

GEOTECHNICAL ENGINEERING REPORT

AIMRIGHT Project No. 14971123

May 1, 2024

Lower Bird Creek WWTP FEB

Prepared for:

STV, Inc.



Construction Materials Testing • Special Inspections • Geotechnical Engineering

May 1, 2024

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Attn: Michael Graves, Vice President
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Re: Geotechnical Engineering Report | Project No. 14971123
Lower Bird Creek WWTP FEB
[151 W 36th St N, Catoosa, OK 74015](#)

It has been a pleasure serving you on this project. AIMRIGHT is pleased to submit this Geotechnical Engineering Report for the proposed construction planned at the referenced site. This report presents the findings of the geotechnical exploration and presents recommendations for design for the project.

We appreciate the opportunity to provide geotechnical consultation services for the subject project. We look forward to serving as your geotechnical engineer and construction materials testing laboratory for the remainder of this and future projects. Please do not hesitate to contact us with any concerns or questions regarding this report.

Respectfully submitted,

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1.0 PROJECT INFORMATION

1.1 Description

We understand that new structures (pump station, splitter box, clarifier) will be constructed on the referenced site. The site is currently developed with existing structures, above/below-grade infrastructure and mainly grass/soil covered with few trees and shrubbery. The final design has been partially completed.

Based on conversations with you, it is our understanding that during the construction of the existing clarifier and adjacent oxidation and basin structures (approximately 10 to 12 years ago), a blasting plan was created and executed to lower the site elevations to 564.5 and 574.5 feet (see attached provided Blasting Plan illustration). The excavations were completed for the existing clarifier and have not been completed for the proposed new structures (pump station, splitter box, clarifier). Excavation of previously blasted material and backfill with properly compacted engineered fill will be required for this project.

The site is generally level with minimal elevation differences across the site. Cut/fill depths have been partially finalized; and we estimate that cut of approximately 6 to 20 feet (including blast zone removal) may be required to reach the final site elevations (~top of slab elevation (ft) at pump station = 576, splitter box = 578, clarifier = 572 to 576 ft).

The structures are anticipated to be supported by a concrete slab-on-ground and wall/spread foundation system. We utilized maximum column loads of 10 to 20 kip and wall loads of 1 to 5 kip per linear foot in our engineering analyses.

1.2 Scope of Services

The primary purpose of this report is to provide geotechnical engineering recommendations for the proposed site development. Our Scope of Services consisted of the following:

- Drilling three (3) soil test borings (borings) to planned depths of approximately 25 feet or 5 feet into rock or auger refusal, whichever occurred first.
- Performing laboratory testing of selected soil samples obtained from the borings.
- Providing engineering analysis and preparation of this report discussing, in general, project description, our scope, exploration, testing, analysis, and recommendations.

The Site/Boring Location Plans, Boring Logs, and other supporting data are presented in the Appendices to this report. Our Scope of Services did not include a survey of boring locations and elevations, rock coring, quantity estimates, preparation of plans or specifications, slope stability analysis, or the identification and evaluation of environmental aspects of the project site.

1.3 Field Exploration

AIMRIGHT located the borings in the field from markings provided by you. The boring elevations indicated on the boring logs were provided by you (see attached provided Survey Data illustration). No claim is made as to the accuracy of the elevations and locations shown on the Boring Logs and Boring Location Plans, and they should be considered approximate.

The borings were advanced using an ATV-mounted drill rig equipped with an automatic hammer (with a standard 140-lb hammer falling a height of 30 inches) and 6-inch diameter continuous flight augers. Representative soil samples were obtained using a standard 18-inch (2-inch outside diameter) split-barrel sampler in general compliance with the Standard Penetration Testing (SPT) method of the American Society of Testing and Materials (ASTM) D1586 standard to evaluate the consistency and general engineering properties of the subsurface soils.

The number of blows required to drive the split-barrel sampler three (3) consecutive 6-inch increments is recorded, and the blows of the last two 6-inch increments are added to obtain the SPT N-value in blows per foot (bpf) representing the penetration resistance of the soil. At regular intervals within the borings, split-spoon samples were visually classified based on texture and plasticity.

During the drilling process, all encounters with groundwater, if any, were recorded. Upon completion of drilling, all borings were backfilled per OWRB requirements.

1.4 Laboratory Testing

The samples obtained from the geotechnical exploration were transported to the AIMRIGHT laboratory where representative samples were selected for testing. Testing consisted of Atterberg limits, sieve analysis, and determination of moisture content in general accordance with the ASTM testing procedures.

2.0 FIELD EXPLORATION FINDINGS

2.1 Subsurface

The subsurface conditions illustrated in the table below represent an estimate of the subsurface conditions based on interpretation of the boring data using normally accepted geotechnical engineering judgments. The transitions between soil strata are usually less distinct than shown on the Boring Logs.

| Stratum | General Depth Interval | Description of Conditions |
|----------------|-----------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Surface | 2 to 3 inches | organic laden soils (topsoil) sampled as silty sand/sandy silt with organics and root matter |
| Existing Soils | 0.1 to 18.5 feet | medium stiff to very stiff with lean, lean-to-fat, fat clay and loose to very dense clayey sand varying amounts of clay, silt, sand, and sandstone, limestone fragments |
| Weathered Rock | 8.5 to 20.5 feet (~el. 576.18 to 564.69 feet) | highly weathered, soft to moderately hard limestone and shale |

Auger refusal was encountered in the borings at depths of approximately 9.5 to 20.5 feet (~el. 575.31 to 562.69 feet). Auger refusal is defined as material that could not be penetrated with the drill rig equipment used on the project. Auger refusal material may be caused by rock, large boulders, rock ledges, lenses, seams, or the top of parent bedrock.

2.2 Groundwater

Groundwater was not encountered during or at the completion of drilling in any of the borings. Water traveling through soil and rock is often unpredictable and may be present at shallow depths. Due to the seasonal changes in groundwater and the unpredictable nature of groundwater paths, groundwater levels will fluctuate. As such, groundwater levels at other times of the year may be different than those described in this report.

Generally, the highest groundwater levels occur in late winter and early spring and the lowest levels in late summer and fall. Therefore, it is necessary during construction to be observant for groundwater seepage in excavations to assess the situation and make necessary changes. Where applicable, the contractor should determine the actual groundwater levels at the time of construction.

3.0 LABORATORY TESTING RESULTS

Laboratory tests were conducted on selected samples in general accordance with ASTM standards. The laboratory testing performed for this project consisted of Atterberg Limits (ASTM D4318), Moisture Content (ASTM D2216), and Sieve Analysis – No. 200 Sieve Wash Method (ASTM D1140) testing. The test results are presented on the Boring Logs and are summarized in the table below.

| Boring No. | Sample Depth Interval (ft) | In-place Moisture Content (%) | Finer than No. 200 Sieve (%) | Atterberg Limits | | |
|------------|----------------------------|-------------------------------|------------------------------|------------------|-------------------|------------------|
| | | | | Liquid Limit (%) | Plastic Limit (%) | Plasticity Index |
| B-14 | 0 to 1.5 | 15.4 | 67.7 | 35 | 16 | 19 |
| | 3.5 to 5 | 8.3 | 33.2 | 30 | 15 | 15 |
| B-15 | 1.5 to 3 | 21.4 | 91.4 | 53 | 17 | 36 |
| | 6 to 7.5 | 23.3 | 88.8 | 52 | 19 | 33 |
| | 13.5 to 15 | 20.4 | 45.0 | 28 | 16 | 12 |
| B-16 | 0 to 1.5 | 14.6 | 70.4 | 36 | 16 | 20 |
| | 3.5 to 5 | 13.8 | 74.8 | 38 | 16 | 22 |

4.0 ANALYSIS & CONCLUSIONS

4.1 Analysis

The following recommendations are based on our observations at the site, interpretation and analysis of the field and laboratory data obtained during this exploration, assumed loads, and our experience with previous exploration and testing with similar projects. Soil penetration data have been used to estimate an allowable bearing pressure and associated settlement using established correlations. Subsurface conditions in unexplored locations may vary from those encountered. If structure location, loadings, or elevations are changed, we request that we be advised so that we may re-evaluate our recommendations. In the event changes are made in the proposed design/construction plans, the recommendations presented in this report shall not be considered valid unless reviewed by AIMRIGHT and modified or verified in writing.

Determination of an appropriate foundation system for a given structure is dependent on the proposed structural loads, soil conditions, and construction constraints such as proximity to other structures, etc. The subsurface exploration aids the geotechnical engineer in determining the soil stratum appropriate for structural support. This determination includes considerations regarding both allowable bearing pressure and compressibility of the soil strata. In addition, since the method of construction greatly affects the soils intended for structural support, consideration must be given to the implementation of suitable methods of site preparation, fill compaction, and other aspects of construction.

Our exploration revealed the following potentially adverse subsurface conditions:

- It is our understanding that during the construction of the existing clarifier and adjacent oxidation and basin structures (approximately 10 to 12 years ago), a blasting plan was created and executed to lower the site elevations to 564.5 and 574.5 feet (see attached provided Blasting Plan illustration). The excavations were completed for the existing clarifier and have not been completed for the proposed new structures (pump station, splitter box, clarifier).
- Existing soils comprised of low to high plastic clay capable of low to high shrink/swell potential was encountered in the boring B-15 at or just below the surface and extending down to varying depths. With respect to shrink/swell, due to the anticipated moisture volumetric changes throughout the seasonal wetting/drying cycles, a potential vertical rise (PVR) range of approximately 0.7 to 1.7 inches (or more) is estimated for the near surface soils within the upper 5 feet.
- Highly weathered, soft to moderately hard limestone and shale was encountered in the borings beginning at depths of approximately 8.5 to 18.5 feet and extending down to the termination depths. Auger refusal was encountered in the borings at depths of approximately 9.5 to 20.5 feet (~el. 562.7 to 575 feet).

4.2 Conclusions

In conclusion, provided the recommendations outlined in this report are followed throughout the design and construction phases of this project, it is our opinion that the site is suitable for the planned development and concrete slab-on-ground and wall/spread foundation may be utilized to support the structures.

- Excavation of previously blasted material and backfill with properly compacted engineered fill will be required for this project. Within all structure footprints, the existing site elevations should be over-excavated to elevation 564.5 feet (clarifier) and 574.5 feet (pump station, splitter box) to remove the previously blasted material. The width of the excavation shall be equal to the depth of excavation.
- At this time, we do not anticipate any construction near boring B-15, however, similar soils may be encountered elsewhere on the site. It is imperative that a geotechnical engineer observe the excavation activities at this site to assist in determining if soils with moderate to high shrink/swell potential are present within the planned pump station, splitter box, and clarifier structure footprints as well as any other construction elements or flatwork (i.e., sidewalks, canopy footings, ramps, patios, equipment slabs, etc.) that are sensitive to movement.
- Installation or excavation of proposed subgrade, foundations, or underground utilities (depending on layout and planned bottom elevations) within some portions of the site will require jackhammering, coring, ripping, or other suitable methods to remove these materials.

5.0 RECOMMENDATIONS

5.1 Site Preparation and Earthwork

Before proceeding with construction, AIMRIGHT recommends conducting a pre-grading meeting to discuss recommendations as outlined in this report. Where appropriate, existing utilities beneath the construction footprints should be properly abandoned; or, should be removed and backfilled with properly compacted engineered fill as outlined in this report.

Any existing structures, pavements, site elements, foreign stockpiles, topsoil/vegetation, wet, soft, or loose soils and any other deleterious non-soil materials should be removed to a minimum distance of 5 feet beyond the structure footprints. Within all structure footprints, the existing site elevations should be over-excavated to elevation 564.5 feet (clarifier) and 574.5 feet (pump station, splitter box) to remove the previously blasted material. The width of the excavation shall be equal to the depth of excavation.

It is imperative that a geotechnical engineer observe the excavation activities at this site to assist in determining if soils with moderate to high shrink/swell potential are present within the planned pump station, splitter box, and clarifier structure footprints as well as any other construction elements or flatwork (i.e., sidewalks, canopy footings, ramps, equipment slabs, etc.) that are sensitive to movement. If such soils are encountered, they should be separated and stockpiled for further evaluation.

Upon completion of required excavations, proof-rolling of the subgrade with a 20 to 30-ton loaded truck or other pneumatic-tired vehicle of similar size and weight should then be performed. Proof-rolling should be performed during a time of good weather and not while the site is wet, frozen, or severely desiccated. All unsuitable materials observed during the evaluation and proof-rolling operations should be over-excavated and replaced with compacted fill or stabilized in place. The possible need for, and extent of over-excavation and/or in-place stabilization required can best be determined at that time.

The upper 8 inches of the existing subgrade in construction areas shall then be scarified, moisture-conditioned and re-compacted to at least ninety-five percent (95%) of the maximum dry density and within ± 2 percentage points of the optimum moisture content as determined by a Standard Proctor (ASTM D698). The moisture content and compaction shall be maintained prior to beginning any fill or aggregate placement and/or construction. At the time of the investigation, the site soils were generally moist. Depending on weather conditions existing prior to and during construction, the near surface soils may need moisture-conditioning to sufficiently enable adequate scarifying and compaction.

We note that some of the near surface materials (i.e., silty clayey sand, sandy silt, silty clay, silt, etc.) will often exhibit shearing as open subgrades under wheel loads and will not hold up well to construction activities, especially during wet periods. A layer of aggregate base or crushed stone quickly placed after subgrade preparation and verification will help confine the subgrade soils and reduce imminent disturbance from construction activities.

5.2 Site Drainage

An important aspect to consider during development of this site is surface water control. During the initiation of grading operations, we recommend that the grading contractor take those steps necessary to enhance surface flow and promote rapid clearing of rainfall and runoff water following rain events.

It should be incumbent on the contractor to maintain favorable site drainage during construction to minimize deterioration of otherwise stable subgrades.

Permanent positive drainage should be provided around the perimeter of the structures to minimize moisture infiltration into the foundation and/or subgrade soils. We recommend areas adjacent to the structures be provided with a fall of at least 6 inches for the first 10 feet outward from the structure areas.

All grades must provide effective drainage away from the structures during and after construction. Water permitted to pond next to the structures can result in unacceptable differential floor slab movements and cracked slabs and/or walls.

After construction and landscaping, AIMRIGHT recommends verifying final grades to document that effective drainage has been achieved. Grades around the structures should also be periodically inspected and adjusted as necessary, as part of the structure's maintenance program.

Roof runoff should be collected in drains or gutters. Roof drains and downspouts should be discharged onto pavements which slope away from the structures or downspouts should be extended a minimum of 10 feet away from the structures.

5.3 Potential Excavation Difficulties

Highly weathered, soft to moderately hard limestone and shale was encountered in the borings beginning at depths of approximately 8.5 to 18.5 feet and extending down to the termination depths.

Auger refusal was encountered in the borings at depths of approximately 9.5 to 20.5 feet (~el. 562.7 to 575 feet).

The previous blasting of rock for this site is understood to have been completed. However, the overall effectiveness of the blasting plan is unknown. Prior to beginning earthwork, test pits should be excavated throughout the planned construction footprints to determine the extent of the blasted zones.

We anticipate the near-surface soils above these depths at the site can be excavated with pans, scrapers, backhoes, and front-end loaders using conventional means and methods.

Our experience indicates rock in a weathered, boulder, and/or massive form may vary erratically in location and depth within the referenced site. Therefore, there is always a potential that these materials could be encountered at shallower depths between the boring locations and should be anticipated during construction. Similarly, the contractor should anticipate some strength variability and difficulties in removing the blasted material in rock zones.

Installation or excavation of proposed subgrade, foundations, or underground utilities (depending on layout and planned bottom elevations) within some portions of the site will require jackhammering, coring, ripping, or other suitable methods to remove these materials.

Please note that excavation of undisturbed rock will not be required for exposed subgrades that have reached 12 inches or more below the planned final soil subgrade (slab) and bearing (footing) elevations unless required otherwise.

5.4 Fill Material

A sample of each material type should be submitted to the geotechnical engineer for evaluation. Frozen material should not be used, and fill should not be placed on a frozen subgrade.

All fill material in structural areas (including utility backfill) should be placed in continuous, horizontal lifts having a maximum pre-compacted thickness of 9 inches. Aggregate base should have a maximum pre-compacted thickness of 6 inches; and fill compacted with hand-held or smaller-sized equipment having a maximum pre-compacted thickness of 4 to 6 inches.

Each lift should be compacted to at least ninety-five percent (95%) of the maximum dry density and within ± 2 percentage points of the optimum moisture content as determined by a Standard Proctor (ASTM D698), unless noted otherwise and maintained throughout construction activities.

A minimum of two (2) field tests to determine in-place density and moisture content should be performed per lift for each 2,000 sf within structural footprints.

Engineered fill should consist of approved materials that are free of organic matter and debris, exhibit a maximum plasticity index (PI) of 22, maximum liquid limit (LL) of 40, and contain a maximum rock size of 1.5 inches.

Existing soils could be used as fill; whereby, upon re-use, the soils meet the requirements for engineered fill as stated in this report. Soils that do not meet engineered fill requirements may be exposed during earthwork activities. AIMRIGHT recommends conducting additional soil sampling and laboratory testing of any excavated or cut existing soils to determine characteristics and stabilization requirements prior to beginning any fill placement.

AIMRIGHT estimates that approximately 4 to 6 percent (based on the soil's compacted dry weight) hydrated lime would be required to reduce the PI of the existing soils to 18 or less. The actual amounts of lime or other appropriate additive should be determined in the field and shall be performed and monitored in general accordance with current ODOT Standard Specifications for Highway Construction Section 307 Subgrade Treatment.

Aggregate base shall meet the requirements for ODOT Type A.

5.5 Shallow Foundation Design

The project structural engineer should determine the final foundation sizes based on the actual design loads, building code requirements, and other structural considerations. Structure foundations may be designed utilizing the following parameters.

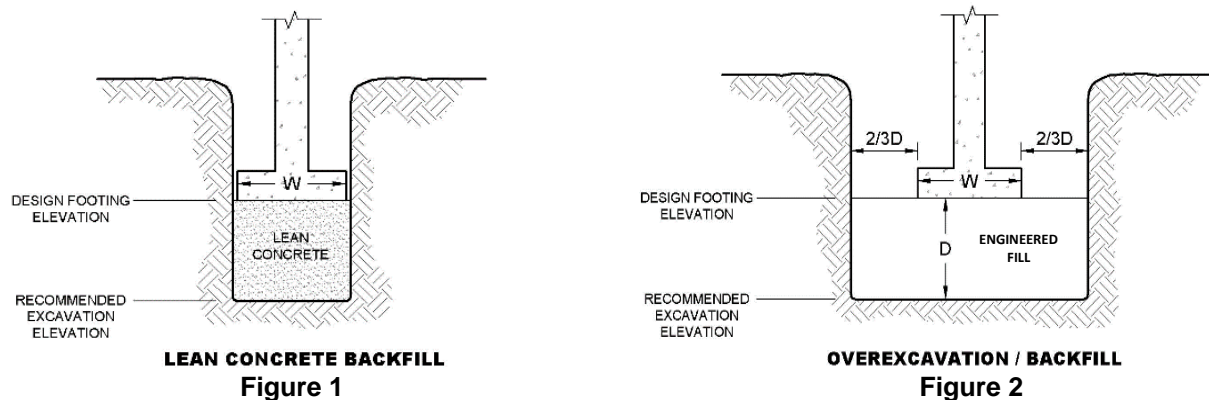
| | | | |
|---------------------------------------------------------------------------------|---------------------|--------------------------------------|----------------|
| Maximum Structural Loads | Wall | 1 to 5 kip/ft | |
| | Column | 10 to 20 kip | |
| Approved Bearing Material | | engineered fill | rock |
| Net Allowable Bearing Pressure¹ (FS ≥ 2.5) | | 2,000 psf | 4,000 psf |
| Coefficient of Sliding Friction², μ | | 0.27 to 0.38 | 0.45 |
| Total Unit Weight², γ | | 100 to 115 pcf | 125 to 135 pcf |
| Angle of Friction², ϕ | | 5° | 35° |
| Rankine Passive Earth Pressure Coefficient², K_p | | 1.19 | 3.69 |
| Minimum Footing Embedment³ | | 24 inches | |
| Minimum Footing Width | | 16 inches (wall); 30 inches (column) | |
| Estimated Maximum Settlement⁴ | Total | ≤ 1 inch | |
| | Differential | ≤ ½ inch | |
| 2018 Earthquake Loads Site Class | | D | |

1. The recommended net allowable bearing pressure is based on foundations within approved bearing materials and is the pressure more than the minimum surrounding overburden pressure at the footing base elevation. Rock was encountered in borings B-14 and B-16 at ~el. 576.18 and 576.31 feet, respectively. It should be anticipated that rock will likely be encountered during the excavations for the pump station, splitter box, and clarifier.
2. Range of values provided for soil types encountered at the site and/or anticipated import material that are prepared in accordance with this report are illustrated, however, actual parameters are dependent on bearing material placed during construction. Values are provided for guidance and should only be utilized by experienced engineers and designers. Exclude total passive pressure resistance within 2 feet of the adjacent lowest final site elevation.
3. Minimum depth applies to both perimeter footings and foundations in unheated areas. Minimum depth will provide frost protection and reduce the potential for moisture variation below the bearing level.
4. The magnitude of the settlements will be highly influenced by the variation in excavation requirements across the structure footprint, the distribution of loads, and the variability of underlying soils. Due to the anticipated backfill depths of approximately 5 to 10 feet within structure footprints, we recommend that the fill areas comprised of newly placed properly compacted engineered fill be allowed to settle for minimum period of 60 days or more prior to construction of the proposed structure foundations. Instrumentation such as settlement plates may be used to monitor stabilization prior to constructing any foundations. Alternatively, ODOT Type A aggregate base may be utilized as backfill to remove such requirements.

5.6 Shallow Foundation Construction

All exposed foundation subgrades should be re-compacted, observed, evaluated, and verified for the design soil bearing pressure by the geotechnical engineer after excavation and prior to concrete placement. This evaluation should include, as a minimum, Dynamic Cone Penetrometer (DCP) testing at the planned bearing elevations at intervals of no less than 35 feet and extending to depths of at least 3 feet below the bearing elevations.

If unsuitable material is encountered during foundation bearing grade testing and inspections (DCP Testing), foundations should; 1) extend deeper to a more suitable bearing material and bear directly on this material; 2) extend deeper to a more suitable bearing material and backfill with lean concrete to the designed bottom of footing elevation (see Figure 1); 3) extend deeper to a more suitable bearing material and backfilled with engineered fill (see Figure 2). If option 3 is selected, the over-excavation should extend laterally to a minimum of 2/3 of the total depth of excavation.



Note: Figures are shown for convenience and excavations shall be conducted with appropriate safety requirements.

To reduce differential settlement, it is imperative to ensure that all shallow foundations bear on a minimum of 12 inches of similar material. Where applicable, to prevent a “point-load” bearing condition where the newly placed engineered fill adjoins weathered rock within wall/column footings, we recommend over-excavating the weathered rock to a minimum depth of 12 inches within the entire length of the wall/column footing and backfilling with properly compacted engineered fill. Alternatively, the engineered fill may be over-excavated down to the weathered rock and backfilled with lean concrete to the designed bearing elevation as illustrated in Figure 1 above.

Foundation excavations must be maintained in a drained/de-watered condition throughout the foundation construction process and water should not be allowed to pond in any excavation. Excavations for footings should be made in such a way as to provide bearing surfaces that are firm and free of loose, soft, wet, or otherwise disturbed soils. Foundations should be concreted as soon as practical after they are excavated, and concrete should also not be placed on frozen or saturated subgrades. When applicable, it is recommended that a 2 to 4-inch-thick “mud mat” of lean concrete be placed on the bearing soils to help protect the bearing surface from rainfall or adverse construction activities.

5.7 Slab-on-ground Design

The structure subgrades should be prepared as described in this report. Four (4) inches or more of granular base should be placed over the final soil subgrade and shall meet the requirements outlined in the table below. A minimum depth of twenty-four (24) inches or more of granular base extending a minimum of 12 inches beyond the slab footprint will reduce the potential for frost heave below the slab. The modulus of subgrade reaction, k, value illustrated in the table below is based on 30-inch diameter plate load test.

| Minimum Percent Finer than 1 ½-inch Sieve | Maximum Percent Finer than No. 200 Sieve | Maximum Plasticity Index | k w/ 4 inches of Granular Base (psi/in) | k w/ 12 inches of Granular Base (psi/in) |
|--------------------------------------------------|-------------------------------------------------|---------------------------------|------------------------------------------------|-------------------------------------------------|
| 100 | 15 | 6 | 125 | 200 |

5.8 Lateral Earth Pressure Parameters

Lateral earth pressures vary as a function of construction sequence, type of backfill and retained soil, the rigidity of the retaining structure and the magnitude of any surface loading, if any, including stresses induced by adjacent building or wall loads on the retained soils. Adjacent footings or other surcharge loads may also exert appreciable additional lateral pressures. The effect of surcharge loads should be added to the recommended earth pressures to determine total lateral stresses.

Excavated in-situ or imported soils should be approved, placed, and compacted as outlined in this report. The values provided for soil types encountered at the site that are prepared in accordance with this report are illustrated, however, actual parameters are dependent on bearing material exposed and/or placed during construction. Values are provided for guidance and should only be utilized by experienced engineers and designers.

| Material Type | Total Unit Weight γ (pcf) | Angle of Friction ϕ (°) | Rankine Earth Pressure Coefficients | | |
|----------------------------|----------------------------------|------------------------------|-------------------------------------|---------------|---------------|
| | | | Active K_a | At-Rest K_o | Passive K_p |
| Clay w/ trace sand | 90 to 110 | 5 | 0.84 | 0.91 | 1.19 |
| Sandy Clay or Clayey Sand | 110 to 115 | 15 | 0.58 | 0.74 | 1.69 |
| Silty Sand or Sand w/ Silt | 115 to 125 | 30 | 0.33 | 0.50 | 3.00 |
| Washed Aggregate | 90 to 105 | 35 | 0.27 | 0.43 | 3.69 |

All material to be considered retained backfill should extend a minimum distance of 0.5 times the wall height laterally from the heel of cantilever wall footings. In backfilling against the walls, care should be taken to prevent the backfill from being over compacted, as this could result in excessive lateral stresses against the walls. Heavy equipment should not operate within 5 feet of walls to prevent excess lateral earth pressures.

All retaining walls should be provided with a positive drainage system, so they are not subject to hydrostatic pressures. We recommend that a minimum one-foot-wide zone of free-draining washed aggregate be constructed adjacent to the back of the walls and extend down to a foundation drain (perforated drainpipe).

Washed aggregate should be placed in lifts no greater than 2 feet in thickness and compacted with a backhoe bucket or similar method. The washed aggregate should be placed using a separation geotextile at the interface between the remaining backfill material. The foundation drain should be positively graded to allow drainage of any water that may collect in the wall backfill.

6.0 CONSTRUCTION MONITORING

We recommend that all earthwork construction be monitored by an experienced engineering technician at AIMRIGHT. Monitoring should include site preparation, subgrade earthwork, engineered fill earthwork, structure foundation systems, conventional and/or structural slabs.

Monitoring will allow AIMRIGHT to confirm the soil conditions on site and evaluate the recommendations presented within this report. If at the time of construction, our recommendations are inappropriate for the project, monitoring will allow us to remediate the recommendations at that time to better serve the project.

Monitoring during construction will also allow for the testing of all construction materials for the project. This includes but is not limited to:

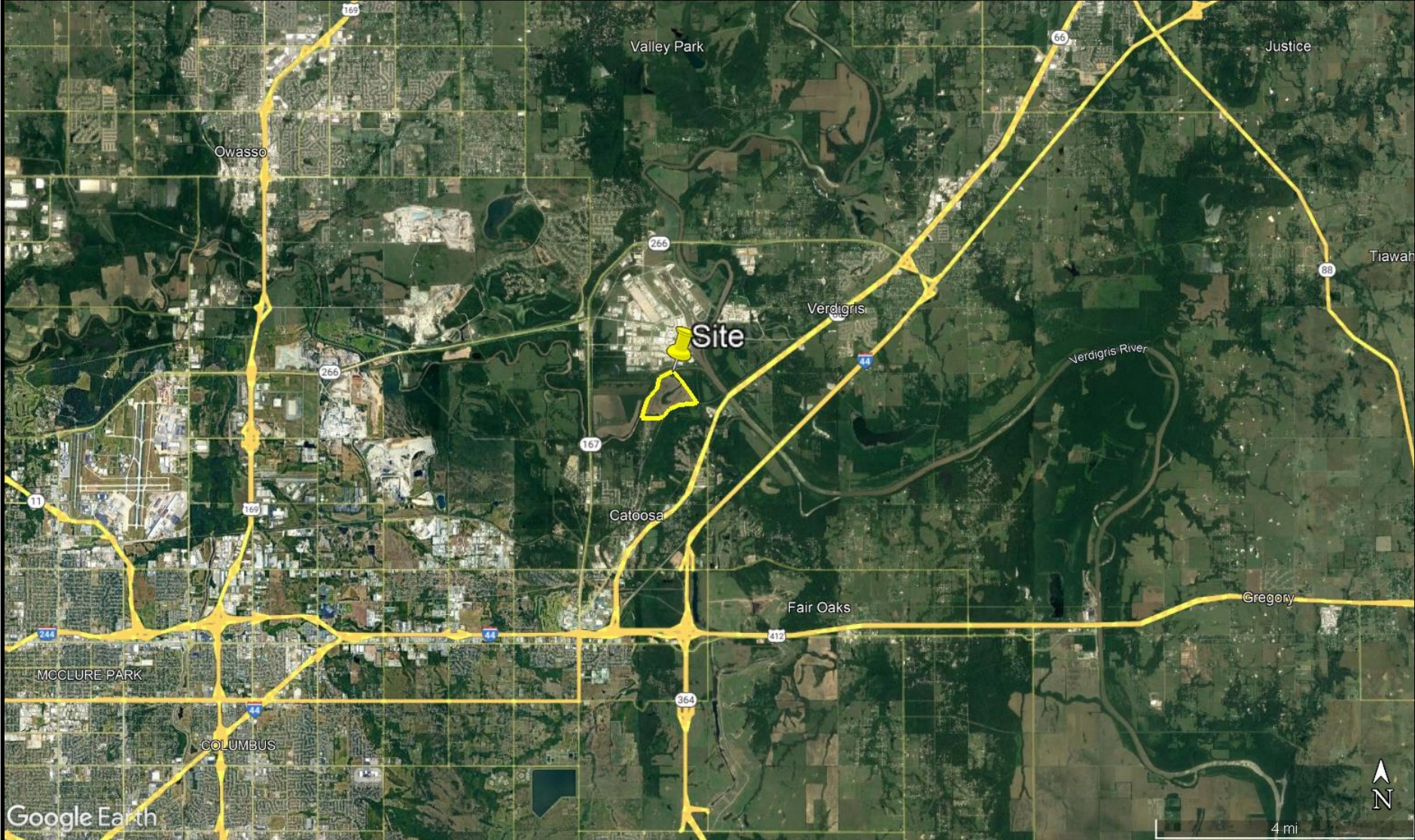
- ✓ subgrade inspection and density testing,
- ✓ structural area fill placement density testing,
- ✓ foundation bearing grade observations and testing,
- ✓ structural and reinforcing steel inspection,
- ✓ concrete testing, and
- ✓ asphaltic concrete testing, as applicable.

We recommend that AIMRIGHT be retained to provide these services based upon our current familiarity with the project subsurface conditions, and the provided intent of the geotechnical recommendations pertaining to the proposed development.

7.0 LIMITATIONS

The recommendations provided are based in part on project information provided to us and they only apply to the specific project and site discussed in this report. If our statements or assumptions concerning the location and design of this project contain incorrect information, or if additional information is available, you should convey the correct or additional information to us and retain us to review our recommendations. We can then modify our recommendations if they are inappropriate for the proposed project.

Regardless of the thoroughness of the geotechnical exploration, there is always a possibility that subsurface conditions will be different from those at a specific boring location and that conditions will not be as anticipated by the designers or contractors. In addition, the construction process may itself alter soil conditions. Therefore, experienced geotechnical personnel should observe and document the construction procedures used and the conditions encountered. Unanticipated conditions and inadequate procedures should be reported to the design team along with timely recommendations to solve the problems created. The conclusions and recommendations presented in this report were derived in accordance with standard geotechnical engineering practices and no other warranty is expressed or implied.

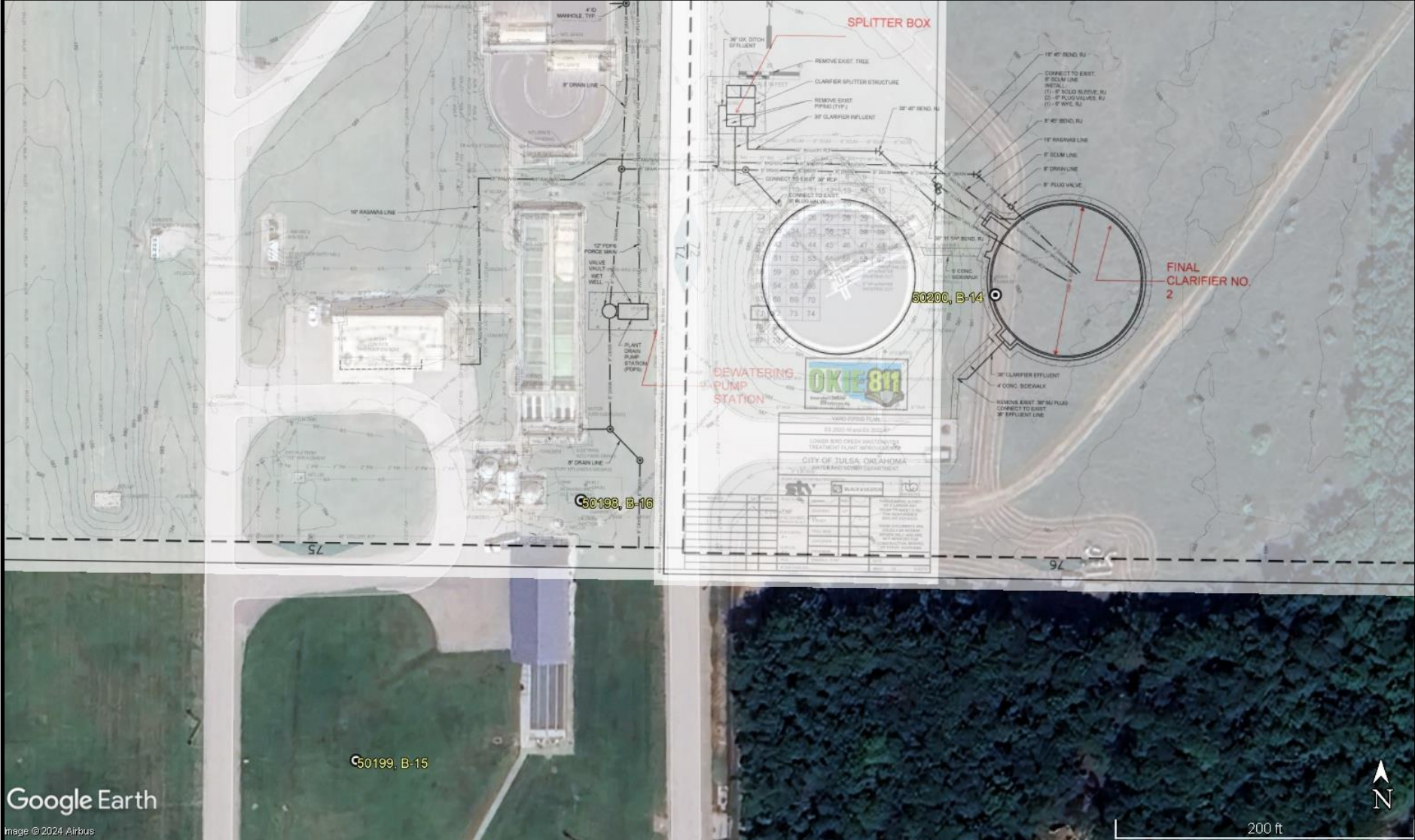


SITE LOCATION PLAN

PROJECT NO.: 14971123
SOURCE: Aerial Imagery

PROJECT: Lower Bird Creek WWTP FEB
CLIENT: STV, Inc.





📍 APPROXIMATE BORING LOCATIONS

BORING LOCATION PLAN

PROJECT NO.: 14971123
SOURCE: Aerial Imagery/Provided Plan

PROJECT: Lower Bird Creek WWTP FEB
CLIENT: STV, Inc.



Google Earth
 image © 2024 Airbus



200 ft



📍 APPROXIMATE BORING LOCATIONS

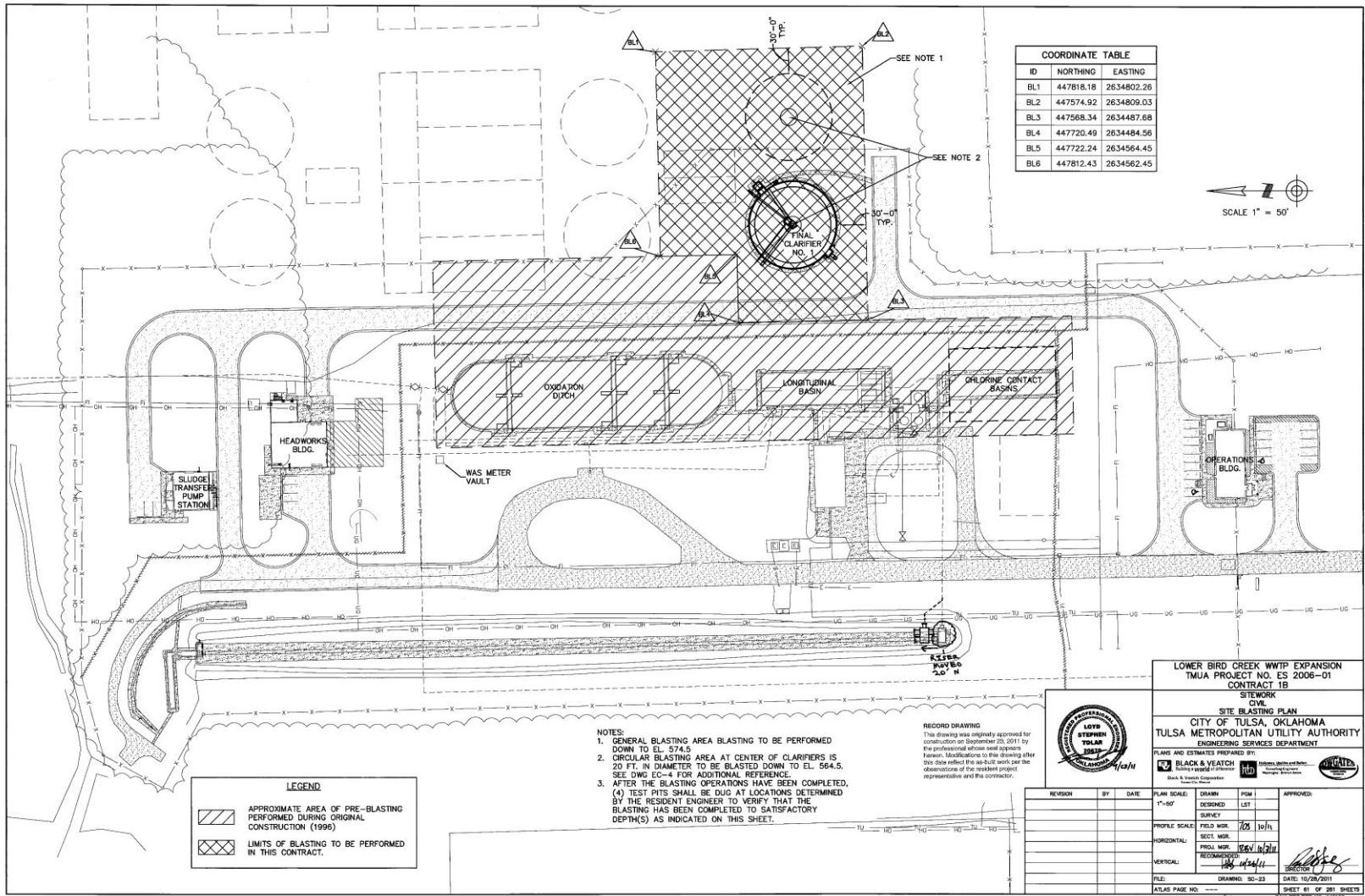
BORING LOCATION PLAN

PROJECT NO.: 14971123
SOURCE: Aerial Imagery

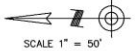
PROJECT: Lower Bird Creek WWTP FEB
CLIENT: STV, Inc.



2: Projects\01101123\14971123\14971123.dwg - Tulsa, OK - WWP\DWG\Contract - 14971123.dwg - Construction\Production\14971123.dwg - 10/22/2011 11:44:52 AM



| COORDINATE TABLE | | |
|------------------|-----------|------------|
| ID | NORTHING | EASTING |
| BL1 | 447818.18 | 2634802.26 |
| BL2 | 447574.92 | 2634809.03 |
| BL3 | 447568.34 | 2634487.68 |
| BL4 | 447720.49 | 2634484.56 |
| BL5 | 447722.24 | 2634564.45 |
| BL6 | 447812.43 | 2634562.45 |



| LEGEND | |
|--------|--------------------------------------------------------------------------------|
| | APPROXIMATE AREA OF PRE-BLASTING PERFORMED DURING ORIGINAL CONSTRUCTION (1996) |
| | LIMITS OF BLASTING TO BE PERFORMED IN THIS CONTRACT. |

- NOTES:**
- GENERAL BLASTING AREA BLASTING TO BE PERFORMED DOWN TO EL. 574.5
 - CIRCULAR BLASTING AREA AT CENTER OF CLARIFIERS IS 20 FT. IN DIAMETER TO BE BLASTED DOWN TO EL. 564.5. SEE DWG EC-4 FOR ADDITIONAL REFERENCE.
 - AFTER THE BLASTING OPERATIONS HAVE BEEN COMPLETED, (4) TEST PITS SHALL BE DUG AT LOCATIONS DETERMINED BY THE RESIDENT ENGINEER TO VERIFY THAT THE BLASTING HAS BEEN COMPLETED TO SATISFACTORY DEPTHS) AS INDICATED ON THIS SHEET.

RECORD DRAWING
 This drawing was originally approved for construction on September 25, 2011 by the professional engineer seal appears herein. Modifications to this drawing after this date reflect the as-built work per the observations of the resident project representative and the contractor.



| | | | |
|----------------------------------------------------------------------------------------------------|--|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|
| LOWER BIRD CREEK WWTP EXPANSION TMA PROJECT NO. ES 2006-01 CONTRACT 1B | | | |
| SITEMWORK CIVIL SITE BLASTING PLAN | | | |
| CITY OF TULSA, OKLAHOMA TULSA METROPOLITAN UTILITY AUTHORITY ENGINEERING SERVICES DEPARTMENT | | | |
| PLANS AND ESTIMATES PREPARED BY: | | | |
| REVISION BY DATE | | PLAN SCALE: DRAWN PSH 1"-50' DESIGNED LST SURVEY PROFILE SCALE: FIELD WORK 10/11 SURVEY HORIZONTAL: FIELD WORK 10/11 RECOMMENDED VERTICAL: 10/11 SECTION | |
| FILE: DRAWING: 90-23 ATLAS PAGE NO: | | APPROVED: DATE: 10/28/2011 SHEET 04 OF 201 SHEETS WWP PROJECT NO: 14971123 | |

BLASTING PLAN

PROJECT NO.: 14971123
SOURCE: Provided Plan

PROJECT: Lower Bird Creek WWTP FEB
CLIENT: STV, Inc.



| PointNo. | Northing(Y) | Easting(X) | Elev(Z) | Description |
|----------|-------------|--------------|----------|----------------------|
| 45917 | 451623.6558 | 2635843.2843 | 568.1379 | BH F-1 |
| 45918 | 451490.0764 | 2636188.7110 | 567.6472 | BH F-2 |
| 45919 | 451345.4796 | 2636532.5211 | 565.5855 | BH F-3 |
| 45920 | 451039.4373 | 2636413.9384 | 566.3600 | BH F-6 |
| 45921 | 451179.6463 | 2636073.1369 | 566.8678 | BH F-5 |
| 45922 | 451315.2920 | 2635718.2726 | 567.3618 | BH F-4 |
| 45923 | 451022.9734 | 2635604.9010 | 566.9407 | BH F-7 |
| 45924 | 450875.3211 | 2635951.4443 | 566.6789 | BH F-8 |
| 45925 | 450742.0137 | 2636300.2954 | 564.0716 | BH F-9 |
| 45926 | 449321.0030 | 2635589.6960 | 564.9314 | BH B-6 |
| 45927 | 449321.7696 | 2635370.7597 | 565.0772 | BH B-5 |
| 45928 | 449308.9827 | 2634953.6049 | 566.2215 | BH B-4 |
| 45929 | 449123.0617 | 2634779.8826 | 566.5219 | BH B-3 |
| 45930 | 449144.2484 | 2634954.0064 | 565.9809 | BH B-7 |
| 45931 | 449146.6489 | 2635176.1207 | 565.3859 | BH B-8 |
| 45932 | 449160.5198 | 2635381.0467 | 564.9319 | BH B-9 |
| 45933 | 449171.4140 | 2635598.8079 | 564.6070 | BH B-10 |
| 45934 | 449001.9320 | 2635594.0126 | 563.1130 | BH B-13 |
| 45935 | 448995.0073 | 2635380.5694 | 563.8538 | BH B-12 |
| 45936 | 448973.2984 | 2634971.5430 | 565.3515 | BH B-11 |
| 45937 | 448833.5668 | 2634660.3341 | 566.5095 | BH BH-2 |
| 45938 | 448671.1102 | 2635325.0917 | 565.6690 | BH BH-1 |
| 45939 | 450053.1557 | 2637151.9116 | 567.6602 | BH F-14 |
| 45940 | 450457.8676 | 2637196.3899 | 566.6130 | BH F-12 |
| 45941 | 450580.8589 | 2636718.1971 | 567.0724 | BH F-10 |
| 45942 | 450895.5510 | 2637109.6802 | 567.3329 | BH F-11 |
| 45943 | 450317.7704 | 2637568.5324 | 567.8293 | BH F-13 |
| 50198 | 447513.8640 | 2634430.8680 | 584.8090 | BH BH-17 B-16 |
| 50199 | 447338.1740 | 2634285.2370 | 583.1860 | BH BH-16 B-15 |
| 50200 | 447656.4490 | 2634703.2050 | 584.6800 | BH BH-15 B-14 |
| 50201 | 448487.2133 | 2634467.1698 | 575.4792 | BH BH C-1 |

Number of points listed> 31

SURVEY DATA

PROJECT NO.: 14971123
SOURCE: Provided Data

PROJECT: Lower Bird Creek WWTP FEB
CLIENT: STV, Inc.



KEY TO SYMBOLS

Symbol Description

Strata Symbols



Topsoil



Low Plasticity Clay



Clayey Sand



Shale



High Plasticity Clay



Low to High Plasticity Clays



Limestone

Misc. Symbols



Auger Refusal

Soil Samplers



Standard Penetration Test