APPENDIX A. GEOTECHNICAL INVESTIGATION

PERSIGO WASTEWATER TREATMENT PLANT
Geotechnical Investigation

2145 River Road
Grand Junction, Colorado 81505

October 22, 2019
WJE No. 2019.3776

Prepared for:
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PURPOSE AND SCOPE

At the request of the City of Grand Junction (CGJ), Wiss, Janney, Elstner Associates, Inc. (WJE) has completed a geotechnical investigation at the Persigo Wastewater Treatment Plant (herein referred to as PWWTP) located at 2145 River Road in Grand Junction, Colorado. The geotechnical investigation is part of the full scope of work for the PWWTP Structural Assessment as outlined in RFP-4653-19-DH, dated June 21, 2019. WJE has not been provided results of prior geotechnical investigations at the site, as it is our understanding that none exist. The objectives of our work are: characterize the subsurface conditions; including soils, bedrock, and groundwater levels for use in the engineering evaluation of the existing facilities; provide preliminary geotechnical recommendations for use in rehabilitation, modification, or improvement of existing facilities as needed; and provide preliminary recommendations for potential new construction at the PWWTP. The specific structures/facilities at the PWWTP to be assessed and evaluated by WJE for this current study include the Raw Sewage Pump Station, Primary Clarifiers, Aeration Basin, Aerobic Digesters, Sludge Processing Unit, and the Anaerobic Digesters.

The scope of work for the geotechnical investigation included:

- Review of available geologic and background information at the PWWTP
- Drilling and sampling 7 boreholes at the PWWTP, near the existing structures that are being assessed and evaluated by WJE
- Installation of 2 piezometers for future monitoring of groundwater levels
- Laboratory testing of selected soil samples
- Engineering evaluation of the results of the field investigation and laboratory testing programs
- Preparation of this report, summarizing our findings and providing preliminary geotechnical recommendations

Included with this report are Table 1: Summary of Laboratory Test Results; Table 2: Equivalent Fluid Unit Weights for “Active” and “At Rest” Conditions; Figure 1: Geologic Map; Figure 2: Borehole Location Map; Figure 3: Summarized Borehole Logs; and Figure 4: Borehole Log Legend. Detailed borehole and piezometer construction diagrams are provided in Appendix I; and laboratory test result sheets are included in Appendix II.

SITE CONDITIONS AND BACKGROUND

The PWWTP site encompasses approximately 50 acres and is located roughly 1.5 miles west of the intersection of U.S Route 6 and Interstate I-70, and 0.8 miles north of the Colorado River. The site gently slopes down to the southwest toward the Colorado River. The preconstruction topographic relief at PWWTP was approximately 12 feet. The post construction topographic relief, including the built-up areas, is approximately 20 feet. Groundwater conditions are expected to be relatively shallow due to the proximity of the site to the Colorado River and nearby gravel pits, where standing water is observed in the pits.

Construction of the PWWTP was completed in 1984, after which the plant has been in service for 35 years. The design capacity of the plant is 25 million gallons per day. Construction drawings indicate that the

PWWTP was designed to allow for future expansion of selected plant facilities. The main facilities that comprise the existing PWWTP include:

- Operation Building
- Headworks
- Grit Removal Units
- Raw Sewage Pump Station
- Primary Clarifier 1 and 2
- Primary Sludge Pump Station
- Aeration Basin
- Aeration Basin Control Unit
- Final Clarifier 1, 2, and 3
- Chlorine Unit
- Chlorine Contact Basins
- Plant Water Pump Station
- Anaerobic Digester 1 and 2
- Sludge Processing Unit
- Aerobic Digester
- Sludge Drying Beds
- Flow Equalization Basins

There are two existing piezometers that we understand have been used to monitor groundwater levels, one of which is located approximately 15 feet west of the Operations Building, and the other is located approximately 50 feet east of the Final Clarifiers. There are two additional piezometers located on the east side of the Flow Equalization Basin that could provide groundwater information; however, PWWTP site personnel were uncertain about the details regarding construction of these piezometers.

The foundation for the Raw Sewage Pump Station is located approximately 20 feet below the ground surface. This foundation is the deepest of any of the structures at the site. The Primary Clarifiers, Aeration Basin, and sections of the Anaerobic Digesters are built on pads. Grade around these facilities was built up with fill.

The foundation types for the structures included in our structural assessment are mat foundations and spread footings, according to "as-built" drawings. During the course of the field work completed for this study, WJE personnel observed the structural foundation at only two core holes located within the Raw Sewage Pump Station, in which no cracking was observed. According to the "as-built" drawings, the mat foundations for the structures are up to 2 feet thick and typically have a 3 to 4 inch sub-slab with a waterproofing membrane, and/or a 3 inch topping slab. The dimensions of the spread footing foundations vary. Of the structures WJE evaluated for this study, the Sludge Processing Unit and the Aerobic Digester have spread footing foundations, while the Raw Sewage Pump Station, Primary Clarifiers, Aeration Basins, and the Anaerobic Digesters have mat foundations.

SITE GEOLOGY

The project site is located in the Colorado Grand Valley near the Colorado River, and is situated between The Colorado National Monument approximately 2.5 miles to the south, and the Book Cliffs approximately 10 miles to the northeast (Figure 1A). A series of regional faults, including the Redlands Fault, are located 2.4 miles southwest of the PWWTP. Bedrock gently dips at approximately 3 to 11 degrees to the northeast at the project site. The site is underlain by the Mancos Shale, which is covered by contemporary overburden soils containing gravels, sands, silts, and clays. Geological units that underlie the site range from Holocene to Upper Cretaceous in age.

Geologic mapping by Scott and Harding (2001) indicates the southern portion of the site, nearest to the Colorado River, consists of "*chiefly gravel in a sand matrix (Qfp)*" that is part of the Colorado River flood-plain and stream channels. The northern portion of the site consists of a "*light-gray sandy clay and silty clay (Qsw) deposited on very gentle slopes north of the Colorado River, derived from the Mancos Shale,"* (Scott and Harding, 2001). The Mancos Shale outcrops approximately 5 miles northeast of the PWWTP site. Bedrock underlying overburden soils is the Mancos Shale, which is described as "*chiefly medium-dark-gray, dark-gray, brownish-gray, and brownish-black fissile shale that weathers to light gray*". Based on subsurface profiles provided with the geological mapping (Figure 1B), the Mancos Shale is expected to be 15 to 30 feet below the ground surface at the project site. The Mancos Shale was encountered at approximately 20 feet below the ground surface at one of the boreholes completed for the subsurface investigation. In general, descriptions provided with the geological mapping (Scott and Harding, 2001) are consistent with the materials encountered during the subsurface investigation.

SITE INVESTIGATION

Drilling Program

The 2019 drilling program at the PWWTP was designed to generally define soil, bedrock, and groundwater conditions at and around the existing PWWTP structures. A total of 7 boreholes were drilled for the investigation at locations shown on Figure 2. Boreholes B-2 and B-5 were completed as piezometers, while the remaining boreholes were backfilled with soil cuttings. The summary borehole logs are provided in Figure 3, with the legend and notes provided on Figure 4. Detailed borehole logs and piezometer construction diagrams are provided in Appendix I.

The boreholes were drilled by HRL Compliance Solutions between September 11 and 13, 2019, using a track mounted Diedrich D90 drill rig. The boreholes were advanced using two methods: 4-inch diameter solid stem auger, and 6-inch diameter ODEX casing. Borehole depths ranged from 14-1/2 to 27 feet below the existing ground surface. Each borehole was logged by a WJE geotechnical engineer.

Subsurface materials were typically sampled at 5 foot intervals using a 2-inch inner diameter California split-barrel sampler. The sampler was driven with a 140-pound hammer falling a vertical distance of 30 inches. The hammer blows were provided by an automatic hammer. The number of blows required to advance the sampler 12 inches was recorded as the penetration resistance or N value. The N values provided in this report were not corrected to account for the diameter of the California sampler. Penetration resistance values provide an indication of the consistency or relative density of the subsurface materials encountered. Sampling was done in general accordance with the Standard Penetration Test (SPT) as described in ASTM D1586, *Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils*. When using the ODEX drilling method, grab samples were collected at selected depths. The groundwater levels were recorded during drilling for all boreholes, and Borehole B-1 was checked 24 hours after drilling before the hole was backfilled. Water level in Borehole B-5 was measured again approximately 24 hours after the piezometer was installed. Water level in Borehole B-2 was measured after the piezometer was installed.

Piezometers were installed in Boreholes B-2 and B-5 to permit monitoring of groundwater levels. The bottoms of Piezometers B-2 and B-5 are 17 and 20 feet 7 inches below the ground surface, respectively. The piezometers were constructed with 2-inch inner diameter schedule 40 PVC pipe. The lower 10 feet of the piezometer pipe is machine slotted (10 slot), which is connected to the solid PVC pipe which extends 3 feet above ground surface. A clean 10-20 silica sand was placed in the annulus around the entire slotted PVC pipe section and extending approximately 2 feet above the slotted section. Bentonite chips were placed above the 10-20 silica sand to seal off the screened interval, and were placed up to about 2 feet below the ground surface. Concrete was placed from the top of the bentonite seal to the ground surface, and a circular lockable steel protective cover which extends approximately 3 feet above ground surface was placed in the concrete. As-built construction diagrams of Piezometers B-2 and B-5 are included in Appendix I with the detailed borehole logs.

Laboratory Testing

Laboratory testing was performed on selected samples obtained from the boreholes to characterize the physical and engineering properties of soil and bedrock materials at the PWWTP. Laboratory tests were conducted by Advanced Terra Testing, Inc. (ATT), of Lakewood, Colorado, in general accordance with ASTM procedures. Laboratory testing included:

- Water Content (ASTM D2216)
- Density (ASTM D7263)
- Atterberg Limits (ASTM D4318)
- Grain Size Distribution (ASTM D6913)
- Swell/Consolidation (Denver Swell)
- Unconfined Compressive Strength (ASTM D2166)

Laboratory test results are summarized on Table 1 on the following page, and are shown on the summary logs on Figure 3 and the detailed logs in Appendix I. Test result sheets are provided in Appendix II.

Table 1 - Summary of Laboratory Test Results

Borehole	Sample Depth (ft)	In situ Moisture Content (%)	In situ Dry Density (pcf)	Gradation			Atterberg Limits		Swell/Consolidation			Unconfined Compression Strength Test		Material Type
				Gravel (%)	Sand (%)	Fines (%)	Liquid Limit (%)	Plasticity Index (%)	Inundation Pressure (psf)	Swell/Cons. (%)	Swell Pressure (psf)	Axial Strain at Peak Stress(%)	Peak Stress (psf)	
B-1	0	14.2	-											
	4	14.5	113	4	41	55	28	14						CL - Sandy lean CLAY, trace gravel
	7	12.8	121											
	15.5	9.4	116											
	20			7	89	4								SP - poorly graded SAND, trace gravel
	26			20	76	4								SP - poorly graded SAND with gravel
B-2	0	7.1	105											
	3	11.5	113	0	1	99	41	23						CL - Lean CLAY, trace sand
	7	29.6	92	0	17	83								*CL - Lean CLAY with sand
	12	8.1	121											
B-3	0	9.9	126											
	4	19.8	108	0	1	99	38	20						CL - Lean CLAY, trace sand
	9	28.7	94	0	2	98	34	17	1080	-1.5	N/A	13	410	CL - Lean CLAY, trace sand
B-4	0	6.8	117											
	4	20.5	102	0	1	99	45	27						CL - Lean CLAY, trace sand
	9	21.8	103	0	51	49								*SC - Clayey SAND
B-5	0	14.8	112	0	9	91	38	21						CL - Lean CLAY, trace sand
	6	18.4	92	0	82	18								*SC - Clayey SAND
	20	9.2	122						2400	0.4	4680			
B-6	0	11.7	100											
	4	16.1	112	2	18	80	36	20						CL - Lean CLAY with sand
	9	16.6	115	0	1	99	36	19	1080	0.1	1830	12	4350	CL- Lean CLAY, trace sand
	14	28.3	95	0	0	100	34	18						CL- Lean CLAY
	19	8.2	125	37	52	11								SW-SC - Well graded SAND with clay and gravel
B-7	0	6.5	115											
	4	15.3	113	0	22	78	30	14						CL - Lean CLAY with sand
	9	28.3	92											

Notes:
(1) Laboratory testing completed by Advanced Terra Testing, Inc. Lakewood, Colorado.
(2) (*) denotes estimated soil classification.

SUBSURFACE CONDITIONS

Following are descriptions of the different materials encountered during the September 2019 geotechnical investigation as presented in this report. The borehole logs (Figures 3 and 4 and Appendix I) and laboratory test result sheets (Appendix II) should be referred to for detailed information.

Topsoil

Topsoil material was encountered in all boreholes ranging from the ground surface to about 1-1/2 feet below the ground surface. The topsoil was a clay soil with trace amounts of sand and gravel, with organic material including grass roots. The moisture of the topsoil ranged from dry to moist, and the color was dark brown.

Lean Clay

The predominant near-surface material encountered at the site is a lean clay with varying amounts of sand and gravel. Lean clay was encountered in all of the boreholes extending from just below the topsoil to depths ranging from 0.5 to 20 feet. Dry unit weights (dry densities) ranged from 92 to 126 pounds per cubic foot (pcf). Moisture contents ranged from 6.5 to 29.6 percent (%). N values ranged from 2 to 44, indicating the material consistency ranges from soft to hard. The lower blow counts were typically obtained in the lean clays below the groundwater level. Plasticity index values range from 14 to 27. Unconfined compressive strength tests on two samples provided strengths of 410 and 4,350 pounds per square foot (psf), respectively. Volumetric changes measured when test specimens were wetted at an applied stress corresponding to overburden stress ranged from 1.5% compression to 0.1% swell. The material color ranged from tan to light and dark brown.

Poorly Graded Sand

Sand with varying amounts of gravel underlies the lean clay, extending to the bottom of the boreholes at depths 27 and 17 feet in Boreholes B-1 and B-2, respectively. Due to difficulties drilling and sampling this material, just one drive sample was obtained using the California split-sampler, and several grab samples were obtained. The drive sample was found to have a moisture content of 8.1 %, and a dry unit weight of 121 pcf. The N value recorded for the one drive sample was 48, indicating the material relative density is dense. The material color was gray to brown.

Clayey Sand

Clayey sand underlies the lean clay in Boreholes B-4, B-5, and B-7, extending to depths of 14, 8-1/2, and 15-1/2 feet, respectively. Dry unit weights ranged from 92 to 103 pcf, and moisture contents ranged from 18.4 to 21.8 %. N values ranged from 15 to 24, indicating the material consistency is medium dense. The material color was light to dark brown.

Gravel and Cobble

Gravel and cobble materials were encountered in Boreholes B-4 and B-5 beneath lean clay and clayey sand, extending to depths of 17-1/2 and 20 feet, respectively. Gravel and cobble sizes and percentages by weight could not be determined accurately due to difficulty drilling and sampling these materials. Nearby fill materials containing native gravel and cobbles indicate that the maximum cobble size is likely approximately 3 to 4 inches. Gravel and cobble cuttings were collected during drilling, but no laboratory testing was performed on these samples due to crushing of the material that resulted from drilling with the ODEX system.

Well Graded Sand with Clay and Gravel

Well graded sand with clay and gravel underlies the lean clay in Borehole B-6, and extends to the bottom of the borehole at 23 feet depth. One sample of this material was obtained using the California split-sampler. The moisture content was determined to be 8.2 %, and the dry unit weight 125 pcf. The N value recorded for the one sample is 45, indicating the material relative density is medium dense. The material color was gray and brown.

Mancos Shale

A dark olive gray shale bedrock was encountered during drilling in Borehole B-5 at an approximate depth of 20 feet bgs. The N value was 50 blows to achieve 1 inch of sampler penetration, indicating the material consistency is very hard. Laboratory test results for dry unit weight and moisture content were 122 pcf and 9.2 %, respectively. The volumetric change measured when the test specimen was wetted at an applied stress corresponding to overburden was 0.4% swell.

Groundwater

Groundwater was encountered in Boreholes B-1, B-2, B-3, B-4, and B-5 at 5-1/2 to 8 feet depth below ground surface (bgs). At Boreholes B-6 and B-7, which were drilled in areas that had been built up by placement of fill, groundwater was encountered at 15 and 9 feet bgs, respectively. These groundwater levels were measured during drilling and shortly after drilling was completed. Groundwater levels may fluctuate significantly in response to numerous factors such as seasonal irrigation and climatic variations.

Groundwater readings were measured on September 13, 2019, at the four existing piezometers and the two new piezometers installed at Boreholes B-2 and B-5. Groundwater levels measured at existing and new piezometers on September 13, 2019 are consistent with one another and ranged from 7 to 9 feet bgs. The groundwater level measured at the existing piezometer west of the operations building was 7-1/2 feet bgs. The groundwater level for the existing piezometer east of the final clarifier was measured at 7 feet bgs. Groundwater levels measured at the existing piezometers east of the flow equalization basin were 7-1/2 and 9 feet bgs. Groundwater levels measured at the new piezometers, Piezometer B-2 (Borehole B-2) and Piezometer B-5 (Borehole B-5), were 8 and 7 feet bgs, respectively.

GEOTECHNICAL ENGINEERING DISCUSSION AND RECOMMENDATIONS

Lateral Earth Pressures

The majority of the facilities at the PWWTP extend below the ground surface and thereby have lateral earth pressures acting against them. The lateral earth pressures will depend on the type of subsurface material present, as well as drainage and groundwater conditions. Where foundations extend below the groundwater level, the lateral pressures acting on the wall increase as a result of the water pressure. In addition, the lateral earth pressure acting on a foundation wall will vary depending on whether or not the wall is restrained from moving. Where a foundation or retaining wall deflects in response to lateral earth pressures, this is referred to as active conditions. Where a foundation wall is restrained and does not deflect due to the lateral earth pressures, this is referred to as the at-rest conditions. At rest earth pressures will be greater than active earth pressures.

Lateral earth pressures are typically estimated using an “equivalent fluid pressure.” The lateral earth pressure acting on a wall at a particular depth is calculated as the depth below the ground surface times the equivalent fluid unit weight. Where the wall extends below the groundwater level, the lateral earth pressure is calculated as the lateral pressure at the groundwater level, calculated as described above, plus the depth below the groundwater level times the equivalent fluid unit weight corresponding to conditions below the groundwater level.

Table 2, below, provides equivalent unit weights for active and at rest conditions and for conditions above and below the groundwater level. These values apply to the case where lean clay soils as described in this report bear against the foundation walls. For the existing PWWTP facilities, the boreholes completed for this study indicate that lean clay materials extend to depths below the bottom or to very near the bottom of all of the foundation walls.

Table 2 - Equivalent Fluid Unit Weights for “Active” and “At Rest” Conditions

Condition	Equivalent Fluid Unit Weight, pcf
Active - Above Groundwater Level	37
Active - Below Groundwater Level	80
At Rest - Above Groundwater Level	57
At Rest - Below Groundwater Level	91

Groundwater Conditions

The depth to groundwater ranged from 7 to 9 feet below the ground surface, except in areas that have been built up with fill. This groundwater range is based on depths measured during drilling, and readings obtained in the existing and new piezometers measured on September 11 to 13, 2019. Groundwater levels measured in the existing four piezometers agree with groundwater levels measured during the drilling program and with measurements in Piezometers B-2 and B-5. It is likely that groundwater levels have varied due to seasonal irrigation and changes in climatic conditions. In order to develop an understanding of how the groundwater level varies, WJE recommends that PWWTP site personnel obtain and record readings at the existing and new piezometers on a monthly basis for a period of 1 to 2 years.

Subgrade Foundation Performance

Considering that it has been approximately 35 years since construction of the PWWTP, and given the subsurface conditions as described in this report, we expect there will be minimal new distress due to foundation or slab-on-ground movement at the facility. Minor structure movement may have occurred during initial loading and soon thereafter. It is also possible that very minor structure movement has occurred due to changing loading conditions and large fluctuations in the groundwater level. Swell/consolidation testing indicates that subsurface materials at the site exhibit minimal volume change when wetted.

Details regarding the performance of the structures WJE evaluated for this study are provided in the WJE Structural Assessment Report.

Preliminary Recommendations for Additional Facilities

We understand that enlargement of the PWWTP could be undertaken in the future and could involve construction of new facilities including Anaerobic Digesters, Primary Clarifiers, Aeration Basins, and Final Clarifiers. Locations for the new facilities are shown on the “Overall Site Plan” drawing. Subsurface investigations completed for this study included boreholes located in the vicinity of these proposed facilities. In the following sections we provide preliminary recommendations for foundation design and construction of these facilities based the findings of the geotechnical investigation as described in this report. Final geotechnical investigations should be completed for these facilities once the new facility locations have been selected and details of the proposed structures are known. We also provide preliminary geotechnical recommendations for these facilities based on where the future structures are shown on the drawings, and the results of this study.

Primary Clarifiers

The existing Primary Clarifiers are located in the central portion of the plant site. The existing structures measure approximately 118 feet at their outer diameter. The structures consist of a conventionally reinforced 8-inch thick concrete mat foundation, with a 2-inch thick grout layer, both of which have a 1:12 slope downwards towards the center of the clarifier. The perimeter walls consist of conventionally reinforced 10-inch thick concrete with two mats of reinforcing. The concrete structure extends approximately 2 feet above grade, and approximately 9 feet below grade. Borehole B-3 was drilled near where it appears that the additional Primary Clarifiers may be constructed. Based on the condition encountered in Borehole B-3, we offer the following preliminary comments and recommendations:

- Foundations similar to those constructed for the existing Primary Clarifiers appear to be a reasonable alternative for new Primary Clarifiers should they be constructed in this area. Design criteria for the foundation should be developed as part of the final geotechnical investigation work. Lateral earth pressures for preliminary design can be estimated using the equivalent fluid unit weights provided in this report. A relatively low N value (2/12) was obtained at 9 feet depth in Borehole B-3. Final geotechnical investigations should further investigate this depth interval to evaluate the potential affect soft lean clays could have on foundation design and construction. It may be prudent to "over-excavate" and replace soft clay if present at or near the mat bearing elevation.

- Excavations for the foundations may extend below the groundwater table. This should be confirmed based on monitoring of piezometer water levels as recommended in this report. Should it be determined that construction dewatering will be required, final geotechnical investigations should include slug testing to evaluate permeability characteristics of the lean clay soils for estimation of dewatering quantities, and for evaluation and design of dewatering alternatives if needed. In addition, final geotechnical investigation work should include development of design and construction recommendations for excavation support alternatives.

- If settlement of these structures is critical, final geotechnical investigations should include Shelby-tube sampling of the lean clay materials and consolidation testing, including time rate measurements for each load increment. However, it is possible, depending on the geometry and other details of the new clarifiers, that these structures *could* be considered to have what is sometimes called a "compensated foundation." This means that the Clarifier, even when full of effluent, weighs the same or less than any soil excavated to allow its construction. If so, settlement concerns may be less crucial. Nevertheless, soft conditions at bearing elevations may introduce constructability issues, which must be considered in design and construction.

Anaerobic Digesters

The existing Anaerobic Digesters are located on the west side of the plant, west of the Primary Clarifiers. The existing circular structures measure approximately 70 feet at their outer diameter. The structures extend approximately 20 feet above grade, and approximately 10 feet below grade. The structures consist of a conventionally reinforced 12-inch thick concrete mat foundation within the digesters, with a conventionally reinforced 14-inch thick concrete slab and 3-inch thick topping within the pump room located between the two tanks. Borehole B-4 was drilled near where it appears that additional Anaerobic Digesters may be constructed. Based on the condition encountered in Borehole B-4, we offer the following preliminary comments and recommendations:

- Mat foundations, similar to the foundations constructed for the existing facilities are a reasonable alternative for new Anaerobic Digesters should they be constructed in this area. Design criteria for the new mat foundation should be developed as part of the final geotechnical investigation work. Lateral earth pressures for preliminary design can be estimated using the equivalent fluid unit weights provided in this report.

- Excavations for the foundations for new Anaerobic Digesters are expected to extend slightly below the groundwater table. This should be confirmed based on monitoring of piezometer water levels as recommended in this report. Should it be determined that construction dewatering will be required, final geotechnical investigations should include slug testing to evaluate permeability characteristics of the lean clay soils for estimation of dewatering quantities, and for evaluation and design of dewatering alternatives if appropriate. In addition, final geotechnical investigation work should include development of design and construction recommendations for excavation support alternatives.

- If total or differential settlement of these structures is critical, final geotechnical investigations should include Shelby-tube sampling of the lean clay materials and consolidation testing including time rate measurements for each load increment. Since the Anaerobic Digesters extend significantly above grade, it is unlikely that these foundations can be considered to be “compensated.”

Aeration Basins

The existing Aeration Basins are located in the south central portion of the plant site. The existing aeration basins measure approximately 123 feet in the north-south direction, and 275 feet in the east-west direction. The aeration basin blower room is situated at the center of the structure (oriented in the north-south direction), and is approximately 30 feet in width. The basin walls extend approximately 2 feet above grade, and approximately 19 feet below grade. To the east and west of the basin blower room, the structure is split equally in the east-west direction by interior basin baffle walls, such that four individual open-air basins are present. The structure of the aeration basin consists of a conventionally reinforced 16-inch thick concrete slab foundation, with a 3-inch thick topping slab. The slab is thickened to 24-inches over an area that is six feet square below the 12-inch square interior columns. The exterior face of the foundation slab is waterproofed with continuous waterproofing that extends up the full height of the perimeter walls. The perimeter walls primarily consist of conventionally reinforced 12-inch thick concrete. Borehole B-6 was drilled near where it appears that the additional Aeration Basins may be constructed. Based on the condition encountered in Borehole B-6, we offer the following preliminary comments and recommendations:

- Mat foundations, similar to the foundations constructed for the existing basins, are likely a reasonable alternative for new Aeration Basins should they be constructed in this area to a similar bearing elevation. Allowable bearing pressures should be developed as part of the final geotechnical investigation work. Lateral earth pressures for preliminary design can be estimated using the equivalent fluid unit weights provided in this report.

- Excavations for foundations for new Aeration Basins, if similar to the existing basins, will extend below the groundwater table, and will likely bottom in lean clay. Final geotechnical investigations should include slug testing in this area to evaluate permeability characteristics of the lean clay soils for estimation of dewatering quantities that will be required, and for evaluation and design of dewatering alternatives. In addition, final geotechnical investigations should include development of design and construction recommendations for excavation support alternatives.

- If settlement of these structures is critical, final geotechnical investigations should include assessment of the compressibility of the deep clayey sand materials including time rate measurements for each load increment. As with the Clarifiers, it is possible that the Aeration Basins may be considered to have "compensated foundations." This should be evaluated when final layout and details are determined.

Final Clarifiers

The existing Final Clarifiers are located at the south end of the plant site. The existing structures are approximately 118 feet at their outer diameter. The structures consist of a conventionally reinforced 12-inch thick concrete mat foundation, which has a 1:12 slope downwards towards the center of the clarifier. The concrete structure extends approximately 2 feet above grade, and approximately 15 feet below grade. Borehole B-7 was drilled near where it appears that the additional Final Clarifiers may be constructed. Based on the condition encountered in Borehole B-7, we offer the following preliminary comments and recommendations:

- Foundations similar to the foundations constructed for the existing clarifiers are likely a reasonable alternative for new Final Clarifiers should they be constructed in this area. Design criteria for the foundation should be developed as part of the final geotechnical investigation work. Lateral earth pressures for preliminary design can be estimated using the equivalent fluid unit weights provided in this report.

- Excavations for new Final Clarifiers, if similar to the existing clarifiers, will extend well below the groundwater table, and will extend into clayey sand that underlies the lean clay encountered at Borehole B-7. Furthermore, it appears that Borehole B-7 did not extend to the bottom of the existing Final Clarifiers. Final geotechnical investigations should extend below the bottom of the new clarifiers and should include slug testing to evaluate permeability characteristics for estimation of dewatering quantities that will be required, and for evaluation and design of dewatering alternatives. In addition, final geotechnical investigations should include development of design and construction recommendations for excavation support alternatives.

- If settlement of these structures is critical, final geotechnical investigations should include assessment of the compressibility of the lean clay and deep clayey sand materials including time rate measurements for each load increment. As with the Clarifiers and Aeration Basins, it is possible that the Final Clarifiers may be considered to have "compensated foundations." This should be evaluated when final layout and details are determined.

Additional Recommendations for Final Geotechnical Investigation

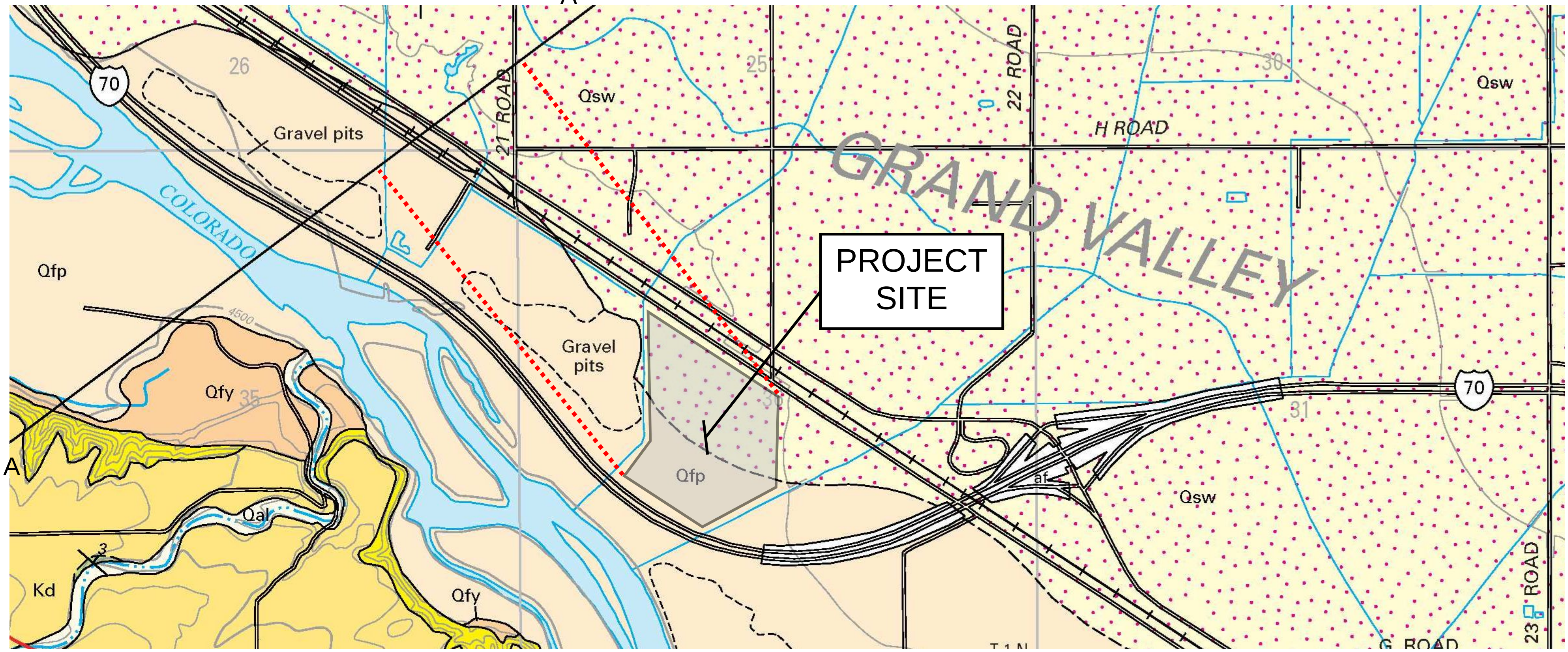
Final geotechnical investigations for new facilities at the PWWTP should be planned when the layout and details of the proposed new facilities have been reasonably defined. As noted above, some of the existing, as well as some of the new facilities, may be considered to have "compensated foundations." However, facilities that cannot be considered to have compensated foundations should be investigated and designed to address potential deep seated settlement. The fact that the existing facilities have generally performed adequately suggests that settlement has not been a significant problem. Nevertheless, we recommend that final investigations for new facilities that cannot reasonably be considered to have a "compensated foundation" include at least one boring to Mancos Shale bedrock for each structure.

GENERAL INFORMATION

Information in this report is intended to provide a geotechnical assessment of the site subsurface conditions, and to provide preliminary recommendations for geotechnical design and construction criteria based on these conditions; no other use is intended or authorized. Additional final geotechnical investigations will be required to support the design and construction of additions to existing facilities or for construction of new structures at the site. The report is based on the subsurface investigation, laboratory test results, site observations, analyses as described herein, and past experience with similar conditions. Variations can and do occur in geological materials, and departures from conditions portrayed in this report are possible. The conclusions and recommendations presented in this report are subject to the limitations and explanations contained herein.

ENGINEERS
ARCHITECTS
MATERIALS SCIENTISTS

FIGURES



DESCRIPTION OF MAP UNITS

Qfp	**Flood-plain and stream-channel deposits (Holocene and late Pleistocene)** —Chiefly gravel in a sand matrix
Qsw	**Sheetwash deposits (Holocene and late Pleistocene)**—Light-gray sandy clay and silty clay deposited on very gentle slope north of the Colorado River, derived from the Mancos Shale
Km	**Mancos Shale (Upper Cretaceous)**—Chiefly medium-dark-gray, dark-gray, brownish-gray, and brownish-black fissile shale that weathers light gray

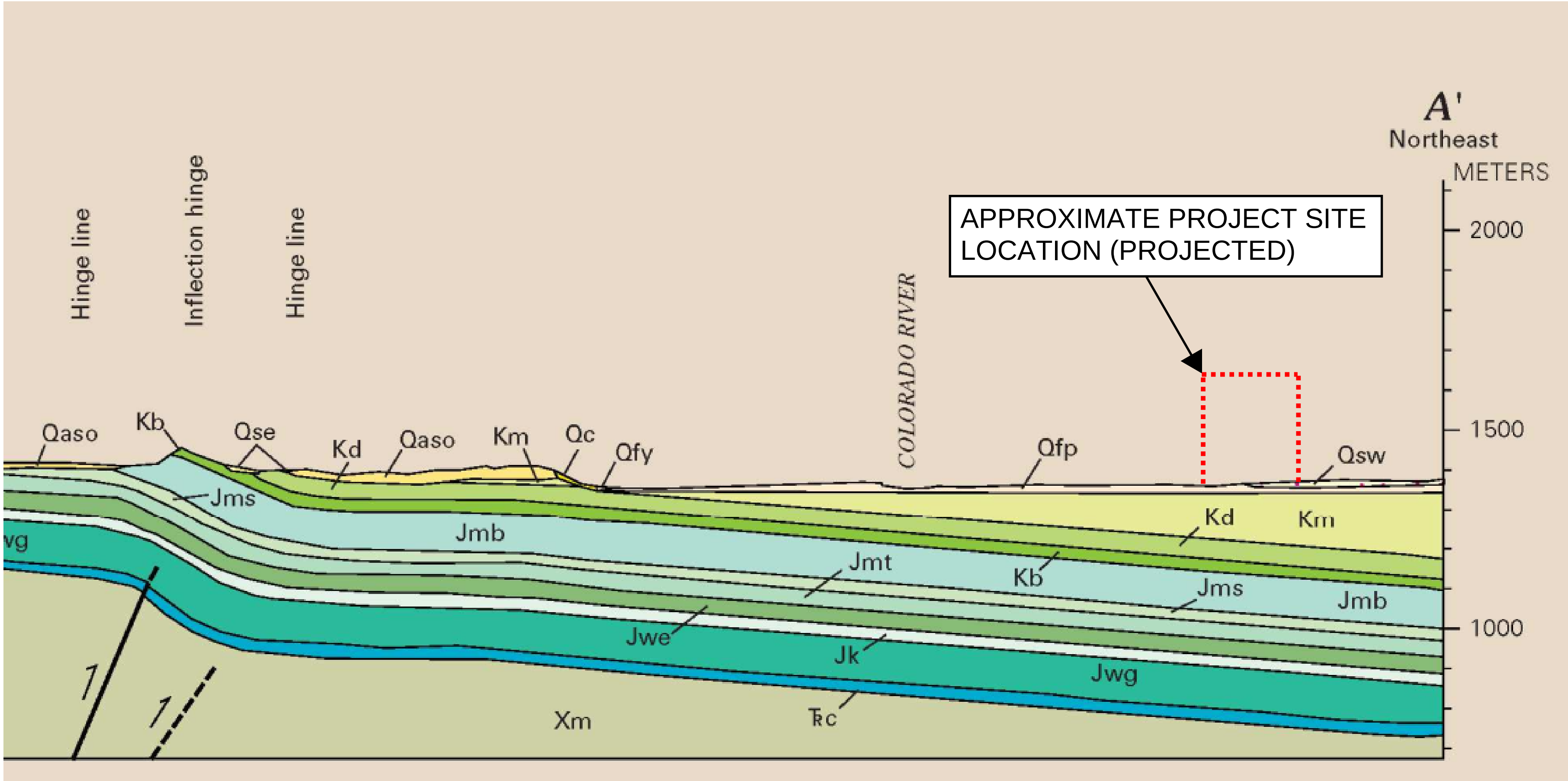
NOTES:

1. THE GEOLOGIC MAP SHOWN IS TAKEN FROM GEOLOGIC MAPPING BY SCOTT AND HARDING, 2001.
2. SEE FIGURE 1B FOR SUBSURFACE PROFILE ALONG A-A' .

WJE ENGINEERS ARCHITECTS MATERIALS SCIENTISTS
Wiss, Janney, Elstner Associates, Inc.
3609 South Wadsworth Boulevard, Suite 400
Lakewood, Colorado 80235
303.914.4300 tel | 303.914.3000 fax
www.wje.com

Project	PERSIGO WASTE WATER TREATMENT PLANT 2145 RIVER ROAD, GRAND JUNCTION, CO
Sheet Title	GEOLOGIC MAP OF COLORADO NATIONAL MONUMENT AND ADJACENT AREAS, MESA COUNTY, COLORADO
Proj. No.	2019.3776.0
Date	10/22/2019
Drawn	DF
Checked	PAS
Scale	NTS

FIGURE 1A



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NOTES:

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2. SEE FIGURE 1A FOR GEOLOGIC MAP.

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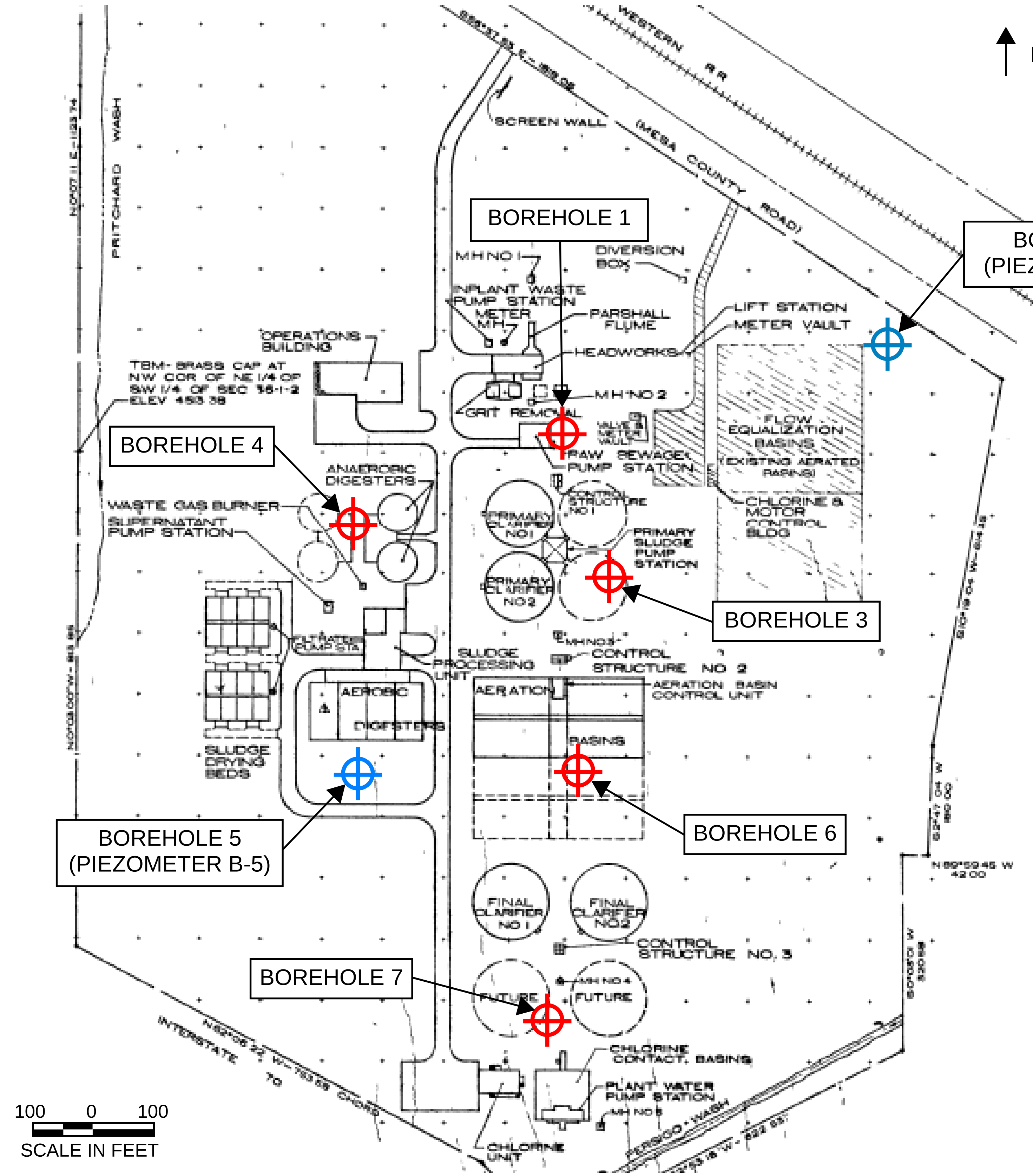
Project
PERSIGO WASTE WATER TREATMENT PLANT
2145 RIVER ROAD, GRAND JUNCTION, CO

Sheet Title
GEOLOGIC MAP OF COLORADO NATIONAL MONUMENT AND ADJACENT AREAS, MESA COUNTY, COLORADO

Proj. No.	2019.3776.0
Date	10/22/2019
Drawn	DF
Checked	PAS
Scale	NTS

FIGURE 1B



LEGEND:

- (red symbol) APPROXIMATE BOREHOLE LOCATION.
- (blue symbol) APPROXIMATE BOREHOLE LOCATION COMPLETED AS A PIEZOMETER.

NOTE:

1. BASEMAP TAKEN FROM PLAN SHEET "PERSIGO WASH WASTEWATER TREATMENT PLANT - OVERALL SITE PLAN" BY HDR DATED MARCH 18, 1981.

WJE ENGINEERS ARCHITECTS MATERIALS SCIENTISTS Wiss, Janney, Elstner Associates, Inc. 3609 South Wadsworth Boulevard, Suite 400 Lakewood, Colorado 80235 303.914.4300 tel | 303.914.3000 fax www.wje.com	Project: PERSIGO WASTE WATER TREATMENT PLANT 2145 RIVER ROAD, GRANDO JUNCTION, CO Sheet Title: BOREHOLE AND PIEZOMETER LOCATION MAP	Client: City of Grand Junction Colorado	Proj. No. 2019.3776.0 Date OCTOBER 22, 2019 Drawn DF Checked PAS/TMM Scale SEE SCALE BAR

Revision	Date	Description

FIGURE 2

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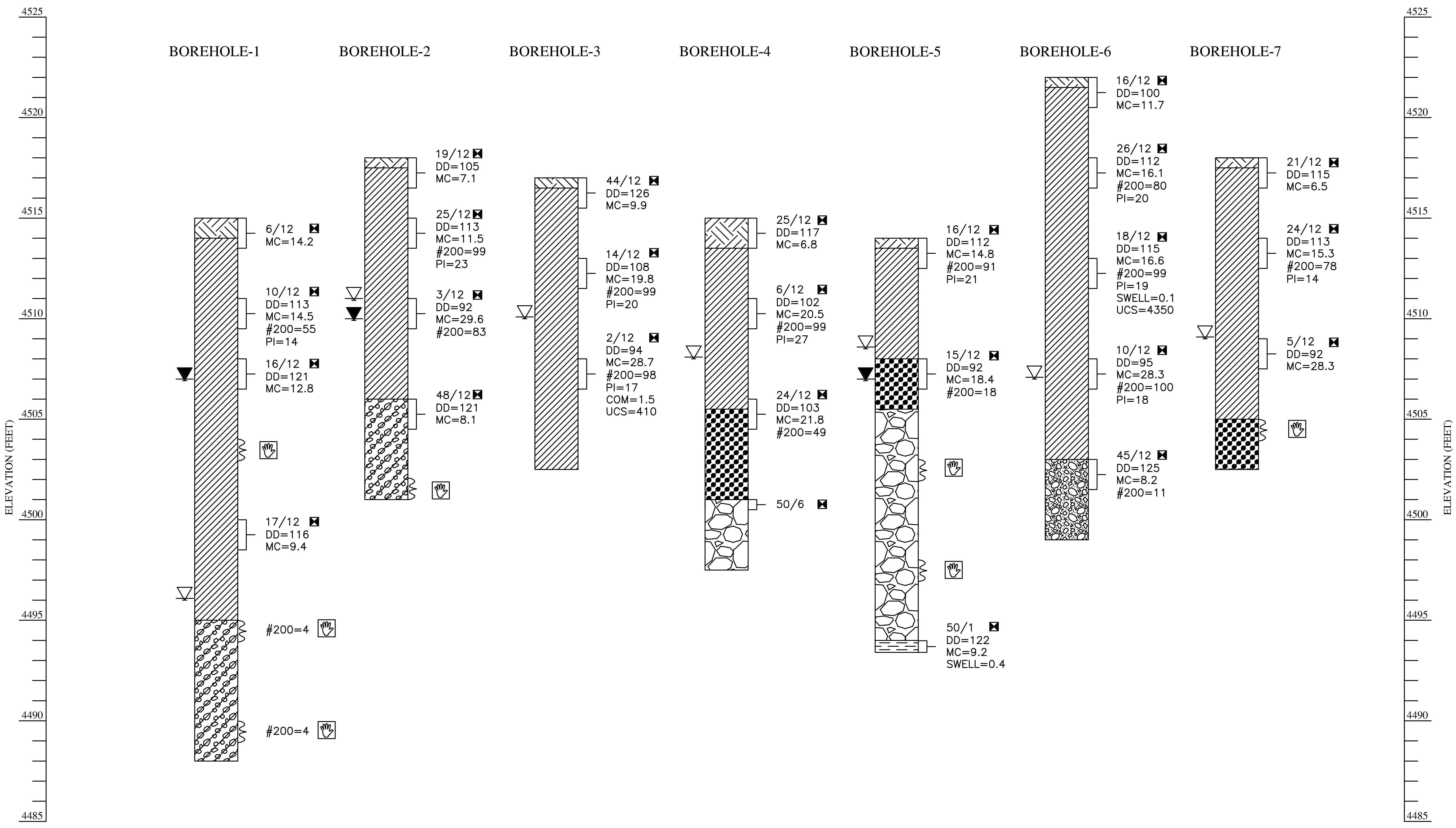
CLIENT: CITY OF GRAND JUNCTION
PROJECT NAME: PERSIGO WASTE WATER TREATMENT PLANT
PROJECT LOCATION: 2145 RIVER ROAD, GRAND JUNCTION, CO
WJE PROJECT NO.: 2019.3776.0

DRILLING CONTRACTOR: HRL COMPLIANCE SOLUTIONS, INC.
DRILLING STARTED: 09/11/2019 COMPLETE: 09/13/2019
DRILLING RIG TYPE: DRIEDRICH D90
LOGGED BY: DANIEL FRANCO

BOREHOLE SUMMARY LOG

FIGURE 3



P:\2019\2019.3xxx\2019.3776.0 – PERSIGO WASTEWATER TREATMENT PLANT (TMM)\2B – Geotech\Soil Boreholes (CAD)\Detailed,Summarized Borings, Constructed Piezometer Diagrams, Legend.dwg

WJE | ENGINEERS
ARCHITECTS
MATERIALS SCIENTISTS

PROJECT NAME: PERSIGO WASTE WATER TREATMENT PLANT
PROJECT LOCATION: 2145 RIVER ROAD, GRAND JUNCTION, CO
CLIENT: CITY OF GRAND JUNCTION
WJE PROJECT NO.: 2019.3776.0

BOREHOLE SUMMARY LOG LEGEND

SAMPLE TYPE

Modified California Sampler (MC)

Approximate Depth Interval of Grab Sample (GS)

MATERIAL

TOPSOIL, CLAY, trace amounts of sand and gravel, dark brown, dry to moist, organics present.

CL—LEAN CLAY, varying amounts of sand and gravel, tan to light to dark brown, dry to wet, low plasticity, soft to hard.

SP—POORLY GRADED SAND, varying amounts of gravel, gray to brown, wet, non—plastic, dense.

SC—CLAYEY SAND, light to dark brown, wet, non—plastic, medium dense.

GRAVEL AND COBBLE, gray, wet, non—plastic.

SW—SC—WELL GRADED SAND WITH CLAY AND GRAVEL, gray to brown, wet, non—plastic, medium dense.

BEDROCK—MANCOS SHALE, dark olive gray, moist, low plasticity, very hard.

Groundwater depth during drilling.

Groundwater depth after 24 hours or piezometer installation.

15/12 indicates 15 blows were required to drive a Modified California sampler 12 inches using a 140 pound hammer falling 30 inches.

LABORATORY TEST

DD= Dry Density (lbs/ft^3)
MC= Moisture Content (%)
#200= Fines Passing No. 200 sieve (%)
PI= Plasticity Index
SWELL= Swell upon wetting (%)
COM= Compression upon wetting (%)
UCS= Unconfined Compressive Strength (lbs/ft^2)

NOTES

1. The boreholes were drilled from September 11 to 13, 2019. A 4—inch diameter solid stem auger and a 6—inch diameter ODEX drill stem powered by a Diedrich D90 were used to advance the boreholes.
2. The lines between materials represent the approximate contact between materials and transitions may be gradual.
3. Groundwater was encountered during drilling. Refer to borehole logs for groundwater information.
4. Borehole locations are approximate as shown on Figure 2. Borehole locations are based on measurements from existing structures. The latitude and longitude coordinates listed in the detailed borehole logs were obtained from Google Earth.
5. Borehole elevations are based on "as recorded" drawings titled "Site Layout & Grading Plan South Half" and "Site Layout & Grading Plan North Half," dated on May 1985, by Henningson, Durham, & Richardson (HDR).

FIGURE 4

APPENDIX I - DETAILED BOREHOLE LOGS AND PIEZOMETER AS-BUILTS

BOREHOLE: B-1

WJE — ENGINEERS, ARCHITECTS, MATERIALS SCIENTISTS

CLIENT: CITY OF GRAND JUNCTION
WJE PROJECT NO.: 2019.3776.0
PROJECT NAME: PERSIGO WASTE WATER TREATMENT PLANT
PROJECT LOCATION: 2145 RIVER ROAD, GRAND JUNCTION,CO

DRILLING STARTED: 09/12/2019 COMPLETE: 09/12/2019
DRILLING CONTRACTOR: HRL COMPLIANCE SOLUTIONS, INC.
DRILLING RIG TYPE: DIEDRICH D90 HOLE DIAMETER(IN.): 6
LOGGED BY: DANIEL FRANCO
GROUND ELEVATION (FT): 4515
COORDINATES: 39.113650°N 108.656613°W
DEPTH TO BEDROCK (FT): NOT ENCOUNTERED
▽ DEPTH TO GROUNDWATER: 19 FEET DURING DRILLING

DEPTH (FT)	MATERIAL DESCRIPTION	SAMPLE TYPE	N VALUE	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	GRAVEL	SAND	FINES	PL	LL	PI	COM/SWELL (%)	UCS PEAK STRESS, (PSF)
0	TOPSOIL	Split spoon	6/12	14.2	–								
	CL – sandy lean CLAY, trace gravel, brown, moist, low plasticity, medium stiff												
5	stiff	Split spoon	10/12	14.5	113	4	41	55	14	28	14		
	▼ stiff	Split spoon	16/12	12.8	121								
10	increasing gravel content in cuttings												
		Grab											
15	stiff	Split spoon	17/12	9.4	116								
	▽												
20	SP – poorly graded SAND, trace gravel, brown, wet, non-plastic	Grab				7	89	4					
25	with gravel	Grab				20	76	4					
27	Bottom of borehole at 27.0 feet.												
30													

COMMENTS: 24 hours after drilling, depth to groundwater was 8 feet.

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WJE | ENGINEERS ARCHITECTS MATERIALS SCIENTISTS

BOREHOLE: B-2

CLIENT: CITY OF GRAND JUNCTION

WJE PROJECT NO.: 2019.3776.0

PROJECT NAME: PERSIGO WASTE WATER TREATMENT PLANT

PROJECT LOCATION: 2145 RIVER ROAD, GRAND JUNCTION,CO

DRILLING STARTED: 09/13/2019 COMPLETE: 09/13/2019

DRILLING CONTRACTOR: HRL COMPLIANCE SOLUTIONS, INC.

DRILLING RIG TYPE: DIEDRICH D90 HOLE DIAMETER(IN.): 6

LOGGED BY: DANIEL FRANCO

GROUND ELEVATION (FT): 4518

COORDINATES: 39.114518°N 108.654717°W

DEPTH TO BEDROCK (FT): NOT ENCOUNTERED

▽ DEPTH TO GROUNDWATER: 7 FEET DURING DRILLING

DEPTH (FT)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	N VALUE	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	GRAIN SIZE DISTRIBUTION (%) GRAVEL	SAND	FINES	ATTERBERG LIMITS PL	LL	PI	COM/SWELL (%)	UCS PEAK STRESS, (PSF)
0		TOPSOIL												
		CL – lean CLAY, trace sand, tan to light brown, dry, low plasticity, stiff		19/12	7.1	105								
		very stiff		25/12	11.5	113	0	1	99	18	41	23		
5														
		▽												
		▼ with sand, wet, soft		3/12	29.6	92	0	17	83					
10		increasing gravel content in cuttings												
		SP – poorly graded SAND with gravel, brown, wet, non–plastic, dense		48/12	8.1	121								
15														
		Bottom of borehole at 17.0 feet.												
20														
25														

COMMENTS: After piezometer installation, depth to groundwater was 8 feet.

WJE | ENGINEERS ARCHITECTS MATERIALS SCIENTISTS

BOREHOLE: B-3

CLIENT: CITY OF GRAND JUNCTION

WJE PROJECT NO.: 2019.3776.0

PROJECT NAME: PERSIGO WASTE WATER TREATMENT PLANT

PROJECT LOCATION: 2145 RIVER ROAD, GRAND JUNCTION,CO

DRILLING STARTED: 09/13/2019 COMPLETE: 09/13/2019

DRILLING CONTRACTOR: HRL COMPLIANCE SOLUTIONS, INC.

DRILLING RIG TYPE: DIEDRICH D90 HOLE DIAMETER(IN.): 4

LOGGED BY: DANIEL FRANCO

GROUND ELEVATION (FT): 4517

COORDINATES: 39.112971°N 108.656259°W

DEPTH TO BEDROCK (FT): NOT ENCOUNTERED

▽ DEPTH TO GROUNDWATER: 7 FEET DURING DRILLING

DEPTH (FT)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	N VALUE	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	GRAIN SIZE DISTRIBUTION (%)			ATTERBERG LIMITS			COM/SWELL (%)	UCS PEAK STRESS, (PSF)
							GRAVEL	SAND	FINES	PL	LL	PI		
0		TOPSOIL												
		CL – lean CLAY, tan to light brown, dry, low plasticity, hard		44/12	9.9	126								
5		trace sand, stiff		14/12	19.8	108	0	1	99	18	38	20		
		▽												
10		moist, soft		2/12	28.7	94	0	2	98	17	34	17	−1.5	410
15		Bottom of borehole at 14.5 feet.												
20														
25														

COMMENTS:

WJE ENGINEERS ARCHITECTS MATERIALS SCIENTISTS

BOREHOLE: B-4

CLIENT: CITY OF GRAND JUNCTION

WJE PROJECT NO.: 2019.3776.0

PROJECT NAME: PERSIGO WASTE WATER TREATMENT PLANT

PROJECT LOCATION: 2145 RIVER ROAD, GRAND JUNCTION,CO

DRILLING STARTED: 09/11/2019 COMPLETE: 09/11/2019

DRILLING CONTRACTOR: HRL COMPLIANCE SOLUTIONS, INC.

DRILLING RIG TYPE: DIEDRICH D90 HOLE DIAMETER(IN.): 6

LOGGED BY: DANIEL FRANCO

GROUND ELEVATION (FT): 4515

COORDINATES: 39.113219°N 108.657758°W

DEPTH TO BEDROCK (FT): NOT ENCOUNTERED

▽ DEPTH TO GROUNDWATER: 7 FEET DURING DRILLING

DEPTH (FT)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	N VALUE	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	GRAIN SIZE DISTRIBUTION (%) GRAVEL	SAND	FINES	ATTERBERG LIMITS PL	LL	PI	COM/SWELL (%)	UCS PEAK STRESS, (PSF)
0		TOPSOIL very stiff		25/12	6.8	117								
		CL – lean CLAY, trace sand, light brown, dry, low plasticity												
5		medium stiff		6/12	20.5	102	0	1	99	18	45	27		
		▽												
10		SC – clayey SAND, light brown, wet, non-plastic, medium dense		24/12	21.8	103	0	51	49					
15		GRAVEL and COBBLE, gray, wet, non-plastic, dense		50/6										
		Bottom of borehole at 17.5 feet.												
20														
25														

COMMENTS:

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WJE ENGINEERS ARCHITECTS MATERIALS SCIENTISTS

BOREHOLE: B-5

CLIENT: CITY OF GRAND JUNCTION

WJE PROJECT NO.: 2019.3776.0

PROJECT NAME: PERSIGO WASTE WATER TREATMENT PLANT

PROJECT LOCATION: 2145 RIVER ROAD, GRAND JUNCTION,CO

DRILLING STARTED: 09/11/2019 COMPLETE: 09/11/2019

DRILLING CONTRACTOR: HRL COMPLIANCE SOLUTIONS, INC.

DRILLING RIG TYPE: DIEDRICH D90 HOLE DIAMETER(IN.): 6

LOGGED BY: DANIEL FRANCO

GROUND ELEVATION (FT): 4514

COORDINATES: 39.112053°N 108.657756°W

DEPTH TO BEDROCK (FT): 20

▽ DEPTH TO GROUNDWATER: 5.5 FEET DURING DRILLING

DEPTH (FT)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	N VALUE	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	GRAIN SIZE DISTRIBUTION (%)			ATTERBERG LIMITS			COM/SWELL (%)	UCS PEAK STRESS, (PSF)
							GRAVEL	SAND	FINES	PL	LL	PI		
0		TOPSOIL												
		CL – lean CLAY, trace sand, light brown, dry, low plasticity, stiff		16/12	14.8	112	0	9	91	17	38	21		
5		▽												
		SC – clayey SAND, light brown, wet, non-plastic, medium dense		15/12	18.4	92	0	82	18					
		GRAVEL and COBBLE, gray, wet, non-plastic												
10														
15														
20		BEDROCK – SHALE, dark olive gray, moist, low plasticity, very hard		50/1	9.2	122							0.4	
		Bottom of borehole at 20.6 feet.												
25														

COMMENTS: After piezometer installation, depth to groundwater was 7 feet.

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WJE ENGINEERS ARCHITECTS MATERIALS SCIENTISTS

BOREHOLE: B-6

CLIENT: CITY OF GRAND JUNCTION

WJE PROJECT NO.: 2019.3776.0

PROJECT NAME: PERSIGO WASTE WATER TREATMENT PLANT

PROJECT LOCATION: 2145 RIVER ROAD, GRAND JUNCTION,CO

DRILLING STARTED: 09/12/2019 COMPLETE: 09/12/2019

DRILLING CONTRACTOR: HRL COMPLIANCE SOLUTIONS, INC.

DRILLING RIG TYPE: DIEDRICH D90 HOLE DIAMETER(IN.): 4

LOGGED BY: DANIEL FRANCO

GROUND ELEVATION (FT): 4522

COORDINATES: 39.112133°N 108.656501°W

DEPTH TO BEDROCK (FT): NOT ENCOUNTERED

▽DEPTH TO GROUNDWATER: 15 FEET DURING DRILLING

DEPTH (FT)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	N VALUE	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	GRAIN SIZE DISTRIBUTION (%) GRAVEL	SAND	FINES	ATTERBERG LIMITS PL	LL	PI	COM/SWELL (%)	UCS PEAK STRESS, (PSF)
0		TOPSOIL												
		CL – lean CLAY, light brown, dry, low plasticity, stiff		16/12	11.7	100								
5		with sand, brown, dry to slightly moist, very stiff		26/12	16.1	112	2	18	80	16	36	20		
10		trace sand, moist, stiff		18/12	16.6	115	0	1	99	17	36	19	0.1	4350
15		▽ brown and gray, wet, stiff		10/12	28.3	95	0	0	100	16	34	18		
20		SW–SC – well graded SAND with clay and gravel, gray and brown, wet, non–plastic, medium dense		45/12	8.2	125	37	52	11					
25		Bottom of borehole at 23.0 feet.												

COMMENTS:

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WJE ENGINEERS ARCHITECTS MATERIALS SCIENTISTS

BOREHOLE: B-7

CLIENT: CITY OF GRAND JUNCTION

WJE PROJECT NO.: 2019.3776.0

PROJECT NAME: PERSIGO WASTE WATER TREATMENT PLANT

PROJECT LOCATION: 2145 RIVER ROAD, GRAND JUNCTION,CO

DRILLING STARTED: 09/13/2019 COMPLETE: 09/13/2019

DRILLING CONTRACTOR: HRL COMPLIANCE SOLUTIONS, INC.

DRILLING RIG TYPE: DIEDRICH D90 HOLE DIAMETER(IN.): 4

LOGGED BY: DANIEL FRANCO

GROUND ELEVATION (FT): 4518

COORDINATES: 39.110957°N 108.656657°W

DEPTH TO BEDROCK (FT): NOT ENCOUNTERED

▽ DEPTH TO GROUNDWATER: 9 FEET DURING DRILLING

DEPTH (FT)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE	N VALUE	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	GRAIN SIZE DISTRIBUTION (%) GRAVEL	SAND	FINES	ATTERBERG LIMITS PL	LL	PI	COM/SWELL (%)	UCS PEAK STRESS, (PSF)
0		TOPSOIL												
		CL – lean CLAY with sand, brown, dry, low plasticity, very stiff		21/12	6.5	115								
5		moist, very stiff		24/12	15.3	113	0	22	78	16	30	14		
		▽												
10		wet, soft		5/12	28.3	92								
		SC – clayey SAND, dark brown, wet, non–plastic												
15														
		Bottom of borehole at 15.5 feet.												
20														
25														

COMMENTS:

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PIEZOMETER AS-BUILT: B-2

WJE | ENGINEERS ARCHITECTS MATERIALS SCIENTISTS

CLIENT: CITY OF GRAND JUNCTION

WJE PROJECT NO.: 2019.3776.0

PROJECT NAME: PERSIGO WASTE WATER TREATMENT PLANT

PROJECT LOCATION: 2145 RIVER ROAD, GRAND JUNCTION,CO

DRILLING STARTED: 09/13/2019 COMPLETE: 09/13/2019

DRILLING CONTRACTOR: HRL COMPLIANCE SOLUTIONS, INC.

DRILLING RIG TYPE: DIEDRICH D90 HOLE DIAMETER(IN.): 6

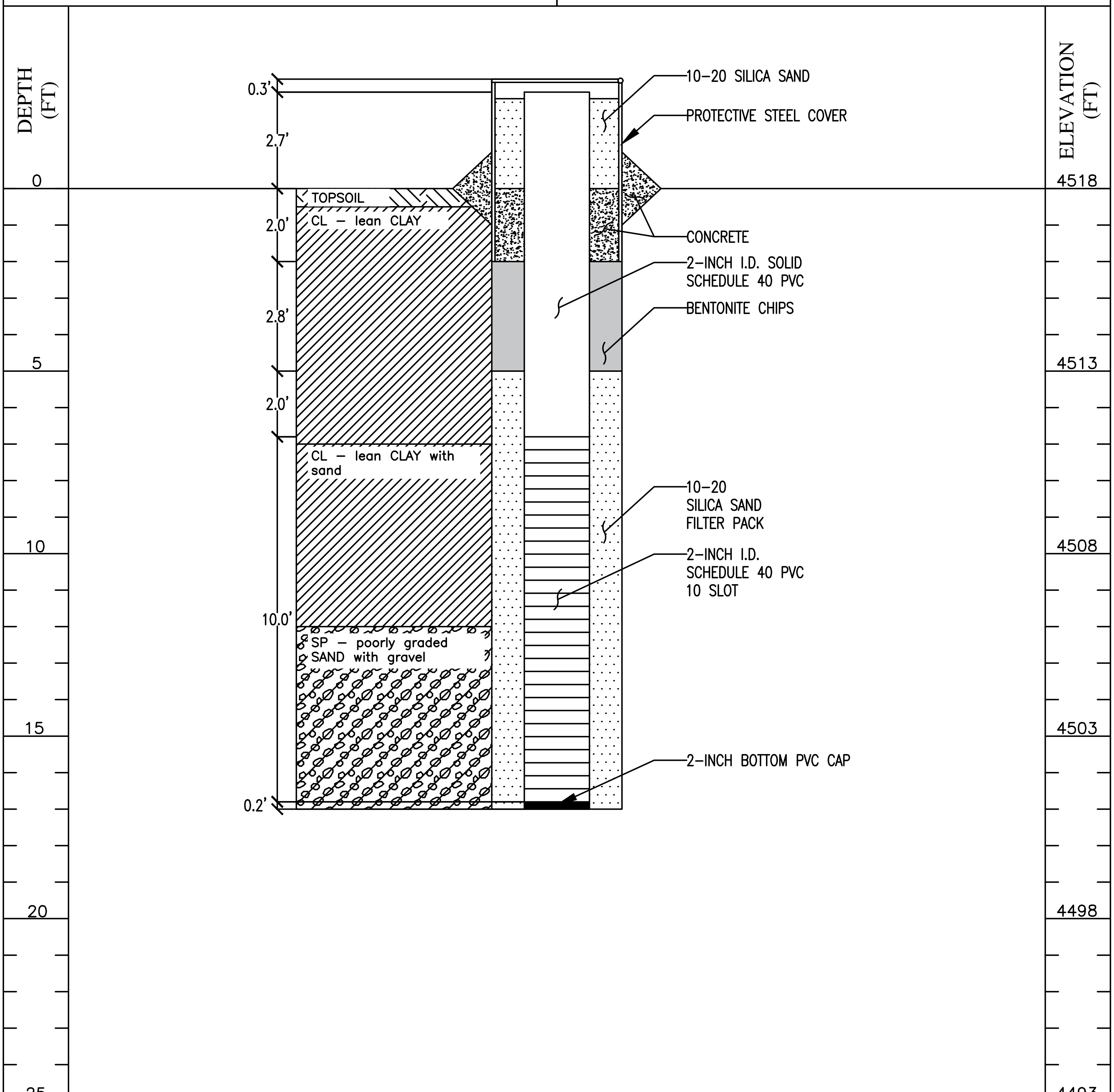
LOGGED BY: DANIEL FRANCO

GROUND ELEVATION (FT): 4518

COORDINATES: 39.114518°N 108.654717°W

DEPTH TO BEDROCK (FT): NOT ENCOUNTERED

DEPTH TO GROUNDWATER: 7 FEET DURING DRILLING



COMMENTS:

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PIEZOMETER AS-BUILT: B-5

WJE ENGINEERS ARCHITECTS MATERIALS SCIENTISTS

CLIENT: CITY OF GRAND JUNCTION

WJE PROJECT NO.: 2019.3776.0

PROJECT NAME: PERSIGO WASTE WATER TREATMENT PLANT

PROJECT LOCATION: 2145 RIVER ROAD, GRAND JUNCTION,CO

DRILLING STARTED: 09/11/2019 COMPLETE: 09/11/2019

DRILLING CONTRACTOR: HRL COMPLIANCE SOLUTIONS, INC.

DRILLING RIG TYPE: DIEDRICH D90 HOLE DIAMETER(IN.): 6

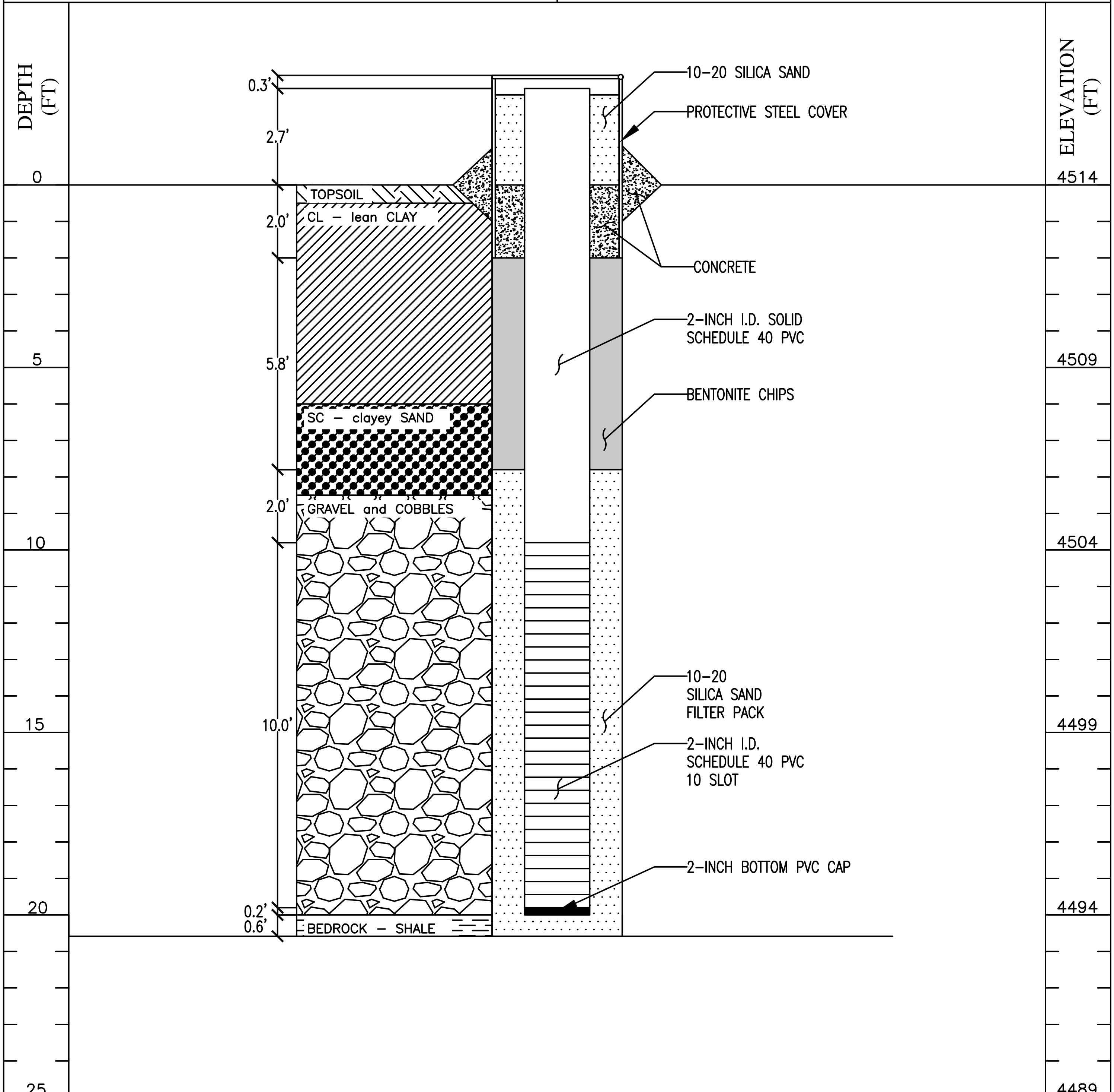
LOGGED BY: DANIEL FRANCO

GROUND ELEVATION (FT): 4514

COORDINATES: 39.112053°N 108.657756°W

DEPTH TO BEDROCK (FT): 20

DEPTH TO GROUNDWATER: 5.5 FEET DURING DRILLING



COMMENTS:

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APPENDIX II - LAB TEST RESULTS

ADVANCED TERRA TESTING

Moisture and Density
ASTM D 2216 and ASTM D 7263

CLIENT	Wiss Janney Elstner	JOB NO.	3020-012
PROJECT	Persigo WWTP	LOCATION	Grand Junction CO
PROJECT NO.	--		

BORING NO.	B-1	B-2	B-2	B-3
DEPTH	4'	3'	7'	4'
SAMPLE NO.				
DATE SAMPLED				
DATE TESTED	09/30/19	09/30/19	09/30/19	09/30/19
TECHNICIAN	CT	ALH	TAF	CT
DESCRIPTION				
Mass of Wet Soil and Pan (g):	273.19	546.03	95.52	365.24
Mass of Dry Soil and Pan (g):	260.48	506.58	74.41	348.60
Mass of Pan (g):	172.73	163.99	3.12	264.74
Moisture (%):	**14.5**	**11.5**	**29.6**	**19.8**
Diameter (in):	1.94	1.94	1.94	1.94
Height (in):	1.00	3.92	1.00	1.00
Mass of Wet Soil and Ring (g):	128.54	490.77	120.52	128.53
Mass of Ring (g):	27.99	108.37	27.99	27.99
Wet Density (lbs/ft³):	**129.9**	**126.1**	**119.5**	**129.9**
Dry Density (lbs/ft³):	**113.4**	**113.1**	**92.2**	**108.4**
Wet Density (kg/m³):	**2080**	**2020**	**1914**	**2080**
Dry Density (kg/m³):	**1817**	**1811**	**1477**	**1736**

BORING NO.	B-4	B-4	B-6	B-7
DEPTH	4'	9'	19'	4'
SAMPLE NO.				
DATE SAMPLED				
DATE TESTED	09/30/19	09/30/19	09/30/19	09/30/19
TECHNICIAN	TAF	TAF	TAF	ALH
DESCRIPTION				
Mass of Wet Soil and Pan (g):	97.69	100.02	107.32	272.67
Mass of Dry Soil and Pan (g):	81.60	82.65	99.41	259.27
Mass of Pan (g):	3.09	3.10	3.09	171.78
Moisture (%):	**20.5**	**21.8**	**8.2**	**15.3**
Diameter (in):	1.94	1.94	1.94	1.94
Height (in):	1.00	1.00	1.00	1.00
Mass of Wet Soil and Ring (g):	122.59	125.00	132.36	128.93
Mass of Ring (g):	27.49	27.99	27.99	27.99
Wet Density (lbs/ft³):	**122.8**	**125.3**	**134.8**	**130.4**
Dry Density (lbs/ft³):	**101.9**	**102.8**	**124.6**	**113.0**
Wet Density (kg/m³):	**1967**	**2007**	**2159**	**2088**
Dry Density (kg/m³):	**1633**	**1647**	**1995**	**1811**
NOTES				

Data entry by:	SPH	Date:	10/1/2019
Checked by:	KMS	Date:	10/2/19
File name:	3020012__Moisture and Density ASTM D7236_0.xls		

ADVANCED TERRA TESTING

Moisture and Density
ASTM D 2216 and ASTM D 7263

CLIENT	Wiss Janney Elstner	JOB NO.	3020-012
PROJECT	Persigo WWTP	LOCATION	Grand Junction CO
PROJECT NO.	--		

BORING NO.	B-1	B-1	B-1	B-2
DEPTH	0'	7'	15.5'	0'
SAMPLE NO.				
DATE SAMPLED				
DATE TESTED	10/01/19	10/01/19	10/01/19	10/01/19
TECHNICIAN	CAL	CAL	CAL	CAL
DESCRIPTION				
Mass of Wet Soil and Pan (g):	345.19	427.22	309.00	351.20
Mass of Dry Soil and Pan (g):	303.17	379.47	283.02	328.49
Mass of Pan (g):	6.66	6.54	6.73	6.67
Moisture (%):	**14.2**	**12.8**	**9.4**	**7.1**
Diameter (in):	Density	1.93	1.93	1.94
Height (in):	Not	3.99	3.12	3.98
Mass of Wet Soil and Ring (g):	Possible	420.64	302.44	344.67
Mass of Ring (g):		0.00	0.00	0.00
Wet Density (lbs/ft³):		**137.0**	**126.9**	**112.1**
Dry Density (lbs/ft³):		**121.4**	**116.0**	**104.7**
Wet Density (kg/m³):		**2194**	**2033**	**1796**
Dry Density (kg/m³):		**1945**	**1858**	**1678**
BORING NO.	B-2	B-3	B-4	B-6
DEPTH	12'	0'	0'	0'
SAMPLE NO.				
DATE SAMPLED				
DATE TESTED	10/01/19	10/01/19	10/01/19	10/01/19
TECHNICIAN	CAL	CAL	CAL	CAL
DESCRIPTION				
Mass of Wet Soil and Pan (g):	288.62	435.67	353.73	249.74
Mass of Dry Soil and Pan (g):	267.38	397.17	331.71	224.22
Mass of Pan (g):	6.68	6.72	6.50	6.41
Moisture (%):	**8.1**	**9.9**	**6.8**	**11.7**
Diameter (in):	1.93	1.93	1.93	1.93
Height (in):	2.80	4.04	3.61	2.85
Mass of Wet Soil and Ring (g):	386.36	429.14	347.37	243.38
Mass of Ring (g):	104.00	0.00	0.13	0.00
Wet Density (lbs/ft³):	**131.1**	**138.1**	**124.8**	**111.7**
Dry Density (lbs/ft³):	**121.2**	**125.7**	**116.9**	**100.0**
Wet Density (kg/m³):	**2100**	**2212**	**1999**	**1790**
Dry Density (kg/m³):	**1942**	**2014**	**1872**	**1602**
NOTES	* filing required due to gravel, side wall voids due to gravel			

Data entry by:	KMS	Date:	10/2/2019
Checked by:	CAL	Date:	10-3-2019
File name:	3020012_Moisture and Density ASTM D7236_1.xls		

ADVANCED TERRA TESTING

Moisture and Density
ASTM D 2216 and ASTM D 7263

CLIENT	Wiss Janney Elstner	JOB NO.	3020-012
PROJECT	Persigo WWTP	LOCATION	Grand Junction CO
PROJECT NO.	--		

BORING NO.	B-5	B-5	B-6	B-6
DEPTH	0'	6'	4'	14'
SAMPLE NO.				
DATE SAMPLED				
DATE TESTED	10/01/19	10/01/19	10/01/19	10/01/19
TECHNICIAN	TAF	TAF	TAF	TAF
DESCRIPTION				
Mass of Wet Soil and Pan (g):	516.09	223.75	273.34	267.45
Mass of Dry Soil and Pan (g):	465.41	210.64	259.36	246.55
Mass of Pan (g):	123.24	139.49	172.36	172.73
Moisture (%):	**14.8**	**18.4**	**16.1**	**28.3**
Diameter (in):	1.94	1.94	1.94	1.94
Height (in):	3.96	1.00	1.00	1.00
Mass of Wet Soil and Ring (g):	502.47	112.38	129.18	123.29
Mass of Ring (g):	109.33	27.98	27.98	27.98
Wet Density (lbs/ft³):	**128.0**	**108.3**	**129.9**	**122.3**
Dry Density (lbs/ft³):	**111.5**	**91.5**	**111.9**	**95.4**
Wet Density (kg/m³):	**2051**	**1735**	**2081**	**1960**
Dry Density (kg/m³):	**1786**	**1465**	**1793**	**1527**

BORING NO.	
DEPTH	
SAMPLE NO.	
DATE SAMPLED	
DATE TESTED	
TECHNICIAN	
DESCRIPTION	
Mass of Wet Soil and Pan (g):	
Mass of Dry Soil and Pan (g):	
Mass of Pan (g):	
Moisture (%):	
Diameter (in):	
Height (in):	
Mass of Wet Soil and Ring (g):	
Mass of Ring (g):	
Wet Density (lbs/ft³):	
Dry Density (lbs/ft³):	
Wet Density (kg/m³):	
Dry Density (kg/m³):	
NOTES	

Data entry by:	CAL	Date:	10/3/2019
Checked by:	KMB	Date:	10/4/19
File name:	3020012__Moisture and Density ASTM D7236_3.xls		

ADVANCED TERRA TESTING

Moisture and Density
ASTM D 2216 and ASTM D 7263

CLIENT	Wiss Janney Elstner	JOB NO.	3020-012
PROJECT	Persigo WWTP	LOCATION	Grand Junction CO
PROJECT NO.	--		

BORING NO.	B-7	B-7
DEPTH	0'	9'
SAMPLE NO.		
DATE SAMPLED		
DATE TESTED	10/01/19	10/01/19
TECHNICIAN	CAL	CAL
DESCRIPTION	*	
Mass of Wet Soil and Pan (g):	365.04	351.51
Mass of Dry Soil and Pan (g):	343.20	275.52
Mass of Pan (g):	6.68	6.73
Moisture (%):	**6.5**	**28.3**
Diameter (in):	1.93	1.92
Height (in):	3.81	3.84
Mass of Wet Soil and Ring (g):	358.50	345.08
Mass of Ring (g):	0.00	0.00
Wet Density (lbs/ft³):	**122.4**	**117.8**
Dry Density (lbs/ft³):	**114.9**	**91.8**
Wet Density (kg/m³):	**1961**	**1887**
Dry Density (kg/m³):	**1841**	**1471**

BORING NO.	
DEPTH	
SAMPLE NO.	
DATE SAMPLED	
DATE TESTED	
TECHNICIAN	
DESCRIPTION	
Mass of Wet Soil and Pan (g):	
Mass of Dry Soil and Pan (g):	
Mass of Pan (g):	
Moisture (%):	
Diameter (in):	
Height (in):	
Mass of Wet Soil and Ring (g):	
Mass of Ring (g):	
Wet Density (lbs/ft³):	
Dry Density (lbs/ft³):	
Wet Density (kg/m³):	
Dry Density (kg/m³):	
NOTES	*B-7 @ 0' Filling required due to gravel.

Data entry by:	KMS	Date:	10/2/2019
Checked by:	CAL	Date:	10/3/2019
File name:	3020012__Moisture and Density ASTM D7236_2.xls		

ADVANCED TERRA TESTING

Image Attachment

CLIENT	Wiss Janney Elstner	BORING NO.	B-1
JOB NO.	3020-012	DEPTH	0'
PROJECT	Persigo WWTP	SAMPLE NO.	
PROJECT NO.	--	DATE SAMPLED	
LOCATION	Grand Junction CO	DESCRIPTION	liner

NOTES	Density Not Possible

File name: 3020012__Image_19_10_02_06_35_04

Atterberg Limits
ASTM D 4318

ADVANCED TERRA TESTING

CLIENT	Wiss Janney Elstner	BORING NO.	B-1
JOB NO.	3020-012	DEPTH	4'
PROJECT	Persigo WWTP	SAMPLE NO.	--
PROJECT NO.	--	DATE SAMPLED	--
LOCATION	Grand Junction CO	SAMPLED BY	--
DATE TESTED	10/08/19	DESCRIPTION	--
TECHNICIAN	TAF		

Plastic Limits

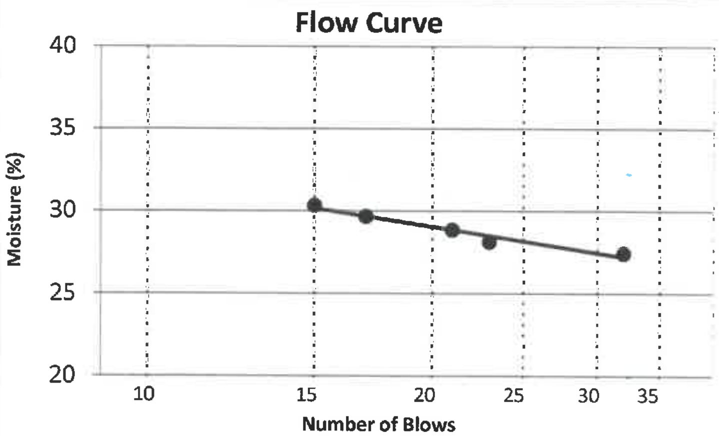
Mass of Wet Pan and Soil (g):	7.79	6.86
Mass of Dry Pan and Soil (g):	6.97	6.17
Mass of Pan (g):	1.07	1.17
Moisture (%)	**13.9**	**13.8**

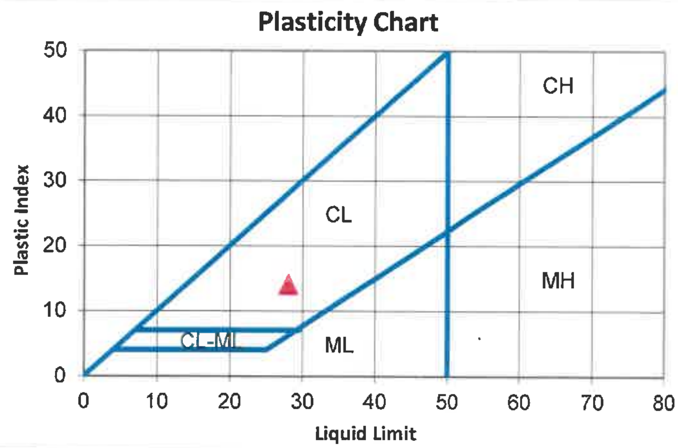
Liquid Limits

Number of Blows	15	17	21	23	32
Mass of Wet Pan and Soil (g):	7.92	8.03	8.05	8.27	7.58
Mass of Dry Pan and Soil (g):	6.34	6.46	6.49	6.70	6.19
Mass of Pan (g):	1.13	1.16	1.10	1.14	1.11
Moisture (%)	**30.3**	**29.7**	**28.9**	**28.1**	**27.4**

Plastic Index

Plastic Limit:	**14**	Atterberg Classification:	CL
Liquid Limit:	**28**	Method:	A
Plastic Index:	**14**		





NOTES

Data entry by:	CAL	Date:	10/9/2019
Checked by:	KMS	Date:	10/9/19
File name:	3020012__Atterberg ASTM D4318_6.xlsm		

Atterberg Limits
ASTM D 4318

ADVANCED TERRA TESTING

CLIENT	Wiss Janney Elstner	BORING NO.	B-2
JOB NO.	3020-012	DEPTH	3'
PROJECT	Persigo WWTP	SAMPLE NO.	--
PROJECT NO.	--	DATE SAMPLED	--
LOCATION	Grand Junction CO	SAMPLED BY	--
DATE TESTED	10/04/19	DESCRIPTION	--
TECHNICIAN	CAL		

Plastic Limits

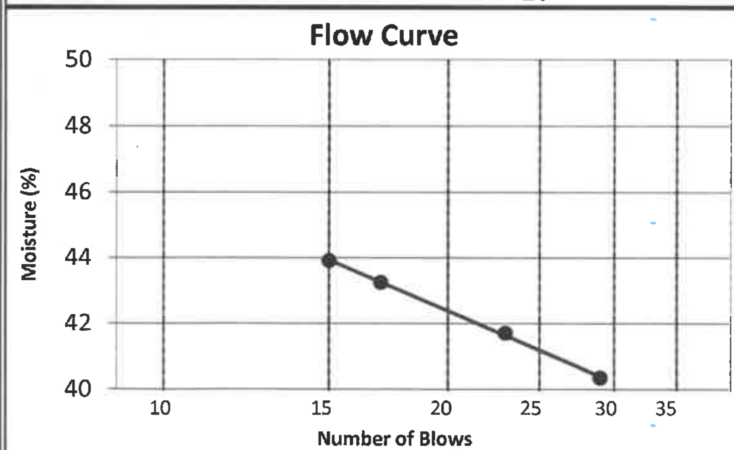
Mass of Wet Pan and Soil (g):	6.64	7.43
Mass of Dry Pan and Soil (g):	5.81	6.50
Mass of Pan (g):	1.14	1.14
Moisture (%)	**17.8**	**17.3**

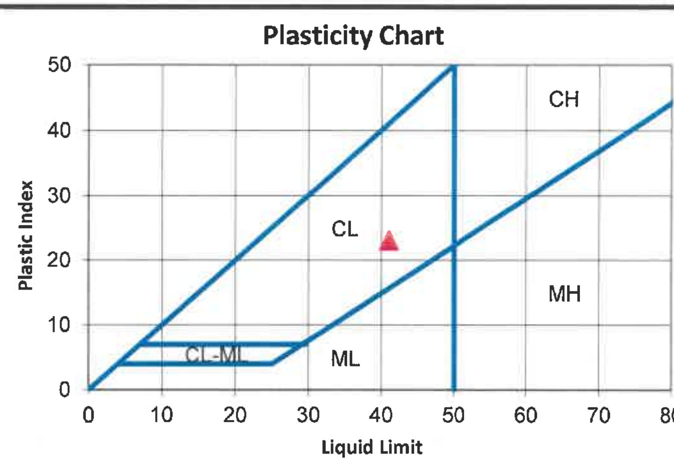
Liquid Limits

Number of Blows	15	17	23	29
Mass of Wet Pan and Soil (g):	10.40	9.77	10.05	9.21
Mass of Dry Pan and Soil (g):	7.58	7.15	7.44	6.87
Mass of Pan (g):	1.15	1.09	1.17	1.07
Moisture (%)	**43.9**	**43.2**	**41.7**	**40.4**

Plastic Index

Plastic Limit:	**18**	Atterberg Classification:	CL
Liquid Limit:	**41**	Method:	A
Plastic Index:	**23**		





NOTES

Data entry by:	CAL	Date:	10/7/2019
Checked by:	SPH	Date:	10-7-19
File name:	3020012__Atterberg ASTM D4318_1.xlsm		

Atterberg Limits
ASTM D 4318

ADVANCED TERRA TESTING

CLIENT	Wiss Janney Elstner	BORING NO.	B-3
JOB NO.	3020-012	DEPTH	4'
PROJECT	Persigo WWTP	SAMPLE NO.	--
PROJECT NO.	--	DATE SAMPLED	--
LOCATION	Grand Junction CO	SAMPLED BY	--
DATE TESTED	10/08/19	DESCRIPTION	--
TECHNICIAN	ALH		

Plastic Limits

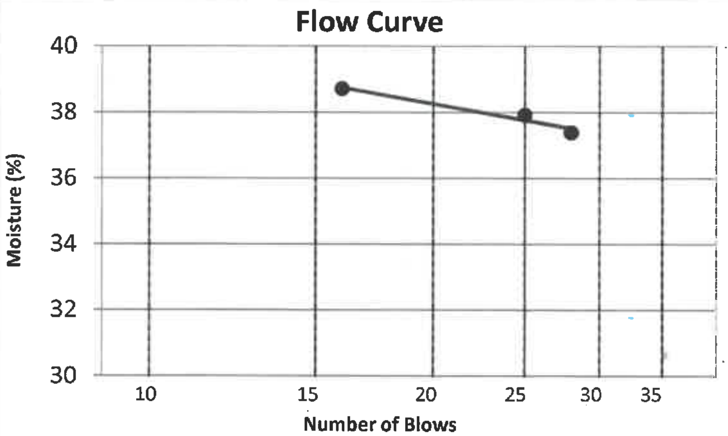
Mass of Wet Pan and Soil (g):	8.36	8.32
Mass of Dry Pan and Soil (g):	7.25	7.21
Mass of Pan (g):	1.17	1.15
Moisture (%)	**18.3**	**18.2**

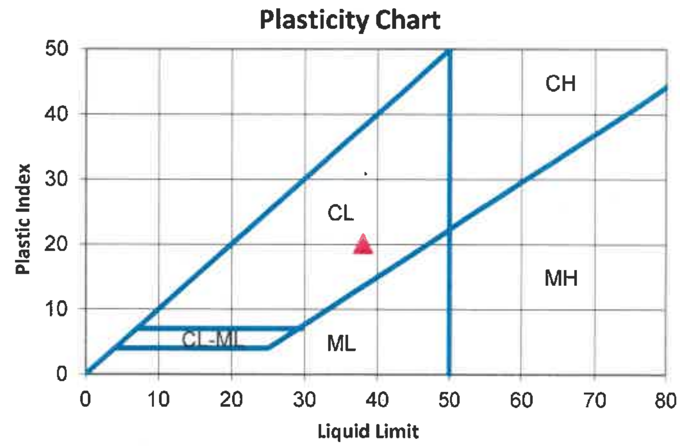
Liquid Limits

Number of Blows	16	25	28
Mass of Wet Pan and Soil (g):	7.63	9.36	11.01
Mass of Dry Pan and Soil (g):	5.79	7.10	8.32
Mass of Pan (g):	1.04	1.14	1.13
Moisture (%)	**38.7**	**37.9**	**37.4**

Plastic Index

Plastic Limit:	**18**	Atterberg Classification:	CL
Liquid Limit:	**38**	Method:	A
Plastic Index:	**20**		





NOTES

Data entry by:	CAL	Date:	10/9/2019
Checked by:	KMS	Date:	10/9/19
File name:	3020012__Atterberg ASTM D4318_7.xlsm		

Atterberg Limits
ASTM D 4318

ADVANCED TERRA TESTING

CLIENT	Wiss Janney Elstner	BORING NO.	B-3
JOB NO.	3020-012	DEPTH	9'
PROJECT	Persigo WWTP	SAMPLE NO.	--
PROJECT NO.	--	DATE SAMPLED	--
LOCATION	Grand Junction CO	SAMPLED BY	--
DATE TESTED	10/04/19	DESCRIPTION	--
TECHNICIAN	BDF		

Plastic Limits

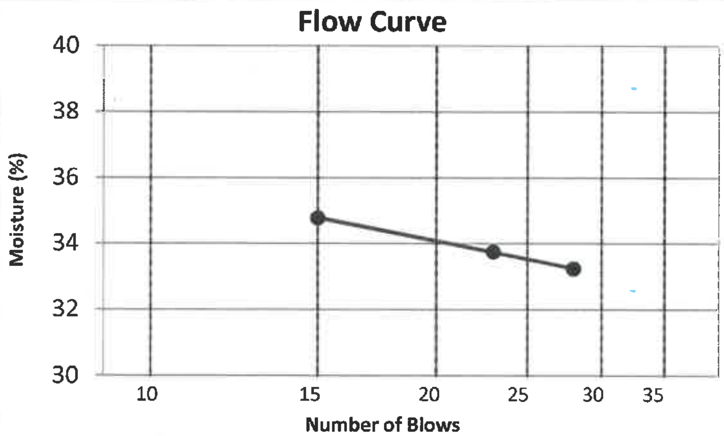
Mass of Wet Pan and Soil (g):	7.94	7.89
Mass of Dry Pan and Soil (g):	6.95	6.92
Mass of Pan (g):	1.09	1.13
Moisture (%)	**16.9**	**16.8**

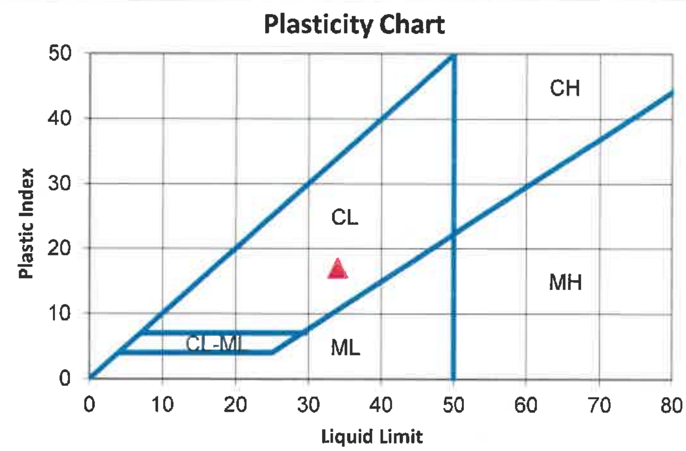
Liquid Limits

Number of Blows	15	23	28
Mass of Wet Pan and Soil (g):	8.96	9.38	8.71
Mass of Dry Pan and Soil (g):	6.94	7.30	6.82
Mass of Pan (g):	1.15	1.14	1.13
Moisture (%)	**34.8**	**33.8**	**33.2**

Plastic Index

Plastic Limit:	**17**	Atterberg Classification:	CL
Liquid Limit:	**34**	Method:	A
Plastic Index:	**17**		





NOTES

Data entry by:	CAL	Date:	10/7/2019
Checked by:	SPH	Date:	10-7-19
File name:	3020012__Atterberg ASTM D4318_2.xlsm		

ADVANCED TERRA TESTING

Atterberg Limits
ASTM D 4318

CLIENT	Wiss Janney Elstner	BORING NO.	B-4
JOB NO.	3020-012	DEPTH	4'
PROJECT	Persigo WWTP	SAMPLE NO.	--
PROJECT NO.	--	DATE SAMPLED	--
LOCATION	Grand Junction CO	SAMPLED BY	--
DATE TESTED	10/04/19	DESCRIPTION	--
TECHNICIAN	BDF		

Plastic Limits

Mass of Wet Pan and Soil (g):	8.20	8.22
Mass of Dry Pan and Soil (g):	7.14	7.17
Mass of Pan (g):	1.15	1.15
Moisture (%)	**17.7**	**17.4**

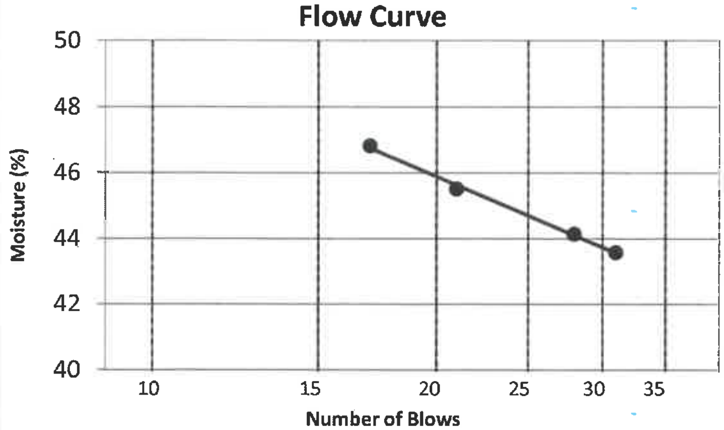
Liquid Limits

Number of Blows	17	21	28	31
Mass of Wet Pan and Soil (g):	11.27	10.55	8.80	9.94
Mass of Dry Pan and Soil (g):	8.03	7.59	6.44	7.26
Mass of Pan (g):	1.09	1.09	1.11	1.10
Moisture (%)	**46.8**	**45.5**	**44.1**	**43.6**

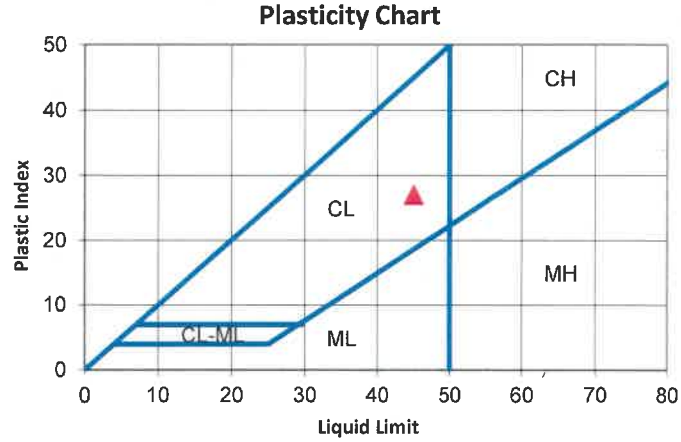
Plastic Index

Plastic Limit:	**18**	Atterberg Classification:	CL
Liquid Limit:	**45**	Method:	A
Plastic Index:	**27**		

Flow Curve



Plasticity Chart



NOTES

Data entry by:	CAL	Date:	10/7/2019
Checked by:	SPH	Date:	10-7-19
File name:	3020012__Atterberg ASTM D4318_3.xlsm		

Atterberg Limits
ASTM D 4318

ADVANCED TERRA TESTING

CLIENT	Wiss Janney Elstner	BORING NO.	B-5
JOB NO.	3020-012	DEPTH	0'
PROJECT	Persigo WWTP	SAMPLE NO.	--
PROJECT NO.	--	DATE SAMPLED	--
LOCATION	Grand Junction CO	SAMPLED BY	--
DATE TESTED	10/09/19	DESCRIPTION	--
TECHNICIAN	TAF		

Plastic Limits

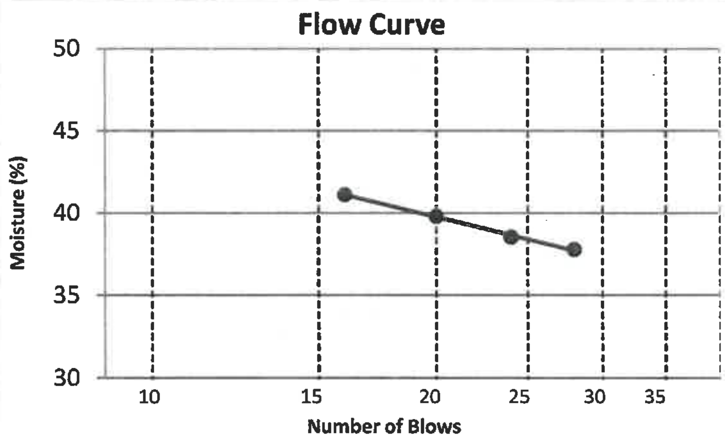
Mass of Wet Pan and Soil (g):	5.95	6.89	7.16
Mass of Dry Pan and Soil (g):	5.26	6.09	6.33
Mass of Pan (g):	1.13	1.32	1.32
Moisture (%)	**16.8**	**16.7**	**16.6**

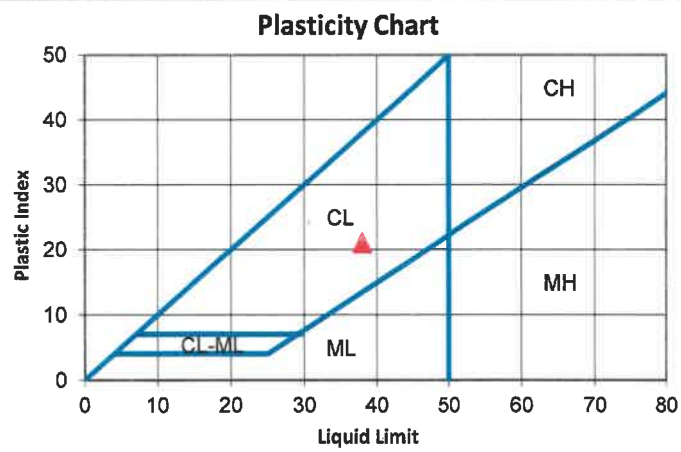
Liquid Limits

Number of Blows	16	20	24	28
Mass of Wet Pan and Soil (g):	7.52	7.45	6.23	4.95
Mass of Dry Pan and Soil (g):	5.72	5.71	4.80	3.92
Mass of Pan (g):	1.32	1.32	1.10	1.17
Moisture (%)	**41.1**	**39.8**	**38.5**	**37.8**

Plastic Index

Plastic Limit:	**17**	Atterberg Classification:	CL
Liquid Limit:	**38**	Method:	A
Plastic Index:	**21**		





NOTES

Data entry by:	CAL	Date:	10/10/2019
Checked by:	KMS	Date:	10/10/19
File name:	3020012__Atterberg ASTM D4318_9.xlsm		

ADVANCED TERRA TESTING

Atterberg Limits
ASTM D 4318

CLIENT	Wiss Janney Elstner		BORING NO.	B-6
JOB NO.	3020-012		DEPTH	4'
PROJECT	Persigo WWTP		SAMPLE NO.	--
PROJECT NO.	--		DATE SAMPLED	--
LOCATION	Grand Junction CO		SAMPLED BY	--
DATE TESTED	10/09/19		DESCRIPTION	--
TECHNICIAN	ALH			

Plastic Limits

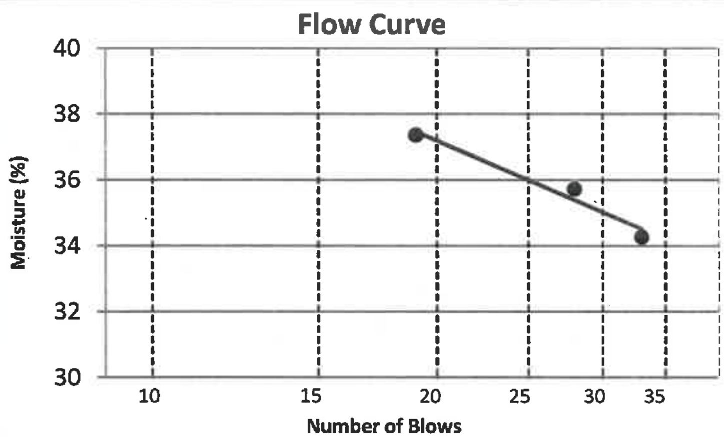
Mass of Wet Pan and Soil (g):	8.44	8.44
Mass of Dry Pan and Soil (g):	7.42	7.42
Mass of Pan (g):	1.16	1.09
Moisture (%)	**16.3**	**16.1**

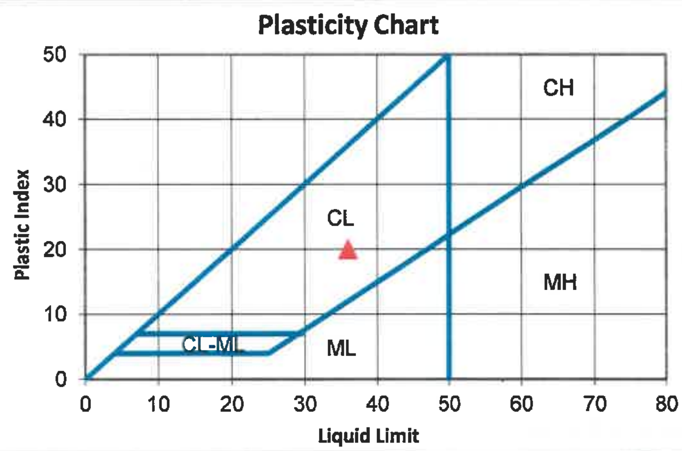
Liquid Limits

Number of Blows	19	28	33
Mass of Wet Pan and Soil (g):	11.71	12.64	11.43
Mass of Dry Pan and Soil (g):	8.83	9.62	8.79
Mass of Pan (g):	1.12	1.17	1.10
Moisture (%)	**37.4**	**35.7**	**34.3**

Plastic Index

Plastic Limit:	**16**	Atterberg Classification:	CL
Liquid Limit:	**36**	Method:	A
Plastic Index:	**20**		





NOTES

Data entry by:	CAL	Date:	10/10/2019
Checked by:	KMS	Date:	10/10/19
File name:	3020012__Atterberg ASTM D4318_8.xlsm		

Atterberg Limits
ASTM D 4318

ADVANCED TERRA TESTING

CLIENT	Wiss Janney Elstner	BORING NO.	B-6
JOB NO.	3020-012	DEPTH	9'
PROJECT	Persigo WWTP	SAMPLE NO.	--
PROJECT NO.	--	DATE SAMPLED	--
LOCATION	Grand Junction CO	SAMPLED BY	--
DATE TESTED	10/03/19	DESCRIPTION	--
TECHNICIAN	BDF		

Plastic Limits

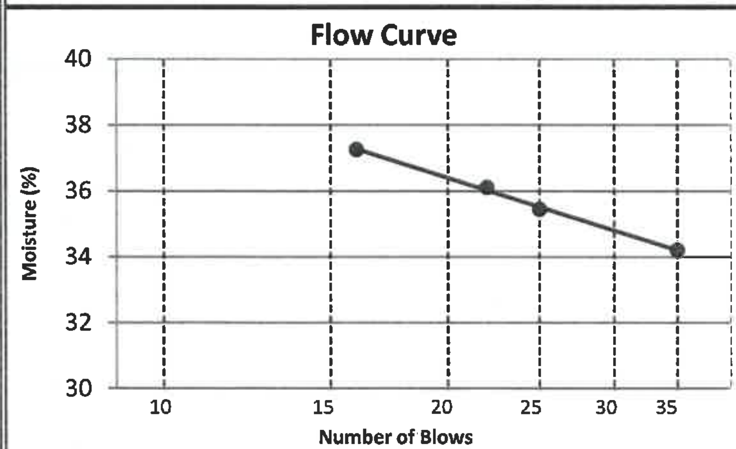
Mass of Wet Pan and Soil (g):	8.04	7.91
Mass of Dry Pan and Soil (g):	7.02	6.92
Mass of Pan (g):	1.14	1.14
Moisture (%)	**17.3**	**17.1**

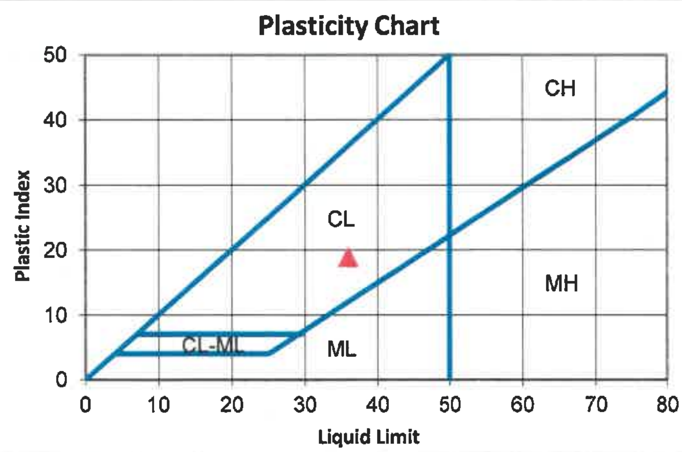
Liquid Limits

Number of Blows	16	22	25	35
Mass of Wet Pan and Soil (g):	10.65	7.66	10.25	9.53
Mass of Dry Pan and Soil (g):	8.07	5.91	7.87	7.39
Mass of Pan (g):	1.14	1.08	1.13	1.14
Moisture (%)	**37.3**	**36.1**	**35.5**	**34.2**

Plastic Index

Plastic Limit:	**17**	Atterberg Classification:	CL
Liquid Limit:	**36**	Method:	A
Plastic Index:	**19**		





NOTES

Data entry by:	KMS	Date:	10/4/2019
Checked by:	SPH	Date:	10-7-19
File name:	3020012__Atterberg ASTM D4318_0.xlsm		

ADVANCED TERRA TESTING

Atterberg Limits
ASTM D 4318

CLIENT	Wiss Janney Elstner	BORING NO.	B-6
JOB NO.	3020-012	DEPTH	14'
PROJECT	Persigo WWTP	SAMPLE NO.	--
PROJECT NO.	--	DATE SAMPLED	--
LOCATION	Grand Junction CO	SAMPLED BY	--
DATE TESTED	10/08/19	DESCRIPTION	--
TECHNICIAN	TAF		

Plastic Limits

Mass of Wet Pan and Soil (g):	8.77	8.63
Mass of Dry Pan and Soil (g):	7.73	7.66
Mass of Pan (g):	1.13	1.33
Moisture (%)	**15.9**	**15.4**

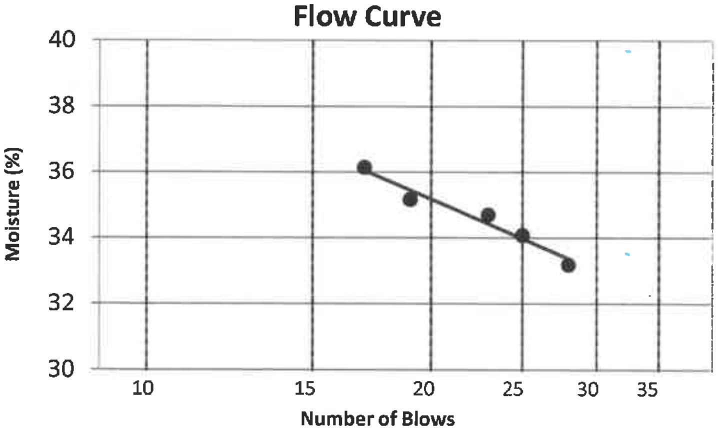
Liquid Limits

Number of Blows	17	19	23	25	28
Mass of Wet Pan and Soil (g):	7.72	7.29	7.86	7.86	7.86
Mass of Dry Pan and Soil (g):	5.97	5.70	6.12	6.13	6.19
Mass of Pan (g):	1.15	1.15	1.12	1.08	1.15
Moisture (%)	**36.1**	**35.2**	**34.7**	**34.1**	**33.2**

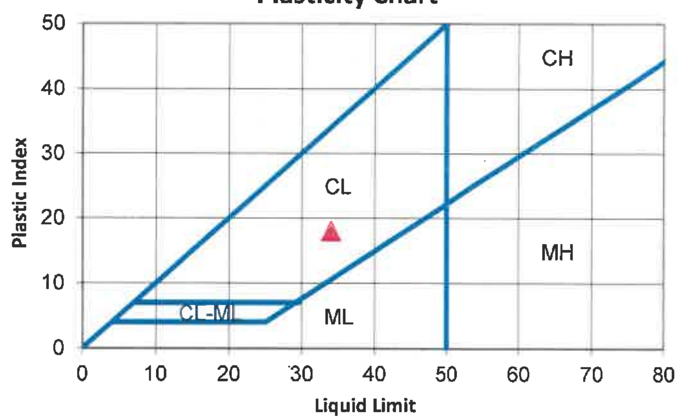
Plastic Index

Plastic Limit:	**16**	Atterberg Classification:	CL
Liquid Limit:	**34**	Method:	A
Plastic Index:	**18**		

Flow Curve



Plasticity Chart



NOTES

Data entry by:	CAL	Date:	10/9/2019
Checked by:	KMS	Date:	10/9/19
File name:	3020012__Atterberg ASTM D4318_5.xlsm		

Atterberg Limits
ASTM D 4318

ADVANCED TERRA TESTING

CLIENT	Wiss Janney Elstner	BORING NO.	B-7
JOB NO.	3020-012	DEPTH	4'
PROJECT	Persigo WWTP	SAMPLE NO.	--
PROJECT NO.	--	DATE SAMPLED	--
LOCATION	Grand Junction CO	SAMPLED BY	--
DATE TESTED	10/08/19	DESCRIPTION	--
TECHNICIAN	ALH		

Plastic Limits

Mass of Wet Pan and Soil (g):	8.52	8.72
Mass of Dry Pan and Soil (g):	7.50	7.70
Mass of Pan (g):	0.97	1.15
Moisture (%)	**15.7**	**15.5**

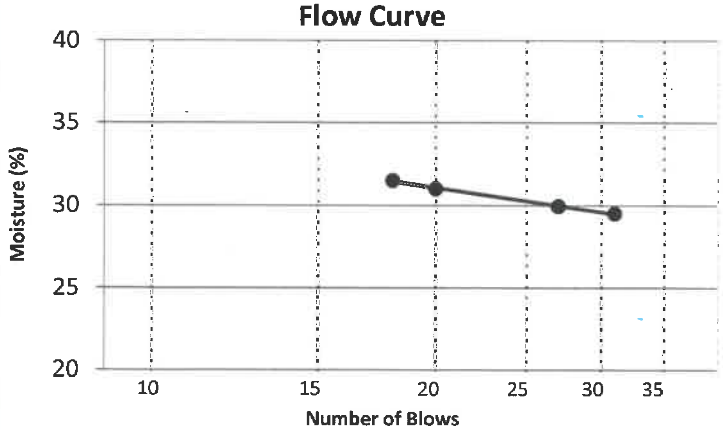
Liquid Limits

Number of Blows	18	20	27	31
Mass of Wet Pan and Soil (g):	11.75	11.98	11.38	11.36
Mass of Dry Pan and Soil (g):	9.20	9.40	9.02	9.03
Mass of Pan (g):	1.11	1.08	1.14	1.13
Moisture (%)	**31.5**	**31.0**	**30.0**	**29.5**

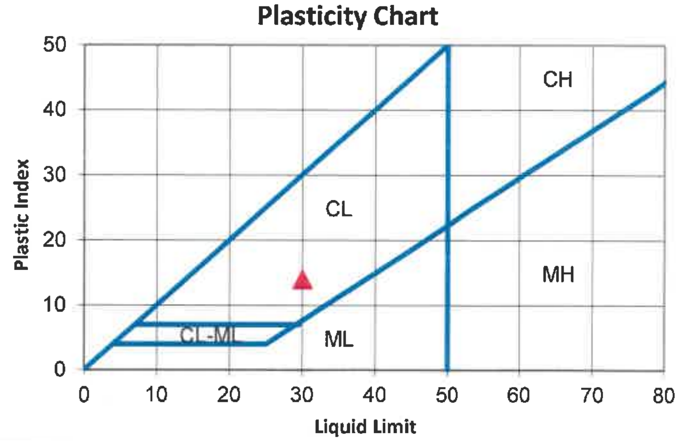
Plastic Index

Plastic Limit:	**16**	Atterberg Classification:	CL
Liquid Limit:	**30**	Method:	A
Plastic Index:	**14**		

Flow Curve



Plasticity Chart



NOTES

Data entry by:	CAL	Date:	10/9/2019
Checked by:	KMS	Date:	10/9/19
File name:	3020012__Atterberg ASTM D4318_4.xlsm		

ADVANCED TERRA TESTING

Grain Size Analysis
ASTM D 6913

CLIENT	Wiss Janney Elstner	BORING NO.	B-1
JOB NO.	3020-012	DEPTH	4'
PROJECT	Persigo WWTP	SAMPLE NO.	--
PROJECT NO.	--	DATE SAMPLED	--
LOCATION	Grand Junction CO	DESCRIPTION	--
DATE TESTED	10/01/19		
TECHNICIAN	ALH		

Hygroscopic Moisture

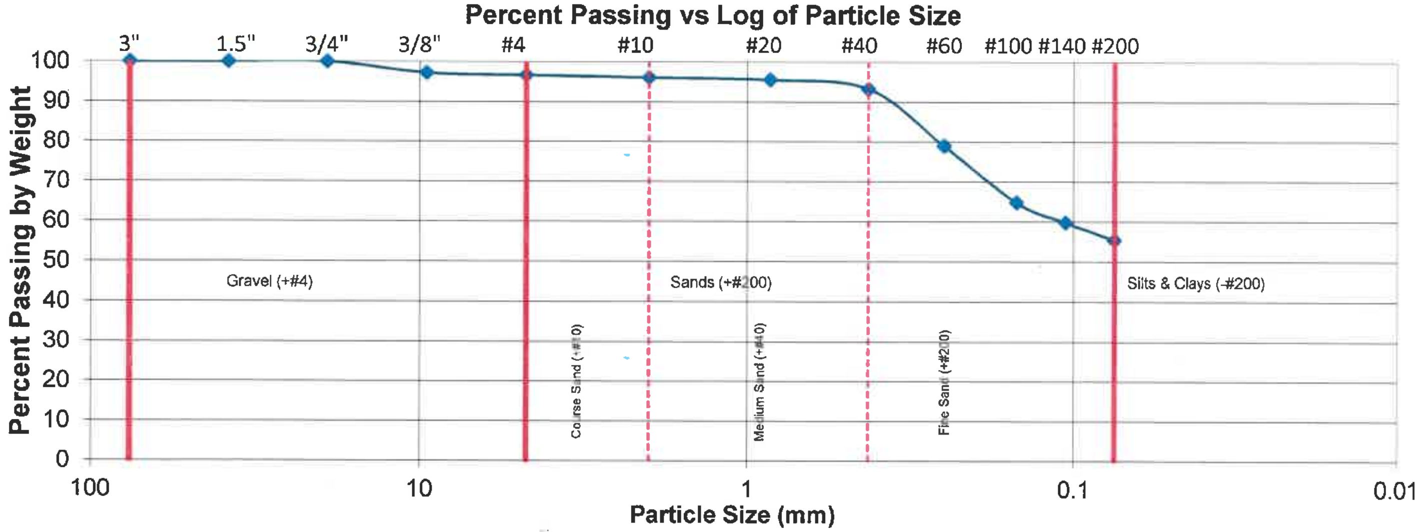
Mass Wet Pan and Soil (g): 273.19
Mass Dry Pan and Soil (g): 260.48
Mass of Pan (g): 172.73
Moisture (%): **14.5**

Sample Data

Total Wet Mass of Sample (g): 100.5
Total Dry Mass of Sample (g): 87.8

Sieve Number	Sieve Size (mm)	Mass of Pan and Soil (g)	Mass of Pan (g)	Mass of Individual Retained Soil (g)	Correction Factor	Percent Passing by Weight (%)
3"	76.2	--	--	--	--	**--**
1.5"	38.1	--	--	--	--	**--**
3/4"	19.05	--	--	--	--	**100.0**
3/8"	9.53	2.5	--	2.5	1.00	**97.2**
#4	4.75	0.51	--	0.51	1.00	**96.6**
#10	2.00	0.49	--	0.49	1.00	**96.0**
#20	0.850	0.50	--	0.50	1.00	**95.5**
#40	0.425	2.0	--	2.0	1.00	**93.2**
#60	0.250	12.5	--	12.5	1.00	**78.9**
#100	0.150	12.5	--	12.5	1.00	**64.7**
#140	0.106	4.4	--	4.4	1.00	**59.7**
#200	0.075	3.8	--	3.8	1.00	**55.3**

Percent Passing vs Log of Particle Size



USCS Classification ASTM D 2487

Atterberg Classification: CL
Group Symbol: CL
USCS Classification: Sandy Lean Clay

Coefficient of Curvature - C_c: --
Coefficient of Uniformity - C_u: --

Data entry by:	CAL	Date:	10/9/2019
Checked by:	KMS	Date:	10/9/19
File name:	3020012__Grain Size Analysis ASTM D6913_12.xlsm		

ADVANCED TERRA TESTING

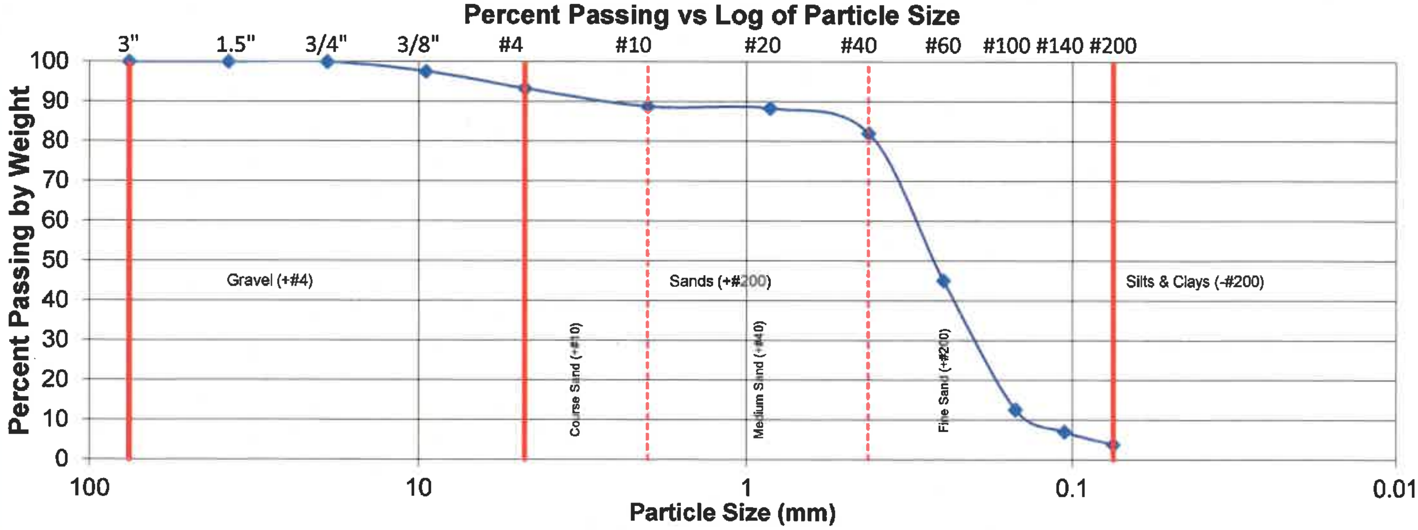
Grain Size Analysis
ASTM D 6913

CLIENT	Wiss Janney Elstner	BORING NO.	B-1
JOB NO.	3020-012	DEPTH	20'
PROJECT	Persigo WWTP	SAMPLE NO.	--
PROJECT NO.	--	DATE SAMPLED	--
LOCATION	Grand Junction CO	DESCRIPTION	--
DATE TESTED	10/01/19		
TECHNICIAN	BNF		

Hygroscopic Moisture of Fines		**Sample Data**	
Mass Wet Pan and Soil (g):	303.08	Total Wet Mass of Sample (g):	1437.8
Mass Dry Pan and Soil (g):	302.45	Total Dry Mass of Sample (g):	1433.1
Mass of Pan (g):	124.06	Split Fraction:	#4
Moisture (%):	**0.4**	Mass of Sub-Sample Fraction (g):	179.02

Sieve Number	Sieve Size (mm)	Mass of Pan and Soil (g)	Mass of Pan (g)	Mass of Individual Retained Soil (g)	Correction Factor	Percent Passing by Weight (%)
3"	76.2	0.0	--	--	--	--
1.5"	38.1	0.0	--	--	--	--
3/4"	19.05	0.0	--	--	--	**100.0**
3/8"	9.53	33.7	--	33.7	1.00	**97.6**
#4	4.75	61.2	--	61.2	1.00	**93.4**
#10	2.00	8.66	--	8.66	0.93	**88.8**
#20	0.850	0.87	--	0.87	0.93	**88.4**
#40	0.425	11.9	--	11.9	0.93	**82.2**
#60	0.250	70.8	--	70.8	0.93	**45.1**
#100	0.150	61.9	--	61.9	0.93	**12.7**
#140	0.106	10.7	--	10.7	0.93	**7.2**
#200	0.075	6.15	--	6.15	0.93	**3.9**

Percent Passing vs Log of Particle Size



USCS Classification ASTM D 2487

Atterberg Classification:	--	Coefficient of Curvature - C_c:	1.01
Group Symbol:	--	Coefficient of Uniformity - C_u:	2.50
USCS Classification:	--		

Data entry by:	KMS	Date:	10/2/2019
Checked by:	CH	Date:	10/3/2019
File name:	3020012__Grain Size Analysis ASTM D6913_4.xlsm		

Grain Size Analysis
ASTM D 6913

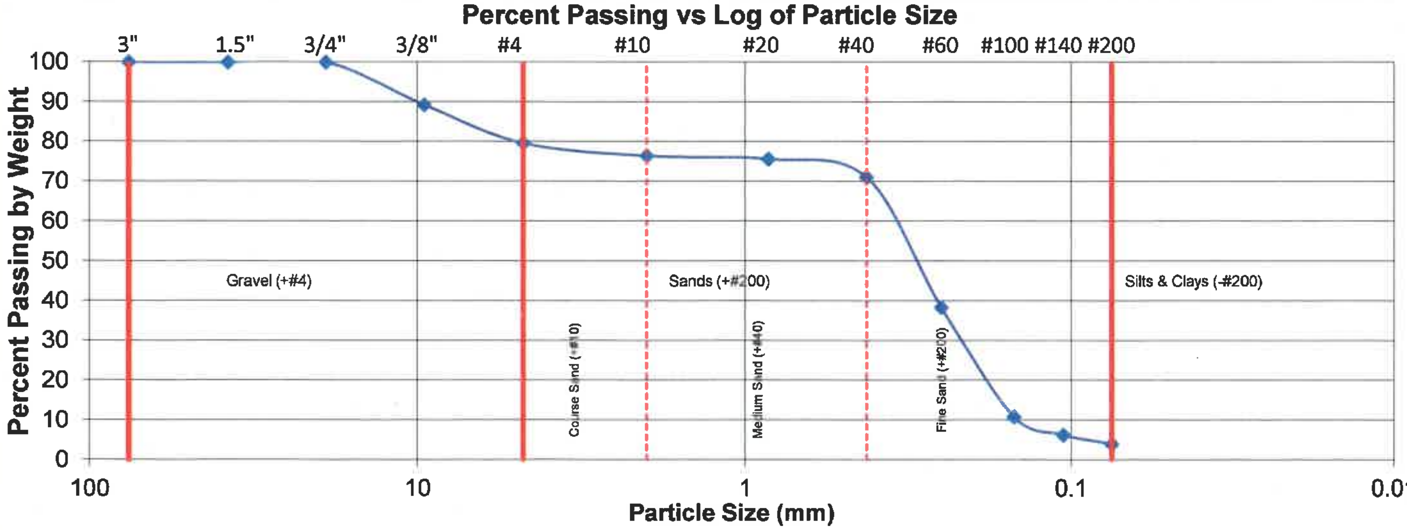
ADVANCED TERRA TESTING

CLIENT	Wiss Janney Elstner	BORING NO.	B-1
JOB NO.	3020-012	DEPTH	26'
PROJECT	Persigo WWTP	SAMPLE NO.	--
PROJECT NO.	--	DATE SAMPLED	--
LOCATION	Grand Junction CO	DESCRIPTION	--
DATE TESTED	10/01/19		
TECHNICIAN	BNF		

Hygroscopic Moisture of Fines		**Sample Data**	
Mass Wet Pan and Soil (g):	333.58	Total Wet Mass of Sample (g):	1086.7
Mass Dry Pan and Soil (g):	332.90	Total Dry Mass of Sample (g):	1083.9
Mass of Pan (g):	123.12	Split Fraction:	#4
Moisture (%):	**0.3**	Mass of Sub-Sample Fraction (g):	210.46

Sieve Number	Sieve Size (mm)	Mass of Pan and Soil (g)	Mass of Pan (g)	Mass of Individual Retained Soil (g)	Correction Factor	Percent Passing by Weight (%)
3"	76.2	0.0	--	--	--	**--**
1.5"	38.1	0.0	--	--	--	**--**
3/4"	19.05	0.0	--	--	--	**100.0**
3/8"	9.53	116.1	--	116.1	1.00	**89.3**
#4	4.75	104.4	--	104.4	1.00	**79.7**
#10	2.00	8.40	--	8.40	0.80	**76.5**
#20	0.850	2.03	--	2.03	0.80	**75.7**
#40	0.425	12.1	--	12.1	0.80	**71.1**
#60	0.250	86.1	--	86.1	0.80	**38.4**
#100	0.150	72.6	--	72.6	0.80	**10.8**
#140	0.106	11.9	--	11.9	0.80	**6.3**
#200	0.075	6.10	--	6.10	0.80	**4.0**

Percent Passing vs Log of Particle Size



USCS Classification ASTM D 2487

Atterberg Classification:	--	Coefficient of Curvature - C_c:	0.93
Group Symbol:	--	Coefficient of Uniformity - C_u:	2.58
USCS Classification:	--		

Data entry by:	KMS	Date:	10/2/2019
Checked by:	CA	Date:	10/3/19
File name:	3020012__Grain Size Analysis ASTM D6913_3.xlsm		

ADVANCED TERRA TESTING

Grain Size Analysis
ASTM D 6913

CLIENT	Wiss Janney Elstner	BORING NO.	B-2
JOB NO.	3020-012	DEPTH	3'
PROJECT	Persigo WWTP	SAMPLE NO.	--
PROJECT NO.	--	DATE SAMPLED	--
LOCATION	Grand Junction CO	DESCRIPTION	--
DATE TESTED	10/01/19		
TECHNICIAN	ALH		

Hygroscopic Moisture

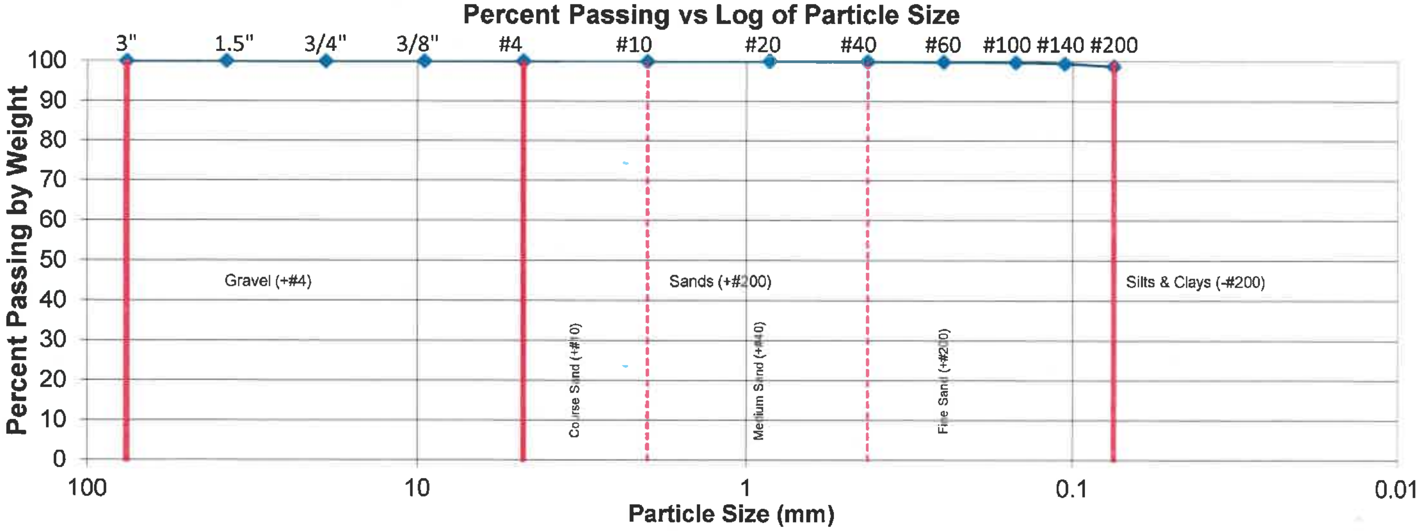
Mass Wet Pan and Soil (g): 546.03
Mass Dry Pan and Soil (g): 506.58
Mass of Pan (g): 163.99
Moisture (%): **11.5**

Sample Data

Total Wet Mass of Sample (g): 382.0
Total Dry Mass of Sample (g): 342.6

Sieve Number	Sieve Size (mm)	Mass of Pan and Soil (g)	Mass of Pan (g)	Mass of Individual Retained Soil (g)	Correction Factor	Percent Passing by Weight (%)
3"	76.2	--	--	--	--	**--**
1.5"	38.1	--	--	--	--	**--**
3/4"	19.05	--	--	--	--	**--**
3/8"	9.53	--	--	--	--	**--**
#4	4.75	--	--	--	--	**--**
#10	2.00	0.0	0.0	--	--	**100.0**
#20	0.850	0.17	0.0	0.17	1.00	**100.0**
#40	0.425	0.26	0.0	0.26	1.00	**99.9**
#60	0.250	0.19	0.0	0.19	1.00	**99.8**
#100	0.150	0.45	0.0	0.45	1.00	**99.7**
#140	0.106	0.87	0.0	0.87	1.00	**99.4**
#200	0.075	2.54	0.0	2.54	1.00	**98.7**

Percent Passing vs Log of Particle Size



USCS Classification ASTM D 2487

Atterberg Classification: CL
Group Symbol: CL
USCS Classification: Lean Clay

Coefficient of Curvature - C_c: --
Coefficient of Uniformity - C_u: --

Data entry by:	CAL	Date:	10/7/2019
Checked by:	SPH	Date:	10-7-19
File name:	3020012__Grain Size Analysis ASTM D6913_6.xlsm		

ADVANCED TERRA TESTING

Grain Size Analysis
ASTM D 6913

CLIENT	Wiss Janney Elstner	BORING NO.	B-2
JOB NO.	3020-012	DEPTH	7'
PROJECT	Persigo WWTP	SAMPLE NO.	--
PROJECT NO.	--	DATE SAMPLED	--
LOCATION	Grand Junction CO	DESCRIPTION	--
DATE TESTED	10/01/19		
TECHNICIAN	BNF		

Hygroscopic Moisture

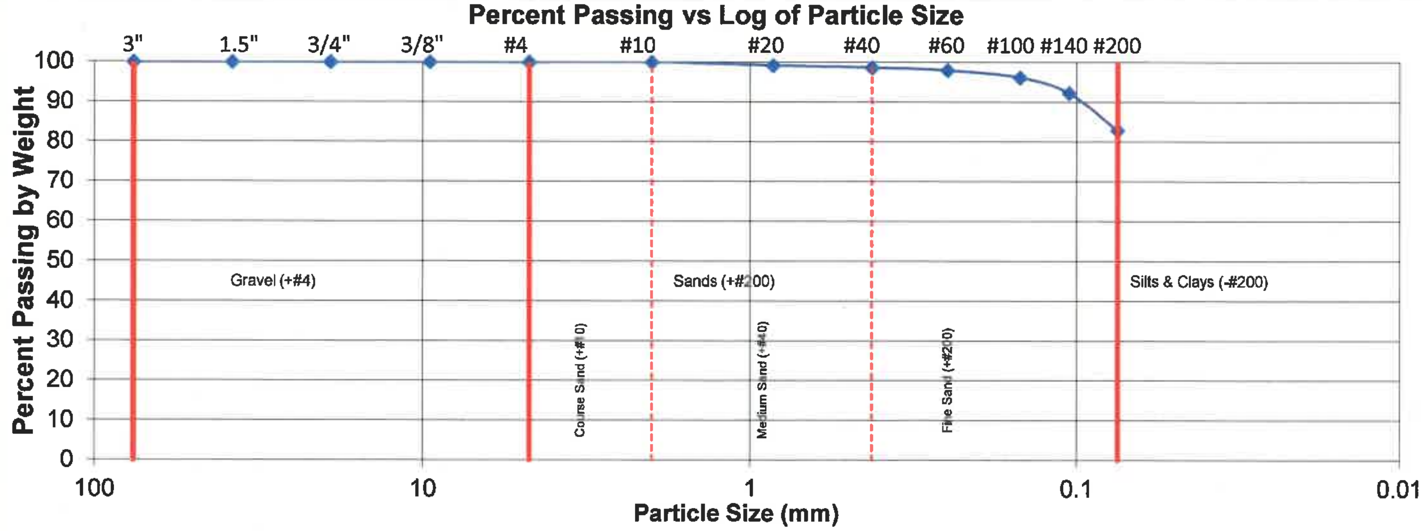
Mass Wet Pan and Soil (g): 95.52
Mass Dry Pan and Soil (g): 74.41
Mass of Pan (g): 3.12
Moisture (%): **29.6**

Sample Data

Total Wet Mass of Sample (g): 92.4
Total Dry Mass of Sample (g): 71.3

Sieve Number	Sieve Size (mm)	Mass of Pan and Soil (g)	Mass of Pan (g)	Mass of Individual Retained Soil (g)	Correction Factor	Percent Passing by Weight (%)
3"	76.2	0.0	--	--	--	--
1.5"	38.1	0.0	--	--	--	--
3/4"	19.05	0.0	--	--	--	--
3/8"	9.53	0.0	--	--	--	--
#4	4.75	0.0	--	--	--	--
#10	2.00	0.0	--	--	--	**100.0**
#20	0.850	0.54	--	0.54	1.00	**99.2**
#40	0.425	0.39	--	0.39	1.00	**98.7**
#60	0.250	0.50	--	0.50	1.00	**98.0**
#100	0.150	1.29	--	1.29	1.00	**96.2**
#140	0.106	2.76	--	2.76	1.00	**92.3**
#200	0.075	6.67	--	6.67	1.00	**83.0**

Percent Passing vs Log of Particle Size



USCS Classification ASTM D 2487

Atterberg Classification: --
Group Symbol: --
USCS Classification: --

Coefficient of Curvature - C_c: --
Coefficient of Uniformity - C_u: --

Data entry by:	KMS	Date:	10/2/2019
Checked by:	CH	Date:	10/3/2019
File name:	3020012__Grain Size Analysis ASTM D6913_2.xlsm		

Grain Size Analysis
ASTM D 6913

ADVANCED TERRA TESTING

CLIENT	Wiss Janney Elstner	BORING NO.	B-3
JOB NO.	3020-012	DEPTH	4'
PROJECT	Persigo WWTP	SAMPLE NO.	--
PROJECT NO.	--	DATE SAMPLED	--
LOCATION	Grand Junction CO	DESCRIPTION	--
DATE TESTED	10/01/19		
TECHNICIAN	ALH		

Hygroscopic Moisture

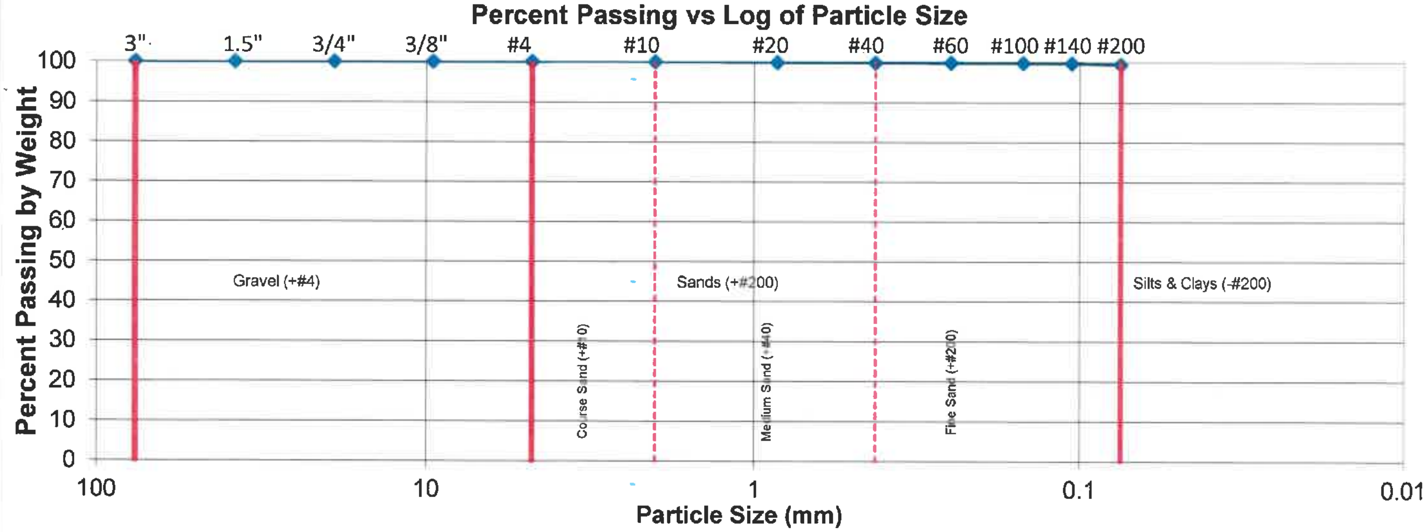
Mass Wet Pan and Soil (g): 365.24
Mass Dry Pan and Soil (g): 348.60
Mass of Pan (g): 264.74
Moisture (%): **19.8**

Sample Data

Total Wet Mass of Sample (g): 100.5
Total Dry Mass of Sample (g): 83.9

Sieve Number	Sieve Size (mm)	Mass of Pan and Soil (g)	Mass of Pan (g)	Mass of Individual Retained Soil (g)	Correction Factor	Percent Passing by Weight (%)
3"	76.2	--	--	--	--	**--**
1.5"	38.1	--	--	--	--	**--**
3/4"	19.05	--	--	--	--	**--**
3/8"	9.53	--	--	--	--	**--**
#4	4.75	--	--	--	--	**--**
#10	2.00	0.00	--	--	--	**100.0**
#20	0.850	0.13	--	0.13	1.00	**99.8**
#40	0.425	0.05	--	0.05	1.00	**99.8**
#60	0.250	0.03	--	0.03	1.00	**99.7**
#100	0.150	0.06	--	0.06	1.00	**99.7**
#140	0.106	0.05	--	0.05	1.00	**99.6**
#200	0.075	0.22	--	0.22	1.00	**99.4**

Percent Passing vs Log of Particle Size



USCS Classification ASTM D 2487

Atterberg Classification: CL
Group Symbol: CL
USCS Classification: Lean Clay

Coefficient of Curvature - C_c: --
Coefficient of Uniformity - C_u: --

Data entry by:	CAL	Date:	10/9/2019
Checked by:	KMS	Date:	10/9/19
File name:	3020012__Grain Size Analysis ASTM D6913_13.xlsm		

ADVANCED TERRA TESTING

Grain Size Analysis
ASTM D 6913

CLIENT	Wiss Janney Elstner	BORING NO.	B-3
JOB NO.	3020-012	DEPTH	9'
PROJECT	Persigo WWTP	SAMPLE NO.	--
PROJECT NO.	--	DATE SAMPLED	--
LOCATION	Grand Junction CO	DESCRIPTION	--
DATE TESTED	10/01/19		
TECHNICIAN	ALH		

Hygroscopic Moisture

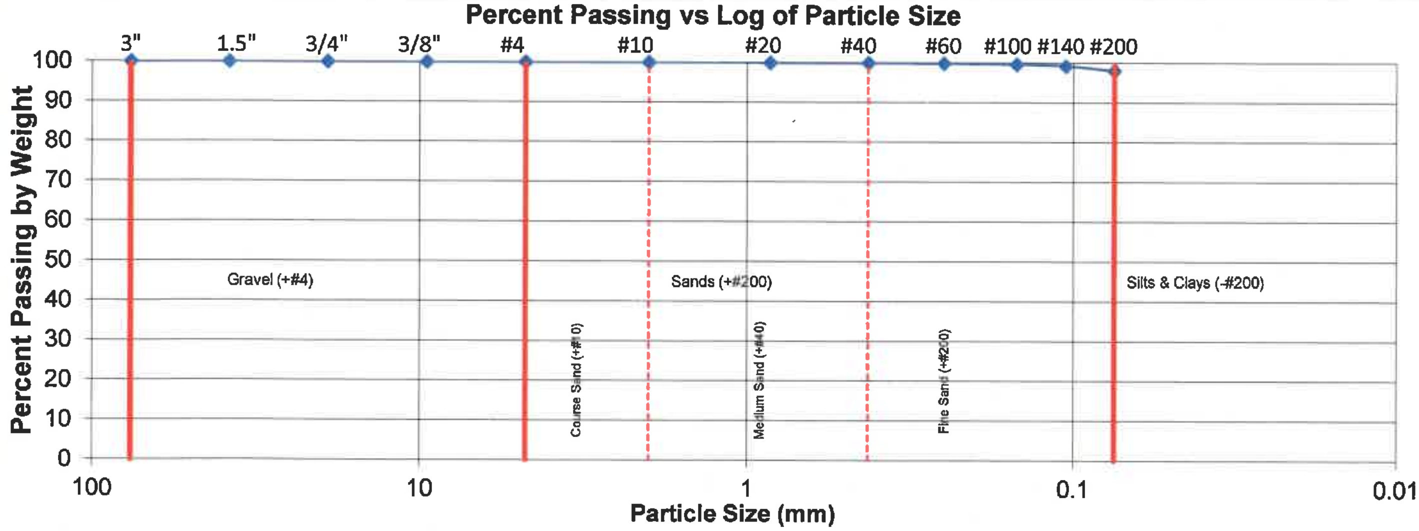
Mass Wet Pan and Soil (g): 245.35
Mass Dry Pan and Soil (g): 243.43
Mass of Pan (g): 139.91
Moisture (%): **1.9**

Sample Data

Total Wet Mass of Sample (g): 105.4
Total Dry Mass of Sample (g): 103.5

Sieve Number	Sieve Size (mm)	Mass of Pan and Soil (g)	Mass of Pan (g)	Mass of Individual Retained Soil (g)	Correction Factor	Percent Passing by Weight (%)
3"	76.2	--	--	--	--	--
1.5"	38.1	--	--	--	--	--
3/4"	19.05	--	--	--	--	--
3/8"	9.53	--	--	--	--	--
#4	4.75	--	--	--	--	--
#10	2.00	0.0	0.0	--	--	--
#20	0.850	0.04	0.0	0.04	1.00	**100.0**
#40	0.425	0.04	0.0	0.04	1.00	**99.9**
#60	0.250	0.09	0.0	0.09	1.00	**99.8**
#100	0.150	0.18	0.0	0.18	1.00	**99.7**
#140	0.106	0.43	0.0	0.43	1.00	**99.2**
#200	0.075	1.21	0.0	1.21	1.00	**98.1**

Percent Passing vs Log of Particle Size



USCS Classification ASTM D 2487

Atterberg Classification: CL
Group Symbol: CL
USCS Classification: Lean Clay

Coefficient of Curvature - C_c: --
Coefficient of Uniformity - C_u: --

Data entry by:	CAL	Date:	10/7/2019
Checked by:	KMS	Date:	10/7/19
File name:	3020012__Grain Size Analysis ASTM D6913_7.xlsm		

ADVANCED TERRA TESTING

Grain Size Analysis
ASTM D 6913

CLIENT	Wiss Janney Elstner	BORING NO.	B-4
JOB NO.	3020-012	DEPTH	4'
PROJECT	Persigo WWTP	SAMPLE NO.	--
PROJECT NO.	--	DATE SAMPLED	--
LOCATION	Grand Junction CO	DESCRIPTION	--
DATE TESTED	10/01/19		
TECHNICIAN	ALH		

Hygroscopic Moisture

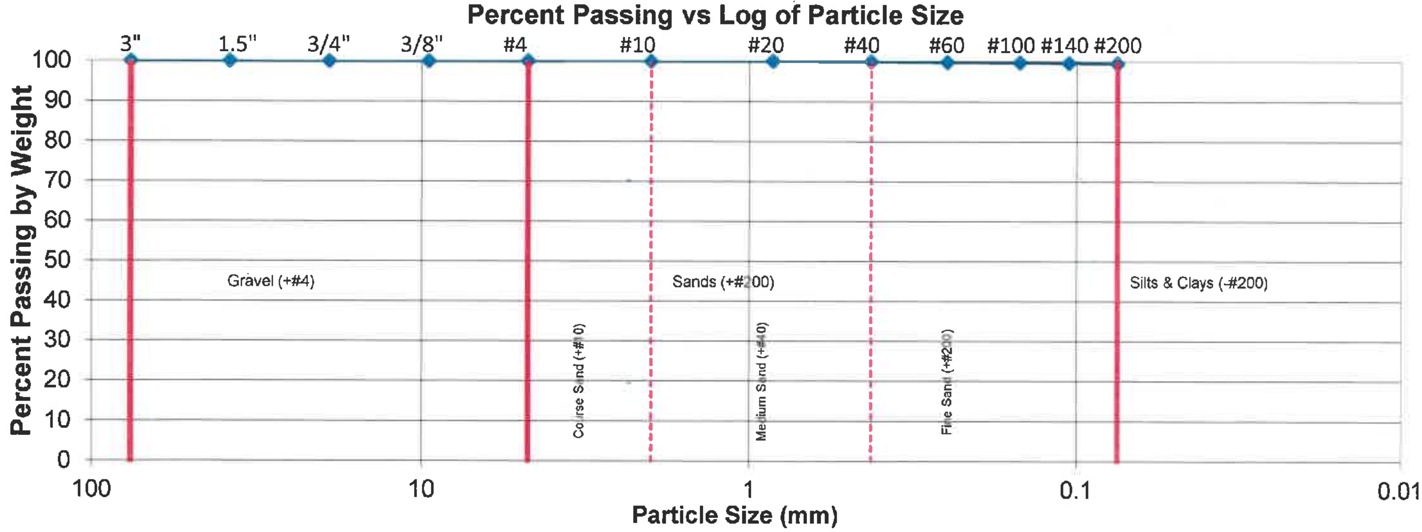
Mass Wet Pan and Soil (g): 97.49
Mass Dry Pan and Soil (g): 81.60
Mass of Pan (g): 3.09
Moisture (%): **20.2**

Sample Data

Total Wet Mass of Sample (g): 94.4
Total Dry Mass of Sample (g): 78.5

Sieve Number	Sieve Size (mm)	Mass of Pan and Soil (g)	Mass of Pan (g)	Mass of Individual Retained Soil (g)	Correction Factor	Percent Passing by Weight (%)
3"	76.2	--	--	--	--	--
1.5"	38.1	--	--	--	--	--
3/4"	19.05	--	--	--	--	--
3/8"	9.53	--	--	--	--	--
#4	4.75	--	--	--	--	--
#10	2.00	0.0	0.0	0.0	1.00	**100.0**
#20	0.850	0.04	0.0	0.0	1.00	**99.9**
#40	0.425	0.06	0.0	0.06	1.00	**99.9**
#60	0.250	0.10	0.0	0.10	1.00	**99.7**
#100	0.150	0.08	0.0	0.08	1.00	**99.6**
#140	0.106	0.05	0.0	0.05	1.00	**99.6**
#200	0.075	0.10	0.0	0.10	1.00	**99.5**

Percent Passing vs Log of Particle Size



USCS Classification ASTM D 2487

Atterberg Classification: CL
Group Symbol: CL
USCS Classification: Lean Clay

Coefficient of Curvature - C_c: --
Coefficient of Uniformity - C_u: --

Data entry by:	CAL	Date:	10/7/2019
Checked by:	SPH	Date:	10-7-19
File name:	3020012__Grain Size Analysis ASTM D6913_8.xlsm		

ADVANCED TERRA TESTING

Grain Size Analysis
ASTM D 6913

CLIENT	Wiss Janney Elstner	BORING NO.	B-4
JOB NO.	3020-012	DEPTH	9'
PROJECT	Persigo WWTP	SAMPLE NO.	--
PROJECT NO.	--	DATE SAMPLED	--
LOCATION	Grand Junction CO	DESCRIPTION	--
DATE TESTED	10/01/19		
TECHNICIAN	BNF		

Hygroscopic Moisture

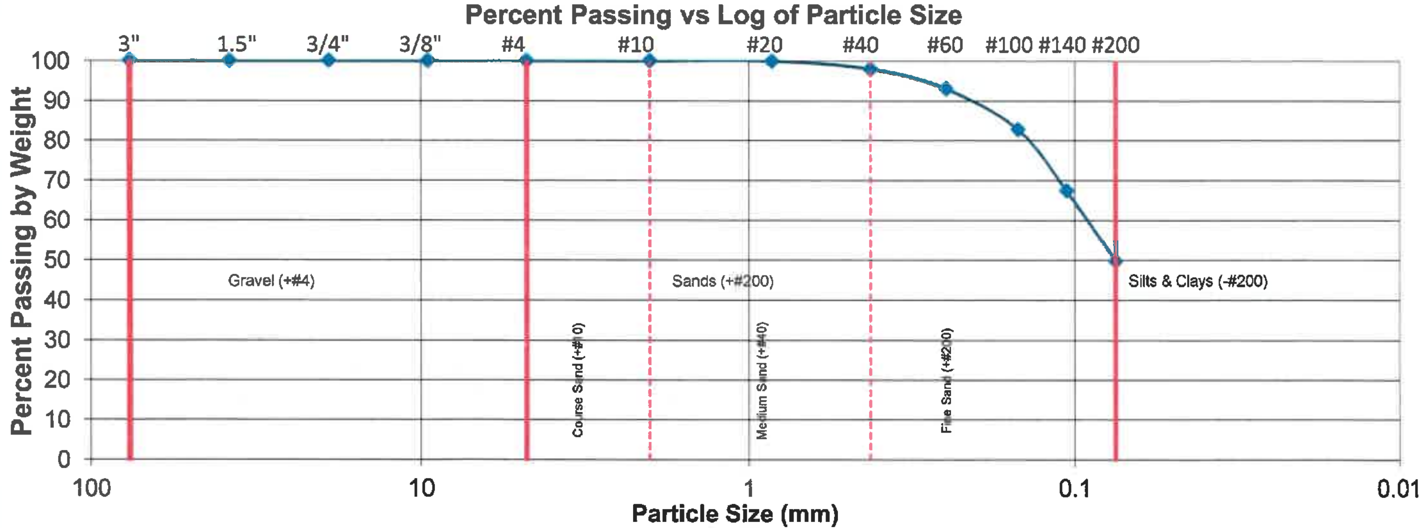
Mass Wet Pan and Soil (g): 100.02
Mass Dry Pan and Soil (g): 82.65
Mass of Pan (g): 3.10
Moisture (%): **21.8**

Sample Data

Total Wet Mass of Sample (g): 96.9
Total Dry Mass of Sample (g): 79.6

Sieve Number	Sieve Size (mm)	Mass of Pan and Soil (g)	Mass of Pan (g)	Mass of Individual Retained Soil (g)	Correction Factor	Percent Passing by Weight (%)
3"	76.2	0.0	--	--	--	--
1.5"	38.1	0.0	--	--	--	--
3/4"	19.05	0.0	--	--	--	--
3/8"	9.53	0.0	--	--	--	--
#4	4.75	0.0	--	--	--	--
#10	2.00	0.0	--	0.0	1.00	**100.0**
#20	0.850	0.0	--	0.0	1.00	**99.9**
#40	0.425	1.6	--	1.6	1.00	**97.9**
#60	0.250	3.9	--	3.9	1.00	**93.0**
#100	0.150	8.1	--	8.1	1.00	**82.8**
#140	0.106	12.3	--	12.3	1.00	**67.3**
#200	0.075	14.1	--	14.1	1.00	**49.6**

Percent Passing vs Log of Particle Size



USCS Classification ASTM D 2487

Atterberg Classification: --
Group Symbol: --
USCS Classification: --

Coefficient of Curvature - C_c: --
Coefficient of Uniformity - C_u: --

Data entry by:	KMS	Date:	10/2/2019
Checked by:	CML	Date:	10/3/2019
File name:	3020012__Grain Size Analysis ASTM D6913_1.xlsm		

Grain Size Analysis
ASTM D 6913

ADVANCED TERRA TESTING

CLIENT	Wiss Janney Elstner	BORING NO.	B-5
JOB NO.	3020-012	DEPTH	0'
PROJECT	Persigo WWTP	SAMPLE NO.	--
PROJECT NO.	--	DATE SAMPLED	--
LOCATION	Grand Junction CO	DESCRIPTION	--
DATE TESTED	10/03/19		
TECHNICIAN	ASE		

Hygroscopic Moisture

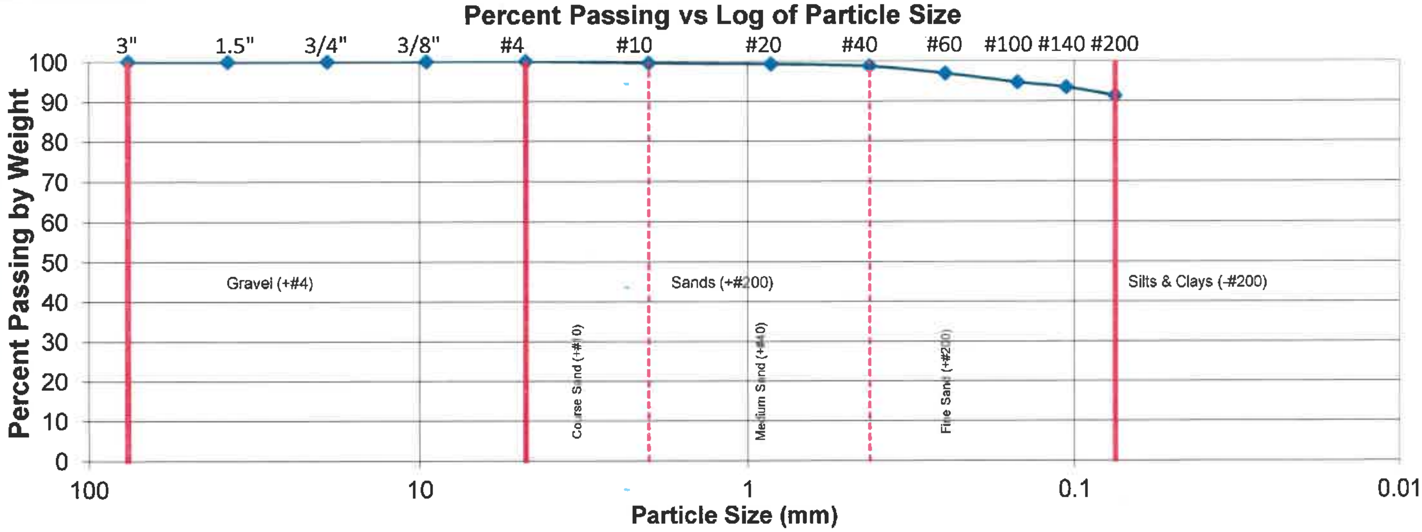
Mass Wet Pan and Soil (g): 516.09
Mass Dry Pan and Soil (g): 465.41
Mass of Pan (g): 123.24
Moisture (%): **14.8**

Sample Data

Total Wet Mass of Sample (g): 392.9
Total Dry Mass of Sample (g): 342.2

Sieve Number	Sieve Size (mm)	Mass of Pan and Soil (g)	Mass of Pan (g)	Mass of Individual Retained Soil (g)	Correction Factor	Percent Passing by Weight (%)
3"	76.2	--	--	--	--	--
1.5"	38.1	--	--	--	--	--
3/4"	19.05	--	--	--	--	--
3/8"	9.53	--	--	--	--	--
#4	4.75	0.0	--	--	--	**100.0**
#10	2.00	1.4	--	1.4	1.00	**99.6**
#20	0.850	1.1	--	1.1	1.00	**99.3**
#40	0.425	2.1	--	2.1	1.00	**98.7**
#60	0.250	6.2	--	6.2	1.00	**96.9**
#100	0.150	7.7	--	7.7	1.00	**94.6**
#140	0.106	4.3	--	4.3	1.00	**93.4**
#200	0.075	7.1	--	7.1	1.00	**91.3**

Percent Passing vs Log of Particle Size



USCS Classification ASTM D 2487

Atterberg Classification: CL
Group Symbol: CL
USCS Classification: Lean Clay

Coefficient of Curvature - C_c: --
Coefficient of Uniformity - C_u: --

Data entry by:	CAL	Date:	10/10/2019
Checked by:	KMS	Date:	10/10/19
File name:	3020012__Grain Size Analysis ASTM D6913_15.xlsm		

Grain Size Analysis
ASTM D 6913

ADVANCED TERRA TESTING

CLIENT	Wiss Janney Elstner	BORING NO.	B-5
JOB NO.	3020-012	DEPTH	6'
PROJECT	Persigo WWTP	SAMPLE NO.	--
PROJECT NO.	--	DATE SAMPLED	--
LOCATION	Grand Junction CO	DESCRIPTION	--
DATE TESTED	10/03/19		
TECHNICIAN	ASE		

Hygroscopic Moisture

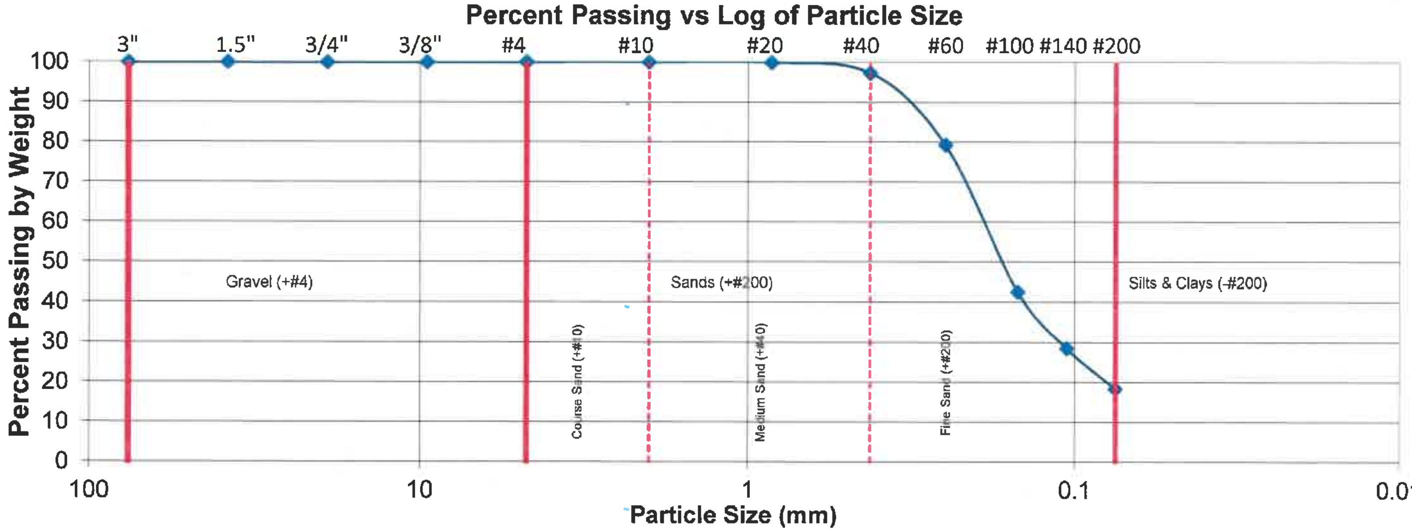
Mass Wet Pan and Soil (g): 223.75
Mass Dry Pan and Soil (g): 210.64
Mass of Pan (g): 139.49
Moisture (%): **18.4**

Sample Data

Total Wet Mass of Sample (g): 84.3
Total Dry Mass of Sample (g): 71.2

Sieve Number	Sieve Size (mm)	Mass of Pan and Soil (g)	Mass of Pan (g)	Mass of Individual Retained Soil (g)	Correction Factor	Percent Passing by Weight (%)
3"	76.2	0.0	--	--	--	--
1.5"	38.1	0.0	--	--	--	--
3/4"	19.05	0.0	--	--	--	--
3/8"	9.53	0.0	--	--	--	--
#4	4.75	0.0	--	--	--	--
#10	2.00	0.0	--	--	--	**100.0**
#20	0.850	0.0	--	0.0	1.00	**99.9**
#40	0.425	1.9	--	1.9	1.00	**97.3**
#60	0.250	12.9	--	12.9	1.00	**79.2**
#100	0.150	26.2	--	26.2	1.00	**42.4**
#140	0.106	9.9	--	9.9	1.00	**28.4**
#200	0.075	7.2	--	7.2	1.00	**18.4**

Percent Passing vs Log of Particle Size



USCS Classification ASTM D 2487

Atterberg Classification: --
Group Symbol: --
USCS Classification: --

Coefficient of Curvature - C_c: --
Coefficient of Uniformity - C_u: --

Data entry by:	KMS	Date:	10/7/2019
Checked by:	cm	Date:	10/8/2019
File name:	3020012__Grain Size Analysis ASTM D6913_9.xlsm		

Grain Size Analysis
ASTM D 6913

ADVANCED TERRA TESTING

CLIENT	Wiss Janney Elstner	BORING NO.	B-6
JOB NO.	3020-012	DEPTH	4'
PROJECT	Persigo WWTP	SAMPLE NO.	--
PROJECT NO.	--	DATE SAMPLED	--
LOCATION	Grand Junction CO	DESCRIPTION	--
DATE TESTED	10/03/19		
TECHNICIAN	ASE		

Hygroscopic Moisture

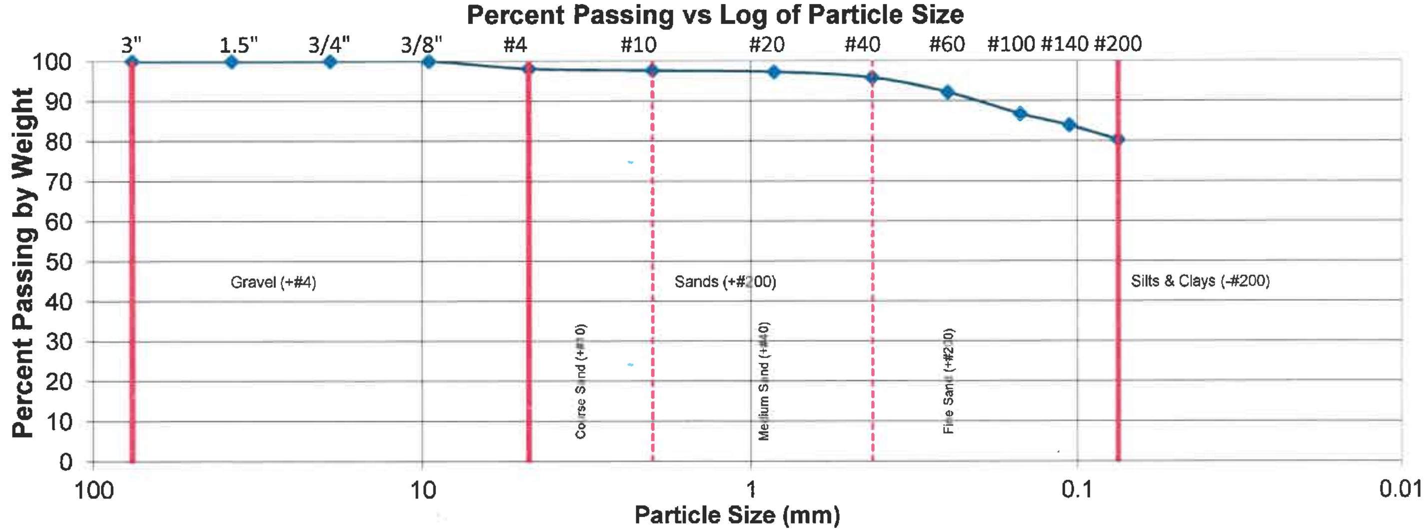
Mass Wet Pan and Soil (g): 273.35
Mass Dry Pan and Soil (g): 259.36
Mass of Pan (g): 172.36
Moisture (%): **16.1**

Sample Data

Total Wet Mass of Sample (g): 101.0
Total Dry Mass of Sample (g): 87.0

Sieve Number	Sieve Size (mm)	Mass of Pan and Soil (g)	Mass of Pan (g)	Mass of Individual Retained Soil (g)	Correction Factor	Percent Passing by Weight (%)
3"	76.2	--	--	--	--	--
1.5"	38.1	--	--	--	--	--
3/4"	19.05	--	--	--	--	--
3/8"	9.53	0.0	--	--	--	**100.0**
#4	4.75	1.7	--	1.7	1.00	**98.1**
#10	2.00	0.38	--	0.4	1.00	**97.6**
#20	0.850	0.31	--	0.3	1.00	**97.3**
#40	0.425	1.3	--	1.3	1.00	**95.8**
#60	0.250	3.2	--	3.2	1.00	**92.1**
#100	0.150	4.7	--	4.7	1.00	**86.7**
#140	0.106	2.5	--	2.5	1.00	**83.9**
#200	0.075	3.1	--	3.1	1.00	**80.3**

Percent Passing vs Log of Particle Size



USCS Classification ASTM D 2487

Atterberg Classification: CL
Group Symbol: CL
USCS Classification: Lean Clay With Sand

Coefficient of Curvature - C_c: --
Coefficient of Uniformity - C_u: --

Data entry by:	CAL	Date:	10/10/2019
Checked by:	KMS	Date:	10/10/19
File name:	3020012__Grain Size Analysis ASTM D6913_14.xlsm		

Grain Size Analysis
ASTM D 6913

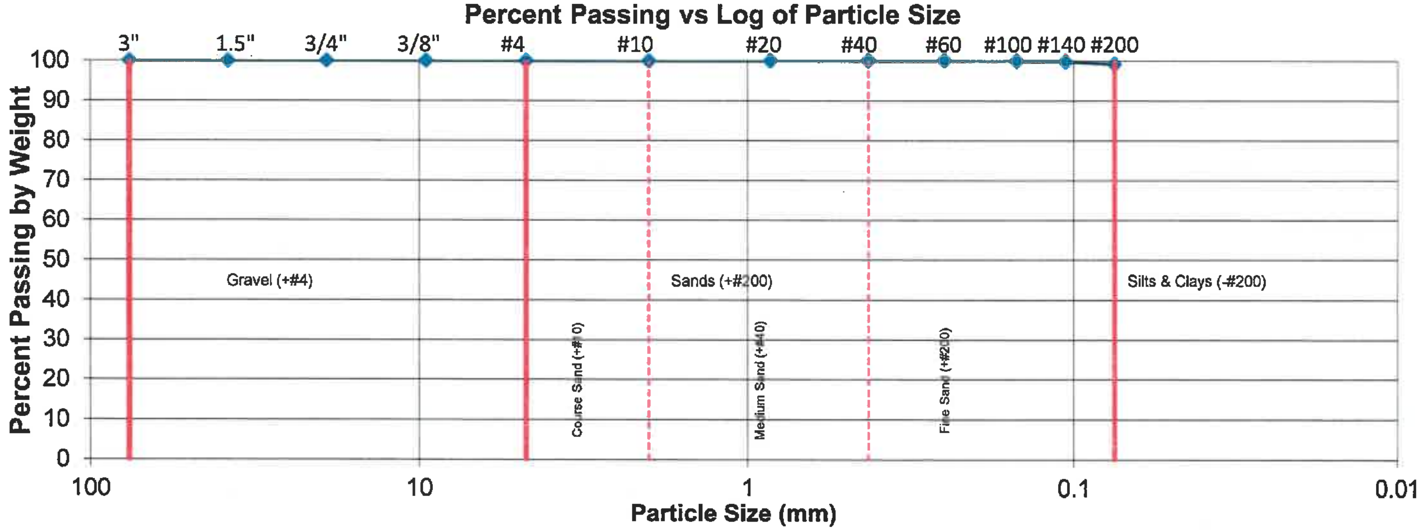
ADVANCED TERRA TESTING

CLIENT	Wiss Janney Elstner	BORING NO.	B-6
JOB NO.	3020-012	DEPTH	9'
PROJECT	Persigo WWTP	SAMPLE NO.	--
PROJECT NO.	--	DATE SAMPLED	--
LOCATION	Grand Junction CO	DESCRIPTION	--
DATE TESTED	10/01/19		
TECHNICIAN	WAR		

Hygroscopic Moisture of Fines		Sample Data	
Mass Wet Pan and Soil (g):	248.91	Total Wet Mass of Sample (g):	259.6
Mass Dry Pan and Soil (g):	246.66	Total Dry Mass of Sample (g):	255.0
Mass of Pan (g):	123.51	Split Fraction:	#4
Moisture (%):	**1.8**	Mass of Sub-Sample Fraction (g):	125.40

Sieve Number	Sieve Size (mm)	Mass of Pan and Soil (g)	Mass of Pan (g)	Mass of Individual Retained Soil (g)	Correction Factor	Percent Passing by Weight (%)
3"	76.2	0.0	--	--	--	--
1.5"	38.1	0.0	--	--	--	--
3/4"	19.05	0.0	--	--	--	--
3/8"	9.53	0.0	--	--	--	--
#4	4.75	0.0	--	--	--	--
#10	2.00	0.0	--	--	--	--
#20	0.850	0.0	--	--	--	--
#40	0.425	0.0	--	--	--	--
#60	0.250	0.0	--	0.0	1.00	**100.0**
#100	0.150	0.1	--	0.1	1.00	**99.9**
#140	0.106	0.2	--	0.2	1.00	**99.7**
#200	0.075	0.8	--	0.8	1.00	**99.1**

Percent Passing vs Log of Particle Size



USCS Classification ASTM D 2487

Atterberg Classification:	CL	Coefficient of Curvature - C_c:	--
Group Symbol:	CL	Coefficient of Uniformity - C_u:	--
USCS Classification:	Lean Clay		

Data entry by:	KMS	Date:	10/4/2019
Checked by:	SPH	Date:	10-7-19
File name:	3020012__Grain Size Analysis ASTM D6913_5.xlsm		

Grain Size Analysis
ASTM D 6913

ADVANCED TERRA TESTING

CLIENT	Wiss Janney Elstner	BORING NO.	B-6
JOB NO.	3020-012	DEPTH	14'
PROJECT	Persigo WWTP	SAMPLE NO.	--
PROJECT NO.	--	DATE SAMPLED	--
LOCATION	Grand Junction CO	DESCRIPTION	--
DATE TESTED	10/04/19		
TECHNICIAN	TAF		

Hygroscopic Moisture

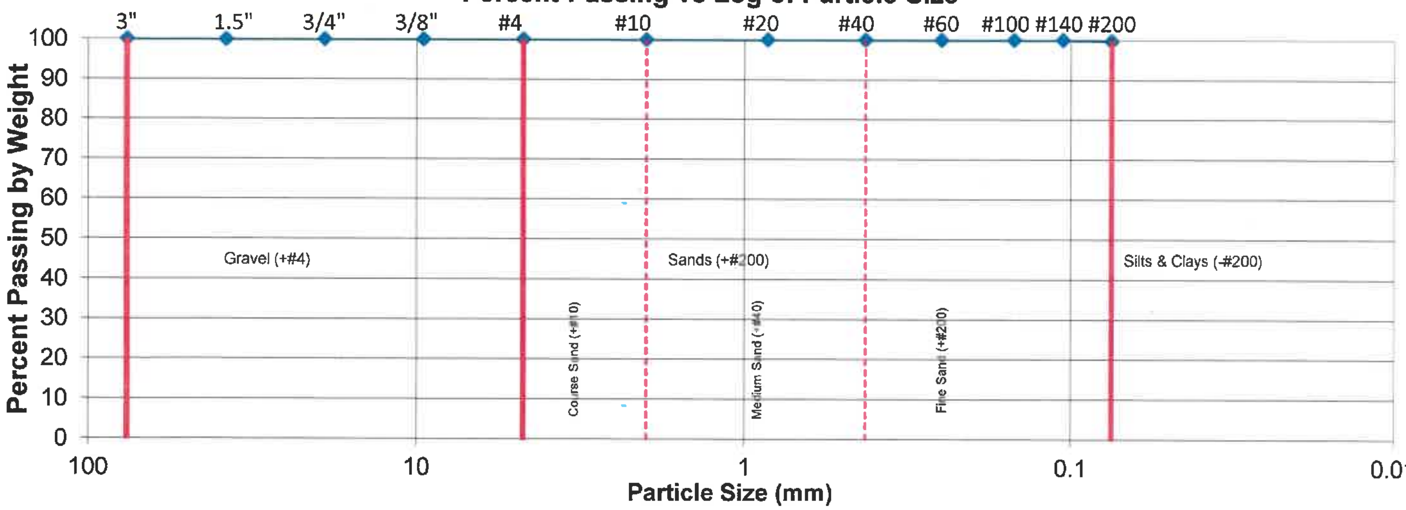
Mass Wet Pan and Soil (g): 267.95
Mass Dry Pan and Soil (g): 246.58
Mass of Pan (g): 172.73
Moisture (%): **28.9**

Sample Data

Total Wet Mass of Sample (g): 95.2
Total Dry Mass of Sample (g): 73.9

Sieve Number	Sieve Size (mm)	Mass of Pan and Soil (g)	Mass of Pan (g)	Mass of Individual Retained Soil (g)	Correction Factor	Percent Passing by Weight (%)
3"	76.2	--	--	--	--	--
1.5"	38.1	--	--	--	--	--
3/4"	19.05	--	--	--	--	--
3/8"	9.53	--	--	--	--	--
#4	4.75	--	--	--	--	--
#10	2.00	--	--	--	--	--
#20	0.850	--	--	--	--	--
#40	0.425	0.0	--	--	--	--
#60	0.250	0.0	--	0.0	1.00	**100.0**
#100	0.150	0.01	--	0.01	1.00	**100.0**
#140	0.106	0.01	--	0.01	1.00	**100.0**
#200	0.075	0.2	--	0.2	1.00	**99.7**

Percent Passing vs Log of Particle Size



USCS Classification ASTM D 2487

Atterberg Classification: CL
Group Symbol: CL
USCS Classification: Lean Clay

Coefficient of Curvature - C_c: --
Coefficient of Uniformity - C_u: --

Data entry by:	CAL	Date:	10/9/2019
Checked by:	KMS	Date:	10/9/19
File name:	3020012__Grain Size Analysis ASTM D6913_11.xlsm		

Grain Size Analysis
ASTM D 6913

ADVANCED TERRA TESTING

CLIENT	Wiss Janney Elstner	BORING NO.	B-6
JOB NO.	3020-012	DEPTH	19'
PROJECT	Persigo WWTP	SAMPLE NO.	--
PROJECT NO.	--	DATE SAMPLED	--
LOCATION	Grand Junction CO	DESCRIPTION	--
DATE TESTED	10/01/19		
TECHNICIAN	BNF		

Hygroscopic Moisture

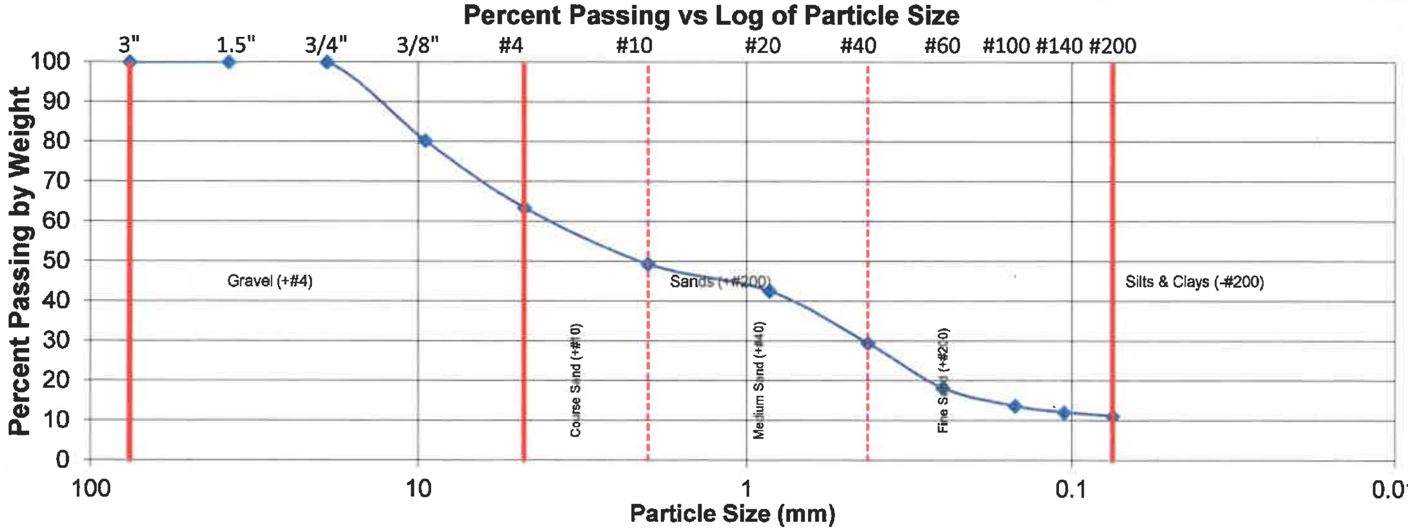
Mass Wet Pan and Soil (g): 107.32
Mass Dry Pan and Soil (g): 99.41
Mass of Pan (g): 3.09
Moisture (%): **8.2**

Sample Data

Total Wet Mass of Sample (g): 104.2
Total Dry Mass of Sample (g): 96.3

Sieve Number	Sieve Size (mm)	Mass of Pan and Soil (g)	Mass of Pan (g)	Mass of Individual Retained Soil (g)	Correction Factor	Percent Passing by Weight (%)
3"	76.2	0.0	--	--	--	**--**
1.5"	38.1	0.0	--	--	--	**--**
3/4"	19.05	0.0	--	0.0	--	**100.0**
3/8"	9.53	19.0	--	19.0	1.00	**80.3**
#4	4.75	16.2	--	16.2	1.00	**63.5**
#10	2.00	13.6	--	13.6	1.00	**49.4**
#20	0.850	6.5	--	6.5	1.00	**42.6**
#40	0.425	12.6	--	12.6	1.00	**29.5**
#60	0.250	10.8	--	10.8	1.00	**18.3**
#100	0.150	4.4	--	4.4	1.00	**13.7**
#140	0.106	1.5	--	1.5	1.00	**12.2**
#200	0.075	0.9	--	0.9	1.00	**11.2**

Percent Passing vs Log of Particle Size



USCS Classification ASTM D 2487

Atterberg Classification: --
Group Symbol: --
USCS Classification: --

Coefficient of Curvature - C_c: 1.30
Coefficient of Uniformity - C_u: 110.74

Data entry by:	KMS	Date:	10/2/2019
Checked by:	CM	Date:	10/3/19
File name:	3020012__Grain Size Analysis ASTM D6913_0.xlsm		

Grain Size Analysis
ASTM D 6913

ADVANCED TERRA TESTING

CLIENT	Wiss Janney Elstner	BORING NO.	B-7
JOB NO.	3020-012	DEPTH	4'
PROJECT	Persigo WWTP	SAMPLE NO.	--
PROJECT NO.	--	DATE SAMPLED	--
LOCATION	Grand Junction CO	DESCRIPTION	--
DATE TESTED	10/01/19		
TECHNICIAN	ALH		

Hygroscopic Moisture

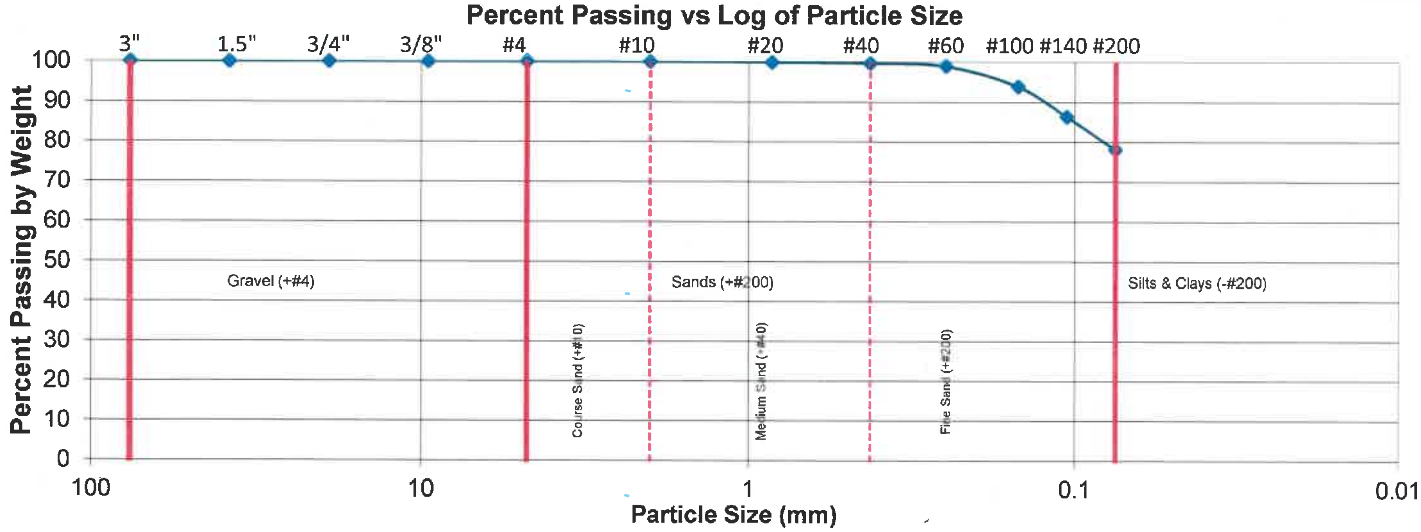
Mass Wet Pan and Soil (g): 272.67
Mass Dry Pan and Soil (g): 259.27
Mass of Pan (g): 171.78
Moisture (%): **15.3**

Sample Data

Total Wet Mass of Sample (g): 100.9
Total Dry Mass of Sample (g): 87.5

Sieve Number	Sieve Size (mm)	Mass of Pan and Soil (g)	Mass of Pan (g)	Mass of Individual Retained Soil (g)	Correction Factor	Percent Passing by Weight (%)
3"	76.2	--	--	--	--	**--**
1.5"	38.1	--	--	--	--	**--**
3/4"	19.05	--	--	--	--	**--**
3/8"	9.53	--	--	--	--	**--**
#4	4.75	--	--	--	--	**--**
#10	2.00	0.0	--	--	--	**100.0**
#20	0.850	0.13	--	0.13	1.00	**99.9**
#40	0.425	0.23	--	0.23	1.00	**99.6**
#60	0.250	0.66	--	0.66	1.00	**98.8**
#100	0.150	4.5	--	4.5	1.00	**93.7**
#140	0.106	6.6	--	6.6	1.00	**86.2**
#200	0.075	7.2	--	7.2	1.00	**78.0**

Percent Passing vs Log of Particle Size



USCS Classification ASTM D 2487

Atterberg Classification: CL
Group Symbol: CL
USCS Classification: Lean Clay With Sand

Coefficient of Curvature - C_c: --
Coefficient of Uniformity - C_u: --

Data entry by:	CAL	Date:	10/9/2019
Checked by:	KMB	Date:	10/9/19
File name:	3020012__Grain Size Analysis ASTM D6913_10.xlsm		

One Dimensional Swell / Collapse

Denver Swell

CLIENT	Wiss Janney Elstner	BORING NO.	B-3
JOB NO.	3020-012	DEPTH	9'
PROJECT	Persigo WWTP	SAMPLE NO.	--
PROJECT NO.	--	DATE SAMPLED	--
LOCATION	Grand Junction CO	SAMPLED BY	--
DATE TESTED	09/20/19	DESCRIPTION	--
TECHNICIAN	ALH		

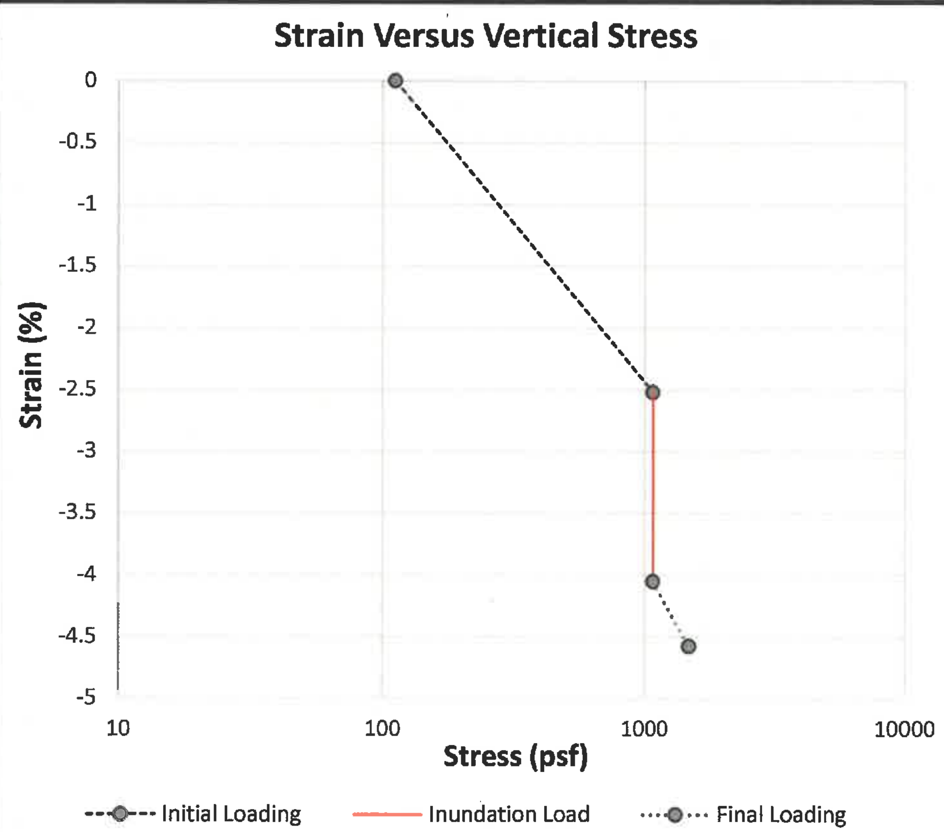
Sample Conditions

Before Test Mass of Wet Soil and Ring (g):	325.87	Initial Wet Density (pcf):	120.8
After Test Mass of Wet Soil and Ring (g):	324.92	Initial Dry Density (pcf):	93.9
Mass of Dry Soil, Ring, and Pan (g):	466.41	Initial Wet Density (kg/m³):	1935
Diameter (in):	1.94	Initial Dry Density (kg/m³):	1503
Initial Height (in):	0.90	Initial Moisture (%):	28.7
Mass of Ring (g):	241.69	Final Wet Density (pcf):	125.6
Mass of Pan (g):	159.32	Final Dry Density (pcf):	98.7
Inundation Load (psf):	1079	Final Wet Density (kg/m³):	2012
Inundation Load (kPa):	52	Final Dry Density (kg/m³):	1581
Oedometer ID:	ATT-15	Final Moisture (%):	27.3

Swell / Collapse Data

Collapse (%):	-1.53	Swell Pressure (psf):	--
		Swell Pressure (kPa):	--

Load (psf)	Deformation (in)	Strain (%)
112	0.0000	0.00
1079	-0.0227	-2.52
Inudated	-0.0365	-4.06
1488	-0.0412	-4.58



Data entry by:	SPH	Date:	9/24/2019
Checked by:	CAL	Date:	9/25/19
File name:	3020012__Swell Colapse ASTM D4546_2.xls		

ADVANCED TERRA TESTING

One Dimensional Swell / Collapse

Denver Swell

CLIENT	Wiss Janney Elstner	BORING NO.	B-5
JOB NO.	3020-012	DEPTH	20'
PROJECT	Persigo WWTP	SAMPLE NO.	--
PROJECT NO.	--	DATE SAMPLED	--
LOCATION	Grand Junction CO	SAMPLED BY	--
DATE TESTED	09/20/19	DESCRIPTION	--
TECHNICIAN	ALH		

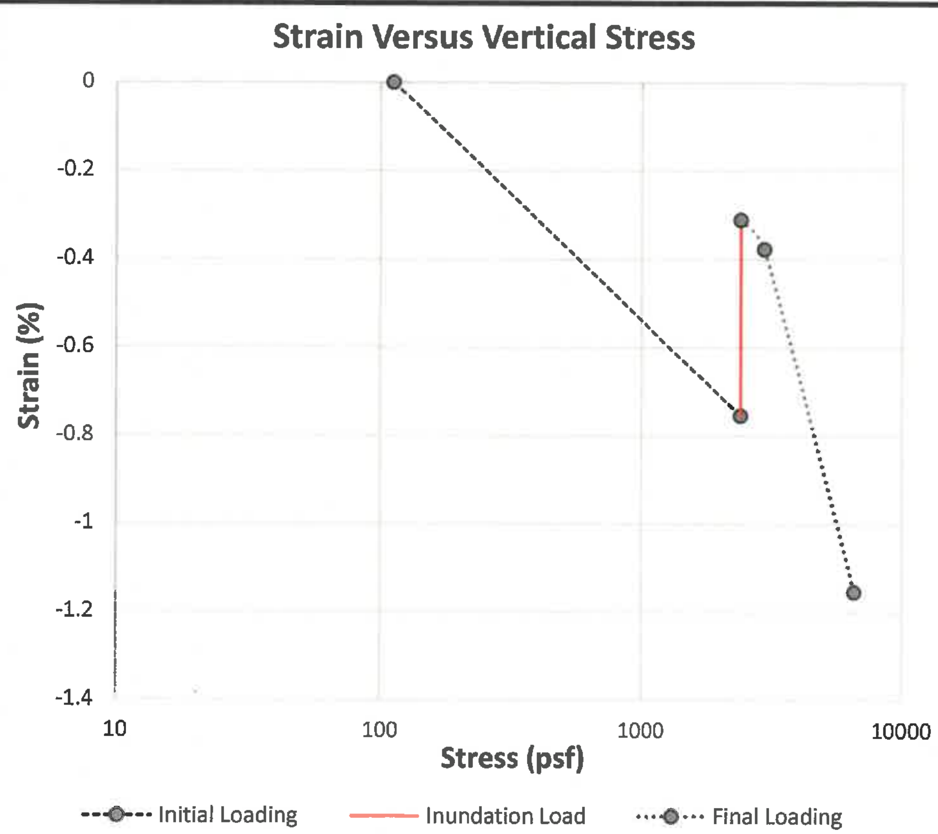
Sample Conditions

Before Test Mass of Wet Soil and Ring (g):	343.53	Initial Wet Density (pcf):	132.6
After Test Mass of Wet Soil and Ring (g):	346.92	Initial Dry Density (pcf):	121.5
Mass of Dry Soil, Ring, and Pan (g):	491.57	Initial Wet Density (kg/m³):	2124
Diameter (in):	1.94	Initial Dry Density (kg/m³):	1945
Initial Height (in):	0.90	Initial Moisture (%):	9.2
Mass of Ring (g):	251.12	Final Wet Density (pcf):	139.6
Mass of Pan (g):	155.81	Final Dry Density (pcf):	123.3
Inundation Load (psf):	2404	Final Wet Density (kg/m³):	2236
Inundation Load (kPa):	115	Final Dry Density (kg/m³):	1975
Oedometer ID:	ATT-16	Final Moisture (%):	13.2

Swell / Collapse Data

Swell (%):	0.44	Swell Pressure (psf):	4682
		Swell Pressure (kPa):	224

Load (psf)	Deformation (in)	Strain (%)
112	0.0000	0.00
2404	-0.0068	-0.76
Inudated	-0.0028	-0.31
2953	-0.0034	-0.38
6513	-0.0104	-1.16



Data entry by:	SPH	Date:	9/24/2019
Checked by:	CAL	Date:	9/25/2019
File name:	3020012__Swell Colapse ASTM D4546_1.xls		

One Dimensional Swell / Collapse

Denver Swell

CLIENT	Wiss Janney Elstner	BORING NO.	B-6
JOB NO.	3020-012	DEPTH	9'
PROJECT	Persigo WWTP	SAMPLE NO.	--
PROJECT NO.	--	DATE SAMPLED	--
LOCATION	Grand Junction CO	SAMPLED BY	--
DATE TESTED	09/20/19	DESCRIPTION	--
TECHNICIAN	ALH		

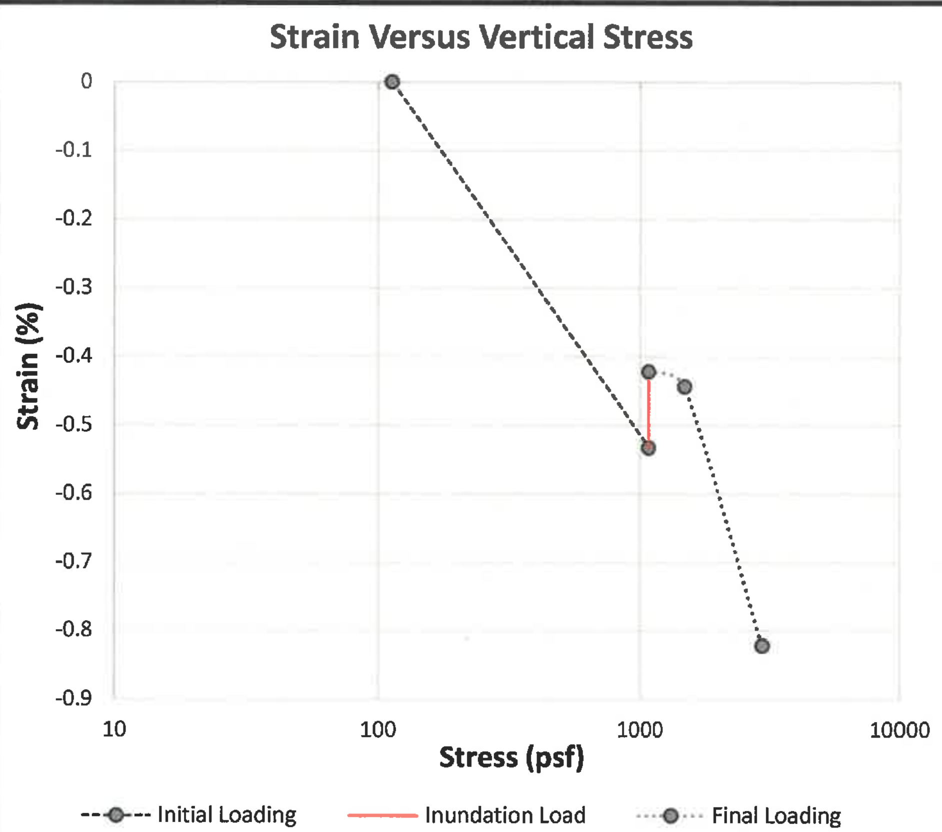
Sample Conditions

Before Test Mass of Wet Soil and Ring (g):	333.40	Initial Wet Density (pcf):	134.3
After Test Mass of Wet Soil and Ring (g):	334.05	Initial Dry Density (pcf):	115.2
Mass of Dry Soil, Ring, and Pan (g):	476.35	Initial Wet Density (kg/m³):	2151
Diameter (in):	1.94	Initial Dry Density (kg/m³):	1845
Initial Height (in):	0.90	Initial Moisture (%):	16.6
Mass of Ring (g):	239.80	Final Wet Density (pcf):	136.8
Mass of Pan (g):	156.28	Final Dry Density (pcf):	116.5
Inundation Load (psf):	1079	Final Wet Density (kg/m³):	2192
Inundation Load (kPa):	52	Final Dry Density (kg/m³):	1867
Oedometer ID:	ATT-17	Final Moisture (%):	17.4

Swell / Collapse Data

Swell (%):	0.11	Swell Pressure (psf):	1833
		Swell Pressure (kPa):	88

Load (psf)	Deformation (in)	Strain (%)
113	0.0000	0.00
1079	-0.0048	-0.53
Inudated	-0.0038	-0.42
1488	-0.0040	-0.44
2954	-0.0074	-0.82



Data entry by:	SPH	Date:	9/24/2019
Checked by:	CAL	Date:	9/25/2019
File name:	3020012__Swell Colapse ASTM D4546_0.xls		

Unconfined Compressive Strength

ASTM D 2166

ADVANCED TERRA TESTING

CLIENT	Wiss Janney Elstner	BORING NO.	B-3
JOB NO.	3020-012	DEPTH	9'
PROJECT	Persigo WWTP	SAMPLE NO.	--
PROJECT NO.	--	DATE SAMPLED	--
LOCATION	Grand Junction CO	DESCRIPTION	liner
DATE TESTED	09/23/19		
TECHNICIAN	CAL		

Test Parameters

Strain Rate (in/min):	0.039167455
Strain Rate (cm/min):	0.099485336

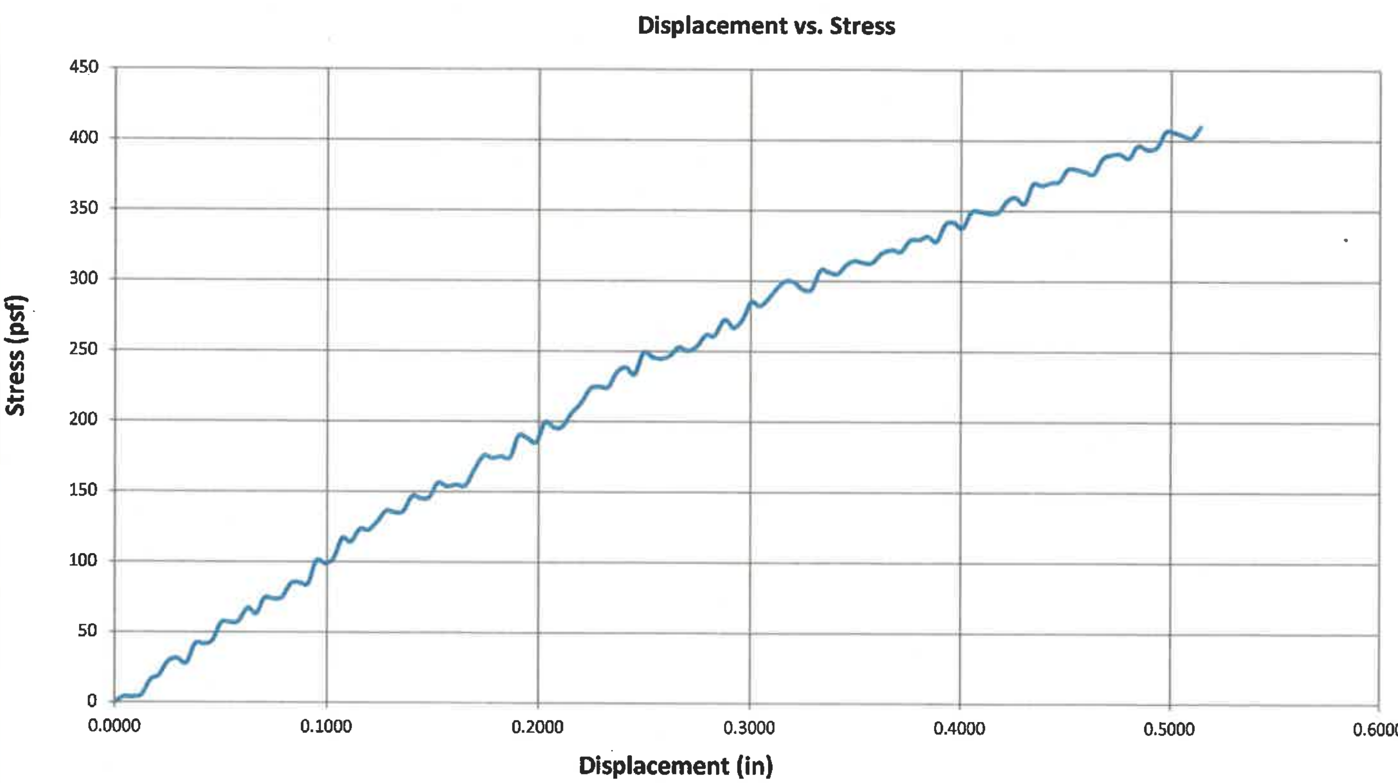
Raw Data Files: WJE_UCS_B-3_9__.txt

Moisture & Density Data

Mass of Wet Soil and Pan (g):	377.34	Initial Wet Density (pcf):	122.8
Mass of Dry Soil and Pan (g):	294.36	Initial Dry Density (pcf):	95.3
Mass of Pan (g):	6.94	Initial Wet Density (kg/m³):	1967
Mass of Wet Soil (g):	370.4	Initial Dry Density (kg/m³):	1526
Initial Diameter (in):	1.93	Initial Moisture (%):	28.9
Initial Height (in):	3.95		

Test Results

Peak Stress (psf):	410	Axial Strain at Peak Stress(%):	13.0
Peak Stress (kPa):	20	Height to Diameter Ratio:	2.0:1



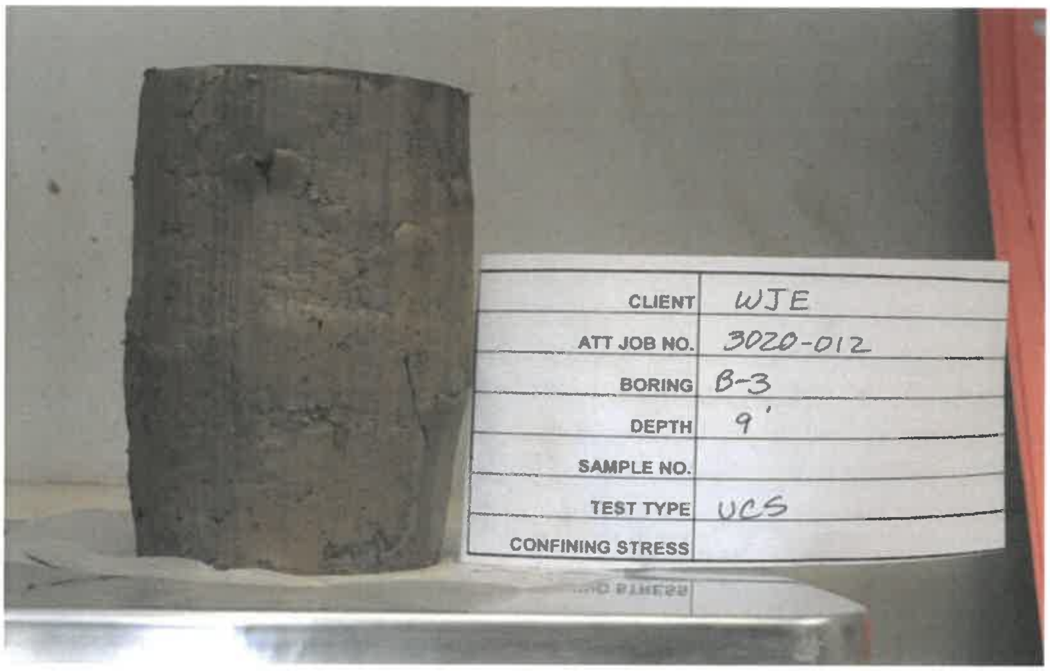
NOTES:

Data entry by:	CAL	Date:	9/24/2019
Checked by:	SPH	Date:	9-24-19
File name:	3020012__UCS ASTM D2166_0.xlsm		

ADVANCED TERRA TESTING

Image Attachment

CLIENT	Wiss Janney Elstner
JOB NO.	3020-012
PROJECT	Persigo WWTP
PROJECT NO.	--
LOCATION	Grand Junction CO



NOTES

File name: 3020012__Image_19_09_24_06_45_04

Unconfined Compressive Strength
ASTM D2166

CLIENT	Wiss Janney Elstner	BORING NO.	B-3
JOB NO.	3020-012	DEPTH	9'
PROJECT	Persigo WWTP	SAMPLE NO.	--
PROJECT NO.	--	DATE SAMPLED	--
LOCATION	Grand Junction CO	DESCRIPTION	liner
DATE TESTED	09/23/19		
TECHNICIAN	CAL		

Displacement (in)	Displacement (cm)	Strain (%)	Average Cross Sectional Area (in²)	Load (lbs)	Load (N)	Stress (psf)	Stress (kPa)
0.0000	0.000	0.00	2.91	0.0	0	0	0
0.0041	0.010	0.10	2.92	0.1	0.4	4.0	0.2
0.0085	0.022	0.22	2.92	0.1	0.4	3.9	0.2
0.0125	0.032	0.32	2.92	0.1	0.5	5.4	0.3
0.0166	0.042	0.42	2.93	0.3	1.4	16	0.8
0.0207	0.053	0.52	2.93	0.4	1.7	19	0.9
0.0248	0.063	0.63	2.93	0.6	2.6	29	1.4
0.0292	0.074	0.74	2.94	0.6	2.8	31	1.5
0.0335	0.085	0.85	2.94	0.6	2.5	28	1.3
0.0376	0.096	0.95	2.94	0.9	3.8	42	2.0
0.0418	0.106	1.06	2.94	0.9	3.8	42	2.0
0.0458	0.116	1.16	2.95	0.9	4.0	44	2.1
0.0498	0.126	1.26	2.95	1.2	5.2	57	2.7
0.0538	0.137	1.36	2.95	1.2	5.2	57	2.7
0.0579	0.147	1.47	2.96	1.2	5.2	57	2.8
0.0623	0.158	1.58	2.96	1.4	6.1	67	3.2
0.0663	0.168	1.68	2.96	1.3	5.8	63	3.0
0.0703	0.179	1.78	2.97	1.5	6.8	74	3.6
0.0744	0.189	1.89	2.97	1.5	6.8	74	3.5
0.0786	0.200	1.99	2.97	1.5	6.9	75	3.6
0.0829	0.211	2.10	2.98	1.8	7.8	85	4.1
0.0870	0.221	2.21	2.98	1.8	7.8	85	4.1
0.0910	0.231	2.31	2.98	1.8	7.8	85	4.0
0.0950	0.241	2.41	2.99	2.1	9.3	101	4.8
0.0991	0.252	2.51	2.99	2.1	9.1	99	4.7
0.1031	0.262	2.61	2.99	2.1	9.5	103	4.9
0.1073	0.273	2.72	2.99	2.4	11	117	5.6
0.1113	0.283	2.82	3.00	2.4	11	114	5.5
0.1155	0.293	2.93	3.00	2.6	11	123	5.9
0.1197	0.304	3.03	3.00	2.6	11	123	5.9
0.1238	0.314	3.14	3.01	2.7	12	129	6.2
0.1279	0.325	3.24	3.01	2.9	13	136	6.5
0.1319	0.335	3.34	3.01	2.8	13	135	6.5
0.1360	0.345	3.45	3.02	2.9	13	136	6.5
0.1402	0.356	3.55	3.02	3.1	14	147	7.0
0.1443	0.367	3.66	3.02	3.1	14	145	7.0
0.1484	0.377	3.76	3.03	3.1	14	146	7.0
0.1525	0.387	3.87	3.03	3.3	15	156	7.5
0.1568	0.398	3.97	3.03	3.2	14	154	7.4
0.1615	0.410	4.09	3.04	3.3	15	155	7.4
0.1655	0.420	4.20	3.04	3.3	15	154	7.4
0.1697	0.431	4.30	3.04	3.5	16	166	7.9
0.1742	0.442	4.42	3.05	3.7	17	176	8.4

Unconfined Compressive Strength
ASTM D2166

CLIENT	Wiss Janney Elstner	BORING NO.	B-3
JOB NO.	3020-012	DEPTH	9'
PROJECT	Persigo WWTP	SAMPLE NO.	--
PROJECT NO.	--	DATE SAMPLED	--
LOCATION	Grand Junction CO	DESCRIPTION	liner
DATE TESTED	09/23/19		
TECHNICIAN	CAL		

Displacement (in)	Displacement (cm)	Strain (%)	Average Cross Sectional Area (in²)	Load (lbs)	Load (N)	Stress (psf)	Stress (kPa)
0.1782	0.453	4.52	3.05	3.7	16	174	8.3
0.1822	0.463	4.62	3.05	3.7	17	175	8.4
0.1866	0.474	4.73	3.06	3.7	17	175	8.4
0.1906	0.484	4.83	3.06	4.0	18	190	9.1
0.1947	0.495	4.94	3.06	4.0	18	188	9.0
0.1989	0.505	5.04	3.07	4.0	18	185	8.9
0.2030	0.516	5.15	3.07	4.3	19	200	10
0.2072	0.526	5.25	3.07	4.2	19	196	9
0.2112	0.536	5.35	3.08	4.2	19	196	9
0.2156	0.548	5.47	3.08	4.4	20	206	10
0.2200	0.559	5.58	3.09	4.6	20	213	10
0.2245	0.570	5.69	3.09	4.8	21	224	11
0.2287	0.581	5.80	3.09	4.8	21	225	11
0.2328	0.591	5.90	3.10	4.8	21	225	11
0.2368	0.601	6.00	3.10	5.1	23	235	11
0.2412	0.613	6.11	3.10	5.1	23	239	11
0.2452	0.623	6.22	3.11	5.0	22	234	11
0.2494	0.633	6.32	3.11	5.4	24	249	12
0.2535	0.644	6.43	3.11	5.3	24	246	12
0.2576	0.654	6.53	3.12	5.3	24	245	12
0.2618	0.665	6.64	3.12	5.4	24	247	12
0.2661	0.676	6.75	3.12	5.5	24	253	12
0.2701	0.686	6.85	3.13	5.4	24	250	12
0.2744	0.697	6.96	3.13	5.5	25	253	12
0.2788	0.708	7.07	3.13	5.7	25	262	13
0.2828	0.718	7.17	3.14	5.7	25	261	13
0.2877	0.731	7.29	3.14	6.0	26	273	13
0.2919	0.741	7.40	3.15	5.8	26	267	13
0.2960	0.752	7.50	3.15	6.0	27	272	13
0.3002	0.763	7.61	3.15	6.3	28	285	14
0.3043	0.773	7.71	3.16	6.2	28	282	14
0.3084	0.783	7.82	3.16	6.3	28	288	14
0.3125	0.794	7.92	3.16	6.5	29	295	14
0.3165	0.804	8.02	3.17	6.6	29	300	14
0.3206	0.814	8.13	3.17	6.6	29	299	14
0.3246	0.824	8.23	3.17	6.5	29	294	14
0.3289	0.835	8.34	3.18	6.5	29	294	14
0.3331	0.846	8.44	3.18	6.8	30	308	15
0.3371	0.856	8.54	3.19	6.8	30	306	15
0.3413	0.867	8.65	3.19	6.8	30	305	15
0.3454	0.877	8.76	3.19	6.9	31	312	15
0.3494	0.887	8.86	3.20	7.0	31	314	15
0.3535	0.898	8.96	3.20	7.0	31	313	15

Unconfined Compressive Strength
ASTM D2166

CLIENT	Wiss Janney Elstner	BORING NO.	B-3
JOB NO.	3020-012	DEPTH	9'
PROJECT	Persigo WWTP	SAMPLE NO.	--
PROJECT NO.	--	DATE SAMPLED	--
LOCATION	Grand Junction CO	DESCRIPTION	liner
DATE TESTED	09/23/19		
TECHNICIAN	CAL		

Displacement (in)	Displacement (cm)	Strain (%)	Average Cross Sectional Area (in²)	Load (lbs)	Load (N)	Stress (psf)	Stress (kPa)
0.3578	0.909	9.07	3.20	7.0	31	313	15
0.3620	0.919	9.18	3.21	7.1	32	320	15
0.3672	0.933	9.31	3.21	7.2	32	322	15
0.3713	0.943	9.41	3.22	7.2	32	321	15
0.3758	0.955	9.53	3.22	7.4	33	329	16
0.3802	0.966	9.64	3.22	7.4	33	330	16
0.3842	0.976	9.74	3.23	7.4	33	332	16
0.3883	0.986	9.84	3.23	7.4	33	328	16
0.3925	0.997	9.95	3.24	7.7	34	340	16
0.3966	1.007	10.05	3.24	7.7	34	342	16
0.4006	1.018	10.15	3.24	7.6	34	338	16
0.4050	1.029	10.27	3.25	7.9	35	349	17
0.4091	1.039	10.37	3.25	7.9	35	350	17
0.4133	1.050	10.48	3.25	7.9	35	348	17
0.4175	1.060	10.58	3.26	7.9	35	349	17
0.4216	1.071	10.69	3.26	8.1	36	357	17
0.4256	1.081	10.79	3.27	8.2	36	360	17
0.4298	1.092	10.89	3.27	8.1	36	355	17
0.4339	1.102	11.00	3.27	8.4	37	369	18
0.4381	1.113	11.11	3.28	8.4	37	368	18
0.4422	1.123	11.21	3.28	8.4	37	370	18
0.4464	1.134	11.32	3.29	8.5	38	371	18
0.4504	1.144	11.42	3.29	8.7	39	380	18
0.4546	1.155	11.52	3.29	8.7	39	380	18
0.4588	1.165	11.63	3.30	8.7	38	378	18
0.4630	1.176	11.74	3.30	8.6	38	376	18
0.4670	1.186	11.84	3.30	8.9	40	387	19
0.4712	1.197	11.94	3.31	9.0	40	390	19
0.4756	1.208	12.06	3.31	9.0	40	390	19
0.4797	1.218	12.16	3.32	8.9	40	388	19
0.4840	1.229	12.27	3.32	9.1	41	396	19
0.4888	1.242	12.39	3.33	9.1	40	394	19
0.4933	1.253	12.50	3.33	9.2	41	396	19
0.4973	1.263	12.61	3.33	9.4	42	406	19
0.5015	1.274	12.71	3.34	9.4	42	406	19
0.5057	1.284	12.82	3.34	9.4	42	404	19
0.5099	1.295	12.93	3.35	9.4	42	402	19
0.5140	1.306	13.03	3.35	9.5	42	410	20

Unconfined Compressive Strength

ASTM D 2166

ADVANCED TERRA TESTING

CLIENT	Wiss Janney Elstner	BORING NO.	B-6
JOB NO.	3020-012	DEPTH	9'
PROJECT	Persigo WWTP	SAMPLE NO.	--
PROJECT NO.	--	DATE SAMPLED	--
LOCATION	Grand Junction CO	DESCRIPTION	liner
DATE TESTED	09/24/19		
TECHNICIAN	CAL		

Test Parameters

Strain Rate (in/min):	0.037
Strain Rate (cm/min):	0.09398

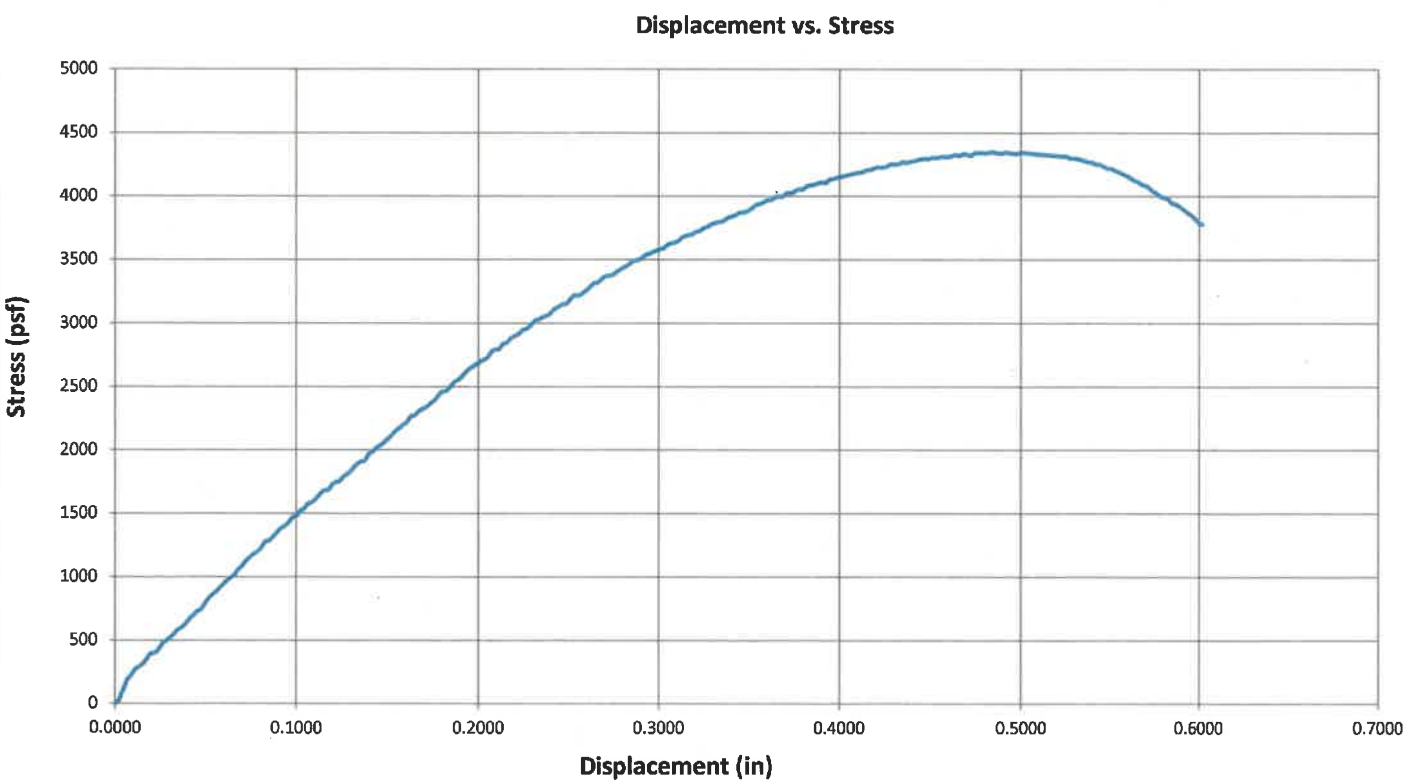
Raw Data Files: WJE_UCS_B-6_9__.txt

Moisture & Density Data

Mass of Wet Soil and Pan (g):	404.34	Initial Wet Density (pcf):	130.0
Mass of Dry Soil and Pan (g):	335.66	Initial Dry Density (pcf):	107.5
Mass of Pan (g):	6.74	Initial Wet Density (kg/m³):	2082
Mass of Wet Soil (g):	397.6	Initial Dry Density (kg/m³):	1722
Initial Diameter (in):	1.92	Initial Moisture (%):	20.9
Initial Height (in):	4.02		

Test Results

Peak Stress (psf):	4346	Axial Strain at Peak Stress(%):	12.0
Peak Stress (kPa):	208	Height to Diameter Ratio:	2.1:1



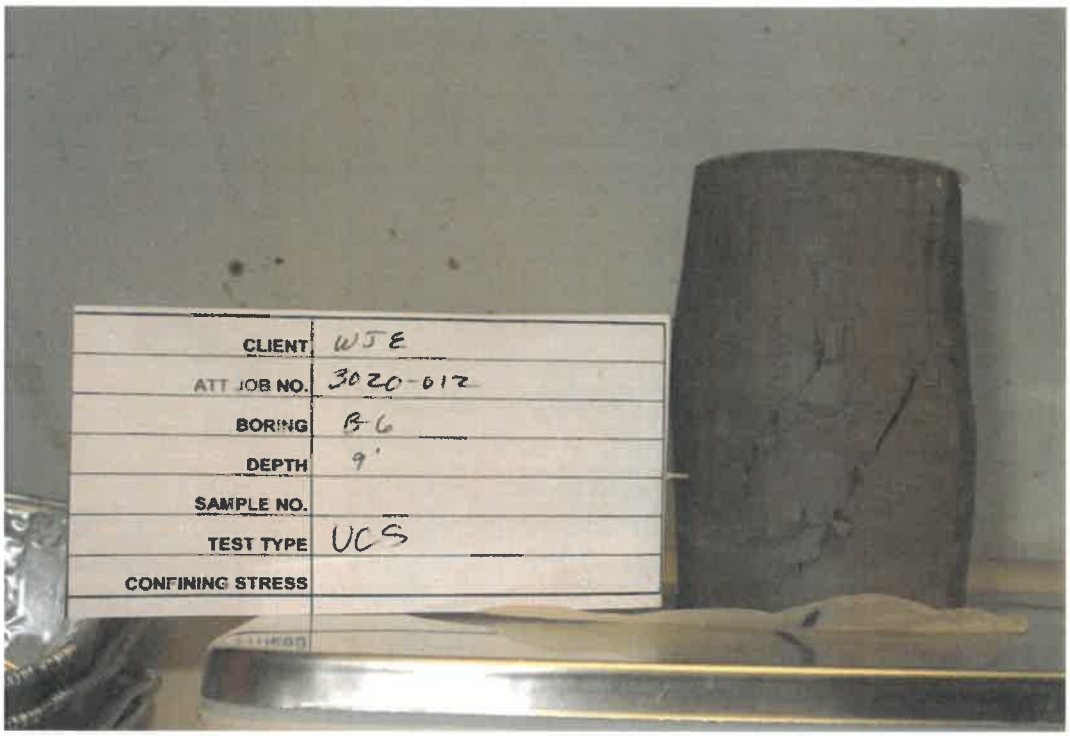
NOTES:

Data entry by:	CAL	Date:	9/25/2019
Checked by:	SPH	Date:	9-25-19
File name:	3020012__UCS ASTM D2166_1.xlsm		

ADVANCED TERRA TESTING

Image Attachment

CLIENT	Wiss Janney Elstner
JOB NO.	3020-012
PROJECT	Persigo WWTP
PROJECT NO.	--
LOCATION	Grand Junction CO



NOTES

File name: 3020012__Image_19_09_25_06_54_26

Unconfined Compressive Strength
ASTM D2166

CLIENT	Wiss Janney Elstner	BORING NO.	B-6
JOB NO.	3020-012	DEPTH	9'
PROJECT	Persigo WWTP	SAMPLE NO.	--
PROJECT NO.	--	DATE SAMPLED	--
LOCATION	Grand Junction CO	DESCRIPTION	liner
DATE TESTED	09/24/19		
TECHNICIAN	CAL		

Displacement (in)	Displacement (cm)	Strain (%)	Average Cross Sectional Area (in²)	Load (lbs)	Load (N)	Stress (psf)	Stress (kPa)
0.0000	0.000	0.00	2.90	0	0	0	0
0.0021	0.005	0.05	2.90	0.6	3	28	1
0.0042	0.011	0.10	2.90	2.1	9	103	5
0.0066	0.017	0.16	2.90	3.8	17	188	9
0.0087	0.022	0.22	2.90	4.5	20	221	11
0.0107	0.027	0.27	2.91	5.4	24	265	13
0.0130	0.033	0.32	2.91	5.9	26	290	14
0.0150	0.038	0.37	2.91	6.3	28	311	15
0.0173	0.044	0.43	2.91	7.1	31	350	17
0.0194	0.049	0.48	2.91	8.0	35	393	19
0.0215	0.055	0.53	2.91	8.1	36	399	19
0.0237	0.060	0.59	2.92	8.6	38	423	20
0.0257	0.065	0.64	2.92	9.5	42	468	22
0.0281	0.071	0.70	2.92	10	45	499	24
0.0304	0.077	0.76	2.92	11	47	525	25
0.0324	0.082	0.81	2.92	11	50	550	26
0.0344	0.087	0.86	2.92	12	53	582	28
0.0365	0.093	0.91	2.92	12	54	599	29
0.0389	0.099	0.97	2.93	13	57	632	30
0.0410	0.104	1.02	2.93	14	61	670	32
0.0430	0.109	1.07	2.93	14	63	695	33
0.0452	0.115	1.12	2.93	15	66	728	35
0.0473	0.120	1.18	2.93	15	67	742	36
0.0494	0.125	1.23	2.93	16	71	786	38
0.0514	0.131	1.28	2.94	17	75	827	40
0.0535	0.136	1.33	2.94	18	78	858	41
0.0556	0.141	1.38	2.94	18	80	881	42
0.0576	0.146	1.43	2.94	19	83	912	44
0.0597	0.152	1.48	2.94	19	86	942	45
0.0619	0.157	1.54	2.94	20	88	973	47
0.0639	0.162	1.59	2.95	20	91	995	48
0.0659	0.167	1.64	2.95	21	93	1018	49
0.0680	0.173	1.69	2.95	22	96	1059	51
0.0701	0.178	1.74	2.95	22	99	1085	52
0.0722	0.183	1.80	2.95	23	103	1127	54
0.0743	0.189	1.85	2.95	24	105	1155	55
0.0764	0.194	1.90	2.95	24	108	1180	56
0.0788	0.200	1.96	2.96	25	110	1201	58
0.0810	0.206	2.01	2.96	25	113	1234	59
0.0830	0.211	2.06	2.96	26	117	1278	61
0.0851	0.216	2.12	2.96	26	118	1286	62
0.0872	0.221	2.17	2.96	27	120	1315	63
0.0894	0.227	2.22	2.96	28	123	1349	65

Unconfined Compressive Strength
ASTM D2166

CLIENT	Wiss Janney Elstner	BORING NO.	B-6
JOB NO.	3020-012	DEPTH	9'
PROJECT	Persigo WWTP	SAMPLE NO.	--
PROJECT NO.	--	DATE SAMPLED	--
LOCATION	Grand Junction CO	DESCRIPTION	liner
DATE TESTED	09/24/19		
TECHNICIAN	CAL		

Displacement (in)	Displacement (cm)	Strain (%)	Average Cross Sectional Area (in²)	Load (lbs)	Load (N)	Stress (psf)	Stress (kPa)
0.0914	0.232	2.27	2.97	28	127	1381	66
0.0937	0.238	2.33	2.97	29	128	1400	67
0.0959	0.244	2.38	2.97	29	131	1430	68
0.0982	0.249	2.44	2.97	30	135	1469	70
0.1003	0.255	2.49	2.97	31	136	1482	71
0.1024	0.260	2.55	2.97	31	140	1522	73
0.1044	0.265	2.60	2.98	32	141	1536	74
0.1064	0.270	2.65	2.98	33	145	1573	75
0.1085	0.276	2.70	2.98	33	146	1586	76
0.1107	0.281	2.75	2.98	33	148	1610	77
0.1129	0.287	2.81	2.98	34	152	1647	79
0.1150	0.292	2.86	2.98	35	155	1677	80
0.1178	0.299	2.93	2.99	35	156	1688	81
0.1198	0.304	2.98	2.99	36	159	1726	83
0.1219	0.310	3.03	2.99	36	161	1746	84
0.1239	0.315	3.08	2.99	36	162	1754	84
0.1261	0.320	3.14	2.99	37	166	1792	86
0.1285	0.326	3.20	2.99	38	168	1813	87
0.1311	0.333	3.26	3.00	39	171	1851	89
0.1333	0.339	3.32	3.00	39	175	1886	90
0.1355	0.344	3.37	3.00	40	177	1908	91
0.1378	0.350	3.43	3.00	40	178	1918	92
0.1400	0.356	3.48	3.00	41	183	1969	94
0.1422	0.361	3.54	3.00	41	184	1986	95
0.1442	0.366	3.59	3.01	42	187	2019	97
0.1464	0.372	3.64	3.01	43	189	2037	98
0.1484	0.377	3.69	3.01	43	192	2060	99
0.1504	0.382	3.74	3.01	44	194	2089	100
0.1525	0.387	3.79	3.01	44	197	2119	101
0.1547	0.393	3.85	3.01	45	200	2152	103
0.1567	0.398	3.90	3.02	46	202	2173	104
0.1589	0.404	3.95	3.02	46	205	2199	105
0.1611	0.409	4.01	3.02	47	207	2223	106
0.1631	0.414	4.06	3.02	48	212	2268	109
0.1652	0.420	4.11	3.02	48	212	2272	109
0.1672	0.425	4.16	3.02	48	215	2302	110
0.1693	0.430	4.21	3.03	49	217	2324	111
0.1713	0.435	4.26	3.03	49	219	2338	112
0.1734	0.440	4.31	3.03	50	221	2360	113
0.1755	0.446	4.36	3.03	50	223	2386	114
0.1776	0.451	4.42	3.03	51	226	2418	116
0.1798	0.457	4.47	3.03	52	230	2454	118
0.1824	0.463	4.54	3.04	52	231	2465	118

Unconfined Compressive Strength
ASTM D2166

CLIENT	Wiss Janney Elstner	BORING NO.	B-6
JOB NO.	3020-012	DEPTH	9'
PROJECT	Persigo WWTP	SAMPLE NO.	--
PROJECT NO.	--	DATE SAMPLED	–
LOCATION	Grand Junction CO	DESCRIPTION	liner
DATE TESTED	09/24/19		
TECHNICIAN	CAL		

Displacement (in)	Displacement (cm)	Strain (%)	Average Cross Sectional Area (in²)	Load (lbs)	Load (N)	Stress (psf)	Stress (kPa)
0.1844	0.468	4.59	3.04	53	234	2496	120
0.1865	0.474	4.64	3.04	53	238	2531	121
0.1886	0.479	4.69	3.04	54	239	2548	122
0.1907	0.484	4.74	3.04	54	242	2571	123
0.1927	0.489	4.79	3.04	55	245	2605	125
0.1947	0.495	4.84	3.05	56	248	2633	126
0.1968	0.500	4.89	3.05	56	250	2653	127
0.1988	0.505	4.94	3.05	57	252	2674	128
0.2009	0.510	5.00	3.05	57	254	2694	129
0.2032	0.516	5.05	3.05	57	256	2712	130
0.2053	0.521	5.11	3.05	58	258	2733	131
0.2074	0.527	5.16	3.06	59	262	2778	133
0.2094	0.532	5.21	3.06	59	264	2790	134
0.2116	0.537	5.26	3.06	59	264	2797	134
0.2137	0.543	5.31	3.06	60	268	2836	136
0.2157	0.548	5.36	3.06	61	269	2845	136
0.2177	0.553	5.41	3.06	61	272	2876	138
0.2199	0.559	5.47	3.07	62	274	2896	139
0.2225	0.565	5.53	3.07	62	276	2916	140
0.2245	0.570	5.58	3.07	63	279	2945	141
0.2266	0.576	5.64	3.07	63	280	2954	141
0.2291	0.582	5.70	3.07	64	283	2982	143
0.2312	0.587	5.75	3.08	64	287	3016	144
0.2334	0.593	5.80	3.08	65	288	3031	145
0.2356	0.598	5.86	3.08	65	290	3045	146
0.2377	0.604	5.91	3.08	65	291	3059	146
0.2398	0.609	5.96	3.08	66	293	3078	147
0.2418	0.614	6.01	3.08	67	296	3110	149
0.2439	0.620	6.07	3.09	67	298	3125	150
0.2462	0.625	6.12	3.09	67	300	3146	151
0.2487	0.632	6.19	3.09	68	301	3154	151
0.2510	0.638	6.24	3.09	68	305	3190	153
0.2530	0.643	6.29	3.09	69	308	3219	154
0.2553	0.648	6.35	3.09	69	307	3216	154
0.2575	0.654	6.40	3.10	70	309	3233	155
0.2595	0.659	6.45	3.10	70	312	3257	156
0.2616	0.664	6.51	3.10	71	314	3283	157
0.2637	0.670	6.56	3.10	71	317	3312	159
0.2658	0.675	6.61	3.10	72	318	3318	159
0.2679	0.680	6.66	3.11	72	320	3341	160
0.2700	0.686	6.71	3.11	73	323	3367	161
0.2723	0.692	6.77	3.11	73	324	3372	161
0.2747	0.698	6.83	3.11	73	325	3381	162

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CLIENT	Wiss Janney Elstner	BORING NO.	B-6
JOB NO.	3020-012	DEPTH	9'
PROJECT	Persigo WWTP	SAMPLE NO.	--
PROJECT NO.	--	DATE SAMPLED	--
LOCATION	Grand Junction CO	DESCRIPTION	liner
DATE TESTED	09/24/19		
TECHNICIAN	CAL		

Displacement (in)	Displacement (cm)	Strain (%)	Average Cross Sectional Area (in^2)	Load (lbs)	Load (N)	Stress (psf)	Stress (kPa)
0.2769	0.703	6.89	3.11	74	328	3408	163
0.2789	0.708	6.94	3.11	74	329	3422	164
0.2810	0.714	6.99	3.12	74	331	3440	165
0.2832	0.719	7.04	3.12	75	333	3460	166
0.2854	0.725	7.10	3.12	75	336	3484	167
0.2875	0.730	7.15	3.12	76	337	3494	167
0.2899	0.736	7.21	3.12	76	338	3506	168
0.2919	0.741	7.26	3.13	77	341	3528	169
0.2941	0.747	7.31	3.13	77	342	3545	170
0.2964	0.753	7.37	3.13	77	344	3558	170
0.2985	0.758	7.42	3.13	78	345	3570	171
0.3005	0.763	7.47	3.13	78	347	3581	171
0.3028	0.769	7.53	3.13	78	348	3592	172
0.3048	0.774	7.58	3.14	79	350	3616	173
0.3068	0.779	7.63	3.14	79	352	3627	174
0.3089	0.785	7.68	3.14	79	353	3635	174
0.3110	0.790	7.73	3.14	80	354	3649	175
0.3132	0.796	7.79	3.14	80	357	3678	176
0.3162	0.803	7.86	3.15	81	359	3693	177
0.3184	0.809	7.92	3.15	81	360	3698	177
0.3205	0.814	7.97	3.15	81	362	3719	178
0.3226	0.819	8.02	3.15	82	363	3724	178
0.3247	0.825	8.08	3.15	82	365	3746	179
0.3268	0.830	8.13	3.15	82	366	3757	180
0.3288	0.835	8.18	3.16	83	368	3778	181
0.3308	0.840	8.23	3.16	83	370	3788	181
0.3331	0.846	8.28	3.16	83	370	3795	182
0.3353	0.852	8.34	3.16	83	371	3802	182
0.3374	0.857	8.39	3.16	84	373	3821	183
0.3395	0.862	8.44	3.17	84	375	3837	184
0.3416	0.868	8.50	3.17	85	376	3844	184
0.3438	0.873	8.55	3.17	85	378	3862	185
0.3458	0.878	8.60	3.17	85	379	3870	185
0.3479	0.884	8.65	3.17	85	380	3875	186
0.3499	0.889	8.70	3.17	86	381	3888	186
0.3521	0.894	8.76	3.18	86	384	3911	187
0.3541	0.899	8.81	3.18	87	386	3933	188
0.3562	0.905	8.86	3.18	87	387	3939	189
0.3582	0.910	8.91	3.18	87	389	3954	189
0.3604	0.915	8.96	3.18	88	390	3969	190
0.3625	0.921	9.02	3.19	88	391	3973	190
0.3647	0.926	9.07	3.19	88	393	3996	191
0.3668	0.932	9.12	3.19	89	394	3997	191

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CLIENT	Wiss Janney Elstner	BORING NO.	B-6
JOB NO.	3020-012	DEPTH	9'
PROJECT	Persigo WWTP	SAMPLE NO.	--
PROJECT NO.	--	DATE SAMPLED	--
LOCATION	Grand Junction CO	DESCRIPTION	liner
DATE TESTED	09/24/19		
TECHNICIAN	CAL		

Displacement (in)	Displacement (cm)	Strain (%)	Average Cross Sectional Area (in²)	Load (lbs)	Load (N)	Stress (psf)	Stress (kPa)
0.3689	0.937	9.17	3.19	89	395	4003	192
0.3710	0.942	9.23	3.19	89	397	4026	193
0.3730	0.947	9.28	3.19	89	397	4022	193
0.3753	0.953	9.33	3.20	90	399	4040	193
0.3774	0.959	9.39	3.20	90	401	4056	194
0.3794	0.964	9.44	3.20	90	401	4053	194
0.3816	0.969	9.49	3.20	91	403	4078	195
0.3837	0.975	9.54	3.20	91	404	4086	196
0.3858	0.980	9.59	3.21	91	405	4092	196
0.3879	0.985	9.65	3.21	91	407	4103	196
0.3900	0.991	9.70	3.21	92	407	4110	197
0.3921	0.996	9.75	3.21	92	407	4105	197
0.3943	1.002	9.81	3.21	92	410	4133	198
0.3966	1.007	9.86	3.22	92	411	4137	198
0.3987	1.013	9.92	3.22	93	412	4148	199
0.4013	1.019	9.98	3.22	93	413	4156	199
0.4035	1.025	10.03	3.22	93	414	4163	199
0.4059	1.031	10.09	3.22	93	416	4173	200
0.4080	1.036	10.15	3.23	94	416	4178	200
0.4102	1.042	10.20	3.23	94	417	4185	200
0.4124	1.047	10.26	3.23	94	418	4191	201
0.4144	1.053	10.31	3.23	94	420	4204	201
0.4166	1.058	10.36	3.23	94	420	4208	201
0.4191	1.065	10.42	3.24	95	422	4220	202
0.4211	1.070	10.47	3.24	95	423	4229	202
0.4233	1.075	10.53	3.24	95	423	4226	202
0.4260	1.082	10.59	3.24	95	424	4235	203
0.4281	1.087	10.65	3.24	96	426	4253	204
0.4305	1.093	10.71	3.25	96	426	4251	204
0.4326	1.099	10.76	3.25	96	427	4255	204
0.4347	1.104	10.81	3.25	96	429	4270	204
0.4368	1.109	10.86	3.25	96	428	4264	204
0.4389	1.115	10.92	3.25	97	429	4272	205
0.4414	1.121	10.98	3.26	97	430	4281	205
0.4440	1.128	11.04	3.26	97	432	4291	205
0.4468	1.135	11.11	3.26	97	433	4296	206
0.4488	1.140	11.16	3.26	97	433	4294	206
0.4509	1.145	11.21	3.26	98	434	4305	206
0.4529	1.150	11.26	3.27	98	434	4301	206
0.4550	1.156	11.32	3.27	98	435	4308	206
0.4571	1.161	11.37	3.27	98	435	4311	206
0.4592	1.166	11.42	3.27	98	436	4309	206
0.4616	1.172	11.48	3.27	98	437	4316	207

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CLIENT	Wiss Janney Elstner	BORING NO.	B-6
JOB NO.	3020-012	DEPTH	9'
PROJECT	Persigo WWTP	SAMPLE NO.	--
PROJECT NO.	--	DATE SAMPLED	--
LOCATION	Grand Junction CO	DESCRIPTION	liner
DATE TESTED	09/24/19		
TECHNICIAN	CAL		

Displacement (in)	Displacement (cm)	Strain (%)	Average Cross Sectional Area (in²)	Load (lbs)	Load (N)	Stress (psf)	Stress (kPa)
0.4637	1.178	11.53	3.28	98	438	4326	207
0.4661	1.184	11.59	3.28	98	437	4320	207
0.4681	1.189	11.64	3.28	99	439	4333	207
0.4702	1.194	11.69	3.28	99	439	4329	207
0.4725	1.200	11.75	3.28	99	438	4321	207
0.4747	1.206	11.81	3.29	99	441	4341	208
0.4769	1.211	11.86	3.29	99	441	4343	208
0.4791	1.217	11.91	3.29	99	441	4341	208
0.4811	1.222	11.96	3.29	99	441	4340	208
0.4833	1.228	12.02	3.29	99	442	4346	208
0.4854	1.233	12.07	3.30	99	442	4345	208
0.4874	1.238	12.12	3.30	99	442	4340	208
0.4894	1.243	12.17	3.30	99	442	4337	208
0.4914	1.248	12.22	3.30	100	443	4344	208
0.4935	1.253	12.27	3.30	100	443	4343	208
0.4957	1.259	12.33	3.31	100	443	4338	208
0.4977	1.264	12.38	3.31	100	443	4335	208
0.5002	1.271	12.44	3.31	100	444	4345	208
0.5023	1.276	12.49	3.31	100	444	4341	208
0.5043	1.281	12.54	3.31	100	444	4339	208
0.5063	1.286	12.59	3.32	100	444	4337	208
0.5084	1.291	12.64	3.32	100	444	4332	207
0.5106	1.297	12.70	3.32	100	444	4331	207
0.5130	1.303	12.76	3.32	100	444	4328	207
0.5150	1.308	12.81	3.32	100	444	4325	207
0.5171	1.313	12.86	3.33	100	444	4323	207
0.5193	1.319	12.91	3.33	100	444	4321	207
0.5214	1.324	12.97	3.33	100	444	4318	207
0.5234	1.329	13.02	3.33	100	444	4314	207
0.5256	1.335	13.07	3.33	100	444	4312	206
0.5276	1.340	13.12	3.34	100	443	4299	206
0.5297	1.345	13.17	3.34	100	443	4299	206
0.5318	1.351	13.23	3.34	100	443	4295	206
0.5339	1.356	13.28	3.34	99	443	4287	205
0.5360	1.361	13.33	3.34	99	442	4279	205
0.5380	1.367	13.38	3.35	99	441	4269	204
0.5401	1.372	13.43	3.35	99	441	4264	204
0.5421	1.377	13.48	3.35	99	440	4252	204
0.5442	1.382	13.53	3.35	99	440	4250	203
0.5463	1.388	13.59	3.35	99	439	4234	203
0.5483	1.393	13.64	3.36	98	437	4219	202
0.5504	1.398	13.69	3.36	98	438	4218	202
0.5526	1.404	13.74	3.36	98	436	4204	201

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CLIENT	Wiss Janney Elstner	BORING NO.	B-6
JOB NO.	3020-012	DEPTH	9'
PROJECT	Persigo WWTP	SAMPLE NO.	--
PROJECT NO.	--	DATE SAMPLED	--
LOCATION	Grand Junction CO	DESCRIPTION	liner
DATE TESTED	09/24/19		
TECHNICIAN	CAL		

Displacement (in)	Displacement (cm)	Strain (%)	Average Cross Sectional Area (in²)	Load (lbs)	Load (N)	Stress (psf)	Stress (kPa)
0.5549	1.409	13.80	3.36	98	435	4191	201
0.5570	1.415	13.85	3.36	98	434	4176	200
0.5591	1.420	13.90	3.37	97	433	4161	199
0.5611	1.425	13.95	3.37	97	431	4146	199
0.5632	1.431	14.01	3.37	97	430	4126	198
0.5652	1.436	14.06	3.37	96	429	4116	197
0.5672	1.441	14.11	3.37	96	427	4096	196
0.5693	1.446	14.16	3.38	96	426	4086	196
0.5713	1.451	14.21	3.38	96	425	4072	195
0.5738	1.457	14.27	3.38	95	422	4039	193
0.5759	1.463	14.32	3.38	95	421	4024	193
0.5780	1.468	14.37	3.38	94	418	3999	191
0.5802	1.474	14.43	3.39	94	417	3988	191
0.5824	1.479	14.48	3.39	94	416	3977	190
0.5844	1.484	14.53	3.39	93	413	3946	189
0.5865	1.490	14.59	3.39	93	413	3940	189
0.5889	1.496	14.65	3.40	92	411	3917	188
0.5910	1.501	14.70	3.40	92	409	3895	187
0.5932	1.507	14.75	3.40	91	407	3872	185
0.5956	1.513	14.81	3.40	91	405	3850	184
0.5977	1.518	14.86	3.40	90	402	3822	183
0.5999	1.524	14.92	3.41	90	399	3791	181
0.6020	1.529	14.97	3.41	89	398	3778	181

APPENDIX B. DISTRESS TERMINOLOGY AND DISCUSSION

B.1. Reinforced Concrete Distress Terminology

Instances of distress were identified through visual observations of the accessible concrete surfaces. ACI CT-18, *Concrete Terminology*, definitions of 'distress' and commonly observed conditions are paraphrased here to provide context for the observations and discussion. In addition, we have defined several other terms as they are intended in this report.

1. *Cracking* - a complete or incomplete separation into two or more parts produced by breaking or fracturing
   a. Map pattern
      (1) intersecting cracks that extend below the surface of hardened concrete; typically caused by shrinkage of the drying surface concrete that is restrained by concrete at greater depths where either little or no shrinkage occurs; vary in width from fine and barely visible to open and well-defined
      (2) the chief symptom of a chemical reaction between alkalis in cement and mineral constituents in aggregate within hardened concrete; due to differential rate of volume change in different members of the concrete
   b. Longitudinal - cracks parallel to the long axis/orientation of the concrete member
   c. Transverse - cracks perpendicular to longitudinal cracks

2. *Distress* - physical manifestation of cracking and distortion in a concrete structure as the result of stress, chemical action, or both

3. *Delamination* - a planar separation in a material that is roughly parallel to the surface of the material, separated, but not fully detached, from a larger mass by a blow, the action of weather, pressure, or expansion within the larger mass

4. *Efflorescence* - a generally white deposit formed when water-soluble compounds emerge in solution from concrete and precipitate by reaction such as carbonation or crystallize by evaporation

5. *Incipient Spall* - an area of concrete which has become mostly separated from the body of the concrete

6. *Mils* - a unit of measurement commonly used for cracks and coating thicknesses that is one thousandth of an inch, 0.001-inches. For example, 50 mils = 0.050-inches and 1/16-inch = 62.5 mils.

7. *Parge Coat* - also referred to as a 'skim coat', a thin layer of cementitious material, usually applied with a trowel, applied to a concrete surface

8. *Paste Erosion* - loss of cement paste at surface of concrete, and increased exposure of aggregate particles

9. *Process Water* - a combination of water, sewage, and chemicals present within the various wastewater structures

10. *Scaling* - local flaking or peeling away of the near-surface portion of hardened concrete or mortar

11. *Service life* - desired useful life based on requirements unique to a given structure, in terms of acceptable performance and operational needs, as defined by the Owner.

12. *<u>Service life modeling</u>* - probabilistic modeling approach that estimates the time required for progression of corrosion-related concrete distress (i.e., delamination and spalls) to initiate, propagate, and then cause distress. The predicted distress over time can then be compared against an assumed definition of acceptable damage, or service life, for the various structures considered. Using these criteria, the modeling estimates the remaining time before the defined service life criteria is reached.

13. *<u>Shrinkage Cracking</u>* - this term is generally used to reference a reduction in volume of the concrete which induces cracking due to restraint of the concrete member. Concrete volume change is attributed to three primary categories: drying shrinkage (loss of moisture), thermal changes, and autogenous shrinkage (chemical shrinkage). Changes in temperature and loss of moisture are typically two of the largest influences on overall volume change. Restraint can be due to geometry of the structure or from external items such as soil or other framing elements.

14. *<u>Spall</u>* - an area of concrete, detached from a concrete member, due to internal expansion of the concrete

B.2. Reinforced Concrete Degradation Mechanisms

B.2.1. Chloride-Induced Corrosion

Chloride ions may be introduced into reinforced concrete either during mixing (e.g., by using chloride-based admixtures or salt-contaminated mixing water or aggregates) or by diffusion from the environment (e.g., by seawater or de-icing chemicals). When the concentration of chloride ions at the surface of the steel reaches a critical “threshold” value, localized corrosion can initiate, typically forming pits near flaws on the steel’s surface. The critical chloride concentration depends upon a number of factors, including the interfacial properties of the steel and concrete, the pH of the pore solution in the concrete, and the electrochemical potential of the steel[1]. Corrosion often proceeds rapidly at cracks in concrete due to high, local chloride concentrations and significant local differences in electrochemical potential. As a result, chloride-induced corrosion is most likely to occur in the tidal and splash exposure zones.

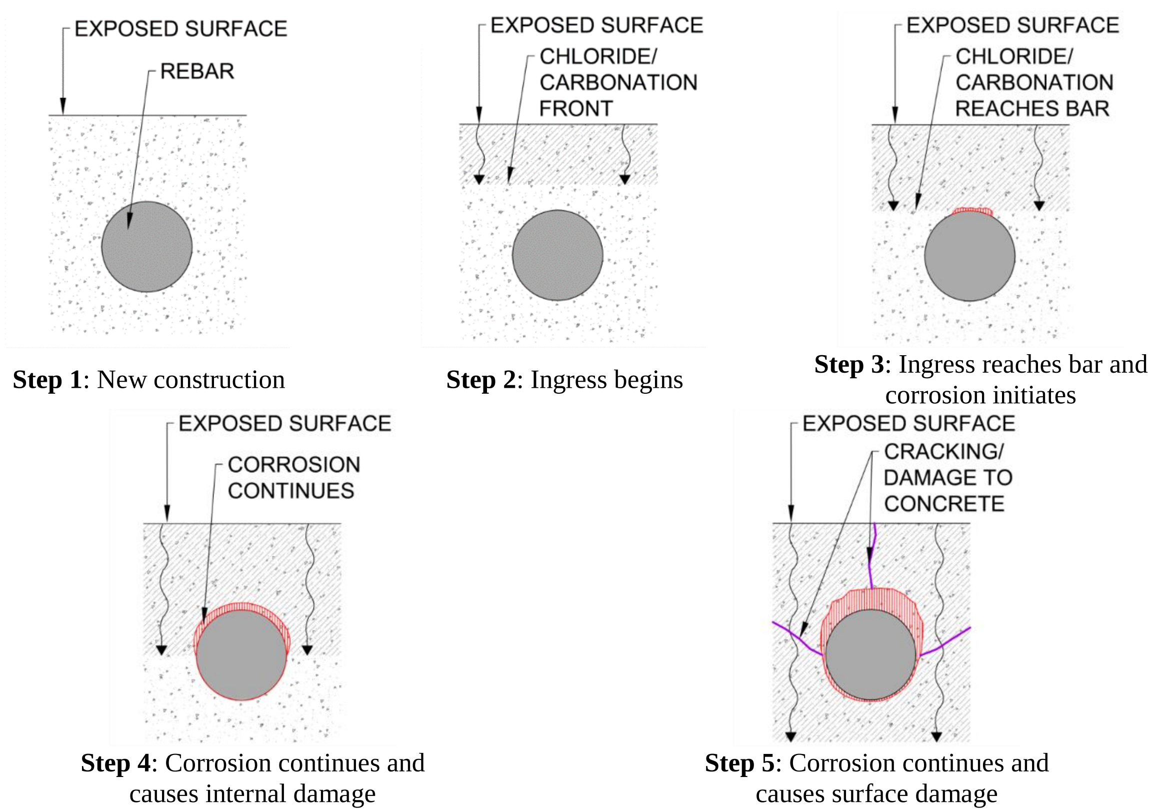

Illustration of corrosion sequence.

B.2.2. Carbonation-Induced Corrosion:

Carbonation is a reaction within concrete between the cement paste and the carbon dioxide in the air, which lowers the pH of the pore solution to about 9 (a pH below about 11.5 will depassivate carbon steel[2]. The carbonation front begins at the concrete surface and along crack surfaces, and slowly advances inward.

[1] Bertolini, L., Elsener, B., Pedeferri, P., Redaelli, E., & Polder, R. (2013). *Corrosion of Steel in Concrete: Prevention, Diagnosis, Repair.* Weinheim, Germany: Wiley-VCH.

[2] Broomfield, J. P. (2007). *Corrosion of Steel in Concrete.* New York: Taylor and Francis.

When the carbonation front reaches the level of the steel reinforcement, the passive film breaks down, enabling corrosion to initiate. The carbonation rate, or the rate at which the front advances through the concrete, depends upon the quality and alkalinity of the concrete and on environmental factors such as temperature and relative humidity. Concretes with low hydroxyl ion concentrations (due to low cement contents and/or use of supplementary cementitious materials [SCMs]) are more susceptible to carbonation[3]. In good-quality concrete exposed to chlorides, carbonation is typically a much slower process than chloride ingress. Partial carbonation (i.e., a reduction in alkalinity but with a resulting pH still greater than 11.5) can lead to more aggressive conditions for corrosion in chloride-contaminated concrete.

B.2.3. Cracking

Concrete cracking is a common occurrence and can occur for a variety of reasons, including shrinkage, thermal strains, and structural loads. Cracking will affect the ability of the concrete cover to protect the reinforcing steel and prevent the buildup of corrosion products that can lead to delamination within concrete. Cracks with active moisture leakage promotes leaching and efflorescence.

B.2.4. Alkali-Aggregate Reaction and Delayed Ettringite Formation

Internal expansion is characteristic of several distress mechanisms, particularly alkali-silica reaction (ASR); however, expansion can also occur as a result of swelling of cement paste from long-term exposure to water. Alkali-silica reaction is a chemical reaction between reactive siliceous aggregate particles and hydroxyl ions in the pore solution of hardened concrete to produce ASR gel. This gel formation results in the consumption (or reduction) of some alkalis and some reactive silica. ASR gel is hygroscopic. Expansive pressures are produced when the gel imbibes water and, if these pressures exceed the tensile strength of the concrete, they produce micro-cracking, and eventually macro-cracking, of the concrete. Water can infiltrate into the concrete through the cracks and cause additional gel expansion, which can lead to more cracking and potentially spalling of the concrete. Three conditions must be present for deleterious ASR to occur: (1) sufficient hydroxyl ion concentration in the pore solution of the concrete, usually due to high alkali content of portland cement; (2) reactive siliceous aggregate; and (3) available moisture. Typically, expansion of unrestrained concrete due to ASR will continue until either the alkalis or reactive silica are consumed, or until the relative humidity within the concrete falls below about 60 percent[4].

Another less common alkali aggregate reaction is alkali carbonate reaction (ACR). Alkali carbonate reaction takes place between some dolomitic (magnesium bearing) limestones and alkalis resulting in the formation of magnesium hydroxide and carbonates. In the presence of moisture the carbonates can swell causing internal pressures and cracking. Avoiding such aggregates is the most effective preventative technique.

Delayed ettringite formation (DEF) is the delayed reaction between sulfate ions and aluminate phases in concrete that results in the formation of expansive products which cause internal stress and cracking. It is common in concrete cured at high temperatures, above about 70-88 °C[5]. This is primarily a concern in mass concrete elements or precast, heat-cured elements. At these elevated temperatures the sulfate and

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[3] Kosmatka, S., & Wilson, M. (2016). *Design and Control of Concrete Mixtures* (16th ed.). Skokie, IL: Portland Cement Association.

[4] Fournier, B., M. A. Bérubé, K. Folliard, and M. D. A. Thomas. *Report on the diagnosis, prognosis, and mitigation of alkali-silica reaction (ASR) in transportation structures. US Department of Transportation, Federal Highway Administration*. Publication FHWA-HIF-09-004, 2010.

[5] Taylor, H. F., Fami, C., & Scivener, K. L. (2001). Delayed ettringite formation. *Cement and Concrete Research*, 683-69

aluminate are absorbed by the C-S-H making them unavailable for ettringite formation. After the material cools, the sulfate is released and reacts the monosulfate, metastable hydration product, to form ettringite. The formation of ettringite results in the development of internal stresses which result in expansion and cracking.

Cement chemistry has a large effect on DEF; however insufficient data is known to predict the risk of expansion based on cement chemistry. The environment in which the concrete is placed also plays and important factor. Concrete surrounded by water will result in rapid DEF expansion. The effect of DEF is slower in a moist air environment and very slow if the concrete dry or submerged in an alkali solution. Avoidance of DEF is best done by controlling and limiting maximum concrete temperatures during curing.

B.2.5. Sulfate Attack

During sulfate attack, sulfate ions react with ionic species within the concrete pore solution to produce either gypsum, ettringite, or thaumasite. The formation of all three products results in the development of internal stresses which lead to cracking. The formation of thaumasite is particularly detrimental because it gradually replaces C-S-H, the primary binding phase in cement. This replacement results in the conversion of sound concrete to a material with no load bearing or binding capability.

Hydrogen sulfide (H_2S) attack of concrete can occur when hydrogen sulfide gas, which is found underground or in the process water as a product of anaerobic bacteria consumption of sulfate compounds in organic matter, is converted by aerobic bacteria to sulfuric acid in moist environments[6]. The formation of this acid on the concrete surface weakens the cementitious paste and can lead to erosion of the surface layer of concrete[7]. This mechanism is most commonly observed in sewer systems where anaerobic conditions exist in the presence of organic matter in close proximity to moist, warm aerobic conditions.

Hydrogen sulfide attack of concrete is most relevant where the oxygen is available to support the sulfuric acid-generating bacteria; as such, below the water line, or at the foundations, oxygen availability will be limited and the risk of acid generation is less.

B.3. Steel Degradation Mechanisms

B.3.1. General Corrosion

General corrosion is the most simplistic form of corrosion, of which steel is uniformly attacked over an entire surface. Carbon steel corrodes readily in moist atmospheric environments, reacting with water and oxygen to form iron oxide, or rust. When corrosion initiates, a “corrosion cell” (also called a “galvanic cell”) is formed. The cell consists of a cathode and an anode that are electrically connected to one another in an electrolyte solution through which ions may travel. The cathode and anode can be sites on separate steel bars in close proximity to one another or two different locations on the same steel bar; as long as the two locations are electrically and ionically connected to one another, they may form a corrosion cell.

Corrosion product generation and metal consumption occurs at the anode, where iron metal becomes oxidized and dissolves into iron ions and electrons. The electrons travel through the electrical connection

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[6] Environmental Protection Agency. (1991). *Hydrogen Sulfide Corrosion: Its Consequences, Detection and Control.* Environmental Protection Agency.

[7] Neville, A. M. (1996). *Properties of Concrete.* Essex, UK: Addison Wesley Longman Limited.

to the cathode, where they are consumed to form hydroxide ions from the reduction of oxygen in water. The hydroxide ions then travel through the electrolyte (such as surface moisture) back toward the anode, where they combine with the iron ions to form iron oxide and iron oxyhydroxide compounds, or rust.

B.3.2. Pitting and Crevice Corrosion

Pitting corrosion is a result of the same corrosion cell as general corrosion, however, this form attacks a localized region, typically resulting in rapid penetration of the surface. Oftentimes, the corrosion cell is established between the interior of the pit and the exterior surface with the interior of the pit assuming the anodic role in the corrosion cell. Pits typically initiate at defects within the material, passive film, or protective film (e.g. holidays in or distress to the steel coating). Propagation rates are difficult to predict, as the process is typically driven by the potential difference between the anodic area within the pit, which may vary within the steel microstructure, and the surrounding cathodic area. Pitting corrosion may be terminated if the surface steel within the pit reaches the potential of the surrounding cathodic area. Additionally, pitting corrosion may stop if the supply of electrolyte is eliminated, either by complete drying of the pit or by infill with corrosion product.

B.3.3. Galvanic Corrosion

Galvanic corrosion is the process of which the corrosion cell is created between dissimilar materials, leading to preferential accelerated corrosion of the anodic material while decreasing the corrosion rate of the cathodic material. A common example of this phenomena is galvanized steel, for which the hot-dip galvanized coating is zinc-based and serves as both a protective and a “sacrificial” coating, for which if the electrolyte penetrates the coating allowing a local corrosion cell to form, the anodic zinc will preferentially corrode, resulting in the slowing of the corrosion rate of the cathodic carbon steel. The process is driven by the difference in potential between the two (or more) materials in a given electrolyte, which determines the direction and magnitude of the current flow.

While it is usually simple to determine the material that will corrode when two materials are in contact, rates of corrosion are very difficult to determine. Electrolyte resistivity, material polarization, and special effects are an example of three factors that play a significant role in corrosion rate. The most effective way of eliminating galvanic corrosion is electrical isolation of dissimilar materials, however, that is not always possible for a given structure.

B.4. Degradation Mechanisms of Protective Elements

B.4.1. Aging Due to Ozone and Moisture

Ozone is an oxygen species that occurs both naturally and unnaturally, typically as a result of industrial combustion. Ozone is an oxidizer which will react with most organic coatings to form free radicals and potentially photochemical embrittlement degradation [8]. Oxygen molecules, moisture, and ions may also permeate through coatings and other materials, which may potentially affect long-term durability. Even high-quality materials will degrade over time through relatively weak areas of cross-link density, microvoids, and cracks. Water typically permeates quicker than oxygen molecules as a function of the smaller molecule size.

[8] Tator, K. B. (2015). Coating Deterioration. *ASM Handbook, Volume 5B, Protective Organic Coatings*. ASM International, 462-473.

B.4.2. Abrasion and Mechanical Damage

Abrasion of protective elements involves the removal of coating, sealant, etc. from a component through contact (or repeated contact) with another surface. Abrasion resistance is a function of the polymer used and exposure of the element. Elements on the topside are particularly susceptible to abrasion or mechanical damage as a result of pedestrian traffic or impact from tools.

B.4.3. Ultraviolet Exposure

Ultraviolet (UV) light, naturally emitted from the sun, is a form of electromagnetic radiation with well-documented detrimental effects on humans at certain wavelengths. This naturally occurring energy has the ability to disrupt covalent bonds between organic coatings as well as damage the elastic properties of sealants and other inorganic materials. Risk and severity of degradation as a result of UV light is a function of material properties.

B.4.4. Thermal Movements

Temperature is a function of the average molecular kinetic energy of a given substance, such as air or water. All matter, including construction materials such as concrete and steel, respond to changes in temperature by changing shape, area, and/or volume. This expansion and/or contraction is a function of temperature change and the material' coefficient of thermal expansion. Inherently, volumetric changes for given temperature differentials vary based on material. With proper bonding and adhesiveness of a coating to a substrate, thermal expansion of a substrate may increase existing micropores or cracks, allowing temporary increased permeability allowance.

B.4.5. Chemical Exposure

Elastomers, coatings, sealants, and all protective elements are susceptible to chemical attack as a result of exposure. The risk and severity of this degradation is dependent on the chemistry of the material as well as the attacking chemical agent. Such reactions may be accidental (e.g. chemical spills) or time-dependent (e.g. formation of carbonic acid as water reacts with atmospheric carbon dioxide). Examples of harmful chemicals that may be present at the WWTP are chlorides, sulfates, oils, and acids.

APPENDIX C. ASSESSMENT METHODS

C.1. Assessment Methods

C.1.1. Concrete Elements - Overall Visual and Sounding Inspection

The visual and sounding surveys of the concrete were performed to identify deterioration, such as cracks, spalls, delaminations, efflorescence, mechanical damage, or other distress conditions that would affect the performance and durability of the structure. Select accessible surfaces were also mechanically sounded using hand-held hammers or other mechanical impactors to identify areas of deterioration that may not be visually evident. Generally, hollow-sounding concrete indicates delamination within the concrete. The approximate size and extent of the identified deterioration, such as delaminations, spalls, staining, or cracking, were documented on electronic plan or elevation sheets.

C.1.2. Concrete Elements - Non-Destructive Evaluation

C.1.2.1. Half-Cell Corrosion Potential (ASTM C876)

Half-cell potential (HCP) testing provides an indication of corrosion risk for reinforcing steel in concrete. Highly negative potential (voltage) readings indicate active corrosion is occurring. HCP measurements do not locate spalls, delaminations, or other damage sites. However, these conditions are often associated with corrosion, and thus usually coincide with more negative potential readings. Anodic (corroding) regions that have not yet caused delaminations or spalls can be identified by this technique, and thus HCPs can be used as an indicator of regions likely to become damaged by corrosion in the near future.

WJE performed HCP testing in general accordance with ASTM C876, *Standard Test Method for Corrosion Potentials of Uncoated Reinforcing Steel in Concrete*. The HCP surveys were performed by establishing an electrical connection (grounding) to the reinforcement and placing a reference electrode (copper/copper sulfate electrode, CSE)[1]) on the surface of the concrete.) on the surface of the concrete. Before commencing HCP measurements, electrical continuity testing was performed in each portion of the structure to verify the electrical continuity between two distant electrical connections to the reinforcing steel. Potentials were measured using an integrated reference cell and voltmeter with a wireless connection to a tablet-based data collection program, specifically XCell by Giatec Scientific. In general, potential measurements were performed in a grid pattern, and a contour map showing differences in measured values was generated for each test area based on the data collected.

Half-cell potentials can be influenced by a number of parameters, including temperature, measurement circuit resistivity, and electrochemical conditions at the steel reinforcement. Concrete resistivity is affected by moisture, chloride content, and surface carbonation. Electrochemical conditions at the steel are affected by the cement pore chemistry, oxygen availability, and chloride concentration. Saturated concrete causes very negative potentials because the oxygen availability is limited, and thus affects the passive film on the bar. As a result of the many factors affecting HCP, it is expected that testing results may vary from location to location, particularly related to distance from the water line or moisture penetration.

Typical ranges for half-cell potentials in a number of conditions per RILEM TC-154 are provided in Table 1. Separately, guidelines for interpretation of the half-cell data per ASTM C876 are shown in Table 2. Interpretation of HCPs using the guidelines in ASTM C876 is generally applicable for chloride-induced corrosion in uncarbonated, atmospherically-exposed elements. In dry, carbonated concrete, potential differences of 150 mV over a 3-foot distance indicate active corrosion.[2]

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[1] The Giatec XCell uses a mercury/mercury (I) chloride electrode in saturated KCl solution. Values are internally converted and reported as CSE equivalent.

[2] Broomfield, J. P. (2007). *Corrosion of Steel in Concrete.* New York: Taylor and Francis.

Table 1. Typical Half-Cell Potential Ranges (RILEM TC-154)

Concrete condition	Typical Range of Half-cell potentials, mV vs CSE, with [risk of corrosion activity]		
	Chloride-contaminated	**Carbonated**	**Chloride free**
Humid, non-saturated	-600 to -400 [high]	-400 to +100 [moderate]	-200 to +100 [low]
Saturated, oxygen-starved	-1000 to -900 [low]	no data	-1000 to -900 [low]
Dry	no data	0 to +200 [low]	0 to +200 [low]

Table 2. Half-Cell Potential Corrosion Risk (ASTM C876)

Uncarbonated or Chloride-Driven Corrosion (based on uncoated rebar in non-saturated conditions)	
HCP vs. CSE	**Corrosion Activity**
> -200 mV	low - 90% probability of no corrosion
-200 to -350 mV	moderate - increasing probability of corrosion
< -350 mV	high - 90% probability of corrosion

C.1.2.2. Corrosion Rate Testing

Corrosion rate testing was performed to verify HCP locations that indicated potential for active corrosion of reinforcement in select elements and provide a general rate of corrosion. The corrosion rate was measured using the Connection-less Electrical Pulse Response Analysis (CEPRA) technique, which is a non-destructive test method for reinforcement, using an iCOR instrument by Giatec. The test method measures the electrical response of a reinforcing bar to constant AC current. The frequency of the current is swept low to high, and the system response is analyzed. Because the voltage response to the current sweep from a corroding rebar to a non-corroding rebar is different, the relative rate of corrosion can be assessed. This is illustrated schematically in Figure 1 and Figure 2 below.

The iCOR manual suggests the qualitative descriptors for corrosion rate measurements by the device as shown in Table 3. In general, the measured rates should not be considered as a precise measurement for evaluating future section loss of the reinforcement, but rather a representative range for the relative severity of the corrosion rate.

Table 3. Interpretation of Corrosion Rate Measurements

Corrosion Rate		Classification
μA/cm^2	**μm/yr**	
< 1.0	< 10	Passive / Low
1 to 3	10 to 30	Moderate
3 to 10	30 to 100	High
> 10	> 100	Severe

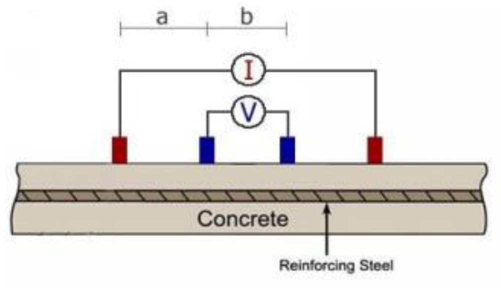


Figure 1. Configuration of four probes on the surface of concrete (figure from iCOR manual).

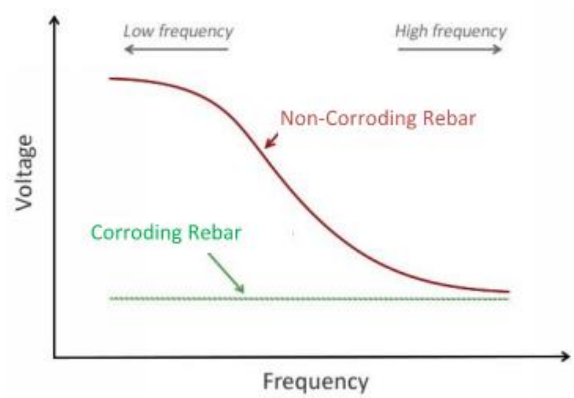


Figure 2. Schematic illustration of the voltage-frequency response of a corroding and non-corroding rebar (figure from iCOR manual).

C.1.2.3. Cover and Bar Spacing Measurements using Ground-Penetrating Radar (GPR))

To measure concrete cover to reinforcing steel, and location, Ground-Penetrating Radar (GPR) testing was performed on surface of the selected elements. GPR is a non-destructive testing technique that involves the use of a high-frequency radar antenna, which transmits electromagnetic radar pulses along a discrete longitudinal scan at the surface of a structural element. Electromagnetic signals reflected from material interfaces having different dielectric properties are collected by the antennae and interpreted. Guidelines for GPR considered during this work included ACI 228.2R-98 *Nondestructive Test Methods for Evaluation of Concrete in Structures* and ASTM D6432 - 11 *Standard Guide for Using the Surface Ground Penetrating Radar Method for Subsurface Investigation*. GPR testing was completed using a handheld GPR 'StructureScan Mini' unit manufactured by GSSI, operating at a central frequency of 2600 MHz.

GPR data was calibrated by drilling holes to and directly measuring the cover depth at representative locations. GPR was also used to locate reinforcement in the vicinity of inspection openings.

C.1.3. Concrete Elements - Inspection Openings

Inspection openings were made by coring through concrete elements in select structures. The locations of the openings were selected to support investigation of notable features visible from the concrete surface, including observed cracking, delamination or potential corrosion of embedded reinforcing bars. The openings were repaired using a prepackaged concrete repair material.

C.1.4. Steel Structure Elements - Overall Visual Inspection

WJE performed a visual inspection of readily accessible steel elements, including the south Anaerobic Digester lid, and open-air blending tank framing at the Sludge Processing Unit. Elements were reviewed for cracks, fractures, corrosion, and section loss. Observations were documented electronically, supplemented with photographs and selected measurements.

C.1.5. Steel Structure Elements - Non-Destructive Evaluation

C.1.5.1. Ultrasonic Steel Thickness Measurements (ASTM E797)

Measuring the thickness of materials using the contact pulse-echo method includes a transducer that transmits and receives the ultrasonic energy or sound waves that the gauge uses to determine the thickness of the material being measured. The device generates an electric initial pulse which is guided to the transmitter element of the probe. Once there, it is converted into a mechanical ultrasonic pulse. By means of a couplant, the ultrasonic pulse is transmitted from the probe to the material to be tested which it passes through at a velocity typical of the material (sound velocity of the material) until it encounters a change in the material. Part of the pulse energy is reflected from there and sent back to the probe (echo).

C.1.5.2. Ultrasonic Coating Thickness Measurements (ASTM D7091)

The instrument employs a measuring probe and the magnetic induction, Hall-effect or eddy current measurement principle in conjunction with electronic micro-processors to produce a coating thickness measurement. The gage probe is placed directly (in a perpendicular position) on the coated surface to obtain a measurement. For gages measuring on ferrous substrates, the magnetic induction or Hall-effect principles are used to measure a change in magnetic field strength within their probes to produce a coating thickness measurement. These gages determine the effect on the magnetic field generated by the probe due to the proximity of the substrate. For gages measuring on non-ferrous metals, the gage probe coil is energized by alternating current that induces eddy currents in the metal substrate. The eddy currents in turn create a secondary magnetic field within the substrate. The characteristics of this secondary field are dependent upon the distance between the probe and the basis metal. This distance (gap) is measured by the probe and shown on the gage display as the thickness (microns or mils) of the intervening coating.

C.1.5.3. Adhesion Testing (ASTM D3359)

Qualitative coating adhesion testing was performed utilizing Test Method A, which includes making an “X” shaped cut though a coating using a razorblade, affixing a piece of tape to the surface of the coating over the “X”, and removing the tape. The amount of coating removed by the tape as a part of the test is rated per the ASTM, and given a value between 5A (no peeling or removal) to 0A (removal beyond the area of the X).

C.1.6. Steel Piping - Overall Visual and Ultrasonic Thickness Survey

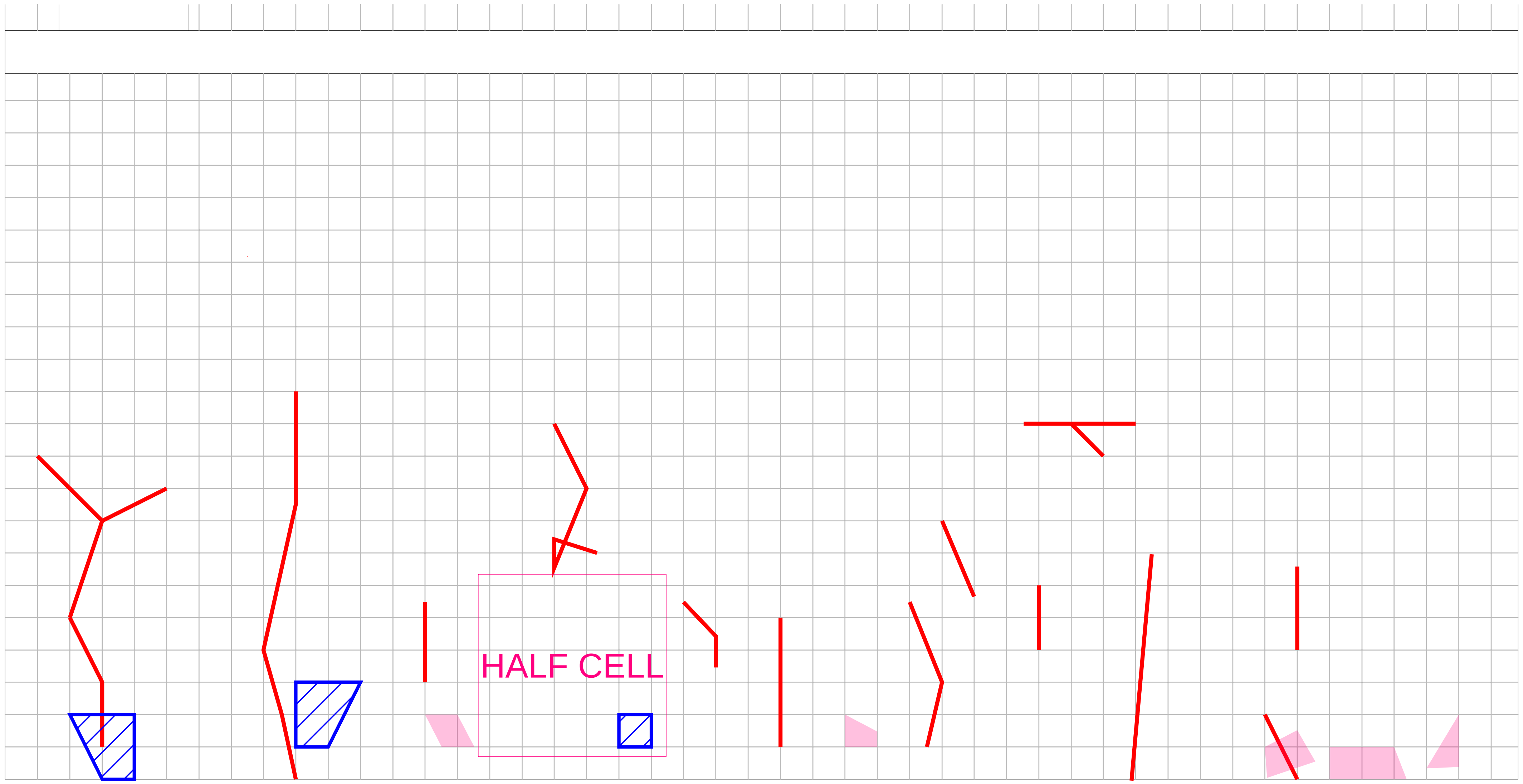
WJE performed a visual inspection of the inlet and outlet piping lines within the Raw Sewage Pump room, as well as the Return Activated and Waste Activated Sludge lines within the Aeration Basin blower room. Elements were inspected for cracks, fractures, corrosion, and section loss. The extent of damage or deterioration was quantified or estimated where observed. Observations were documented electronically, supplemented with photographs and selected measurements.

C.1.7. Steel Piping - Non-Destructive Evaluation

C.1.7.1. Ultrasonic Steel Thickness Measurements (ASTM E797)

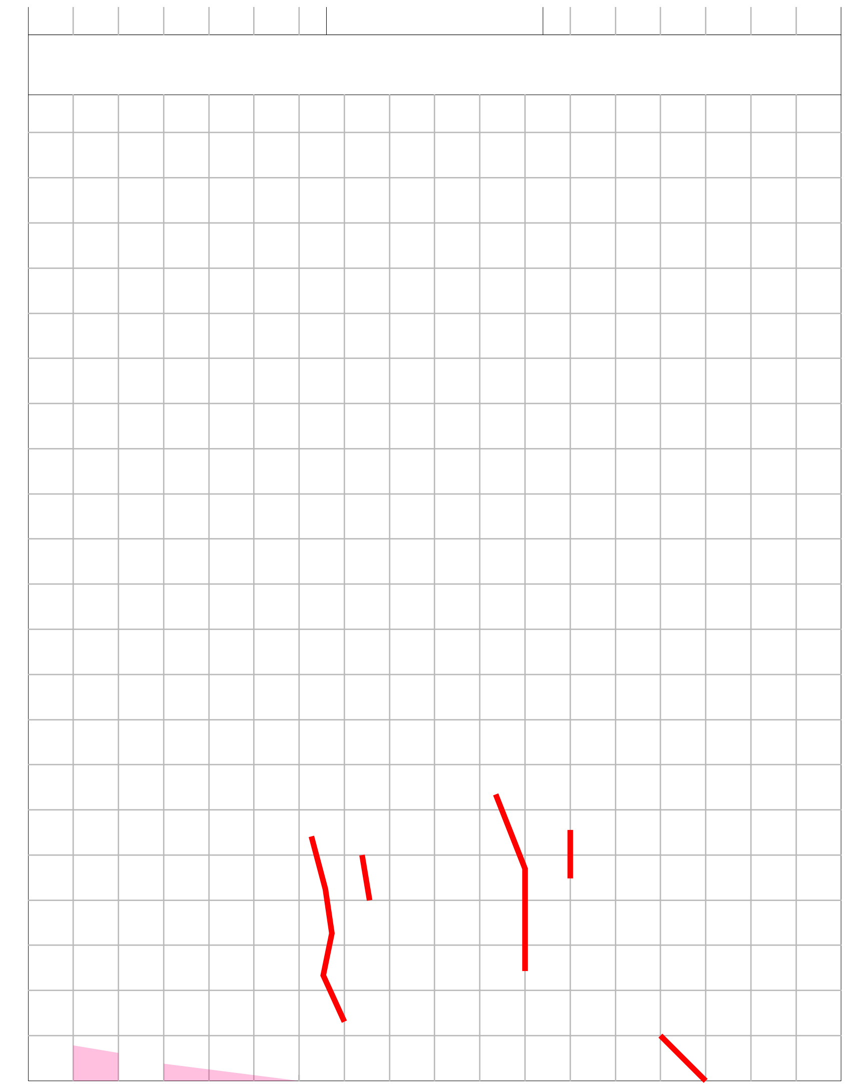
See Steel Structure Elements section, as process and equipment used is the same for both areas.

APPENDIX D. FIELD SHEETS



1 SOUTH WALL INTERIOR ELEVATION

Scale: 1 box - 1'-0"



2 WEST WALL INTERIOR ELEVATION

Scale:1 box - 1'-0"

DRAWING LEGEND:

- CRACK
- DELAMINATION
- DISTRESS
- PASTE EROSION
- PONDING WATER
- INSPECTION OPENING

DRAWING NOTES:

BP	- BOWED PANEL	JT-LK	- JOINT LEAK	SJ	- SEALANT JOINT DISTRESS
EFL	- EFFLORESCENCE	MPC	- MAP PATTERN CRACKING		
ER	- EXPOSED REINFORCING	PS	- PIPE STAINING		

WJE ENGINEERS ARCHITECTS MATERIAL SCIENTISTS

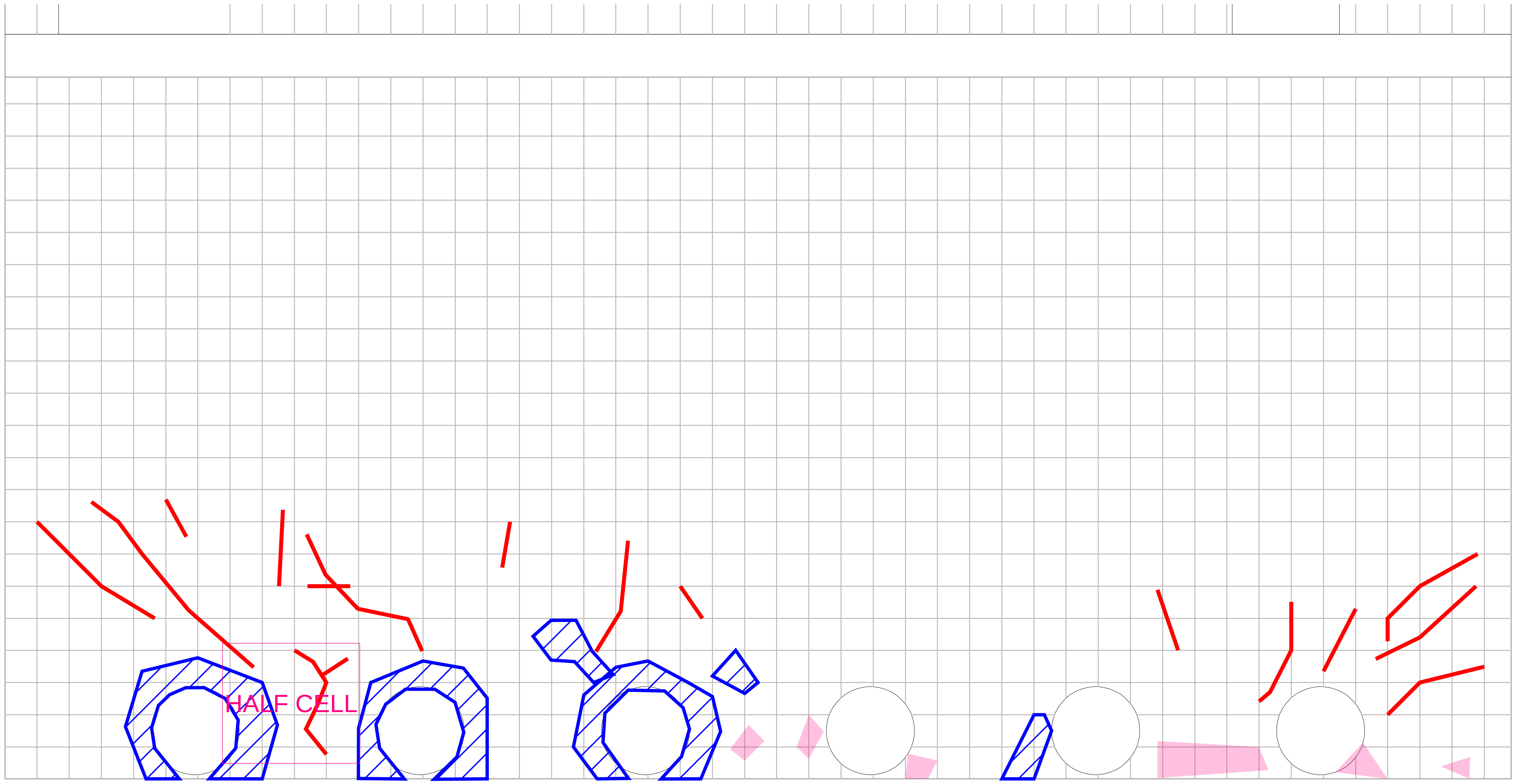
Wiss, Janney, Elstner Associates, Inc.

PERSIGO WASTE WATER TREATMENT PLANT
GRAND JUNCTION, COLORADO
WJE No. 2019.3776.0

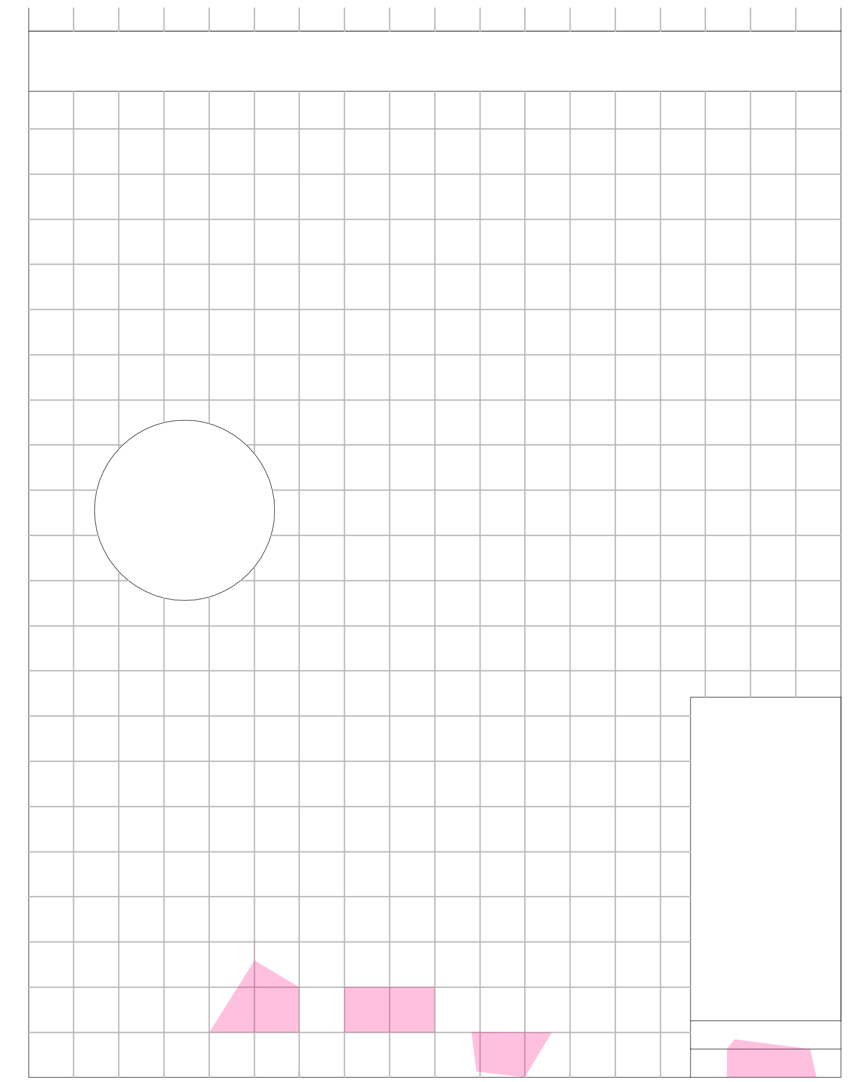
RAW SEWAGE PUMP STATION

FIGURE No.

RS.01



1 NORTH WALL INTERIOR ELEVATION
Scale: 1 box - 1'-0"



2 EAST WALL INTERIOR ELEVATION
Scale: 1 box - 1'-0"

DRAWING LEGEND:

- CRACK
- DELAMINATION
- DISTRESS
- PASTE EROSION
- PONDING WATER
- INSPECTION OPENING

DRAWING NOTES:

BP	- BOWED PANEL	JT-LK	- JOINT LEAK	SJ	- SEALANT JOINT DISTRESS
EFL	- EFFLORESCENCE	MPC	- MAP PATTERN CRACKING		
ER	- EXPOSED REINFORCING	PS	- PIPE STAINING		

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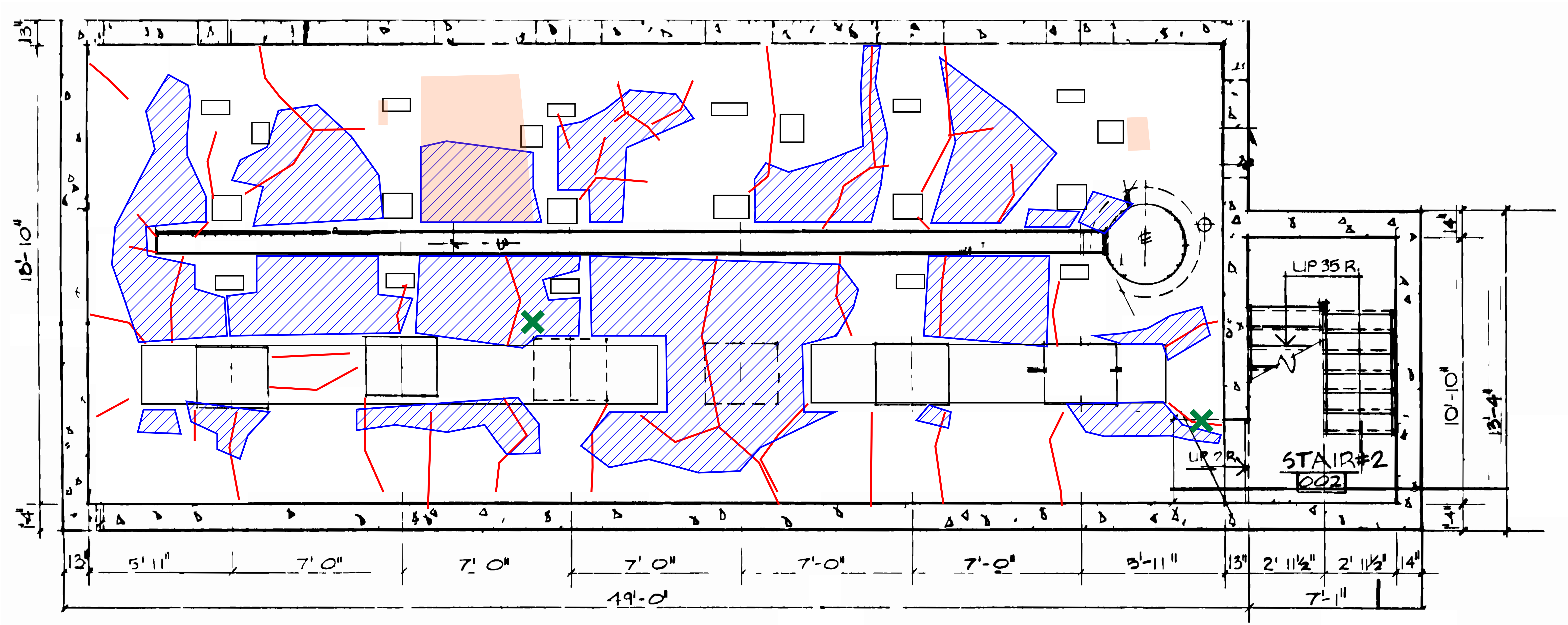
RAW SEWAGE PUMP STATION

FIGURE No.
RS.02



1 Pit Floor Plan
Scale: Dimensioned as Indicated on Drawing

DRAWING LEGEND:

- CRACK	- PASTE EROSION
- DELAMINATION	- PONDING WATER
- DISTRESS	- INSPECTION OPENING

DRAWING NOTES:

BP - BOWED PANEL	JT-LK - JOINT LEAK	SJ - SEALANT JOINT DISTRESS
EFL - EFFLORESCENCE	MPC - MAP PATTERN CRACKING	
ER - EXPOSED REINFORCING	PS - PIPE STAINING	

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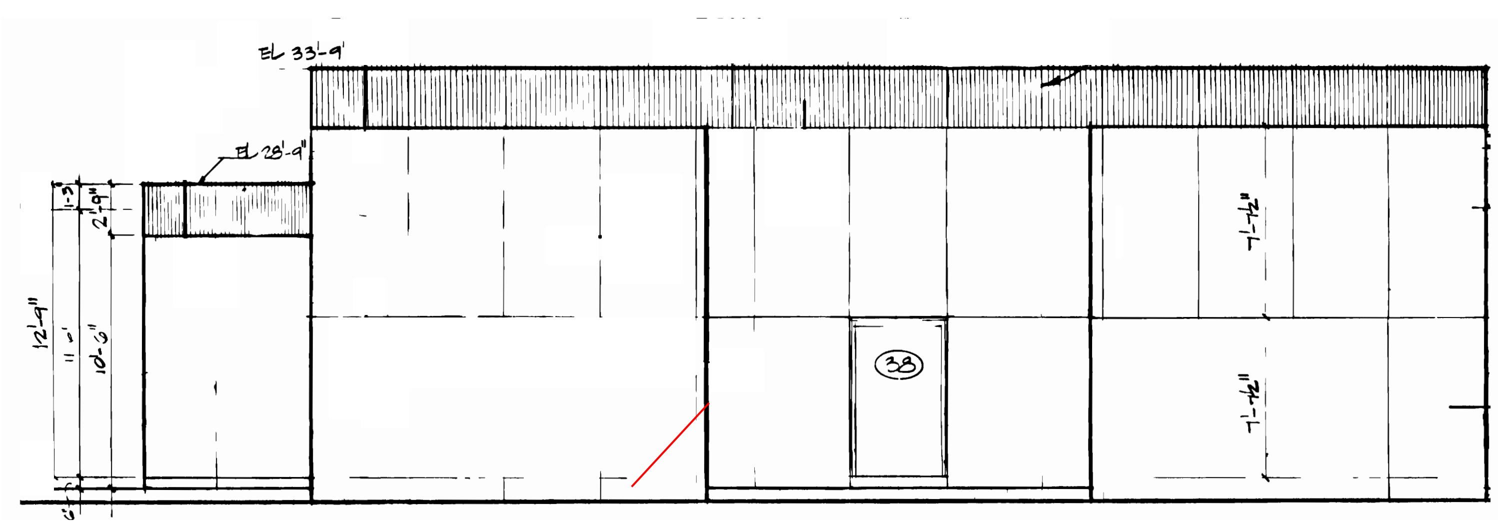
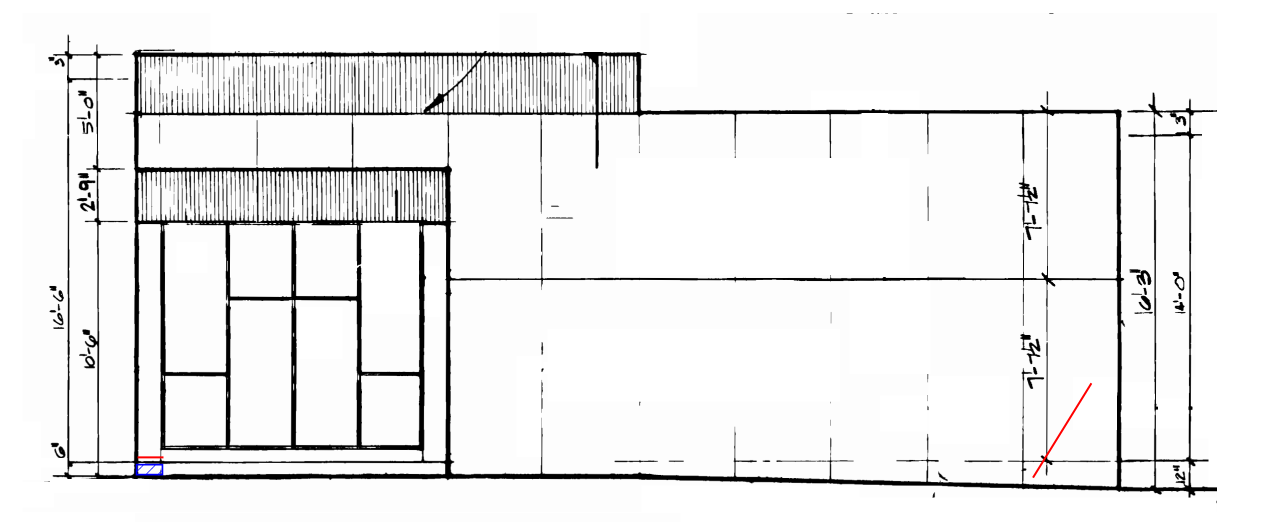
RAW SEWAGE PUMP STATION

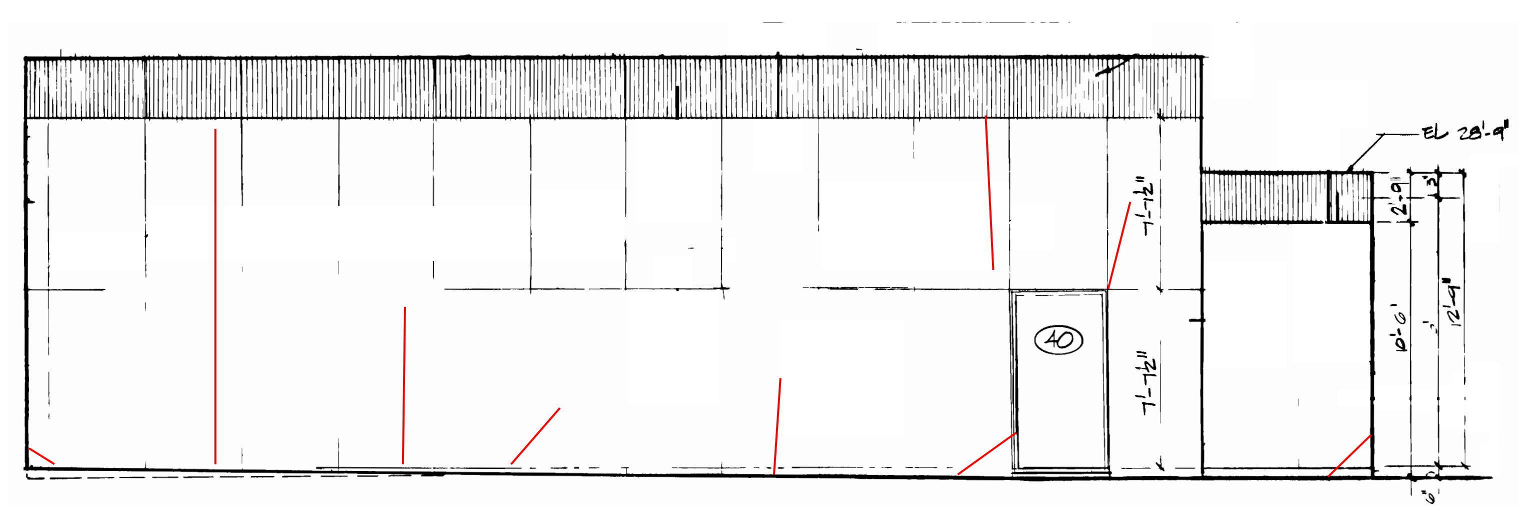
FIGURE No.
RS.03



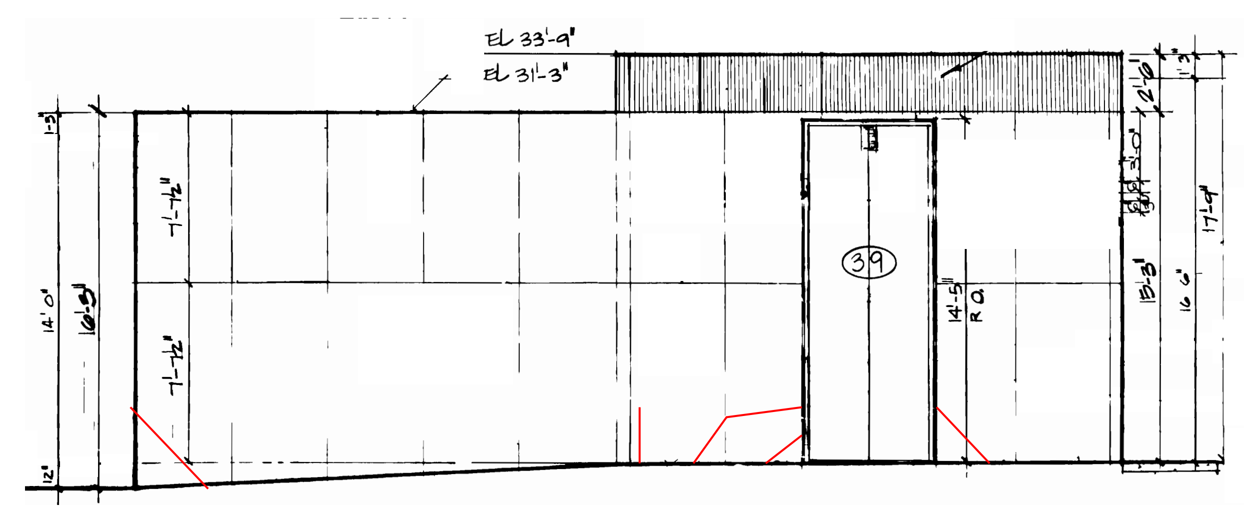
1 North Elevation
Scale: Dimensioned as Indicated on Drawing



2 East Elevation
Scale: Dimensioned as Indicated on Drawing



3 South Elevation
Scale: Dimensioned as Indicated on Drawing



4 West Elevation
Scale: Dimensioned as Indicated on Drawing

DRAWING LEGEND:

- CRACK
- PASTE EROSION
- DELAMINATION
- PONDING WATER
- DISTRESS
- INSPECTION OPENING

DRAWING NOTES:

- BP - BOWED PANEL
- JT-LK - JOINT LEAK
- SJ - SEALANT JOINT DISTRESS
- EFL - EFFLORESCENCE
- MPC - MAP PATTERN CRACKING
- ER - EXPOSED REINFORCING
- PS - PIPE STAINING

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RAW SEWAGE PUMP STATION

FIGURE No.
RS.04

1 Clarifier #1 - Unwrapped Exterior
Scale: Dimensioned as Indicated on Drawing

DRAWING LEGEND:

- CRACK
- PASTE EROSION
- DELAMINATION
- PONDING WATER
- DISTRESS
- INSPECTION OPENING

DRAWING NOTES:

BP - BOWED PANEL
JT-LK - JOINT LEAK
SJ - SEALANT JOINT DISTRESS
EFL - EFFLORESCENCE
MPC - MAP PATTERN CRACKING
ER - EXPOSED REINFORCING
PS - PIPE STAINING

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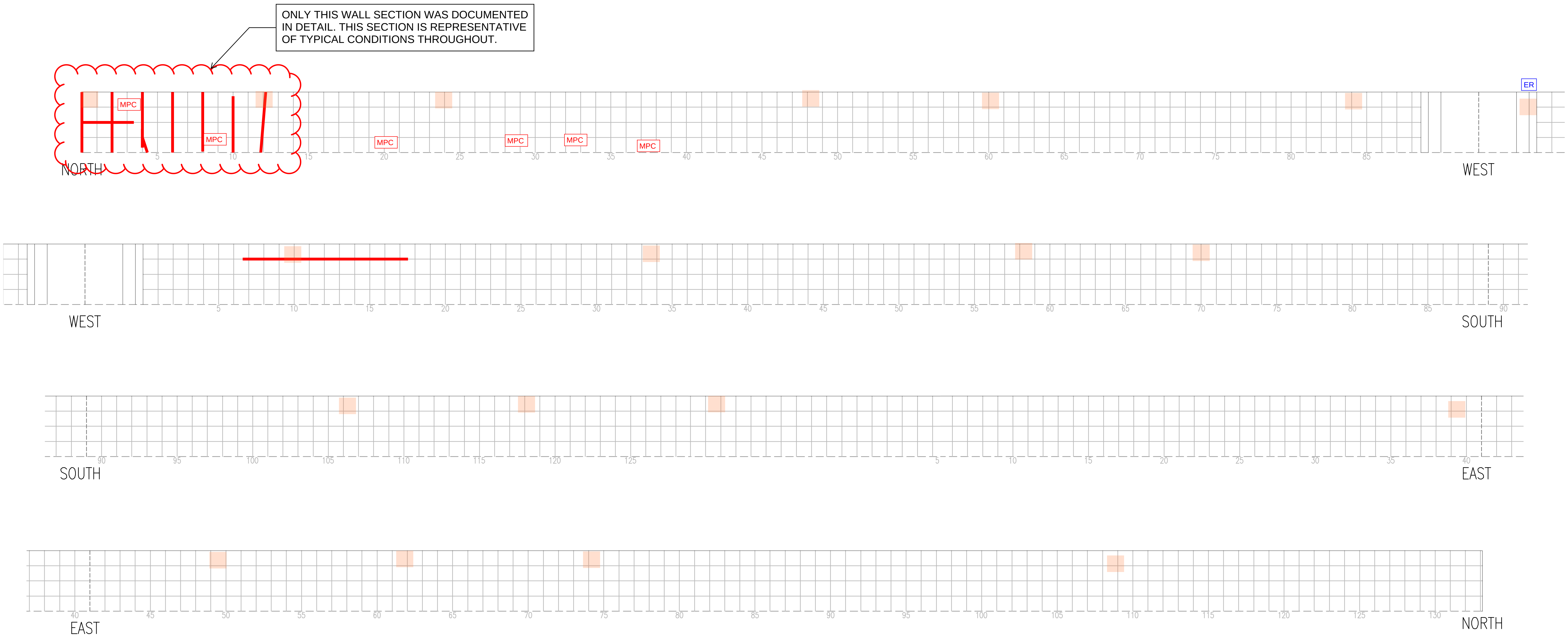
PRIMARY CLARIFIER #1

FIGURE No.
PC1.01



1 Clarifier #2 - Unwrapped Exterior

Scale: Dimensioned as Indicated on Drawing

DRAWING LEGEND:

- CRACK
- DELAMINATION
- DISTRESS
- PASTE EROSION
- PONDING WATER
- INSPECTION OPENING

DRAWING NOTES:

BP - BOWED PANEL
EFL - EFFLORESCENCE
ER - EXPOSED REINFORCING
JT-LK - JOINT LEAK
MPC - MAP PATTERN CRACKING
PS - PIPE STAINING
SJ - SEALANT JOINT DISTRESS

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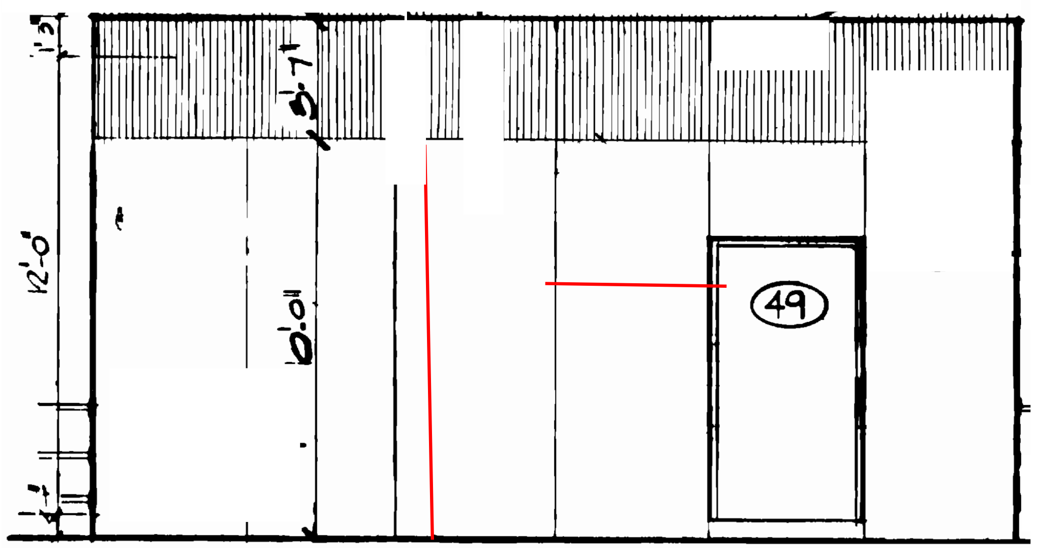
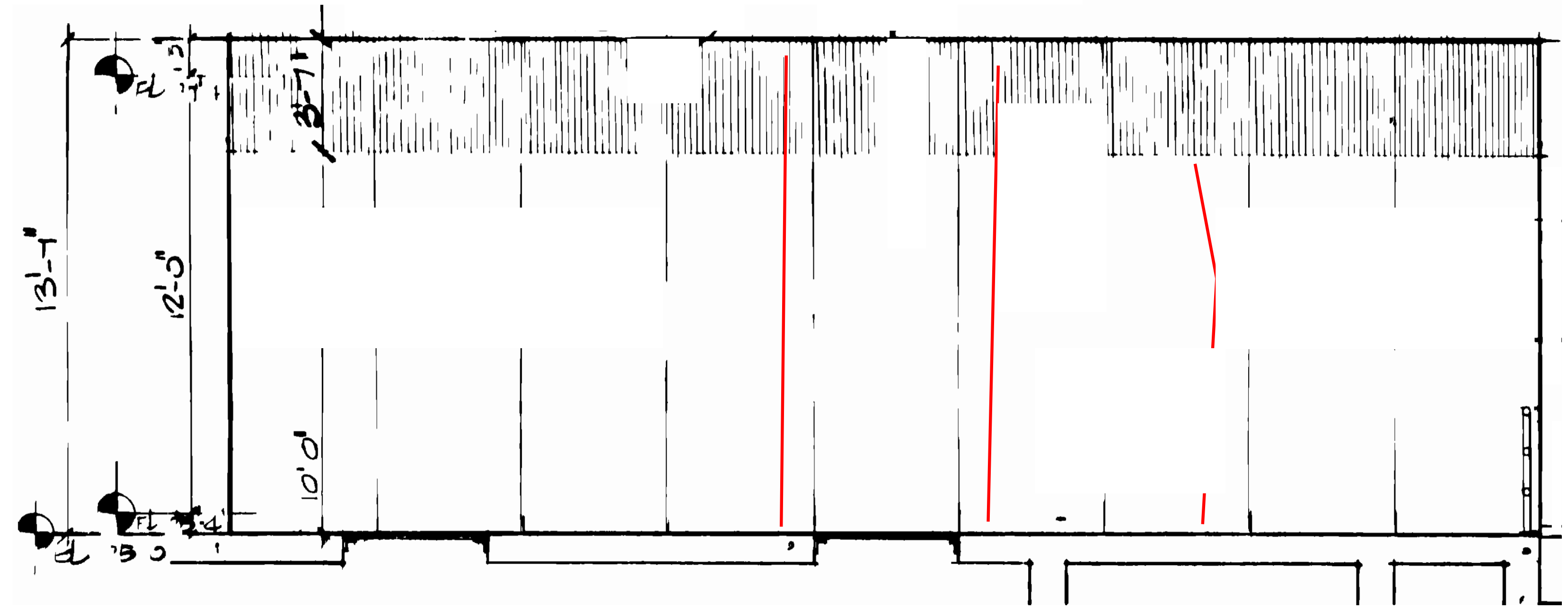
GRAND JUNCTION, COLORADO
WJE No. 2019.3776.0

PRIMARY CLARIFIER #2

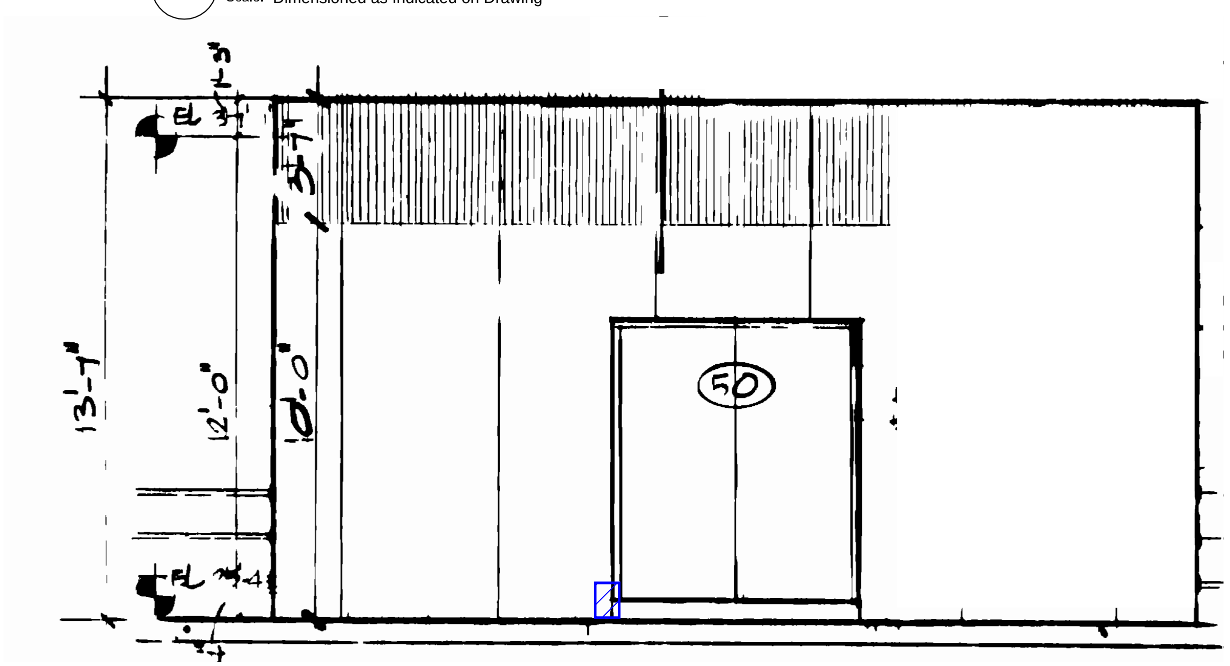
FIGURE No.
PC2.01



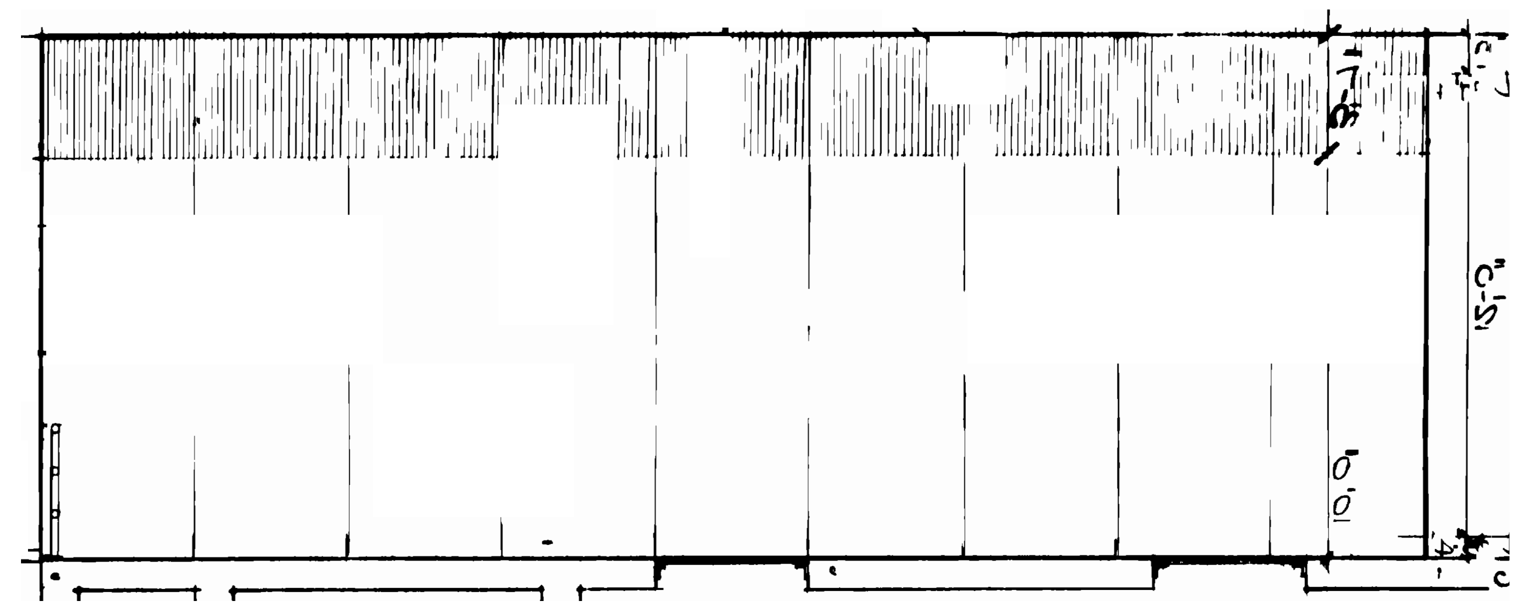
1 North Elevation
Scale: Dimensioned as Indicated on Drawing



2 East Elevation
Scale: Dimensioned as Indicated on Drawing



3 South Elevation
Scale: Dimensioned as Indicated on Drawing



4 West Elevation
Scale: Dimensioned as Indicated on Drawing

DRAWING LEGEND:

- CRACK	- PASTE EROSION
- DELAMINATION	- PONDING WATER
- DISTRESS	- INSPECTION OPENING

DRAWING NOTES:

BP - BOWED PANEL	JT-LK - JOINT LEAK	PS - PIPE STAINING
EFL - EFFLORESCENCE	MPC - MAP PATTERN CRACKING	SJ - SEALANT JOINT DISTRESS
ER - EXPOSED REINFORCING	PD - POST BASE DISTRESS	

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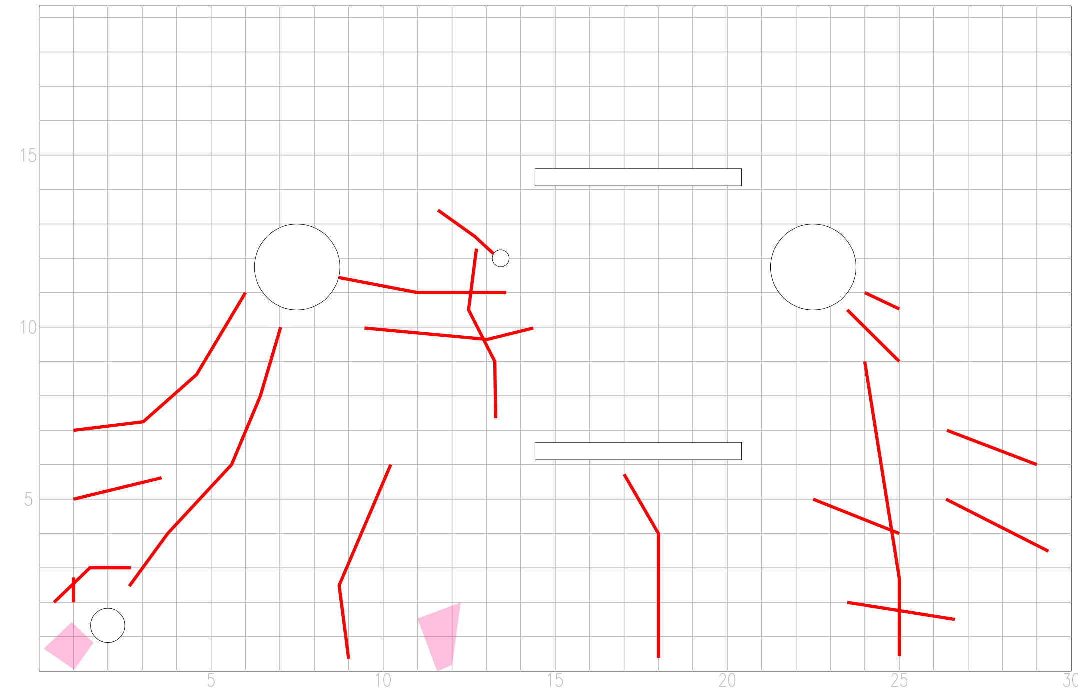
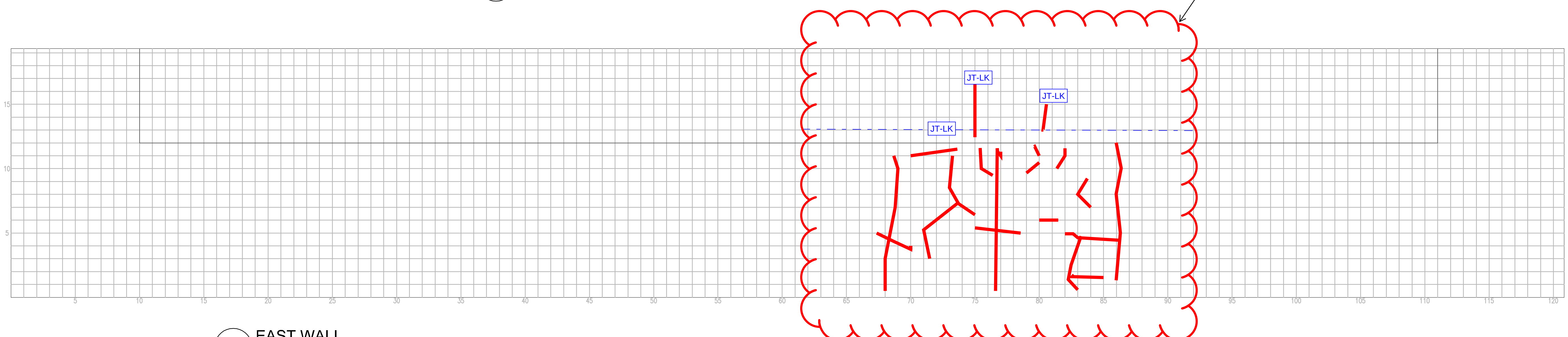
AERATION BASIN EXTERIOR WALLS

FIGURE No.
AB.01



1 NORTH WALL
Scale: 1 box - 1'-0"

ONLY THIS WALL SECTION WAS DOCUMENTED IN DETAIL. THIS SECTION IS REPRESENTATIVE OF TYPICAL CONDITIONS THROUGHOUT.



2 EAST WALL
Scale: 1 box - 1'-0"

DRAWING LEGEND:

- CRACK
- DELAMINATION
- DISTRESS
- PASTE EROSION
- PONDING WATER
- INSPECTION OPENING

DRAWING NOTES:

BP	- BOWED PANEL	JT-LK	- JOINT LEAK	PS	- PIPE STAINING
EFL	- EFFLORESCENCE	MPC	- MAP PATTERN CRACKING	SJ	- SEALANT JOINT DISTRESS
ER	- EXPOSED REINFORCING	PD	- POST BASE DISTRESS		

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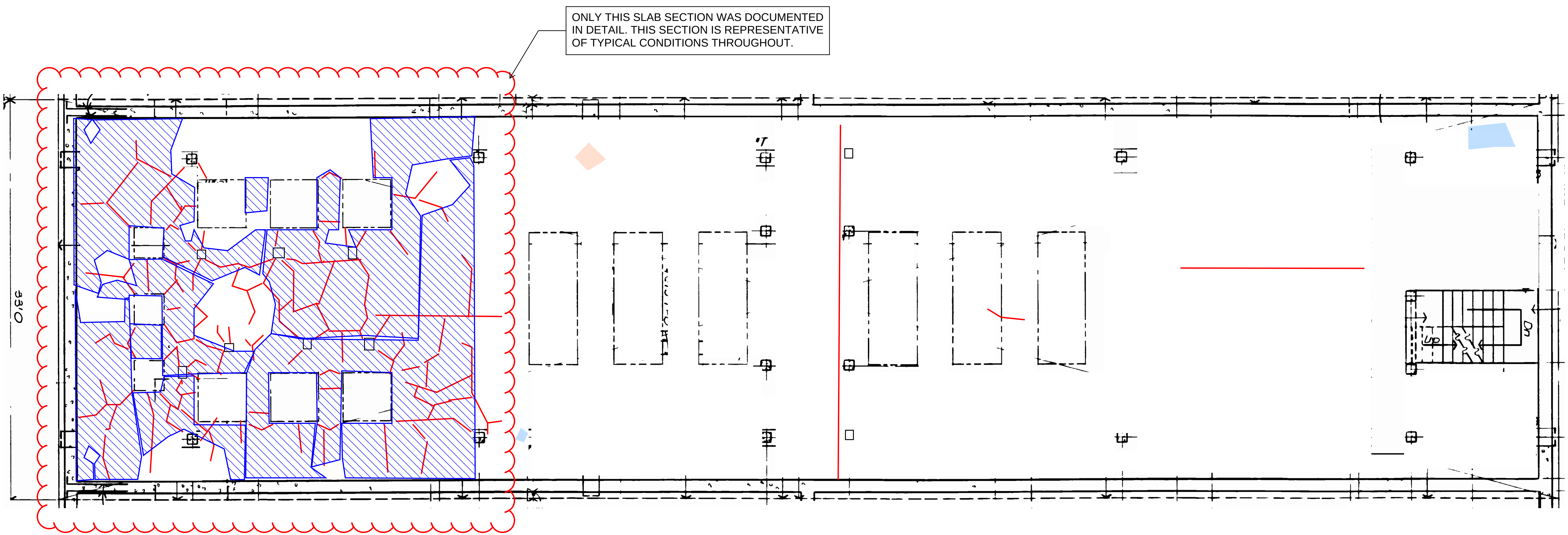
AERATION BASIN INTERIOR WALLS

FIGURE No. **AB.02**



1 Blower Room Slab Plan

Scale: Dimensioned as Indicated on Drawing

DRAWING LEGEND:

- CRACK	- PASTE EROSION
- DELAMINATION	- PONDING WATER
- DISTRESS	- INSPECTION OPENING

DRAWING NOTES:

BP - BOWED PANEL	JT-LK - JOINT LEAK	PS - PIPE STAINING
EFL - EFFLORESCENCE	MPC - MAP PATTERN CRACKING	SJ - SEALANT JOINT DISTRESS
ER - EXPOSED REINFORCING	PD - POST BASE DISTRESS	

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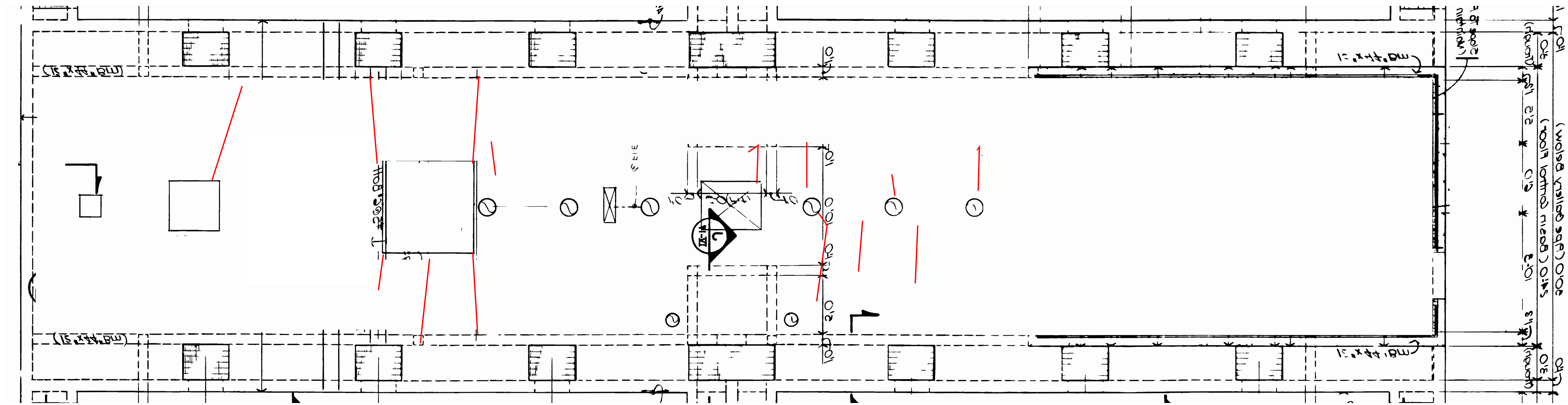
AERATION BASIN BLOWER ROOM SLAB

FIGURE No. **AB.03**



1 Catwalk Soffit Plan

Scale: Dimensioned as Indicated on Drawing

DRAWING LEGEND:

- CRACK
- DELAMINATION
- DISTRESS
- PASTE EROSION
- PONDING WATER
- INSPECTION OPENING

DRAWING NOTES:

BP	BOWED PANEL
EFL	EFFLORESCENCE
ER	EXPOSED REINFORCING
JT-LK	JOINT LEAK
MPC	MAP PATTERN CRACKING
PD	POST BASE DISTRESS
PS	PIPE STAINING
SJ	SEALANT JOINT DISTRESS

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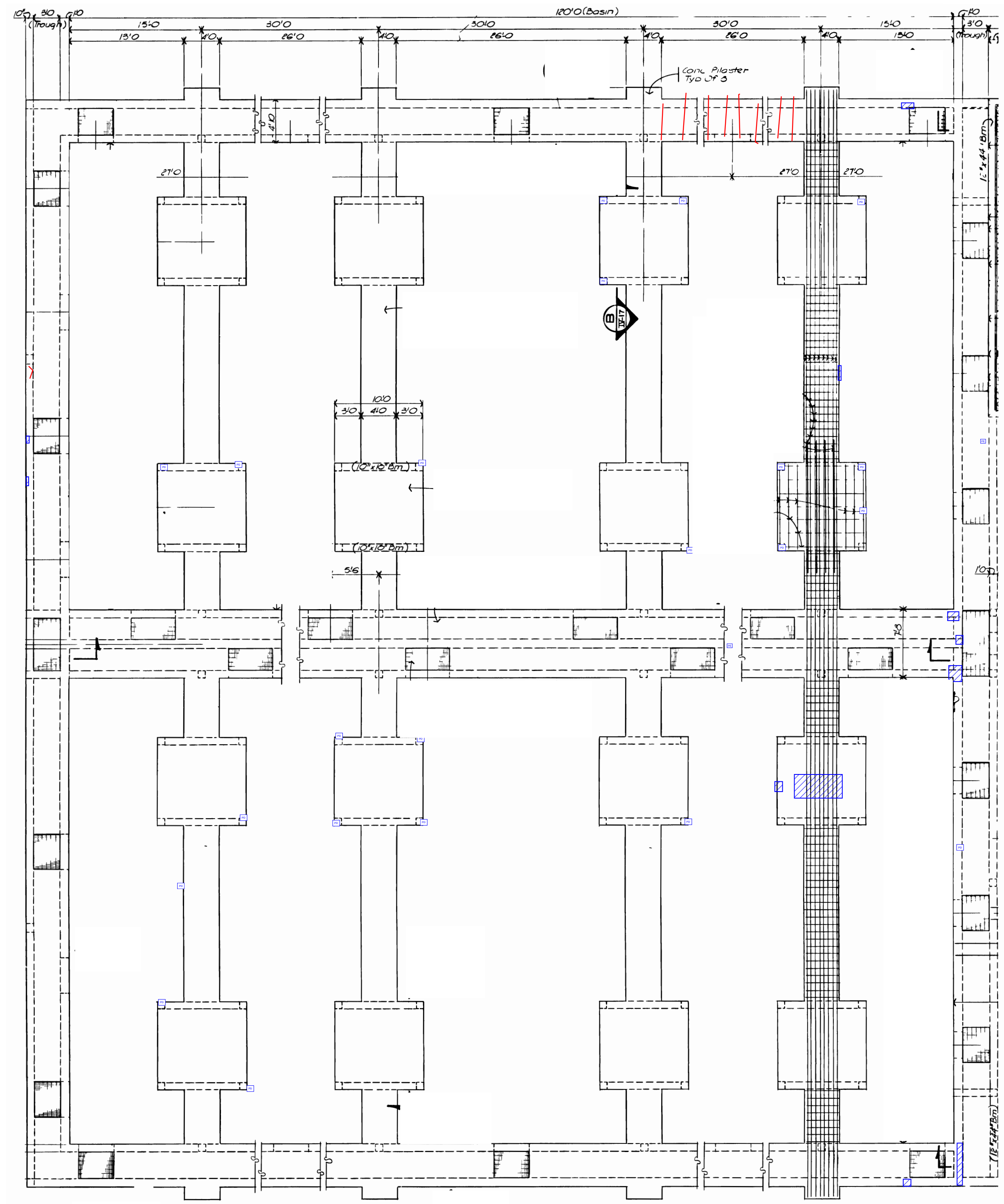
AERATION BASIN CATWALK SOFFIT

FIGURE No.

AB.04



1 West End Catwalks
Scale: Dimensioned as Indicated on Drawing

DRAWING LEGEND:

- CRACK
- DELAMINATION
- DISTRESS
- PASTE EROSION
- PONDING WATER
- INSPECTION OPENING

DRAWING NOTES:

BP	BOWED PANEL
EFL	EFFLORESCENCE
ER	EXPOSED REINFORCING
JT-LK	JOINT LEAK
MPC	MAP PATTERN CRACKING
PD	POST BASE DISTRESS
PS	PIPE STAINING
SJ	SEALANT JOINT DISTRESS

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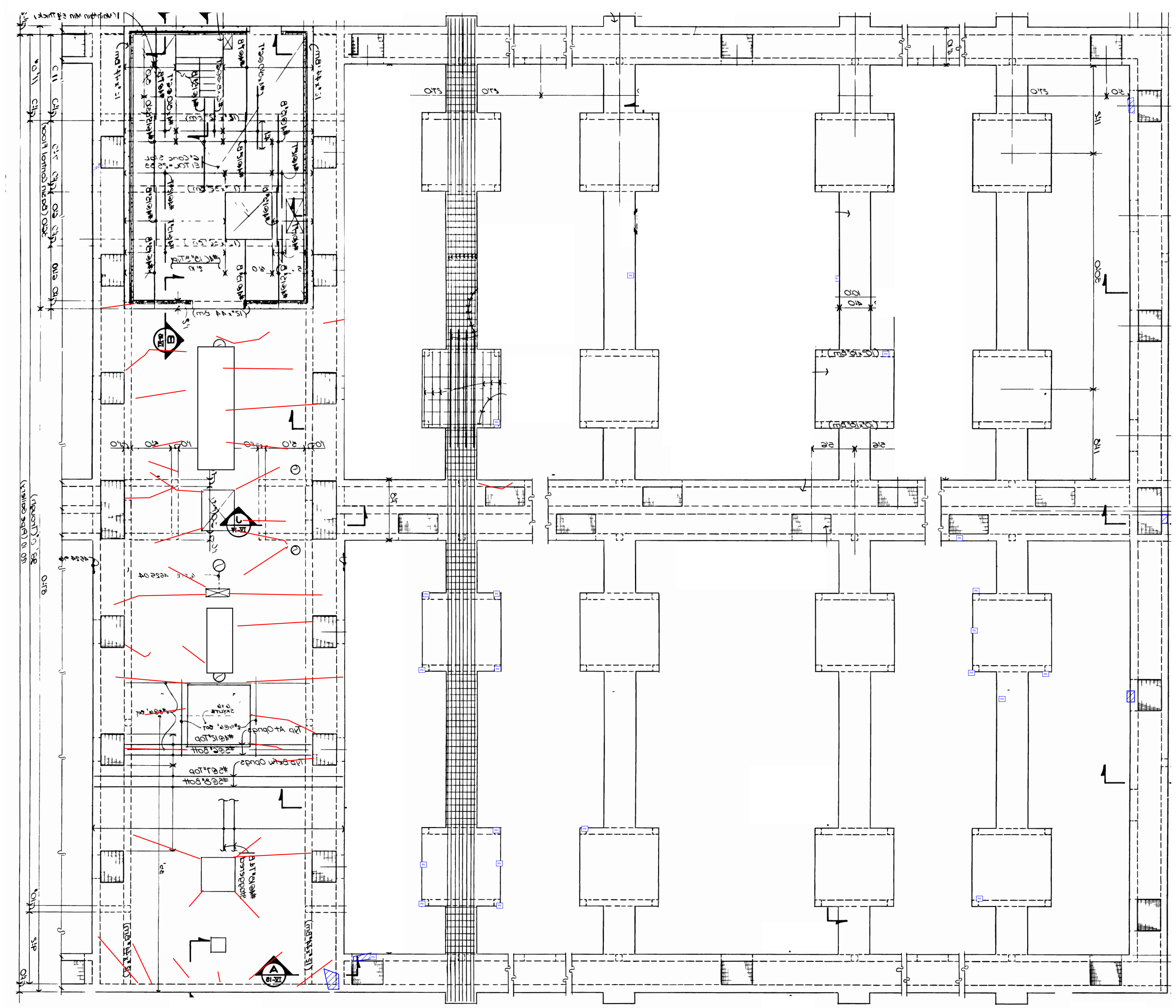
AERATION BASIN CATWALKS

FIGURE No. **AB.05**



1 East End Catwalks
Scale: Dimensioned as Indicated on Drawing

DRAWING LEGEND:

- CRACK
- PASTE EROSION
- DELAMINATION
- PONDING WATER
- DISTRESS
- INSPECTION OPENING

DRAWING NOTES:

- BP - BOWED PANEL
- EFL - EFFLORESCENCE
- ER - EXPOSED REINFORCING
- JT-LK - JOINT LEAK
- MPC - MAP PATTERN CRACKING
- PD - POST BASE DISTRESS
- PS - PIPE STAINING
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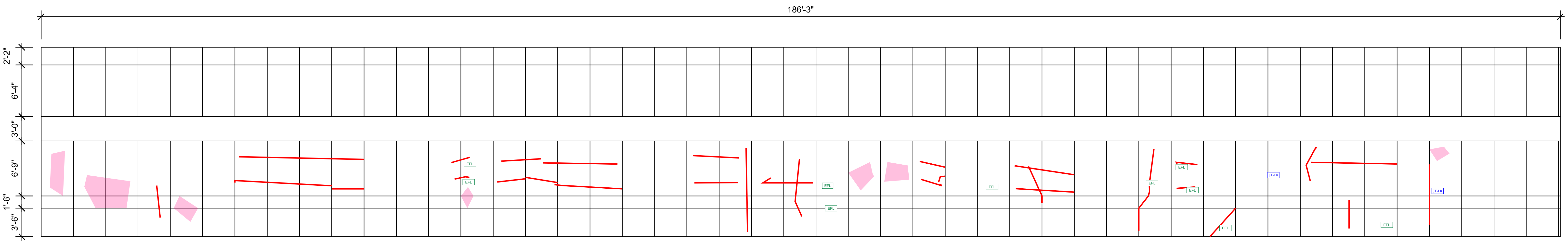
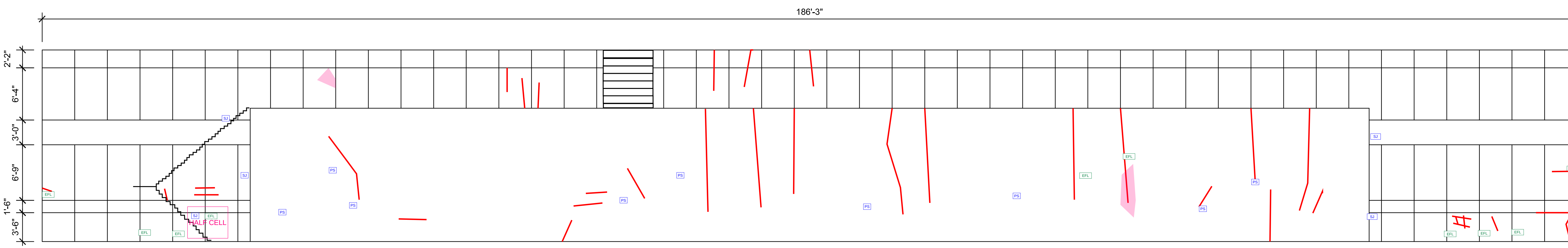
AERATION BASIN CATWALKS

FIGURE No.
AB.06



1 South Elevation
Scale: Dimensioned as Indicated on Drawing



2 North Elevation
Scale: Dimensioned as Indicated on Drawing

DRAWING LEGEND:

- CRACK
- DELAMINATION
- DISTRESS
- PASTE EROSION
- PONDING WATER
- INSPECTION OPENING

DRAWING NOTES:

- BP - BOWED PANEL
- EFL - EFFLORESCENCE
- ER - EXPOSED REINFORCING
- JT-LK - JOINT LEAK
- MPC - MAP PATTERN CRACKING
- PS - PIPE STAINING
- SJ - SEALANT JOINT DISTRESS

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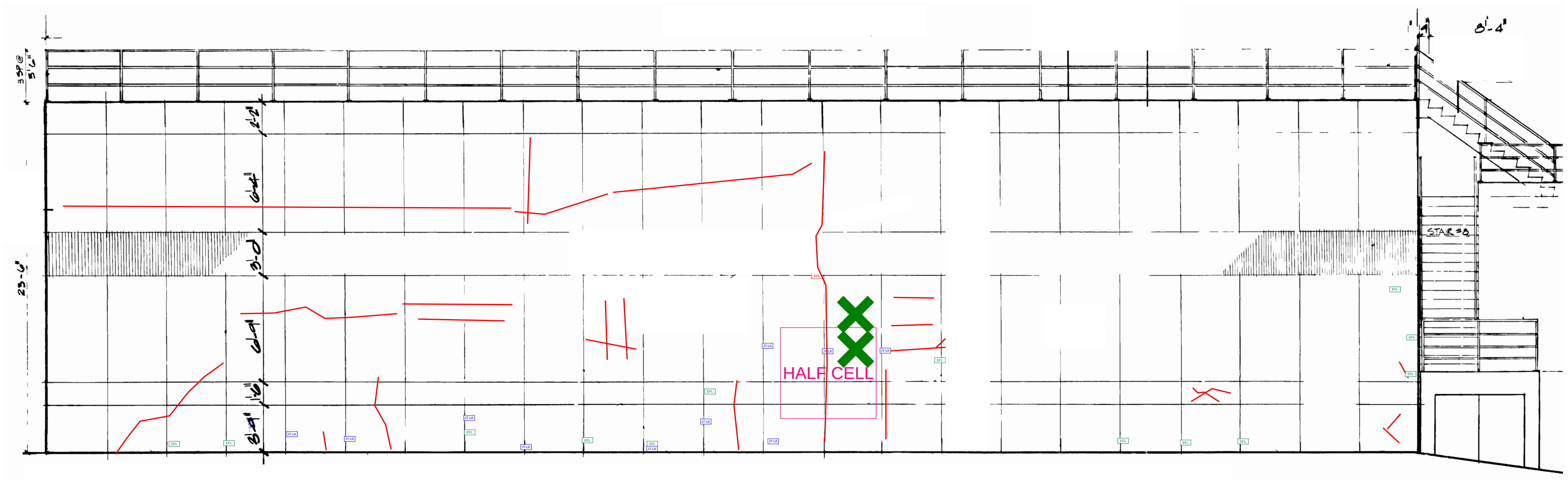
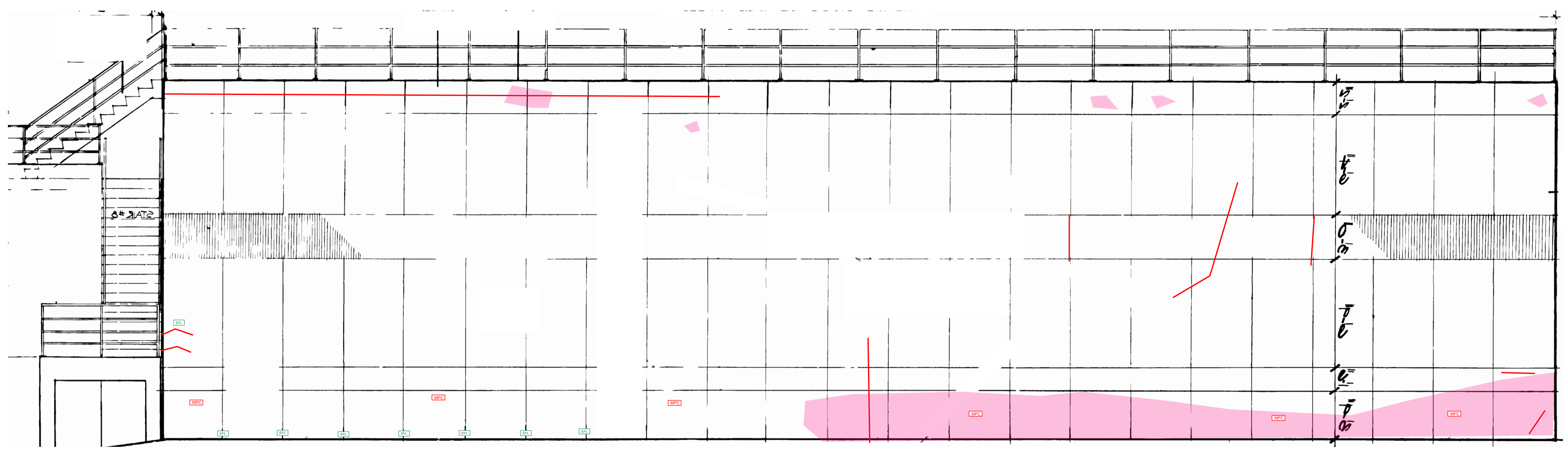
WJE No. 2019.3776.0

AEROBIC DIGESTER

FIGURE No.
AD2.01



1 East Elevation
Scale: Dimensioned as Indicated on Drawing



1 West Elevation
Scale: Dimensioned as Indicated on Drawing

DRAWING LEGEND:

- CRACK
- DELAMINATION
- DISTRESS
- PASTE EROSION
- PONDING WATER
- INSPECTION OPENING

DRAWING NOTES:

BP	BOWED PANEL
EFL	EFFLORESCENCE
ER	EXPOSED REINFORCING
JT-LK	JOINT LEAK
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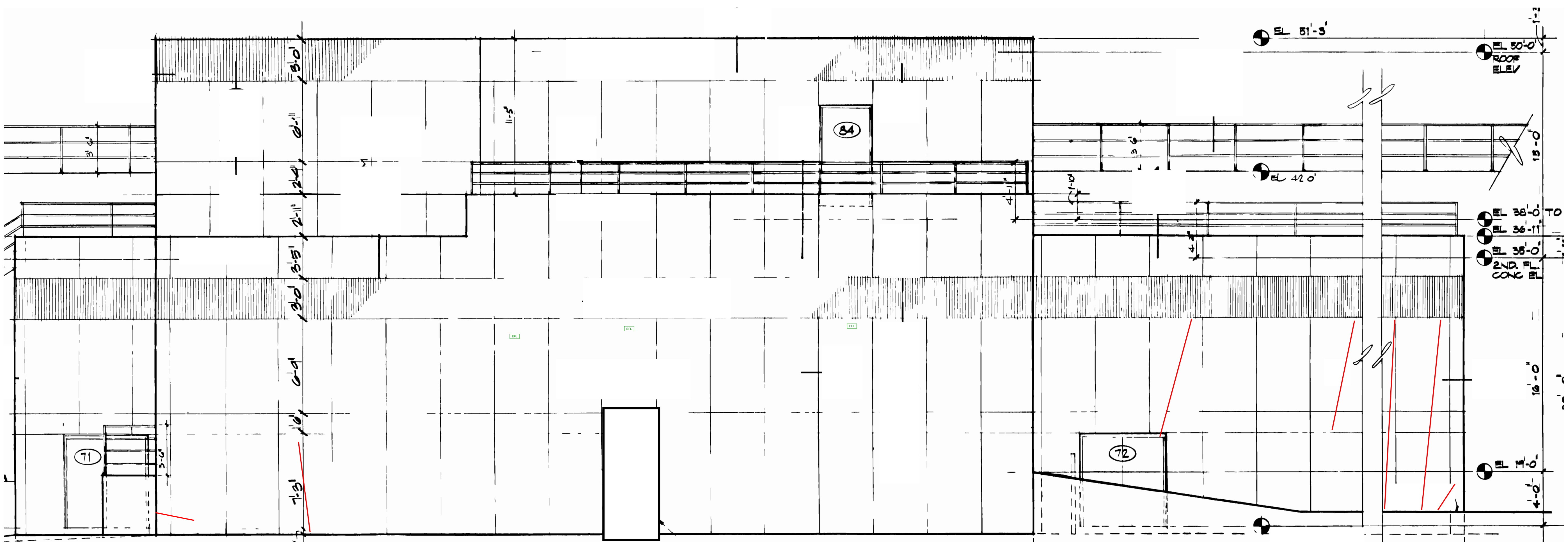
AEROBIC DIGESTER

FIGURE No.
AD2.02



1 North Elevation

Scale: Dimensioned as Indicated on Drawing

DRAWING LEGEND:

- CRACK
- PASTE EROSION
- DELAMINATION
- PONDING WATER
- DISTRESS
- INSPECTION OPENING

DRAWING NOTES:

- BP - BOWED PANEL
- JT-LK - JOINT LEAK
- PS - PIPE STAINING
- EFL - EFFLORESCENCE
- MPC - MAP PATTERN CRACKING
- SJ - SEALANT JOINT DISTRESS
- ER - EXPOSED REINFORCING
- PD - POST BASE DISTRESS

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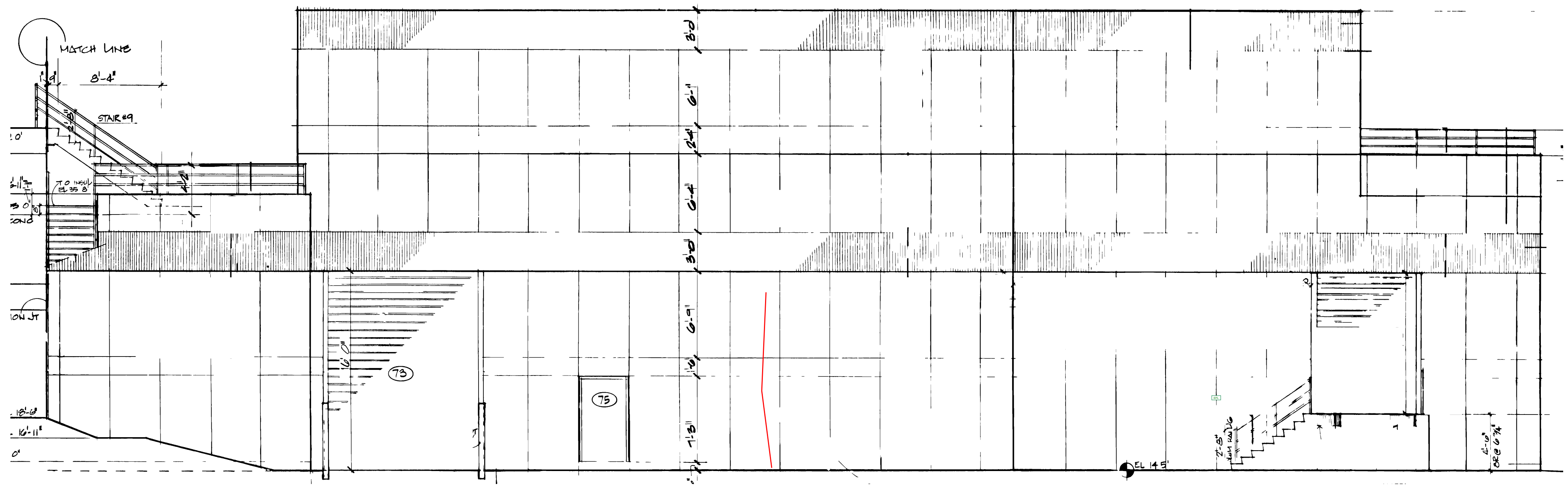
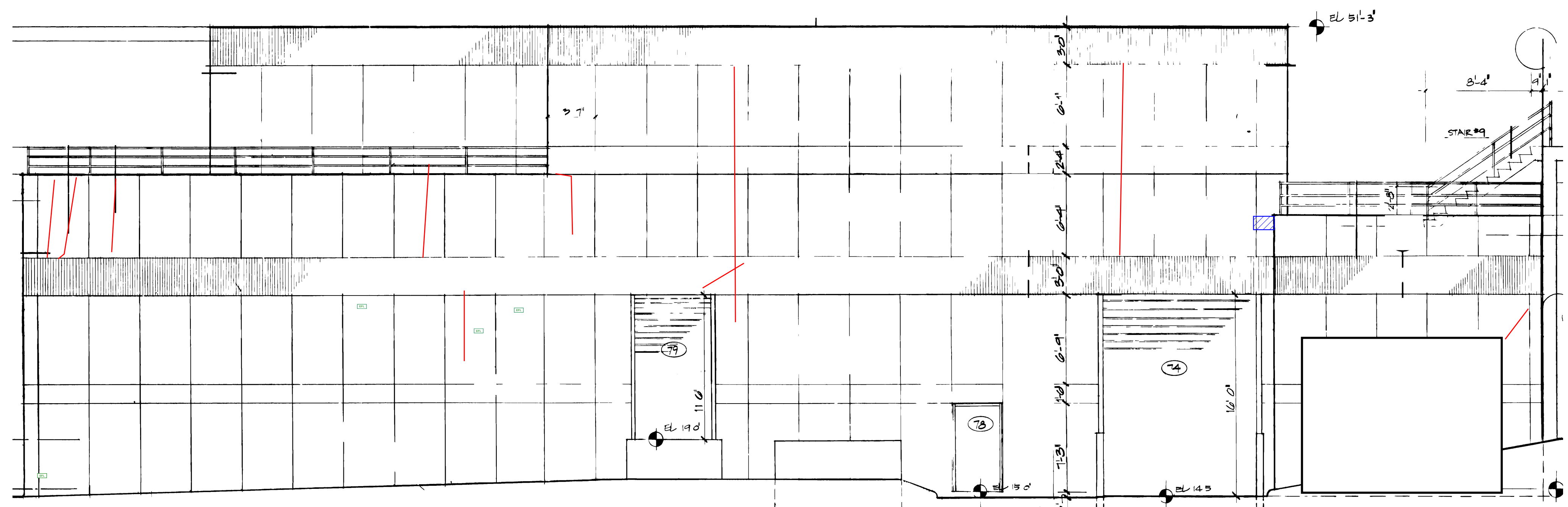
SLUDGE PROCESSING UNIT

FIGURE No.
SP.01



1 East Elevation
Scale: Dimensioned as Indicated on Drawing



2 West Elevation
Scale: Dimensioned as Indicated on Drawing

DRAWING LEGEND:

- CRACK
- DELAMINATION
- DISTRESS
- PASTE EROSION
- PONDING WATER
- INSPECTION OPENING

DRAWING NOTES:

- BP - BOWED PANEL
- EFL - EFFLORESCENCE
- ER - EXPOSED REINFORCING
- JT-LK - JOINT LEAK
- MPC - MAP PATTERN CRACKING
- PD - POST BASE DISTRESS
- PS - PIPE STAINING
- SJ - SEALANT JOINT DISTRESS

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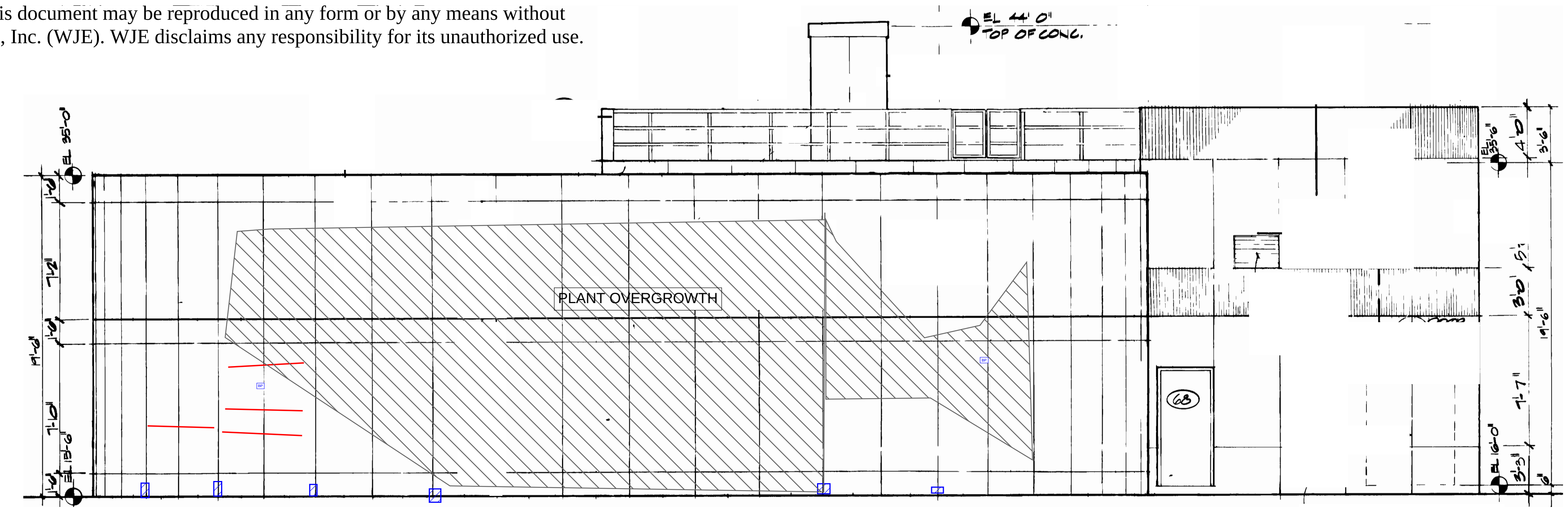
GRAND JUNCTION, COLORADO
WJE No. 2019.3776.0

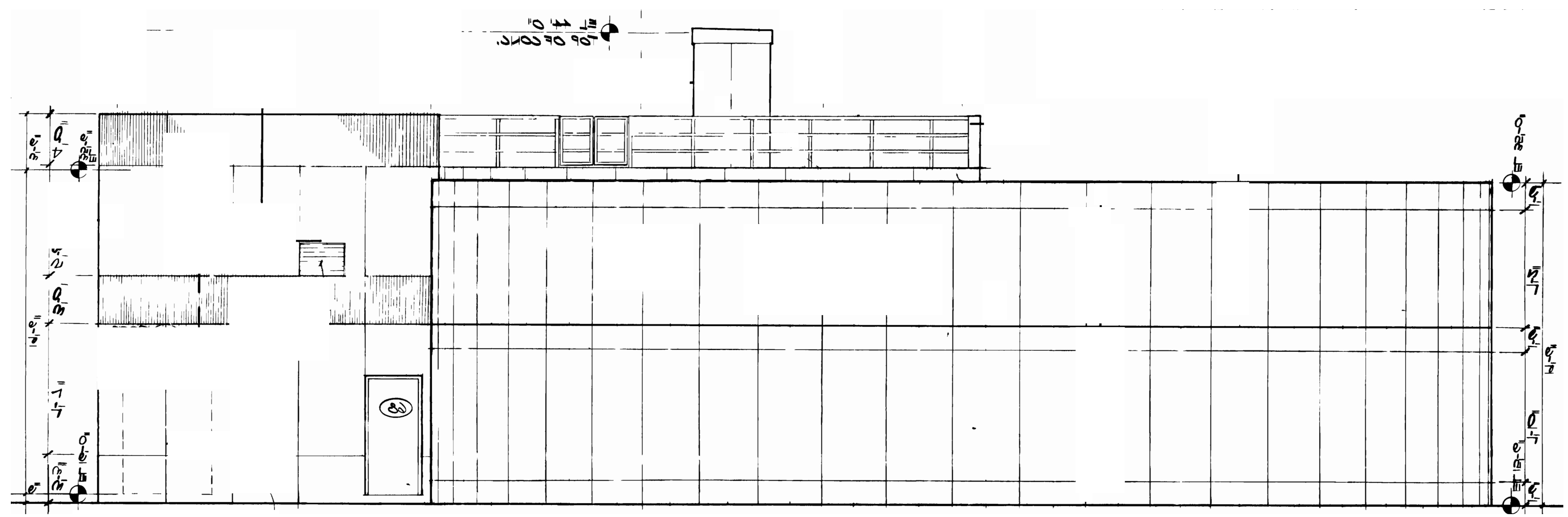
SLUDGE PROCESSING UNIT

FIGURE No.
SP.02



1 North Elevation

Scale: Dimensioned as Indicated on Drawing



2 South Elevation

Scale: Dimensioned as Indicated on Drawing

DRAWING LEGEND:

- CRACK
- DELAMINATION
- DISTRESS
- PASTE EROSION
- PONDING WATER
- INSPECTION OPENING

DRAWING NOTES:

- BP - BOWED PANEL
- EFL - EFFLORESCENCE
- ER - EXPOSED REINFORCING
- JT-LK - JOINT LEAK
- MPC - MAP PATTERN CRACKING
- PD - POST BASE DISTRESS
- PS - PIPE STAINING
- SJ - SEALANT JOINT DISTRESS

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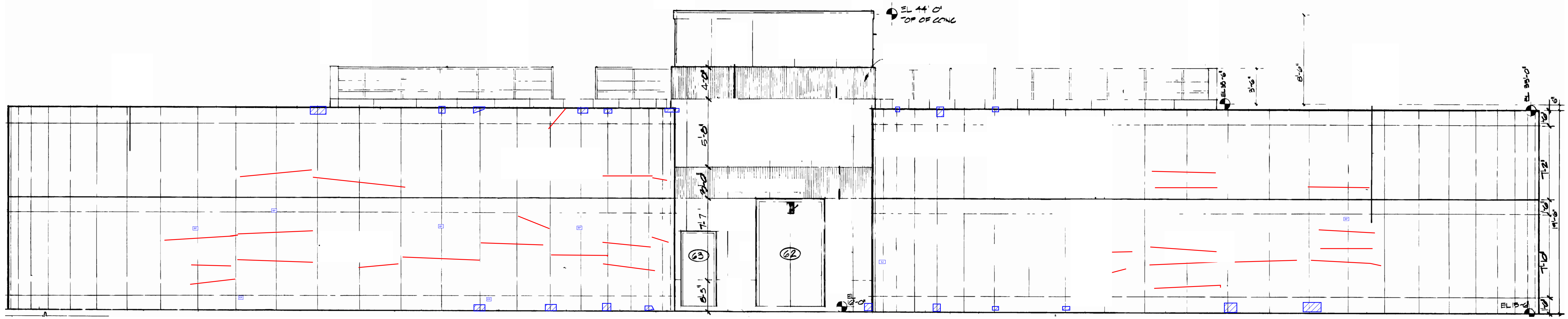
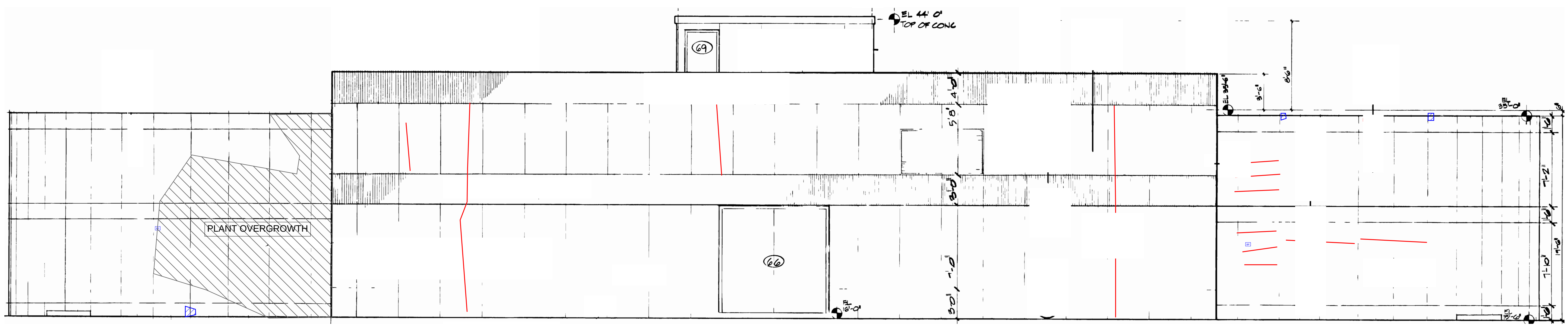
WJE No. 2019.3776.0

ANAEROBIC DIGESTER

FIGURE No.
AD2.01



1 East Elevation
Scale: Dimensioned as Indicated on Drawing



2 West Elevation
Scale: Dimensioned as Indicated on Drawing

DRAWING LEGEND:

- CRACK
- DELAMINATION
- DISTRESS
- PASTE EROSION
- PONDING WATER
- INSPECTION OPENING

DRAWING NOTES:

BP	- BOWED PANEL	JT-LK	- JOINT LEAK	PS	- PIPE STAINING
EFL	- EFFLORESCENCE	MPC	- MAP PATTERN CRACKING	SJ	- SEALANT JOINT DISTRESS
ER	- EXPOSED REINFORCING	PD	- POST BASE DISTRESS		

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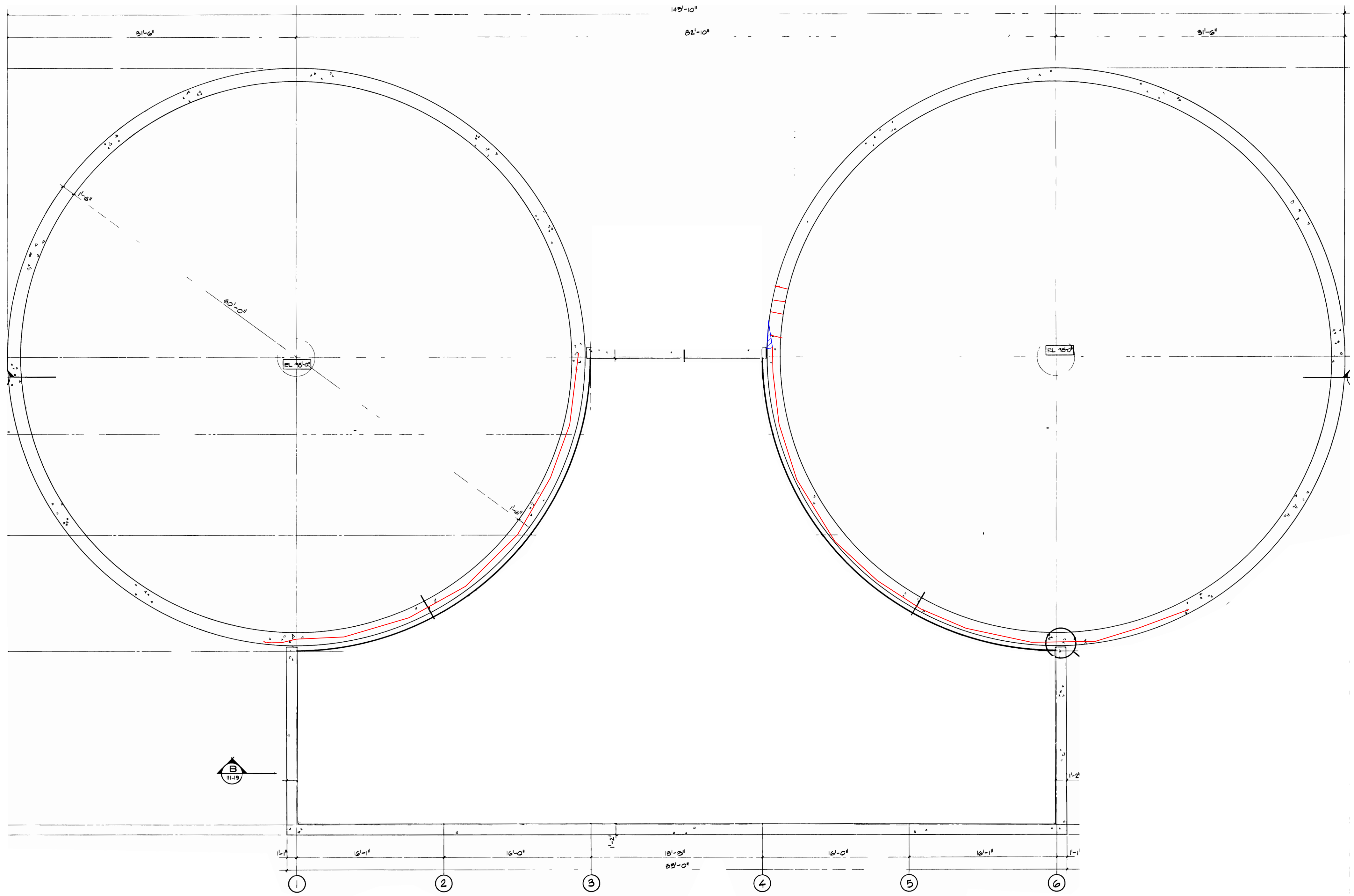
ANAEROBIC DIGESTER

FIGURE No.
AD2.02



1 Digester Lids
Scale: Dimensioned as Indicated on Drawing

DRAWING LEGEND:

- CRACK
- PASTE EROSION
- DELAMINATION
- PONDING WATER
- DISTRESS
- INSPECTION OPENING

DRAWING NOTES:

BP - BOWED PANEL	JT-LK - JOINT LEAK	PS - PIPE STAINING
EFL - EFFLORESCENCE	MPC - MAP PATTERN CRACKING	SJ - SEALANT JOINT DISTRESS
ER - EXPOSED REINFORCING	PD - POST BASE DISTRESS	

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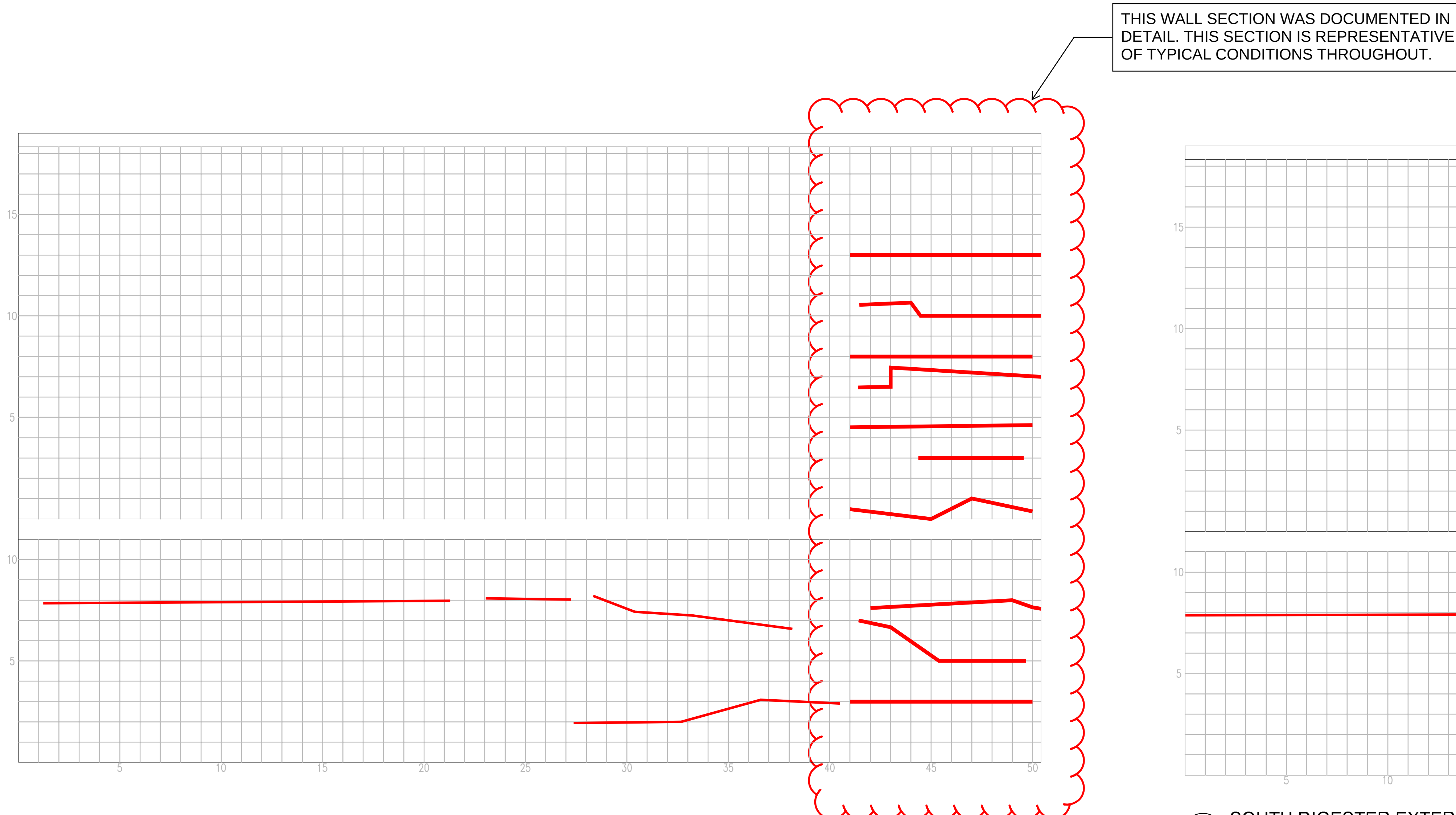
PERSIGO WASTE WATER TREATMENT PLANT
GRAND JUNCTION, COLORADO
WJE No. 2019.3776.0

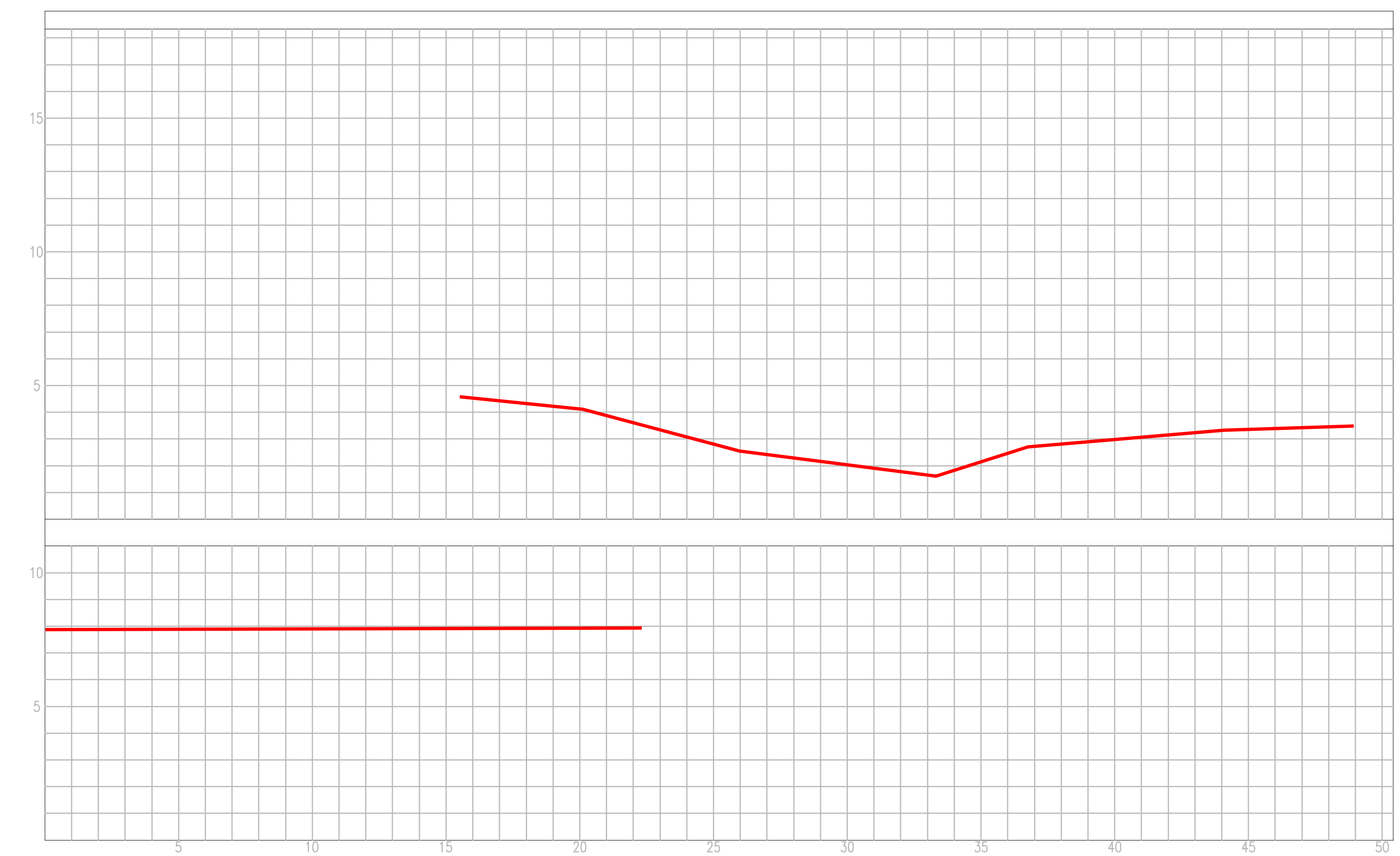
ANAEROBIC DIGESTER

FIGURE No.
AD2.03



1 NORTH DIGESTER EXTERIOR WALL (AS VIEWED FROM INSIDE BUILDING)

Scale: 1/4" = 1 Dimensioned as Indicated on Drawing



2 SOUTH DIGESTER EXTERIOR WALL (AS VIEWED FROM INSIDE BUILDING)

Scale: Dimensioned as Indicated on Drawing

DRAWING LEGEND:

- CRACK
- PASTE EROSION
- DELAMINATION
- PONDING WATER
- DISTRESS
- INSPECTION OPENING

DRAWING NOTES:

BP	- BOWED PANEL	JT-LK	- JOINT LEAK	PS	- PIPE STAINING
EFL	- EFFLORESCENCE	MPC	- MAP PATTERN CRACKING	SJ	- SEALANT JOINT DISTRESS
ER	- EXPOSED REINFORCING	PD	- POST BASE DISTRESS		

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PERSIGO WASTE WATER TREATMENT PLANT
GRAND JUNCTION, COLORADO
WJE No. 2019.3776.0

ANAEROBIC DIGESTER

FIGURE No.
AD2.04

APPENDIX E. STRUCTURAL CALCULATIONS

Wiss, Janney, Elstner Associates, Inc.
3609 South Wadsworth Blvd #400
Lakewood, CO 80235-2123

Title: Anaerobic Digester - Exterior Wall Panels
Project: Persigo WWTP
Number: 2019.3776
Performed by: TMM
Checked by: DES
Date: 12/6/2019

Concrete Wall Exposed to Wind Loads

The purpose of this calculation is to evaluate the ability of the exterior walls (panels) at the Anaerobic Digesters to resist loads assuming that the specified ties are not present. This requires the panels to span the full height, and be connected top and bottom, which has not been confirmed. Concrete analysis per ACI 318-14 as referenced by IBC 2018.

Loading and Geometry Assumptions:

$l := 19ft$ vertical span of exterior wall panel

$h := 4in$ thickness of exterior wall panel Note, this does not meet minimum wall thickness of ACI 11.3.1.1, L/30

$b := 12in$ $A_g := b \cdot h = 48 \cdot in^2$ $\frac{l}{30} = 7.6 \cdot in$

Wind Load ASCE 7-16:

$K_z := 0.9$ @20' Exp C $K_{zt} := 1.0$ not applicable $K_d := 1.0$ round tank $K_e := \frac{(0.86 + 0.83)}{2} = 0.845$

4500 ft elevation

$V := 115$ mph per cat IV and location

$q := 0.00256 \cdot K_z \cdot K_{zt} \cdot K_d \cdot K_e \cdot V^2 \cdot psf = 25.747 \cdot psf$

$GC_p := 0.9$ Negative put in as positive as a worst case suction load at H/D = 0.33

$GC_{pi} := 0.18$ Internal pressure coefficient, based on partially enclosed or enclosed, assumed

$p := q \cdot (GC_p + GC_{pi}) = 27.807 \cdot psf$

$M_{u\_wind} := \frac{(1.0 \cdot p \cdot 12in \cdot l^2)}{8} = 1.255 \cdot kip \cdot ft$

Properties and Analysis Assumptions:

$f_c := 4000psi$ (IV-39) $f_y := 60ksi$ (IV-39) $\phi := 0.9$

Self Weight:

$w := 150pcf \cdot b \cdot h = 50 \cdot plf$

$P_{u\_mid} := 1.2w \cdot \frac{l}{2} = 570 \cdot lbf$

Section Review (A / IV-28, #3@18")

Positive moment due to Wind Suction

$d_b := \frac{3in}{8} = 0.375 \cdot in$ $A_b := 0.11in^2$ $s := 18in$

$clr := 1.5in$ Assumed

$A_s := A_b \cdot \frac{12in}{s} = 0.073 \cdot in^2$

$d := h - clr - \frac{d_b}{2} = 2.313 \cdot in$

$a := \frac{A_s \cdot f_y}{0.85 \cdot f_c \cdot b} = 0.108 \cdot in$

$M_n := A_s \cdot f_y \cdot \left(d - \frac{a}{2}\right) = 0.828 \cdot kip \cdot ft$

$\phi \cdot M_n = 0.745 \cdot kip \cdot ft$

$D\_C := \frac{M_{u\_wind}}{\phi \cdot M_n} = 1.684$ greater than 1, so not sufficient

Modify based on observations of reinforcing spacing and cover at one panel

$d_b := \frac{3in}{8} = 0.375 \cdot in$ $A_b := 0.11in^2$ $s := 8in$ Observations indicate spacing of 6 to 10" as opposed to the specified 18"

$clr := 1.25in$ Measured

$A_s := A_b \cdot \frac{12in}{s} = 0.165 \cdot in^2$

$d := h - clr - \frac{d_b}{2} = 2.563 \cdot in$

$a := \frac{A_s \cdot f_y}{0.85 \cdot f_c \cdot b} = 0.243 \cdot in$

$M_n := A_s \cdot f_y \cdot \left(d - \frac{a}{2}\right) = 2.014 \cdot kip \cdot ft$

$\phi \cdot M_n = 1.813 \cdot kip \cdot ft$

$D\_C := \frac{M_{u\_wind}}{\phi \cdot M_n} = 0.692$ Less than 1, so possibly sufficient

Modify demand based on observed eccentricity

$p := 150 \cdot pcf \cdot 12in \cdot h \cdot 1 = 950 \cdot lbf$

$e := 1in$ assumed eccentricity

$M_{u\_ecc} := e \cdot p \cdot 1.2 = 0.095 \cdot kip \cdot ft$

$M_{u\_total} := M_{u\_wind} + M_{u\_ecc} = 1.35 \cdot kip \cdot ft$

$D\_C := \frac{M_{u\_total}}{\phi \cdot M_n} = 0.745$

demand to capacity ratio less than 1, possibly sufficient assuming boundary conditions are as assumed. Requires exploratory openings to confirm.

Check Axial

$P_0 := 0.85 \cdot f_c \cdot (A_g - A_s) + f_y \cdot A_s = 172.539 \cdot kip$

$P_n := 0.80 \cdot P_0 = 138.031 \cdot kip$

$\phi P_n := 0.65 \cdot P_n = 89.72 \cdot kip$

Okay by inspection

Check Axial and Flexural

$Ecc := \frac{M_{u\_total}}{P_{u\_mid}} = 28.417 \cdot in$

Flexure driven, okay based on above calculations

Review Cracking Moment

$S := \frac{(b \cdot h^2)}{6} = 32 \cdot in^3$

$M_{cr} := 7.5 \cdot \left(\frac{f_c}{psi}\right)^{.5} \cdot S \cdot psi = 1.265 \cdot kip \cdot ft$

$M := \frac{M_{u\_ecc}}{1.2} + \frac{M_{u\_wind}}{1.6} = 0.863 \cdot kip \cdot ft$

Service moment less than cracking moment. Therefore, observed cracking not indicated by assumed loading.

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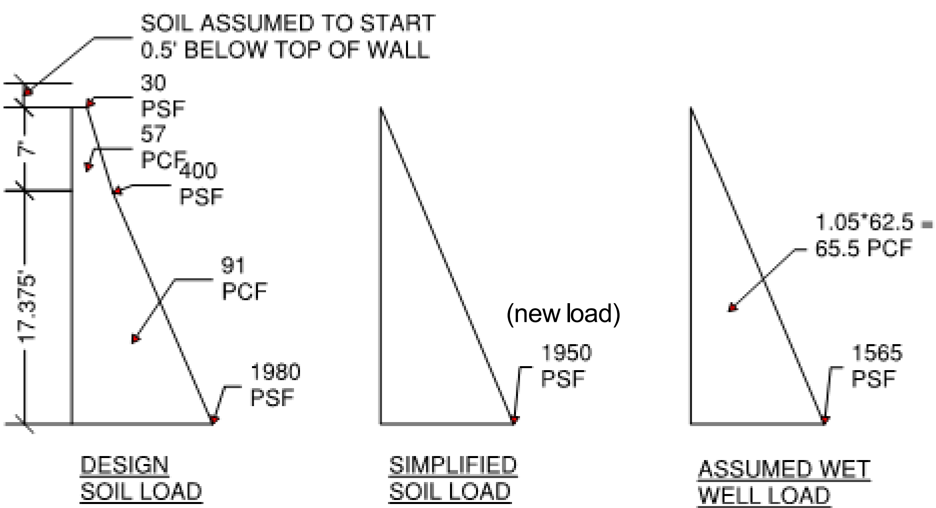
3609 South Wadsworth Blvd #400
Lakewood, CO 80235

Concrete Wall Evaluation for Soil Loads

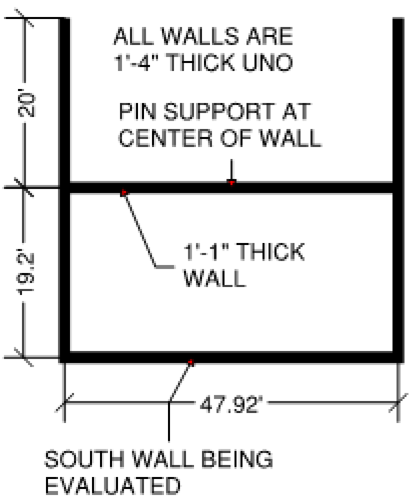
Title: Raw Sewage Pump Room - Walls
Project: Persigo WWTP
Number: 2019.3776
Performed by: TMM
Checked by: AGL
Date: 10/18/2019

The purpose of this calculation is to evaluate the foundation walls of the Raw Sewage Pump Station. These calculations focus in particular on the south wall, which is the largest unsupported wall, and based on our assessment has varying degrees of cracking. This assessment was completed using soil loads from the current WJE geotechnical evaluation, and original design. PCA Rectangular Concrete Tank design aid was used to determine the resulting bending moments in the wall due to the soil loading.

Loading and Geometry Assumptions:



(original loading approximately 0.77 times new)



SAP MODEL DIMENSIONS - PLAN VIEW

Note height in SAP model was reduced to clear height (to top of slab)

Properties and Analysis Assumptions:

$f_c := 4000psi$ (IV-39) $f_y := 60ksi$ (IV-39) $h := 16in$ $b := 12in$ $\phi := 0.9$ $l := 25ft$ $A_g := h \cdot b = 192 \cdot in^2$

Moment Capacity for each section

Interior Face (POSITIVE MOMENT)

Mx (Vertical) - T / IV-10, #5@6"

$d_b := \frac{5in}{8} = 0.625 \cdot in$ $A_b := 0.31in^2$ $s := 6in$

$clr := 2in$ MEASURED

$A_{s1} := A_b \cdot \frac{12in}{s} = 0.62 \cdot in^2$

$d := h - clr - \frac{d_b}{2} = 13.688 \cdot in$

$a := \frac{A_{s1} \cdot f_y}{0.85 \cdot f_c \cdot b} = 0.912 \cdot in$

$M_n := A_{s1} \cdot f_y \cdot \left(d - \frac{a}{2}\right) = 41.018 \cdot kip \cdot ft$

$\phi \cdot M_n = 36.916 \cdot kip \cdot ft$

My (horizontal) - R / IV-10, #5@10"

$d_b := \frac{5in}{8} = 0.625 \cdot in$ $A_b := 0.31in^2$ $s := 10in$

$clr := 2in - d_b = 1.375 \cdot in$ BASED ON VERTICAL MEASURED

$A_s := A_b \cdot \frac{12in}{s} = 0.372 \cdot in^2$

$d := h - clr - \frac{d_b}{2} = 14.313 \cdot in$

$a := \frac{A_s \cdot f_y}{0.85 \cdot f_c \cdot b} = 0.547 \cdot in$

$M_n := A_s \cdot f_y \cdot \left(d - \frac{a}{2}\right) = 26.112 \cdot kip \cdot ft$

$\phi \cdot M_n = 23.501 \cdot kip \cdot ft$

Exterior Face (NEGATIVE MOMENT)

Mx (Vertical) - R / IV-10, #8@6"

$d_b := \frac{8in}{8} = 1 \cdot in$ $A_b := 0.79in^2$ $s := 6in$ #8 @6" OC

$clr := 2in$ ASSUMED

$A_s := A_b \cdot \frac{12in}{s} = 1.58 \cdot in^2$

$d := h - clr - \frac{d_b}{2} = 13.5 \cdot in$

$a := \frac{A_s \cdot f_y}{0.85 \cdot f_c \cdot b} = 2.324 \cdot in$

$M_n := A_s \cdot f_y \cdot \left(d - \frac{a}{2}\right) = 97.472 \cdot kip \cdot ft$

$\phi \cdot M_n = 87.725 \cdot kip \cdot ft$

My (horizontal) - I / IV-11, #6@6"

$d_b := \frac{6in}{8} = 0.75 \cdot in$ $A_b := 0.44in^2$ $s := 6in$ #6 @6" OC

$clr := 1.375in$ ASSUMED

$A_s := A_b \cdot \frac{12in}{s} = 0.88 \cdot in^2$

$d := h - clr - \frac{d_b}{2} = 14.25 \cdot in$

$a := \frac{A_s \cdot f_y}{0.85 \cdot f_c \cdot b} = 1.294 \cdot in$

$M_n := A_s \cdot f_y \cdot \left(d - \frac{a}{2}\right) = 59.853 \cdot kip \cdot ft$

$\phi \cdot M_n = 53.868 \cdot kip \cdot ft$

Cracking Moment

$$S := \frac{(b \cdot h^2)}{6} = 512 \cdot in^3$$

$$M_{cr} := 7.5 \cdot \left(\frac{f_c}{psi}\right)^{.5} \cdot S \cdot psi = 20.239 \cdot kip \cdot ft$$

SAP model modified to cracked moment of inertia for all areas where service level moment exceeded cracking moment.

Summary of Flexural Demand and Capacity

PCA Rectangular Concrete Tank Moment Demands

$a := 24ft$ height of wall

$b := 48ft$ width of wall

$\frac{b}{a} = 0.042$ Therefore, use PCA Case 4, with top of wall pin supported, and all other sides fixed.

Mu = 1.6* coeff * q * a ^2 /1000

Moment Summary Based on Original Soil Loading

Moment Location		PCA Coefficient	Demand (k*ft/ft)	Capacity (k*ft/ft)	D/C
Vertical Direction	Positive, Interior	26	36.5	36.9	0.99
	Negative, Exterior	62	87.1	87.7	0.99
Horizontal Direction	Positive, Interior	10	14.0	23.5	0.60
	Negative, Exterior	37	52.0	53.9	0.96

Moment Summary Based on New Soil Loading

Moment Location		PCA Coefficient	Demand (k*ft/ft)	Capacity (k*ft/ft)	D/C
Vertical Direction	Positive, Interior	26	47.4	36.9	1.29
	Negative, Exterior	62	113.1	87.7	1.29
Horizontal Direction	Positive, Interior	10	18.2	23.5	0.78
	Negative, Exterior	37	67.5	53.9	1.25

As the conservative PCA tables indicate an overstress, review with more refined SAP model

Moment Location		Demand (k*ft/ft) - SAP	Capacity (k*ft/ft)	D/C
Vertical Direction	Positive, Interior	38	36.9	1.03
	Negative, Exterior	83	87.7	0.95
Horizontal Direction	Positive, Interior	15	23.5	0.64
	Negative, Exterior	32	53.9	0.59

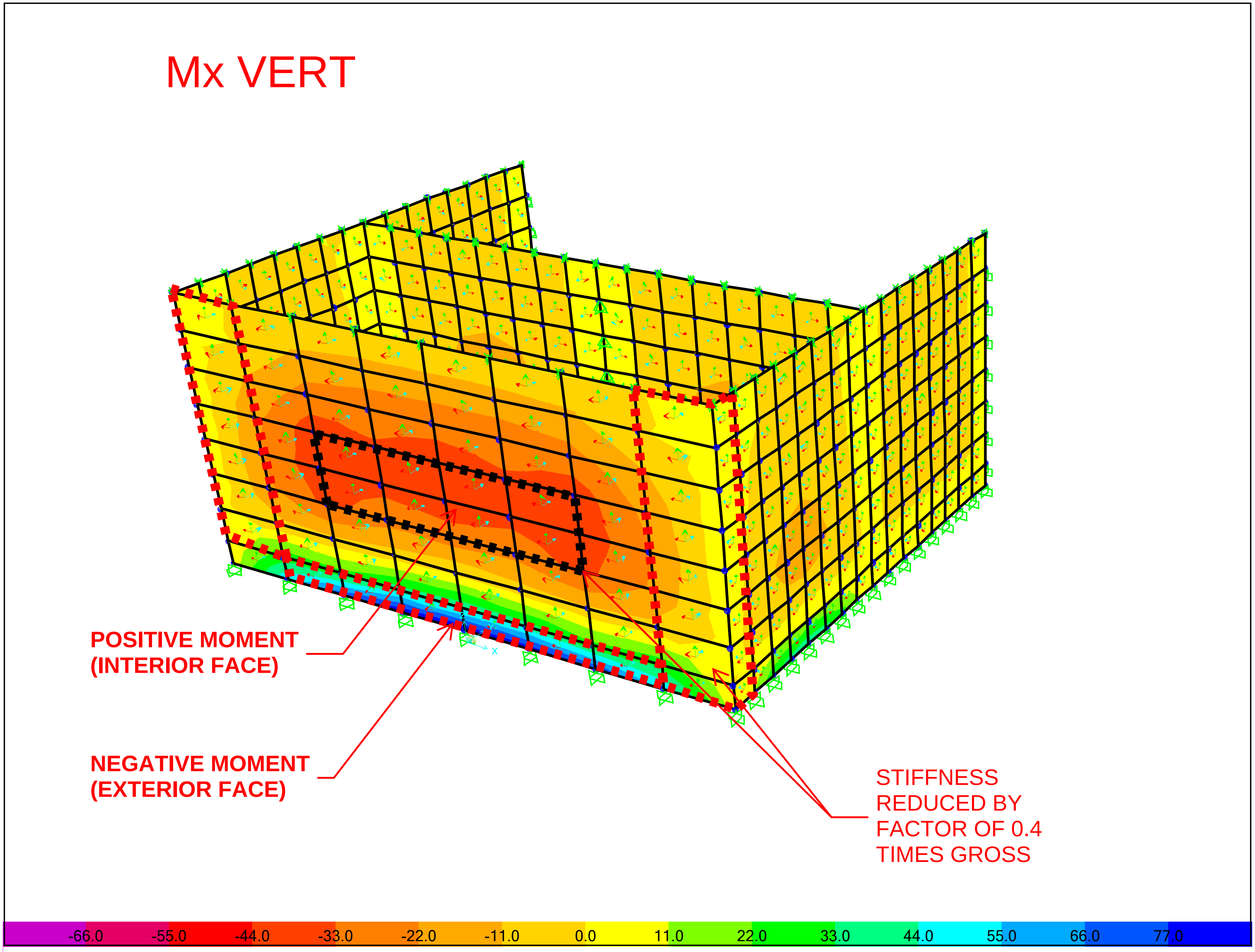
Flexural capacity for both new and original soil loading okay

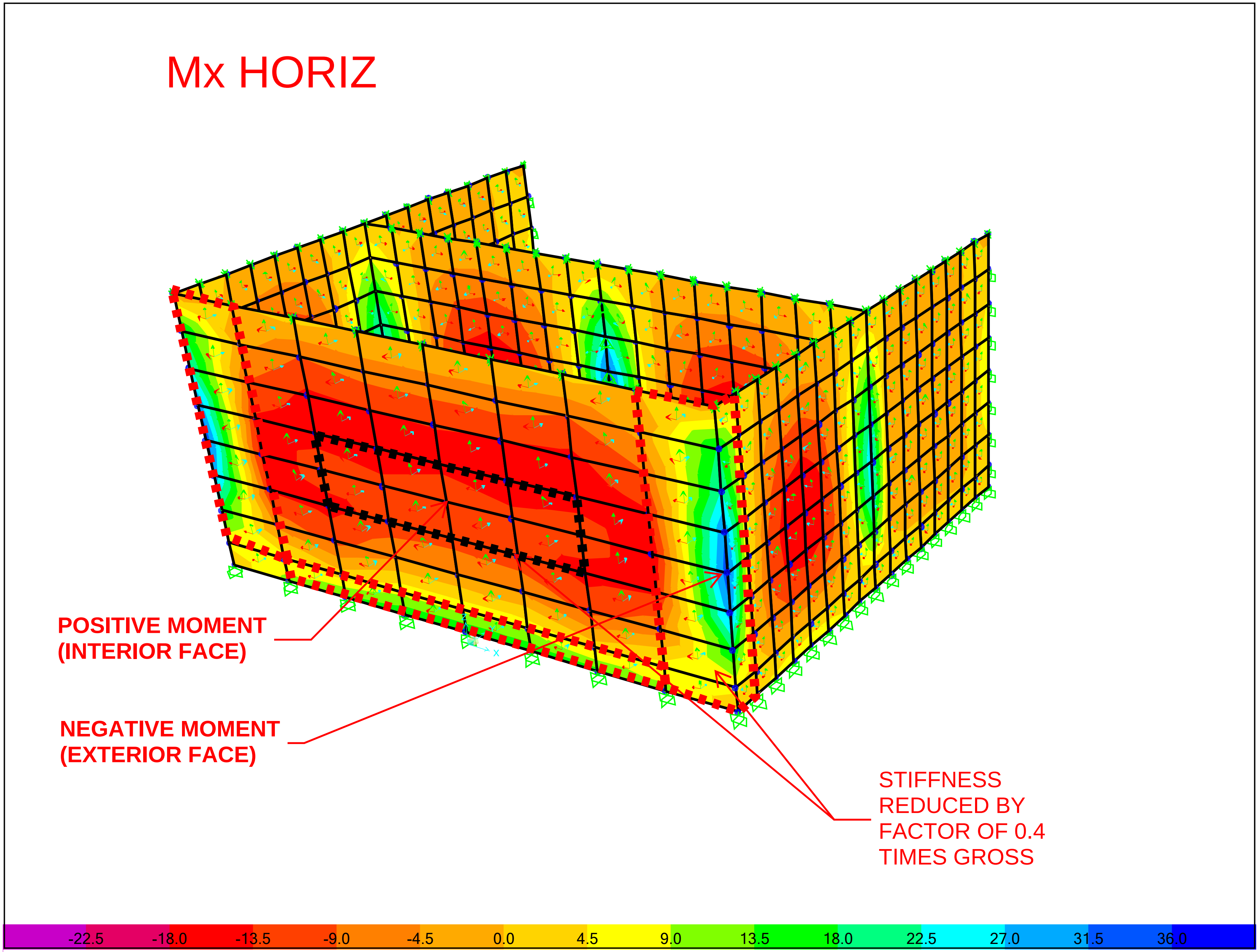
Check Axial Capacity

$P_0 := 0.85 \cdot f_c \cdot (A_g - A_{s1}) + f_y \cdot A_{s1} = 687.892 \cdot kip$

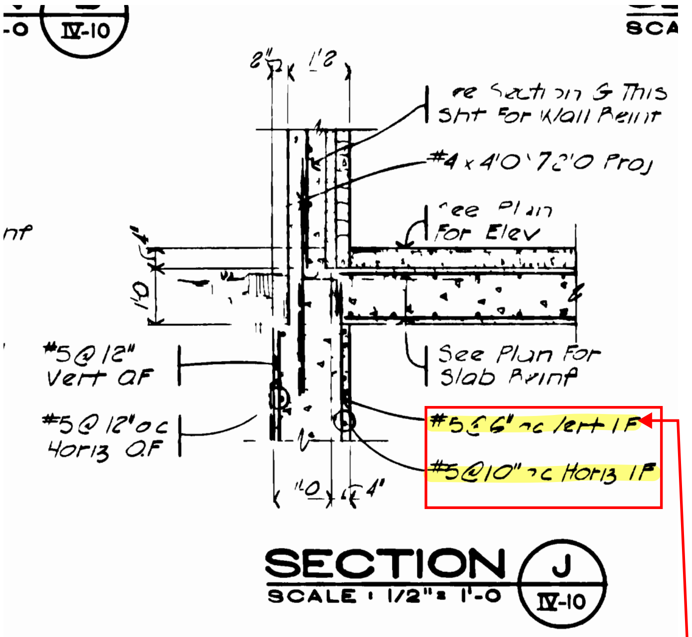
$P_n := 0.80 \cdot P_0 = 550.314 \cdot kip$

$\phi P_n := 0.65 \cdot P_n = 357.704 \cdot kip$ Okay by inspection

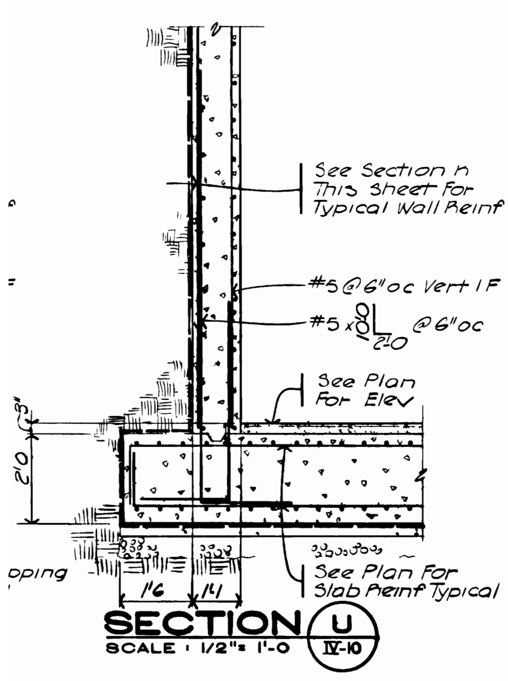

Mx VERT
POSITIVE MOMENT
(INTERIOR FACE)
NEGATIVE MOMENT
(EXTERIOR FACE)
STIFFNESS
REDUCED BY
FACTOR OF 0.4
TIMES GROSS
-66.0
-55.0
-44.0
-33.0
-22.0
-11.0
0.0
11.0
22.0
33.0
44.0
55.0
66.0
77.0

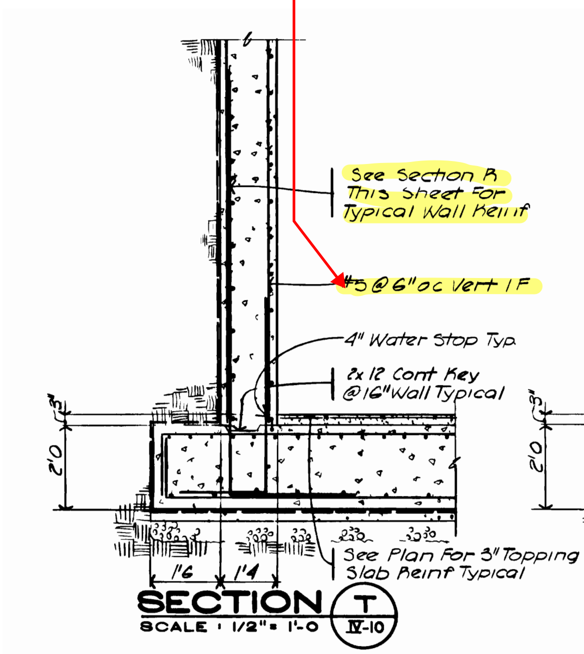

Mx HORIZ
POSITIVE MOMENT
(INTERIOR FACE)
NEGATIVE MOMENT
(EXTERIOR FACE)
STIFFNESS
REDUCED BY
FACTOR OF 0.4
TIMES GROSS
-22.5
-18.0
-13.5
-9.0
-4.5
0.0
4.5
9.0
13.5
18.0
22.5
27.0
31.5
36.0

Applicable Excerpts from Original Drawings

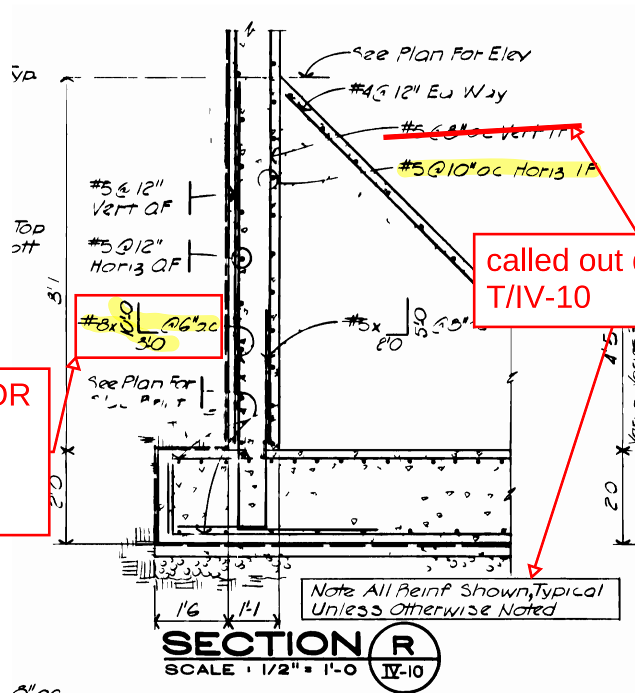


TYPICAL INTERIOR FACE REINF





EXTERIOR SLAB VERT DOWEL

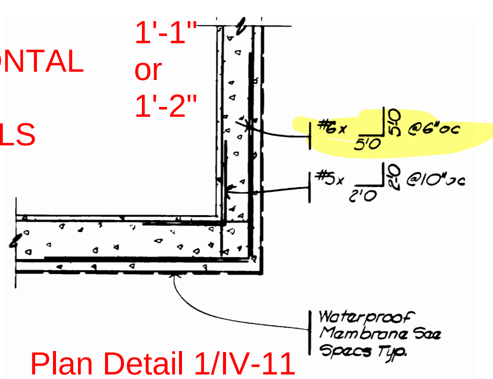


called out different on T/IV-10

HORIONTAL BAR DOWELS

1'-1" or 1'-2"

1'-4"



Plan Detail 1/IV-11

Wiss, Janney, Elstner Associates, Inc.
3609 South Wadsworth Blvd #400
Lakewood, CO 80235

Concrete Slab Evaluation for Hydro Loads

Title: Raw Sewage Pump Room - Slab
Project: Persigo WWTP
Number: 2019.3776
Performed by: TMM
Checked by: AGL
Date: 10/18/2019

The purpose of this calculation is to evaluate the structural slab of the Raw Sewage Pump Station as concerns were raised over its integrity due to observed slab cracking throughout the Pump Room (foundation level).

Loading and Geometry Assumptions:

b = 46'
a = 18'

Use PCA Rectangular Concrete Tank Design Aid to determine moments. Case 10.

b / a = 2.5, uniform load

Only needs to resist hydrostatic pressure, assume 17.5' below the groundwater level.

Mu = 1.6* coeff * q * a ^ 2 /1000

Moment Demand (Mu)

$$0.112 \cdot 1.6 \cdot (62.4\text{pcf} \cdot 17.5\text{ft}) \cdot 12\text{in} \cdot (18 \cdot \text{ft})^2 = 63.402 \cdot \text{kip} \cdot \text{ft}$$

$$0.032 \cdot 1.6 \cdot (62.4\text{pcf} \cdot 17.5\text{ft}) \cdot 12\text{in} \cdot (18 \cdot \text{ft})^2 = 18.115 \cdot \text{kip} \cdot \text{ft}$$

Properties and Analysis Assumptions:

$f_c := 4000\text{psi}$ (IV-39) $f_y := 60\text{ksi}$ (IV-39) $h := 24\text{in}$ $b := 12\text{in}$ $\phi := 0.9$

Interior Face, TOP (POSITIVE MOMENT)

Mx (Short Direction) - Foundation Plan IV-9, #6@6"

$d_b := \frac{6in}{8} = 0.75 \cdot in$ $A_b := 0.44in^2$ $s := 6in$

$clr := 2in$ ASSUMED

$A_s := A_b \cdot \frac{12in}{s} = 0.88 \cdot in^2$

$d := h - clr - \frac{d_b}{2} = 21.625 \cdot in$

$a := \frac{A_s \cdot f_y}{0.85 \cdot f_c \cdot b} = 1.294 \cdot in$

$M_n := A_s \cdot f_y \cdot \left(d - \frac{a}{2}\right) = 92.303 \cdot kip \cdot ft$

$\phi \cdot M_n = 83.073 \cdot kip \cdot ft$

My (Long Direction) - Foundation Plan IV-9, #6@6"

$d_b := \frac{6in}{8} = 0.75 \cdot in$ $A_b := 0.44in^2$ $s := 6in$

$clr := 2in + d_b = 2.75 \cdot in$ ASSUMED

$A_s := A_b \cdot \frac{12in}{s} = 0.88 \cdot in^2$

$d := h - clr - \frac{d_b}{2} = 20.875 \cdot in$

$a := \frac{A_s \cdot f_y}{0.85 \cdot f_c \cdot b} = 1.294 \cdot in$

$M_n := A_s \cdot f_y \cdot \left(d - \frac{a}{2}\right) = 89.003 \cdot kip \cdot ft$

$\phi \cdot M_n = 80.103 \cdot kip \cdot ft$

Both greater than demand, therefore okay

APPENDIX F. CONDITION ASSESSMENT MEMORANDUM

WJE ENGINEERS ARCHITECTS MATERIALS SCIENTISTS

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www.wje.com

CONDITION ASSESSMENT MEMORANDUM

To: Kirsten Armbruster, City of Grand Junction, Public Works kirstena@gjcity.org

From: Terry McGovern, PE

Date: October 23, 2019

Project: Persigo Wastewater Treatment Plant
WJE No. 2019.3776

Subject: Condition Assessment Memorandum and Recommended Additional Investigation

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This condition assessment memorandum is to serve as an interim document providing a summary of the observed distress in each reviewed structure, and targeted recommendations for sample extraction and testing is warranted to refine our final discussion and recommendations for the repair and/or maintenance of the structures. A report documenting the complete findings of our assessment, including an associated document review, inspection methodologies, discussion of the remaining useful life, recommendations for repair, and opinion of probable repair costs will be provided upon completion of any additional sampling and testing. Representative photographs of our observations of each structure are provided in Appendix A.

Summary of Observations and Discussion of Additional Testing

General Exterior Conditions

Distress to the exterior walls typically included map patterned and both horizontal and vertical cracking, and isolated areas of corrosion staining likely due to ferrous-containing aggregate, such as pyrite or magnetite, which are both naturally occurring minerals. In addition, the parge or “rubbed” finish coat which was present on the exterior of structure was delaminated or spalled at numerous areas. Multiple cracks and exterior joints also exhibited efflorescence staining, indicative of long-term moisture migration of process water through the exterior walls.

The following outlines our general observations and recommendations for further investigation, grouped by structure. Note that the preliminary costs provided at the end of this memo include a general line item for fees incurred for mobilization/demobilization of staff to and from the site, and expenses for on-site personnel to perform any additional assessment for one 10-hour day. At this time, we anticipate that we would be able to complete the entirety of the work described below in 3 full days on-site.

Raw Sewage Pump Station

Concrete distress at the pump room slab was primarily localized within the topping slab and included delaminations and cracking. Inspection openings (cores) indicated that the cracking does not extend into the structural slab. This destructive testing verified that the observed cracking and delaminations are isolated to the topping and are not in the main structural slab.

Cracking at the interior concrete walls appears to be widespread, but multiple layers of textured coating masked the cracking at many locations so the full-extent is not known. Several cracks had propagated through the coating, but the cracking at the coating surface was relatively narrow compared to the widths observed at the level of the concrete where coating was removed for half-cell potential testing. Coating delaminations were present near the base of the walls and included efflorescence and concrete paste loss behind the coating in some locations. This indicates that some moisture is likely penetrating through the wall and leading to the noted concrete and coating distress. Similarly, the half-cell potential testing we performed at two interior wall locations indicated some potential for corrosion of the internal reinforcing steel, with corrosion potentials greatest towards the bottom of the walls and adjacent to inlet piping locations, where an increased moisture content is expected.

Sample extraction via coring should be performed to verify the type and depth of the observed cracking at the wall interior, so that the root cause of their formation can be identified, allowing us to opine on if the cracking poses a structural concern. Furthermore, limited petrography and chloride content testing would allow for evaluation of the likelihood for corrosion to initiate in the future. In addition, inspection openings can be taken from areas of leakage and potential corrosion to observe the condition of the reinforcing steel to determine if the concrete surface distress is indicative of on-going corrosion.

Primary Clarifiers

In addition to typical general cracking as described above, the most prominent form of deterioration was paste erosion, which was evident at both the interior and exterior faces of the clarifier walls. The erosion was concentrated at areas where moisture condensate is likely to accumulate, namely at roof attachment nodes, as well as at the splash zone at the interior of the tanks.

We understand that elevated levels of hydrogen sulfide are present within the process water, as is expected within wastewater operations, and this is likely the root cause of the paste erosion distress. Deterioration of concrete due to hydrogen sulfide attack involves a rather complicated series of reactions that are initiated by bacteria decomposing portions of the process water which eventually involve production of acid that can attack both the cement paste and certain types of aggregate. Extraction of core samples from the interior of one of the clarifiers, and laboratory testing of these samples, would allow us to more accurately identify the nature and severity of the distress and refine our recommendations. Specifically, a petrographic review and chemical testing would determine the general extent and depth of the paste erosion, as well as the propagation of potentially deleterious ions into the concrete, such as chlorides or sulfates. Work on the interior of the tank would require that the tank be shut down, and that the perimeter trough be drained and cleaned to allow for access and coring.

Aeration Basin

Concrete distress at the aeration basin blower room was primarily localized within the topping slab, including cracking and widespread delaminations. This distress was similar to that observed at the Raw Sewage Pump Station, and further review is not warranted to determine if this distress extends into the structural slab based on our observations at that structure.

Cracking observations at the interior walls was somewhat inhibited by the multiple layers of textured coating that had been installed, similar to the Raw Sewage Pump Station. Through-wall moisture infiltration was present at the underside of the elevated troughs adjacent to the central catwalk. The ceiling soffit of the blower room also exhibited multiple cracks, particularly at through-slab penetrations and skylight reentrant corners. These cracks exhibited staining on the interior of the structure at several locations; however, additional distress in the form of spalls or delaminations were not observed.

Based on the observed surface staining at the elevated troughs, an investigative opening should be created to observe the reinforcing condition at an active leak location, or where evidence of persistent past leakage is present. This opening will allow us to confirm the current levels of corrosion of the reinforcing bars. In addition, a core sample from this location, for limited petrography and chloride content testing, will allow for evaluation of the likelihood for corrosion to initiate in the future. Access at this location will need to be provided via a bakers scaffold, or other means, as the elevated trough is approximately fourteen feet above the walking surface within the blower room.

Aerobic Digester

Multiple areas of efflorescence and existing through-wall moisture intrusion were noted, and while our half-cell potential testing indicated an elevated probability of corrosion at the east elevation wall, an inspection opening (core) at an area of potential corrosion activity revealed clean non-corroded reinforcing steel, indicating that the HCP readings are likely being skewed by deposits and moisture present at the observed cracking. Nevertheless, the presence of widespread and long-term moisture migration through the digester walls warrants a core extraction in order to determine the general quality, chloride content and carbonation level of the concrete through extraction of samples, petrography and chemical testing. As one core was approved during our site visit, we propose to also evaluate this core petrographically. Furthermore, a petrographic review of the map pattern cracking at the exterior walls can provide information regarding the type and age of cracking, and help determine if potential other distress mechanisms, such as alkali-silica reaction (ASR) is contributing to the noted deterioration. The observations on this core could reasonably be assumed to represent similar distress found on numerous other structures.

Deterioration of longitudinal bars and spalling of concrete was observed to be isolated to the stairwells, and is likely attributable to moisture accumulating on the top surfaces of the stair (potentially containing additional chlorides from applied de-icing salts), which runs down and around onto the soffit where it later evaporates and deposits efflorescence and chlorides, which have in turn resulted in corrosion of embedded reinforcing and concrete distress. No additional assessment is warranted at the stairs.

Sludge Processing Unit

Efflorescence staining, indicative of more long-term moisture egress, was identified at the base of the walls at several crack locations. The presence of widespread and long-term moisture migration through the blending tank walls warrants a core extraction in order to determine the general quality (through petrography), chloride content and carbonation level of the concrete (through chemical testing). Furthermore, an investigative opening should be created to observe the reinforcing condition at an active leak location, or where evidence of persistent past leakage is present. This opening will allow us to confirm the current levels of corrosion of the reinforcing bars.

Anaerobic Digester

Concrete distress on the exterior of the tanks included cracking of the panels and bowing or offset of these panels from the concrete wall backing. In addition, spalls were present at many corners of the panels, revealing steel plates embedded in the walls and cap piece, which likely serve as connections. The concrete cap present on the top surface of the composite wall system exhibited a widened longitudinal crack 6 to 8-inches from the exterior of the cap, which roughly correlates to the location of the interior concrete wall below. The construction of these panels appears to deviate from the details on the original construction drawings, and it is unclear how these panels are attached back to the main structure. The bowing and offset of the panels indicates a potential instability of the exterior panels or wythe of concrete. To further evaluate the anchorage, and construction of the panels, exploratory openings should be performed to review the spall conditions at the top and bottom of the panels, as well as in the field of the panel to determine if the specified ties are present, and what their condition is. This work would require access to the upper portions of the panels via an articulating boom lift, and a contractor to assist with creation of the exploratory openings.

Steel Lid Coating

The coating at the top and sides of the lid was evaluated using several non-destructive and semi destructive techniques. It should be noted that the off-white or cream colored coating on the top of the lid, and the black coating on the sides of the lid appear to be different coating systems, with much different thicknesses. Overall, each of the coatings exhibited similar visual distress, including chalking and flaking of the coating. Based on our limited assessment, the coatings appeared to be well-bonded. The substrate steel lid also exhibited only isolated locations of corrosion distress, and based on these combined observations, no additional assessment is recommended at the digester lid at this time.

Steel Piping

WJE performed spot thickness verification on piping components within the Raw Sewage Pump Room and Aeration Basin, by randomly selecting locations on the steel pipe and fittings to identify the range of section loss in those elements. Inspections performed provided good coverage for uniform corrosion loss (i.e. oxygenated water corroding carbon steel). The readings show some degree of thinning, but no readings indicated imminent failure due to corrosion and wall loss. Additionally, the plates installed to cover prior leaks were not located exclusively at or near weld seams, suggesting that the corrosion mechanism is not strongly electrolytic.

Based on our observations and measurements, and the service conditions expected, the most likely cause of the previous leaks is a broad category of ‘under-deposit’ corrosion, which can be the result of Sulfur-Reducing Bacteria (SRB’s) or simply solids adhering to the wall of the piping and locally changing the corrosion behavior of the steel. The observations made to date provide a reasonable basis to conclude that the piping is generally Fit For Service, but that future leaks can (and will) appear with little warning. In contrast, demonstrating that *all* corrosion spots, similar to those which have likely caused past leaks, have been identified would require a very thorough inspection. This inspection would require approximately one measurement per 0.25 square inch (0.5” grid) to find and quantify each corrosion location. This could be done manually, or with Automated Ultrasonic Testing (AUT) in the ‘C-Scan” mode. In order to protect against all future leaks, the C-Scans would likely need to be repeated on an annual or bi-annual basis as sludge deposits can form anywhere in the piping system, and progress rapidly. Based on the limited level of risk and the extraordinary cost of full-coverage UT thickness scanning, we do not recommend additional testing be performed at this time.

Proposed Additional Assessment

Based on observations during our initial visual assessment, and our discussions provided above, a summary of the recommendations for additional assessment are provided in Table 1. A brief description of the general additional assessment techniques is also provided.

Table 1. Scope of Additional Assessment

Structure	Additional Assessment Method	Quantity	Fees	Expenses	TOTAL
General	Mobilization/Demobilization (2 staff on-site)	1	$ 4,300	$ 1,800	$ 6,100
	Each Working Day (2 staff on-site, 10hr days)	3	$ 3,000	$ 400	$ 10,200
	Additional Assessment Incorporation into Reports	1	$ 5,000	$ -	$ 5,000
	Total for General Additional Assessment				**$ 21,300**
Raw Sewage Pump Station	1) Core Extraction/Repair (1 core)	3	$ -	$ 100	$ 300
	2) Laboratory Study				
	a) Petrographic Examination (1 core)	1	$ -	$ 1,500	$ 1,500
	b) Limited Petrographic Examination (1 core)	1	$ -	$ 900	$ 900
	c) Chloride Content (5 tests per core)	3	$ -	$ 1,000	$ 3,000
	3) Inspection Openings (number of cores or 1'x1' openings)	1	$ -	$ 100	$ 100
	Total for Raw Sewage Pump Station				**$ 5,800**
Primary Clarifiers	1) Core Extraction/Repair (1 core)	3	$ -	$ 100	$ 300
	2) Laboratory Study				
	a) Petrographic Examination (1 core)	1	$ -	$ 1,500	$ 1,500
	b) Limited Petrographic Examination (1 core)	1	$ -	$ 900	$ 900
	c) Chloride and Sulfate Content (5 tests each per core)	3	$ -	$ 1,750	$ 5,250
	3) Inspection Openings (number of cores or 1'x1' openings)	0	$ -	$ 100	$ -
	Total for Primary Clarifiers				**$ 7,950**
Aeration Basin	1) Core Extraction/Repair (1 core)	1	$ -	$ 100	$ 100
	2) Laboratory Study				
	a) Petrographic Examination (1 core)	0	$ -	$ 1,500	$ -
	b) Limited Petrographic Examination	1	$ -	$ 900	$ 900
	c) Chloride Content (5 tests per core)	1	$ -	$ 1,000	$ 1,000
	3) Inspection Openings (number of cores or 1'x1' openings)	1	$ -	$ 100	$ 100
	4) Special Access for Coring and Inspection Opening	1	$ -	$ 1,000	$ 1,000
	Total for Aeration Basin				**$ 3,100**
Aerobic Digester	1) Core Extraction/Repair (1 core)	2	$ -	$ 100	$ 200
	2) Laboratory Study				
	a) Petrographic Examination (1 core)	1	$ -	$ 1,500	$ 1,500
	b) Limited Petrographic Examination (1 core)	1	$ -	$ 900	$ 900
	c) Chloride Content (5 tests per core)	2	$ -	$ 1,000	$ 2,000
	3) Inspection Openings (number of cores or 1'x1' openings)	0	$ -	$ 100	$ -
	Total for Aerobic Digester				**$ 4,600**
Sludge Processing Unit	1) Core Extraction/Repair (1 core)	1	$ -	$ 100	$ 100
	2) Laboratory Study				
	a) Petrographic Examination (1 core)	1	$ -	$ 1,500	$ 1,500
	b) Limited Petrographic Examination (1 core)	0	$ -	$ 900	$ -
	c) Chloride Content (5 tests per core)	1	$ -	$ 1,000	$ 1,000
	3) Inspection Openings (number of cores or 1'x1' openings)	1	$ -	$ 100	$ 100
	Total for Sludge Processing Unit				**$ 2,700**
Anaerobic Digester	1) Core Extraction/Repair	0	$ -	$ 100	$ -
	2) Laboratory Study				
	a) Petrographic Examination (1 core)	0	$ -	$ 1,850	$ -
	b) Limited Petrographic Examination (1 core)	0	$ -	$ 1,000	$ -
	c) Chloride Content (5 tests per core)	0	$ -	$ 1,000	$ -
	3) Inspection Openings (number of cores or 1'x1' openings)	3	$ -	$ 100	$ 300
	4) Contractor Assistance for Openings	1	$ -	$ 2,750	$ 2,750
	5) Articulating Boom Lift Rental for Openings	1	$ -	$ 2,000	$ 2,000
	Total for Anaerobic Digesters				**$ 5,050**
TOTAL					**$ 50,500**

Core Extraction

Drilled core samples will be obtained for laboratory testing in accordance with ASTM C42, *Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete*. We anticipate that the cores will be 3 or 4 inches (nominal) in diameter. Cores will be approximately 6 to 10 inches long to permit determination of the chloride ion profile at the core exterior. We will use GPR to locate, and either avoid or target reinforcement prior to taking cores. In addition, at select locations with distress, concrete will be removed to create an inspection opening for quantifying section loss in the reinforcing bars, if corrosion is observed. Core holes will be repaired following coring operations using a rapid setting concrete repair material.

Petrographic Analysis

Concrete cores will be evaluated using methods outlined in ASTM C856, *Petrographic Examination of Hardened Concrete*, to characterize composition and general quality of the concrete, as well as to identify the presence of potential distress mechanisms, such as alkali-silica reaction (ASR). Both in-depth and brief petrographic examinations will be performed.

Carbonation Testing

Testing will be performed on cores to assess depth of carbonation in the various structural elements using a phenolphthalein indicator solution. Carbonation is a chemical change that reduces the natural alkalinity of the concrete over time due to exposure to carbon dioxide in the atmosphere. The reduction in alkalinity increases the potential for reinforcement corrosion. Carbonation testing will be performed as a part of the petrographic studies.

Chloride Testing

Cores from various exposure conditions for each structure will be tested for chloride content versus depth from the surface using a modified version of ASTM C1152, *Standard Test Method for Acid-Soluble Chloride in Mortar and Concrete*, or ASTM C1218, *Standard Test Method for Water-Soluble Chloride in Mortar and Concrete*. Up to five slices from each core designated for chloride testing will be cut and pulverized for chloride content measurement. Test results will support determination of the chloride concentrations at the depth of reinforcement and supply essential information for discussion of service-life as well as potential service-life modeling.

Sulfate Testing

In a similar approach to that outlined for the chloride testing above, the total sulfur content of isolated cores from the Primary Clarifiers will be determined by evolution and infrared detection. Further tests for sulfate content may be performed in general accordance with ATM C265, *Standard Test Method for Water Extractable Sulfate in Hydrated Hydraulic Cement Mortar.* The results from this testing will help provide information regarding the paste erosion observed at this structure, given the known elevated levels of hydrogen sulfide within the process water at this structure.

Concrete Service Life Modeling

As part of a more in-depth assessment, service life modeling could be performed using WJE's in-house service life model. This modeling estimates the time required for progression of corrosion-related concrete distress (i.e., delamination and spalls) to initiate, propagate, and then cause distress over the life of the structure. This modeling is used to assist in identification of appropriate repair approaches, determine if corrosion mitigation strategies are warranted, and prioritize items for repair and protection. As with any service life discussion, the service life in a given setting must initially be defined based on requirements unique to the structures being modeled, in terms of performance and operational needs. The predicted damage over time can then be compared against an assumed definition of acceptable damage, or service life, for the various structures considered. Using these criteria, the modeling estimates the remaining time before the defined service life criteria is reached.

At this time, we do not believe that the extent of deterioration warrants the level of evaluation and laboratory testing required to perform an in-depth service-life model for each structure. However, based on the results from petrographic and chemical analysis discussed above, we can re-evaluate and discuss potential benefits of service-life modeling on select structures if that is something the CGJ would like to consider.

Closing

We look forward to discussing this memorandum in detail with you during our upcoming virtual meeting.

APPENDIX A

Photos and observations from assessment performed to date, separated by structure.

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Figure 4. Noted delamination, adjacent to the central trench drain, highlighted in blue

Figure 5. Observed paste erosion at piping element support

Figure 6. Typical concrete support pedestal

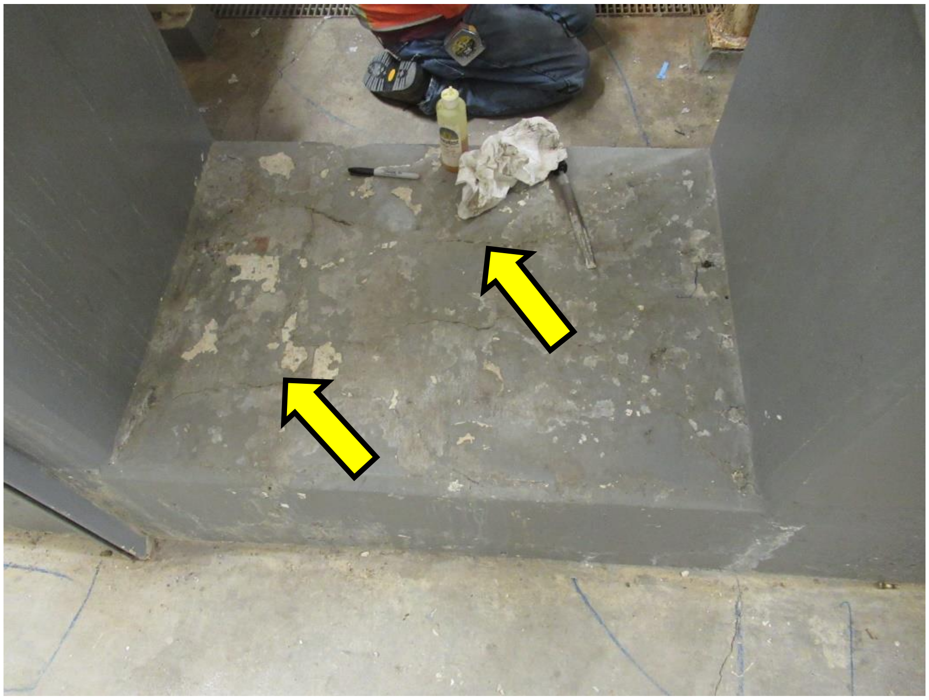

Figure 7. Noted cracking on topside of support pedestal

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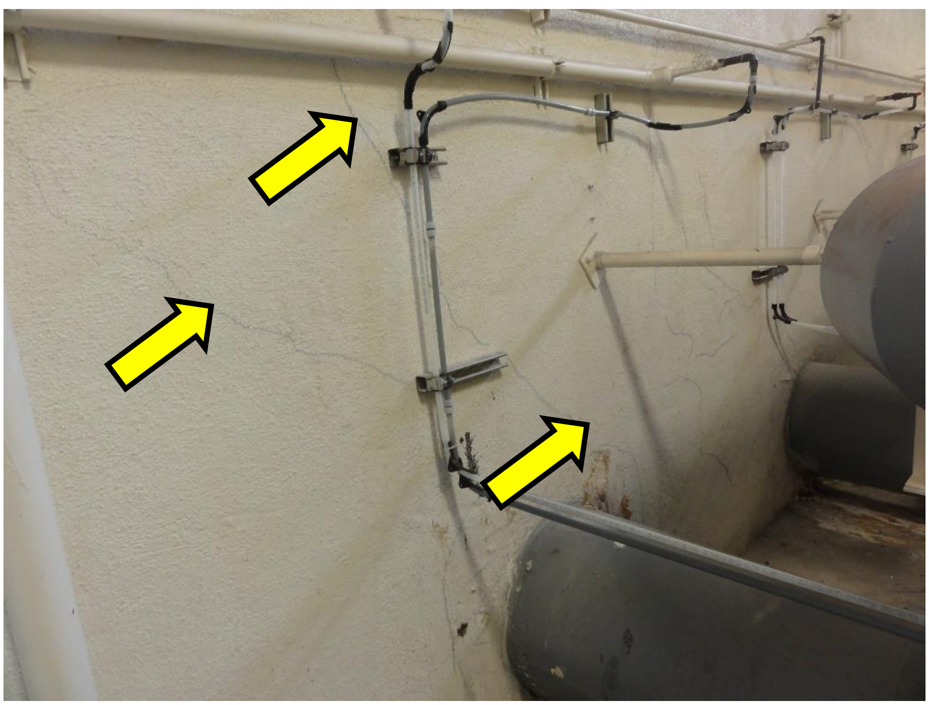
Figure 9. Typical coating installation at interior wall surfaces, with crack highlighted where coating was removed.



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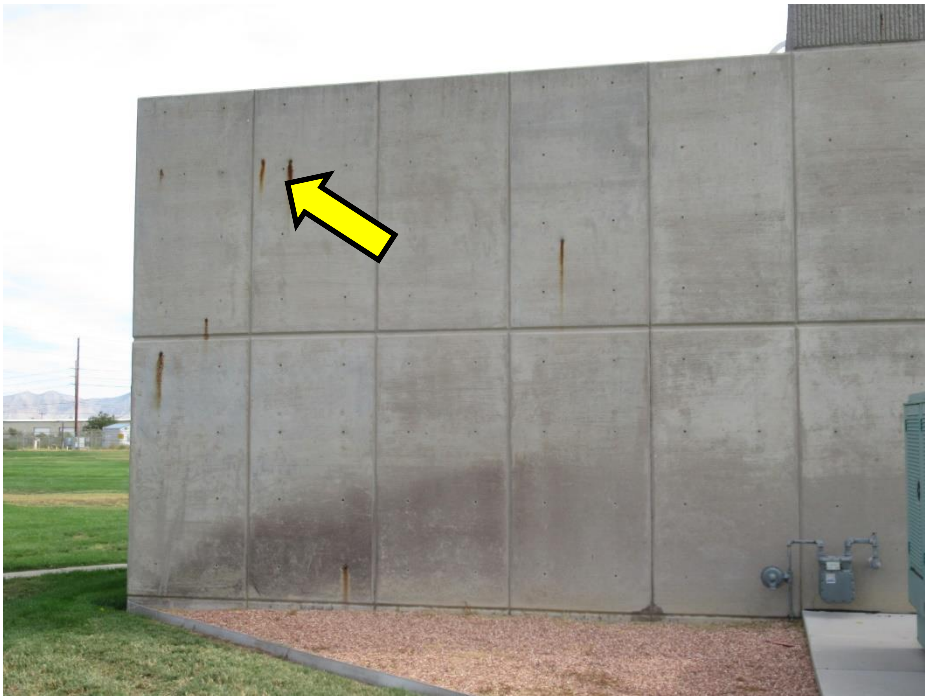

Figure 15. Typical and isolated corrosion staining at aggregate particles

Figure 16. Isolated cracking at base of wall location

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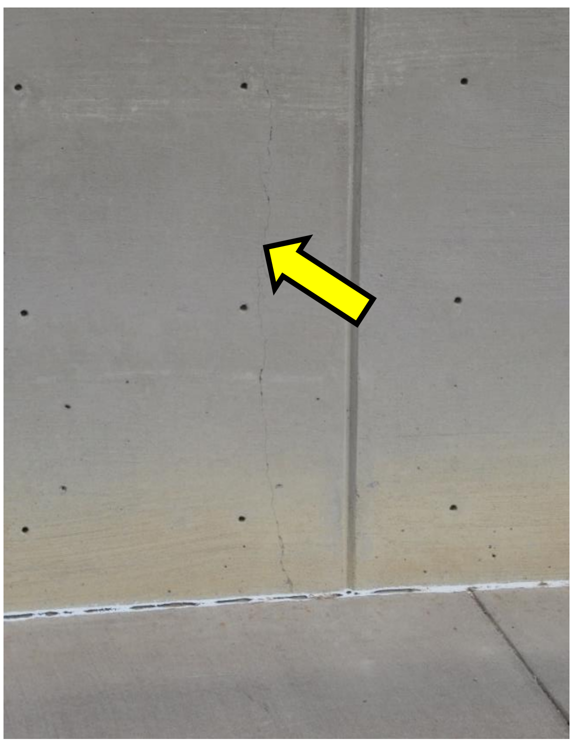

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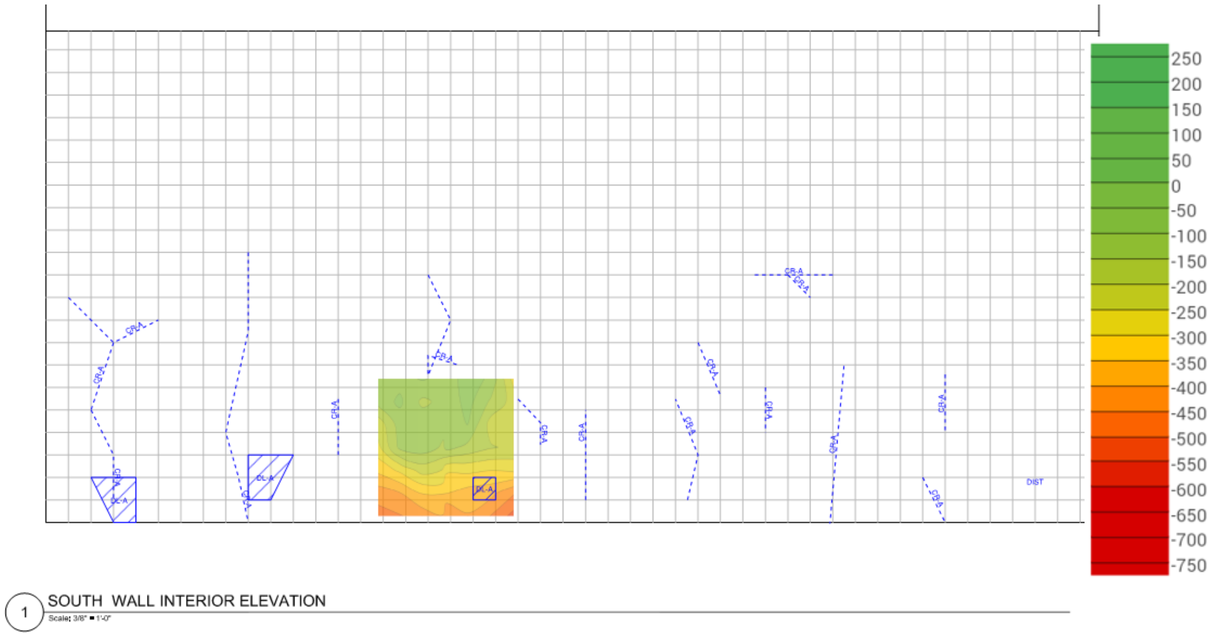

Figure 21. Half-cell potential data overlaid on top of field notes from delamination and crack survey, at the south elevation interior foundation wall. The color scale is in mV and the reference electrode is a CSE

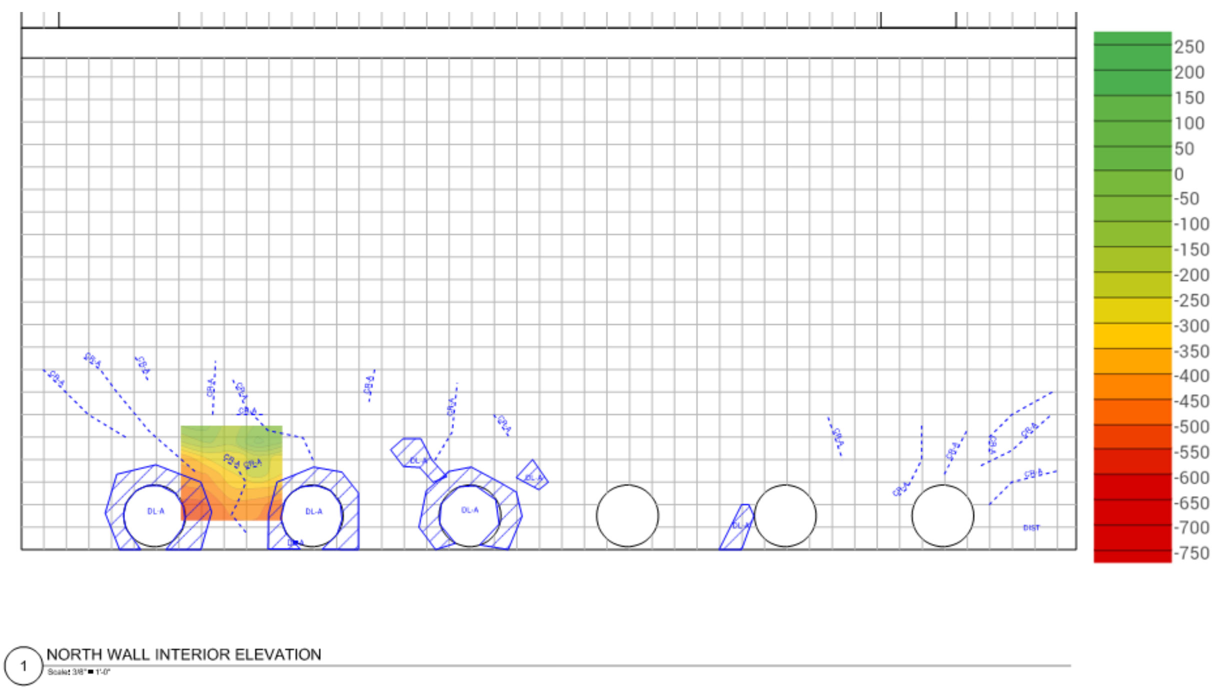

Figure 22. Half-cell potential data overlaid on top of field notes from delamination and crack survey, at the north elevation interior demising wall. The color scale is in mV and the reference electrode is a CSE

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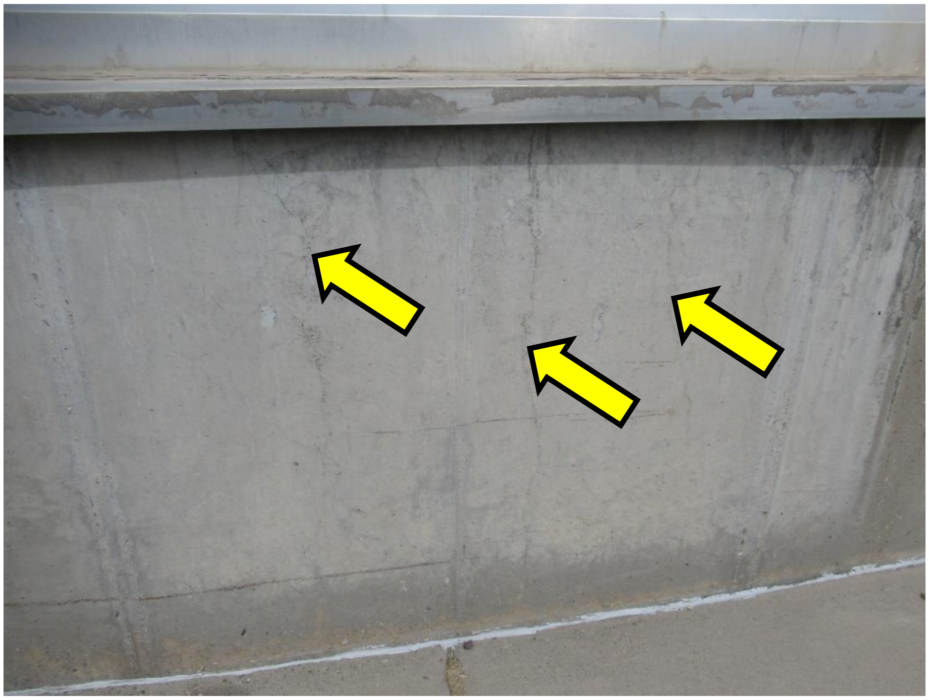

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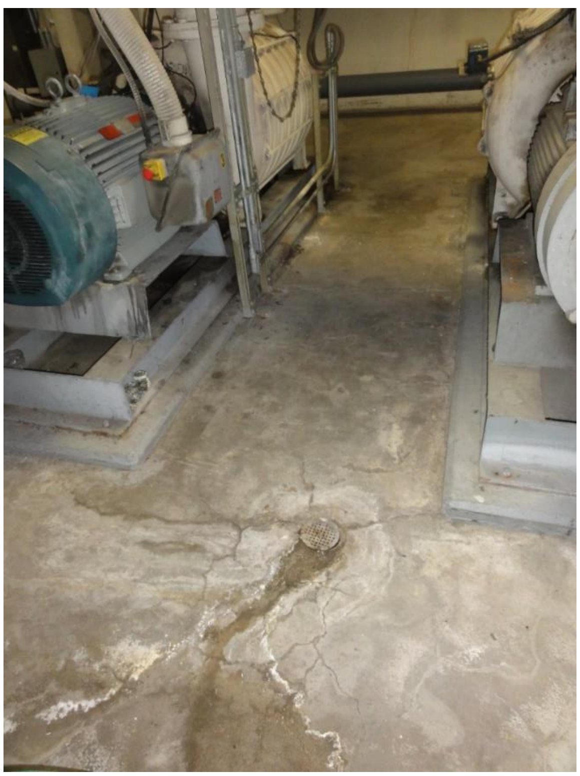

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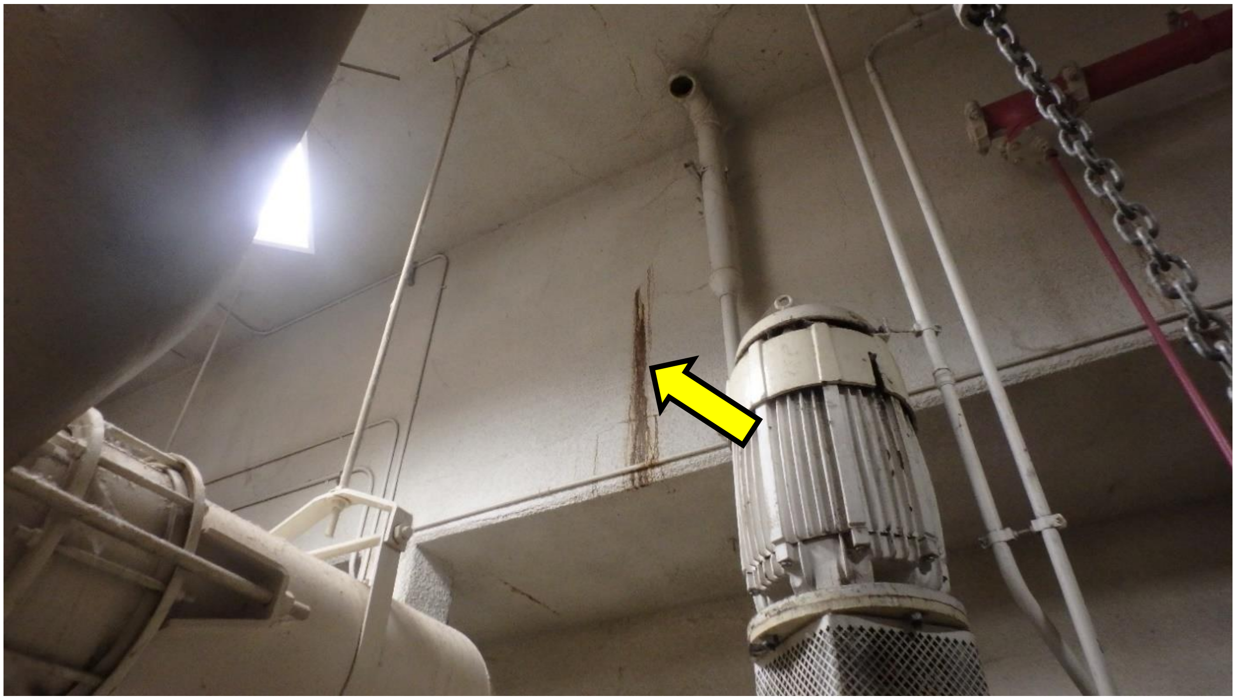

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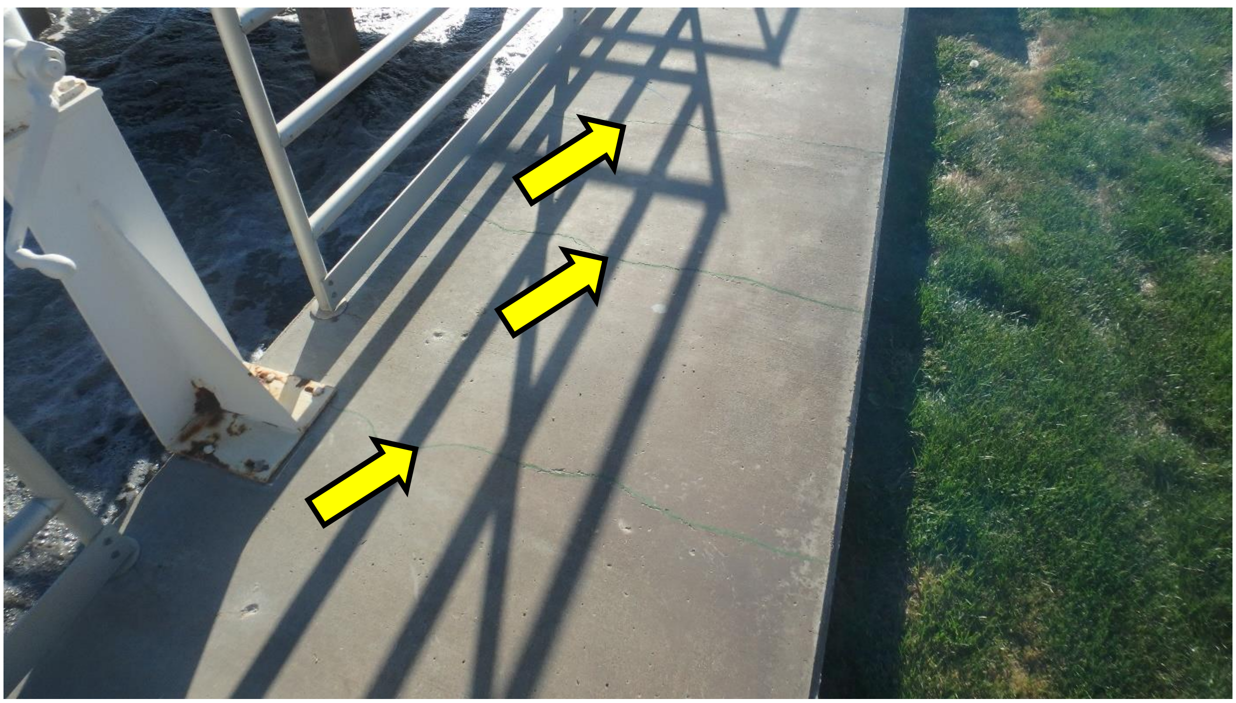

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Aerobic Digester

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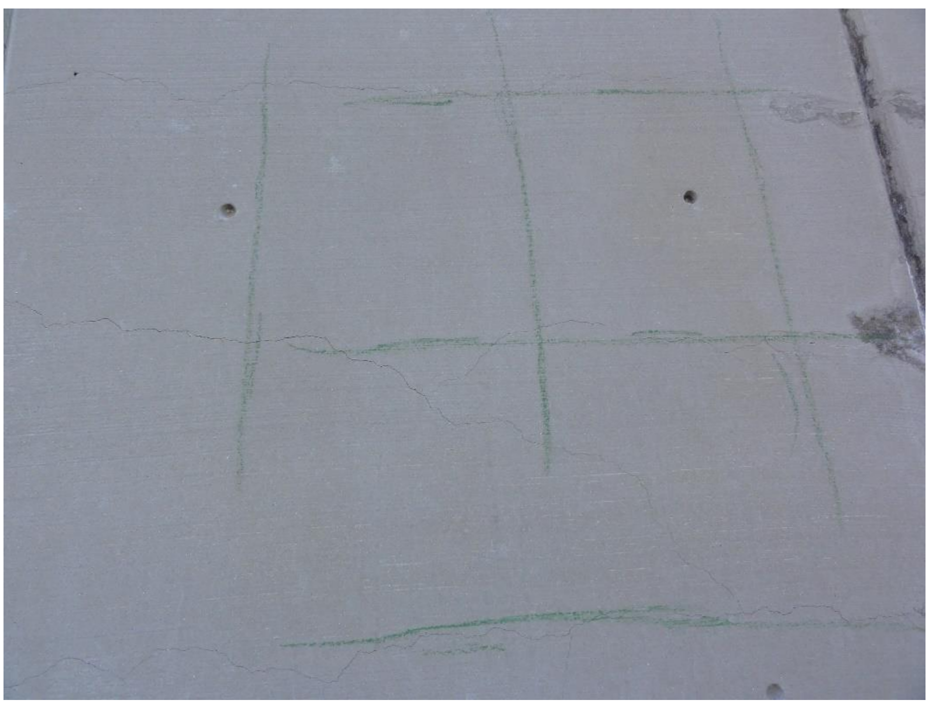

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Figure 60. Evidence of moisture intrusion and efflorescence staining at reveal joints

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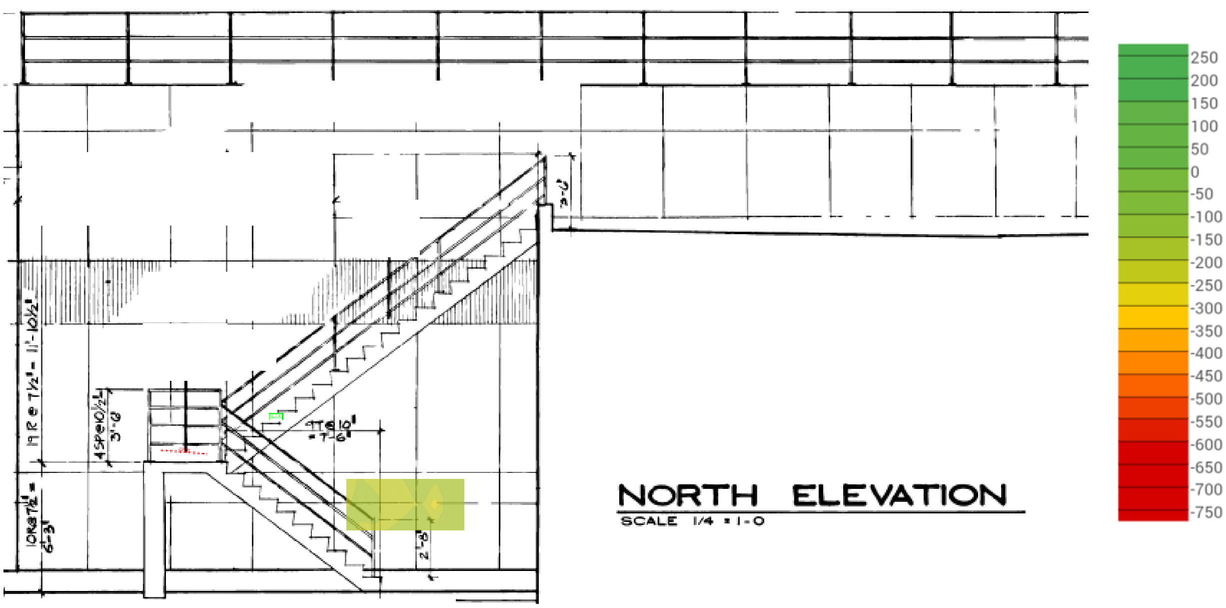
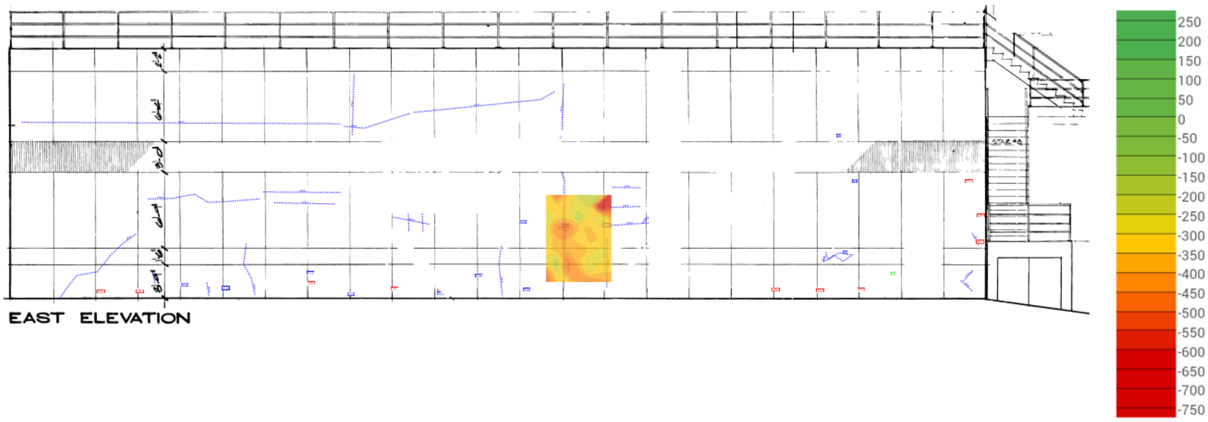


Figure 73. Half-cell potential data overlaid on top of field notes from delamination and crack survey, at the north elevation exterior wall. The color scale is in mV and the reference electrode is a CSE



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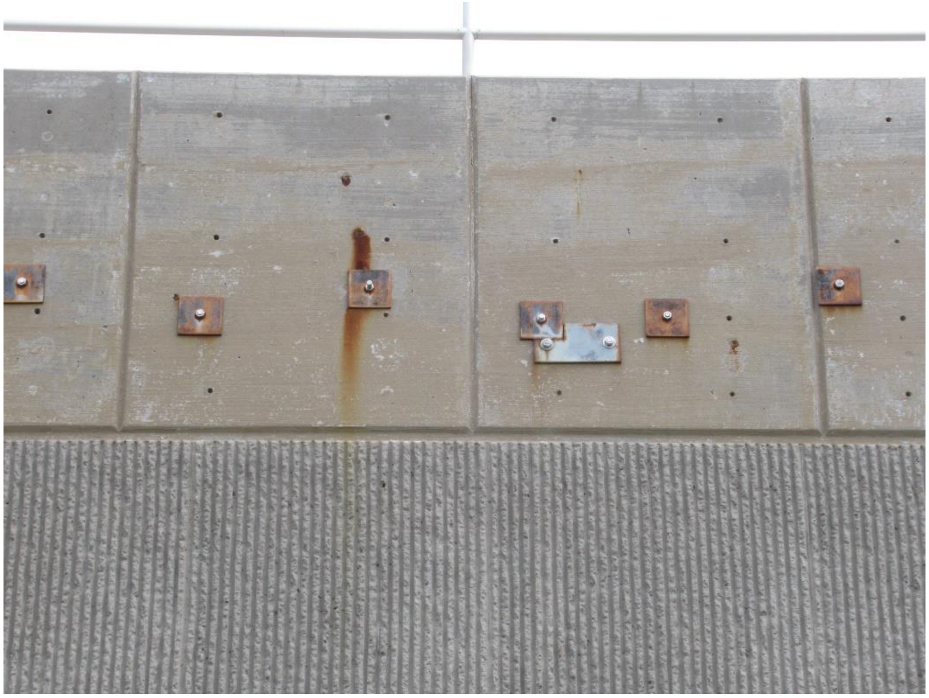

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Figure 92. Coating thickness correlated to corrosion distress, note black coating thickness measurements in mils

Anaerobic Digester

Figure 93. Overall view of the east elevation of the Anaerobic Digesters, with the Anaerobic Digester Building situated in the center

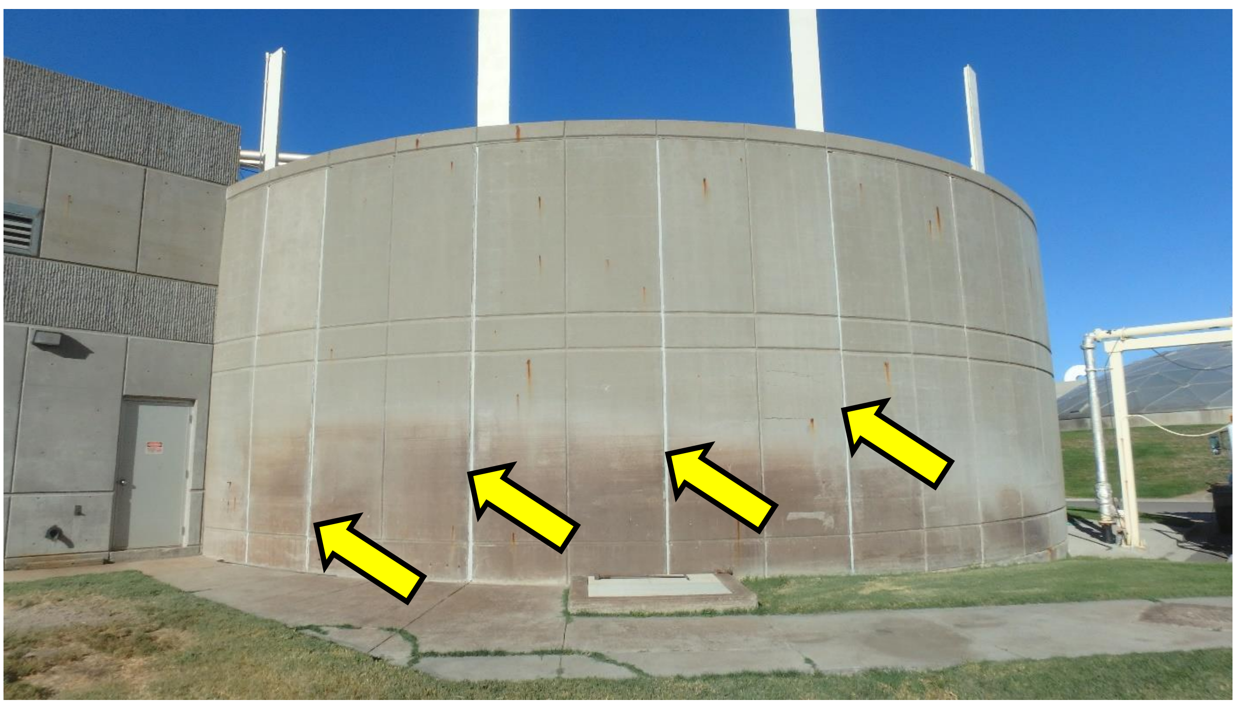

Figure 94. Overall view of the exterior panels and sealant joints (arrows)

Figure 95. Plant overgrowth on north digester exterior

Figure 96. Transverse cracking observed on multiple panels

Figure 97. Spalled concrete at upper corner of exterior panel

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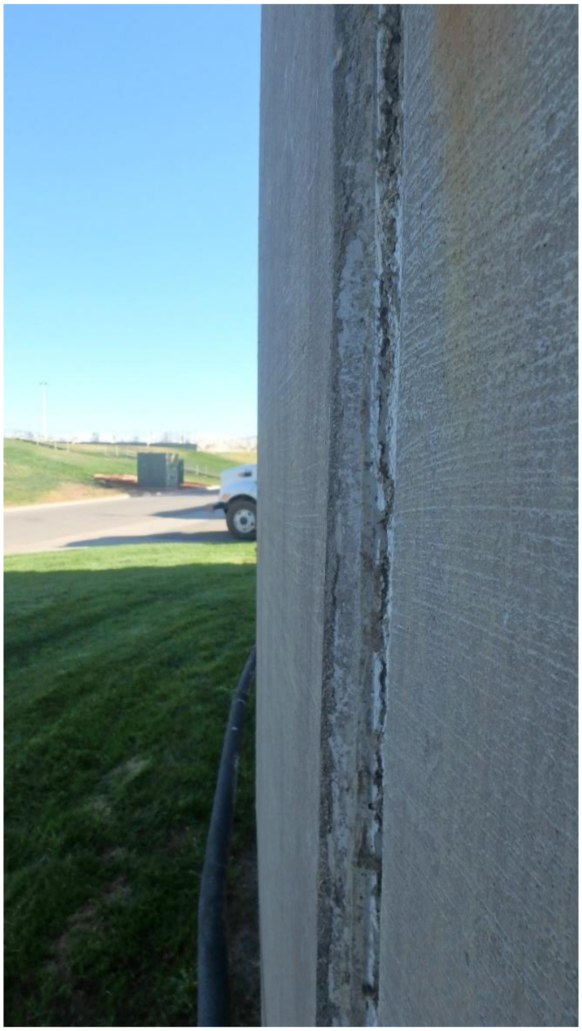

Figure 99. Outward bowing of panel in the background at a vertical sealant joint, with respect to the panel in the foreground

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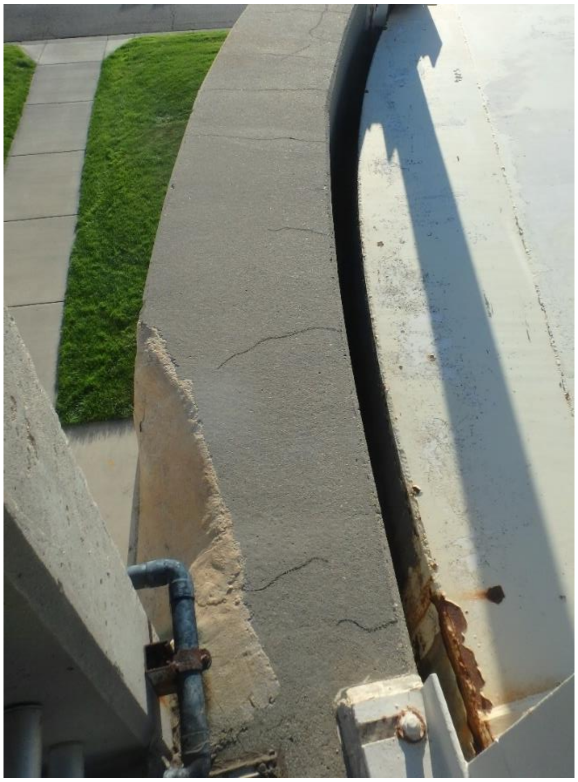

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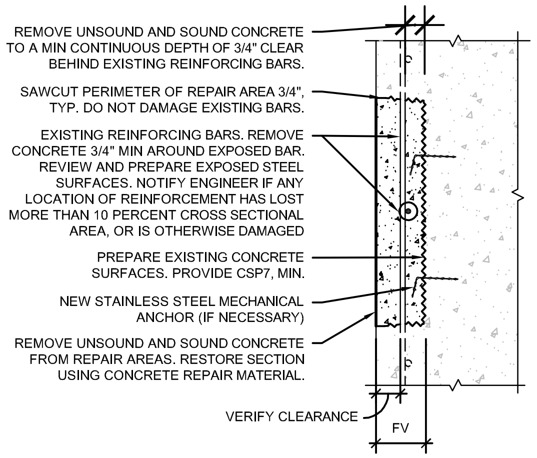
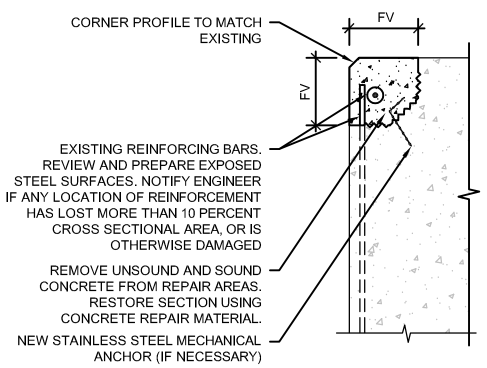
Figure 108. Flaking of coating at south digester lid


Figure 109. Overall view of "X" tape cut at lid coating, note result is 4A, indicating good adhesion

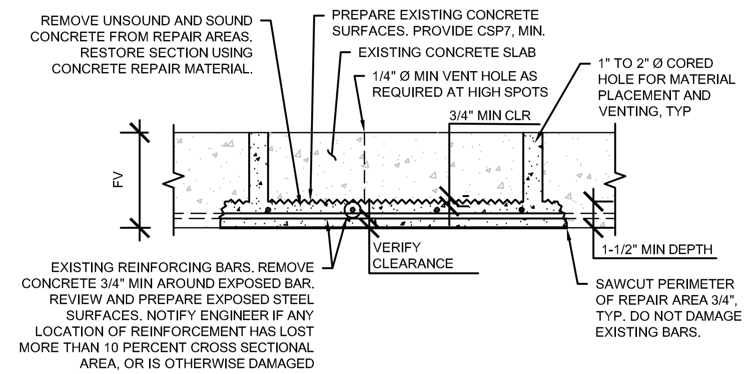
APPENDIX G. CONCEPTUAL DESIGNS



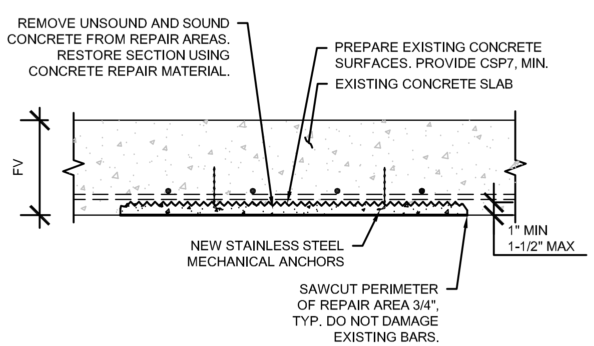
1 PARTIAL DEPTH VERTICAL REPAIR
SCALE: Not to Scale



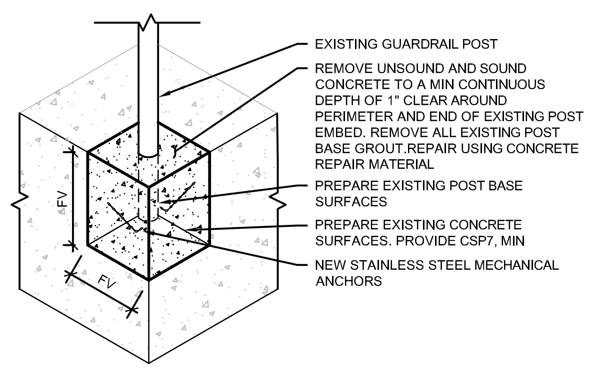
2 CORNER REPAIR
SCALE: Not to Scale



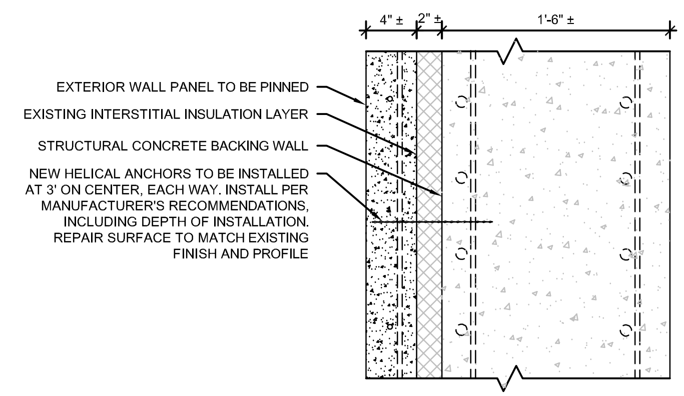
3 OVERHEAD REPAIR
SCALE: Not to Scale



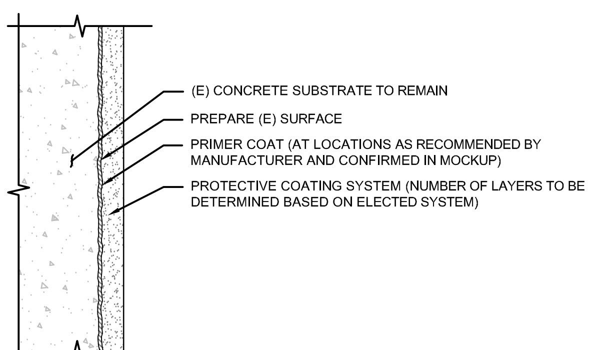
4 SHALLOW OVERHEAD REPAIR
SCALE: Not to Scale



5 GUARDRAIL POST REPAIR AT AERATION BASIN
SCALE: Not to Scale



6 SUPPLEMENTAL ANCHORAGE AT ANAEROBIC DIGESTER PANELS
SCALE: Not to Scale



7 PROTECTIVE COATING SYSTEM
SCALE: Not to Scale

TYPICAL COATING NOTES:

THESE NOTES SHALL APPLY TO ALL COATING WORK UNLESS OTHERWISE NOTED ON A SPECIFIC DETAIL.

1. COATING TERMINATIONS AND DETAILS AT JOINTS, CRACKS AND SIMILAR SHALL CONFORM TO THE DETAILS HEREIN, OR MANUFACTURER DETAILS FOR ITEMS NOT SHOWN. CONFIRM REQUIREMENTS OF DETAILS/REQUIREMENTS HEREIN WITH COATING MANUFACTURER. NOTIFY ENGINEER OF DISCREPANCIES BETWEEN THESE DRAWINGS AND MANUFACTURER TYPICAL DETAILS OR WRITTEN INSTRUCTIONS. ENGINEER SHALL DETERMINE WHICH REQUIREMENT(S) APPLY. DO NOT PROCEED WITH WORK UNTIL RECEIVING DIRECTION FROM ENGINEER.
2. CONFIRM CONCRETE OR CONCRETE REPAIRS HAVE APPROPRIATELY CURED AND ARE AT MOISTURE LEVELS BELOW THE COATING MANUFACTURER'S REQUIREMENTS.
3. PREPARE SURFACE TO PROFILE OF CSP 3 OR 4.
4. UNIFORMLY CLEAN AND INCREASE SURFACE BY ABRASIVE BLAST PER ASTM D4259.
5. REMOVE LOOSE MATERIAL AND CLEAN SURFACES PER ASTM D4258.
6. REMOVE AND REPLACE, OR INSTALL JOINT SEALANTS. ROUT AND SEAL CRACKS AS SPECIFIED.
7. INSTALL COATING AT STRUCTURES INDICATED.

TYPICAL CONCRETE REPAIR NOTES:

THESE NOTES SHALL APPLY TO ALL CONCRETE REPAIR WORK UNLESS NOTED OTHERWISE ON SPECIFIC DETAILS.

1. SOUND AND MARK ALL REPAIR AREAS ON CONCRETE SURFACE. NOTIFY ENGINEER AND OWNER OF ANY LOCATIONS WHICH EXCEED 5 PERCENT INCREASE OVER THOSE SHOWN ON DRAWINGS. AWAIT APPROVAL PRIOR TO PROCEEDING WITH CONCRETE REMOVAL.
2. INSTALL SHORING AS REQUIRED. NOTIFY ENGINEER OF LOCATIONS WHERE EXTENT OF DETERIORATION OR SUSPECT EXISTING CONSTRUCTION INDICATES THAT SHORING MAY BE NECESSARY.
3. REMOVE ALL LOOSE CONCRETE FROM THE DETERIORATED AREA.
4. CONCRETE REMOVAL AREAS:
   - 4.A. MAKE A SAWCUT AROUND THE ENTIRE PERIMETER OF THE REPAIR AREA. SHAPE SHALL BE RECTANGULAR IN PLAN, AND SHALL AVOID RE-ENTRANT CORNERS.
   - 4.B. EXTEND REMOVAL AND REPLACEMENT AT LEAST 4 INCHES BEYOND EDGE OF UNSOUND CONCRETE.
   - 4.C. THE CUT SHALL BE MADE TO A DEPTH OF 1/2 INCH, IF POSSIBLE. IF THERE ARE AREAS AROUND THE PERIMETER OF THE DETERIORATED AREAS WHERE STEEL REINFORCING IS CLOSER TO THE SURFACE THAN NOTED SAWCUT DEPTH, THEN NO SAW CUT SHALL BE MADE IN THOSE AREAS. INSTEAD OF A SAWCUT, THE PERIMETER OF THE AREA SHALL BE CAREFULLY CHIPPED AWAY WITH A LIGHT DUTY CHIPPING HAMMER TO ACHIEVE AS CLOSE TO A SMOOTH UNIFORM EDGE AS POSSIBLE (I.E. SIMULATE A SAWCUT PERIMETER).
5. CONCRETE REMOVAL PROCEDURE:
   - 5.A. REMOVE UNSOUND AND CONCRETE AND, AS NECESSARY, SOUND CONCRETE USING EITHER 15-LB CHIPPING HAMMER (DETAIL WORK ADJACENT TO AND BENEATH REINFORCING STEEL) OR 30-LB CHIPPING HAMMER (REMOVAL OF CONCRETE AT REPAIR AREAS).
   - 5.B. MINIMUM REMOVAL DEPTH AS SHOWN ON DRAWINGS. AVOID ABRUPT CHANGES IN DEPTH OF REMOVAL.
   - 5.C. CLEARANCE AROUND REINFORCING BARS OF AT LEAST 3/4 INCHES.
   - 5.D. TAKE CARE NOT TO EXCESSIVELY VIBRATE THE EXPOSED REINFORCING WITH THE CHIPPING HAMMER, IN ORDER TO AVOID FRACTURING ANY OF THE CONCRETE THAT IS BONDED TO THE REINFORCEMENT OUTSIDE THE PERIMETER OF THE REPAIR.
   - 5.E. PROVIDE CONCRETE SURFACE PROFILE AS SPECIFIED OR INDICATED ON THE DRAWINGS. UNLESS NOTED OTHERWISE, CSP 7, MIN SHALL BE PROVIDED.
   - 5.F. LIMIT CHIPPING HAMMER SIZE AND IMPACT ANGLE TO MINIMIZE DAMAGE TO SOUND CONCRETE. IMPACT ANGLE SHALL BE NO MORE THAN 60° TO SURFACE.
6. REMOVE MICROFRACTURED OR BRUISED CONCRETE BY ABRASIVE BLASTING (OR OTHER APPROVED METHOD) THE EXPOSED CONCRETE SURFACES WITHIN THE AREA OF THE REMOVAL. BE SURE TO ABRASIVE BLAST THE VERTICAL SAWCUT EDGES AROUND THE PERIMETER.
7. PER SSPC SP6, COMMERCIAL BLAST CLEAN THE EXPOSED REINFORCING STEEL BY ABRASIVE BLASTING TO REMOVE ALL RUST SCALE FROM ALL STEEL REINFORCING BARS AND EMBEDDED ITEMS. EXERCISE CARE TO PREPARE UNDERSIDES OF REINFORCING BARS.
   - 7.A. NOTIFY ENGINEER OF REINFORCING BARS THAT HAVE LESS THAN 1/2 INCH OF CONCRETE COVER.
8. CAREFULLY INSPECT THE EXPOSED STEEL REINFORCING BARS FOR LOSS OF SECTION DUE TO CORROSION. THE INSPECTION SHOULD TAKE PLACE AFTER ABRASIVE BLASTING OF THE STEEL REINFORCING. ANY STEEL REINFORCING WITH MORE THAN 10 PERCENT LOSS OF SECTION SHALL BE BROUGHT TO THE ATTENTION OF THE ENGINEER FOR POSSIBLE FURTHER REMEDIAL ACTION.
9. INSTALL SUPPLEMENTAL MECHANICAL ANCHORS OR REINFORCING BAR AT ANY REPAIR AREA IN WHICH THE EXISTING OR NEW REINFORCING IS NOT COMPLETELY ENCAPSULATED WITHIN THE NEW REPAIR MATERIAL, AS FOLLOWS.
   - 9.A. INSTALL HELICAL ANCHORS PER MANUFACTURER'S INSTRUCTIONS
   - 9.B. ANCHORS SHALL BE INSTALLED AT THE FOLLOWING MINIMUM FREQUENCIES, WHICHEVER IS GREATER:
     - 9.B.1. TWO (2) ANCHORS PER ONE (1) SQUARE FOOT OF REPAIR AREAS, UNIFORMLY SPACED.
     - 9.B.2. TWO (2) ANCHORS PER REPAIR AREA, UNIFORMLY SPACED
   - 9.C. ANCHORS SHALL BE INSTALLED TO MANUFACTURER SPECIFIED MINIMUM EMBEDMENT, 1 1/2-INCHES.
   - 9.D. AFTER BEING INSTALLED, THE ANCHORS SHALL BE :
     - 9.D.1. BENT INTO AN "L" SHAPE SUCH THAT 1/2 INCH CLEAR IS PROVIDED BETWEEN THE ANCHOR AND THE EXISTING CONCRETE MATERIAL.
     - 9.D.2. THE TAIL OF THE "L" SHALL BE A MINIMUM OF 1-INCH LONG.
     - 9.D.3. CLEAR COVER FROM THE OUTER EDGE OF THE ANCHOR TO THE FACE OF THE REPAIR SHALL BE 1-INCH MINIMUM.
10. IMMEDIATELY CLEAN THE ENTIRE AREA OF THE REPAIR WITH HIGH PRESSURE, OIL FREE, COMPRESSED AIR.
11. IMMEDIATELY COAT ALL EXPOSED STEEL REINFORCING WITH TWO COATS OF CORROSION - INHIBITING COATING OR EPOXY. TAKE CARE NOT TO GET ANY OF THE COATING ON THE SURROUNDING CONCRETE SURFACES.
12. AS SOON AS THE COATING HAS CURED (AS RECOMMENDED BY MANUFACTURER), FORM (IF REQUIRED) AND PLACE THE CEMENTITIOUS REPLACEMENT MATERIAL TO RESTORE THE PROFILE OF THE EXISTING SECTION. ENSURE THAT REPAIR AREAS ARE CLEAN AND PROPERLY CONDITIONED PRIOR TO STARTING PLACEMENT. IF SPECIFIED BY THE ENGINEER, BUILD-OUT THE FORM WORK TO ACHIEVE AT LEAST 1 INCH OF COVER OVER THE EXPOSED REINFORCING STEEL.
13. INTERNALLY AND EXTERNALLY VIBRATE THE MATERIAL AS IT IS PLACED TO ACHIEVE PROPER CONSOLIDATION.
14. WET CURE FOR 7 DAYS OR UNTIL MATERIAL HAS ACHIEVED 75 PERCENT OF ITS REQUIRED 28-DAY COMPRESSIVE STRENGTH; OR LONGER IF SPECIFIED BY THE MANUFACTURER FOR PROPRIETARY MATERIALS.
15. PROTECT REPLACEMENT MATERIAL FROM WEATHER AND MAINTAIN ABOVE 55° F FOR A MINIMUM OF 7 DAYS.
16. REMOVE THE FORMS AFTER CONCRETE HAS REACHED 75 PERFECT OF REQUIRED STRENGTH. CAREFULLY INSPECT THE REPAIR FOR IMPROPER CONSOLIDATION, CRACKING AROUND THE PERIMETER, OR DEBONDING OF NEW CONCRETE. IF THESE CONDITIONS EXIST, NOTIFY THE ARCHITECT/ENGINEER FOR POSSIBLE REMEDIAL ACTION OR REPLACEMENT OF THE REPAIR.
17. SOUND REPAIR AREAS TO CONFIRM INTEGRITY. DELAMINATED AND/OR DISTRESSED AREAS MUST BE REMOVED AND REPAIRED.
18. REMOVE SHORING WHEN CONCRETE HAS REACHED MINIMUM REQUIRED STRENGTH.

APPENDIX H. ENGINEER'S OPINION OF PROBABLE COSTS

	High Priority			Medium Priority			Low Priority			Structure Total
	Quantity	Unit Price	Total Cost	Quantity	Unit Price	Total Cost	Quantity	Unit Price	Total Cost	
Raw Sewage Pump Station										
1) Concrete repairs (SF)			$ -	1,300	$ 200	$ 260,000			$ -	$ 260,000
2) Allowance for pipe inlet seal investigation			$ -	Allowance	$ 5,000	$ 5,000			$ -	$ 5,000
3) Allowance for pipe inlet replacement (each)			$ -			$ -	5	$ 7,500	$ 37,500	$ 37,500
4) Remove and replace topping slab (SF)			$ -			$ -	750	$ 100	$ 75,000	$ 75,000
Total for Raw Sewage Pump Station			$ -			$ 265,000			$ 112,500	$ 377,500
General Conditions & Mobilization (25%)			$ -			$ 66,300			$ 28,100	$ 94,400
Project Contingency (25%)			$ -			$ 66,300			$ 28,100	$ 94,400
Engineering Allowance (15%)			$ -			$ 39,800			$ 16,900	$ 56,700
Grand Total for Raw Sewage Pump Station			*$ -*			*$ 437,400*			*$ 185,600*	*$ 623,000*
Primary Clarifiers										
1) Concrete repairs (SF)	350	$ 200	$ 70,000			$ -			$ -	$ 70,000
2) Allowance for additional analysis (core extraction, laboratory studies) of concrete to select appropriate protective coating	Allowance	$ 8,000	$ 8,000			$ -			$ -	$ 8,000
3) Surface preparation of eroded surfaces prior to installation of protective coating system			$ -	34,000	$ 10	$ 340,000			$ -	$ 340,000
4) Installation of a protective coating system (SF)			$ -	34,000	$ 45	$ 1,530,000			$ -	$ 1,530,000
5) Allowance for installation of a new gasket between domed roof and concrete wall	Allowance	$ 25,000	$ 25,000			$ -			$ -	$ 25,000
6) Allowance for inspection of roof node attachment hardware	Allowance	$ 5,000	$ 5,000			$ -			$ -	$ 5,000
Total for Primary Clarifiers			$ 108,000			$ 1,870,000			$ -	$ 1,978,000
General Conditions & Mobilization (25%)			$ 27,000			$ 467,500			$ -	$ 494,500
Project Contingency (25%)			$ 27,000			$ 467,500			$ -	$ 494,500
Engineering Allowance (15%)			$ 16,200			$ 280,500			$ -	$ 296,700
Grand Total for Primary Clarifiers			*$ 178,200*			*$ 3,085,500*			*$ -*	*$ 3,263,700*
Aeration Basin										
1) Concrete repairs (SF)			$ -			$ -	700	$ 200	$ 140,000	$ 140,000
2) Concrete repairs at guardrail posts (each)			$ -	40	$ 500	$ 20,000			$ -	$ 20,000
3) Rout and seal catwalk topside cracks above blower room (LF)			$ -	300	$ 5	$ 1,500			$ -	$ 1,500
4) Allowance for additional analysis (core extraction, laboratory studies) of concrete to select appropriate protective coating			$ -	Allowance	$ 5,500	$ 5,500			$ -	$ 5,500
5) Installation of a protective coating system (SF)			$ -			$ -	67,000	$ 45	$ 3,015,000	$ 3,015,000
6) Allowance for pipe inlet seal investigation			$ -			$ -	Allowance	$ 5,000	$ 5,000	$ 5,000
7) Allowance for pipe inlet replacement (each)			$ -			$ -	9	$ 5,000	$ 45,000	$ 45,000
8) Remove and replace topping slab (SF)			$ -			$ -	3,700	$ 100	$ 370,000	$ 370,000
Total for Aeration Basin			$ -			$ 27,000			$ 3,575,000	$ 3,602,000
General Conditions & Mobilization (25%)			$ -			$ 6,800			$ 893,800	$ 900,600
Project Contingency (25%)			$ -			$ 6,800			$ 893,800	$ 900,600
Engineering Allowance (15%)			$ -			$ 4,100			$ 536,300	$ 540,400
Grand Total for Aeration Basins			*$ -*			*$ 44,700*			*$ 5,898,900*	*$ 5,943,600*
Aerobic Digester										
1) Concrete repairs (SF)			$ -	50	$ 200	$ 10,000	1,800	$ 200	$ 360,000	$ 370,000
2) Allowance for additional analysis (core extraction, laboratory studies) of concrete to select appropriate protective coating			$ -	Allowance	$ 5,500	$ 5,500			$ -	$ 5,500
3) Installation of a protective coating system (SF)			$ -			$ -	42,000	$ 45	$ 1,890,000	$ 1,890,000
Total for Aerobic Digester			$ -			$ 15,500			$ 2,250,000	$ 2,265,500
General Conditions & Mobilization (25%)			$ -			$ 3,900			$ 562,500	$ 566,400
Project Contingency (25%)			$ -			$ 3,900			$ 562,500	$ 566,400
Engineering Allowance (15%)			$ -			$ 2,300			$ 337,500	$ 339,800
Grand Total for Aerobic Digester			*$ -*			*$ 25,600*			*$ 3,712,500*	*$ 3,738,100*
Sludge Processing Unit										
1) Concrete repairs (SF)			$ -			$ -	150	$ 200	$ 30,000	$ 30,000
2) Allowance for additional analysis (core extraction, laboratory studies) of shotcrete to select appropriate protective coating			$ -	Allowance	$ 5,500	$ 5,500			$ -	$ 5,500
3) Installation of a protective coating system (SF)			$ -			$ -	5,500	$ 45	$ 247,500	$ 247,500
Total for Sludge Processing Unit			$ -			$ 5,500			$ 277,500	$ 283,000
General Conditions & Mobilization (25%)			$ -			$ 1,400			$ 69,400	$ 70,800
Project Contingency (25%)			$ -			$ 1,400			$ 69,400	$ 70,800
Engineering Allowance (15%)			$ -			$ 800			$ 41,600	$ 42,400
Grand Total for Sludge Processing Unit			*$ -*			*$ 9,100*			*$ 457,900*	*$ 467,000*
Anaerobic Digester										
1) Concrete repairs (SF)	500	$ 200	$ 100,000			$ -	150	$ 200	$ 30,000	$ 130,000
2) Allowance for panel attachment investigation	Allowance	$ 5,000	$ 5,000			$ -			$ -	$ 5,000
3) Allowance for installation of supplemental anchorage of panels	Allowance	$ 70,000	$ 70,000			$ -			$ -	$ 70,000
5) Installation of a protective coating system (SF)			$ -			$ -	18,000	$ 45	$ 810,000	$ 810,000
6) Installation of sheet metal coping flashing (LF)	400	$ 25	$ 10,000			$ -			$ -	$ 10,000
7) Clean and re-coat south digester lid (SF)			$ -			$ -	3,000	$ 5	$ 15,000	$ 15,000
Total for Anaerobic Digester			$ 185,000			$ -			$ 855,000	$ 1,040,000
General Conditions & Mobilization (25%)			$ 46,300			$ -			$ 213,800	$ 260,100
Project Contingency (25%)			$ 46,300			$ -			$ 213,800	$ 260,100
Engineering Allowance (15%)			$ 27,800			$ -			$ 128,300	$ 156,100
Grand Total for Anaerobic Digester			*$ 305,400*			*$ -*			*$ 1,410,900*	*$ 1,716,300*
Steel Framing at Sludge Processing										
1) Alowance for removing and replacing all bolted connections			$ -			$ -	Allowance	$ 5,000	$ 5,000	$ 5,000
2) Allowance for cleaning and re-coating of steel framing			$ -			$ -	Allowance	#######	$ 100,000	$ 100,000
Total for Steel Framing at Sludge Processing			$ -			$ -			$ 105,000	$ 105,000
General Conditions & Mobilization (25%)			$ -			$ -			$ 26,300	$ 26,300
Project Contingency (25%)			$ -			$ -			$ 26,300	$ 26,300
Engineering Allowance (15%)			$ -			$ -			$ 15,800	$ 15,800
Grand Total for Steel Framing at Sludge Process.			*$ -*			*$ -*			*$ 173,400*	*$ 173,400*
GRAND TOTAL			*$ 483,600*			*$ 3,602,300*			*$ 11,839,200*	*$ 15,925,100*