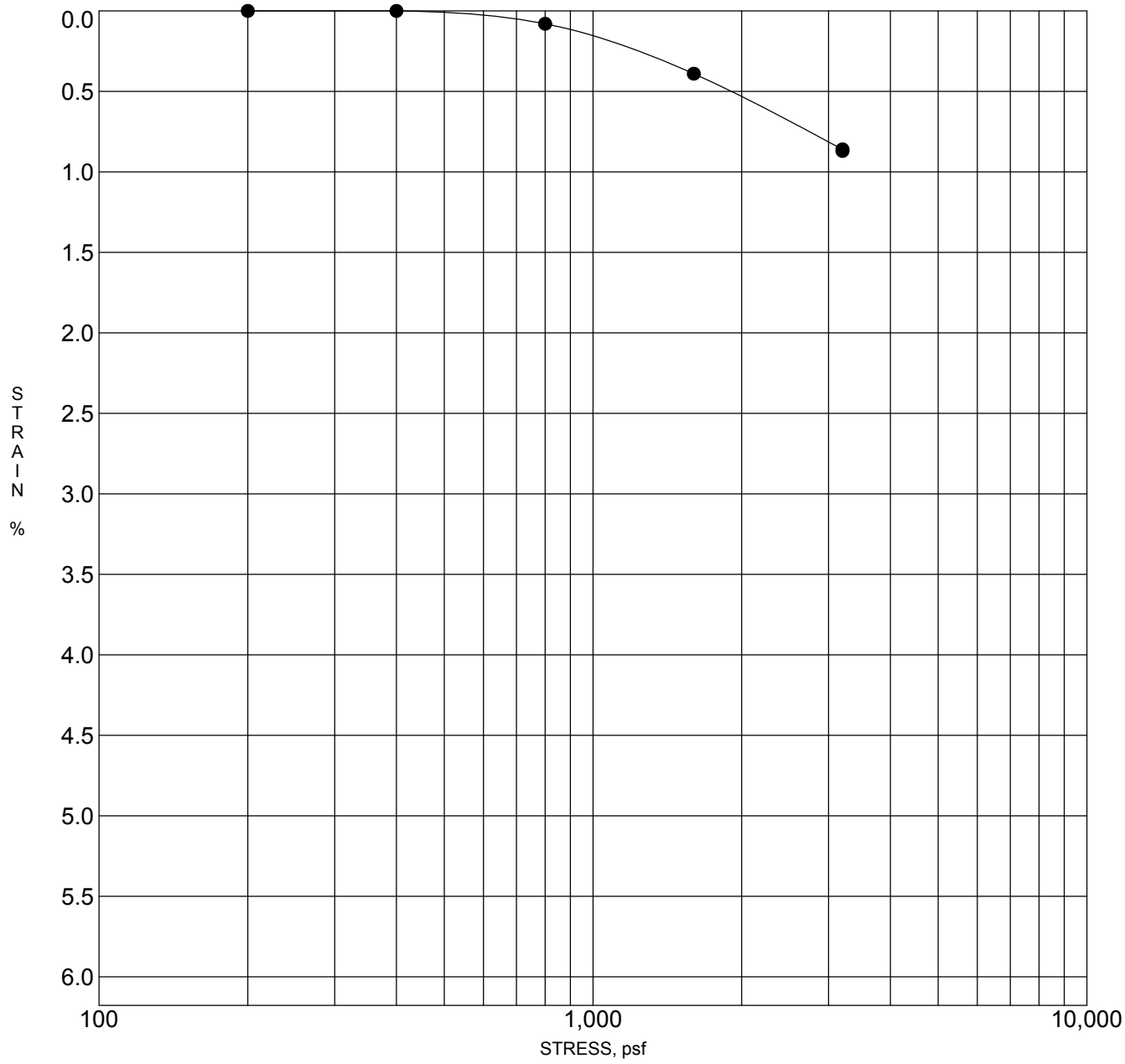
PROJECT: Phoenix Avenue Box Culvert **PROJECT NO.:** 171323SF

LOCATION: 107 W. Phoenix Avenue **DATE:** 7/26/17

BORING NO.: B- 2 **SAMPLE NO.:** RS-5 **SAMPLE DEPTH:** 7.5 to 8.5 **LABORATORY NO.:** VK158

LIQUID LIMIT: 42 **PLASTIC LIMIT:** 22 **PLASTICITY INDEX:** 19

CLASSIFICATION: GC **ASTM SOIL DESCRIPTION:** CLAYEY GRAVEL with SAND



Sample inundated at end of test at 3200 psf

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GEOTECH CONSOLIDATION 171323SF.GPJ GENGEO.GDT 8/30/17

MOISTURE-DENSITY RELATIONS

PROJECT: Phoenix Avenue Box Culvert **PROJECT NO.: 171323SF**

LOCATION: 107 W. Phoenix Avenue **DATE: 7/26/17**

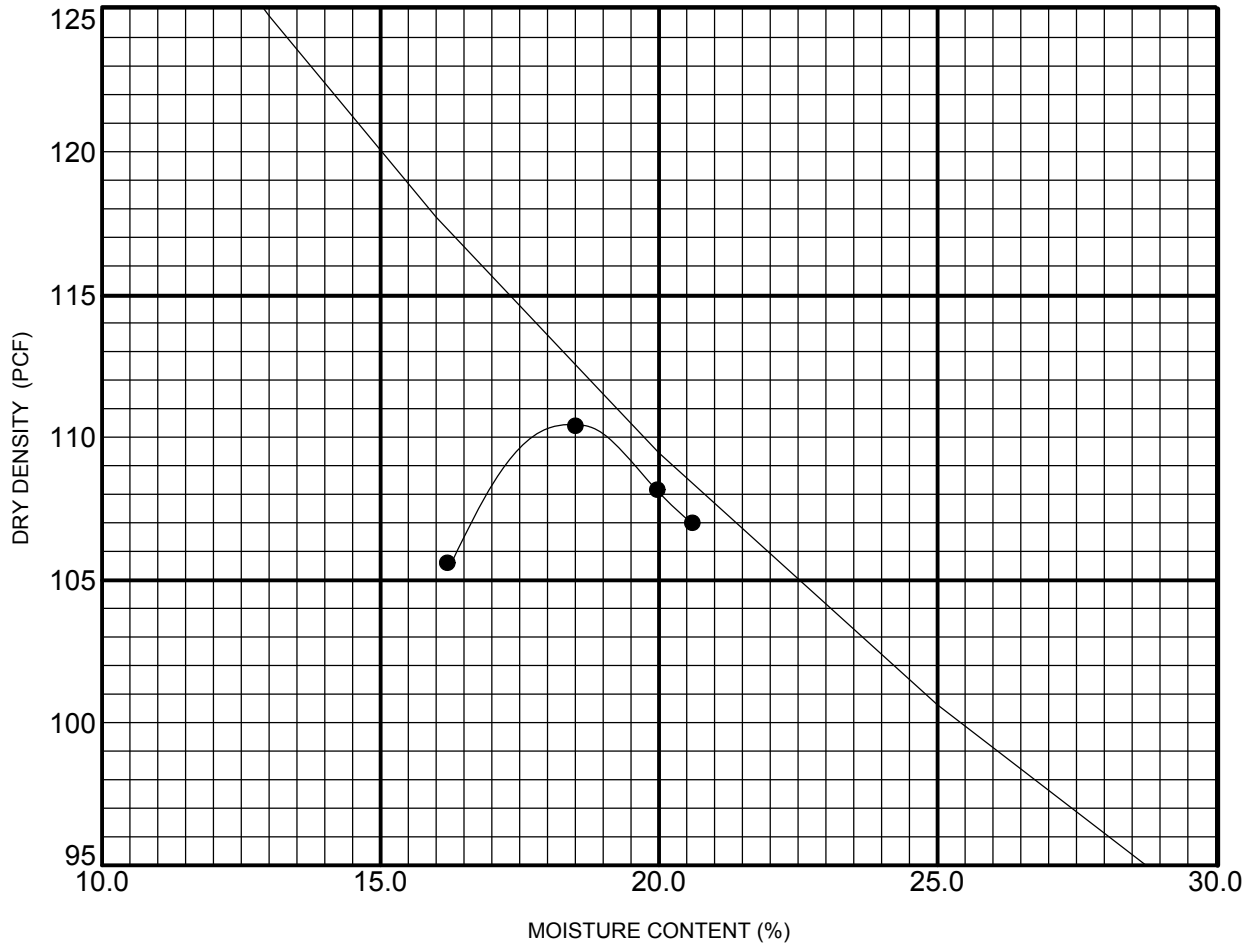
BORING NO.: B- 2 **SAMPLE NO.: BS-4** **SAMPLE DEPTH: 5.5 to 7.5** **LABORATORY NO.: VK157**

METHOD OF COMPACTION: D698A

LIQUID LIMIT: 34 **PLASTIC LIMIT:** 16 **PLASTICITY INDEX:** 19

CLASSIFICATION: CL **ASTM SOIL DESCRIPTION:** SANDY LEAN CLAY

MAXIMUM DRY DENSITY: **110.4 PCF** OPTIMUM MOISTURE CONTENT: **18.5%**



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GEOTECH PROCTOR 171323SF.GPJ 8/30/17

SWELL TEST DATA

BORING or TEST PIT No.	SAMPLE DEPTH, ft	MAXIMUM DRY DENSITY (pcf)	OPTIMUM MOISTURE CONTENT (%)	REMOLDED DRY DENSITY (pcf)	INITIAL MOISTURE CONTENT (%)	PERCENT COMPACTION	FINAL MOISTURE CONTENT (%)	CONFINING LOAD (psf)	TOTAL SWELL (%)
B- 2, BS-4	7.5	110.4	18.5	104.7	17.8	94.8	21	100	1.4

Phoenix Avenue Box Culvert
107 W. Phoenix Avenue
Flagstaff, Arizona
Project No. 171323SF

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SWELL TEST 171323SF.GPJ GENGEO.GDT 8/30/17