Liberty Pipeline Company

Upper System Tank

Technical Specifications

Prepared By

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November 2016

SECTION 4 – GENERAL TECHNICAL REQUIREMENTS
SECTION 4.1
SUMMARY OF AND APPROACH TO WORK

4.1.1 GENERAL: The work to be performed under this project shall consist of furnishing all labor, materials, and equipment necessary or required to complete the work in all respects as shown on the plans and as herein specified. All work, materials, and services not expressly shown or called for in the Contract Documents which may be necessary to complete the construction of the work in good faith shall be performed, furnished, and installed by the CONTRACTOR as though originally so specified or shown, at no increase in cost to the OWNER.

4.1.2 WORK COVERED BY CONTRACT DOCUMENTS: The project includes work to be completed as follows:

Construct 250,000 gallon buried concrete tank, with associated pipe work. Includes bedrock blasting, conventionally-reinforced concrete tank, approx. 1,000ft of 10-inch PVC mainline.

4.1.3 CONTRACT METHOD: The work hereunder will be constructed under both a unit-price and lump sum contract. The CONTRACTOR shall include the General Conditions and Supplementary Conditions as a part of all of its subcontract agreements.

4.1.4 WORK SEQUENCE: Work should proceed in a sequence and manner to minimize down-time (of services, Owner's personnel, Contractor's and Sub-contractor's personnel, etc) and disruption.

4.1.5 APPROACH TO WORK: The work on this project must proceed in a systematic way with a minimum of inconvenience to the public. The CONTRACTOR will confine his operations to as small a portion of work per crew as feasible. The following requirements will be strictly enforced:

4.1.5.1 GRAVEL SURFACE PLACEMENT: The maximum distance behind the gravel surface placement shall be 1,000 feet.

4.1.5.2 CONCURRENT CLEAN-UP: Final clean-up, removal of equipment, barricades and similar items, and restoration of all surfaces to the final condition will have been completed concurrent with the completion of the trench surface restoration.

4.1.5.3 INCLEMENT WEATHER CLEAN-UP: Should construction be halted because of inclement weather conditions, the CONTRACTOR will completely clean up all areas and maintain all streets in good condition during the shut-down period. No excavation in paved streets will be allowed if weather conditions do not permit re-paving of the pipeline trench.

4.1.6 CONTRACTOR USE OF PROJECT SITE: The CONTRACTOR's use of the project site shall be limited to its construction operations, including on-site storage of materials, on-site fabrication facilities, and field offices.

4.1.7 PERMITS AND EASEMENTS: Refer to General Conditions. The OWNER will furnish the required permits and construction easements to the extent shown on the drawings. Additional easements or permits required by the CONTRACTOR shall be obtained by CONTRACTOR at no additional expense to the OWNER.

4.1.8 PROJECT SECURITY: The CONTRACTOR shall make adequate provisions, subject to the approval of the ENGINEER, to protect the project and CONTRACTOR's facilities from fire, theft, and vandalism, and the public from unnecessary exposure to injury.

4.1.9 NO SUNDAY WORK: Except under conditions covered in the General Conditions, no work will be permitted on the Project on Sundays.

SECTION 4.2
PROJECT COORDINATION

4.2.1 SINGLE CONTRACT RESPONSIBILITY: The work included in these Contract Documents shall be performed under the responsibility of a single prime contract. The CONTRACTOR is responsible for the coordination of all the work, whether performed by his own personnel or his subcontractors, and shall keep his workmen and suppliers informed of project progress to avoid delay in completion of the work.

4.2.2 COORDINATION OF PROJECT ELEMENTS: Coordinate work of the various Sections of Specifications to assure efficient and orderly sequence of installation of construction elements, with provision for accommodation of items to be installed later.

4.2.3 CONCURRENT CONSTRUCTION: The OWNER and/or utility owners may be working within the project area while this contract is in progress. If so, the CONTRACTOR shall schedule his work in conjunction with these other organizations to minimize mutual interference.

4.2.4 TESTING COORDINATION: All testing requirements specified shall be competed by a testing agency approved by the Owner, coordinated by the Contractor and paid for by the OWNER. Payment will be in the form of reimbursement at the invoiced cost of the testing facility. Completion of testing as required in these specifications, the entity having jurisdiction or the Owner shall be the responsibility of the Contractor.

SECTION 4.3
CONSTRUCTION SURVEYING

4.3.1 CONSTRUCTION SURVEYING: The Contractor shall be responsible for any and all of its surveying needs. The Engineer shall lend limited assistance to the Contractor's surveyor to help establish horizontal and vertical control, at no cost to the Contractor.

SECTION 4.4
ABBREVIATIONS

4.4.1 GENERAL: Wherever in the Contract Documents references are made to the standards, specifications, or other published data of the various national, regional, or local organizations, such organizations may be referred to by their acronym or abbreviation only. As a guide to the user of these specifications, the following acronyms or abbreviations which may appear in the Contract Documents shall have the meanings indicated herein.

4.4.2 ABBREVIATIONS AND ACRONYMS:

AAR	Association of American Railroads
AASHTO	American Association of the State Highway and Transportation Officials
ACI	American Concrete Institute
AGA	American Gas Association
AGC	Associated General Contractors
AI	The Asphalt Institute
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
ANSI	American National Standards Institute, Inc.
APWA	American Public Works Association
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASOC	American Society of Quality Control
ASSE	American Society of Sanitary Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society
AWWA	American Water Works Association
BBC	Basic Building Code, Building Officials and Code Administrators International
CEMA	Conveyors Equipment Manufacturer's Association
CGA	Compressed GAS Association
CLFMI	Chain Link Fence Manufacturer's Institute
CMA	Concrete Masonry Association
CRSI	Concrete Reinforcing Steel Institute
EIA	Electronic Industries Association
ETL	Electrical Test Laboratories
ICBO	International Conference of Building Officials
IEEE	Institute of Electrical and Electronics Engineers
IES	Illuminating Engineering Society
IME	Institute of Makers of Explosives
ISA	Instrument Society of America
ISO	International Organization for Standardization
ITE	Institute of Traffic Engineers
MBMA	Metal Building Manufacturer's Association
NACE	National Association of Corrosion Engineers

SECTION 4.5
REFERENCE STANDARDS

4.5.1 TITLES OF SECTIONS AND SUB-SECTIONS: Captions accompanying specifications sections and sub-sections are for convenience of reference only, and do not form a part of the Specification.

4.5.2 APPLICABLE PUBLICATIONS: Whenever in the Contract Documents references are made to published specifications, codes, standards, or other requirements, it shall be understood that wherever no date is specified, only the latest specifications, standards or requirements of the respective issuing agencies which have been published as of the date that the work is advertised for bids, shall apply; except to the extent that said standards or requirements may be in conflict with applicable laws, ordinances, or governing codes. No requirements set forth herein or shown on the drawings shall be waived because of any provision of, or omission from, said standards or requirements.

4.5.3 SPECIALISTS, ASSIGNMENTS: In certain instances, specification text requires (or implies) that specific work is to be assigned to specialists or expert entities, who must be engaged for the performance of that work. Such assignments shall be recognized as special requirements and shall not be interpreted so as to conflict with the enforcement or building codes and similar regulations governing the work; also they are not intended to interfere with local union jurisdiction settlements and similar conventions. Such assignments are intended to establish which party or entity involved in a specific unit of work is recognized as "expert" for the indicated construction processes or operations. Nevertheless, the final responsibility for fulfillment of the entire set of contract requirements remains with the CONTRACTOR.

4.5.4 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS:

4.5.4.1 CONFORM TO OR EXCEED REQUIREMENTS: Without limiting the generality of other requirements of the specifications, all work specified herein shall conform to or exceed the requirements of all applicable codes and the applicable requirements of the following documents to the extent that the provisions of such documents are not in conflict with the requirements of the Contract Documents nor the applicable codes.

4.5.4.2 UNIFORM BUILDING CODES: Reference herein to "Building Code" or UBC shall mean that Uniform Building Code of the International Conference of Building Officials (ICBO). The latest edition of the code as approved and used by the local agency as of the date of award, as adopted by the agency having jurisdiction, shall apply to the work herein, including all addenda, modifications, amendments, or other lawful changes thereto.

4.5.4.3 MOST STRINGENT REQUIREMENTS: In case of conflict between codes, reference standards, drawings and the other Contract Document, the most stringent requirements shall govern. All conflicts shall be brought to the attention of the ENGINEER for clarification and directions prior to ordering or providing any materials or labor. The CONTRACTOR shall bid the most stringent requirements.

4.5.4.4 APPLICABLE STANDARD SPECIFICATIONS: The CONTRACTOR shall construct the work specified herein in accordance with the requirements of the Contract Documents and the following referenced codes, standards, and specifications listed herein:

References in the Contract Documents to "Standard Specifications" shall mean the Contract Documents including all current supplements, addenda, and revisions thereof.

References herein to "OSHA Regulations for Construction" shall mean Title 29, Part 1926, Construction Safety and Health Regulations, Code of Federal Regulations (OSHA), including all changes and amendments thereto.

References herein to "OSHA Standards" shall mean Title 29, Part 1910, Occupational Safety and Health Standards, Code of Federal Regulations (OSHA), including all changes and amendments thereto.

UTAH DEPARTMENT OF TRANSPORTATION (UDOT) REQUIREMENTS. The CONTRACTOR's work shall conform to UDOT specifications for excavation on State highways.

IBC	International Building Code, Latest Edition
IMC	International Mechanical Code, Latest Edition
IPC	International Plumbing Code, Latest Edition
	Life Safety Code (NFPA 101), Latest Edition
	National Electric Code (NEC-NFPA 70), Latest Edition
	State of Utah Public Drinking Water Regulations
	Rules and Regulations Governing Excavation Work
UOSHA	Utah Occupational Safety and Health Administration
AASHTO	American Association of State Highway
ACI	American Concrete Institute
AGC	Associated General Contractors of America
AI	Asphalt Institute
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
EJCDC	Engineers' Joint Contract Documents Committee
UL	Underwriter's Laboratories, Inc.

Protection of life, health, and public welfare as it relates to execution of the construction contract is the responsibility of the CONTRACTOR. Neither the OWNER nor the ENGINEER will provide observation, inspection, supervision, or any comment on plans, procedures, or actions employed at the project as they relate to safety of life, health, or public welfare. If conditions are imposed by the ENGINEER or OWNER which interfere with, or imply actions detrimental to safety, written notice shall be issued by the CONTRACTOR and a decision shall be returned to the CONTRACTOR for action prior to effecting any unsafe procedure or condition.

SECTION 4.6
PROJECT MEETINGS

4.6.1 PRE-CONSTRUCTION CONFERENCE: Prior to the commencement of work at the site, a pre-construction conference will be held at a mutually agreed time and place which shall be attended by the CONTRACTOR, its superintendent, and its subcontractors as appropriate. Other attendees will be:

- Engineer and the Resident Project Representative
- Representatives of OWNER; Governmental representatives as appropriate
- Utility company representatives
- Others as requested by CONTRACTOR, OWNER, or ENGINEER

4.6.1.1 PRE-CONSTRUCTION SUBMITTALS: Unless previously submitted to the ENGINEER, the CONTRACTOR shall bring to the conference one copy each of the following:

- Progress schedule
- Procurement schedule of major equipment and materials and items requiring long lead time
- Shop drawing/sample/substitute or "Or Equal" submittal schedule

4.6.1.2 PRE-CONSTRUCTION CONFERENCE PURPOSE: The purpose of the conference is to designate responsible personnel and establish a working relationship. Matters requiring coordination will be discussed and procedures for handling such matters established. The complete agenda will be furnished to the CONTRACTOR prior to the meeting date, which may include the following:

- CONTRACTOR'S tentative schedules
- Transmittal, review, and distribution of CONTRACTOR'S submittals
- Processing applications for payment
- Maintaining record documents
- Critical work sequencing
- Field decisions and Change Orders
- Use of project site, office and storage areas, security, housekeeping, and OWNER's needs
- Major equipment deliveries and priorities
- CONTRACTOR'S assignments for safety and first aid

4.6.1.3 PRE-CONSTRUCTION VIDEO RECORDS: The ENGINEER will produce a pre-construction video record of areas where work is to be performed. The video record shall be of professional quality and the coverage shall be such, as to allow accurate determination of location, size and condition, etc. of existing features and improvements within the rights-of-way. The ENGINEER shall provide the OWNER with a copy of the video in an acceptable format, before construction begins.

4.6.1.4 PRE-CONSTRUCTION CONFERENCE MINUTES: The ENGINEER will preside at the pre-construction conference and will arrange for keeping the minutes and distributing the minutes to all persons in attendance.

4.6.2 PROGRESS MEETINGS: The ENGINEER shall schedule and hold regular on-site progress meetings at least weekly and at other times as required by progress of the work. The CONTRACTOR, ENGINEER, and all subcontractors active on the site shall be represented at each meeting. The CONTRACTOR may at its discretion request attendance by representatives of its suppliers, manufacturer's, and other subcontractors.

4.6.2.1 PROGRESS MEETING MINUTES: The ENGINEER shall preside at the meetings and provide for keeping and distribution of the minutes. The purpose of the meetings will be to review the progress of the work, maintain coordination of efforts, discuss changes in scheduling, and resolve other problems which may develop.

SECTION 4.7
CONTRACTOR SUBMITTALS

4.7.1 SHOP DRAWING SUBMITTAL:

4.7.1.1 SUBMITTAL COPIES: The CONTRACTOR shall furnish to the ENGINEER for review three (3) copies of each shop drawing submittal. The term "Shop Drawings" as used herein shall be understood to include detail design calculations, shop drawings, fabrication and installation drawings, erection drawings, lists, graphs, operating instructions, catalog sheets, data sheets, and similar items. Shop drawings and submittal requirements shall include interpretations of proposed or required configurations not shown on the drawings, so a document record of such can be approved.

4.7.1.2 SUBMITTAL TIME TABLE: Drawings shall be submitted sufficiently in advance to allow the ENGINEER not less than ten regular working days for examining the drawings. These drawings shall be accurate, distinct, and complete and shall contain all required information, including satisfactory identification of items and unit assemblies in relation to the contract drawings and/or specifications.

4.7.1.3 SUBMITTAL APPROVAL: When the shop drawings are approved by the ENGINEER, two sets of prints will be returned to the CONTRACTOR marked "Approved", "Approved, Except as Noted", or similar notation; if changes or corrections are necessary, one set will be returned to the CONTRACTOR with such changes or corrections, indicated by a brief statement, and the CONTRACTOR shall correct and resubmit the drawings, in triplicate, when requested by the ENGINEER.

4.7.1.4 REBAR SUBMITTALS: Approval of shop drawings will not be required of reinforcing steel that is detailed by the CONTRACTOR in accordance with the plans and specifications. Any change from the plans and specifications that is made by the CONTRACTOR in reinforcing steel as well as any other change shall be approved by the ENGINEER in a written change order prior to any work being altered from that already approved for construction.

4.7.1.5 FABRICATION SCHEDULE: Fabrication of an item may be commenced only after the ENGINEER has reviewed the pertinent submittals and returned copies to the CONTRACTOR marked either "Approved" or "Approved - Except as Noted". Corrections indicated on submittals shall be considered as changes necessary to meet the requirements of the Contract Documents and shall not be taken as the basis of claims for extra work.

4.7.1.6 PRE-SUBMITTAL REVIEW: All CONTRACTOR shop drawing submittals shall be carefully reviewed by an authorized representative of the CONTRACTOR, prior to submission to the ENGINEER.

4.7.1.7 RESPONSIBILITY AND RISK: The ENGINEER's review of CONTRACTOR shop drawing submittals shall not relieve the CONTRACTOR of the entire responsibility for the corrections of details and dimensions. The CONTRACTOR shall assume all responsibility and risk for any misfits due to any errors in CONTRACTOR submittals.

The CONTRACTOR shall be responsible for dimensions and the design of adequate connections and details.

4.7.2 SAMPLES SUBMITTAL:

4.7.2.1 ITEM SAMPLE: Whenever requested of the ENGINEER, the CONTRACTOR shall submit at least one sample of each item or material to the ENGINEER for acceptance at no additional cost to the OWNER.

4.7.2.2 PRE-ORDERING SAMPLES: Samples, as required herein, shall be submitted for acceptance prior to ordering such material for delivery to the job site, and shall be submitted in an orderly sequence so that dependent materials or equipment can be assembled and reviewed without causing delays in the Work.

4.7.2.3 COLORS AND TEXTURES: Unless otherwise specified, all colors and textures of specified items will be selected by the ENGINEER from the manufacturer's standard colors and standard materials, products, or equipment lines.

4.7.3 OPERATIONS AND MAINTENANCE MANUAL SUBMITTAL:

4.7.3.1 MANUAL ORGANIZATION: The CONTRACTOR shall furnish to the ENGINEER three (3) identical sets of Operation and Maintenance manuals. Each set shall consist of one or more volumes, each of which shall be bound in a standard size, 3-ring, loose-leaf, vinyl plastic hard cover binder suitable for bookshelf storage. Binder ring size shall not exceed 2.5 inches. A table of contents shall be provided which indicates all equipment in the Operation and Maintenance manuals

4.7.3.2 MANUAL CONTENTS: The CONTRACTOR shall include in the Operation and Maintenance manuals full details for care and maintenance for all visible surfaces as well as the following for each item of mechanical, electrical, and instrumentation equipment:

Complete operating instructions, including location of controls, special tools or other equipment required, related instrumentation, and other equipment needed for preventive maintenance procedures and schedules.

- Preventive maintenance procedures and schedules.
- Complete parts lists, by generic title, identification number, and catalog number, complete with exploded views of each assembly.
- Disassembly and re-assembly instructions.
- Name and location of nearest supplier and spare parts warehouse.
- Name and location of manufacturer.
- Recommended troubleshooting and start-up procedures.
- Prints of the record drawings, including diagrams and schematics, as required under the electrical and instrumentation portions of these specifications.

4.7.3.3 SUBMITTAL TIME: All Operation and Maintenance manuals shall be submitted in final form to the ENGINEER not later than the 75 percent of construction completion date. All discrepancies found by the ENGINEER in the Operation and Maintenance manuals shall be corrected by the CONTRACTOR prior to final acceptance of the project at no additional cost to the OWNER.

SECTION 4.8
QUALITY CONTROL

4.8.1 INSPECTION OF MATERIALS: At the option of the ENGINEER, materials to be supplied under this contract will be tested and/or inspected either at their place of origin or at the site of the work. The CONTRACTOR shall give the ENGINEER written notification well in advance of actual readiness of materials to be tested and/or inspected at point of origin. Satisfactory tests and inspections at the point of origin shall not be construed as a final acceptance of the material nor shall it preclude re-testing or re-inspection at the site of the work.

The CONTRACTOR shall furnish such samples of materials as are requested by the ENGINEER, without charge. No material shall be used until it has been approved by the ENGINEER. See Section 4.7, Contractors Submittals.

4.8.2 AUTHORITY AND DUTIES OF INSPECTOR:

4.8.2.1 SCOPE OF INSPECTION: Inspectors employed by the OWNER shall be authorized to inspect all work done and materials furnished. Such inspection may extend to all or any part of the work, and to the preparation, fabrication, or manufacture of the materials to be used. The inspector is not authorized to alter or waive the provisions of these specifications.

4.8.2.2 INSPECTOR ROLE: An inspector is placed on the work to keep the ENGINEER informed of the progress of the work and the manner in which it is being done; also to call the CONTRACTOR's attention to any non-conformance with the plans and specifications, not to act as foreman for the CONTRACTOR. The inspector shall have authority to reject defective material and to reject any work that is being improperly performed, subject to the final decision of the ENGINEER. The inspector will exercise such additional authority only as may from time to time be delegated to him from the ENGINEER.

4.8.2.3 CONTRACTOR OBLIGATION: The inspection of the work shall not relieve the CONTRACTOR of any of his obligations to fulfill his contract as herein provided, and unsuitable materials may be rejected notwithstanding that such work and materials may have been overlooked and accepted or estimated for payment.

4.8.3 TESTS AND INSPECTIONS: Refer to General Conditions for responsibilities.

The OWNER shall employ and pay for the services of a qualified independent testing consultant, approved by the ENGINEER to perform specified services for the testing of:

- Soils Compaction Control
- Paving and Surfacing Replacement
- Materials Testing (Concrete, grout, Surface Finishes, etc.)

The Contractor shall arrange for the performance of all other tests and inspections required by the Contract Documents.

4.8.4 REQUIREMENTS FOR INDEPENDENT TESTING CONSULTANTS:

4.8.4.1 QUALIFICATIONS: Comply with basic requirements of ASTM E329, "Standards of Recommended Practice for Inspection and Testing Agencies for Concrete, Steel, and Bituminous Materials as Used in Construction", latest edition.

4.8.4.2 TEST REPORTS: Testing agency shall be instructed to submit directly to ENGINEER, all reports of tests or inspections made, showing compliance, irregularities or deficiencies, identifying project, date of test, location in project, applicable specification section, applicable standard(s) for compliance, observations relating to compliance, name and signature of inspector.

4.8.5 CONTRACTOR RESPONSIBILITIES: Furnish above qualification data and expedite submittals if and when testing consultant is employed by CONTRACTOR. Provide access to the work and furnish casual labor and facilities to accommodate inspections and tests. When tests fail to meet specified requirements, CONTRACTOR shall arrange for re-testing after conditions have been corrected. Conduct such re-testing at no additional expense to the OWNER.

SECTION 4.9
PROTECTION OF EXISTING FACILITIES

4.9.1 GENERAL: Any existing facilities disturbed which are located in the line of work such as curbs, gutters, sidewalks, driveways, fences, underground pipes, conduits, or utilities, shall be cleaned up and restored in kind by the CONTRACTOR and in accordance with the specifications contained herein governing the various types of services involved.

4.9.2 RESTORATION OF FENCES: Where it is necessary to remove any fence to facilitate the CONTRACTOR's operation, the CONTRACTOR shall obtain prior agreement with the OWNER for removal of the fence, and shall be responsible for any damage due to negligence of the CONTRACTOR. As soon as practical, the fence shall be restored substantially to the same or improved condition as it was in, prior to the commencement of the work.

4.9.3 INTERFERING STRUCTURES AND UTILITIES: The CONTRACTOR shall exercise all possible caution to prevent damage to existing structures and utilities, whether above ground or underground. It shall be the responsibility of the CONTRACTOR to locate and expose all existing underground and overhead structures and utilities in such a manner as to prevent damage to same. The CONTRACTOR shall notify all utility offices concerned at least 48 hours in advance of construction operations in which a utility agency's facilities may be involved. This shall include, but not be limited to, irrigation water, culinary water, telephone, cable television, gas, sewer, and power. The CONTRACTOR shall be responsible for any and all changes to, reconnections to public utility facilities encountered or interrupted during prosecution of the work (refer to General Conditions). The CONTRACTOR shall contract with and pay Public Utility Agencies for work required in connection with all utility interferences and handle all necessary notifications, scheduling, coordination, and details. The cost of public utility interferences shall be included in the CONTRACTOR's lump sum or unit price bid covering the major contract facility to which interference or changes are attributable.

4.9.3.1 PRIVATE PROPERTY: Any damages to private property, either inside or outside the limits of the easements provided by the OWNER, shall be the responsibility of the CONTRACTOR. Any roads, structures, or utilities damaged by the work shall be repaired or replaced in a condition equal to or better than the condition prior to the damage. Such repair or replacement shall be accomplished at the CONTRACTOR's expense without additional compensation from the OWNER, unless otherwise specified.

4.9.3.2 RESPONSIBILITIES: The CONTRACTOR shall remove and replace small miscellaneous structures such as fences and culverts which are damaged by the construction activity at his own expense without additional compensation from the OWNER. The CONTRACTOR shall replace these structures in a condition as good as or better than their original condition, unless otherwise specified.

4.9.3.3 SPECIFIED PROTECTION: At points where the CONTRACTOR's operations are adjacent to or across properties of railway, telegraph, telephone, irrigation canal, power, cable television, gas, water, or adjacent to other property (damage to which might result in considerable expense, loss, and inconvenience), no work shall be started until all arrangements necessary for the protection thereof have been made.

4.9.3.4 UTILITY LOCATIONS: The locations of the major existing culinary water lines, gas pipes, sewer lines, underground power, cable television, and telephone lines that are shown on the plans, were taken from city maps, and maps supplied by the utility owner. Preliminary investigations have indicated they are generally reliable. However, it should be expected that some location discrepancies will occur.

4.9.3.5 UTILITY INTERRUPTIONS: In the event of interruption to culinary water, or to other utility services as a result of accidental breakage of located utilities, or as a result of being exposed or unsupported, the CONTRACTOR shall promptly notify the proper authority. The CONTRACTOR shall cooperate with the authority in restoration of service as soon as possible, and shall bear all cost of repair. In no case shall interruption of any water or utility service be allowed outside working hours unless prior approval is received.

4.9.4 RIGHTS-OF-WAY:

4.9.4.1 CONFINE CONSTRUCTION: The CONTRACTOR shall be required to confine construction operations within the dedicated rights-of-way for public through fares, or within areas for which construction easements have been obtained, unless they have made special arrangements with the affected property owners in advance. The CONTRACTOR shall be required to protect stored materials, cultivated trees and crops, and other items located adjacent to the proposed construction site.

4.9.4.2 ENGINEER'S DIRECTION: The ENGINEER may direct the type and size of equipment used, and the methods, for work performed on the rights-of-way across private properties, to avoid or minimize injury to trees, shrubs, gardens, lawns, fences, driveways, retaining walls, or other improvements within the rights-of-way.

4.9.4.3 PROPERTY OWNER ACCESS: Property owners affected by the construction shall be notified by the CONTRACTOR at least 48 hours in advance of the time the construction begins. During all construction operations, the CONTRACTOR shall construct and maintain such facilities as may be required to provide access by all property owners to their property. No person shall be cut off from access to his property for a period exceeding 8 hours unless the CONTRACTOR has made special arrangements with the affected person. The CONTRACTOR shall, daily or more frequently if necessary, grade all disturbed areas to be smooth for motor vehicle traffic.

SECTION 4.10
TEMPORARY FACILITIES AND CONTROLS

4.10.1 GENERAL: CONTRACTOR shall be responsible for providing or arranging with subcontractors for all temporary utilities, facilities and controls during the construction period.

4.10.2 TEMPORARY UTILITIES:

4.10.2.1 WATER: The CONTRACTOR shall be responsible for locating a source of water supply, adequate for use for construction, drinking, sanitation, and fire protection purposes, and for all connections, distribution facilities, and costs associated therewith.

4.10.2.2 ELECTRIC POWER AND LIGHTING: The CONTRACTOR shall be responsible for locating a temporary source of electrical energy for use during the construction period, and for providing needed power to the site. Temporary electrical work shall meet the requirements of the National Electrical Code (NFPA 70), latest edition. Disconnect and remove all temporary equipment and materials upon completion of construction, and repair all damage caused by temporary installations.

4.10.2.3 FIELD OFFICES AND STORAGE FACILITIES: Provide and maintain storage sheds, trailers or other facilities as necessary to store and protect materials, tools and equipment.

4.10.2.4 SANITARY FACILITIES: Fixed or portable chemical toilets shall be provided wherever needed for the use of employees. Toilets at construction job sites shall conform to the requirements of Part 1926 of the OSHA Standards for Construction. The CONTRACTOR shall establish a regular daily collection of all sanitary and organic wastes. All wastes and refuse from sanitary facilities provided by the CONTRACTOR or organic material wastes from any other source related to the CONTRACTOR's operations shall be disposed of away from the site in a manner satisfactory to the ENGINEER and in accordance with all laws and regulations pertaining thereto.

4.10.2.5 FENCES AND BARRICADES: Refer to General Conditions and Section 4.9 for responsibilities with respect to protection of persons and property.

Provide and maintain temporary fences, barriers, lights, guardrails and barricades as indicated in the Contract Documents, or as necessary to regulate vehicular and pedestrian traffic, to secure the work and adjacent property, and to protect persons and property. Obtain necessary approvals and permits and provide temporary expedients as necessary to accommodate controls.

SECTION 4.11
MATERIAL AND EQUIPMENT

4.11.1 REQUIRED MATERIALS: All materials incorporated in the project shall be new and shall fully comply with the specifications. Unless otherwise clearly provided in the specifications, all workmanship, equipment, materials, and articles incorporated in the work covered by the contract are to be of the best available grade of their respective kinds. Whenever, in the specifications, any material, article, device product, fixture, form, type of construction, or process is indicated or specified by patent or proprietary name, by name of manufacturer, or by catalog number, such specifications shall be deemed to be used for the purpose of establishing a standard of quality and facilitating the description of the material or process desired and shall be deemed to be followed by the words "or approved equal" and the CONTRACTOR may in such case, upon receiving the ENGINEER's approval, purchase and use any item, type, or process which shall be substantially equal in every respect to that indicated or specified.

4.11.2 PRODUCTS LIST: Within ten (10) days after date of the Contract, submit to ENGINEER two (2) copies of complete list of all products which are proposed for installation. Tabulate list by, and be complete for, each specifications section. Include with listing of each product the name and address of manufacturer, trade name, model or catalog designation, reference standard, manufacturer's performance and test data, and subcontractor, as applicable.

4.11.3 REFERENCE STANDARDS: Reference in the specifications to standard specifications or publications or technical societies or governmental agencies, such as ASTM, ANSI, AISC, ACI, ASW, AWWA, Federal Specifications, or Commercial Standards shall refer to latest edition adopted and published 30 days prior to receiving bids, unless specifically noted otherwise in the Contract Documents. It shall be understood that all manufacturers, producers and their agents of materials required shall have such reference standards available for reference and be fully familiar with their requirements as pertains to their product, material or equipment.

In case of conflict between reference standards and project specifications, project specifications shall govern. In case of conflict between reference standards and codes, the one having the more stringent requirements shall govern.

4.11.4 MANUFACTURER'S INSTRUCTIONS: Refer to General Conditions. CONTRACTOR shall obtain and distribute necessary copies of manufacturer's instructions, including two copies to the ENGINEER. If a conflict exists between the manufacturer's instructions and the Contract Documents, notify the ENGINEER in writing and obtain his instruction prior to proceeding.

4.11.5 PRODUCT DELIVERY, STORAGE AND HANDLING: Deliver materials, products and equipment to the project site in undamaged condition in manufacturer's original, unopened containers or packaging with identifying labels intact and legible. Arrange deliveries in accordance with the Construction Schedule and in ample time to facilitate inspection prior to installation to avoid unnecessary delays in the construction process.

Store and handle products as prescribed by manufacturer or as specified in the Contract Documents in a manner to protect from damage by moisture, weather, abuse or construction operations.

4.11.6 EQUIPMENT: All equipment which is proposed to be used on the work shall be of sufficient size and in such mechanical condition as to meet requirements of the work and to produce a satisfactory quality of work. Equipment used on any portion of the project shall be such that no injury to the roadway, adjacent property or other highways will result from its use. When the methods and equipment to be used by the CONTRACTOR in accomplishing the construction are not prescribed in the contract, the CONTRACTOR is free to use any methods or equipment that he demonstrates to the satisfaction of the ENGINEER will accomplish the contract work in conformity with the requirements of the contract.

SECTION 4.12
SITE ACCESS AND STORAGE

4.12.1 HIGHWAY LIMITATIONS: The CONTRACTOR shall make its own investigation of the condition of available public and private roads and of clearances, restrictions, bridge load limits, and other limitations affecting transportation and ingress and egress to the site of the work. It shall be the CONTRACTOR's responsibility to construct and maintain any haul roads required for its construction operations.

4.12.2 STREET USE: Nothing shall be construed to entitle the CONTRACTOR to the exclusive use of any public street, alleyway, or parking area during the performance of the work hereunder, and the CONTRACTOR shall so conduct operations as not to interfere unnecessarily with the authorized work of utility companies or other agencies in such streets, alleys, ways, or parking areas. No street shall be closed to the public without first obtaining permission of the ENGINEER and proper governmental authority. Where excavation is being performed in primary streets or highways, one lane in each direction shall be kept open to traffic at all times unless otherwise provided or shown. Toe boards shall be provided to retain excavated material if required by the ENGINEER or the agency having jurisdiction over the street or highway. Fire hydrants on or adjacent to the work shall be kept accessible to fire-fighting equipment at all times. Temporary provisions shall be made by the CONTRACTOR to assure the use of sidewalks and the proper functioning of all gutters, sewer inlets, and other drainage facilities.

4.12.3 CONTRACTOR'S WORK AND STORAGE AREA: The CONTRACTOR shall make arrangements for any necessary off-site storage or shop areas necessary for the proper execution of the work. The Contractor is free to utilize available space at the Owner’s facilities, with the understanding that the Contractor will be entirely responsible for any shipping or transportation costs, and any negative impacts to facilities or traffic control as a result of using said facilities.

SECTION 4.13
ENVIRONMENTAL CONTROLS

4.13.1 EXPLOSIVES AND BLASTING: The use of explosives on the work will not be permitted unless permission is granted by the ENGINEER on a case by case basis. In the event blasting becomes necessary, a blasting plan shall be submitted for prior approval by the ENGINEER. Costs for blasting will be determined by an approved change order unless a bid item for such work is included in the Bid Form.

4.13.2 DUST ABATEMENT: The CONTRACTOR shall furnish all labor, equipment, and means required and shall carry out effective measures at his own expense wherever and as often as necessary to prevent its operation from producing dust in amounts damaging to property, cultivated vegetation, or domestic animals, or causing a nuisance to persons living in or occupying buildings in the vicinity. The CONTRACTOR shall be responsible for any damage resulting from any dust originating from operations. The dust abatement measures shall be continued until the CONTRACTOR is relieved of further responsibility by the ENGINEER.

4.13.3 STORM AND GROUND WATER: The CONTRACTOR shall provide and maintain at all times during construction, ample means and devices with which to promptly remove and properly dispose of all water entering the excavation or other parts of the work, whether the water be surface or underground water.

4.13.3.1 PROTECT EXISTING DRAINAGE: In excavation, fill, and grading operations, care shall be taken to disturb the preexisting drainage pattern as little as possible. Particular care shall be taken not to direct drainage water onto private property or into streets or drainage ways inadequate for the increased flow. The ENGINEER will not approve the filling of ditches, washes, drainage-ways, wet-lands, etc., which may in his opinion create water control problems.

4.13.3.2 SEDIMENT CONTROL: The CONTRACTOR shall maintain effective means to minimize the quantity of sediments leaving the work area either by storm water or the CONTRACTORS own dewatering operations.

4.13.4 NOISE ABATEMENT: In inhabited areas, particularly residential, operations shall be performed in a manner to minimize unnecessary noise generation. In residential areas, particular consideration shall be given to noise generated by repair and service activities during the night hours.

4.13.5 WASTE DISPOSAL: The CONTRACTOR shall provide for the disposal of all surplus materials, waste products, debris, etc., and shall make necessary arrangements for such disposal. The CONTRACTOR shall obtain written permission from property owner(s) prior to disposing of any surplus materials, waste products, debris, etc., on private property, and shall also obtain the approval of the ENGINEER prior to such disposal.

4.13.5.1 NUISANCES: The ENGINEER will not approve disposal operations which will, in his opinion, create unsightly and/or unsanitary nuisances.

4.13.5.2 DISPOSAL SITE: The CONTRACTOR shall maintain the disposal site(s) in a reasonable condition of appearance and safety during the construction period as required by the ENGINEER.

4.13.5.3 FINAL ACCEPTANCE: Prior to final acceptance of the project the CONTRACTOR shall have completed the leveling and cleanup of the disposal site(s) to the satisfaction of the ENGINEER.

4.13.6 RESTORATION OF CONSTRUCTION SITE: Clean-up of all construction debris, excess excavation, excess material, and complete restoration of all fences, irrigation structures, ditches, culverts, and similar items shall be completed immediately following final backfill. The CONTRACTOR shall stockpile the excavated trench material so as to do the least damage to adjacent areas, or fences, regardless of whether these are on private property or public rights-of-way. All excavated areas and areas where excavated material has been stockpiled on grassed or planted land shall be left in a condition equivalent to their original surface and free from all rocks, gravel, boulders, or other foreign materials.

4.13.7 RUBBISH CONTROL: During the progress of the work, the CONTRACTOR shall keep the site of the work and other areas used by it in a neat and clean condition, and free from any accumulation of rubbish. The CONTRACTOR shall dispose of all rubbish and waste materials of any nature occurring at the work site, and shall establish regular intervals of collection and disposal of such materials and waste. The CONTRACTOR shall also keep its haul roads free from dirt, rubbish, and unnecessary obstructions resulting from its operations. Disposal of all rubbish and surplus materials shall be off the site of construction in accordance with local codes and ordinances with all applicable safety laws, and the particular requirements of Part 1926 of the OSHA Safety and Health Standards for Construction.

4.13.8 CHEMICALS: All chemicals used during project construction or furnished for project operation, whether defoliant, soil sterilant, herbicide, pesticide, disinfectant, polymer, rasctant or of other classification, shall show approval of the U.S. Department of Agriculture. Use of all such chemicals and disposal of residues shall be in strict accordance with the printed instruction of the manufacturer.

4.13.9 CULTURAL RESOURCES: The CONTRACTOR's attention is directed to the National Historic Prevention Act of 1976 (16 U.S.C. 470) and 36 CFR 800 which provides for the preservation of potential historical architectural, archeological, or cultural resources (hereinafter called "cultural resources"). The CONTRACTOR shall conform to the applicable requirements of the National Historic Preservation Act of 1976 as it relates to the preservation of cultural resources. In the event potential cultural resources are discovered during subsurface excavations at the site of construction, the following procedures shall be instituted:

4.13.9.1 CEASE CONSTRUCTION OPERATIONS: The ENGINEER will issue a Field Order directing the CONTRACTOR to cease all construction operations at the location of such potential cultural resources find.

4.13.9.2 ARCHEOLOGICAL REVIEW: Such Field Order shall be effective until such time as a qualified archeologist can be called to assess the value of these potential cultural resources and make recommendations to the OWNER and ENGINEER.

4.13.9.3 WORK SUSPENSION: If the archeologist determines that the potential find is a bona fide cultural resource, at the direction of the ENGINEER, the CONTRACTOR shall suspend work at the location of the find under the provisions for changes contained in Article 16 of the General Conditions.

SECTION 4.14
PROJECT CLOSEOUT

4.14.1 FINAL CLEANUP: The CONTRACTOR shall promptly remove from the vicinity of the completed work, all rubbish, unused materials, concrete forms, construction equipment, and temporary structures and facilities used during construction. Final acceptance of the work by the OWNER will be withheld until the CONTRACTOR has satisfactorily complied with the foregoing requirements for final cleanup of the project site.

4.14.2 TOUCH-UP AND REPAIR: The CONTRACTOR shall touch up or repair all finished surfaces on structures, equipment, fixtures, or whatever, that have been damaged prior to final acceptance. Surface on which such touch-up or repair cannot be successfully accomplished shall be completely refinished or in the case of hardware and similar small items, the item shall be replaced.

4.14.3 CLOSEOUT TIMETABLE: The CONTRACTOR shall establish dates for equipment testing, acceptance periods, and on-site instruction periods (as required under the Contract). Such dates shall be established not less than one week prior to beginning any of the foregoing items, to allow the OWNER, the ENGINEER, and their authorized representatives sufficient time to schedule attendance at such activities.

4.14.4 SUBMITTALS: Submit with or prior to Application for Final Payment, Consent or Surety to Final Payment and remaining releases, waivers, guarantees and all project data required by the Contract Documents.

4.14.4.1 PROJECT RECORD DOCUMENTS: CONTRACTOR shall notify ENGINEER in writing that certified copies of results for all earth compaction tests conducted have been submitted. Letter shall include a summary list of all tests conducted showing date and location.

4.14.4.2 TRENCH SETTLEMENT: Replacement of earth fill or backfill, where it has settled below the required finish elevations, shall be considered as part of such required repair work, and any repair or resurfacing which becomes necessary by reason of such required repair work shall be completed by the CONTRACTOR at no cost to the OWNER.

SECTION 5 – SITE WORK REQUIREMENTS

SECTION 5.1
PIPELINE TRENCH EXCAVATION AND BACKFILL

5.1.1 DESCRIPTION: The CONTRACTOR shall furnish all labor, materials, tools and equipment, and perform all work necessary to complete required excavations and backfills. Work shall also include required grading for completion of water lines and associated appurtenances all in accordance with the plans and these specifications.

The work shall include: clearing the site; loosening, loading, removing, transporting and disposing of materials, wet and dry, necessary for construction; sheeting and bracing; draining and dewatering; backfill of trenches, excavations, and pits; compaction, compaction testing, leveling, signing, detours, mobilization, and clean up.

5.1.2 MATERIALS:

5.1.2.1 PIPE STABILIZATION MATERIAL: Wherever the subgrade material does not afford a sufficiently solid foundation to support the pipe and superimposed load, where water must be drained to maintain a dry bottom for pipe installation, or where solid rock intrudes into the bottom of the trench, the subgrade shall be excavated to a minimum depth of 8 inches below pipe bedding and replaced with crushed rock or pit run gravel.

Gravel for pipe stabilization material shall be clean crushed rock or pit run gravel conforming to the following gradation:

Screen	Percent Passing
3"	100
3/4"	5

The gravel material shall be deposited over the entire trench width and compacted by tamping, rolling, or other suitable methods. In addition, the material shall be graded to produce a uniform and continuous support for pipe bedding material or installed pipe as specified.

5.1.2.1 PIPE BEDDING MATERIAL: Pipe bedding is fill material in the pipe zone. The pipe zone is defined as the envelope area 6 inches below the bottom of the pipe to 12 inches above the top of the pipe, and any lateral area within 9 inches of any pipe, pipeline structure or appurtenance.

Pipe bedding material may be excavated or imported material consisting of loose earth, sand or gravel conforming to the following gradation specifications:

- DUCTILE IRON PIPE BEDDING MATERIAL

Screen	Percent Passing
1"	100
1/2"	5

- PVC or HDPE PIPE BEDDING MATERIAL

Screen	Percent Passing
3/4"	100
No. 4	5

- CONCRETE PIPE BEDDING MATERIAL

Screen	Percent Passing
1"	100
No. 4	5

5.1.2.3 SELECT BACKFILL MATERIAL: Select backfill material shall be granular, readily compactable and shall be free from alkali, salt, and petroleum products, roots, sod, limbs, and other vegetative matter, slag, cinders, ashes and rubbish, or other material that in the opinion of the ENGINEER may be objectionable.

Conforming to the following gradation specifications:

Sieve Size	Percent Passing by Weight
6 inch (2-inch if under UDOT roadway)	100
No. 10	50 max.
No. 40	30 max.
No. 200	15 max.

Material from excavation may be used if it will meet all requirements of select backfill, including compaction requirements as specified for type of surface improvement above trench.

5.1.3 CONSTRUCTION:

5.1.3.1 TRENCH EXCAVATION: Trench excavation shall be described as the excavation of quicksand, sand, crushed slag, clay, loam, earth, hardpan, boulder-clay, boulders, bituminous or gravel roadway surface, together with removal of old timber, railroad ties, stone-filled or stone abutments and piers, boundaries, concrete and stone masonry, and every other class of material.

5.1.3.2 SOLID ROCK EXCAVATION AND BLASTING: Blasting will not be permitted, except by written permission from the ENGINEER on a case by case basis. If the CONTRACTOR seeks blasting permission, and is granted that permission by the ENGINEER, he must exercise great care and will be held responsible for and will assume all liability connected with the blasting and use of explosives. He will be liable for all damage to work on adjacent property, all injuries, lawsuits, complaints, and any other actual or alleged damages.

- BLASTING EXPERTS: Blasting shall be done only by experienced, qualified blasters. Blasting shall be done in accordance with the recommendations for best practice in the AGC Manual of Accident Prevention in Construction and in accordance with the recommendations for best practice of the Institute of

Makers of Explosives. Blasting shall comply with State and OSHA requirements.

- COVERED BLASTING: All blasting near dwellings must be covered with heavy mats to prevent flying rock fragments. No blasting shall be done within 15 feet of completed work.

- SAFETY RULES: The CONTRACTOR shall observe all safety rules for the handling of explosives, and in no case shall blasting caps be stored near the explosives. No blasting shall be done outside the regular working hours except with special approval.

5.1.3.4 TRENCH WIDTH: The trench shall be excavated such that the new pipe is always centered in the trench. The clear trench width at the horizontal diameter of the pipe must not be less than the outside diameter of the pipe plus 18 inches. The maximum clear width of trench at the top of the pipe must not be more than the outside diameter of the pipe plus 24 inches.

Backfill with earth under structures or valves will not be permitted. Any unauthorized excess excavation below the elevation indicated for foundation of any structures shall be backfilled in accordance with these specifications for "Granular Backfill Material" and "Pipe Foundation Material", as appropriate, at the CONTRACTOR's expense.

5.1.3.5 SHEETING, BRACING AND SHORING OF EXCAVATIONS: Excavations shall be sheeted, braced, and shored as required to support the walls of the excavations, to eliminate sliding and settling and as may be required to protect the workmen, the work in progress, and existing utilities, structures and improvements. All such sheeting, bracing, and shoring shall comply with the requirements of the Utah State Industrial Commission, Occupational Safety and Health Act (OSHA), and accident prevention and safety provisions of the contract.

The CONTRACTOR shall be fully responsible for the adequacy of methods and materials used in trench sheeting, bracing, shoring, and/or other systems provided to protect workmen. Injury to or death of workmen resulting from inadequate trench safety measures shall be the full and complete responsibility of the CONTRACTOR.

All damages resulting from lack of adequate sheeting, bracing and shoring shall be the responsibility of the CONTRACTOR, and the CONTRACTOR shall complete all necessary repairs or reconstruction at his own expense resulting from such damage.

Sheeting or shoring that does not extend below the centerline of the pipe may be removed at the discretion and responsibility of the CONTRACTOR after the trench backfill has been placed and compacted to a level 12 inches above the top of the pipe. Following removal of the sheeting or bracing, the trench shall be immediately backfilled and compacted.

5.1.3.6 PIPE FOUNDATION AND BEDDING MATERIAL INSTALLATION: Pipe foundation and bedding material installation consists of preparing an acceptable pipe foundation, excavating the pipe groove in the prepared foundation and backfilling from the foundation to 12 inches above the top of the pipe. All piping shall be protected from lateral displacement and possible damage resulting from impact or unbalanced loading during backfilling operations by being adequately bedded.

- PIPE FOUNDATION: Shall consist of undisturbed natural soil in the bottom of the trench, or a built-up foundation of bedding material if conditions and these specifications so warrant. Wherever the trench subgrade material does not afford a sufficiently solid foundation to support the pipe and superimposed load, and/or where groundwater must be drained, or where solid rock intrudes into the trench bottom the trench shall be excavated below the bottom of the pipe bedding approximately 8 inches, and filled with clean, compacted pipe stabilization material.

- PIPE GROOVE: A pipe groove shall be excavated in the pipe foundation to receive the bottom quadrant of the pipe so that the installed pipe will be true to line and grade. Bell holes shall be dug after the trench bottom has been graded. Bell holes shall be excavated so that only the barrel of the pipe bears on the pipe foundation.

- PIPE BEDDING FROM PIPE FOUNDATION TO 12 INCHES ABOVE TOP OF PIPE: Bedding material shall be deposited and compacted in layers not to exceed 8 inches in uncompacted depth. Deposition and compaction of bedding materials shall be done simultaneously and uniformly on both sides of the pipe. All bedding materials shall be placed in the trench with hand tools or other approved method in such a manner that they will be scattered alongside the pipe and not dropped into the trench in compact masses.

5.1.3.7 TRENCH BACKFILL: The trench shall be backfilled from 12 inches above the top of the pipe to the natural surface level or the finished grade specified on the Drawings with excavated materials consisting of good sound earth, sand, gravel. No bituminous pavement, concrete, rock, or other lumpy material may be used in the backfill unless these materials are scattered and do not exceed 6 inches in any dimension. Decomposable or vegetative material shall not be used in backfilling.

5.1.3.8 EXCAVATED WASTE MATERIAL: All excess material shall be hauled away from the construction site and disposed of in an area obtained by the CONTRACTOR and approved by the ENGINEER. The CONTRACTOR shall be responsible for all rights-of-way, easements, and access associated with the disposal of excess excavated material. He shall further be responsible to obtain permission from the property owner or person(s) controlling the property where the CONTRACTOR plans to dispose of excavated material. No compensation will be made to the CONTRACTOR for disposal of excess excavated material.

Excavated material shall be piled in a manner that will not endanger the work and will avoid obstructing sidewalks and driveways. Gutters and irrigation ditches shall be kept clear or other satisfactory provisions made for street drainage.

Grading of the area surrounding the trenches, including excavated materials, shall be performed as necessary to prevent surface water from flowing into trenches, or other excavations.

5.1.3.9 COMPACTION: Compaction shall be the responsibility of the CONTRACTOR. He shall select the methods to be used and carefully perform the work of backfilling and compaction so as to prevent damage to new or existing piping. Any new or existing piping damaged during the CONTRACTOR's work shall be replaced as directed by the ENGINEER with new piping.

5.1.3.10 COMPACTION TESTING: Compaction testing requirements called for herein are only minimum and are required for the purpose of indicating, during construction, the quality of materials and compaction. Dips or uneven surface caused by post settlement of any trenches, excavation, fill, or embankment that show up within the 1 year warranty period shall be repaired by the CONTRACTOR at no additional cost to the OWNER.

- MAXIMUM DENSITY: Maximum density as used in these specifications shall be defined as the maximum density obtained in the laboratory by an AASHTO T-180 test. In place density of compacted backfill will be determined by use of nuclear density determining equipment.

- COMPACTION PERCENTAGE: Unless otherwise specified, fills shall be compacted as indicated in the following tabulation:

Location	Percent of Maximum Density
Backfill adjacent to structure	90
Fill under structure	95
Fill areas for pipeline construction	95
Pipe bedding	90
Trench backfill (Outside roadway right-of-way)	90
Trench backfill (Inside roadway right-of-way)	97

- COMPACTION CONFIRMATION: It shall be the responsibility of the CONTRACTOR to accomplish the specified compaction for backfill, fill, etc., and to control all earthwork operations by tests or other means approved by the ENGINEER to verify and confirm that the CONTRACTOR is complying at all times with the requirements of the specifications.

- INDEPENDENT TESTING: Material tests are required and shall be made by an independent testing laboratory hired and paid for by the OWNER, with full responsibility for coordinating said testing being borne by the CONTRACTOR. In areas where compacted backfill material is specified for pipeline trenches or around structures, the following amounts of satisfactory field density tests are required:

  - Street crossings, every 50 feet of crossing length, or portion thereof:
    2 Tests per 50-foot segment (18" above top of pipe and top of subbase).

  - Trenches running parallel to the roadway:
    2 Tests per 500 feet (18" above top of pipe and top of subbase).

- PROCTOR TESTS: Earth material specified in this section having specific gradation requirements shall have a soil gradation and proctor analysis performed to verify compliance and used as a basis for compaction tests. The number of times each type of material shall be tested is as follows:

  - When material is being imported:
    1 Test per borrow site.
    1 Additional test per material change.

  - When native material is approved:

1 Test per geographical area where the composition and material gradation visually remains unchanged.

The term "test" shall mean a single test with acceptable results, i.e., equal to or greater than the specified minimums. In the event compaction tests results fall below the required minimum, the CONTRACTOR shall recompact and test the material until a test with acceptable results is obtained.

- TEST RESULTS: Copies of test results prepared by the independent testing laboratory will be transmitted to the CONTRACTOR at the same time they are transmitted to the ENGINEER.

Successful performance of field density tests by the independent testing laboratory at any given location shall not relieve the CONTRACTOR of his responsibility to meet the specified density requirements for the complete project.

Additional tests directed by the ENGINEER shall be made at locations selected by the ENGINEER.

5.1.3.11 RESTORATION OF CONSTRUCTION SITE: During the progress of the Work, the CONTRACTOR shall clean up all construction debris, excess excavation, and excess materials, and shall restore all fences, irrigation structures, ditches, culverts, and similar items. The CONTRACTOR shall stockpile the excavated trench material so as to do the least damage to adjacent grassed areas, or fences, regardless of whether these are on private property or public rights-of-way. All excavated materials shall be removed from grassed and planted areas and these surfaces shall be left in conditions equivalent to their original surface and free from all rocks, gravel, boulders, or other foreign materials.

The roadway including shoulders, slopes, ditches, and borrow pits shall be smoothly trimmed, and shaped by machinery, or other satisfactory methods, to the lines, grades and cross-sections, as established, or to equal or better condition than that which existed before construction efforts started, and shall be so maintained until accepted. Any surplus material not suitable for spreading along the road to widen the existing shoulder or raise the grade shall be hauled away or disposed of.

5.1.3.12 CONTRACTOR'S RESPONSIBILITY: The CONTRACTOR will be responsible to see that the backfilling, consolidation and compaction are properly and adequately done. Settlement of trenches within a period of one year after final acceptance of the project, or longer period, if so required by the entity from whom excavation/cut permits were obtained for completion of the Work, shall be considered incontrovertible evidence of inadequate compaction, and the CONTRACTOR shall be responsible for correcting the condition in accordance with the provisions of these Specifications, including the replacement of the surface materials.

5.1.4 MEASUREMENT AND PAYMENT: As specified in Section 1.4 of the Contract Documents.

End of Section

SECTION 5.2
PLACEMENT, REMOVAL AND RESTORATION OF SURFACE IMPROVEMENTS

5.2.1 DESCRIPTION: The CONTRACTOR shall be responsible for the protection and the restoration or replacement of any improvements existing on public or private property at the start of work or placed during the progress of the work. Surfacing material removed will be loaded, hauled and disposed of by the CONTRACTOR in approved disposal areas at no additional expense to the OWNER. Existing improvements shall include but not be limited to permanent surfacing, curbs, gutters, sidewalks, planted areas, ditches, driveways, culverts, fences, signing, and walls. All improvements shall be reconstructed to equal or better, in all respects than the existing improvements removed. Provide all signing, barricades, flagman or signals as necessary to provide safe travel to the public.

5.2.1.1 FIELD VERIFICATION OF IMPROVEMENTS: In submitting a bid, the CONTRACTOR will be deemed to have carefully examined the site of the work and to have acquainted himself with all conditions relating to the protection and restoration of existing improvements. The ENGINEER does not guarantee that all improvements are shown on the Drawings, and it shall be the CONTRACTOR's responsibility to provide in his bid for the protection and restoration of all existing improvements whether or not each is provided for specifically on the Drawings and/or Bid Form.

5.2.2 MATERIALS:

5.2.2.1 GRAVEL SURFACE: Material for use on gravel surfaces shall be obtained from sound, tough, durable gravel or rock meeting the following requirements for grading:

Sieve Size	Percent Passing
1-inch sieve	100
1/2-inch sieve	79 - 91
No. 4 sieve	49 - 61
No. 16 sieve	27 - 35
No. 200 sieve	7 - 11

5.2.2.2 UNTREATED BASE COURSE: Untreated base course shall be in accordance with Utah Department of Transportation Standard Specifications, 2012, Section 02721, Table 2:

Table 2

Gradation Limits		
Sieve Size	**Job Mix Gradation Target Band**	**Job Mix Gradation Tolerance**
1½ inch	100	
1 inch	90 - 100	±9.0
¾ inch	70 - 85	±9.0
½ inch	65 - 80	±9.0
⅜ inch	55 - 75	±9.0
No. 4	40 - 65	±7.0
No. 16	25 - 40	±5.0
No. 200	7 - 11	±3.0

5.2.2.3 BITUMINOUS SURFACE COURSE: Bituminous surface course gradation shall be in accordance with Utah Department of Transportation Standard Specifications, 2012, Section 02741, Table 6:. Actual gradation to be used shall be approved by the ENGINEER.

Table 6

Aggregate Gradations (Percent Passing by Dry Weight of Aggregate)					
Sieve Size		**1 inch**	**¾ inch**	**½ inch**	**⅜ inch**
Control Sieves	**1½ inch**	100.0			
	1 inch	90.0 - 100.0	100.0		
	¾ inch	<90	90.0 - 100.0	100.0	
	½ inch		<90	90.0 – 100.0	100.0
	⅜ inch			<90	90.0 - 100.0
	No. 4				< 90
	No. 8	19.0 - 45.0	23.0 - 49.0	28.0 - 58.0	32.0 - 67.0
	No. 200	1.0 - 7.0	2.0 - 8.0	2.0 – 10.0	2.0 – 10.0

5.2.2.4 TACK COAT: Tack coat shall be SS-1 Diluted with an equal amount of water.

5.2.2.5 CONCRETE: See Section 5.6.3 of these specifications.

5.2.2.6 SOD AND VEGETATION: All materials shall be from sources approved by the ENGINEER; however, such approval does not relieve the CONTRACTOR from responsibilities for growth, maintenance and replacement as specified herein.

5.2.2.7 TOPSOIL: Topsoil shall be fertile, friable, natural loam, surface soil, reasonably free of clay lumps, brush, weeds, and other litter, and free of rocks, stumps, stones larger than 2 inches in any dimension, and other extraneous or toxic matter harmful to plant growth. Obtain topsoil only from naturally well-drained sites where topsoil occurs in a depth of not less than 4 inches. Do not obtain from bogs or marshes.

5.2.2.8 OTHERS: Other materials may be required by the authorities having jurisdiction such as Local, State or Federal entities (e.g., irrigation company canals, city, county or

state roads, Bureau of Reclamation canals). It is the Contractor's responsibility to ensure that the improvement owner's requirements are met.

5.2.3 CONSTRUCTION:

5.2.3.1 REMOVAL OF CONCRETE OR ASPHALT SURFACES: The pavement, sidewalk, curb and gutter, driveway, etc. shall be cut vertically along the lines forming the trench, or nearest full joint, in such a manner as to not cause damage to adjoining pavement, sidewalk, curb and gutter, driveway, etc. An undercut level at the rate of 1 inch per foot of thickness or an underlap joint will be provided at the proposed junction between old and new surfaces. The portion to be removed shall be broken up in a manner that will not cause damage to the pavement or concrete outside the limits of the trench; however, any pavement damaged by operations outside the limits of the trench shall be replaced. Broken paving materials shall be removed immediately from the site of the work. The ENGINEER shall approve all saw cut locations.

5.2.3.2 GRAVEL SURFACE: Where trenches are excavated through gravel surfaced areas such as roads and shoulders, parking areas, unpaved driveways, etc., the gravel surface shall be restored to a minimum depth of 4 inches. The gravel shall be placed in the trench at the time it is backfilled. The surface shall be maintained by blading, sprinkling, rolling, adding gravel, etc., to maintain a safe, uniform surface satisfactory to the ENGINEER. Excess material shall be removed.

5.2.3.3 BASE COURSE AND TEMPORARY GRADED SURFACE: On paved areas, base course shall be placed in the top of the trench to a depth such that the final compacted thickness of the base course below the bottom of the pavement shall be equal to the existing base course but not less than 10 inches. This base course layer shall be brought flush with the paved surface and maintained in a smooth, rut free condition until time for the pavement to be placed.

5.2.3.4 TACK COAT: Tack coat shall be applied at the rate of 0.05 to 0.15 gal/SY. A hand sprayer or brush shall be used to apply tack coat to vertical faces of previously constructed bituminous pavement (over 1/2 hour hence) prior to placing an adjacent or parallel pass, curbs, gutters, slab edges, and all structures to be in actual contact with the bituminous pavement. Tack coat shall also be applied uniformly at the same rate to the horizontal top surface of each lift of bituminous pavement prior to placing the next lift of bituminous pavement to promote a bond between the two courses of pavement. None of the material shall penetrate into the pavement and for this reason the application should be limited.

Prior to applying the material, the surface to be treated shall be swept or flushed free of dust or other foreign material. Protect all surfaces not required to receive tack coat from any inadvertent application.

The temperature range of the tack coat at the time of application shall be such that the viscosity will be between 50 and 100 centistokes as determined in accordance with ASTM Designation D-2710.

Under no circumstances shall traffic be permitted to travel over the tacked surface. If detours cannot be provided, restrict operation to a width that will permit at least one-way traffic over the remaining portion of the roadbed. If one-way traffic is provided, the traffic shall be controlled in accordance with governing authority.

After application of tack coat, sufficient time shall be given to allow for complete separation of asphalt and water before paving operations begin. The tack coat shall be applied on only as many surfaces as will be paved against in the same day.

5.2.3.5 BITUMINOUS SURFACE: Trenches to be resurfaced shall be graded and rolled to provide a subgrade consisting of granular backfill and base course which is firm and unyielding. Density of the subgrade materials shall be 95 percent of AASHTO T-180. Mud or other soft or spongy material shall be removed and the void filled with base course and rolled and tamped thoroughly in layers not exceeding 12 inches in thickness. The edges of trenches which are broken during subgrade preparation shall be removed and trimmed neatly before resurfacing.

Mixing, placing, spreading and compaction of a minimum 3-inch bituminous surface course (greater depths may be required as shown on the Drawings) shall conform to applicable parts of Utah Department of Transportation Standard Specifications, 2012, excluding pay factor allowances.

5.2.3.5.1 UDOT ROADWAY: When trenching occurs within a UDOT roadway, a 2" deep mill and fill is required: 20' on each side of the trench, when crossing, and from lane stripe to lane stripe on any lane, or portion of lane with trench construction within it. Pavement markings must be restored with new material similar to that which was removed.

5.2.3.6 CONCRETE CURBS, GUTTER, SIDEWALKS AND DRIVEWAYS: Existing improvements shall be removed and replaced to the next joint or scoring line beyond the actually damaged or broken sections; or in the event that joints or scoring lines do not exist or are three or more feet from the removed or damaged section, the damaged portions shall be removed by saw cutting full-depth.

All new concrete shall match, as nearly as possible, the appearance of adjacent concrete improvements. Where necessary, lampblack or other pigments shall be added to the new concrete to obtain the desired results.

Concrete forms shall be true to line and of sufficient strength to ensure against bulging or displacement.

Contraction and expansion joints shall match original construction in placement and size, unless otherwise required by local jurisdiction having authority.

Reinforcement shall be replaced as in original construction, and dowelled into edges of existing concrete, unless otherwise required by local jurisdiction having authority, and shall be installed in accordance with applicable CRSI and ACI Standards.

Finishing and curing shall be in accordance with local jurisdiction having authority.

5.2.3.7 PLANTED AREAS: Prior to placing topsoil and/or sod, examine and repair the subgrade as necessary to assure a smooth and even surface which will match grade and contours of surrounding undisturbed ground. Finish grade construction areas to match grade prior to construction activities. Assure that a positive slope away from all building walls is maintained for at least 10 feet to prevent runoff from approaching walls.

5.2.3.8 SPRINKLING SYSTEMS: Restore all sprinkling systems disturbed, removed, or damaged by construction operations in a condition at least equal to that prior to construction.

5.2.3.9 MISCELLANEOUS IMPROVEMENTS: All other improvements interrupted or removed to permit the construction specified herein shall be restored. Miscellaneous improvements to be restored shall include, but shall not be limited to, the following:

Traffic Signs
Mail Boxes
Drainage and Irrigation Ditches
Culverts
Canals and Canal Structures
Bridges and Bridge Abutments
Fences

5.2.3.10 PROTECTION: Protect all restored improvements form damage in accordance with these specifications, unless otherwise required by local jurisdiction having authority.

End of Section

SECTION 5.3
CULINARY WATERLINE AND APPURTENANCES

5.3.1 DESCRIPTION: The CONTRACTOR shall install all pipe, furnish and install: Valves, valve boxes, fire hydrants, service connects, meter boxes, check valves, air release valves, pipe bedding material; furnish and install all couplings, fittings, bolts, nuts, gaskets, jointing materials, and appurtenances as shown and specified, and as required for a complete and workable piping system.

All products incorporated into the project shall be new. All materials and products in contact with culinary water shall be certified compliant with NSF standard 60 or 61, as applicable.

5.3.2 MATERIALS:

5.3.2.1 DUCTILE IRON PIPE: (Refer to Section 5.8, "Ductile Iron Pipe").

5.3.2.2 PVC C-900/905 PIPE: (Refer to Sec. 5.5, "PVC AWWA C-900/905 Water Pipe").

5.3.2.3 FIRE HYDRANTS: Fire hydrants shall be of a "traffic model" type design conforming to AWWA C-502 Specifications. Hydrants shall be supplied with two 2-1/2-inch and one 4-1/2-inch nozzles. All nozzles shall have national standard threading. A one cubic yard gravel sump shall be provided at each hydrant for drainage. Fire hydrants shall be Mueller Super Centurion or District-approved equal.

5.3.2.4 ISOLATION VALVES: All main line isolation valves shall conform to Standard AWWA C509 for Resilient-Seated Gate Valves or C504 for Rubber-Seated Butterfly Valves, as applicable. All valves shall be designed for 150 psi working pressure or above. The valves shall be mechanical joint unless otherwise indicated on the plans.

All buried valves shall be installed complete with two-piece, cast iron, screw slip, 5-1/4-inch shaft valve box with adjustable height to bring the top of the valve box flush with the ground surface. The valve box shall not be less than 5 inches in diameter, shall have a minimum thickness of 3/16 inch, and shall be provided with suitable base cover. The word "WATER" shall be cast on the cover. Valve boxes shall be "Tyler" or equal.

5.3.2.5 CAST IRON FITTINGS: Fittings shall be of the short body design and shall meet ANSI Specification A 21.10 and shall have mechanical or push-on rubber gasket type joints. Fittings inside structures or where otherwise noted on the drawings shall be ASA Class 125 flanged design with full face rubber gaskets. All exterior surfaces of pipe and fittings shall be coated with hot coal tar as specified in the Proposed American Standard Specifications for Coal Tar Dip Coatings for Cast Iron Pipe and Fittings.

5.3.2.6 COUPLINGS: Couplings shall be equal to the product of Romac, JCM, Smith-Blair, or Dresser with cast iron couplings being used on all ductile iron pipe. Couplings shall be of the straight, transition, or reducing style as required by the specific installation. All steel fittings and bolts shall be coated with a non-oxide coating.

5.3.2.7 CORPORATION STOPS: Connections to main lines shall be made through AWWA thread-type corporation stops with flared copper connection..

5.3.2.8 PIPE FOR SERVICE CONNECTIONS: Pipe for water services shall be minimum 1” diameter 200 psi CTS poly pipe for potable water service.

5.3.2.9 METER BOX SETTER ASSEMBLY: A typical meter box assembly (for a single family dwelling) shall consist of a copper setter, FORD VBHC 72-18W-44-44Q or approved equal, 18-inch riser with angle ball valve on the inlet side and Utah State approved dual check valves on the outlet side. Connection to the copper service lines at the base of the setter shall be made with compression connections. All meter setter assemblies shall be no more than 20 inches and not less than 18 inches from finish ground level. The water meter shall be supplied and installed by the OWNER.

5.3.2.10 METER BOXES AND LIDS: Meter boxes shall be round 18 inches inside diameter precast concrete boxes 36 inches deep. The lids for meter boxes shall be cast iron with a lifter worm lock, operated by a large pentagon head bolt, and shall be D&L 2240 or an approved equal with a 2" hole to accommodate meter reading. All meter boxes shall be installed and inspected in accordance with the approved drawings.

5.3.2.11 THRUST BLOCKS: The material for thrust blocks shall be concrete which shall have a compressive strength of no less than 2,000 psi in 7 days.

5.3.2.12 UNDERGROUND WARNING TAPE AND LOCATION WIRE: The tape shall be a 2-inch metallic core with a polyethylene cover, blue in color, and have the words "Caution Water Line Buried Below" imprinted on it. The tape shall be Style No. 2WAT as manufactured by Seton Name Plate Company of New Haven, Connecticut, or approved equal. Copper location wire shall be at least #14 plastic coated solid wire.

5.3.2.13 CHECK VALVES: Check valves shall prevent reverse flow in the pipelines. The check valves shall have steel or ductile iron body with bronze trim, stainless steel spring, and resilient seat. The valves shall be Class 125 or better. The check valve shall be a Val-Matic Swing Flex or approved equal.

5.3.2.14 CONNECTION HARDWARE: Except where otherwise shown or specified, acceptable bolts and cap screws are:

1) Carbon steel:
    a) Conforming to the requirements of ASTM A307 Grade A or higher yield and tensile strengths. The corresponding nuts shall conform to ASTM A563 Grade A or higher yield and tensile strengths.
    b) All bolts and nuts shall be coated with TRIPAC 2000 coating system. Anti-seize compound shall not be utilized with the blue nuts.
2) Stainless steel:
    a) Conforming to the requirements of ASTM F593. The corresponding nuts shall conform to ASTM F594.
    b) Nuts shall be finished with TRIPAC 2000 coating system. Anti-seize compound shall not be utilized with the blue nuts.

5.3.2.15 OTHERS: Other materials as specified on the drawings.

5.3.3 CONSTRUCTION:

5.3.3.1 DELIVERY, STORAGE AND HANDLING: Load and unload pipe, fittings, specials, valves, and accessories by lifting with hoists or skidding so as to avoid shock or damage. Do not skid or roll pipe on skidways against pipe already on the ground. Lifting of pipe during unloading and placing into the trench shall be done using two nylon slings placed at the quarter points of the pipe sections. The slings shall bear uniformly against the pipe. Under no circumstances shall the pipe or accessories be dropped into

the trench. When not being handled, the pipe shall be supported on timber cradles or on properly prepared ground, graded to eliminate all rock being transported, the pipe shall be supported at all times in a manner which will not permit distortion or damage to the lining or coating. Any unit of pipe that, in the opinion of the ENGINEER, is damaged beyond repair by the CONTRACTOR shall be removed from the site of the work and replaced with another unit. No payment will be made for damaged pipe or for repairs to such damaged pipe. The use of chains or cables for handling the pipe is not permitted.

Each length of pipe shall be unloaded opposite or near the place where it is to be laid in the trench.

5.3.3.2 CONNECTIONS TO EXISTING MAINS: Connections to existing mains shall be made where indicated on the plans. The CONTRACTOR shall determine the exact pipe size and material and provide applicable valves, fittings, and couplings to make a smooth and straight transition into the existing pipe line(s). All connections shall be made and visually inspected for leakage with the line under pressure prior to backfilling. Connections will normally be made with a tee, cross, or other similar type connector.

The CONTRACTOR must uncover the connection area and determine the needs for the connection prior to turning off the water. The water may be turned off Monday through Friday between the hours of 9:00 am and 4:00 pm only. The OWNER must be given 24 hours notice prior to turning off the water to any portion of the system. The CONTRACTOR must make reasonable efforts to avoid disruption of water service.

5.3.3.3 WATER MAINS: Water mains shall be installed in accordance with the AWWA standard for the type of pipe and as may be further referenced in Section 5.3.2. The open ends of all pipelines under construction shall be covered and effectively sealed at the end of the day's work.

5.3.3.4 FIRE HYDRANTS: All fire hydrants shall be installed with a 1 cubic yard gravel sump and concrete thrust block. See Construction Drawings for thrust blocking. Concrete shall not be placed around joints, bolts, or drain holes. Cover all metal contact areas with a poly wrap material prior to concrete placement. All hydrants shall be installed with the upper safety flange at least 2-1/2 inches and not more than 6 inches above ground level. All hydrants shall be installed with the steamer nozzle facing the street unless otherwise approved by the OWNER.

5.3.3.5 ISOLATION VALVES: The CONTRACTOR shall furnish and install isolation valves at the locations shown on the drawings. The valves shall include either valve, valve box with lid, or valve, and hand wheel as indicated on the drawings. The valves shall have mechanical joint ends, non-rising stem, O-ring, seals, operating nut and extension as required, or hand wheel, and iron body-bronze resilient seat. The valves shall meet or exceed AWWA Standard C-509.

Valves will be inspected, cleaned, set in line, and jointed to pipe with mechanical or flanged joints as indicated on the plans. All mainline valves shall have a concrete base poured in place onto which the valve is anchored against movement by straps on both sides of the valve housing. Steel anchor rods shall be rush-proofed or painted.

5.3.3.6 VALVE BOXES: All buried valves shall be installed complete with two-piece, cast iron, 5-1/4-inch shaft valve box with locking lid. The lid shall have the work "WATER" cast in the metal.

Valves and valve boxes shall be installed where shown on the drawings. Valves and valve boxes shall be set plumb. Valve boxes shall be centered directly over the valve. Valves shall be aligned with property lines where possible. Earth fill shall be carefully tamped around the valve box to a distance of 4 feet on all sides of the box, or to the undisturbed trench face if less than 4 feet. Valve boxes shall have the interiors cleaned of all foreign matter before installation.

All valve boxes located in streets shall be installed as nearly to grade as possible. After the pavement is in place, the valve boxes shall be raised to grade, the surrounding asphalt shall be neatly cut to form a circular opening 2 feet and 6 inches in diameter with the valve box centered, and a concrete collar shall be cast around the box. Valve boxes in off-road areas shall extend 2 inches above grade.

5.3.3.7 FITTINGS: Bends, tees, reducers, flange adapters, and adaptor couplings shall be inspected, cleaned, and jointed to pipe as specified by the manufacturer. Reaction or thrust blocking shall be applied at bends of 11-1/4 degrees and more, at plugs, caps, and at tees.

5.3.3.8 WATER SERVICE CONNECTIONS: Make service connections and install service lines as shown on the Construction Drawings, or as directed by the OWNER's representative. Use teflon tape on all taps. Locate service taps in the upper quadrant of the main line, approximately 45 degrees. The minimum distance between taps is 24 inches, with a 5 degree stagger. Do not make service taps within 24 inches of the end of the main line.

Excavate and backfill in accordance with Section 5.1, "Excavation and Backfill for Buried Pipelines". All work must be inspected by the OWNER prior to backfilling. Pressure test all services before backfilling. Make no service connections until main line is fully accepted by the OWNER. Extend service line to meter and 5 feet beyond meter and plug as indicated on the contract drawings. Coordinate service location with property owner and OWNER prior to beginning work.

Record station of service connection to main line and record location and depth of end of service line, tying distances to at least two surface landmarks. Sketch information on an 8-1/2 x 11 inch form and record any particular problems.

5.3.3.9 THRUST BLOCK INSTALLATION: Thrust blocks shall be provided at reducers and valves where shown on the drawings, at all tees, plugs, and caps, and at bends deflecting 11-1/4 degrees or more.

Thrust blocks shall be placed between solid ground and the fitting to be anchored; the area of bearing on the pipe and on the ground in each instance shall be that shown on the drawings. The block shall, unless otherwise shown or directed, be so located as to contain the resultant thrust force and so that the pipe and fitting joints will be accessible for repair.

5.3.3.10 UNDERGROUND WARNING TAPE AND LOCATION WIRE: The CONTRACTOR shall furnish and install an underground warning tape as the trench is backfilled. The tape shall be placed directly over the waterline and to a depth of 24 inches below the finished ground surface. The copper wire shall be in the bottom of the pipe trench.

5.3.3.11 SEPARATION OF WATER MAINS FROM SANITARY SEWER: The horizontal distance between pressure water mains and sanitary sewer lines shall be at least ten feet. Where a water main and a sewer line must cross, the water main shall be at least 18 inches above the sewer line. Separation distances shall be measured edge-to-edge (i.e. from the nearest edges of the facilities). Water mains and sewer lines shall not be installed in the same trench.

5.3.4 MEASUREMENT AND PAYMENT: As specified in Section 1.4 of the Contract Documents.

End of Section

SECTION 5.4
DISINFECTION AND TESTING OF WATER LINES

5.4.1 DESCRIPTION: Except as otherwise provided herein, the CONTRACTOR shall furnish all equipment, labor, and materials required for testing and disinfecting hydraulic structures and pipelines as specified. Water for testing and disinfecting will be furnished by the OWNER; however, the CONTRACTOR shall be responsible for coordinating with the OWNER the acquisition and use of the water for testing and disinfection procedures.

Disinfection shall be accomplished by chlorination in accordance with AWWA standard C-651.

Each completed section shall be disinfected and tested prior to introduction into the drinking water system.

Release of water from structures and pipelines, after completion of testing and disinfection, shall be in conformance with the most recent version of AWWA Standard C-651.

5.4.2 PROCEDURES:

5.4.2.1 PRELIMINARY CLEANING AND FLUSHING: Prior to both testing and disinfecting, all pipelines shall be thoroughly washed, flushed or blown out, under the direction of the OWNER. Flushing shall be accomplished through hydrants, valves, blow-offs, or other means provided by the CONTRACTOR and approved by the OWNER sufficient to provide for a 2.5 foot per second flushing velocity in the pipeline.

5.4.2.2 HYDROSTATIC TESTS: Prior to testing, all piping shall be flushed or blown out as appropriate. The CONTRACTOR shall test all piping either in sections or as a unit. Mortar-lined piping shall not be tested before the mortar lining has attained an age of 14 days. The test shall be made by closing valves when available, or by placing temporary bulkheads in the pipe and filling the line slowly with water. Care shall be taken to see that all air vents are open during filling. After the piping or section thereof has been filled, it shall be allowed to stand under a slight pressure for a sufficient length of time to allow the mortar lining to absorb what water it will and to allow the escape of air from any air pockets. During this period, bulkheads, valves, and connections shall be examined for leaks. If any are found, corrective measures satisfactory to the OWNER shall be taken. The test shall consist of holding a minimum pressure of 150 psi on the section being tested for a minimum period of 2 hours using either pneumatic or hydraulic means to maintain the pressure. Suitable means shall be provided by the CONTRACTOR for determining the quantity of water lost by leakage under the test pressure. All visible leaks shall be repaired as directed by the ENGINEER. The maximum allowable leakage shall be as follows:

Pipe Size (inches)	Allowable Leakage (gal/hr/1000 feet of pipe)
4	0.37
6	0.55
8	0.74
10	0.92
12	1.10
14	1.29

In the case of pipelines that fail to pass the prescribed leakage test, the CONTRACTOR shall determine the cause of the excessive leakage, shall take corrective measures necessary to repair the leaks, and shall again test the pipelines, all at no additional cost to the OWNER.

5.4.2.3 DISINFECTING PIPELINES:

- CHLORINATION: A chlorine-water mixture shall be applied by means of a solution-feed chlorinating device. The chlorine solution shall be applied at one end of the piping or pipeline through a tap in such manner that as the pipeline is filled with water, the dosage applied to the water entering the pipe shall be approximately 50 ppm. Care shall be taken to prevent the strong chlorine solution in the line being treated from flowing back into the line supplying the water.

- RETENTION PERIOD: Chlorinated water shall be retained in the pipeline long enough to destroy all non-spore-forming bacteria. This period shall be at least 24 hours. After the chlorine-treated water has been retained for the required time, the chlorine residual at the pipe extremities and at other representative points shall be at least 25 ppm.

- CHLORINATING VALVES: During the process of chlorinating the piping and pipelines, all valves and other appurtenances where possible shall be operated while the pipeline is filled with the heavily-chlorinated water.

5.4.2.4 FLUSHING: After both pressure testing and chlorination, all pipelines shall be flushed. Flushing shall be accomplished through fire hydrants, end of line blow offs with a minimum of 2-inch diameter or, the CONTRACTOR shall install a tap sufficient in size to provide for a 2.5-foot per second flushing velocity in the pipeline.

The following is the flow quantity required to provide a 2.5-foot per second flushing velocity:

Pipe Size (inches)	Flow (GPM)
4	100
6	200
8	400
10	600
12	900
14	1,200
16	1,600
18	2,000
20	2,500

5.4.2.5 VERIFICATION: Before a pipeline is put into service, verification of disinfection shall be made as outlined in AWWA Standard C-651 Satisfactory bacteriological test results taken no less than 24 hours apart, one from each end of the pipeline being tested if over 500’ long, will be evidence of proper disinfection.

5.4.3 MEASUREMENT AND PAYMENT: Payment for cleaning, pre-flushing, hydrostatic testing, disinfecting, final flushing, verification of disinfection and connection(s) to approved and in-service lines shall be included in the lineal foot price of installed pipe.

End of Section

SECTION 5.5
PVC AWWA C-900/905 WATER PIPE

5.5.1 DESCRIPTION: The work includes providing and installing PVC AWWA C-900/905 water pipe with integral bell and spigot joints.

5.5.2 MATERIALS:

5.5.2.1 PIPE: Pipe shall be AWWA C-900 or C-905, depending on the nominal diameter of the pipe, with material compound being 12454A, per ASTM D1784. Pipe shall be of the dimension ratio shown on the plans.

5.5.2.2 JOINTS: The Elastomeric Seal (gasket) shall conform to ASTM F477. The gasketed joint assembly shall conform to ASTM D3139, and the installation of the C900 pipe shall conform to Uni-Bell-3, AWWA M23 installation guide.

5.5.2.3 FITTINGS: Fittings shall be short body cast iron or ductile iron, iron pipe size for PVC application, and in accordance with AWWA C-110. They shall be capable of withstanding, without bursting hydrostatic tests of three times the rated water working pressure. The fittings shall be furnished with mechanical, or flange joints and shall conform to the dimensions and weights given in AWWA C-110 and AWWA C-111.

5.5.2.4 SERVICE CONNECTIONS: Service connection to PVC plastic pressure pipe shall be by nylon painted cast iron "Romac" double stainless steel strap service saddles or approved equal specifically designed for plastic pipe.

5.5.2.5 QUALITY ASSURANCE: Each standard and random length of pipe is to be tested to four times the class pressure of the pipe for a minimum of 5 seconds. The integral bell is to be tested with the pipe. Randomly selected samples shall be tested in accordance with ASTM D1599 to withstand, without failure, pressures listed below when applied in 60 to 70 seconds: Class 150, a minimum burst pressure of 775 PSI; Class 200, a minimum burst pressure of 985 psi.

5.5.3 CONSTRUCTION:

5.5.3.1 INSTALLATION: The trench bottom shall be stable, smooth and free of frozen material, clodded dirt, and stones over 3/4 inch in diameter. Bell holes should be provided at each joint for easier assembly and uniform support. Large rocks must be removed to provide 6 inches clearance in all directions from pipe and accessories. The pipe shall be installed with proper bedding providing uniform support under the pipe. Backfill materials shall be worked under the pipe to provide adequate haunching. Initial backfill material should be placed to a minimum of 6 inches over the pipe. All pipe embedment material shall be selected and placed carefully, avoiding stones over 3/4-inch, frozen lumps, and debris.

5.5.3.2 INSTALLATION OF LOCATOR TAPE AND LOCATION WIRE: PVC pipelines shall be furnished with metallic locating tape laid along the centerline of the pipe trench at a depth of 24 inches below finish grade. The CONTRACTOR shall furnish manufacturer's literature, completely describing the tape proposed to be installed. No tape shall be installed prior to approval of the Engineer. Copper location wire shall be placed in the bottom of the trench with the installation of

pipe. The ends of the wire shall be coiled and terminated inside valve boxes to permit connection to pipeline locating devices.

5.5.3.3 GRAVEL FOUNDATION FOR PIPE: Wherever the subgrade material does not afford a sufficiently solid foundation to support the pipe and superimposed load, and where groundwater must be drained, the subgrade shall be excavated to such depth as may be necessary and replaced with crushed rock or gravel compacted into place.

Gravel for PVC pipe foundations shall be clean crushed rock or gravel with 100% passing a 3/4-inch screen and 5% passing a No. 4 sieve.

5.5.4 MEASUREMENT AND PAYMENT Section 1.4.9 takes precedence over the following if there is a discrepancy between the two sections.

PVC AWWA C-900/905 WATER PIPE: PVC pipe measurement shall be per lineal foot installed piping of the type, size and class shown on the drawings and in the bidding schedule (payment shall be made as part of another Bid Item if PVC pipe is not specifically included as a bid item). Measurement shall be along the centerline of the pipe as measured in the field following construction. No deduct in length for payment will be made for valve & fittings.

Payment will be made per Bid Item only after the surface restoration, including, but not limited to, gravel and asphalt restoration, has been completed and accepted.

Payment to install pipelines shall be at the unit price in the Bid Schedule. Payment shall be full compensation for mobilization, cutting asphalt pavement; unclassified excavation; imported material for pipe bedding; trench backfill; location tape; tracer wire storing and installing the pipe, fittings, elbows and couplings; removal and disposal of excess or rejected excavated materials; compaction; thrust blocks; pressure testing; disinfecting, dechlorination, flushing and placing the line into service. Payment shall also include compensation for restoration of miscellaneous improvements damaged during construction.

End of Section

SECTION 5.6
PORTLAND CEMENT CONCRETE

5.6.1 DESCRIPTION: This section of the specifications defines materials to be used in all portland cement concrete work and requirements for mixing, placing, finishing, and curing.

5.6.2 MATERIALS: Materials used in portland cement concrete and reinforcing of portland cement concrete shall meet the following requirements:

5.6.2.1 CEMENT: Portland cement shall be Type II or as approved by the Engineer and shall comply with the Standard Specification for Portland Cement, ASTM C-150. POZZOLANS, FLY ASH AND/OR SILICA FUME SHALL NOT BE USED.

5.6.2.2 AGGREGATES: Concrete aggregates shall conform to Tentative Specifications for Concrete Aggregates, ASTM C-33.

5.6.2.3 WATER: Water used in mixing concrete shall be clean and free from oil, acid, salt, injurious amounts of alkali, organic matter or other deleterious substances.

5.6.2.4 ENTRAINING AGENT: An air-entraining agent shall be used in all concrete exposed to the weather. The agent shall conform to ASTM Designation C-175 and C-260.

5.6.2.5 ADMIXTURES: No admixtures unless approved by the Engineer. Calcium chloride shall not be used in reinforced concrete.

5.6.2.6 FLY ASH: No fly ash shall be added without mix design approved by the Engineer.

5.6.2.7 REINFORCED STEEL: All bar material used for reinforcement of concrete shall be intermediate grade steel free of rust conforming to the requirements of ASTM Designation A-615 GR-60 and shall be deformed in accordance with ASTM Designation A-305.

5.6.2.8 WELDED WIRE FABRIC: Welded wire fabric for concrete reinforcement shall conform to the requirements of ASTM A-185.

5.6.3 CONSTRUCTION: For the purpose of practical identification, concrete has been divided into three classes: Class A, B, and C. Basic requirements and use for each class are defined as follows:

Class	Minimum Cement (sacks/c.y.)	Minimum 28-day Comp. Strength (psi)	Primary Use
A	6	4000	Reinforced Structural Concrete
B	6	3500	Sidewalks, curbs, and gutters, cross gutters, pavements, and non-reinforced footings and foundations
C	5	2500	Thrust blocks, anchors, mass concrete

Note: Above specifications contain 94 pound sacks of Portland Cement.

All concrete shall also comply with the following requirements.

AGGREGATES: The maximum size of the aggregate shall be not larger than one-fifth of the narrowest dimension between forms within which the concrete is to be cast, nor larger than three-fourths of the minimum clear spacing between reinforcing bars or between reinforcing bars and forms. For non-reinforced concrete slabs, the maximum size of aggregates shall not be larger than one-fourth the slab thickness.

WATER: Sufficient water shall be added to the mix to produce concrete with the minimum practicable slump. The slump of mechanically vibrated concrete shall not exceed four inches. **NO** concrete shall be placed with a slump in excess of five inches. The maximum permissible water-cement ratio (including free moisture on aggregates) shall be 5 and 5-3/4 gallons per bag of cement respectively for Class A and B air entrained concrete.

AIR-ENTRAINING: Air content for air-entrained concrete shall comply with the following:

Course Aggregate Size (in.)	Air Content %
1-1/2 to 2-1/2	5 ± 1
3/4 or 1	6 ± 1
3/8 or 1/2	7 ± 1

The air-entraining agent shall be added as liquid to the mixing water by means of mechanical equipment capable of accurate measurement and control.

5.6.3.1 FORMS: Forms shall be substantially built and adequately braced so as to withstand the liquid weight of concrete. All linings, studding, walling and bracing shall be such as to prevent bulging, spreading, or loss of true alignment while pouring and displacement of concrete while setting. Metal forms shall be used for sidewalk work unless otherwise specified by the Engineer. All edge forms for sidewalk pavements, curbs, and gutters shall be of sufficient rigidity and adequately braced to accurately maintain line and grade. Prior to concrete placement, all forms shall be lightly coated with oil to prevent concrete adhesion to form materials.

Exposed vertical and horizontal edges of the concrete in structures shall be chamfered by the placing of molding in the forms or as directed by the Engineer and as indicated in the plans.

FORM STRIPPING: Forms shall remain in-place for at least the following time periods after completion of a concrete pour in a given section of forms:

Walls and columns:	24 hours
Roof deck:	10 days

5.6.3.2 JOINTS: Joints shall be provided for sidewalk and curb and gutter as follows:

SIDEWALKS: Shall have scribed joints at intervals of 4 feet which joints shall be approximately 3/16" wide and be approximately 1/4 of the total slab thickness. In addition, 1/2-inch expansion joints shall be provided at 50-foot intervals and at locations where sidewalks adjoin curbs or existing sidewalks, driveways, building walls or aprons. Expansion joints shall be provided at 4-foot intervals where manholes, valve boxes or meter boxes are located.

5.6.3.3 REINFORCEMENT AND EMBEDDED ITEMS: Reinforcing steel shall be clean and free from rust, scale, paint, grease or other foreign matter which might impair the bond. It shall be accurately bent and shall be tied to prevent displacement when concrete is poured. Reinforcing steel shall be held in place by only metal or concrete ties, braces and supports. No steel shall extend from or be visible on any finished surface and shall have a minimum of 1 1/2" concrete cover. Bars shall be grade 60.

The Contractor shall use concrete chairs for holding the steel away from the subgrade, and spreader or other type bars for securing the steel in place. The spreader bars shall be not less than 3/8-inch in diameter.

5.6.3.4 PREPARATIONS: Before batching and placing concrete, all equipment for mixing and transporting the concrete shall be cleaned, all debris and ice shall be removed from the places to be occupied by the concrete, forms shall be thoroughly wetted or oiled, and masonry filler units that will be in contact with concrete shall be well drenched and the reinforcements shall be thoroughly cleaned of ice or other coatings. Water shall be removed from spaces to receive concrete. When placing concrete on earth surfaces, the surfaces shall be free from frost, ice, mud, and water. When the subgrade surface is dry soil or pervious material, it shall be sprayed with water immediately before placing of concrete or shall be covered with waterproof sheathing paper or a plastic membrane. No concrete shall be placed until the surfaces have been inspected and approved by the Engineer or Inspector.

COMPACTION: All subgrade and backfill materials shall be compacted in accordance with Section 5.1.3.10.

5.6.3.5 CONCRETE MIXING: All concrete shall be ready-mixed and delivered in accordance with ASTM C-94. The concrete shall be mixed until there is a uniform distribution of the materials. Sufficient water shall be used in mixing concrete to produce a mixture which will flatten and quake when deposited in place, but not enough to cause it to flow. Sufficient water shall be used in concrete in which reinforcement is to be embedded, to produce a mixture which will flow sluggishly when worked and which, at the same time, can be conveyed from the mixer to the forms without segregation of aggregate. In no case shall the quantity of water used be sufficient to cause the

collection of a surplus in the forms or exceed the maximum allowable slump as specified in 5.6.3.

5.6.3.6 DEPOSITING: Concrete shall be deposited as nearly as practical in its final position to avoid segregation due to rehandling or flowing. The concrete placing shall be carried on at such a rate that the concrete is at all times plastic and flows readily into the corners of forms and reinforcing bars. No concrete that has partially hardened or been contaminated by foreign material shall be deposited in the work, nor shall retempered concrete be used. No concrete shall be dropped more than 3 feet. Concrete delivered to the job site having a temperature that exceeds 90 degrees Fahrenheit shall not be placed. Concrete cooling methods during hot weather will be approved by the Engineer.

All concrete in structures shall be vibrator compacted during the operation of placing, and shall be thoroughly worked around reinforcement and embedded fixtures and into the corners of the forms.

CONSTRUCTION JOINTS: All construction joints shall be located and prepared as shown on the drawings or otherwise approved in writing by the Engineer. Unanticipated cold joints may be cause for rejection of the entire poured section in which the cold joint is located, at the sole discretion of the Engineer, in consultation with others. Rejected sections shall be demolished and re-poured by the Contractor as specified at no additional cost to the Owner.

5.6.3.7 PLACING CONCRETE IN COLD WEATHER: No concrete shall be poured where the air temperature is lower than 40 degrees Fahrenheit, at a location where the concrete cannot be covered or protected from the surrounding air. Where concrete is poured below a temperature of 35 degrees Fahrenheit the ingredients of the concrete shall be heated so that the temperature of the mixture shall not be less than 50 degrees or more than 100 degrees Fahrenheit. Before mixing, the heated aggregates shall not exceed 125 degrees Fahrenheit and the temperature of the heated water shall not exceed 175 degrees Fahrenheit. Cement shall not be added while the temperature of the mixed aggregates and water is greater than 100 degrees Fahrenheit. When there is likelihood of freezing during the curing period, the concrete shall be protected by means of an insulating covering and/or heating the concrete for a period of not less than 7 days after placing. The temperature must be maintained at a minimum of 40 degrees Fahrenheit. Concrete shall not be placed on frozen soil. Equipment for protecting concrete from freezing shall be available at the job site prior to placing concrete. Particular care shall be exercised to protect edges and exposed corners from freezing. In the event heating is employed, care shall be taken to insure that no part of the concrete becomes dried out or is heated to temperatures above 90 degrees Fahrenheit. The housing, covering, or other protection used shall remain in place and intact at least 24 hours after the artificial heating is discontinued. Combustion heaters shall not be used during the first 24 hours unless precautions are taken to prevent exposure of the concrete to exhaust gases that contain carbon dioxide.

5.6.3.8 FINISHING:

FORMED SURFACE FINISHES - Provide the following finishes unless indicated or shown otherwise on the drawings.

ROUGH FORM FINISH - Applies to all surfaces not exposed to view such as surfaces in contact with earth backfill. Repair defects and patch tie holes. Remove fins exceeding 1/4 inch in height. Otherwise leave surfaces with the texture imparted by the forms.

SMOOTH FORM FINISH - Applies to all exposed surfaces and interior surfaces of vaults and pits. Use form facing material to produce a smooth, hard, uniform surface. Support with backing capable of preventing specified deflection. Do not use material with raised grain, torn surfaces, worn edges, patches, dents, or other defects which will impair the texture of the concrete surface. Keep the number of seams to a minimum. Repair and patch all tie holes and defects. Remove all fins.

GROUT CLEANED FINISH - Smooth rubbed finish shall be produced by "brush-off" sandblasting or grinding with a stone wheel or grinder on all exposed wall surfaces prior to filling holes to expose all holes near the surface of the concrete. The wall surface shall then be rubbed with a mortar consisting of one part portland cement and 1-1/2 parts of fine sand passing the 100 screen with enough water and an emulsified bonding agent to have the consistency of thick creme. The wall surface shall be thoroughly wetted. Apply the grout by rubbing it over the entire area with clean burlap, sponge rubber floats, or trowels. Surface shall be wiped clean and most cured.

SLAB FINISHES - Unless specified or otherwise shown on the drawings, apply finishes to slabs as follows:

FLOATED FINISH - Use for surfaces to be trowel finished or to be broom finished. After the concrete has been placed, consolidated, struck off, and leveled, do not work further until water sheen has disappeared and the surface has been stiffened. When water sheen has disappeared and surface has stiffened, float with a hand float or with a bladed power trowel equipped with float shoes, or with a powered disc float. During or after the first floating, planeness of surface shall be checked with a 10-ft. straightedge applied at not less than two differed angles. Cut down all high spots and fill all low spots to produce a surface level tolerance of 1/4 inch in 10 feet throughout. Then refloat immediately to a uniform sandy texture.

TROWELED FINISH - Use for interior floors intended as walking surfaces. The surface shall first be float-finished as specified above. Next, power trowel followed by hand troweling. The first troweling after power floating shall produce smooth surface which is free of defects but which may still show some trowel marks. Additional trowelings shall be done by hand after the surface has hardened. Accomplish final troweling when a ringing sound is produced as the trowel is moved over the surface. Thoroughly consolidate surface by the hand troweling until the finished surface is free of trowel marks, uniform in texture and appearance and level within a tolerance of 1/4 inch in 10 feet in all directions. On surfaces intended to support floor coverings, defects which show through the floor covering shall be removed by grinding.

BROOM OR BELT FINISH - Use for exterior horizontal walks and slabs. Immediately after the concrete has received a float finish as specified above, provide a coarse transverse scored texture by drawing a broom or burlap belt across the surface.

5.6.3.9 CURING AND PROTECTION: As soon as the concrete has hardened sufficiently to prevent damage, the finished surface shall be protected for curing one of the following ways:

Application of a curing compound, conforming to "Specifications for Liquid Membrane-Forming Compounds for Curing Concrete" ASTM C-309. The compound shall be light in color and shall be applied in accordance with the manufacturers recommendations

immediately after any water sheen, which may develop after finishing has disappeared from the concrete surface.

Ponding of water on the surface or continuous sprinkling. Application of light colored waterproof plastic materials, conforming to “Specifications for Waterproof Sheet Materials for Curing Concrete” ASTM C-171, placed and maintained in contact with the surface of the concrete. The freshly finished surface shall be protected from hot sun and drying winds until it can be sprinkled or covered as above specified. The concrete surface must not be damaged or pitted by rain. The contractor shall provide and use, when necessary, sufficient tarpaulins to completely cover all sections that have been placed within the preceding twelve (12) hours.

The Contractor shall erect and maintain suitable barriers to protect the finished surface. Any section damaged from traffic or other causes occurring prior to its official acceptance, shall be repaired or replaced by the Contractor at his own expense in accordance with these specifications.

Defective concrete conditions or surfaces shall be removed, replaced, or repaired, without further cost to the OWNER, in accordance with these specifications.

5.6.3.10 CONCRETE TESTING: The Engineer may order the taking of concrete test cylinders to check the required compressive strengths. If taken, samples will be made in accordance with ASTM C172 and tested as follows:

a. Air Content: Test for air content shall be performed in accordance with ASTM C 173 or ASTM C 231. A minimum of 1 test shall be conducted each time a slump test is made.

b. Slump: At least 1 slump test shall be made on randomly selected batches of each mixture of concrete for every 50 cubic yards of ready-mixed concrete delivered to the job site. Also note the time batched at the plant and the starting time when unloading began at the site. Tests shall be performed in accordance with ASTM C 143.

c. Temperature: Concrete and air temperatures shall be measured and recorded with each set of cylinders and the air temperature shall also be recorded when the air temperature at the site is 40 degrees F or below and/or 90 degrees F or above.

EVALUATION AND ACCEPTANCE OF CONCRETE

a. Frequency of Testing: Samples for strength tests of each class of concrete placed each day shall be taken not less than once a day, nor less than once for each 50 cubic yards of concrete, nor less than once for each 3000 square feet of surface area for slabs or walls. If this sampling frequency results in less than 5 strength tests for a given class of concrete, tests shall be made from at least 5 randomly selected trucks or from each truck if fewer than 5 truck loads are used. Field cured specimens for determining form removal time or when a structure may be put in service shall be made in numbers directed to check the adequacy of curing and protection of concrete in the structure. The specimens shall be removed from the molds at the age of 24 hours and shall be cured and protected, insofar as practicable, in the same manner as that given to the portion of the structure the samples represent.

b. Testing Procedures: Cylinders for acceptance tests shall be molded and cured in accordance with ASTM C 31. Cylinders shall be tested in accordance with ASTM C 39. A strength test shall be the average of the strengths of two cylinders made from the same sample of concrete and tested at 28 days or at another specified test age.

c. Evaluation of Results: Concrete specified on the basis of compressive strength will be considered satisfactory if the averages of all sets of three consecutive strength test results equal or exceed the specified strength and no individual strength test result falls below the required strength by more than 500 pounds per square inch.

d. Unless noted otherwise, make a minimum of four (4) concrete cylinders each time a test is required. When concrete is being placed in suspended slabs, beams and retaining walls make two (2) extra cylinders that must be cured on site. The extra cylinders will be used to determine when to remove forms and/or when to backfill.

In-place concrete may be cored for testing. Cost of all laboratory testing shall be the responsibility of the Owner. Any retesting required because of test failures shall be the responsibility of the Contractor. All concrete delivered to the job site shall be accompanied by a ticket specifying: bag mix, air content, etc. Said ticket shall be given to the Engineer's Inspector who may field check slump and air entrainment compliance.

5.6.3.11 Miscellaneous: All other items, including, but not limited to, waterstops and joint sealant, shall be as shown on the Drawings.

End of Section

SECTION 5.7

EARTHWORK

5.7.1 DESCRIPTION: Extent of earthwork is indicated on drawings. Preparation of bedding of pipe and trenching is included in Section 5.1 “Trench Excavation and Backfill”.

“Excavation" consists of removal of material encountered to subgrade elevations indicated and subsequent relocation of materials removed. Perform excavation work in compliance with applicable requirements of governing authorities having jurisdiction. “Embankment” includes compacted backfill in specified lifts and densities.

A copy of the geotechnical report prepared for this project as appended to this specification book for the information of the CONTRACTOR. In the event of a conflict between this Section 5.7 and the project-specific geotechnical report, the more robust direction shall govern.

5.7.2 MATERIALS:

5.7.2.1 SATISFACTORY MATERIALS: Materials are defined as those complying with ASTM D2487 soil classification groups GW, GP, GM, SM, SW and SP.

5.7.2.2 UNSATISFACTORY SOIL MATERIALS: Unsatisfactory soil materials are defined as those complying with ASTM D2487 soil classifications groups GC, SC, ML, CL, CH, OL, OH and PT.

5.7.2.3 STRUCTURAL FILL: All fill placed for the support of the proposed water tank, appurtenant structures, or concrete flatwork should consist of structural fill. We anticipate that the majority of the on-site coarse-grained soils and residual bedrock will be suitable for use as structural fill provided that they are free of vegetation, frozen material, and debris, and contain no inert materials larger than 6 inches in nominal size.

Alternatively, structural fill may consist of an imported granular soil with a maximum of 50 percent passing the No. 4 mesh sieve and a maximum fines content (minus No.200 mesh sieve) of 15 percent. The fines should have a liquid limit less than 25 and plasticity index less than 10.

Soil not meeting the aforementioned criteria may be suitable for use as structural fill. These soils should be evaluated on a case-by-case basis and should be approved by the Engineer prior to use.

5.7.2.4 BACKFILL AND FILL MATERIALS: Backfill within 2 feet of structures shall be 2-inch minus, well-graded granular material, free of debris, waste, frozen materials, vegetable and other deleterious matter. Fill material used elsewhere may consist of well-graded, non-expansive material, free of

5.7.2.5 COMPACTION TESTING: Owner may employ at Owners Expense, testing laboratory to perform soil testing and inspection service for quality control testing during earthwork operations.

5.7.2.6 SITE CONDITIONS: Data on indicated subsurface conditions at the end of this section are not intended as representations or warranties of accuracy or continuity between soil borings. It is expressly understood that Owner will not be responsible for interpretations or conclusions drawn therefrom by Contractor. Data is made available for convenience of Contractor. Contractor may make additional test borings and other exploratory operations at no cost to Owner.

5.7.3 CONSTRUCTION: Locate existing underground utilities in areas of work. If utilities are to remain in place, provide adequate means of support and protection during earthwork operations. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult utility owner immediately for directions. Cooperate with owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to the satisfaction of utility owner.

Do not interrupt existing utilities serving facilities occupied and used by Owner or others during occupied hours, except when permitted in writing by Engineer and then only after acceptable temporary utility services have been provided.

Provide minimum of 48-hour notice to Engineer, and receive written notice to proceed before interrupting any utility.

Demolish and completely remove from site any and all existing underground utilities identified for removal. Coordinate with utility companies for shut-off of services if lines are active.

5.7.3.1 EXPLOSIVES: The use of explosives is not permitted without written approval of ENGINEER and OWNER and any and all Authorities Having Jurisdiction over the use of explosives.

Procedures and liabilities as outlined in Section 5.1.3.3, Solid Rock Excavation And Blasting, shall be followed if the use of explosives is necessary.

5.7.3.2 PROTECTIONS OF PERSONS AND PROPERTY: Barricade open excavations occurring as part of this work. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by earthwork operations.

5.7.3.3 EXCAVATION CLASSIFICATIONS: The following classifications of excavation will be made when rock excavation is encountered in work:

Earth Excavation - Includes excavation of pavements and other obstructions visible on ground surface; underground structures, utilities and other items indicated to be demolished and removed; together with earth and other materials encountered that are not classified as rock or unauthorized excavation.

Rock Excavation in Trenches and Pits - Includes removal and disposal of materials and obstructions encountered which cannot be excavated with a 1.0 cubic yard (heaped) capacity, 42 inch wide bucket on track-mounted power excavator equivalent to Caterpillar Model 215, rated at not less than 90 HP flywheel power and 30,000 lb. drawbar pull. Trenches in excess of 10' - 0" in width and pits in excess of 30' - 0" in length or width are classified as open excavation.

Rock Excavation in Open Excavations - Includes removal and disposal of materials and obstructions encountered, which cannot be dislodged and excavated with modern track-mounted heavy-duty excavation equipment without drilling, blasting or ripping.

Typical of materials classified as rock are boulders 1/2 cu. yd. or more in volume, solid rock, rock in ledges, and rock-hard cementitious aggregate deposits.

Intermittent drilling, blasting or ripping performed to increase production and not necessary to permit excavation of material encountered will be classified as earth excavation.

Do not perform rock excavation work until material to be excavated has been cross-sectioned and classified by the Engineer. Such excavation will be paid on basis of contract conditions relative to changes in work.

Rock Payment Lines are limited to the following:

Two feet outside of concrete work for which forms are required, except footings. One foot outside perimeter of footings, unless specifically modified in the construction drawings or geotechnical report for the specific Project under construction. In pipe trenches, 6 inches below invert elevation of pipe and 2 feet wider than inside diameter of pipe, but not less than 3 feet minimum trench width. Neat outside dimensions of concrete work where no forms are required. Under slabs on grade, 6 inches below bottom of concrete slab.

Unauthorized Excavation - Consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of Engineer. Unauthorized excavation, as well as remedial work directed by Engineer, shall be at Contractor's expense.

Under footings, foundation bases, or retaining walls, fill unauthorized excavation by extending indicated bottom elevation of footing or base to excavation bottom, without altering required top elevation. Lean concrete fill may be used to bring elevations to proper position, when acceptable to Engineer.

Elsewhere, backfill and compact unauthorized excavations as specified for authorized excavations of same classification, unless otherwise directed by Engineer.

Additional Excavation: When excavation has reached required subgrade elevations, notify Engineer who will make an inspection of conditions.

If unsuitable bearing materials are encountered at required subgrade elevation, carry excavations deeper and replace excavated material as directed by Engineer. Removal of unsuitable material and its replacement as directed will be paid on basis of contract conditions relative to changes in work.

5.7.3.4 STABILITY OF EXCAVATIONS: Slope sides of excavations to comply with local codes and ordinances having jurisdiction. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated.

Maintain sides and slopes of excavations in safe condition until completion of backfilling.

5.7.3.5 SHORING AND BRACING: Provide materials for shoring and bracing, such as sheet piling, uprights, stringers and cross-braces, in good serviceable condition.

Establish requirements for trench shoring and bracing to comply with local codes and authorities having jurisdiction.

Maintain shoring and bracing in excavations regardless of time period excavations will be open. Carry down shoring and bracing as excavation progresses.

5.7.3.6 DEWATERING: Prevent surface water and subsurface or groundwater from flowing into excavations and from flooding project site and surrounding area.

Do not allow water to accumulate in excavations. Remove water to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to stability of subgrades and foundations. Provide and maintain pumps, well points, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.

Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey rain water and water removed from excavations to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches.

5.7.3.7 MATERIAL STORAGE Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade and shape stockpiles for proper drainage. Locate and retain soil materials away from edge of excavations. Do not store within drip line of trees indicated to remain. Dispose of excess soil material and waste materials as herein specified.

5.7.3.8 COLD WEATHER PROTECTION: Protect excavation bottoms against freezing when atmospheric temperature is less than 35°F. (I°C).

5.7.3.9 COMPACTION: Control soil compaction during construction providing minimum percentage of density specified for each area classification indicated below.

Structural Fill and Sub-Ballast: Compact top 8 inches of subgrade and each layer of structural fill material or sub-ballast at 95% maximum modified proctor density ASTM D 1557). Maximum compacted thickness of any one lift shall not exceed 6-inches.

Sub-Grade: Compact top 6 inches of subgrade and each layer of backfill or fill material at 90% maximum modified proctor density (ASTM D 1557).

Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water to surface of subgrade, or layer of soil material. Apply water in manner to prevent free water appearing on surface during or subsequent to compaction operations.

Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density.

Soil material that has been removed because it is too wet to permit compaction may be stockpiled or spread and allowed to dry. Assist drying by dicing, harrowing or pulverizing until moisture content is reduced to a satisfactory value.

5.7.3.10 BACKFILL AND FILL: Place acceptable soil material in layers not exceeding 8 inches (uncompacted depth) and compact each layer prior to placement of next layer to required subgrade elevations, for each area classification listed below.

Sub-ballast, use structural fill material, or satisfactory excavated or borrow material, or combination of both.

Under Ballast, use sub-ballast material.

Backfill excavations as promptly as work permits, but not until completion of the following:

Acceptances of construction below finish grade including, where applicable, damp proofing, waterproofing, and perimeter insulation.

Inspection, testing, approval, and recording locations of underground utilities.

5.7.3.11 GROUND SURFACE PREPARATION: Remove vegetation, debris, unsatisfactory materials, obstructions, and deleterious materials from ground surface prior to placement of fills. Plow, strip, or break-up sloped surfaces steeper than 1 vertical to 4 horizontal so that fill material will bond with existing surface.

When existing ground surface has a density less than that specified under "Compaction" for particular area classification, break up ground surface, pulverize, moisture-condition to optimum moisture content, and compact to required depth and percentage of maximum density.

5.7.3.12 PLACEMENT AND COMPACTION: Place backfill and fill materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

Place backfill and fill materials evenly adjacent to structures, piping or conduit to required elevations. Take care to prevent wedging action of backfill against structures or displacement of piping or conduit by carrying material uniformly around structure, piping or conduit to approximately same elevation in each lift.

5.7.3.13 GRADING: Uniformly grade areas within limits of grading under this section including adjacent transition areas. Smooth finished surface within specified tolerances, compact with uniform levels or slopes between point s where elevations are indicated, or between such points and existing grades.

Finish surfaces free from irregular surface changes, and as follows:

Ballast and Sub-Ballast: Shape surface of areas under Ballast and Sub-Ballast to line, grade and cross-section, with finish surface not more than 2 inches above or below required subgrade elevation.

Compaction: After grading, compact subgrade surfaces to the depth and indicated percentage of maximum dry or relative density for each area classification.

5.7.3.14 MAINTENANCE:

Protection of Graded Areas: Protect newly graded areas from traffic and erosion. Keep free of trash and debris. Repair and re-establish grades in settled, eroded, and rutted areas to specified tolerances.

Reconditioning Compacted Areas: Where subsequent construction operations or adverse weather disturbs completed compacted areas, scarify surface, re-shape, and compact to required density prior to further construction.

Settling: Where settling is measurable or observable at excavated areas during general project warranty period, remove surface (pavement, lawn or other finish), add backfill material, compact, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

5.7.3.15 DISPOSAL OF EXCESS AND WASTE MATERIALS

Removal to Designated Areas on Owner's Property: Transport acceptable excess excavated material to designated soil storage areas on Owner's property. Stockpile soil or spread as directed by Engineer.

Removal from Owner's Property: Remove waste materials, including unacceptable excavated material, trash and debris, and dispose of it off Owner's property, in a legal manner.

End of Section

SECTION 5.8
DUCTILE IRON PIPE

5.8.1 DESCRIPTION: This section covers the requirements for ductile iron pressure pipe materials, installation and inspection.

5.8.2 MATERIALS:

5.8.2.1 DUCTILE IRON PIPE: Ductile iron pipe shall conform to all requirements of AWWA C-151 and ANSI A-21.51 "Ductile Iron Pipe, Centrifugally Cast in Metal Molds or Sand Lined Molds, For Water or Other Liquids." Pipe shall be pressure class 350. Pipe shall meet the requirements of NSF Standard 61 and be so stamped.

5.8.2.2 JOINTS - General: Flanged fittings shall not be used in buried applications unless specifically identified on the plans.

- MECHANICAL JOINTS: All mechanical joints shall meet requirements of ANSI A-21.6 and ANSI 21.11. All gasket surfaces shall be smooth and free from imperfections. All mechanical joint gaskets shall be less than one year old. Bolts shall meet all requirements of 5.3.2.14 above. All bolts shall be of the proper size and length to match the size of pipe fitting as per drawings.

- PUSH-ON JOINTS: Push-on joints will be used for main line 6-inch, 8-inch and 10-inch ductile iron pipe for this project. All push-on joints shall meet the requirements of ANSI 21.11. Gaskets shell be free from defects and not over one year old.

  Lubricants shall be non-toxic and have no deteriorating effects on gasket materials. It shall not impart taste, odor or flavor to water in a pipe. It shall conform in every way to ANSI 21.11.

- FLANGED JOINTS: Flanged joints shall be bolted firmly with machine, stud or cap bolts of proper size. Flanges may be cast integrally with the pipe or may be screwed or threaded pipe. Flanges shall be faced and drilled and of proper dimensions and class, for size and pressure required. All flanges shall meet requirements of ANSI A 21.10, "American Standard for Cast Iron Fittings."

  Bolts and nuts, unless otherwise specified, shall be made of the best quality refined iron or metal steel and have clean, well-fitting threads. Bolts will be provided with standard hexagonal nuts and standard hexagonal heads. Bolts shall be of the diameter required for each flange and, when installed, shall be of length so that no more than 3/8 inch or less than 1/8 inch extends past face of nut. Gaskets shall be 1/16 inch thick, made of best quality sheet gasket material or equal. A gasket for each flange joint of proper size, ring type or full face shall be installed.

- COMPRESSION JOINTS: Compression joints shall be mechanical joint cast iron sleeve with armor guard gaskets, Rockwell 441 or Flange adaptor Rockwell Type 900 or approved equal, as specified on approved drawings.

5.8.2.3 FITTINGS:

- MECHANICAL JOINT FITTINGS: Mechanical Joint Fittings shall conform to ANSI A 21.10," American Standard For Cast Iron Fittings."

- PUSH-ON FITTINGS: Push-on fittings shall conform to ANSI A 21.10 with bells, sockets, and plain ends per ANSI A 21.11.

- FLANGED FITTINGS: Flanged fittings shall conform to ANSI 21.10, "American Standard For Cast Iron Fittings."

All flanges shall be faced and drilled. Where cap screws or stud bolts are needed, flanges shall be tapped to support cap screws or stud bolts as per approved drawings.

5.8.2.4 CEMENT MORTAR LINING: Ductile iron pipe and fittings shall be lined with cement mortar in accordance with the requirements of the "American National Standard for Cement Mortar Lining for Cast Iron and Ductile Iron Pipe and Fittings for Water" (ANSI A21.4 AWWA C104).

5.8.2.5 COAL TAR COATING: Pipe and fittings installed above-grade shall be bare (no coal-tar coating applied) so that a two-part epoxy paint may be applied without the necessity of removing the coal tar coating. Pipe and fittings that are below-grade shall be coated to resist corrosion with a coal tar coating.

5.8.3 CONSTRUCTION:

5.8.3.1 INSTALLATION: Ductile iron pipe shall be installed in accordance with the "American National Standard for Installation of Gray and Ductile Cast-Iron Water Mains and Appurtenances" (ANSI/AWWA C600).

Tees, elbows, crosses, and reducers shall be used for changes in direction and outlets, unless otherwise specified on the drawings.

Anchors, thrust bolts and thrust blocks shall be placed at valves, elbows, tees, etc., as shown on the approved drawings or as directed by the ENGINEER.

All ductile iron pipe installation shall proceed on a stable foundation, with joints closely and accurately fitted. Joints shall be clean and dry, and a non-toxic joint lubricant, as recommended by the pipe supplier, shall be applied uniformly to the mating joint and gasket surfaces to facilitate easy, positive joint closure. All push-on joints shall have brass wedges as supplied by the pipe manufacturer, and installed as per standard push-on joint specifications unless otherwise directed by the ENGINEER.

All pipe shall be installed with uniform bearing under the full length of the barrel, with suitable excavations being made to receive pipe bells and fittings.

Bedding material shall be compacted around the pipe to firmly bed the pipe in position. If adjustment of position of a pipe length is required after being laid, it shall be removed and rejoined as for new pipe installation. In addition to the above requirements, all pipe installation shall comply with the specific requirements of the pipe manufacturer.

Each pipe shall be laid true to line and grade and in such a manner as to form a close concentric joint with adjoining pipe and to prevent sudden offsets to the flow line. All joint offsets shall be made as specified in AWWA Standard for "Installation of Water

Mains" C-600. As work progresses, the interior of the pipe shall be cleared of dirt and superfluous materials. Where cleaning after laying is difficult because of small pipe size, a suitable swab or drag shall be kept in the pipe and pulled forward past each joint immediately after jointing as set, and pipe shall not be laid when conditions of the trench or weather is unsuitable for such work. At all times when work is in progress, all open ends of the pipe and fittings shall be securely closed to the satisfaction of the ENGINEER, so that no water, earth, or other substance will enter the pipe or fittings.

5.8.3.2 PIPE STABILIZATION MATERIAL: Wherever the subgrade material does not afford a sufficiently solid foundation to support the pipe and superimposed load, and where groundwater must be drained, or where solid rock intrudes into the trench, the subgrade shall be excavated to a minimum depth of 8 inches below pipe bedding as may be necessary and replaced with crushed rock, or pit run gravel.

Gravel for ductile iron pipe stabilization material shall be clean gravel with 100 percent passing a 3-inch screen and 5 percent passing a Number 3/4-inch sieve (refer to Section 5.2, "Pipeline Trench Excavation and Backfill").

5.8.3.3 PIPE BEDDING: All pipes shall be protected from lateral displacement and possible damage resulting from impact or unbalanced loading during backfilling operations by being adequately bedded. A groove shall be excavated in the bottom of the trench to receive the bottom quadrant of the pipe. Before preparing the groove, the trench bottom shall be excavated or filled, with approved bedding material, and compacted to an elevation sufficiently above the grade of the pipe so that, when completed, the pipe will be true to line and grade. Bell holes and pipe fitting holes shall be excavated so that only the barrel of the pipe and bottom quadrant of the fitting receives bearing from the trench bottom

Pipe bedding materials placed at any point below the midpoint of the pipe shall be deposited and compacted in layers not to exceed 10 inches in uncompacted depth. Deposition and compaction of bedding materials shall be done simultaneously and uniformly on both sides of the pipe. Compaction shall be accomplished with hand or mechanical compactors. All bedding materials shall be placed into the trench with hand tools or other approved method in such a manner that they will be scattered alongside the pipe and not dropped or pushed into the trench in compact masses. Bedding materials shall be loose earth, free from lumps, boulders or other debris, sand materials free from roots, sod, or other vegetable matter. All bedding materials shall be approved by the OWNER and ENGINEER.

In the event trench materials are not satisfactory for pipe bedding, modified bedding materials will be required. Modified bedding shall consist of placing compacted granular material on each side of and to the level of 12 inches above the top of the pipe.

Modified bedding materials shall be graded as follows: 100 percent passing a 1-inch screen and 5 percent passing a 1/2-inch screen. All modified bedding materials shall be approved by the ENGINEER (refer to Section 5.1, "Pipeline Trench Excavation and Backfill").

5.8.3.4 CLEANING AND FLUSHING: The CONTRACTOR shall take every precaution to remove dirt, grease, and all other foreign matter from each length of piping before making connections in the field. After each section of piping is installed, is shall be thoroughly cleaned to remove rocks, dirt, and other foreign matter by washing, sweeping, scraping, or other method that will not harm the lining or pipe.

Water required for flushing shall be furnished by the CONTRACTOR. All temporary connections for flushing and drainage shall be furnished, installed, and subsequently removed by the CONTRACTOR.

All open ends of pipes shall be bulkheaded or plugged when workmen are not on the job or in the immediate area to prevent rocks or other foreign matter from entering the pipe (refer to Section 5.4, "Disinfection and Testing of Water lines").

End of Section

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Geotechnical Investigation
LPC – Upper System Tank
6970 North Durfee Way
Liberty, UT.

GeoStrata Job No. 746-010

June 27, 2016

Prepared for:

Gardner Engineering
5150 South 375 East
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1.0 EXECUTIVE SUMMARY

This report presents the results of a Geotechnical Investigation conducted for the proposed buried 250,000-gallon water tank to be constructed at 6970 North Durfee Way in Liberty, Utah (see Plate A-1, *Site Vicinity Map*). The purposes of this investigation were to assess the nature and engineering properties of the subsurface soils at the site and to provide recommendations for the design and construction of foundations and cut/fill slopes.

Based on the subsurface conditions encountered at the site, it is our opinion that the subject site is suitable for the proposed construction provided that the recommendations contained in this report are complied with.

Subsurface soil conditions were investigated by advancing two exploratory test pits to depths ranging from 3 to 5½ feet below the existing site grade. Based on our observations and geologic literature review, the subject site is overlain by 6 inches of gravelly topsoil. Underlying the topsoil we encountered Upper Proterozoic-aged feldspathic quartzite bedrock. This bedrock deposit persisted to the full depth of our investigation.

Conventional ring-wall or mat footings may be used to support the proposed structure. Bedrock will likely be encountered in excavations for the proposed water tank. Heavy excavation equipment and/or blasting may be necessary to remove bedrock and oversized material. Foundations may be established upon undisturbed native soils or bedrock and proportioned using a net bearing capacity of **4,000 psf.** Differential settlement of the structure if founded as described in this report should be on the order of ½ the total settlement over 30 feet.

All temporary excavations may be sloped at a maximum 1 horizontal to 1 vertical (1H:1V) slope. Permanent slopes may be designed using a 3 horizontal to 1 vertical (3H:1V) slope to maintain slope stability.

NOTE: This executive summary is not intended to replace the report of which it is part and should not be used separately from the report. The executive summary omits a number of details, any one of which could be crucial to the proper application of this report.

2.0 INTRODUCTION

2.1 PURPOSE AND SCOPE OF WORK

This report presents the results of a Geotechnical Investigation conducted for the proposed buried 250,000-gallon water tank to be constructed at 6970 North Durfee Way in Liberty, Utah (see Plate A-1, *Site Vicinity Map*). The purposes of this investigation were to assess the nature and engineering properties of the subsurface soils at the site and to provide recommendations for the design and construction of foundations and cut/fill slopes.

The scope of work completed for this study included a site reconnaissance, subsurface exploration, soil sampling, engineering analyses, and preparation of this report. Our services were performed in accordance with our proposal and your signed authorization.

The recommendations contained in this report are subject to the limitations presented in the "Limitations" section of this report (Section 7.1).

2.2 PROJECT DESCRIPTION

The subject property is located at 6970 North Durfee Way in Liberty, Utah. An existing water tank was observed adjacent to the location of the proposed water tank. Footings for the proposed water tank are to be constructed at a depth of 16 to 19 feet below existing ground surface and the top of the tank will sit at an elevation near the current ground surface. Grading will be conducted both uphill and downhill from the proposed tank to create a level ground surface around the perimeter of the tank, which will steepen slopes on both the uphill and downhill sides of the tank.

Our understanding of the proposed development is based on information provided by the client, including a preliminary site plan. No construction drawings were available at the time this investigation was completed; however, we understand that site development will involve constructing a 250,000-gallon water tank approximately 16 feet in height. Construction of the tank will require both cut and fill slopes into the hillside. We understand that these slopes will have grades of 3H:1V (horizontal to vertical). This report does not address the construction or design of any associated pipelines.

3.0 METHODS OF STUDY

3.1 FIELD INVESTIGATION

As a part of this investigation, subsurface soil conditions were explored by completing two investigatory test pits to depths ranging from 3 to 5½ feet below the existing site grade. The approximate locations of the explorations are shown on Plate A-2, (*Exploration Location Map)* in Appendix A. Exploration points were placed to provide a representative cross section of the subsurface soil conditions. Test pit refusal was encountered at the final depth of each of the test pits on competent bedrock. Subsurface soil conditions as encountered in the explorations were logged at the time of our investigation by a geotechnical engineer and are presented on the enclosed Test Pit Logs, Plates B-1 through B-2 in Appendix B. A *Soils Symbols Description Key* used in the test pit logs is included as Plate B-3.

The test pits were excavated using a CAT 320C trackhoe. Bulk soil samples were obtained from each of the test pit locations; undisturbed soil samples were not obtained due to the granular nature of the soil profile. All samples were transported to our laboratory to evaluate the engineering properties of the various earth materials observed. The soils were classified according to the Unified Soil Classification System (USCS) by the Geotechnical Engineer. Classifications for the individual soil units are shown on the attached Test Pit Logs.

3.2 ENGINEERING ANALYSIS

Engineering analyses were performed using soil data obtained from the field observations. Appropriate factors of safety were applied to the results consistent with industry standards and the accepted standard of care.

Excavation stability was evaluated based on the field conditions encountered and soil type. Occupational Safety and Health (OSHA) minimum requirements are typically prescribed unless conditions warrant further flattening of excavation walls.

4.0 GENERALIZED SITE CONDITIONS

4.1 SURFACE CONDITIONS

At the time of our subsurface investigation the site of the proposed tank existed as a vacant, undeveloped lot with light to moderate amounts of vegetation cover. An existing water tank was present, approximately 50 feet northwest of the proposed water tank. Numerous angular cobbles and boulders were observed on the surface of the property. In general, the property slopes down moderately to steeply to the southeast and east. The site is located at an elevation of approximately 5,970 feet above mean sea level.

4.2 SUBSURFACE CONDITIONS

As previously discussed, the subsurface soil conditions were explored at the site by excavating two test pits at representative locations at the subject site. The test pits extended to depths ranging from 3 to 5½ feet below existing site grade. The soils encountered in the test pit explorations were visually classified and logged during our field investigation and are included on the test pit logs in Appendix B (Plates B-1 through B-2). The subsurface conditions encountered during our investigation are discussed below.

4.2.1 *Soils/Bedrock*

Based on our observations and geologic literature review, the subject site is overlain by 6 inches of gravelly topsoil. Underlying the topsoil we encountered Upper Proterozoic-aged feldspathic quartzite bedrock. This bedrock deposit persisted to the full depth of our investigation. The geologic units encountered are discussed below:

Topsoil: Generally consists of brown, moist, Silty GRAVEL (GM) with sand. These soils typically have an organic appearance and texture, and contain numerous fine roots. Topsoil and is expected to overlie the majority of the site.

Upper Proterozoic-aged Feldspathic Quartzite Bedrock: The bedrock encountered at the site consisted of a moderately weathered, strong, red-brown feldspathic quartzite. This unit was encountered at depths ranging from ½ to 5½ feet below the existing site grade. Trackhoe refusal was encountered in both test pits in this bedrock unit.

4.2.2 *Groundwater*

Groundwater was not encountered in any of the explorations completed for this investigation, and is not expected to impact the development. It is our experience that during snowmelt, runoff, irrigation on the property and surrounding properties, high precipitation events, and other activities, the groundwater level can rise several feet. Fluctuations in the groundwater level should be expected over time.

5.0 GEOLOGIC CONDITIONS

5.1 GEOLOGIC SETTING

The subject site is located at an elevation of approximately 5,980 feet within the foothills of the northeastern portion of Ogden Valley. The Ogden Valley is a fault trough bounded on both the east and the west by faults that dip towards the middle of the valley. This fault trough contains unconsolidated deposits of clay, sand, and gravel, whose thickness in places is more than 600 feet. These materials are stream and lake deposits and in places are well sorted and stratified. The lake sediments were laid down in a small lake that occupied Ogden Valley and that was connected with glacial Lake Bonneville at its high stage by an arm of water that occupied Ogden Canyon. More recently, sediments associated with the North, Middle, and South Forks of the Ogden River have been deposited (Leggette, R.M, and others, 1937).

5.2 TECTONIC SETTING

The site lies within the north-south trending belt of seismicity known as the Intermountain Seismic Belt (ISB) (Hecker, 1993). The ISB extends from northwestern Montana through southwestern Utah. An active fault is defined as a fault that has had activity within the Holocene (<11ka). No active faults are mapped through or immediately adjacent to the site (Black et. al, 2003). The site is located approximately 4 miles east of the of the nearest mapped portion of the Weber segment of the Wasatch fault zone. The most recent movement along the Weber Segment of the Wasatch Fault Zone occurred during the Quaternary Period, and there is evidence that as many as 10 to 15 earthquakes have occurred along this segment in the last 15,000 years (Hecker, 1993). A location near Kaysville Utah indicated that the Weber Segment has a measurable offset of 1.4 to 3.4 meters per event (McCalpin, and others, 1994). The Weber Segment may be capable of producing earthquakes as large as magnitude 7.5 (Ms) and has a recurrence interval of approximately 1,200 years. The site is also located approximately 32 miles east of the East Great Salt Lake Fault Zone (Hecker, 1993). Evidence suggests that this fault zone has been active during the Holocene (0 to 30,000 yrs) and has segment lengths comparable to that of the Wasatch Fault Zone, indicating that it is capable of producing earthquakes of a comparable magnitude (7.5 Ms). Each of the faults listed above have shown evidence of movement during the Holocene, and are therefore considered active.

Seismic hazard maps depicting probabilistic ground motions and spectral response have been developed for the United States by the U.S. Geological Survey as part of NEHRP/NSHMP (Frankel et al, 1996). These maps have been incorporated into both *NEHRP Recommended Provisions for Seismic Regulations for New Buildings and Other Structures* (FEMA, 1997) and the *International Building Code* (IBC) (International Code Council, 2015). Spectral responses for the Maximum Considered Earthquake (MCE_R) are shown in the table below. These values generally correspond to a two percent probability of exceedance in 50 years (2PE50) for a "firm rock" site. To account for site effects, site coefficients which vary with the magnitude of spectral acceleration are used. Based on our field exploration, it is our opinion that this location is best described as a Site Class B. The spectral accelerations are shown in the table below. The spectral accelerations are calculated based on the site's approximate latitude and longitude of 41.3853° and -111.8999˚ respectively and the USGS Seismic Design Maps web based application. Based on IBC, the site coefficients are F_a=1.00 and F_v= 1.00. From this procedure the peak ground acceleration (PGA) is estimated to be 0.43g.

MCE_R Seismic Response Spectrum Spectral Acceleration Values for IBC Site Class B[a]

Site Location: **Latitude = 41.3853 N** **Longitude = 111.8999 W**	**Site Class B Site Coefficients:** **Fa = 1.00** **Fv = 1.00**
Spectral Period (sec)	**Response Spectrum Spectral Acceleration (g)**
0.2	$\mathbf{S_{MS}}=(F_a * S_s=1.00*1.06) = 1.06$
1.0	$\mathbf{S_{M1}}=(F_v * S_1=1.00*0.37) = 0.37$

[a] IBC 1613.3.4 recommends scaling the MCE values by 2/3 to obtain the design spectral response acceleration values; values reported in the table above have not been reduced.

6.0 ENGINEERING ANALYSIS AND RECOMMENDATIONS

6.1 GENERAL CONCLUSIONS

Supporting data upon which the following recommendations are based have been presented in the previous sections of this report. The recommendations presented herein are governed by the physical properties of the earth materials encountered as part of our subsurface exploration and the anticipated design data discussed in the PROJECT DESCRIPTION section. If subsurface conditions other than those described herein are encountered in conjunction with construction, and/or if design and layout changes are initiated, GeoStrata must be informed so that our recommendations can be reviewed and revised as changes or conditions may require.

Based on the subsurface conditions encountered at the site, it is our opinion that the subject site is suitable for the proposed development provided that the recommendations contained in this report are incorporated into the design and construction of the project.

The following sub-sections present our recommendations for general site grading, excavation, temporary cut stability, foundations and moisture protection.

6.2 EARTHWORK

Prior to the placement of foundations, general site grading is recommended to provide proper support for foundations, exterior concrete flatwork, and concrete slabs-on-grade. Site grading is also recommended to provide proper drainage away from the water tank foundation and moisture control on the subject property and to aid in preventing differential movement in foundation materials as a result of variations in subgrade moisture conditions.

6.2.1 General Site Preparation and Grading

Based on our current understanding of the project, the tank is to be buried. Although not expected, any underground obstructions or existing utilities under the proposed tank footprint should be removed and/or rerouted. Any resulting removal cavities should be properly backfilled with compacted fill.

Within areas to be graded (below proposed structures, fill sections, concrete flatwork), any existing vegetation, debris, or otherwise unsuitable soils should be removed. Any soft, loose,

frozen, disturbed, or undocumented fill (if encountered) soils should also be removed. Following the removal of vegetation, unsuitable soils, and loose or disturbed soils, as described above, site grading may be conducted to bring the site to design elevations.

Based on our observations in the test pits excavated for the site investigation, there are approximately 0 to 6 inches of topsoil throughout the proposed development. This topsoil should be removed prior to placement of structural fill, structures, and concrete flatwork.

A GeoStrata representative should observe the site preparation and grading operations to assess that the recommendations presented in this report are complied with and to provide an assessment of the exposed soils

6.2.2 *Temporary Excavation Stability*

As mentioned previously, the tank is to be fully buried. As such, the worst-case scenario of a fully-buried tank (20 foot excavation) was modeled using Slide, a computer program incorporating (among others) Bishop's Simplified Method of analysis. Calculations for stability were developed by searching for the minimum factor of safety for a circular-type failure. Homogeneous earth materials (lacustrine sands and clays) and arcuate failure surfaces were assumed.

Strength parameters used in our analyses were developed based on our observations within the test pits, experience, and engineering judgment. Based on our observations, the site is underlain by approximately 0.5 feet of topsoil and 2.5 to 5 feet of weathered bedrock which overlies relatively solid, un-weathered bedrock. Strength testing was not feasible for these materials due to their granular nature. As such, the following assumed strength parameters were assigned;

Soil Type	Friction Angle (ϕ)	Cohesion (psf)
Soil (GM)	33	0
Weathered Bedrock	35	500
Fresh Bedrock	45	3000

Strength values and the modeled depth of the soil unit were based on explorations completed on the site.

Groundwater was not encountered during our investigation, nor were there any indications, such as springs or groundwater seeps, that groundwater exists near the current site grade. As such,

groundwater is anticipated to be relatively deep and was not modeled as part of this slope stability analysis. If groundwater or high moisture conditions are encountered during construction, GeoStrata should be notified as updated stability modeling will need to be performed prior to continued construction.

The modeled geometry of the slope as well as the anticipated structure location were based on information obtained from the client. Based on this information, we modeled the critical state (maximum cut height of 20 feet) although the recommendations made within are applicable for slopes of lesser heights. Results of our stability analysis for temporary slopes are included in Appendix C (Plate C-1 to Plate C-2).

It is recommended that the temporary slope may be constructed at a 1 horizontal to 1 vertical slope (1H:1V). It is possible that this slope may be steepened if it is observed that the fracture sets change in direction or dip that reduce the potential for these sets to adversely impact the excavation. GeoStrata should inspect the exposed bedrock prior to steepening the slope beyond the recommended 1H:1V slope.

Loose soil and rock near the top of excavations should be benched back to minimize raveling problems. Suspect rocks and material near the top of the excavation should be knocked loose by equipment or by hand to avoid a rock fall hazard to workers. We further recommend that a minimum of 4 feet be provided around the outside diameter of the tank to allow a fall zone for loose material that may fall into the excavation. Additionally, netting, fencing or material will likely need to be placed on the slope to protect workers from raveling of near surface soils and potential rock fall hazards. The contractor is ultimately responsible for site safety and pertinent OSHA requirements should be met to provide a safe work environment. If site specific conditions arise that require engineering analysis in accordance with OSHA regulations, GeoStrata can respond and provide recommendations as needed. Qualified personnel should inspect all excavations frequently to evaluate stability. We recommend that a GeoStrata representative be on-site during all excavations to assess the exposed foundation soils.

6.2.3 *Stability of Resulting Permanent Slopes*

Using the strength values described above, the stability of the resulting permanent slopes located to the northeast and southwest of the tank were modeled for both static and pseudo-static conditions. Using the assumptions for soil strength parameters described previously, the resulting permanent slopes as shown on the provided site plan with a maximum slope steepness of

2.5H:1V meet the minimum factor-of-safety of 1.5 and 1.1 for static and seismic conditions, respectively. The results of the stability analyses are presented in Appendix C (Plate C-3 to Plate C-6).

6.2.4 *Rippability and Oversize Material*

As mentioned previously, the results of our field investigation indicate that the site is underlain by 0.5 feet of soil which in turn overlies 2½ to 5 feet of moderately weathered bedrock. Based on the seismic velocities measured during our survey, it is likely that the weathered bedrock will require large excavation equipment to rip. The relatively fresh bedrock contains horizons that do not appear to be rippable, and will likely require blasting to excavate.

6.2.5 *Structural Fill*

All fill placed for the support of the proposed water tank, appurtenant structures, or concrete flatwork should consist of structural fill. We anticipate that the majority of the on-site coarse-grained soils and residual bedrock will be suitable for use as structural fill provided that they are free of vegetation, frozen material, and debris, and contain no inert materials larger than 6 inches in nominal size. Alternatively, structural fill may consist of an imported granular soil with a maximum of 50 percent passing the No. 4 mesh sieve, a maximum fines content (minus No.200 mesh sieve) of 15 percent. The fines should have a liquid limit less than 25 and plasticity index less than 10. Soil not meeting the aforementioned criteria may be suitable for use as structural fill. These soils should be evaluated on a case-by-case basis and should be approved by the Geotechnical Engineer prior to use.

Structural fill should be placed in maximum 8-inch loose lifts and compacted by equipment capable of compacting an 8-inch left on a horizontal plane, unless otherwise approved by the Geotechnical Engineer. Structural fill beneath the tank base should be compacted to at least 95 percent of the maximum dry density, as determined by ASTM D-1557. The moisture content should be slightly above optimum at the time of compaction. Also, prior to placing fill, the excavations should be observed by GeoStrata to confirm that unsuitable materials have been removed. In addition, proper grading should precede placement of structural fill, as described in the General Site Preparation and Grading subsection (6.2.1) of this report.

Utility trenches backfilled below pavement sections or structures should be backfilled with structural fill compacted to at least 95 percent of ASTM D-1557. Trenches in non-structural areas should be backfilled and compacted to approximately 90 percent of the maximum density.

6.3 FOUNDATIONS

Conventional ring-wall or mat foundation bearing entirely on either native granular soils, a minimum of 1½ feet of structural fill, or bedrock may be used to support the proposed tank. Conventional spread and strip footings may be proportioned for a maximum net allowable bearing capacity of **4,000 pounds per square foot (psf)**.

Based on our field observations and considering the presence of shallow bedrock, we recommend that the footings for the proposed tank be established entirely on bedrock or entirely on soil. If a bedrock/soil transition zone is encountered during excavation, then the footings should be deepened such that all footings bear on competent bedrock. Alternatively, the building pad may be over-excavated 18 inches below the bottom of the proposed footings and replaced with structural fill, such that the footings bear entirely on a uniform fill blanket. Footings should be a minimum of 3 feet wide and exterior shallow footings should be embedded at least 42 inches below final grade for frost protection and confinement purposes. Isolated interior footings should be a minimum of 4 feet wide and also be embedded a minimum of 42 inches below final grade for confinement purposes. Finally, it is recommended that a drainage system be constructed under the interior of the tank. Recommendations for a drainage system can be found in Section 6.5.2 of this report. All footing excavations should be observed by the Geotechnical Engineer prior to footing placement.

Settlements of properly designed and constructed conventional footings, founded as described above, are anticipated to be less than 1 inch. Differential settlements are expected to be on the order of ½ the total settlement over a distance of 30 feet.

6.4 LATERAL RESISTANCE AND EARTH PRESSURES

Lateral forces imposed upon conventional foundations due to wind or seismic forces may be resisted by the development of passive earth pressures and friction between the base of the footing and the supporting subgrade. In determining the frictional resistance, a coefficient of friction of 0.43 for structural fill against concrete should be used.

Ultimate lateral earth pressures from *granular* backfill acting against retaining walls and buried structures may be computed from the lateral pressure coefficients or equivalent fluid densities presented in the following table:

Condition	Lateral Pressure Coefficient	Equivalent Fluid Density (pounds per cubic foot)
Active*	0.29	37
At-rest**	0.46	57
Passive*	3.39	424
Seismic Active***	0.37	46
Seismic Passive***	-0.71	-89

* Based on Coulomb's equation

** Based on Jaky

*** Based on Mononobe-Okabe Equation

These coefficients and densities assume level, granular backfill with no buildup of hydrostatic pressures. The force of the water should be added to the presented values if hydrostatic pressures are anticipated. If sloping backfill is present, we recommend the geotechnical engineer be consulted to provide more accurate lateral pressure parameters once the design geometry is established.

Walls and structures allowed to rotate slightly should use the active condition. If the element is constrained against rotation, the at-rest condition should be used. These values should be used with an appropriate factor of safety against overturning and sliding. A value of 1.5 is typically used. Additionally, if passive resistance is calculated in conjunction with frictional resistance, the passive resistance should be reduced by ½.

For seismic analyses, the *active* and *passive* earth pressure coefficient provided in the table is based on the Mononobe-Okabe pseudo-static approach and only accounts for the dynamic horizontal thrust produced by ground motion. Hence, the resulting dynamic thrust pressure *should be added* to the static pressure to determine the total pressure on the wall. The pressure distribution of the dynamic horizontal thrust may be closely approximated as an inverted triangle with stress decreasing with depth and the resultant acting at a distance approximately 0.6 times the loaded height of the structure, measured upward from the bottom of the structure.

The coefficients shown assume a vertical wall face. Hydrostatic and surcharge loadings, if any, should be added. Over-compaction behind walls should be avoided. Resisting passive earth pressure from soils subject to frost or heave, or otherwise above prescribed minimum depths of embedment, should usually be neglected in design.

6.5 MOISTURE PROTECTION AND DRAINAGE

Over-wetting of the soils by natural or man-made means prior to or during construction may result in softening and pumping, causing equipment mobility problems and difficulty in achieving uniform compaction. Every effort should be taken to ensure positive drainage away from the tank. The recommended minimum slope is five percent (5%) away from the tank. Moisture should not be allowed to infiltrate the subgrade in the vicinity of, or upslope from, the tank.

6.5.1 Surface Drainage

Final design grades around the tank should direct runoff away from foundation elements. Design strategies to minimize ponding and infiltration near the tank should be implemented. Diversion berms or ditches should be placed uphill of the tank, if applicable, to direct runoff away from the tank area. Additionally, since the tank is to be partially or completely buried, a drainage system should be considered on the uphill portion of the tank wall to prevent the buildup of hydrostatic pressures.

6.5.2 Tank Under-Drainage

Consideration should be given to installing a subdrainage system under the tank. This system should consist of a 40-mil thick polyethylene or high-density polyethylene (HDPE) membrane placed under the tank, sloped for drainage. This liner should then be covered with at least a 6-inch thick layer of either crushed aggregate base or pervious backfill. Perforated Schedule 80 polyvinyl chloride (PVC) pipe should be embedded in the gravel, spaced no more than 15-feet on center under the tank, and wrapped in a non-woven filter fabric such as a Mirafi 140N or equivalent, with perforations facing down. This perforated pipe drainage system should collect any leakage under the tank, above the membrane, at the low collection point of the membrane. This drainage pipe can then be manifolded together for leak monitoring, and discharge by gravity to a low-lying suitable discharge, or to a sump with a pump.

7.0 CLOSURE

7.1 LIMITATIONS

The recommendations contained in this report are based on limited field exploration and our understanding of the proposed construction. This investigation was completed for the proposed water tank and should not be used for other projects. The subsurface data used in the preparation of this report were obtained from the explorations made for this investigation. It is likely that variations in the soil and groundwater conditions will exist. The nature and extent of variations may not be evident until construction occurs. If any conditions are encountered at this site that are different from those described in this report, our firm should be immediately notified so that we may make any necessary revisions to recommendations contained in this report. In addition, if the scope of the proposed construction changes from that described in this report, our firm should also be notified.

This report was prepared in accordance with the generally accepted standard of practice at the time the report was written. No other warranty, expressed or implied, is made.

It is the Client's responsibility to see that all parties to the project including the Designer, Contractor, Subcontractors, etc. are made aware of this report in its entirety. The use of information contained in this report for bidding purposes should be done at the Contractor's option and risk.

7.2 ADDITIONAL SERVICES

The recommendations made in this report are based on the assumption that an adequate program of tests and observations will be made during the construction. GeoStrata staff should be on site to document compliance with these recommendations and to verify geologic conditions are as anticipated. Our services should include, but not necessarily be limited to, the following:

- Observations and testing during site preparation, earthwork and structural fill placement.
- Consultation as may be required during construction, including verification that the geologic conditions are as anticipated during excavation and design of shoring if deemed necessary based on actual geologic conditions encountered during construction.

We also recommend that project plans and specifications be reviewed by us as they are developed to verify compatibility with our conclusions and recommendations. Additional information concerning the scope and cost of these services can be obtained from our office.

We appreciate the opportunity to be of service on this project. Should you have any questions regarding the report or wish to discuss additional services, please do not hesitate to contact us at your convenience at (801) 501-0583.

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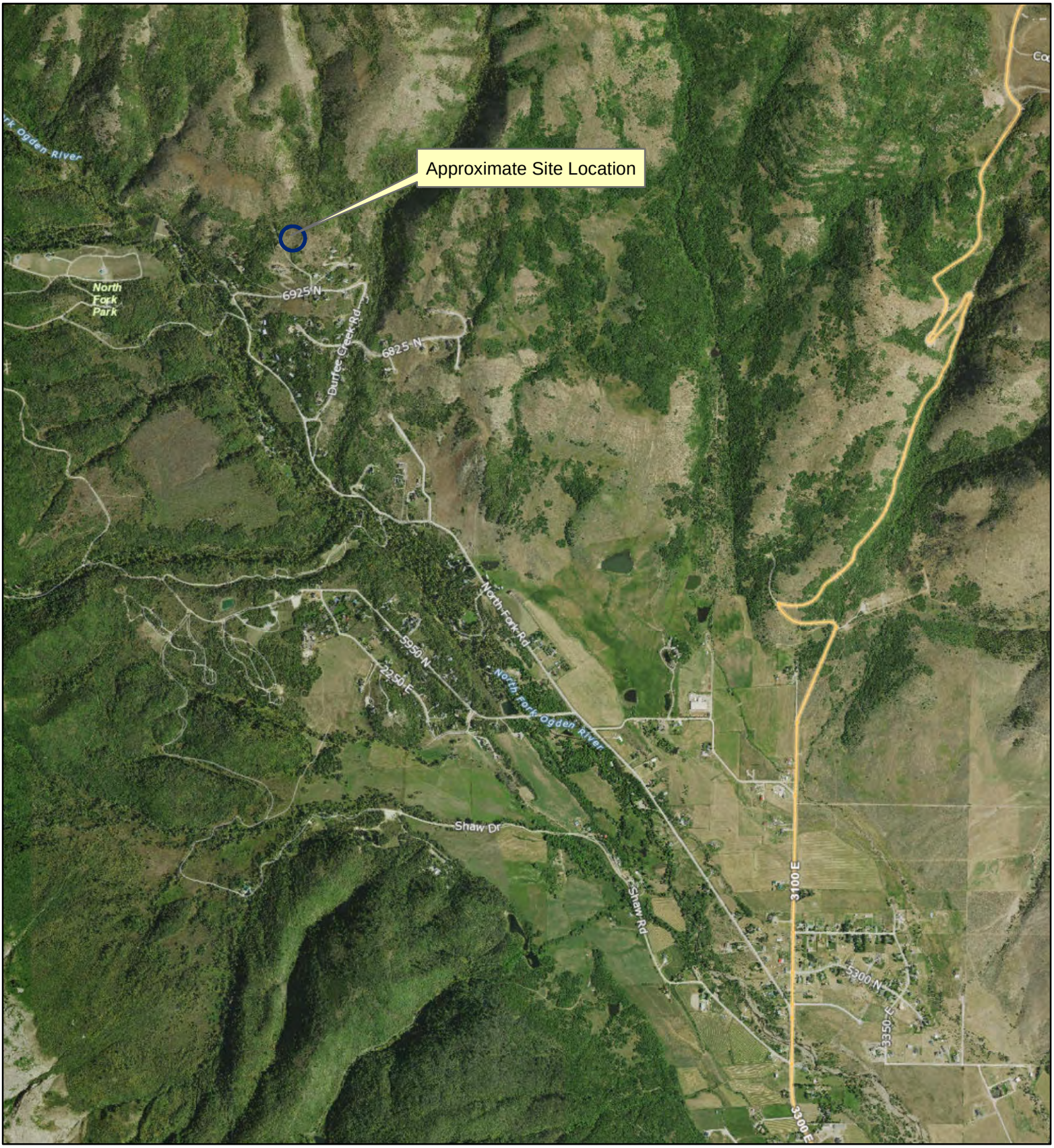


0 750 1,500 3,000 4,500 6,000 Feet

1:24,000

Base Map:
Utah AGRC Hybrid Base Map

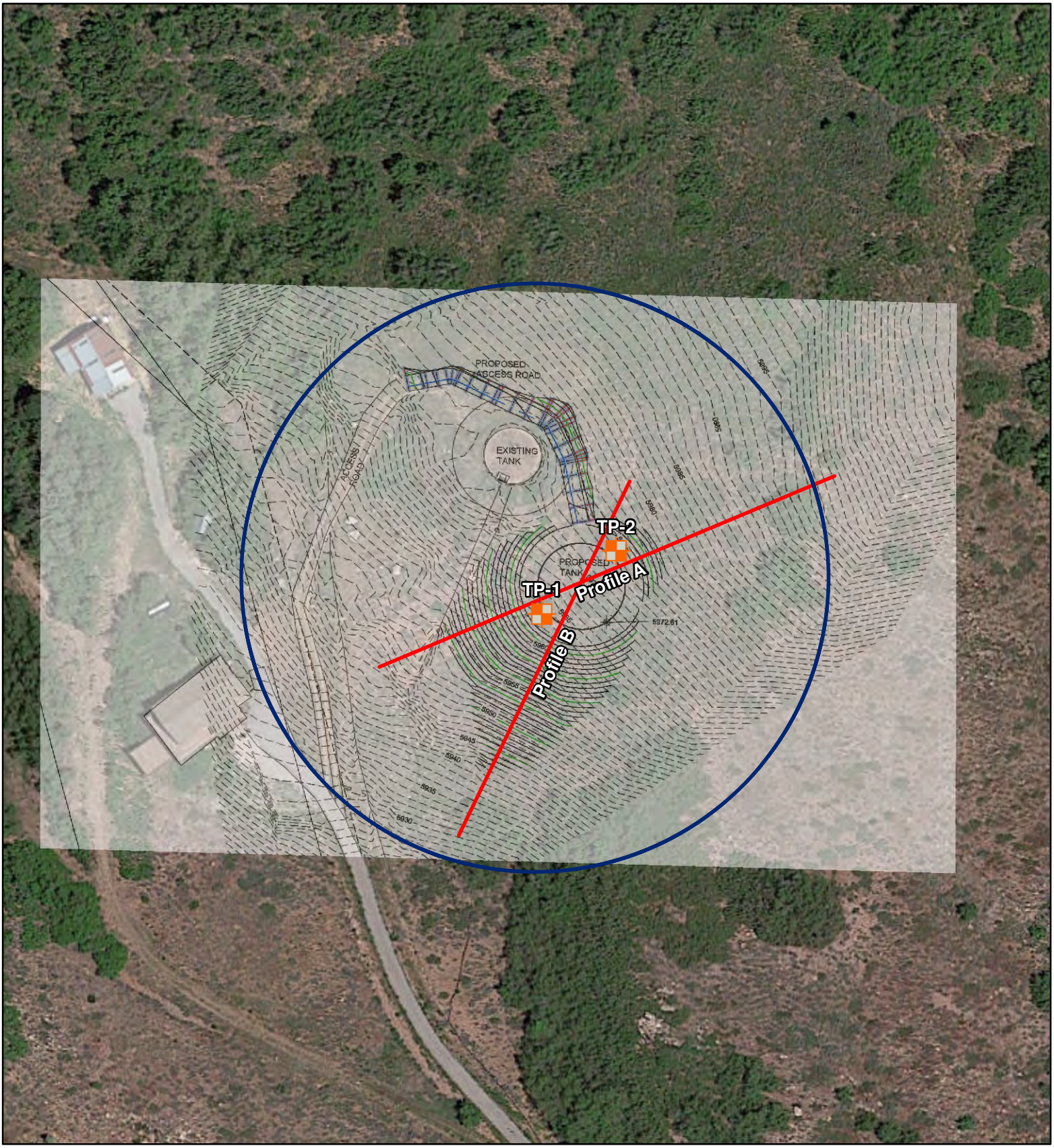
N

GeoStrata

Gardner Engineering
LPC - Upper System Tank
Liberty, UT
Project Number: 746-010

Site Vicinity Map

Plate A-1



0 30 60 120 180 240 Feet

1:1,000

Base Map:
Utah AGRC Hybrid Base Map
Site Plan, Gardner Engineering, 2016

N

GeoStrata

Legend

- Approximate Test Pit Location
- Slope Profile
- Approximate Site Boundary

Gardner Engineering
LPC - Upper System Tank
Liberty, UT
Project Number: 746-010

Exploration Location Map

Plate A-2

DATE
STARTED: 6/6/16
COMPLETED: 6/6/16
BACKFILLED: 6/6/16

Gardner Engineering
LPT - Upper System Tank
Liberty, UT
Project Number 746-010

GeoStrata Rep: D. Brown
Rig Type: CAT 320 C

TEST PIT NO:
TP-1
Sheet 1 of 1

LOCATION
NORTHING EASTING ELEVATION

DEPTH METERS	DEPTH FEET	SAMPLES	WATER LEVEL	GRAPHICAL LOG	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index	Moisture Content and Atterberg Limits (Plastic Limit / Moisture Content / Liquid Limit)
0	0					TOPSOIL; Silty GRAVEL with sand - brown, moist						
						BEDROCK; Feldspathic Quartzite - moderately weathered, hard, red-brown, white, light purple						
1	5					- test pit refusal @ 5.5-ft						
						Bottom of Test Pit @ 5.5 Feet						
2												
3												

Moisture Content and Atterberg Limits
Plastic Limit — Moisture Content — Liquid Limit
10 20 30 40 50 60 70 80 90

LOG OF TEST PITS (B) TEST PIT LOGS.GPJ GEOSTRATA.GDT 6/24/16

GeoStrata

SAMPLE TYPE
- GRAB SAMPLE
- 3" O.D. THIN-WALLED HAND SAMPLER

WATER LEVEL
- MEASURED
- ESTIMATED

NOTES:

Plate
B-1

DATE
STARTED: 6/6/16
COMPLETED: 6/6/16
BACKFILLED: 6/6/16

Gardner Engineering
LPT - Upper System Tank
Liberty, UT
Project Number 746-010

GeoStrata Rep: D. Brown
Rig Type: CAT 320 C

TEST PIT NO:
TP-2
Sheet 1 of 1

DEPTH
METERS
FEET
SAMPLES
WATER LEVEL
GRAPHICAL LOG
UNIFIED SOIL CLASSIFICATION

LOCATION
NORTHING EASTING ELEVATION

MATERIAL DESCRIPTION

Dry Density(pcf)
Moisture Content %
Percent minus 200
Liquid Limit
Plasticity Index

Moisture Content and Atterberg Limits
Plastic Limit | Moisture Content | Liquid Limit
10 20 30 40 50 60 70 80 90

0 / 0

TOPSOIL; Silty GRAVEL with sand - brown, moist

BEDROCK; Feldspathic Quartzite - moderately weathered, hard, red-brown, white, light purple

- test pit refusal @ 3-ft

1

Bottom of Test Pit @ 3 Feet

5

2

3

LOG OF TEST PITS (B) TEST PIT LOGS.GPJ GEOSTRATA.GDT 6/24/16

GeoStrata

SAMPLE TYPE
- GRAB SAMPLE
- 3" O.D. THIN-WALLED HAND SAMPLER

WATER LEVEL
- MEASURED
- ESTIMATED

NOTES:

Plate
B-2

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			USCS SYMBOL	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS (More than half of material is larger than the #200 sieve)	GRAVELS (More than half of coarse fraction is larger than the #4 sieve)	CLEAN GRAVELS WITH LITTLE OR NO FINES	GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
			GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
		GRAVELS WITH OVER 12% FINES	GM	SILTY GRAVELS, GRAVEL-SILT-SAND MIXTURES
			GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
	SANDS (More than half of coarse fraction is smaller than the #4 sieve)	CLEAN SANDS WITH LITTLE OR NO FINES	SW	WELL-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES
			SP	POORLY-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES
		SANDS WITH OVER 12% FINES	SM	SILTY SANDS, SAND-GRAVEL-SILT MIXTURES
			SC	CLAYEY SANDS SAND-GRAVEL-CLAY MIXTURES
FINE GRAINED SOILS (More than half of material is smaller than the #200 sieve)	SILTS AND CLAYS (Liquid limit less than 50)		ML	INORGANIC SILTS & VERY FINE SANDS, SILTY OR CLAYEY FINE SANDS, CLAYEY SILTS WITH SLIGHT PLASTICITY
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			OL	ORGANIC SILTS & ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS (Liquid limit greater than 50)		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILT
			CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH	ORGANIC CLAYS & ORGANIC SILTS OF MEDIUM-TO-HIGH PLASTICITY
HIGHLY ORGANIC SOILS			PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

LOG KEY SYMBOLS

BORING SAMPLE LOCATION

TEST-PIT SAMPLE LOCATION

WATER LEVEL (level after completion)

WATER LEVEL (level where first encountered)

CEMENTATION

DESCRIPTION	DESCRIPTION
WEAKELY	CRUMBLES OR BREAKS WITH HANDLING OR SLIGHT FINGER PRESSURE
MODERATELY	CRUMBLES OR BREAKS WITH CONSIDERABLE FINGER PRESSURE
STRONGLY	WILL NOT CRUMBLE OR BREAK WITH FINGER PRESSURE

OTHER TESTS KEY

C	CONSOLIDATION	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	DS	DIRECT SHEAR
UC	UNCONFINED COMPRESSION	T	TRIAXIAL
S	SOLUBILITY	R	RESISTIVITY
O	ORGANIC CONTENT	RV	R-VALUE
CBR	CALIFORNIA BEARING RATIO	SU	SOLUBLE SULFATES
COMP	MOISTURE/DENSITY RELATIONSHIP	PM	PERMEABILITY
CI	CALIFORNIA IMPACT	-200	% FINER THAN #200
COL	COLLAPSE POTENTIAL	Gs	SPECIFIC GRAVITY
SS	SHRINK SWELL	SL	SWELL LOAD

MODIFIERS

DESCRIPTION	%
TRACE	<5
SOME	5 - 12
WITH	>12

MOISTURE CONTENT

DESCRIPTION	FIELD TEST
DRY	ABSENCE OF MOISTURE, DUSTY, DRY TO THE TOUCH
MOIST	DAMP BUT NO VISIBLE WATER
WET	VISIBLE FREE WATER, USUALLY SOIL BELOW WATER TABLE

GENERAL NOTES

1. Lines separating strata on the logs represent approximate boundaries only. Actual transitions may be gradual.
2. No warranty is provided as to the continuity of soil conditions between individual sample locations.
3. Logs represent general soil conditions observed at the point of exploration on the date indicated.
4. In general, Unified Soil Classification designations presented on the logs were evaluated by visual methods only. Therefore, actual designations (based on laboratory tests) may vary.

STRATIFICATION

DESCRIPTION	THICKNESS	DESCRIPTION	THICKNESS
SEAM	1/16 - 1/2"	OCCASIONAL	ONE OR LESS PER FOOT OF THICKNESS
LAYER	1/2 - 12"	FREQUENT	MORE THAN ONE PER FOOT OF THICKNESS

APPARENT / RELATIVE DENSITY - COARSE-GRAINED SOIL

APPARENT DENSITY	SPT (blows/ft)	MODIFIED CA. SAMPLER (blows/ft)	CALIFORNIA SAMPLER (blows/ft)	RELATIVE DENSITY (%)	FIELD TEST
VERY LOOSE	<4	<4	<5	0 - 15	EASILY PENETRATED WITH 1/2-INCH REINFORCING ROD PUSHED BY HAND
LOOSE	4 - 10	5 - 12	5 - 15	15 - 35	DIFFICULT TO PENETRATE WITH 1/2-INCH REINFORCING ROD PUSHED BY HAND
MEDIUM DENSE	10 - 30	12 - 35	15 - 40	35 - 65	EASILY PENETRATED A FOOT WITH 1/2-INCH REINFORCING ROD DRIVEN WITH 5-LB HAMMER
DENSE	30 - 50	35 - 60	40 - 70	65 - 85	DIFFICULT TO PENETRATED A FOOT WITH 1/2-INCH REINFORCING ROD DRIVEN WITH 5-LB HAMMER
VERY DENSE	>50	>60	>70	85 - 100	PENETRATED ONLY A FEW INCHES WITH 1/2-INCH REINFORCING ROD DRIVEN WITH 5-LB HAMMER

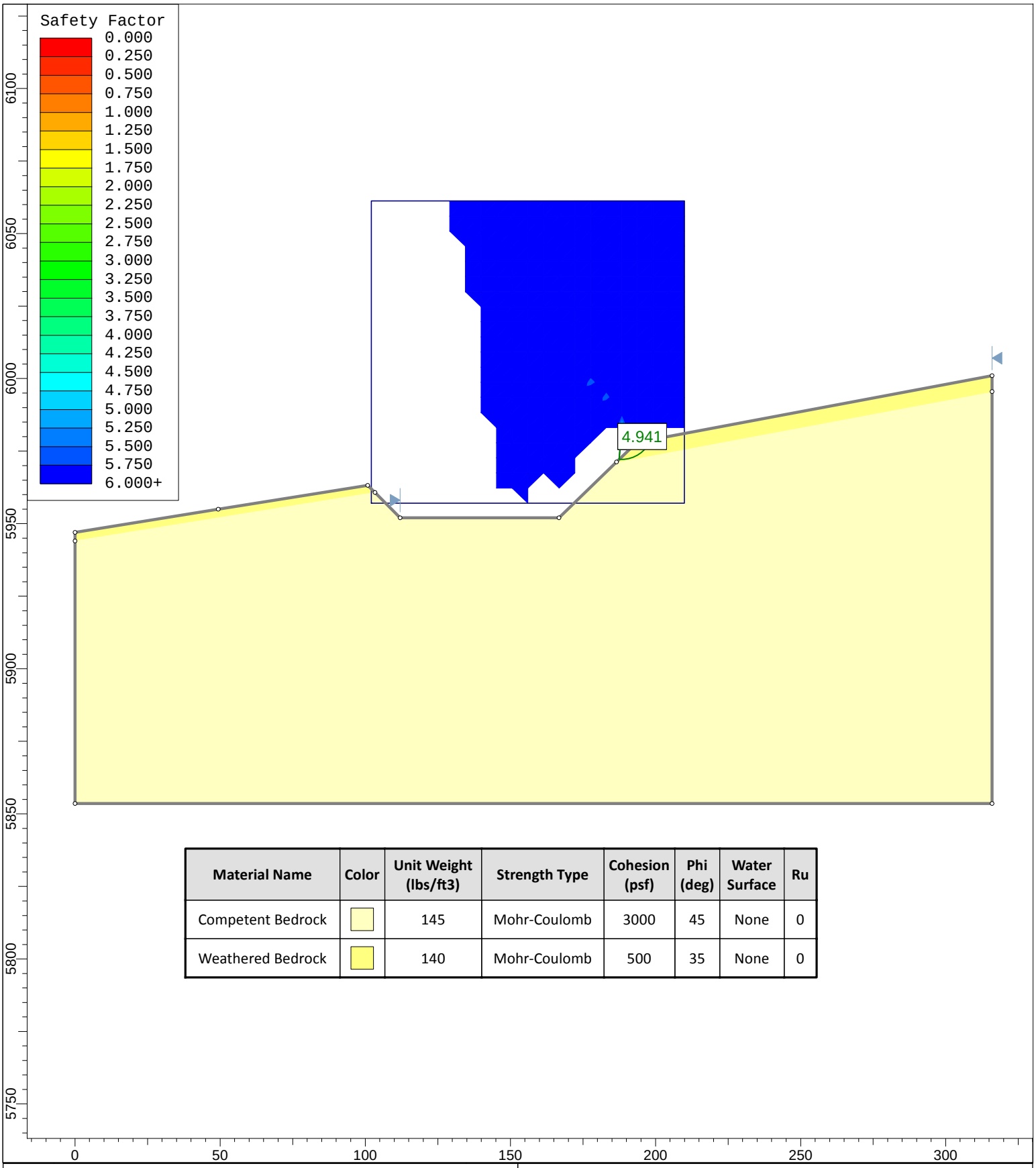
CONSISTENCY - FINE-GRAINED SOIL		TORVANE	POCKET PENETROMETER	FIELD TEST
CONSISTENCY	SPT (blows/ft)	UNTRAINED SHEAR STRENGTH (tsf)	UNCONFINED COMPRESSIVE STRENGTH (tsf)	
VERY SOFT	<2	<0.125	<0.25	EASILY PENETRATED SEVERAL INCHES BY THUMB. EXUDES BETWEEN THUMB AND FINGERS WHEN SQUEEZED BY HAND.
SOFT	2 - 4	0.125 - 0.25	0.25 - 0.5	EASILY PENETRATED ONE INCH BY THUMB. MOLDED BY LIGHT FINGER PRESSURE.
MEDIUM STIFF	4 - 8	0.25 - 0.5	0.5 - 1.0	PENETRATED OVER 1/2 INCH BY THUMB WITH MODERATE EFFORT. MOLDED BY STRONG FINGER PRESSURE.
STIFF	8 - 15	0.5 - 1.0	1.0 - 2.0	INDENTED ABOUT 1/2 INCH BY THUMB BUT PENETRATED ONLY WITH GREAT EFFORT.
VERY STIFF	15 - 30	1.0 - 2.0	2.0 - 4.0	READILY INDENTED BY THUMBNAIL.
HARD	>30	>2.0	>4.0	INDENTED WITH DIFFICULTY BY THUMBNAIL.

GeoStrata

Soil Symbols Description Key

Gardner Engineering
LPC – Upper System Tank
Liberty, UT
Project Number: 746-010

Plate B-3



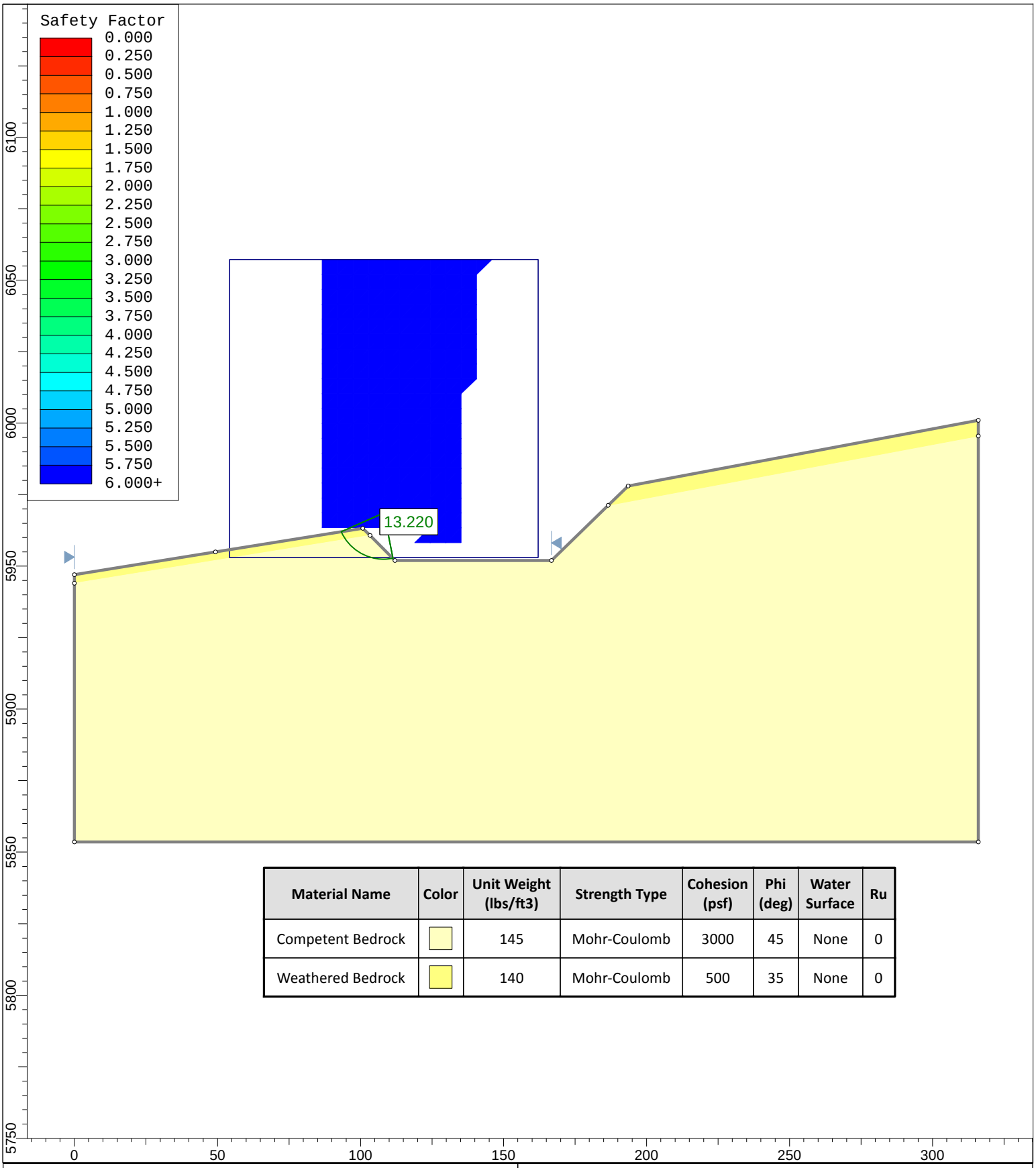
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Competent Bedrock		145	Mohr-Coulomb	3000	45	None	0
Weathered Bedrock		140	Mohr-Coulomb	500	35	None	0

GeoStrata

Excavation Stability - Profile A Uphill

Gardner Engineering
LPT - Upper System Tank
Liberty, UT
Project Number: 746-001

Plate C-1

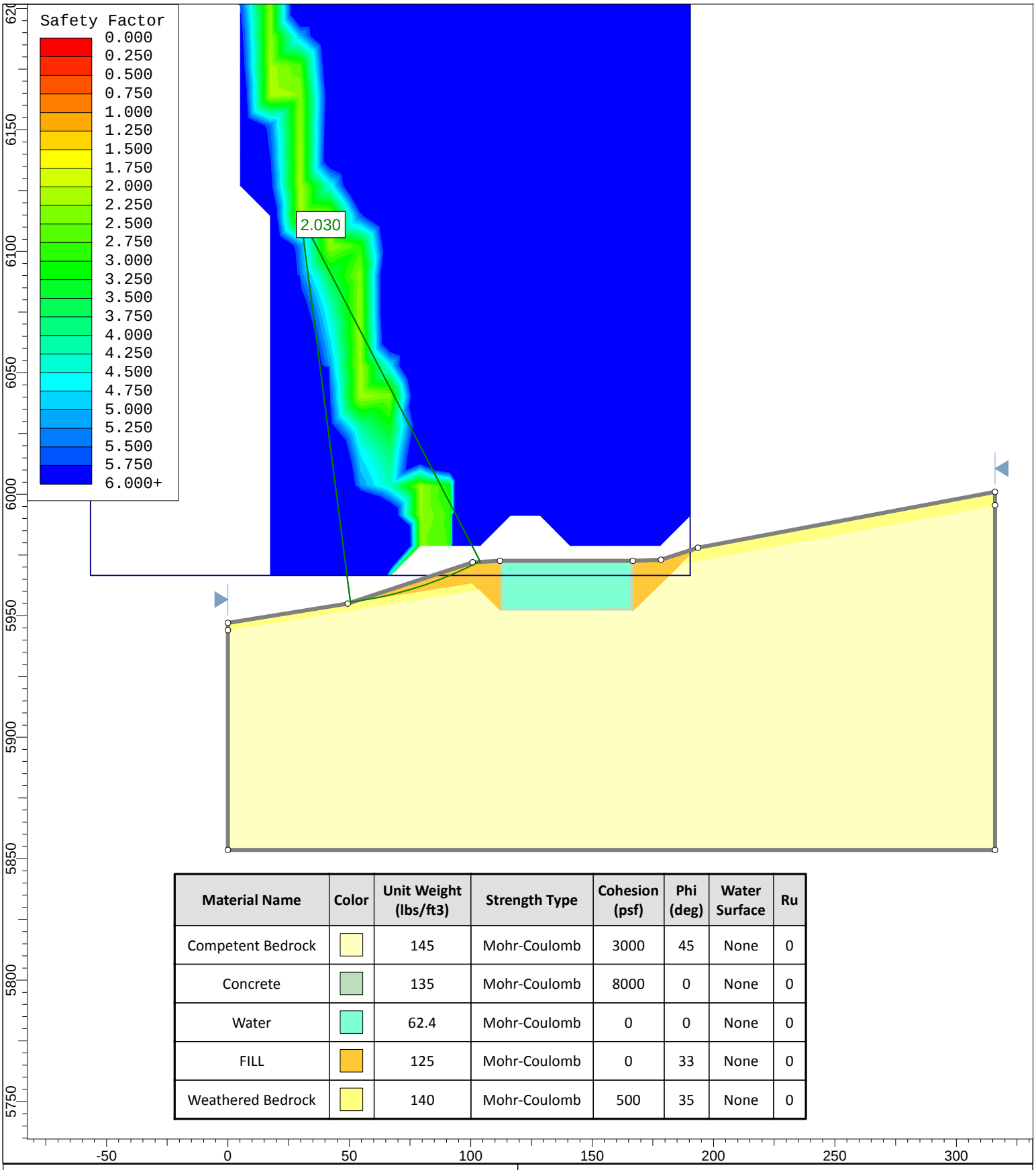


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Competent Bedrock		145	Mohr-Coulomb	3000	45	None	0
Weathered Bedrock		140	Mohr-Coulomb	500	35	None	0

Excavation Stability - Profile A Downhill

Gardner Engineering
LPT - Upper System Tank
Liberty, UT
Project Number: 746-001

Plate C-2



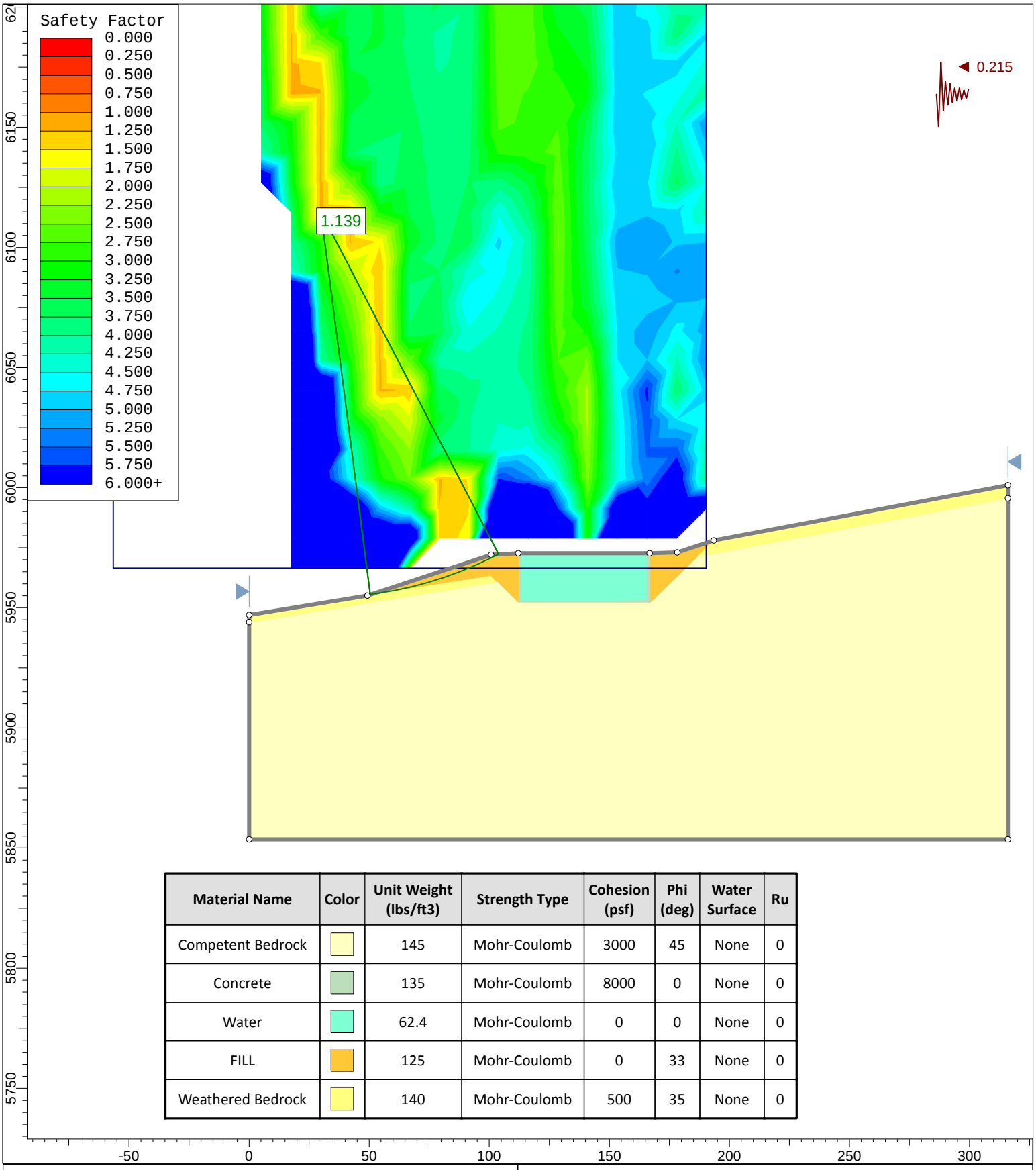
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Competent Bedrock		145	Mohr-Coulomb	3000	45	None	0
Concrete		135	Mohr-Coulomb	8000	0	None	0
Water		62.4	Mohr-Coulomb	0	0	None	0
FILL		125	Mohr-Coulomb	0	33	None	0
Weathered Bedrock		140	Mohr-Coulomb	500	35	None	0

GeoStrata

Global Stability - Profile A Static

Gardner Engineering
LPT - Upper System Tank
Liberty, UT
Project Number: 746-001

Plate C-3



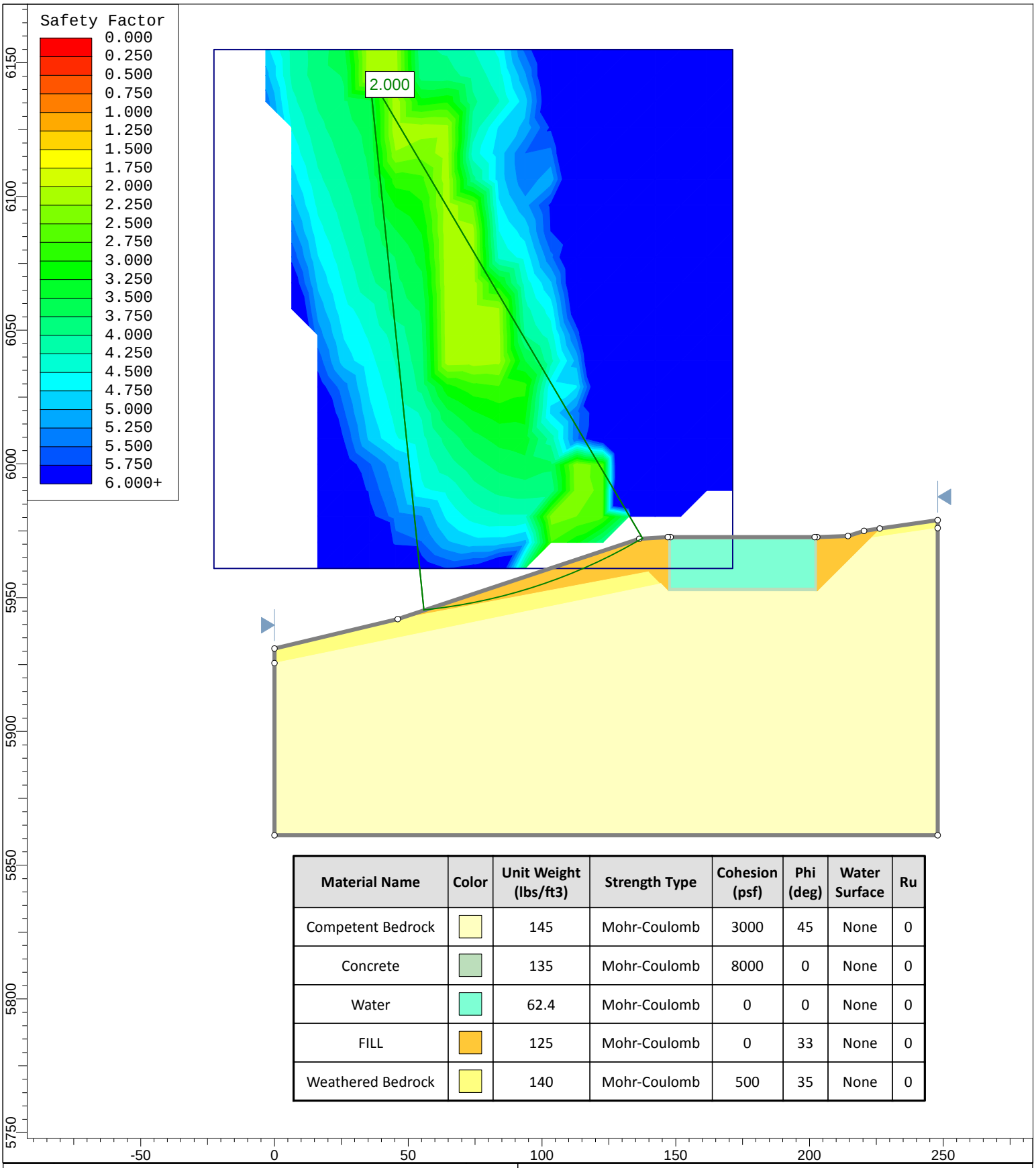
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Competent Bedrock		145	Mohr-Coulomb	3000	45	None	0
Concrete		135	Mohr-Coulomb	8000	0	None	0
Water		62.4	Mohr-Coulomb	0	0	None	0
FILL		125	Mohr-Coulomb	0	33	None	0
Weathered Bedrock		140	Mohr-Coulomb	500	35	None	0

GeoStrata

Global Stability - Profile A Pseudo Static

Gardner Engineering
LPT - Upper System Tank
Liberty, UT
Project Number: 746-001

Plate C-4



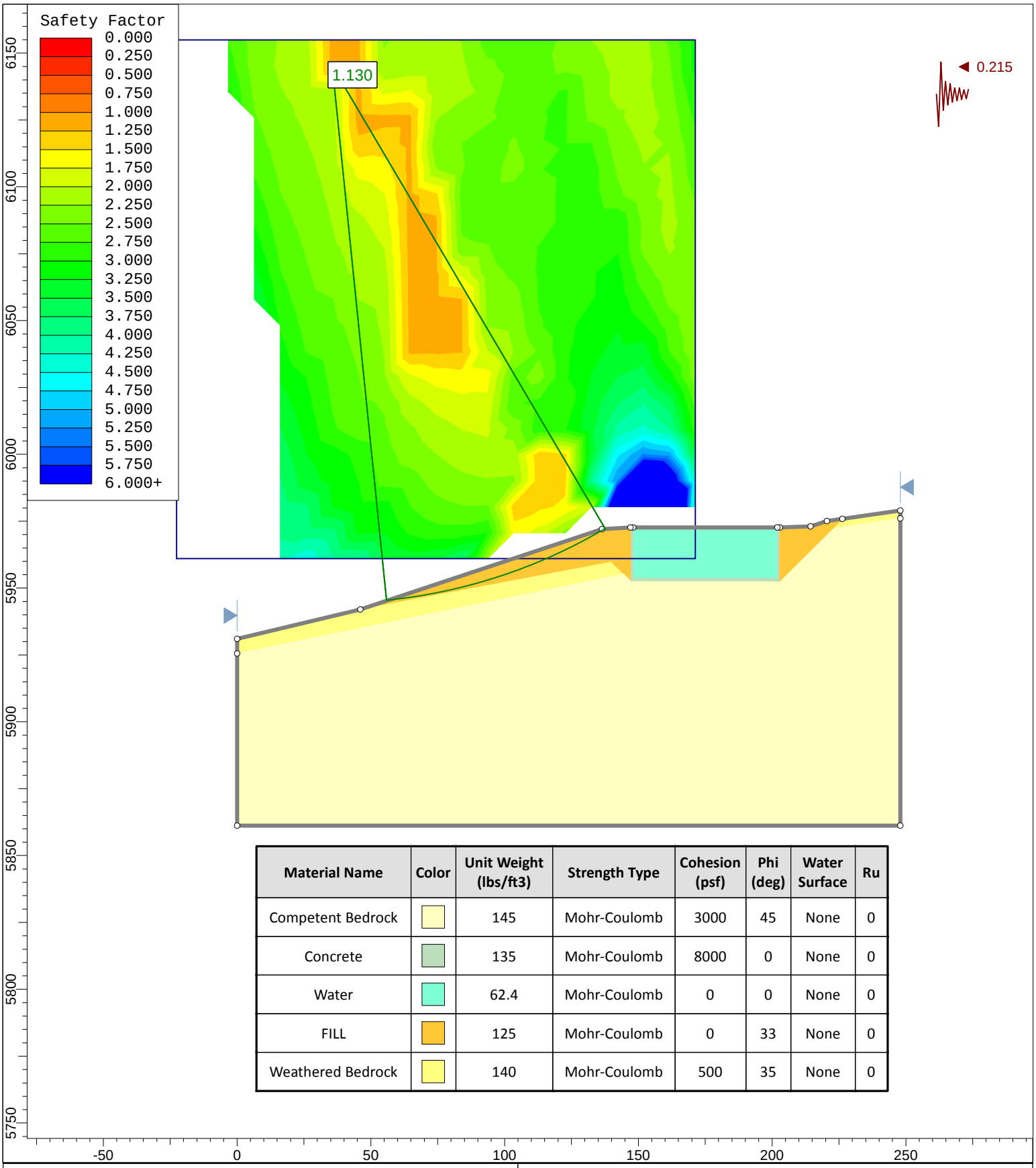
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Competent Bedrock		145	Mohr-Coulomb	3000	45	None	0
Concrete		135	Mohr-Coulomb	8000	0	None	0
Water		62.4	Mohr-Coulomb	0	0	None	0
FILL		125	Mohr-Coulomb	0	33	None	0
Weathered Bedrock		140	Mohr-Coulomb	500	35	None	0

GeoStrata

Global Stability - Profile B Static

Gardner Engineering
LPT - Upper System Tank
Liberty, UT
Project Number: 746-001

Plate C-5



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Competent Bedrock		145	Mohr-Coulomb	3000	45	None	0
Concrete		135	Mohr-Coulomb	8000	0	None	0
Water		62.4	Mohr-Coulomb	0	0	None	0
FILL		125	Mohr-Coulomb	0	33	None	0
Weathered Bedrock		140	Mohr-Coulomb	500	35	None	0

GeoStrata

Global Stability - Profile B Pseudo Static

Gardner Engineering
LPT - Upper System Tank
Liberty, UT
Project Number: 746-001

Plate C-6