# City of Cottonwood

## Engineering Dept.

Date: 06.24.2016

Response to comments submitted in regards to City of Cottonwood, IFB 2016-PW-10.

1. *A Pre Bid meeting will take place at 9:00 A.M. on Friday, July 1, 2016 onsite. Prospective bidders shall furnish their own PPE (consisting of hard hat, safety vest, steel toed work boots and safety glasses) for the site visit.*

2. Whose responsibility is it to construct the Access Road to the Steel Tank site?
   A) Steel Tank Contractor
   B) Reclamation Project Contractor

   *The proposed tank site is adjacent to the new Riverfront Water Reclamation Facility currently under construction. There are two developed access points to the site, one from 10th Street (identified as the Felix Construction jobsite entrance) and a second via a maintenance road at the east end of Riverfront Drive. Site access will need to be coordinated with Felix Construction and depending on the route chosen for access, maintenance of the access road shall be performed by the Steel Tank contractor unless coordinated with Felix Construction and identified in writing.*

3. Soils report is needed for the design of the tank foundation. Will the City provide report?

   *A copy of the soils report and Addendum #4 to the Riverfront WRF project addressing the requirement to proof load the tank site soils for 1-week prior to the connection of site piping are attached.*

4. Will there be site drawings available to for the Steel Tank Site?

   *Copies of the plan sheets showing the site plan of the Riverfront WRF and the location of the proposed Bolted Steel Tank are attached.*

5. Will you be able to provide Geo Tech Report where the Tank will be resting on?

   *See response to #5 above.*

6. Where is the specific location of the tank?

   *See site plan attached (Sheet C6).*

7. Will the site be graded flat by the City?

   *The site has been built up per the recommendations outlined in the geotechnical report and Addendum #4, is rough graded and compacted.*


1490 W Mingus Avenue. Cottonwood, AZ 86326 PHONE: 928.634.8033 FAX: 928.634.7285

8. What permits will be required? ADEQ? City of Cottonwood building permits?

   *City of Cottonwood Building Permit*

9. Will utility connections to the tank be by the City?

   *Connections will need to be coordinated with Felix Construction.*

10. P 42, 2.3 refers to plans. Are plans available?

    *See response to #8 above.*

11. P42, 3.1 refers to foundation design. Is that design available? It also state that soils report is included in contract documents. Is there a soils report available?

    *See response to #5 above.*

12. The specifications reference Drawings; however, there were no drawings included with the Solicitation package.

    *See response to #8 above.*

13. The solicitation package is also lacking to specify the type of base desired. Concrete? Concrete ring with structural fill?

    *The site is built up with 4' of structural fill per the geotechnical report. Prospective bidders shall submit bid pricing for both foundation options.*

14. We would also like to see the layout and general arrangement of the site.

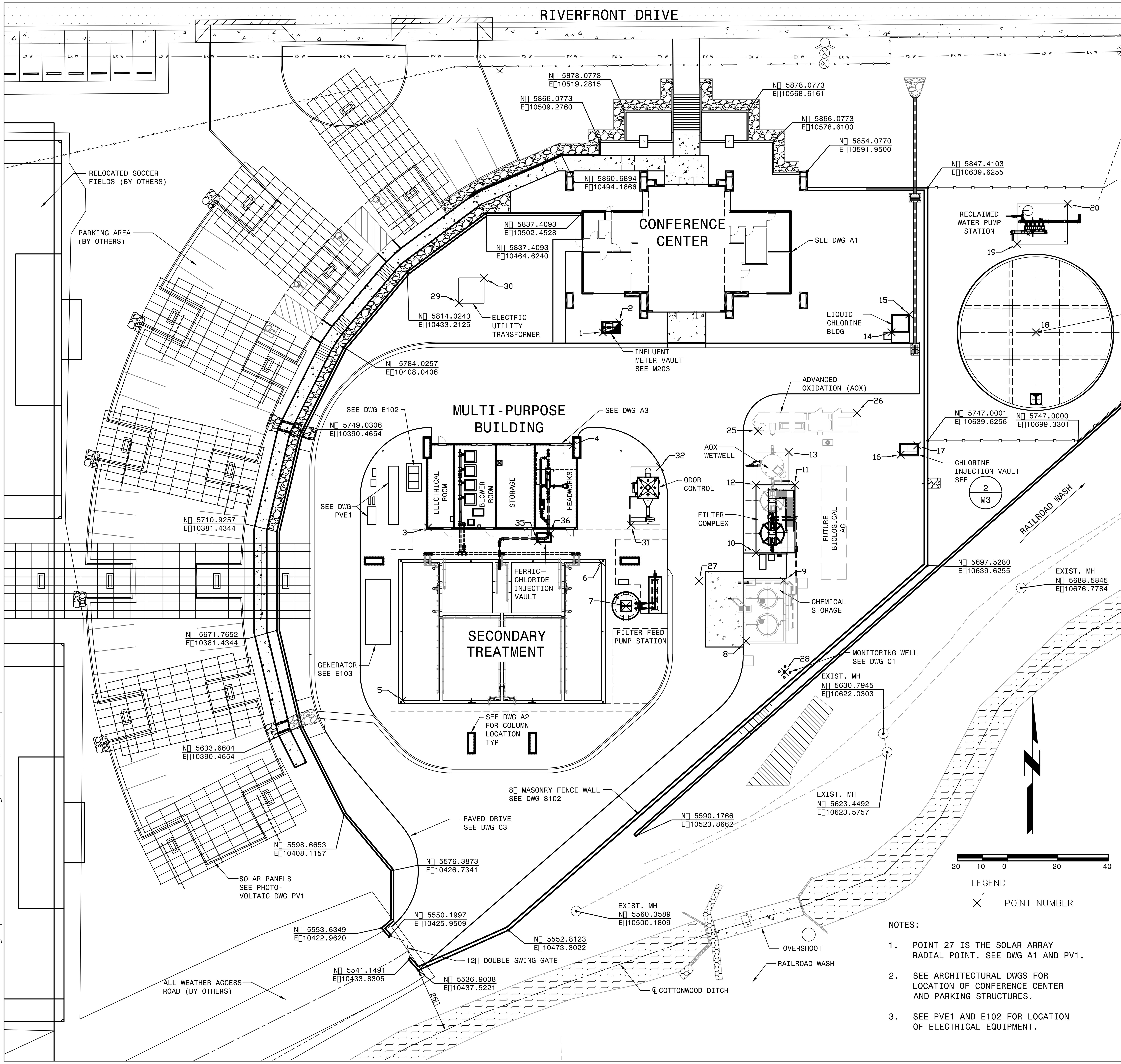
    *See response to #8 above.*

15. Have you considered Cathodic Protection Corrosion Control for this new tank? It works with a good coated tank to inhibit Corrosion and extend the life of the tank.

    *The soils report conducted for the site indicated a low corrosive potential for site soils to metallic objects. Therefore, we are not specifying Cathodic Protection (CP) as a requirement for this tank. If CP is integral to the proposed tank design, then the prospective bidder can arrange with the City to perform a soils test at their expense and include such system in their bids accordingly.*

16. Will there be any plan drawings for this tank? They mention inlet piping, outlet piping and drain piping, will these just be pipe nozzle connections at the tank wall and someone else supplying the rest of the piping?

    *This will be issued next week.*




NOTES:

1. POINT 27 IS THE SOLAR ARRAY RADIAL POINT. SEE DWG A1 AND PV1.
2. SEE ARCHITECTURAL DWGS FOR LOCATION OF CONFERENCE CENTER AND PARKING STRUCTURES.
3. SEE PVE1 AND E102 FOR LOCATION OF ELECTRICAL EQUIPMENT.

STRUCTURE & EQUIPMENT COORDINATES

| PNT# | STRUCTURE | NORTHING | EASTING | DESCRIPTION |
|---|---|---|---|---|
| 1 | INFLUENT METER VAULT SW | 5789.9700 | 10510.8143 | SW INSIDE CORNER |
| 2 | INFLUENT METER VAULT NE | 5793.9700 | 10517.3143 | NE INSIDE CORNER |
| 3 | MULTI-PURPOSE SW | 5712.6024 | 10441.4287 | SW INSIDE CORNER |
| 4 | MULTI-PURPOSE NE | 5745.2684 | 10498.7612 | NE INSIDE CORNER |
| 5 | AERO-MOD BUILDING SW | 5643.9423 | 10431.2617 | SW INSIDE CORNER |
| 6 | AERO-MOD BUILDING NE | 5698.6923 | 10510.2617 | NE INSIDE CORNER |
| 7 | FILTER FEED PUMP STATION | 5681.5000 | 10520.0000 | CENTER OF WETWELL |
| 8 | CHEMICAL STORAGE SW | 5667.4837 | 10567.5115 | SW INSIDE CORNER |
| 9 | CHEMICAL STORAGE NE | 5691.4827 | 10582.5109 | NE INSIDE CORNER |
| 10 | FILTER COMPLEX SW | 5702.5029 | 10571.5172 | SW CORNER |
| 11 | FILTER COMPLEX NE | 5729.4911 | 10587.0104 | NE CORNER |
| 12 | AOX WETWELL SW | 5729.4911 | 10571.5172 | SW CORNER |
| 13 | AOX WETWELL NE | 5742.4647 | 10584.5115 | NE CORNER |
| 14 | GAS CHLORINE BLDG SW | 5790.1065 | 10625.2915 | SW OUTSIDE CORNER |
| 15 | GAS CHLORINE BLDG NE | 5797.1065 | 10632.2915 | NE OUTSIDE CORNER |
| 16 | CHLORINE INJECTION SW | 5741.5000 | 10628.9600 | SW INSIDE CORNER |
| 17 | CHLORINE INJECTION NE | 5745.1600 | 10635.4600 | NE INSIDE CORNER |
| 18 | RECLAIMED WATER RESERVOIR | 5790.0000 | 10682.6255 | CENTER OF TANK |
| 19 | RECLAIMED WATER STATION SW | 5825.0000 | 10675.1335 | SW CORNER |
| 20 | RECLAIMED WATER STATION NE | 5841.0000 | 10695.1335 | NE CORNER |
| 21 | INFLUENT PUMP STATION SW | 5864.8783 | 10810.0087 | SW INSIDE CORNER |
| 22 | INFLUENT PUMP STATION NE | 5870.8783 | 10824.0087 | NE INSIDE CORNER |
| | | | | |
| | | | | |
| 25 | AOX SW | 5750.7980 | 10572.2816 | SW INSIDE CORNER |
| 26 | AOX NE | 5758.1313 | 10611.6150 | NE INSIDE CORNER |
| 27 | RADIAL PT | 5691.3454 | 10548.9539 | SEE NOTE 1 |
| 28 | MONITORING WELL | 5655.2440 | 10582.9085 | CENTER OF WELL |
| 29 | ELECTRIC UTILITY TRANSFORMER SW | 5801.6186 | 10453.6198 | SW CORNER |
| 30 | ELECTRIC UTILITY TRANSFORMER NE | 5811.6186 | 10463.6198 | NE CORNER |
| 31 | ODOR CONTROL SW | 5713.6808 | 10521.9669 | SW CORNER |
| 32 | ODOR CONTROL NE | 5736.6779 | 10533.4620 | NE CORNER |
| | | | | |
| | | | | |
| 35 | FERRIC CHLORIDE INJECTION VAULT SW | 5707.1021 | 10484.9387 | SW INSIDE CORNER |
| 36 | FERRIC CHLORIDE INJECTION VAULT NE | 5710.1021 | 10489.9387 | NE INSIDE CORNER |

0 1/2 1
IF THIS BAR DOES NOT MEASURE 1", THEN DRAWING IS NOT TO SCALE


CALL TWO WORKING DAYS BEFORE YOU DIG
602-263-1100
1-800-STAKE-IT
(OUTSIDE MARICOPA COUNTY)


# CITY OF COTTONWOOD

## RIVERFRONT WATER RECLAMATION FACILITY

CIVIL SITE PLAN HORIZONTAL CONTROL

EXPIRES 06-30-18


WOOD/PATEL
CIVIL ENGINEERS
HYDROLOGISTS
LAND SURVEYORS
CONSTRUCTION MANAGERS
2051 W. Northern Ave.
Phoenix, AZ 85021
(602) 335-8500
www.woodpatel.com
PHOENIX • MESA • TUCSON

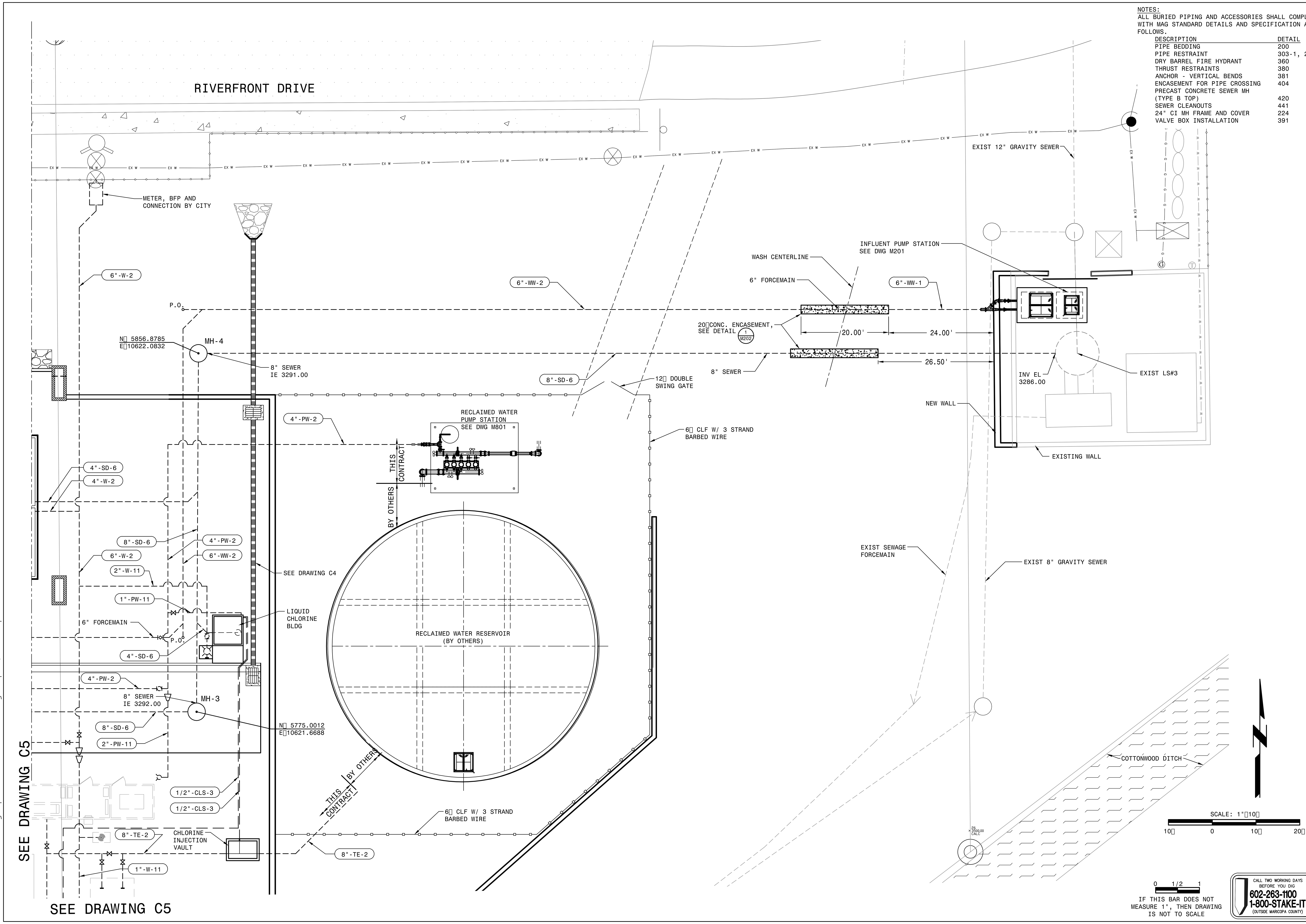

ENGINEER K KNICKERBOCKER
DESIGNER L ANDERSON
CAD TECHNICIAN J COOPER
SCALE 1"=20'
DATE 09/28/2015
JOB NUMBER 113700
DRAWING C3



N:\2011\113700 Riverfront\Dwg\90percent\CAD\ 09-3100-C3.dwg - Sep 28,2015 4:26pm

NOTES:
ALL BURIED PIPING AND ACCESSORIES SHALL COMPLY WITH MAG STANDARD DETAILS AND SPECIFICATION AS FOLLOWS.

| DESCRIPTION | DETAIL |
|---|---|
| PIPE BEDDING | 200 |
| PIPE RESTRAINT | 303-1, 2 |
| DRY BARREL FIRE HYDRANT | 360 |
| THRUST RESTRAINTS | 380 |
| ANCHOR - VERTICAL BENDS | 381 |
| ENCASEMENT FOR PIPE CROSSING | 404 |
| PRECAST CONCRETE SEWER MH (TYPE B TOP) | 420 |
| SEWER CLEANOUTS | 441 |
| 24" CI MH FRAME AND COVER | 224 |
| VALVE BOX INSTALLATION | 391 |




SEE DRAWING C5

SEE DRAWING C5

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IF THIS BAR DOES NOT MEASURE 1", THEN DRAWING IS NOT TO SCALE

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# CITY OF COTTONWOOD
## RIVERFRONT WATER RECLAMATION FACILITY
### SITE YARD PIPING PLAN 2

Riverfront Water Reclamation Facility

Registered Professional Engineer (Civil) 13634 K.L. KNICKERBOCKER ARIZONA, U.S.A.
EXPIRES 06-30-18


WOOD/PATEL
CIVIL ENGINEERS
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CONSTRUCTION MANAGERS
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Phoenix, AZ 85021
(602) 335-8500
www.woodpatel.com
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ENGINEER K KNICKERBOCKER
DESIGNER L ANDERSON
CAD TECHNICIAN J COOPER
SCALE 1"□10□
DATE 09/28/2015
JOB NUMBER 113700
DRAWING C6
SHEET 12 OF 176

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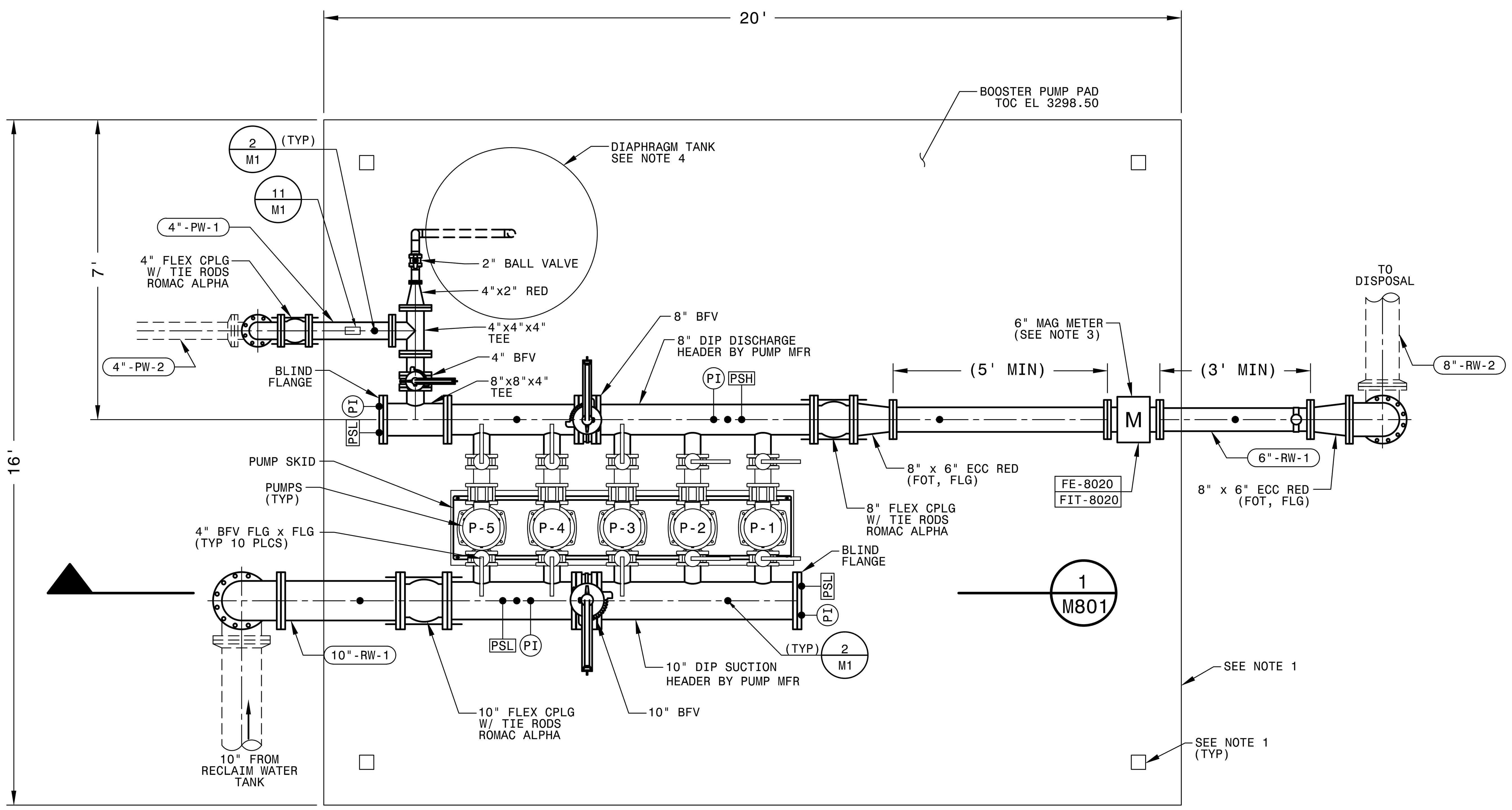


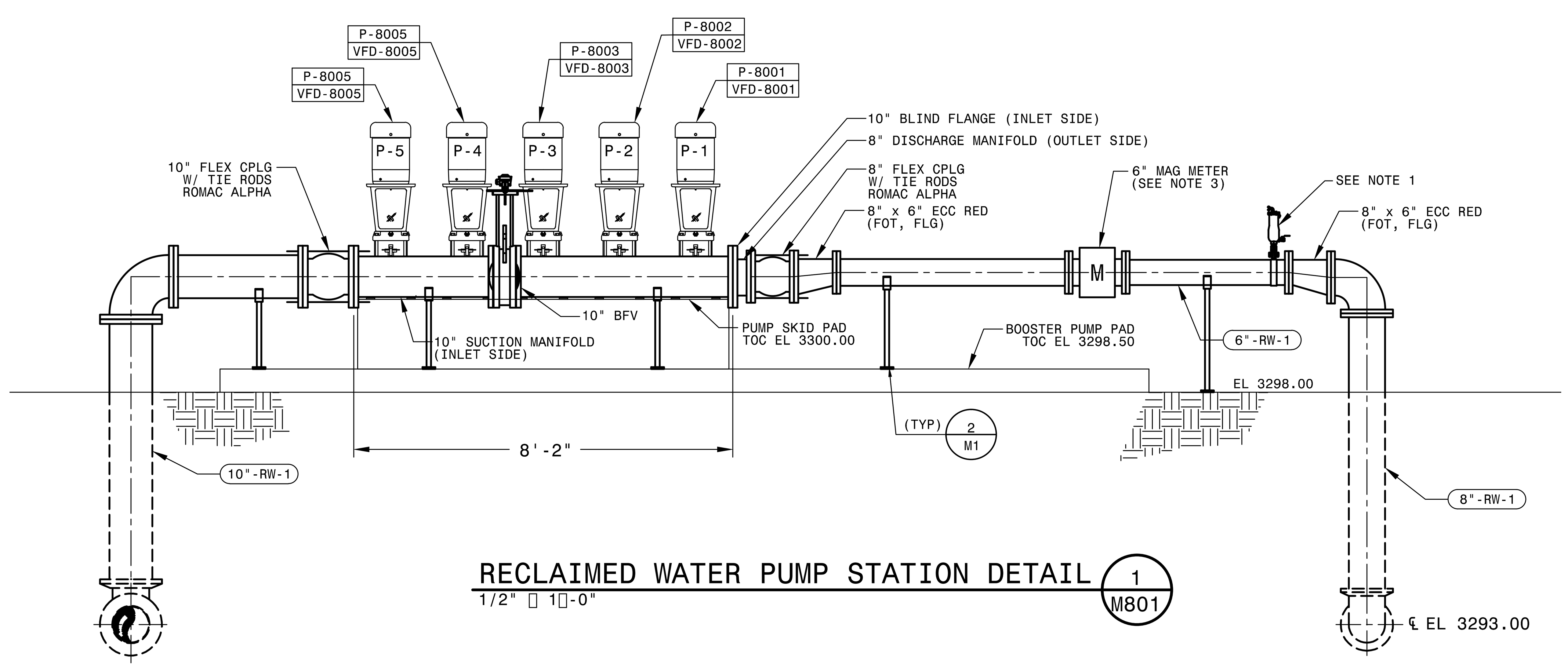

RECLAIMED WATER PUMP STATION PLAN

1/2" = 1'-0"

SCALE: 1/2"=1'-0"

NOTES:

1. SEE S801 FOR SUN SHADE CANOPY AND SLAB.
2. PROVIDE TAP AND 1" DIA AIR RELEASE VALVE ON PUMP DISCHARGE HEADER IN ACCORDANCE WITH SPEC. SECTION 15103.
3. CONTRACTOR SHALL INSTALL MAGNETIC FLOW METER ON DISCHARGE HEADER.
4. BLADDER TANK AS MANUFACTURED BY JOHN WOOD COMPANY, MODEL JOER-22-017 OR APPROVED EQUAL.




RECLAIMED WATER PUMP STATION DETAIL

1/2" = 1'-0"

1
M801

0 1/2 1
IF THIS BAR DOES NOT MEASURE 1", THEN DRAWING IS NOT TO SCALE

CALL TWO WORKING DAYS BEFORE YOU DIG
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1-800-STAKE-IT
(OUTSIDE MARICOPA COUNTY)

# CITY OF COTTONWOOD
## RIVERFRONT WATER RECLAMATION FACILITY
### RECLAIMED WATER PUMP STATION PLAN AND DETAIL

Riverfront Water Reclamation Facility

Registered Professional Engineer
Certificate No. 13634
K.L. KNICKERBOCKER
ARIZONA, U.S.A.
EXPIRES 06-30-18

WOOD/PATEL
CIVIL ENGINEERS
HYDROLOGISTS
LAND SURVEYORS
CONSTRUCTION MANAGERS
2051 W. Northern Ave.
Phoenix, AZ 85021
(602) 335-8500
www.woodpatel.com
PHOENIX • MESA • TUCSON

| | |
|---|---|
| ENGINEER | K. KNICKERBOCKER |
| DESIGNER | L. ANDERSON |
| CAD TECHNICIAN | J. COOPER |
| SCALE | - |
| DATE | 09/28/2015 |
| JOB NUMBER | 113700 |
| DRAWING | M801 |
| SHEET | 44 OF 176 |

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**GEOTECHNICAL EVALUATION**

**RIVERFRONT WATER RECLAMATION FACILITY**
**SEC: RIVERFRONT ROAD AND 10TH STREET**
**COTTONWOOD, ARIZONA**
**JOB NO. 2521JW415**


**Western Technologies Inc.**
The Quality People
Since 1955

FLAGSTAFF – ARIZONA
2400 East Huntington Drive
Flagstaff, Arizona 86004-8934
(928) 774-8700 • fax 774-6469


**NOTICE**
Electronic Copy of Final Document; sealed original document is with Maximilian Kemnitz AZ P.E. No. 35389

Prepared for:

**WOOD/PATEL AND ASSOCIATES**

March 22, 2012

Registered Professional Engineer (Civil)
CERTIFICATE NO. 35389
MAXIMILIAN KEMNITZ
Date Signed 3/22/12
ARIZONA, U.S.A.
Expires 9/30/12


Maximilian Kemnitz, P.E.
Geotechnical Engineer

Reviewed by: Bruce M. Mac Ilroy, P.E.
Senior Geotechnical Engineer





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**Western Technologies Inc.**
The Quality People
Since 1955

2400 East Huntington Drive
Flagstaff, Arizona 86004
(928) 774-8700 • fax (928) 774-6469

March 22, 2012

Wood/Patel and Associates
2061 West Northern Avenue, Suite 100
Phoenix, Arizona 85021

Attn: Mr. Kenneth Knickerbocker, P.E., R.L.S.
Director, Wastewater

Re: Geotechnical Evaluation
Riverfront Water Reclamation Facility
SEC: Riverfront Road and 10th Street
Cottonwood, Arizona

Job No. 2521JW415

Western Technologies Inc. has completed the geotechnical evaluation for the proposed Riverfront Water Reclamation Facility in Cottonwood, Arizona. This study was performed in general accordance with our proposal number 2521PR248 dated May 19, 2011. The results of our study, including the boring location diagram, laboratory test results, boring logs, and the geotechnical recommendations are attached.

We have appreciated being of service to you in the geotechnical engineering phase of this project and are prepared to assist you during the construction phases as well. If design conditions change, or if you have any questions concerning this report or any of our testing, inspection, design and consulting services, please do not hesitate to contact me. I look forward to working with you on future projects.

Sincerely,
WESTERN TECHNOLOGIES, INC.
Geotechnical Engineering Services

Maximilian Kemnitz, P.E.
Geotechnical Engineer

Copies to: Addressee (3)

## TABLE OF CONTENTS

**GEOTECHNICAL EVALUATION**
**RIVERFRONT WATER RECLAMATION FACILITY**
**SEC: RIVERFRONT ROAD AND 10TH STREET**
**COTTONWOOD, ARIZONA**
**JOB NO. 2521JW415**

## 1.0 PURPOSE

This report contains the results of our geotechnical evaluation for the proposed Riverfront Water Reclamation Facility in Cottonwood, Arizona. The purpose of these services is to provide information and recommendations regarding:

- foundation design parameters
- slab-on-grade support
- lateral earth pressures
- earthwork
- asphalt pavement sections
- drainage
- groundwater
- excavation conditions
- slopes
- corrosivity

Results of the field exploration, field tests, and laboratory testing program are presented in the Appendices.

## 2.0 PROJECT DESCRIPTION

Project information supplied by Mr. Kenneth Knickerbocker, P.E., and Mr. Larry Anderson, P.E., with Wood/Patel and Associates (Wood/Patel) indicates that the proposed water reclamation facility will comprise a new treatment plant building, an administration/visitor building, treatment units south of the administration building, a buried reclaimed water storage tank located west of the treatment building, and site piping. The site will be raised to an approximate elevation of 3,300 feet above mean sea level (AMSL), and will require about 2 to 8 feet of fill to reach final site grade. Site piping will generally be 5 to 8 feet below final site grade. Asphalt concrete pavement for passenger and light truck parking will be located west of the plant building, and two soccer fields are planned west of the parking.

The treatment plant building will include a rectangular tank about 140 feet long and 40 feet wide, established about 18 feet below final site grade; approximately at elevation 3,282 feet AMSL. The tank will be constructed with reinforced concrete and will be 18 feet tall with 2 feet of freeboard. We anticipate that pressures on the interior of the tank will be approximately 1,000 pounds per square foot (psf). Maximum wall and column loads for the building and tank are assumed to be about 4 to 5 kips per lineal foot (klf) and 50 kips, respectively.

We anticipate that the administration/visitor building will be a single-story structure with a concrete slab-on-grade, constructed approximately at final site grade. The building will likely utilize shallow spread foundations with maximum wall and column loads of about 3 klf and 30 kips, respectively.

The buried reclaimed water tank will be 60 feet in diameter and 15 feet tall with 3 feet of freeboard, constructed about 15 feet below final site grade; approximately at elevation 3,285 feet AMSL. The tank will be of reinforced concrete construction with a concrete ring foundation. We anticipate that pressures on the interior of the tank will be approximately 800 psf due to fluid in the tank, and perimeter footings will carry the weight of the tank structure, approximately 3 klf.

Equipment will typically be established on equipment pads consisting of a mat-type or slab-on-grade foundation. These include blowers, headworks screen, grit basin and filters. In addition, there will be a 6-foot diameter, 1,200-gallon chemical storage tank established on a slab-on-grade. Pressures below the various equipment pads will be relatively light. About 500 psf is estimated for the filter pad, and other equipment pads will typically be 200 psf or less.

Should any of this information be incorrect, we request that the Client notify WT immediately.

## 3.0 SCOPE OF SERVICES

### 3.1 Field Exploration

Four borings were drilled to a depth of about 25 feet bgs and five borings were drilled to a depth of 10 feet bgs in locations selected by Wood/Patel. Based on topographic information provided by Wood/Patel, the approximate boring elevations are shown on the logs, and the approximate boring locations are shown on the attached boring location diagram. Logs of the borings are presented in Appendix A. Subsoils encountered during drilling were examined visually and sampled at selected depth intervals.

A field log was prepared for each boring. These logs contain visual classifications of the materials encountered during drilling as well as interpolation of the subsurface conditions between samples. Final logs, included in Appendix A, represent our interpretation of the field logs and include modifications based on laboratory observations and tests of the field samples. The final logs describe the materials encountered, their thicknesses, and the locations where samples were obtained.

The Unified Soil Classification System was used to classify soils. The soil classification symbols appear on the boring logs and are briefly described in Appendix A.

### 3.2 Laboratory Analyses

Laboratory analyses were performed on representative soil samples to aid in material classification and to estimate pertinent engineering properties of the on-site soils for preparation of this report. Testing was performed in general accordance with applicable ASTM and Arizona methods. The following tests were performed and the results are presented in Appendix B.

- Water content
- Dry density
- Compression/Consolidation
- Expansion
- Shear strength
- Gradation
- Plasticity
- Water soluble salts and sulfates
- ANSI corrosivity suite

### 3.3 Analyses and Report

Using the exploration and test data, we have performed engineering analyses oriented toward the purposes of our services. Results of our evaluation are presented herein and include a boring location diagram, boring logs, laboratory tests results, results of engineering analyses, conclusions and recommendations.

The scope of our services did not include any environmental assessment or investigation for the presence or absence of hazardous or toxic materials in the soil, surface water, groundwater or air, on, below or around this site. All conditions noted or observed are strictly for the information of our client. If environmental information is required, we recommend an environmental assessment be conducted which addresses environmental concerns.

## 4.0 SITE CONDITIONS

### 4.1 Surface

At the time of our exploration, a majority of the site comprised a soccer field and vacant areas. The site elevation varied from about 3292 along River Front Road, bordering the north side of the site, to 3297 along the Cottonwood drainage ditch, bordering the south side of the site. The Cottonwood drainage ditch was about 4 feet wide and 3 feet deep, and was elevated on a fill embankment with a crest elevation of approximately at 3,300 feet AMSL. Dense trees were located along the drainage ditch. We understand that the ditch is unlined. Spread fill and construction debris were observed on the surface of the site, primarily east of the soccer field. Site drainage was generally to the north-northeast.

### 4.2 Subsurface

As presented on the boring logs, surface soils to depths of about 9 to 14 feet were predominantly found to be firm to hard, low to medium plasticity clays and silts. Silty sand fill was encountered in some of the borings; to depths of 1 to 2 feet in Boring Nos. 2 and 3, and to a depth of about 5 feet in Boring No. 7 where a fill berm was present around the soccer field. The materials underlying the surface soils and extending to depths of exploration (10 to 25 feet below existing site grade) consisted of loose to medium dense sands and gravels, with varying amounts of fines. The logs in Appendix A show details of the subsurface conditions encountered during the field exploration.

### 4.3 Groundwater

Groundwater was encountered in Boring Nos. 1 through 4 at depths of 17 to 18 feet below the existing site grade, at approximate elevations of 3275 to 3278 feet AMSL. Water levels were checked at the completion of the individual borings; however, caving of the borings prevented additional measurements. Fluctuation of groundwater levels may occur for various reasons, such as variations in precipitation, evaporation, surface runoff, groundwater withdrawal and recharge. A more accurate evaluation of groundwater levels would require installing and monitoring piezometers over an extended time period.

## 5.0 GEOTECHNICAL PROPERTIES AND ANALYSIS

### 5.1 Laboratory Tests

Laboratory test results indicate that soils encountered in the borings varied from low to medium plasticity; the clay soils which were predominant within the upper 9 to 15 feet below existing site grade were typically of medium plasticity and exhibited a medium to high swell potential.

Laboratory test results indicated that fine grained and granular subsoils exhibited low to high compressibility at existing water contents and under approximate foundation loads. Low to very high additional compression occurred when the water content was increased under approximate foundation loads.

### 5.2 Field Tests

Native subsoils across the site exhibited predominantly low to moderate resistance to penetration using the standard penetration test method (ASTM D1586) and test method ASTM D3550. The common trend is for lower blow counts with increasing depth, particular where groundwater was encountered. This corresponds to a low bearing capacity and high settlement potential for native soils in the vicinity of groundwater in their present condition

## 6.0 RECOMMENDATIONS

### 6.1 General

Recommendations contained in this report are based on our understanding of the project criteria described in Section 2.0, **PROJECT DESCRIPTION**, and the assumption that the soil and subsurface conditions are those disclosed by the borings. Others may change the plans, final elevations, number and type of structures, foundation loads, and slab-on-grade elevations during design or construction. Substantially different subsurface conditions from those described herein may be encountered or become known. Any changes in the project criteria or subsurface conditions should be brought to our attention in writing.

### 6.2 Design Considerations

The borings indicate the presence of clay soils on the site. The clay soils may expand or shrink with changes in moisture content. Structures and related improvements situated on expansive clay soils could be subject to relatively large movements if the foundation soils experience an increase in moisture content. Due to the final site grade being 3 to 8 feet above the existing site grade, low to non-expansive import soils should be used in structure areas to mitigate the potential for damaging effects due to moisture changes in the clay soils. We recommend that selective grading be implemented such that the existing clay soils are not present within 4 feet of the bottom of any slabs-on-grade. Where some removal of clay soils is required to meet this requirement, the clay soils may be used in non-structural fill areas. In general, expansive clay soils should not be used as fill adjacent to or below rigid structures or slabs-on-grade. It should be understood that if moisture penetrates expansive soils, there could be some heave and resultant cracking/distress of the proposed structures and related improvements.

Due to the presence of soft to firm and loose soils at the site, and the presence of compressible fine-grained and granular soils, WT recommends removal and recompaction of these soils within structure areas below foundations and slabs-on-grade. The depth of removal will depend on the foundation type and the condition of soils exposed in excavations. Additional discussion is presented in the **EARTHWORK** section of this report. As previously recommended, moderately to highly expansive clay soils should not be used as fill adjacent to or below rigid structures or slabs-on-grade. Due to the extensive import fill required to raise the site, we anticipate sufficient granular soils will be available during earthwork to enable placement of low to non-expansive soils adjacent to or below rigid structures.

Groundwater was encountered during the current explorations at depths of approximately 17 to 18 feet below the ground surface at the time of our exploration, at approximate elevations of 3275 to 3278 feet AMSL). Therefore, dewatering may be required to facilitate construction where excavations are performed near groundwater elevation. Contractors should satisfy themselves as to the necessity of dewatering and the necessary dewatering methods. Stabilization of soft, wet soils near the groundwater level may also be required and recommendations are presented in the **EARTHWORK** section of this report. Unless permanent dewatering systems are provided, the design of the walls and floors should include provisions for anticipated hydrostatic pressures where there is the potential for water to rise above structure finish floor elevations.

### 6.3 Foundations

Considering the subsurface conditions and the proposed construction, the improvements may be founded on conventional spread foundations, mat type foundations, or slabs-on-grade. Due to significant collapse and settlement potentials, foundations should be established on engineered fill material placed in accordance with the recommendations presented in the **EARTHWORK** section of this report, and as summarized herein.

Conventional spread foundations should be established on at least 3 feet of engineered fill placed in accordance with the recommendations presented in the **EARTHWORK** section of this report. Upon removal of soils below the footing bottom to this depth, proof-rolling should be performed to identify any soft to firm, loose, or otherwise unstable soils. Additional removal and recompaction should be performed where soft to firm, loose, or otherwise unstable soils are still present at depths greater than 3 feet below the footing bottom. Footings should bear at least 18 inches below the lowest adjacent finished grade and may be designed to impose a maximum dead plus live-load pressure of up to 2000 pounds per square foot (psf).

Recommended minimum widths of column and wall footings are 24 inches and 16 inches, respectively. Finished grade is the lowest adjacent grade for perimeter footings and floor level for interior footings.

Where structures are established on mat-type foundations or slabs-on-grade, these foundations/slabs-on-grade should also be established on a minimum of 3 feet of engineered fill. These foundations or slabs-on-grade may be designed for an allowable bearing pressure of up to 500 psf where the foundation is established within the upper 10 feet below final site grade, and up to 1,500 psf where the foundation is established at depths of 15 feet or greater below final site grade. Dewatering will likely be required to facilitate removals and recompaction of existing soils below foundations for the structures to be established at about 18 feet below the final site grade, at approximate elevation 3,282 feet AMSL. For design of mat-type foundations or slabs-on-grade, we recommend using a modulus of subgrade reaction (k) of 150 pounds per cubic inch (pci).

Based on our understanding of the various structure types and load conditions, we anticipate total and differential settlements for foundations established as recommended, should not exceed 1 inch and ¾ inch, respectively. As previously indicated, foundations should be established on engineered fill.

Consideration should also be given to the potential for groundwater to rise and the effect on below grade structures. Structures should be designed to compensate for the occurrence of lateral and buoyant forces.

Footings founded near the upper clay soils may be subject to movements associated with the shrinking and swelling of the clay soils as their moisture contents change. In order to minimize the effects of this movement, footings should be suitably reinforced to make them as rigid as possible, and consideration given to using flexible connections or other design elements with attached or penetrating piping or other features. WT recommends use of granular soils at the site as fill within structure/foundation areas to mitigate these movements.

We recommend that the geotechnical engineer or his representative observe the bottom of required overexcavation to determine if soft to firm, loose, or otherwise unstable soils are present. This condition may warrant additional removal beyond the minimum removal depth specified. In addition, the geotechnical engineer or his representative should observe footing excavations before reinforcing steel and concrete are placed. It should be determined whether the soils exposed are similar to those anticipated for support of the footings. Any improperly placed fill, disturbed soils or otherwise unacceptable soils should be undercut to suitable materials and backfilled with approved fill materials or lean concrete. Alternate recommendations may be appropriate for localized areas. Soil backfill should be properly compacted.

## 6.4 Lateral Design Criteria

For relatively shallow cantilevered walls above any free water surface with level backfill and no surcharge loads, recommended equivalent fluid pressures and coefficients of base friction for unrestrained elements are:

- Active:
  Undisturbed subsoil ........ 42 psf/ft
  Compacted granular backfill ........ 30 psf/ft
  Compacted site soils (non-clay) ........ 37 psf/ft
  Clay site soils ........ not recommended for use against walls

- Passive:
  Shallow continuous footings ........ 250 psf/ft
  Shallow square footings ........ 375 psf/ft

- Coefficient of base friction, native sand ........ 0.40*
- Coefficient of base friction, native clay ........ 0.30*

* The coefficient of base friction for the native sands and clay soils should be reduced to 0.30 and 0.20, respectively, when used in conjunction with passive pressure.

We anticipate that certain structures, such as the secondary treatment basins and the buried reclaimed water storage tank, will have walls located below the final ground surface and therefore, should be designed to resist lateral earth pressure. It is assumed that the top of the walls will be restrained and will be essentially unable to rotate under the action of the earth pressure. Such walls should therefore be designed for the "at rest" stress condition. For this case, earth pressure may be evaluated using the following equation:

- $P_h = K_o (D_w Z + q_s) + W_w(Z - d)$

The term $W_w(Z - d)$ is applicable only below the groundwater table, where:

$P_h$ = the horizontal earth pressure at any depth below the ground surface (Z).
$W_w$ = unit weight of water.
Z = depth to any point below the ground surface.
d = depth to groundwater.

$D_W$ = wet unit weight of the soil backfill. The wet unit weight of the on-site soils used as engineered fill may be expected to range from approximately 110 to 125 pcf. Below a groundwater table, $D_W$ is the buoyant weight.

$q_s$ = uniform surcharge load, if any. Add equivalent uniform surcharge to account for construction equipment or facility equipment loads.

$K_o$ = at rest earth pressure coefficient as follows:
$K_o$ = 0.5 for sands and silty sands (SP, SP-SM, SM)
$K_o$ = 0.6 for sandy clay, clayey sand or silty clay (SC, CL)

Groundwater was encountered during our subsurface exploration. The designer should consider the likelihood of the groundwater table rising or the possibility of a transient groundwater table due to seasonal rainfall, groundwater movement, and the drainage characteristics of the area. The groundwater term should be used if no permanent drainage system is incorporated along the outside of a structure. If a drainage system is included which will not allow the development of any water (hydrostatic) pressure outside a structure, then the groundwater term may be omitted. Drainage systems should be carefully designed to insure that long-term permanent drainage is accomplished.

These design recommendations are based upon the following assumptions:

- Horizontal backfill,
- 95 percent compactive effort on wall backfill (ASTM D698),
- No safety factor. (A safety factor of 2 or more is recommended when computing restraining forces),
- Uniform surcharge (if any),
- Negligible wall friction. It is recommended that no wall friction be used since the value of wall friction is dependent on the degree of compaction immediately adjacent to the wall.

Fill against footings, stem walls, and below grade walls should be compacted to densities specified in **EARTHWORK**. Medium to high plasticity clay soils should not be used as backfill against subgrade walls. Compaction of each lift adjacent to walls should be accomplished with hand-operated tampers or other lightweight compactors. Overcompaction may cause excessive lateral earth pressures which could result in wall movements.

## 6.5 Seismic Considerations

For structural designs based upon the 2006 IBC, the site class is D.

### 6.6 Slab-on-Grade Support

Slabs-on-grade can be supported on properly placed and compacted low expansive engineered fill. Slabs should not be placed on the expansive on-site clay soils. The slab subgrade should be prepared by the procedures outlined in this report. A minimum 4 inch thick layer of base course should be provided beneath all slabs-on-grade. For design of slabs-on-grade, we recommend using a modulus of subgrade reaction (k) of 150 pci. Where there is the potential for the groundwater table to be higher than slab elevations, hydrostatic pressure relief or resistance should be provided in the design for structures when empty.

All concrete placement and curing operations should follow the American Concrete Institute manual recommendations. Improper curing techniques and/or high slump (water-cement ratio) could cause excessive shrinkage, cracking or curling. The plastic properties of the concrete should be documented at the time of placement and specimens should also be prepared for strength testing to verify compliance with project specifications.

### 6.7 Drainage

The major cause of soil problems in this vicinity is moisture increase in soils below structures. Therefore, it is extremely important that positive drainage be provided during construction and maintained throughout the life of the proposed improvements. Infiltration of water into utility or foundation excavations must be prevented during construction.

### 6.8 Corrosivity

The chemical test results indicate that the site soils are negligibly corrosive to concrete. We recommend Type II Portland cement be used for all concrete on and below grade.

The soluble salts concentration of subsoils suggests low corrosive potential for underground metallic conduits, and only minor additional corrosion of buried conduits in areas where soils become moist. Special protection does not appear necessary for copper piping except where dissimilar metals are joined or placed in close proximity. Wrappings or protective coatings could be used to extend the life expectancy of galvanized or black steel piping. Manufacturer's representatives should be contacted regarding the specific corrosivity resistance for their particular product.

Corrosivity test results in accordance with ANSI A21.5-1972 may be found on Plates B-2 and B-3 in Appendix B. These results suggest that some of the on-site clay soils will be corrosive to ductile iron pipe and protection against exterior corrosion is necessary. The information derived from this testing should be used as an aid in choosing the construction materials that will be in contact with these soils and that will need to be resistant to various corrosive forces. Manufacturer's representatives should be contacted regarding the specific corrosivity resistance for their particular product.

## 6.9 Pavements

Based on existing subgrade conditions, the following minimum pavement sections are recommended for the areas indicated:

| Traffic Area | Asphalt Concrete Pavement (inches) | Base Course (inches) |
|---|---|---|
| Passenger car parking and drives (low traffic frequency) | 3 | 4 |
| Major access drives (medium traffic frequency) | 3 | 6 |

Bituminous surfacing should be constructed of dense-graded, central plant-mix, asphalt concrete. Base course and asphalt concrete should conform to applicable Yavapai County or City of Cottonwood specifications.

Material and compaction requirements should conform to recommendations presented under **EARTHWORK**. The gradient of paved surfaces should ensure positive drainage. Water should not pond in areas directly adjoining paved sections. The native subgrade soils will soften and lose stability if subjected to conditions which result in an increase in water content.

Due to the high static loads imposed by parked trucks in loading and unloading areas and at dumpster locations, we recommend that a rigid pavement section be considered for these areas. A minimum 6 inch thick concrete pavement over 4 inches of aggregate base course material is recommended. This minimum pavement section is also recommended for rigid pavements receiving vehicular traffic.

### 6.9.1 Pavement Analyses

The recommended pavement sections are based on the following conditions. This firm should be contacted if any of these conditions change so that revised recommendations can be provided, if necessary.

a. A minimum correlated R-value of 25 for the on-site soils which corresponds to a resilient modulus of approximately 14,800 pounds per square inch. Any required fills should be constructed using on-site or imported materials with subgrade support characteristics equal to or greater than the subgrade soils in the area being filled.

b. Structural coefficients of 0.40 for asphalt concrete and 0.12 for aggregate base course material.

c. A present serviceability index of 4.5, a terminal serviceability index of 2.5, an overall standard deviation of 0.35, a reliability factor of 85 percent, a drainage coefficient of 0.85, a seasonal variation factor of 3.2, and a design life of 20 years.

d. A total 18-kip equivalent single axle load (ESAL) in excess of 80,000 for the major access drives and 40,000 for the passenger car parking areas.

### 6.10 Underground Utility Systems

All underground piping within or near the proposed structures should be designed with flexible couplings so minor deviations in alignment up to 1 inch (most structures) to 1 ½ inches (for the chemical storage tanks) do not result in breakage or distress. Utility knockouts in stem walls should be oversized to accommodate differential movements.

## 7.0 EARTHWORK

### 7.1 General

The conclusions contained in this report for the proposed construction are contingent upon compliance with recommendations presented in this section. Any excavating, trenching, or disturbance which occurs after completion of the earthwork must be backfilled, compacted and tested in accordance with the recommendations contained herein. It is not reasonable to rely upon our conclusions and recommendations if any future unobserved and untested trenching, grading or backfilling occurs.

Although underground facilities such as tanks, cesspools, utilities, or other abandoned improvements were not observed, such features might be encountered during construction. In addition, some spread fill was observed east of the soccer field. These features should be demolished and/or removed in accordance with the recommendations of the geotechnical engineer. Any loose or disturbed soils resulting from demolition and/or removal of existing facilities should also be removed and/or recompacted as engineered fill, and any excavations should be backfilled in accordance with recommendations presented herein.

## 7.2 Site Clearing

Strip and remove existing vegetation, organic topsoils, debris, existing berms, and any other deleterious materials from near surface building areas. The building area is defined as that area within a structures footprint plus 5 feet beyond the perimeter of the footprint. All exposed surfaces should be free of mounds and depressions which could prevent uniform compaction.

## 7.3 Excavation

We anticipate that excavations for the proposed construction can be accomplished with conventional equipment. WT recommends dewatering of the areas of deep excavation, or where excavation will be near the groundwater table.

On-site clay and fine-grained soils will pump or become unworkable at high water contents. Workability may be improved by scarifying and drying. Overexcavation of wet zones and replacement with native or imported granular materials may be necessary. Stabilization in place may also be necessary and WT can provide recommendations as necessary based on conditions encountered during construction.

We recommend that the contractor retain a geotechnical engineer to observe the soils exposed in all excavations and provide engineering design for the slopes. This will provide an opportunity to classify the soil types encountered, and to modify the excavation slopes as necessary. This also allows the opportunity to analyze the stability of the excavation slopes during construction.

### 7.3.1 Temporary Excavations

Excavations into the on-site soils will encounter a variety of conditions. Caving soils such as loose sands will be encountered. The individual contractor should be made responsible for designing and constructing stable, temporary excavations as required to maintain stability of both the excavation sides and bottom. All excavations should be sloped or shored in the interest of safety following local, and federal regulations, including current OSHA excavation and trench safety standards.

For this site, the overburden soils consisting of clay soils can be considered Type B and C soils, and the on-site sands as Type C soils when applying the OSHA regulations. OSHA recommends a maximum slope inclination of 1:1 (horizontal:vertical) for Type B soils, and 1.5:1 for Type C soils.

Slopes may need to be flattened depending on conditions exposed during construction. If there is not enough space for sloped excavations, shoring should be used. Exposed slopes should be kept moist (not saturated) during construction. Traffic and surcharge loads should be at least 10 feet from the top of the excavation.

### 7.4 Spread Foundation Preparation

Spread foundations should be underlain by at least 3 feet of properly compacted fill. Depending on the amount of fill placed to reach final grades, in some areas it may be necessary remove some of the existing soils to achieve this fill depth below foundations. Upon removal of soils to the required depth, proof-rolling should be performed to identify any soft to firm, loose, or otherwise unstable soils. Additional removal and recompaction should be performed where soft to firm, loose, or otherwise unstable soils are still present at depths greater than 3 feet below the footing bottom. Removals should extend a minimum of 3 feet beyond the footing edges in plan view. Where foundations are near groundwater, additional removals may not be practicable and WT should be consulted to provide additional recommendations for stabilization of existing soils to facilitate fill placement and compaction. The removed soils should be replaced with properly compacted engineered fill material with a low expansive potential.

### 7.5 Mat Foundation or Slab-on-Grade Preparation

Mat foundations or slabs-on-grade should be founded on imported engineered fill material. Where clay soils are present at mat or slab elevations, remove existing clay soils to a minimum depth of 3 feet below the bottom of mats/slabs. Upon removal of soils to the required depth, proof-rolling should be performed to identify any soft to firm, loose, or otherwise unstable soils. Additional removal and recompaction should be performed where soft to firm, loose, or otherwise unstable soils are still present at depths greater than 3 feet below the footing bottom. Removals should extend a minimum of 3 feet beyond the mat/slab edges in plan view. Where mat/slabs are near groundwater, additional removals may not be practicable and WT should be consulted to provide additional recommendations for stabilization of existing soils to facilitate fill placement and compaction. Following necessary removals, scarify, moisten or dry as required, and compact the subgrade soils to a minimum depth of 8 inches. The subgrade preparation is to be accomplished in a manner which will result in uniform water contents and densities after compaction. Replace the removed soils with properly compacted, low expansive, engineered fill material.

A representative of the geotechnical engineer should observe the proof-rolling and compaction activities for evidence of soft to firm, loose, or otherwise unstable soils, to determine if additional removals or stabilization will be required. These conditions should be evaluated at the time of construction with appropriate recommendations provided at that time. Deeper foundations may be located near the existing groundwater table and as such recompaction may be problematic; therefore, as previously indicated, dewatering is recommended to facilitate construction in areas where deep excavations are required.

### 7.6 Pavement Preparation

Prior to placement of fill and/or pavement materials, the exposed subgrade soils should be proof-rolled to verify that stable subgrade conditions exist. Where stable subgrade conditions exist, the subgrade should be scarified, moistened as required, and recompacted for a minimum depth of 8 inches prior to placement of fill and pavement materials. Due to the amount of fill required to reach final site grades, we do not anticipate that clay soils will be located within 3 feet of final site grade. On-site clay soils should not be used as fill within 3 feet of final site grade in pavement areas.

### 7.7 Materials

a. Clean on-site, native soils or imported materials with a low expansive potential and a maximum particle dimension of 6 inches may be used as fill material for the following:

- foundation areas
- slab-on-grade areas
- pavement areas
- backfill

b. On-site clay soils are not recommended for use beneath slabs-on-grade or as backfill in structure or pavement areas. Clay soils may be used as fill in non-structural areas.

c. Imported soils should conform to the following:

- Gradation (ASTM C136): percent finer by weight

| Gradation (ASTM C136) | percent finer by weight |
|---|---|
| 6" | 100 |
| 4" | 85-100 |
| 3/4" | 70-100 |
| No. 4 Sieve | 50-100 |
| No. 200 Sieve | 50 (max) |

- Maximum expansive potential (%)* .......................................... 1.5

- Maximum soluble sulfates (%) .................................................. 0.10

* Measured on a sample compacted to approximately 95 percent of the ASTM D698 maximum dry density at about 3 percent below optimum water content. The sample is confined under a 100 psf surcharge and submerged.

d. Base course should conform to applicable Yavapai County or City of Cottonwood specifications.

### 7.8 Placement and Compaction

a. Place and compact fill in horizontal lifts, using equipment and procedures that will produce recommended water contents and densities throughout the lift.

b. Uncompacted fill lifts should not exceed 9 inches.

c. Materials should be compacted to the following:

| Material | Minimum Percent Compaction (ASTM D698) |
|---|---|
| • On-site soils, reworked and fill: | |
| Below footings | 95 |
| Below slabs-on-grade | 90 |
| Below pavement | 95 |
| • Imported fill: | |
| Below footings | 95 |
| Below slabs-on-grade | 90 |
| Below pavement | 95 |
| • Aggregate base | |
| Below slabs-on-grade | 95 |
| Below pavement | 100 |
| • Miscellaneous backfill | 90 |

e. On-site clay soils should be compacted with a moisture content in the range of minus 1 to plus 3 percent of optimum. Imported soils with low expansive potential should be compacted with a moisture content in the range of 3 percent below to 3 percent above optimum.

### 7.9 Groundwater Control

Because of the relatively high groundwater level, difficulty may be encountered during excavation and construction of the proposed deeper improvement elements. For smaller structures, a gravity drainage system, sump pump, or other conventional minor dewatering procedure may be sufficient to maintain relatively dry conditions during construction. For larger structures, an extensive gravity drainage system, well points, or other comprehensive dewatering procedure may be necessary.

Below grade structure should be protected by suitable means from hydrostatic uplift.

Excavations extending below the water table and into the deposits of sand may cause the soil to become "quick-acting" when the confining effect of the surcharge is removed. If the excavations are to extend only a foot or so below the water table, it is expected that the water can be controlled by permitting it to drain into temporary construction sumps. If deeper excavations are contemplated, or if the groundwater table rises, it may be necessary to provide a well point system.

### 7.10 Compliance

Recommendations for slabs-on-grade, foundations and pavement elements supported on compacted fills or prepared subgrade depend upon compliance with **EARTHWORK** recommendations. To assess compliance, observation and testing should be performed under the direction of a geotechnical engineer.

## 8.0 LIMITATIONS

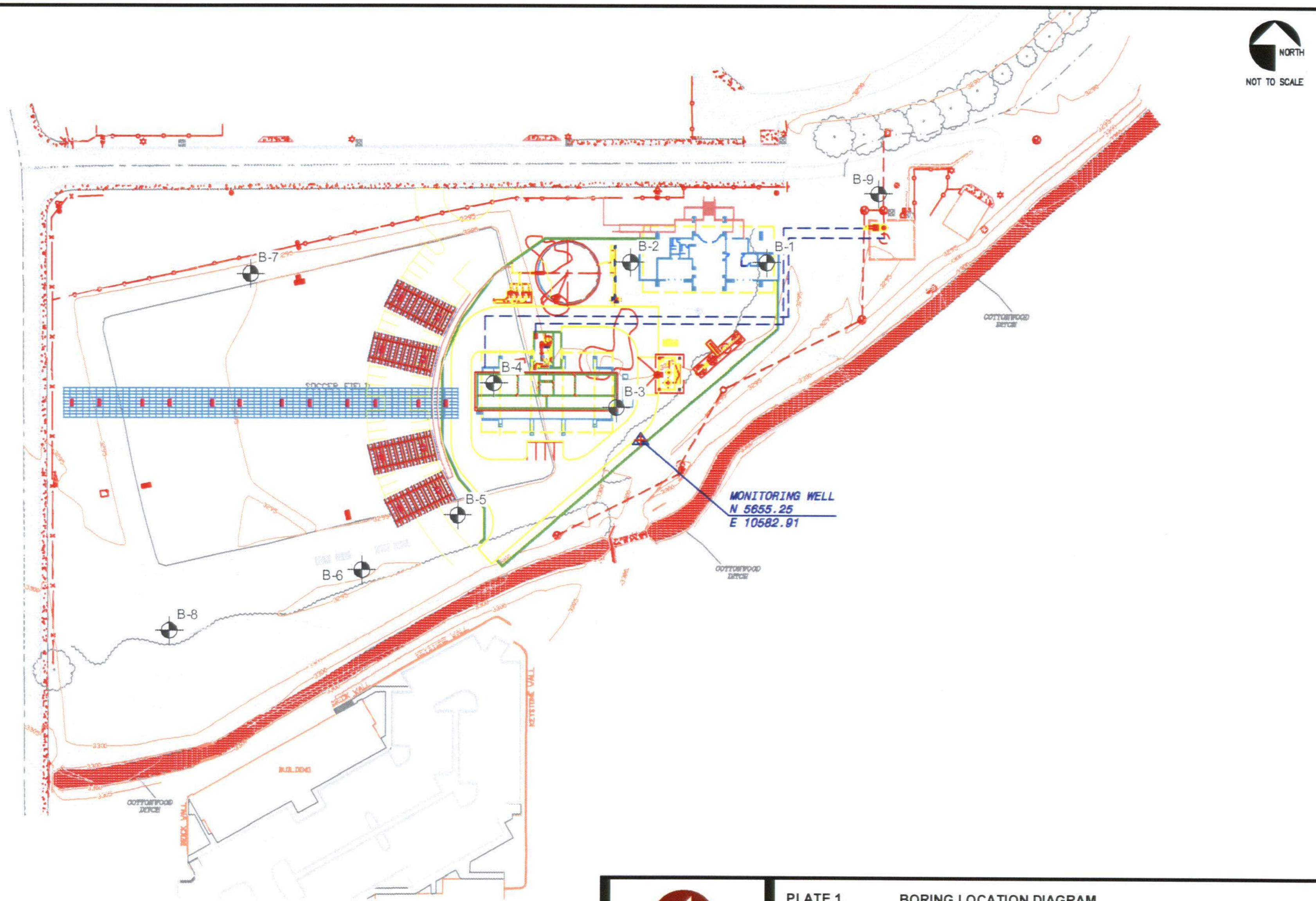
This report has been prepared assuming the project criteria described in Section 2.0. If changes in the project criteria occur, or if different subsurface conditions are encountered or become known, the conclusions and recommendations presented herein shall become invalid. In any such event, WT should be contacted in order to assess the effect that such variations may have on our conclusions and recommendations.

The recommendations presented are based entirely upon data derived from a limited number of samples obtained from widely spaced borings or test pits. The attached logs are indicators of subsurface conditions only at the specific locations and times noted. This report assumes the uniformity of the geology and soil structure between borings and/or test pits, however variations can and often do exist. Whenever any deviation, difference or change is encountered or becomes known, WT should be contacted.

This report is valid for the earlier of one year from the date of issuance, a change in circumstances, or discovered variations. After expiration, no person or entity shall rely on this report without the express written authorization of WT.

## 9.0 CLOSURE

We prepared this report as an aid to the designers of the proposed project. The comments, statements, recommendations and conclusions set forth in this report reflect the opinions of the authors. These opinions are based upon data obtained at the location of the borings, and from laboratory tests. Work on your project was performed in accordance with generally accepted standards and practices utilized by professionals providing similar services in this locality. No other warranty, express or implied, is made.




LEGEND:

⌖ APPROXIMATE BORING LOCATION

Western Technologies Inc.

PLATE 1. **BORING LOCATION DIAGRAM**
Riverfront Water Reclamation Facility

WT Job No. 2521JW415

| | |
|---|---|
| **Allowable Soil Bearing Capacity** | The recommended maximum contact stress developed at the interface of the foundation element and the supporting material. |
| **Backfill** | A specified material placed and compacted in a confined area. |
| **Base Course** | A layer of specified material placed on a subgrade or subbase. |
| **Base Course Grade** | Top of base course. |
| **Bench** | A horizontal surface in a sloped deposit. |
| **Caisson** | A concrete foundation element cast in a circular excavation which may have an enlarged base. Sometimes referred to as a cast-in-place pier. |
| **Concrete Slabs-on-Grade** | A concrete surface layer cast directly upon a base, subbase or subgrade. |
| **Crushed Rock Base Course** | A base course composed of crushed rock of a specified gradation. |
| **Differential Settlement** | Unequal settlement between or within foundation elements of a structure. |
| **Engineered Fill** | Specified material placed and compacted to specified density and/or moisture conditions under observations of a representative of a soil engineer. |
| **Existing Fill** | Materials deposited through the action of man prior to exploration of the site. |
| **Existing Grade** | The ground surface at the time of field exploration. |
| **Expansive Potential** | The potential of a soil to expand (increase in volume) due to absorption of moisture. |
| **Fill** | Materials deposited by the actions of man. |
| **Finished Grade** | The final grade created as a part of the project. |
| **Gravel Base Course** | A base course composed of naturally occurring gravel with a specified gradation. |
| **Heave** | Upward movement |
| **Native Grade** | The naturally occurring ground surface. |
| **Native Soil** | Naturally occurring on-site soil. |
| **Rock** | A natural aggregate of mineral grains connected by strong and permanent cohesive forces. Usually requires drilling, wedging, blasting or other methods of extraordinary force for excavation. |
| **Sand & Gravel Base** | A base course of sand and gravel of a specified gradation. |
| **Sand Base Course** | A base course composed primarily of sand of a specified gradation. |
| **Scarify** | To mechanically loosen soil or break down existing soil structure. |
| **Settlement** | Downward movement. |
| **Soil** | Any unconsolidated material composed of discrete solid particles, derived from the physical and/or chemical disintegration of vegetable or mineral matter, which can be separated by gentle mechanical means such as agitation in water. |
| **Strip** | To remove from present location. |
| **Subbase** | A layer of specified material placed to form a layer between the subgrade and base course. |
| **Subbase Grade** | Top of subbase. |
| **Subgrade** | Prepared native soil surface. |

| | |
|---|---|
| RIVERFRONT WATER RECLAMATION FACILITY | |
| Definition of Terminology | |
| **Western Technologies Inc.** | |
| Job No.: 2521JW415 | Plate: A-1 |

## COARSE-GRAINED SOILS
LESS THAN 50% FINES*

| GROUP SYMBOLS | DESCRIPTION | MAJOR DIVISIONS |
|---|---|---|
| **GW** | WELL-GRADED GRAVELS OR GRAVEL-SAND MIXTURES, LESS THAN 5% FINES | GRAVELS<br>MORE THAN HALF OF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE SIZE |
| **GP** | POORLY-GRADED GRAVELS OR GRAVEL-SAND MIXTURES, LESS THAN 5% FINES | |
| **GM** | SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES, MORE THAN 12% FINES | |
| **GC** | CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES, MORE THAN 12% FINES | |
| **SW** | WELL-GRADED SANDS OR GRAVELLY SANDS, LESS THAN 5% FINES | SANDS<br>MORE THAN HALF OF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE SIZE |
| **SP** | POORLY-GRADED SANDS OR GRAVELLY SANDS, LESS THAN 5% FINES | |
| **SM** | SILTY SANDS, SAND-SILT MIXTURES, MORE THAN 12% FINES | |
| **SC** | CLAYEY SANDS, SAND-CLAY MIXTURES, MORE THAN 12% FINES | |

**NOTE:** Coarse-grained soils receive dual symbols if they contain 5% to 12% fines (e.g., SW-SM, GP-GC).

## FINE-GRAINED SOILS
MORE THAN 50% FINES

| GROUP SYMBOLS | DESCRIPTION | MAJOR DIVISIONS |
|---|---|---|
| **ML** | INORGANIC SILTS, VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS | SILTS AND CLAYS<br>LIQUID LIMIT LESS THAN 50 |
| **CL** | INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS | |
| **OL** | ORGANIC SILTS OR ORGANIC SILT-CLAYS OF LOW PLASTICITY | |
| **MH** | INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDS OR SILTS, ELASTIC SILTS | SILTS AND CLAYS<br>LIQUID LIMIT MORE THAN 50 |
| **CH** | INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS | |
| **OH** | ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY | |
| **PT** | PEAT, MUCK AND OTHER HIGHLY ORGANIC SOILS | HIGHLY ORGANIC SOILS |

**NOTE:** Fine-grained soils may receive dual classification based upon plasticity characteristics.

### SOIL SIZES

| COMPONENT | SIZE RANGE |
|---|---|
| BOULDERS | Above 12 in. |
| COBBLES | 3 in. – 12 in. |
| GRAVEL | No. 4 – 3 in. |
| Coarse | 3/4 in. – 3 in. |
| Fine | No. 4 – 3/4 in. |
| SAND | No. 200 – No. 4 |
| Coarse | No. 10 – No. 4 |
| Medium | No. 40 – No. 10 |
| Fine | No. 200 – No. 40 |
| *Fines (Silt or Clay) | Below No. 200 |

**NOTE:** Only sizes smaller than three inches are used to classify soils

### CONSISTENCY

| CLAYS & SILTS | BLOWS PER FOOT* |
|---|---|
| VERY SOFT | 0 - 2 |
| SOFT | 2 - 4 |
| FIRM | 4 - 8 |
| STIFF | 8 - 16 |
| VERY STIFF | 16 - 32 |
| HARD | Over 32 |

### RELATIVE DENSITY

| SANDS & GRAVELS | BLOWS PER FOOT* |
|---|---|
| VERY LOOSE | 0 - 4 |
| LOOSE | 4 - 10 |
| MEDIUM DENSE | 10 - 30 |
| DENSE | 30 - 50 |
| VERY DENSE | Over 50 |

*Number of blows of 140 pound hammer falling 30 inches to drive a 2 inch O.D. (1 3/8 inch ID) split spoon (ASTM D1586).

### PLASTICITY OF FINE GRAINED SOILS

| PLASTICITY INDEX | TERM |
|---|---|
| 0 | NON-PLASTIC |
| 1 – 7 | LOW |
| 8 – 25 | MEDIUM |
| Over 25 | HIGH |

### DEFINITION OF WATER CONTENT

DRY
SLIGHTLY DAMP
DAMP
MOIST
WET
SATURATED

| RIVERFRONT WATER RECLAMATION FACILITY | |
|---|---|
| Method of Soil Classification | |
| **Western Technologies Inc.** | |
| Job No.: 2521JW415 | Plate: A-2 |

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The number shown in "**BORING NO.**" refers to the approximate location of the same number indicated on the "Boring Location Diagram" as positioned in the field by pacing from property lines and/or existing features.

"**ELEVATION**" refers to ground surface elevation at the boring location established by interpolation from contours on the site plan by .............

"**TYPE/SIZE BORING**" refers to the exploratory equipment used in the boring wherein **HSA = hollow stem auger**

"**R" in Blows/Foot**" refers to the number of blows of a 140-pound weight, dropped 30 inches, required to advance a 2.42-inch-inside-diameter ring sampler a distance of 1 foot. Refusal to penetration is considered more than 50 blows per foot.

"**N" in Blows/Foot**" refers to the number of blows of a 140-pound weight, dropped 30 inches, required to advance a two-inch-outside-diameter split-barrel sampler a distance of 1 foot, Standard Penetration Test (ASTM D1586). Refusal to penetration is defined as more than 100 blows per foot.

"**Sample Type**" refers to the form of sample recovery, in which **N = Split-barrel sample, R = Ring sample, G = Grab Sample**

"**Dry Density, pcf**" refers to the laboratory-determined dry density in pounds per cubic foot. The double vertical line within the ring symbol indicates that no sample was recovered. The symbol "**DU**" indicates that determination of dry density was not possible.

"**Water Content, %**" refers to the laboratory-determined moisture content in percent ASTM D2216.

"**Unified Classification**" refers to the soil type as defined by "Method of Soil Classification". The soils were classified visually in the field and, where appropriate, classifications were modified by visual examination of samples in the laboratory and/or by appropriate tests.

These notes and boring logs are intended for use in conjunction with the purposes of our services defined in the text. Boring log data should not be construed as part of the construction plans nor as defining construction conditions.

Boring logs depict our interpretations of subsurface conditions at the locations and on the dates noted. Variations in subsurface conditions and soil characteristics may occur between borings. Groundwater levels may fluctuate due to seasonal variations and other factors.

The stratification lines shown on the boring logs represent our interpretation of the approximate boundary between soil types based upon visual field classification. The transition between materials is approximate and may be far more or less gradual than indicated.

| | |
|---|---|
| RIVERFRONT WATER RECLAMATION FACILITY | |
| Boring Log Notes | |
| **Western Technologies Inc.** | |
| Job No.: 2521JW415 | Plate: A-3 |

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EXCAVATION DATE: **2-9-12**
LOCATION: **See Location Diagram**
ELEVATION: **Approx. 3293 ft.**

# BORING NO. 1

EQUIPMENT TYPE: **CME-55**
EXCAVATION TYPE: **7" HSA**
FIELD ENGINEER: **M. Morris**

| MOISTURE CONTENT (% OF DRY WT.) | DRY DENSITY (LBS/CU FT) | SAMPLE TYPE | BLOWS/FT. %REC./RQD | DEPTH (FEET) | USCS | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|
| | | | | 0 | CL | Sandy Lean CLAY; trace gravel, brown, stiff, dry to damp |
| 7.7 | 83 | R | 15 | | | |
| | | G | | | | |
| 10.0 | 81 | R | 19 | 5 | | |
| 5.5 | 86 | R | 17 | 10 | ML | Sandy SILT; light brown, stiff, damp |
| | | G | | | | |
| | | | | | SP | Poorly Graded SAND; with gravel, tan, loose, damp to moist |
| 9.5 | 98 | R | 9 | 15 | | |
| | | | | | | Saturated. Groundwater encountered (approximate elevation 3,275 feet AMSL). ▼ |
| 19.1 | 113 | R | 26 | 20 | | |
| | | | | | | medium dense |
| | | | | | GW | Well Graded GRAVEL; with sand, medium dense, saturated |
| | | N | 24 | 25 | | |
| | | | | | | **Boring stopped at 26.5 feet.** |

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

N- STANDARD PENETRATION TEST
R- RING SAMPLE
NR- NO SAMPLE RECOVERY
G- GRAB SAMPLE
B- BUCKET SAMPLE

NOTES: **Groundwater initially encountered at about 18 feet.**
**Hole caved to 13 feet following auger withdrawal.**

**WESTERN TECHNOLOGIES INC.**

PROJECT: **RIVERFRONT WRF**
REF. NO.: **2521JW415**

PLATE **A-4**

## BORING LOG

EXCAVATION DATE: 2-9-12
LOCATION: See Location Diagram
ELEVATION: Approx. 3293.5 ft.

# BORING NO. 2

EQUIPMENT TYPE: CME-55
EXCAVATION TYPE: 7" HSA
FIELD ENGINEER: M. Morris

| MOISTURE CONTENT (% OF DRY WT.) | DRY DENSITY (LBS/CU FT) | SAMPLE TYPE | SAMPLE | BLOWS/FT. %REC./RQD | DEPTH (FEET) | USCS | GRAPHIC | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|---|---|
| | | | | | 0 | | | Silty SAND (FILL); orange brown, damp |
| 16.1 | 94 | R | | 15 | | CL | | Lean CLAY; with sand, trace gravel, dark brown, stiff, damp |
| | | G | | | | | | |
| | | R | | 12 | 5 | | | |
| | | | | | | GC | | Clayey GRAVEL; brown, medium dense, damp |
| | | N | | 20 | 10 | | | |
| | | | | | | SP | | SAND; with gravel, tan, medium dense, moist |
| 19.3 | 108 | R | | 16 | 15 | | | |
| | | | | | | | | wet |
| | | | | | | | | Saturated. Groundwater encountered (approximate elevation 3,276.5 feet AMSL). ▼ |
| | | N | | 43 | 20 | | | |
| | | N | | 31 | 25 | | | |
| | | | | | | | | **Boring stopped at 26.5 feet.** |

N- STANDARD PENETRATION TEST
R- RING SAMPLE
NR- NO SAMPLE RECOVERY
G- GRAB SAMPLE
B- BUCKET SAMPLE

NOTES: **Groundwater initially encountered at about 17 feet.**
**Hole caved to 12 feet following auger withdrawal.**

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

WESTERN TECHNOLOGIES INC.

PROJECT: RIVERFRONT WRF
REF. NO.: 2521JW415

## BORING LOG

PLATE A-5

EXCAVATION DATE: **2-9-12**
LOCATION: **See Location Diagram**
ELEVATION: **Approx. 3295 ft.**

# BORING NO. 3

EQUIPMENT TYPE: **CME-55**
EXCAVATION TYPE: **7" HSA**
FIELD ENGINEER: **M. Morris**

| MOISTURE CONTENT (% OF DRY WT.) | DRY DENSITY (LBS/CU FT) | SAMPLE TYPE | BLOWS/FT. %REC./RQD | DEPTH (FEET) | USCS | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|
| | | | | 0 | SM | FILL: Silty SAND; brown, slightly damp |
| | | | | | CL | Sandy Lean CLAY; trace gravel, brown, stiff to hard, damp |
| 9.9 | 93 | R | 50-10" | | | |
| | | G | | | | |
| 8.5 | 87 | R | 25 | 5 | | |
| 30.4 | 88 | R | 21 | 10 | | |
| | | | | | | with gravel |
| | | G | | | | |
| 9.5 | 78 | R | 5 | 15 | SM | Silty SAND; brown, very loose to medium dense, wet |
| | | | | | | Saturated. Groundwater encountered (approximate elevation 3,277 feet AMSL). |
| | | N | 8 | 20 | | |
| | | N | 15 | 25 | | |
| | | | | | | **Boring stopped at 26.5 feet.** |

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

N- STANDARD PENETRATION TEST
R- RING SAMPLE
NR- NO SAMPLE RECOVERY
G- GRAB SAMPLE
B- BUCKET SAMPLE

NOTES: **Groundwater initially encountered at about 18 feet.**
**Hole caved to 12 feet following auger withdrawal.**

**WESTERN TECHNOLOGIES INC.**

PROJECT: **RIVERFRONT WRF**
REF. NO.: **2521JW415**

PLATE **A-6**

## BORING LOG

EXCAVATION DATE: **2-10-12**
LOCATION: **See Location Diagram**
ELEVATION: **Approx. 3295 ft.**

# BORING NO. 4

EQUIPMENT TYPE: **CME-55**
EXCAVATION TYPE: **7" HSA**
FIELD ENGINEER: **M. Morris**

| MOISTURE CONTENT (% OF DRY WT.) | DRY DENSITY (LBS/CU FT) | SAMPLE TYPE | BLOWS/FT. %REC./RQD | DEPTH (FEET) | USCS | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|
| | | | | 0 | CL | Lean CLAY; with sand, dark brown, firm, moist |
| 23.5 | 96 | R | 9 | | | |
| | | G | | | | |
| 18.6 | 93 | R | 7 | 5 | | |
| | | R | 13 | 10 | SM | Silty SAND; tan, loose to medium dense, moist |
| 4.3 | 102 | R | 26 | 15 | | |
| | | | | | | with gravel, wet |
| | | | | | | Saturated. Groundwater encountered (approximate elevation 3,278 feet AMSL). ▼ |
| | | N | 25 | 20 | | |
| | | N | 18 | 25 | | |
| | | | | 26.5 | | **Boring stopped at 26.5 feet.** |

N- STANDARD PENETRATION TEST
R- RING SAMPLE
NR- NO SAMPLE RECOVERY
G- GRAB SAMPLE
B- BUCKET SAMPLE

NOTES: **Groundwater initially encountered at about 17 feet.**
**Hole caved to 12 feet following auger withdrawal.**

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

**WESTERN TECHNOLOGIES INC.**

PROJECT: **RIVERFRONT WRF**
REF. NO.: **2521JW415**

PLATE **A-7**

## BORING LOG

EXCAVATION DATE: **2-10-12**
LOCATION: **See Location Diagram**
ELEVATION: **Approx. 3295.5 ft.**

# BORING NO. 5

EQUIPMENT TYPE: **CME-55**
EXCAVATION TYPE: **7" HSA**
FIELD ENGINEER: **M. Morris**

| MOISTURE CONTENT (% OF DRY WT.) | DRY DENSITY (LBS/CU FT) | SAMPLE TYPE | BLOWS/FT. %REC./RQD | DEPTH (FEET) | USCS | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|
| | | | | 0 | CL | Sandy Lean CLAY; brown, firm to stiff, damp |
| 17.0 | 77 | R | 25 | | | |
| | | G | | | | |
| 10.4 | 86 | R | 13 | 5 | | |
| | | | | | | moist |
| | | | | | | wet |
| 32.6 | 86 | R | 6 | 10 | | |
| | | | | 11 | | **Boring stopped at 11 feet.** |
| | | | | 15 | | |
| | | | | 20 | | |
| | | | | 25 | | |

N- STANDARD PENETRATION TEST
R- RING SAMPLE
NR- NO SAMPLE RECOVERY
G- GRAB SAMPLE
B- BUCKET SAMPLE

NOTES: **Groundwater was not encountered.**

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

**WESTERN TECHNOLOGIES INC.**

PROJECT: **RIVERFRONT WRF**
REF. NO.: **2521JW415**

## BORING LOG

PLATE **A-8**

EXCAVATION DATE: **2-10-12**
LOCATION: **See Location Diagram**
ELEVATION: **Approx. 3296 ft.**

# BORING NO. 6

EQUIPMENT TYPE: **CME-55**
EXCAVATION TYPE: **7" HSA**
FIELD ENGINEER: **M. Morris**

| MOISTURE CONTENT (% OF DRY WT.) | DRY DENSITY (LBS/CU FT) | SAMPLE TYPE | BLOWS/FT. %REC./RQD | DEPTH (FEET) | USCS | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|
| | | | | 0 | CL | Lean CLAY; brown, stiff, damp |
| 16.1 | 90 | R | 16 | | | |
| | | G | | | | |
| 16.3 | 80 | R | 16 | 5 | | |
| | | | | | | damp to moist |
| 21.4 | 84 | R | 12 | 10 | | |
| | | | | | | **Boring stopped at 11 feet.** |
| | | | | 15 | | |
| | | | | 20 | | |
| | | | | 25 | | |

N- STANDARD PENETRATION TEST
R- RING SAMPLE
NR- NO SAMPLE RECOVERY
G- GRAB SAMPLE
B- BUCKET SAMPLE

NOTES: **Groundwater was not encountered.**

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

**WESTERN TECHNOLOGIES INC.**

PROJECT: **RIVERFRONT WRF**
REF. NO.: **2521JW415**

**BORING LOG**

PLATE **A-9**

EXCAVATION DATE: **2-10-12**
LOCATION: **See Location Diagram**
ELEVATION: **Approx. 3296 ft.**

# BORING NO. 7

EQUIPMENT TYPE: **CME-55**
EXCAVATION TYPE: **7" HSA**
FIELD ENGINEER: **M. Morris**

| MOISTURE CONTENT (% OF DRY WT.) | DRY DENSITY (LBS/CU FT) | SAMPLE TYPE | BLOWS/FT. %REC./RQD | DEPTH (FEET) | USCS | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|
| | | G | | 0 | | FILL: Silty SAND (BERM); brown, slightly damp |
| 4.1 | 106 | R | 40 | | | |
| 15.5 | 86 | R | 13 | 5 | CL | Sandy CLAY; dark brown, firm to stiff, damp |
| 12.3 | 88 | R | 8 | 10 | | |
| | | | | | | **Boring stopped at 10 feet.** |
| | | | | 15 | | |
| | | | | 20 | | |
| | | | | 25 | | |

N- STANDARD PENETRATION TEST
R- RING SAMPLE
NR- NO SAMPLE RECOVERY
G- GRAB SAMPLE
B- BUCKET SAMPLE

NOTES: **Groundwater was not encountered.**

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

**WESTERN TECHNOLOGIES INC.**

PROJECT: **RIVERFRONT WRF**
REF. NO.: **2521JW415**

**BORING LOG**

PLATE **A-10**

EXCAVATION DATE: 2-10-12
LOCATION: **See Location Diagram**
ELEVATION: **Approx. 3293 ft.**

# BORING NO. 8

EQUIPMENT TYPE: **CME-55**
EXCAVATION TYPE: **7" HSA**
FIELD ENGINEER: **M. Morris**

| MOISTURE CONTENT (% OF DRY WT.) | DRY DENSITY (LBS/CU FT) | SAMPLE TYPE | SAMPLE | BLOWS/FT. %REC./RQD | DEPTH (FEET) | USCS | GRAPHIC | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|---|---|
| | | | | | 0 | CL | | Lean CLAY; brown, stiff to very stiff, damp |
| 13.1 | 79 | R | | 20 | | | | |
| | | G | | | | | | |
| 15.7 | 77 | R | | 24 | 5 | | | |
| | | | | | | | | moist |
| 26.4 | 80 | R | | 14 | 10 | | | |
| | | | | | 11 | | | **Boring stopped at 11 feet.** |
| | | | | | 15 | | | |
| | | | | | 20 | | | |
| | | | | | 25 | | | |

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

N- STANDARD PENETRATION TEST
R- RING SAMPLE
NR- NO SAMPLE RECOVERY
G- GRAB SAMPLE
B- BUCKET SAMPLE

NOTES: **Groundwater was not encountered.**

**WESTERN TECHNOLOGIES INC.**

PROJECT: **RIVERFRONT WRF**
REF. NO.: **2521JW415**

PLATE **A-11**

**BORING LOG**

# BORING NO. 9

EXCAVATION DATE: 2-10-12
LOCATION: See Location Diagram
ELEVATION: Approx. 3292 ft.

EQUIPMENT TYPE: CME-55
EXCAVATION TYPE: 7" HSA
FIELD ENGINEER: M. Morris

| MOISTURE CONTENT (% OF DRY WT.) | DRY DENSITY (LBS/CU FT) | SAMPLE TYPE | SAMPLE | BLOWS/FT. %REC./RQD | DEPTH (FEET) | USCS | GRAPHIC | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|---|---|
| | | | | | 0 | GM | | Silty GRAVEL; tan, medium dense, damp |
| 15.3 | 95 | R | | 24 | 2 | SM-ML | | Silty SAND; tan brown, loose to medium dense, damp to moist |
| 18.1 | 95 | R | | 8 | 5 | | | |
| | | G | | | | | | |
| 16.0 | 88 | R | | 7 | 10 | | | |
| | | | | | 11 | | | Boring stopped at 11 feet. |
| | | | | | 15 | | | |
| | | | | | 20 | | | |
| | | | | | 25 | | | |

N- STANDARD PENETRATION TEST
R- RING SAMPLE
NR- NO SAMPLE RECOVERY
G- GRAB SAMPLE
B- BUCKET SAMPLE

NOTES: Groundwater was not encountered.

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

WESTERN TECHNOLOGIES INC.

PROJECT: RIVERFRONT WRF
REF. NO.: 2521JW415

PLATE A-12

**BORING LOG**

# PHYSICAL PROPERTIES

| BORING NO. | DEPTH (FEET) | SOIL CLASSIFICATION | PARTICLE SIZE DISTRIBUTION, % PASSING BY WEIGHT | | | | | | ATTERBERG LIMITS | | SOIL PROPERTY | | EXPANSION | | WATER SOLUBLE MATTER (PPM) | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 IN. | NO. 4 | NO. 10 | NO. 40 | NO. 200 | 2 μ | LL | PI | INITIAL DRY DENSITY (PCF) | INITIAL WATER CONTENT (%) | SURCHARGE (KSF) | EXPANSION (%) | SALTS | SULFATES | |
| 1 | 2-5 | CL | 100 | 99 | 95 | 88 | 56.8 | | 28 | 10 | | | | | | | 2 |
| 1 | 11-14 | ML | | 100 | 99 | 94 | 51.4 | | | NP | | | | | 207 | 19 | 2 |
| 2 | 2-5 | CL | 100 | 98 | 97 | 93 | 73.6 | | 27 | 12 | 115.6 | 11.9 | 0.1 | 3.2 | 524 | 104 | 2,6,7 |
| 3 | 2-5 | CL | 100 | 97 | 94 | 89 | 58.1 | | 27 | 11 | | | | | | | 2 |
| 4 | 2-5 | CL | | | 100 | 96 | 85.1 | | 33 | 17 | 118.0 | 11.2 | 0.1 | 5.0 | 219 | 23 | 2,6,7 |
| 6 | 2-7 | CL | | | 100 | 98 | 91.1 | | 37 | 18 | 115.6 | 11.9 | 0.1 | 7.7 | 303 | 68 | 2,6,7 |
| 7 | 0-5 | SM | 100 | 99 | 98 | 94 | 40.4 | | 19 | 1 | | | | | | | 2 |
| 8 | 2-5 | CL | | | 100 | 97 | 87.8 | | 43 | 24 | | | | | | | 2 |
| 9 | 5-10 | SM-ML | 93 | 88 | 85 | 75 | 46.4 | | | NP | | | | | | | 2 |

**REMARKS:**

**CLASSIFICATION / PARTICLE SIZE**
1. Visual Classification
2. Laboratory Tested
3. Minus No. 200 Only

**MOISTURE-DENSITY RELATIONSHIP**
4. Tested ASTM D698/AASHTO T99
5. Tested ASTM D1557/AASHTO T180

**REMOLDED SWELL**
6. Compacted Density (approximately 95% of ASTM D698 maximum density at moisture content slightly below optimum)
7. Submerged to approximate saturation
8. Dry Density determined from one ring of a multi-ring sample

Note: NP **NONPLASTIC**

COTTONWOOD RIVERFRONT WTF

Physical Properties

**Western Technologies Inc.**

Job No.: 2521JW415 | Plate: B-1

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This test procedure can be found in Appendix A of ANSI A21.5-1972 and consists of tests of 5 soil properties: resistivity, pH, redox potential, sulfides, and moisture condition.

The test results are summarized below:

Boring No.: 1
Depth (ft.): 11-14

| Analysis | Results | Points |
|---|---|---|
| Resistivity (ohm-cm) | 60,030 | 0 |
| pH | 7.8 | 0 |
| Redox Potential (mV) | +24 | 4 |
| Sulfides | TRACE | 2 |
| Moisture | GOOD | 0 |
| | Total Points: | 6 |

The test procedure states that if the sum of the points is less than 10, the soil is considered noncorrosive to ductile iron pipe and special protection against exterior corrosion is unnecessary. This conclusion is limited to soil corrosion and does not include consideration of stray direct current.

Boring No.: 2
Depth (ft.): 2-5

| Analysis | Results | Points |
|---|---|---|
| Resistivity (ohm-cm) | 38,019 | 0 |
| pH | 6.9 | 3 |
| Redox Potential (mV) | -21 | 5 |
| Sulfides | TRACE | 2 |
| Moisture | POOR | 2 |
| | Total Points: | 12 |

The test procedure states that if the sum of the points is greater than 10, the soil is considered corrosive to ductile iron pipe and special protection against exterior corrosion is necessary. This conclusion is limited to soil corrosion and does not include consideration of stray direct current.

| RIVERFRONT WATER RECLAMATION FACILITY | |
|---|---|
| Corrosivity Test Results | |
| **Western Technologies Inc.** | |
| Job No.: 2521JW415 | Plate: B-2 |

This test procedure can be found in Appendix A of ANSI A21.5-1972 and consists of tests of 5 soil properties: resistivity, pH, redox potential, sulfides, and moisture condition.

The test results are summarized below:

Boring No.: 4
Depth (ft.): 2-5

| Analysis | Results | Points |
|---|---|---|
| Resistivity (ohm-cm) | 34,349 | 0 |
| pH | 6.8 | 0 |
| Redox Potential (mV) | +63 | 3.5 |
| Sulfides | TRACE | 2 |
| Moisture | POOR | 2 |
| | Total Points: | 7.5 |

The test procedure states that if the sum of the points is less than 10, the soil is considered noncorrosive to ductile iron pipe and special protection against exterior corrosion is unnecessary. This conclusion is limited to soil corrosion and does not include consideration of stray direct current.

Boring No.: 6
Depth (ft.): 2-7

| Analysis | Results | Points |
|---|---|---|
| Resistivity (ohm-cm) | 31,349 | 0 |
| pH | 6.3 | 0 |
| Redox Potential (mV) | -11 | 5 |
| Sulfides | PRESENT | 3.5 |
| Moisture | POOR | 2 |
| | Total Points: | 10.5 |

The test procedure states that if the sum of the points is greater than 10, the soil is considered corrosive to ductile iron pipe and special protection against exterior corrosion is necessary. This conclusion is limited to soil corrosion and does not include consideration of stray direct current.

# SOIL PROPERTIES

| BORING NO. | DEPTH (FEET) | SOIL CLASSIFICATION | SOIL PROPERTY: INITIAL DRY DENSITY (PCF) | SOIL PROPERTY: INITIAL WATER CONTENT (%) | SHEAR STRENGTH: C (KSF) | SHEAR STRENGTH: Ø (DEGREES) | PERMEABILITY: K (CM/SECOND) | SPECIFIC GRAVITY | WATER SOLUBLE MATTER (PPM): SALTS | WATER SOLUBLE MATTER (PPM): SULFATES | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 5-6 | CL | | | 0.3 | 24.6 | | | | | DS (underlined) |
| 4 | 10-11 | SM | | | 0.0 | 35.0 | | | | | DS (underlined) |

**NOTE:** Initial Dry Density and Initial Water Content are in-situ values unless otherwise noted.

**LEGEND:**
**SHEAR STRENGTH TEST METHOD**
**DS** Direct Shear
**DS** (underlined) Direct Shear (Saturated)
**UC** Unconfined Compression
**UU** Unconsolidated Undrained
**CU** (underlined) Consolidated Undrained with Pore Pressure
**CU** Consolidated Undrained
**CD** Consolidated Drained

**REMARKS:**
1. Compacted Density (approximately 95% of ASTM D698 at moisture value slightly below optimum).
2. Visual Classification.
3. Constant Head.
4. Falling Head.

| RIVERFRONT WATER RECLAMATION FACILITY | |
|---|---|
| Soil Properties | |
| **Western Technologies Inc.** | |
| Job No.: 2521JW415 | Plate: B-4 |

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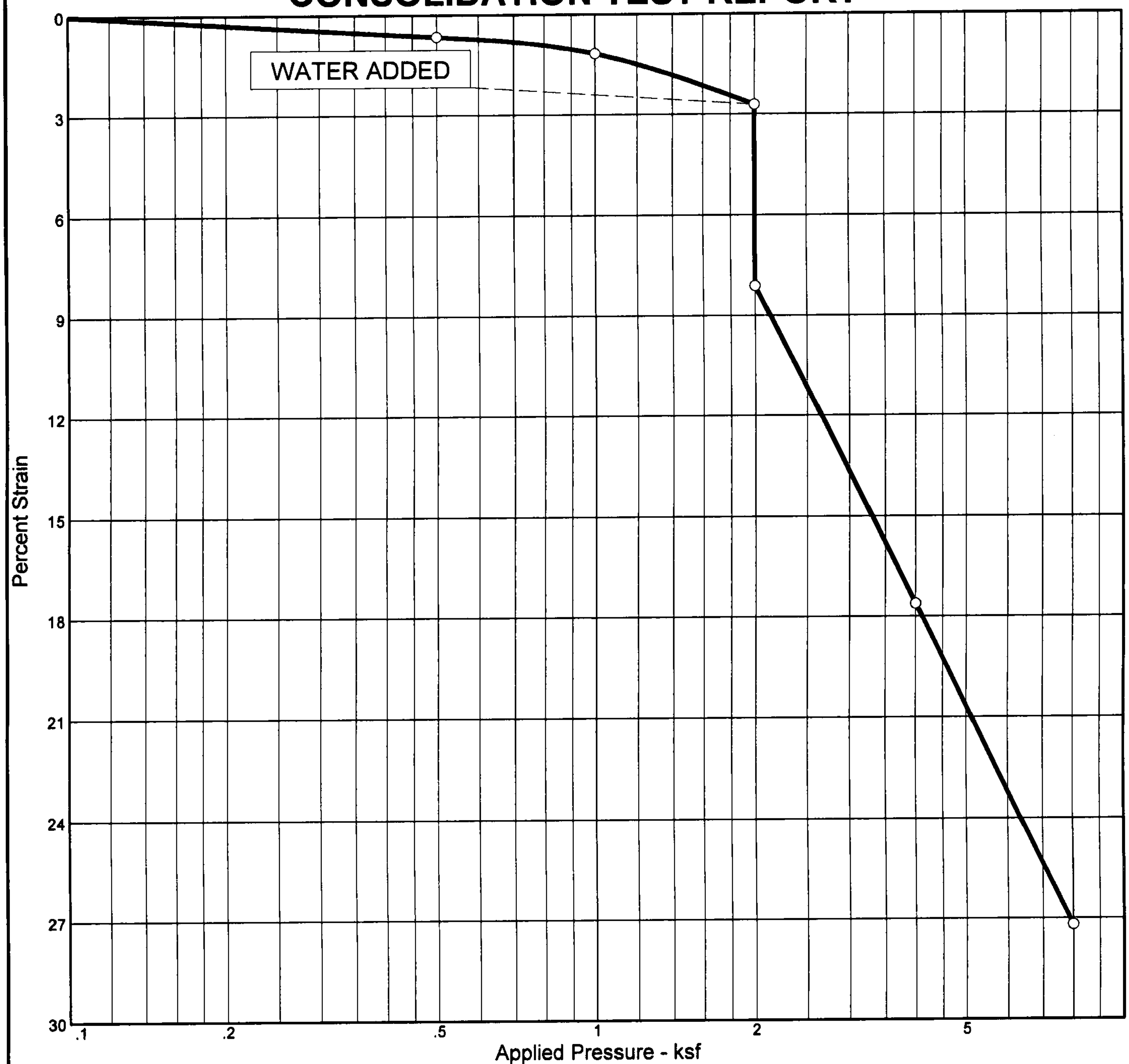
# CONSOLIDATION TEST REPORT




| Natural | | Dry Dens. (pcf) | LL | PI | Sp. Gr. | Overburden (ksf) | $P_c$ (ksf) | $C_c$ | $C_r$ | Swell Press. (ksf) | Clpse. % | $e_o$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sat. | Moist. | | | | | | | | | | | |
| 20.5 % | 7.7 % | 82.8 | | | 2.65 | | | | | | 5.4 | 0.999 |

| MATERIAL DESCRIPTION | USCS | AASHTO |
|---|---|---|
| SANDY LEAN CLAY | CL | |

**Project No.** 2521JW415 **Client:** WOOD/PATEL AND ASSOCIATES

**Project:** RIVERFRONT WRF

**Source:** RING SAMPLE **Sample No.:** BORING 1 **Elev./Depth:** 2-3 FEET

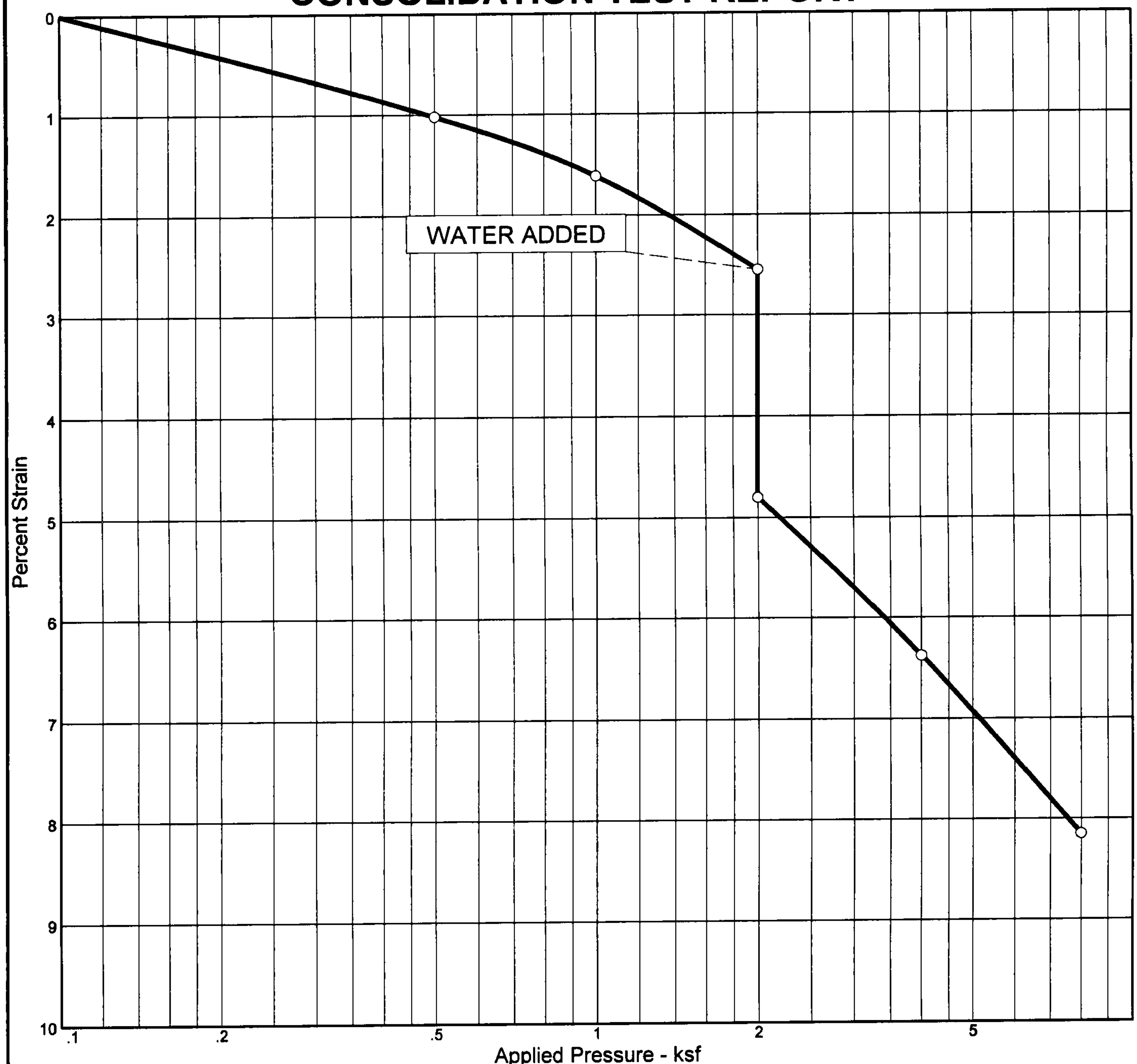
**Remarks:**

**Western Technologies, Inc.**

**Flagstaff, AZ**

**Figure** B-5

# CONSOLIDATION TEST REPORT




| Natural | | Dry Dens. (pcf) | LL | PI | Sp. Gr. | Overburden (ksf) | $P_c$ (ksf) | $C_c$ | $C_r$ | Swell Press. (ksf) | Clpse. % | $e_o$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sat. | Moist. | | | | | | | | | | | |
| 36.2 % | 9.5 % | 97.6 | | | 2.65 | | | | | | 2.2 | 0.694 |

| MATERIAL DESCRIPTION | USCS | AASHTO |
|---|---|---|
| SANDY SILT | ML | |

**Project No.** 2521JW415 **Client:** WOOD/PATEL AND ASSOCIATES

**Project:** RIVERFRONT WRF

**Source:** RING SAMPLE **Sample No.:** BORING 1 **Elev./Depth:** 15-16

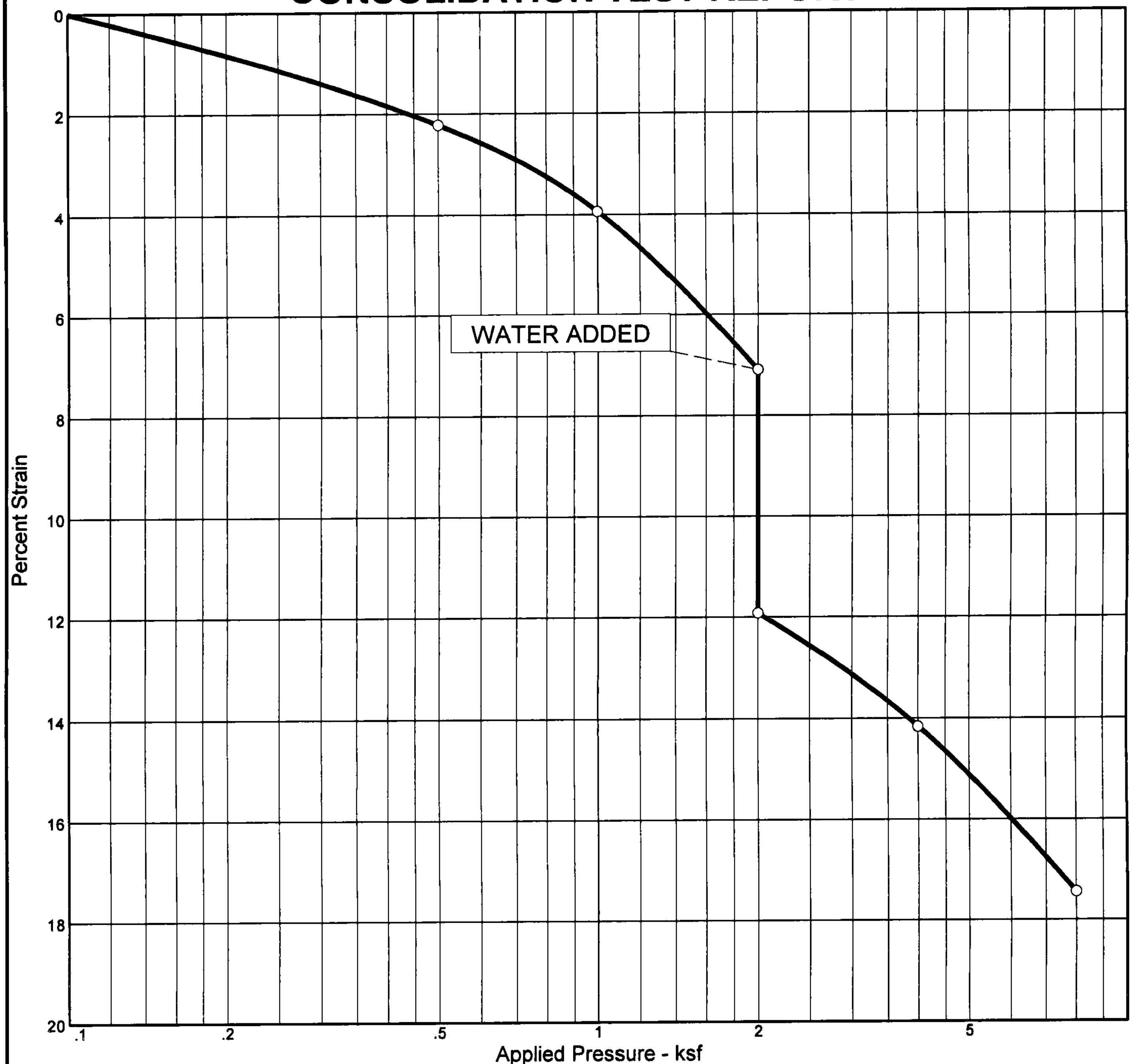
**Remarks:**

**Western Technologies, Inc.**

**Flagstaff, AZ**

**Figure** B-6

# CONSOLIDATION TEST REPORT




| Natural | | Dry Dens. (pcf) | LL | PI | Sp. Gr. | Overburden (ksf) | $P_c$ (ksf) | $C_c$ | $C_r$ | Swell Press. (ksf) | Clpse. % | $e_o$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sat. | Moist. | | | | | | | | | | | |
| 56.5 % | 16.1 % | 94.3 | | | 2.65 | | | | | | 4.8 | 0.754 |

| MATERIAL DESCRIPTION | USCS | AASHTO |
|---|---|---|
| LEAN CLAY WITH SAND | CL | |

**Project No.** 2521JW415 **Client:** WOOD/PATEL AND ASSOCIATES

**Project:** RIVERFRONT WRF

**Source:** RING SAMPLE **Sample No.:** BORING 2 **Elev./Depth:** 2-3 FEET

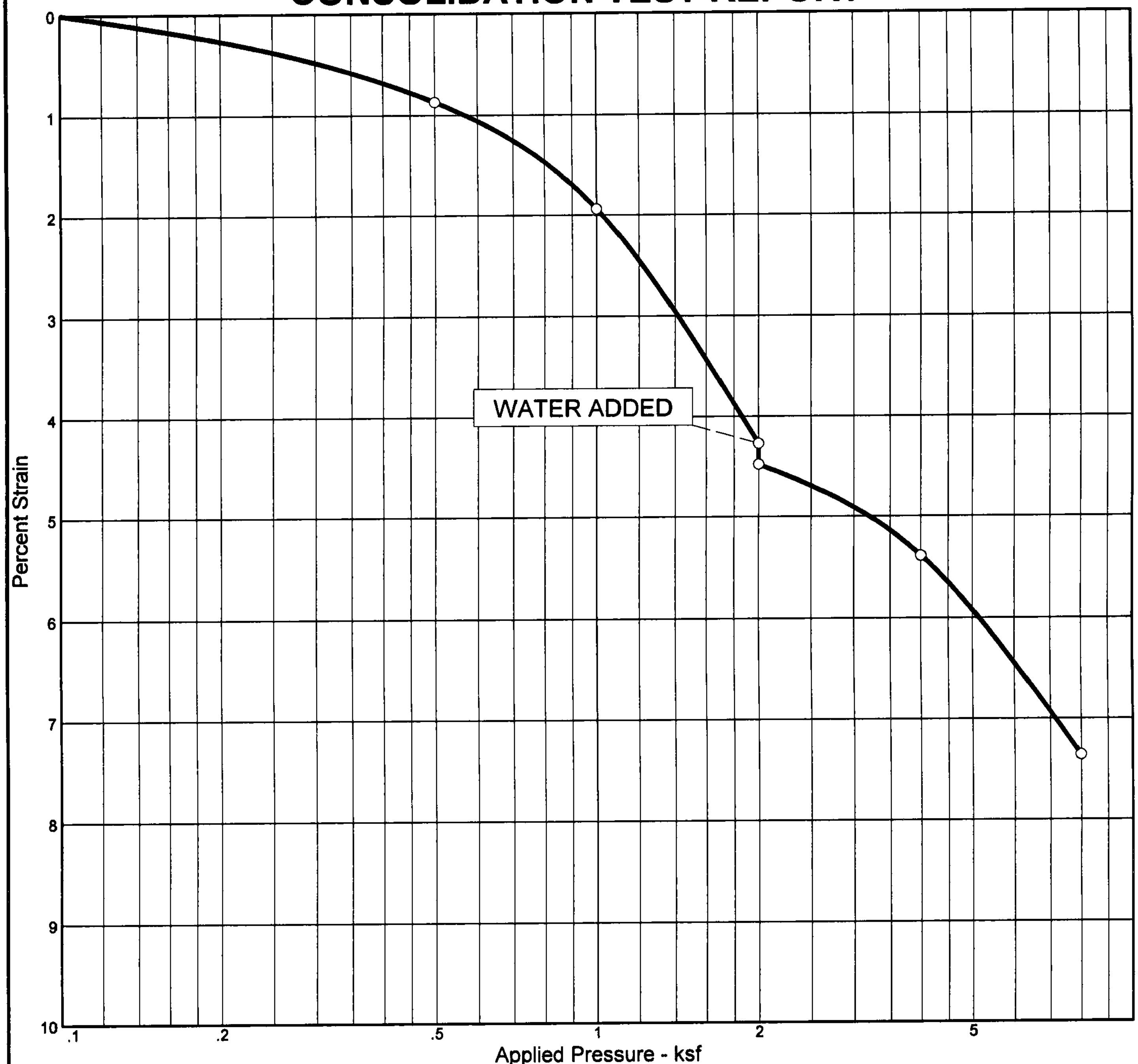
**Remarks:**

**Western Technologies, Inc.**

**Flagstaff, AZ**

**Figure** B-7

# CONSOLIDATION TEST REPORT




| Natural | | Dry Dens. (pcf) | LL | PI | Sp. Gr. | Overburden (ksf) | $P_c$ (ksf) | $C_c$ | $C_r$ | Swell Press. (ksf) | Clpse. % | $e_o$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sat. | Moist. | | | | | | | | | | | |
| 95.3 % | 19.3 % | 107.7 | | | 2.65 | | | | | | 0.2 | 0.536 |

| MATERIAL DESCRIPTION | USCS | AASHTO |
|---|---|---|
| SAND WITH GRAVEL | SP | |

**Project No.** 2521JW415 **Client:** WOOD/PATEL AND ASSOCIATES

**Project:** RIVERFRONT WRF

**Source:** RING SAMPLE **Sample No.:** BORING 2 **Elev./Depth:** 15-16 FEET

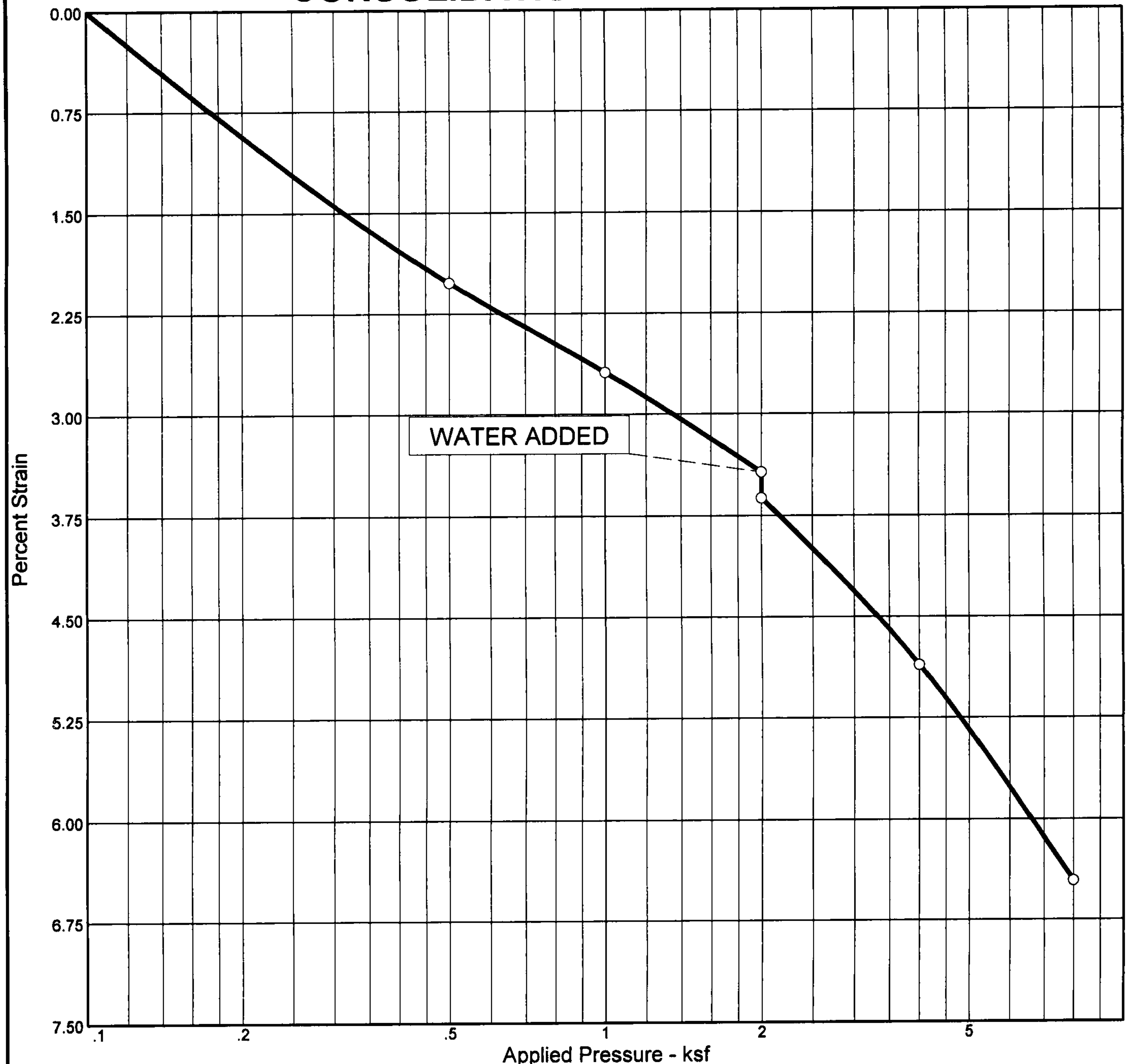
**Western Technologies, Inc.**

**Flagstaff, AZ**

**Remarks:**

**Figure** B-8

# CONSOLIDATION TEST REPORT




| Natural | | Dry Dens. (pcf) | LL | PI | Sp. Gr. | Overburden (ksf) | $P_c$ (ksf) | $C_c$ | $C_r$ | Swell Press. (ksf) | Clpse. % | $e_o$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sat. | Moist. | | | | | | | | | | | |
| 91.6 % | 30.4 % | 88.0 | | | 2.65 | | | | | | 0.2 | 0.881 |

| MATERIAL DESCRIPTION | USCS | AASHTO |
|---|---|---|
| SANDY LEAN CLAY | CL | |

**Project No.** 2521JW415 **Client:** WOOD/PATEL AND ASSOCIATES

**Project:** RIVERFRONT WRF

**Source:** RING SAMPLE **Sample No.:** BORING 3 **Elev./Depth:** 10-11 FEET

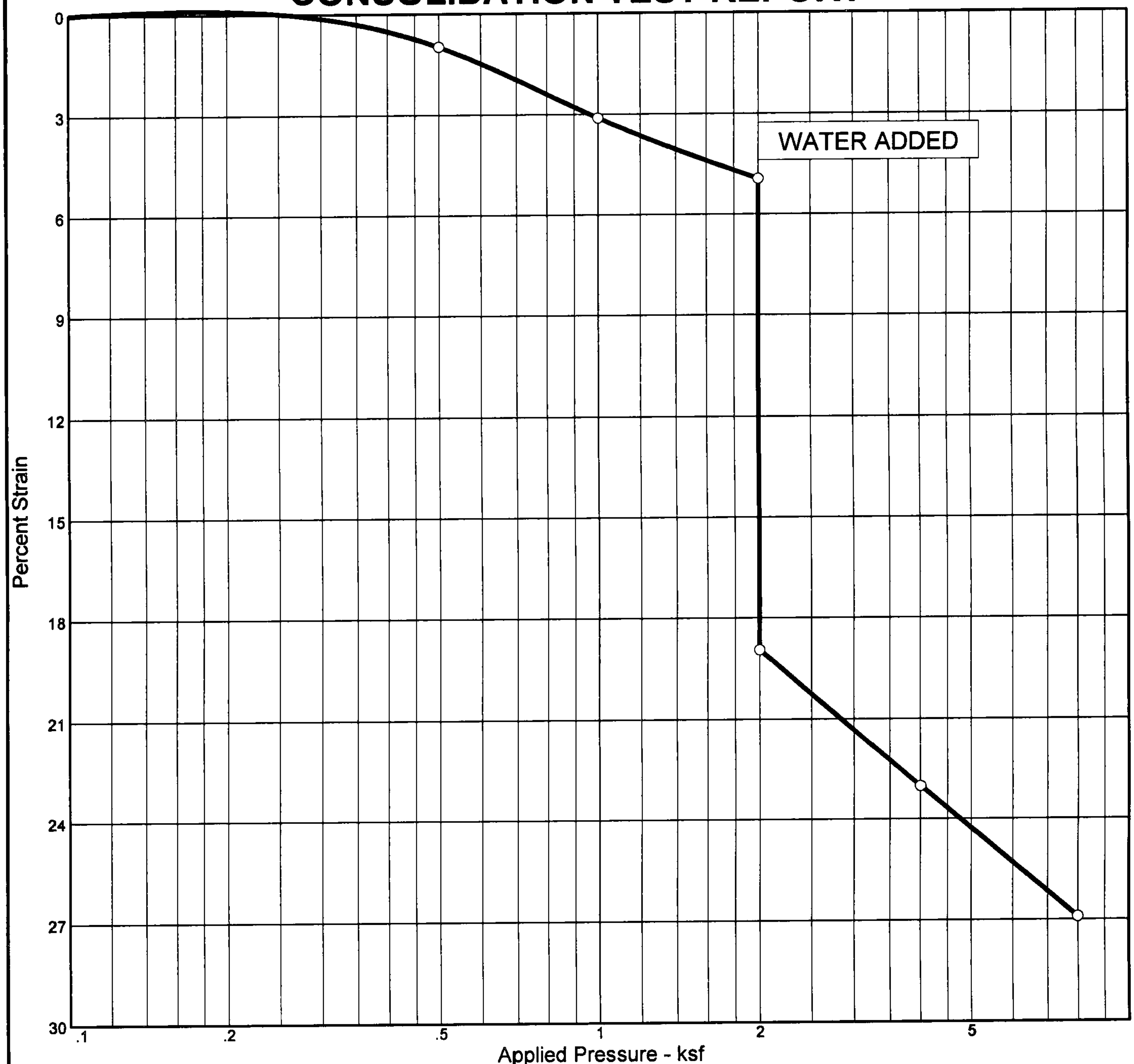
**Remarks:**

**Western Technologies, Inc.**

**Flagstaff, AZ**

**Figure** B-9

# CONSOLIDATION TEST REPORT




| Natural | | Dry Dens. (pcf) | LL | PI | Sp. Gr. | Overburden (ksf) | $P_c$ (ksf) | $C_c$ | $C_r$ | Swell Press. (ksf) | Clpse. % | $e_o$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sat. | Moist. | | | | | | | | | | | |
| 22.3 % | 9.5 % | 77.6 | | | 2.65 | | | | | | 14.0 | 1.133 |

| MATERIAL DESCRIPTION | USCS | AASHTO |
|---|---|---|
| SILTY SAND | SM | |

**Project No.** 2521JW415 **Client:** WOOD/PATEL AND ASSOCIATES

**Project:** RIVERFRONT WRF

**Source:** RING SAMPLE **Sample No.:** BORING 3 **Elev./Depth:** 15-16 FEET

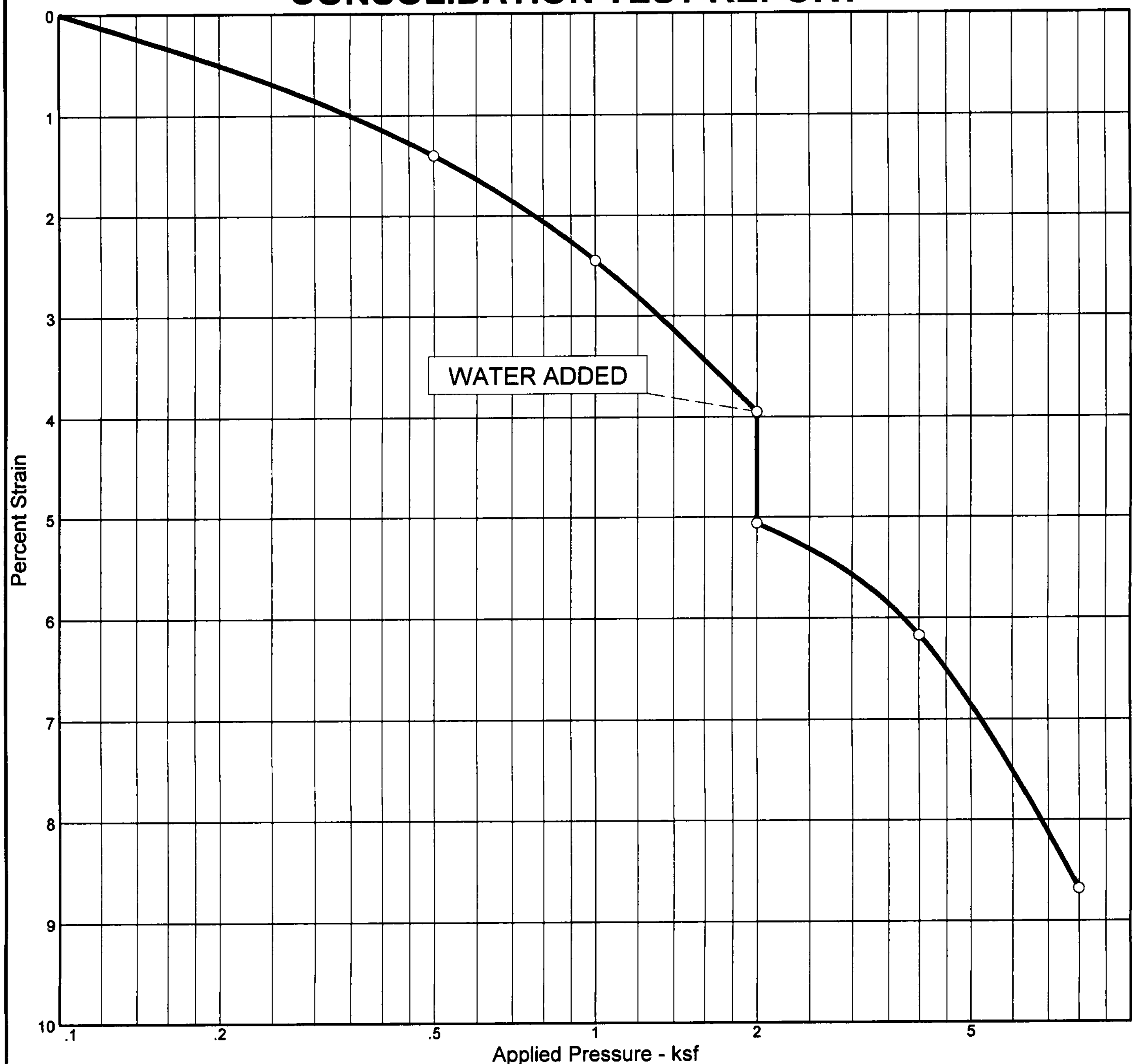
**Western Technologies, Inc.**

**Flagstaff, AZ**

**Remarks:**

**Figure** B-10

# CONSOLIDATION TEST REPORT




| Natural | | Dry Dens. (pcf) | LL | PI | Sp. Gr. | Overburden (ksf) | $P_c$ (ksf) | $C_c$ | $C_r$ | Swell Press. (ksf) | Clpse. % | $e_o$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sat. | Moist. | | | | | | | | | | | |
| 86.3 % | 23.5 % | 96.0 | | | 2.65 | | | | | | 1.1 | 0.723 |

| MATERIAL DESCRIPTION | USCS | AASHTO |
|---|---|---|
| LEAN CLAY WITH SAND | CL | |

**Project No.** 2521JW415 **Client:** WOOD/PATEL AND ASSOCIATES

**Project:** RIVERFRONT WRF

**Source:** RING SAMPLE **Sample No.:** BORING 4 **Elev./Depth:** 2-3 FEET

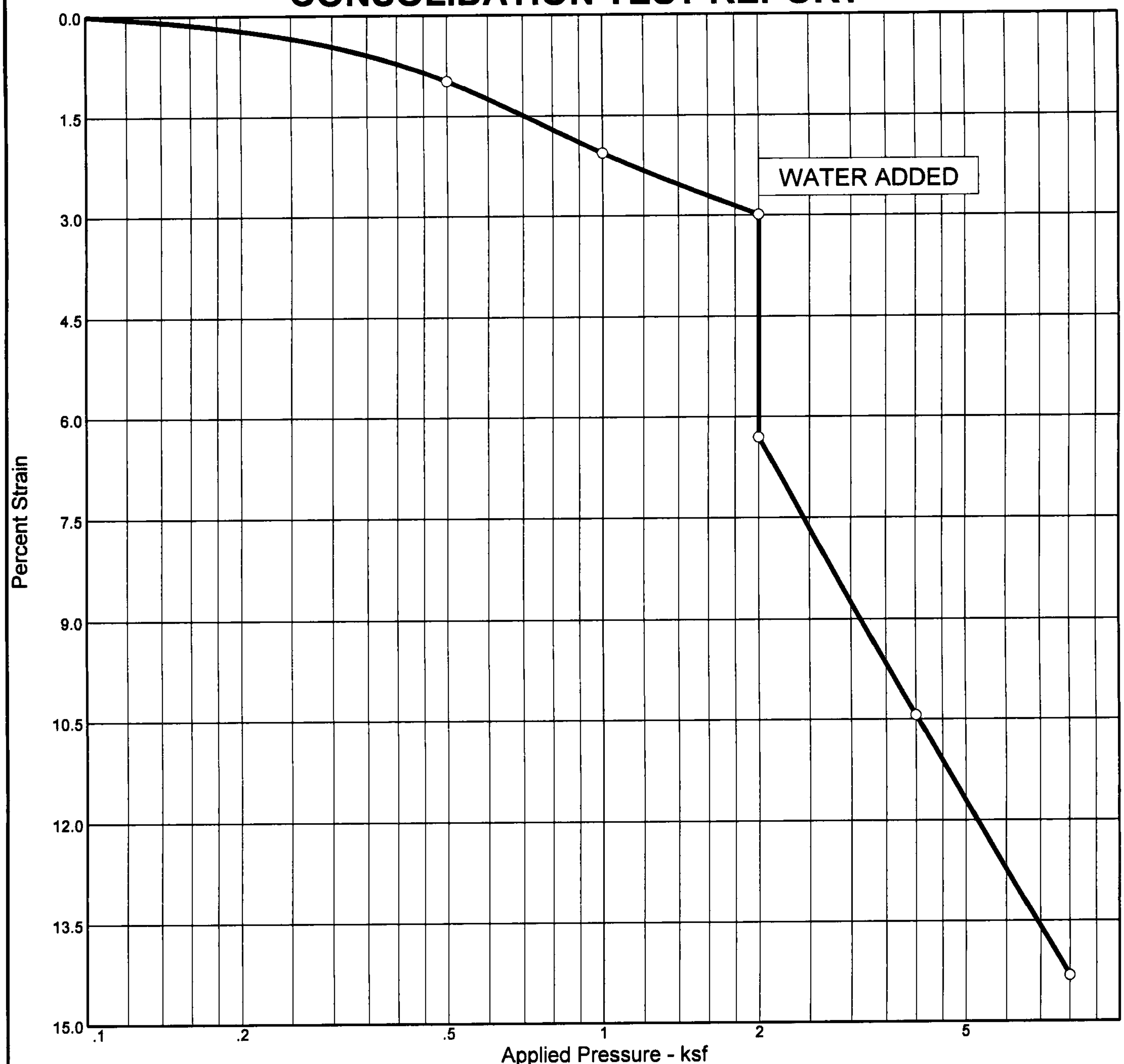
**Remarks:**

**Western Technologies, Inc.**

**Flagstaff, AZ**

**Figure** B-11

# CONSOLIDATION TEST REPORT




| Natural | | Dry Dens. (pcf) | LL | PI | Sp. Gr. | Overburden (ksf) | $P_c$ (ksf) | $C_c$ | $C_r$ | Swell Press. (ksf) | Clpse. % | $e_o$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sat. | Moist. | | | | | | | | | | | |
| 63.8 % | 18.6 % | 93.2 | | | 2.65 | | | | | | 3.3 | 0.774 |

| MATERIAL DESCRIPTION | USCS | AASHTO |
|---|---|---|
| LEAN CLAY WITH SAND | CL | |

**Project No.** 2521JW415 **Client:** WOOD/PATEL AND ASSOCIATES

**Project:** RIVERFRONT WRF

**Source:** RING SAMPLE **Sample No.:** BORING 4 **Elev./Depth:** 5-6 FEET

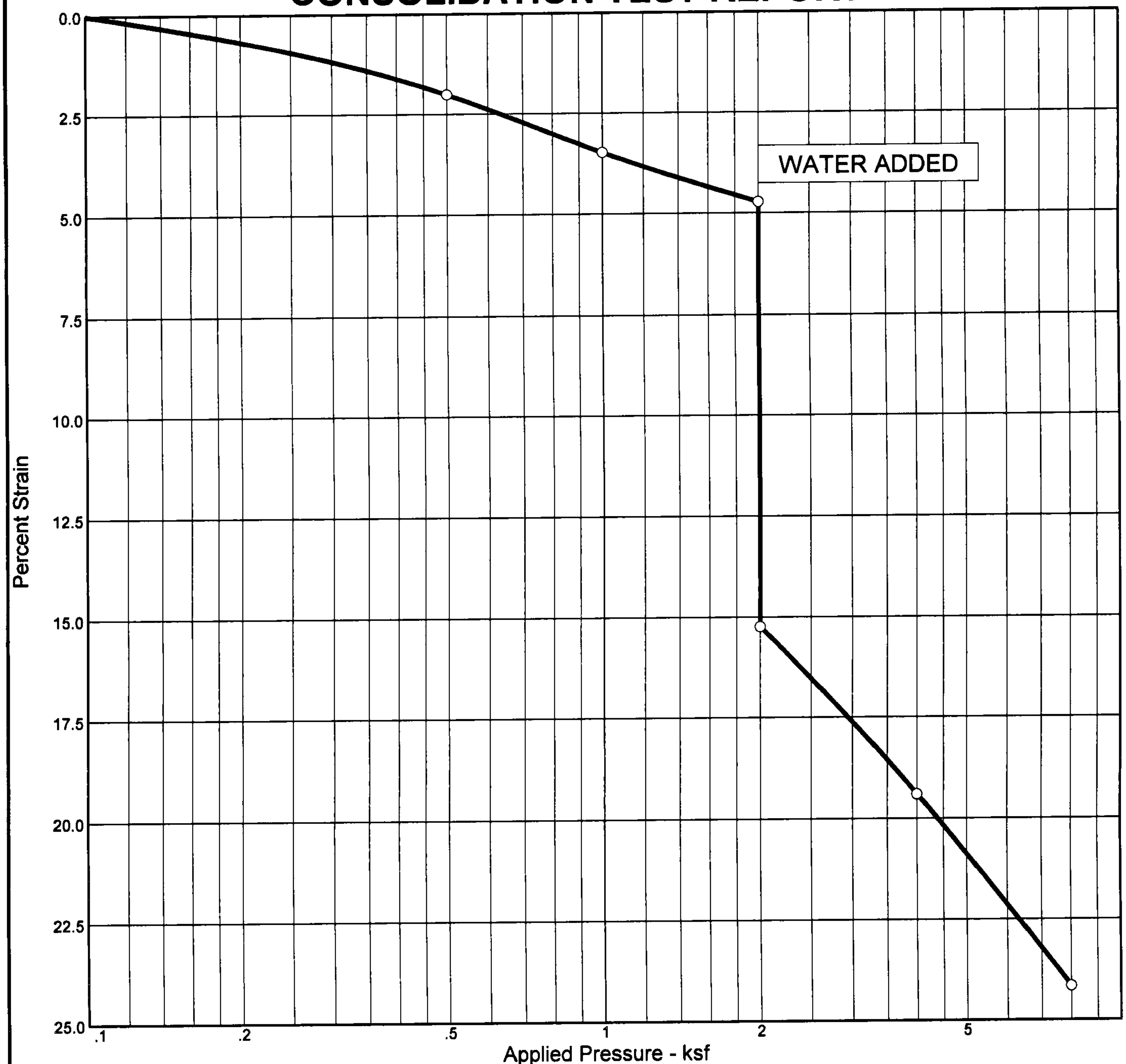
**Western Technologies, Inc.**

**Flagstaff, AZ**

**Remarks:**

**Figure** B-12

# CONSOLIDATION TEST REPORT




| Natural | | Dry Dens. (pcf) | LL | PI | Sp. Gr. | Overburden (ksf) | $P_c$ (ksf) | $C_c$ | $C_r$ | Swell Press. (ksf) | Clpse. % | $e_o$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sat. | Moist. | | | | | | | | | | | |
| 29.8 % | 10.4 % | 86.2 | | | 2.65 | | | | | | 10.5 | 0.920 |

| MATERIAL DESCRIPTION | USCS | AASHTO |
|---|---|---|
| SANDY LEAN CLAY | CL | |

**Project No.** 2521JW415 **Client:** WOOD/PATEL AND ASSOCIATES

**Project:** RIVERFRONT WRF

**Source:** RING SAMPLE **Sample No.:** BORING 5 **Elev./Depth:** 5-6 FEET

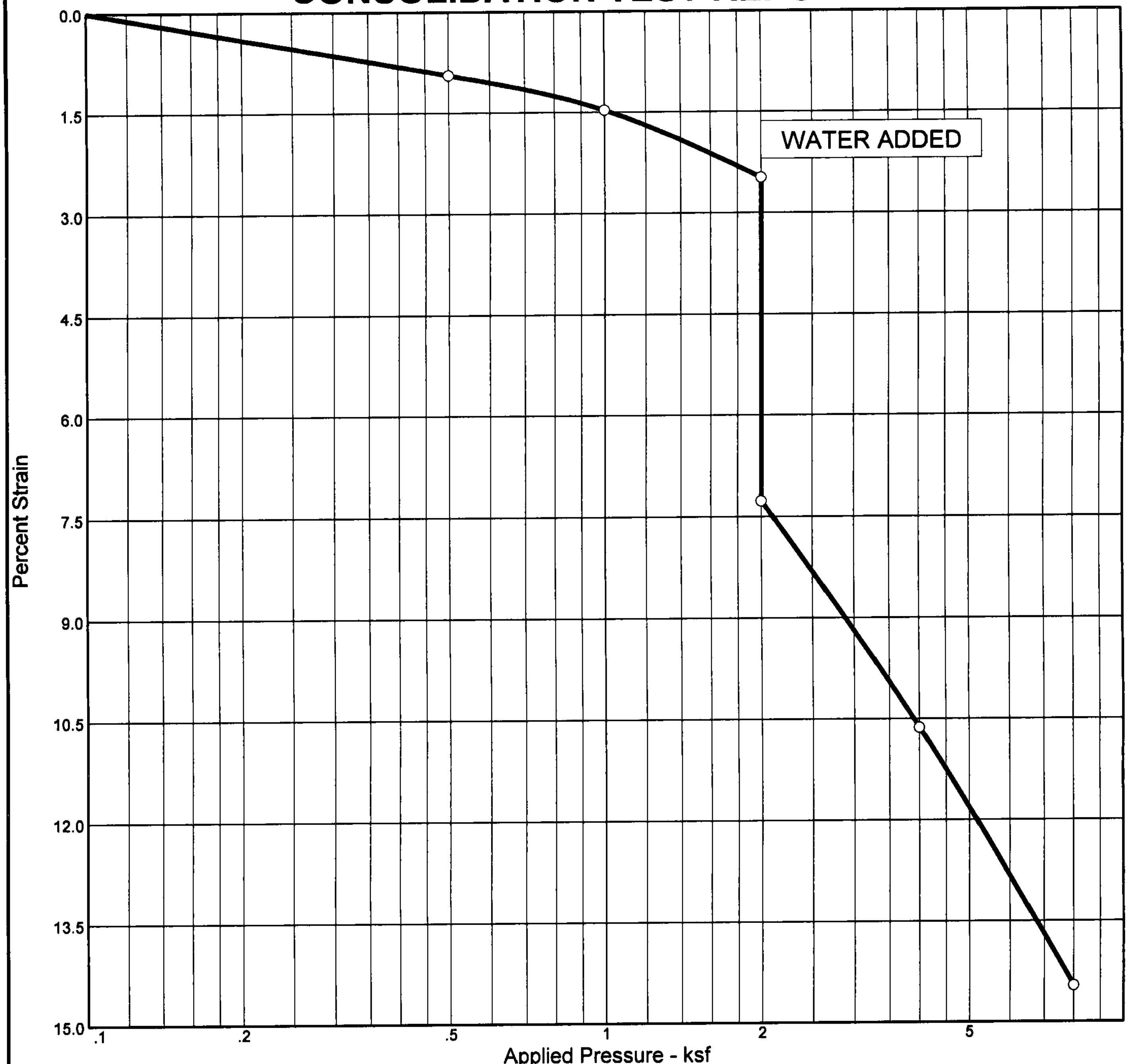
**Remarks:**

**Western Technologies, Inc.**

**Flagstaff, AZ**

**Figure** B-13

# CONSOLIDATION TEST REPORT




| Natural | | Dry Dens. (pcf) | LL | PI | Sp. Gr. | Overburden (ksf) | $P_c$ (ksf) | $C_c$ | $C_r$ | Swell Press. (ksf) | Clpse. % | $e_o$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sat. | Moist. | | | | | | | | | | | |
| 50.8 % | 16.1 % | 89.9 | | | 2.65 | | | | | | 4.8 | 0.841 |

| MATERIAL DESCRIPTION | USCS | AASHTO |
|---|---|---|
| LEAN CLAY | CL | |

**Project No.** 2521JW415 **Client:** WOOD/PATEL AND ASSOCIATES

**Project:** RIVERFRONT WRF

**Source:** RING SAMPLE **Sample No.:** BORING 6 **Elev./Depth:** 2-3 FEET

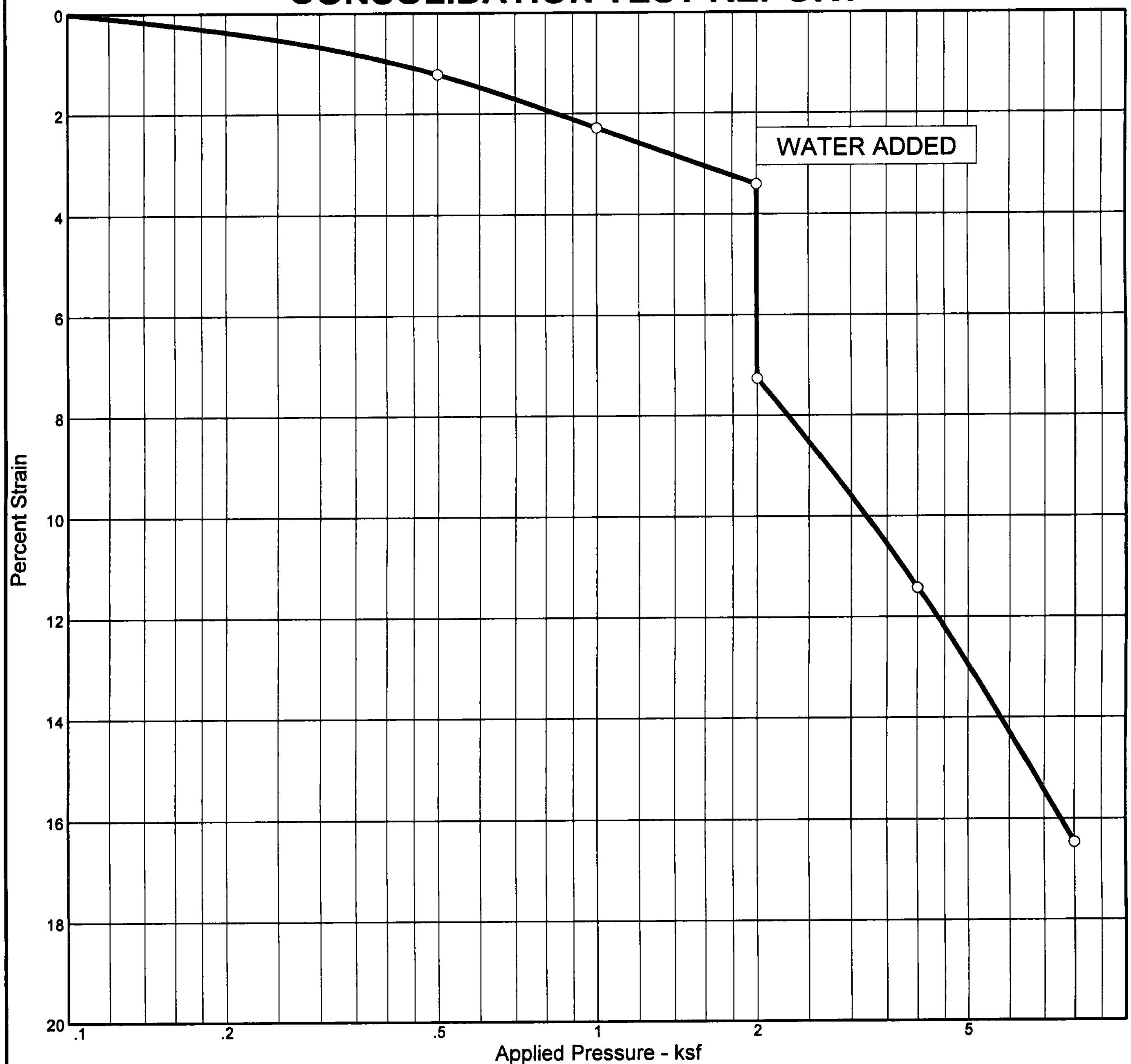
**Western Technologies, Inc.**

**Flagstaff, AZ**

**Remarks:**

**Figure** B-14

# CONSOLIDATION TEST REPORT




| Natural | | Dry Dens. (pcf) | LL | PI | Sp. Gr. | Overburden (ksf) | $P_c$ (ksf) | $C_c$ | $C_r$ | Swell Press. (ksf) | Clpse. % | $e_o$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sat. | Moist. | | | | | | | | | | | |
| 65.3 % | 18.1 % | 95.4 | | | 2.65 | | | | | | 3.9 | 0.734 |

| MATERIAL DESCRIPTION | USCS | AASHTO |
|---|---|---|
| SILTY SAND | SM | |

**Project No.** 2521JW415 **Client:** WOOD/PATEL AND ASSOCIATES

**Project:** RIVERFRONT WRF

**Source:** RING SAMPLE **Sample No.:** BORING 9 **Elev./Depth:** 5-6 FEET

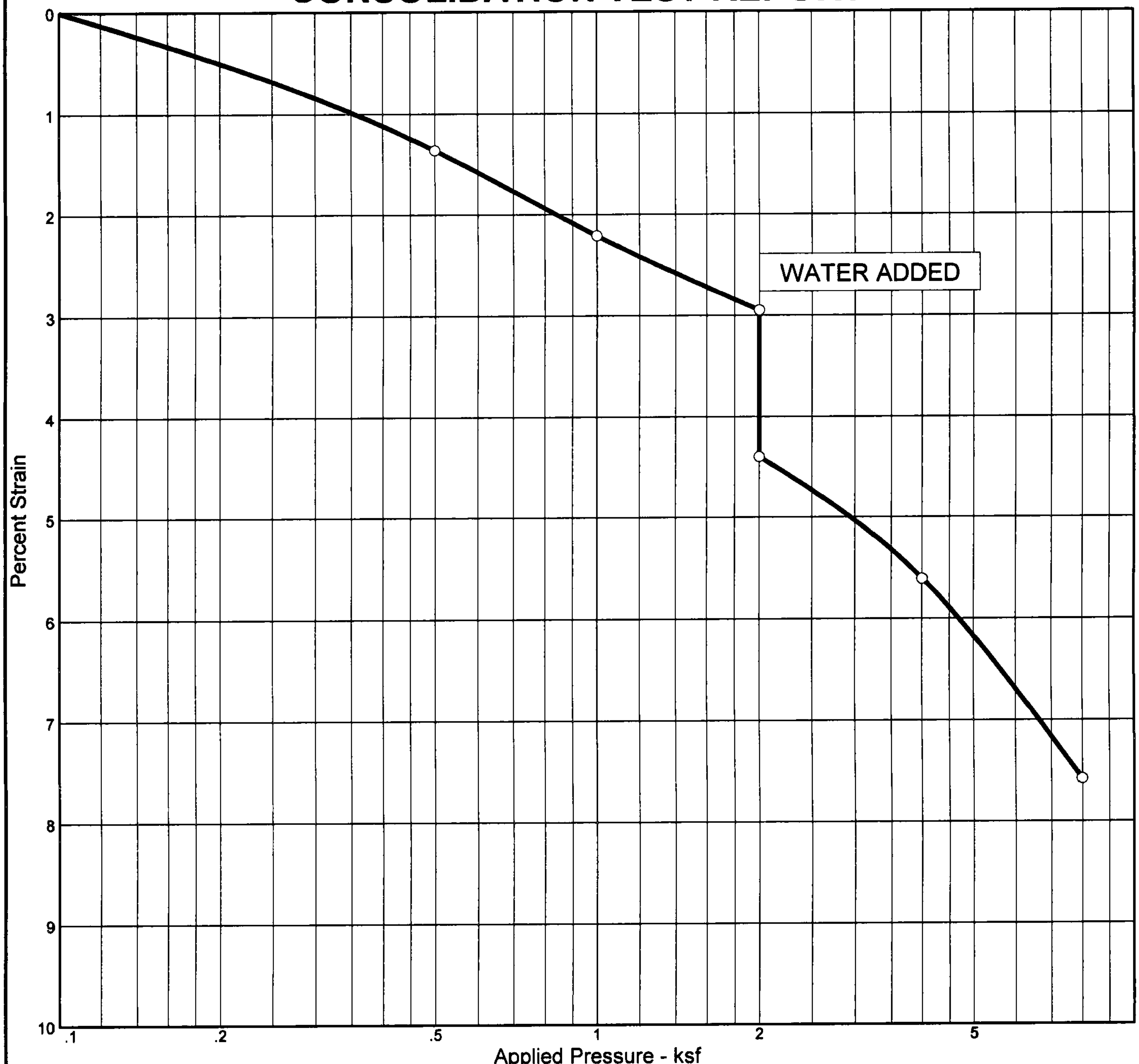
**Remarks:**

**Western Technologies, Inc.**

**Flagstaff, AZ**

**Figure** B-15

# CONSOLIDATION TEST REPORT




| Natural | | Dry Dens. (pcf) | LL | PI | Sp. Gr. | Overburden (ksf) | $P_c$ (ksf) | $C_c$ | $C_r$ | Swell Press. (ksf) | Clpse. % | $e_o$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sat. | Moist. | | | | | | | | | | | |
| 47.7 % | 16.0 % | 87.6 | | | 2.65 | | | | | | 1.4 | 0.888 |

| MATERIAL DESCRIPTION | USCS | AASHTO |
|---|---|---|
| SILTY SAND | SM | |

**Project No.** 2521JW415 **Client:** WOOD/PATEL AND ASSOCIATES

**Project:** RIVERFRONT WRF

**Source:** RING SAMPLE **Sample No.:** BORING 9 **Elev./Depth:** 10-11 FEET

**Western Technologies, Inc.**

**Flagstaff, AZ**

**Remarks:**

**Figure** B-16

**CITY OF COTTONWOOD**
**RIVERFRONT WATER RECLAMATION FACILITY**
**CONSTRUCTION DOCUMENTS**
**Project No. 15007**

Addendum No. 4

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**Date:** February 25, 2016

**Subject:** Addendum No. 4 to the Construction Documents dated September 2015

## A. SCOPE

1. This addendum forms a part of the Construction Documents and clarifies, corrects, or modifies the original Documents prepared by *Pineview Consulting, LLC*.

   This Addendum No. 4 consists of page AD4-1 and covers the following changes and additions.

## B. GEOTECH REPORT

1. The Geotechnical Evaluation Report dated March 22, 2012, prepared by Western Technologies, Inc. (WT) is amended to include subbase preparation for the above-ground steel storage reclaimed water reservoir as follows: “WT estimates 2 inches total and 1 inch differential settlement for the water tank constructed at final site grade (i.e., a 60-foot diameter tank with a bottom bearing pressure of 1500 psf). It is understood that about 4 feet of fill will be placed in the area of the tank to reach final site grade. Additional removal and replacement at subgrade elevation (at existing grade prior to placement of fill) will not be necessary, unless proof-rolling indicates soft, loose or unstable soils are present; in which case those soils should be removed and properly recompacted as engineered fill. During or after proof-rolling, the subgrade should be scarified a minimum of 8 inches, watered as necessary, and recompacted prior to placing the additional 4 plus feet of engineered fill. The compaction levels and moisture content recommendations presented in our report will still apply. Subgrade preparation should extend at least 3-feet outside the diameter of the storage tank.”

2. The tank shall be filled with water and allowed to preload the base for 1 week prior to connecting external piping.

END OF ADDENDUM No. 4


EXPIRES 06–30–18