

**REFERENCE
DOCUMENTS
ATTACHMENTS**

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Attachment A

**ENCROACHMENT GUIDELINES FOR JORDAN AQUEDUCT
REACH 1, 2, 3, AND 4, AND THE U.S. DEPARTMENT OF THE
INTERIOR BUREAU OF RECLAMATION ENGINEERING
AND O&M GUIDELINES FOR CROSSINGS**

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EXHIBIT "A"

ENCROACHMENT GUIDELINES FOR JORDAN AQUEDUCT, REACH 1, 2, 3 & 4

PROTECTION CRITERIA

A. Surface structures that generally will be allowed to be constructed within United States rights-of-way include asphalt roadways, with no utilities within roadway, non reinforced parking lots, curbs, gutters and sidewalks, walkways, driveways. However, where United States system pipe has specific maximum and minimum cover designation the special requirements for roadways, parking lots and driveways crossing over the pipe shall be obtained from the United States for the maximum allowable external loading or minimum cover. **HOWEVER, IT IS UNDERSTOOD THAT ALL SURFACE STRUCTURES SHALL BE ANALYZED AND CONSIDERED ON AN INDIVIDUAL BASIS.**

B. Structures that may not be constructed in, on, or along United States rights-of-way include but are not limited to, permanent structures such as retaining walls, block walls, buildings, garages, decks, carports, mobile homes with permanent foundations, swimming pools, block, cement, fences, or rock fences and walls as designated by the United States.

C. No trees or vines will be allowed within the rights-of-way of the United States.

D. All temporary or permanent changes in ground surfaces within United States rights-of-way are to be considered to be encroaching structures and must be handled as such. Earthfills and cuts on adjacent property shall not encroach onto United States rights-of-way without prior approval by the United States.

E. Existing gravity drainage of the United States rights-of-way must be maintained. No new concentration of surface or subsurface drainage may be directed onto or under the United States rights-of-way without adequate provision for removal of drainage water or adequate protection of the United States rights-of-way.

F. Prior to construction of any structure that encroaches within United States rights-of-way, an excavation must be made to determine the location of existing United States facilities. The excavation must be made by or in the presence of water users or the United States.

G. Any contractor or individual constructing improvements in, on, or along United States rights-of-way must limit his construction to the encroaching structure previously approved and construct the improvements strictly in accordance with plans or specifications.

H. The ground surfaces within United States rights-of-way must be restored to a condition equal to that which existed before the encroachment work began or as shown on the approved plans or specifications.

I. The owner of newly constructed facilities that encroach on United States rights-of-way shall notify the United States and/or the District upon completion of construction and shall provide the

District with one copy and the United States with two copies of as-built drawings showing actual improvements in, on, or along the rights-of-way.

J. Except in case of ordinary maintenance and emergency repairs, an owner of encroaching facilities shall give the District at least 10 days notice in writing before entering upon United States rights-of-way for the purpose of reconstructing, repairing, or removing the encroaching structure or performing any work on or in connection with the operation of the encroaching structure.

K. If unusual conditions are proposed for the encroaching structure or unusual field conditions within United States rights-of-way are encountered, the United States reserves the right to impose more stringent criteria than those prescribed herein.

L. All backfill material within United States rights-of-way shall be compacted to 90 percent of maximum density unless otherwise shown. Mechanical compaction shall not be allowed within 6 inches of the projects works whenever possible. In no case will mechanical compaction using heavy equipment be allowed over the project works or within 18 inches horizontally of the projects works.

M. That the backfilling of any excavation or around any structure within the United States rights-of-way shall be compacted in layers not exceeding 6 inches thick to the following requirements: (1) cohesive soils to 90 percent maximum density specified by ASTM Part 19, D-698, method A; (2) noncohesive soils to 70 percent relative density specified by ANSI/ASTM Part 19, d-2049, par. 7.1.2, wet method.

N. Any nonmetallic encroaching structure below ground level shall be accompanied with a metallic strip within the United States rights-of-way.

O. Owners of encroaching facilities shall notify the United States at (801) 379-1000 and/or the District at (801) 565-4300 at least forty-eight (48) hours in advance of commencing construction to permit inspection by the United States and/or the District.

P. No use of United States lands or rights-of-way shall be permitted that involve the storage of hazardous material.

RECLAMATION

Managing Water in the West

Engineering and O&M Guidelines for Crossings

Bureau of Reclamation Water Conveyance Facilities
(Canals, Pipelines, and Similar Facilities)

Attachment B



U.S. Department of the Interior
Bureau of Reclamation
Technical Service Center
Denver, Colorado

April 2008

Mission Statements

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian Tribes and our commitments to island communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

Engineering and O&M Guidelines for Crossings

**Bureau of Reclamation Water Conveyance Facilities
(Canals, Pipelines, and Similar Facilities)**

Acronyms and Abbreviations

| | |
|-------------|---|
| AASHTO | American Association of State Highway and Transportation Official |
| AOE | authorized operating entity |
| AWWA | American Water Works Association |
| CFR | Code of Federal Regulations |
| CPS | cathodic protection system |
| DOT | Department of Transportation |
| HDD | horizontal directional drilling |
| kV | kilovolt(s) |
| MERL | Materials Engineering and Research Laboratory |
| O&M | operations and maintenance |
| Reclamation | Bureau of Reclamation |
| ROW | right-of-way |
| WB-67 | 67-foot wheelbase |

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Appendix A General Requirements for Installing Bored and Jacked Pipe Undercrossings

Appendix B Guidelines – Removal of Trees and Other Vegetative Growth from Earth Dams, Dikes, and Conveyance Features (*Appendix B of Review and Operation and Maintenance Program Field Examination Guidelines*)

1.0 PURPOSE

These are general guidelines for Bureau of Reclamation (Reclamation) offices to follow when reviewing the engineering and operations and maintenance (O&M) factors in outside entity requests for authorization to cross (encroach upon) Reclamation lands that contain project features such as levees, canals, pipelines, or other water conveyance facilities owned or administered by Reclamation. These guidelines include a general overview of the permitting process administered by Reclamation Lands Groups for allowing a particular use on lands where Reclamation holds a fee or an easement right-of-way interest. These engineering and construction recommendations are minimum guidelines for engineers to use in reviewing and evaluating these portions of the applications.

2.0 GENERAL PERMIT INFORMATION

Applicants requesting to cross any Reclamation land, facility, or water body must obtain a written land use authorization from Reclamation. Requirements for obtaining a use authorization to cross Reclamation project land and water surfaces are in the Code of Federal Regulations (CFR) at 43 CFR 429 and Reclamation Manual LND 08-01. The applicant must complete the *Standard Form (SF) 299, "Application for Transportation and Utility Systems and Facilities on Federal Lands,"* or similar forms in use at the local Reclamation office. The form can be obtained by contacting the involved Reclamation office, or it can be accessed electronically at Reclamation's Web site at: <http://www.usbr.gov/pmts/lands>.

Applicants can contact their local Reclamation office to discuss their proposed use before filing an application for a use authorization.

3.0 ENGINEERING AND O&M REVIEW CONSIDERATIONS

3.1 Introduction

Technical review of the crossing evaluates impacts on any existing Reclamation facility and **does not determine the adequacy of the crossing design for the applicant's intended purpose.**

The use authorization or consent document specifies criteria which, if followed, would not be deemed unreasonable interference. These review guidelines are strictly limited to those criteria which:

Engineering and O&M Guidelines for Crossings

- Protect Reclamation's facility and/or appurtenant facility from damage
- Ensure unrestricted flow and quality of water in Reclamation's facility
- Do not diminish the ability to perform O&M of Reclamation's facility, including access
- Prevent any burden of liability

These guidelines are provided as recommendations that apply to most Reclamation facilities. Each Reclamation office and/or authorized operating entity (AOE) should apply these guidelines using **sound engineering judgment** that best applies to their facilities and existing conditions. Additional Reclamation guidelines for specific locations (e.g., Central Arizona Project Reach 11 Basin Guidelines) may also apply and may be provided to applicants when necessary. These guidelines are minimums, and local conditions may be more stringent depending on the direct impacts to facilities and lands. AOE's may have additional requirements.

Uses that may be deemed reasonable within Reclamation pipeline easements include greenbelts, asphalt roadways, flexible pavement parking lots, transverse curbs and gutters, and sidewalks. Canals and pipelines may have overhead power and telephone lines (but not their supporting poles), transverse fences with gated openings (no walls), and similar surface and overhead structures.

3.2 General

The following individual items should be addressed by the applicant and evaluated by Reclamation and/or AOE as they may affect the Reclamation facility's engineering and O&M aspects. If unusual conditions are proposed for the encroaching structure or unusual field conditions within a Reclamation facility right-of-way (ROW) are encountered, Reclamation reserves the right to impose more stringent criteria than prescribed in these guidelines.

1. Structures that should not be constructed on Reclamation pipeline or canal ROW (whether fee owned or easement) include foundations, buildings, garages, carports, trailers, street light standards, supports for large signs, walls, longitudinal fences (except security/safety fences), power or telephone poles, and similar surface structures.
2. Prior to construction, a joint inspection should be conducted and the condition of existing facilities documented. Reclamation's ROW should be restored to pre-existing conditions following completion of work.

3. When applications are requesting public use of trails and maintenance roads adjacent to or crossing Reclamation canals, these facilities should be fenced for safety to separate them from open canal water, except when Reclamation's ROW is used as a greenbelt and the applicant accepts legal hazard responsibility. Trails and maintenance roads should be fenced on an as-needed basis whenever such fencing is warranted for public safety, restricted access, security, etc. If a fence is allowed within Reclamation's ROW, Reclamation should approve the fence materials. Any gates allowed within Reclamation's ROW should be at least 16 feet wide. Reclamation will be provided with full access through any fences or gates.
4. Prior to construction of any structure that encroaches within a Reclamation pipeline or canal ROW, a "pothole excavation" should be made to determine the locations of any existing Reclamation and non-Reclamation facilities and their appurtenant features that may be affected. Potholing is the practice of digging test holes to expose underground utilities to determine the horizontal and vertical location of the utility.

All work within 18 inches of the facility should be done using hand-held tools only. The excavation should be made by or in the presence of Reclamation and/or AOE personnel. The presence of a Reclamation and/or AOE inspector may be required throughout the excavation process, but this presence in no way relieves the applicant or their contractor of responsibility.

The resultant elevation information should be delineated on the profile view and labeled as:

POTHOLED ELEVATION XX.X
Surface Elevation XX.X

The pothole excavation should be filled in, or a safety fence installed, prior to departing the site each day.

5. If Reclamation facilities need to be modified to avoid adverse impacts from the applicant's crossing facility, the applicant should be responsible for the cost of such modifications.

Engineering and O&M Guidelines for Crossings

6. A temporary permit may be required for visual inspections, ground and aerial surveys,¹ or potholing that requires physical entrance onto a Reclamation facility. **A use authorization or consent document issued by Reclamation and/or AOE should be obtained prior to entering or crossing Reclamation's ROW for any activity.**
7. Applications should include a project description, calculations, specifications, and detailed construction plans showing plan views, profiles and sections, and grading plans of proposed work within or adjacent to Reclamation's ROW. Plans should show an easily recognizable boundary (tied to a known corner) and Reclamation's ROW and Reclamation stationing or mile post designation.

All Reclamation facilities should be shown and labeled (e.g., "Centerline of xx-inch Reclamation Pipeline," "Reclamation Communication and Control Cable," etc.) The type and weight of the construction equipment crossing Reclamation pipelines, roads, and bridges as well as the crossing locations should be included. Additional information, as identified in following individual specific feature sections of these guidelines, should also be included with the application for review.

Any engineering or land survey drawing should contain the appropriate registered engineer's or land surveyor's stamp and signature. A construction schedule outlining the anticipated duration of the construction should be submitted. A minimum of two² copies of the application (including calculations, specifications, and plans) should be submitted to Reclamation and/or AOE for review and approval.

8. For crossings of all Reclamation facilities, Reclamation and/or AOE personnel familiar with the facilities (including cathodic protection systems) will obtain and provide copies of existing files showing information about existing buried facilities (center of pipeline, depth of cover, size of pipe, class of pipe, etc.) to the applicant.
9. Existing Reclamation facilities (e.g., canal lining, canal check structure, turnout structure, etc.) and appurtenances (e.g., existing blow-offs, air valves, vents, manholes, and/or cathodic protection test stations) and existing non-Reclamation facilities on Reclamation's ROW (e.g., petroleum pipelines, natural gas pipelines, communications lines, powerlines, water lines, sewer lines, storm drain lines, etc.) **should be protected** in place prior to and during construction.

¹ Aerial surveys require placing on-the-ground survey control markers.

² Revise per local Reclamation office and/or AOE practice.

The applicant and/or their contractor may be liable for all damages to Reclamation facilities and appurtenances as a result of construction and for any other damages or losses suffered by Reclamation or its water contractors, including power, irrigation, municipal and industrial water supply, and communication losses.

10. Trench excavation should comply with the most current Occupational Safety and Health Administration standards or Reclamation Health and Safety Standards, whichever are more stringent. Trench backfill should be placed in 4- to 6-inch lifts if hand compacted or no more than 8-inch lifts if power compacted. Trench backfill within Reclamation's ROW should be compacted to 95 percent relative compaction (ASTM D 698, Standard Proctor) (or 90 percent of ASTM D 1557). Mechanical compaction using heavy equipment (greater than 2,000 pounds) should not be used within 18 inches of the Reclamation pipeline. Flowable fill (or controlled low strength material) should be substituted for compacted pipe embedment under canals and may be used when crossing pipelines.
11. Erosion control measures, including re-vegetation, should be implemented after completing construction.
12. If existing drainage features are to be modified during construction, detailed drawings showing the proposed drainage replacement/restoration should be submitted with the application for review and approval. The applicant is responsible for the care and handling of storm water runoff both during and after construction.
13. The applicant should not divert surface runoff³ toward Reclamation canal or canal embankments. The 100-year storm⁴ surface runoff should use detention basins outside of Reclamation's ROW. Lined drainage channels should be designed to transfer flow from the detention basins to the existing cross drainage facilities that drained the original area. Also refer to "4.4 Storm Water Cross Drainage."
14. Proposed temporary or permanent modifications to the existing cover over Reclamation pipelines should be subject to review and approval by Reclamation and/or AOE. Design parameters for roadway, parking lot, and driveway crossings over the pipe should also be subject to review and approval by Reclamation and/or AOE.

³ Subdivision or commercial development on the uphill side of canals that pave large areas and have large roof areas will greatly increase peak storm runoff—most city development requires retention basins. Applicants should provide the same retention basins that are required for similar development projects.

⁴ Revise per Reclamation field office for specific canal if a higher storm frequency is required.

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15. When a Reclamation pipeline system being crossed has pipe with an “A” cover pipe designation (less than 5 feet of earth), the applicant is to analyze the crossing to show “A” pipe load carrying capability exists to meet their carrying requirements or replace the “A” pipe with pipe of sufficient load carrying capability.
16. Reclamation’s ongoing O&M activities should not be disrupted during construction. The primary or secondary operating road should be kept available for Reclamation and/or AOE use at all times.
17. Detectable warning tape may be required over below-ground utilities. Refer to “3.3 Detectable Warning Tape.”
18. The points where the proposed utilities enter and exit Reclamation’s ROW should be plainly and permanently marked by sign posts extending 5 feet above grade. Applicants should provide sign posts directly above their utilities and at all angle points within Reclamation’s ROW. The distance between adjacent sign posts should not exceed 500 feet. Sign posts should contain the name of owner/operator, contents of the pipeline, utility identification, and emergency contact telephone number. Sign posts for angle points that lie within roads or canals should be offset and have a reference noted. The locations of the sign posts should be shown on the plans.
19. Following completion of work, applicants should provide as-built drawings of their facilities on Reclamation’s ROW. Reclamation as-built drawings are to be updated by the appropriate Reclamation office and/or AOE to reflect the crossing. As-built drawings may be maintained by the AOE, but should remain accessible to Reclamation upon request.

3.3 Detectable Warning Tape

Detectable warning tape may be required over below-ground utilities situated within Reclamation’s ROW and should be a minimum of 18 inches above the utility and between 18 and 30 inches below the ground surface. Warning tapes should conform to the following specifications:

- a. For potable water lines, the warning tape should be a 3-inch-wide blue detectable tape imprinted with “**CAUTION BURIED POTABLE WATER LINE.**”
- b. For nonpotable water lines, the warning tape should be a 3-inch-wide purple detectable tape imprinted with “**CAUTION BURIED NONPOTABLE WATER LINE.**”

- c. For sewer and storm drain lines, the warning tape should be a 3-inch-wide green detectable tape imprinted with “**CAUTION BURIED (type) LINE.**”
- d. For gas, oil, and steam chemical lines, the warning tape should be a 3-inch-wide yellow detectable tape imprinted with “**CAUTION BURIED (type) LINE.**”
- e. For telecommunications, telephone, and television conduit(s), the warning tape should be a 3-inch-wide orange detectable tape imprinted with “**CAUTION BURIED (type) CONDUIT.**”
- f. For electrical, street lighting, and traffic signal conduit(s), the warning tape should be a 3-inch-wide red detectable tape imprinted with “**CAUTION BURIED (type) CONDUIT.**”

4.0 SPECIFIC FEATURE REVIEW GUIDELINES

4.1 Bridges

- 1. New bridge crossings (vehicular, pedestrian, and utility) should be perpendicular (between 70 and 90 degrees) to the centerline of the water conveyance facility and at locations approved by Reclamation and/or the AOE. Exceptions to the policy may be considered on an individual basis.
- 2. Public use bridges in urban areas should be spaced no closer together than 1/3 mile (about 4 blocks or 1,700 feet) apart. This is to ensure O&M operations are not overly restricted.
- 3. Bridge crossings should be of free span design. Consideration of any anticipated (known or ongoing) canal subsidence issues, anticipated raising of the canal lining, or anticipated increases in the canal’s high water level should be made. The minimum vertical clearance between the bottom of the superstructure and the top of the canal lining should be 3 feet. For unlined canals, the vertical clearance may be measured to the high water level. If this minimum clearance is reduced by subsidence or by future Reclamation modifications to the canal lining, the minimum clearance should be re-established at the applicant’s expense. The minimum horizontal clearance from the face of the abutment to the top of the canal lining should be 5 feet. For unlined canals, the horizontal clearance may be measured to the high water level.

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These clearances are suggested to minimize impact on the canal section during construction and future inspections and O&M. Applicants may request to re-construct a canal section if Reclamation's operations are impacted by close construction during periods when the canal is normally unwatered. If so, vertical clearances may be reduced to 1 foot and horizontal clearance to 3 feet.

4. Canal O&M roads should intersect public roads at bridges at right angles for proper visibility. This may require the applicant to acquire additional ROW for use if the existing canal ROW is not sufficient. American Association of State Highway and Transportation Official (AASHTO) criteria for sight distances at the intersection of O&M roads and roadways at new bridges should be met to allow O&M vehicles to cross them safely.
5. Driving piles at concrete-lined canals should not be permitted. Any abutment foundation support piles, at concrete-lined canals, should be drilled and cast-in-place.

At a minimum, the applicant's drilling and piling plan should include:

- Drilling methods and equipment
- Methods for preserving existing foundation material
- Methods and equipment to determine the presence of quick soil conditions or scouring and caving
- The proposed method for casing installation and removal if casings are used
- Methods and equipment for accurately determining the depth of concrete and actual or theoretical volume placed

At a minimum, the applicant's contingency plan should include:

- Means to repair in a certain time
- Minimum flows after event
- Review of geotechnical conditions surrounding the pile locations
- Assessment of how the proposed mitigations will address geotechnical conditions
- Methods for restoring foundation material

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- A list of material, equipment, and personnel with qualifications to be used during mitigation work
 - A seal from a Professional Engineer on all relevant plans and drawings
6. The submitted plan drawings for the bridge should contain the following information:
 - a. Superstructure, abutments, railings, embankments, and drainage, including details and sections
 - b. Type of materials (concrete, steel, timber, etc.) used for different members
 - c. Details of cast-in-place foundation piles, if any, on both sides of the canal
 - d. The elevation of the bottom of the superstructure and the clearance between the top of the canal lining (or high water level if unlined canal) to the superstructure or bottom of deck slab, whichever is lowest
 - e. Design loadings
 - f. Design standards on which the bridge is based (AASHTO, etc.)
 7. The calculations and specifications for the bridge should be submitted to Reclamation and/or AOE for review.
 8. The right lane turn radius from the new road onto a Reclamation operating road should comply with the provisions of a 67-foot wheelbase⁵ (WB-67) truck turning template in the AASHTO manual on Geometric Design of Highway and Streets.
 9. Details of any proposed utilities to be attached to an existing bridge include:
 - a. Anchor bolt locations should not intercept the critical reinforcing steel of the bridge.

⁵ The field office should adjust these provisions according to anticipated needs.

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- b. Utilities should be placed and anchored under bridge decks and through utility openings, if they are present. The utility should be placed off center in the utility opening, if possible, to allow for future utility additions.
 - c. If an expansion joint is used in the pipeline, the joint should be placed near the bridge deck expansion joint.
 - d. Holes through bridge concrete or abutment and retaining walls for passage of utilities should be allowed by core drilling. The annular space between the utility and core hole surface should be completely filled with an elastomeric sealant to prevent loss of material or water piping from behind the wingwalls and abutments.
 - e. Submit calculations showing the effects of the weights of the proposed utilities on the load carrying capacity of the bridge for Reclamation review.
 - f. Intermediate supports for the utility should withstand the same seismic load considerations as the bridge.
 - g. Load limit signs should be placed adjacent to the bridge, as required under AASHTO criteria.
 - h. Beam guardrails should be installed at bridges and bridge approaches, as required under AASHTO criteria.
10. The applicant will be responsible for changes to Reclamation existing ROW; bridge O&M approach roads; existing fencing, gates, and signs; and the addition of new fencing, O&M gates, cattle guards, signs, etc.

4.2 Landscaping

- 1. No landscaping or other changes in ground surfaces within Reclamation pipeline and canal/lateral ROW should be made without advance written permission of Reclamation through the application process. Landscaping changes may (1) limit, prevent, or hamper O&M access; (2) increase the costs of operations and maintenance of the facility; (3) impact facility reliability; or (4) create a public nuisance or liability issue.
- 2. Open space with natural hiking trails and walkways may be permitted if vehicle access to Reclamation pipeline and appurtenant facilities for patrol and maintenance is provided.

3. The following may apply within Reclamation's ROW:
 - a. The easement may be used as a greenbelt upon Reclamation approval.
 - b. Ground cover and shrubs are permitted upon Reclamation approval.
 - c. Trees and vines should not be allowed. See Appendix B of *Review of Operation and Maintenance Program Field Examination Guidelines* (reproduced as appendix B at the end of these guidelines).
4. All temporary or permanent changes in ground surfaces within Reclamation pipeline and canal ROW are considered encroaching structures and are handled as such. Earthfills and cuts on adjacent property should not encroach onto Reclamation pipeline and canal ROW. Excavations of adjacent property (even property not within Reclamation's purview) within the projection of the Reclamation embankment line may impact embankment stability and should be evaluated.
5. Permanent landscaping structures should not be allowed within the exterior limits of a Reclamation linear facility ROW (fee owned or easement).
6. Pressurized lawn and park sprinkler irrigation lines (3-inch maximum size) and isolation valves within Reclamation easements that run parallel to a Reclamation pipeline should be installed at least 15 feet from the edge of the Reclamation pipeline.

Irrigating lawns and flower beds along canal embankments should not overwater the area or threaten the embankment stability.

4.3 Roadway Crossing

Note: This type of encroachment also includes parking areas and recreational trails.

1. The applicant should submit a grading plan as part of the application.
2. If the roadway crosses a Reclamation pipeline system that has a cover pipe designation of "A," refer to "3.2 General."

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3. If the applicant intends to modify existing drainage features during construction, detailed drawings showing the proposed drainage replacement/restoration should be submitted with the application for review and approval. (Refer to “3.2 General.”)
4. If the proposed roadway includes a bridge crossing over a Reclamation canal or pipeline, Reclamation and/or AOE should review and approve the vertical clearance and location of the abutments. (Refer to “4.1 Bridges.”)
5. Streets, roads, or parking areas crossing Reclamation pipeline easements are permissible. All streets, roads, and parking surfaces are to be asphalt or other flexible pavement. Depressed curbs or driveways should be provided for Reclamation vehicular access when new roads cross Reclamation pipelines or canals.
6. Roadway ditch drainage should not be allowed to flow into the canal. Drainage should be retained and released in a controlled way to maintain peak discharges that are less than any peak historical runoff rate before these modifications. Applicants should direct drainage to an original sub-basin cross drainage culvert or overchute. (Refer to “3.2 General” and “4.4 Storm Water Cross Drainage.”)
7. If existing roadway embankments are to be widened, the work should be conducted in accordance with the provisions of construction in the applicable State Department of Transportation (DOT) Standard Specifications.

4.4 Storm Water Cross Drainage

1. Upslope development impacts historic natural drainage volumes and peak flow rates. Development re-grades and revises drainage sub-basins. Revised ground cover from constructing roads, parking areas, and buildings may result in the need to change the cross drainage features (culverts and/or overchutes) along Reclamation canals.
2. A hydrologic study should accompany all plans that modify the existing drainage across and/or along Reclamation facilities. The study or report should show the proposed flows of the canal and the associated crossings. The drainage study or report should show that the downstream system can accept the flows without creating any flooding to properties adjacent to or downstream of the canal.
3. All drainage crossings, whether existing or proposed, should carry the peak runoff of a 100-year event while preventing any storm water from entering the canal and/or ponding against the canal embankment.

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4. Urban runoff should not be allowed to enter into, or drain onto, Reclamation's land. All flows generated outside Reclamation's ROW should enter the storm drain system prior to entering Reclamation's ROW. Piped connections are preferred, but concrete-lined channels may be acceptable upon Reclamation's review.
5. The new crossing under a canal should be designed with 3 feet vertical clearance from the top of the cross drainage structure to the bottom of the canal (or liner). The structure should extend completely across Reclamation's ROW.
6. New overcrossings of the canal should have 2 feet of vertical clearance from the top of the liner and 2 feet of horizontal clearance from the support abutments to the outside edge of the canal lining. The O&M road crossing of the cross drainage structure should be structurally capable of withstanding highway-legal vehicle loadings and provide at least 1 foot of cover in the roadway.
7. Pipe crossing barriers should be installed on all pipe overcrossings.
8. All drainage flow should be discharged to a downstream storm drainage system owned, operated, and maintained by a public agency (such as a city or county) or into areas such as channels, roadways, parks, wetland basins, or other non-private lands that can accept the concentrated flows from the drainage crossing.
9. All drainage from upland property should be collected by the applicant's installed system of curbs and inlets within their property and discharged into a non-Reclamation public agency's drainage system.
10. New drainage system designs will not use ponding against the existing canal embankment for temporary detention of storm runoff that will not immediately pass through existing or new crossings.

Proposed permanent detention facilities adjacent to Reclamation's property should include engineered fill beyond the canal ROW to provide, at a minimum, a fill-width maintenance access roadway between the canal property and the basin. The applicant shall submit a geotechnical report verifying that the canal embankments can perform as detention basin embankments. The design should provide for sufficient freeboard to contain the 100-year event within the proposed basin adjacent to Reclamation's property and shall have adequate protection from seepage and erosion.

The ownership and related O&M of the embankments shall be the responsibility of the applicant requesting the crossing.

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11. When grading operations upstream of existing canal drainage crossings are scheduled to take longer than a normal construction season to complete, temporary basins shall be installed. These temporary basins should be designed to detain the 100-year event, capture silt from the disturbed area, and meter the flows across the existing drain crossings without spilling flows into the canal.
12. Unless Reclamation specifies otherwise, the applicant should remove or plug and abandon existing drainage crossings that are not used by the development unless they are shown to provide an additional measure of safety for the canal by reducing the likelihood of spill into the canal caused by extreme runoff flows. Otherwise, these crossings should remain in place for Reclamation's benefit and will not require ownership transfer to a public agency.

These crossings must discharge into the non-Reclamation public agency's storm drainage systems or into areas such as channels, roadways, parks, wetland basins, or other nonprivate lands that can accept the concentrated flows from the drainage crossing in the case of an extreme runoff event.

Grading in Reclamation property should be preserved or revised to direct extreme runoff flows into these unused drainage crossings without allowing said flows to enter into the canal until the crossings reach their capacity.

4.5 Subdivision

Urban developments are reaching Reclamation's lands and ROWs. These are general guidelines for accommodating development in subdivisions (refer to "3.2 General" and "4.4 Storm Water Cross Drainage").

1. Permanent structures should not be permitted within Reclamation fee-owned linear ROWs.
2. Open space with natural hiking trails and vegetation may be allowable.
3. Where subdivision development is adjacent to a canal, fencing should include these characteristics:
 - a. Temporary chain link fences must be installed prior to removing any portion of existing fences.

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- b. Upon completion of grading for drainage and other work, fencing should be installed along the subdivision's boundary length of the adjacent ROW plus 150 feet beyond the development's property boundary. The fence should be per project standards and at the applicant's expense.
 - c. The new fence should be located 1 foot outside of Reclamation's ROW. The fence location should be shown on the improvement plans.
4. Use of Reclamation pipeline easements as part of residential subdivision lots should not be allowed. Pipeline easements may be included within the subdivision greenbelt or similar use areas.
5. Drawings should include all proposed improvements (i.e., streets, utilities, landscaping, etc.) within, and adjacent to, Reclamation's ROW.
6. Trees or vines should not be allowed within a Reclamation pipeline or canal ROW. See Appendix B of *Review and Operation and Maintenance Program Field Examination Guidelines* (reproduced as appendix B at the end of these guidelines).
7. Streets, roads, or parking areas using Reclamation easements may be permissible. All streets, roads, and parking surfaces should be asphalt or other flexible pavement. Depressed curbs or driveways should be provided for Reclamation vehicular access when new roads cross Reclamation pipelines or canals.
8. Where fencing is proposed within Reclamation easements, a minimum 16-foot-wide gate should be provided for Reclamation access.
9. Pipelines containing sewage, oil, gasoline, natural gas, or hazardous materials should only cross perpendicular (between 70 and 90 degrees) to the Reclamation pipeline or canal and be installed with the necessary safety measures and separation clearance as required in "4.6 Utility Crossing."
10. Electroliers, posts, etc., should be installed at the maximum distance possible from the edge of the pipeline or canal.
11. If crossing a Reclamation pipeline system that has "A" cover pipe designation, refer to recommendations in "3.2 General."

4.6 Utility Crossing

Note: All pipelines, electrical, and communication lines and conduits are referred to as “utilities” in these guidelines.

4.6.1 Casings

The Reclamation Materials Engineering and Research Laboratory’s (MERL) position is to avoid using casing pipes around metallic carrier pipelines (steel, ductile iron, cast iron, reinforced concrete, pretensioned concrete cylinder, etc.) whenever possible. The experience of the corrosion community in general is that these casings often cause corrosion-control problems. Furthermore, dielectric (plastic, fiberglass, etc.) casings, or even dielectrically coated casings, should not be used. They can shield the carrier pipe from receiving cathodic protection current.

Cathodic protection to a buried metallic pipeline is more trouble free and more certain without a casing pipe. MERL recommends relying on effective corrosion control measures on the carrier pipeline rather than relying on a casing pipe (which may shield cathodic protection current) to direct a leak away from Reclamation property.

4.6.2 Overhead Line Crossing

1. Overhead wires across Reclamation pipeline and canal ROWs should be at least 32 feet above all ground levels in the Reclamation ROW. For electrical powerlines of 69 kilovolts (kV) or higher voltage, the minimum clearance should be 40 feet plus 0.25 inch per kV of line-to-line voltage above 450 kV. In any case, the minimum clearance is to be that determined to be needed with an ambient temperature of 120 degrees Fahrenheit.
2. Reclamation has the following requirements for overhead crossings:
 - a. Poles or towers should not be allowed within Reclamation’s ROW.
 - b. Overhead electrical and communication lines should cross perpendicular (between 70 and 90 degrees) to the centerline of the Reclamation facility.
 - c. If necessary, fence grounding is to be provided for existing fence lines, especially under power transmission lines.

3. A marker warning sign should be provided that shows the clearance and electrical line voltage. The warning sign should face oncoming traffic and state, “**DANGER, HIGH VOLTAGE OVERHEAD.**”

4.6.3 Utility Crossing Reclamation’s Canal

Utility crossings include open ditch laterals, subsurface and surface drains, levees, and similar facilities.

General Requirements:

1. Utilities crossing Reclamation canals should be designed to cross perpendicular (between 70 and 90 degrees).
2. Pier construction in the canal for new utility crossing(s) should not be allowed. New utility crossings should be free span design.
3. Open cut crossings of Reclamation canals and ditches, when allowed, should require replacing linings to re-establish the original construction style and materials (i.e., disturbed concrete lining panels should be removed in their entirety and replaced, membrane lining and earth or concrete protective cover should be re-constructed, gravel and canal under-drainage systems should be re-established to full working order, etc.) Proposals should be submitted for approval with the crossing permit application.
4. For trench excavation and backfill requirements, refer to “3.2 General.”
5. Boring and jacking of a utility through canal embankments or protective levees should not be permitted. Boring and jacking of a utility should be constructed through the embankment foundation materials. Applicants should make special design and construction considerations with bored crossings under canals containing water during construction. Among these should be using proper bentonite slurry to seal the annulus space between the utility conduit and the boring cavity from canal seepage. Refer to appendix A for more details to be considered.

The applicant’s drilling plan should cover:

- a. Drilling methods and equipment
- b. Methods for preserving existing foundation material
- c. Methods and equipment to determine the presence of quick soil conditions or scouring and caving

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- d. Proposed method for casing installation and removal if casings are used
- e. Methods and equipment for accurately determining the depth of concrete and actual or theoretical volume placed

The applicant's contingency plan should cover:

- a. Means to repair in a certain time
 - b. Minimum flows after event
 - c. Review of geotechnical conditions surrounding the pile locations
 - d. Assessment of how the proposed mitigations will address geotechnical conditions
 - e. Methods for restoring foundation material
 - f. List of material, equipment, and personnel with qualifications to be used during mitigation work
 - g. A seal from a Professional Engineer on all relevant plans and drawings
6. When horizontal directional drilling (HDD) or other trenchless methods are used, canal seepage conditions may be aggravated by the collapse of the canal foundation material into the annular void between the bore and pipe. Penetration through the top stratum of fine-grained materials may concentrate seepage at those locations. Pipe installed with trenchless methods should proceed only after completion of a comprehensive evaluation of the following:
- (a) Comprehensive understanding of the subsurface soil and groundwater conditions to a minimum depth of 20 feet below the lowest pipe elevation
 - (b) Locations of the HDD pipe penetration entry and exit
 - (c) Construction procedure
 - (d) Allowable uplift pressures
 - (e) Onsite quality control and quality assurance monitoring during construction operation

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- (f) Grouting of the pipe annulus
- (g) Backfilling of any excavated areas
- (h) Repair and reinstatement of the construction staging areas

A geotechnical report should be submitted with the application for review prior to approval of the proposed utility crossing.

Directional drilling under a canal may be considered if a minimum clearance of 25 feet to the bottom of the canal lining is maintained for utilities with less than a 24-inch outside diameter. Larger utility crossings should be considered on an individual basis and may require additional clearance from the bottom of the canal lining.

7. Cut and cover constructed utilities under Reclamation canals should have a minimum cover of 36 inches when within Reclamation's ROWs. Bored construction utilities should have a minimum of 3 diameters cover.
8. Reclamation's ongoing O&M activities should not be disrupted during crossing construction. The primary or secondary operating road should be kept available for Reclamation use at all times.
9. Canal embankments should be re-built or repaired with materials and standards equal to or better than the existing embankments.
10. Drawings should be stamped and signed by a Professional Engineer and contain the following information:
 - a. Canal milepost or station at each proposed crossing, utility size and location, and type of utility or material transported
 - b. Maximum utility operating pressure, type of pipe, joints, wall thickness, maximum test pressure, and description of test procedures
 - c. Type of sleeve/casing (when allowed) including diameter, joints, and wall thickness
 - d. For utilities attached to a bridge or an overchute, details showing the structure name, superstructure, abutments, embankments, protective dikes, method of attachment, spacing of utility supports on the structure, location of other attached utilities, and structural calculations

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- e. Protective coatings and corrosion control measures
- f. Method of handling pipeline expansion and contraction
- g. Location of nearest shutoff valve on each side of the crossing
- h. Location and details of thrust restraint
- i. Design code(s) used for the utility crossing
- j. Location, including depth, of the buried pipeline communication and control cables
- k. Other existing utility easements in the immediate vicinity

Hazardous Material Carrier Requirements:

1. Pipelines carrying hazardous material or pollutants (e.g., oils, gasoline, sewage, contaminated waters, and nonpotable waters) should be designed for a reduced risk of failure in the portion within Reclamation's ROW. The design should require either:
 - a. Designing the crossing pipeline with an additional 50 percent working pressure factor
 - or*
 - b. Using secondary containment (casing pipe) for all hazardous material pipelines
2. To minimize the amount of any hazardous material entering the canal, Reclamation may require the installation of a block (gate) valve and or a check valve on each side of the canal between the ROW boundary and the embankment. When selecting the type of the valves, take into the account the flow direction and the terrain.
3. A final hazardous material spill contingency plan and an emergency response plan should be approved by Reclamation prior to start of construction.
4. A monitoring program and/or Supervisory Control and Data Acquisition System alarm may be required depending on the hazardous material transported. This applies to all "overcrossings" and "undercrossings" when the hydraulic grade line is within 60 inches of the canal liner or when local geology would promote this requirement.

Attaching Utilities to Bridges and Overchutes:

Note: Reclamation does not guarantee the long-term availability of bridges or overchutes as support devices for utility crossings because they may require structural modifications or alterations to accommodate widening, repairs, subsidence offsets, etc., to such an extent that service may be interrupted or stopped. Reclamation may determine the bridge is no longer required and may remove it. In that event, the owner/operator of each utility attached to a bridge or an overchute may be required to re-locate or permanently remove their utility at their own expense.

Specific details for attaching utilities to bridges are:

- a. Utilities should not be placed on the bridge deck.
- b. Anchor bolt locations should not intercept the critical reinforcing steel of the bridge.
- c. Utilities should be placed and anchored under bridge decks between girders and through utility openings, if they are present. The utility should be placed off center in the utility opening, if possible, to allow for future utility additions.
- d. If an expansion joint is used in the pipeline, it should be placed near the bridge deck expansion joint.
- e. Holes through bridge concrete or abutment and retaining walls for passage of utilities may be allowed and should be core drilled. The annular space between the utility and core hole surface should be completely filled with an elastomeric sealant to prevent loss of material or water piping from behind the wingwalls and abutments.
- f. Calculations showing the effects of the weights of the proposed utilities on the load carrying capacity of the bridge should be submitted for Reclamation review.
- g. Intermediate supports for the utility should withstand the seismic conditions of the bridge.

4.6.4 Utility Crossing Reclamation's Underground Pipelines

1. The applicant should submit the procedures, excavation plans, schedules, as well as type and weight of the construction equipment to be used for crossing the Reclamation pipeline.

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2. High voltage, direct current powerlines should not be permitted to encroach on the Reclamation pipeline ROW, except in unusual circumstances and with proper cathodic protection considerations.
3. For proposed metallic pipelines, refer to “5.0 Cathodic Protection Requirements.”
4. For utilities crossing above or under the Reclamation pipeline, the vertical clearance between the utility and Reclamation pipeline should be a minimum of 12 inches.
5. The location of the Reclamation pipeline and the communication and control cables throughout the area of the proposed construction should be shown on the plans. Prior to Reclamation and/or AOE issuing a use authorization or consent document, the pipeline and the cable(s) should be located and exposed by potholing. The pothole locations should be shown on the drawings. The pothole elevations should be referenced to Reclamation stationing or milepost. (Refer to “3.2 General.”)
6. Drawings should contain the following information:
 - a. Reclamation milepost or station at each proposed crossing, pipeline size and location, and type of utility or material transported.
 - b. Maximum utility operating pressure, type of pipe and joints, maximum test pressure and description of test procedures, wall thickness, and utility pipe classification.
 - c. Type of sleeve/casing pipe (when allowed) including diameter, joints, and wall thickness.
 - d. Protective coatings and corrosion control measures.
 - e. Location of nearest shutoff valve on each side of the crossing.
 - f. Location and details of thrust restraint.
 - g. Design code(s) used for utility crossing.
 - h. Location, including depth of the Reclamation pipeline and the communication and control cables.
 - i. Other existing utility easements in the immediate vicinity.

7. Detectable warning tape may be required over trenched utilities. (Refer to “3.3 Detectable Warning Tape.”)
8. For trench excavation and backfill requirements, refer to “3.2 General.”
9. Embankments should not be permitted within Reclamation’s ROW where underground pipeline exists.

4.6.5 Utility Crossing Under Reclamation’s Roadways

1. The applicant should supply typical cross sections that show existing ground surface elevations, utility trench invert elevations, and utility details.
2. For trench excavation and backfill requirements, refer to “3.2 General.”
3. Conduits with diameters up to 24 inches should be bored and jacked underneath pavements. Larger conduits may be considered on an individual basis. Pavement or road surfaces should not be cut unless an acceptable detour, if required, is approved. The cover over the conduit(s) when within Reclamation’s ROWs should be a minimum of 36 inches. (Refer to “3.2 General.”)
4. Unless otherwise approved, the applicant should replace existing Reclamation roads and parking surfaces that are removed or damaged by the applicant’s construction activities in accordance with provisions in the latest edition of the applicable State DOT Standard Specifications.
5. If existing road embankments are to be widened, the work should be conducted in accordance with the provisions of embankment construction in the applicable State DOT Standard Specifications.
6. Detectable warning tape may be required over buried utilities. (Refer to “3.3 Detectable Warning Tape.”)

5.0 CATHODIC PROTECTION REQUIREMENTS

5.1 Cathodically Protected Metallic Pipelines

Unless approved in writing by Reclamation, metallic pipelines or those containing metallic reinforcement (e.g., reinforced concrete) installed within Reclamation’s ROW should have a suitable bonded dielectric coating (see “5.2 Protective Coatings for Corrosion Control”) and be cathodically protected. Impressed current cathodic protection rectifiers and deep-well anode systems should not be

Engineering and O&M Guidelines for Crossings

permitted within Reclamation facilities without prior approval from MERL's Corrosion Technology Group. All submittals should include details of the cathodic protection system (CPS) and its appurtenances.

1. All existing Reclamation cathodic protection test stations, cables running to these stations, rectifiers, anode beds, and any other appurtenances should be located prior to any grading or excavation. The test stations should be staked and flagged. The test stations, cables running to these stations, any anode beds, etc., should be suitably enclosed or protected during construction to prevent damage. No re-location or modification of the test stations, cables, anode beds, etc., is allowed without prior approval from MERL's Corrosion Technology Group.
2. Generally, the CPS to the proposed pipeline should be the sacrificial anode type unless the proposed installation continues an existing pipeline that uses impressed current type of cathodic protection.
3. A means of monitoring the effectiveness of the CPS on the proposed pipeline should be provided within Reclamation's ROWs. The number of anodes and test stations will differ with each project. Test stations should be located at every anode bed connection and should not be more than 1,000 feet apart. A test station should also be located where any metallic pipeline crosses over or under a metallic Reclamation pipeline, metallic fence, other metallic structure embedded in the ground, or comes within 20 feet of a Reclamation structure on or embedded in the ground. Both the proposed cathodically protected pipeline and the Reclamation pipeline should be monitored regularly using these test stations. Monitoring results should be reported to MERL's Corrosion Technology Group. In addition, the owner of the proposed crossing pipeline should investigate and mitigate any adverse potential shift caused by the proposed pipeline on the Reclamation pipeline. Owners of proposed crossing pipelines should return Reclamation pipelines to their original electrochemical potentials or to more benign potentials. Mitigation measures should be approved by MERL's Corrosion Technology Group. The effectiveness of mitigation measures should be confirmed in the presence of a Reclamation representative following installation.

For those pipelines under DOT regulation, the application and monitoring of the CPS should conform to Title 49 CFR, Part 195, any special provisions of this guideline, and the provisions of NACE International RP 0169, in that order. For other pipelines, any special provisions of this guideline should take precedence, followed by the provisions of NACE RP 0169.

5.2 Protective Coatings for Corrosion Control

1. *Atmospheric Exposed Pipe*

The coating should be a high build modified aluminum epoxy mastic primer and top coated with a high build aliphatic urethane. The type of coating should be listed in the submitted plans and specifications. Information should include the surface preparation and the thickness of the coating to be applied.

2. *Buried Pipe*

The type of coating may vary from project to project due to geology and soil corrosivity and should be considered on an individual basis. The type of coating should be listed in the submitted plans and specifications. Information should include the surface preparation and the thickness of the coating to be applied.

REFERENCES

- Application for Transportation and Utility Systems and Facilities on Federal Lands, <http://www.ntia.doc.gov/FROWsite/SF-299_2006.pdf>.
- Application for Use of Reclamation Project Land and Water Surfaces, <<http://www.usbr.gov/pmts/lands/>>.
- Bureau of Reclamation Right-of-Use Application, <<http://www.usbr.gov/pmts/lands/FINAL7-2540-5-06ExpDate03312009.pdf>>.
- California Department of Water Resources - Encroachment Permit Guidelines.
- Central Arizona Project, Reach 11 Guidelines.
- GP Region Billings MT – Standard Crossing & Clearance Requirements, Utility Lines and Cables, drawing 40-600-51. The office also uses a Preliminary Project Description Form and a Special Use Permit.
- NACE, International RP 0169, “Standard Recommended Practice – Control of External Corrosion on Underground or Submerged Metallic Piping Systems.”
- PN Region Burley ID – Overhead and underground crossing clearances.
- Policy on Geometric Design of Highway and Streets, American Association of State Highway and Transportation Officials (AASHTO), Fifth Edition, 2004.
- Reclamation, 2005. Preliminary drawing 103-D-1700 that provides general requirements for installation of crossings, June 2005.
- Reclamation Manual, Directive and Standards LND 08-01, Land Use Authorizations, <<http://www.usbr.gov/recman/lnd/lnd08-01.pdf>>.
- Title 29 CFR, Part 195.
- U.S. Army Corps of Engineers – Engineering and Design, Design and Construction of Levees EM 1110-2-1913, 30 Apr 2000, CECW-EG Washington, DC 20314-1000.

GLOSSARY

Bored and jacked – This terminology is a general way of referring to a family of trenchless methods.

Bridge, class A – Vehicular bridge used by the public. May or may not be owned by the Bureau of Reclamation.

Consent Document Permit – Permit required across fee-owned lands.

Detention basin – An artificial flow control structure used to contain flood water for a limited period of a time, thereby providing protection for areas downstream. Detention basins provide a way to reduce storm peak flows, while retention basins hold water for an extended period of time. These basins are generally a part of a larger engineered flood water management system.

Electroliers – A branching frame, often of ornamental design, used to support electric illuminating lamps.

Pothole excavation – See potholing.

Potholing – The practice of digging test holes to expose underground utilities (e.g., cables) to determine the horizontal and vertical location of these utilities.

Trenchless methods – Procedures for installing pipe without using traditional trench cut and cover methods. These trenchless methods may be referred to as bore and jack, tunneling, horizontal directional drilling, and microtunneling, among others.

Water conveyance facility – Canal, ditch, pipeline, drain, levee, open or closed laterals, and similar facilities and their associated appurtenant features.

Appendix A

General Requirements for Installing Bored and Jacked Pipe Undercrossings

Bored and Jacked Under the Canal – This terminology is a general way of referring to a family of trenchless technologies. Similar guidance to the requirements listed below should be followed no matter what method is used for installation.

1. Installing a lone carrier pipe (without casing) is encouraged. Refer to “4.6 Utility Crossing,” and “4.6.1 Casings” for information on cautions of using casings around metallic carrier pipe.
2. Plans must show carrier/casing pipe type, diameter, and thickness. Casing pipes should be steel pipe (American Water Works Association [AWWA] C-200) and have 1/4-inch minimum wall thickness. Applicants should provide the type of carrier pipe and appropriate bell dimensions for said carrier pipe to verify annular clearances.
3. When installing pipe while the canal is unwatered, a minimum of 3 pipe diameters or 60 inches of clearance (whichever is greater) between the top of the pipe and the bottom of the canal must be maintained. However, 72 inches or more clearance is recommended.
4. Provide a minimum of 3 inches of clearance between the carrier and casing pipes at all points (including bells).
5. A bulkhead or effective sealing device should be provided at both ends of each casing pipe to seal the annular space between the two pipes. Vent pipe should be included to allow ventilation and reduce the risk of condensation buildup and flooding.
6. As a result of the installation process, an annular void is usually created around the outside of the casing pipe. Provisions should be made to pressure grout or effectively seal (e.g., bentonite slurry) this void space.
7. Requirements below are provided to establish minimums for determination of the length of pipe to be installed. It is strongly recommended that pipes be installed perpendicular (between 70 and 90 degrees) to the canal alignment. Regardless, the pipe must extend completely through the Bureau of Reclamation’s (Reclamation) right-of-way (ROW). These minimums do not relieve the applicant’s engineer from performing an onsite investigation or other work to determine local conditions that may require additional pipe length.

Jacking pit configuration, location, and length of pipe to be installed should be based on the following parameters:

- a. One operating road shall remain open to vehicular traffic at all times.

- b. The minimum operating road embankment top width to be maintained during construction should be either 14 feet wide, the width of the existing embankment, or as required by Reclamation.
 - c. As a minimum, jacking pit excavations should not be within:
 - (1) A line drawn from the outside edge of the operating road embankment extended downward and away from the canal at a slope of 3/4 horizontal to 1 vertical.
 - (2) A line drawn from the outside edge of the top of the concrete lining extended downward and away from the canal at a slope of 1 horizontal to 1 vertical.
 - d. To contain the slurry during installation, jacking pits should be constructed so that natural ground or a compacted dike is entirely around the pit to an elevation at least 1 foot above the top of the canal lining.
 - e. All excavations should be in compliance with Occupation Safety and Health Administration regulations and Reclamation's Health and Safety Standards.
 - f. If the contractor elects to install shoring in the jacking pits, all shoring designs should be prepared by a Professional Engineer knowledgeable in said type of work. A copy of the shoring designs should be submitted to Reclamation.
8. Jacking pits should be backfilled with native material and mechanically compacted to 95 percent of the maximum dry density per ASTM D-698.
9. The contractors should be responsible for any damage to the canal section during the construction of a crossing, and the contractor shall repair the damage at their own expense.
10. If an emergency situation develops during construction, the contractor should immediately notify appropriate contacts with Reclamation. Reclamation must approve further work at that point.
11. The minimum distance between two jacked pipes should be 10 feet.
12. Any pressure lines installed within Reclamation's ROW must have adequate thrust restraint at bends and valves. Specified design pressures and thrust restraint calculations shall be provided to Reclamation to confirm the design configuration.

Appendix B

Guidelines – Removal of Trees and Other Vegetative Growth from Earth Dams, Dikes, and Conveyance Features

Excerpted from: Review of Operation and Maintenance Program Field Examination Guidelines

**GUIDELINES
REMOVAL OF TREES AND OTHER VEGETATIVE GROWTH
FROM EARTH DAMS, DIKES, AND CONVEYANCE FEATURES***

Growth of trees and other significant vegetation on or adjacent to earth dams, dikes, and conveyance features, should be prevented from becoming established for the following reasons:

1. To allow proper surveillance and inspection of the structures and adjacent areas for seepage, cracking, sinkholes, settlement, deflection, and other signs of distress.
2. To allow adequate access for normal and emergency Operation and Maintenance (O&M) activities.
3. To prevent damage to the structures due to root growth, such as shortened seepage paths through embankments; voids in embankments from decayed roots or toppled trees; expansion of cracks or joints of concrete walls, canal lining, or pipes; and plugging of perforated or open-jointed drainage pipes.
4. To discourage animal/rodent activity (by eliminating their food source and habitat), thereby preventing voids within embankments and possible shortened seepage paths.
5. To allow adequate flow-carrying capability of water conveyance channels (e.g., spillway inlet and outlet channels; open canals, laterals, and drains).

The growth of trees and potentially detrimental vegetation should be prevented during its early stages as part of the operating office or entity's normal O&M program. Early control is generally the most cost effective means of avoiding potential adverse effects on these structures from their continued growth. Control efforts may consist of applying herbicides, spraying, cutting, and/or removing the trees or undesirable vegetation.

Suggested clearance zones (areas of control) adjacent to these structures are provided within these guidelines. Concerted efforts should be made to maintain these clearance zones. However, site-specific conditions, such as landscaping, accessibility, erosion susceptibility of material in the area, type of abutment material, original construction clearance zone, right-of-way easement, etc., may influence the necessity or success of these control efforts.

Should trees and/or other significant vegetation become established, proper O&M of earth embankment dams, dikes, and conveyance features, may require their discriminate removal. During the Review of Operation and Maintenance examination for the facility or system, the examiners should use these guidelines, along with their experience and professional judgment, to evaluate the need for removal of such established growth.

If trees and other significant growth are identified by the examination team in locations delineated by these guidelines, a determination should be made regarding their need for removal. If the identified vegetation is deemed to be in location such that its existence is not considered to be detrimental and therefore does not require removal, sufficient justification should be provided during the examination and included within the associated report to support that determination.

* Enclosure to memorandum dated April 26, 1989, from Manager, Project Operation Services Staff, to all Regional Directors, Subject: Revised Guidelines — *Removal of Trees and Other Vegetative Growth From Earth Dams, Dikes, and Conveyance Features.*

When, in the opinion of an Review of Operation and Maintenance examination team, such established growth requires removal, specific followup procedures should be addressed as part of the examination. Such procedures may include the need for right-of-way easement determination; the need for an assessment for potential environmental impacts (any impact assessments should be coordinated with designated regional or project office environmental staff); whether removal of the root system is necessary and to what extent; the method of removal and recompaction of material within the void created; and the need for any erosion stabilization measures.

National Environmental Policy Act compliance is required relative to such tree and vegetation removal. Additionally, the application of herbicides should comply with applicable provisions of the Endangered Species Act. The determination of appropriate procedures to be followed in assessing potential environmental impacts and mitigation (including those to wildlife and its habitat) will be the responsibility of each regional and/or project office. This will include the preparation of an appropriate National Environmental Policy Act document and an assessment of the need for mitigation prior to the onset of removal activities. Appropriate National Environmental Policy Act compliance may include a Categorical Exclusion Checklist, an environmental assessment followed by a Finding of No Significant Impact, or an Environmental Impact Statement.

The following guidelines and associated clearance zones should be used for all Reclamation earth dams, dikes, and conveyance features. They are not considered "policy;" rather, they are guides which should be used with reasonable judgment and practicality.

1. Trees and detrimental vegetative growth should be prevented from becoming established on the surface of all earth dam, dike, and conveyance feature embankments. A small amount of shallow-rooted vegetation may be acceptable to aid in erosion protection and slope stabilization. Mowing of grass and other small vegetation is desirable and may be necessary to allow proper surveillance of the surfaces and observation of animal/rodent activity.
2. A clearance zone of 25 feet beyond each contact (groins and toe) of earth dam embankments and dikes should be maintained of all trees and detrimental vegetation. Similarly, a clearance zone of 15 feet should be maintained beyond the outside toe of all fill sections/embankments for open canals and laterals. These clearance zones may need to be extended for seepage areas or other conditions where proper surveillance or access may be warranted.
3. Earth dam, dike, and conveyance feature (open canal and lateral) embankments have large tree growth or stumps from previously cut trees on or near them should be evaluated, usually in conjunction with an Review of Operation and Maintenance examination, for any necessary future action, (i.e., monitor, excavation and backfill, rebuild, etc.). Generally, sizable old root systems of large trees should be grubbed out and the embankment replaced and compacted to prevent the development of piping action or erosion. Likewise, any sizable voids resulting from animal/rodent burrowing activity should be filled and compacted. Seeding may be necessary for protection from surface erosion.
4. Spillway inlet and outlet channels, outlet works discharge channels, and other open conveyance channels (open canals, laterals, and drains) should be free of vegetative growth that could significantly impede water flow or reduce design capacity.
5. A clearance zone of 25 feet adjacent to all concrete structures associated with such facilities should be maintained of all trees and detrimental vegetative growth to prevent damage from root growth, to allow proper surveillance, and to allow adequate O&M access.

6. Associated cut slopes adjacent to open canals and laterals should be kept clear of vegetation which, if toppled and/or uprooted, could affect operations or O&M access.

7. For pipe conveyance systems (such as siphons, aqueducts, discharge lines, perforated or open-jointed drains, etc.), to provide O&M access and to prevent root encroachment, a clearance zone should be maintained 15 feet from each side of the pipeline. However, in some cases, farming of annual crops over pipelines may be permissible.

* * * * *

Easement Encroachment Application for the Jordan Aqueduct Right-of-Way



(Please fill out this form completely. If additional space is needed, the information can be included on a separate sheet of paper).

TO: Jordan Valley Water
Conservancy District
Attn: Property Manager
8215 South 1300 West
West Jordan, Utah 84088
(801) 565-4300

FROM: _____

PRELIMINARY REQUIREMENTS:

1. Fees and Associated Costs:

- a. \$150 application fee, payable by check, to the Jordan Valley Water Conservancy District. \$100 application fee payable by check, to the United States Bureau of Reclamation. The application fee(s) should be mailed to the address listed in the "To" section above.
- b. If after review of the application the District determines the proposed easement encroachments cannot be granted, the District will refund the application fee.
- c. The District will determine the additional expense it will incur to construct, operate, maintain, and replace the Jordan Aqueduct Easement due to subsurface improvements proposed within its exclusive right-of-way by each encroaching party. The additional expense will be paid by the encroaching party as provided by the Encroachment Agreement.
- d. Email the application materials to benp@jvwcd.org. Title the subject line "JVWCD Encroachment" followed by a dash and the encroaching party's last name or company name (Example: JVWCD Encroachment – Smith or JVWCD Encroachment – Jordan Valley Water).

2. Plans and Specifications:

- a. Attach an editable set of legible, electronic PDF format, full size plans, specifications, maps, and/or drawings, including both Plan AND Profile, for the District to review and provide feedback. After the review is complete and any necessary revisions have been made, a set of the final exhibits will be required for the final application.
- b. All drawings must show the Jordan Aqueduct Easement boundaries and pipeline, and be clearly identified.

NOTE: Application will NOT be reviewed until exhibits that show the existing condition and proposed encroachments are received. Exhibits should include the easement boundary and the District's pipeline(s) and related facilities.

JORDAN VALLEY WATER CONSERVANCY DISTRICT

**EASEMENT ENCROACHMENT APPLICATION
JORDAN AQUEDUCT RIGHT-OF-WAY**

Page 2

APPLICATION INFORMATION:

1. Legal name, address, telephone number, and email address of Applicant:

2. Full legal name and title of individual(s) who will sign encroachment document. The individual(s) listed should be the owner(s) of the property as described on the Deed, or an authorized signer who has the legal authority to execute the agreement on behalf of applicant:

3. Detailed description of the proposed use of area encumbered by the easement (Example: 9" PVC water line; 22" RCP storm drain; 8" sewer line inside a 12" steel casing, two 2" HDPE conduits, one with 96-count fiber optic cable and another with 432-count fiber optic cable, grading, etc.):

4. Location of proposed use:

- a. Address (Street, City, State, Zip Code. Include Coordinates if available):

- b. Section _____ Township _____ Range _____

JORDAN VALLEY WATER CONSERVANCY DISTRICT

**EASEMENT ENCROACHMENT APPLICATION
JORDAN AQUEDUCT RIGHT-OF-WAY**

Page 3

5. Length of time requested (if not permanent):

6. Anticipated Construction:

a. Date of Commencement: _____

b. Date of Completion: _____

I certify that the information provided in this application is true, complete, and accurate to the best of my knowledge and belief, and is provided in good faith. I also understand:

- (i) this application is for informational purposes only and it does not constitute authority to encroach, occupy, possess or otherwise use the right-of-way;
- (ii) that I must execute a written agreement for a right-of-way; and,
- (iii) no work within, encroachment upon, occupancy, possession or other use may be undertaken until the District, and the United States Bureau of Reclamation, and I have executed a written agreement.

Signature of Applicant: _____ Date: _____

Printed Name of Applicant: _____

**APPLICATION FOR TRANSPORTATION, UTILITY SYSTEMS, TELECOMMUNICATIONS AND FACILITIES
ON FEDERAL LANDS AND PROPERTY**

FORM APPROVED
OMB Control Number: 0596-0249
Expiration Date: 2/28/2023

FOR AGENCY USE ONLY

NOTE: Before completing and filing the application for an authorization (easement, right-of-way, lease, license or permit), the applicant should completely review this package, including instructions, and schedule a pre-application meeting with representatives of the agency responsible for processing the application. Each agency may have specific and unique requirements to be met in preparing and processing the application. Many times, with the help of the agency representative, the application can be completed at the pre-application meeting.

Application Number

Date Filed

| | | |
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| 1. Name and address of applicant | 2. Name and address of authorized agent if different from item 1 | 3. Applicant telephone number and email: Authorized agent telephone number and email: |
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| | |
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| <p>4. As applicant are you? (check one)</p> <p>a. <input type="checkbox"/> Individual</p> <p>b. <input type="checkbox"/> Corporation*</p> <p>c. <input type="checkbox"/> Partnership/Association*</p> <p>d. <input type="checkbox"/> State Government/State Agency</p> <p>e. <input type="checkbox"/> Local Government</p> <p>f. <input type="checkbox"/> Federal Agency</p> <p>* If checked, complete supplemental page</p> | <p>5. Specify what application is for: (check one)</p> <p>a. <input type="checkbox"/> New authorization</p> <p>b. <input type="checkbox"/> Renewing existing authorization number</p> <p>c. <input type="checkbox"/> Amend existing authorization number</p> <p>d. <input type="checkbox"/> Assign existing authorization number</p> <p>e. <input type="checkbox"/> Existing use for which no authorization has been received *</p> <p>f. <input type="checkbox"/> Other*</p> <p>* If checked, provide details under item 7</p> |
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6. If an individual, or partnership, are you a citizen(s) of the United States? Yes No

7. Project description (describe in detail): (a) Type of use or occupancy, (e.g., canal, pipeline, road, telecommunications); (b) related structures and facilities; (c) physical specifications (Length, width, grading, etc.); (d) term of days/years needed; (e) time of year of use or operation; (f) Volume or amount of product to be transported; (g) duration and timing of construction; and (h) temporary work areas needed for activity/construction (Attach additional sheets, if additional space is needed.)

8. Attach a map covering area and show location of project proposal.

9. State or Local government approval: Attached Applied for Not Required

10. Nonrefundable application fee: Attached Not required To be determined by agency

11. Does project cross international boundary or affect international waterways? Yes No (if "yes," indicate on map)

12. Give statement of your technical and financial capability to construct, operate, maintain, and terminate system for which authorization is being requested.

13a. Describe other alternative locations considered.

b. Why were these alternatives not selected?

c. Give explanation as to why it is necessary to use or occupy Federal assets (lands or buildings).

14. List authorizations and pending applications filed for similar projects which may provide information to the authorizing agency. (Specify number, date, code, or name)

15. Provide statement of need for project, including the economic feasibility and items such as: (a) cost of proposal (construction, operation, and maintenance); (b) estimated cost of next best alternative; and (c) expected public benefits.

16. Describe probable effects on the population in the area, including the social and economic aspects, and the rural lifestyles.

17. Describe likely environmental effects that the proposed project will have on: (a) air quality; (b) visual impact; (c) surface and ground water quality and quantity; (d) the control or structural change on any stream or other body of water; (e) existing noise levels; and (f) the surface of the land, including vegetation, permafrost, soil, and soil stability; and, (g) historic or archaeological resources or properties.

18. Describe the probable effects that the proposed project will have on (a) populations of fish, plant life, wildlife, and marine life, including threatened and endangered species; and (b) marine mammals, including hunting, capturing, collecting, or killing these animals.

19. State whether any hazardous material, as defined in this paragraph, would be used, produced, transported or stored on or in a federal building or federal lands or would be used in connection with the proposed use or occupancy. "Hazardous material" shall mean (a) any hazardous substance under section 101(14) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. § 9601(14); (b) any pollutant or contaminant under section 101(33) of CERCLA, 42 U.S.C. § 9601(33); (c) any petroleum product or its derivative, including fuel oil, and waste oils; and (d) any hazardous substance, extremely hazardous substance, toxic substance, hazardous waste, ignitable, reactive or corrosive materials, pollutant, contaminant, element, compound, mixture, solution or substance that may pose a present or potential hazard to human health or the environment under any applicable environmental laws. The holder shall not store any hazardous materials at the site without prior written approval from the authorized officer. This approval shall not be unreasonably withheld. If the authorized officer provides approval, this permit shall include (or in the case of approval provided after this permit is issued, shall be amended to include) specific terms addressing the storage of hazardous materials, including the specific type of materials to be stored, the volume, the type of storage, and a spill plan. Such terms shall be proposed by the holder and are subject to approval by the authorized officer.

20. Name all the Federal Department(s)/Agency(ies) where this application is being filed.

I HEREBY CERTIFY, That I am of legal age and authorized to do business in the State and that I have personally examined the information contained in the application and believe that the information submitted is correct to the best of my knowledge.

Signature of Applicant

Date

Title 18, U.S.C. Section 1001, makes it a crime for any person knowingly and willfully to make to any department or agency of the United States any false, fictitious, or fraudulent statements or representations as to any matter within its jurisdiction.

GENERAL INFORMATION
ALASKA NATIONAL INTEREST LANDS

This application will be used when applying for a right-of-way, permit, license, lease, or certificate for the use of Federal lands which lie within conservation system units and National Recreation or Conservation Areas as defined in the Alaska National Interest lands Conservation Act. Conservation system units include the National Park System, National Wildlife Refuge System, National Wild and Scenic Rivers System, National Trails System, National Wilderness Preservation System, and National Forest Monuments.

Transportation utility systems telecommunication installations facility uses for which the application may be used are:

1. Canals, ditches, flumes, laterals, pipes, pipelines, tunnels, and other systems for the transportation of water.
2. Pipelines and other systems for the transportation of liquids other than water, including oil, natural gas, synthetic liquid and gaseous fuels, and any refined product produced therefrom.
3. Pipelines, slurry and emulsion systems, and conveyor belts for transportation of solid materials.
4. Systems for the transmission and distribution of electric energy.
5. Wired and wireless systems for transmission or reception of radio, television, telephone, telegraph, and other electronic signals, and other means of communications.
6. Improved right-of-way for snow machines, air cushion vehicles, and all-terrain vehicles.
7. Roads, highways, railroads, tunnels, tramways, airports, landing strips, docks, and other systems of general transportation.

This application must be filed simultaneously with each Federal department or agency requiring authorization to establish and operate your proposal.

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P.O. Box 21628
Juneau, Alaska 99802-1628
Telephone: (907) 586-7847
(or a local Forest Service Office)

Department of the Interior
Bureau of Indian Affairs (BIA)
Alaska Regional Office
709 West 9th Street
Juneau, Alaska 99802
Telephone: (907) 586-7177

Department of the Interior
Alaska State Office
Bureau of Land Management
222 West 7th Avenue #13
Anchorage, Alaska 99513
Public Room: 907-271-5960
FAX: 907-271-3684
(or a local BLM Office)

U.S. Fish & Wildlife Service (FWS)
Office of the Regional Director
1011 East Tudor Road
Anchorage, Alaska 99503
Telephone: (907) 786-3440

National Park Service (NPS)
Alaska Regional Office
240 West 5th Avenue
Anchorage, Alaska 99501
Telephone: (907) 644-3510

Department of Transportation
Federal Aviation Administration
Alaska Region AAL-4, 222 West 7th Ave., Box 14
Anchorage, Alaska 99513-7587
Telephone: (907) 271-5285

NOTE - The Department of Transportation has established the above central filing point for agencies within that Department. Affected agencies are: Federal Aviation Administration (FAA), Coast Guard (USCG), Federal Highway Administration (FHWA), Federal Railroad Administration (FRA).

OTHER THAN ALASKA NATIONAL INTEREST LANDS

Use of this form is not limited to National Interest Conservation Lands of Alaska.

Individual department/agencies may authorize the use of this form by applicants for transportation, utility systems, telecommunication installations and facilities on other Federal lands outside those areas described above.

For proposals located outside of Alaska, applications will be filed at the local agency office or at a location specified by the responsible Federal agency.

SPECIFIC INSTRUCTIONS
(Items not listed are self-explanatory)

- 7 Attach preliminary site and facility construction plans. The responsible agency will provide instructions whenever specific plans are required.
- 8 Generally, the map must show the section(s), township(s), and range(s) within which the project is to be located. Show the proposed location of the project on the map as accurately as possible. Some agencies require detailed survey maps. The responsible agency will provide additional instructions.
- 9, 10, and 12 The responsible agency will provide additional instructions.
- 13 Providing information on alternate locations in as much detail as possible, discussing why certain locations were rejected and why it is necessary to use Federal assets will assist the agency(ies) in processing your application and reaching a final decision. Include only reasonable alternate locations as related to current technology and economics.
- 14 The responsible agency will provide instructions.
- 15 Generally, a simple statement of the purpose of the proposal will be sufficient. However, major proposals located in critical or sensitive areas may require a full analysis with additional specific information. The responsible agency will provide additional instructions.
- 16 through 19 Providing this information with as much detail as possible will assist the Federal agency(ies) in processing the application and reaching a decision. When completing these items, you should use a sound judgment in furnishing relevant information. For example, if the project is not near a stream or other body of water, do not address this subject. The responsible agency will provide additional instructions.

Application must be signed by the applicant or applicant's authorized representative.

Note - Filings with any Interior agency may be filed with any office noted above or with the Office of the Secretary of the Interior, Regional Environmental Officer, P.O. Box 120, 1675 C Street, Anchorage, Alaska 99513.

EFFECT OF NOT PROVIDING INFORMATION

Disclosure of the information is voluntary. If all the information is not provided, the proposal or application may be rejected.

DATA COLLECTION STATEMENT

The Federal agencies collect this information from proponents and applicants requesting a right-of-way, permit, license, lease, or certification for use of Federal assets. The Federal agencies use this information to evaluate a proponent's or applicant's proposal to use Federal assets.

BURDEN STATEMENT

According to the Paperwork Reduction Act of 1995, an agency may not conduct or sponsor, and a person is not required to respond to a collection of information unless it displays a valid OMB control number. The valid OMB control number for this information collection is 0596-0249. The time required to complete this information collection is estimated to average 8 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. The authority to collect this information is derived from 47 U.S.C. 1455(c)(3) and 16 U.S.C. 3210.

USDA NONDISCRIMINATION STATEMENT

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or part of an individual's income is derived from any public assistance. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotope, etc.) should contact USDA's TARGET Center at 202-720-2600 (voice and TDD).

To file a complaint of discrimination, write USDA, Director, Office of Civil Rights, 1400 Independence Avenue, SW, Washington, DC 20250-9410 or call toll free (866) 632-9992 (voice). TDD users can contact USDA through local relay or the Federal relay at (800) 877-8339 (TDD) or (866) 377-8642 (relay voice). USDA is an equal opportunity provider and employer.

The Privacy Act of 1974 (5 U.S.C. 552a) and the Freedom of Information Act (5 U.S.C. 552) govern the confidentiality to be provided for information received by the Forest Service.

SUPPLEMENTAL

| NOTE: The responsible agency(ies) will provide instructions | CHECK APPROPRIATE BLOCK | |
|---|--------------------------|--------------------------|
| I - PRIVATE CORPORATIONS | ATTACHED | FILED * |
| a. Articles of Incorporation | <input type="checkbox"/> | <input type="checkbox"/> |
| b. Corporation Bylaws | <input type="checkbox"/> | <input type="checkbox"/> |
| c. A certification from the State showing the corporation is in good standing and is entitled to operate within the State | <input type="checkbox"/> | <input type="checkbox"/> |
| d. Copy of resolution authorizing filing | <input type="checkbox"/> | <input type="checkbox"/> |
| e. The name and address of each shareholder owning 3 percent or more of the shares, together with the number and percentage of any class of voting shares of the entity which such shareholder is authorized to vote and the name and address of each affiliate of the entity together with, in the case of an affiliate controlled by the entity, the number of shares and the percentage of any class of voting stock of that affiliate owned, directly or indirectly, by that entity, and in the case of an affiliate which controls that entity, the number of shares and the percentage of any class of voting stock of that entity owned, directly or indirectly, by the affiliate. | <input type="checkbox"/> | <input type="checkbox"/> |
| f. If application is for an oil or gas pipeline, describe any related right-of-way or temporary use permit applications, and identify previous applications. | <input type="checkbox"/> | <input type="checkbox"/> |
| g. If application is for an oil and gas pipeline, identify all Federal lands by agency impacted by proposal. | <input type="checkbox"/> | <input type="checkbox"/> |
| II - PUBLIC CORPORATIONS | | |
| a. Copy of law forming corporation | <input type="checkbox"/> | <input type="checkbox"/> |
| b. Proof of organization | <input type="checkbox"/> | <input type="checkbox"/> |
| c. Copy of Bylaws | <input type="checkbox"/> | <input type="checkbox"/> |
| d. Copy of resolution authorizing filing | <input type="checkbox"/> | <input type="checkbox"/> |
| e. If application is for an oil or gas pipeline, provide information required by item "I - f" and "I - g" above. | <input type="checkbox"/> | <input type="checkbox"/> |
| III - PARTNERSHIP OR OTHER UNINCORPORATED ENTITY | | |
| a. Articles of association, if any | <input type="checkbox"/> | <input type="checkbox"/> |
| b. If one partner is authorized to sign, resolution authorizing action is | <input type="checkbox"/> | <input type="checkbox"/> |
| c. Name and address of each participant, partner, association, or other | <input type="checkbox"/> | <input type="checkbox"/> |
| d. If application is for an oil or gas pipeline, provide information required by item "I - f" and "I - g" above. | <input type="checkbox"/> | <input type="checkbox"/> |

* If the required information is already filed with the agency processing this application and is current, check block entitled "Filed." Provide the file identification information (e.g., number, date, code, name). If not on file or current, attach the requested information.

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Attachment C

SF 299 Permit Application

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ATTACH DRAWINGS AFTER COORDINATION

APPLICATION FOR TRANSPORTATION, UTILITY SYSTEMS, TELECOMMUNICATIONS AND FACILITIES ON FEDERAL LANDS AND PROPERTY

FORM APPROVED
 OMB Control Number: 0596-0249
 Expiration Date: 1/31/2027

FOR AGENCY USE ONLY

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Application Number

Date Filed

| | | |
|----------------------------------|--|--|
| 1. Name and address of applicant | 2. Name and address of authorized agent if different from item 1 | 3. Applicant telephone number and email: Authorized agent telephone number and email: |
|----------------------------------|--|--|

| | |
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6. If an individual, or partnership, are you a citizen(s) of the United States? Yes No

7. Project description (describe in detail): (a) Type of use or occupancy, (e.g., canal, pipeline, road, telecommunications); (b) related structures and facilities; (c) physical specifications (Length, width, grading, etc.); (d) term of days/years needed; (e) time of year of use or operation; (f) Volume or amount of product to be transported; (g) duration and timing of construction; and (h) temporary work areas needed for activity/construction (Attach additional sheets, if additional space is needed.)

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Anchorage, Alaska 99513
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Note - Filings with any Interior agency may be filed with any office noted above or with the Office of the Secretary of the Interior, Regional Environmental Officer, P.O. Box 120, 1675 C Street, Anchorage, Alaska 99513.

PUBLIC BURDEN STATEMENT

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|---|--------------------------|--------------------------|
| I - PRIVATE CORPORATIONS | ATTACHED | FILED * |
| a. Articles of Incorporation | <input type="checkbox"/> | <input type="checkbox"/> |
| b. Corporation Bylaws | <input type="checkbox"/> | <input type="checkbox"/> |
| c. A certification from the State showing the corporation is in good standing and is entitled to operate within the State | <input type="checkbox"/> | <input type="checkbox"/> |
| d. Copy of resolution authorizing filing | <input type="checkbox"/> | <input type="checkbox"/> |
| e. The name and address of each shareholder owning 3 percent or more of the shares, together with the number and percentage of any class of voting shares of the entity which such shareholder is authorized to vote and the name and address of each affiliate of the entity together with, in the case of an affiliate controlled by the entity, the number of shares and the percentage of any class of voting stock of that affiliate owned, directly or indirectly, by that entity, and in the case of an affiliate which controls that entity, the number of shares and the percentage of any class of voting stock of that entity owned, directly or indirectly, by the affiliate. | <input type="checkbox"/> | <input type="checkbox"/> |
| f. If application is for an oil or gas pipeline, describe any related right-of-way or temporary use permit applications, and identify previous applications. | <input type="checkbox"/> | <input type="checkbox"/> |
| g. If application is for an oil and gas pipeline, identify all Federal lands by agency impacted by proposal. | <input type="checkbox"/> | <input type="checkbox"/> |
| II - PUBLIC CORPORATIONS | | |
| a. Copy of law forming corporation | <input type="checkbox"/> | <input type="checkbox"/> |
| b. Proof of organization | <input type="checkbox"/> | <input type="checkbox"/> |
| c. Copy of Bylaws | <input type="checkbox"/> | <input type="checkbox"/> |
| d. Copy of resolution authorizing filing | <input type="checkbox"/> | <input type="checkbox"/> |
| e. If application is for an oil or gas pipeline, provide information required by item "I - f" and "I - g" above. | <input type="checkbox"/> | <input type="checkbox"/> |
| III - PARTNERSHIP OR OTHER UNINCORPORATED ENTITY | | |
| a. Articles of association, if any | <input type="checkbox"/> | <input type="checkbox"/> |
| b. If one partner is authorized to sign, resolution authorizing action is | <input type="checkbox"/> | <input type="checkbox"/> |
| c. Name and address of each participant, partner, association, or other | <input type="checkbox"/> | <input type="checkbox"/> |
| d. If application is for an oil or gas pipeline, provide information required by item "I - f" and "I - g" above. | <input type="checkbox"/> | <input type="checkbox"/> |

* If the required information is already filed with the agency processing this application and is current, check block entitled "Filed." Provide the file identification information (e.g., number, date, code, name). If not on file or current, attach the requested information.

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Attachment D

Geotechnical
Report

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GEOTECHNICAL INVESTIGATION

JVWCD SOUTHWEST AQUEDUCT REACH 2

Salt Lake County, Utah

*Prepared for:
Bowen Collins & Associates*

June 2024

RB&G
ENGINEERING, INC.

June 4, 2024

Bowen Collins & Associates
Attn: Jason Leuttinger, P.E.
154 East 14075 South
Draper, UT 84020

Re: Geotechnical Investigation – JWCD Southwest Aqueduct Reach 2

Dear Mr. Leuttinger:

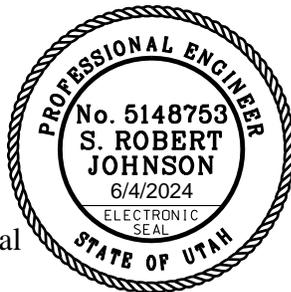
A Geotechnical Investigation has been completed for the Jordan Valley Water Conservancy District Southwest Aqueduct Reach 2 project in Salt Lake County, Utah. The results of this study are summarized in the report transmitted herewith.

We appreciate the opportunity of providing this service for you. If there are any questions relating to the information contained herein, please call.

Sincerely,

RB&G ENGINEERING, INC.

S. Robert Johnson, P.E., Principal



GEOTECHNICAL INVESTIGATION

JVWCD Southwest Aqueduct Reach 2

Salt Lake County, Utah

Prepared for:
Bowen Collins & Associates

June 2024

RB&G ENGINEERING, INC.

JVWCD SOUTHWEST AQUEDUCT REACH 2

Salt Lake County, Utah

Geotechnical Investigation

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JVWCD SOUTHWEST AQUEDUCT REACH 2

Salt Lake County, Utah

Geotechnical Investigation

1 INTRODUCTION

This report outlines the findings of a geotechnical investigation performed for the proposed Jordan Valley Water Conservancy District (JVWCD) project, located primarily in the city of Riverton, Salt Lake County, Utah. RB&G Engineering is serving as a geotechnical consultant to Bowen Collins & Associates, who has been retained by JVWCD for design of the project.

Figure 1 is a Vicinity Map showing the approximate location of the project relative to the surrounding area. The primary purpose of this investigation was to evaluate the characteristics of the subsurface soils throughout the alignment to provide geotechnical information for pipeline design.

1.1 PROJECT DESCRIPTION

The project will include the installation of approximately 10,500 feet of 66-inch diameter welded steel pipeline within existing JVWCD easements along 3200 West Street between approximately 13400 South and 11800 South Streets. The project location and vicinity are shown on Figure 1. Figures 2a through 2f show the approximate locations of borings completed for the project.

2 GEOLOGICAL AND EXISTING CONDITIONS

2.1 REGIONAL GEOLOGY

The Wasatch Front consists of a series of down dropped valleys which extend from Utah Valley to the south through the Salt Lake Valley, Davis, Ogden and Weber Counties to the north. The Salt Lake Valley is a large sediment filled basin bounded by the Traverse Mountains to the north, the Oquirrh Mountains to the west, and the abruptly climbing Wasatch Mountains to the east. The valley is the result of Basin and Range extensional faulting associated with the Salt Lake City segment of the Wasatch Fault Zone, which trends predominately north-south near the base of the

Wasatch Mountains. The Wasatch Fault is classified as a normal, down to the west, fault. The valley floor contains thousands of feet of alluvium and lacustrine (lake-bottom) soil deposits.

During the Pleistocene (23,000 to 11,000 years ago), the climate became much colder and wetter compared to recent historical conditions. Glaciation was common at high altitudes, while lower altitudes experienced more rain. During this time, Lake Bonneville (the largest of the Pleistocene lakes) began spreading over much of northern and central Utah and extended into several valleys of southeastern Idaho. The lake experienced several cycles of regression and transgression during a 3,500-year period before reaching an elevation of about 5,090 feet (msl) and breaching into the Snake River Plain near Zenda, Idaho (Bonneville Phase). The lake stabilized at the Red Rock Pass threshold at an elevation of approximately 4,740 feet (Provo Phase) about 14,500 years ago. During Lake Bonneville times, thousands of feet of clay, silt, sand and gravel were deposited within the valleys along the Wasatch Front. Changes to a drier and warmer climate eventually resulted in the overall regression of the lake to the modern-day levels of the Great Salt Lake and Utah Lake.¹

2.2 GEOLOGY OF PROJECT AREA

A geologic map of the project area is shown on Figure 3.² It will be noted from Figure 3 that the surficial soils throughout the entirety of the project area have been mapped as fine-grained lacustrine deposits (Qlf). This map unit is described as consisting primarily of soils such as laminated silt, clayey silt, and sandy silt with isolated pebbles, cobbles, and thin lenses of sand and gravel. The exposed thickness of these surface deposits identified by geologic studies is in the range of 1 to 40 feet.

2.3 GEOLOGIC HAZARDS

Based upon geologic mapping of the project area, the water pipeline alignment does not cross known faults. The project alignment is located about 6.6 miles to the west of the mapped surface expression of the Wasatch fault zone (WFZ). The West Valley fault zone is located about 8 miles north of the project. The Oquirrh fault zone is about 12 miles to the west of the project area. Geologic hazards applicable to the project include ground shaking, subsidence, and liquefaction during a seismic event on the Wasatch fault zone or other fault systems in the vicinity. Seismic hazards are discussed in further detail in the next section of this report.

¹ *Major Levels of Great Salt Lake and Lake Bonneville*, Utah Geological Survey Map 73, by D.R. Currey, G. Atwood, and D.R. Mabey, April 1984.

² *Geologic Map of the Midvale Quadrangle, Salt Lake County, Utah*, Utah Geological Survey Map 177, by F.D. Davis, 2000.

2.4 FAULTING AND SEISMICITY

Ground shaking, subsidence, and liquefaction are among potential seismic hazards that apply to the project area and much of the Salt Lake Valley. The potential for the project to be affected by surface rupture associated with a mapped fault is low.

The WFZ is characterized as an active normal fault with down to the west displacement. The Salt Lake Section section of the WFZ can generate earthquake magnitudes in the order of 7.2, however, a simultaneous rupture of multiple segments of the WFZ could theoretically produce an earthquake with a magnitude of 7.5.

Earthquake considerations applicable to the project, including site class and mapped ground acceleration values, are discussed in Section 5.3 of this report.

2.5 EXISTING SITE CONDITIONS

The project alignment follows 3200 West Street from south to north. The natural topography of the project area is relatively flat, with an overall ground slope averaging between 1 and 2 percent down to the east. The existing ground surface profile along 3200 West is relatively level south of 12600 South and north of 12100 South, with about 20 feet of fall traveling north over the approximately ½-mile distance between 12600 and 12100 South.

The proposed pipeline would be located beneath the 3200 West asphalt-paved roadway for much of its length, except for an unpaved stretch where 3200 West is interrupted between Thorngrove Circle (approx. 12500 South) and Emery Forest Lane (12330 South). Land use along 3200 West is mostly residential. In general, the pavements in the area are in fair to good condition with evidence of longitudinal, transverse, and localized areas of alligator cracks, many of which have been sealed. There is a section between 13400 South and Coupe Deville Lane / Blue Heeler Way (13220 South) that has newer asphalt with no visible cracks.

Most of the section of the alignment between Thorngrove Circle and Emery Forest Lane is on land owned by the Salt Lake County Water Conservancy District. From Thorngrove Circle to 12600 South the alignment is unpaved and includes a small park landscaped with grass on the south end followed by a gravel strip running along the east side of a car wash, with boulders placed throughout the gravel strip. From 12600 South to just north of Elmwood Drive the alignment is located within the fenced Bureau of Reclamation easement. This easement has an asphalt paved trail running most of its length, with grass on either side of the trail. Between Elmwood Drive and Emery Forest Lane the alignment passes through a residential property that is landscaped with grass and trees.

A trenchless crossing is anticipated where the alignment crosses 12600 South, and where the alignment crosses under an existing JVWCD water line near 12075 South.

3 GEOTECHNICAL EXPLORATION METHODS

3.1 SUBSURFACE EXPLORATIONS

Geotechnical borings were planned for 16 locations along the proposed pipeline alignment to evaluate the subsurface soil and water conditions. Our client subsequently determined that Boring 12 would not be necessary, so this boring number was not used. The boring locations are shown on Figure 2 and logs depicting conditions encountered and interpreted from the borings are included in the appendix. Each of the boring numbers includes the prefix “24-BH” to indicate that the borehole was completed in the year 2024. This prefix is generally omitted from the discussion that follows.

The geotechnical borings for the project were performed using CME 55 rotary drill rigs, with a tri-cone rock bit and NW casing or and HQ casing advancer system used to advance the borings. Water was used as the drilling fluid. During the subsurface exploration, sampling was generally conducted at 3-foot depth intervals in the upper 21 feet and at 5-foot intervals at greater depths. Both disturbed and undisturbed samples were obtained during the field explorations. The boring logs are included in the appendix to this report.

Disturbed samples were obtained by driving a 2-inch or 2.5-inch (O.D.) split spoon sampling tube through a distance of 18 inches using a 140-pound weight dropped from a distance of 30 inches. NWJ drill rods were used during the drilling and sampling. The hammers used for sampling are tested annually as outlined in ASTM D 4633. Based on the most recent of these tests, the ratio of actual energy delivered to the theoretical maximum energy of a 140-pound weight after a 30-inch free fall averages 0.76 for the automatic trip hammer on the 08-CME-55 drill rig and 0.87 for the hammer on the 20-CME-55 drill rig.

The number of hammer blows required to drive the sampling spoon through each 6-inch increment of penetration is shown on the boring logs. The sum of the last two blow counts, which represents the number of blows recorded while driving the sampling spoon through 12 inches, is defined as the penetration value, N . Sampler refusal (more than about 50 blows required to drive through a 6-inch interval) was encountered at some depths, in which case the number of blows corresponding to the observed penetration is shown on the boring log.

Penetration values corrected for overburden and hammer energy provide a good indication of the in-place density of sandy soil; however, they only provide an indication of the relative stiffness of cohesive soil, since the penetration resistance of soil of this type is a function of moisture content. Corrections applied to the blow counts recorded in the field to calculate the corrected standard penetration (N_1)₆₀ values shown on the boring logs were as follows:

- Sampler size correction for 2.5-inch OD sampler (where applicable): multiply by 0.938.
- Hammer energy correction from 76% or 87% average measured hammer energy ratio to 60% standard energy ratio: multiply by 1.27 and 1.45, respectively.

- Overburden correction: multiply by $C_N = (P_a / \sigma'_v)^{0.5} \leq 1.7$

where: P_a = atmospheric pressure, approximated as 2,000 psf,

σ'_v = effective vertical stress, calculated using assumed average total soil unit weights of 115 pcf above the water table and 120 pcf below the water table, and hydrostatic pore pressure calculated from the measured or estimated groundwater level.

The Standard Penetration Test (SPT) corrections listed above are basic corrections based on generalized interpretations and assumptions. More refined and/or additional corrections may be appropriate for specific design applications.

Considerable care must be exercised in interpreting the penetration value in gravelly-type soil, particularly where the size of the granular particles exceeds the inside diameter of the sampling spoon. If the spoon can be driven through the full 18 inches with reasonable sample recovery, the penetration value generally provides a good indication of the in-place density of gravelly-type soil.

Relatively undisturbed samples of intact soil were obtained within the borings by pushing thin walled (Shelby) sampling tubes into the subsurface soil using the hydraulic pressure on the drill rig. The tubes had nominal outside diameters of 2.75 inches and nominal wall thickness of 0.06 inch. The depths at which Shelby tube samples were obtained are identified on the boring logs.

Miniature vane shear tests, which provide an indication of the undrained shearing strength of cohesive soil, were performed during the field explorations. The results of these tests are shown on the boring logs as “torvane” values in units of tons per square foot.

Soil samples were classified visually in the field and reviewed in the laboratory according to the Unified Soil Classification System. A description of the Unified Soil Classification System is included in the appendix, and the symbols designating soil types according to this system are presented on the boring logs.

Piezometers for groundwater monitoring were installed to a depth of 30 feet in Borings 7, 8, 15, and 16. The piezometers consist of one-inch diameter PVC pipes, with a 10-ft slotted section (0.02-inch slot widths) between depths of 20 and 30 feet. The annular space around the slotted section of pipe was filled with 10/20 silica sand, and bentonite hole plug chips were used to fill the annulus above and below the sand filter zone. A riser-type cover was installed over the piezometer at Boring 7. Flush-mount covers were installed over the other three piezometers, which were located in areas of existing pavement. A slotted PVC pipe was also placed temporarily in Boring 9 after drilling to allow short-term monitoring of groundwater levels.

3.2 LABORATORY TESTING

Laboratory tests performed during this investigation to define the characteristics of the subsurface soils included in-place dry unit weight (ASTM D 7263), natural moisture content (ASTM D 2216),

Atterberg limits (ASTM D 4318), grain size analysis (ASTM C 117, C 136), unconfined compressive strength (ASTM D 2166), direct shear (ASTM D 3080) and one-dimensional consolidation (ASTM D 2435). Electrochemical testing, including soil pH, resistivity, and percentages of sulfates, chlorides, and soluble salts in the soil were also conducted on selected samples.

Grain size analysis and Atterberg limits were used to evaluate soil classification designations. Density and moisture content determinations were conducted to evaluate in-place conditions. Consolidation, unconfined compression, and direct shear tests were performed to assess soil compressibility and strength characteristics for design. The results of laboratory tests performed during this investigation are presented on the boring logs and summarized on tables and plots located in the appendix.

4 SUBSURFACE SOIL AND WATER CONDITIONS

The table below lists approximate ground surface elevations (from Google Earth), exploration depths, and groundwater levels for the test holes completed during this study. It should be understood that the elevations estimated from Google Earth are only approximate and will not typically be consistent with the survey datum nor the level of survey accuracy required for detailed design and construction of the project.

TABLE 1 SUMMARY OF TEST HOLES

| Test Hole Number | Approximate Ground Surface Elevation (ft) | Exploration Depth (ft) | Groundwater Measurements | | |
|------------------|---|------------------------|---------------------------|------------------------------------|------------------------------|
| | | | Depth to Groundwater (ft) | Approx. Groundwater Elevation (ft) | Water Level Measurement Date |
| 24-BH-01 | 4563 | 26.5 | Not Measured | N/A | 4/1/2024 |
| 24-BH-02 | 4560 | 22.5 | Dry | N/A | 4/1/2024 |
| 24-BH-03 | 4558 | 22.5 | Dry | N/A | 4/2/2024 |
| 24-BH-04 | 4561 | 22.5 | Dry | N/A | 4/2/2024 |
| 24-BH-05 | 4565 | 22.5 | Dry | N/A | 4/2/2024 |
| 24-BH-06 | 4567 | 22.5 | Dry | N/A | 4/1/2024 |
| 24-BH-07 | 4565 | 41.5 | 29.3* | 4536* | 5/23/2024 |
| 24-BH-08 | 4564 | 41.5 | Dry to 30.5' | N/A | 5/23/2024 |
| 24-BH-09 | 4559 | 22.5 | Dry to 21.4' | N/A | 5/23/2024 |
| 24-BH-10 | 4554 | 22.5 | Not Measured | N/A | 4/5/2024 |
| 24-BH-11 | 4552 | 22.5 | Not Measured | N/A | 4/5/2024 |
| 24-BH-13 | 4548 | 41 | Dry to 30' | N/A | 5/23/2024 |
| 24-BH-14 | 4548 | 41 | Dry to 30' | N/A | 5/23/2024 |
| 24-BH-15 | 4551 | 22.5 | Not Measured | N/A | 4/8/2024 |
| 24-BH-16 | 4554 | 22 | 15 | 4539 | 4/8/2024 |

*Water detected at bottom of 24-BH-07 appears to be wet soil, and not likely groundwater.

Borings were drilled in the existing 3200 West roadway, except for Borings 7, 8, and 9 which were located on the county water conservancy district property. The existing asphalt pavement thickness measured in the borings varied between 3 and 5 inches. The asphalt pavement was underlain by granular fill ranging from about 6 inches to 2 feet thick. The fill beneath the pavement classified

predominantly as silty sand with gravel (USCS symbol SM), and occasionally as silty gravel with sand (GM), gravel with silt and sand (GP-GM), clayey sand with gravel (SC), and sand with silt and gravel (SP-SM).

The shallow subgrade soils, whether beneath the pavement section or at the existing ground surface, classified as lean clay (CL) with varying amounts of sand in 14 of the 15 borings. Boring 13 was the outlier in this respect, with the subgrade consisting of silty sand (SM). The lean clay in the other 14 borings extended to depths of about 5 to 11 feet below the existing ground surface. Below the initial subgrade deposits, the borings encountered interbedded layers of lean clay (CL), silty clay (CL-ML), silt (ML, plastic and nonplastic), gravels (GM, GP-GM, GP, and GC), and sands (SM, SP-SM, and SC-SM). Dense sands and gravels are encountered more often with depth, especially below 20 feet. In general, cohesive soils (clays and silts) are more prevalent in the southern part of the alignment, and dense gravels tend to be encountered more frequently in the northern section of the alignment.

Properties of the native subgrade soils determined from field and laboratory testing are summarized briefly in the following subsections.

4.1 CLAY

Plasticity, gradation, and strength properties of the tested lean clay, sandy lean clay, lean clay with sand, and sandy silty clay (CL and CL-ML) samples obtained during the subsurface explorations are summarized below.

TABLE 2 PROPERTIES OF CLAY SAMPLES

| Soil Property | No. of Tests | Range | Average |
|---|--------------|--------------|---------|
| Dry Unit Weight (pcf) | 12 | 67.2 – 110.7 | 92.0 |
| Moisture Content (%) | 19 | 16.1 - 55.6 | 27.6 |
| Liquid Limit (%) | 19 | 23 - 48 | 33 |
| Plasticity Index (%) | 19 | 4 – 25 | 14 |
| Gravel Content (%) | 6 | 0 - 8 | 2 |
| Sand Content (%) | 6 | 22 - 44 | 30 |
| Silt/Clay Content (%) | 6 | 56 – 77 | 68 |
| Undrained Shear Strength from Torvane (psf) | 58 | 200 – 3560 | 1262 |
| Unconfined Compressive Strength (psf) | 8 | 361 – 3766 | 1895 |

One-dimensional consolidation testing was performed on seven relatively undisturbed samples of lean clay obtained from the project borings. The results of these tests indicate the cohesive soils along the alignment are moderately compressible at load intensities exceeding about 1 tsf. The consolidation test specimens were initially loaded to 0.5 tsf in their as-received moisture condition, after which each specimen was inundated and allowed to absorb moisture. None of the tested samples exhibited significant volume change upon wetting. This observation suggests the cohesive soils do not have notable potential for moisture sensitivity problems such as collapse or expansion.

4.2 SILT

Plasticity, gradation, and strength properties of the tested silt and silt with sand (ML) samples obtained during the subsurface explorations are summarized below.

TABLE 3 PROPERTIES OF SILT SAMPLES

| Soil Property | No. of Tests | Range | Average |
|---|--------------|-------------|---------|
| Dry Unit Weight (pcf) | 3 | 79.4 – 99.0 | 88.9 |
| Moisture Content (%) | 5 | 17.1 – 44.6 | 26.0 |
| Liquid Limit (%) | 3 | 22 – 44 | 29 |
| Plasticity Index (%) | 3 | 2 – 16 | 7 |
| Gravel Content (%) | 2 | 0 – 2 | 1 |
| Sand Content (%) | 2 | 38 – 50 | 44 |
| Silt/Clay Content (%) | 2 | 50 – 60 | 55 |
| Undrained Shear Strength from Torvane (psf) | 3 | 300 – 1020 | 773 |
| Unconfined Compressive Strength (psf) | 1 | 605 | 605 |

Direct shear testing was performed on three specimens of plastic silt with sand cut from the Shelby tube sample obtained at a depth of 15 feet in Boring 14. The test results indicated a friction angle of approximately 38 degrees with approximately 350 psf cohesion. We do not recommend using these test results for design, as they are unusually high for plastic silt and unlikely to be representative of in-place drained soil strengths for this material type.

4.3 SAND

The results of laboratory classification and strength tests performed on samples of sand with silt, sand with silt and gravel, clayey sand, clayey sand with gravel, silty clayey sand, silty sand, and silty sand with gravel (SP-SM, SC, SC-SM, and SM) are tabulated below.

TABLE 4 PROPERTIES OF SAND SAMPLES

| Soil Property | No. of Tests | Range | Average |
|-----------------------|--------------|---------|---------|
| Moisture Content (%) | 9 | 9 - 25 | 14.5 |
| Gravel Content (%) | 9 | 1 - 38 | 19 |
| Sand Content (%) | 9 | 39 – 67 | 49 |
| Silt/Clay Content (%) | 9 | 7 – 49 | 32 |

One SC-SM sample was identified as containing plastic fines. Atterberg limits testing of this sample indicates a liquid limit of 28 and a plasticity index of 7.

4.4 GRAVEL

USCS classifications of the predominantly gravelly soil types tested in the laboratory included gravel with silt and sand, and silty gravel with sand (GP-GM and GM). Tested properties of these samples included the following.

TABLE 5 PROPERTIES OF GRAVEL SAMPLES

| Soil Property | No. of Tests | Range | Average |
|-----------------------|--------------|-----------|---------|
| Moisture Content (%) | 2 | 6.7 - 9.4 | 8.1 |
| Gravel Content (%) | 2 | 48 - 49 | 49 |
| Sand Content (%) | 2 | 35 - 42 | 39 |
| Silt/Clay Content (%) | 2 | 10 - 16 | 13 |

4.5 CORROSION POTENTIAL AND CONTAMINANTS

Electrochemical properties were tested for nine samples. The results of these tests are summarized below.

TABLE 6 ELECTROCHEMICAL PROPERTIES TESTED SAMPLES

| Boring Number | Sample Depth (ft) | Soil Type | pH | Resistivity (ohm-cm) | Sulfates (ppm) | Chlorides (ppm) | Soluble Salts (%) |
|---------------|-------------------|-----------|-----|----------------------|----------------|-----------------|-------------------|
| 24-BH-01 | 6-7.5 | CL | 8.4 | 810 | 70 | 239 | 0.90 |
| 24-BH-04 | 3-4.5 | CL | 8.7 | 1100 | 27 | 177 | 2.28 |
| 24-BH-07 | 9-10.5 | SM | 8.0 | 1700 | 169 | < 12 | 0.40 |
| 24-BH-08 | 21-22.5 | CL | 8.5 | 1500 | 214 | 19 | 1.15 |
| 24-BH-13 | 6-7.5 | SM | 8.4 | 1400 | 40 | 45 | 0.65 |
| 24-BH-13 | 9-10.5 | CL | 8.0 | 1700 | 23 | 61 | 1.27 |
| 24-BH-14 | 12-13.5 | CL | 8.4 | 1200 | 15 | 82 | 2.71 |
| 24-BH-14 | 21-22.5 | GP-GM | 8.0 | 3800 | 13 | 16 | 0.47 |
| 24-BH-16 | 9-10.5 | CL | 8.2 | 510 | 78 | 916 | 1.39 |

The tested pH, resistivity values, and sulfate contents are typical of natural soils in the Salt Lake valley. The resistivity values are generally low and correspond to relatively aggressive potential for corrosion of steel placed in contact with the soil. The sample tested from Boring 16 had an elevated chlorides content, which further suggests potential for accelerated corrosion of metal infrastructure installed in the ground.

The tested water-soluble sulfate contents indicate a sulfate exposure class S0 in accordance with the American Concrete Institute Structural Concrete Building Code (ACI 318-14). No special concrete requirements are indicated by ACI 318-14 for soils in this category.

No visual evidence or odors indicative of contamination were observed in the samples obtained during this investigation.

5 ENGINEERING ANALYSIS & RECOMMENDATIONS

5.1 TRENCH CONSTRUCTION RECOMMENDATIONS

It is anticipated that the pipeline construction will be performed within open trenches, except for potential trenchless crossings of 12600 South between Borings 7 and 8 and a second, deeper

trenchless crossing beneath an existing pipeline near borings 13 and 14. Due to site constraints, it is anticipated that shoring will be required for excavations within or adjacent to existing roadway alignments.

5.1.1 EXCAVATION

Trench excavation should comply with OSHA safety standards. For un-shored excavations, the cohesive soils in the project area generally vary between OSHA Type A and B type soils, which can generally accommodate slopes of $\frac{3}{4}H:1V$ or $1H:1V$ (horizontal to vertical), respectively, for excavation slopes up to 20 feet deep.

Some softer cohesive soils, including most of the clay and silt in Boring 1 and selected clay layers identified as “soft” or “very soft” in Borings 14, 15, and 16, fall under OSHA Type C soils, as does much of the sandy and silty soil encountered in the upper 15 to 30 feet of the soil profile. OSHA allows excavations in Type C soils to be sloped as steep as $1.5H:1V$ in excavations as deep as 20 feet. Excavations deeper than about 5 feet will often be in a Type A or Type B over Type C scenario, which will generally limit slopes in un-shored excavations to be no steeper than $1.5H:1V$.

It should be noted that OSHA requires daily inspections of excavations by a competent person as well as inspections prior to the start of work, as needed throughout the shift, after every rainstorm, and after other hazard increasing occurrences (OSHA 1926.651(k)(1)). The competent person is responsible for classifying soil and rock deposits in accordance with OSHA 1926 Subpart P Appendix A.

Shoring for the project should be designed by an experienced engineer licensed in the State of Utah. Shoring design is typically performed by an engineer working for the contractor selected to construct the project. This approach allows the shoring design to utilize materials and equipment readily available to the contractor. It is recommended that the shoring design be reviewed by an experienced engineer on behalf of the Owner prior to installation. Lateral earth pressures that may be considered for shoring design are discussed in Section 5.2 of this report.

5.1.2 DEWATERING

Groundwater, and indications thereof, were not encountered within 30 feet of the existing ground surface. Dewatering on a significant scale is not likely to be necessary for the project; however, it is possible that some collection and removal of water perched on clayey soil layers will be required.

5.1.3 BACKFILL

The trench for the proposed pipeline will be excavated beneath the existing roadway. Lean clay and sandy soils obtained from the project excavations and used as backfill can adequately support

the roadway provided the fill soil is properly moisture conditioned, placed, and compacted. We recommend that soil used to backfill the trenches be moisture conditioned to within 2% of the optimum moisture content as determined by ASTM D 698 (standard proctor), the backfill be placed in loose lifts not exceeding 12 inches, and the soil be compacted to an in-place unit weight equal to at least 95% of the maximum laboratory density determined by ASTM D 698. We recommend the trench backfill be compacted to at least 92% of the maximum laboratory density in open areas where structures or pavement will not be constructed.

Unfortunately, the in-place moisture content of much of the existing cohesive soil within the likely excavation zone is significantly greater than the optimum moisture content. Moisture conditioning these soils will require drying the soil to within 2% of the optimum moisture content. Moisture conditioning could be accomplished by spreading the soil and allowing it to dry to near optimum moisture content, or by using lime or other additives to absorb the excess moisture. Alternatively, the trenches could be backfilled with imported granular fill to facilitate moisture-conditioning and compaction.

If imported soil is used as trench backfill above the pipe zone, it is recommended that this soil be granular with less than 30% fines. We recommend the backfill have a maximum size of 3 inches and less than 30% retained on the ¾ inch sieve. The fraction finer than a No. 40 sieve should have a plasticity index less than 6. Granular fill placed in locations where structures or pavement will be constructed should be compacted to at least 95% of ASTM D1557. We recommend that granular fill be compacted to at least 92% of ASTM D1557 at locations where structures or pavement will not be constructed.

We recommend that bedding and backfill within the pipe zone comply with the more stringent of APWA and JWCD standards. Construction of the pavement sections at the top of the trenches, including subbase, base, and pavement materials, should meet the more stringent of APWA or Riverton City standards. Utah Department of Transportation standards should be met for any work that may impact state routes or other UDOT facilities.

5.2 LATERAL EARTH PRESSURES

The following equation can be used to compute lateral earth pressures:

$$P = \frac{1}{2} \gamma K H^2$$

Where

- P = total lateral force on wall, plf
- K = earth pressure coefficient
- γ = unit weight of soil (125 pcf)
- H = height of retained soil against wall

The earth pressure coefficient used in designing earth retaining structures for the project will depend upon the amount of shear resistance mobilized within the retained soil. Active lateral earth pressures can typically be assumed in design of retaining systems that are relatively flexible and can deflect at least 0.2 percent of the wall height at the top of the wall. For the native soils at this project site, we recommend an active earth pressure coefficient of 0.42 be used to calculate the lateral earth pressures. If the project includes flexible retaining systems that will only retain granular compacted fill, an active earth pressure coefficient of 0.30 can be used for design.

If earth retaining structures are rigid and/or restrained such that deflections will be less than 0.2 percent of the wall height during backfilling, and the backfill is granular soil, we recommend an at-rest earth pressure coefficient of 0.50 be used to calculate the lateral earth pressure. This condition may be appropriate for the design of manholes or other rigid structures that will be backfilled with granular soil.

If passive earth pressure will be relied upon to restrain lateral movement, we recommend a coefficient of 2.4 be used for the native soils at the site. The passive earth pressure coefficient can be increased to 3.3 if granular compacted backfill is used to restrain lateral movement.

The resultant earth pressure force for the conditions described above can be assumed to act horizontally at a vertical distance above the base of the wall equal to 1/3 of the height of the retained or resisting soil mass.

If seismic design is required for project retaining structures, the additional active earth pressure due to the Maximum Considered Earthquake (MCE) may be estimated using a coefficient of 0.29 or 0.22 for native soils or granular backfill respectively. The seismic ground motion will also reduce the available passive resistance. This reduction may be accounted for as an earth pressure acting in the direction opposite the passive resistance and computed using a coefficient of 0.6. The pressure diagrams for these incremental seismic forces may be roughly approximated as inverted triangles, such that the resultant forces of the seismic components act at heights of approximately $2H/3$ above the base of the wall.

All of the above recommendations assume the surface of the soil retained behind the structure or shoring is essentially horizontal (i.e., no backslope). It should also be recognized that the pressures calculated by the above equation are earth pressures only and do not include hydrostatic pressures. Where hydrostatic pressures may exist behind a retaining structure, we recommend either the wall be designed to resist hydrostatic pressure, or that a drainage system be placed behind the wall to prevent the development of hydrostatic pressures.

5.3 SEISMIC CONSIDERATIONS

Based upon conditions encountered in the project borings and our experience in the project vicinity, which includes borings and shear wave velocity testing to depths of 100 feet, the site can be classified as Site Class D for seismic design in accordance with ASCE 7.

Mapped probabilistic peak ground acceleration (PGA) values and spectral acceleration (SA) values for periods of 0.2 and 1.0 second have been calculated for the intersection of 12600 S and 3200 W (latitude 40.5224, longitude -111.9672) using the USGS U.S. Seismic Design Maps with the ASCE 7-22 design standard. The seismic design parameters are tabulated below.

**TABLE 7 SITE CLASS D DESIGN AND
MCE GROUND MOTION VALUES**

| Period | Design | MCE |
|-------------|--------------|---------------|
| PGA (0 sec) | n/a | 0.60 g (PGAM) |
| 0.2 sec SA | 0.97 g (SDS) | 1.45 g (SMS) |
| 1.0 sec SA | 0.70 g (SD1) | 1.05 g (SM1) |

We do not anticipate at this time that seismic design will be a significant aspect of the project. However, we can provide more detailed geotechnical/seismic recommendations for use with ASCE 7-16 or ASCE7-22 if needed.

5.3.1 MITIGATION OF SEISMIC HAZARDS

The potential for liquefaction of loose to medium-dense sand and silt deposits is very low, since the water table is more than 30 feet below the ground surface. No known active faults are mapped near enough to the proposed pipeline to pose major or unique hazards in terms of fault surface rupture or subsidence. No special design provisions or mitigation of liquefaction or lateral spread hazards are recommended for the project.

5.4 OTHER DESIGN AND CONSTRUCTION CONSIDERATIONS

While Type I or Type II cement is acceptable, it is recommended that Type II or Type V cement be used for concrete in contact with the native soils due to its increased resistance to sulfate attack.

Soils at the bottoms of excavations may be too soft to provide an adequate working surface in some areas. Stabilization methods will depend upon conditions encountered. Moderately soft areas may be stabilized by over-excavating to a depth of about twelve inches, placing a 4-ounce non-woven geotextile separation fabric and a geogrid (or alternatively a higher-strength woven geotextile, and backfilling with well-graded sandy gravel fill compacted to least 90% of the maximum laboratory density determined using ASTM D 1557. Very soft areas may be stabilized by pressing 3” to 8” angular to sub-angular cobble rock or broken concrete into the subgrade in

lifts no thicker than 12 inches at a time. If the subgrade is not stable after pressing in two 12-inch lifts of cobbles or broken concrete, we recommend the subgrade be left undisturbed for 24 to 48 hours to allow soil pore water pressures to dissipate before attempting further stabilization. Where cobbles are used for subgrade stabilization, excess rock that cannot be tamped into the subgrade should be removed to avoid leaving voids between cobbles. If voids are left between cobbles, migration of soil particles into the voids over time could result in settlement of the pipeline, trench backfill, and surface elements such as pavements.

6 LIMITATIONS AND CLOSURE

The findings and recommendations presented in this report are the results of geotechnical explorations and analyses conducted for design of the project. It should be recognized that soil materials are inherently heterogeneous and that conditions may exist at the site which could not be defined during the explorations described herein.

If conditions are encountered during construction which differ from those presented in this report, it is requested that RB&G Engineering be informed in order that appropriate action may be taken.

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FIGURES

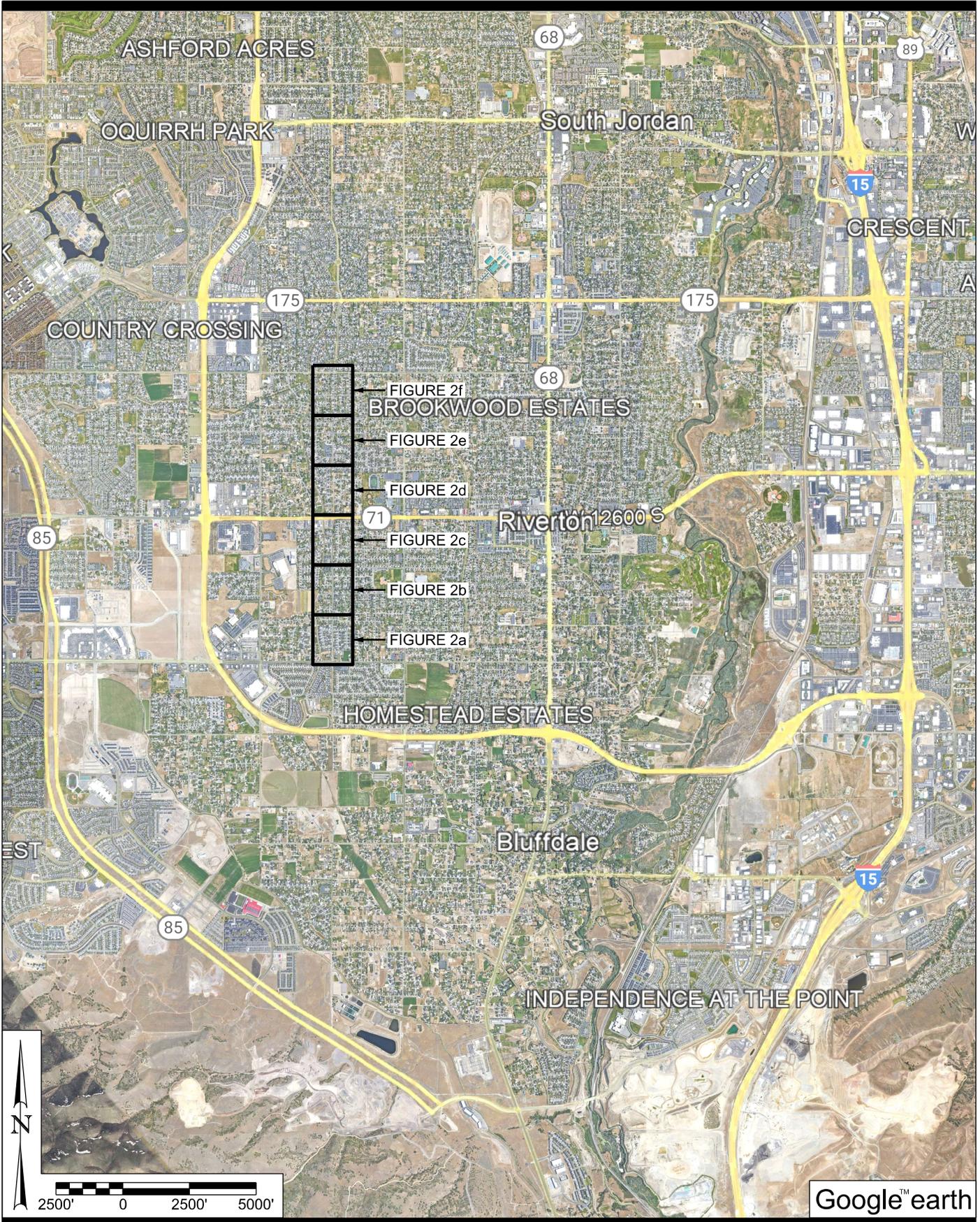


Figure 1 VICINITY MAP
 JWCD SW Aqueduct Reach 2
 Riverton, Salt Lake County, Utah

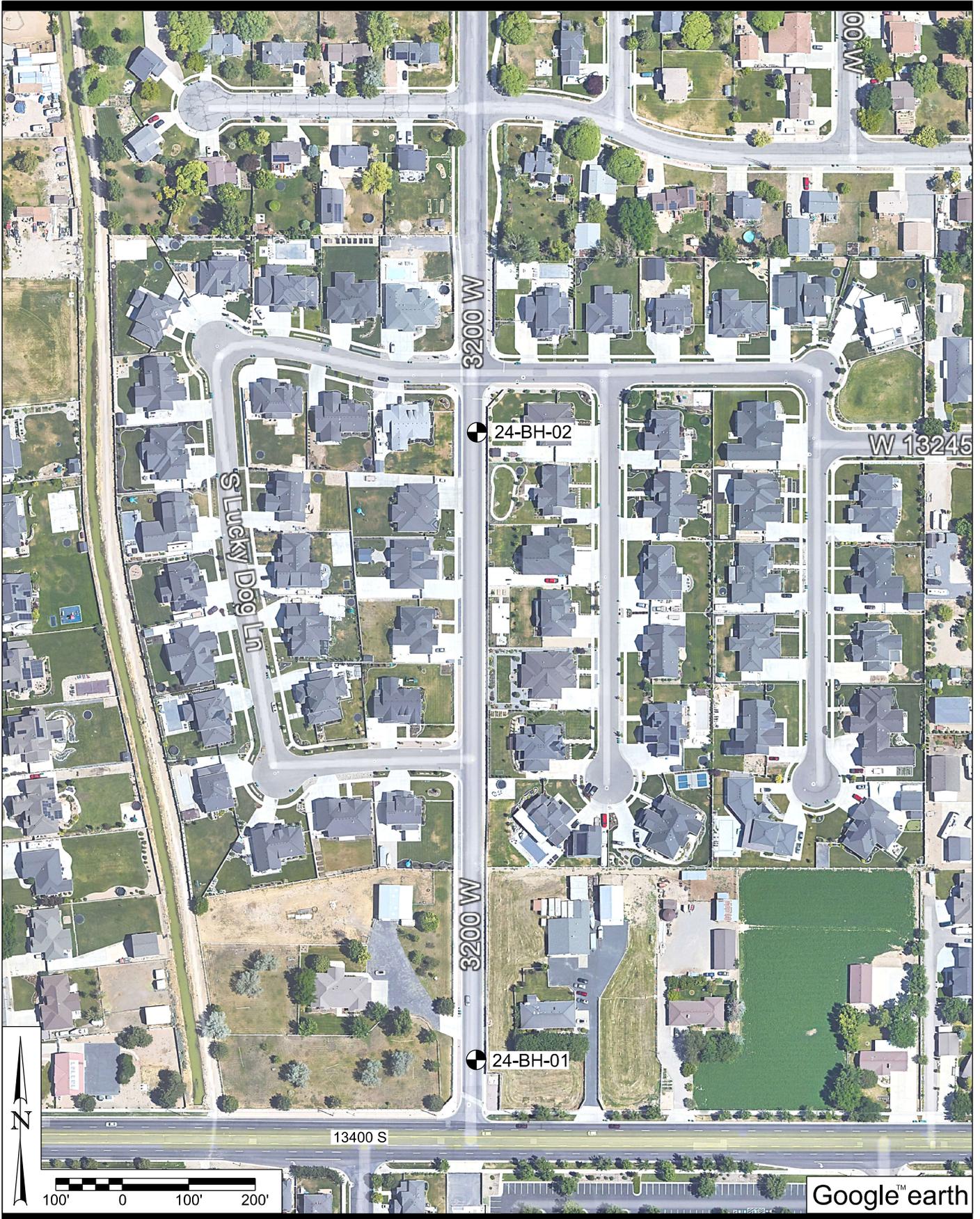


Figure 2a SITE PLAN & TEST HOLE LOCATIONS

JVWCD SW Aqueduct Reach 2
 Riverton, Salt Lake County, Utah

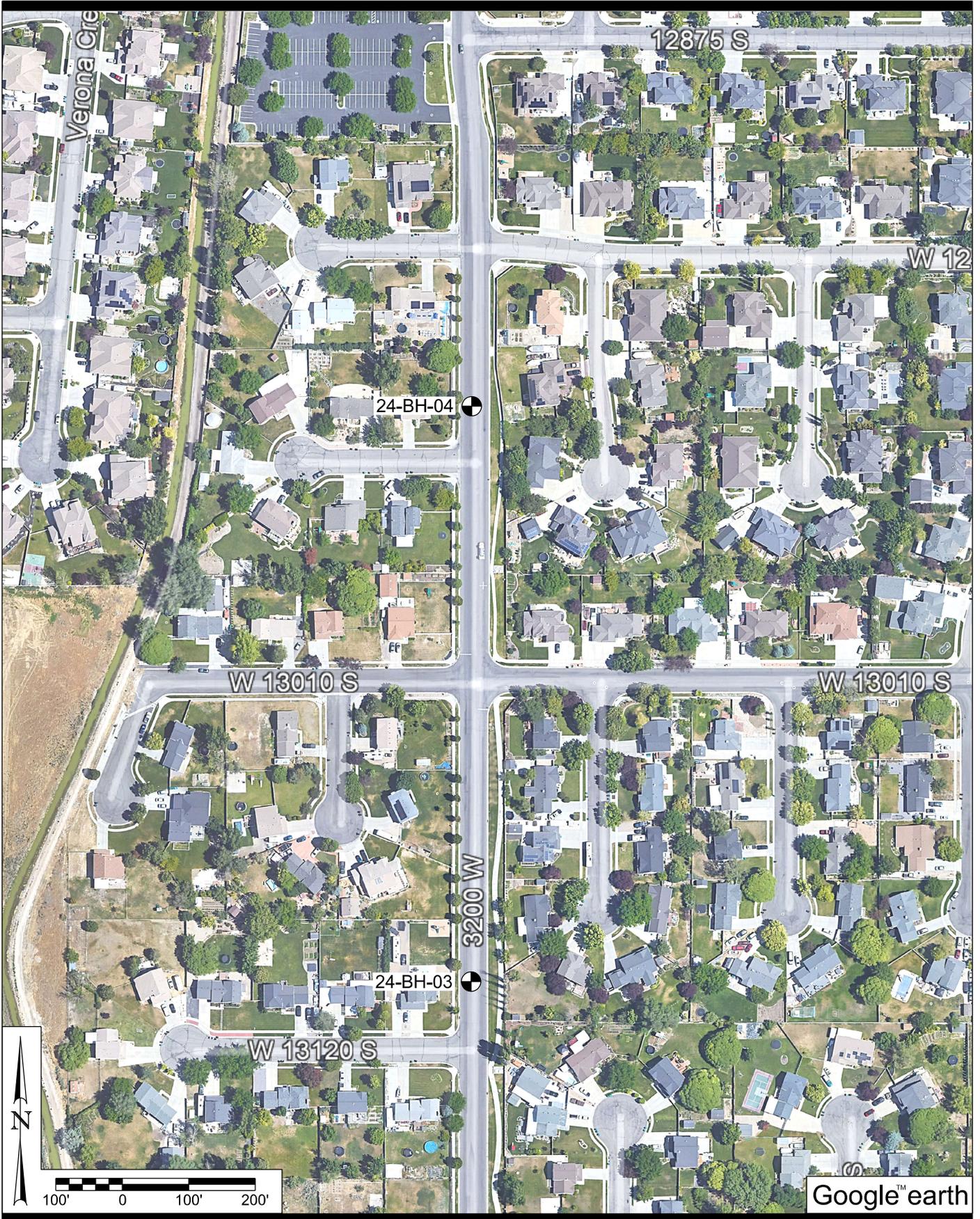


Figure 2b SITE PLAN & TEST HOLE LOCATIONS

*JVWCD SW Aqueduct Reach 2
 Riverton, Salt Lake County, Utah*

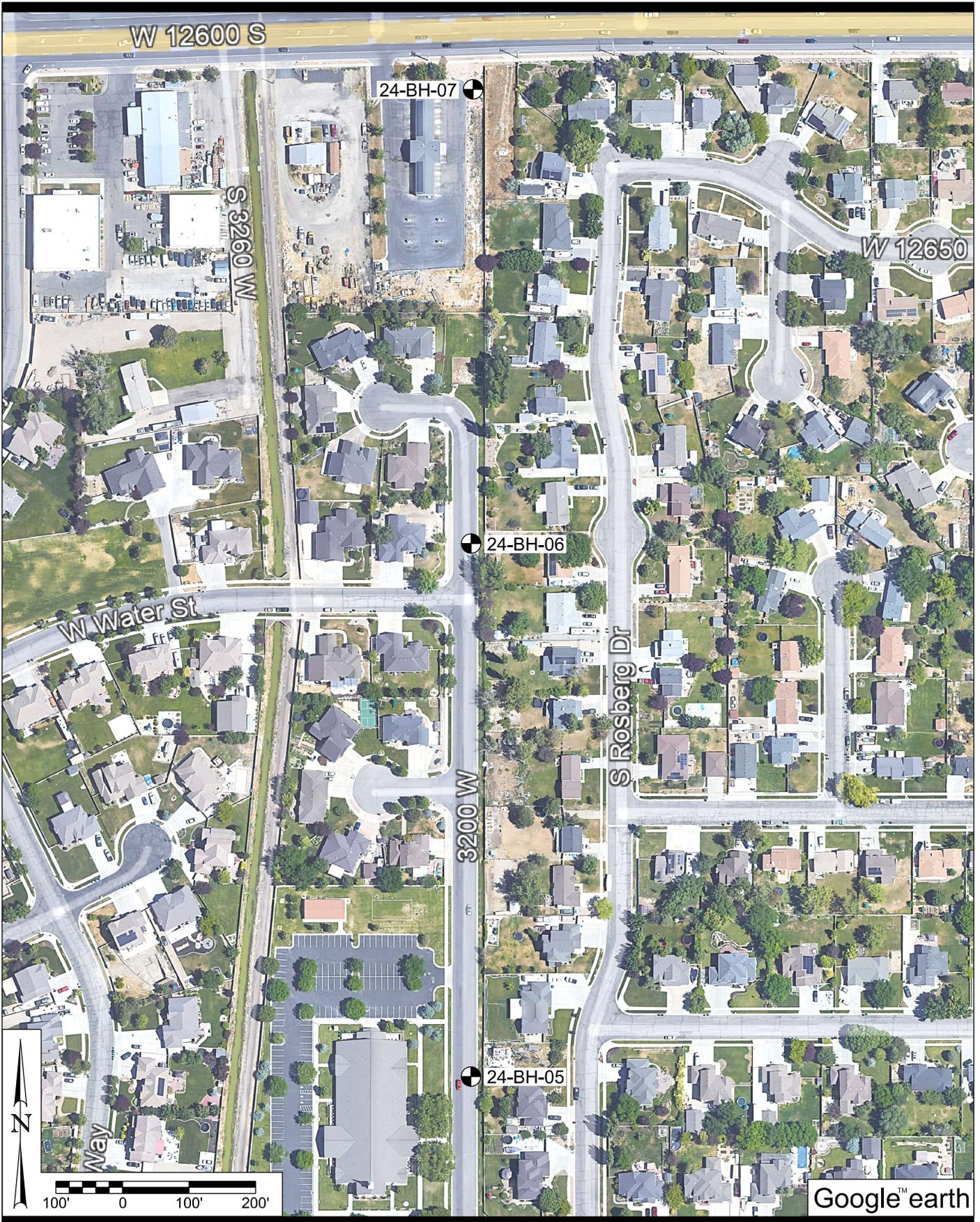


Figure 2c SITE PLAN & TEST HOLE LOCATIONS

JVWCD SW Aqueduct Reach 2
 Riverton, Salt Lake County, Utah



Figure 2d SITE PLAN & TEST HOLE LOCATIONS

*JVWCD SW Aqueduct Reach 2
 Riverton, Salt Lake County, Utah*

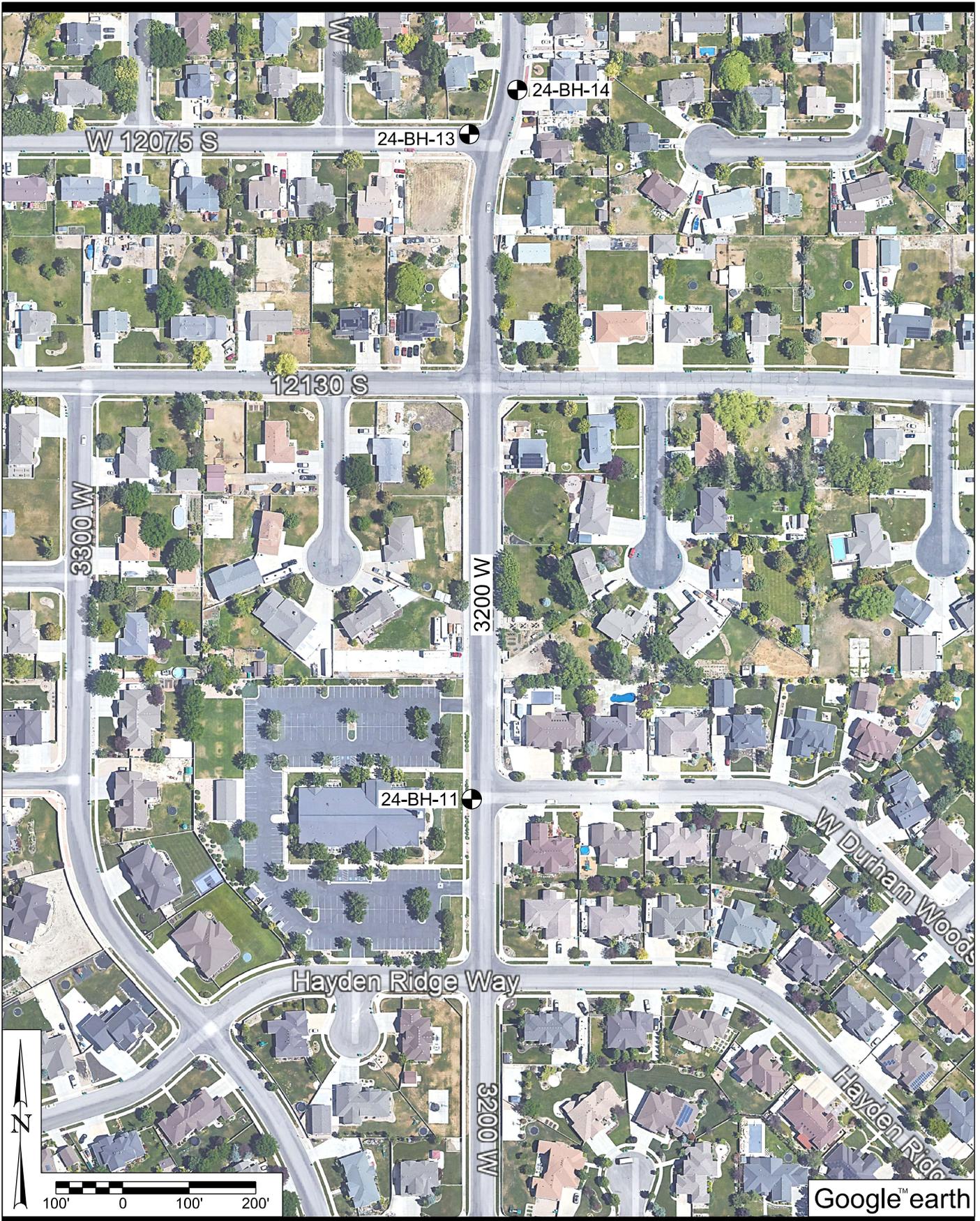
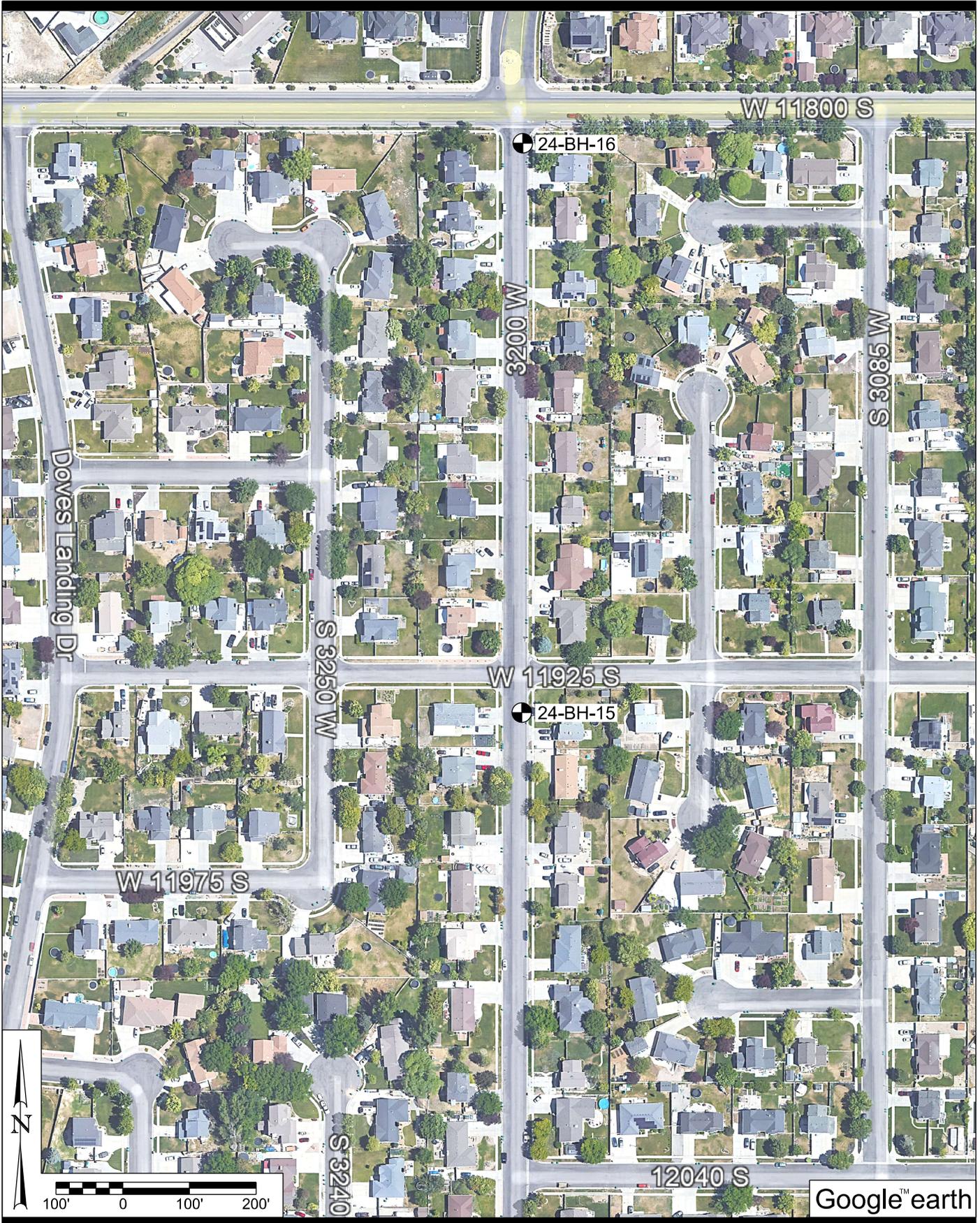


Figure 2e SITE PLAN & TEST HOLE LOCATIONS

*JVWCD SW Aqueduct Reach 2
Riverton, Salt Lake County, Utah*



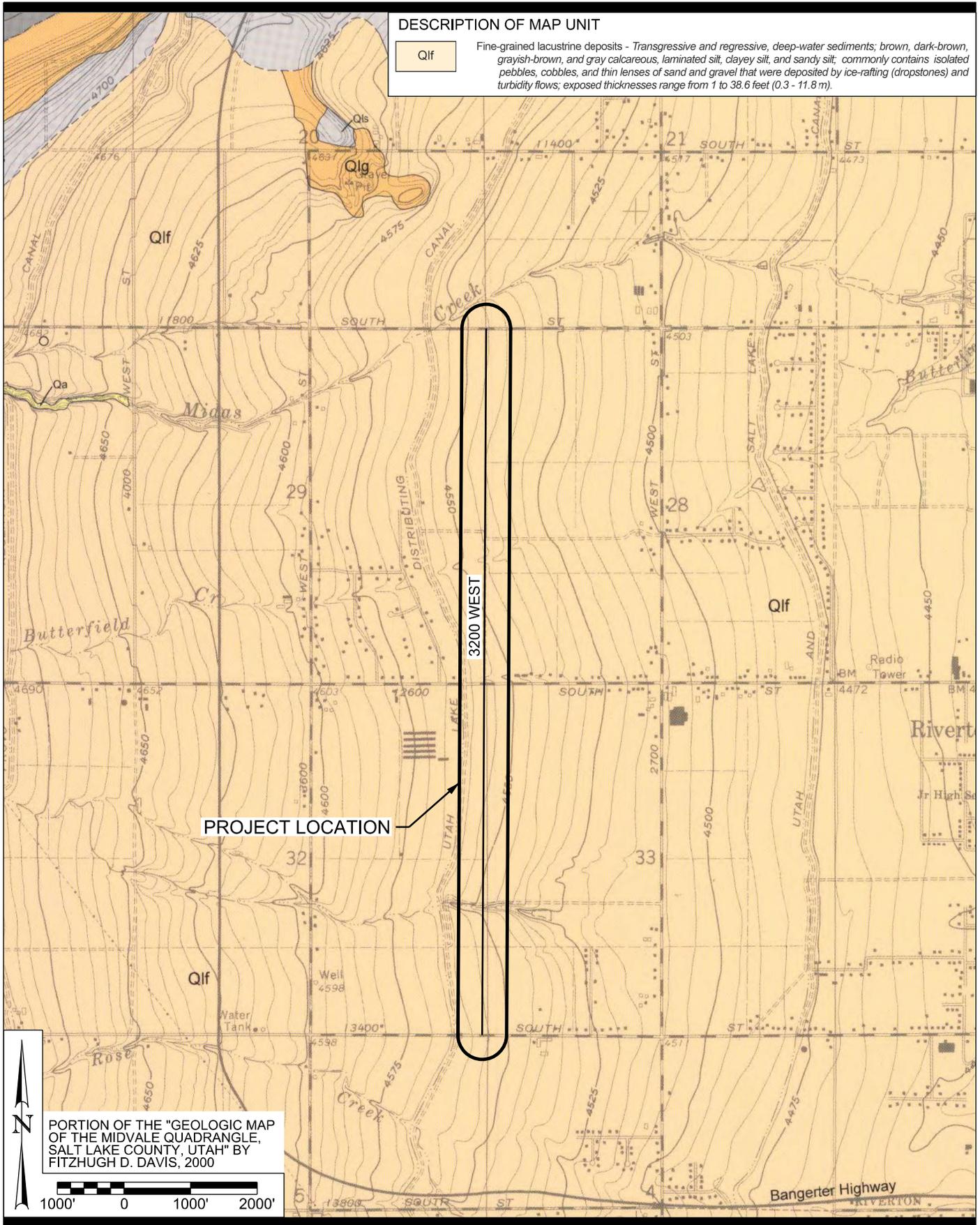
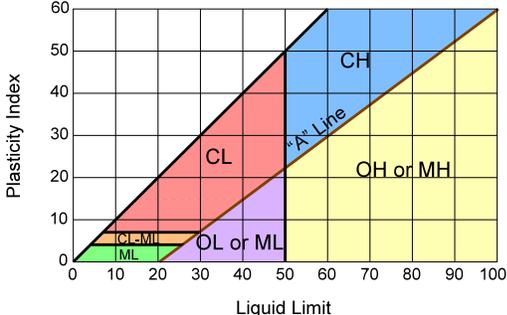


Figure 3 GEOLOGIC MAP & UNIT DESCRIPTION
 JWVCD SW Aqueduct Reach 2
 Riverton, Salt Lake County, Utah

APPENDIX

Unified Soil Classification System

| Major Divisions | | Group Symbols | Typical Names | Laboratory Classification Criteria | | | | |
|---|--|--|--|--|--|---|---|-------------------------|
| COARSE-GRAINED SOILS <i>more than half of material is larger than No. 200 sieve</i> | Gravels <i>more than half of coarse fraction is larger than No. 4 sieve size</i> | Clean Gravels <i>little or no fines</i> | GW Well graded gravels, gravel-sand mixtures, little or no fines | <i>For laboratory classification of coarse-grained soils</i> $C_u = \frac{D_{60}}{D_{10}}$ Greater than 4 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 | | | | |
| | | Gravels With Fines <i>appreciable amount of fines</i> | GP Poorly graded gravels, gravel-sand mixtures, little or no fines | | | GM* | d Silty gravels, poorly graded gravel-sand-silt mixtures | |
| | | | u | | | | | |
| | | GC Clayey gravels, poorly graded gravel-sand-clay mixtures | | | | | | |
| | Sands <i>more than half of coarse fraction is smaller than No. 4 sieve size</i> | Clean Sands <i>little or no fines</i> | SW Well graded sands, gravelly sands, little or no fines | <i>Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows:</i> Less than 5% GW, GP, SW, SP 5% to 12% Borderline cases requiring use of dual symbols** | <i>For laboratory classification of fine-grained soils</i> | | | |
| | | Sands with Fines <i>appreciable amount of fines</i> | SP Poorly graded sands, gravelly sands, little or no fines | | | SM* | d Silty sands, poorly graded sand-silt mixtures | |
| | | | u | | | | | |
| | | SC Clayey sands, poorly graded sand-clay mixtures | | | | | | |
| | | FINE-GRAINED SOILS <i>more than half of material is smaller than No. 200 sieve</i> | Silts and Clays <i>liquid limit is less than 50</i> | | | ML Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity |  | Plasticity Chart |
| | | | | | | CL Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays | | |
| OL Organic silts and organic silt-clays of low plasticity | | | | | | | | |
| Silts and Clays <i>liquid limit is greater than 50</i> | MH Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts | | | | | | | |
| | CH Inorganic clays of high plasticity, fat clays | | | | | | | |
| | OH Organic clays of medium to high plasticity, organic silts | | | | | | | |
| HIGHLY ORGANIC SOILS | Pt | Peat and other highly organic soils | | | | | | |

*Division of **GM** and **SM** groups into subdivisions of **d** and **u** for roads and airfields only. Subdivision is based on Atterberg limits; suffix **d** used when liquid limit is 28 or less and the PI is 6 or less, the suffix **u** used when liquid limit is greater than 28.

***Borderline classification*: Soils possessing characteristics of two groups are designated by combinations of group symbols. (For example **GW-GC**, well graded gravel-sand mixture with clay biner.)

DRILL HOLE LOG

BORING NO. 24-BH-01

PROJECT: JWCD SW AQUEDUCT REACH 2

SHEET 1 OF 1

CLIENT: BOWEN, COLLINS & ASSOCIATES

PROJECT NUMBER: 202301-040-23-01

LOCATION: APPROX. LAT: 40.50812° N, LONG: 111.96725° W

DATE STARTED: 4/1/24

DRILLING METHOD: 08-CME-55 / HQ CASING ADVANCER

DATE COMPLETED: 4/1/24

DRILLER: T.K., K.C.

GROUND ELEVATION: _____

DEPTH TO WATER - INITIAL: ▽ N.M.

AFTER 24 HOURS: ▼ N.M.

LOGGED BY: M.S.H., J.B.

| Elev. (ft) | Depth (ft) | Lithology | Sample | | Material Description | Dry Density (pcf) | Moisture Content (%) | Atter. | | Gradation | | | Other Tests |
|------------|------------|-----------|--------|------------------------|----------------------|--|---|--------------|--------------|------------|----------|---------------|------------------------|
| | | | Type | See Legend | | | | Liquid Limit | Plast. Index | Gravel (%) | Sand (%) | Silt/Clay (%) | |
| | | | 15 | 12,8,7,(33) T 1.31 | GP-GM CL | lt. brown, moist, med. dense brown, moist, very stiff | 3" ASPHALT GRAVEL W/SILT & SAND (fill) | | | | | | |
| | | | 12 | 0/18", (0) T < 0.10 | CL | brown, wet, very soft | LEAN CLAY | | | | | | |
| | 5 | | 16 | Pushed T 0.15 | CL | brown, wet, very soft to firm | | 74.4 | 42.4 | 32 | 10 | | CT UC 361 psf |
| | | | 11 | 1,2,2,(9) T 0.35 | CL | brown, wet, firm | LEAN CLAY W/SAND | | | | | | Chem. |
| | 10 | | 13 | T 0.15 1,2,2,(7) | CL SC | brown, very moist, soft brown, wet, loose | CLAYEY SAND | | | | | | |
| | | | 12 | Pushed T 0.15 | ML | brown, wet, soft | SANDY SILT plastic | 88.3 | 22.4 | 22 | 2 | | UC 605 psf |
| | 15 | | 13 | 3,2,3,(7) | CL | brown, very moist, soft | SANDY LEAN CLAY | | | | | | |
| | | | 12 | 4,4,12,(23) | SC-SM | brown, wet, med. dense | SILTY CLAYEY SAND | | | | | | |
| | 20 | | 14 | 3,4,5,(12) | SC-SM | brown, wet, med. dense | | 25.0 | 28 | 7 | 3 | 51 | 46 |
| | | | 15 | Pushed T 0.10 | SC-SM CL | brown, wet brown, wet, very soft | SILTY CLAYEY SAND W/GRAVEL SANDY LEAN CLAY | | | | | | |
| | 25 | | 12 | 9,13,20,(37) | SM | brown, wet, dense | SILTY SAND W/GRAVEL | | | | | | |
| | | | | | | | BOTTOM OF HOLE | | | | | | |

DH LOG V8-2014-1 JWCD SW AQUEDUCT.GPJ US EVAL.GDT 6/4/24

LEGEND:

- 2" OD Split Spoon (SPT) Split Spoon Sample
- 2.5" OD Split Spoon
- 3" OD Split Spoon

Thin-Walled Tube Sample

- Blow Count per 6" (N₆₀) Value
- Torque Value (tsf)
- Pocket Penetrometer (tsf) With Liners
- Pushed Torque Value (tsf)
- Pocket Penetrometer (tsf)

OTHER TESTS

- UC = Unconfined Compression
- CT = Consolidation
- DS = Direct Shear
- UU = Unconsolidated, Undrained
- CU = Consolidated, Undrained
- Chem. = pH, Resistivity, Sulfate, Chloride, Soluble Salts
- Hyd. = Hydrometer
- DC = Dispersive Clay

RB&G
ENGINEERING, INC.

DRILL HOLE LOG

BORING NO. 24-BH-03

PROJECT: JWCD SW AQUEDUCT REACH 2

SHEET 1 OF 1

CLIENT: BOWEN, COLLINS & ASSOCIATES

PROJECT NUMBER: 202301-040-23-01

LOCATION: APPROX. LAT: 40.51341° N, LONG: 111.96728° W

DATE STARTED: 4/2/24

DRILLING METHOD: 20-CME-55 / NW CASING TO 20'

DATE COMPLETED: 4/2/24

DRILLER: S.W., J.H.

GROUND ELEVATION: _____

DEPTH TO WATER - INITIAL: ▽ DRY' AFTER 24 HOURS: ▼ N.M.

LOGGED BY: T.D., J.B.

| Elev. (ft) | Depth (ft) | Lithology | Sample | | | Material Description | Dry Density (pcf) | Moisture Content (%) | Atter. | | Gradation | | | Other Tests |
|------------|------------|-----------|--------|-----------------------|-------------|---|-------------------|----------------------|---------------|--------------|--------------|------------|----------|--------------|
| | | | Type | Rec. (in) | See Legend | | | | USCS (AASHTO) | Liquid Limit | Plast. Index | Gravel (%) | Sand (%) | |
| | | | 18 | 8,6,16,(49) T 1.78 | SP-SM CL | 3" ASPHALT SAND W/SILT & GRAVEL (fill) brown, moist, med. dense dk. brown, moist, very stiff SANDY LEAN CLAY | | | | | | | | |
| | 5 | | 12 | 2,3,7,(24) T 1.63 | CL | LEAN CLAY W/SAND dk. brown, very moist, very stiff | | | | | | | | |
| | | | 12 | Pushed T 0.50 | CL | gray, wet, firm | 72.1 | 55.6 | 45 | 20 | | | | UC 1,362 psf |
| | 10 | | 16 | 1,3,3,(11) T 0.51 | ML | SILT W/SAND plastic gray-brown, very moist, stiff | | | | | | | | |
| | | | 7 | 2,4,3,(11) T 0.62 | CL | LEAN CLAY W/SAND brown, moist, stiff | | | | | | | | |
| | 15 | | 1 | Pushed | CL | SANDY LEAN CLAY W/GRAVEL brown, moist | | | | | | | | |
| | | | 10 | 16,20,19,(55) | GP-GM | GRAVEL W/SILT & SAND possible cobbles brown, very moist, dense | | | | | | | | |
| | 20 | | 12 | 4,5,7,(15) T 1.00 | CL | SANDY LEAN CLAY trace gravels brown, moist, stiff | | 22.6 | 37 | 21 | | | | |
| | | | 17 | 0/12",3,(4) T 0.50 | CL | SANDY LEAN CLAY brown, moist, firm | | | | | | | | |
| | | | | | | BOTTOM OF HOLE | | | | | | | | |

DH LOG-V8-2014-1 JWCD SW AQUEDUCT.GPJ US EVAL.GDT 6/4/24

LEGEND:

-  2" OD Split Spoon (SPT) Split Spoon Sample
-  2.5" OD Split Spoon
-  3" OD Split Spoon

-  Thin-Walled Tube Sample

- Blow Count per 6" (N₆₀) Value
- 2,3,2,(6) ← Torvane (tsf)
- T 0.45 ← Pocket Penetrometer (tsf) With Liners
- PP 2.0 ←
- Pushed T 0.45 ← Torvane (tsf)
- PP 2.0 ← Pocket Penetrometer (tsf)

OTHER TESTS

- UC = Unconfined Compression
- CT = Consolidation
- DS = Direct Shear
- UU = Unconsolidated, Undrained
- CU = Consolidated, Undrained
- Chem. = pH, Resistivity, Sulfate, Chloride, Soluble Salts
- Hyd. = Hydrometer
- DC = Dispersive Clay



DRILL HOLE LOG

BORING NO. 24-BH-05

PROJECT: JWCD SW AQUEDUCT REACH 2

SHEET 1 OF 1

CLIENT: BOWEN, COLLINS & ASSOCIATES

PROJECT NUMBER: 202301-040-23-01

LOCATION: APPROX. LAT: 40.51800° N, LONG: 111.96728° W

DATE STARTED: 4/1/24

DRILLING METHOD: 20-CME-55 / NW CASING TO 20'

DATE COMPLETED: 4/2/24

DRILLER: S.W., MAX H., J.H.

GROUND ELEVATION: _____

DEPTH TO WATER - INITIAL: ▽ DRY' AFTER 24 HOURS: ▼ N.M.

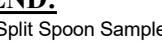
LOGGED BY: C.P., T.D., J.B.

| Elev. (ft) | Depth (ft) | Lithology | Sample | | | Material Description | Dry Density (pcf) | Moisture Content (%) | Atter. | | Gradation | | | Other Tests |
|------------|------------|-----------|--------|------------------|------------|--|-------------------|----------------------|---------------|--------------|--------------|------------|----------|--------------|
| | | | Type | Rec. (in) | See Legend | | | | USCS (AASHTO) | Liquid Limit | Plast. Index | Gravel (%) | Sand (%) | |
| | | | | | | 4" ASPHALT SAND W/SILT & GRAVEL (fill) | | | | | | | | |
| | | | 15 | 5,2,2,(9) | SP-SM | lt. brown, moist | | | | | | | | |
| | | | | | CL | brown, moist, soft | | | | | | | | |
| | | | 8 | Pushed T 1.25 | CL | lt. brown, moist, very stiff | 94.6 | 22.5 | | | | | | |
| | 5 | | | | | SANDY LEAN CLAY | | | | | | | | |
| | | | 12 | T 0.63 1,2,1,(6) | CL | brown, moist, stiff | | | | | | | | |
| | | | | | ML | brown-gray, moist, loose | | | | | | | | |
| | | | | | | SANDY SILT plastic | | | | | | | | |
| | 10 | | 9 | 6,4,4,(14) | SM | gray-orange, moist, med. dense | | | | | | | | |
| | | | | | | SILTY SAND | | | | | | | | |
| | | | 14 | Pushed T 0.50 | CL | brown, moist, firm | 99.2 | 21.6 | 26 | 11 | | | | UC 1,280 psf |
| | | | | | | SANDY LEAN CLAY | | | | | | | | |
| | 15 | | 11 | 11,15,30,(64) | GM | brown, moist, dense | | | | | | | | |
| | | | | | | SILTY GRAVEL W/SAND possible cobbles | | | | | | | | |
| | 20 | | 13 | 41,22,24,(56) | GP-GM | brown, moist, dense | | | | | | | | |
| | | | | | | GRAVEL W/SILT & SAND possible cobbles | | | | | | | | |
| | | | 11 | 13,31,29,(68) | GP-GM | brown, moist, dense | | | | | | | | |
| | | | | | | BOTTOM OF HOLE | | | | | | | | |

DH LOG V8-2014-1 JWCD SW AQUEDUCT.GPJ US EVAL.GDT 6/4/24

LEGEND:

-  2" OD Split Spoon (SPT) Split Spoon Sample
-  2.5" OD Split Spoon
-  3" OD Split Spoon

-  Thin-Walled Tube Sample

- Blow Count per 6" (N₆₀) Value
- T 0.45 ← Torvane (tsf)
- PP 2.0 ← Pocket Penetrometer (tsf) With Liners
- Pushed T 0.45 ← Torvane (tsf)
- PP 2.0 ← Pocket Penetrometer (tsf)

OTHER TESTS

- UC = Unconfined Compression
- CT = Consolidation
- DS = Direct Shear
- UU = Unconsolidated, Undrained
- CU = Consolidated, Undrained
- Chem. = pH, Resistivity, Sulfate, Chloride, Soluble Salts
- Hyd. = Hydrometer
- DC = Dispersive Clay



DRILL HOLE LOG

BORING NO. 24-BH-06

PROJECT: JWCD SW AQUEDUCT REACH 2

SHEET 1 OF 1

CLIENT: BOWEN, COLLINS & ASSOCIATES

PROJECT NUMBER: 202301-040-23-01

LOCATION: APPROX. LAT: 40.52020° N, LONG: 111.96728° W

DATE STARTED: 4/1/24

DRILLING METHOD: 08-CME-55 / HQ CASING ADVANCER

DATE COMPLETED: 4/1/24

DRILLER: T.K., J.H.

GROUND ELEVATION: _____

DEPTH TO WATER - INITIAL: ▽ N.M. AFTER 24 HOURS: ▼ DRY'

LOGGED BY: M.S.H., J.B.

| Elev. (ft) | Depth (ft) | Lithology | Sample | | | Material Description | Dry Density (pcf) | Moisture Content (%) | Atter. | | Gradation | | | Other Tests |
|------------|------------|-----------|--------|----------------------|------------|--|-------------------|----------------------|---------------|--------------|--------------|------------|----------|--------------------------|
| | | | Type | Rec. (in) | See Legend | | | | USCS (AASHTO) | Liquid Limit | Plast. Index | Gravel (%) | Sand (%) | |
| | | | | | | 5" ASPHALT | | | | | | | | |
| | | | 8 | 7,7,9,(35) | SM | lt. brown, moist, dense SILTY SAND W/GRAVEL (fill) | | | | | | | | |
| | | | 18 | 6,3,4,(15) T 0.50 | CL | gray, moist, firm LEAN CLAY | | | | | | | | |
| | 5 | | | | | SAND W/SILT & GRAVEL | | | | | | | | |
| | | | 11 | Pushed | SP-SM | lt. brown, moist | | | | | | | | |
| | | | 14 | 20,32,31,(99+) | GP-GM | lt. brown, moist, very dense GRAVEL W/SILT & SAND possible cobbles | | 6.7 | | NP | 48 | 42 | 10 | |
| | | | | | | SILTY SAND | | | | | | | | |
| | 10 | | 6 | 3,2,3,(9) | CL | brown, moist, firm LEAN CLAY W/SAND | | | | | | | | |
| | | | | | | SILTY SAND trace gravels | | | | | | | | |
| | | | 17 | Pushed | SM | brown, moist | | | | | | | | |
| | | | | | | GRAVEL W/SILT & SAND possible cobbles | | | | | | | | |
| | 15 | | 14 | 5,24,26,(71) | GP-GM | lt. brown, moist, dense | | | | | | | | |
| | | | | | | SANDY SILT | | | | | | | | |
| | | | | | | SANDY LEAN CLAY W/GRAVEL | | 91.4 | 26.9 | 45 | 25 | | | CT UC 2,001 psf |
| | 20 | | 12 | Pushed T 0.41 | CL | brown, moist, firm | | | | | | | | |
| | | | | | | SILTY CLAYEY GRAVEL W/SAND possible cobbles | | | | | | | | |
| | | | 14 | 17,31,22,(64) | GC-GM | lt. brown, moist, dense | | | | | | | | |
| | | | | | | BOTTOM OF HOLE | | | | | | | | |

DH LOG-V8-2014-1 JWCD SW AQUEDUCT.GPJ US EVAL.GDT 6/4/24

LEGEND:

- 2" OD Split Spoon (SPT) Split Spoon Sample
- 2.5" OD Split Spoon
- 3" OD Split Spoon

- Thin-Walled Tube Sample

- Blow Count per 6" (N₆₀) Value
- Torvane (tsf)
- Pocket Penetrometer (tsf) With Liners
- Pushed Torvane (tsf)
- Pushed Pocket Penetrometer (tsf)

OTHER TESTS

- UC = Unconfined Compression
- CT = Consolidation
- DS = Direct Shear
- UU = Unconsolidated, Undrained
- CU = Consolidated, Undrained
- Chem. = pH, Resistivity, Sulfate, Chloride, Soluble Salts
- Hyd. = Hydrometer
- DC = Dispersive Clay



DRILL HOLE LOG

BORING NO. 24-BH-07

PROJECT: JWCD SW AQUEDUCT REACH 2

SHEET 1 OF 1

CLIENT: BOWEN, COLLINS & ASSOCIATES

PROJECT NUMBER: 202301-040-23-01

LOCATION: APPROX. LAT: 40.52208° N, LONG: 111.96727° W

DATE STARTED: 3/21/24

DRILLING METHOD: 20-CME-55 / NW CASING TO 35'

DATE COMPLETED: 3/22/24

DRILLER: S.W., J.H.

GROUND ELEVATION: _____

DEPTH TO WATER - INITIAL: ▽ 20.7'

AFTER 24 HOURS: ▼ 29.3' 5/23/24**

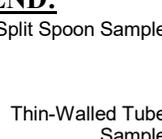
LOGGED BY: T.D., M.S.H., J.B.

| Elev. (ft) | Depth (ft) | Lithology | Sample | | | Material Description | Dry Density (pcf) | Moisture Content (%) | Atter. | | Gradation | | | Other Tests |
|------------|------------|-----------|--------|-------------------------|-------------|---|-------------------|----------------------|---------------|--------------|--------------|------------|----------|--------------------|
| | | | Type | Rec. (in) | See Legend | | | | USCS (AASHTO) | Liquid Limit | Plast. Index | Gravel (%) | Sand (%) | |
| | | | 13 | 5,7,10,(37) PP 4.25 | CL | dk. brown, moist, hard SANDY LEAN CLAY W/GRAVEL | | | | | | | | |
| | 5 | | 14 | Pushed T 0.67 | CL | gray, wet, stiff LEAN CLAY W/SAND | | 46.1 | 44 | 16 | | | | CT |
| | | | 10 | Pushed | ML | gray, very moist SANDY SILT plastic | | | | | | | | |
| | 10 | | 13 | 6,6,5,(21) | ML | gray, very moist, med. dense | | | | | | | | |
| | | | 14 | 8,9,10,(32) | SM | brown, very moist, dense SILTY SAND | | | | | | | | Chem. |
| | 15 | | 17 | 3,3,7,(15) | SM CL | brown, very moist brown, moist, stiff SANDY LEAN CLAY | | | | | | | | |
| | | | 13 | 4,4,7,(15) | GC CL | brown, moist brown, moist, stiff CLAYEY GRAVEL W/SAND LEAN CLAY W/SAND | | 20.4 | 36 | 22 | | | | |
| | 20 | | 14 | T 0.38 3,9,50,(76) | CL GM | brown, moist, firm brown, moist, very dense SILTY GRAVEL W/SAND slightly plastic fines, possible cobbles | | | | | | | | |
| | | | 14 | Pushed T 0.88 | CL | brown, moist, stiff SANDY LEAN CLAY | | | | | | | | |
| | 25 | | 13 | 13,6,6,(13) T 0.35 | SC-SM CL | brown, moist brown, moist, firm SILTY CLAYEY SAND LEAN CLAY | | | | | | | | |
| | 30 | | 12 | Pushed T 0.36 | CL | brown-gray, moist, firm to stiff SANDY LEAN CLAY | 110.7 | 16.1 | 30 | 13 | 0 | 44 | 56 | UC 3,766 psf |
| | 35 | | 15 | 16,18,24,(40) | ML | brown, wet, dense SANDY SILT | | | | | | | | |
| | 40 | | 16 | 13,13,15,(23) T 1.13 | CL | gray, moist, very stiff SANDY LEAN CLAY | | | | | | | | |
| | 45 | | | | | BOTTOM OF HOLE | | | | | | | | |

DH LOG V8-2014-1 JWCD SW AQUEDUCT.GPJ US EVAL.GDT 6/4/24

LEGEND:

-  2" OD Split Spoon (SPT) Split Spoon Sample
-  2.5" OD Split Spoon
-  3" OD Split Spoon

-  Thin-Walled Tube Sample

-  Blow Count per 6" (N₆₀) Value
-  Torvane (tsf)
-  Pocket Penetrometer (tsf) With Liners
-  Pushed Torvane (tsf)
-  Pushed Pocket Penetrometer (tsf)

OTHER TESTS

- UC = Unconfined Compression
- CT = Consolidation
- DS = Direct Shear
- UU = Unconsolidated, Undrained
- CU = Consolidated, Undrained
- Chem. = pH, Resistivity, Sulfate, Chloride, Soluble Salts
- Hyd. = Hydrometer
- DC = Dispersive Clay



DRILL HOLE LOG

BORING NO. 24-BH-08

PROJECT: JWCD SW AQUEDUCT REACH 2

SHEET 1 OF 1

CLIENT: BOWEN, COLLINS & ASSOCIATES

PROJECT NUMBER: 202301-040-23-01

LOCATION: APPROX. LAT: 40.52253° N, LONG: 111.96719° W

DATE STARTED: 3/20/24

DRILLING METHOD: 20-CME-55 / NW CASING TO 40'

DATE COMPLETED: 3/21/24

DRILLER: S.W., A.K., J.H.

GROUND ELEVATION: _____

DEPTH TO WATER - INITIAL: ▽ DRY' AFTER 24 HOURS: ▼ DRY to 30'

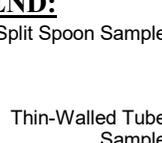
LOGGED BY: T.D., M.N.H., J.B.

| Elev. (ft) | Depth (ft) | Lithology | Sample | | | Material Description | Dry Density (pcf) | Moisture Content (%) | Atter. | | Gradation | | | Other Tests |
|------------|------------|-----------|--------|-----------------------|------------|---|-------------------|----------------------|---------------|--------------|--------------|------------|----------|-------------|
| | | | Type | Rec. (in) | See Legend | | | | USCS (AASHTO) | Liquid Limit | Plast. Index | Gravel (%) | Sand (%) | |
| | | | 6 | 6,3,4,(15) | SP-SM | black-dk. brown, moist, med. dense 4" ASPHALT SAND W/SILT & GRAVEL (ASPHALT MILLINGS) (fill) | | | | | | | | |
| | | | 11 | Pushed | CL | gray, wet | | | | | | | | |
| | 5 | | 6 | 3,3,4,(15) PP 2.75 | CL | brown, moist, very stiff | | | | | | | | |
| | | | 6 | 0/12",3,(6) T 0.35 | CL | lt. brown, very moist, firm | | | | | | | | |
| | 10 | | 10 | 3,2,4,(10) | SP-SM | brown, wet, loose | | | | | | | | |
| | | | 12 | 8,12,14,(38) | SP-SM | brown, wet, dense | | 9.2 | | NP | 26 | 67 | 7 | |
| | 15 | | 5 | 12,7,5,(16) | SP-SM | brown, wet, med. dense | | | | | | | | |
| | | | 14 | 3,6,6,(16) | CL-ML | brown, moist, stiff | | 19.6 | 23 | 4 | 0 | 35 | 65 | |
| | 20 | | 18 | 2,3,3,(7) T 0.40 | CL | lt. brown, wet, firm | | | | | | | | |
| | | | 0 | Pushed | - | no recovery | | | | | | | | Chem. |
| | | | | | | GRAVELS (driller's observation) | | | | | | | | |
| | 25 | | 15 | 6,5,6,(12) | ML | brown, wet, med. dense | | 25.7 | | NP | 0 | 50 | 50 | |
| | | | | | | SANDY SILT clay lenses | | | | | | | | |
| | 30 | | 9 | 14,16,25,(39) | SP-SM | brown, wet, dense | | | | | | | | |
| | | | | | | SAND W/SILT & GRAVEL | | | | | | | | |
| | 35 | | 11 | 32,43,39,(72) | SP-SM | brown, wet, very dense | | | | | | | | |
| | | | | | | SILTY GRAVEL W/SAND possible cobbles | | | | | | | | |
| | 40 | | 12 | 36,53,39,(76) | GM | brown, wet, very dense | | | | | | | | |
| | | | | | | BOTTOM OF HOLE | | | | | | | | |
| | 45 | | | | | Note: Standpipe piezometer installed to depth of 30'. No water encountered at 30' on 5/23/24. | | | | | | | | |

DH LOG V8-2014-1 JWCD SW AQUEDUCT.GPJ US EVAL.GDT 6/4/24

LEGEND:

-  2" OD Split Spoon (SPT) Split Spoon Sample
-  2.5" OD Split Spoon
-  3" OD Split Spoon

-  Thin-Walled Tube Sample

- Blow Count per 6" (N₆₀) Value
- T 0.45 Torvane (tsf)
- PP 2.0 Pocket Penetrometer (tsf) With Liners
- Pushed T 0.45 Torvane (tsf)
- PP 2.0 Pocket Penetrometer (tsf)

OTHER TESTS

- UC = Unconfined Compression
- CT = Consolidation
- DS = Direct Shear
- UU = Unconsolidated, Undrained
- CU = Consolidated, Undrained
- Chem. = pH, Resistivity, Sulfate, Chloride, Soluble Salts
- Hyd. = Hydrometer
- DC = Dispersive Clay



DRILL HOLE LOG

BORING NO. 24-BH-09

PROJECT: JWCD SW AQUEDUCT REACH 2

SHEET 1 OF 1

CLIENT: BOWEN, COLLINS & ASSOCIATES

PROJECT NUMBER: 202301-040-23-01

LOCATION: APPROX. LAT: 40.52525° N, LONG: 111.96719° W

DATE STARTED: 3/20/24

DRILLING METHOD: 20-CME-55 / NW CASING TO 20'

DATE COMPLETED: 3/20/24

DRILLER: S.W., A.K.

GROUND ELEVATION: _____

DEPTH TO WATER - INITIAL: ▽ 13.7'

AFTER 24 HOURS: ▼ DRY 5/23/24

LOGGED BY: T.D., J.B.

| Elev. (ft) | Depth (ft) | Lithology | Sample | | | Material Description | Dry Density (pcf) | Moisture Content (%) | Atter. | | Gradation | | | Other Tests |
|------------|------------|-----------|--------|-----------------------|------------|---|-------------------|----------------------|---------------|--------------|--------------|------------|--------------------------|-------------|
| | | | Type | Rec. (in) | See Legend | | | | USCS (AASHTO) | Liquid Limit | Plast. Index | Gravel (%) | Sand (%) | |
| | | | 10 | 2,3,7,(22) T 1.73 | CL | dk. brown, moist, very stiff LEAN CLAY W/SAND trace gravels | | | | | | | | |
| | | | 13 | 3,3,5,(19) T 0.45 | CL | lt. brown, very moist, firm LEAN CLAY | | | | | | | | |
| | 5 | | 0 | Pushed | - | no recovery | | | | | | | | |
| | | | 15 | 10,30,30,(99+) | SP-SM | lt. brown, moist SILTY SAND brown, moist, very dense SAND W/SILT & GRAVEL | | | | | | | | |
| | 10 | | 14 | 5,6,8,(23) T 0.25 | CL-ML | brown, moist, firm SANDY SILTY CLAY | 20.5 | 27 | 6 | 8 | 22 | 70 | | |
| | | | 9 | 9,9,24,(48) | GM | brown, moist, med. dense SILTY GRAVEL W/SAND slightly plastic fines, possible cobbles | | | | | | | | |
| | 15 | | 15 | 11,5,5,(13) T 0.50 | CL | brown, moist, stiff SANDY LEAN CLAY W/GRAVEL | | | | | | | | |
| | | | 15 | | CL | brown, moist, stiff SANDY LEAN CLAY | | | | | | | | |
| | 20 | | 3 | 19,9,8,(21) | GP | brown, wet, loose GRAVEL W/SAND likely sluff, poor sample | | | | | | | | |
| | | | 16 | Pushed T 0.98 | CL | brown, moist, stiff LEAN CLAY W/SAND | 98.9 | 20.1 | 30 | 12 | 0 | 23 | 77 | |
| | | | | | | BOTTOM OF HOLE | | | | | | | | |
| | 25 | | | | | Note: Temporary slotted PVC pipe placed to bottom of boring for "After 24 Hours" water level measurement shown. | | | | | | | CT UC 2,690 psf | |

DH LOG V8-2014-1 JWCD SW AQUEDUCT.GPJ US EVAL.GDT 6/4/24

LEGEND:

-  2" OD Split Spoon (SPT) Split Spoon Sample
-  2.5" OD Split Spoon
-  3" OD Split Spoon

-  Thin-Walled Tube Sample

-  Blow Count per 6" (N₆₀) Value
-  Torvane (tsf)
-  Pocket Penetrometer (tsf) With Liners
-  Pushed Torvane (tsf)
-  Pushed Pocket Penetrometer (tsf)

OTHER TESTS

- UC = Unconfined Compression
- CT = Consolidation
- DS = Direct Shear
- UU = Unconsolidated, Undrained
- CJ = Consolidated, Undrained
- Chem. = pH, Resistivity, Sulfate, Chloride, Soluble Salts
- Hyd. = Hydrometer
- DC = Dispersive Clay



DRILL HOLE LOG

BORING NO. 24-BH-10

PROJECT: JWCD SW AQUEDUCT REACH 2

SHEET 1 OF 1

CLIENT: BOWEN, COLLINS & ASSOCIATES

PROJECT NUMBER: 202301-040-23-01

LOCATION: APPROX. LAT: 40.52724° N, LONG: 111.96727° W

DATE STARTED: 4/5/24

DRILLING METHOD: 20-CME-55 / NW CASING TO 20'

DATE COMPLETED: 4/5/24

DRILLER: S.W., A.K.

GROUND ELEVATION: _____

DEPTH TO WATER - INITIAL: ∇ N.M. AFTER 24 HOURS: ▼ N.M.

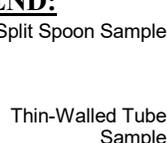
LOGGED BY: C.P., J.B.

| Elev. (ft) | Depth (ft) | Lithology | Sample | | | Material Description | Dry Density (pcf) | Moisture Content (%) | Atter. | | Gradation | | | Other Tests |
|------------|------------|-----------|--------|---------------------|------------|--|-------------------|----------------------|---------------|--------------|--------------|------------|----------|--------------|
| | | | Type | Rec. (in) | See Legend | | | | USCS (AASHTO) | Liquid Limit | Plast. Index | Gravel (%) | Sand (%) | |
| | | | | | | 4" ASPHALT | | | | | | | | |
| | | | 10 | 13,13.5,(40) | SM | lt. brown, sl. moist, dense SILTY SAND W/GRAVEL (fill) | | | | | | | | |
| | | | 18 | 2,2.2,(9) T 0.50 | CL | gray, wet, firm LEAN CLAY W/SAND trace gravels | | | | | | | | |
| | 5 | | 15 | 12,17,21,(81) | SM | brown to gray, very moist, very dense SILTY SAND W/GRAVEL | | | | | | | | |
| | | | 6 | Pushed T 0.86 | CL | gray, moist, stiff LEAN CLAY W/GRAVEL | 98.0 | 25.0 | 38 | 18 | | | | UC 2,270 psf |
| | 10 | | 9 | 23,13,7,(33) | GC | gray, moist, med. dense CLAYEY GRAVEL W/SAND possible cobbles | | | | | | | | |
| | | | 7 | 25,15,9,(35) | GP-GM | brown, moist, med. dense GRAVEL W/SILT & SAND possible cobbles | | | | | | | | |
| | 15 | | 11 | Pushed | CL | gray, moist SANDY LEAN CLAY | | | | | | | | |
| | | | 17 | 5,6,4,(13) | ML | gray-brown, wet, med. dense SANDY SILT | | | | | | | | |
| | 20 | | 18 | 2,1,2,(4) | CL-ML | gray-brown, wet, soft SANDY SILTY CLAY plastic | | 24.4 | 23 | 5 | 4 | 28 | 68 | |
| | | | | | | BOTTOM OF HOLE | | | | | | | | |

DH LOG-V8-2014-1 JWCD SW AQUEDUCT.GPJ US EVAL.GDT 6/4/24

LEGEND:

-  2" OD Split Spoon (SPT) Split Spoon Sample
-  2.5" OD Split Spoon
-  3" OD Split Spoon

-  Thin-Walled Tube Sample

- Blow Count per 6" (N₆₀) Value
- 2,3,2,(6) ← Torvane (tsf)
- T 0.45 ← Pocket Penetrometer (tsf) With Liners
- PP 2.0 ← Torvane (tsf)
- PP 2.0 ← Pocket Penetrometer (tsf)

OTHER TESTS

- UC = Unconfined Compression
- CT = Consolidation
- DS = Direct Shear
- UU = Unconsolidated, Undrained
- CU = Consolidated, Undrained
- Chem. = pH, Resistivity, Sulfate, Chloride, Soluble Salts
- Hyd. = Hydrometer
- DC = Dispersive Clay

RB&G

ENGINEERING, INC.

DRILL HOLE LOG

BORING NO. 24-BH-13

PROJECT: JWCD SW AQUEDUCT REACH 2

SHEET 1 OF 1

CLIENT: BOWEN, COLLINS & ASSOCIATES

PROJECT NUMBER: 202301-040-23-01

LOCATION: APPROX. LAT: 40.53184° N, LONG: 111.96729° W

DATE STARTED: 4/3/24

DRILLING METHOD: 20-CME-55 / NW CASING TO 40'

DATE COMPLETED: 4/3/24

DRILLER: S.W., J.H.

GROUND ELEVATION: _____

DEPTH TO WATER - INITIAL: ∇ 33.1' AFTER 24 HOURS: ▼ DRY TO 30'

LOGGED BY: C.P., J.B.

| Elev. (ft) | Depth (ft) | Lithology | Sample | | | Material Description | Dry Density (pcf) | Moisture Content (%) | Atter. | | Gradation | | | Other Tests |
|------------|------------|-----------|--------|----------------------|-------------|--|-------------------|----------------------|---------------|--------------|--------------|------------|----------|-------------|
| | | | Type | Rec. (in) | See Legend | | | | USCS (AASHTO) | Liquid Limit | Plast. Index | Gravel (%) | Sand (%) | |
| | | | 18 | 6,7,6,(29) | SM | lt. brown, moist brown, moist, med. dense | | | | | | | | |
| | | | 8 | 2,1,2,(7) T 0.31 | SM | brown, moist, loose | | | | | | | | |
| | 5 | | 17 | Pushed | SM | brown, moist | | | | | | | | Chem. |
| | 10 | | 14 | 1,2,1,(5) T 0.52 | CL | dk. brown, moist, stiff | | | | | | | | Chem. |
| | 15 | | 11 | 5,6,18,(38) | SM | dk. brown, moist, dense | | 16.2 | NP | 10 | 48 | 42 | | |
| | 20 | | 12 | 4,4,6,(13) T 0.25 | CL | brown, moist, firm | | 20.9 | 27 | 12 | 2 | 28 | 70 | |
| | 25 | | 0 | 10,7,10,(20) | - | no recovery | | | | | | | | |
| | 30 | | 13 | 32,27,22,(51) | GC | brown, moist, dense | | | | | | | | |
| | 35 | | 17 | 3,8,24,(30) | CL ML | gray, moist brown, wet, dense | | 31.7 | 40 | 21 | | | | |
| | 40 | | 13 | 23,29,17,(41) | GP-GM ML | red, wet brown, wet, dense | | | | | | | | |
| | | | 8 | 54,60/4" | GM | brown, wet, very dense | | | | | | | | |
| | | | | | | BOTTOM OF HOLE | | | | | | | | |

DH LOG V8-2014-1 JWCD SW AQUEDUCT.GPJ US EVAL.GDT 6/4/24

LEGEND:

-  2" OD Split Spoon (SPT) Split Spoon Sample
-  2.5" OD Split Spoon
-  3" OD Split Spoon

-  Thin-Walled Tube Sample

-  Blow Count per 6" (N)₆₀ Value
-  Torvane (tsf)
-  Pocket Penetrometer (tsf) With Liners
-  Pushed Torvane (tsf)
-  Pushed Pocket Penetrometer (tsf)

- #### OTHER TESTS
- UC = Unconfined Compression
 - CT = Consolidation
 - DS = Direct Shear
 - UU = Unconsolidated, Undrained
 - CU = Consolidated, Undrained
 - Chem. = pH, Resistivity, Sulfate, Chloride, Soluble Salts
 - Hyd. = Hydrometer
 - DC = Dispersive Clay



DRILL HOLE LOG

BORING NO. 24-BH-14

PROJECT: JWCD SW AQUEDUCT REACH 2

SHEET 1 OF 1

CLIENT: BOWEN, COLLINS & ASSOCIATES

PROJECT NUMBER: 202301-040-23-01

LOCATION: APPROX. LAT: 40.53202° N, LONG: 111.96703° W

DATE STARTED: 4/4/24

DRILLING METHOD: 20-CME-55 / NW CASING TO 30'

DATE COMPLETED: 4/4/24

DRILLER: S.W., J.H.

GROUND ELEVATION: _____

DEPTH TO WATER - INITIAL: ▽ 23.8' AFTER 24 HOURS: ▼ DRY TO 30'

LOGGED BY: C.P., J.B.

| Elev. (ft) | Depth (ft) | Lithology | Sample | | | Material Description | Dry Density (pcf) | Moisture Content (%) | Atter. | | Gradation | | | Other Tests |
|------------|------------|-----------|--------|----------------------|------------|--------------------------------------|-------------------|----------------------|---------------|--------------|--------------|------------|----------|-------------|
| | | | Type | Rec. (in) | See Legend | | | | USCS (AASHTO) | Liquid Limit | Plast. Index | Gravel (%) | Sand (%) | |
| | | | 17 | 6,6,3,(20) T 0.87 | SM CL | orange, moist black, moist, stiff | | | | | | | | |
| | | | 13 | Pushed T 0.35 | CL | gray, wet, firm | | | | | | | | |
| | 5 | | 16 | 1,2,3,(11) T 0.10 | CL | gray, wet, very soft | | | | | | | | |
| | 10 | | 9 | 5,6,7,(22) | SM | gray, moist, med. dense | 17.5 | | NP | 10 | 41 | 49 | | |
| | | | 12 | 4,3,3,(9) T 0.65 | CL | brown-gray, moist, stiff | | | | | | | Chem. | |
| | 15 | | 12 | Pushed T 0.50 | ML | brown, very moist, firm | 19.4 | 22 | 3 | | | | DS | |
| | 20 | | 14 | 31,32,44,(92) | GM | brown, very moist, very dense | | | | | | | | |
| | | | 16 | 18,41,42,(94) | GP-GM | brown, wet, very dense | | | | | | | Chem. | |
| | 25 | | 12 | 13,12,15,(28) | SM | brown, moist, med. dense | 12.1 | | NP | 38 | 39 | 23 | | |
| | 30 | | 6 | 4,2,4,(6) T 0.60 | CL | gray, moist, stiff | | | | | | | | |
| | 35 | | 12 | 9,15,14,(29) | ML SM | gray, wet orange, wet, med. dense | 17.1 | | NP | 2 | 38 | 60 | | |
| | 40 | | 9 | 37,60/3" | GP-GM | brown to red, wet, very dense | | | | | | | | |
| | | | | | | BOTTOM OF HOLE | | | | | | | | |

LEGEND:

- 2" OD Split Spoon (SPT) Split Spoon Sample
- 2.5" OD Split Spoon
- 3" OD Split Spoon

- Thin-Walled Tube Sample

- Blow Count per 6" (N₆₀) Value
- Torvane (tsf)
- Pocket Penetrometer (tsf) With Liners
- Pushed Torvane (tsf)
- Pushed Pocket Penetrometer (tsf)

OTHER TESTS

- UC = Unconfined Compression
- CT = Consolidation
- DS = Direct Shear
- UU = Unconsolidated, Undrained
- CU = Consolidated, Undrained
- Chem. = pH, Resistivity, Sulfate, Chloride, Soluble Salts
- Hyd. = Hydrometer
- DC = Dispersive Clay

DH LOG V8-2014-1 JWCD SW AQUEDUCT.GPJ US EVAL.GDT 6/4/24



DRILL HOLE LOG

BORING NO. 24-BH-15

PROJECT: JWCD SW AQUEDUCT REACH 2

SHEET 1 OF 1

CLIENT: BOWEN, COLLINS & ASSOCIATES

PROJECT NUMBER: 202301-040-23-01

LOCATION: APPROX. LAT: 40.53442° N, LONG: 111.96701° W

DATE STARTED: 4/8/24

DRILLING METHOD: 20-CME-55 / NW CASING TO 20'

DATE COMPLETED: 4/8/24

DRILLER: S.W., A.K.

GROUND ELEVATION: _____

DEPTH TO WATER - INITIAL: ∇ N.M. AFTER 24 HOURS: ∇ N.M.

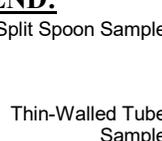
LOGGED BY: C.P., J.B.

| Elev. (ft) | Depth (ft) | Lithology | Sample | | | Material Description | Dry Density (pcf) | Moisture Content (%) | Atter. | | Gradation | | | Other Tests |
|------------|------------|-----------|--------|----------------------|------------|---|-------------------|----------------------|---------------|--------------|--------------|------------|----------|-------------|
| | | | Type | Rec. (in) | See Legend | | | | USCS (AASHTO) | Liquid Limit | Plast. Index | Gravel (%) | Sand (%) | |
| | | | | | | 4" ASPHALT | | | | | | | | |
| | | | 16 | 9,9,6,(33) T 1.50 | SM | lt. brown, sl. moist, dense | | | | | | | | |
| | | | | | CL | black, moist, very stiff | | | | | | | | |
| | | | 7 | Pushed T 0.75 | CL | dk. brown, moist, stiff | | 20.0 | 27 | 8 | | | | CT |
| | 5 | | | | | SANDY LEAN CLAY | | | | | | | | |
| | | | 15 | 1,2,2,(9) T 0.25 | CL | dk. brown to gray, very moist, soft | | | | | | | | |
| | | | 10 | 1,3,4,(13) T 0.20 | CL | brown & gray, very moist, soft | | | | | | | | |
| | | | 12 | 15,38,41,(99+) | GM | brown, moist, very dense | | | | | | | | |
| | | | | | | SILTY GRAVEL W/SAND possible cobbles | | | | | | | | |
| | | | 9 | 29,33,23,(74) | GM | lt. brown, moist, dense | | | | | | | | |
| | | | 8 | Pushed | ML | brown, moist | | | | | | | | |
| | | | 13 | 26,34,36,(84) | GM | brown, moist, very dense | | 9.4 | NP | 49 | 35 | 16 | | |
| | | | | | | SANDY SILT trace gravels | | | | | | | | |
| | | | 10 | 13,30,41,(80) | GM | brown, moist, very dense | | | | | | | | |
| | | | | | | SILTY GRAVEL W/SAND possible cobbles | | | | | | | | |
| | | | | | | BOTTOM OF HOLE | | | | | | | | |

DH LOG-V8-2014-1 JWCD SW AQUEDUCT.GPJ US EVAL.GDT 6/4/24

LEGEND:

-  2" OD Split Spoon (SPT) Split Spoon Sample
-  2.5" OD Split Spoon
-  3" OD Split Spoon

-  Thin-Walled Tube Sample

- Blow Count per 6" (N₆₀) Value
- 2,3,2,(6) ← Torvane (tsf)
- T 0.45 ← Pocket Penetrometer (tsf) With Liners
- PP 2.0 ← Torvane (tsf)
- T 0.45 ← Pocket Penetrometer (tsf)
- PP 2.0 ←

OTHER TESTS

- UC = Unconfined Compression
- CT = Consolidation
- DS = Direct Shear
- UU = Unconsolidated, Undrained
- CU = Consolidated, Undrained
- Chem. = pH, Resistivity, Sulfate, Chloride, Soluble Salts
- Hyd. = Hydrometer
- DC = Dispersive Clay

RB&G

ENGINEERING, INC.

DRILL HOLE LOG

BORING NO. 24-BH-16

PROJECT: JWCD SW AQUEDUCT REACH 2

SHEET 1 OF 1

CLIENT: BOWEN, COLLINS & ASSOCIATES

PROJECT NUMBER: 202301-040-23-01

LOCATION: APPROX. LAT: 40.53676° N, LONG: 111.96700° W

DATE STARTED: 4/8/24

DRILLING METHOD: 20-CME-55 / NW CASING TO 20'

DATE COMPLETED: 4/8/24

DRILLER: S.W., A.K.

GROUND ELEVATION: _____

DEPTH TO WATER - INITIAL: ▽ 15.0'

AFTER 24 HOURS: ▼ N.M.

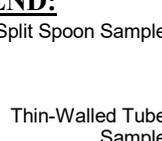
LOGGED BY: C.P., J.B.

| Elev. (ft) | Depth (ft) | Lithology | Sample | | | Material Description | Dry Density (pcf) | Moisture Content (%) | Atter. | | Gradation | | | Other Tests |
|------------|------------|-----------|--------|----------------------|------------|--|-------------------|----------------------|---------------|--------------|--------------|------------|----------|--------------|
| | | | Type | Rec. (in) | See Legend | | | | USCS (AASHTO) | Liquid Limit | Plast. Index | Gravel (%) | Sand (%) | |
| | | | | | | 4" ASPHALT | | | | | | | | |
| | | | 18 | 11,14,12,(57) | | SM lt. brown-brown, sl. moist, very dense SILTY SAND W/GRAVEL (fill) | | | | | | | | |
| | | | 12 | 2,3,5,(19) T 1.53 | | CL dk. brown, very moist, very stiff LEAN CLAY W/SAND | | | | | | | | |
| | 5 | | 13 | Pushed T 0.65 | | CL dk. brown, wet, stiff | 94.8 | 23.7 | 24 | 8 | | | | UC 1,426 psf |
| | | | 18 | 1,2,2,(7) T 0.23 | | CL gray, very moist, soft LEAN CLAY W/SAND silt lenses | | | | | | | | Chem. |
| | 10 | | 10 | 5,9,7,(25) | | SM brown-red, wet, med. dense SILTY SAND trace gravels | | 15.2 | | NP | 18 | 52 | 30 | |
| | | | 14 | 41,44,43,(99+) | | GC-GM brown, wet, very dense SILTY CLAYEY GRAVEL W/SAND possible cobbles | | | | | | | | |
| | | | 12 | 6,7,23,(39) | | GC white, wet, med. dense CLAYEY GRAVEL W/SAND possible cobbles | | | | | | | | |
| | 20 | | 8 | 27,69/6" | | GP-GM lt. brown, wet, very dense GRAVEL W/SILT & SAND possible cobbles | | | | | | | | |
| | | | | | | BOTTOM OF HOLE | | | | | | | | |

DH LOG V8-2014-1 JWCD SW AQUEDUCT.GPJ US EVAL.GDT 6/4/24

LEGEND:

-  2" OD Split Spoon (SPT) Split Spoon Sample
-  2.5" OD Split Spoon
-  3" OD Split Spoon

-  Thin-Walled Tube Sample

- Blow Count per 6" (N)₆₀ Value
- Torque Value (tsf)
- Pocket Penetrometer (tsf) With Liners
- Pushed Torque Value (tsf)
- Pocket Penetrometer (tsf)

OTHER TESTS

- UC = Unconfined Compression
- CT = Consolidation
- DS = Direct Shear
- UU = Unconsolidated, Undrained
- CU = Consolidated, Undrained
- Chem. = pH, Resistivity, Sulfate, Chloride, Soluble Salts
- Hyd. = Hydrometer
- DC = Dispersive Clay



Table 1

SUMMARY OF TEST DATA

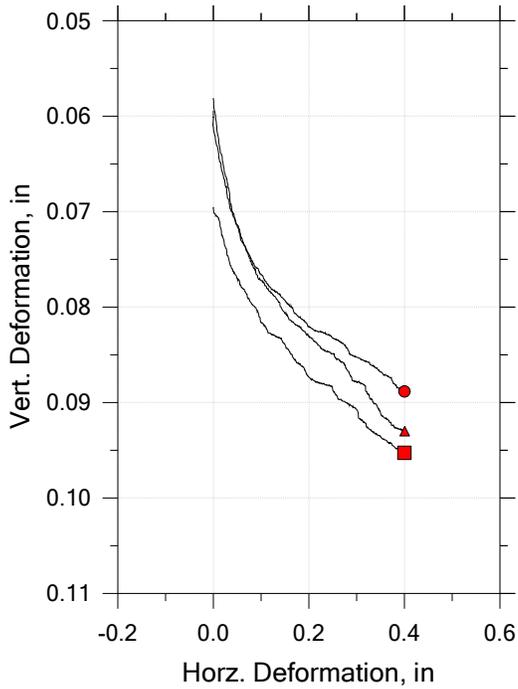
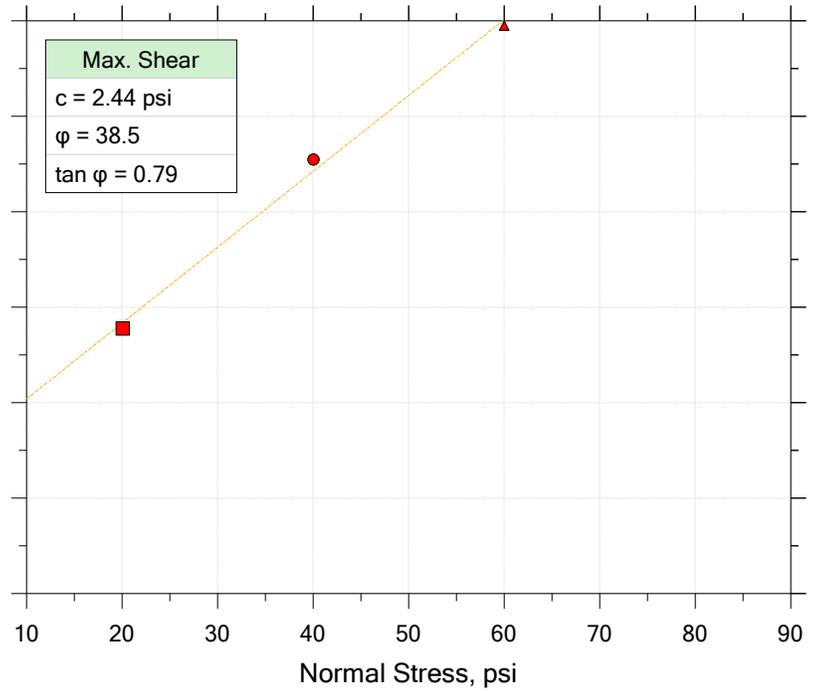
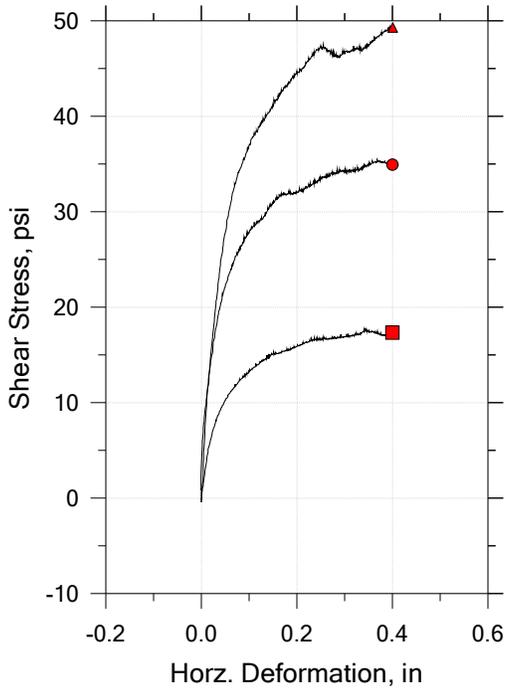
PROJECT LOCATION: JVWCD SW Aquaduct Reach 2
 see site plan

PROJECT NO. FEATURE: 202301-040 - Task 23-01
66" Pipeline

| HOLE NO. | DEPTH BELOW GROUND SURFACE (ft) | IN-PLACE | | UNCONFINED OR UU TRIAXIAL COMPRESSIVE STRENGTH (psf) | ATTERBERG LIMITS | | | MECHANICAL ANALYSIS | | | PERCENT FINER THAN 0.005 mm | UNIFIED SOIL CLASSIFICATION SYSTEM |
|----------|---------------------------------|-----------------------|--------------|--|------------------|-------------------|----------------------|---------------------|--------------|---------------------|-----------------------------|------------------------------------|
| | | DRY UNIT WEIGHT (pcf) | MOISTURE (%) | | LIQUID LIMIT (%) | PLASTIC LIMIT (%) | PLASTICITY INDEX (%) | PERCENT GRAVEL | PERCENT SAND | PERCENT SILT & CLAY | | |
| 24-BH-01 | 4.5-6 | 74.4 | 42.4 | UC 361 | 32 | 22 | 10 | | | | | CL |
| | 12-13.5 | 88.3 | 22.4 | UC 605 | 22 | 20 | 2 | | | | | ML |
| | 18-19.5 | | 25.0 | | 28 | 21 | 7 | 3 | 51 | 46 | | SC-SM |
| 24-BH-02 | 3-4.5 | 89.8 | 30.9 | | 31 | 19 | 12 | | | | | CL |
| | 12.5-14 | | 14.2 | | | | NP | 29 | 46 | 25 | | SM |
| 24-BH-03 | 6-7.5 | 72.1 | 55.6 | UC 1,362 | 45 | 25 | 20 | | | | | CL |
| | 18-19.5 | | 22.6 | | 37 | 16 | 21 | | | | | CL |
| 24-BH-04 | 9-10.5 | | 8.9 | | | | NP | 1 | 56 | 43 | | SM |
| | 12-13.5 | 100.4 | 17.6 | | 29 | 15 | 14 | | | | | CL |
| 24-BH-05 | 3-4.5 | 94.6 | 22.5 | | | | | | | | | |
| | 12-13.5 | 99.2 | 21.6 | UC 1,280 | 26 | 15 | 11 | | | | | CL |
| 24-BH-06 | 7-8.5 | | 6.7 | | | | NP | 48 | 42 | 10 | | GP-GM |
| | 18-19.5 | 91.4 | 39.2 | UC 2,001 | 45 | 20 | 25 | | | | | CL |
| 24-BH-07 | 3-4.5 | 79.4 | 44.6 | | 44 | 28 | 16 | | | | | ML |
| | 15-16.5 | | 20.4 | | 36 | 14 | 22 | | | | | CL |
| | 30-31.1 | 110.7 | 16.1 | UC 3,766 | 30 | 17 | 13 | 0 | 44 | 56 | | CL |
| 24-BH-08 | 12-13.5 | | 9.2 | | | | NP | 26 | 67 | 7 | | SP-SM |
| | 18-19.5 | | 19.6 | | 23 | 19 | 4 | 0 | 35 | 65 | | CL-ML |
| | 25-26.5 | | 25.7 | | | | NP | 0 | 50 | 50 | | ML |
| 24-BH-09 | 9-10.5 | | 20.5 | | 27 | 21 | 6 | 8 | 22 | 70 | | CL-ML |
| | 21-22.5 | 98.9 | 20.1 | UC 2,690 | 30 | 18 | 12 | 0 | 23 | 77 | | CL |
| 24-BH-10 | 9-9.5 | 98.0 | 25.0 | UC 2,277 | 38 | 20 | 18 | | | | | CL |
| | 21-22.5 | | 24.4 | | 23 | 18 | 5 | 4 | 28 | 68 | | CL-ML |
| 24-BH-11 | 6-7.5 | 67.2 | 51.0 | | 48 | 26 | 22 | | | | | CL |
| | 12-13.5 | | 11.9 | | | | NP | 35 | 40 | 25 | | SM |
| 24-BH-13 | 12-13.5 | | 16.2 | | | | NP | 10 | 48 | 42 | | SM |
| | 18-19.5 | | 20.9 | | 27 | 15 | 12 | 2 | 28 | 70 | | CL |
| | 30-31.5 | | 31.7 | | 40 | 19 | 21 | | | | | CL |
| 24-BH-14 | 9-10.5 | | 17.5 | | | | NP | 10 | 41 | 49 | | SM |
| | 15-16.5 | 99.0 | 20.2 | | 22 | 19 | 3 | | | | | ML |
| | 25-26.5 | | 12.1 | | | | NP | 38 | 39 | 23 | | SM |
| | 35-36.5 | | 17.1 | | | | NP | 2 | 38 | 60 | | ML |
| 24-BH-15 | 3-4.5 | 106.9 | 21.0 | | 27 | 19 | 8 | | | | | CL |
| | 18.7-20.2 | | 9.4 | | | | NP | 49 | 35 | 16 | | GM |
| 24-BH-16 | 6-7.5 | 94.8 | 23.7 | UC 1,426 | 24 | 16 | 8 | | | | | CL |
| | 12-13.5 | | 15.2 | | | | NP | 18 | 52 | 30 | | SM |

NP=Non-Plastic

Direct Shear Test

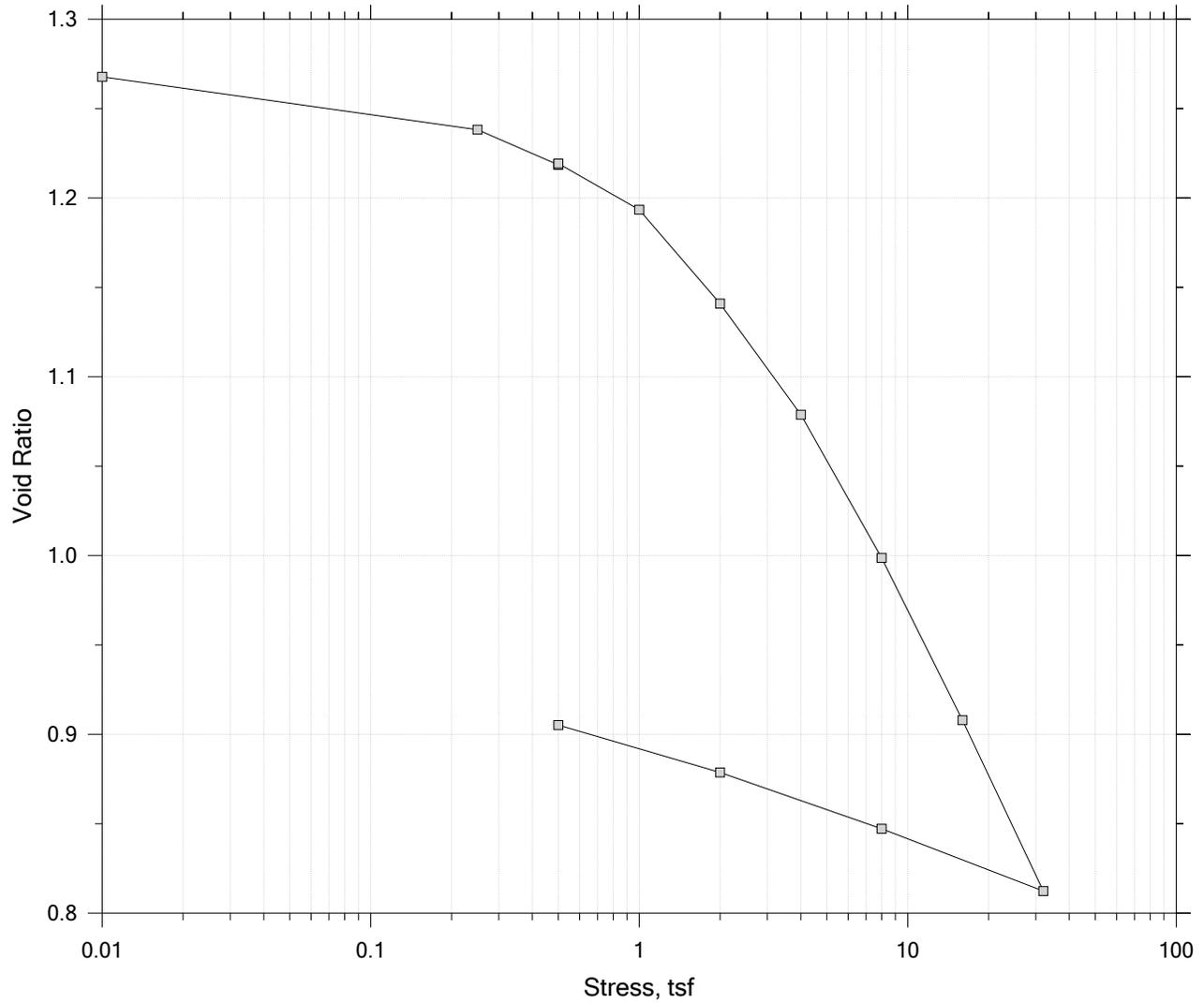


| Symbol | ■ | ● | ▲ | |
|------------------------|-----------------------|----------|----------|---------|
| Test No. | 20 psi | 40 psi | 60 psi | |
| Sample No. | 1 | 2 | 3 | |
| Shape | Circular | Circular | Circular | |
| Initial | Dimension, in | 2.37 | 2.36 | 2.37 |
| | Area, in ² | 4.4115 | 4.3744 | 4.4115 |
| | Height, in | 0.902 | 0.98 | 0.98 |
| | Moisture Content | 19.99 | 20.20 | 20.30 |
| | Dry Density, pcf | 96.20 | 101.6 | 99.15 |
| | Saturation, % | 71.77 | 82.66 | 78.30 |
| Final | Void Ratio | 0.75218 | 0.65972 | 0.7 |
| | Consol. Height, in | 0.83244 | 0.92057 | 0.92183 |
| | Consol. Void Ratio | 0.61705 | 0.55906 | 0.59909 |
| | Moisture Content, % | 19.99 | 20.20 | 20.30 |
| Final | Dry Density, pcf | 107.6 | 111.7 | 109.5 |
| | Saturation, % | 95.19 | 107.08 | 101.75 |
| | Void Ratio | 0.56709 | 0.50924 | 0.53864 |
| | Normal Stress, psi | 20.065 | 40.023 | 59.999 |
| Max. Shear Stress, psi | 17.78 | 35.47 | 49.526 | |
| Ult. Shear Stress, psi | 17.338 | 34.953 | 49.323 | |
| Time to Failure, min | 548 | 608 | 639 | |
| Disp. Rate, %/min | 0.00063 | 0.00063 | 0.00063 | |

| | | |
|--------------------------------|--------------------------|---------------------------------|
| Project Name: JWVCD | Location: see site plan | Project Number: 202301-40-21-01 |
| Boring Number: 23-BH-14 | Tester: LP | Checker: |
| Sample Number: 1 | Test Date: 4-19-2024 | Depth: 15-16.5 |
| Test Number: 20 psi | Preparation: Shelby Tube | Elevation: NA |
| Client: | Classification: | Group Symbol: |
| Description: Silt (plastic) ML | | |
| Remarks: | | |

Consolidation Test

Summary Report

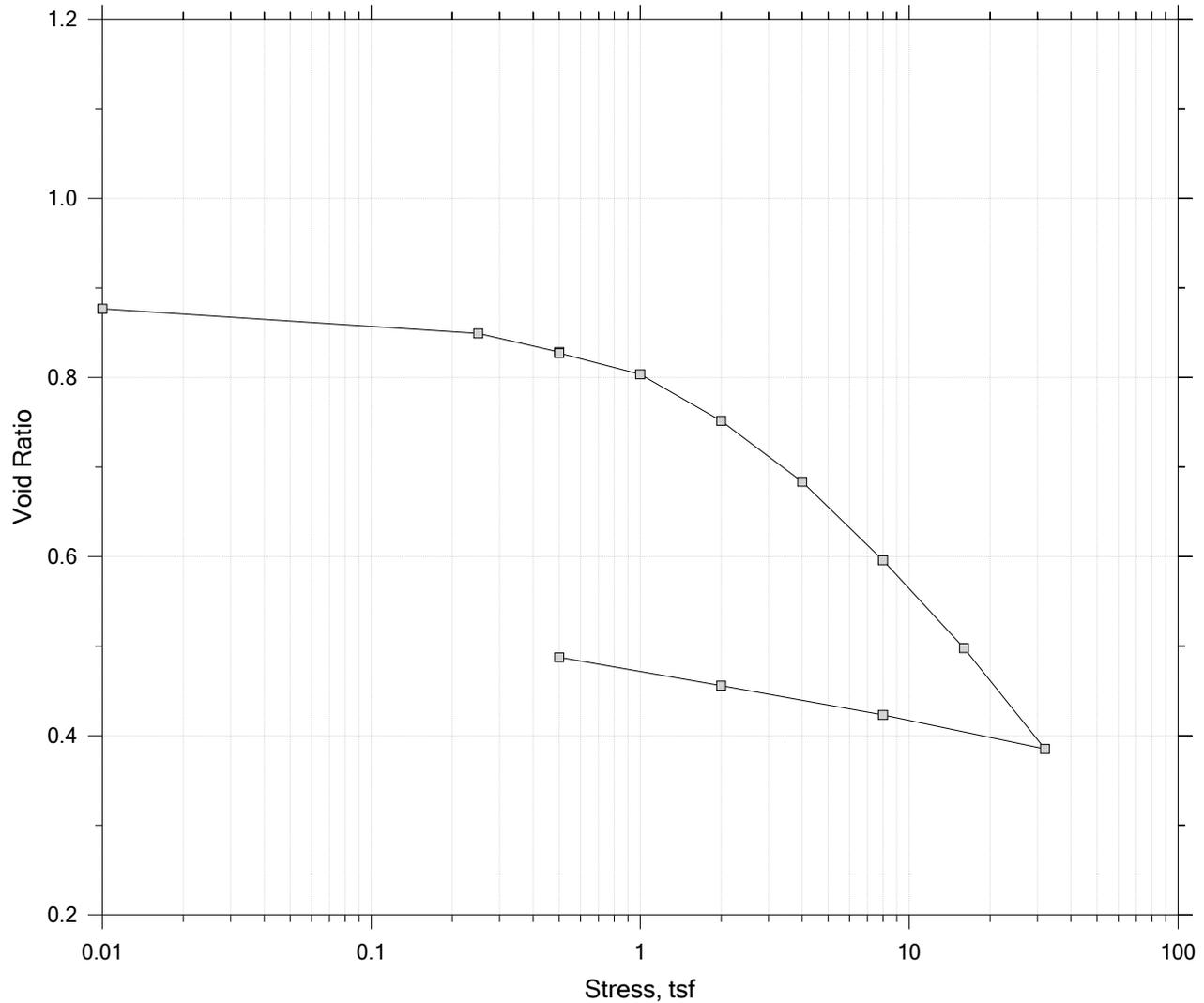


| | | | | Before Test | After Test | |
|---|--------|---------------------------|----------|----------------------|------------|---------|
| Current Vertical Effective Stress, tsf: --- | | | | Water Content, % | 42.41 | 28.92 |
| Preconsolidation Stress, tsf: --- | | | | Dry Unit Weight, pcf | 74.35 | 88.464 |
| Compression Ratio: --- | | | | Saturation, % | 90.38 | 86.26 |
| Specimen Diameter, in: 2.37 | | Specimen Height, in: 0.93 | | Void Ratio | 1.27 | 0.91 |
| LL: 32 | PL: 22 | PI: 10 | GS: 2.70 | Back Pressure, tsf | 0.29837 | 0.30067 |

| | | |
|--|--------------------------|---------------------------------|
| Project Name: JVWCD Aquaducts | Location: see site plan | Project Number: 202301-40-23-01 |
| Boring Number: 23-BH-01 | Tester: LP | Checker: |
| Sample Number: 1 | Test Date: 4/17/2024 | Depth: 4.5-6' |
| Test Number: 1 | Preparation: Shelby Tube | Elevation: |
| Description: Lean Clay CL | | |
| Remarks: Load Frame #68. Collapse Swell. Water added at start of Step 4. | | |
| Displacement at End of Increment | | |

Consolidation Test

Summary Report

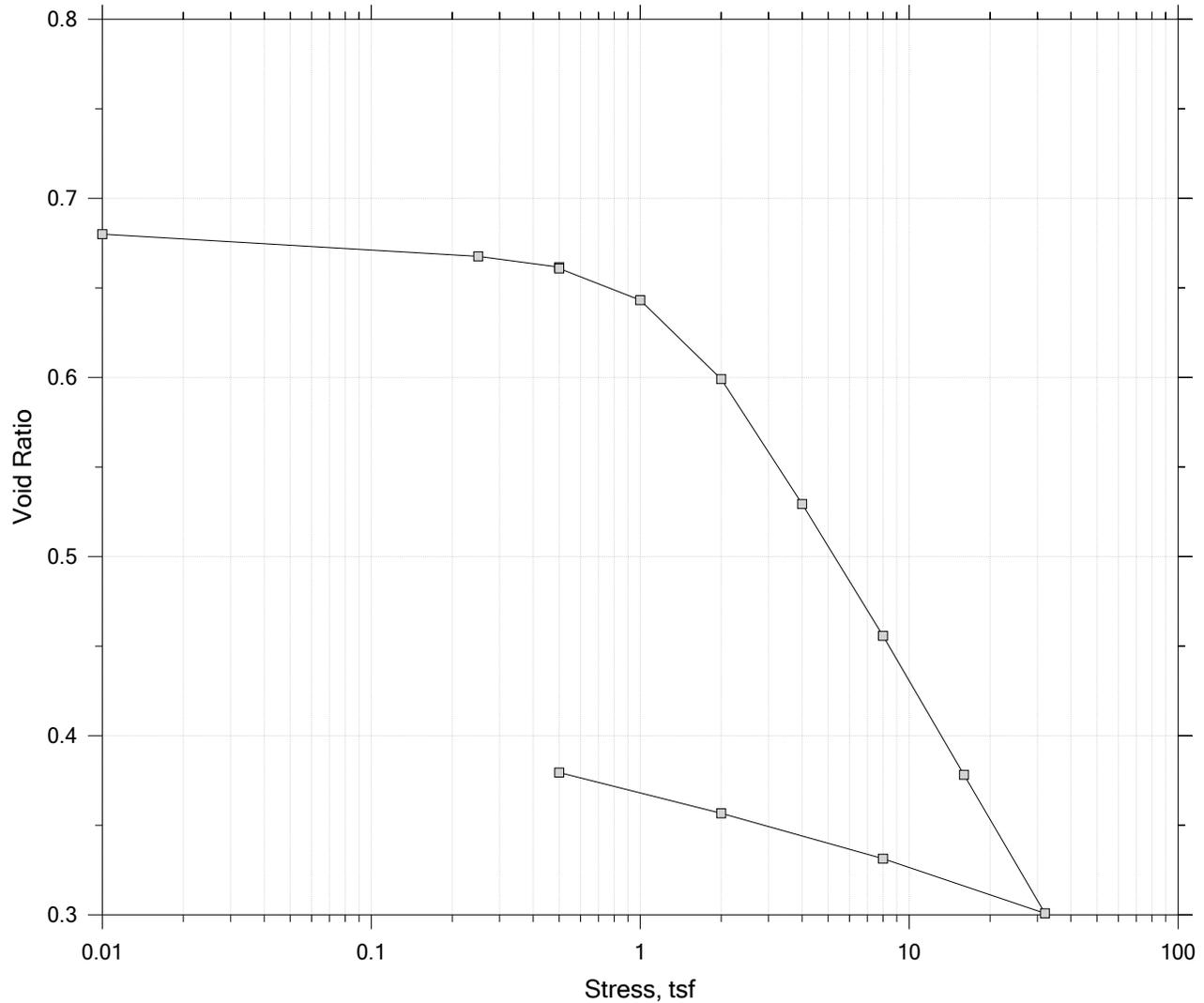


| | | | | Before Test | After Test | |
|---|--------|----------------------------|----------|----------------------|------------|--------|
| Current Vertical Effective Stress, tsf: --- | | | | Water Content, % | 30.87 | 24.09 |
| Preconsolidation Stress, tsf: --- | | | | Dry Unit Weight, pcf | 89.822 | 113.32 |
| Compression Ratio: --- | | | | Saturation, % | 95.08 | 133.43 |
| Specimen Diameter, in: 2.37 | | Specimen Height, in: 0.902 | | Void Ratio | 0.88 | 0.49 |
| LL: 31 | PL: 19 | PI: 12 | GS: 2.70 | Back Pressure, tsf | 4.048 | 4.112 |

| | | | | |
|--|--------------------------------------|--|--------------------------|---------------------------------|
| | Project Name: JVWCD | | Location: See site plan | Project Number: 202301-40-23-01 |
| | Boring Number: 23-BH-2 | | Tester: LP | Checker: |
| | Sample Number: 1 | | Test Date: 4-17-2024 | Depth: 3-4.5' |
| | Test Number: 1 | | Preparation: Shelby Tube | Elevation: |
| | Description: Lean Clay CL | | | |
| | Remarks: Loadframe #69 Colapse Swell | | | |
| | Displacement at End of Increment | | | |

One-Dimensional Consolidation by ASTM D2435 - Method A

Summary Report

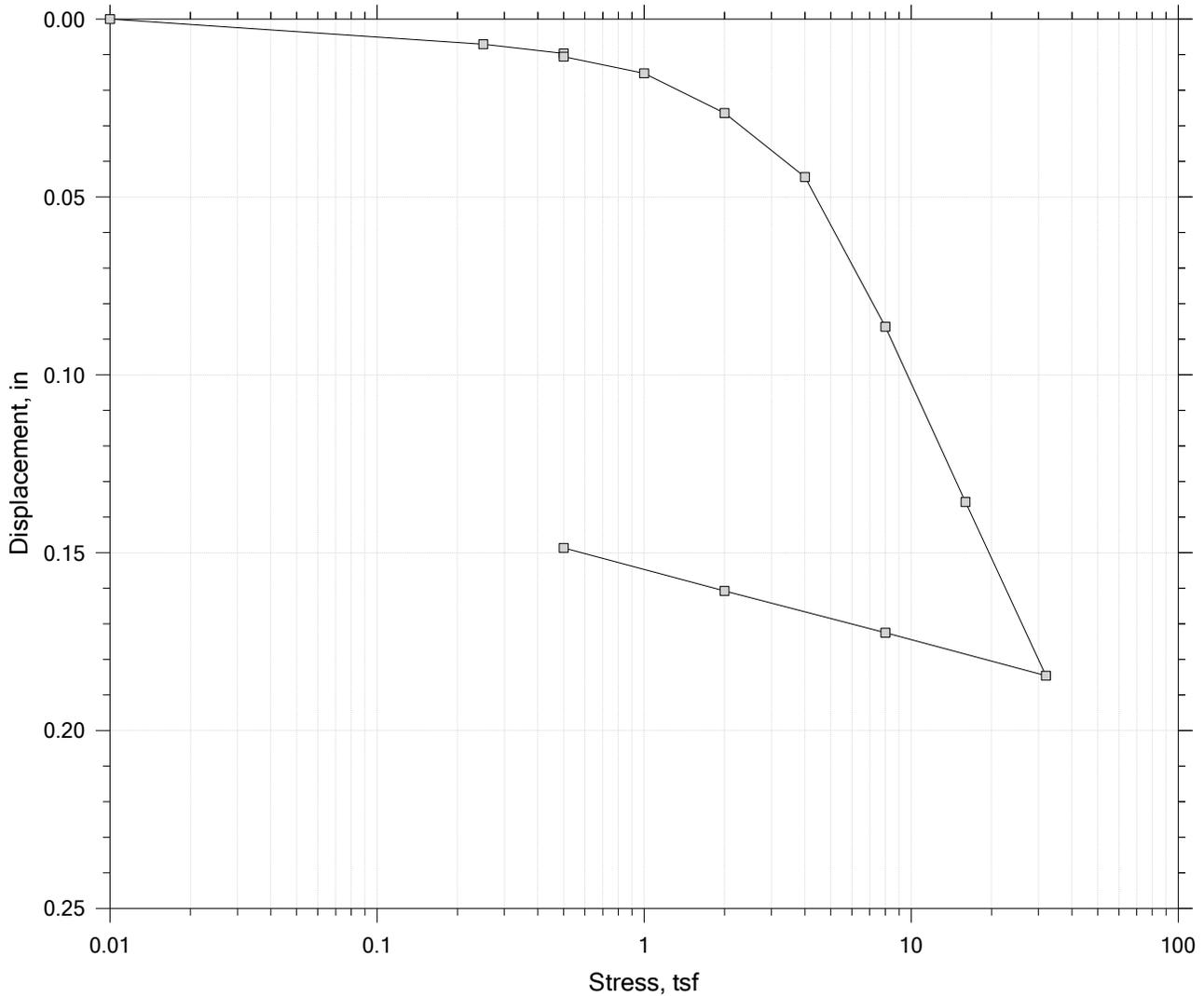


| | | Before Test | After Test | |
|---|----------------------------|----------------------|------------|--------|
| Current Vertical Effective Stress, tsf: --- | | Water Content, % | 17.61 | 14.48 |
| Preconsolidation Stress, tsf: --- | | Dry Unit Weight, pcf | 100.37 | 122.19 |
| Compression Ratio: --- | | Saturation, % | 69.97 | 103.02 |
| Specimen Diameter, in: 2.37 | Specimen Height, in: 0.927 | Void Ratio | 0.68 | 0.38 |
| LL: 29 | PL: 15 | PI: 14 | GS: 2.70 | |

| | | |
|---|--------------------------|---------------------------------|
| Project Name: JVWCD Aquaduct | Location: See site plan | Project Number: 202301-40-23-01 |
| Boring Number: 23-BH-04 | Tester: LP | Checker: |
| Sample Number: 1 | Test Date: 4/17/2024 | Depth: 12-13.5 |
| Test Number: 1 | Preparation: Shelby Tube | Elevation: |
| Description: Lean Clay CL | | |
| Remarks: Load Frame #72. Collapse Swell | | |
| Displacement at End of Increment | | |

Consolidation Test

Summary Report

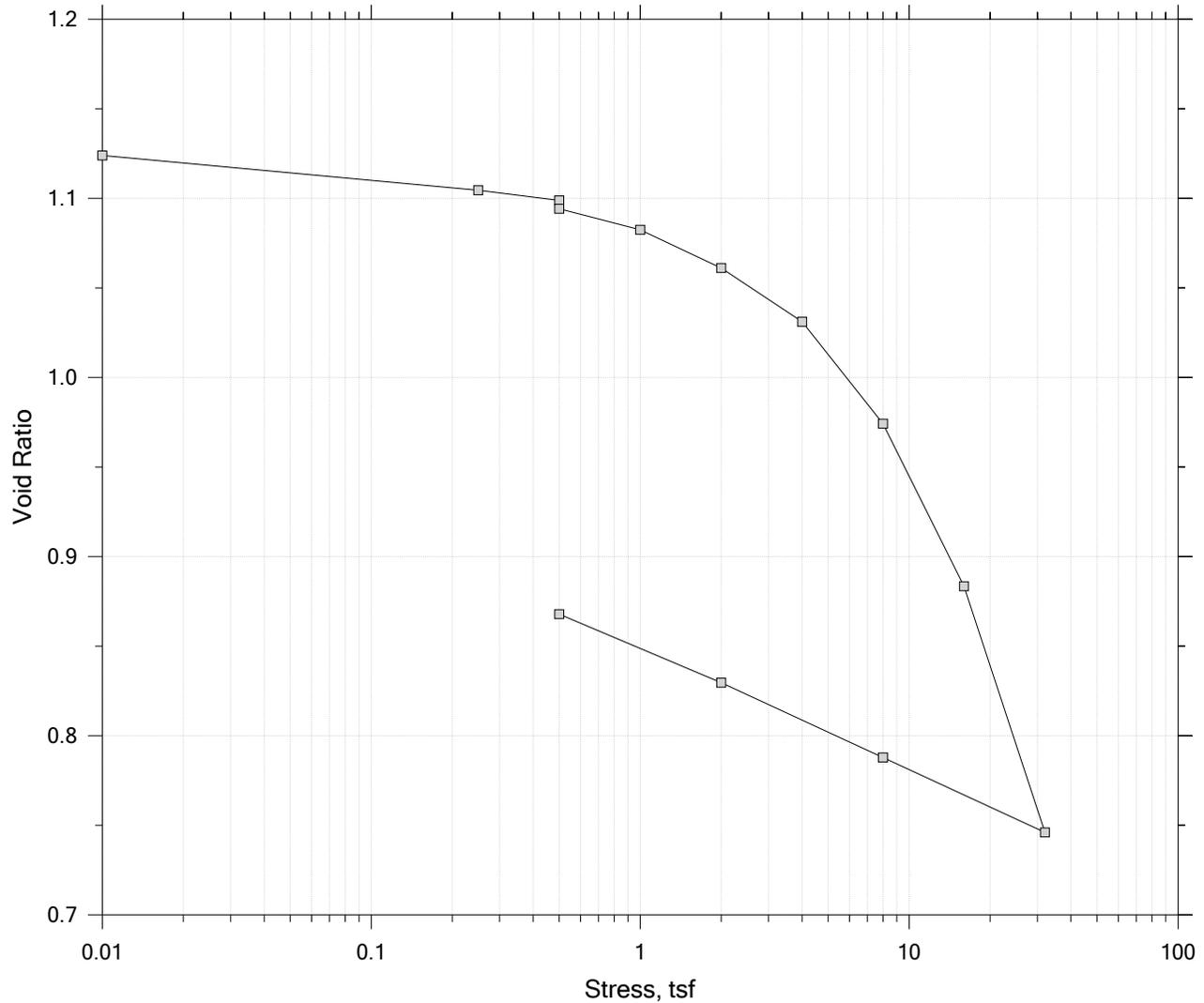


| | | | | Before Test | After Test | |
|---|--------|----------------------------|----------|----------------------|------------|----------|
| Current Vertical Effective Stress, tsf: --- | | | | Water Content, % | 29.16 | 23.04 |
| Preconsolidation Stress, tsf: --- | | | | Dry Unit Weight, pcf | 91.731 | 108.3 |
| Compression Ratio: --- | | | | Saturation, % | 94.02 | 111.81 |
| Specimen Diameter, in: 2.37 | | Specimen Height, in: 0.972 | | Void Ratio | 0.84 | 0.56 |
| LL: 45 | PL: 20 | PI: 25 | GS: 2.70 | Back Pressure, tsf | 0.001152 | 0.001152 |

| | | |
|---|--------------------------|---------------------------------|
| Project Name: JWCD Aquaduct | Location: See site plan | Project Number: 202301-40-23-01 |
| Boring Number: 23-BH-06 | Tester: JB | Checker: |
| Sample Number: 1 | Test Date: 4-22-2024 | Depth: 18-19.5' |
| Test Number: 1 | Preparation: Shelby Tube | Elevation: |
| Client: | Classification: | Group Symbol: |
| Description: Lean Clay CL | | |
| Remarks: Load frame #71. Collapse Swell | | |
| Displacement at End of Increment | | |

One-Dimensional Consolidation by ASTM D2435 - Method A

Summary Report

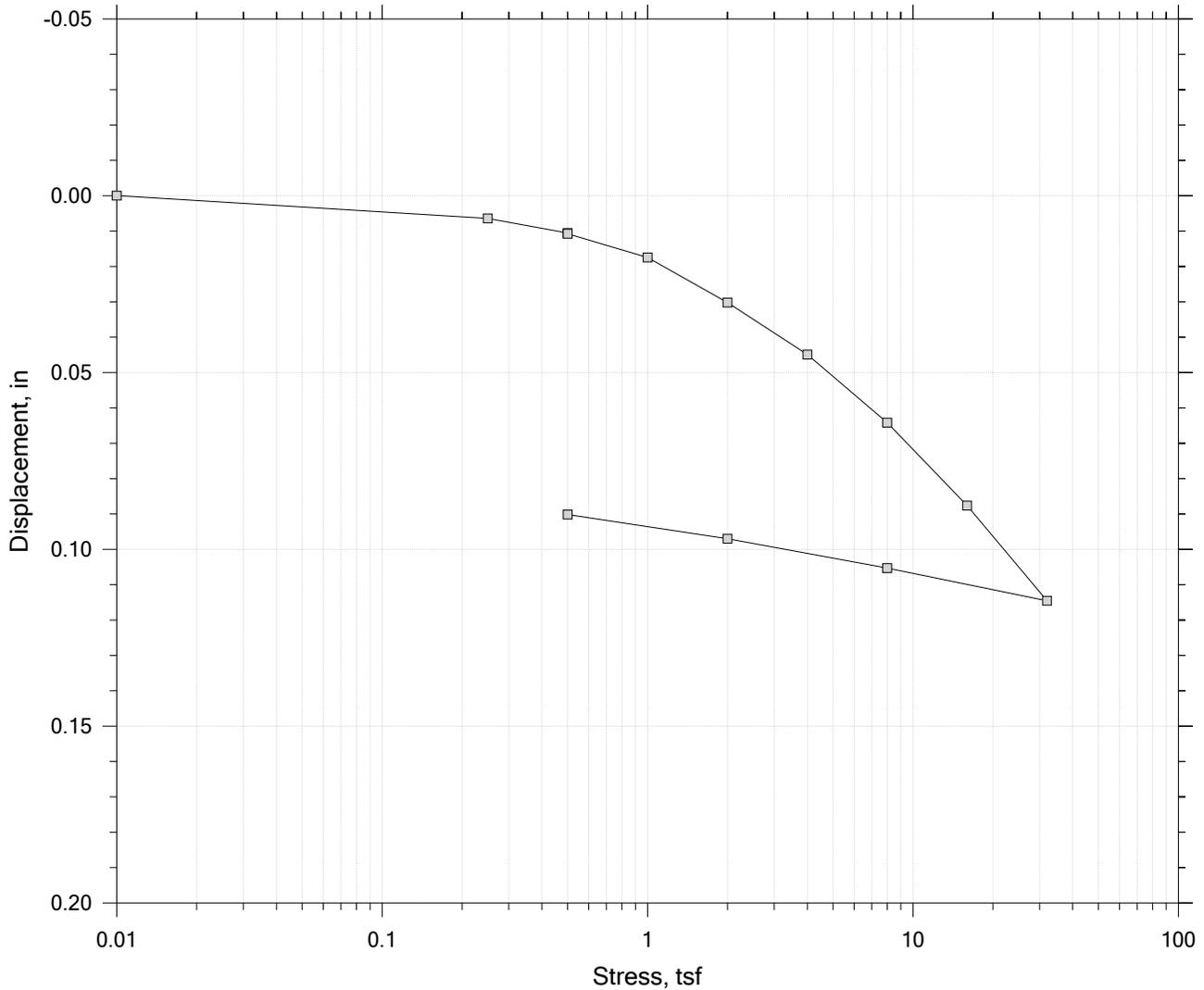


| | | | | Before Test | After Test |
|---|----------------------------|----------------------|------------|-------------|------------|
| Current Vertical Effective Stress, tsf: --- | | Water Content, % | | 44.58 | 39.91 |
| Preconsolidation Stress, tsf: --- | | Dry Unit Weight, pcf | | 79.374 | 90.264 |
| Compression Ratio: --- | | Saturation, % | | 107.12 | 124.25 |
| Specimen Diameter, in: 2.37 | Specimen Height, in: 0.966 | | Void Ratio | 1.12 | 0.87 |
| LL: 44 | PL: 16 | PI: 28 | GS: 2.70 | | |

| | | |
|---|--------------------------|---------------------------------|
| Project Name: JVWCD Aquaduct | Location: See site plan | Project Number: 202301-40-23-01 |
| Boring Number: 23-BH-07 | Tester: JB | Checker: |
| Sample Number: 1 | Test Date: 4-22-2024 | Depth: 3-4.5' |
| Test Number: 1 | Preparation: Shelby Tube | Elevation: |
| Description: Silt (plastic) ML | | |
| Remarks: Load Frame #72. Collapse Swell | | |
| Displacement at End of Increment | | |

Consolidation Test

Summary Report

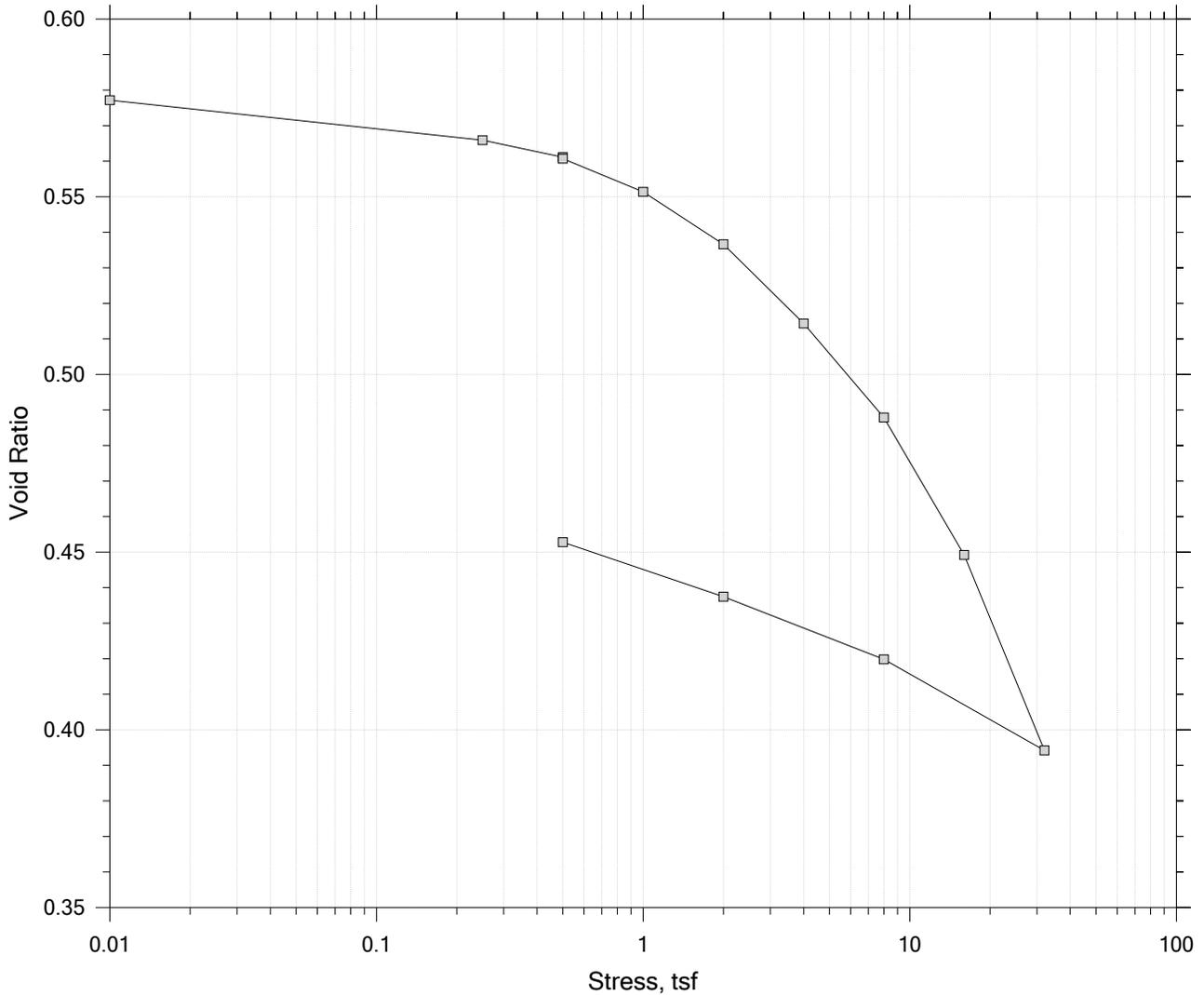


| | | | | Before Test | After Test | |
|---|--------|----------------------------|----------|----------------------|------------|----------|
| Current Vertical Effective Stress, tsf: --- | | | | Water Content, % | 20.13 | 17.38 |
| Preconsolidation Stress, tsf: --- | | | | Dry Unit Weight, pcf | 98.902 | 108.85 |
| Compression Ratio: --- | | | | Saturation, % | 77.16 | 85.57 |
| Specimen Diameter, in: 2.37 | | Specimen Height, in: 0.987 | | Void Ratio | 0.70 | 0.55 |
| LL: 30 | PL: 18 | PI: 12 | GS: 2.70 | Back Pressure, tsf | 0.001152 | 0.001152 |

| | | |
|---|--------------------------|---------------------------------|
| Project Name: JWCD Aquaduct | Location: See site plan | Project Number: 202301-40-23-01 |
| Boring Number: 23-BH-09 | Tester: LP | Checker: |
| Sample Number: 1 | Test Date: 4/17/2024 | Depth: 21-22.5' |
| Test Number: 1 | Preparation: Shelby Tube | Elevation: |
| Client: | Classification: | Group Symbol: |
| Description: Lean Clay w/ Sand CL | | |
| Remarks: Load frame #71. Collapse Swell | | |
| Displacement at End of Increment | | |

Consolidation Test

Summary Report



| | | | | Before Test | After Test | |
|---|--------|---------------------------|----------|----------------------|------------|--------|
| Current Vertical Effective Stress, tsf: --- | | | | Water Content, % | 21.04 | 18.52 |
| Preconsolidation Stress, tsf: --- | | | | Dry Unit Weight, pcf | 106.89 | 116.02 |
| Compression Ratio: --- | | | | Saturation, % | 98.46 | 110.47 |
| Specimen Diameter, in: 2.37 | | Specimen Height, in: 0.97 | | Void Ratio | 0.58 | 0.45 |
| LL: 27 | PL: 19 | PI: 8 | GS: 2.70 | Back Pressure, tsf | 4.08 | 4.112 |

| | | |
|--------------------------------------|--------------------------|---------------------------------|
| Project Name: JVWCD | Location: See site plan | Project Number: 202301-40-23-01 |
| Boring Number: 23-BH-15 | Tester: JB | Checker: |
| Sample Number: 1 | Test Date: 4-22-2024 | Depth: 3-4.5' |
| Test Number: 1 | Preparation: Shelby Tube | Elevation: |
| Description: Lean Clay CL | | |
| Remarks: Loadframe #69 Colapse Swell | | |
| Displacement at End of Increment | | |