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Submitted by
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June 1, 2020

Final Summary Report
Structural Integrity Assessment

Return Water Pond
Four Corners Power Plant
Fruitland, New Mexico

Prepared for:
Arizona Public Service

AECOM Job No. 60596770
June 2020

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List of Acronyms

APS	Arizona Public Service
ASTM	American Society for Testing and Materials
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
CWTP	Combined Waste Treatment Pond
EAP	Emergency Action Plan
EL	Elevation
EPA	Environmental Protection Agency
FCPP	Four Corners Power Plant
FGD	Flue Gas Desulfurization
ft	feet
HDPE	High Density Polyethylene
HPC	Hazard Potential Classification
LAI	Lined Ash Impoundment
LDWP	Lined Decant Water Pond
NMOSE	New Mexico Office of the State Engineer
pcf	pounds per cubic foot
PMP	Probable Maximum Precipitation
PMF	Probable Maximum Flood
psf	pounds per square foot
RCRA	Resource Conservation and Recovery Act
RWP	Return Water Pond
USCS	Unified Soil Classification System
USGS	United States Geological Survey

Certification Statement

Certification Statement for:

- **40 CFR § 257.74(a)(2)(ii) – Initial Hazard Potential Classification for New CCR Surface Impoundments**
- **40 CFR § 257.74(d)(3) – Initial Structural Stability Assessment for New CCR Surface Impoundments**
- **40 CFR § 257.74(e)(2) – Initial Safety Factor Assessment for New CCR Surface Impoundments**

CCR Unit: Arizona Public Service Company; Four Corners Power Plant; Return Water Pond

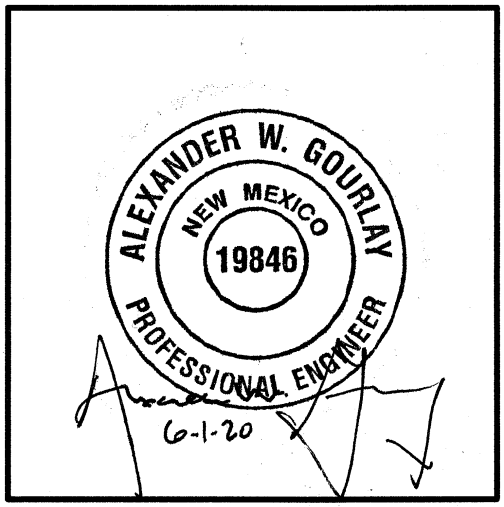
I, Alexander W. Gourlay, being a Registered Professional Engineer in good standing in the State of New Mexico, do hereby certify, to the best of my knowledge, information, and belief, that the information contained in this certification has been prepared in accordance with the accepted practice of engineering. I certify, for the above-referenced CCR Unit, that the initial hazard potential classification, initial structural stability assessment, and initial safety factor assessment was conducted in accordance with the requirements of 40 CFR § 257.74.

Alexander W. Gourlay, P.E.

Printed Name

June 1, 2020

Date



1 Introduction

Arizona Public Service Company (APS) contracted AECOM to assist in the initial structural integrity assessment of the Return Water Pond (RWP), a new coal combustion residual (CCR) surface impoundment facility with two cells (labeled the "FGD Cell" and the "RWP Cell" but collectively referenced as the RWP) at the Four Corners Power Plant (FCPP) on the Navajo Nation in Fruitland, New Mexico. Figure 1-1 shows the location of the RWP at the FCPP.

1.1 Report Purpose and Description

The purpose of this report is to document the initial structural integrity assessment for the RWP. The RWP is a new CCR surface impoundment owned and operated by APS. In 2015, the United States Environmental Protection Agency (EPA) finalized Federal Rule 40 Code of Federal Regulations (CFR) *§* 257.74 (EPA 2015) regulating CCRs under subtitle D of the Resource Conservation and Recovery Act (RCRA) (the Rule). As part of this Rule, owners and operators of new CCR surface impoundments must complete initial structural integrity assessments to document the hazard potential classification; document whether the design, construction, operation, and maintenance of the CCR unit is consistent with recognized and generally accepted good engineering practices for the maximum volume of CCR and CCR wastewater which can be impounded therein; and document whether the calculated factors of safety in the initial safety factor assessment achieve the minimum safety factors in the CCR Rule.

1.2 EPA Regulatory Requirements

Pursuant to 40 CFR *§* 257.74 (EPA 2015), an initial structural integrity assessment must be performed for each new CCR surface impoundment. The assessment must address the following elements:

- *Periodic Hazard Potential Classification Assessment (40 CFR § 257.74(a)(2))* – The owner or operator of the CCR unit must conduct initial and periodic hazard potential classification assessments of the CCR unit, document the hazard potential classification, and document the basis for the hazard potential classification.

- *Emergency Action Plan (EAP) (40 CFR §257.74(a)(3))* – Prepare and maintain a written EAP for high and significant hazard CCR units. The EAP must be evaluated at least every five years, updated, and revised to ensure the information within is accurate.

In addition, the following elements must be addressed for new CCR units, such as the RWP, that have a height of five feet or more and a storage volume of 20 acre-ft (ac-ft) or more, or have a height of 20 feet or more:

- *History of Construction (40 CFR § 257.74(c))* – Compile the design and construction plans for the CCR unit.

- *Periodic Structural Stability Assessment (40 CFR § 257.74(d))* – Document whether the design, construction, operation and maintenance of the CCR unit is consistent with recognized and generally accepted good engineering practice for the maximum volume of CCR and CCR wastewater which can be impounded therein.

- *Periodic Safety Factor Assessment (40 CFR § 257.74(e))* – Document whether the calculated factors of safety for the CCR unit achieve the minimum safety factors for the critical cross section of the embankment under the end-of-construction loading condition; the long-term, maximum storage pool loading condition; the maximum surcharge pool loading condition; the seismic loading condition; and the post-earthquake loading condition for dikes constructed of soils that have susceptibility to liquefaction.

The owner or operator of new CCR surface impoundments, such as the RWP, must complete the initial assessments completed prior to the initial receipt of CCR in the unit. The owner or operator of the CCR unit must conduct and complete the periodic assessments every five years.

1.3 Report Organization

This report is organized into the following sections:

Report Section	Applicable CFR 40 Part 257 Citation
• Section 1 – Introduction	
• Section 2 – Hazard Potential Classification	§ 257.74(a)(2) Initial hazard classification assessment
• Section 3 – History of Construction	§ 257.74(c)(1) History of construction
• Section 4 – Structural Stability Assessment	§ 257.74(d) Periodic structural stability assessment
• Section 5 – Safety Factor Assessment	§ 257.74(e) Periodic safety factor assessment
• Section 6 – Conclusions	
• Section 7 – Limitations	
• Section 8 – References	
• Figures	
• Appendix A – Record Drawings	
• Appendix B – Safety Factor Calculation	
• Appendix C – Elevation-Area-Capacity Curves	
• Appendix D – Construction Specifications	
• Appendix E – Operations & Maintenance Information	

1.4 Facility Description

The FCPP is an electric generating station located within the Navajo Nation, near Fruitland, New Mexico. The FCPP is operated by APS and owned by a consortium of utility companies. The FCPP consists of two coal-fired electrical generating units, Units 4 and 5. Units 1, 2, and 3 ceased generation in 2013 and were then decommissioned. The two generating units are cooled by water from Morgan Lake, a man-made reservoir located immediately north of the Plant. Five existing CCR units are located at the FCPP: the Combined Waste Treatment Pond (CWTP) located immediately east of the Plant; the Lined Ash Impoundment (LAI) located approximately 1 mile west of the Plant; the Lined Decant Water Pond (LDWP) located approximately 1.5 miles west of the Plant and adjacent to the LAI; the Return Water Pond (RWP) located approximately 0.5 miles west of the Plant; and the Dry Fly Ash Disposal Area (DFADA), a landfill located approximately 2 miles southwest of the Plant and south of the LAI. Figure 1-1 shows the location of the RWP.

The RWP was constructed in 2019. The RWP cell will be used as a storage facility for water pumped from the LDWP and Pond 3 pump house. The FGD cell will be used to store small or emergency discharges from the Plant FGD system.

The RWP is a geosynthetic-lined dike with 3 horizontal : 1 vertical (3H:1V) upstream and downstream slopes constructed using processed weathered shale and sandstone material from the excavation footprint. The dike crest width is 20 feet and the maximum height is approximately 12 feet. The RWP liner system consists of a primary 60-mil HDPE geomembrane liner, a drainage geonet, a secondary 60-mil HDPE geomembrane liner, a geosynthetic clay liner (GCL), and a prepared subgrade (scarified, proof-rolled, and compacted). The RWP has a surface area of 5.13 acres and a storage capacity of 38.6 ac-ft (at elevation 5379 feet).

2 Hazard Potential Classification

40 CFR § 257.74(a) requires the owner or operator of the CCR unit to complete an initial hazard potential classification prior to the initial receipt of CCR in the unit and periodic hazard potential classification assessments of the CCR unit every five years. This document is intended to meet the criteria for the initial hazard potential classification.

2.1 Methodology and Design Criteria

Per the Rule, the hazard potential classification provides an indication of the possible adverse incremental consequences that result from the release of water or stored contents due to failure or mis-operation of the CCR surface impoundment. The classification is based solely on the consequences of failure. As such, it is not dependent on the condition of the embankment or the likelihood of failure. Classifications per the Rule are separate from relevant and/or applicable federal, state or local dam safety regulatory standards, which may also include hazard classification definitions, and are not intended to substitute for other regulatory hazard potential classifications.

The Rule defines three hazard potential classifications as follows:

High hazard potential CCR surface impoundment – A diked surface impoundment where failure or mis-operation will probably cause loss of human life.

Low hazard potential CCR surface impoundment – A diked surface impoundment where failure or mis-operation results in no probable loss of life and low economic and/or environmental losses. Losses are principally limited to the surface impoundment owner's property.

Significant hazard potential CCR surface impoundment – A diked surface impoundment where failure or mis-operation results in no probable loss of human life, but can cause economic loss, environmental damage, disruption of lifeline facilities, or impact other concerns.

The hazard potential of the RWP was assessed qualitatively per the above definitions. The qualitative assessment process is generally performed in a step-wise manner by first determining whether the CCR unit could be classified as low hazard potential based on immediately obvious factors such as proximity to property lines and/or surface water bodies. If the CCR unit does not meet the criteria for the low hazard potential classification, the structure is assessed to determine whether it meets the criteria for the high hazard potential classification. The potential for loss of human life differentiates between high and significant hazard potential in the CCR Rule; therefore, if the CCR unit does not meet the criteria for high hazard potential, it would be classified as a significant hazard potential structure.

The potential for downstream loss of life is assessed by reviewing land use in areas downstream (to the west) from the RWP, where inundation is likely in the event of a release. The RWP has a storage capacity of 38.6 ac-ft and a maximum embankment height of approximately 12 feet. The impoundment's position downstream of on-site office facilities, the FHI trailers, and the Four Corners Power Plant (FCPP) significantly reduces human exposure to an embankment failure. Affected facilities downstream of the RWP are the ash disposal areas on the Plant lease property. The nearest downstream body of water is the Chaco River, approximately 1.6 miles west of the RWP. Due to the presence of the existing ash disposal areas and surface water diversion facilities, water from the RWP is not likely to reach the Chaco River in the event of a complete embankment failure.

2.2 Hazard Potential Classification Results

Inspection of the RWP and its immediate surroundings relative to property lines, surface water bodies, and structures that could potentially be impacted by a release indicate that the failure or mis-operation of the RWP is not likely to cause loss of human life and that any economic and environmental losses incurred due to such a failure would be principally limited to the Plant property. Therefore, the RWP meets the criteria for a "Low Hazard Potential CCR Surface Impoundment" on the premise that a "failure or mis-operation" of the RWP will result in "no probable loss of human life and low economic and/or environmental losses".

3 History of Construction

40 CFR § 257.74(c)(1) requires the owner or operator of the CCR unit to compile the design and construction plans for the CCR unit. This section is intended to meet the requirement for the compilation of the design and construction plans for the CCR unit.

3.1 Methodology

AECOM reviewed the construction and record documents for information regarding the history of construction for the RWP. Per the Rule, the compiled history of construction is to include, to the extent feasible, the following information:

i. Information identifying the CCR Unit, its purpose and the name and address of the owner/operator;

ii. The location of the CCR unit on the most recent USGS or another topographic map;

iii. A statement of the purpose for which the CCR unit is being used;

iv. Name and size of the watershed within which the CCR unit is located;

v. A description of the physical and engineering properties of the foundation and abutment materials on which the CCR unit was constructed;

vi. A description of the type, size, and physical and engineering properties of each embankment zone;

vii. Provide detailed engineering drawings;

viii. A description of the type, purpose and location of instruments;

ix. Area-capacity curves for the CCR unit;

x. A description of spillway and diversion design features;

xi. Construction specifications and provisions for surveillance, maintenance, and repair of the CCR unit; and

xii. Any record of knowledge of structural instability.

3.2 RWP Construction Summary

The RWP construction information is summarized in Table 3-1:

Table 3-1. History of Construction for the RWP

Item	As-Constructed/ Current	Comments	Reference Document(s)
(i) Name and Address of Owner	Arizona Public Service Company (APS): 400 North 5th Street Phoenix, Arizona 85004	---	---
(i) Name associated with the CCR unit	Return Water Pond (RWP)	---	---
(i) State ID No.	(none)	The RWP does not meet the requirements to be regulated by the State of New Mexico.	---
(ii) Location on USGS Quadrangle Map	The Fruitland Quadrangle, the SW ¼ of the NE ¼ of Section 35, Township 29N, Range 16W.	See Figure 3-1	The Fruitland Quadrangle (USGS 2017)
(iii) Statement of Purpose	Temporary storage of discharges from the LAI and Pond 3 pump house	---	---
(iv) Name of Watershed	Chaco watershed	---	NRCS *Rapid Watershed Assessment*
(iv) Size of Watershed (ac)	2,931,265	---	NRCS *Rapid Watershed Assessment*

<table>
<tr><th>Item</th><th>As-Constructed/ Current</th><th>Comments</th><th>Reference Document(s)</th></tr>
<tr><td colspan="4">Material Properties</td></tr>
<tr><td colspan="4">Embankment</td></tr>
<tr><td>(v) Physical and Engineering Properties of the Embankment</td><td>The RWP consists of a homogeneous embankment constructed using suitable weathered shale and sandstone excavated from the site’s footprint and broken down into sand and clay. The engineering properties are based on laboratory tests performed on samples collected during the test pit investigation conducted prior to construction and laboratory tests performed on similar materials from the Dames & Moore (1990) report:
<table><tr><th>Material</th><th>γ_{sat} (pcf)</th><th>c′ (psf)</th><th>ϕ′ (°)</th><th>c (psf)</th><th>ϕ (°)</th></tr><tr><td>Embankment (Sandy Clay) Design Values</td><td>125</td><td>200</td><td>25</td><td>100</td><td>16.5</td></tr></table>The laboratory data are included in the RWP Stability Calculation Package included in Appendix B. The RWP embankment was compacted to 100% of the maximum dry density as defined by ASTM D 698.</td><td>---</td><td>RWP Construction Specifications (AECOM 2018)

RWP Stability Calculation Package (Attachment B)</td></tr>
<tr><td>(vi) Construction Specifications (Embankment)</td><td>• Constructed between June 2019 and September 2019
• Fill lift thickness = 8 inches (maximum compacted thickness)
• Minimum degree of compaction = 100% of the Standard Proctor
• Minimum field test frequency
o 1 field density test (ASTM D 1556 or ASTM D 6938) per lift for every 5,000 square feet of embankment
o 1 particle size distribution and gradation analysis (ASTM D 422) for each source
o 1 moisture/density test (ASTM D 698) for every 5,000 cubic yards of material placed
o 1 Atterberg limits test (ASTM D 4318) for every 5,000 cubic yards of material placed</td><td>---</td><td>RWP Construction Specifications (AECOM 2018)</td></tr>
</table>

<table>
<tr><th>Item</th><th>As-Constructed/ Current</th><th>Comments</th><th>Reference Document(s)</th></tr>
<tr><td colspan="4">Foundation</td></tr>
<tr><td>(v) Physical and Engineering Properties of the Foundation</td><td>The RWP foundation was observed to be composed primarily of weathered shale and sandstone during the 2018 test pit excavation and 2019 construction. Based on AECOM's experience with the weathered shale underlying the ash disposal area at the Plant, the foundation material for the RWP was assumed to consist entirely of weathered shale with the following properties:
<table>
<tr><th>Material</th><th>γ_{sat} (pcf)</th><th>c′ (psf)</th><th>ϕ′ (°)</th><th>c (psf)</th><th>ϕ (°)</th></tr>
<tr><td>Native Ground Design Values</td><td>120</td><td>-</td><td>-</td><td>500</td><td>30</td></tr>
</table>
The RWP was constructed on a subgrade scarified and compacted to 95% of the maximum dry density as defined by ASTM D 698.</td><td>---</td><td>LAI Engineering Design Report (URS, 2012)

RWP Stability Calculation Package (Attachment B)</td></tr>
<tr><td>(vi) Construction Specifications (Foundation)</td><td>• The specifications for structural fill are PI ≤ 10, the largest particles should be no greater in dimension than ½ the thickness of the compacted lift, and be within the following gradation:
<table>
<tr><th>Sieve</th><th>Percent Passing (By Weight</th></tr>
<tr><td>6 inches</td><td>100</td></tr>
<tr><td>No. 3</td><td>30-70</td></tr>
<tr><td>No. 200</td><td>0-12</td></tr>
</table>
• Subgrade was compacted and proofrolled to identify soft spots or other deficiencies prior to filling and placing. Proofrolling was repeated until successful. Unsuitable material was overexcavated an additional 6 inches in areas with failing proofroll tests.
• Areas beneath the embankment were overexcavated 12 inches, then scarified and compacted an additional 12 inches.
• Fill lift thickness = 8 inches (maximum compacted thickness)
• Minimum degree of compaction for scarified subgrade = 95% of the Standard Proctor
• Minimum field test frequency
o 1 oven-dry moisture content (ASTM D 2216/ASTM D 4643) for every 200,000 square feet of subgrade and every 10 nuclear density tests
o 1 particle size distribution and gradation analysis (ASTM D 422) for every 200,000 square feet and every noticeable material change
o 1 moisture/density test (ASTM D 698) for every 200,000 square feet of material tested and every noticeable material change
o 1 sand cone test (ASTM D 1556) for every 10 nuclear density tests
o 1 in-place nuclear density test (ASTM D 6938) for every 50,000 square feet of subgrade
o 1 Atterberg limits test (ASTM D 4318) for every 200,000 square feet and noticeable material change</td><td>---</td><td>RWP Construction Specifications (AECOM 2018)</td></tr>
</table>

Item	As-Constructed/ Current	Comments	Reference Document(s)
(vii) Detailed Dimensional Drawings	The RWP Record Drawings are included in Appendix A. Sheet 13 shows the Dead Pool Storage up to EL 5370.55 feet, the Operational Storage up to EL 5372.20 feet, 30 days of Outage Storage up to EL 5379.00 feet, and 2.1 feet of freeboard above the Outage Storage. The RWP has no upstream run-on and is sized for the 100-year, 24-hour rainfall event. The RWP may impound FGD slurry if needed; however, the RWP is not intended to be a holding pond for FGD slurry. Features that could adversely affect operation of the CCR unit are the relative inflexibility of the system to support large volumes of water in the event of upset conditions at the Plant and leaks in the lower portion of the liner that would require the pond to be emptied to complete repairs.	---	---
(viii) Type and Purpose of Instrumentation	The RWP does not have any instruments associated with it.	---	---
(ix) Area-Capacity Curves	Elevation-area-capacity curves are included as Appendix C.		
(x) Spillway Description and Diversion Design Features, Capacities, and Calculations	The RWP does not have a spillway. Inflow is directly controlled by Plant personnel. The RWP is a rectangular diked embankment with no upstream run-on; therefore, there are no diversion features.	---	---
(xi) Construction Specifications and Provisions for Surveillance, Maintenance and Repair	The Construction Specifications are included as Appendix D and the Operations & Maintenance information is included as Appendix E	---	---
(xii) Record of Structural Instability	There is no known structural instability of the CCR unit.	---	---

4 Structural Stability Assessment

40 CFR § 257.74(d) requires the owner of operator of the CCR unit to conduct initial and periodic structural stability assessments and document whether the design, construction, operation, and maintenance of the CCR unit is consistent with recognized and generally accepted good engineering practices for the maximum volume of CCR and CCR wastewater which can be impounded. New CCR impoundments must be assessed for (i) stable foundations and abutments; (ii) adequate slope protection to protect against surface erosion, wave action, and adverse effects of sudden drawdown; (iii) dikes mechanically compacted to a density sufficient to withstand the range of loading conditions in the CCR unit; (iv) vegetated slopes of dikes and surrounding areas; (v) spillway adequacy; (vi) hydraulic structures underlying the base of the CCR unit; (vii) stability during inundation by an adjacent water body. This section is intended to satisfy this requirement.

4.1 Foundation and Abutments

Per the requirements of 40 CFR § 257.74(d)(1)(i), new CCR surface impoundments must be assessed for "*Stable foundations and abutments*."

The RWP was constructed between June 2019 and September 2019. The RWP is founded on native soil primarily consisting of hard weathered shale and sandstone. The native soils and shale underlying the RWP appear to be competent materials based on test pits excavated within the RWP footprint prior to construction; nearby well logs for LS-1, LS-2, and MW-50A (AECOM 2017); and observations during construction. Based on knowledge of the site and available geologic information, AECOM does not believe that the presence of the RWP will cause significant differential settling across the weathered shale or sandstone underlying the site.

The RWP was constructed by excavating the existing weathered shale and sandstone from the pond footprint and using a portion of the excavated material to construct the perimeter embankment. The maximum excavation for the RWP is approximately 12 feet in the vicinity of the leachate collection and recovery system (LCRS) risers in both cells. The maximum external embankment height, measured from EL 5381 feet at the crest to approximate EL 5368.9 on the north side of the impoundment, is 12 feet. This relatively short embankment height applies a loading of approximately 1,500 psf to the underlying shale and sandstone foundation. Based on AECOM's experience with other embankments constructed on similar foundation soils at the FCPP, this additional overburden stress is not expected to cause any significant differential or total settlement. In addition, there are no identified geologic or geomorphologic features that could cause the area of the RWP to become unstable. Lastly, the impounded water level in the RWP is monitored by APS personnel and APS could reduce the impounded water level if required to maintain the safe operation of the CCR unit.

4.2 Slope Protection

Per the requirements 40 CFR § 257.74(d)(1)(ii), new CCR surface impoundments must be assessed for "*Adequate slope protection to protect against surface erosion, wave action, and adverse effects of sudden drawdown*."

The upstream slopes of the RWP are lined with a primary HDPE liner, a geonet, a geosynthetic clay liner (GCL), and a secondary HDPE liner to protect the slopes from erosion and wave action. The leak collection system and composite geosynthetic liner system provide protection against the adverse effects of wave action and sudden drawdown by preventing impounded water from reaching the embankment. The downstream slopes are seeded with native grasses, including warm season and cool season grasses. Additionally, APS has a program to regularly inspect, identify, and repair any erosion rills at all its CCR units. APS intends to regrade and recompact any areas that erode in the future.

4.3 Dike Compaction

Per the requirements 40 CFR § 257.74(d)(1)(iii), new CCR surface impoundments must be assessed for "*Dikes mechanically compacted to a density sufficient to withstand the range of loading conditions in the CCR unit*."

The RWP embankment is composed of weathered shale and sandstone broken down into sand and clay. The RWP embankment was compacted to 100 percent of the maximum dry density as defined by ASTM D 698 and tested in accordance with the requirements of the project Construction Quality Assurance Plan. Embankment materials observed not to meet the compaction criteria received additional compactive effort until either nuclear density gauge (ASTM D 6938) or sand cone test (ASTM D 1556) data indicated conformance. Therefore, the RWP embankment appears to have been constructed with materials that were compacted to a density sufficient to withstand the range of loading conditions in the CCR unit.

4.4 Slope Vegetation

Per the requirements 40 CFR § 257.74(d)(1)(iv), new CCR surface impoundments must be assessed for "*Vegetated slopes of dikes and surrounding areas, except for slopes which have an alternate form or forms of slope protection*." The United States Court of Appeals for the District of Columbia Circuit remanded *with vacatur* the phrase "*not to exceed a height of six inches above the slope of the dike*" from this subsection of the Rule.

As noted in Section 4.2, the downstream slope, which is comprised of sandy clay, was seeded with native grasses, including warm season and cool season grasses, upon the completion of construction. The upstream slope is covered by a geosynthetic composite liner system and therefore is excluded from the vegetated slope requirements since it uses an alternate form of slope protection.

4.5 Spillways

Per the requirements 40 CFR § 257.74(d)(1)(v), new CCR surface impoundments must be assessed for "*A single spillway or a combination of spillways configured as specified in paragraph (d)(1)(v)(A) of this section. The combined capacity of all spillways must be designed, constructed, operated, and maintained to adequately manage flow during and following the peak discharge from the event specified in paragraph (d)(1)(v)(B) of this section*."

The RWP is sized, and APS will manage water levels within it, to contain the 100-year, 24-hour rainfall event. The RWP does not have a spillway. The RWP has 4.6 ac-ft of deadpool storage to EL 5370.55 feet and 28.1 ac-ft of operational and outage storage to EL 5379.00 feet. APS controls the inflow to the RWP and will manage levels so that they do not rise above EL 5379.00. The remaining 2.1 feet (to the crest EL 5381.10 feet) is reserved for storage of the 100-year, 24-hour rainfall event.

4.6 Hydraulic Structures

Per the requirements 40 CFR § 257.74(d)(1)(vi), new CCR surface impoundments must be assessed for "*Hydraulic structures underlying the base of the CCR unit or passing through the dike of the CCR unit that maintain structural integrity and are free of significant distortion, bedding deficiencies, sedimentation, and debris which may negatively affect the operation of the hydraulic structures*."

The are no hydraulic structures underlying the base of the CCR unit. There are several shallowly buried inlet and outlet pipes for flow to and from the pond that pass through the dike of the CCR unit.

Four HDPE inlet pipes penetrate the embankment at the northwest side of the FGD Cell. These pipes are located on top of the finished grade along the upstream and downstream slopes and pass through the embankment 1 foot below finished grade along the crest, where they are encased in controlled low strength material (CLSM).

One HDPE inlet pipe penetrates the northwest side of the RWP Cell. The HDPE pipe is on top of the primary HDPE liner along the upstream and downstream slopes. It passes through the embankment 1 foot below finished grade along the crest, where it is encased in CLSM.

The RWP outlet consists of one 6-inch diameter corrugated HDPE pipe located on top of the finished grade. The HDPE pipe is on top of the primary HDPE liner along the upstream and downstream slopes. It passes through the embankment 1 foot below finished grade along the crest, where it is encased in CLSM and terminates at a pump located on the downstream side of the embankment.

Two 16-inch diameter solid wall HDPE DR17 LCRS riser pipes are installed between the primary and secondary HDPE liners along the upstream slopes of the northernmost corners of both the FGD Cell and the RWP Cell. Each set of pipes is surrounded by free-draining gravel (ASTM C 33 No. 67) with 6 inches of cover between the top of the pipe and the primary HDPE liner. The free-draining gravel in the pipe trenches is a continuation of the free-draining gravel in each of the sumps, thereby allowing any water that leaks out of the pipes to be recollected in the sump.

4.7 Downstream Water Body

Per the requirements 40 CFR § 257.74(d)(1)(vii), new CCR surface impoundments must be assessed as follows "*For CCR units with downstream slope which can be inundated by the pool of an adjacent water body, such as a river, stream or lake, downstream slopes that maintain structural stability during low pool of the adjacent water body or sudden drawdown of the adjacent water body*."

The RWP is located on a mesa, in an area of relatively higher elevation. There are no upstream or downstream water bodies and therefore, no risk to structural stability of inundation of the downstream slope of the RWP by an adjacent body of water.

4.8 Other Issues

No site conditions or deficiencies have been identified that could affect the structural stability of the RWP impoundment.

4.9 Structural Stability Assessment Results

AECOM did not identify any structural stability deficiencies that would affect the structural condition of the RWP based on the documents developed, provided, and reviewed as part of this assessment. AECOM assesses that the design and construction of the RWP are consistent with recognized and generally accepted good engineering practice for the maximum volume of CCR and CCR wastewater which can be impounded therein.

5 Safety Factor Assessment

40 CFR § 257.74(e) requires the owner or operator of a new CCR surface impoundment to conduct initial and periodic safety factor assessments and document whether the calculated factors of safety achieve the minimum safety factors specified in the Rule. As the RWP is a new CCR surface impoundment, this section summarizes the initial safety factor assessment for the CCR unit.

5.1 Methodology and Design Criteria

Slope stability analyses were performed to document minimum factors of safety for loading conditions identified by 40 CFR § 257.74(e) using the software program SLOPE/W (GEO-SLOPE International 2012). The analyses were performed using Spencer's Method, a limit equilibrium method of slices that satisfies both force and moment equilibrium, in addition to incorporating the effects of interslice forces. The analyses incorporate pore pressure distributions and strength and density properties described in Sections 5.3 and 5.4. The complete slope stability results are presented in Appendix B.

5.2 Critical Cross-Section

The factor of safety against slope instability was calculated for the critical cross-section of the RWP embankment. The critical cross-section is the cross-section that is anticipated to be most susceptible to structural failure for a given loading condition. The critical cross-section thus represents a "most-severe" case. The RWP features 3H:1V (horizontal : vertical) upstream slopes and 3H:1V downstream slopes. A portion of the lower downstream slope is over-steepened to 2H:1V by the presence of a v-ditch at the toe. However, the critical cross-section was assessed to be the tallest section, a 12-foot tall, 3H:1V downstream slope located on the northern end of the site (Figure 5 of Appendix B). The embankment consists of a clay-sand mixture created using shale and sandstone excavated from the RWP footprint.

5.3 Subsurface Stratigraphy and Material Properties

An idealized model of subsurface stratigraphic conditions for the critical cross-section was developed based on material type correlations, previously reported material properties developed for the FCPP ash disposal area (Dames & Moore 1990 and URS 2012), and laboratory testing of the material excavated from the proposed footprint of the RWP (Appendix B). The stratigraphic units described as follows were used to develop SLOPE/W models for each cross-section.

Compacted Embankment: The material properties for the "Compacted Embankment" were based on a mixture of shale and sandstone anticipated to be excavated during RWP construction. The material was expected to exhibit the same properties as the mixture of shale and sandstone recovered from test pits RWP-1 (sample REP-1) and RWP-2 (sample REP-4) during the 2018 AECOM exploration (Appendix B). The unit weight assigned to the embankment material is based on 95 percent of the moisture-density relationship determined in the laboratory using ASTM D 698 Method B (Appendix B). The hydraulic conductivity is based on typical values provided in Figure 8.3.2.3.1-1 of USBR Design Standards No. 13, Chapter 8: Seepage (USBR 2014). The USBR guidance indicates clayey sand (USCS – SC) typically has a horizontal permeability between 1 x 10-6 cm/s and 1,000 x 10-6 cm/s (or 1 x 10^{-3} cm/s). This calculation package uses the higher value of 1 x 10^{-3} cm/s. The USBR (2014) suggests that typical dams will have anisotropy (k_H/k_V) ratios ranging from 2 to 10. Using the USBR (2014) guidance, the compacted embankment material is assigned an anisotropy ratio of 10 (SEEP/W accepts anisotropy inputs as k_V/k_H, resulting in a value of 0.1). Table 5-1 summarizes these values.

The "Compacted Embankment" drained material strength is based on the results of direct shear tests (ASTM D 3080) performed on remolded samples recovered from test pits excavated in the footprint of the RWP as part of this project. The "Compacted

Embankment" undrained material strength is based on triaxial compression test data from samples of compacted shale recovered during the 1989 Dames & Moore geotechnical investigation near the current location of the RWP (Dames & Moore 1990). For the calculation package presented in Appendix B, the drained triaxial parameters are similar to the drained direct shear parameters and the clay portion of the embankment is expected to control the undrained behavior of the homogeneous material. The percentage of clay in the embankment varies; samples of embankment material subjected to sieve analyses (ASTM C 136) during construction contained between 22 and 50 percent fines. Table 5-2 summarizes these values.

Native Ground: The hydraulic conductivity properties for the "Native Ground" are based on the properties of "Weathered Shale (Native Ground)" originally developed for the weathered shale that underlies the nearby (LAI) (URS 2012). Although the RWP is situated on a bluff approximately 200 feet above the bottom of the LAI, the geologic history of the site and the field investigation AECOM conducted in April 2018 indicate the shale underlying the proposed RWP embankment is similar to the shale underlying the LAI. Table 5-1 summarizes these values.

The "Native Ground" undrained material strength is based on the properties of "Weathered Shale (Native Ground)" originally included in the 2012 LAI Design Report (URS 2012). Table 5-2 summarizes these values.

Table 5-1. Seepage Material Properties – RWP Safety Factor Assessment

Material	Material Properties				
	Unit Weight, γ_m (pcf)	Saturated Unit Weight, γ_{sat} (pcf)	Horizontal Hydraulic Conductivity (ft/day)[1]	Horizontal Hydraulic Conductivity (cm/s)[1]	Anisotropy (k_v/k_h)[2]
Compacted Embankment	120	125	2.835	1.0×10^{-3}	0.1
Native Ground (URS 2012)[3]	120	125	2.835×10^{-3}	1.0×10^{-6}	0.1

1) SEEP/W requires a horizontal hydraulic conductivity input.
2) The hydraulic conductivity anisotropy input for SEEP/W is expressed as the ratio of vertical hydraulic conductivity to horizontal hydraulic conductivity.
3) The Native Ground hydraulic conductivity is based on a matric suction function in which the horizontal hydraulic conductivity at low matric suction pressures is equal to 2.835×10^{-3} ft/day.

Table 5-2. Strength Material Properties – RWP Safety Factor Assessment

Material	Material Properties					
	Moist Unit Weight, γ_m (pcf)	Saturated Unit Weight, γ_{sat} (pcf)	Drained Strength		Undrained Strength	
			Cohesion, c' (psf)	Friction Angle, ϕ' (degrees)	Cohesion, c (psf)	Friction Angle, ϕ (degrees)
Compacted Embankment	120	125	200	25	100	16.5
Native Ground	120	125	-	-	500	30

5.4 Embankment Pore Pressure Distribution

Water levels within the embankment are anticipated to be nonexistent because of the two HDPE liners, GCL, LCRS, and typically shallow water depth intended to be maintained in the reservoir. To produce a pore pressure distribution in the embankment, the slope stability cross-section neglects the upstream liner system and assumes two steady-state pore pressure situations develop: the first with the reservoir at the Operational Storage elevation (EL 5372.20 feet) and the second at the 30-Day Outage Storage elevation (EL 5379.00 feet). Both pore pressure distributions were incorporated into the embankment loading conditions described in Section 5.5.

5.5 Embankment Loading Conditions

Per 40 CFR § 257.74(e)(1)(i) through (iv), the following loading conditions were analyzed for each developed stability cross-section:

- Long-term, maximum storage pool
- Maximum surcharge pool
- Seismic loading, and
- Liquefaction Loading

These loading conditions are described in the following sub-sections.

Long-Term, Maximum Storage Pool: The maximum storage pool loading is the maximum water level that will be maintained for a sufficient length of time for steady-state seepage or hydrostatic conditions to develop within the embankment. This loading condition is evaluated to document whether the CCR surface impoundment can withstand a maximum expected pool elevation with full development of the anticipated saturation in the embankment under long-term loading. The long-term, maximum storage pool loading condition considers a pool elevation in the CCR unit that is equivalent to the Operational Storage level. The loading condition uses shear strengths expressed as effective stress and with pore water pressures that correspond to the long-term condition.

For the RWP, the safety factor for the long-term, maximum storage pool was calculated for the reservoir level at EL 5372.20 feet as shown in the Record Drawings (Appendix A).

Maximum Surcharge Pool: The maximum surcharge pool loading is the temporary rise in pool elevation above the maximum storage pool elevation to which the CCR surface impoundment could be subject under inflow design flood state. This loading condition is evaluated to document whether the downstream slope of the CCR surface impoundment embankment can withstand the short-term impact of a raised pool level.

For the RWP, the safety factor for the maximum surcharge pool was calculated for the 30-Day Outage Storage level at EL 5379.00 feet.

Seismic Loading: Seismic loading was evaluated to document whether the embankment is capable of withstanding a design earthquake without damage to the foundation or embankment that would cause a discharge of its contents. The seismic loading condition is assessed for a seismic loading event with a two percent probability of exceedance in 50 years, equivalent to a return period of approximately 2,500 years. A pseudostatic analysis was used to represent the seismic loading condition.

The seismic response of soil embankments is incorporated into the limit equilibrium analysis method by adding a horizontal force to simulate the seismic force acting on the embankment during an earthquake. The horizontal force is applied in the pseudo-static analyses through the addition of a seismic coefficient into the limit equilibrium calculations. The seismic coefficient was selected using the following procedure:

1. Determine the peak horizontal ground acceleration (PGA) generated in bedrock at the site by an earthquake having the 2 percent probability of exceedance in 50 years;
2. Select a Site Class which incorporates the effects of seismic wave propagation through the top 100 feet in the soil profile above bedrock, and calculate the adjusted for Site Class effects, PGA_M;

3. Calculate the maximum transverse acceleration at the crest of the embankment, PGA_{crest}, using the PGA_M from step two; and
4. Adjust the PGA_{crest} using the method developed by Makdisi and Seed (1977) to account for the variation of induced average acceleration with embankment depth to calculate the seismic coefficient.

Each of these steps is discussed in more detail in Appendix B. The pseudostatic analyses incorporated a horizontal seismic coefficient of 0.102g.

The phreatic conditions in the RWP for the seismic loading analysis were set to EL 5379.00 feet to match the maximum surcharge pool. For the seismic loading condition, total shear strength parameters summarized in Table 5-2 were used because it is anticipated that the embankment would behave in an undrained manner due to the relatively rapid loading induced during the seismic event.

Liquefaction Loading: The liquefaction factor of safety is evaluated for CCR embankments that show, through representative soil sampling, construction documentation, or anecdotal evidence from personnel with knowledge of construction of the CCR units, that soils of the embankment or foundation are susceptible to liquefaction.

Based on construction documentation and weathered rock materials described in nearby well logs, the weathered shale and sandstone underlying the RWP is not susceptible to liquefaction and the liquefaction factor of safety is not calculated.

5.6 Safety Factor Assessment Results

Table 5-3 summarizes the results of the safety factor analysis for the RWP. The safety factor calculation presented in Appendix B includes a more detailed discussion of the results.

Table 5-3. Summary of Calculated Safety Factors

Loading Condition	Required Factor of Safety(1)	Calculated Factor of Safety
Long-term, Maximum Storage Pool	1.50	3.40 (Upstream)
		3.11 (Downstream)
Maximum Surcharge Pool	1.40	4.36 (Upstream)
		2.69 (Downstream)
End-of-Construction	1.30	1.93 (Upstream)
		1.77 (Downstream)
Seismic	1.00	1.53 (Upstream)
		1.11 (Downstream)

Note: (1) From 40 CFR § 257.74(e)(1)(i) through (iv) (EPA 2015)

The calculated factors of safety for the three critical cross-sections along the RWP Perimeter Embankment exceed the required minimum values for the long-term, maximum storage pool; the maximum surcharge pool; and the seismic (pseudo-static) loading conditions.

6 Conclusions

Based on the findings and results of the structural integrity assessment, AECOM provides the following conclusions for the RWP at the FCPP.

- The RWP is classified as a Low Hazard Potential CCR surface impoundment.
- The RWP embankment is founded on a stable foundation consisting of weathered shale and sandstone.
- The RWP embankment has two HDPE liners, a GCL, and an LCRS on the upstream slope. The downstream slopes are vegetated with native grasses. In addition, APS has a regular program of inspection and repair of erosion rills.
- The RWP embankment was mechanically compacted to a density sufficient to withstand the range of loading conditions anticipated at the site.
- The RWP has 2 feet of freeboard (8.2 ac-ft) to contain the 100-year, 24-hour rain event in addition to 23.2 ac-ft of storage for Plant outages, and 4.9 ac-ft of operational storage. The 100-year, 24-hour rain event consists of only direct precipitation since there are no upstream structures.
- Factors of safety greater than the minimum values required by the CCR Rule were calculated for the critical cross-section at the RWP for loading conditions associated with the maximum storage pool water level, maximum surcharge pool water level, and design level seismic event.
- Based on review of available records concerning the RWP and the results of the stability analyses, no deficiencies were noted that would affect the structural condition of the dam.

7 Limitations

This report is for the sole use of APS on this project only and is not to be used for other projects. In the event that conclusions based upon the data obtained in this report are made by others, such conclusions are the responsibility of others. The Initial Structural Stability Assessment presented in this report is based on available information identified in the Reference Section of this report. Therefore, the Certification of Professional Opinion is limited to the information available to AECOM at the time the Assessment was performed in accordance with current practice and the standard of care. Standard of care is defined as the ordinary diligence exercised by fellow practitioners in this area performing the same services under similar circumstances during the same period. Professional judgments presented herein are primarily based on information from previous reports that were assumed to be accurate, knowledge of the site, and partly on our general experience with dam safety evaluations performed on other dams. No warranty or guarantee, either written or implied, is applicable to this work.

The use of the words “certification” and/or “certify” in this document shall be interpreted and construed as a Statement of Professional Opinion and is not and shall not be interpreted or construed as a guarantee, warranty, or legal opinion.

8 References

AECOM, 2017. “CCR Monitoring Well Network Report and Certification, Four Corners Power Plant, Fruitland, New Mexico.” September 18.

AECOM, 2018. *Construction Specifications – Arizona Public Service – Four Corners Power Plant, Units 4 & 5 – WA# FCC06814 – Return Water Pond – Installation Contract – AECOM Project No. 60566008*.

Dames & Moore, 1990. “Raising Ash Dams 3 and 6 – Four Corners Steam Electric Station.” Prepared for Arizona Public Service Company. August 29.

Ebasco, 1959, “Coal Reserves, Water Availability and Site Selection, Four Corners Project: Volume III, Engineering Geology,” Prepared for Arizona Public Service Company, September 29.

GEO-SLOPE International, 2012, GeoStudio 2012, Version 8.15.5.11777, August 2015 Release.

Idriss, I.M. and Boulanger, R.W., 2008, “Soil Liquefaction During Earthquakes,” Earthquake Engineering Research Institute, Monograph No MNO-12.

Makdisi, F.I. and Seed, H.B., 1977, “A Simplified Procedure for Estimating Earthquake-Induced Deformations in Dams and Embankments,” Report No. UCB/EERC-77/19, University of California, Berkeley, August.

URS, 2012, “Engineering Design Report Lined Ash Impoundment 5280 Lift Four Corners Power Plant San Juan County, New Mexico, NMOSE File No. D634,” Prepared for Arizona Public Service. March.

United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS), (no date). *Rapid Watershed Assessment – Chaco Watershed*. HUC8 14080106.

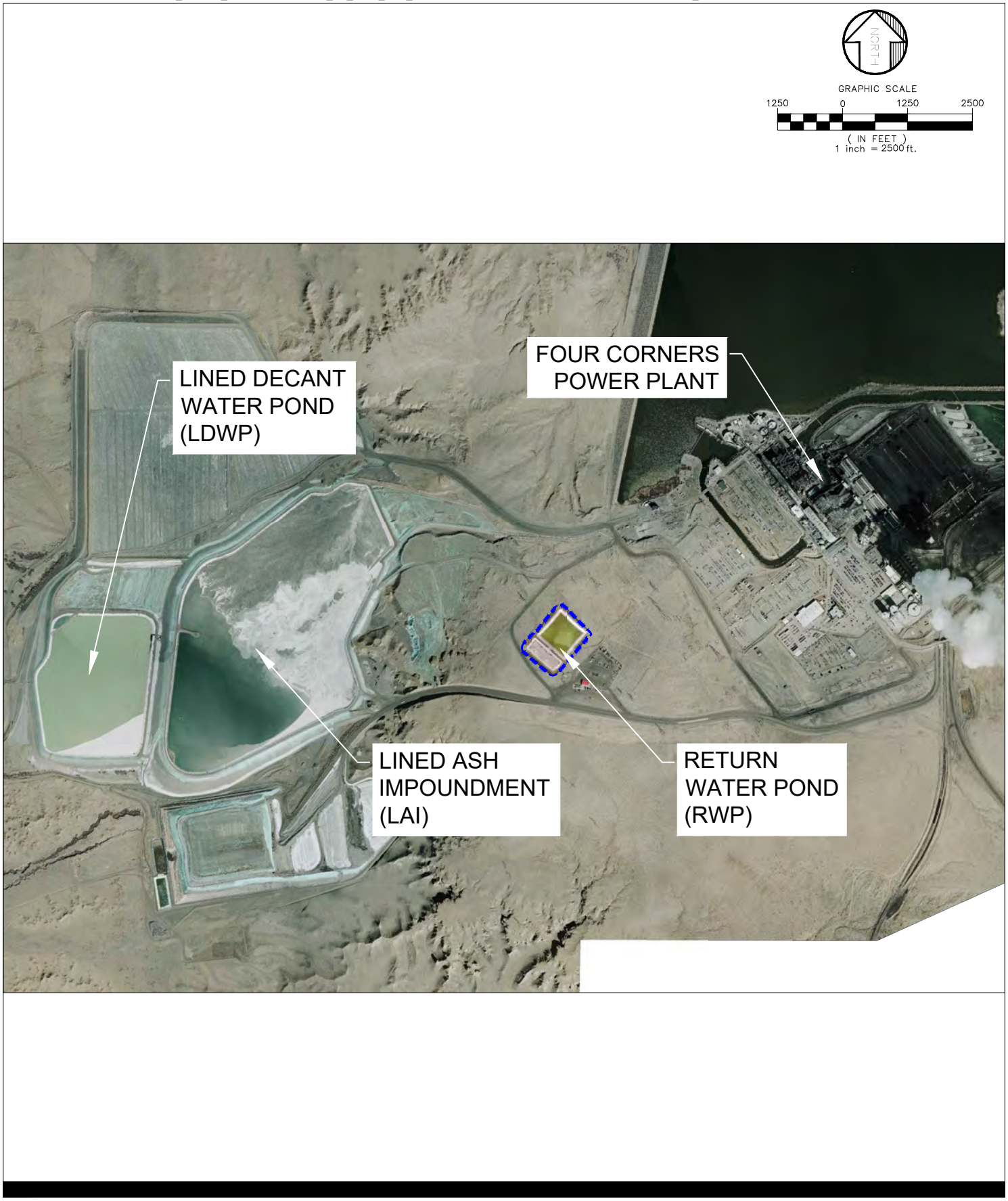
United Stated Department of Interior, Bureau of Reclamation (USBR), 2014. *Design Standards No. 13 – Embankment Dams*. Chapter 8: Seepage. Phase 4 (Final). January.

United States Environmental Protection Agency (EPA), 2015. *40 CFR Parts 257 and 261 – Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule, Federal Register Vol. 80, No. 74, April 17*.

United States Geological Survey (USGS), 2017. *Fruitland Quadrangle – New Mexico-San Juan Co. – 7.5-Minute Series*.

Figures

Last saved by: LEE.WRIGHT(2020-02-24) Last Plotted: 2020-02-24
Filename: P:\PROJECTS\ARIZONA_PUBLIC_SERVICE\60596770_FC_RWP_SG3_ENG\900-CAD GIS\910 CAD\25 SKETCHES\FIGURE 1-1_SITE VICINITY MAP.DWG



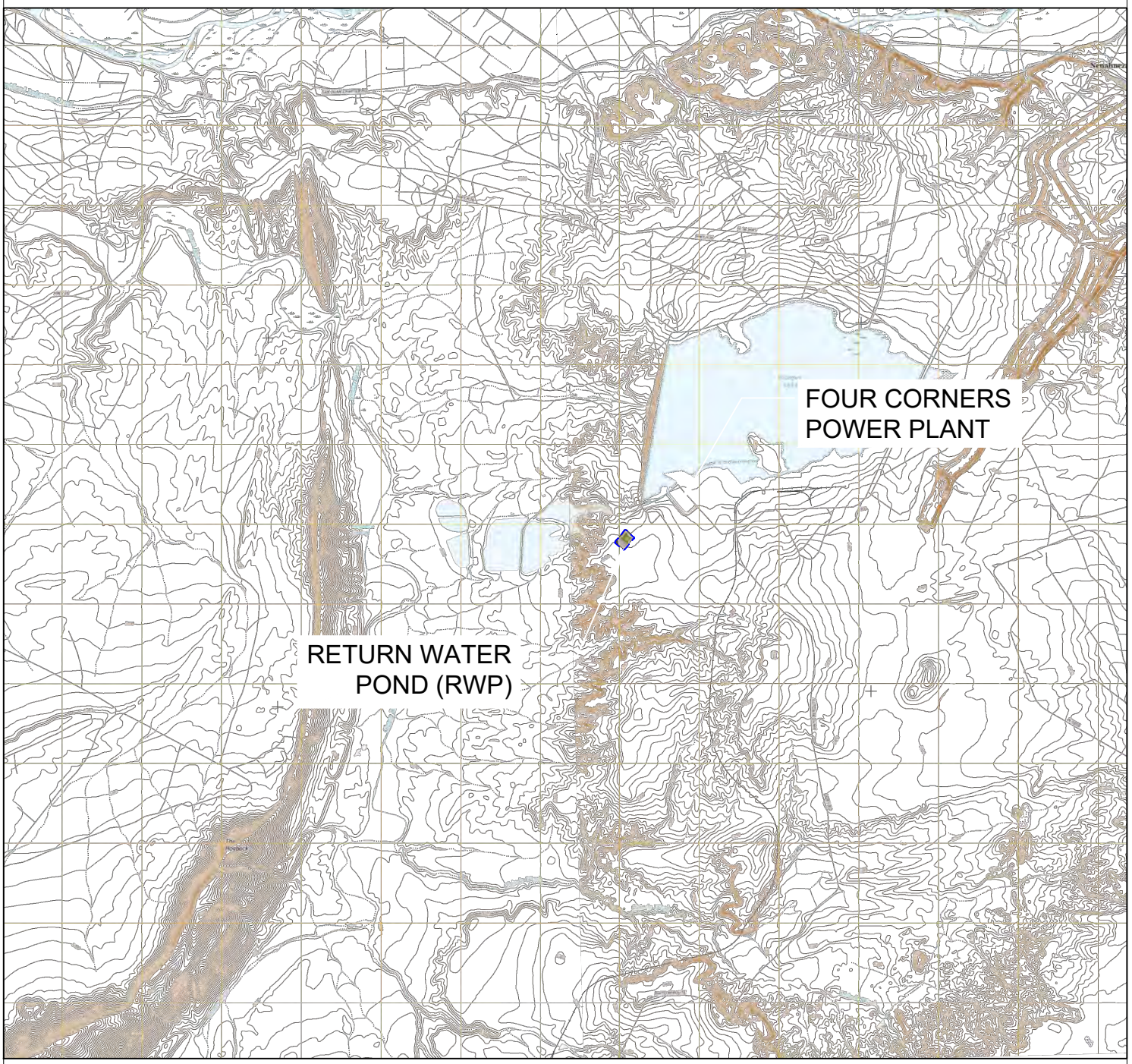
FOUR CORNERS POWER PLANT
STRUCTURAL INTEGRITY REPORT
ARIZONA PUBLIC SERVICE
Project No. 60596770

SITE VICINITY MAP

AECOM

FIGURE 1-1

Last saved by: LEE.WRIGHT(2020-02-26) Last Plotted: 2020-02-26
Filename: P:\PROJECTS\ARIZONA_PUBLIC_SERVICE\60596770_FC_RWP_SG3_ENG\900-CAD GIS\910 CAD\25 SKETCHES\FIGURE 3-1_TOPOGRAPHY.DWG



REFERENCES:

United States Geological Survey (USGS), 2017. *Fruitland Quadrangle - New Mexico-San Juan Co. - 7.5-Minute Series*
United States Geological Survey (USGS), 2017. *The Hogback North Quadrangle - New Mexico-San Juan Co. - 7.5-Minute Series*

FOUR CORNERS POWER PLANT
STRUCTURAL INTEGRITY REPORT
ARIZONA PUBLIC SERVICE
Project No. 60596770

SITE TOPOGRAPHY MAP

AECOM

FIGURE 3-1

Last saved by: LEE.WRIGHT(2020-02-24) Last Plotted: 2020-02-24
Filename: P:\PROJECTS\ARIZONA_PUBLIC_SERVICE\60596770_FC_RWP_SG3_ENG\900-CAD GIS\910 CAD\25 SKETCHES\FIGURE 5-1_CROSS SECTION LOCATION.DWG

FOUR CORNERS POWER PLANT
STRUCTURAL INTEGRITY REPORT
ARIZONA PUBLIC SERVICE
Project No. 60596770

CROSS-SECTION LOCATION FOR SAFETY FACTOR ASSESSMENT

AECOM

FIGURE 5-1

Appendix A.
Record Drawings

FOUR CORNERS POWER PLANT, UNITS 4 AND 5

ARIZONA PUBLIC SERVICE COMPANY

FCPP RETURN WATER POND

WA# FCC06814

DRAWING INDEX

DRAWING NUMBER	TITLE
FC45CM-X-41-WP-AP-170003-97	COVER SHEET
FC45CM-X-98-WP-AP-200485-2	GENERAL NOTES, LEGEND, AND ABBREVIATIONS
FC45CM-C-16-WP-AP-200485-3	EXISTING CONDITIONS PLAN
FC45CM-C-16-WP-AP-200485-4	GEOTECHNICAL INVESTIGATION LOCATION MAP
FC45CM-C-16-WP-AP-200485-5	KEY PLAN
FC45CM-C-16-WP-AP-200485-6	POND 3 PUMP HOUSE PLAN
FC45CM-C-16-WP-AP-200485-7	RETURN WATER PIPELINE PLAN 1
FC45CM-C-16-WP-AP-200485-8	RETURN WATER PIPELINE PLAN 2
FC45CM-C-16-WP-AP-200485-9	RETURN WATER PIPELINE PLAN 3
FC45CM-C-16-WP-AP-200485-10	RETURN WATER PIPELINE PLAN 4
FC45CM-C-16-WP-AP-200485-11	RETURN WATER POND PLAN
FC45CM-C-16-WP-AP-200485-12	GRADING AND DRAINAGE PLAN
FC45CM-C-65-WP-AP-200485-13	LINER SECTIONS AND DETAILS
FC45CM-C-65-WP-AP-200485-14	GRADING SECTIONS AND DETAILS
FC45CM-C-65-WP-AP-200485-15	RETURN WATER PIPING SECTIONS AND DETAILS
FC45CM-C-65-WP-AP-200485-16	FENCING SECTIONS AND DETAILS
FC45CM-C-65-WP-AP-200485-17	UTILITY VAULT DETAILS
FC45CM-M-05-BP-AP-156257-1	THICKENER UNDERGROUND PIPE ROUTING PLAN VIEW
FC04UN-M-02-BP-AP-82117-410B	U4 THICKENER UNDERFLOW SYSTEM PUMPS P&ID
FC04UN-M-02-BP-AP-82118-410B	U5 THICKENER UNDERFLOW SYSTEM PUMPS P&ID
FC45CM-M-02-BP-AP-82119-1	THICKENER UNDERFLOW TO LINED ASH IMPOUNDMENT P&ID
FC45CM-S-98-WP-AP-200485-24	STRUCTURAL GENERAL NOTES
FC45CM-S-47-WP-AP-200485-25	STRUCTURAL PLAN AND SECTION
FC45CM-S-65-WP-AP-200485-26	STRUCTURAL SECTIONS AND DETAILS
FC45CM-M-02-WP-AP-200485-27	RETURN WATER POND P&ID
FC00CM-M-02-HB-BR-82114-10F	ASH POND 6-CHACO WASH SEEPAGE INTERCEPT SYSTEM P&ID
FC00CM-M-02-HB-BR-82114-10G	ASH HANDLING SYSTEM LINED DECANT WATER POND P&ID
FC00CM-C-56-BP-LK-56052-5	PUMPING STATION-PIPING&GENERAL ARRANGEMENT PLANS&ELEVATIONS
FC45CM-M-16-WP-AP-200485-34	MECHANICAL RETURN WATER POND PUMPING STATION PLAN
FC45CM-P-65-WP-AP-200485-35	LCRS PUMP SECTION, SCHEDULE AND DETAILS
FC45CM-M-65-WP-AP-200485-36	MECHANICAL SEWAGE EFFLUENT PUMPING STATION PLAN
FC45CM-E-98-WP-AP-200485-37	ELECTRICAL LEGEND
FC45CM-E-16-WP-AP-200485-38	ELECTRICAL OVERALL SITE KEY PLAN
FC45CM-E-16-WP-AP-200485-39	ELECTRICAL POND 3 SITE PLAN
FC45CM-E-16-WP-AP-200485-40	ELECTRICAL RETURN WATER POND PLAN
FC45CM-E-16-WP-AP-200485-41	RWP AND SEWAGE EFFLUENT PUMPING STATION PLANS
FC45CM-E-16-WP-AP-200485-42	ELECTRICAL ASH DISPOSAL PUMPING STATION PLAN
FC45CM-E-01-WP-AP-200485-43	ELECTRICAL ONE-LINE DIAGRAMS
FC45CM-E-49-WP-AP-200485-44	ELECTRICAL DETAILS
FC00CM-E-03-HB-BR-39128-1	EVAPORATION PONDS MCC
FC00CM-E-03-HB-BR-39128-2	EVAPORATION PONDS BOM
FC00CM-E-03-HB-BR-39128-3	EVAPORATION PONDS SCHEMATICS
FC00CM-E-04-HB-BR-39129-3	EVAPORATION PONDS CONTROLS
FC45CM-E-16-WP-AP-200485-51	EXISTING PUMP SITE UPGRADE
FC45CM-E-16-WP-AP-200485-52	ASH POND PUMP STATION EXTENSION
FC45CM-E-19-WP-AP-200485-53	PAD AND CONDUIT DETAIL 1
FC45CM-E-19-WP-AP-200485-54	PAD AND CONTUIT DETIAL 2

1

REFERENCE DRAWINGS

DRAWING NUMBER	TITLE
FC45CM-M-05-BAP-AP-156257-3	THICKENER SYSTEM - UTILITY VAULT / ISO VIEWS & DETAILS

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PHOENIX AZ, 85072-3933

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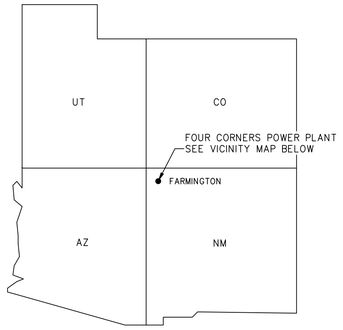
COUNTY ROAD 6675
FRUITLAND, NM 87416

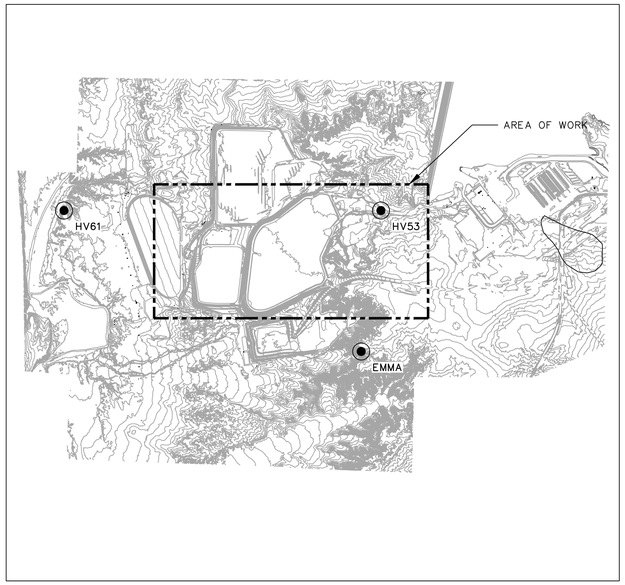
IN CASE OF EMERGENCY AT FOUR CORNERS POWER PLANT CALL 505-598-8311 OR 3911 ON A PLANT TELEPHONE



LOCATION MAP

N.T.S.

NORTH



VICINITY MAP

N.T.S.

NORTH

SAFETY

1. WORKING SAFELY IS A CONDITION OF EMPLOYMENT AT ARIZONA PUBLIC SERVICE (APS). IT IS EXPECTED THAT ALL PERSONS ON SITE WILL FOLLOW THE APS PROCESSES, POLICIES, AND PROCEDURES.
2. CONTRACTORS ARE RESPONSIBLE FOR THE SAFE AND HEALTHFUL PERFORMANCE OF WORK BY EACH OF THEIR EMPLOYEES, SUBCONTRACTORS, VENDORS OR SUPPORT PERSONNEL ENTERING THE SITE.
3. MINIMUM PERSONAL PROTECTIVE EQUIPMENT (PPE) USAGE REQUIREMENTS FOR PERSONNEL AT THE SITE SHALL INCLUDE WEARING LONG PANTS AND LONG SLEEVE SHIRTS MADE FROM NON MELTING MATERIAL, HARD HATS, HEARING PROTECTION, ADVANCED SAFETY EYEWEAR (SPOGGLES), APPROPRIATE GLOVES, AND SAFETY TOE BOOTS. ADDITIONAL PPE MAY BE REQUIRED TO SAFELY PERFORM SPECIFIC TASKS.

GENERAL NOTES

1. FOUR CORNERS POWER PLANT IS A COAL FIRED GENERATING PLANT ON THE NAVAJO INDIAN RESERVATION NEAR FRUITLAND, NEW MEXICO.

DATUM

1. NEW MEXICO WEST ZONE (3003). STATE PLANE COORDINATE SYSTEM. US SURVEY FEET. HORIZONTAL: NORTH AMERICAN DATUM OF 1983 (NAD 83).
   VERTICAL: NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88).
2. PRESERVE AND PROTECT EXISTING SURVEY MONUMENTS. ESTABLISH NORTHING, EASTING, AND ELEVATIONS OF SURVEY MONUMENTS AND REPORT COORDINATES TO ENGINEER PRIOR TO CONSTRUCTION.

CONTROL POINTS AND BENCHMARKS

POINT	NORTHING	EASTING	ELEVATION	DESCRIPTION
EMMA	N2,066,529.495	E2,528,708.477	5382.251'	ALUMINUM CAP
HV53	N2,070,581.505	E2,529,275.542	5331.214'	SCE BRASS CAP
HV61	N2,070,581.682	E2,520,166.590	5085.898'	SCE BRASS CAP

REFERENCE DATA

- THE OVERALL TOPOGRAPHIC SURVEY WAS PROVIDED BY AERIAL MAPPING COMPANY INC. ON APRIL 14, 2014
- TOPOGRAPHIC SURVEY FOR THE PROJECT SITE WAS PROVIDED BY SAKURA ENGINEERING AND SURVEYING ON APRIL 11, 2018

THESE RECORD DRAWINGS DATED 01/17/20 AND TITLED "FOR RECORD" HAVE BEEN DEVELOPED FROM AS-BUILT MARKUPS AND MAY NOT REPRESENT THE FINAL PROJECT, AS CONSTRUCTED, IN EVERY DETAIL. THESE RECORD DRAWINGS HAVE BEEN PREPARED BASED ON INFORMATION SUPPLIED BY OTHERS AND THE ENGINEER HAS NOT VERIFIED THE ACCURACY OR COMPLETENESS OF THE INFORMATION.

1

NO.	DATE	REVISION	DWN	CHD	EXD	RVWD	APVD	W.A.
1	01-17-20	FOR RECORD	AWF	DEM				FCC06814

AECOM
7720 N. 16th Street Suite 100
Phoenix, Arizona 85020
(602) 371-1100

FOUR CORNERS POWER PLANT
RETURN WATER POND

COVER SHEET

SCALE AS NOTED DATE 10/04/19

WORK SAFELY TODAY

DWN	EXD	APPROVED	W A
AWF	---	DAVID E. MICKANEN	FCC06814
CHD DEM	RVWD ---	DRAWING APPROVED BY	

UNIT	DISC	TYPE	SYS	SUBSYS	NUMBER	SHEET
FC45CM	X	41	WP	AP	200485	97

NMOC 811 Dial 8-1-1 or 1-800-321 2537

DRAWING: P:\Projects\Arizona_Public_Service\60566008_FCPP_Return_Water_Pond_SG2\900_CAD_GIS\910_CAD\20-SHEETS\APS_EDCS_Drawings\2_DRAWING_REVISIONS\FC45CM-X-41-WP-AP-170003-97.dwg

GENERAL NOTES:

1. ALL WORK SHALL BE PERFORMED IN A WORKMANLIKE MANNER TO THE ENTIRE SATISFACTION OF THE OWNER AND ENGINEER AND IN ACCORDANCE WITH THE BEST RECOGNIZED TRADE PRACTICES.
2. ALL WORK SHALL COMPLY WITH APPLICABLE STATE, FEDERAL, AND LOCAL CODES AND THE PROJECT SPECIFICATIONS. ALL NECESSARY LICENSES AND/OR PERMITS SHALL BE OBTAINED BY THE CONTRACTOR AT HIS EXPENSE.
3. ENGINEER SHALL BE NOTIFIED A MINIMUM OF FORTY-EIGHT (48) HOURS IN ADVANCE OF SITE INSPECTIONS, TESTING VERIFICATIONS, AND FOR ANY OTHER PORTION OF THE WORK REQUIRING ENGINEERS SERVICES AT THE JOB SITE.
4. CONTRACTOR SHALL NOTIFY ENGINEER NOT LESS THAN SEVEN (7) DAYS PRIOR TO STARTING WORK IN ORDER THAT ENGINEER MAY TAKE NECESSARY MEASURES TO INSURE PRESERVATION OF SURVEY MONUMENTS. CONTRACTOR SHALL NOT DISTURB PERMANENT SURVEY MONUMENTS WITHOUT THE CONSENT OF ENGINEER AND SHALL NOTIFY ENGINEER AND BEAR EXPENSE OF REPLACING ANY THAT MAY BE DISTURBED WITHOUT PERMISSION. REPLACEMENT SHALL BE DONE ONLY BY A NEW MEXICO REGISTERED PROFESSIONAL SURVEYOR. WHEN A CHANGE IS MADE IN THE FINISHED ELEVATION OF THE PAVEMENT OF ANY ROADWAY IN WHICH A PERMANENT SURVEY MONUMENT IS LOCATED, CONTRACTOR SHALL, AT HIS OWN EXPENSE, ADJUST THE MONUMENT COVER TO THE NEW GRADE UNLESS OTHERWISE SPECIFIED.
5. CONTRACTOR SHALL READ AND MAKE CAREFUL EXAMINATION OF THE PLANS, SPECIFICATIONS, QUANTITIES, AND MATERIALS AND SHALL VISIT THE SITE OF THE PROPOSED CONSTRUCTION TO BECOME FAMILIAR WITH SITE CONDITIONS AND LIMITATIONS BEFORE MAKING A PROPOSAL. CONTRACTOR SHALL MAKE ANY INVESTIGATIONS NECESSARY TO DETERMINE THE EXTENT OF THE WORK REQUIRED TO CONSTRUCT THE PROJECT. CONTRACTOR SHALL BE RESPONSIBLE FOR ANY AND ALL ERRORS RESULTING FROM FAILURE TO MAKE SUCH AN EXAMINATION. ANY INFORMATION DERIVED FROM THE MAPS, PLANS, SPECIFICATIONS, PROFILES, DRAWINGS OR FROM ENGINEER, WILL NOT RELIEVE CONTRACTOR FROM ANY RISK OR FROM FULFILLING THE TERMS OF THE CONTRACT.
6. ANY EXISTING OR NEW SITE FEATURES OR OTHER IMPROVEMENTS DAMAGED BY CONTRACTOR DURING CONSTRUCTION SHALL BE REPAIRED BY CONTRACTOR TO EQUAL OR BETTER CONDITION AT NO ADDITIONAL COST TO THE OWNER.
7. CONTRACTOR SHALL NOT INSTALL ITEMS AS SHOWN ON THE PLANS WHEN IT IS OBVIOUS THAT FIELD CONDITIONS ARE DIFFERENT THAN SHOWN IN THE DESIGN. SUCH CONDITIONS SHOULD BE BROUGHT TO THE ATTENTION OF THE PROJECT MANAGER. IN THE EVENT CONTRACTOR DOES NOT NOTIFY PROJECT MANAGER, CONTRACTOR ASSUMES FULL RESPONSIBILITY AND EXPENSE FOR ANY REVISIONS NECESSARY.
8. NEITHER THE OWNER, CONSTRUCTION MANAGER, NOR THE ENGINEER OF RECORD WILL ENFORCE ANY SAFETY MEASURE OR REGULATION. CONTRACTOR SHALL DESIGN, CONSTRUCT AND MAINTAIN ALL SAFETY DEVICES, INCLUDING TRAFFIC CONTROL AND SHORING, AND SHALL BE SOLELY RESPONSIBLE FOR CONFORMING TO ALL LOCAL, STATE, AND FEDERAL SAFETY AND HEALTH STANDARDS, LAWS AND REGULATIONS. IF ANYONE IN AN AUTHORITY OR SUPERVISORY POSITION SEES ANYTHING WRONG OR A SERIOUS LIFE THREATENING SITUATION CAUSED BY CONTRACTOR, THAT PERSON SHALL HAVE THE RIGHT TO STOP THE JOB UNTIL SITUATION IS CORRECTED.
9. CONTRACTOR WILL BE RESPONSIBLE FOR ANY MONUMENTATION AND/OR BENCHMARKS THAT WILL BE DISTURBED OR DESTROYED BY CONSTRUCTION.
10. CONTRACTOR SHALL ASSUME SOLE AND COMPLETE RESPONSIBILITY FOR JOB SITE CONDITIONS DURING THE COURSE OF CONSTRUCTION OF THIS PROJECT, INCLUDING SAFETY OF ALL PERSONS AND PROPERTY; THAT THIS REQUIREMENT SHALL APPLY 24 HOURS A DAY AND NOT BE LIMITED TO NORMAL WORKING HOURS; AND THAT CONTRACTOR SHALL DEFEND, INDEMNIFY, AND HOLD OWNER AND ENGINEER HARMLESS OF ANY AND ALL LIABILITY, REAL OR ALLEGED, IN CONNECTION WITH THE PERFORMANCE OF WORK ON THE PROJECT, EXCEPTING LIABILITY ARISING FROM THE SOLE NEGLIGENCE OF OWNER OR ENGINEER.
11. CONTRACTOR IS RESPONSIBLE FOR THE PROTECTION OF HIS WORK FROM RAINFALL, STORM DRAINAGE, OR FLOOD SO THAT IT DOES NOT DELAY CONSTRUCTION OR DAMAGE COMPLETED WORK OR DOWNSTREAM PROPERTIES THROUGHOUT CONSTRUCTION.
12. QUANTITIES SHOWN ARE FOR ESTIMATING PURPOSES ONLY AND TO COMPARE AND CANVAS BIDS. ACTUAL PAY QUANTITIES WILL BE DETERMINED IN THE FIELD FOR AUTHORIZED CHANGES THAT AFFECT THE QUANTITIES.
13. CONTRACTOR SHALL BE RESPONSIBLE FOR GENERAL SAFETY DURING CONSTRUCTION. ALL CONSTRUCTION PRACTICES AND PROCEDURES SHALL COMPLY WITH THE PERTINENT PROVISIONS OF THE OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA) STANDARDS (TITLE 29, CODE OF FEDERAL REGULATIONS).
14. CONTRACTOR SHALL MAINTAIN A DEBRIS FREE WORK SITE. PROVIDE TRASH RECEPTACLES FOR ALL WASTE MATERIAL INCLUDING PERSONAL WASTE SUCH AS LUNCH BAGS.
15. CONTRACTOR SHALL BE RESPONSIBLE FOR MAINTAINING THE SITE IN A NEAT AND ORDERLY MANNER THROUGHOUT THE CONSTRUCTION PROCESS. ALL MATERIALS SHALL BE STORED WITHIN APPROVED CONSTRUCTION AREAS.
16. ALL WORK SHALL BE IN ACCORDANCE WITH THE CONTRACT DOCUMENTS, WHICH INCLUDES THESE DRAWINGS, THE PROJECT SPECIFICATIONS, AND ANY ADDITIONS AND SUPPLEMENTS.
17. CONSTRUCTION ACCESS TO BE AT DESIGNATED LOCATIONS ONLY. CONTACT OWNER'S REP. FOR SPECIFIC INSTRUCTIONS.
18. DISPOSAL OF UNSUITABLE MATERIAL AND ITEMS DESIGNED FOR REMOVAL WITHOUT SALVAGE SHALL BE IN ACCORDANCE WITH LANDFILL (DISPOSAL) SITE REQUIREMENTS.
19. CONTRACTOR SHALL PERFORM HIS OWN SURVEY TO ESTABLISH HORIZONTAL AND VERTICAL CONTROL FOR THE PROJECT.
20. WHERE NOTED ON PLANS OR DRAWINGS, COMPLY WITH THE 2014 EDITION OF THE NEW MEXICO STATE DEPARTMENT OF TRANSPORTATION (NMDOT) STANDARD SPECIFICATIONS FOR HIGHWAY AND BRIDGE CONSTRUCTION (STANDARD SPECS),
21. ANY DISCREPANCIES BETWEEN DRAWINGS AND SPECIFICATIONS SHALL BE BROUGHT TO ENGINEERS ATTENTION FOR RESOLUTION.
22. CONTRACTOR SHALL KEEP ON SITE WITHIN THE PROJECT AREA THE PROJECT SAFETY PLAN. ALL WORKERS SHALL HAVE ACCESS TO THE SAFETY PLAN AT ALL TIMES.

UTILITY NOTES:

1. CONTRACTOR TO USE EXTREME CAUTION NOT TO DISTURB OR DAMAGE EXISTING STORM DRAIN, PIPELINES, SITE EQUIPMENT, VALVES, MANHOLES AND ALL SUBSURFACE UTILITIES THROUGHOUT CONSTRUCTION. CONTRACTOR SHALL LOCATE ALL SURFACE UTILITY FEATURES PRIOR TO CONSTRUCTION AND SHALL PLACE VISIBLE MARKERS TO MARK UTILITY FEATURES NOT TO BE DISTURBED. IF DAMAGED THEN REPAIR AT CONTRACTOR'S EXPENSE.
2. CONTRACTOR SHALL NOTIFY ALL APPLICABLE UTILITY COMPANIES AND COORDINATE UTILITY LINE SPOTS AT LEAST SEVEN (7) WORKING DAYS PRIOR TO ANY DIGGING OR EXCAVATION.
3. TWO (2) WORKING DAYS PRIOR TO ANY CONSTRUCTION, CONTRACTOR MUST CONTACT LINE LOCATING SERVICES NMOC: TOLL FREE AT 1-800-321-2537 FOR LOCATION OF EXISTING UTILITIES.

UTILITY NOTES CONT.:

4. CONTRACTOR SHALL FIELD VERIFY ALL EXISTING UTILITY LOCATIONS AND SHALL NOTIFY THE ENGINEER IMMEDIATELY OF ANY DISCREPANCIES. ALL ELECTRICAL, TELEPHONE, CABLE TV, GAS AND OTHER UTILITY LINES, CABLES AND APPURTENANCES ENCOUNTERED DURING CONSTRUCTION THAT REQUIRE RELOCATION SHALL BE COORDINATED WITH THAT UTILITY, BE IT PRIVATE OR CITY OWNED. CONTRACTOR SHALL BE RESPONSIBLE FOR COORDINATION OF ALL NECESSARY UTILITY ADJUSTMENTS. CONTRACTOR MAY BE REQUIRED TO RESCHEDULE HIS ACTIVITIES TO ALLOW UTILITY CREWS TO PERFORM THEIR REQUIRED WORK.
5. ALL UNDERGROUND UTILITIES SHOWN ON THESE DRAWINGS SHOULD BE CONSIDERED APPROXIMATE ONLY.
6. THE INFORMATION SHOWN ON THESE DRAWINGS CONCERNING TYPE AND LOCATION OF UNDERGROUND AND OTHER UTILITIES IS NOT GUARANTEED TO BE ACCURATE OR ALL-INCLUSIVE. CONTRACTOR IS RESPONSIBLE FOR MAKING HIS OWN DETERMINATIONS AS TO THE TYPE AND LOCATION OF UNDERGROUND AND OTHER UTILITIES AS MAY BE NECESSARY TO AVOID DAMAGE THERETO. CONTRACTOR SHALL USE EXTREME CARE WHEN PERFORMING ANY DEMOLITION OR GRADING OPERATIONS IN THE PROXIMITY OF THESE EXISTING UTILITIES. ANY DAMAGE TO EXISTING UTILITIES WILL BE REPAIRED AT THE CONTRACTOR'S EXPENSE. NOTIFY OWNER WHEN ANY UNIDENTIFIED UTILITIES ARE DISCOVERED.
7. OBTAIN WRITTEN AUTHORIZATION FROM THE OWNER'S REPRESENTATIVE AND FROM THE UTILITY OWNERS PRIOR TO INTERRUPTING ANY EXISTING UTILITY (IE: WATER, SEWER, GAS, ELECTRICAL, OR TELEPHONE).
8. CONSTRUCTION SHALL COMPLY WITH GOVERNING CODES AND REQUIREMENTS. CONTRACTOR SHALL CONDUCT ALL REQUIRED TESTS TO THE SATISFACTION OF THE UTILITY COMPANY'S AND OWNER'S INSPECTING AUTHORITIES.
9. CONTRACTOR SHALL COMPLY TO THE FULLEST EXTENT WITH THE LATEST STANDARDS OF OSHA DIRECTIVES, INCLUDING 29 CFR PART 1926 SUBPART P, OR ANY OTHER AGENCY HAVING JURISDICTION FOR EXCAVATION AND TRENCHING PROCEDURE. CONTRACTOR SHALL USE SUPPORT SYSTEMS, SLOPING, BENCHING AND OTHER MEANS OF PROTECTION. THIS IS TO INCLUDE, BUT NOT LIMITED FOR ACCESS AND EGRESS FROM ALL EXCAVATION AND TRENCHING.
10. HYDRO-EXCAVATE TO A MINIMUM DEPTH OF 6 FEET TO FIELD VERIFY ALL EXISTING UNDERGROUND FACILITIES AND/OR UTILITIES.

GRADING AND DRAINAGE NOTES:

1. CONTRACTOR'S SOILS ENGINEER SHALL CERTIFY THAT THE REQUIRED INSPECTIONS AND TESTS HAVE BEEN PERFORMED AND THAT SUCH TESTS COMPLY WITH CODE.
2. EXERCISE SUFFICIENT SUPERVISORY CONTROL DURING GRADING AND CONSTRUCTION TO ENSURE COMPLIANCE WITH THE APPROVED PLANS AND SPECIFICATIONS.
3. SUBGRADE PREPARATION SHALL BE IN ACCORDANCE WITH PROJECT SPECIFICATION SECTION 312300.
4. FILLS SHALL BE COMPACTED THROUGHOUT TO AT LEAST 95% OF THE MAXIMUM DRY DENSITY AS DETERMINED BY ASTM D698, "STANDARD TEST METHOD FOR LABORATORY COMPACTION CHARACTERISTICS OF SOIL USING STANDARD EFFORT."
5. FILL AREAS SHALL BE CLEARED OF ALL VEGETATION AND DEBRIS, PROOFROLLED AND SCARIFIED, HAVE SUBDRAINS INSTALLED (IF ANY) AND APPROVED BY THE GRADING INSPECTOR AND SOILS ENGINEER PRIOR TO THE PLACING OF FILL.
6. NO ROCK OR SIMILAR MATERIAL GREATER THAN 6 INCHES IN DIAMETER SHALL BE PLACED IN THE FILL UNLESS APPROVED BY THE ENGINEER.
7. DEGREE OF COMPACTION OR RELATIVE COMPACTION SHALL BE DETERMINED BY ASTM D698, "STANDARD TEST METHOD FOR LABORATORY COMPACTION CHARACTERISTICS OF SOIL USING STANDARD EFFORT".
8. HAUL PERMITS, WHEN REQUIRED, MUST BE OBTAINED BY CONTRACTOR PRIOR TO WORK.

GEOSYNTHETICS NOTES:

1. HDPE GEOMEMBRANE SHALL CONFORM TO GEOSYNTHETIC RESEARCH INSTITUTE (GRI) TEST METHOD GM13(A), "STANDARD SPECIFICATION FOR TEST METHODS, TEST PROPERTIES, AND TESTING FREQUENCY FOR HIGH DENSITY POLYETHYLENE (HDPE) SMOOTH AND TEXTURED GEOMEMBRANES."
2. GEOMEMBRANE SHALL HAVE A 60-MIL MINIMUM AVERAGE THICKNESS.
3. GEOSYNTHETIC CLAY LINER (GCL) SHALL CONFORM TO GRI TEST METHOD GCL3, "STANDARD SPECIFICATIONS FOR TEST METHODS, REQUIRED PROPERTIES, AND TESTING FREQUENCIES OF GEOSYNTHETIC CLAY LINERS (GCL)".

ABBREVIATIONS

AASHTO	AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS
ABC	AGGREGATE BASE COURSE
AC	ACRE
APPROX	APPROXIMATE
APS	ARIZONA PUBLIC SERVICE COMPANY
ASTM	AMERICAN SOCIETY FOR TESTING AND MATERIALS
BP	BURIED PIPE
BMP	BEST MANAGEMENT PRACTICES
C	CIVIL
CCR	COAL COMBUSTION RESIDUALS
CL	CENTERLINE
CLR	CLEAR
CLSM	CONTROLLED LOW STRENGTH MATERIAL
COR	CORNER
CTR	CENTER
DEMO	DEMOLITION
DFADA	DRY FLY ASH DISPOSAL AREA
DIA	DIAMETER
DIP	DUCTILE IRON PIPE
DWG	DRAWING
DR	DIMENSION RATIO
E	EASTING
EL	ELEVATION
EMBED	EMBEDMENT
EP	END POINT
EXIST	EXISTING
FDG	FLUE GAS DESULPHURIZATION
FG	FINISH GRADE
FLG	FLANGE
FNC	FENCE
FT	FEET/FOOT
GA	GUAGE
GCL	GEOSYNTHETIC CLAY LINER
GD	GRAVITY DRAIN
GPM	GALLONS PER MINUTE
GRI	GEOSYNTHETIC RESEARCH INSTITUTE
GSKT	GASKET
HDPE	HIGH DENSITY POLYETHYLENE
HORZ	HORIZONTAL
HP	HIGH POINT
LAI	LINED ASH IMPOUNDMENT
LCRS	LEAK COLLECTION AND RECOVERY SYSTEM
LDWP	LINED DECANT WATER POND
LF	LINEAR FOOT
MAX	MAXIMUM
MUTCD	MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES
MIN	MINIMUM
MW	MONITORING WELL
NMDOT	NEW MEXICO DEPARTMENT OF TRANSPORTATION
NMOC	NEW MEXICO ONE CALL
N	NORTHING
NAD	NORTH AMERICAN DATUM
NAVD	NORTH AMERICAN VERTICAL DATUM
NTS	NOT TO SCALE
O.C.	ON CENTER
OD	OUTSIDE DIAMETER
OHE	OVERHEAD ELECTRIC POWER
OSHA	OCCUPATIONAL SAFETY & HEALTH ADMINISTRATION
OS&Y	OUTSIDE SCREW AND YOKE
OZ	OUNCE
P	PIPE
PC	POINT OF CURVATURE
P&ID	PROCESS AND INSTRUMENTATION DIAGRAM
PI	POINT OF INTERSECTION
PLCS	PLACES
PSI	POUNDS PER SQUARE INCH
PT	POINT OF TANGENCY
PVI	POINT OF VERTICAL INTERSECTION
R	RADIUS
REQ'D	REQUIRED
RWI	RETURN WATER INLET
RWP	RETURN WATER POND
S	BAR SPACING
SCHED	SCHEDULE
SEC	SECTION
SPEC.	SPECIFICATION
SS	STAINLESS STEEL
STA	STATION
STD	STANDARD
SY	SQUARE YARD
THRU	THROUGH
TP	TIE POINT
TYP	TYPICAL
UON	UNLESS OTHERWISE NOTED
YD	YARD
W/	WITH

LEGEND

- EXISTING 1' CONTOURS
- EXISTING 5' CONTOURS (5180)
- PROPOSED 1' CONTOURS
- PROPOSED 5' CONTOURS (5180)
- EXISTING GRADE
- LIMITS OF DISTURBANCE
- EXISTING DIRT ROAD
- EXISTING FENCE
- EXISTING FENCE (X—X—X—X—X)
- PROPOSED FENCE (X—X—X—X—X)
- OVERHEAD POWERLINE (OHE)
- EXISTING OVERHEAD POWERLINE (OHE)
- EXISTING UNDERGROUND ELECTRIC (UGE)
- EXISTING PIPE
- TEMPORARY STAGING AREA
- FINISHED GRADE
- MAX WATER LEVEL
- PROPOSED ABOVE GROUND PIPE (P—P)
- EXISTING ABOVE GROUND PRESSURE PIPE (P—P)
- EXISTING BURIED PIPE (P—P)
- BURIED PIPE ALIGNMENT (BP—BP)
- RETURN WATER INLET PIPE (RWI—RWI)
- GRAVITY DRAIN (GD—GD)
- SANITARY SEWER (SS)
- GEOMEMBRANE
- GCL
- GEONET

LEGEND

- FREE DRAINING GRAVEL
- C33 SAND AND NUMBER 6 STONE
- CONCRETE
- STRUCTURAL FILL
- COMPACTED SUBGRADE
- GRAVEL SURFACING / PAVEMENT
- GENERAL FILL
- SAND
- GROUT
- NATURAL GROUND / EXISTING GROUND SURFACE
- CONTROLLED LOW STRENGTH MATERIAL
- DEMOLITION
- STOCKPILE / LAYDOWN AREA
- REVEGETATION

LEGEND SYMBOLS

- DIRECTION OF FLOW
- 1 — FINAL GRADE CONTROL POINT
- A / 1 — SECTION LETTER AND PAGE NUMBER
- SEE DETAIL X / 1 — DETAIL NUMBER AND PAGE NUMBER
- 5124.59 — EXISTING POINT ELEVATIONS
- MW-67 — EXISTING MONITORING WELL
- RWP-1 — RWP TEST PITS (2018)
- LS-1 — EXISTING MONITORING WELL
- MW-7 — EXISTING MONITORING WELL
- DIAMETER
- EXISTING POWER TOWER
- CENTER LINE
- POWER POLE

LEGEND MONUMENTS

- BM — BENCHMARK
- FOUND BRASS OR ALUMINUM CAP AS NOTED
- EXISTING SURFACE MONUMENT
- SITE TEMPORARY BENCHMARK (TBM)

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1

NO.	DATE	REVISION	DWN	CHD	EXD	RVWD	APVD	W.A.
1	01-17-20	FOR RECORD	AWF	DEM				FCC06814

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FOUR CORNERS POWER PLANT
RETURN WATER POND

GENERAL NOTES, LEGEND, AND ABBREVIATIONS

aps

SCALE NONE DATE 10/04/19

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DEM			

UNIT	DISC	TYPE	SYS	SUBSYS	NUMBER	SHEET
FC45CM	X	98	WP	AP	200485	2

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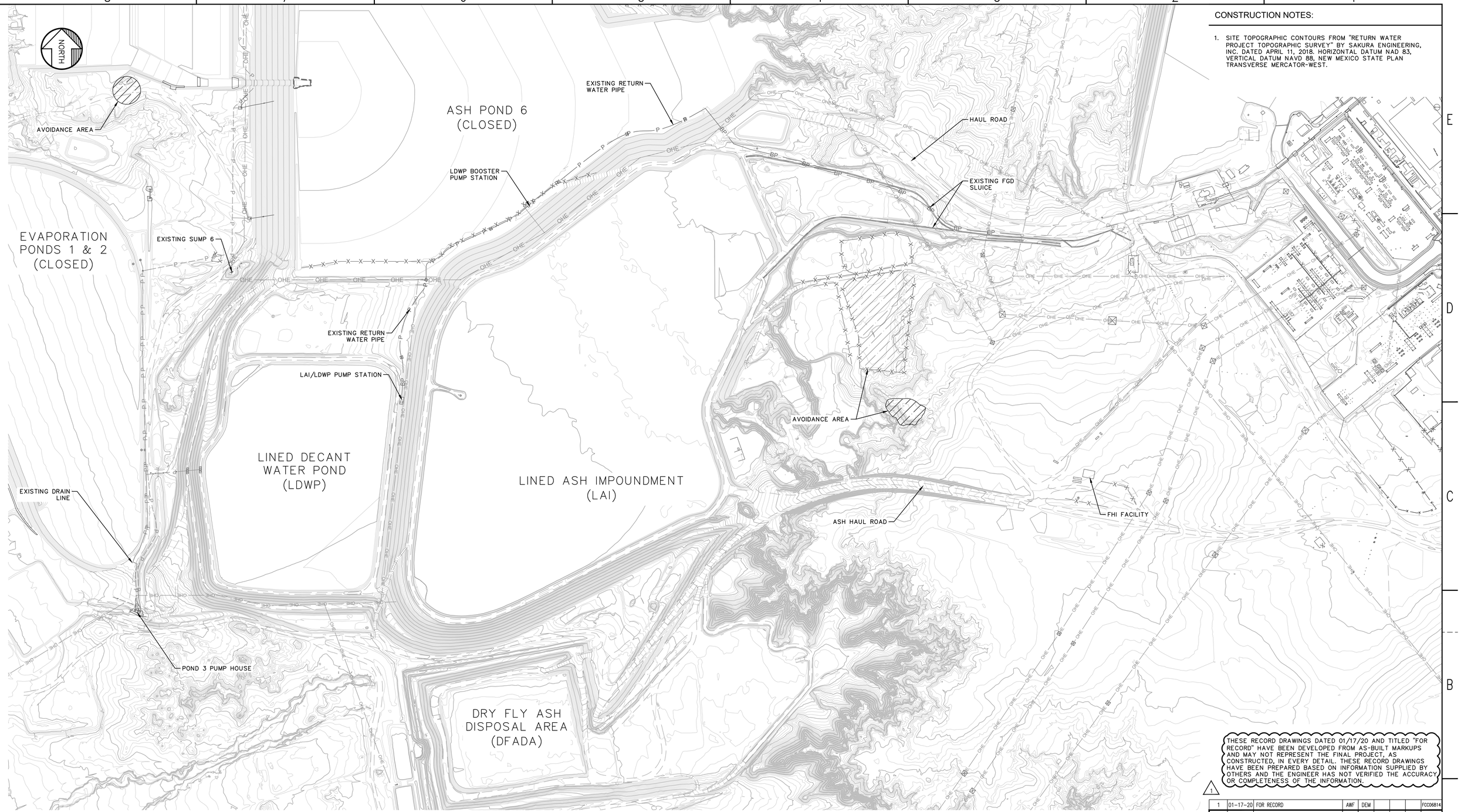

CONSTRUCTION NOTES:

1. SITE TOPOGRAPHIC CONTOURS FROM "RETURN WATER PROJECT TOPOGRAPHIC SURVEY" BY SAKURA ENGINEERING, INC. DATED APRIL 11, 2018. HORIZONTAL DATUM NAD 83, VERTICAL DATUM NAVD 88, NEW MEXICO STATE PLAN TRANSVERSE MERCATOR-WEST.

EXISTING CONDITIONS PLAN
SCALE: 1"=300' (FULL SIZE)

GRAPHIC SCALE
300 0 300 600
(IN FEET)
1 inch = 300 ft.

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NO.	DATE	REVISION	DWN	CHD	EXD	RVWD	APVD	W.A.
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EXISTING CONDITIONS PLAN

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SCALE 1" = 300' DATE 10/04/19

DWN	EXD	APPROVED	W A
AWF	---	DAVID E. MICKANEN	FCC06814
CHD DEM	RVWD ---	DRAWING APPROVED BY	

UNIT	DISC	TYPE	SYS	SUBSYS	NUMBER	SHEET
FC45CM	C	41	WP	AP	200485	3

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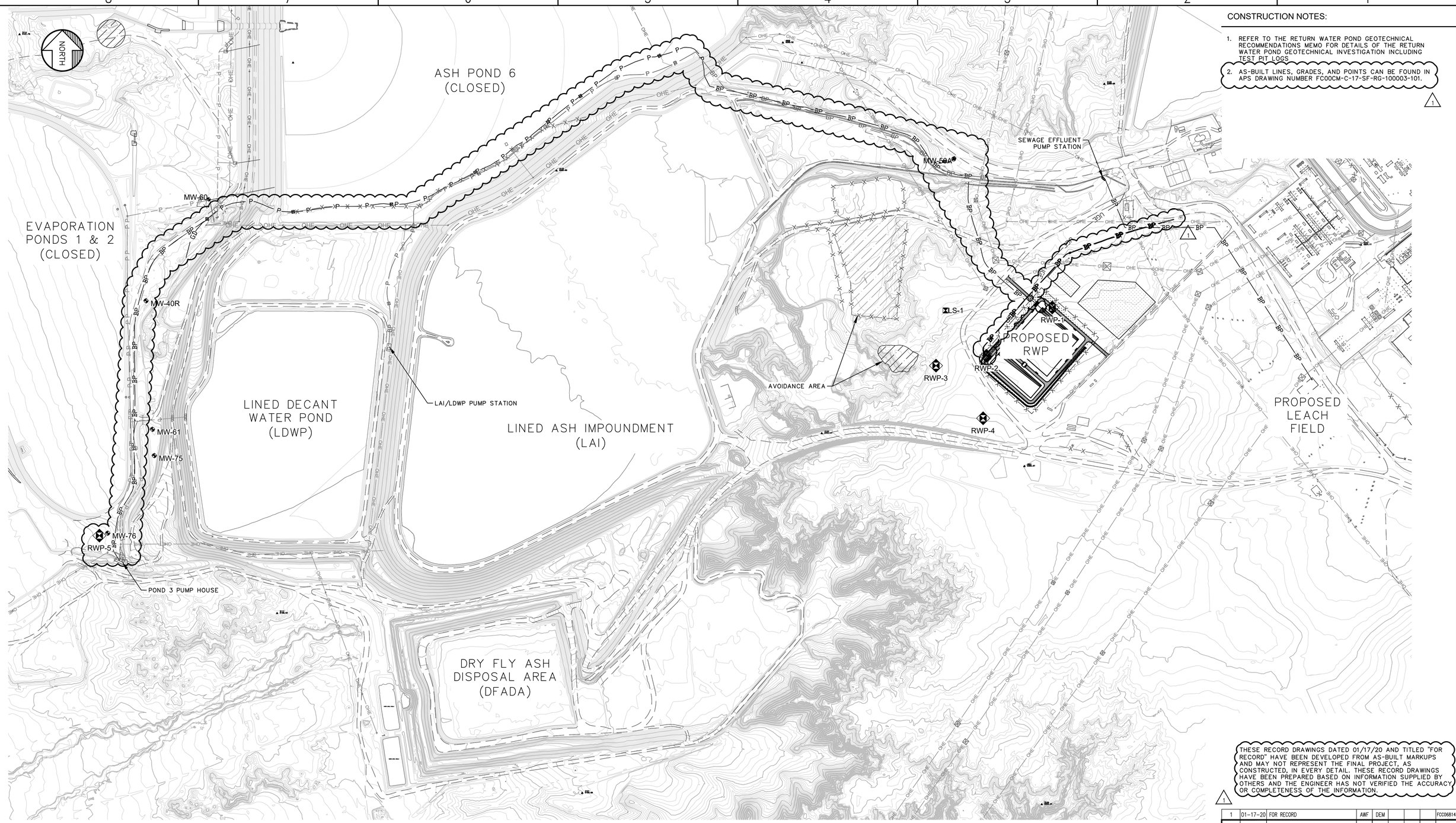

CONSTRUCTION NOTES:

1. REFER TO THE RETURN WATER POND GEOTECHNICAL RECOMMENDATIONS MEMO FOR DETAILS OF THE RETURN WATER POND GEOTECHNICAL INVESTIGATION INCLUDING TEST PIT LOGS
2. AS-BUILT LINES, GRADES, AND POINTS CAN BE FOUND IN APS DRAWING NUMBER FC00CM-C-17-SF-RG-100003-101.

GEOTECHNICAL INVESTIGATION
LOCATION MAP
SCALE: 1"=300' (FULL SIZE)

GRAPHIC SCALE
600 0 300 600
(IN FEET)
1 inch = 300 ft.

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NO.	DATE	REVISION	DWN	CHD	EXD	RVWD	APVD	W.A.
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FOUR CORNERS POWER PLANT
RETURN WATER POND

GEOTECHNICAL INVESTIGATION LOCATION MAP

aps

SCALE 1"=300' DATE 10/04/19

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AWF	---	DAVID E. MICKANEN	FCC06814
CHD	RVWD	DRAWING APPROVED BY	
DEM	---		

UNIT	DISC	TYPE	SYS	SUBSYS	NUMBER	SHEET
FC45CM	C	16	WP	AP	200485	4

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NORTH

AVOIDANCE AREA

ASH POND 6
(CLOSED)

LDWP BOOSTER PUMP STATION

EXISTING SUMP 6

APPROXIMATE LOCATION OF TRANSITION FROM BURIED TO ABOVE GROUND PIPE

PROPOSED ABOVE GROUND PIPE

EXISTING LDWP RETURN WATER PIPELINE ALIGNMENT

LAI/LDWP PUMP STATION

EVAPORATION PONDS 1 & 2
(CLOSED)

7
LINED DECANT WATER POND
(LDWP)

LINED ASH IMPOUNDMENT
(LAI)

BURIED PIPE ALIGNMENT

EXISTING DRAIN LINE ALIGNMENT

POND 3 PUMP HOUSE

DRY FLY ASH DISPOSAL AREA
(DFADA)

HAUL ROAD

EXISTING CONCRETE "V" DITCH

EXISTING RETURN WATER PIPE

SEWAGE EFFLUENT PUMP STATION

APPROXIMATE LOCATION OF TIE-IN TO EXISTING RETURN WATER PIPE ALIGNMENT

BURIED PIPE ALIGNMENTS SEE NOTE 6

THICKENER DISPOSAL LINES TIE-POINT

AVOIDANCE AREA

PROPOSED RETURN WATER POND (RWP)

FHI FACILITY

ASH HAUL ROAD

PROPOSED LEACH FIELD

CONSTRUCTION NOTES:

1. ALL UNDERGROUND UTILITIES SHOWN ON THESE DRAWINGS SHOULD BE CONSIDERED APPROXIMATE ONLY.
2. HYDRO-EXCAVATE TO A MINIMUM DEPTH OF 6 FEET TO FIELD VERIFY ALL EXISTING UNDERGROUND FACILITIES AND/OR UTILITIES AT CONFLICT LOCATIONS.
3. ALIGNMENT OF PIPELINE SHOWN ON DRAWINGS IS CONCEPTUAL. CONTRACTOR CAN PROPOSE REVISED PIPE ALIGNMENTS WHICH MUST BE SUBMITTED TO ENGINEER FOR APPROVAL.
4. CONTRACTOR SHALL MAKE MINOR ADJUSTMENTS IN THE FIELD FOR PIPE ROUTING AND INSTALLED LENGTHS.
5. CONTRACTOR SHALL INSTALL APCO SERIES 140 AIR/VACCUM VALVE (AVV) AT ALL LOCAL HIGH POINTS IN PIPELINE. ALL AVV SHALL BE INSTALLED WITH ISOLATED VALVE AND VALVE CAN FOR BURIED PIPE.
6. AS-BUILT LINES, GRADES, AND POINTS CAN BE FOUND IN APS DRAWING NUMBER FC00CM-C-17-SF-RG-100003-101.

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KEY PLAN
SCALE: 1"=300' (FULL SIZE)

GRAPHIC SCALE
300 0 300 600
(IN FEET)
1 inch = 300 ft.

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FOUR CORNERS POWER PLANT
RETURN WATER POND

KEY PLAN

aps

SCALE 1"=300' DATE 10/04/19

DWN	EXD	APPROVED	W A
AWF	---	DAVID E. MICKANEN	FCC06814
CHD	RVWD	DRAWING APPROVED BY	
DEM	---		

UNIT	DISC	TYPE	SYS	SUBSYS	NUMBER	SHEET
FC45CM	C	16	WP	AP	200485	5

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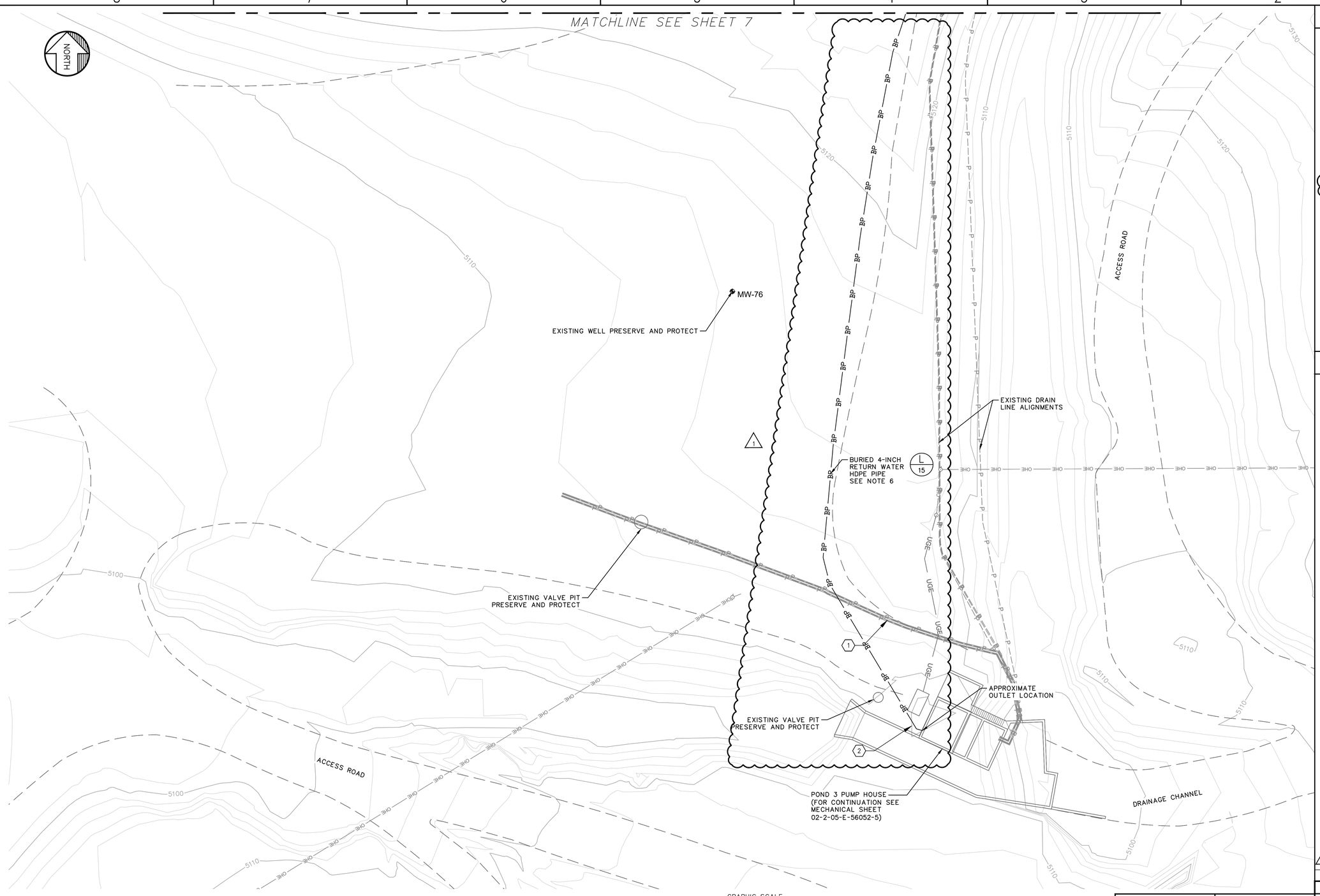
DRAWING: P:\Projects\Arizona_Public_Service\60566008_FCPP_Return_Water_Pond_SG2\900_CAD_GIS\910_CAD\20-SHEETS\APS_EDCS_Drawings\2_DRAWING_REVISIONS\FC45CM-C-16-WP-AP-200485-5.dwg



POND 3 PUMP HOUSE PLAN
SCALE: 1"=20' (FULL SIZE)

GRAPHIC SCALE
20 0 20 40
(IN FEET)
1 inch = 20 ft.

CONSTRUCTION NOTES:

1. ALL UNDERGROUND UTILITIES SHOWN ON THESE DRAWINGS SHOULD BE CONSIDERED APPROXIMATE ONLY.
2. HYDRO-EXCAVATE TO A MINIMUM DEPTH OF 6 FEET TO FIELD VERIFY ALL EXISTING UNDERGROUND FACILITIES AND/OR UTILITIES AT CONFLICT LOCATIONS.
3. ALIGNMENT OF PIPELINE SHOWN ON DRAWINGS IS CONCEPTUAL. CONTRACTOR CAN PROPOSE REVISED PIPE ALIGNMENTS WHICH MUST BE SUBMITTED TO ENGINEER FOR APPROVAL.
4. CONTRACTOR SHALL MAKE MINOR ADJUSTMENTS IN THE FIELD FOR PIPE ROUTING AND INSTALLED LENGTHS.
5. CONTRACTOR SHALL INSTALL APCO SERIES 140 AIR/VACCUM VALVE (AVV) AT ALL LOCAL HIGH POINTS IN PIPELINE. ALL AVV SHALL BE INSTALLED WITH ISOLATED VALVE AND VALVE CAN FOR BURIED PIPE.
6. AS-BUILT LINES, GRADES, AND POINTS CAN BE FOUND IN APS DRAWING NUMBER FC00CM-C-17-SF-RG-100003-101.

KEY NOTES:

1. CROSSING PIPES. SEE NOTE 1.
2. BUILDING TIE POINT. SEE SHEET FC00CM-C-56-BP-LK-56052-5 FOR CONTINUATION.

THESE RECORD DRAWINGS DATED 01/17/20 AND TITLED "FOR RECORD" HAVE BEEN DEVELOPED FROM AS-BUILT MARKUPS AND MAY NOT REPRESENT THE FINAL PROJECT, AS CONSTRUCTED, IN EVERY DETAIL. THESE RECORD DRAWINGS HAVE BEEN PREPARED BASED ON INFORMATION SUPPLIED BY OTHERS AND THE ENGINEER HAS NOT VERIFIED THE ACCURACY OR COMPLETENESS OF THE INFORMATION.

NO.	DATE	REVISION	DWN	CHD	EXD	RVWD	APVD	W.A.
1	01-17-20	FOR RECORD	AWF	DEM				FCC06814

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Phoenix, Arizona 85020
(602) 371-1100

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FOUR CORNERS POWER PLANT
RETURN WATER POND

POND 3 PUMP HOUSE PLAN

aps

SCALE 1"=20' DATE 10/04/19

DWN	EXD	APPROVED	W A
AWF	---	DAVID E. MICKANEN	FCC06814
CHD	RVWD	DRAWING APPROVED BY	
DEM	---		

UNIT	DISC	TYPE	SYS	SUBSYS	NUMBER	SHEET
FC45CM	C	16	WP	AP	200485	6

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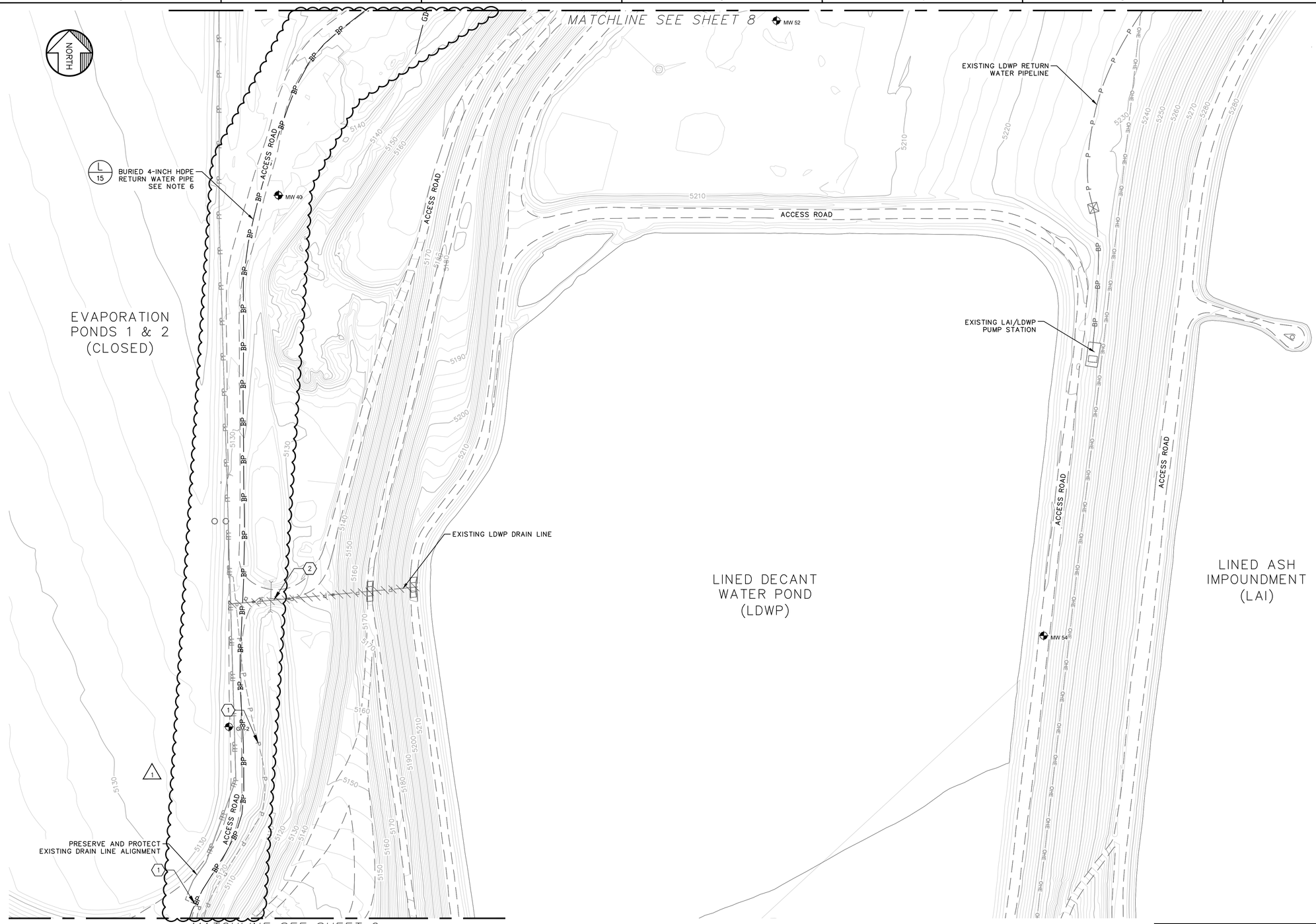

RETURN WATER PIPELINE PLAN 1
SCALE: 1"=100' (FULL SIZE)

CONSTRUCTION NOTES:

1. ALL UNDERGROUND UTILITIES SHOWN ON THESE DRAWINGS SHOULD BE CONSIDERED APPROXIMATE ONLY.
2. HYDRO-EXCAVATE TO A MINIMUM DEPTH OF 6 FEET TO FIELD VERIFY ALL EXISTING UNDERGROUND FACILITIES AND/OR UTILITIES AT CONFLICT LOCATIONS.
3. ALIGNMENT OF PIPELINE SHOWN ON DRAWINGS IS CONCEPTUAL. CONTRACTOR CAN PROPOSE REVISED PIPE ALIGNMENTS WHICH MUST BE SUBMITTED TO ENGINEER FOR APPROVAL.
4. CONTRACTOR SHALL MAKE MINOR ADJUSTMENTS IN THE FIELD FOR PIPE ROUTING AND INSTALLED LENGTHS.
5. CONTRACTOR SHALL INSTALL APCO SERIES 140 AIR/VACCUM VALVE (AVV) AT ALL LOCAL HIGH POINTS IN PIPELINE. ALL AVV SHALL BE INSTALLED WITH ISOLATED VALVE AND VALVE CAN FOR BURIED PIPE.
6. AS-BUILT LINES, GRADES, AND POINTS CAN BE FOUND IN APS DRAWING NUMBER FC00CM-C-17-SF-RG-100003-101.

△1

KEY NOTES:

(1) CROSSING PIPES. SEE NOTE 1.

(2) ABANDON IN PLACE.

THESE RECORD DRAWINGS DATED 01/17/20 AND TITLED "FOR RECORD" HAVE BEEN DEVELOPED FROM AS-BUILT MARKUPS AND MAY NOT REPRESENT THE FINAL PROJECT, AS CONSTRUCTED, IN EVERY DETAIL. THESE RECORD DRAWINGS HAVE BEEN PREPARED BASED ON INFORMATION SUPPLIED BY OTHERS AND THE ENGINEER HAS NOT VERIFIED THE ACCURACY OR COMPLETENESS OF THE INFORMATION.

△1

NO.	DATE	REVISION	DWN	CHD	EXD	RVWD	APVD	W.A.
1	01-17-20	FOR RECORD	AWF	DEM				FCC06814

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FOUR CORNERS POWER PLANT
RETURN WATER POND

RETURN WATER PIPELINE PLAN 1

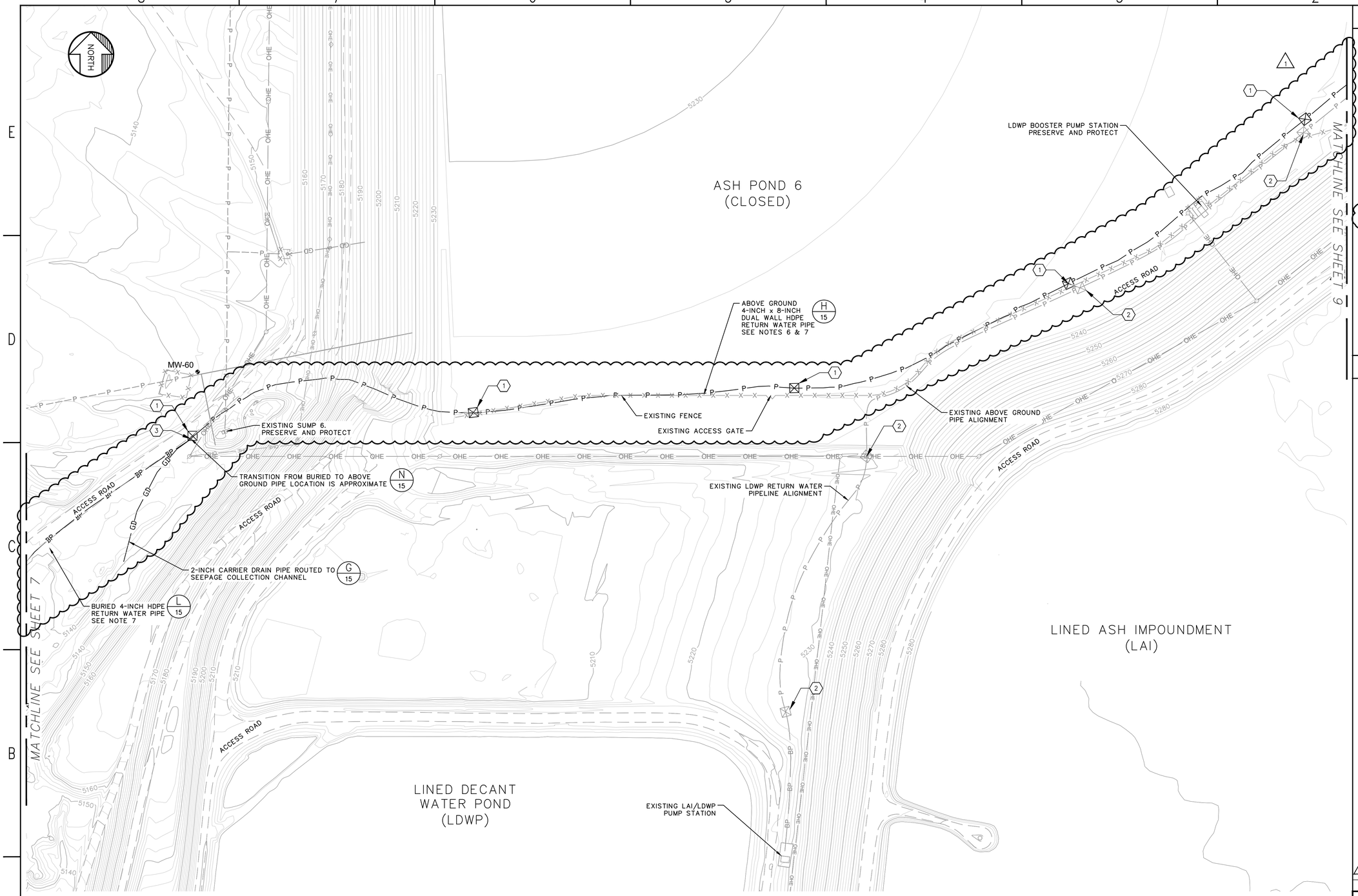
aps

SCALE 1"=100' DATE 10/04/19

DWN	EXD	APPROVED	W A
AWF	---	DAVID E. MICKANEN	FCC06814
CHD	RVWD	DRAWING APPROVED BY	
DEM	---		

UNIT	DISC	TYPE	SYS	SUBSYS	NUMBER	SHEET
FC45CM	C	16	WP	AP	200485	7

DRAWING: P:\Projects\Arizona_Public_Service\60566008_FCPP_Return_Water_Pond_SG2\900_CAD_GIS\910_CAD\20-SHEETS\APS_EDCS_Drawings\2_DRAWING_REVISIONS\FC45CM-C-16-WP-AP-200485-7.dwg



CONSTRUCTION NOTES:

1. ALL UNDERGROUND UTILITIES SHOWN ON THESE DRAWINGS SHOULD BE CONSIDERED APPROXIMATE ONLY.
2. HYDRO-EXCAVATE TO A MINIMUM DEPTH OF 6 FEET TO FIELD VERIFY ALL EXISTING UNDERGROUND FACILITIES AND/OR UTILITIES AT CONFLICTS.
3. ALIGNMENT OF PIPELINE SHOWN ON DRAWINGS IS CONCEPTUAL. CONTRACTOR CAN PROPOSE REVISED PIPE ALIGNMENTS WHICH MUST BE SUBMITTED TO ENGINEER FOR APPROVAL.
4. CONTRACTOR SHALL MAKE MINOR ADJUSTMENTS IN THE FIELD FOR PIPE ROUTING AND INSTALLED LENGTHS.
5. CONTRACTOR SHALL INSTALL APCO SERIES 140 AIR/VACCUM VALVE (AVV) AT ALL LOCAL HIGH POINTS IN PIPELINE. ALL AVV SHALL BE INSTALLED WITH ISOLATED VALVE AND VALVE CAN FOR BURIED PIPE.
6. HDPE DUAL WALL PIPING SHALL BE ISCO DUAL CONTAINMENT PIPING OR EQUAL AND SHALL BE INSTALLED AND TESTED IN ACCORDANCE WITH MANUFACTURERS RECOMMENDATIONS.
7. AS-BUILT LINES, GRADES, AND POINTS CAN BE FOUND IN APS DRAWING NUMBER FC00CM-C-17-SF-RG-100003-101.

△1

KEY NOTES:

(1) CONTRACTOR SHALL INSTALL CLSM BALLAST AT A SPACING OF APPROXIMATELY 600 FT ON CENTER. LOCATION OF BALLAST SHOWN ON DRAWING IS APPROXIMATE. SEE DETAIL 5 ON SHEET 15.

(2) EXISTING PIPE BALLAST. PRESERVE AND PROTECT.

(3) PIPE END TERMINATION. SEE DETAIL 3 ON SHEET 15.

RETURN WATER PIPELINE PLAN 2
SCALE: 1"=100' (FULL SIZE)

GRAPHIC SCALE
100 0 100 200
(IN FEET)
1 inch = 100 ft.

△1 THESE RECORD DRAWINGS DATED 01/17/20 AND TITLED "FOR RECORD" HAVE BEEN DEVELOPED FROM AS-BUILT MARKUPS AND MAY NOT REPRESENT THE FINAL PROJECT, AS CONSTRUCTED, IN EVERY DETAIL. THESE RECORD DRAWINGS HAVE BEEN PREPARED BASED ON INFORMATION SUPPLIED BY OTHERS AND THE ENGINEER HAS NOT VERIFIED THE ACCURACY OR COMPLETENESS OF THE INFORMATION.

NO.	DATE	REVISION	DWN	CHD	EXD	RVWD	APVD	W.A.
1	01-17-20	FOR RECORD	AWF	DEM				FCC06814

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FOUR CORNERS POWER PLANT
RETURN WATER POND

RETURN WATER PIPELINE PLAN 2

aps

SCALE 1"=100 DATE 10/04/19

DWN	EXD	APPROVED	W A
AWF	---	DAVID E. MICKANEN	FCC06814
CHD	RVWD	DRAWING APPROVED BY	
DEM	---		

UNIT	DISC	TYPE	SYS	SUBSYS	NUMBER	SHEET
FC45CM	C	16	WP	AP	200485	8

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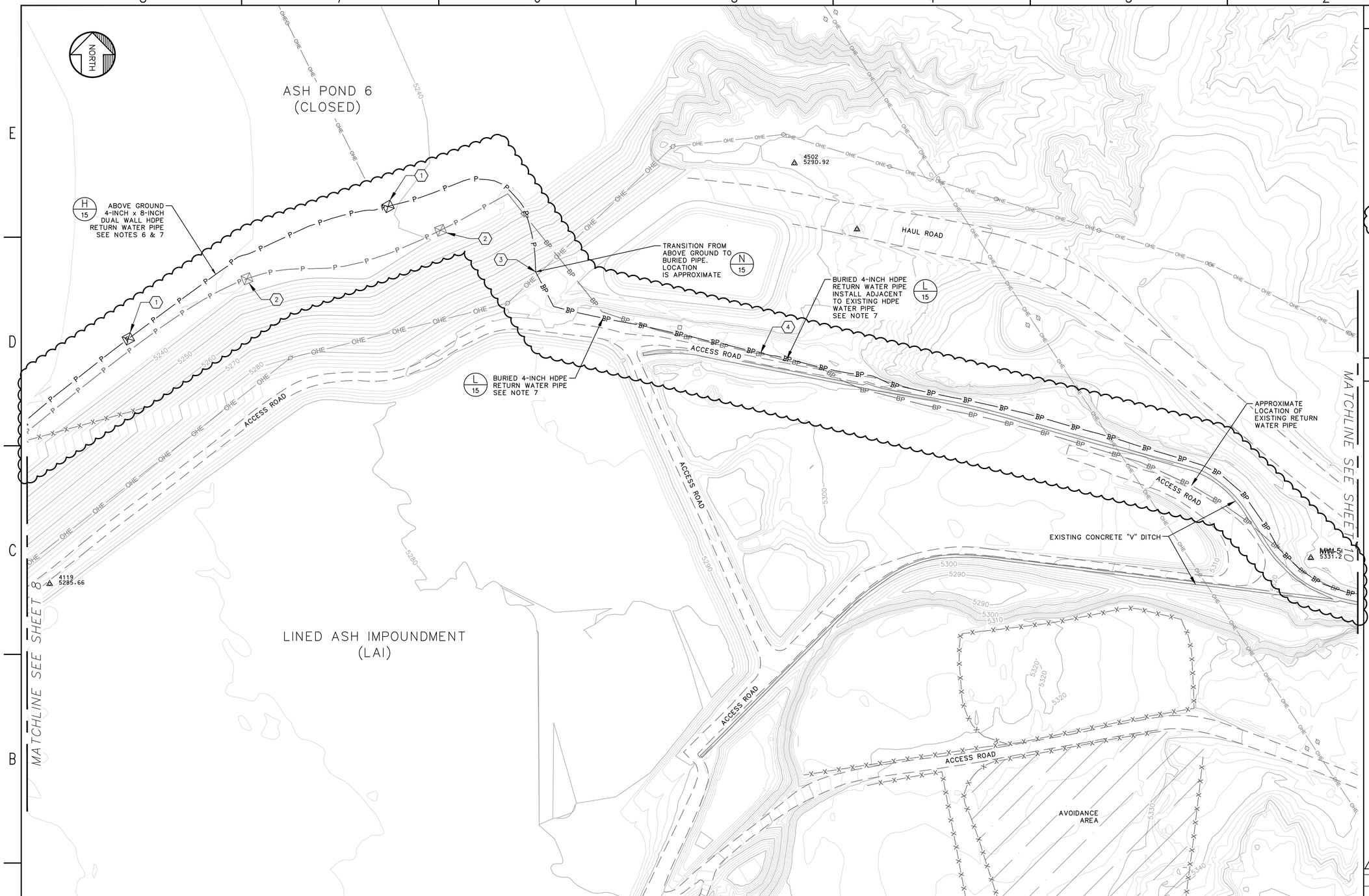

RETURN WATER PIPELINE PLAN 3
SCALE: 1"=100' (FULL SIZE)

GRAPHIC SCALE
100 0 100 200
(IN FEET)
1 inch = 100 ft.

CONSTRUCTION NOTES:

1. ALL UNDERGROUND UTILITIES SHOWN ON THESE DRAWINGS SHOULD BE CONSIDERED APPROXIMATE ONLY.
2. HYDRO-EXCAVATE TO A MINIMUM DEPTH OF 6 FEET TO FIELD VERIFY ALL EXISTING UNDERGROUND FACILITIES AND/OR UTILITIES AT CONFLICTS.
3. ALIGNMENT OF PIPELINE SHOWN ON DRAWINGS IS CONCEPTUAL. CONTRACTOR CAN PROPOSE REVISED PIPE ALIGNMENTS WHICH MUST BE SUBMITTED TO ENGINEER FOR APPROVAL.
4. CONTRACTOR SHALL MAKE MINOR ADJUSTMENTS IN THE FIELD FOR PIPE ROUTING AND INSTALLED LENGTHS.
5. CONTRACTOR SHALL INSTALL APCO SERIES 140 AIR/VACCUM VALVE (AVV) AT ALL LOCAL HIGH POINTS IN PIPELINE. ALL AVV SHALL BE INSTALLED WITH ISOLATED VALVE AND VALVE CAN FOR BURIED PIPE.
6. HDPE DUAL WALL PIPING SHALL BE ISCO DUAL CONTAINMENT PIPING OR EQUAL AND SHALL BE INSTALLED AND TESTED IN ACCORDANCE WITH MANUFACTURERS RECOMMENDATIONS.
7. AS-BUILT LINES, GRADES, AND POINTS CAN BE FOUND IN APS DRAWING NUMBER FC00CM-C-17-SF-RG-100003-101.

△2

KEY NOTES:

1. CONTRACTOR SHALL INSTALL CLSM BALLAST AT A SPACING OF APPROXIMATELY 600 FT ON CENTER. LOCATION OF BALLAST SHOWN ON DRAWING IS APPROXIMATE. SEE DETAIL 5 ON SHEET 15.
2. EXISTING PIPE BALLAST. PRESERVE AND PROTECT.
3. PIPE END TERMINATION, SEE DETAIL 4 ON SHEET 15.
4. BURIED 4-INCH HDPE PIPE. FOLLOW EXISTING HDPE PIPE ALIGNMENT. SEE SECTIONS L AND K ON SHEET 15.

THESE RECORD DRAWINGS DATED 01/17/20 AND TITLED "FOR RECORD" HAVE BEEN DEVELOPED FROM AS-BUILT MARKUPS AND MAY NOT REPRESENT THE FINAL PROJECT, AS CONSTRUCTED, IN EVERY DETAIL. THESE RECORD DRAWINGS HAVE BEEN PREPARED BASED ON INFORMATION SUPPLIED BY OTHERS AND THE ENGINEER HAS NOT VERIFIED THE ACCURACY OR COMPLETENESS OF THE INFORMATION.

△2

NO.	DATE	REVISION	DWN	CHD	EXD	RVWD	APVD	W.A.
2	01-17-20	FOR RECORD	AWF	DEM				FCC06814
1	12-14-18	REVISED PIPELINE TRANSITION LOCATION	AWF	DEM				FCC06814

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RETURN WATER PIPELINE PLAN 3

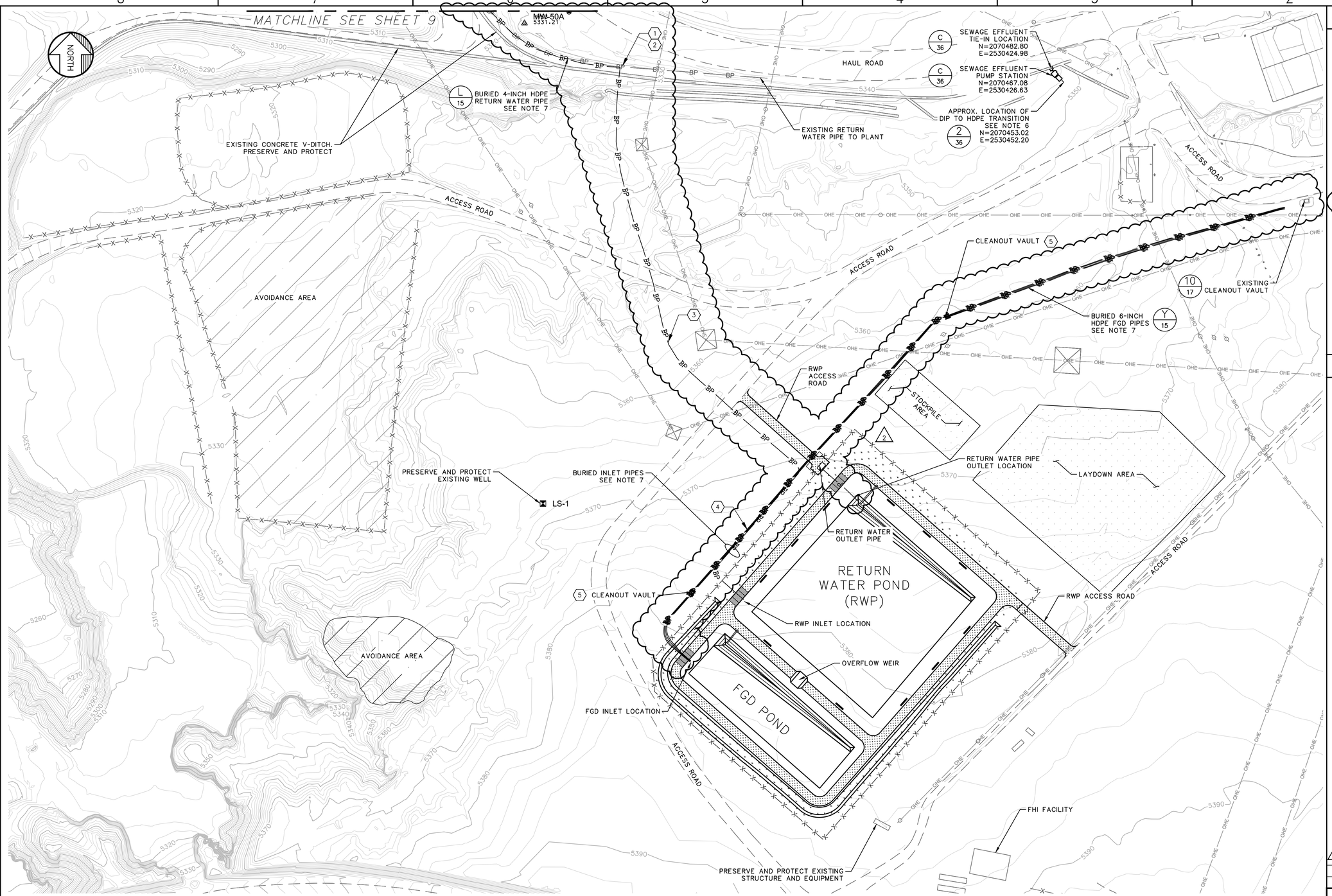
aps

SCALE 1"=100' DATE 10/04/19

DWN	EXD	APPROVED	W A
AWF	---	DAVID E. MICKANEN	FCC06814
CHD DEM	RVWD ---	DRAWING APPROVED BY	

UNIT	DISC	TYPE	SYS	SUBSYS	NUMBER	SHEET
FC45CM	C	16	WP	AP	200485	9

DRAWING: P:\Projects\Arizona_Public_Service\60566008_FCPP_Return_Water_Pond_SG2\900_CAD_GIS\910_CAD\20-SHEETS\APS_EDCS_Drawings\2_DRAWING_REVISIONS\FC45CM-C-16-WP-AP-200485-9.dwg



CONSTRUCTION NOTES:

1. ALL UNDERGROUND UTILITIES SHOWN ON THESE DRAWINGS SHOULD BE CONSIDERED APPROXIMATE ONLY.
2. HYDRO-EXCAVATE TO A MINIMUM DEPTH OF 6 FEET TO FIELD VERIFY ALL EXISTING UNDERGROUND FACILITIES AND/OR UTILITIES.
3. ALIGNMENT OF PIPELINE SHOWN ON DRAWINGS IS CONCEPTUAL. CONTRACTOR CAN PROPOSE REVISED PIPE ALIGNMENTS WHICH MUST BE SUBMITTED TO ENGINEER FOR APPROVAL.
4. CONTRACTOR SHALL MAKE MINOR ADJUSTMENTS IN THE FIELD FOR PIPE ROUTING AND INSTALLED LENGTHS.
5. CONTRACTOR SHALL INSTALL APCO SERIES 140 AIR/VACCUM VALVE (AVV) AT ALL LOCAL HIGH POINTS IN PIPELINE. ALL AVV SHALL BE INSTALLED WITH ISOLATED VALVE AND VALVE CAN FOR BURIED PIPE.
6. CONTRACTOR TO INSTALL 150# BLIND FLANGE.
7. AS-BUILT LINES, GRADES, AND POINTS CAN BE FOUND IN APS DRAWING NUMBER FC00CM-C-17-SF-RG-100003-101.

2

KEY NOTES:

1. APPROXIMATE LOCATION OF TIE-IN TO EXISTING RETURN WATER PIPE ALIGNMENT AT EXISTING FLANGE. CONTRACTOR TO INSTALL 2 STAINLESS STEEL TAPPING SLEEVES SPACED 5-FT APART. ROMAC SST-H OR APPROVED EQUAL.
2. AMERICAN FLOW CONTROL 2500-1 RESILIENT WEDGE GATE VALVE, OS&Y.
3. MULTI-PIPE TRENCH. SEE SECTION P ON SHEET 15.
4. MULTI-PIPE TRENCH. SEE SECTION X ON SHEET 15.
5. NEW CLEANOUT VAULT. SEE DETAIL 1 ON APS DRAWING NUMBER 156257 SHEET 3.
6. NEW LEACH FIELD PIPELINE. SEE SHEET 18.

RETURN WATER PIPELINE PLAN 4
SCALE: 1"=100' (FULL SIZE)

GRAPHIC SCALE
100 0 100 200
(IN FEET)
1 inch = 100 ft.

THESE RECORD DRAWINGS DATED 01/17/20 AND TITLED "FOR RECORD" HAVE BEEN DEVELOPED FROM AS-BUILT MARKUPS AND MAY NOT REPRESENT THE FINAL PROJECT, AS CONSTRUCTED, IN EVERY DETAIL. THESE RECORD DRAWINGS HAVE BEEN PREPARED BASED ON INFORMATION SUPPLIED BY OTHERS AND THE ENGINEER HAS NOT VERIFIED THE ACCURACY OR COMPLETENESS OF THE INFORMATION.

2

NO.	DATE	REVISION	DWN	CHD	EXD	RVWD	APVD	W.A.
2	01-17-20	FOR RECORD	AWF	DEM				FCC06814
1	7-17-19	SEWERLINE DELETED	AWF	DEM				FCC06814

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RETURN WATER POND

RETURN WATER PIPELINE PLAN 4

aps

SCALE 1"=100' DATE 10/04/19

DWN	EXD	APPROVED	W A
AWF	---	DAVID E. MICKANEN	FCC06814
CHD	RVWD	DRAWING APPROVED BY	
DEM	---		

UNIT	DISC	TYPE	SYS	SUBSYS	NUMBER	SHEET
FC45CM	C	16	WP	AP	200485	10

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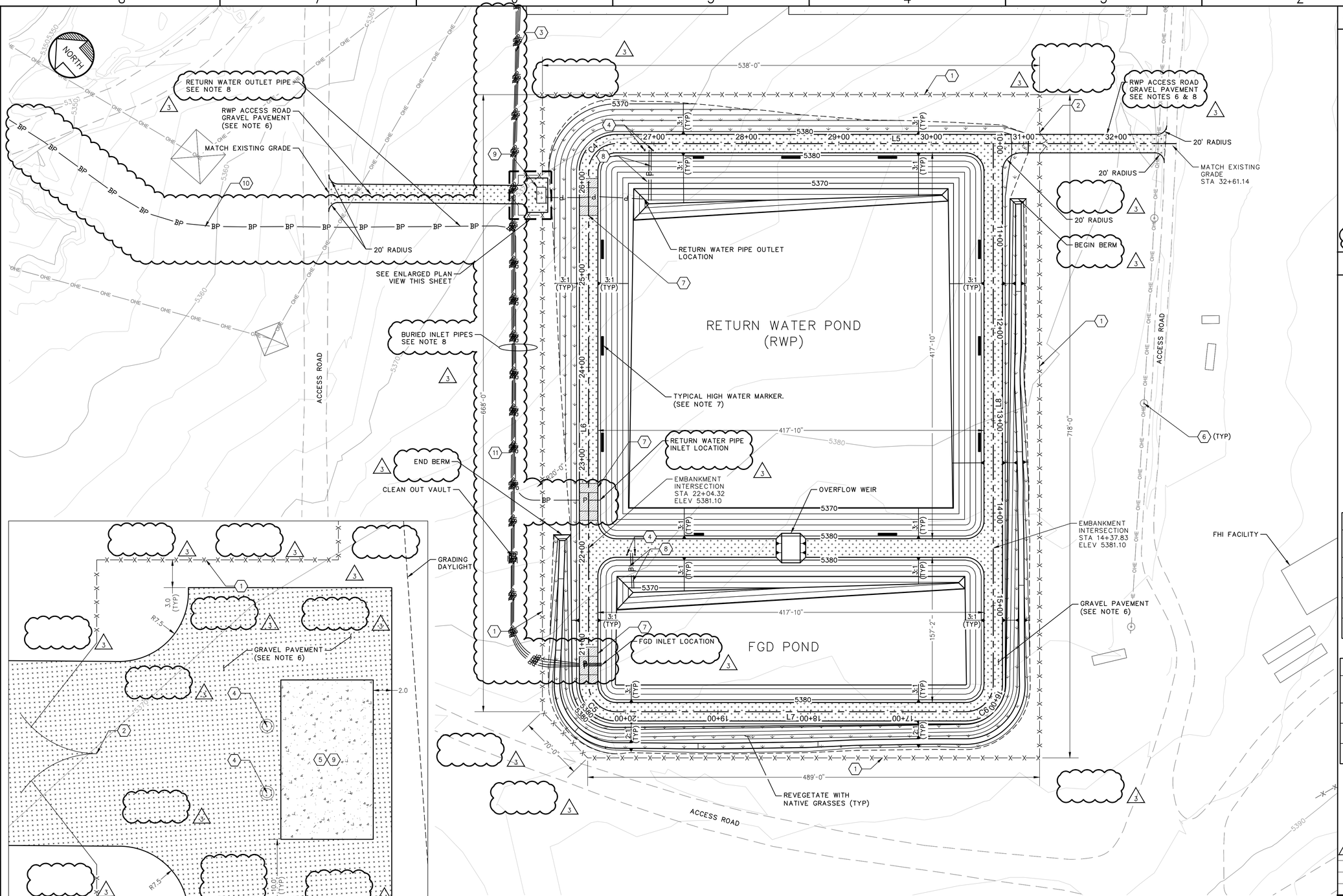

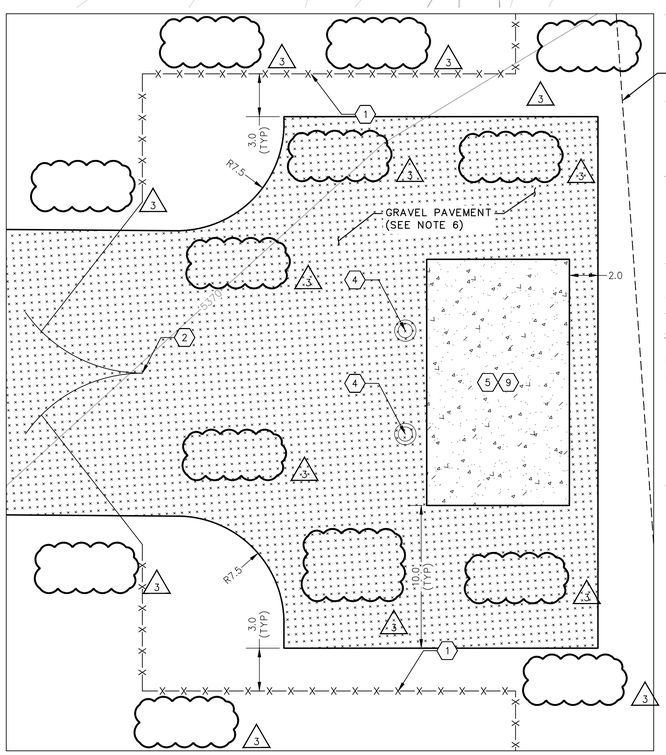

ENLARGED PLAN VIEW
SCALE: 1"=5' (FULL SIZE)

GRAPHIC SCALE
5 0 5 10
(IN FEET)
1 inch = 5 ft.

RETURN WATER POND PLAN
SCALE: 1"=50' (FULL SIZE)

GRAPHIC SCALE
50 0 50 100
(IN FEET)
1 inch = 50 ft.

CONSTRUCTION NOTES:

1. ALL UNDERGROUND UTILITIES SHOWN ON THESE DRAWINGS SHOULD BE CONSIDERED APPROXIMATE ONLY.
2. HYDRO-EXCAVATE TO A MINIMUM DEPTH OF 6 FEET TO FIELD VERIFY ALL EXISTING UNDERGROUND FACILITIES AND/OR UTILITIES AT CONFLICT LOCATIONS.
3. ALIGNMENT OF PIPELINE SHOWN ON DRAWINGS IS CONCEPTUAL. CONTRACTOR CAN PROPOSE REVISED PIPE ALIGNMENTS WHICH MUST BE SUBMITTED TO ENGINEER FOR APPROVAL.
4. CONTRACTOR SHALL MAKE MINOR ADJUSTMENTS IN THE FIELD FOR PIPE ROUTING AND INSTALLED LENGTHS.
5. CONTRACTOR SHALL INSTALL APCO SERIES 140 AIR/VACCUM VALVE (AVV) AT HIGH POINTS IN PIPELINE.
6. GRAVEL PAVEMENT SHALL CONSIST OF 6 INCHES OF TYPE II ABC COMPACTED AS PER SPEC SECTION 31 23 00 AND NMDOT SPEC SECTION 303.
7. HIGH WATER MARKER SHALL CONSIST OF RED HDPE LINER AND SHALL BE 2 FEET WIDE BY 20 FEET LONG AND SHALL BE EVENLY SPACED. MARKER SHALL BE EXTRUSION WELDED TO THE PRIMARY LINER AT ELEVATION 5,379 FEET.
8. AS-BUILT LINES, GRADES, AND POINTS CAN BE FOUND IN APS DRAWING NUMBER FCOOCM-C-17-SF-RG-100003-101. (3)

KEY NOTES:

(1) NEW 4-FT HIGH FENCE. SEE DETAILS 6 AND 9 ON SHEET 16.
(2) DOUBLE SWING GATE. SEE DETAIL 8 ON SHEET 16.
(3) MULTI-PIPE TRENCH. SEE SECTION Y ON SHEET 15.
(4) GUARD POST. SEE DETAIL 7 ON SHEET 16.
(5) PUMP SLAB. SEE SHEET 26.
(6) EXISTING POWER POLE. PRESERVE AND PROTECT.
(7) PIPE CROSSING. SEE SECTION M ON SHEET 15.
(8) LCRS RISER PIPE. SEE SECTION A ON SHEET 13.
(9) NEW RETURN WATER PUMPS. SEE RWP PUMP PAD PLAN ON SHEET 34.
(10) MULTI-PIPE TRENCH. SEE SECTION P ON SHEET 15.
(11) MULT-PIPE TRENCH. SEE SECTION X ON SHEET 15.

LINE TABLE-CNTR LINE ELEV=5381.1 FT

LINE	LENGTH	BEARING	START NORTHING EASTING	END NORTHING EASTING
L5	605.80	S48°44'20"E	2069602.74 2530021.26	2069203.22 2530476.64
L6	555.06	N41°15'40"E	2069182.73 2529612.87	2069599.97 2529978.93
L7	377.85	N48°44'20"W	2068891.23 2529899.67	2069140.42 2529615.64
L8	585.03	S41°15'40"W	2069333.77 2530327.83	2068894.00 2529942.01

CURVE TABLE-CNTR LINE ELEV=5381.1 FT

CURVE	LENGTH	RADIUS	DELTA	START NORTHING EASTING	END NORTHING EASTING
C4	47.11	29.99	90°00'00"	2069599.97 2529978.93	2069602.74 2530021.26
C5	47.09	29.98	90°00'00"	2069140.42 2529615.64	2069182.73 2529612.87
C6	47.12	30.00	90°00'00"	2068894.00 2529942.01	2068891.23 2529899.67

THESE RECORD DRAWINGS DATED 01/17/20 AND TITLED "FOR RECORD" HAVE BEEN DEVELOPED FROM AS-BUILT MARKUPS AND MAY NOT REPRESENT THE FINAL PROJECT, AS CONSTRUCTED, IN EVERY DETAIL. THESE RECORD DRAWINGS HAVE BEEN PREPARED BASED ON INFORMATION SUPPLIED BY OTHERS AND THE ENGINEER HAS NOT VERIFIED THE ACCURACY OR COMPLETENESS OF THE INFORMATION. (3)

NO.	DATE	REVISION	DWN	CHD	EXD	RVWD	APVD	W.A.
3	01-17-20	FOR RECORD	AWF	DEM				FCC06814
2	7-17-19	SEWERLINE DELETED	AWF	DEM				FCC06814
1	12-14-18	REVISED KEY NOTE	AWF	DEM				FCC06814

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RETURN WATER POND

RETURN WATER POND PLAN

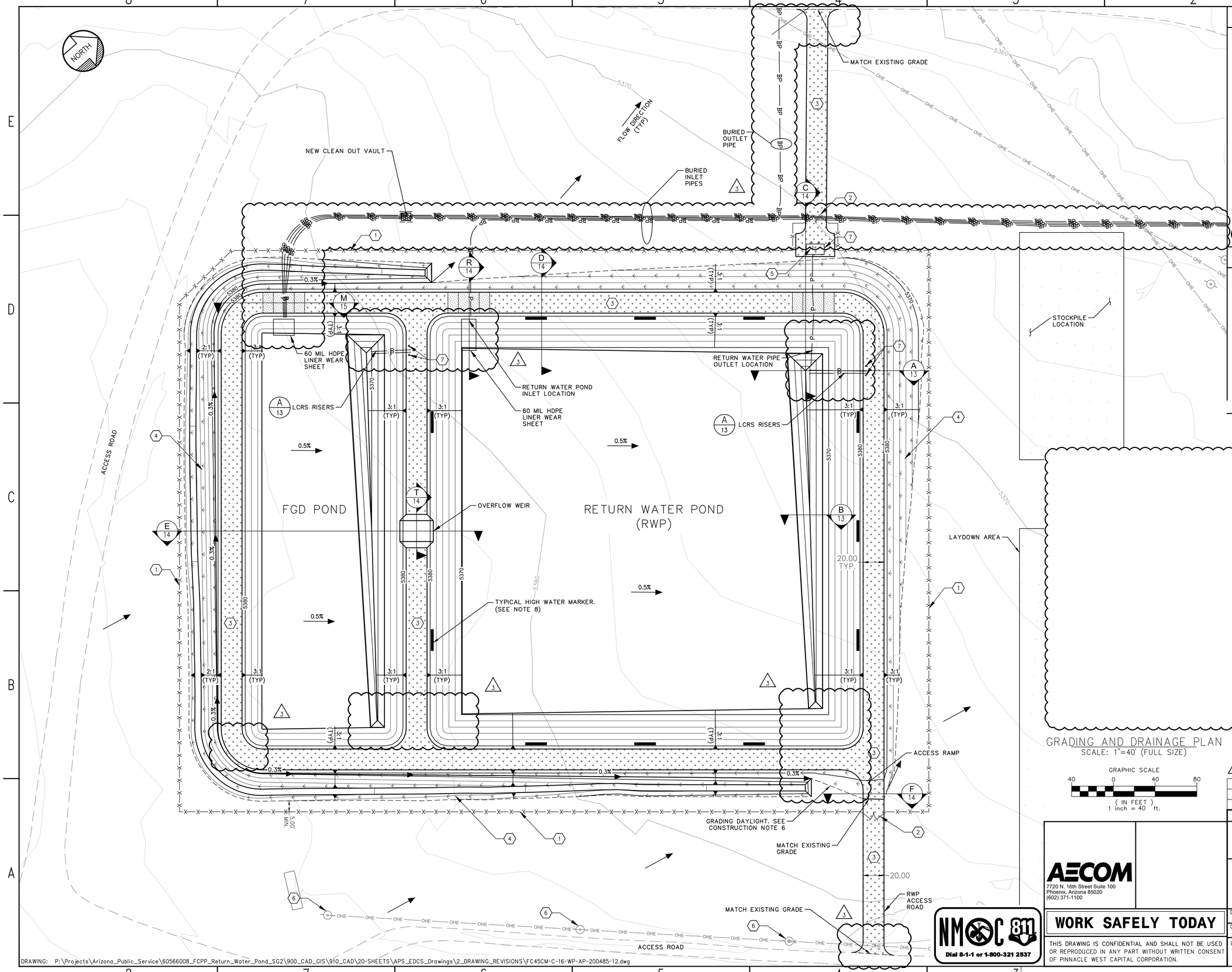
aps

SCALE AS NOTED DATE 10/04/19

DWN	EXD	APPROVED	W A
AWF	---	DAVID E. MICKANEN	FCC06814
CHD DEM	RVWD ---	DRAWING APPROVED BY	

UNIT	DISC	TYPE	SYS	SUBSYS	NUMBER	SHEET
FC45CM	C	16	WP	AP	200485	11

DRAWING: P:\Projects\Arizona_Public_Service\60566008_FCPP_Return_Water_Pond_SG2\900_CAD_GIS\910_CAD\20-SHEETS\APS_EDCS_Drawings\2_DRAWING_REVISIONS\FC45CM-C-16-WP-AP-200485-11.dwg



CONSTRUCTION NOTES:

1. ALL UNDERGROUND UTILITIES SHOWN ON THESE DRAWINGS SHOULD BE CONSIDERED APPROXIMATE ONLY.
2. HYDRO-EXCAVATE TO A MINIMUM DEPTH OF 6 FEET TO FIELD VERIFY ALL EXISTING UNDERGROUND FACILITIES AND/OR UTILITIES AT CONFLICT LOCATIONS.
3. ALIGNMENT OF PIPELINE SHOWN ON DRAWINGS IS CONCEPTUAL. CONTRACTOR CAN PROPOSE REVISED PIPE ALIGNMENTS WHICH MUST BE SUBMITTED TO ENGINEER FOR APPROVAL.
4. CONTRACTOR SHALL MAKE MINOR ADJUSTMENTS IN THE FIELD FOR PIPE ROUTING AND INSTALLED LENGTHS.
5. CONTRACTOR SHALL INSTALL APCO SERIES 140 AIR/VACCUM VALVE (AVV) AT HIGH POINTS IN PIPELINE.
6. BACKFILL TO PROVIDE POSITIVE DRAINAGE AROUND ACCESS RAMP.
7. GRAVEL PAVEMENT SHALL CONSIST OF 6 INCHES OF TYPE II ABC COMPACTED AS PER SPEC SECTION 31 23 00 AND NMDOT SPEC SECTION 303.
8. HIGH WATER MARKER SHALL CONSIST OF RED HDPE LINER AND SHALL BE 2 FEET WIDE BY 20 FEET LONG AND SHALL BE EVENLY SPACED. MARKER SHALL BE EXTRUSION WELDED TO THE PRIMARY LINER AT ELEVATION 5,379 FEET.
9. AS-BUILT LINES, GRADES, AND POINTS CAN BE FOUND IN APS DRAWING NUMBER FC000CM-C-17-SF-RG-100003-101.

KEY NOTES: (3)

1. NEW 4-FT HIGH FENCE. SEE DETAILS 6 AND 9 ON SHEET 16.
2. DOUBLE SWING GATE. SEE DETAIL 8 ON SHEET 16.
3. 6" GRAVEL PAVEMENT. SEE NOTE 7.
4. REVEGETATE NON-LINED BERMS WITH NATIVE GRASSES.
5. PUMP SLAB. SEE SHEET 26 AND 31.
6. EXISTING POWER POLE. PRESERVE AND PROTECT.
7. GUARD POSTS. SEE DETAIL 7 ON SHEET 16

GRADING AND DRAINAGE PLAN

SCALE: 1"=40' (FULL SIZE)

GRAPHIC SCALE
40 0 40 80
(IN FEET)
1 inch = 40 ft.

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(3)

NO.	DATE	REVISION	DWN	CHD	EXD	RVWD	APVD	W.A.
3	01-17-20	FOR RECORD	AWF	DEM				FCC06814
2	7-17-19	SEWERLINE DELETED	AWF	DEM				FCC06341
1	05-16-19	UPDATED POINT ELEVATIONS	AWF	DEM				FCC06341

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FOUR CORNERS POWER PLANT
RETURN WATER POND

GRADING AND DRAINAGE PLAN

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SCALE 1"=40' DATE 10/04/19

DWN	EXD	APPROVED	W A
AWF	---	DAVID E. MICKANEN	
CHD	RVWD	DRAWING APPROVED BY	FCC06814
CHD	---		

UNIT	DISC	TYPE	SYS	SUBSYS	NUMBER	SHEET
FC45CM	C	16	WP	AP	200485	12

WORK SAFELY TODAY

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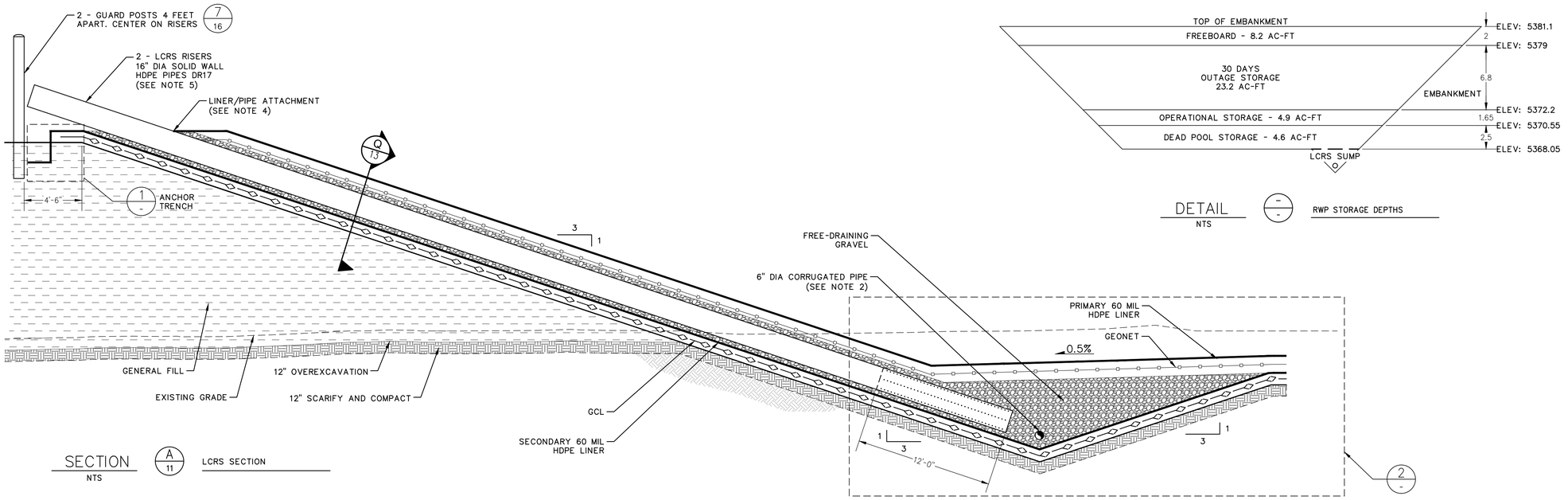
DRAWING: P:\Projects\Arizona_Public_Service\60566008_FCPP_Return_Water_Pond_SG2\900_CAD_GIS\910_CAD\20-SHEETS\APS_EDCS_Drawings\2_DRAWING_REVISIONS\FC45CM-C-16-WP-AP-200485-12.dwg



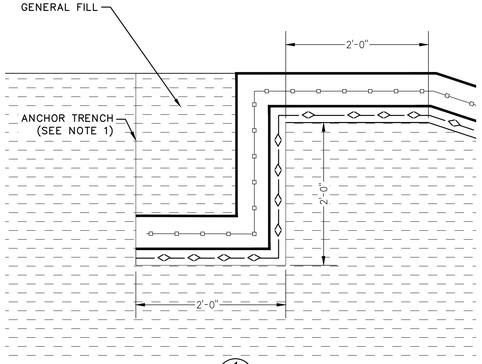
SECTION A/11 NTS — LCRS SECTION

DETAIL -/- NTS — RWP STORAGE DEPTHS

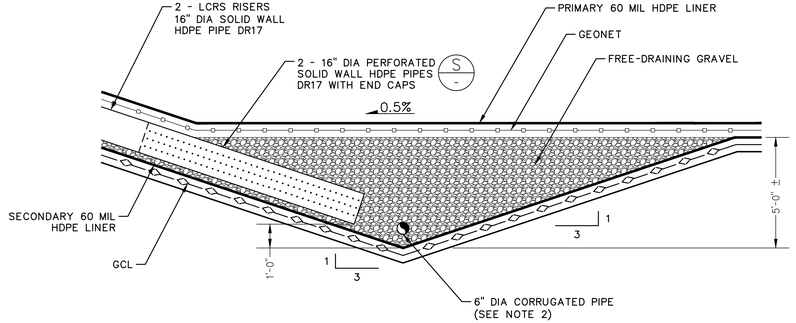
CONSTRUCTION NOTES:

1. ANCHOR TRENCH INTENDED TO PULL OUT. MODIFICATION TO ANCHOR TRENCH DETAIL MUST BE APPROVED BY ENGINEER.
2. ADS (OR EQUAL) SINGLE WALL HIGH DENSITY CORRUGATED POLYETHYLENE HEAVY DUTY PERFORATED PIPE MEETING ASTM F667 WITH TYPE B SLOT PATTERN.
3. CLSM TO BE 1 FOOT THICK EXCEPT AT ANCHOR TRENCH.
4. HDPE LINER SHALL BE ATTACHED TO PIPE BY EXTRUSION WELDING LINER TO PIPE OR ANOTHER METHOD WITH ENGINEER APPROVAL.
5. FOR LCRS RISER PUMPS AND APPURTENANCES SEE SHEET 35. ADD CAP TO PIPE WITHOUT PUMP INSTALLED.
6. AS-BUILT LINES, GRADES, AND POINTS CAN BE FOUND IN APS DRAWING NUMBER FC00CM-C-17-SF-RG-100003-101.

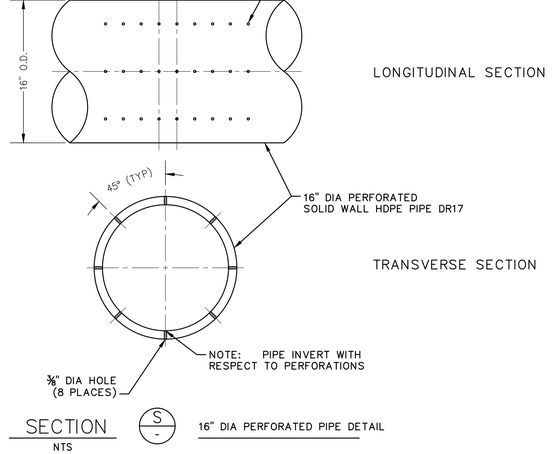
△1



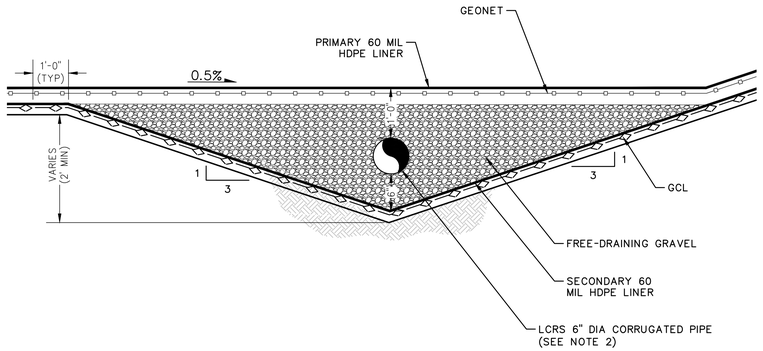
DETAIL 1/- NTS — ANCHOR TRENCH DETAIL



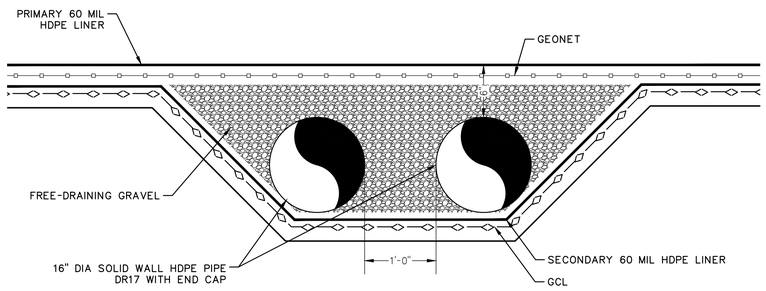
DETAIL 2/- NTS — LCRS SUMP DETAIL



SECTION S/- NTS — 16" DIA PERFORATED PIPE DETAIL



SECTION B/12 NTS — LCRS DRAIN SECTION



SECTION Q/13 NTS — LCRS RISER SECTION

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△1

NO.	DATE	REVISION	DWN	CHD	EXD	RVWD	APVD	W.A.
1	01-17-20	FOR RECORD	AWF	DEM				FCC06814

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LINER SECTIONS AND DETAILS

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CHD	RVWD	DRAWING APPROVED BY	
CHD	---		

UNIT	DISC	TYPE	SYS	SUBSYS	NUMBER	SHEET
FC45CM	C	65	WP	AP	200485	13

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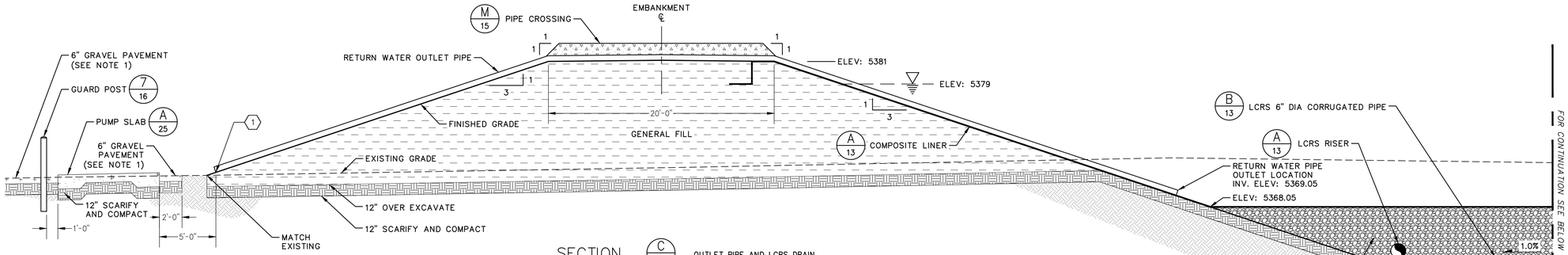
CONSTRUCTION NOTES:

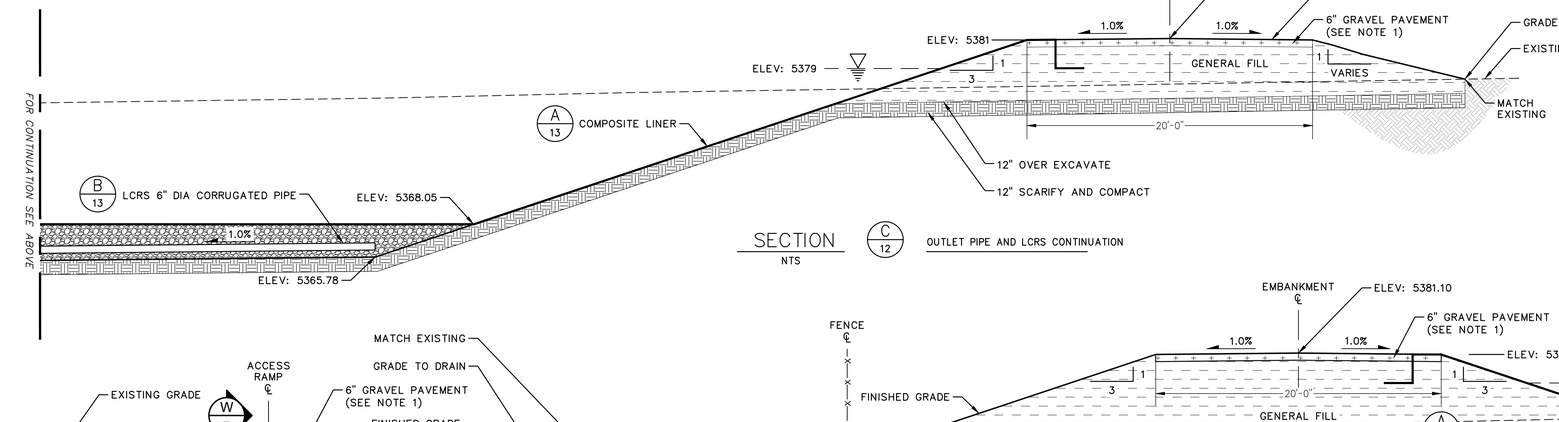
1. GRAVEL PAVEMENT SHALL CONSIST OF 6 INCHES OF TYPE II ABC COMPACTED AS PER SPEC SECTION 31 23 00 AND NMDOT SPEC SECTION 303. (1)
2. AS-BUILT LINES, GRADES, AND POINTS CAN BE FOUND IN APS DRAWING NUMBER FC00CM-C-17-SF-RG-100003-101.

KEY NOTES:

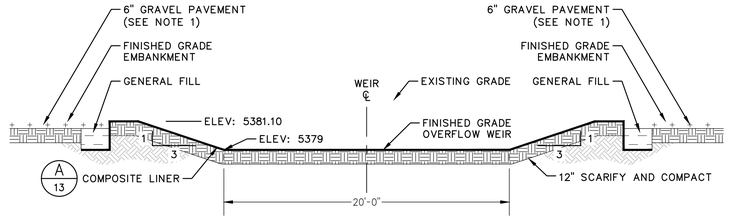
(1) RETURN WATER PIPE. SEE MECHANICAL SHEETS FOR CONNECTION DETAILS.



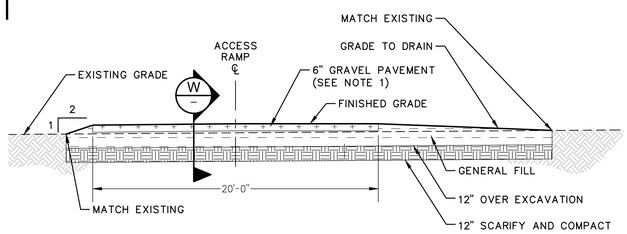
SECTION C 12 OUTLET PIPE AND LCRS DRAIN
NTS



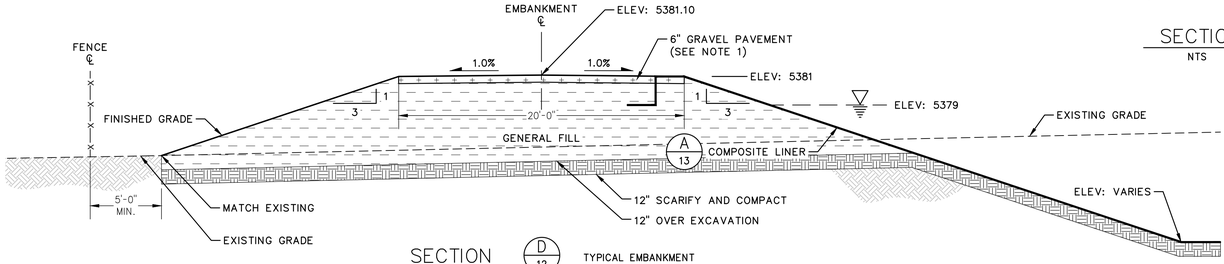
SECTION C 12 OUTLET PIPE AND LCRS CONTINUATION
NTS



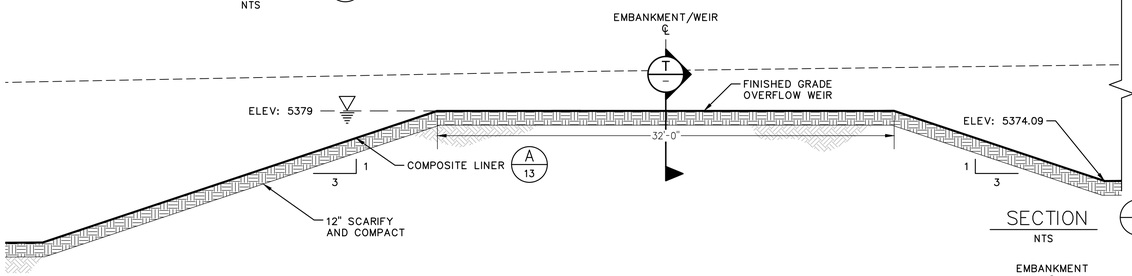
SECTION T 12 OVERFLOW WEIR
NTS

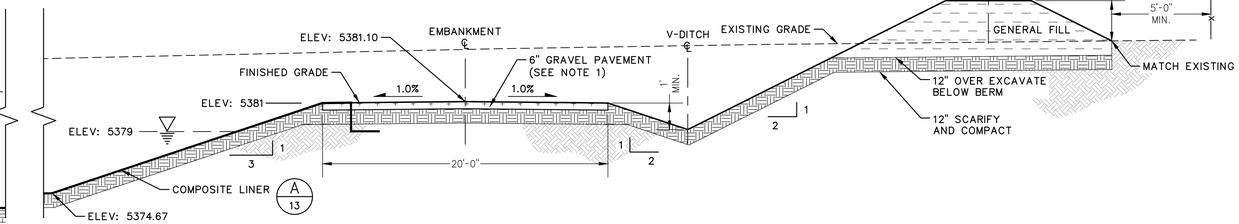


SECTION F 12 TYPICAL ACCESS RAMP
NTS

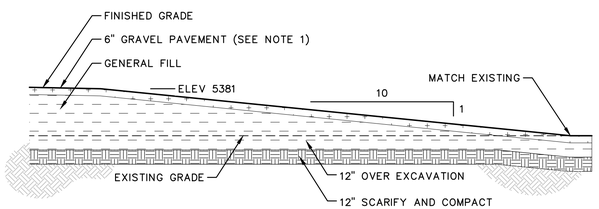


SECTION D 12 TYPICAL EMBANKMENT
NTS

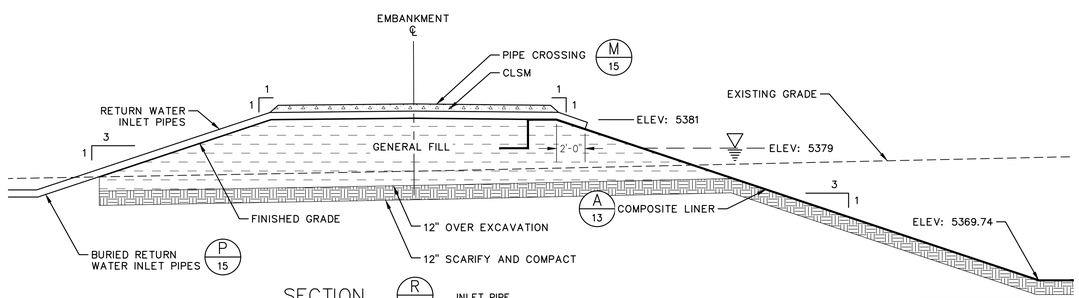




SECTION E 12 TYPICAL EMBANKMENT WITH BERM
NTS



SECTION W – ACCESS RAMP
NTS



SECTION R 12 INLET PIPE
NTS

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1	01-17-20	FOR RECORD	AWF	DEM				FCC06814

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SCALE AS NOTED DATE 10/04/19

DWN	EXD	APPROVED	W A
AWF	---	DAVID E. MICKANEN	FCC06814
CHD	RVWD	DRAWING APPROVED BY	
DEM	---		

UNIT	DISC	TYPE	SYS	SUBSYS	NUMBER	SHEET
FC45CM	C	65	WP	AP	200485	14

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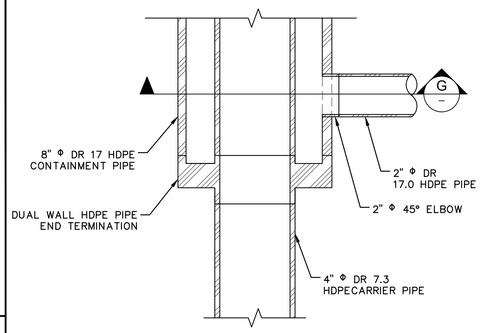
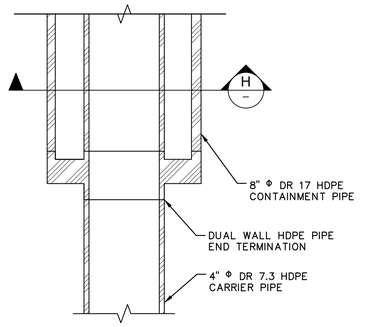
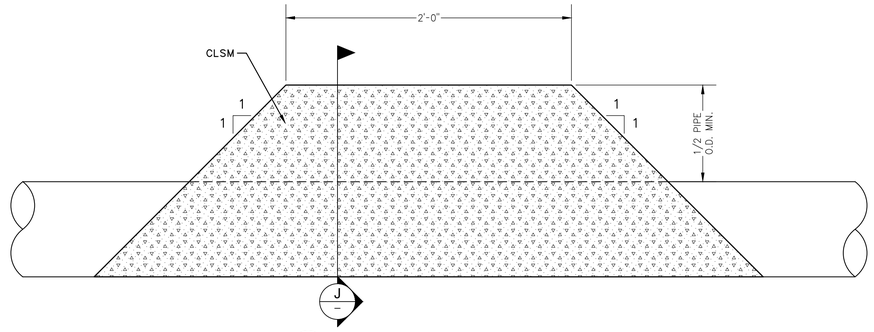


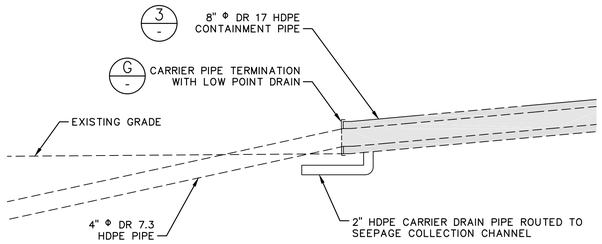
DETAIL NTS (3/8) PIPE END TERMINATION WITH DRAIN PIPE



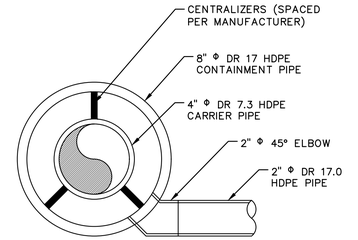
DETAIL NTS (4/9) PIPE END TERMINATION WITHOUT DRAIN PIPE



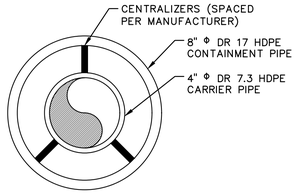
DETAIL NTS (5/8) CLSM CEMENT BALLAST



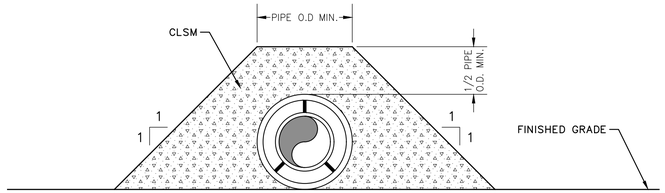
SECTION NTS (N/8) BURIED/ABOVE GROUND TRANSITION



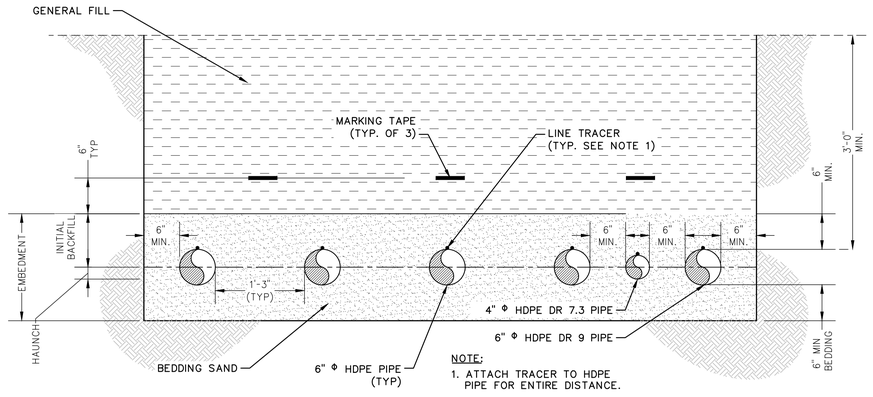
SECTION NTS (G/8) DUAL WALL WITH DRAIN PIPE



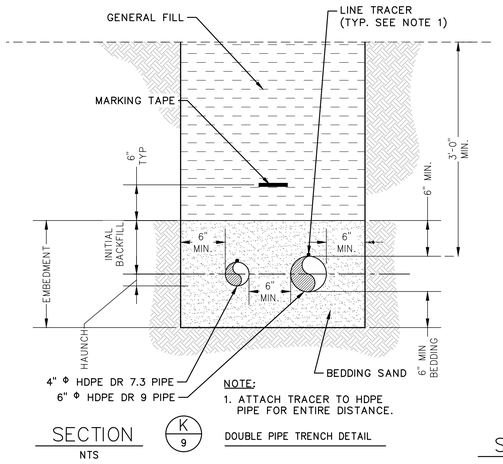
SECTION NTS (H/8) DUAL WALL PIPE



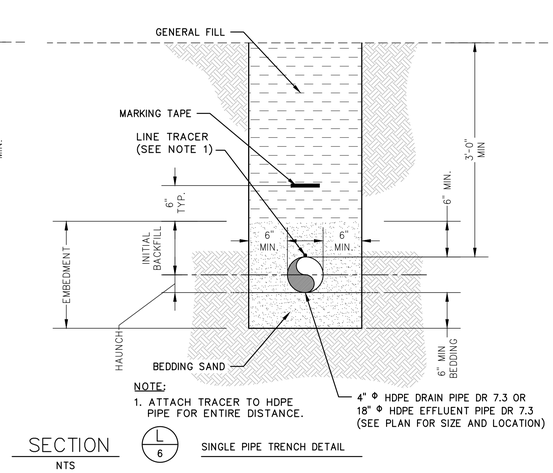
SECTION NTS (J/-) CLSM BALLAST



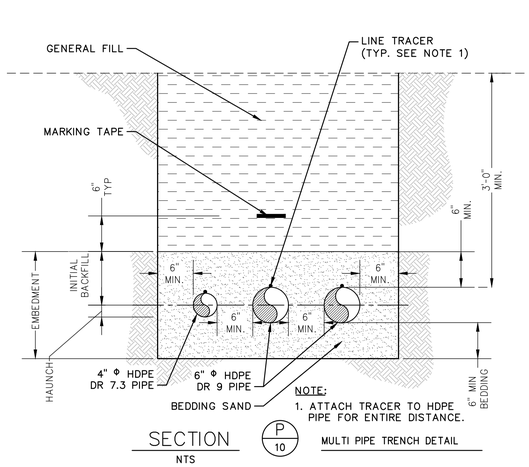
SECTION NTS (X/10) MULTI PIPE TRENCH DETAIL



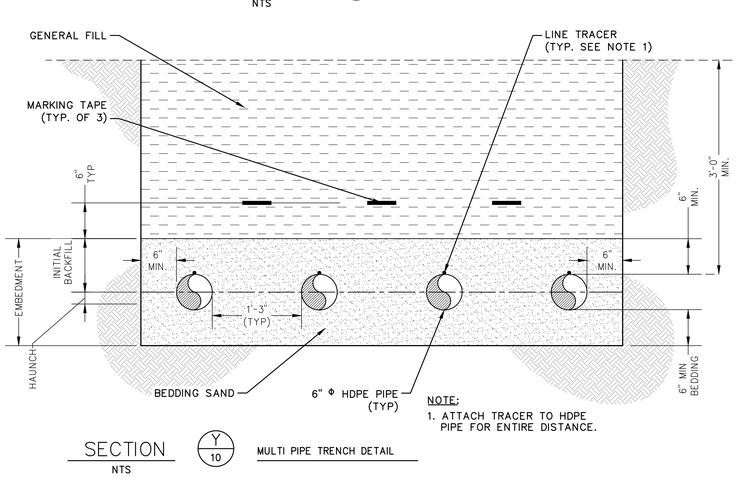
SECTION NTS (K/9) DOUBLE PIPE TRENCH DETAIL



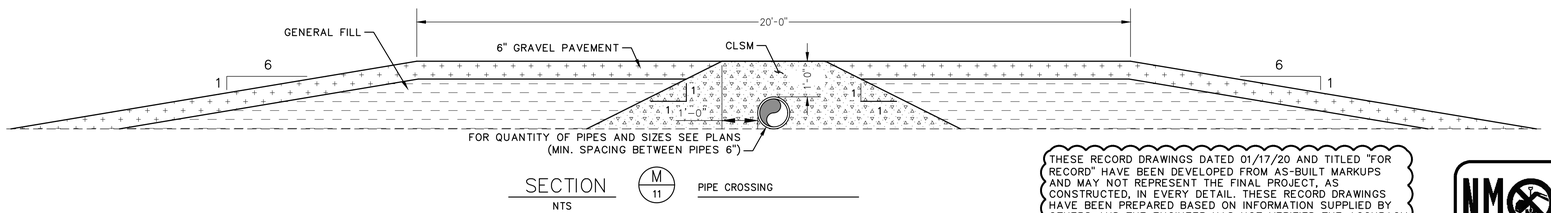
SECTION NTS (L/6) SINGLE PIPE TRENCH DETAIL



SECTION NTS (P/10) MULTI PIPE TRENCH DETAIL



SECTION NTS (Y/10) MULTI PIPE TRENCH DETAIL



SECTION NTS (M/11) PIPE CROSSING

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NO.	DATE	REVISION	DWN	CHD	EXD	RVWD	APVD	W.A.
1	01-17-20	FOR RECORD	AWF	DEM				FCC06814

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FOUR CORNERS POWER PLANT
RETURN WATER POND

RETURN WATER PIPING SECTIONS AND DETAILS

aps

SCALE AS NOTED DATE 10/04/19

DWN	EXD	APPROVED	W A
AWF	---	DAVID E. MICKANEN	FCC06814
CHD	RVWD	DRAWING APPROVED BY	
DEM	---		

UNIT	DISC	TYPE	SYS	SUBSYS	NUMBER	SHEET
FC45CM	C	65	WP	AP	200485	15

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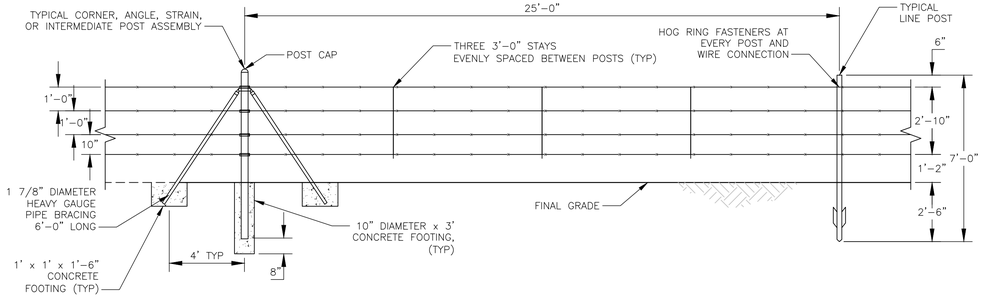
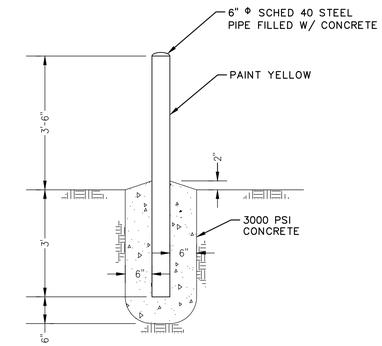
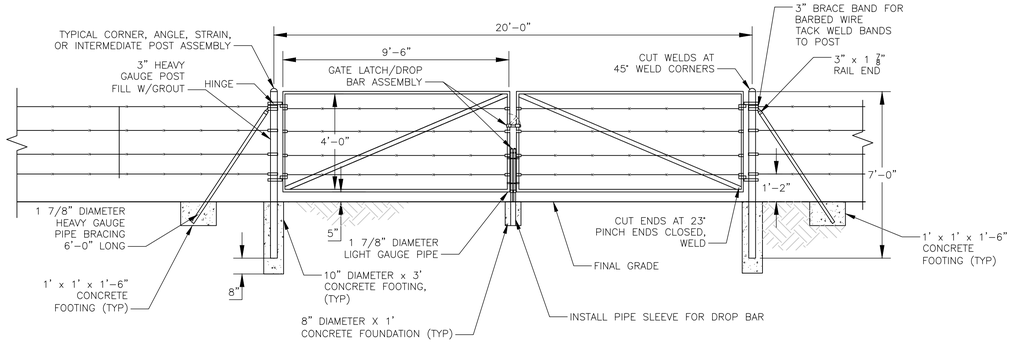


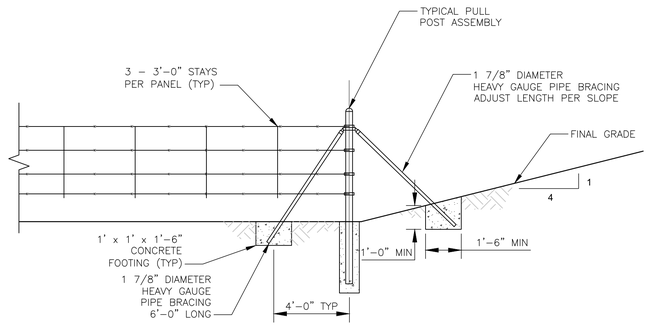
DETAIL 6/11 TYPICAL FENCING
NTS



DETAIL 7/11 GUARD POST OR BOLLARD
NTS



DETAIL 8/8 DOUBLE SWING GATE
NTS



DETAIL 9/9 END TERMINATION DETAIL
NTS

GENERAL CONSTRUCTION NOTES:

1. DETAILS SHOWN ARE TO CLARIFY REQUIREMENTS AND ARE NOT INTENDED TO LIMIT OTHER TYPES OF FENCE SECTION AND METHODS OF INSTALLATION THAT COMPLY WITH THE SPECIFICATIONS.
2. FENCE FITTINGS (WIRE TIES, RAILS, POSTS, BRACES, TENSION BARS ETC.) SHALL BE IN ACCORDANCE WITH ASTM F626.
3. ALL FENCING MATERIALS (BRACING, FITTINGS, ETC.) SHALL BE HOT DIPPED GALVANIZED IN ACCORDANCE WITH ASTM A392 AND ASTM F1083.
4. USE STANDARD WEIGHT SCH. 40 STEEL PIPE FOR FENCE POSTS.
5. INSTALL FENCING AND GATES IN ACCORDANCE WITH ASTM F567.

GROUNDING NOTES:

1. CONTRACTOR TO PROVIDE FENCE GROUNDING BY CONNECTING TO EXISTING GROUNDING SYSTEM (SEE ELECTRICAL SHEETS FOR GROUNDING DETAILS AND REQUIREMENTS).
2. FOR GROUNDING NOTES AND DETAIL SEE ELECTRICAL SHEETS.
3. SEE ELECTRICAL SHEETS FOR GROUNDING LOCATIONS AND SPECIFICATIONS.

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1	01-17-20	FOR RECORD	AWF	DEM				FCC06814

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AWF	---	DAVID E. MICKANEN	FCC06814
CHD	RVWD	DRAWING APPROVED BY	
DEM	---		

UNIT	DISC	TYPE	SYS	SUBSYS	NUMBER	SHEET
FC45CM	C	65	WP	AP	200485	16

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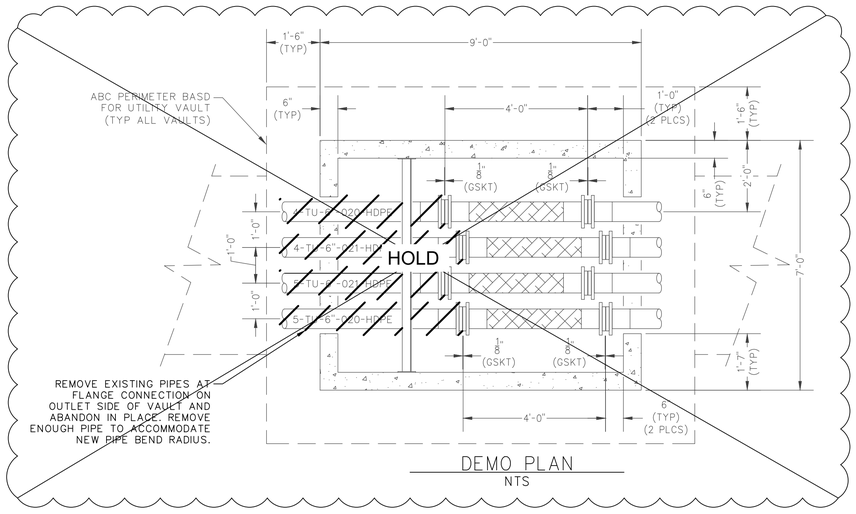
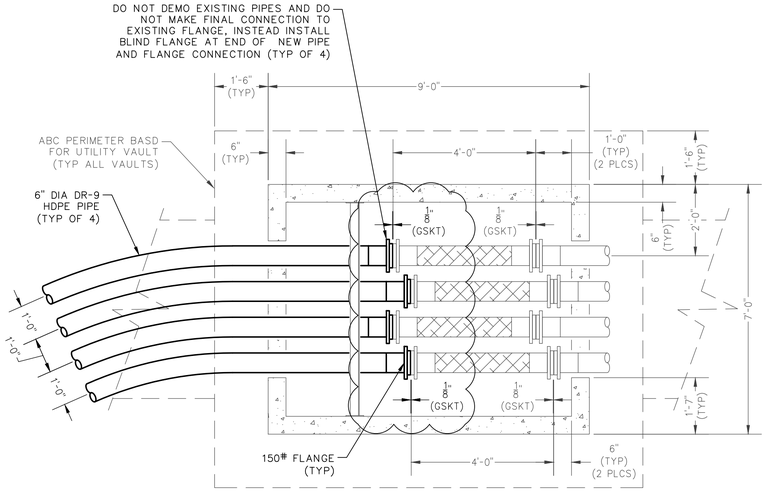


DEMO PLAN
NTS



CONSTRUCTION PLAN
NTS

DETAIL 10/10 EXISTING UTILITY VAULT
NTS

NOTES

1. AS-BUILT LINES, GRADES, AND POINTS CAN BE FOUND IN APS DRAWING NUMBER FC00CM-C-17-SF-RG-100003-101.

△2

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△1

NO.	DATE	REVISION	DWN	CHD	EXD	RVWD	APVD	W.A.
2	01-17-20	FOR RECORD	AWF	DEM				FCC06814
1	12-19-18	REVISED PIPE THICKNESS TO DR-9	AWF	DEM				FCC06814

AECOM
7720 N. 16th Street Suite 100
Phoenix, Arizona 85020
(602) 371-1100

FOUR CORNERS POWER PLANT
RETURN WATER POND

UTILITY VAULT DETAILS

aps

SCALE AS NOTED DATE 10/04/19

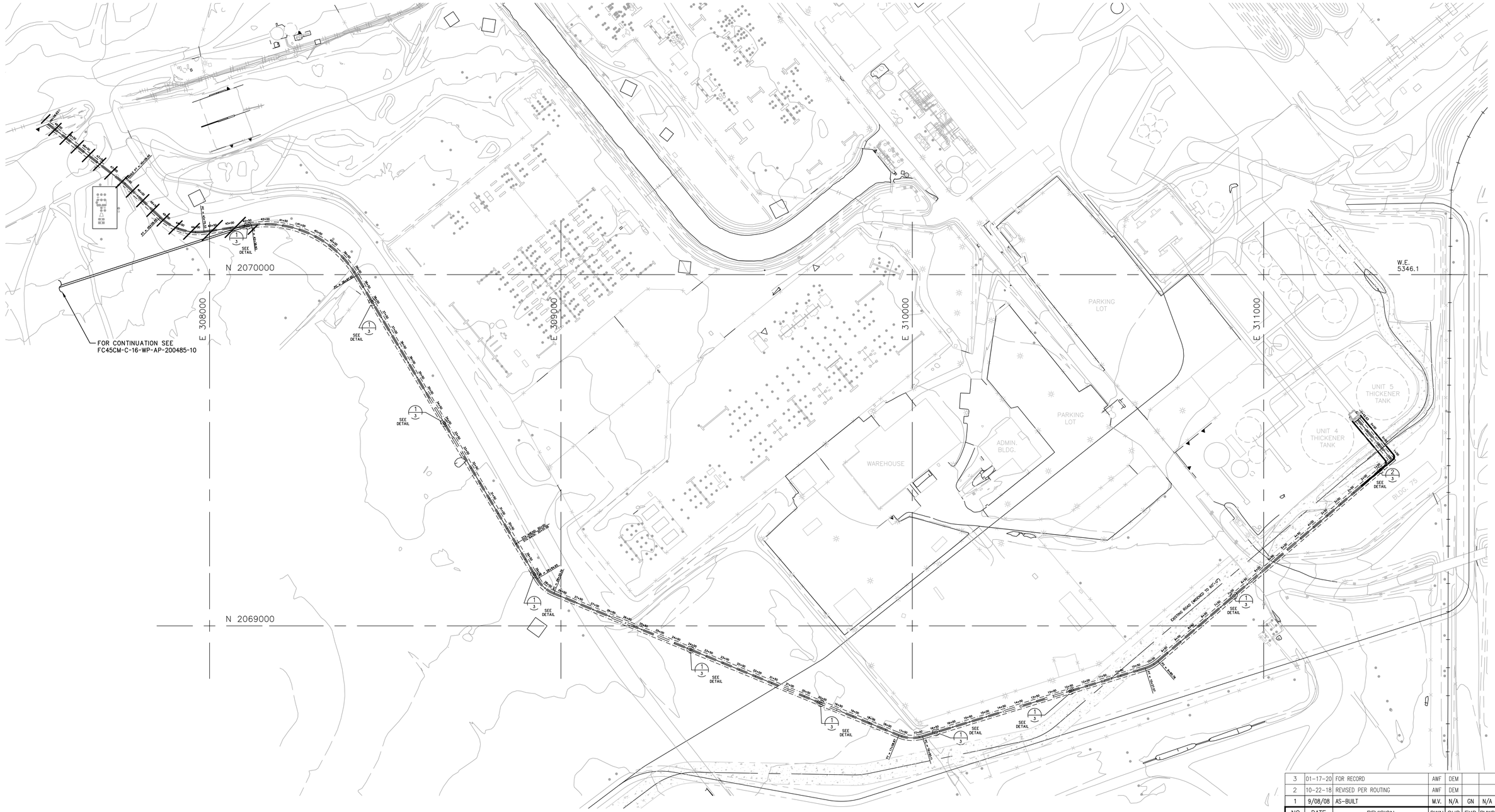
DWN	EXD	APPROVED	W A
AWF	---	DAVID E. MICKANEN	FCC06814
CHD DEM	RVWD ---	DRAWING APPROVED BY	

UNIT	DISC	TYPE	SYS	SUBSYS	NUMBER	SHEET
FC45CM	C	65	WP	AP	200485	17

WORK SAFELY TODAY

NMOC 811 Dial 8-1-1 or 1-800-321 2537

DRAWING: \\Phoenix.us.ie.urs\Phoenix\Projects\Arizona_Public_Service\60566008_FCPP_Return_Water_Pond_SG2\900_CAD_GIS\910_CAD\20-SHEETS\APS_EDCS_Drawings\2_DRAWING_REVISIONS\FC45CM-C-65-WP-AP-200485-17.dwg



NO.	DATE	REVISION	DWN	CHD	EXD	RVWD	APVD	W.A.
3	01-17-20	FOR RECORD	AWF	DEM				FCC06814
2	10-22-18	REVISED PER ROUTING	AWF	DEM				FCC06814
1	9/08/08	AS-BUILT	M.V.	N/A	GN	N/A	DDG	FBC90023

FOUR CORNERS – UNITS 4 & 5 THICKENER SYSTEM
TKR UNDERFLOW SLURRY DISPOSAL TO LINED ASH IMPOUNDMENT UNDERGROUND PIPE ROUTING / PLAN VIEW

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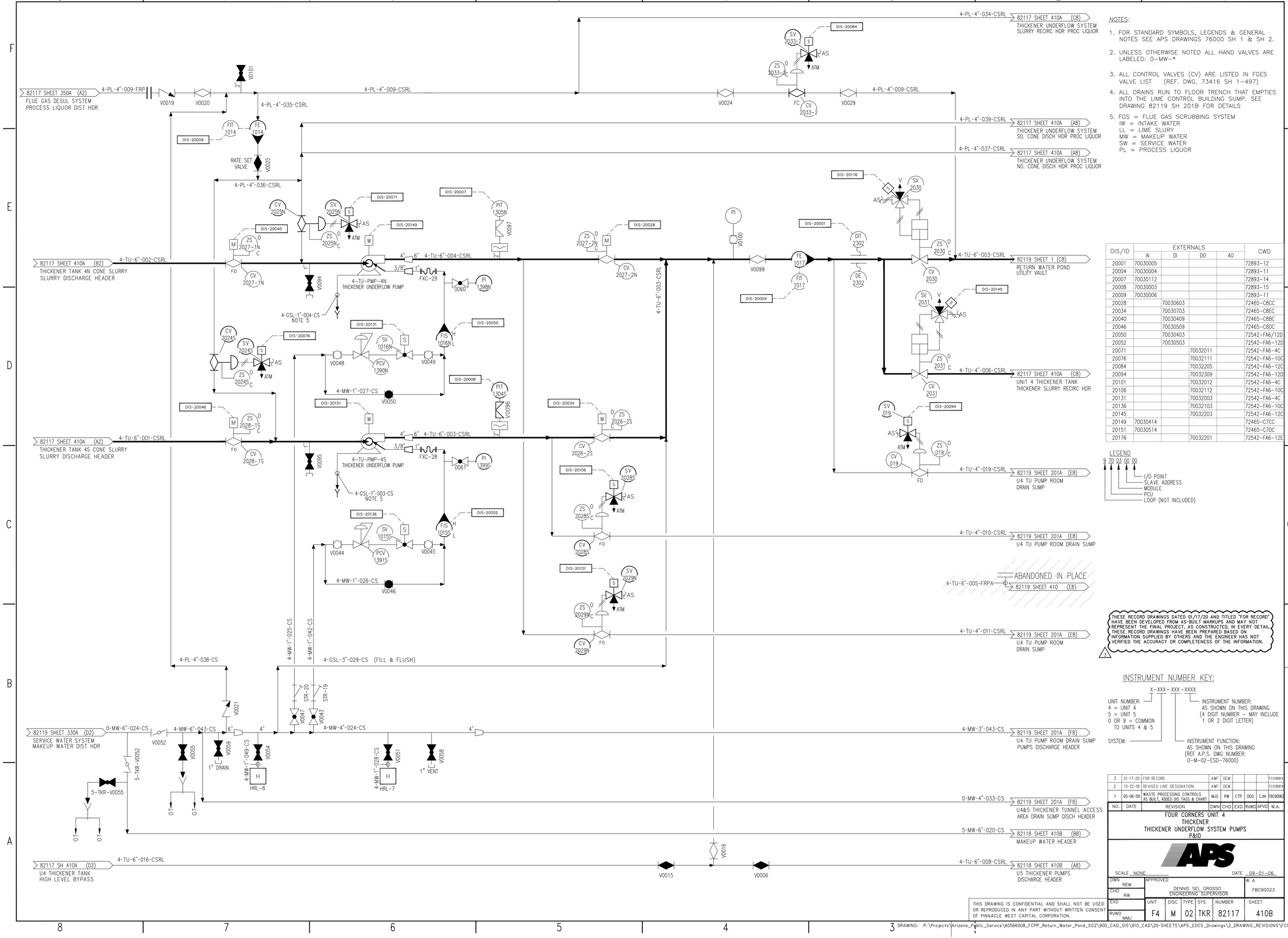
3

SCALE 1:50 DATE 2-1-06

DWN M.V.	APPROVED DENNIS DEL GROSSO ENGINEERING SUPERVISOR						W A FBC90023
CHD RW							
EXD GN	UNIT	DISC	TYPE	SYS	NUMBER		SHEET
RVWD	F45	M	05	TKR	156257		1



NOTES:

1. FOR STANDARD SYMBOLS, LEGENDS & GENERAL NOTES SEE APS DRAWINGS 76000 SH 1 & SH 2.
2. UNLESS OTHERWISE NOTED ALL HAND VALVES ARE LABELED: 0-MW-*
3. ALL CONTROL VALVES (CV) ARE LISTED IN FGES VALVE LIST (REF. DWG. 73416 SH 1-497)
4. ALL DRAINS RUN TO FLOOR TRENCH THAT EMPTIES INTO THE LIME CONTROL BUILDING SUMP. SEE DRAWING 82119 SH 201B FOR DETAILS
5. FGS = FLUE GAS SCRUBBING SYSTEM
   IW = INTAKE WATER
   LL = LIME SLURRY
   MW = MAKEUP WATER
   SW = SERVICE WATER
   PL = PROCESS LIQUOR

OIS/ID	EXTERNALS				CWD
	AI	DI	DO	AO	
20001	70030005				72893-12
20004	70030004				72893-11
20007	70030112				72893-14
20008	70030003				72893-15
20009	70030006				72893-11
20028		70030603			72465-C8CC
20034		70030703			72465-C8EC
20040		70030409			72465-C8BC
20046		70030509			72465-C8DC
20050		70030403			72542-FA6/12D
20052		70030503			72542-FA6-12D
20071			70032011		72542-FA6-4C
20076			70032111		72542-FA6-10C
20084			70032205		72542-FA6-12C
20094			70032309		72542-FA6-12D
20101			70032012		72542-FA6-4C
20106			70032112		72542-FA6-10C
20131			70032003		72542-FA6-4C
20136			70032103		72542-FA6-10C
20145			70032203		72542-FA6-12C
20149	70030414				72465-C7CC
20151	70030514				72465-C7DC
20176			70032201		72542-FA6-12E

LEGEND

9 70 03 00 00
- I/O POINT
- SLAVE ADDRESS
- MODULE
- PCU
- LOOP (NOT INCLUDED)

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3

INSTRUMENT NUMBER KEY:

X-XXX-XXX-XXXX
- UNIT NUMBER: 4 = UNIT 4; 5 = UNIT 5; 0 OR 9 = COMMON TO UNITS 4 & 5
- SYSTEM:
- INSTRUMENT FUNCTION: AS SHOWN ON THIS DRAWING (REF A.P.S. DWG NUMBER: 0-M-02-ESD-76000)
- INSTRUMENT NUMBER: AS SHOWN ON THIS DRAWING (4 DIGIT NUMBER - MAY INCLUDE 1 OR 2 DIGIT LETTER)

NO.	DATE	REVISION	DWN	CHD	EXD	RVWD	APVD	W.A.
3	01-17-20	FOR RECORD	AWF	DEM				FCC06814
2	10-22-18	REVISED LINE DESIGNATION	AWF	DEM				FCC06814
1	05-06-09	WASTE PROCESSING CONTROLS AS BUILT, ADDED OIS TAGS & CHART	MJG	RW	CTP	DDG	CJN	FBC90062

FOUR CORNERS UNIT 4
THICKENER
THICKENER UNDERFLOW SYSTEM PUMPS
P&ID

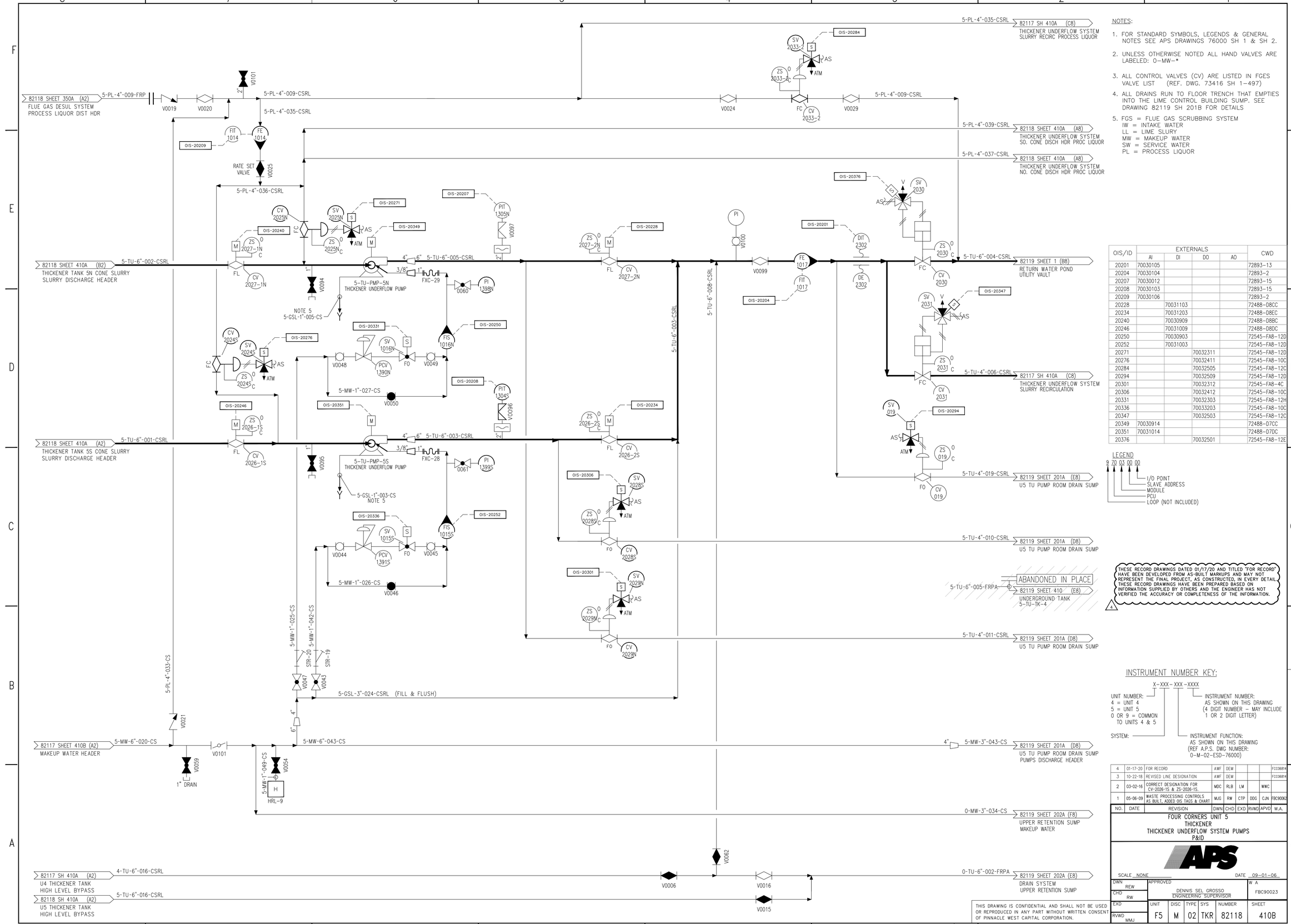
APS

SCALE NONE DATE 09-01-06

DWN	APPROVED	W A
REW	DENNIS SEL GROSSO ENGINEERING SUPERVISOR	FBC90023
CHD RW		
EXD		
RVWD MMJ		

UNIT	DISC	TYPE	SYS	NUMBER	SHEET
F4	M	02	TKR	82117	410B

DRAWING: P:\Projects\Arizona_Public_Service\60566008_FCPP_Return_Water_Pond_SG2\900_CAD_GIS\910_CAD\20-SHEETS\APS_EDCS_Drawings\2_DRAWING_REVISIONS\FC04UN-M-02-E



NOTES:

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   SW = SERVICE WATER
   PL = PROCESS LIQUOR

OIS/ID	EXTERNALS AI	DI	DO	AO	CWD
20201	70030105				72893-13
20204	70030104				72893-2
20207	70030012				72893-15
20208	70030103				72893-15
20209	70030106				72893-2
20228		70031103			72488-D8CC
20234		70031203			72488-D8EC
20240		70030909			72488-D8BC
20246		70031009			72488-D8DC
20250		70030903			72545-FA8-12D
20252		70031003			72545-FA8-12D
20271			70032311		72545-FA8-12D
20276			70032411		72545-FA8-10C
20284			70032505		72545-FA8-12C
20294			70032509		72545-FA8-12D
20301			70032312		72545-FA8-4C
20306			70032412		72545-FA8-10C
20331			70032303		72545-FA8-12H
20336			70033203		72545-FA8-10C
20347			70032503		72545-FA8-12C
20349	70030914				72488-D7CC
20351	70031014				72488-D7DC
20376			70032501		72545-FA8-12E

LEGEND

9 70 03 00 00
- I/O POINT
- SLAVE ADDRESS
- MODULE
- PCU
- LOOP (NOT INCLUDED)

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X-XXX-XXX-XXXX
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NO.	DATE	REVISION	DWN	CHD	EXD	RVWD	APVD	W.A.
4	01-17-20	FOR RECORD	AWF	DEM				FCC06814
3	10-22-18	REVISED LINE DESIGNATION	AWF	DEM				FCC06814
2	03-02-16	CORRECT DESIGNATION FOR CV-2026-1S & ZS-2026-1S.	MDC	RLB	LM		WWC	
1	05-06-09	WASTE PROCESSING CONTROLS AS BUILT, ADDED OIS TAGS & CHART	MJG	RW	CTP	DDG	CJN	FBC90062

FOUR CORNERS UNIT 5
THICKENER
THICKENER UNDERFLOW SYSTEM PUMPS
P&ID

SCALE NONE DATE 09-01-06

DWN	APPROVED	W A
REW	DENNIS SEL GROSSO ENGINEERING SUPERVISOR	FBC90023
CHD RW		
EXD		
RVWD MMJ		

UNIT	DISC	TYPE	SYS	NUMBER	SHEET
F5	M	02	TKR	82118	410B

DRAWING: P:\Projects\Arizona_Public_Service\60566008_FCPP_Return_Water_Pond_SG2\900_CAD_GIS\910_CAD\20-SHEETS\APS_EDCS_Drawings\2_DRAWING_REVISIONS\F(

G-82114 SH 9C (E3)
COMBINED WASTE TREATMENT POND
LOW VOL. DREDGE OUTFALL
10"-HDPE

G-82115 SH 1E (E1)
BRINE CONC. THICKENER FEED TANK
8"-HDPE

82115 SH 1E (C1)
BRINE CONC. TKNR FEED TANK
6"-HDPE

FLEX HOSE

NEW CONCRETE TRENCH (ALPINE SLIDE)

EXISTING CONCRETE TRENCH (ALPINE SLIDE)

LINED ASH IMPOUNDMENT

EXISTING CONCRETE TRENCH (ALPINE SLIDE)

FLOW

24-O-440-2

24-O-440-3

24-O-440-1

24-O-440-4

OVERFLOW

OPEN TRENCH

BASIN #3

10"-HDPE

24"-HDPE
(OVERFLOW)

ABANDON IN PLACE

UG

RETURN
WATER
POND

BASIN #4

10"-HDPE

CSRL
(TYP.)

FLEX HOSE
(TYP.)

HDPE
(TYP.)

UTILITY VAULT

4-TU-6"-020-HDPE

82117 SH 410B (D2)
UNIT 4 THICKENER
4-TU-6"-003-CSRL

4-TU-6"-021-HDPE

5-TU-6"-020-HDPE

82118 SH 410B (D2)
UNIT 5 THICKENER
5-TU-6"-004-CSRL

5-TU-6"-021-HDPE

4-TU-4"-022-HDPE

4-TU-4"-023-HDPE

5-TU-4"-022-HDPE

5-TU-4"-023-HDPE

BASIN #1

ABANDONED IN PLACE

14"ø LEVEL
EQUALIZATION
LINE

BARGE BAY

BARGE

FOR BARGE PIPING
SEE G-82116 SH 1A

8"-HDPE

G-82116 SH 1A
TO BRINE CONCENTRATE

ABANDONED IN PLACE

CV 2040 C

CV 2041 C

ZS 2040 C

ZS 2041 C

VIEW PORT
4"-150#
BLIND FLANGE

O-TU-8"-024-HDPE

82119 SH 202A ( )
UPPER RETENTION SUMP

THICKENER WITHDRAW 4A DRAIN 9190/70R CONTROL WIRING DIAGRAM 72465 SHEET C7GC	OIS12146, OIS12147, OIS12067, OIS12068
THICKENER WITHDRAW 4B DRAIN 9190/70R CONTROL WIRING DIAGRAM 72465 SHEET C7HC	OIS12151, OIS12152, OIS12069, OIS12070
THICKENER WITHDRAW 5A DRAIN 9190/70R CONTROL WIRING DIAGRAM 72488 SH D7HC	OIS12267, OIS12268, OIS12346, OIS12347
THICKENER WITHDRAW 5B DRAIN 9190/70R CONTROL WIRING DIAGRAM 72488 SH D7GC	OIS12269, OIS12270, OIS12351, OIS12352

82114 SH 10F (C2)
ASH POND INTERCEPT SUMP #6
8"-CS

NOTES:

1. FOR STANDARD SYMBOLS, REFERENCE DRAWINGS, LEGEND AND GERERAL NOTES SEE APS DRAWING No. 76000.
2. THIS PORTION WAS REMOVED FROM 82114 SH 10F AND REVISED.

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NO.	DATE	REVISION	DWN	CHD	EXD	RVWD	APVD	W.A.
2	01-17-20	FOR RECORD	AWF	DEM				FCC06814
1	10-22-18	REVISED PIPE ROUTING	AWF	DEM				FCC06814

FOUR CORNERS - UNITS 4 & 5
THICKENER SYSTEM
THICKENER UNDERFLOW TO LINED ASH IMPOUNDMENT
P&ID

APS

SCALE NONE DATE 5/22/06

DWN M.V./REW	APPROVED DENNIS DEL GROSSO ENGINEERING SUPERVISOR	W A FBC90023
CHD		
EXD GN	UNIT F45 / DISC M / TYPE 02 / SYS TKR / NUMBER 82119	SHEET 1
RVWD MMJ		

DRAWING: P:\Projects\Arizona_Public_Service\60566008_FCPP_Return_Water_Pond_SG2\900_CAD_GIS\910_CAD\20-SHEETS\APS_EDCS_Drawings\2_DRAWING_REVISIONS\FC45CM-M-02-BP-AP-82119-1.dwg

STRUCTURAL NOTES

GENERAL:

G1. SCOPE
THE NOTES ON THIS SHEET AND STRUCTURAL DETAILS ARE TYPICAL AND APPLY TO THE ENTIRE PROJECT WHETHER SPECIFICALLY CALLED OUT OR NOT, EXCEPT WHERE THERE ARE SPECIFIC INDICATIONS TO THE CONTRARY ON STRUCTURAL SHEETS. IF THERE ARE QUESTIONS, THEY SHALL BE SUBMITTED TO THE STRUCTURAL ENGINEER AND ANSWERED IN WRITING PRIOR TO CONSTRUCTION.

G2. APPLICABLE SPECIFICATIONS AND CODES
A. INTERNATIONAL BUILDING CODE (IBC) 2015
B. ACI 318-14
C. ACI 350-06
D. ASCE 7-10
E. AISC STEEL CONSTRUCTION MANUAL, 14TH EDITION

G3. DESIGN CRITERIA, APPLIES TO ALL STRUCTURES (UNO)
A. OCCUPANCY CATEGORY: III
B. DEAD LOAD:
MATERIAL WEIGHT
C. LIVE LOAD:
PUMP STATION: 40 PSF

G4. SAFETY
A. SAFETY AND STRUCTURE STABILITY DURING CONSTRUCTION ARE THE SOLE RESPONSIBILITY OF THE CONTRACTOR. STRUCTURES HAVE BEEN DESIGNED TO RESIST THE DESIGN LIVE LOADS ONLY AS A COMPLETED STRUCTURE. PROVIDE TEMPORARY BRACING AND SHORING AS REQUIRED FOR STABILITY DURING CONSTRUCTION.
B. SHORING AND RESHORING OF ELEVATED STRUCTURAL SLABS SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR. CONTRACTOR SHALL SUBMIT DOCUMENTS SHOWING METHOD OF SHORING TO THE ENGINEER FOR INFORMATION ONLY.

G5. OPENINGS
A. OPENINGS FOR PIPES, DUCTS, CONDUITS, ETC. ARE NOT ALL SHOWN ON THE STRUCTURAL DRAWINGS. COORDINATE AND PROVIDE OPENINGS AS REQUIRED TO ACCOMMODATE ALL WORK SHOWN OR SPECIFIED IN THE CONTRACT DOCUMENTS AND OTHERWISE REQUIRED FOR THE FURNISHING OF A FUNCTIONALLY COMPLETE PROJECT. REINFORCE AROUND OPENINGS PER STANDARD STRUCTURAL DETAILS UNLESS OTHERWISE SHOWN.
B. COORDINATE FINAL SIZE AND LOCATION OF ALL OPENINGS WITH THE ACTUAL EQUIPMENT SUPPLIED, PROJECT REQUIREMENTS, AND WITH FIELD CONDITIONS.
C. THE ENGINEER OF RECORD PERMITS NO OPENINGS OR ALTERATIONS THROUGH BEAMS OR COLUMNS UNLESS DETAILED ON THE STRUCTURAL DRAWINGS OR APPROVED IN WRITING.

G6. STANDARD DETAILS
THE STANDARD DETAILS DEPICT TYPICAL DETAILING TO BE USED ON THIS PROJECT. IF CONDITIONS ARE NOT EXPLICITLY SHOWN ON THE DRAWINGS THEY SHALL BE MADE SIMILAR TO THE STANDARD DETAILS. OBTAIN APPROVAL OF ENGINEER IN WRITING FOR SIMILAR CONDITIONS PRIOR TO CONSTRUCTION.

G7. THE CONTRACTOR SHALL FIELD VERIFY ALL EXISTING CONDITIONS, DIMENSIONS, AND ELEVATIONS PRIOR TO START OF CONSTRUCTION AS REQUIRED TO COORDINATE NEW CONSTRUCTION. NOTIFY ENGINEER OF ANY DISCREPANCIES OR CONFLICTS FOUND IN CONTRACT DOCUMENTS AND/OR FIELD CONDITIONS.

G9. SEE CIVIL DRAWINGS FOR ALL EXTERIOR PAVING AND FLATWORK.

G10. ALL WATERSTOPS SHALL BE 6 IN PVC, UNLESS NOTED OTHERWISE, SEE SPECIFICATIONS FOR ADDITIONAL INFORMATION. THE CONTRACTOR SHALL BE RESPONSIBLE TO MAKE ALL WATERSTOPS CONTINUOUS AND ALL JOINTS LEAK-FREE, AS REQUIRED.

G11. CONTRACTOR SHALL BE RESPONSIBLE FOR REPAIRING ANY LEAKS IN WATER BEARING STRUCTURES UTILIZING EPOXY INJECTION MATERIALS.

G12. SHOP DRAWINGS SHALL BE FURNISHED FOR REVIEW BEFORE ANY FABRICATION AND ERECTION. POORLY EXECUTED SHOP DRAWINGS SHALL BE REJECTED AND RESUBMITTED.

CONCRETE:

C1. CAST-IN-PLACE CONCRETE
A. CLASS A CONCRETE, TYPE II PORTLAND CEMENT, ASTM C150 W/ 20% FLY ASH CLASS F CONFORMING TO ASTM C618
B. F'c = 4,500 PSI @ 28 DAYS
C. MAXIMUM WATER CEMENT RATIO = 0.45
D. EXPOSURE CLASS: F2/S2, AIR ENTRAINED
E. MAX SLUMP: 4"

C2. ALL REINFORCING STEEL SHALL CONFORM TO ASTM A615, GRADE 60 (Fy = 60 KSI).

C3. COARSE AGGREGATE SHALL BE WELL GRADED CRUSHED STONE, NATURAL ROCK CONFORMING TO REQUIREMENT OF ASTM C33, AND SHALL CONTAIN LESS THAN PERCENT ASBESTOS BY WEIGHT OR VOLUME.

C4. ALL SPLICES SHALL BE CLASS B, TENSION LAPS UNLESS NOTED ON PLAN.

C5. REINFORCING BARS SHALL HAVE MATCHING CORNER BARS.

C6. DOWEL CONCRETE WALLS AND PIERS INTO FOOTINGS AND BASE SLABS WITH DOWELS THE SAME SIZE AND SPACING AS VERTICAL REINFORCEMENT. EXTEND DOWELS TO WITHIN 3"OF BOTTOM OF FOOTING, TERMINATED WITH ACI STD. 90 DEGREE HOOK, UNLESS OTHERWISE NOTED.

C7. CONCRETE COVER: UNLESS OTHERWISE NOTED, PROVIDE CONCRETE COVER FOR REINFORCING ACCORDING TO DETAIL.

C8. PLACEMENT OF CONCRETE SHALL BE IN CONFORMANCE WITH ACI 117-10 "SPECIFICATION FOR TOLERANCES FOR CONCRETE CONSTRUCTION AND MATERIALS AND COMMENTARY."

C9. ALL CONCRETE WORK SHALL BE IN ACCORDANCE WITH THE LATEST EDITIONS OF THE AMERICAN CONCRETE INSTITUTE STANDARDS. "BUILDING CODE REQUIREMENTS FOR STRUCTURAL CONCRETE"(ACI 318), "SPECIFICATIONS FOR STRUCTURAL CONCRETE FOR BUILDINGS"(ACI 301), AND "CODE REQUIREMENTS FOR ENVIRONMENTAL ENGINEERING CONCRETE STRUCTURES AND COMMENTARY"(ACI 350).

C10. REFER TO OTHER DISCIPLINE DRAWINGS PRIOR TO CONSTRUCTION FOR EMBEDDED ITEMS AND PENETRATIONS NOT SHOWN ON STRUCTURAL DRAWINGS AS REQUIRED TO ACCOMMODATE ALL WORK SHOWN OR SPECIFIED IN THE CONTRACT DOCUMENTS AND OTHERWISE REQUIRED FOR THE FURNISHING OF A FUNCTIONALLY COMPLETE PROJECT. REINFORCE AROUND OPENINGS PER STANDARD STRUCTURAL DETAILS UNLESS OTHERWISE SHOWN.

C11. CONDUITS AND PIPES MAY NOT BE EMBEDDED WITHIN A SLAB, WALL, OR BEAM WITHOUT PRIOR APPROVAL OF ENGINEER.

C12. UNLESS NOTED OTHERWISE PROVIDE 3/4"X3/4"CHAMFERS AT ALL EXPOSED EDGES. NOT ALL CHAMFERS MAY BE SHOWN ON DRAWINGS.

C13. ANCHOR BOLTS NOT SPECIFIED BY ENGINEER SHALL BE DESIGNED AND CERTIFIED BY A REGISTERED PROFESSIONAL ENGINEER, RETAINED BY THE CONTRACTOR, IN ACCORDANCE WITH APPLICABLE PROJECT AND CODE REQUIREMENTS. SUBMIT AS A SHOP DRAWING FOR REVIEW BY THE ENGINEER. COORDINATE LOCATION, SIZE AND EMBEDMENT PRIOR TO CASTING CONCRETE.

C14. ABSOLUTELY NO WELDING OF REINFORCING BARS OR TORCHING TO BEND REINFORCING BARS SHALL BE ALLOWED WITHOUT SPECIFIC APPROVAL FROM THE STRUCTURAL ENGINEER.

C15. POST-INSTALLED DRILL AND EPOXY ANCHORS INTO CONCRETE SHALL BE HILTI HIT-HY 200 ADHESIVE ANCHORING SYSTEM, OR APPROVED EQUAL, WITH MINIMUM 3/4"DIAMETER, A36 ANCHOR WITH MINIMUM OF 6"EMBEDMENT UNLESS OTHERWISE SHOWN.

C16. PRIOR TO INSTALLING POST-INSTALLED ANCHORS INTO CONCRETE, THE CONTRACTOR SHALL LOCATE REINFORCING. DO NOT DAMAGE CONCRETE REINFORCING.

C17. COMPLY WITH CURING PROCEDURE SET FORTH IN ACI 301, ACI 308.

STEEL:

S1. MATERIALS SHALL CONFORM TO THE STANDARDS LISTED:
A. WIDE FLANGE SECTIONS: ASTM A992 OR ASTM A572, GRADE 50 (Fy=50 KSI)
B. STRUCTURAL BOLTS: ASTM A325
C. NON-STRUCTURAL BOLTS: ASTM A307
D. HSS: ASTM A500 GRADE B
E. ALL STEEL MEMBERS AND BOLTS SHALL BE HOT DIP GALVANIZED.

S2. DIMENSIONS: TO CENTERLINES OF COLUMNS AND BEAMS, TOP SURFACES OF BEAMS AND TUBES AND BACKS OF CHANNELS AND ANGLES UNO.

S3. BOLTED CONNECTIONS UNLESS NOTED OTHERWISE:
A. STRUCTURAL: 3/4"DIAMETER MIN., TYPE N, FULL DEPTH CONNECTION, (2) BOLTS MINIMUM
B. ANCHOR RODS: 3/4"DIAMETER MIN., (4) BOLTS MINIMUM, MINIMUM 12"EMBED INTO CONCRETE, PROJECTION ABOVE CONCRETE, AS REQUIRED.
C. NON-STRUCTURAL: 5/8"DIAMETER MIN.

S4. ALL BOLTED STRUCTURAL CONNECTIONS ARE BEARING TYPE CONNECTIONS UNLESS OTHERWISE SPECIFIED TO BE SLIP-CRITICAL. PROVIDE LOAD INDICATING WASHERS AT SLIP-CRITICAL CONNECTIONS.

S5. ALL WELDING SHALL BE DONE BY CERTIFIED WELDERS AND SHALL BE DONE IN ACCORDANCE WITH THE LATEST STANDARDS OF THE AWS AND AISC. INSPECT ALL WELDING IN ACCORDANCE WITH THE SPECIAL INSPECTIONS AND SPECIFICATIONS.

S6. WHEN FILLET WELD SIZE IS NOT INDICATED, PROVIDE MAXIMUM WELD SIZE BASED ON CONNECTED MATERIAL THICKNESSES IN ACCORDANCE WITH AISC SPECIFICATIONS.

S7. ALL STRUCTURAL STEEL FABRICATION AND ERECTION SHALL CONFORM TO AISC 360, STEEL CONSTRUCTION MANUAL AND AISC 341, SEISMIC DESIGN MANUAL.

S8. PLACE NATURAL CAMBER OF BEAMS UPWARD.

S9. DO NOT FIELD CUT OR ALTER STRUCTURAL MEMBERS WITHOUT ENGINEER'S APPROVAL.

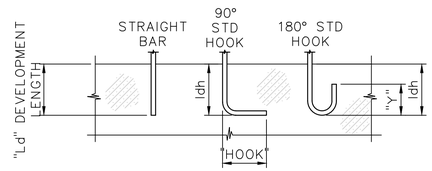
S10. FIELD REPAIR OF DAMAGED GALVANIZED COATING BY SHERWIN WILLIAMS PRO-CRYL UNIVERSAL PRIMER, B66-310 SERIES AND SHERWIN WILLIAMS PRO INDUSTRIAL O VOC SEMI-GLOSS, B66W650 SERIES OR EQUAL.

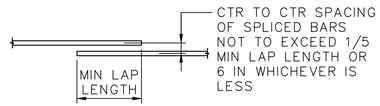
SPECIAL INSPECTIONS:

SP1. SPECIAL INSPECTIONS SHALL BE PROVIDED TO MEET THE REQUIREMENTS OF IBC CHAPTER 17 IN THE FOLLOWING CATEGORIES:
-SUBGRADE PREPARATION
-WELDING
-ANCHOR BOLTS
-HIGH STRENGTH BOLTING

BAR SIZE	DIAMETER (d_b) (INCHES)	DEVELOPMENT LENGTH (l_d) (INCHES)		CLASS B LAP SPLICE (INCHES)		90° STD HOOK (INCHES)		180° STD HOOK "Y"
		"TOP" BARS	OTHER	"TOP" BARS	OTHER	HOOK	l_{dh}	
		REINFORCING BARS IN TENSION						
#3	0.375	18	14	24	18	6	7	6
#4	0.5	25	19	32	25	8	10	6
#5	0.625	31	24	40	31	10	12	6
#6	0.75	37	28	48	37	12	14	6
#7	0.875	54	42	70	54	14	17	7
#8	1.0	62	47	80	62	16	19	8
#9	1.125	70	54	90	70	19	21	11
#10	1.25	78	60	102	78	22	24	12
#11	1.375	87	67	113	87	24	27	13
#14	1.75	104	80	136	104	30	32	14
		REINFORCING BARS IN COMPRESSION						
#3	0.375	8		12				
#4	0.5	9		15				
#5	0.625	12		19				
#6	0.75	14		23				
#7	0.875	17		26				
#8	1.0	19		30				
#9	1.125	21		34				
#10	1.25	24		38				
#11	1.375	27		42				
#14	1.75	32		51				

HOOKED BARS SHALL NOT BE USED IN COMPRESSION





NOTES:

1. "TOP" BARS SHALL BE HORIZONTAL REINFORCEMENT PLACED SO THAT MORE THAN 12" OF FRESH CONCRETE IS CAST IN THE MEMBER BELOW THE DEVELOPMENT LENGTH OR SPLICE.
2. CLEAR SPACING OF BARS BEING DEVELOPED OR SPLICED SHALL
A. NOT BE LESS THAN d_b, HAVE CLEAR COVER NOT LESS THAN d_b, AND STIRRUPS OR TIES THROUGHOUT L_d NOT LESS THAN THE CODE MINIMUM OR;
B. CLEAR SPACING OF BARS BEING DEVELOPED OR SPLICED NOT LESS THAN $2d_b$ AND CLEAR COVER NOT LESS THAN d_b. WHERE d_b =DIAMETER OF REINFORCING BAR AND L_d = DEVELOPMENT LENGTH.
3. ALL LAP SPLICES SHALL BE CLASS B UNLESS NOTED OTHERWISE.
4. WHEN SPLICING BAR OF DIFFERENT SIZE, THE LENGTH OF LAP SHALL BE GOVERNED BY THE LARGER DIAMETER BAR.
5. SPLICES ARE TO BE MADE SO THAT THE GIVEN DISTANCES TO FACE OF CONCRETE WILL BE MAINTAINED.
6. SPLICES SHALL BE STAGGERED TO GIVE 12 INCHES CLEAR BETWEEN ENDS OF ADJACENT SPLICES, IF BARS ARE SPACED CLOSER THAN 6 INCHES OR 6 BAR DIAMETERS.

STANDARD HOOK & REINF LAP SPLICE
SCALE: NTS

CONSTRUCTION NOTES:

1. THE CONTRACTOR SHALL FIELD VERIFY ALL EXISTING CONDITIONS, DIMENSIONS, AND ELEVATIONS PRIOR TO START OF CONSTRUCTION AS REQUIRED TO COORDINATE NEW CONSTRUCTION. NOTIFY ENGINEER OF ANY DISCREPANCIES OR CONFLICTS FOUND IN CONTRACT DOCUMENTS AND/OR FIELD CONDITIONS.

THESE RECORD DRAWINGS DATED 01/17/20 AND TITLED "FOR RECORD" HAVE BEEN DEVELOPED FROM AS-BUILT MARKUPS AND MAY NOT REPRESENT THE FINAL PROJECT, AS CONSTRUCTED, IN EVERY DETAIL. THESE RECORD DRAWINGS HAVE BEEN PREPARED BASED ON INFORMATION SUPPLIED BY OTHERS AND THE ENGINEER HAS NOT VERIFIED THE ACCURACY OR COMPLETENESS OF THE INFORMATION.
1

NO.	DATE	REVISION	DWN	CHD	EXD	RVWD	APVD	W.A.
1	01-17-20	FOR RECORD	AWF	DEM				FCC06814

AECOM
7720 N. 16th Street Suite 100
Phoenix, Arizona 85020
(602) 371-1100

WORK SAFELY TODAY

FOUR CORNERS POWER PLANT
RETURN WATER POND

STRUCTURAL GENERAL NOTES

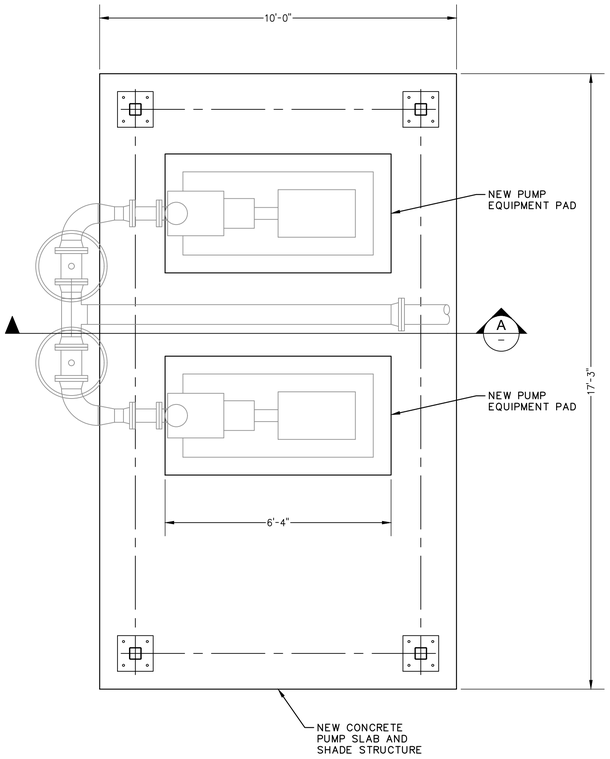
aps

SCALE AS NOTED DATE 10/04/19

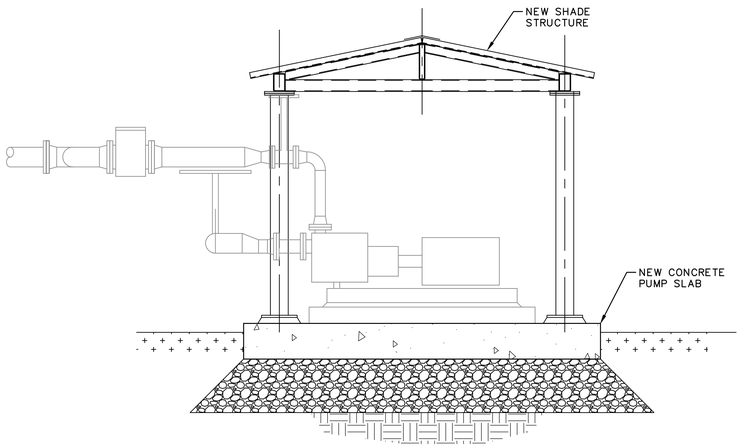
DWN	EXD	APPROVED	W A
CM	---	ROBERT E. HAWTHORNE	FCC06814
CHD	RVWD	DRAWING APPROVED BY	
HM	---		

UNIT	DISC	TYPE	SYS	SUBSYS	NUMBER	SHEET
FC45CM	S	98	WP	AP	200485	24

DRAWING: P:\Projects\Arizona_Public_Service\60566008_FCPP_Return_Water_Pond_SG2\900_CAD_GIS\910_CAD\20-SHEETS\APS_EDCS_Drawings\2_DRAWING_REVISIONS\FC45CM-S-98-WP-AP-200485-24.dwg



PLAN VIEW
RETURN WATER PUMP SLAB
SCALE: 1/2"=1'-0" (FULL SIZE)



SECTION A- SHADE STRUCTURE
1/2"=1'-0"

GRAPHIC SCALE
2 0 2 4
(IN FEET)
1 inch = 2 ft.

CONSTRUCTION NOTES:

1. THE CONTRACTOR SHALL FIELD VERIFY ALL EXISTING CONDITIONS, DIMENSIONS, AND ELEVATIONS PRIOR TO START OF CONSTRUCTION AS REQUIRED TO COORDINATE NEW CONSTRUCTION. NOTIFY ENGINEER OF ANY DISCREPANCIES OR CONFLICTS FOUND IN CONTRACT DOCUMENTS AND/OR FIELD CONDITIONS.

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1

NO.	DATE	REVISION	DWN	CHD	EXD	RVWD	APVD	W.A.
1	01-17-20	FOR RECORD	AWF	DEM				FCC06814

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Phoenix, Arizona 85020
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FOUR CORNERS POWER PLANT
RETURN WATER POND

STRUCTURAL PLAN AND SECTION

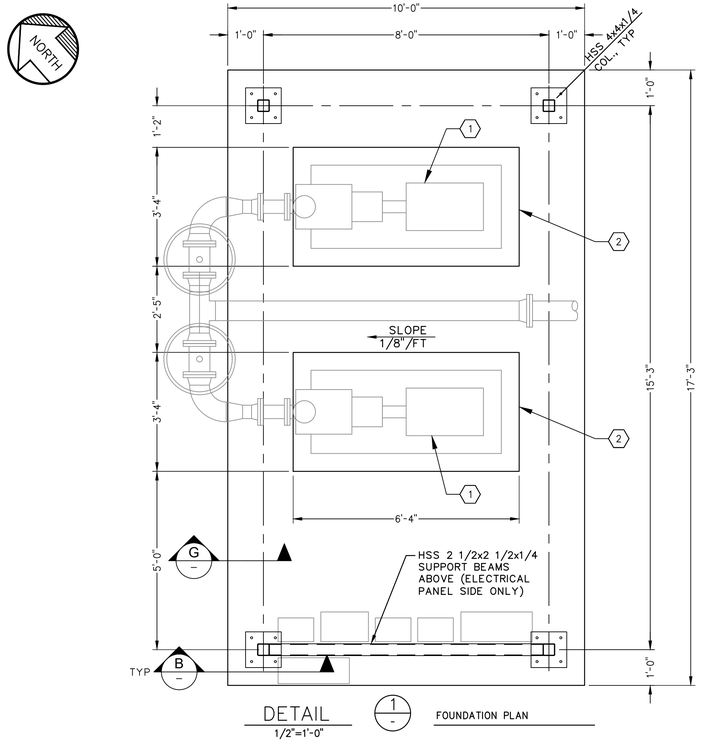
aps

SCALE 1"=2' DATE 10/04/19

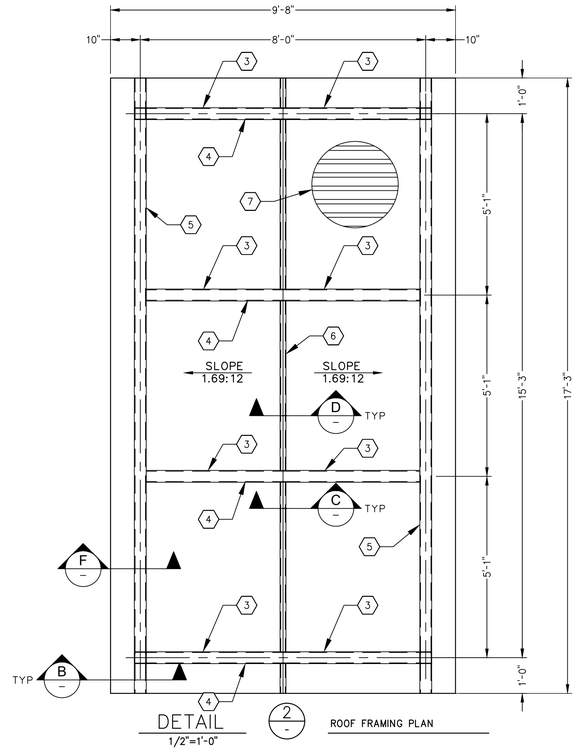
DWN	EXD	APPROVED	W A
CM	---	ROBERT E. HAWTHORNE	FCC06814
CHD	RVWD	DRAWING APPROVED BY	
HM	---		

UNIT	DISC	TYPE	SYS	SUBSYS	NUMBER	SHEET
FC45CM	S	47	WP	AP	200485	25

DRAWING: P:\Projects\Arizona_Public_Service\60566008_FCPP_Return_Water_Pond_SG2\900_CAD_GIS\910_CAD\20-SHEETS\APS_EDCS_Drawings\2_DRAWING_REVISIONS\FC45CM-S-47-WP-AP-200485-25.dwg



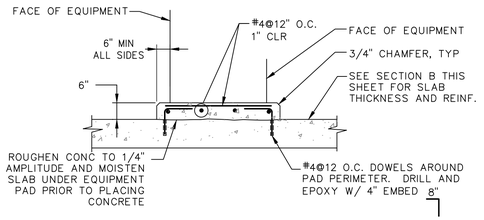
DETAIL 1/2"=1'-0" (1) FOUNDATION PLAN



DETAIL 1/2"=1'-0" (2) ROOF FRAMING PLAN

NOTES:

1. THE MINIMUM PAD SIZE SHALL BE AS INDICATED OR AS DETERMINED BY THE EQUIPMENT MANUFACTURER.
2. THE SIZE, NUMBER, TYPE, LOCATION AND THE THREAD PROJECTION OF THE ANCHOR BOLTS SHALL BE DETERMINED BY THE EQUIPMENT MANUFACTURER. HOLD CONCRETE ANCHOR BOLTS IN POSITION WITH A TEMPLATE WHILE PAD IS BEING PLACED.
3. USE PIPE SLEEVES TO PROVIDE THE ANCHOR BOLT A MINIMUM MOVEMENT OF 1/2" IN ALL DIRECTIONS. THE MINIMUM SLEEVE LENGTH SHALL BE 8 TIMES THE BOLT DIAMETER. SLEEVES SHALL BE FILLED WITH NON-SHRINK GROUT AFTER EQUIPMENT IS INSTALLED.
4. PIPE SLEEVES SHALL HAVE A MINIMUM INTERNAL DIAMETER 1" GREATER AND A MAXIMUM INTERNAL DIAMETER 3" GREATER THAN THE ANCHOR BOLT DIAMETER.
5. EQUIPMENT BASES SHALL BE INSTALLED LEVEL UNLESS NOTED OTHERWISE ON THE PLANS.
6. PROVIDE WEDGES OR SHIMS TO SUPPORT THE BASE WHILE THE NON-SHRINK GROUT IS PLACED. TEMPORARY LEVELING NUTS SHALL BE BACKED OFF. THE WEDGES OR SHIMS THAT REMAIN IN PLACE SHALL NOT BE EXPOSED TO VIEW.
7. SEE MECH, PROCESS AND ELEC DRAWINGS FOR EQUIP PAD LOCATIONS, SIZES AND THICKNESSES.



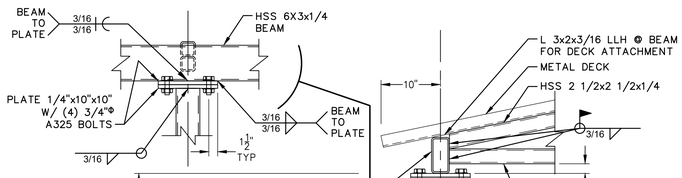
DETAIL NTS (3) EQUIPMENT PAD

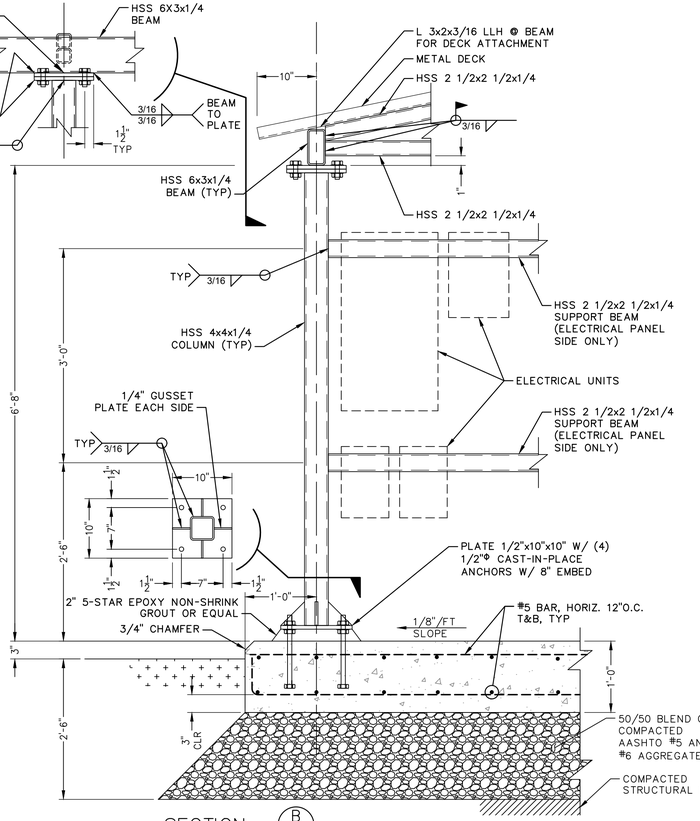
CONSTRUCTION NOTES:

1. THE CONTRACTOR SHALL FIELD VERIFY ALL EXISTING CONDITIONS, DIMENSIONS, AND ELEVATIONS PRIOR TO START OF CONSTRUCTION AS REQUIRED TO COORDINATE NEW CONSTRUCTION. NOTIFY ENGINEER OF ANY DISCREPANCIES OR CONFLICTS FOUND IN CONTRACT DOCUMENTS AND/OR FIELD CONDITIONS.

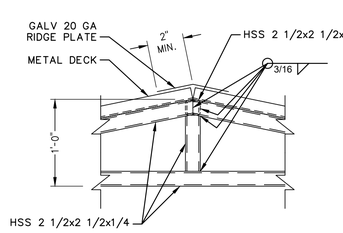
KEY NOTES:

(1) NEW RETURN WATER POND PUMPS, SEE MECHANICAL FOR ADDITIONAL INFORMATION.
(2) 76"x40"x6" THICK EQUIPMENT PAD, SEE DETAIL 3 THIS SHEET.
(3) ROOF FRAMING MEMBER HSS 2 1/2 x 2 1/2 x 1/4 ABOVE.
(4) ROOF FRAMING MEMBER HSS 2 1/2 x 2 1/2 x 1/4 BELOW.
(5) ROOF FRAMING MEMBER HSS 6 x 3 x 1/4.
(6) RIDGE BEAM HSS 2 1/2 x 2 1/2 x 1/4.
(7) VULCRAFT TYPE 1.5A 20 GA GALV. METAL DECK. FASTEN WITH #12 SCREWS W/ NEOPRENE WASHERS @ 36/4 PATTERN AT SUPPORTS AND #12 SCREWS @ 12"O.C. SIDE LAPS.

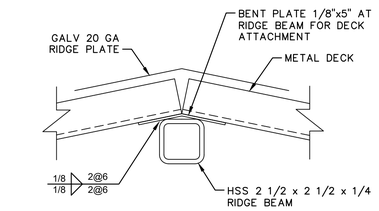




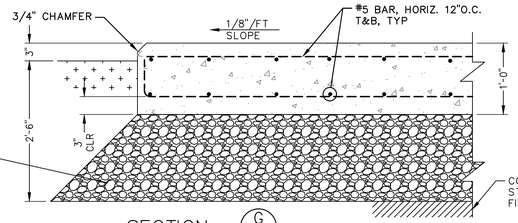
SECTION 1"=1'-0" (B) TYPICAL STRUCTURE FRAMING



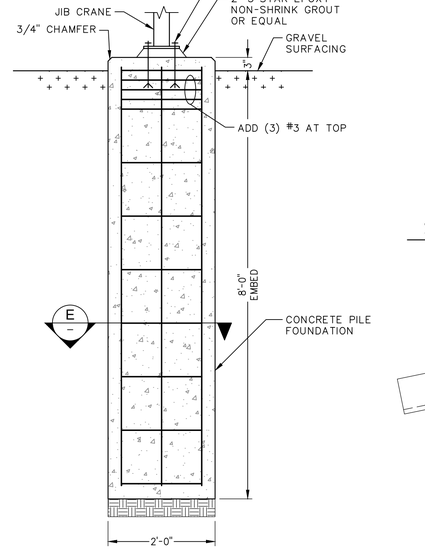
SECTION 1"=1'-0" (C) TYPICAL STRUCTURE FRAMING



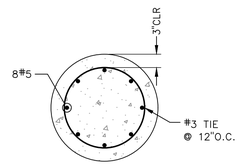
SECTION 3"=1'-0" (D) TYPICAL STRUCTURE FRAMING



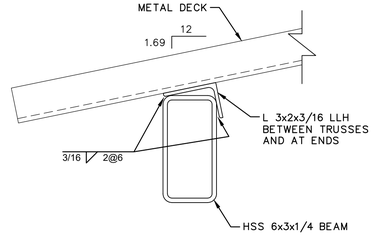
SECTION 1"=1'-0" (G) SLAB EDGE



DETAIL NTS (4) CRANE PEDESTAL



SECTION NTS (E) CRANE PEDESTAL



SECTION 3"=1'-0" (F) TYPICAL STRUCTURE FRAMING

GRAPHIC SCALE
2 0 2 4
(IN FEET)
1 inch = 2 ft.

GRAPHIC SCALE
1 0 1 2
(IN FEET)
1 inch = 1 ft.

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2

NO.	DATE	REVISION	DWN	CHD	EXD	RVWD	APVD	W.A.
2	01-17-20	FOR RECORD	AWF	DEM				FCC06814
1	12/20/18	REVISED AGGREGATE	LDB	HM			REH	

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Phoenix, Arizona 85020
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FOUR CORNERS POWER PLANT
RETURN WATER POND

STRUCTURAL SECTIONS AND DETAILS

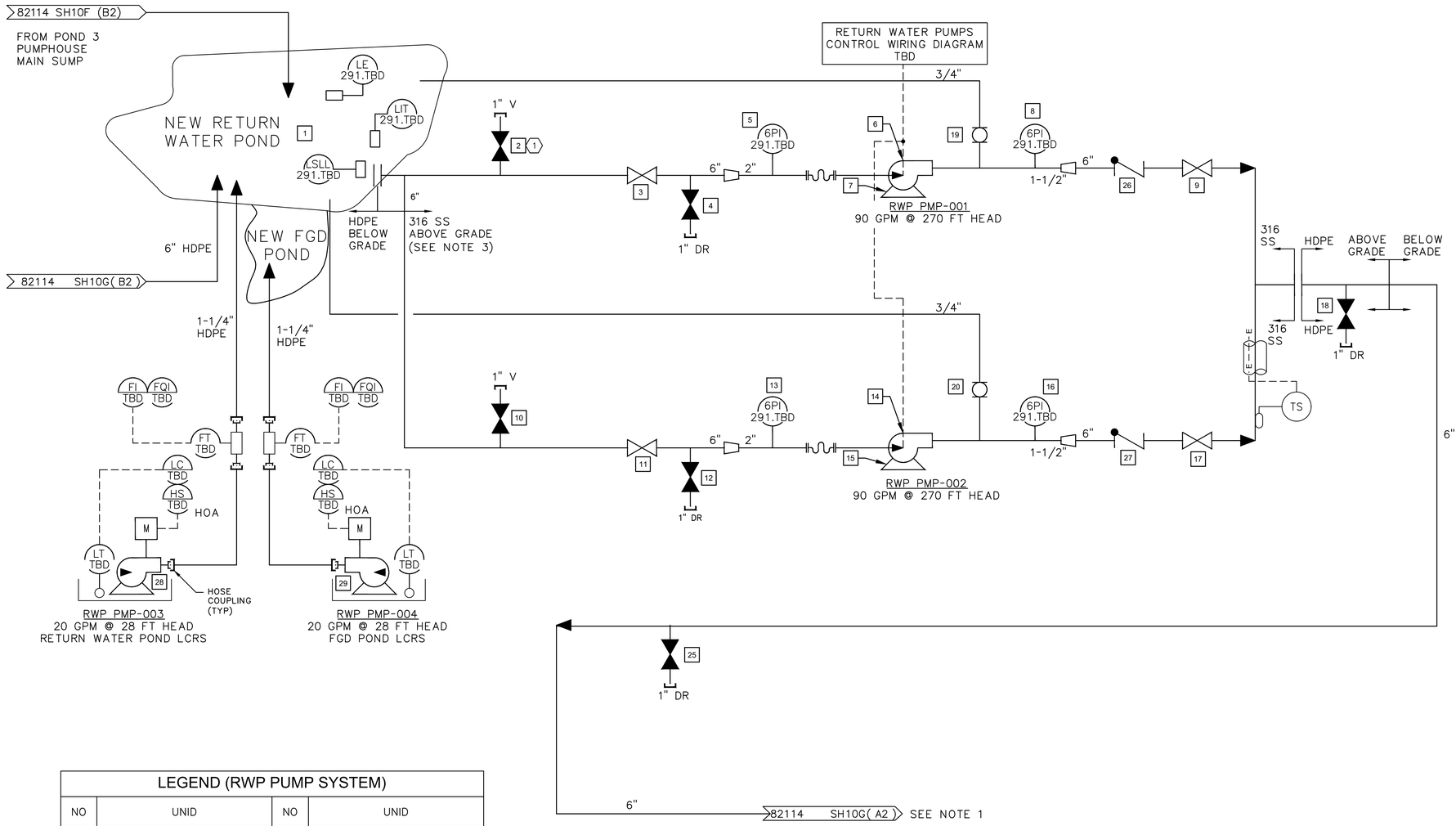
aps

SCALE AS NOTED DATE 10/04/19

DWN	EXD	APPROVED	W A
CM	---	ROBERT E. HAWTHORNE	FCC06814
CHD	RVWD	DRAWING APPROVED BY	
HM	---		

UNIT	DISC	TYPE	SYS	SUBSYS	NUMBER	SHEET
FC45CM	S	65	WP	AP	200485	26

DRAWING: P:\Projects\Arizona_Public_Service\60566008_FCPP_Return_Water_Pond_SG2\900_CAD_GIS\910_CAD\20-SHEETS\APS_EDCS_Drawings\2_DRAWING_REVISIONS\FC45CM-S-65-WP-AP-200485-26.dwg



LEGEND (RWP PUMP SYSTEM)			
NO	UNID	NO	UNID
1	FC00CM-BP-RWP-POND-001	15	FC00CM-BP-RWP-MTR-002
2	FC00CM-BP-RWP-VLV-V001	16	FC00CM-BP-RWP-IND-PI291TBD
3	FC00CM-BP-RWP-VLV-V002	17	FC00CM-BP-RWP-VLV-V008
4	FC00CM-BP-RWP-VLV-V003	18	FC00CM-BP-RWP-VLV-V009
5	FC00CM-BP-RWP-IND-PI291TBD	19	FC00CM-BP-RWP-BV-001
6	FC00CM-BP-RWP-PMP-001	20	FC00CM-BP-RWP-BV-002
7	FC00CM-BP-RWP-MTR-001	21	NOT USED
8	FC00CM-BP-RWP-IND-PI391TBD	22	NOT USED
9	FC00CM-BP-RWP-VLV-V004	23	NOT USED
10	FC00CM-BP-RWP-VLV-V005	24	NOT USED
11	FC00CM-BP-RWP-VLV-V006	25	FC00CM-BP-RWP-VLV-V011
12	FC00CM-BP-RWP-VLV-V007	26	FC00CM-BP-RWP-CKV-002
13	FC00CM-BP-RWP-IND-PI291TBD	27	FC00CM-BP-RWP-CKV-003
14	FC00CM-BP-RWP-PMP-002	28	FC00CM-BP-RWP-PMP-003
		29	FC00CM-BP-RWP-PMP-004

CONSTRUCTION NOTES:

1. CONNECT TO 8" HDPE TO PLANT.

GENERAL CONSTRUCTION NOTES:

1. SEE FC-M-ADS-82114-10F-L FOR UNID LEGEND.
2. FOR STANDARD SYMBOLS, REFERENCE DRAWINGS, LEGEND AND GENERAL NOTES, SEE APS DRAWING G-76000.
3. ALL ABOVE GRADE EXTERIOR PIPING AND PUMPS HEAT TRACED AND INSULATED.

KEYED NOTES:

(1) EQUIPMENT/VALVE/INSTRUMENT NUMBER [2]. SEE LEGEND FOR UNID NUMBER

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3

NO.	DATE	REVISION	DWN	CHD	EXD	RVWD	APVD	W.A.
3	01-17-20	FOR RECORD	AWF	DEM				FCC06814
2	12/17/18	REVISED PUMP FLOW & TDH & PIPE SIZES	DB	JM				
1	11/29/18	SWAP CHECK AND GATE VALVE LOCATIONS	DB	JM				

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Phoenix, Arizona 85020
(602) 371-1100

NMOC 811 Dial 8-1-1 or 1-800-321 2537

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FOUR CORNERS POWER PLANT
RETURN WATER POND

RETURN WATER POND P&ID

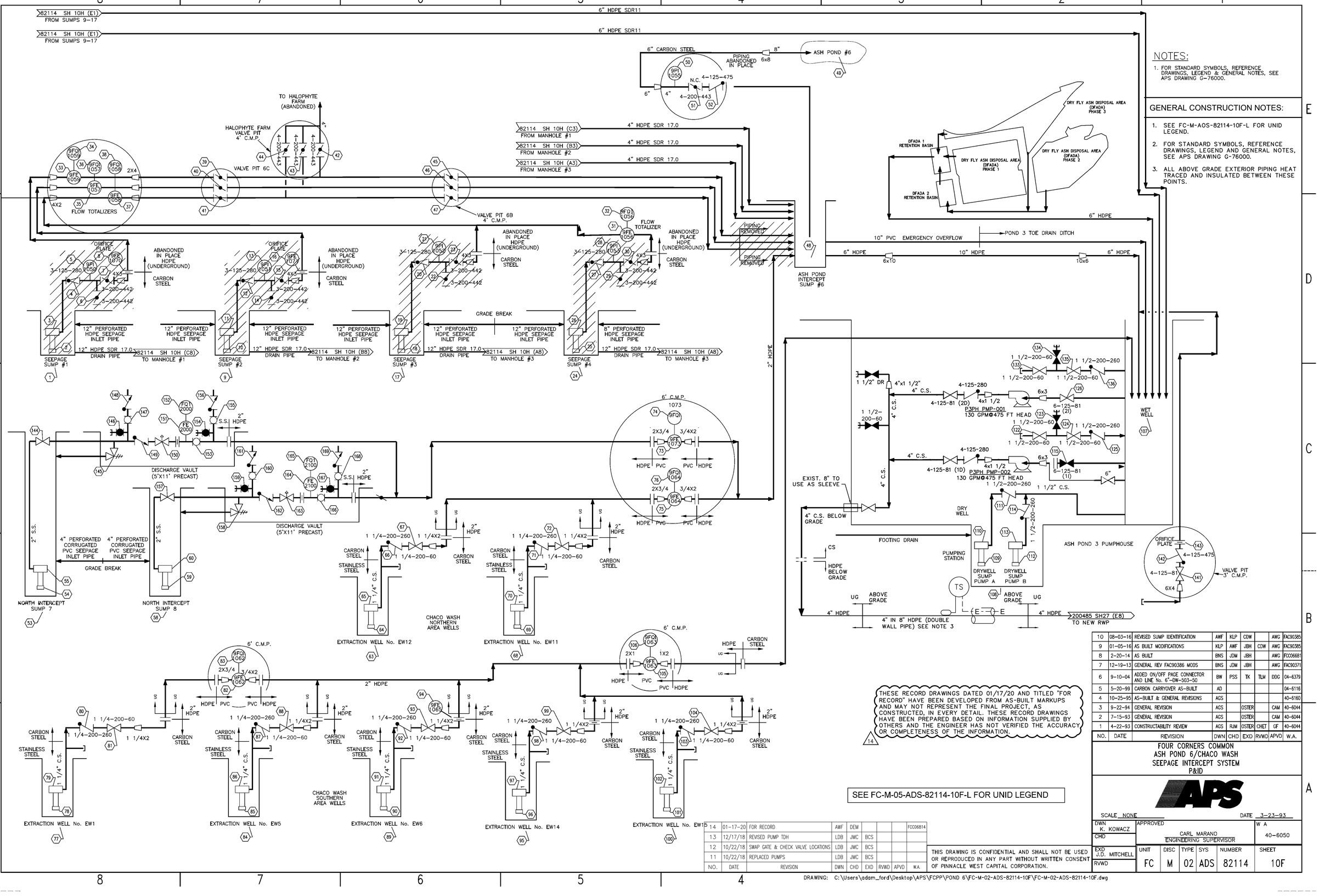
aps

SCALE NONE DATE 10/04/19

DWN	EXD	APPROVED	W A
LDB	---	JACK MCCONWELL	FCC06814
CHD	RVWD	DRAWING APPROVED BY	
BCS	---		

UNIT	DISC	TYPE	SYS	SUBSYS	NUMBER	SHEET
FC45CM	M	02	WP	AP	200485	27

DRAWING: P:\Projects\Arizona_Public_Service\60566008_FCPP_Return_Water_Pond_SG2\900_CAD_GIS\910_CAD\20-SHEETS\APS_EDCS_Drawings\2_DRAWING_REVISIONS\FC45CM-M-02-WP-AP-200485-27.dwg



NOTES:

1. FOR STANDARD SYMBOLS, REFERENCE DRAWINGS, LEGEND & GENERAL NOTES, SEE APS DRAWING G-76000.

GENERAL CONSTRUCTION NOTES:

1. SEE FC-M-AOS-82114-10F-L FOR UNID LEGEND.
2. FOR STANDARD SYMBOLS, REFERENCE DRAWINGS, LEGEND AND GENERAL NOTES, SEE APS DRAWING G-76000.
3. ALL ABOVE GRADE EXTERIOR PIPING HEAT TRACED AND INSULATED BETWEEN THESE POINTS.

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14

SEE FC-M-05-ADS-82114-10F-L FOR UNID LEGEND

NO.	DATE	REVISION	DWN	CHD	EXD	RVWD	APVD	W.A.
10	08-03-16	REVISED SUMP IDENTIFICATION	AWF	KLP	CDW		AWG	FAC90385
9	01-05-16	AS BUILT MODIFICATIONS	KLP	AWF	JBH	CDW	AWG	FAC90385
8	2-20-14	AS BUILT	BNS	JDM	JBH		AWG	FCC06681
7	12-19-13	GENERAL REV FAC90386 MODS	BNS	JDM	JBH		AWG	FAC90371
6	9-10-04	ADDED ON/OFF PACE CONNECTOR AND LINE No. 6"-DW-503-50	BW	PSS	TK	TLM	DDG	04-6379
5	5-20-99	CARBON CARRYOVER AS-BUILT	AD					04-5116
4	10-25-95	AS-BUILT & GENERAL REVISIONS	AGS					40-6160
3	9-22-94	GENERAL REVISION	AGS		OSTER		CAM	40-6044
2	7-15-93	GENERAL REVISION	AGS		OSTER		CAM	40-6044
1	4-22-93	CONSTRUCTABILITY REVIEW	AGS	RJW	OSTER	CHET	GF	40-6044

NO.	DATE	REVISION	DWN	CHD	EXD	RVWD	APVD	W.A.
14	01-17-20	FOR RECORD	AWF	DEM				FCC06814
13	12/17/18	REVISED PUMP TDH	LDB	JMC	BCS			
12	10/22/18	SWAP GATE & CHECK VALVE LOCATIONS	LDB	JMC	BCS			
11	10/22/18	REPLACED PUMPS	LDB	JMC	BCS			

DRAWING: C:\Users\adam_ford\Desktop\APS\FCPP\POND 6\FC-M-02-ADS-82114-10F\FC-M-02-ADS-82114-10F.dwg

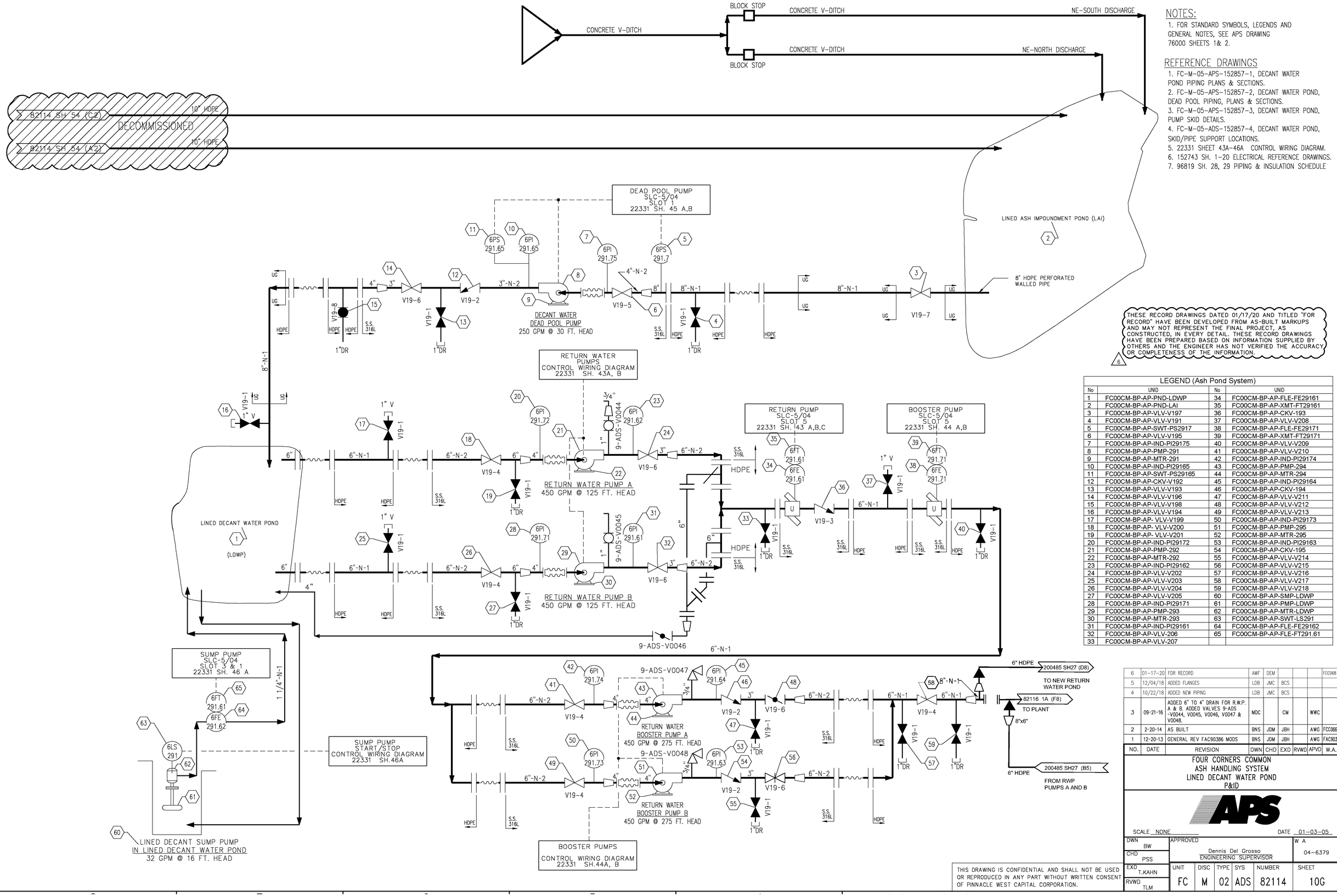
FOUR CORNERS COMMON ASH POND 6/CHACO WASH SEEPAGE INTERCEPT SYSTEM P&ID

SCALE NONE

DATE 3-23-93

DWN	APPROVED	W A
K. KOWACZ	CARL MARANO ENGINEERING SUPERVISOR	40-6050
CHD		
EXD J.D. MITCHELL		
RVWD		

UNIT	DISC	TYPE	SYS	NUMBER	SHEET
FC	M	02	ADS	82114	10F



NOTES:

1. FOR STANDARD SYMBOLS, LEGENDS AND GENERAL NOTES, SEE APS DRAWING 76000 SHEETS 1& 2.

REFERENCE DRAWINGS

1. FC-M-05-APS-152857-1, DECANT WATER POND PIPING PLANS & SECTIONS.
2. FC-M-05-APS-152857-2, DECANT WATER POND, DEAD POOL PIPING, PLANS & SECTIONS.
3. FC-M-05-APS-152857-3, DECANT WATER POND, PUMP SKID DETAILS.
4. FC-M-05-ADS-152857-4, DECANT WATER POND, SKID/PIPE SUPPORT LOCATIONS.
5. 22331 SHEET 43A-46A CONTROL WIRING DIAGRAM.
6. 152743 SH. 1-20 ELECTRICAL REFERENCE DRAWINGS.
7. 96819 SH. 28, 29 PIPING & INSULATION SCHEDULE

THESE RECORD DRAWINGS DATED 01/17/20 AND TITLED "FOR RECORD" HAVE BEEN DEVELOPED FROM AS-BUILT MARKUPS AND MAY NOT REPRESENT THE FINAL PROJECT, AS CONSTRUCTED, IN EVERY DETAIL. THESE RECORD DRAWINGS HAVE BEEN PREPARED BASED ON INFORMATION SUPPLIED BY OTHERS AND THE ENGINEER HAS NOT VERIFIED THE ACCURACY OR COMPLETENESS OF THE INFORMATION.

6

LEGEND (Ash Pond System)			
No	UNID	No	UNID
1	FC00CM-BP-AP-PND-LDWP	34	FC00CM-BP-AP-FLE-FE29161
2	FC00CM-BP-AP-PND-LAI	35	FC00CM-BP-AP-XMT-FT29161
3	FC00CM-BP-AP-VLV-V197	36	FC00CM-BP-AP-CKV-193
4	FC00CM-BP-AP-VLV-V191	37	FC00CM-BP-AP-VLV-V208
5	FC00CM-BP-AP-SWT-PS2917	38	FC00CM-BP-AP-FLE-FE29171
6	FC00CM-BP-AP-VLV-V195	39	FC00CM-BP-AP-XMT-FT29171
7	FC00CM-BP-AP-IND-PI29175	40	FC00CM-BP-AP-VLV-V209
8	FC00CM-BP-AP-PMP-291	41	FC00CM-BP-AP-VLV-V210
9	FC00CM-BP-AP-MTR-291	42	FC00CM-BP-AP-IND-PI29174
10	FC00CM-BP-AP-IND-PI29165	43	FC00CM-BP-AP-PMP-294
11	FC00CM-BP-AP-SWT-PS29165	44	FC00CM-BP-AP-MTR-294
12	FC00CM-BP-AP-CKV-V192	45	FC00CM-BP-AP-IND-PI29164
13	FC00CM-BP-AP-VLV-V193	46	FC00CM-BP-AP-CKV-194
14	FC00CM-BP-AP-VLV-V196	47	FC00CM-BP-AP-VLV-V211
15	FC00CM-BP-AP-VLV-V198	48	FC00CM-BP-AP-VLV-V212
16	FC00CM-BP-AP-VLV-V194	49	FC00CM-BP-AP-VLV-V213
17	FC00CM-BP-AP- VLV-V199	50	FC00CM-BP-AP-IND-PI29173
18	FC00CM-BP-AP- VLV-V200	51	FC00CM-BP-AP-PMP-295
19	FC00CM-BP-AP- VLV-V201	52	FC00CM-BP-AP-MTR-295
20	FC00CM-BP-AP-IND-PI29172	53	FC00CM-BP-AP-IND-PI29163
21	FC00CM-BP-AP-PMP-292	54	FC00CM-BP-AP-CKV-195
22	FC00CM-BP-AP-MTR-292	55	FC00CM-BP-AP-VLV-V214
23	FC00CM-BP-AP-IND-PI29162	56	FC00CM-BP-AP-VLV-V215
24	FC00CM-BP-AP-VLV-V202	57	FC00CM-BP-AP-VLV-V216
25	FC00CM-BP-AP-VLV-V203	58	FC00CM-BP-AP-VLV-V217
26	FC00CM-BP-AP-VLV-V204	59	FC00CM-BP-AP-VLV-V218
27	FC00CM-BP-AP-VLV-V205	60	FC00CM-BP-AP-SMP-LDWP
28	FC00CM-BP-AP-IND-PI29171	61	FC00CM-BP-AP-PMP-LDWP
29	FC00CM-BP-AP-PMP-293	62	FC00CM-BP-AP-MTR-LDWP
30	FC00CM-BP-AP-MTR-293	63	FC00CM-BP-AP-SWT-LS291
31	FC00CM-BP-AP-IND-PI29161	64	FC00CM-BP-AP-FLE-FE29162
32	FC00CM-BP-AP-VLV-206	65	FC00CM-BP-AP-FLE-FT291.61
33	FC00CM-BP-AP-VLV-207		

NO.	DATE	REVISION	DWN	CHD	EXD	RVWD	APVD	W.A.
6	01-17-20	FOR RECORD	AWF	DEM				FCC06814
5	12/04/18	ADDED FLANGES	LDB	JMC	BCS			
4	10/22/18	ADDED NEW PIPING	LDB	JMC	BCS			
3	09-21-16	ADDED 6" TO 4" DRAIN FOR R.W.P. A & B. ADDED VALVES 9-ADS -V0044, V0045, V0046, V0047 & V0048.	MDC		CM		WWC	
2	2-20-14	AS BUILT	BNS	JDM	JBH		AWG	FCC06681
1	12-20-13	GENERAL REV FAC90386 MODS	BNS	JDM	JBH		AWG	FAC90371

FOUR CORNERS COMMON
ASH HANDLING SYSTEM
LINED DECANT WATER POND
P&ID

SCALE NONE DATE 01-03-05

DWN	APPROVED	W A
BW	Dennis Del Grosso	04-6379
CHD PSS	ENGINEERING SUPERVISOR	
EXD T.KAHN		
RVWD TLM		

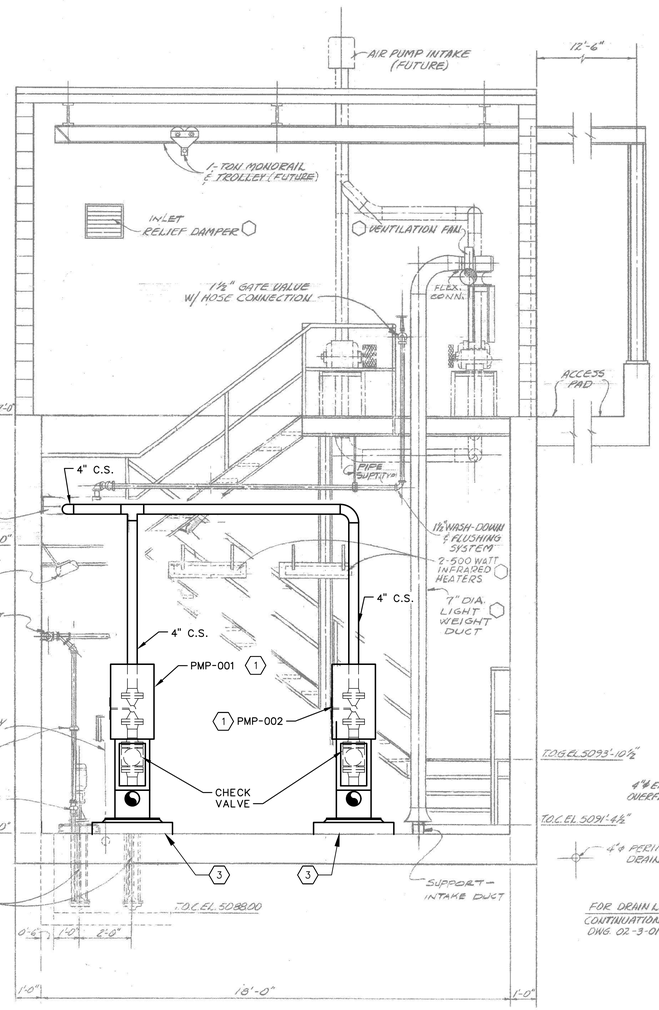
UNIT	DISC	TYPE	SYS	NUMBER	SHEET
FC	M	02	ADS	82114	10G

PUMP SCHEDULE

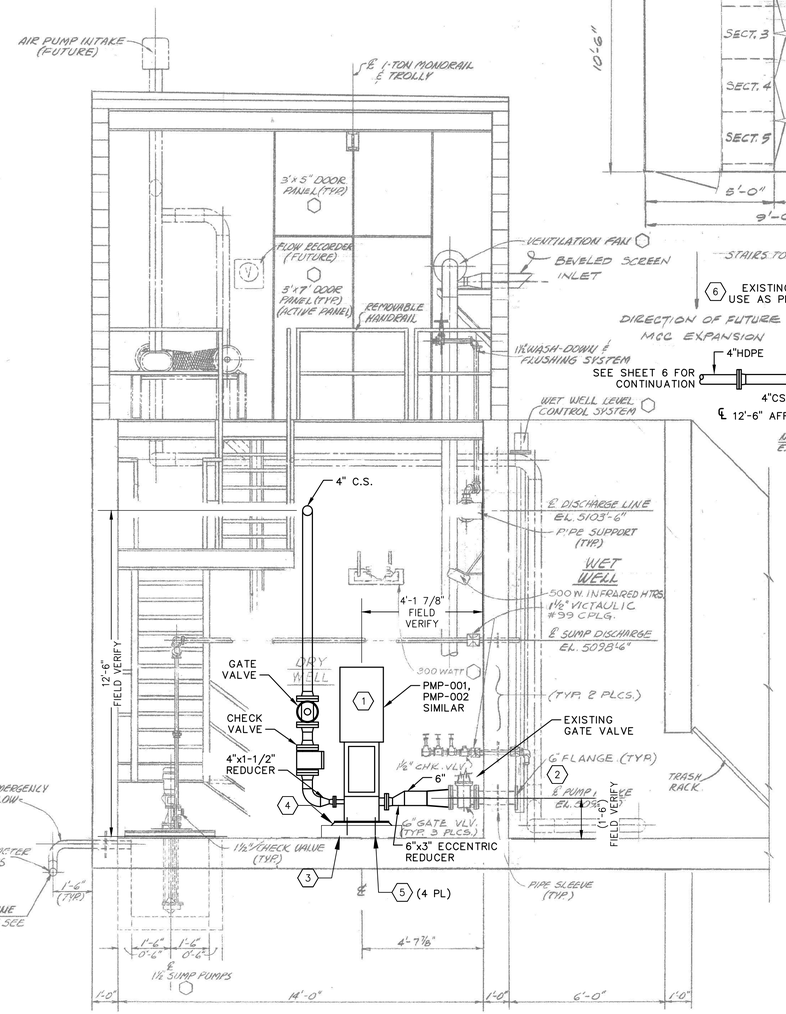
MARK	MANUFACTURER	MODEL NUMBER	PUMP TYPE	GPM	HEAD (FT.WG.)	MOTOR DATA			SERVICE	CONFIGURATION	WEIGHT (LBS)	MIN. EFFICIENCY		REMARKS
						MAX. HP	RPM	VOLT/PH				PUMP %	MOTOR %	
P3PH PMP-001	FLOWSERVE	2K3x1.5V-13RV M3V	IN-LINE	130	475	100	3550	460/3	WATER	VERTICAL IN-LINE	2071	39.4	95	OWNER FURNISHED
P3PH PMP-002	FLOWSERVE	2K3x1.5V-13RV M3V	IN-LINE	130	475	100	3550	460/3	WATER	VERTICAL IN-LINE	2071	39.4	95	OWNER FURNISHED

CONSTRUCTION NOTES:

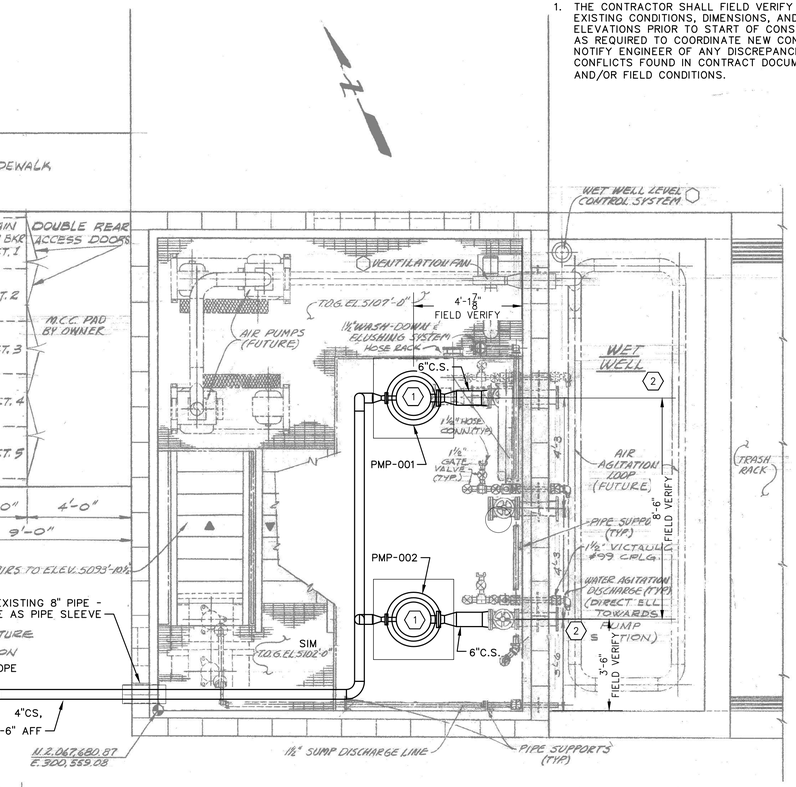
1. THE CONTRACTOR SHALL FIELD VERIFY ALL EXISTING CONDITIONS, DIMENSIONS, AND ELEVATIONS PRIOR TO START OF CONSTRUCTION AS REQUIRED TO COORDINATE NEW CONSTRUCTION. NOTIFY ENGINEER OF ANY DISCREPANCIES OR CONFLICTS FOUND IN CONTRACT DOCUMENTS AND/OR FIELD CONDITIONS.



ELEVATION - LOOKING WEST
SCALE: 3/8" = 1'-0"



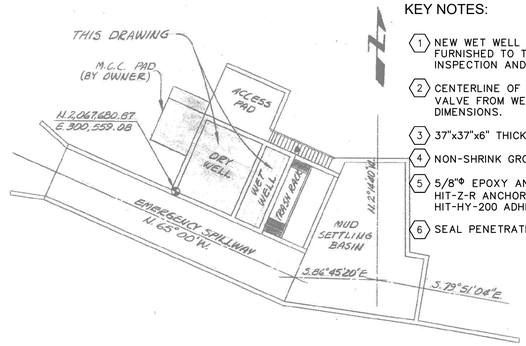
ELEVATION - LOOKING NORTH
SCALE: 3/8" = 1'-0"



PLAN
WET WELL AND DRY WELL
SCALE: 3/8" = 1'-0"

KEY NOTES:

1. NEW WET WELL PUMP. PUMPS WILL BE OWNER FURNISHED TO THE CONTRACTOR FOR INSTALLATION, INSPECTION AND TESTING.
2. CENTERLINE OF EXISTING 6" SUCTION PIPING AND VALVE FROM WET WELL IS 1'-6" AFF. FIELD VERIFY DIMENSIONS.
3. 37"x37"x6" THICK HOUSEKEEPING PAD.
4. NON-SHRINK GROUT, MIN. 1" THICK, 2" THICK MAX.
5. 5/8"ø EPOXY ANCHORS, HILTI STAINLESS STEEL HIT-Z-R ANCHORS, MIN EMBEDMENT 3-3/4". HILTI HIT-HY-200 ADHESIVE.
6. SEAL PENETRATION, USE LINK SEAL LS-475-C-7.



LOCATION PLAN
SCALE: 1/16" = 1'-0"

NOTES:
1. FOR STAIRS, PLATFORMS AND OTHER STRUCTURAL DETAILS, SEE STRUCTURAL DRAWINGS REFERENCED BELOW.
2. ITEMS TO BE SPECIFIED BY OWNER
3. ALL 1½" PIPE IS THREADED.
4. FLAT FACE GASKETS SHALL BE USED AGAINST CAST IRON VALVES & E.L. PUMPS.

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NO.	REVISIONS	DATE	BY	CH'D	APP'D
1	REVISE MARK, PAD & ADD CCT. BKRS, RELOCATE WASHDOWN & FLUSHING SYSTEM, ALSO AGITATION BY SCHG. SPECIFY VENTURI	11-8-76	MG	[illegible]	
2	RELOCATED PUMPS & REROUTED AND CHANGED PIPING		JSB		
3	"AS-BUILT" PER FIELD MARKUP.	9-28-88	[illegible]	ERA	
4	ADD 6"ø BY-PASS WITH RESTRICTING ORIFICE & PLACES ON PUMP DISCHARGE PIPING, ADDED VENTURI MEASURING DEVICE REF	3-25-98	VIC	[illegible]	
5	REPLACE PUMPS/PIPING	----	LDB	JMC	BCS
6	SWAP CHECK AND GATE VALVE LOCATIONS	11-29-18	LDB	JMC	BCS
7	UPDATED PUMP SCHEDULE	12-17-18	LDB	JMC	BCS
8	FOR RECORD	01-17-20	AWF	DEM	

REFERENCE DRAWINGS		
02-2-04	CIVIL - DISCHARGE LINE & ACC. RD. - PLAN & DETAILS	
02-2-06	CIVIL - PUMPING STATION - EXCAVATION	
02-2-10	CIVIL - PUMPING STATION - FINAL GRADING	
02-3-01&02	CONCRETE - PUMPING STA. & SPILLWAY - PLANS, SECT. & DET.	
02-3-03	CONCRETE - " " " - SECTIONS & ELEV.	
02-3-04&05	CONCRETE - PUMPHOUSE - PLANS, SECTIONS & DETAILS	

PRINT RECORD																				
DATE	10/1/76	11/16/76	3/31																	
FOR	F.A.	AFC	AFC																	
REVISED	0	1	2																	
CUSTOMER	4	4	4																	
FIELD	4	4																		
INTRA CO.	5	4	2																	

ENG. RECORD		
DRAWN	WEGm	9/27/76
CHECKED	S.A.H.	9/29/76
MECH. CK.		
STRUCT. CK.		
ELECT. CK.		
PIPING CK.		
INSTR. CK.		
CIVIL CK.	SAH	9/11/80

DRAWING STATUS	
ISSUED	DATE
PRELIMINARY FOR COMMENTS AND/OR APPROVAL	
APPROVED FOR CONSTRUCTION	11/1/76
REVISED & APPROVED FOR CONSTRUCTION 2ND REV. 3	3/24/80

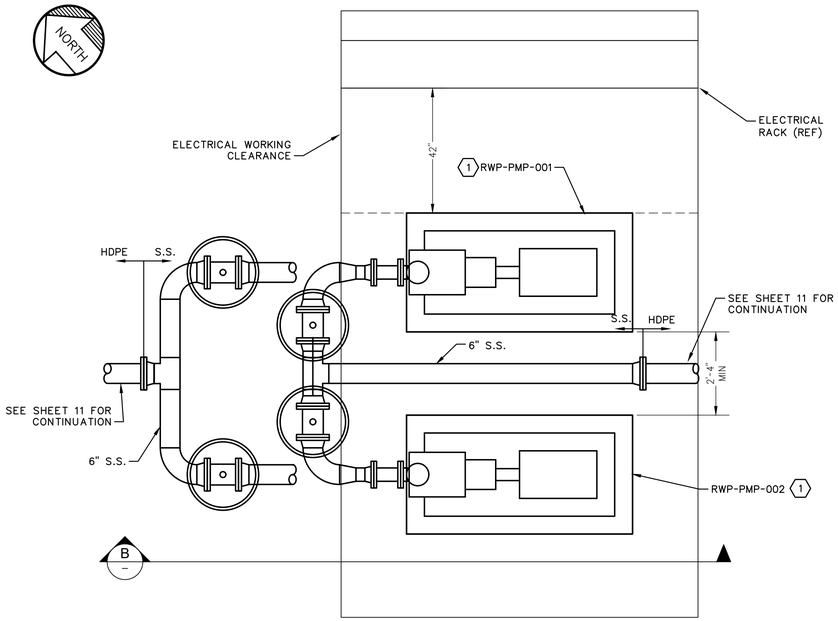
NOT APPROVED FOR CONSTRUCTION UNLESS SIGNED & DATED. DESTROY ALL PRINTS BEARING EARLIER DATE &/OR REVISION NO.

PUMPING STATION - PIPING & GENERAL ARRANGEMENT PLANS & ELEVATIONS
ARIZONA PUBLIC SERVICE CO.
FOUR CORNERS POWER PLANT

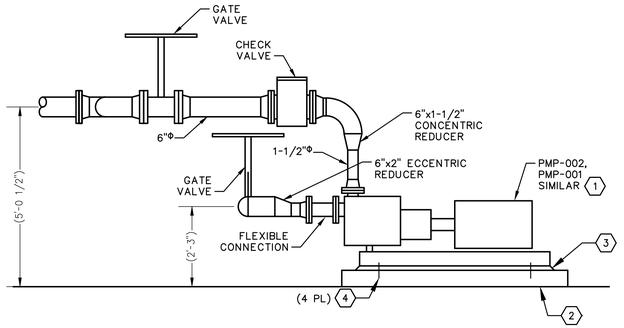
SCALE: AS SHOWN
Stearns-Roger INCORPORATED
ORDER NO. C-15749 X000002

DWG. NO. 02-2-05
SHEET NO. APS NO. E-56052
5 OF 11
REV. 4

Form 22200-S1



RWP PUMP PAD PLAN
SCALE: 1/2"=1'-0" (FULL SIZE)



SECTION B/34 RWP PUMP PAD
1/2"=1'-0"

PUMP SCHEDULE

MARK	MANUFACTURER	MODEL NUMBER	PUMP TYPE	GPM	HEAD (FT.WG.)	MOTOR DATA MAX. HP	RPM	VOLT/PH	SERVICE	CONFIGURATION	WEIGHT (LBS)	MIN. EFFICIENCY PUMP %	MOTOR %	REMARKS
RWP PMP-001	FLOWSERVE	2K2x1.5US-10ARV	SELF PRIMING	90	270	30	3500	460/3	WATER	HORIZONTAL BASE MOUNTED	1260	30.5	92	OWNER FURNISHED
RWP PMP-002	FLOWSERVE	2K2x1.5US-10ARV	SELF PRIMING	90	270	30	3500	460/3	WATER	HORIZONTAL BASE MOUNTED	1260	30.5	92	OWNER FURNISHED

CONSTRUCTION NOTES:

1. THE CONTRACTOR SHALL FIELD VERIFY ALL EXISTING CONDITIONS, DIMENSIONS, AND ELEVATIONS PRIOR TO START OF CONSTRUCTION AS REQUIRED TO COORDINATE NEW CONSTRUCTION. NOTIFY ENGINEER OF ANY DISCREPANCIES OR CONFLICTS FOUND IN CONTRACT DOCUMENTS AND/OR FIELD CONDITIONS.
2. PIPE SUPPORTS ARE NOT SHOWN FOR CLARITY. CONTRACTOR SHALL PROVIDE SUPPORTS PER SPECIFICATIONS.

KEY NOTES:

1. THE NEW RETURN WATER POND PUMPS WILL BE OWNER FURNISHED TO THE CONTRACTOR FOR INSTALLATION, INSPECTION AND TESTING.
2. 76"x40"x6" THICK HOUSEKEEPING PAD.
3. NON-SHRINK GROUT, MIN. 1" THICK, 2" THICK MAX.
4. 3/4"Φ EPOXY ANCHORS. HILTI STAINLESS STEEL HIT-Z-R ANCHORS, MIN. EMBED 4". HILTI HIT-HY-200 ADHESIVE.

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3

NO.	DATE	REVISION	DWN	CHD	EXD	RVWD	APVD	W.A.
3	01-17-20	FOR RECORD	AWF	DEM				FCC06814
2	12/17/18	REVISED PUMP FLOW & TSH & PIPE SIZES	DB	JM				
1	11/29/18	SWAP CHECK AND GATE VALVE LOCATIONS	DB	JM				

GRAPHIC SCALE
2 0 2 4
(IN FEET)
1 inch = 2 ft.

AECOM
7720 N. 16th Street Suite 100
Phoenix, Arizona 85020
(602) 371-1100

NMOC 811 Dial 8-1-1 or 1-800-321 2537

WORK SAFELY TODAY

FOUR CORNERS POWER PLANT
RETURN WATER POND

MECHANICAL RETURN WATER POND PUMPING STATION PLAN

aps

SCALE 1/2" = 1'-0" DATE 10/04/19

DWN	EXD	APPROVED	W A
LDB	---	JACK MCCONWELL	FCC06814
CHD	RVWD	DRAWING APPROVED BY	
BCS	---		

UNIT	DISC	TYPE	SYS	SUBSYS	NUMBER	SHEET
FC45CM	M	16	WP	AP	200485	34

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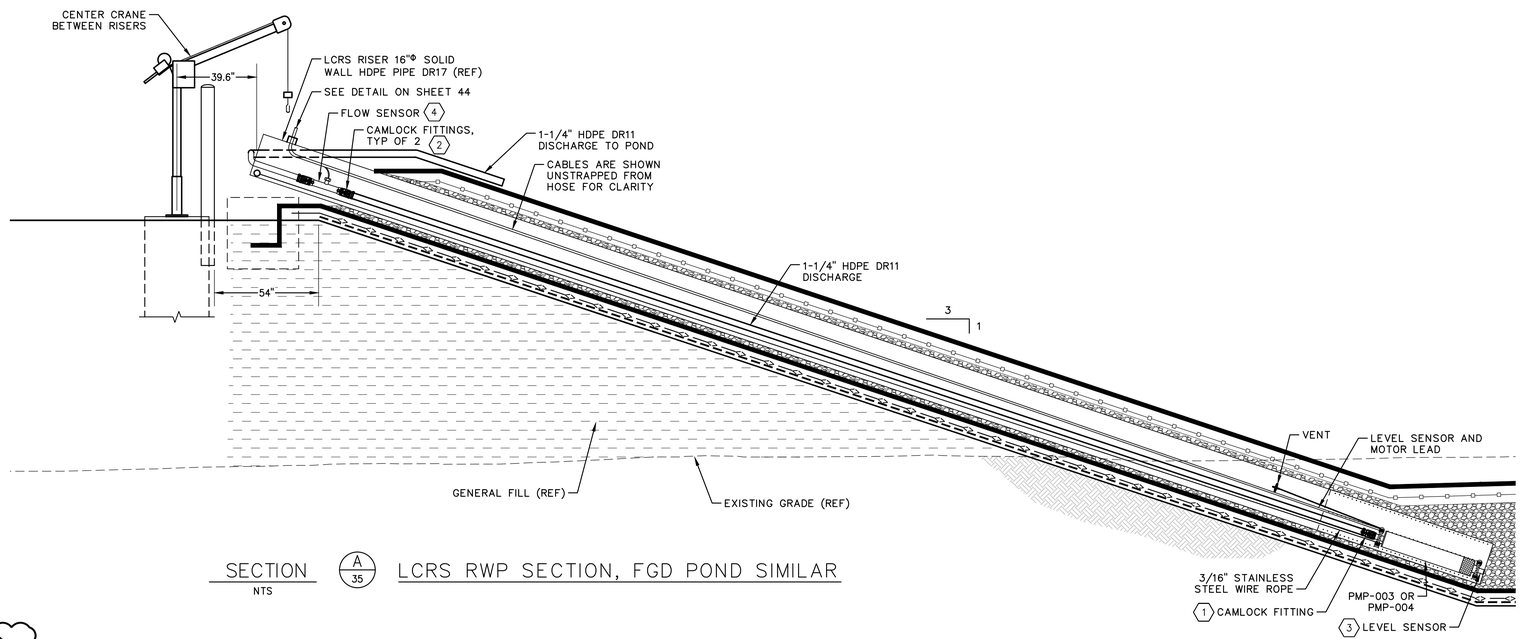
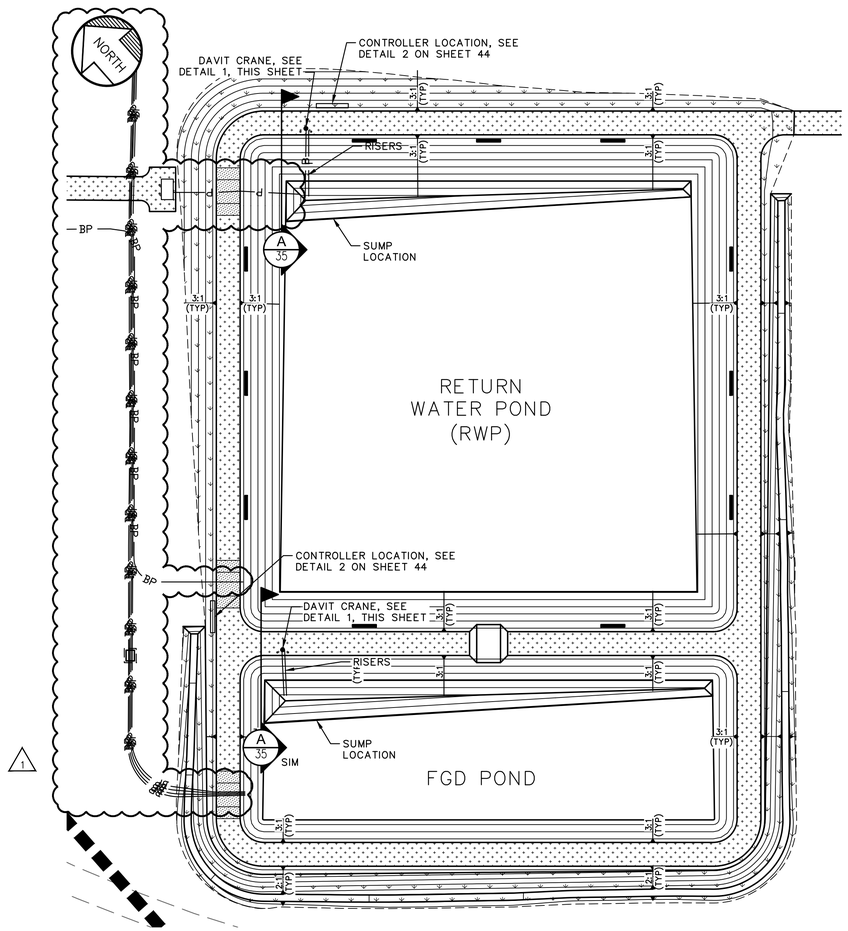


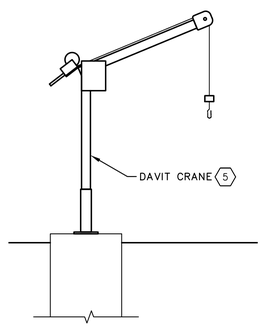
SECTION A/35 LCRS RWP SECTION, FGD POND SIMILAR
NTS



RWP POND LCRS PLAN
SCALE: NTS

PUMP SCHEDULE

MARK	MANUFACTURER	MODEL NUMBER	PUMP TYPE	GPM	HEAD (FT.WG.)	MOTOR DATA MAX. HP	RPM	VOLT/PH	SERVICE	CONFIGURATION	WEIGHT (LBS)	MIN. EFFICIENCY PUMP %	MOTOR %	REMARKS
RWP PMP-003	EPG	SERIES 3 SUREPUMP MODEL WDPT 3-2	316SS WHEELED SUMP DRAINER	20	28	0.5	3450	460/3	WATER	SUBMERSIBLE HORIZONTAL/ANGLED	67	52.8	95	PROVIDE WITH 60' 3/16" CABLE, LEVEL SENSOR AND CABLE, AND 80' OF MOTOR LEAD FOR RWP PUMP
RWP PMP-004	EPG	SERIES 3 SUREPUMP MODEL WDPT 3-2	316SS WHEELED SUMP DRAINER	20	28	0.5	3450	460/3	WATER	SUBMERSIBLE HORIZONTAL/ANGLED	67	52.8	95	PROVIDE WITH 60' 3/16" CABLE, LEVEL SENSOR AND CABLE, AND 80' OF MOTOR LEAD FOR FGD POND PUMP



DETAIL 1/- LCRS CRANE DETAIL
NTS

CONSTRUCTION NOTES:

1. THE CONTRACTOR SHALL FIELD VERIFY ALL EXISTING CONDITIONS, DIMENSIONS, AND ELEVATIONS PRIOR TO START OF CONSTRUCTION AS REQUIRED TO COORDINATE NEW CONSTRUCTION. NOTIFY ENGINEER OF ANY DISCREPANCIES OR CONFLICTS FOUND IN CONTRACT DOCUMENTS AND/OR FIELD CONDITIONS.
2. AS-BUILT LINES, GRADES, AND POINTS CAN BE FOUND IN APS DRAWING NUMBER FC00CM-C-17-SF-RG-100003-101. 1

KEYED NOTES:

1. DIXON 125-C-SS HOSE COUPLER WITH DIXON 1-1/4" FNPT ADAPTER 125-A-SS, TYPE 316 STAINLESS STEEL.
2. DIXON 125-C-SS HOSE COUPLER WITH DIXON 1-1/4" MNPT ADAPTER 125-F-SS, TYPE 316 STAINLESS STEEL.
3. EPG SUBMERSIBLE LEVEL SENSOR, 0-5 PSIG.
4. EPG E SERIES EP125 FLOW SENSOR, INSTALLED IN CLASS 150 TYPE 316 STAINLESS STEEL 1-1/4" FNPT TEE.
5. GALVANIZED STEEL DAVIT CRANE, 500 LB CAPACITY, FIRST MATE 500 SERIES MODEL 5122M1, WITH MANUALLY OPERATED WINCH WITH WINCH COVER, AND 60 FT OF 3/16" 316SS WIRE ROPE (MODEL WS19-60NS), PEDESTAL MOUNT (522GAL), AND 1/2"Φ TYPE 316 STAINLESS STEEL ANCHOR KIT (MODEL AN50A-5S316). SEE DETAIL ON SHEET 26 FOR PEDESTAL.

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NO.	DATE	REVISION	DWN	CHD	EXD	RVWD	APVD	W.A.
1	01-17-20	FOR RECORD	AWF	DEM				FCC06814

AECOM
7720 N. 16th Street Suite 100
Phoenix, Arizona 85020
(602) 371-1100

NMOC 811 Dial 8-1-1 or 1-800-321 2537

WORK SAFELY TODAY

FOUR CORNERS POWER PLANT
RETURN WATER POND

LCRS PUMP SECTION, SCHEDULE AND DETAILS

aps

SCALE AS NOTED DATE 10/04/19

DWN	EXD	APPROVED	W A
LDB	---	JACK MCCONWELL	FCC06814
CHD BCS	RVWD ---	DRAWING APPROVED BY	

UNIT	DISC	TYPE	SYS	SUBSYS	NUMBER	SHEET
FC45CM	M	65	WP	AP	200485	35

DRAWING: P:\Projects\Arizona_Public_Service\60566008_FCPP_Return_Water_Pond_SG2\900_CAD_GIS\910_CAD\20-SHEETS\APS_EDCS_Drawings\2_DRAWING_REVISIONS\FC45CM-P-65-WP-AP-200485-35.dwg

PUMP SCHEDULE

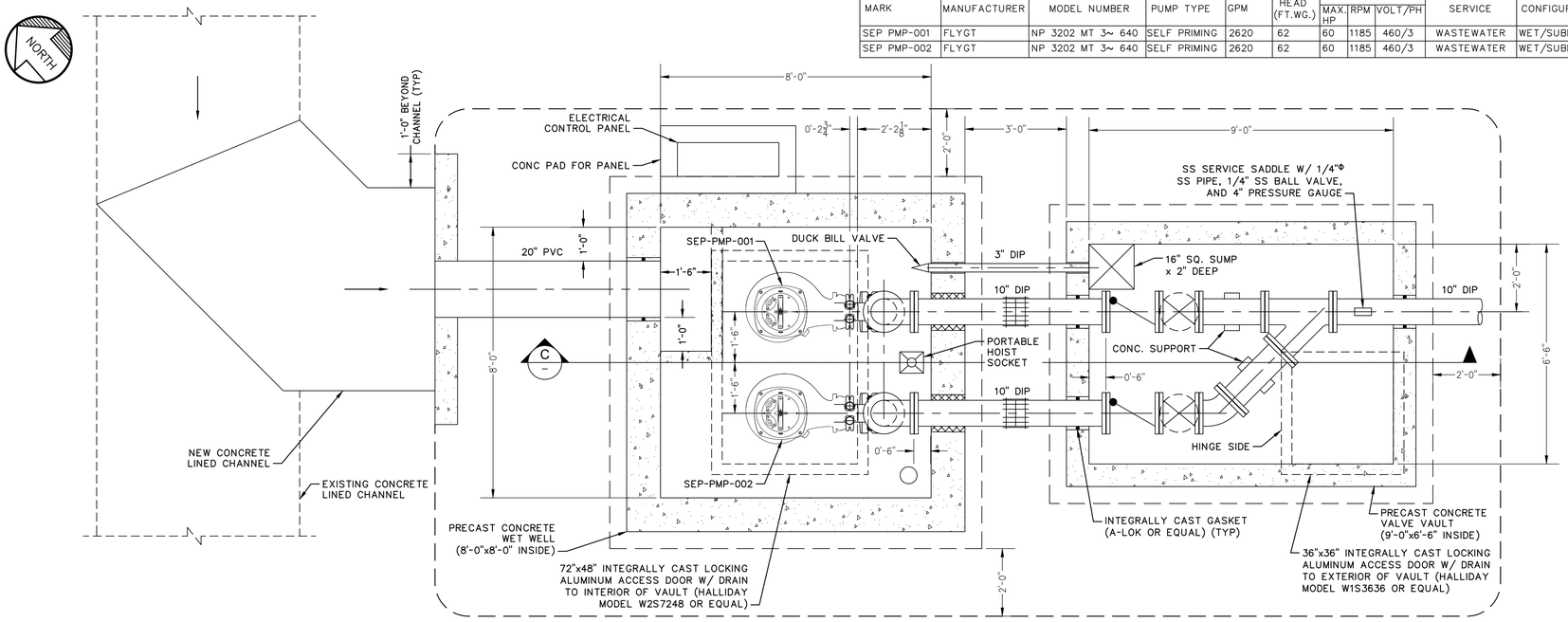
MARK	MANUFACTURER	MODEL NUMBER	PUMP TYPE	GPM	HEAD (FT.WG.)	MOTOR DATA MAX. HP	RPM	VOLT/PH	SERVICE	CONFIGURATION	WEIGHT (LBS)	MIN. EFFICIENCY PUMP %	MOTOR %	REMARKS
SEP PMP-001	FLYGT	NP 3202 MT 3~ 640	SELF PRIMING	2620	62	60	1185	460/3	WASTEWATER	WET/SUBMERSIBLE	1280	82	84	-
SEP PMP-002	FLYGT	NP 3202 MT 3~ 640	SELF PRIMING	2620	62	60	1185	460/3	WASTEWATER	WET/SUBMERSIBLE	1280	82	84	-

CONSTRUCTION NOTES:

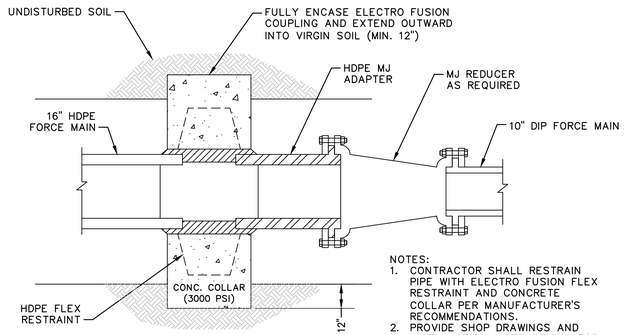
1. THE CONTRACTOR SHALL FIELD VERIFY ALL EXISTING CONDITIONS, DIMENSIONS, AND ELEVATIONS PRIOR TO START OF CONSTRUCTION AS REQUIRED TO COORDINATE NEW CONSTRUCTION. NOTIFY ENGINEER OF ANY DISCREPANCIES OR CONFLICTS FOUND IN CONTRACT DOCUMENTS AND/OR FIELD CONDITIONS.

KEY NOTES:

(1) NOT USED.

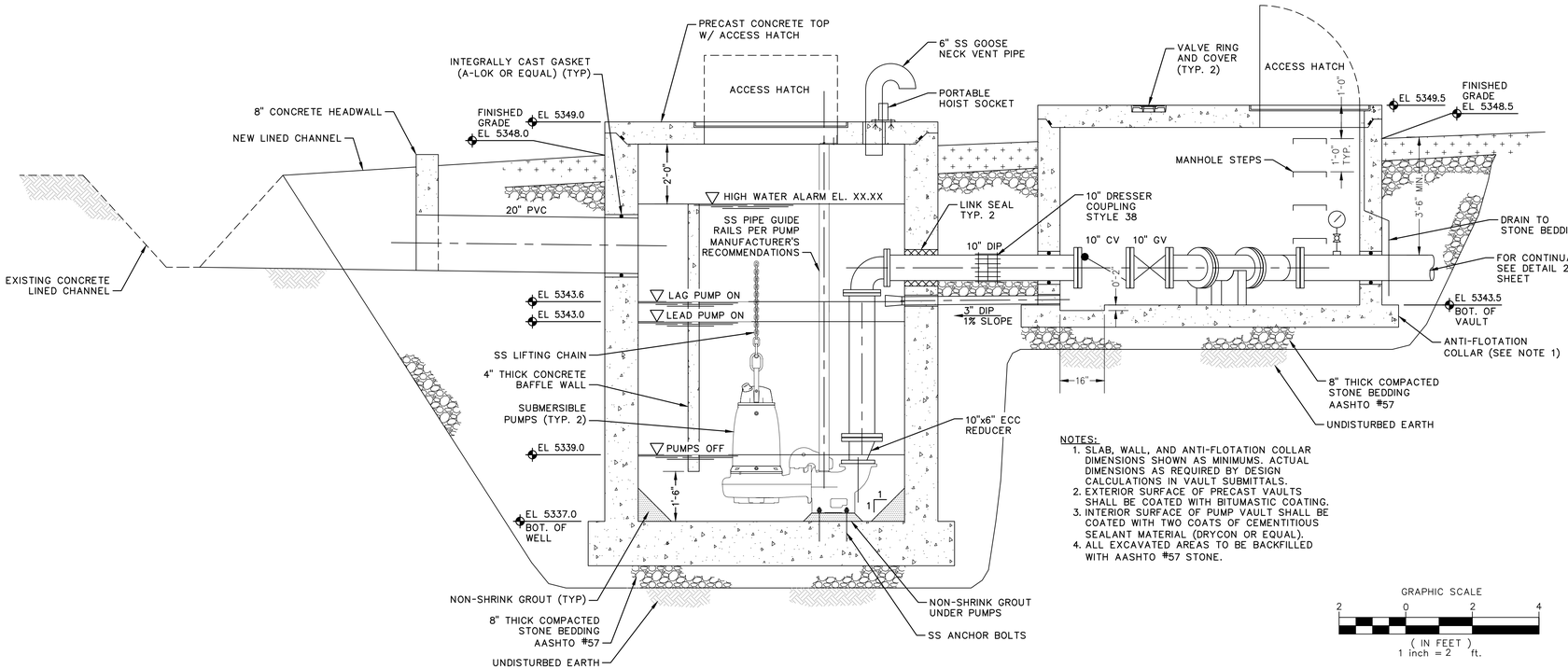


SEWAGE EFFLUENT PUMP STATION PLAN
SCALE: 1/2"=1'-0" (FULL SIZE)



NOTES:
1. CONTRACTOR SHALL RESTRAIN PIPE WITH ELECTRO FUSION FLEX RESTRAINT AND CONCRETE COLLAR PER MANUFACTURER'S RECOMMENDATIONS.
2. PROVIDE SHOP DRAWINGS AND INSTALLATION INSTRUCTIONS FOR ALL COMPONENTS OF CONNECTION.

DETAIL (2) PLAN VIEW - HDPE TO DIP CONNECTION
NTS



SECTION (C) SEWAGE EFFLUENT PUMP STATION
1/2"=1'-0"

NOTES:
1. SLAB, WALL, AND ANTI-FLOTATION COLLAR DIMENSIONS SHOWN AS MINIMUMS. ACTUAL DIMENSIONS AS REQUIRED BY DESIGN CALCULATIONS IN VAULT SUBMITTALS.
2. EXTERIOR SURFACE OF PRECAST VAULTS SHALL BE COATED WITH BITUMASTIC COATING.
3. INTERIOR SURFACE OF PUMP VAULT SHALL BE COATED WITH TWO COATS OF CEMENTITIOUS SEALANT MATERIAL (DRYCON OR EQUAL).
4. ALL EXCAVATED AREAS TO BE BACKFILLED WITH AASHTO #57 STONE.

GRAPHIC SCALE
2 0 2 4
(IN FEET)
1 inch = 2 ft.

THESE RECORD DRAWINGS DATED 01/17/20 AND TITLED "FOR RECORD" HAVE BEEN DEVELOPED FROM AS-BUILT MARKUPS AND MAY NOT REPRESENT THE FINAL PROJECT, AS CONSTRUCTED, IN EVERY DETAIL. THESE RECORD DRAWINGS HAVE BEEN PREPARED BASED ON INFORMATION SUPPLIED BY OTHERS AND THE ENGINEER HAS NOT VERIFIED THE ACCURACY OR COMPLETENESS OF THE INFORMATION.
3

NO.	DATE	REVISION	DWN	CHD	EXD	RVWD	APVD	W.A.
3	01-17-20	FOR RECORD	AWF	DEM				FCC06814
2	7-17-19	SEWERLINE DELETED	AWF	DEM				FCC06814
1	12-17-18	REVISED PUMP INFO	LDB	DEM			RPS	

AECOM
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Phoenix, Arizona 85020
(602) 371-1100

WORK SAFELY TODAY

NMOC 811 Dial 8-1-1 or 1-800-321 2537

FOUR CORNERS POWER PLANT
RETURN WATER POND

MECHANICAL SEWAGE EFFLUENT PUMPING STATION PLAN

aps

SCALE AS NOTED DATE 10/04/19

DWN	EXD	APPROVED	W A
CAM	---	RIPAN SAHA	FCC06814
CHD RKS	RVWD ---	DRAWING APPROVED BY	

UNIT	DISC	TYPE	SYS	SUBSYS	NUMBER	SHEET
FC45CM	M	65	WP	AP	200485	36

DRAWING: P:\Projects\Arizona_Public_Service\60566008_FCPP_Return_Water_Pond_SG2\900_CAD_GIS\910_CAD\20-SHEETS\APS_EDCS_Drawings\2_DRAWING_REVISIONS\FC45CM-M-65-WP-AP-200485-36.dwg

SYMBOLS

LIGHTING

- A / 1, a — 2'X4' FLUORESCENT LIGHT FIXTURE
  A = FIXTURE TYPE
  1 = CIRCUIT NUMBER
  a = SWITCH CONTROLLING FIXTURE
- A / 1, a — 1'X4' FLUORESCENT LIGHT FIXTURE
  A = FIXTURE TYPE
  1 = CIRCUIT NUMBER
  a = SWITCH CONTROLLING FIXTURE
- A — 1'X4' WALL MOUNTED FLUORESCENT LIGHT FIXTURE
- A / 1, a — 2'X2' FLUORESCENT LIGHT FIXTURE
  A = FIXTURE TYPE
  1 = CIRCUIT NUMBER
  a = SWITCH CONTROLLING FIXTURE
- 2'X4' FLUORESCENT LIGHT FIXTURE WITH EMERGENCY BALLAST OR EMERGENCY BATTERY PACK
- 1'X4' FLUORESCENT LIGHT FIXTURE WITH EMERGENCY BALLAST OR EMERGENCY BATTERY PACK
- A / A — RECESSED OR CEILING MOUNTED INCANDESCENT LIGHT FIXTURE, LETTER DENOTES FIXTURE TYPE
- A — WALL MOUNTED INCANDESCENT LIGHT FIXTURE, LETTER DENOTES FIXTURE TYPE
- A / a — CEILING OR PENDANT MOUNTED LIGHT FIXTURE, LETTER DENOTES FIXTURE TYPE, SUBSCRIPT INDICATES CONTROL
- X — CEILING MOUNTED DOUBLE FACE EXIT LIGHT, LETTER DENOTES FIXTURE TYPE, ARROW DENOTES DIRECTIONAL ARROWS
- X — CEILING MOUNTED SINGLE FACE EXIT LIGHT
- X — WALL MOUNTED EXIT LIGHT
- EMERGENCY LIGHT FIXTURE, RECHARGEABLE TYPE
- POLE MOUNTED LUMINAIRE
- LT/C — POLE MOUNTED LIGHT WITH CONCRETE BASE

SWITCHES

- S_a — SINGLE POLE SWITCH, 20A, 120/277V, LOWER CASE LETTER DENOTES CONTROL
- S_3 — THREE-WAY SWITCH, 20A, 120/277V
- S_4 — FOUR-WAY SWITCH, 20A, 120/277V
- S_D — DIMMER SWITCH, 1500 WATT (FLUORESCENT TYPE) UNLESS OTHERWISE NOTED
- S_T — MOTOR RATED SWITCH, WITH THERMAL OVERLOAD PROTECTION
- OS — WALL MOUNTED OCCUPANCY SENSOR WITH OVERRIDE SWITCH (LIGHTING)
- OS — CEILING MOUNTED ULTRASONIC OCCUPANCY SENSOR (LIGHTING)
- MD — MOTION DETECTOR
- MOTION DETECTOR
- 30A — NON-FUSIBLE DISCONNECT SWITCH, NUMBER INDICATES SWITCH SIZE
- F — FUSIBLE DISCONNECT SWITCH
- T — THERMOSTAT

GROUNDING/LIGHTNING PROTECTION

- AIR TERMINAL
- CONNECTION POINT
- EXOTHERMIC WELD
- GROUND CONNECTION
- GROUNDING ROD
- GROUNDING BUS BAR

PANELBOARDS/POWER EQUIPMENT

- T — PAD MOUNTED TRANSFORMER
- LP-x — LIGHTING PANELBOARD
- PP-x — POWER PANELBOARD
- 1 — MOTOR, NUMBER INDICATES HORSEPOWER

RECEPTACLES/J-BOXES

- 20A, 120V, SIMPLEX RECEPTACLE
- 20A, 120V, DUPLEX RECEPTACLE
- GFCI WP — 20A, 120V, GROUND FAULT CIRCUIT INTERRUPTER DUPLEX RECEPTACLE WITH WEATHERPROOF COVER
- 20A, 120V, DUPLEX RECEPTACLE, CEILING MOUNTED
- 20A, 120V, DUPLEX RECEPTACLE, IN FLOOR BOX
- 20A, 120V, DOUBLE DUPLEX RECEPTACLE
- 20A, 120V, DOUBLE DUPLEX RECEPTACLE, CEILING MOUNTED
- 20A, 120V, DOUBLE DUPLEX RECEPTACLE, IN FLOOR BOX
- SPECIAL PURPOSE RECEPTACLE, GROUNDING TYPE, WALL MOUNTED (NEMA TYPE & AMP RATING AS NOTED)
- SPECIAL PURPOSE RECEPTACLE, GROUNDING TYPE, CEILING MOUNTED (NEMA TYPE & AMP RATING AS NOTED)
- J — JUNCTION BOX, RECESSED/CEILING MOUNTED
- J — JUNCTION BOX, WALL MOUNTED
- JUNCTION BOX, FLUSH IN FLOOR
- HOME RUN WITH 1 NEUTRAL, 1 HOT, 1 GROUND

COMMUNICATIONS/SPECIAL SYSTEMS

- COMBINATION TELEPHONE/DATA OUTLET, WALL MOUNTED (1 VOICE; 2 DATA JACKS)
- COMBINATION TELEPHONE/DATA OUTLET, IN FLOOR BOX (1 VOICE; 2 DATA JACKS)
- C — UNDERGROUND COMMUNICATIONS DUCTS
- TELEPHONE OUTLET, WALL MOUNTED
- CCTV CAMERA, WALL MOUNTED
- PA WP — EXTERIOR PUBLIC ADDRESS SPEAKER
  WP = WEATHERPROOF
- S — WALL MOUNTED SPEAKER
- S — CEILING SPEAKER, FLUSH MOUNTED
- IC — INTERCOM OUTLET, WALL MOUNTED
- (#) — DATA OUTLET, WALL MOUNTED (# REFERS TO QUANTITY IF MORE THAN ONE)

FIRE ALARM SYSTEM

- FACP — FIRE ALARM CONTROL PANEL
- FAAN — FIRE ALARM ANNUNCIATOR PANEL
- F — FIRE ALARM MANUAL PULL STATION, WALL MOUNTED
- F — FIRE ALARM BELL, WALL MOUNTED
- F — FIRE ALARM HORN/STROBE, ONE ASSEMBLY, WALL MOUNTED
- F — FIRE ALARM FLASHING STROBE LIGHT, WALL MOUNTED
- D — DUCT DETECTOR
- FIRE ALARM HEAT DETECTOR, COMBINATION TYPE, CEILING MOUNTED
- 2 — SMOKE DETECTOR
- TS — TAMPER SWITCH
- FS — FLOW SWITCH
- PS — PRESSURE SWITCH
- END OF LINE RESISTOR

ONE-LINE DIAGRAM

- 480 Δ / 208Y/120 — 45 KVA — TRANSFORMER, DELTA-WYE CONNECTION
- 100AF / 100AT — CIRCUIT BREAKER
  AF = FRAME RATING IN AMPERES
  AT = TRIP RATING IN AMPERES
- 100A — DISCONNECT SWITCH, RATED AS NOTED
- 20A — FUSE, RATING AS NOTED
- DRAWOUT BREAKER
- MANUAL OR AUTOMATIC TRANSFER SWITCH
- CONNECTION POINT
- 1 / 30A — COMBINATION MAGNETIC STARTER
  1 = INDICATES NEMA STARTER SIZE
  30A = INDICATES DISCONNECT RATING
- 1 — MAGNETIC STARTER
  1 = INDICATES NEMA STARTER SIZE
- E — UNDERGROUND ELECTRICAL
- E PRI — UNDERGROUND ELECTRICAL
  PRIMARY POWER CIRCUIT IN CONCRETE ENCASED DUCT

ABBREVIATIONS

A	AMPERE
AD	AIR DRYER
A.F.F.	ABOVE FINISHED FLOOR
A.F.G.	ABOVE FINISHED GRADE
AIC	AMPERES INTERRUPTING CAPACITY
APPROX	APPROXIMATELY
AWG	AMERICAN WIRE GAUGE
BC	BARE COPPER
C	CONDUIT
CA	AIR COMPRESSOR
CCT	CIRCUIT
CB	CIRCUIT BREAKER
CKT	CIRCUIT
℄	CENTER LINE
CO	CONDUIT ONLY
CONC	CONCRETE
CT	CURRENT TRANSFORMER
CU	COPPER
CWP	WATER CONDENSOR
DWP	DOMESTIC WATER PUMP
(E)	EXISTING
EF	EXHAUST FAN
EMH	ELECTRICAL MANHOLE
EMCS	ENERGY MONITORING AND CONTROL SYSTEM
EP	HAZARDOUS CLASSIFICATION - EXPLOSION PROOF
EWC	ELECTRIC WATER COOLER
FA	FIRE ALARM
FACP	FIRE ALARM CONTROL PANEL
FC	FAN COIL
FLR	FLOOR
FT	FEET
GA	GAUGE
GFCI	GROUND FAULT CIRCUIT INTERRUPTER
GND	GROUND
GRS	GALAVANIZED RIDGID STEEL
HID	HIGH INTENSITY DISCHARGE
HH	HANDHOLE
HPF	HIGH POWER FACTOR
HP	HEAT PUMP
HPS	HIGH PRESSURE SODIUM
IN	INCHES
INCAND	INCANDESCENT
KCMIL	THOUSAND CIRCULAR MILLS
KVA	KILOVOLT AMPERE
KWH	KILOWATT-HOUR
LAN	LOCAL AREA NETWORK
LT	LONG TIME
LP	LIGHTING PANEL
M	METER
MAX	MAXIMUM
MCC	MOTOR CONTROL CENTER
MDP	MAIN DISTRIBUTION PANELBOARD
MIN	MINIMUM
mm	MILLIMETER
N/A	NOT APPLICABLE
NIC	NOT IN CONTRACT
OC	ON CENTER
OCEW	ON CENTER EACH WAY
OH	OVERHEAD
O/P	OUTPUT
PA	PUBLIC ADDRESS
PB	PULL BOX
PR	PAIR
PSI	POUNDS PER SQUARE INCH
PT	POTENTIAL TRANSFORMER
PP	POWER PANEL / POWER POLE
PVC	POLYVINYL CHLORIDE
RGS	RIGID GALVANIZED STEEL
RH	RADIANT HEATER
RM	ROOM
RMS	ROOT MEAN SQUARE
RP	RECEPTACLE PANEL
RSC	RIGID STEEL CONDUIT
ST	SHORT TIME
SYM	SYMMETRICAL
T	TRANSFORMER
TC	TERMINAL CABINET
TTB	TELEPHONE TERMINAL BOARD
TVSS	TRANSIENT VOLTAGE SURGE SUPPRESSION & FILTERING
TW/SHLD	TWISTED SHIELDED
TYP	TYPICAL
UH	UNIT HEATER
UON	UNLESS OTHERWISE NOTED
V	VOLT
VMS	VARIABLE MESSAGE SIGN
W	WATT-WIM
W/	WITH
WP	WEATHERPROOF
XP	EXPLOSION PROOF
XFMR	TRANSFORMER

GENERAL CONSTRUCTION NOTES:

1. CALL BEFORE YOU DIG IN THE STATE OF NEW MEXICO. CALL 1-800-321-ALERT FOR THE NEW MEXICO ONE CALL SYSTEM.
2. MINIMUM POWER CABLE SIZE FOR THIS INSTALLATION SHALL BE #12 AWG.
3. MINIMUM CONDUIT SIZE IS 3/4".

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1

NO.	DATE	REVISION	DWN	CHD	EXD	RVWD	APVD	W.A.
1	01-17-20	FOR RECORD	AWF	DEM				FCC06814

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7720 N. 16th Street Suite 100
Phoenix, Arizona 85020
(602) 371-1100

NMOC 811 Dial 8-1-1 or 1-800-321 2537

WORK SAFELY TODAY

FOUR CORNERS POWER PLANT
RETURN WATER POND

ELECTRICAL LEGEND

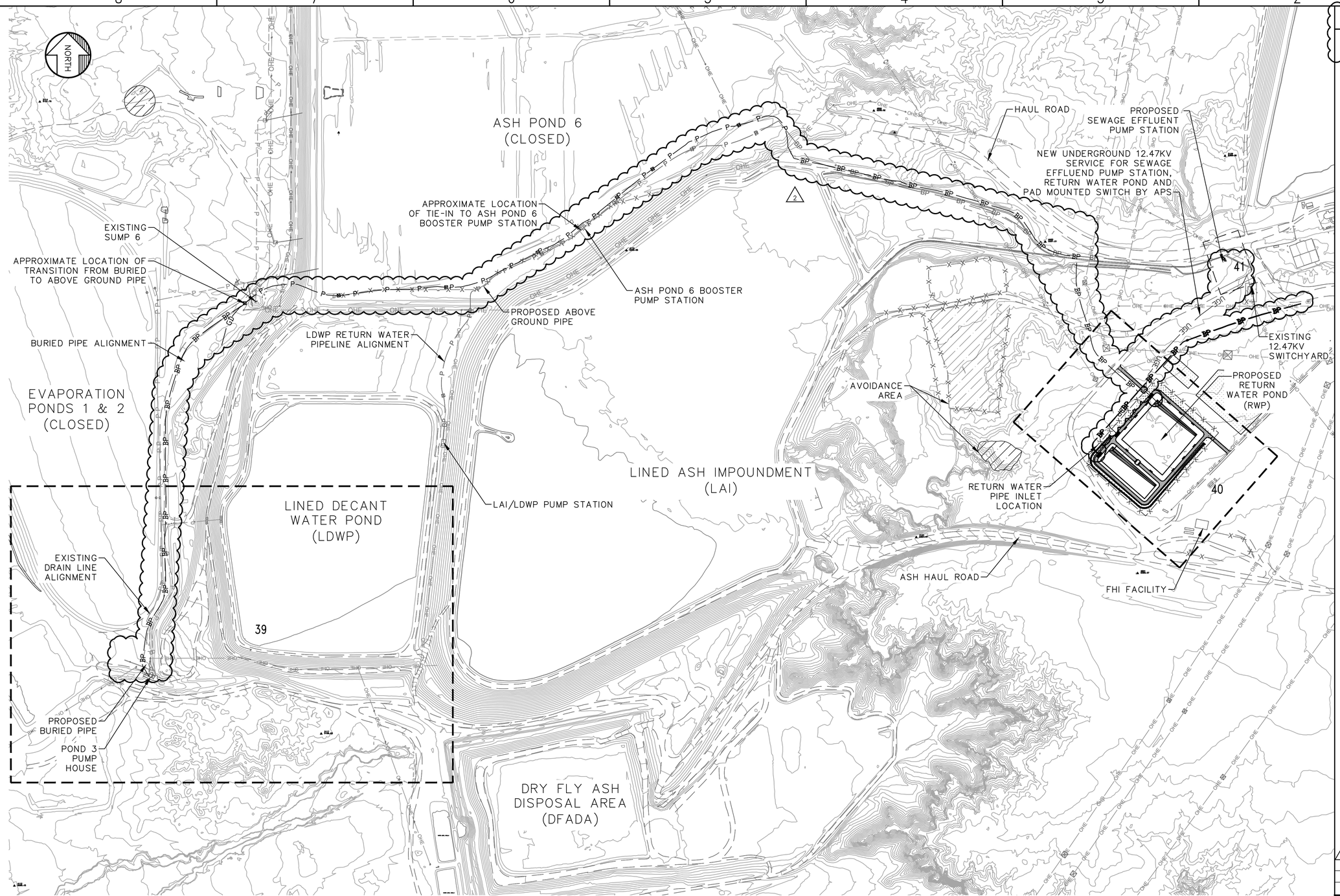
aps

SCALE NONE DATE 10/04/19

DWN	EXD	APPROVED	W A
LDB	---	GENE MOE	FCC06814
CHD DEM	RVWD ---	DRAWING APPROVED BY	

UNIT	DISC	TYPE	SYS	SUBSYS	NUMBER	SHEET
FC45CM	E	98	WP	AP	200485	37

DRAWING: P:\Projects\Arizona_Public_Service\60566008_FCPP_Return_Water_Pond_SG2\900_CAD_GIS\910_CAD\20-SHEETS\APS_EDCS_Drawings\2_DRAWING_REVISIONS\FC45CM-E-98-WP-AP-200485-37.dwg



ELECTRIAL PLAN VIEW
SCALE: 1"=300' (FULL SIZE)

GRAPHIC SCALE
300 0 300 600
(IN FEET)
1 inch = 300 ft.

CONSTRUCTION NOTES:

1. AS-BUILT LINES, GRADES, AND POINTS CAN BE FOUND IN APS DRAWING NUMBER FC00CM-C-17-SF-RG-100003-101.

△2

△2 THESE RECORD DRAWINGS DATED 01/17/20 AND TITLED "FOR RECORD" HAVE BEEN DEVELOPED FROM AS-BUILT MARKUPS AND MAY NOT REPRESENT THE FINAL PROJECT, AS CONSTRUCTED, IN EVERY DETAIL. THESE RECORD DRAWINGS HAVE BEEN PREPARED BASED ON INFORMATION SUPPLIED BY OTHERS AND THE ENGINEER HAS NOT VERIFIED THE ACCURACY OR COMPLETENESS OF THE INFORMATION.

NO.	DATE	REVISION	DWN	CHD	EXD	RVWD	APVD	W.A.
2	01-17-20	FOR RECORD	AWF	DEM				FCC06814
1	5-16-19	CHANGE TO GROUNDED Y SERVICE	LDB	DEM			EDM	

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(602) 371-1100

NMOC 811
Dial 8-1-1 or 1-800-321 2537

WORK SAFELY TODAY

FOUR CORNERS POWER PLANT
RETURN WATER POND

ELECTRICAL OVERALL SITE KEY PLAN

aps

SCALE 1" = 300' DATE 10/04/19

DWN	EXD	APPROVED	W A
LDB	---	GENE MOE	FCC06814
CHD DEM	RVWD ---	DRAWING APPROVED BY	

UNIT	DISC	TYPE	SYS	SUBSYS	NUMBER	SHEET
FC45CM	E	16	WP	AP	200485	38

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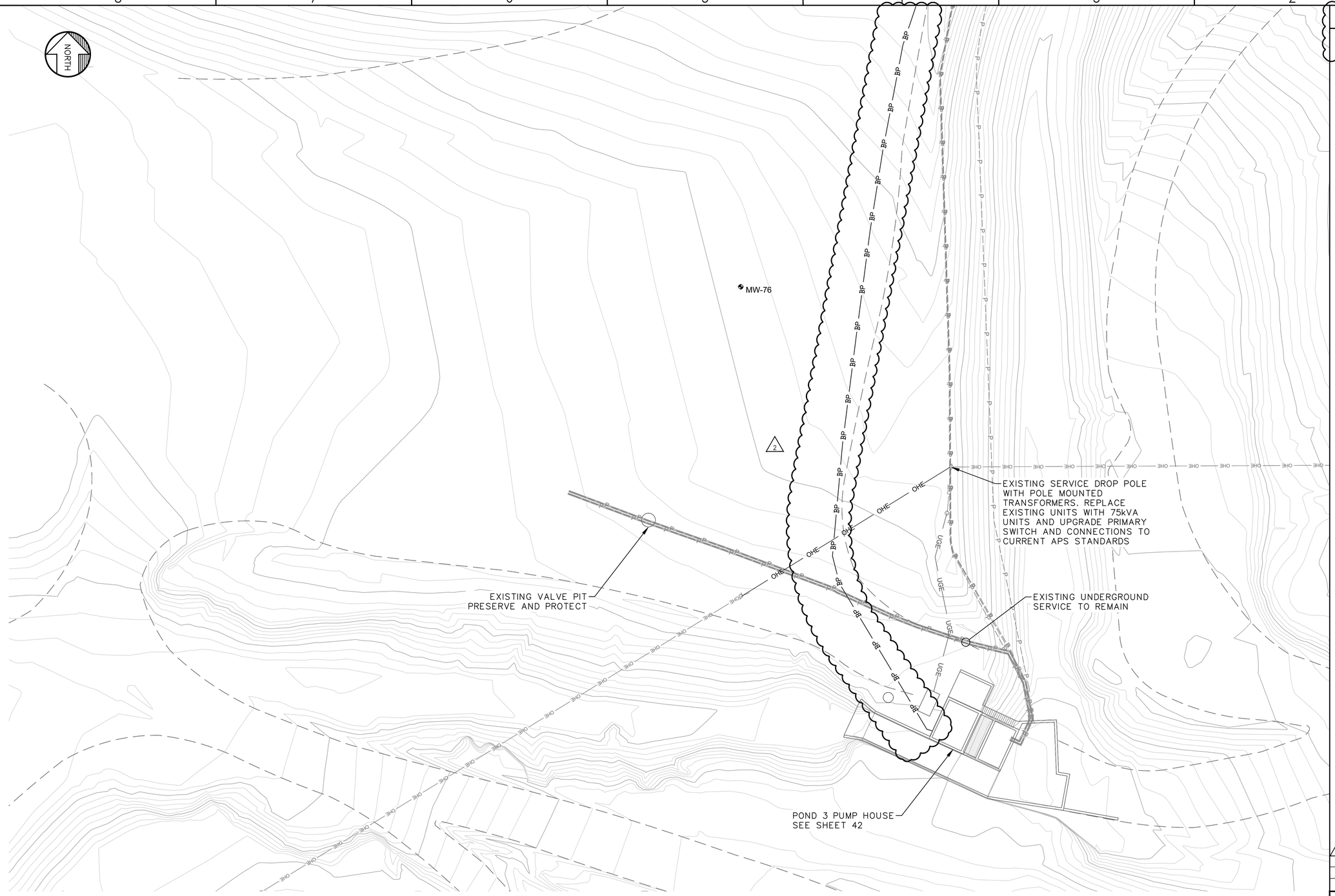

PLAN VIEW
SCALE: 1"=20' (FULL SIZE)

GRAPHIC SCALE
20 0 20 40
(IN FEET)
1 inch = 20 ft.

CONSTRUCTION NOTES:

1. AS-BUILT LINES, GRADES, AND POINTS CAN BE FOUND IN APS DRAWING NUMBER FC00CM-C-17-SF-RG-100003-101.

2

THESE RECORD DRAWINGS DATED 01/17/20 AND TITLED "FOR RECORD" HAVE BEEN DEVELOPED FROM AS-BUILT MARKUPS AND MAY NOT REPRESENT THE FINAL PROJECT, AS CONSTRUCTED. IN EVERY DETAIL. THESE RECORD DRAWINGS HAVE BEEN PREPARED BASED ON INFORMATION SUPPLIED BY OTHERS AND THE ENGINEER HAS NOT VERIFIED THE ACCURACY OR COMPLETENESS OF THE INFORMATION.

2

NO.	DATE	REVISION	DWN	CHD	EXD	RVWD	APVD	W.A.
2	01-17-20	FOR RECORD	AWF	DEM				FCC06814
1	5-16-19	CHANGE TO GROUNDED Y SERVICE	LDB	DEM			EDM	

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Phoenix, Arizona 85020
(602) 371-1100

FOUR CORNERS POWER PLANT
RETURN WATER POND

ELECTRICAL POND 3 SITE PLAN

aps

SCALE 1" = 20' DATE 10/04/19

DWN	EXD	APPROVED	W A
LDB	---	GENE MOE	FCC06814
CHD	RVWD	DRAWING APPROVED BY	
DEM	---		

UNIT	DISC	TYPE	SYS	SUBSYS	NUMBER	SHEET
FC45CM	E	16	WP	AP	200485	39

WORK SAFELY TODAY

NMOC 811 Dial 8-1-1 or 1-800-321 2537

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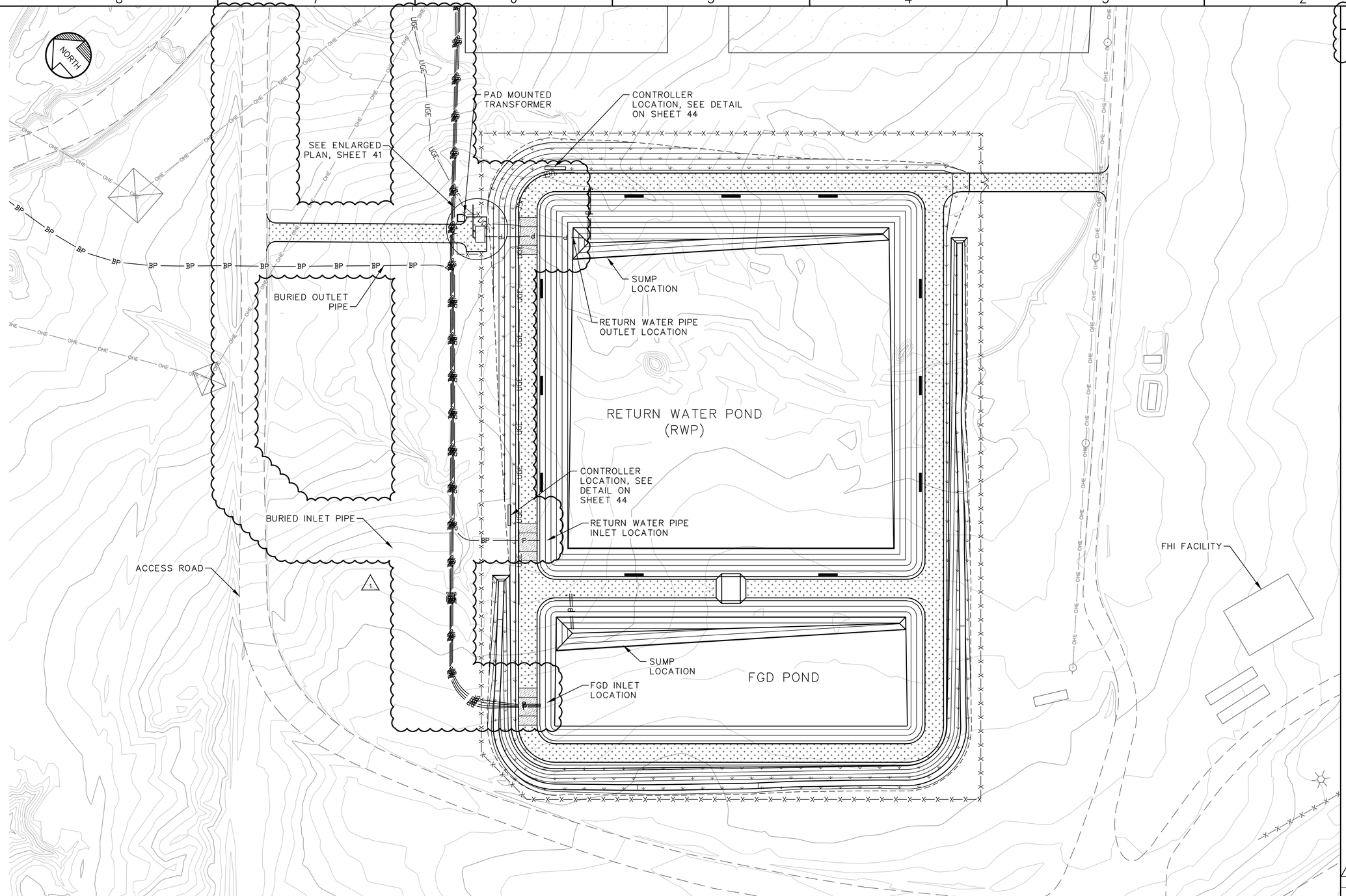


PLAN VIEW
SCALE: 1"=50' (FULL SIZE)

GRAPHIC SCALE
50 0 50 100
(IN FEET)
1 inch = 50 ft.

CONSTRUCTION NOTES:

1. AS-BUILT LINES, GRADES, AND POINTS CAN BE FOUND IN APS DRAWING NUMBER FC00CM-C-17-SF-RG-100003-101.

THESE RECORD DRAWINGS DATED 01/17/20 AND TITLED "FOR RECORD" HAVE BEEN DEVELOPED FROM AS-BUILT MARKUPS AND MAY NOT REPRESENT THE FINAL PROJECT, AS CONSTRUCTED, IN EVERY DETAIL. THESE RECORD DRAWINGS HAVE BEEN PREPARED BASED ON INFORMATION SUPPLIED BY OTHERS AND THE ENGINEER HAS NOT VERIFIED THE ACCURACY OR COMPLETENESS OF THE INFORMATION.

NO.	DATE	REVISION	DWN	CHD	EXD	RVWD	APVD	W.A.
1	01-17-20	FOR RECORD	AWF	DEM				FCC06814

AECOM
7720 N. 16th Street Suite 100
Phoenix, Arizona 85020
(602) 371-1100

WORK SAFELY TODAY

NMOC 811 Dial 8-1-1 or 1-800-321 2537

FOUR CORNERS POWER PLANT
RETURN WATER POND

ELECTRICAL RETURN WATER POND PLAN

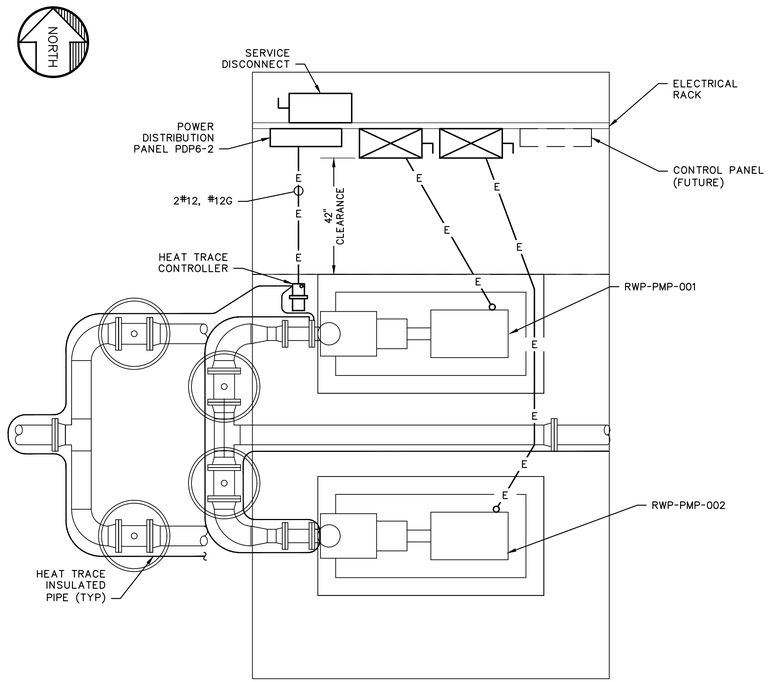
aps

SCALE 1" = 50' DATE 10/04/19

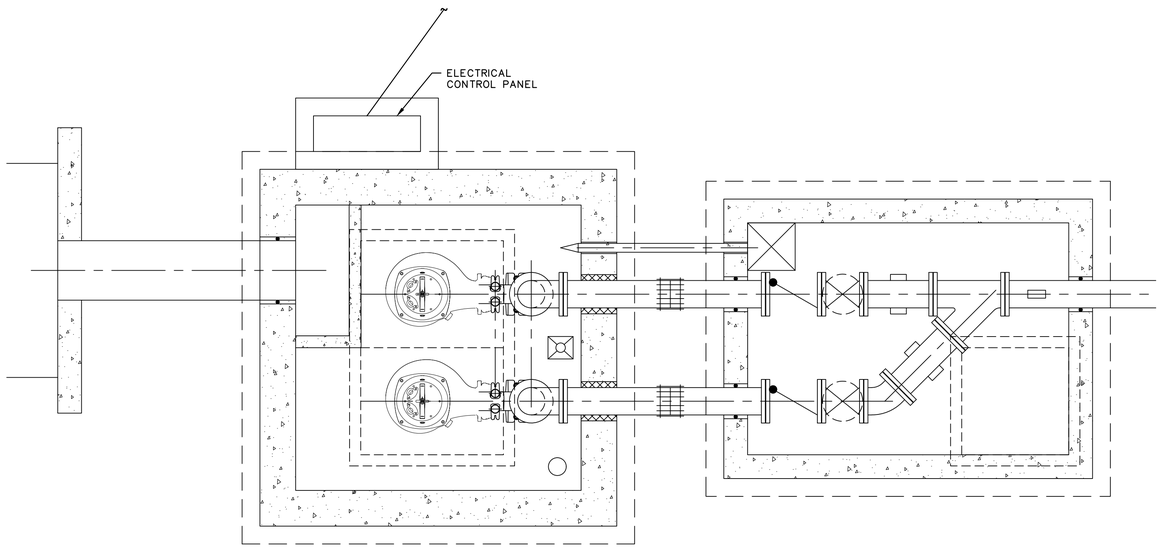
DWN	EXD	APPROVED	W A
LDB	---	GENE MOE	FCC06814
CHD	RVWD	DRAWING APPROVED BY	
DEM	---		

UNIT	DISC	TYPE	SYS	SUBSYS	NUMBER	SHEET
FC45CM	E	16	WP	AP	200485	40

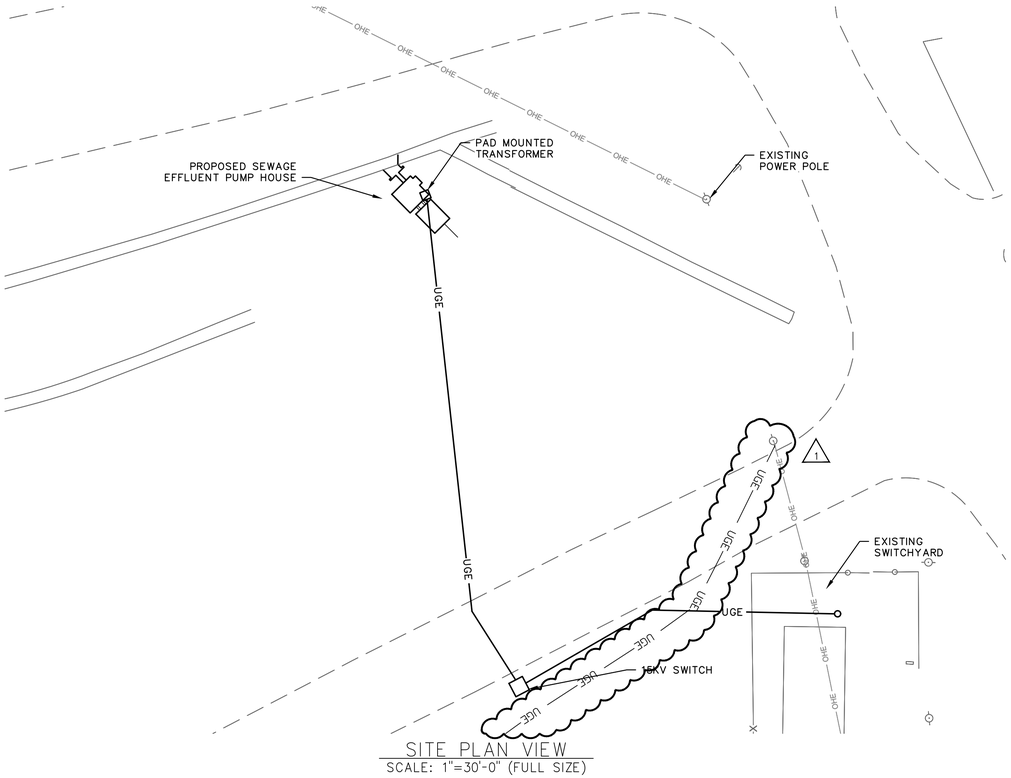
DRAWING: P:\Projects\Arizona_Public_Service\60566008_FCPP_Return_Water_Pond_SG2\900_CAD_GIS\910_CAD\20-SHEETS\APS_EDCS_Drawings\2_DRAWING_REVISIONS\FC45CM-E-16-WP-AP-200485-40.dwg



PLAN VIEW
SCALE: 1/2"=1'-0" (FULL SIZE)



PLAN VIEW
SCALE: 1/2"=1'-0" (FULL SIZE)



SITE PLAN VIEW
SCALE: 1"=30'-0" (FULL SIZE)

GENERAL NOTES:

1. REFER TO SHEET 43 FOR CONDUIT/CABLE INFORMATION.
2. AS-BUILT LINES, GRADES, AND POINTS CAN BE FOUND IN APS DRAWING NUMBER FC00CM-C-17-SF-RG-100003-101.

△1

THESE RECORD DRAWINGS DATED 01/17/20 AND TITLED "FOR RECORD" HAVE BEEN DEVELOPED FROM AS-BUILT MARKUPS AND MAY NOT REPRESENT THE FINAL PROJECT, AS CONSTRUCTED, IN EVERY DETAIL. THESE RECORD DRAWINGS HAVE BEEN PREPARED BASED ON INFORMATION SUPPLIED BY OTHERS AND THE ENGINEER HAS NOT VERIFIED THE ACCURACY OR COMPLETENESS OF THE INFORMATION.

△1

NO.	DATE	REVISION	DWN	CHD	EXD	RVWD	APVD	W.A.
1	01-17-20	FOR RECORD	AWF	DEM				FCC06814

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(602) 371-1100

FOUR CORNERS POWER PLANT
RETURN WATER POND

RWP AND SEWAGE EFFLUENT PUMPING STATION PLANS

aps

SCALE 1/2" = 1'-0" DATE 10/04/19

DWN	EXD	APPROVED	W A
LDB	---	GENE MOE	FCC06814
CHD DEM	RVWD ---	DRAWING APPROVED BY	

UNIT	DISC	TYPE	SYS	SUBSYS	NUMBER	SHEET
FC45CM	E	16	WP	AP	200485	41

NMOC 811 Dial 8-1-1 or 1-800-321 2537

WORK SAFELY TODAY

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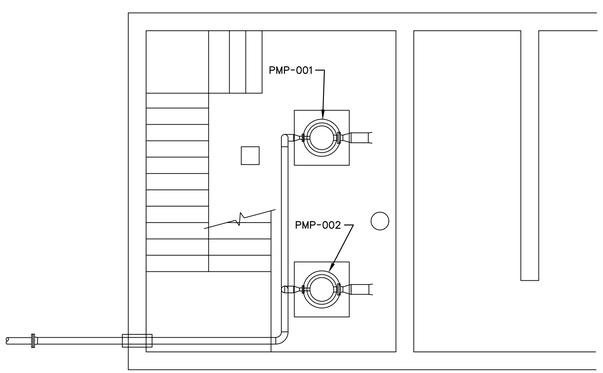
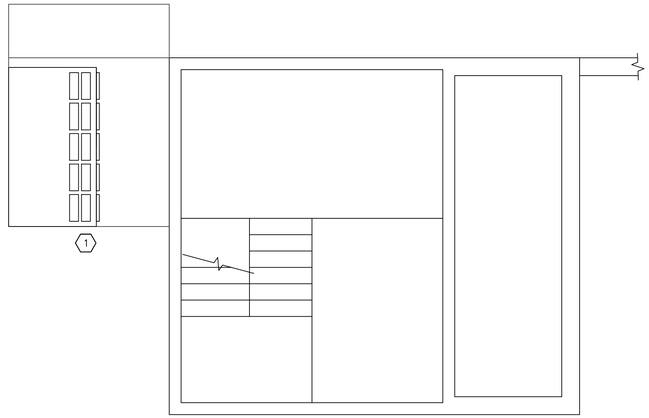


ELECTRICAL LOWER LEVEL PLAN
SCALE: 1/4"=1'-0" (FULL SIZE)



ELECTRICAL UPPER LEVEL PLAN
SCALE: 1/4"=1'-0" (FULL SIZE)

CONSTRUCTION NOTES:

1. THE CONTRACTOR SHALL FIELD VERIFY ALL EXISTING CONDITIONS, DIMENSIONS, AND ELEVATIONS PRIOR TO START OF CONSTRUCTION AS REQUIRED TO COORDINATE NEW CONSTRUCTION. NOTIFY ENGINEER OF ANY DISCREPANCIES OR CONFLICTS FOUND IN CONTRACT DOCUMENTS AND/OR FIELD CONDITIONS.

KEY NOTES:

(1) NEW MCC BUS, 800A, 480V/3Φ/3W, 65kAIC.

GRAPHIC SCALE
4 0 4 8
(IN FEET)
1 inch = 4 ft.

NMOC 811
Dial 8-1-1 or 1-800-321 2537

AECOM
7720 N. 16th Street Suite 100
Phoenix, Arizona 85020
(602) 371-1100

WORK SAFELY TODAY

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1

NO.	DATE	REVISION	DWN	CHD	EXD	RVWD	APVD	W.A.
1	01-17-20	FOR RECORD	AWF	DEM				FCC06814

FOUR CORNERS POWER PLANT
RETURN WATER POND

ELECTRICAL ASH DISPOSAL PUMPING STATION PLAN

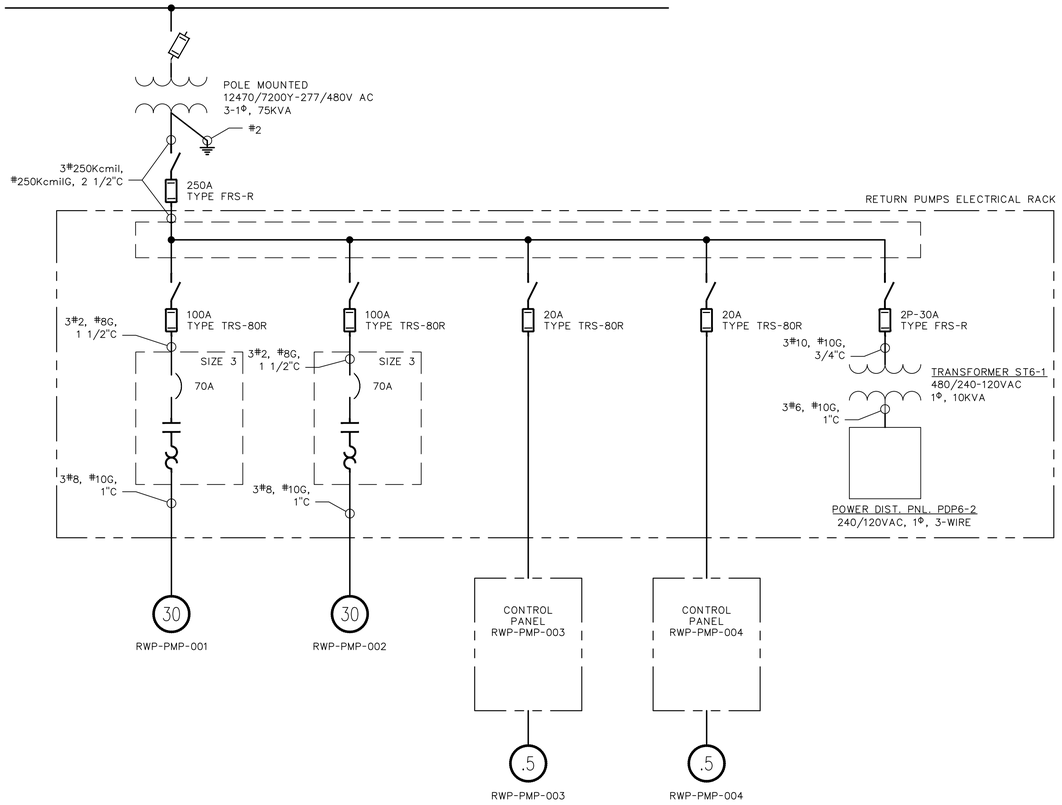
aps

SCALE 1/4" = 1'-0" DATE 10/04/19

DWN	EXD	APPROVED	W A
LDB	---	GENE MOE	FCC06814
CHD	RVWD	DRAWING APPROVED BY	
DEM	---		

UNIT	DISC	TYPE	SYS	SUBSYS	NUMBER	SHEET
FC45CM	E	16	WP	AP	200485	42

DRAWING: P:\Projects\Arizona_Public_Service\60566008_FCPP_Return_Water_Pond_SG2\900_CAD_GIS\910_CAD\20-SHEETS\APS_EDCS_Drawings\2_DRAWING_REVISIONS\FC45CM-E-16-WP-AP-200485-42.dwg



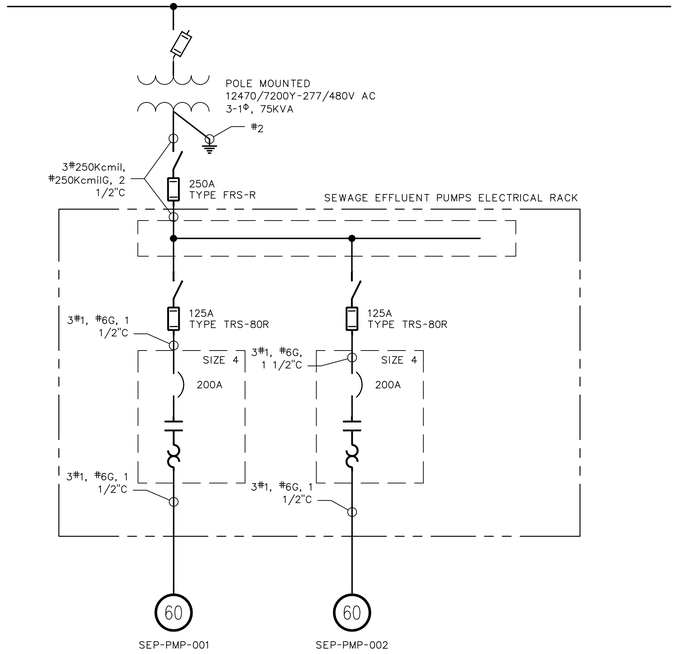
ONE-LINE DIAGRAM (1/-) RETURN WATER PUMP STATION
NTS

PANEL: PDP6-2 PHASE: 1 WIRE: 3 WITH GROUND LOCATION: RETURN PUMPS EQUIPMENT RACK
TYPE: NEMA 3R
VOLTAGE: 240 / 120 V MAIN CIRCUIT BREAKER: 60A MCB MOUNTING: SURFACE
SPD: YES BREAKER TYPE: BOLT ON
BUSSING AMPS: ## FED FROM: 10KVA TRANSF'R PANEL DEVICE MIN. RATING: 10,000 A RMS SYMMETRICAL

DESCRIPTION	BRANCH CHARACTERISTICS LOAD VA A	LOAD VA B	BKR TR	CCT NO	Ø	CCT NO	BKR TR	LOAD VA A	LOAD VA B	DESCRIPTION
LIGHTS	300.		20	1	A	2	20	360.		RECEPTACLES
CONTROL PANEL (FUTURE)		500.	20	3	B	4	20		750.	HEAT TRACE
SPARE			20	5	A	6	20			SPARE
SPARE			20	7	B	8	20			SPARE
SPACE			20	9	A	10				SPACE
SPACE				11	B	12				SPACE
SPACE				13	A	14				SPACE
SPACE				15	B	16				SPACE
SPACE				17	A	18				SPACE
SPACE				19	B	20				SPACE
SPACE				21	A	22				SPACE
SPACE				23	B	24				SPACE
	300	500						360	750	

TOTAL CONNECTED VA:
PHASE A= 660
PHASE B= 1250
SUBTOTAL = 1910 SECTION 1
SECTION 2
TOTAL = 1910 LESS MOTOR STARTING

TOTAL CONNECTED AMPS 8.0 A MANUFACTURER AND TYPE
TOTAL DEMAND AMPS 8.0 A 8.0 A X 125% FUTURE 8.9 A
TOTAL DEMAND VA = 1910 VA X 125% FUTURE = 2387.5 VA
MOTOR STARTING AMPS 0



ONE-LINE DIAGRAM (2/-) SEWAGE EFFLUENT PUMP STATION
NTS

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NO.	DATE	REVISION	DWN	CHD	EXD	RVWD	APVD	W.A.
3	01-17-20	FOR RECORD	AWF	DEM				FCC06814
2	5-16-19	CHANGE TO GROUNDED Y SERVICE	LDB	DEM			EDM	
1	12-14-18	REVISED PUMP INFO	LDB	DEM			EDM	

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FOUR CORNERS POWER PLANT
RETURN WATER POND

ELECTRICAL ONE-LINE DIAGRAMS

aps

SCALE NONE DATE 10/04/19

DWN	EXD	APPROVED	W A
LDB	---	GENE MOE	FCC06814
CHD	RVWD	DRAWING APPROVED BY	
DEM	---		

UNIT	DISC	TYPE	SYS	SUBSYS	NUMBER	SHEET
FC45CM	E	01	WP	AP	200485	43

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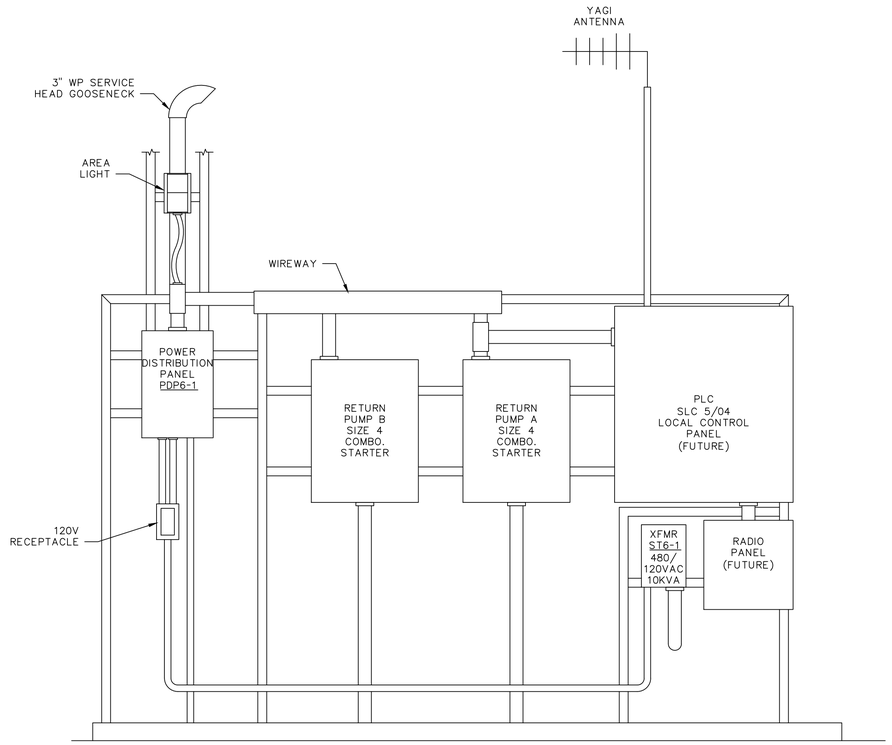
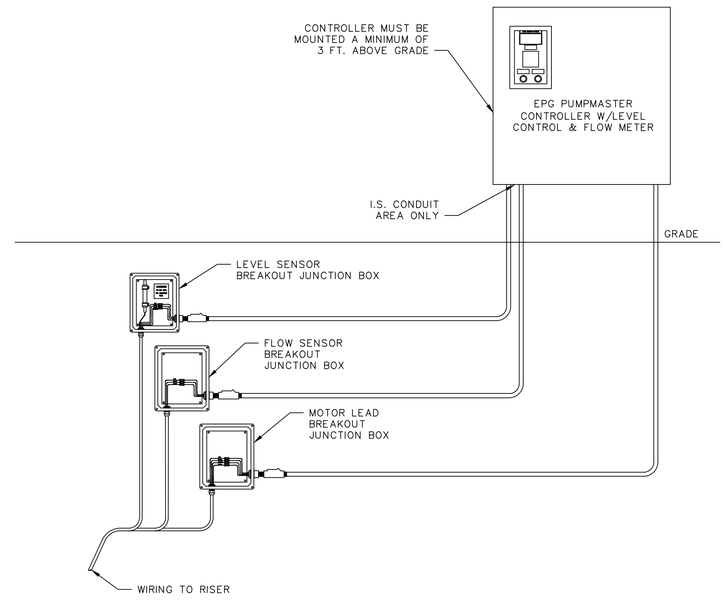


DETAIL (1/42) RETURN PUMPS EQUIPMENT RACK
NTS



DETAIL (2/35) LCRS PUMP EQUIPMENT RACK
NTS

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NO.	DATE	REVISION	DWN	CHD	EXD	RVWD	APVD	W.A.
1	01-17-20	FOR RECORD	AWF	DEM				FCC06814

FOUR CORNERS POWER PLANT
RETURN WATER POND

ELECTRICAL DETAILS

AECOM
7720 N. 16th Street Suite 100
Phoenix, Arizona 85020
(602) 371-1100

aps

SCALE NONE DATE 10/04/19

DWN	EXD	APPROVED	W A
LDB	---	GENE MOE	FCC06814
CHD	RVWD	DRAWING APPROVED BY	
DEM	---		

UNIT	DISC	TYPE	SYS	SUBSYS	NUMBER	SHEET
FC45CM	E	49	WP	AP	200485	44

WORK SAFELY TODAY

NMOC 811 Dial 8-1-1 or 1-800-321 2537

DRAWING: P:\Projects\Arizona_Public_Service\60566008_FCPP_Return_Water_Pond_SG2\900_CAD_GIS\910_CAD\20-SHEETS\APS_EDCS_Drawings\2_DRAWING_REVISIONS\FC45CM-E-49-WP-AP-200485-44.dwg

M O T O R C O N T R O L C E N T E R

TO ONELINE DWG.#B-39117

3 - 1Φ XFMRS
75 KVA PER
Φ
7.2KV-480V

4-1/C 250 MCM AA CABLE
(INCLUDING GROUND)

UNDERGROUND ENTRANCE

800/5A

600 A. 480 V 3Ø, 3W, 60 HZ BUS

METERING

A AS

V VS

1A

MAIN BREAKER 600 A.

1B

AIR AGITATION BLOWER #1 1-HP (FUTURE)	SIZE 1 30A	2A	
AIR AGITATION BLOWER # 2 1-HP (FUTURE)	SIZE 1 30A	2B	WET WELL SUMP PUMP A — 100 — 4#2/0, #6G, 2"C — S4 200A — 3A
VENT FAN 1.5HP	SIZE 1 30A	2C	
SPARE	SIZE 1 30A	2D	WET WELL SUMP PUMP B — 100 — 4#2/0, #6G, 2"C — S4 200A — 3B
SPARE	SIZE 1 30A	2E	
SPARE	SIZE 1 30A	2F	SPARE — NOTE 2 — SIZE 3 100A — 3C

30A PUMPING STATION HEATERS 4AL

60A WELDING RECEPTACLE 4AR

100A

70A LIGHTING TRANSFORMER FEEDER 4BR

4BL

LIGHTING PANEL
24 CIRCUIT 3Ø 4-WIRE
208/120V 60 HZ
4C

45 KVA
LIGHTING XFMR.
3Ø 60 HZ
PRI. 480V
SEC. 208/120V
2-PRI. TAP ± 2 1/2%
ABOVE AND BELOW
4D

BLANK 5A

BLANK 5B

20A DRY WELL SUMP PUMP "A"

20A DEWATERING WELL PUMPS #1 & #2

5CL 5CR

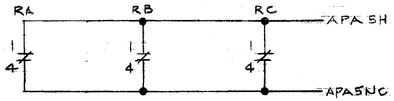
30A DRY WELL SUMP PUMP "B"

60A

5DL 5DR

FULLY EQUIPPED FOR FUTURE SIZE 3 — 5E

TEMP GROUND DETECTOR MOUNTED IN SECT. IA METERING PANEL



PLAN VIEW

600 A. HORIZ. BUS

1	2	3	4	5
METERING & GROUND DETECTOR 1A	2A SIZE 1	SIZE 4 3A	A CIR BKR 30A L / CIR BKR 60A R	5A SIZE 2
			B CIR BKR 100A L / CIR BKR 70A R	5B SIZE 2
MAIN BREAKER 800A FRAME 600A TRIP	2B SIZE 1		C 24 CIRCUIT LIGHTING PANEL	CIR BKR 20A 5CL / CIR BKR 20A 5CR
	2C SIZE 1			
	2D SIZE 1	SIZE 4 3B		CIR BKR 30A 5DL / CIR BKR 60A 5DR
UNDERGROUND CABLE ENTRANCE COMPARTMENT	2E SIZE 1		LIGHTING TRANSFORMER 45 KVA 3Ø 60 HZ PRI. 480V SEC. 208/120V	
1B	2F SIZE 1	SIZE 3 3C	4D	SIZE 3 5E

GROUND BUS

ANNUNCIATOR PANEL

8" DEEP BOX

FRONT ELEVATION
480V. MOTOR CONTROL CENTER

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CONSTRUCTION NOTES:

1. EXISTING MCC, 480V/3Φ/3W. REPLACE EXISTING WET WELL PUMP STARTERS WITH NEW UNITS FOR 100HP MOTORS. REBUILD EXISTING MCC UNIT WITH SIZE 4 STARTERS SIMILAR TO A-B BULLETIN 2113.
2. SPARE STARTER CAN BE REMOVED AND TURNED OVER TO APS IF SPACE IS REQUIRED FOR NEW STARTERS.

NO.	DATE	REVISION	DWN	CHD	EXD	RVWD	APVD	W.A.
10	01-17-20	FOR RECORD	AWF	DEM				FC006814
9	5/16/19	CHANGE TO GROUNDED Y	LDB	DEM			EDM	
8	12/14/18	SERVICE MODIFY PUMP INFO	LDB	DEM			EDM	
7	10/04/19	INSTALL NEW PUMPS	LDB	DEM			EDM	
6	04-26-16	TITLE UPDATE	GWB				WAC	FAC90406
5	12/16	REVISED PER AS BUILT	VID	RLM		RLM	[illegible]	04-6540
4	11/16	ADDED ANNUNCIATOR	VJM					
3	2/16	ADDED UPDATED DATA	VID	WRU		RLM		99-4-107-10
2	1/16	ADDED UPDATED DATA	VID	WRU		RLM		99-4-107-10
1	6/15/15	ADDED UPDATED DATA	VID	WRU		RLM		99-4-107-10

FOUR CORNERS COMMON
ASH DISPOSAL
EVAPORATION PONDS MCC

aps

SCALE NONE — DATE 5-24-76

WORK SAFELY TODAY

DWN	VID
CHD	WRU
EXD	PBP
RVWD	XXX
APPROVED	XXX
DRAWING APPROVED BY	
W A	99-4-107-10

UNIT	DISC	TYPE	SYS	NUMBER	SHEET
FC	E	03	ADS	39128	1

APS DWG. NO.: FC00CM-E-03-HB-BR-39128-1

MOTOR CONTROL CENTER LAYOUT

BILL OF MATERIALS

UNIT NO	ENGRAVED GRAVOPLY NAMEPLATE STANDARD 3/4" x 3-1/4" – MAX. 3 LINES 5/32" HIGH, 20 CHARACTERS PER LINE BLACK CHARACTERS ON WHITE FIELD ☐ OTHER ___	MOTOR OR LOAD KW OR HP	FLA	SIZE	TYPE	CIR. BKR.	TRIP SET.	(4)(3)(7) FSBL SWITCH	FUSE TYPE FUSE CLIPS	OL HTR.	PILOT DEV.	TOTAL AUX NO	NC	CONTROL XFMR VOLT AMPS	FUSE SIZE	CATALOG NUMBER 5642-	WIRING DIAGRAM	NOTE
1A	METERING COMPARTMENT				24" DOOR											WD-56549-B03	⑥
1B	MAIN BREAKER	—	—	—	(1)B BKR	KM3	B600	—	—	—	—	—	—	—	C-DZQ	"	
2A	AIR AGITATION BLOWER #1	1		1	FVNR	EF3	A005 (3.4A)	—	—	3/4 6	2	1	100	2A	DCCAB-1-STR-STG-7-12-26	WD-56549-A-01	
2B	AIR AGITATION BLOWER #2	1		1	FVNR	EF3	A005 (3.4A)	—	—	3/4 6	2	1	100	2A	DCCAE-1-STR-STG-7-12-26	"	
2C	VENT FAN	1.5		1	FVNR	EF3	A006 (4.4A)	—	—	3/4 6	2	1	100	2A	DDCAE-1-STR-STG-1-12-26	"	
2D	SPARE			1	FVNR	EF3	A006 (4.4A)	—	—	3/4 6	2	1	100	2A	DICAB-1-STR-STG-1-12-26	"	
2E	SPARE			1	FVNR	EF3	A006 (4.4A)	—	—	3/4 6	2	1	100	2A	DICAB-1-STR-STG-7-12-26	"	
2F	SPARE			1	FVNR	EF3	A006 (4.4A)	—	—	3/4 6	2	1	100	2A	DICAB-1-STR-STG-1-12-26	"	
3A	MAIN SUMP PUMP #1	100		3	FVNR	EF3	A150 (96A)	—	—	3/4 6	2	1	150	3A		"	
3B	MAIN SUMP PUMP #2	100		3	FVNR	EF3	A150 (96A)	—	—	3/4 6	2	1	150	3A		"	
3C	SPARE			3	FVNR	EF3	A150 (96A)	—	—	3/4 6	2	1	150	3A	DOEAB-1-STR-STG-7-12-26	"	
4AL	PUMPING STATION HEATERS	—	—	—	(2)A BKR	EF3	B030	—	—	—	—	—	—	—	C-DZM-94	AB-SA-100-15	
4AR	WELDING RECEPTACLES	—	—	—	(2)A BKR	EF3	B060	—	—	—	—	—	—	—	C-DZM-94	"	
4BL	BLANK	—	—	—	(2)A BKR	EF3	B100	—	—	—	—	—	—	—	C-DZM-94	"	
4BR	LIGHTING TRANSFORMER FEEDER	—	—	—	(2)A BKR	EF3	B070	—	—	—	—	—	—	—	C-DZM-94	"	
4C	LIGHTING PANEL				24 CIRCUIT			30,4W 208/120V 60HZ							PLUG IN PANEL	WD-56549-B04	⑨
4D	45 KVA LIGHTING TRANSFORMER				45 KVA			XFMR 30-60HZ (480V-208/120V)								"	
5A	BLANK				(2)E SPACE	DOOR											
5B	BLANK				(2)E SPACE	DOOR											
5CL	DRY WELL SUMP PUMP "A"				(2)A BKR	EF3	B020								C-DZM-94	AB-SA-100-15	
5CR	DEWATERING WELL PUMPS #1 & 2				(2)A BKR	EF3	B020								C-DZM-94	"	
5DL	DRY WELL SUMP PUMP "B"				(2)A BKR	EF3	B020								C-DZM-94	"	
5DR	BLANK				(2)A BKR	EF3	B060								C-DZM-94	"	
5E	BLANK				(2)E SPACE	DOOR											
5F	BLANK				(2)E SPACE	DOOR											

PILOT DEVICE SYMBOLS ⑧

SS	START-STOP	HO	HAND-OFF SELECTOR	PB	OFF	A	AMBER PILOT LIGHT	W	WHITE PILOT LIGHT
ST	START	HOA	HAND-OFF-AUTO SELECTOR	R	RED PILOT LIGHT	B	BLUE PILOT LIGHT	K	KEY OPERATED
SP	STOP	FRS	FORWARD-REVERSE-STOP	G	GREEN PILOT LIGHT				

⑧ ADD "X" TO ABOVE SYMBOLS TO INDICATE A SPECIAL CLARIFIED IN NOTES.

VERTICAL SECTIONS

NEMA Class I (1, 11) — Wiring Type B (A, B, C)

Master Terminal Block for Type C Located ___ (Tic: Bottom or Rear)

NEMA Enclosure Type NEMA 3 W.I. (1, 1A, 12) — Depth 15" * (15" Std.)

Equipment Mtg. FRONT ONLY (Front Only, Back to Back) — Shipping Split Between Sections 2 and 3 (Maximum shipping length 100") 4 4 5

Finish ASA No. 61 (ASA No. 61 Gray is Standard) — Wireways: Top 12" (12" Standard) Bottom 6" (6" Standard)

Sliding Shutters: For Vertical Bus NO (Yes or No) — Lifting Angle Furnished: Yes ☒ No ☐

Power Supply 480 Volts 3 Phase 3 Wire 60 Hertz

Bus Amps: Main Hor. 600A. (600 Amp Std.) ☒ Al ☐ Cu (Optional)

Vertical 300 A. (300 Amp Std.) ☒ Al ☐ Cu (Optional)

Braced For: ☒ 42,000 Sym. Standard. ☐ 65,000 Sym. Optional. ☐ 100,000 Sym. Optional.

Ground Bus Ampacity 300A Neutral Bus Ampacity ___

Incoming Cable 1 Per Phase 500 MCM Neutral ___ Ground 2-#4/0 CLAMP TYPE LUG (BURNDY NA2B)
Maximum conduit size top or bottom 3" For larger conduit consult factory

Incoming Bus Duct: Amps ___ Type ___

Terminal Lugs Furnished By ✓ Factory ___ Field CWI PRESSURE Type/Size 500MCM BURNDY YA OR EQUAL

Cables Terminating at Top ___ (Section No.) Bottom 1 (Section No.)

Pull Box Height ☐ 12" ☐ 15" ☐ 18" ☐ Other ___

Main Circuit Breaker 600 AMP (Rating) Fusible Switch ___ (Amperes) Fuse Type ___ (Size)

* EXCEPT SECTION 4 15" 20" DEEP

SPECIFICATIONS

PLUG-IN UNITS

Circuit Breakers: Magnetic Trip STARTERS (ET) Thermal Magnetic Trip BRANCH FEEDERS (ET)

Fused Switch ___
Note: All Fusible Starter Units are Designed Based on Using Dual Element Power Fuse as Standard

If Other, Specify ___

Control Voltage: 120 V ☒ 480 V ☐ Other ___

Control Transformer: Primary Fuse ☐ Secondary Fuse ☒

Wireway Side and Flash Barriers For Plug-In Modules: Yes ☒ No ☐

Control Circuit Wiring ☒ Standard Type THHN 90°C, Color Red, No. 14 AWG
☐ Other, Specify ___

Power Wiring ☒ Standard Type THHN 90°C, Color Black
☐ Other, Specify ___

(P)(2) Terminal Blocks ☐ Standard Connectron Type N3
☒ Other, Specify CONNECTRON NU-2 (RING TONGUE)

NOTES

E. ONE 120V. AC GFI WALL RECEPTACLE (DUPLEX CONVENIENCE OUTLET) PROVIDED.
(2) RING TONGUE TERMINALS PROVIDED ON ALL CONTROL WIRING.
(3) O.L. HEATERS PROVIDED BY OTHERS.
(4) ADJ. AMPS COMPR. O.L.'s PROVIDED.
(5) 120V. AC SPACE HEATERS PROVIDED IN EACH SECTION. (REF WD-56549-A02)
"ONE ADJUSTABLE THERMOSTAT PROVIDED TO CONTROL THE ABOVE."
(6) IN CONJUNCTION WITH MAIN BREAKER, THIS COMPARTMENT CONTAINS 1 SWITCHBOARD TYPE AMMETER 0-800A; 1 SWITCHBOARD TYPE VOLTMETER 0-600V; 1 TYPE C77 AMMETER/VOLTMETER SWITCH FOR EACH; 2 800/5A CT
(7) TRANSFORMER TYPE PILOT LIGHTS PROVIDED.
(8) PROVIDE MAX. # OF SPARE TERMINAL BLOCKS WITHOUT INCREASING UNIT SPACE.
(9) SEPERATE BRANCH CIRCUITS SHALL BE PROVIDED FOR LIGHTS AND SPACE HEATERS. THE FOLLOWING BREAKERS PROVIDED IN PANELBOARD:
2-QPI-B015's, 22 QPI-B020's

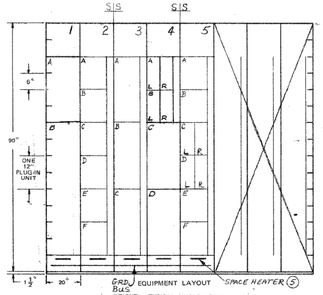
(1) BOTTOM PLATES PROVIDED.
NEMA 3 ENCLOSURE NOTES:
A. PROVIDE A DOOR AT EACH END OF WALKWAY. DOORS TO HAVE 3 POINT LATCH AND SUITABLE STRONG DEVICE TO HOLD THE DOOR IN FULL OPEN POSITION. DOORS SHALL BE GASKETED AND PROVIDED WITH LOCKS.
B. DUST FILTERS AND FILTERED AIR PRESSURE TYPE CONSTRUCTION SHALL BE FURNISHED.
C. SCREENED AND BAFFLED VENTILATING OPENINGS SHALL BE PROVIDED AT THE TOP AND BOTTOM OF THE ENCLOSURE.
D. TWO 120V. AC INTERIOR LIGHTS AND SWITCHES PROVIDED, ONE INSIDE EACH OF THE ENCLOSURE DOORS. (CONT. ABOVE)

PART I.
2.2 OSHA GOVERNS THE INSTALLATION & USE OF OUR EQUIPMENT, NOT IT'S MANUFACTURING.
3.08 CONNECTRON NU-2 TERMINAL BLOCKS PROVIDED.
PART II

5.3 THE BOTTOM VERTICAL BUS BARRIER IS 6⅛" FROM THE FLOOR (SEE SKETCH BELOW)
6.4 OUR STANDARD ADJUSTABLE THERMOSTAT WILL BE PROVIDED FOR CONTROL OF SPACE HEATER (IN LIEU OF DIFFERENTIAL THERMOSTAT.)
6. ALL BUS CONNECTIONS WILL BE BOLTED.
9. ITE STD. TIN PLATED COPPER STABS WILL BE UTILIZED. (USE OF ANY OTHER PLATING WOULD VOID THE UL LISTING OF OUR DEVICE.
9.1 UNITS ONCE INSERTED WILL BE SECURED IN PLACE VIA A SCREW & PANEL MECHANISM. THEY MAY BE PADLOCKED IN THE WITHDRAWN POSITION HOWEVER POSITIVE STOPS ARE PROVIDED IN NEITHER POSITION.
15. OUR STD. XFMR. TYPE PILOT LIGHTS WILL BE PROVIDED.
16. NAMEPLATES, AS DESCRIBED ABOVE NAMEPLATE DATA ON THIS DWG. WILL BE PROVIDED.
18. OUR STANDARD PAINT SYSTEM (ELECTROSTATICALLY APPLIED DRY EPOXY POWDER) WILL BE UTILIZED. QUALITY FAR EXCEEDS THAT SPECIFIED.

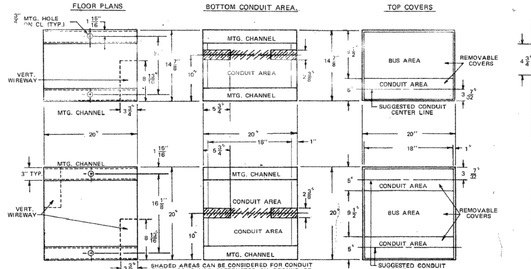
EXCEPTIONS TO CONTRACT SPECIFICATIONS

MOTOR CONTROL CENTER DESIGNATION EVAPORATION POND MCC



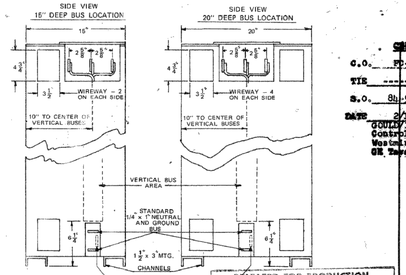
WEIGHT – TYPICAL SINGLE VERTICAL SECTION

15" DEEP SECTION	20" FRONT ENTRY ONLY	20" BACK TO BACK
WITHOUT MODULES 290 lbs. WITH 6-12" MODULES 530 lbs.	WITHOUT MODULES 320 lbs. WITH 6-12" MODULES 560 lbs.	WITHOUT MODULES 320 lbs. WITH 12-12" MODULES 800 lbs.



CONSTRUCTION DETAILS

SIDE PANELS – 12 GAUGE STEEL DOORS – STEEL, TO UL STANDARDS 15" – BACK PANELS – 14 GAUGE STEEL.	20" – REAR DOORS – 14 GAUGE STEEL SUPPORTS – 12 GAUGE STEEL MOUNTING PANEL – 12 GAUGE STEEL



RELEASED FOR PRODUCTION
DATE 2/14/77
REV. LEVEL 2 DATE 2/14/77
RELEASED BY Gravares APP'D BY ___

APPROVAL
CERTIFIED PRINTS
C.O. FC-76-12203
TIE ---
S.O. 84-56549
DATE 2/16/77
GUARANTEE
Control & Systems Division
Westinghouse Operation
Orange

This Drawing Has Been Prepared Based On:
☒ Contract Specifications
☒ Contract Drawings
☐ Other Information ___

Dwg. No. 84-56547-00	Sht. 1 of 1	Rev. Level 1
Customer ARIZONA PUBLIC SERVICE COMPANY PHOENIX, ARIZONA		
Job Title FOUR CORNERS ASH DISPOSAL ARIZONA PUBLIC SERVICE COMPANY		
Consult. Engr. PHOENIX, ARIZONA		
Customer P.O. FC-76-12203		
Shop Order No. 84-56549		

Rev.	Date	Alteration	By	Appvl
1	1-13-77	REVISED AS PER CUST. APPR'D AS NOTED LAYOUT		RGH
2	2-14-77	REARRANGED UNITS CORRECT GND LUG ADD MCC's	GHT	

Drawn	R.A. MAYBERRY	Date 9-24-76
Approved	RAY HAUGEN	Date 10-6-76
Approved		Date

THESE RECORD DRAWINGS DATED 01/17/20 AND TITLED "FOR RECORD" HAVE BEEN DEVELOPED FROM AS-BUILT MARKUPS AND MAY NOT REPRESENT THE FINAL PROJECT, AS CONSTRUCTED, IN EVERY DETAIL. THESE RECORD DRAWINGS HAVE BEEN PREPARED BASED ON INFORMATION SUPPLIED BY OTHERS AND THE ENGINEER HAS NOT VERIFIED THE ACCURACY OR COMPLETENESS OF THE INFORMATION.

4

I·T·E Imperial

NO.	DATE	REVISION	DWN	CHD	EXD	RVWD	APVD	W.A.
4	01-17-20	FOR RECORD	AWF	DEM				FCC06814
3	10/04/19	INSTALL NEW PUMPS	LDB	DEM			EDM	
2	04-26-16	TITLE UPDATE	GWB				WAC	FAC90406
1	11-01-78	ADDED SUMP PUMP "B"	JJM					

FOUR CORNERS COMMON
ASH DISPOSAL
EVAPORATION POND MCC

aps

SCALE NONE — DATE 03-07-77

DWN	VID	APPROVED	W A
CHD	WRU	DRAWING APPROVED BY	99-4-107-10
EXD	PBP		
RVWD			

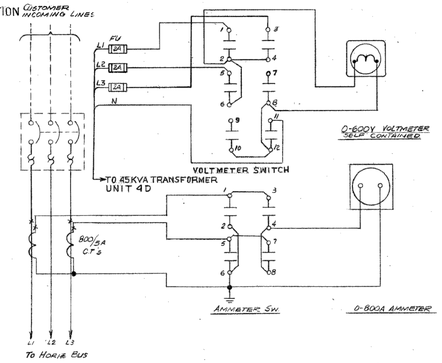
UNIT	DISC	TYPE	SYS	NUMBER	SHEET
FC	E	14	ADS	39128	2

WORK SAFELY TODAY

APS DWG. NO.: FC-E-14-ADS-39128-2

Form 6.10-8R (Supersedes Form 6.10-8Q)

SECTION 1A



CAT. NO. C77-3001-6EE2-3092

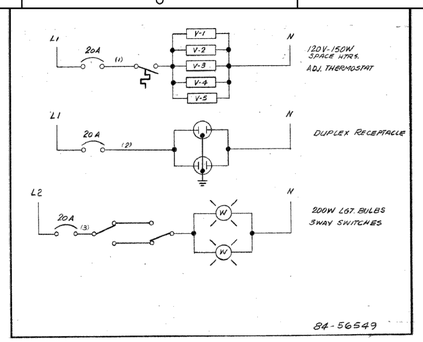
MAINT'D HANDLE POS.			M	M	M	M	M	M	M
NAME PLATE			1-2	2-3	3-1	OFF	1	2	3
STAGE 1	3 4	1 2	1-2	X		X		X	
			3-4		X				X
2	7 8	5 6	5-6					X	
			7-8			X			
3	11 12	9 10	9-10	X	X				
			11-12				X	X	X

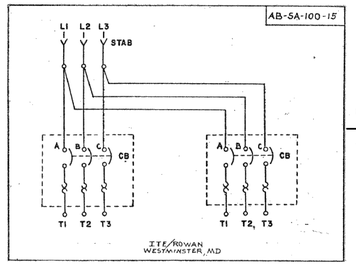
X-DENOTES CONTACTS CLOSED AT EACH HANDLE POITION
TERMINAL CONNECTIONS SHOWN BACK OF BOARD

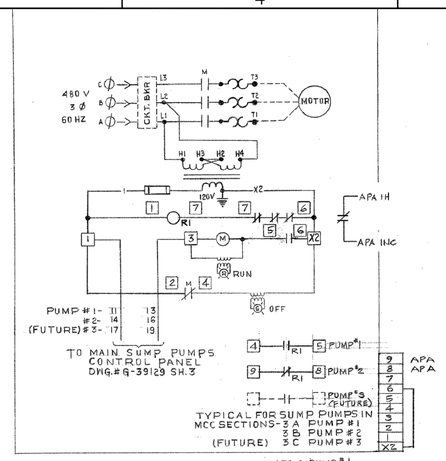
CAT. NO. C77-2001-2002-4002 *Ammeter Switch*

HANDLE POS.	MAINT.D	M		M		M		M	
	INTERM.D		INT.		INT.		INT.		INT.
NAME PLATE		OFF		1		2		3	
STAGE 1	3 4	1-2	X	X				X	X
		3-4		X	X	X	X		
2	7 8	5-6	X	X	X	X			X
		7-8				X	X	X	X

X-DENOTES COTACTS CLOSED AT EACH HANDLE POSITION
TERMINAL CONNECTIONS SHOWN BACK OF BOARD

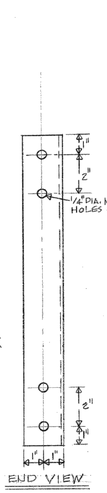


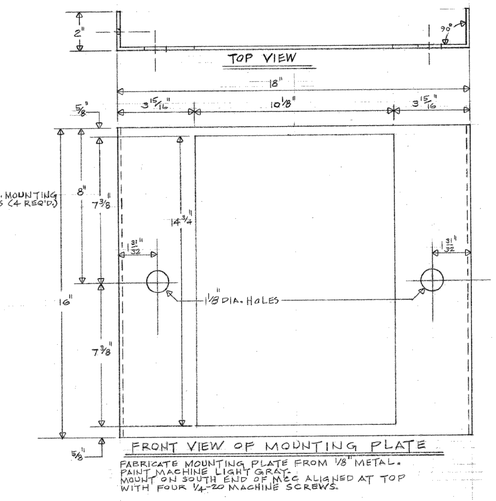




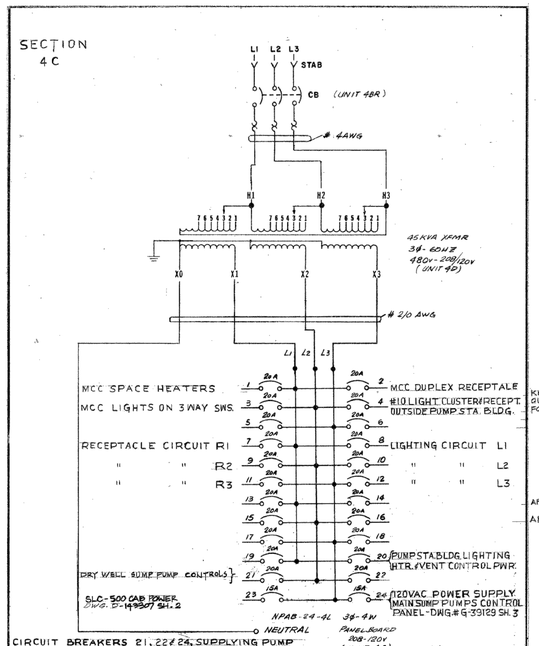
CONSTRUCTION NOTES:

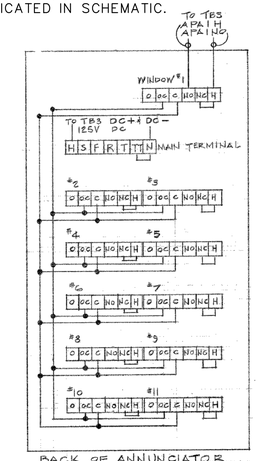
1. REPLACE EXISTING WET WELL PUMP STARTERS WITH NEW UNITS FOR 100HP MOTORS. WIRE AS INDICATED IN SCHEMATIC.

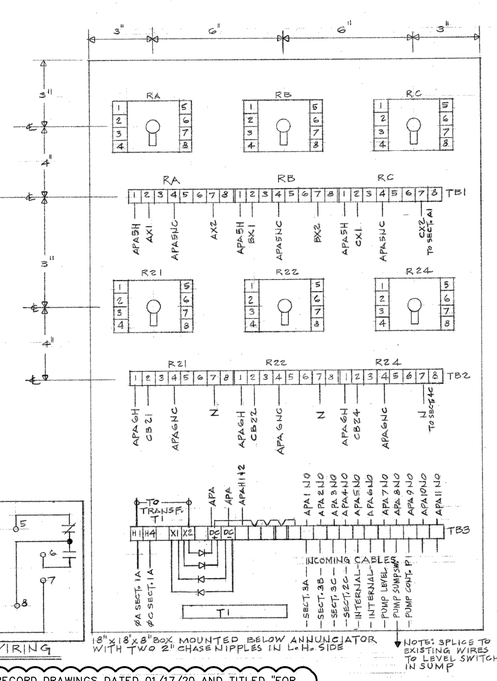


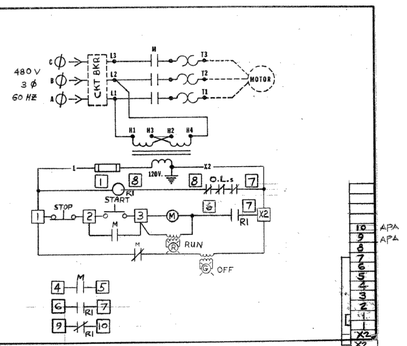


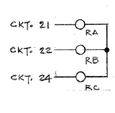
SECTION 4C

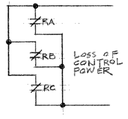


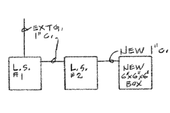


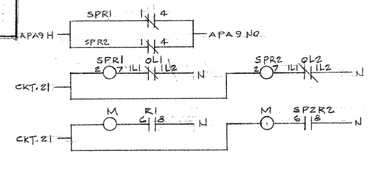


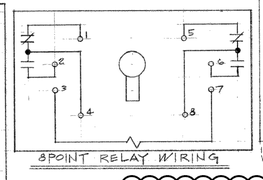












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7

NO.	DATE	REVISION	DWN	CHD	EXD	RVWD	APVD	W.A.
7	01-17-20	FOR RECORD	AWF	DEM				FCC06814
6	10/04/19	INSTALL NEW PUMPS	LDB	DEM			EDM	
5	04-27-16	TITLE UPDATE	GWB				WAC	FAC90406
4	2/96	RECORD REDLINES	RW	RW	LM		TEM	4510 JJ
3	11/95	ADDED ANNUNCIATOR	NWL					
2	7/95	REV PER RLD MKT	J L	WK	BWC	EWC		
1	9-4-77	DATA UPDATE	VID					10-7-77

FOUR CORNERS COMMON
ASH DISPOSAL
EVAPORATION POND MCC

aps

SCALE NONE DATE 03-07-77

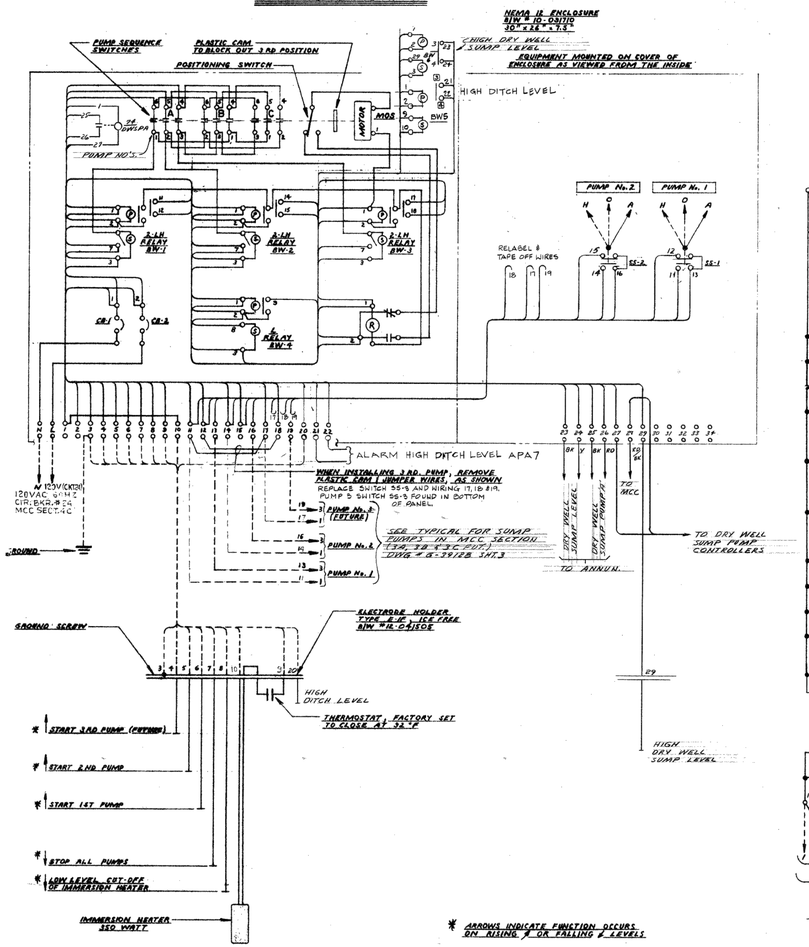
WORK SAFELY TODAY

DWN	VID	APPROVED	W A
CHD	WRU	DRAWING APPROVED BY	99-4-107-10
EXD	PBP		
RVWD			

UNIT	DISC	TYPE	SYS	NUMBER	SHEET
FC	E	04	ADS	39128	3

APS DWG. NO.: FC-E-04-ADS-39128-3

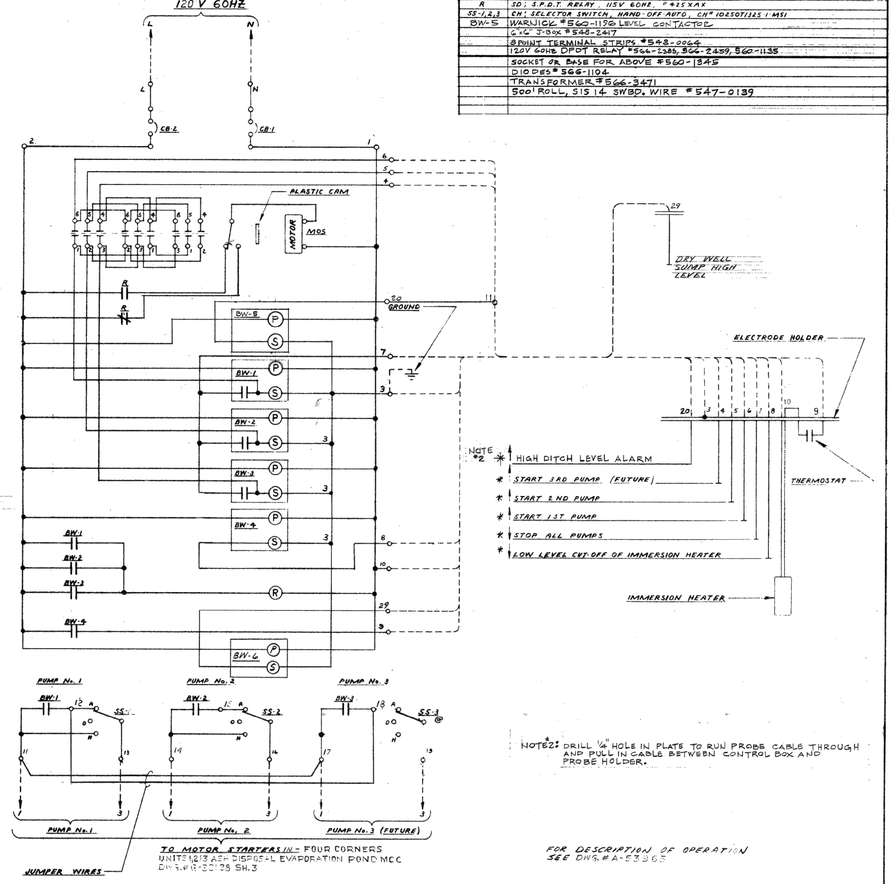
WIRING DIAGRAM



* ARROWS INDICATE FUNCTION OCCURS ON RISING # OR FALLING # LEVELS

ELEMENTARY DIAGRAM

BKR. 24 MCC SECT. 4C
TO AC LINE
120 V 60HZ



NOTE #2: DRILL 1/4" HOLE IN PLATE TO RUN PROBE CABLE THROUGH AND PULL IN CABLE BETWEEN CONTROL BOX AND PROBE HOLDER.

FOR DESCRIPTION OF OPERATION SEE DWG # A-53965

SOLID LINES BY B/W
DOTTED LINES BY OTHERS

BILL OF MATERIAL

SYMBOL	DESCRIPTION
BW-1, 2, 3	B/W; TYPE "2LH" RELAY ; # 115 V 60HZ S-220 V. "#11-043300
BW-4	B/W; TYPE "L" RELAY ; # 115 V 60HZ S-220 V. "#11-043400
MOS	B/W; MOTOR OPERATED ALTERNATOR SWITCH, 115V 60HZ, "#10-012500
CB-1, 2	3W ; CIRCUIT BREAKER, 1 POLE, 10 AMP. 120/240V. "#QLC-1010
R	3D ; 3 P.D.T. RELAY 115V. 60HZ. "#12 XA1
SS-1, 2, 3	EN ; SELECTOR SWITCH, HAND-OFF-AUTO, CAT 10250T125 "#MS1
BW-5	WARWICK #560-1196 LEVEL CONTACTOR
	C.R. J-30K #586-2417
	8 POINT TERMINAL STRIPS #548-0064
	120V 60HZ DPDT RELAY #566-1385, 566-2459, 560-1135
	SOCKET OR BASE FOR ABOVE #560-1345
	DIODES #566-1104
	TRANSFORMER #566-3471
	500' ROLL, 515 14 SWBD. WIRE #547-0139

REF. DWGS.
MAIN SUMP PUMP OPERATING INSTRUCTIONS - A-53965

CONSTRUCTION NOTES:

1. LEVEL CONTROLS TO INTERLOCK WITH NEW MAIN SUMP PUMP STARTERS.

P.O. # 30004080

CUSTOMER			
ARIZONA PUBLIC SERVICE CO. PHOENIX, ARIZONA	A	WIRING REVISED	5-4-77
	SYM	REVISION	APP DATE
ENGINEERS	JOB	4 C. POWER PLANT FRUITLAND, NEW MEXICO	
DR JED DATE 4-15-77 APP DWN DATE 4-15-77	DRAWING NO.	S-5078-1	

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7

THIS INFORMATION IS REMOVED FROM THIS DWG AND IS SHOWN ON C.W.D NO. B-22332 SH. 606

NO.	DATE	REVISION	DWN	CHD	EXD	RVWD	APVD	W.A.
7	01-17-20	FOR RECORD	AWF	DEM				FCC06814
6	10/22/18	INSTALL NEW PUMPS	LDB	DEM			EDM	
5	04-27-16	TITLE UPDATE	GWB				WAC	FAC90406
4	12-92	REVISED PER AS BUILT	WAGW	RJM		JWF	JWF	94-5060
3	7-29-92	LTG. AS-BUILT	MEM		TLM	BB		45-02-11 A

FOUR CORNERS COMMON
ASH DISPOSAL PUMPING STATION
LIGHTING & CONTROL

aps

SCALE NONE — DATE 03-07-77

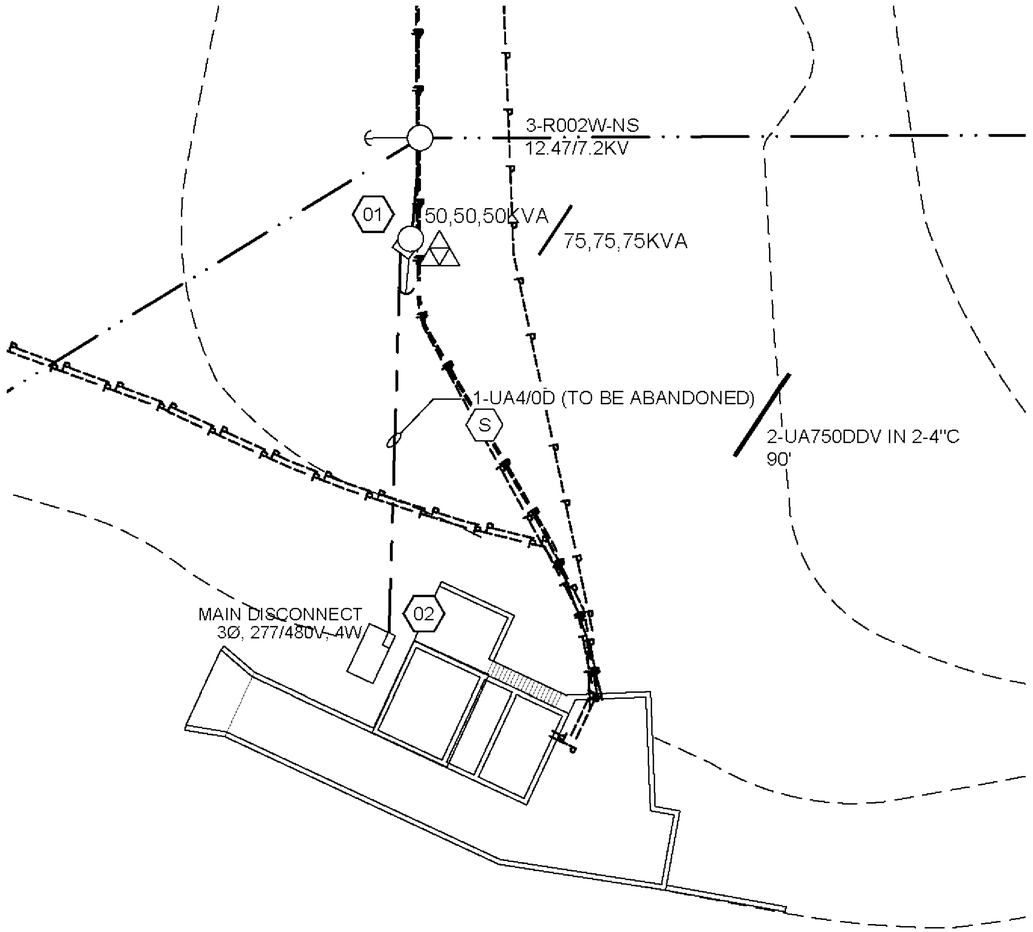
DWN	APPROVED	W A
VID		99-4-107-R8
CHD WRU	DRAWING APPROVED BY	
EXD PBP		
RVWD		

UNIT	DISC	TYPE	SYS	NUMBER	SHEET
FC	E	04	PLS	39129	3

WORK SAFELY TODAY

APS DWG. NO.: FC-E-04-PLS-39129-3

WA445678
FOUR CORNERS EXISTING PUMP STATION UPGRADES



GENERAL PURPOSE NOTES:

REPLACE CROSS ARM
REMOVE 3-50KVA TRANSFORMERS (480V, 3W)
INSTALL 3-75KVA TRANSFORMERS (277/480V, 3Ø, 4W)
REPLACE TRANSITION
INSTALL 2-4" CONDUIT FROM POLE TO BREAKER
SECTION, RUN 2 SETS OF UA750DDV

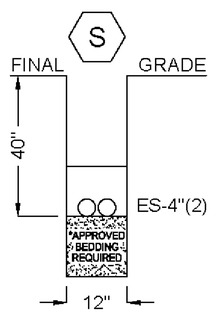
SPEC CODES:

01
REMOVE
3470.WS3PUR002W
7185.WFFF44
7482.AD(3)
5052.W2UA750DDV

INSTALL
3471.SS3PUR002W
7185.WGGG42 75,75,75KVA 12.5KV (277/480V)
7482.AD(3)
2263.B1(3)
5052.W2A750DDV

02
INSTALL
2705.UA750DDV(2)

(INSTALL)
TOTAL WIRE DATA FOOTAGE:
SECONDARY / SERVICE / ST. LT. / D-D
6220.UA750DDV= 300'



APS UTILITIES KEY

EXISTING		PROPOSED
W	WATER	W
S	SEWER	S
G	GAS	G
SD	STORM DRAIN	SD
IRR	IRRIGATION	IRR
TS	TRAFFIC SIGNAL	TS
T	TELE	T
CATV	CATV	CATV
FO	FIBER	FO

UG ELECTRIC NOMINAL TRANSMISSION (69KV)*
UG ELECTRIC NOMINAL PRIMARY (12.47Y/7.200V)*
UG ELECTRIC NOMINAL SECONDARY/SERVICE (120/240V)*
OH ELECTRIC NOMINAL TRANSMISSION (69KV)*
OH ELECTRIC NOMINAL PRIMARY (12.47Y/7.200V)*
OH ELECTRIC NOMINAL SECONDARY/SERVICE (120/240V)*
CONDUIT
TRENCH RUNNING LINE
* UNLESS OTHERWISE NOTED

APS SYMBOLS LEGEND

EXISTING EQUIPMENT	PROPOSED EQUIPMENT	DESCRIPTION
		- PADMOUNTED TRANSFORMER
S	S	- SWITCHING CABINETS
	J	- 1Ø SWITCHING CABINET
		- OH/UG CAPACITOR BANK
		- J-BOX / PULL BOX
		- MANHOLES
		-OH TRANSFORMER
		-OH SWITCH (KPF)
		- APS OWNED POLE
		- APS OWNED STEEL POLE
		- APS OWNED JOINT USE POLE
		- DIP (TRANSITION) POLE
		- STREET LIGHT
		- DUSK TO DAWN LIGHT

DATA MODIFIED PER FIELD CONDITIONS

N

Contact Arizona 811 at least two full working days before you begin excavation
ARIZONA811
Call 811 or click Arizona811.com

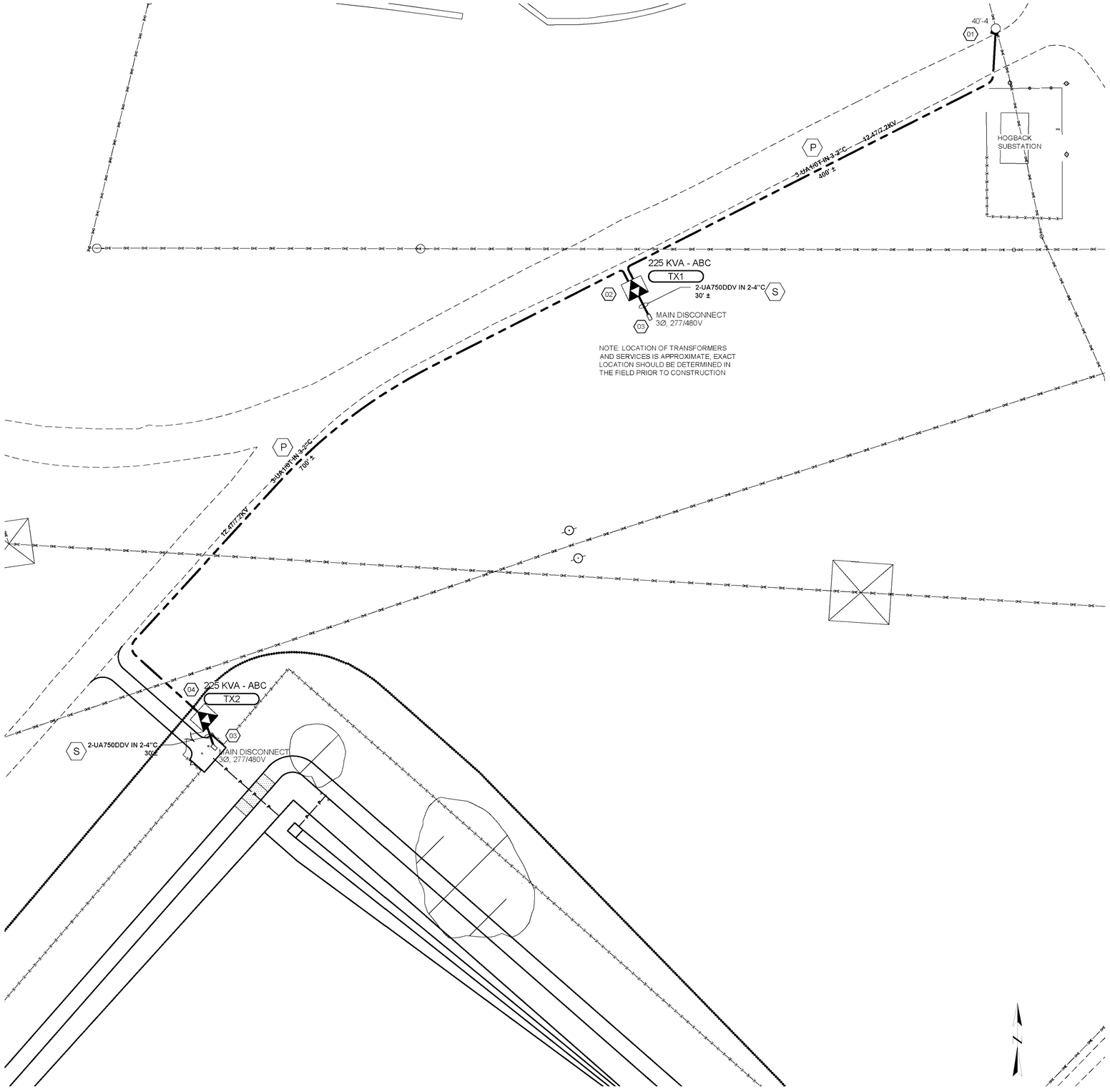
CONTACT: JOE CARTER			
PHONE: 928-773-6476		PGR/MOBILE: 602-818-1466	
INSPECTOR: N/A			
PHONE: N/A		PGR/MOBILE: N/A	
NO.	DATE	DESCRIPTION	BY

aps — FOUR CORNERS EXISTING PUMP SITE UPGRADE

WO#:	WA445678	DATE:	07/05/2018
BY:	R. FLAKE	SCALE:	1:50
FILENAME:	FOUR CORNERS PUMP STATION PREALIGN	SHEET:	1 OF 1

APS DWG. NO.: FC45CM-E-16-WP-AP-200485-51.dwg

WA445678
FOUR CORNERS
RETURN WATER POND
PUMP FEEDER



CONSTRUCTION NOTES:

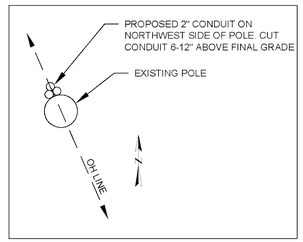
01 **INSTALL**
5255.W1KR002W
2640.K20(3)
8881.DQ(3)

02 **INSTALL**
7665.B364 225 KVA 12,470V (277/480V) IN-LINE
2705.UA4/0DV(4)
8881.DQ(3) (APS TO PROVIDE, CUSTOMER TO INSTALL)
8881.GQV(2) (APS TO PROVIDE, CUSTOMER TO INSTALL)

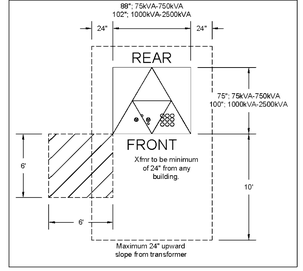
(2 LOCATIONS) 03 **INSTALL**
2705.UA4/0DV(4)
8881.GQV(2) (APS TO PROVIDE, CUSTOMER TO INSTALL)

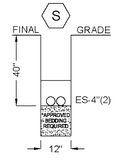
04 **INSTALL**
7666.B364 1,000 KVA 12,470V (277/480V) END-OF-LINE
2705.UA4/0DV(4)
8881.DQ(3) (APS TO PROVIDE, CUSTOMER TO INSTALL)
8881.GQV(2) (APS TO PROVIDE, CUSTOMER TO INSTALL)

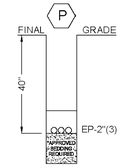
W1 **INSTALL**
6215.UA1/0T(3600)
6220.UA4/0DV(170)
8895.MR(3800)
8895.MM(4)



CLEAR ZONE AROUND TRANSFORMER







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ARIZONA811

Call 811 or click Arizona811.com

APS UTILITIES KEY

EXISTING		PROPOSED
W	WATER	W
S	SEWER	S
G	GAS	G
SD	STORM DRAIN	SD
IRR	IRRIGATION	IRR
TS	TRAFFIC SIGNAL	TS
T	TELE	T
CATV	CATV	CATV
FO	FIBER	FO

UG ELECTRIC NOMINAL TRANSMISSION (69KV)*
UG ELECTRIC NOMINAL PRIMARY (12.470/7.200V)*
UG ELECTRIC NOMINAL SECONDARY/SERVICE (120/240V)*
OH ELECTRIC NOMINAL TRANSMISSION (69KV)*
OH ELECTRIC NOMINAL PRIMARY (12.470/7.200V)*
OH ELECTRIC NOMINAL SECONDARY/SERVICE (120/240V)*
CONDUIT
TRENCH RUNNING LINE

* UNLESS OTHERWISE NOTED

APS SYMBOLS LEGEND

EXISTING EQUIPMENT	PROPOSED EQUIPMENT	DESCRIPTION
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J	J	- 1Ø SWITCHING CABINET
		- OH/UG CAPACITOR BANK
		- J-BOX / PULL BOX
		- MANHOLES
		-OH TRANSFORMER
		-OH SWITCH (KPF)
		- APS OWNED POLE
		- APS OWNED STEEL POLE
		- APS OWNED JOINT USE POLE
		- DIP (TRANSITION) POLE
		- STREET LIGHT
		- DUSK TO DAWN LIGHT

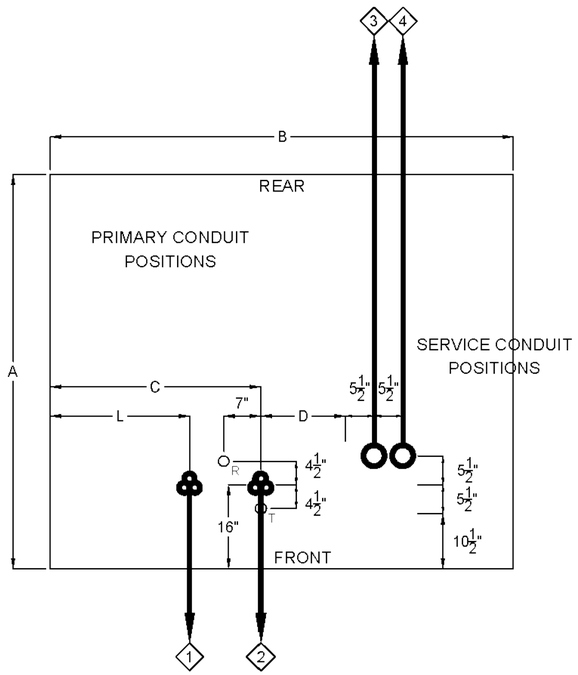
DATA MODIFIED PER FIELD CONDITIONS

CONTACT: JOE CARTER			
PHONE: 928-773-6475		PGR/MOBILE: 602-818-1456	
INSPECTOR: N/A			
PHONE: N/A		PGR/MOBILE: N/A	
1	6/6/19	REV TRENCH DETAILS	RVF
NO.	DATE	DESCRIPTION	BY

aps	FOUR CORNERS ASH POND PUMP STATION EXTENSION
WO#: WA445678	DATE: 07/05/2018
BY: R. FLAKE	SCALE: 1:50
FILENAME: FOUR CORNERS PUMP STATION PRELIM.DWG	SHEET 1 OF 1

APS DWG. NO.: FC45CM-E-16-WP-AP-200485-52.dwg

SERVICE SECTION SIZE (AMPS)	SERVICE VOLTAGE	QUANTITY and SIZE OF CONDUITS			PAD SIZE and CONDUIT LOCATION (inches)				
		PRIMARY		SECONDARY	A	B	C	D	L
600 - 1000	277/480	2-4"	6-2"	2-4"	75	88	40	16	26-1/2



CABLE & CONDUIT NOTES:

1. C2"(3), 90°, 36"R SWEEPS TO TRANSITION POLE
   3-UA1/0T TO TRANSITION POLE
2. C2"(3), 90°, 36"R SWEEPS TO TX2
   3-UA1/0T TO TX2
3. C4"(1), 90°, 36"R SWEEPS TO DISCONNECT
   1-UA750DDV TO DISCONNECT
4. C4"(1), 90°, 36"R SWEEPS TO DISCONNECT
   1-UA750DDV TO DISCONNECT

GENERAL NOTES:

1. ALL TRANSFORMER LOCATIONS SHALL COMPLY WITH ALL CODES, ORDINANCES, AND REGULATIONS WITHIN THE STATE OF ARIZONA OR OTHERWISE SPECIFIED BY APS.
2. CUSTOMER TO PROVIDE ALL WORK INVOLVED WITH THE PAD AND CONDUITS.
3. ALL CONDUITS MUST BE INSPECTED AND APPROVED PRIOR TO BACKFILLING.
4. ALL CONCRETE FORMS AND CONDUITS AND REBAR (IF REQUIRED) MUST BE IN PLACE AND APPROVED PRIOR TO POURING PAD.
5. ANY VARIATIONS FROM THE ABOVE REQUIREMENTS MUST BE GIVEN IN WRITING AND SIGNED BY AN APS REPRESENTATIVE.
6. A MINIMUM 24-HOUR NOTICE IS REQUIRED FOR INSPECTIONS.
   R = GROUND ROD SLEEVE, NOTE 7.
   T = COMMUNICATION GROUND SLEEVE, NOTE 8.
   (S) = 5" SLEEVE LOCATION 18" DEEP

PAD SPECIFICATIONS:

1. THE FOLLOWING MINIMUM UNOBSTRUCTED CLEARANCES FROM THE EDGE OF THE PAD ARE REQUIRED:
   HORIZONTAL CLEARANCES: 2' TO THE REAR AND SIDES 10' TO THE FRONT
   VERTICAL CLEARANCES: 30' ABOVE THE PAD AND HORIZONTAL CLEARANCE AREAS
   REFER TO T&D STANDARDS 1278-1279 FOR ALL APPLICABLE CLEARANCE REQUIREMENTS.
2. ALL BACKFILL BENEATH THE PAD SHALL BE COMPACTED TO A MINIMUM OF 90 PERCENT OF MAXIMUM DENSITY, AND SHALL NOT CONTAIN ROCKS LARGER THAN 1-1/2 INCHES IN THEIR GREATEST DIMENSION. BACKFILL MATERIAL SHALL CONTAIN ENOUGH FINES TO FILL ALL VOIDS.

   ONE-SACK ABC SLURRY SHALL NOT BE INSTALLED BENEATH EQUIPMENT PADS. IF SLURRY BACKFILL IS INSTALLED BENEATH EQUIPMENT PADS, ONE OF THE FOLLOWING OPTIONS SHALL BE UTILIZED:

   OPTION 1:
   ONE-SACK CEMENT SAND SLURRY AS SPECIFIED IN T&D STANDARDS 8601, 19.5
   OPTION 2:

FLYASH, TYPE F	250 POUNDS
WATER	50 GALLONS
FINE AGGREGATE (SAND)	3,117 POUNDS

   OPTION 3:

CEMENT	52 POUNDS
FLYASH, TYPE F	240 POUNDS
WATER	55 GALLONS
FINE AGGREGATE (SAND)	2,820 POUNDS

   CONCRETE MIXING TICKET MUST BE PROVIDED DESCRIBING THE MATERIAL, OTHERWISE THE MATERIAL IS UNACCEPTABLE.
3. PAD TO BE MADE IN ONE CONTINUOUS POUR OF CONCRETE, 3000 PSI AT 28 DAYS, 3/8 INCH AGGREGATE, 3 TO 5-INCH SLUMP. TOP OF PAD TO BE TROWELED SMOOTH AND LEVEL. SURFACE IS TO HAVE A LIGHT BROOMED FINISH AND ALL EXPOSED EDGES ARE TO BE ROUNDED TO A 3/4-INCH RADIUS.

   REFER TO THE MATERIAL SPECIFICATIONS 7990 FOR COMPLETE PAD SPECIFICATIONS.
4. REINFORCING STEEL IS REQUIRED [NO]

   REINFORCEMENT IS NOT REQUIRED IF PAD IS POURED-IN-PLACE IN A LOCATION UNLIKELY TO BE UNDERMINED BY DRAINAGE, ETC.
5. MINIMUM REQUIRED PAD THICKNESS IS 6 INCHES.
6. TOP OF PAD TO BE A MINIMUM OF 4 INCHES ABOVE SURROUNDING FINISHED GRADE.
7. R--PROVISION FOR GROUND ROD--INSTALL SLEEVE THROUGH PAD, 1-INCH MINIMUM I.D., WITH NO OBSTRUCTION BENEATH. ALTERNATE SLEEVE LOCATIONS ARE ALONG AN IMAGINARY CENTER LINE BETWEEN THE PRIMARY DUCTS. LOCATION TO BE BASED ON AVOIDING CONDUIT SWEEPS WHEN DRIVING GROUND ROD.
8. T--PROVISION FOR COMMUNICATIONS GROUND--INSTALL SLEEVE THROUGH PAD, 1 INCH MINIMUM I.D., WITH NO OBSTRUCTION BENEATH. LOCATION TO BE BASED ON AVOIDING CONDUIT SWEEPS.

CONDUIT SPECIFICATIONS:

1. ALL SERVICE CONDUCTORS SHALL BE INSTALLED IN RIGID NON-METALLIC CONDUITS FROM TRANSFORMER TO SERVICE ENTRANCE SECTION.
2. ALL PRIMARY CONDUCTORS SHALL BE INSTALLED IN RIGID NON-METALLIC CONDUITS.
3. RIGID NON-METALLIC CONDUIT IS DEFINED AS PVC AND SHALL BE MARKED AS FOLLOWS:

SWEEPS -	PVC SCH 40 NEMA TC-2
STRAIGHT SECTIONS -	PVC DB L00 MODULUS 400,000 PSI ASTM F-512 PVC DB 120 MODULUS 400,000 PSI ASTM F-512 PVC SCH 40 NEMA TC-2 PVC SCH 80 NEMA TC-2

4. ONLY GOOD FOR CONDUIT 4" OR LARGER.

   APPLY PURPLE PRIMER/CLEANER ASTM F656 TO ALL PVC JOINTS PRIOR TO APPLYING A COATING OF GRAY PVC TO PVC CEMENT ASTM 02564.

FOR INSPECTION CONTACT:	
PHONE:	
INSPECTION IS REQUIRED AFTER CONDUITS ARE INSTALLED, AND BEFORE PAD IS POURED.	
INSPECTED BY:	DATE:
FINAL INSPECTION BY:	DATE:

REV 01/25/12

TX1

APS CONSTRUCTION SYMBOL

SOURCE: DIP POLE

5. IF STEEL SWEEPS, BENDS AND CONDUIT ARE USED; THEY SHALL BE GALVANIZED PER ANSI C80.1 AND HALF-LAPPED WITH SUITABLE 20-MIL TAPE, TO A TOTAL THICKNESS OF 40 MILS. POLYKEN #900 2" BLACK TAPE (OR EQUIVALENT) SHALL BE HALF-LAPPED OVER POLYKEN #927 BLACK PRIMER (OR EQUIVALENT).
6. ALL NON-METALLIC CONDUIT SWEEPS AND ELBOWS SHALL HAVE INTERNALLY CHAMFERED ENDS.
7. UNLESS OTHERWISE SPECIFIED, SWEEPS, BENDS AND CONDUITS SHALL BE 4-INCH IPS WITH MINIMUM RADIUS SWEEPS OF 36 INCHES FOR PRIMARY AND 24 INCHES FOR SERVICE. EXCEPTION: USE 36" SWEEPS FOR 750 MCM SECONDARY UNLESS OTHERWISE SPECIFIED.
8. ALL SWEEPS INTO TRANSFORMER PAD SHALL EXTEND A MINIMUM OF 1 INCH AND A MAXIMUM OF 2 INCHES ABOVE THE TOP OF THE PAD UPON CABLE INSTALLATION. CONDUIT ENDS SHALL BE CAPPED OR PLUGGED, NOT GLUED. NON-EXPOSED CONDUITS STUBBED OUT FOR FUTURE EXTENSIONS SHALL BE PLUGGED.
9. PRIMARY CONDUITS SHALL BE INSTALLED WITH A MINIMUM COVER OF 36 INCHES; SERVICE CONDUITS SHALL BE INSTALLED WITH A MINIMUM COVER OF 24 INCHES, UNLESS OTHERWISE SPECIFIED. DIMENSIONS GIVEN ARE FROM FINAL GRADE TO THE TOP OF THE DUCT BANK.
10. WHERE SERVICE CONDUITS MUST BE INSTALLED DIRECTLY UNDER A BUILDING FOUNDATION, THE CONDUITS SHALL BE CONCRETE ENCASED AND THE TOP OF THE ENCASEMENT SHALL HAVE A MINIMUM OF 24 INCHES CLEAR SEPARATION BELOW THE STRUCTURE FOUNDATION. ENCASEMENT SHALL CONSIST OF A 3-INCH CONCRETE ENVELOPE.
11. THE CUSTOMER SHALL MANDRILL ALL CONDUITS AND IS RESPONSIBLE FOR THE USABILITY OF THE CONDUIT SYSTEM AT THE TIME APS INSTALLS CONDUCTORS.
12. PULL LINES SHALL BE PROVIDED BY APS AND INSTALLED BY THE CUSTOMER.
13. ARROWS, SHOWN ON PAD DETAIL (LEFT), INDICATE THE DIRECTION SWEEPS AND CONDUITS ARE TO BE POSITIONED.

JOB NUMBER	DATE	DESCRIPTION	REV BY

LOCATION: LIFT STATION

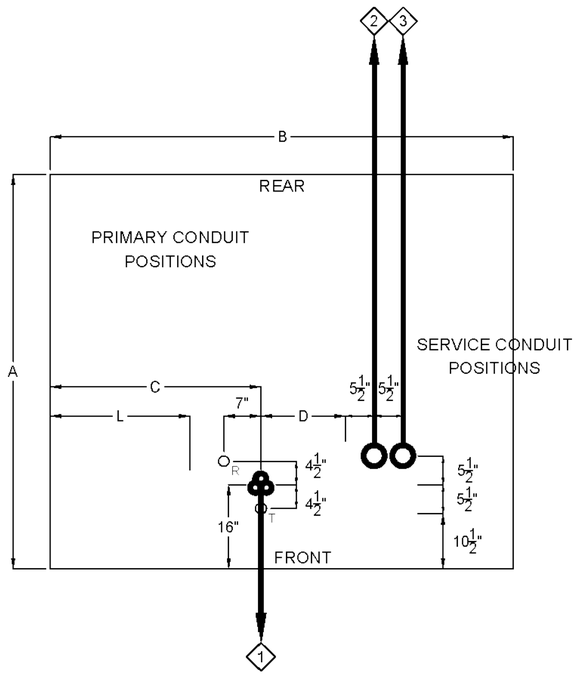
aps

7665 THRU 7667
3-PHASE TRANSFORMER
PAD AND CONDUIT DETAIL

WO#:	WA445678	DATE:	5/22/19
BY:	R. FLAKE	SCALE:	NTS
FILENAME:	TX1.dwg		

APS DWG. NO.: FC45CM-E-19-WP-AP-200485-53.dwg

SERVICE SECTION SIZE (AMPS)	SERVICE VOLTAGE	QUANTITY and SIZE OF CONDUITS			PAD SIZE and CONDUIT LOCATION (inches)				
		PRIMARY		SECONDARY	A	B	C	D	L
600 - 1000	277/480	2-4"	6-2"	2-4"	75	88	40	16	26-1/2



CABLE & CONDUIT NOTES:

1. C2"(3), 90°, 36"R SWEEPS TO TX1
   3-UA1/0T TO TX1
2. C4"(1), 90°, 36"R SWEEPS TO DISCONNECT
   1-UA75DDDV TO DISCONNECT
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   1-UA75DDDV TO DISCONNECT

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4. ONLY GOOD FOR CONDUIT 4" OR LARGER.

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FOR INSPECTION CONTACT:
PHONE:
INSPECTION IS REQUIRED AFTER CONDUITS ARE INSTALLED, AND BEFORE PAD IS POURED. INSPECTED BY: DATE:
FINAL INSPECTION BY: DATE:

REV 01/25/12

TX2

APS CONSTRUCTION SYMBOL

SOURCE: DIP POLE

5. IF STEEL SWEEPS, BENDS AND CONDUIT ARE USED; THEY SHALL BE GALVANIZED PER ANSI C80.1 AND HALF-LAPPED WITH SUITABLE 20-MIL TAPE, TO A TOTAL THICKNESS OF 40 MILS. POLYKEN #900 2" BLACK TAPE (OR EQUIVALENT) SHALL BE HALF-LAPPED OVER POLYKEN #927 BLACK PRIMER (OR EQUIVALENT).
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13. ARROWS, SHOWN ON PAD DETAIL (LEFT), INDICATE THE DIRECTION SWEEPS AND CONDUITS ARE TO BE POSITIONED.

JOB NUMBER	**DATE**	**DESCRIPTION**	**REV BY**

LOCATION: RETURN WATER POND

aps

7665 THRU 7667
3-PHASE TRANSFORMER
PAD AND CONDUIT DETAIL

WO#:	WA445678	DATE:	5/22/19
BY:	R. FLAKE	SCALE:	NTS
FILENAME:	TX2.dwg		

APS DWG. NO.: FC45CM-E-19-WP-AP-200485-54.dwg

Appendix B.
Safety Factor Calculation

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Figures

Tables

Attachments

1 INTRODUCTION

The purpose of this calculation is to document the calculated factor of safety for the Return Water Pond (RWP) at Arizona Public Service's (APS) Four Corners Power Plant (FCPP) in Fruitland, New Mexico. The RWP has a maximum embankment height of 12 feet and a storage capacity of 38.6 acre-feet at elevation (EL) 5379 feet. The maximum height and storage capacity qualify this embankment as a non-jurisdictional dam under the New Mexico Administrative Code (NMAC) (State of New Mexico 2018). However, the RWP will receive CCR-impacted discharges from the LAI and Pond 3 pumphouse, classifying it as a "new CCR surface impoundment" under 40 CFR Part 257 *Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule* (the CCR Rule, EPA 2015).

In April 2018, AECOM conducted a geotechnical exploration at the proposed RWP site (AECOM 2018b). The exploration consisted of excavating test pits and performing laboratory tests on the recovered material. Two test pits were excavated in the proposed RWP footprint, two test pits were excavated in an alternative location, and a fifth test pit was excavated near the Pond 3 pumphouse. The laboratory testing program consisted of Atterberg limits (ASTM D 4318), Sieve Analyses (ASTM C 117, C 136), Standard Proctor curves (ASTM D 698), and Direct Shear (ASTM D 3080) tests.

2 ANALYSIS CRITERIA

As a new CCR surface impoundment, the RWP embankment is designed to meet the following factors of safety against slope instability under the CCR Rule (40 CFR Part 257):

- Long-term, maximum storage pool FS = 1.50 (§ 257.74(e)(ii))
- Maximum surcharge pool FS = 1.40 (§ 257.74(e)(iii))
- End-of-Construction FS = 1.30 (§ 257.74(e)(i))
- Seismic loading FS = 1.00 (§ 257.74(e)(iv))

The 2018 laboratory testing was performed on samples recovered from the RWP foundation and expected to be similar to the soils used to construct the RWP embankment. Based on the

results of the laboratory tests, the foundation and embankment soils are not expected to be susceptible to liquefaction.

3 ANALYSIS INPUTS

The following inputs were used in the analysis:

- The geometry for the cross-section analyzed in this calculation package is based on the configuration of the RWP at the location of an historic drainage channel beneath the northern half of the perimeter embankment (Figure 5). The embankment height is at a maximum of approximately 12 feet above the existing ground surface in this area.

- The subsurface topography is based on the post-construction conditions. The subsurface stratigraphy is generally based on test pit observations from the 2018 AECOM exploration (AECOM 2018b).

- The safety factor calculations for stability of slopes were performed using the software program SLOPE/W, commercially available through GEO-SLOPE International, Ltd. (GEO-SLOPE International, 2016).

- Material properties used in the safety factor assessment are based on previously reported subsurface material properties developed for the 5280 Lift Design Report for the nearby Lined Ash Impoundment (URS 2012), Ash Ponds 3 and 6 (Dames & Moore 1990), and design properties for the compacted RWP embankment based on laboratory testing of the proposed embankment material.

- The embankment is homogeneous in that weathered shale and sandstone excavated from the site footprint were mixed in such a way that there are no lenses or zones of differing materials.

- The upstream slope of the embankment features two 60-mil HDPE liners and a geosynthetic clay liner as part of the fluid containment system. Although it is unlikely that the three liners would fail simultaneously and remain in a leaking condition long enough to develop a steady-state phreatic surface in the embankment, the calculation package includes a steady-state seepage evaluation and uses the resulting steady-state phreatic surface in the slope stability model.

- The maximum normal operational water level in the RWP is at elevation (EL) 5372.2 feet.

- The maximum surcharge water level in the RWP is at EL 5379 feet. The additional 6.8 feet of storage above the operation water level is equivalent to 30 days of storage during an outage at the FCPP. The RWP is expected to be filled to this elevation at least once each year.

- The crest is at EL 5381 feet.

- The seismic loading is developed from Unified Hazard Tool based on the 2014 United States Geological Survey (USGS) Earthquake Hazard and Probability Maps (USGS 2018).

4 ASSUMPTIONS

Assumptions used in this calculation package include:

- The shale portion of the interbedded sandstone/shale unit is assumed to be the weaker material, and therefore it is judged appropriate to adopt the “weathered shale” material characterized in the 5280 Lift Design Report (URS 2012).

- The clay (weathered shale) portion of the sandstone/shale material used to construct the embankment is expected to control the undrained strength of the material. The undrained strength is based on compacted shale presented in *Raising Ash Dams 3 and 6* (Dames & Moore 1990).

- The material encountered during the 2018 AECOM exploration (Appendix A) is assumed to be representative of the material used to construct the embankment.

5 SAFETY FACTOR ASSESSMENT

The safety factor assessment in this calculation package is conducted for the tallest section of the proposed embankment. The calculations document minimum factors of safety for loading conditions identified by 40 CFR § 257.74(e) using the software program SLOPE/W (GEO-SLOPE International, Ltd. 2016). The analyses are performed using Spencer’s Method, a limit equilibrium method of slices that satisfies both force and moment equilibrium in addition to incorporating the effects of interslice forces.

5.1 Critical Stability Cross-Section

The factor of safety against slope instability is calculated for the critical cross-section of the RWP embankment. The critical cross-section is the cross-section that is anticipated to be most susceptible to structural failure for a given loading condition. The critical cross-section thus represents a "most-severe" case. The RWP will feature 3H:1V (horizontal : vertical) slopes (upstream and downstream) and the critical cross-section for each loading case is expected to be the tallest cross-section, located on the northern end of the site. The crest is 20 feet wide and the maximum embankment height is approximately 12 feet (Figure 5). The embankment consists of a shale-sandstone mixture created using soils excavated from the RWP footprint.

5.2 Laboratory Results

The samples recovered from the test pits excavated during the 2018 AECOM geotechnical exploration form the primary basis for the material properties in the seepage and stability model. The recovered material was combined by location and depth to create composite samples for the testing program. The laboratory tests consisted of Atterberg limits (ASTM D 4318), Sieve Analyses (ASTM C 117, C 136), Standard Proctor curves (ASTM D 698), and Direct Shear (ASTM D 3080). The AECOM *Geotechnical Recommendations Memo* (AECOM 2018b) provides additional information pertaining to the geotechnical exploration and laboratory testing. Based on the selected configuration of the RWP, composite samples from test pits RWP-1 and RWP-2 are assumed to be the most representative of the embankment construction material (Attachment A).

5.3 Seepage Analysis

5.3.1 Seepage Material Properties

The seepage material properties used in the safety factor assessment are primarily based on material type correlations and previously reported material properties developed for the FCPP ash disposal area (URS 2012).

Compacted Embankment: The material properties for the "Compacted Embankment" are based on a mixture of shale and sandstone anticipated to be excavated during RWP construction. The material is expected to exhibit the same properties as the mixture of shale and sandstone recovered from test pits RWP-1 (sample REP-1) and RWP-2 (sample REP-4) during the 2018 AECOM exploration (AECOM 2018b). The unit weight assigned to the embankment material is based on 95 percent of the moisture-density relationship determined

in the laboratory using ASTM D 698 Method B (Appendix A). The hydraulic conductivity is based on typical values provided in Figure 8.3.2.3.1-1 of USBR Design Standards No. 13, Chapter 8: Seepage (USBR 2014). The USBR guidance indicates clayey sand (USCS – SC) typically has a horizontal permeability between 1 x 10^{-6} cm/s and 1,000 x 10^{-6} cm/s (or 1 x 10^{-3} cm/s). This calculation package uses the higher value of 1 x 10^{-3} cm/s. The USBR (2014) suggests that typical dams will have anisotropy (k_H/k_V) ratios ranging from 2 to 10. Using the USBR (2014) guidance, the compacted embankment material is assigned an anisotropy ratio of 10 (SEEP/W accepts anisotropy inputs as k_V/k_H, resulting in a value of 0.1). Table 1 presents these values.

Native Ground: The material properties for the "Native Ground" are based on the properties of "Weathered Shale (Native Ground)" originally developed for the weathered shale that underlies the nearby (LAI) (URS 2012). Although the RWP is situated on a bluff approximately 200 feet above the bottom of the LAI, the geologic history of the site and the field investigation AECOM conducted in April 2018 indicate the shale underlying the proposed RWP embankment is similar to the shale underlying the LAI. Table 1 presents these values.

Table 1 – Material Properties Used for the Seepage Analysis

Material	Material Properties				
	Unit Weight, γ_m (pcf)	**Saturated Unit Weight, γ_{sat} (pcf)**	**Horizontal Hydraulic Conductivity (ft/day)[1]**	**Horizontal Hydraulic Conductivity (cm/s)[1]**	**Anisotropy $(k_v/k_h)^2$**
Compacted Embankment	120	125	2.835	1.0 x 10^{-3}	0.1
Native Ground (URS 2012)[3]	120	125	2.835 x 10^{-3}	1.0 x 10^{-6}	0.1

1) SEEP/W requires a horizontal hydraulic conductivity input.
2) The hydraulic conductivity anisotropy input for SEEP/W is expressed as the ratio of vertical hydraulic conductivity to horizontal hydraulic conductivity.
3) The Native Ground hydraulic conductivity is based on a matric suction function in which the horizontal hydraulic conductivity at low matric suction pressures is equal to 2.835 x 10^{-3} ft/day.

The graphical results of the steady-state seepage analyses are shown on C01 and C02 in Attachment C for the normal operating condition (impounded water at EL 5372.2 feet) and the maximum operating condition (impounded water at EL 5379 feet), respectively.

5.3.2 Exit Gradients

In addition to estimating the phreatic surface, the seepage analyses also calculate the steady-state hydraulic gradients within the finite element model.

The hydraulic gradients at the toe of the embankment, defined as the exit gradients, were used to calculate a factor of safety with respect to piping by using the following equation presented by USBR Design Standard No. 13 (USBR 2014):

i_{cr} / i_e = Factor of Safety (with respect to vertical exit gradients)

Where i_{cr} = critical exit gradient = i'_m / i_w

i'_m = the buoyant (submerged) unit weight of soil, $i'_m = i_t - i_w$

i_t = the total unit weight of soil

i_w = the unit weight of water

i_e = the maximum exit gradient (vertical)

The total unit weight of soil at the location of seepage exit, calculated buoyant unit weight, calculated critical exit gradient, maximum exit gradient from the seepage analysis, and the calculated exit gradient factor of safety for each embankment configuration analyzed are summarized in Table 2 below.

Table 2 – Exit Gradient Factors of Safety

Seepage Analysis	Critical Exit Gradient				Maximum Exit Gradient From SEEP/W (i_e)	Factor of Safety for Seepage Exit Gradient
	Material at Location of Seepage Exit	Total Unit Weight (pcf)	Calculated Buoyant Unit Weight (pcf)	Calculated Critical Exit Gradient (i_{cr})		
Normal – EL 5372.2	Native Ground	125	62.6	1.003	0.1335	7.5
Maximum Pool – EL 5379	Native Ground	125	62.6	1.003	0.4889	2.1

The factor of safety for the seepage exit gradient is less than the factor of safety of 3.0 recommended by USBR Design Standard No. 13 (USBR 2014) for the maximum pool elevation scenario. However, this scenario assumes that all three liners fail and impounded water seeps

through the RWP embankment long enough to develop steady-state conditions. Inflow to and outflow from the RWP is actively controlled and monitored by APS, so any unsanctioned decrease in pool elevation would likely trigger an inspection by on-site personnel and steady-state conditions would be unlikely to develop. AECOM believes that in this instance, a factor of safety for the seepage exit gradient equal to 2.1 is acceptable.

5.4 Slope Stability Analysis

5.4.1 Slope Stability Material Properties

The slope stability material properties used in the safety factor assessment are primarily based on laboratory testing of the material excavated from the proposed footprint of the RWP and previously reported material properties developed for the FCPP ash disposal area.

Compacted Embankment: The "Compacted Embankment" drained material strength is based on the results of direct shear tests (ASTM D 3080) performed on remolded samples recovered from test pits excavated in the proposed footprint of the RWP as part of this project. The "Compacted Embankment" undrained material strength is based on triaxial compression test data from samples of compacted shale recovered during the 1989 Dames & Moore geotechnical investigation (Dames & Moore 1990). For the sample presented in Attachment A2, the drained triaxial parameters are similar to the drained direct shear parameters and the clay portion of the embankment is expected to control the undrained behavior of the homogeneous material. Samples of embankment material subjected to sieve analyses (ASTM C 136) during construction contained between 22 and 50 percent fines. Table 3 presents the strength values.

Native Ground: The "Native Ground" undrained material strength is based on the properties of "Weathered Shale (Native Ground)" originally included in the 2012 LAI Design Report (URS 2012). Table 3 presents these values.

Table 3 – Material Properties Used for the Safety Factor Assessment

Material	Material Properties					
	Moist Unit Weight, γ_m (pcf)	Saturated Unit Weight, γ_{sat} (pcf)	Drained Strength		Undrained Strength	
			Cohesion, c' (psf)	Friction Angle, ϕ' (degrees)	Cohesion, c (psf)	Friction Angle, ϕ (degrees)
Compacted Embankment	120	125	200	25	100	16.5
Native Ground	120	125	-	-	500	30

5.4.2 Embankment Loading Conditions

Per 40 CFR § 257.74(e), the following loading conditions were considered for the stability cross-section on both the upstream and downstream slopes:

- Long-term, maximum storage pool (§ 257.74(e)(ii))
- Maximum surcharge pool (§ 257.74(e)(iii))
- End-of-construction (§ 257.74(e)(i))
- Seismic loading (§ 257.74(e)(iv))

The four loading conditions are described in the following subsections. The loading condition definitions are based on the text presented in Section VI of the preamble to the 2015 EPA CCR Rule (EPA 2015).

Long-Term, Maximum Storage Pool (§ 257.74(e)(ii))

The long-term, maximum storage pool loading is the maximum water level that can be maintained that will result in the full development of a steady-state seepage condition. This loading condition is evaluated to document whether the CCR surface impoundment can withstand a maximum expected pool elevation with full development of saturation in the embankment under long-term loading. The long-term, maximum storage pool water elevation used in the calculation is based on the maximum operating level developed as part of the RWP design. The factors of safety are calculated using drained shear strengths.

For long-term maximum storage pool analysis, the pool in the RWP is EL 5372.2 feet.

Maximum Surcharge Pool (§ 257.74(e)(iii))

The maximum surcharge pool loading condition is calculated to evaluate the effect of a raised level (e.g. flood surcharge) on the stability of the downstream slope. Similar to the long-term maximum loading condition, for the purpose of this analysis, the maximum surcharge pool loading condition is assumed to exist sufficiently long enough for steady-state seepage conditions to develop fully within the embankment. The factors of safety are calculated using drained shear strengths.

For the maximum surcharge pool analysis, the pool in the RWP is EL 5379 feet.

End-of-Construction Loading (§ 257.74(e)(i))

The end-of-construction loading condition is analyzed for new construction under the initial filling condition. The factors of safety are calculated using undrained shear strengths.

For the end-of-construction analysis, the pool in the RWP is EL 5372.2 feet.

Seismic Loading (§ 257.74(e)(iv))

The seismic loading condition is evaluated to document whether the impoundment is capable of withstanding a design earthquake. The seismic loading is assessed for a seismic event with a 2% probability of exceedance in 50 years, equivalent to a return period of approximately 2,500 years. A pseudostatic analysis is used to represent the seismic loading because the peak horizontal bedrock acceleration at the site is not likely to be high enough to cause significant embankment deformation. Hynes-Griffin and Franklin (1984) indicate that a pseudostatic stability analysis is sufficient if:

- The composite drained-undrained strength envelope is used and the undrained shear strength of clayey materials is reduced by 20 percent,
- The factor of safety is greater than 1.0,
- Acceptable permanent displacements are less than 1 meter (3.28 feet), and
- The seismic coefficient is equal to at least one-half of the predicted peak horizontal bedrock acceleration (PGA).

For the RWP analysis:

- A composite drained-undrained strength envelope is considered, but the undrained strength is lower than the drained strength throughout the envelope. This assumption is conservative for the RWP because the maximum embankment height in the model is approximately 12 feet and the normal stress on the base of the slices is less than 1,200 psf (Duncan et al. 2014, Shafiee et al. 2008).
- The factor of safety in the RWP analysis is greater than 1.0.
- The RWP embankment is designed to normally impound approximately 4.15 feet of water as operational and dead pool storage with the remaining volume dedicated to outage storage (30 days, or 23 acre-feet). This allows the embankment to withstand a 1-meter displacement.
- The seismic coefficient used in the pseudostatic analysis is conservatively modified to account for the seismic site class and the peak transverse acceleration at the crest, assuming the peak transverse acceleration acts long enough to affect the embankment.

Based on the above factors, a pseudostatic analysis is judged to be sufficient for the RWP seismic loading.

For the seismic loading condition, the pool in the RWP is EL 5379 feet.

Horizontal Seismic Coefficient: The peak horizontal bedrock acceleration for a Site Class "B/C" boundary, based on the United States Geological Survey (USGS) Unified Hazard Tool, with a 2% probability of exceedance in 50 years, is 0.0747g, as presented in Attachment A (USGS 2018). The RWP embankment is underlain by the Lewis Shale and Pictured Cliffs Sandstone, the two units encountered in the test pit investigation. Previous investigations at the site (Amec 2003, AECOM 2015, AECOM 2018a, and AECOM 2018c) indicated that the Lewis Shale and Pictured Cliffs Sandstone are highly weathered to completely weathered and typically have Standard Penetration Test (SPT) N-values greater than 50 blows per foot. Therefore, a Site Classification of C "Very Dense Soil and Soft Rock" is assigned to the RWP embankment foundation. Site Class definitions are summarized in Table 20.3-1 from ASCE 7-16 (2017) and shown in Figure 1.

Table 20.3-1 Site Classification

Site Class	$\bar{v}_s$	$\bar{N}$ or $\bar{N}_{ch}$	$\bar{s}_u$
A. Hard rock	>5,000 ft/s	NA	NA
B. Rock	2,500 to 5,000 ft/s	NA	NA
C. Very dense soil and soft rock	1,200 to 2,500 ft/s	>50 blows/ft	>2,000 lb/ft^2
D. Stiff soil	600 to 1,200 ft/s	15 to 50 blows/ft	1,000 to 2,000 lb/ft^2
E. Soft clay soil	<600 ft/s	<15 blows/ft	<1,000 lb/ft^2
	Any profile with more than 10 ft of soil that has the following characteristics: — Plasticity index $PI > 20$, — Moisture content $w \geq 40\%$, — Undrained shear strength $\bar{s}_u < 500$ lb/ft^2		
F. Soils requiring site response analysis in accordance with Section 21.1	See Section 20.3.1		

Figure 1 – Table 20.3-1 from ASCE 7-16 (2017)

The PGA at the ground surface for Site Class C, or PGA_M, is determined by amplifying the PGA for rock (Site Class B) using the following equation presented in ASCE 7-16 (ASCE 2017):

$$PGA_M = F_{PGA}(PGA)$$

$$PGA_M = 1.3(0.0747g)$$

$$PGA_M = 0.0971g$$

Where: PGA_M = Maximum considered earthquake geometric mean peak ground acceleration adjusted for Site Class effects
PGA = Mapped maximum considered earthquake geometric mean peak ground acceleration
F_{PGA} = Site coefficient from Table 11.8-1 (Figure 2)

TABLE 11.8-1 Site Coefficient F_{PGA}

	Mapped Maximum Considered Geometric Mean (MCE_G) Peak Ground Acceleration, PGA					
Site Class	**PGA ≤ 0.1**	**PGA = 0.2**	**PGA = 0.3**	**PGA = 0.4**	**PGA = 0.5**	**PGA ≥ 0.6**
A	0.8	0.8	0.8	0.8	0.8	0.8
B	0.9	0.9	0.9	0.9	0.9	0.9
C	1.3	1.2	1.2	1.2	1.2	1.2
D	1.6	1.4	1.3	1.2	1.1	1.1
E	2.4	1.9	1.6	1.4	1.2	1.1
F	See Section 11.4.8					

Note: Use straight-line interpolation for intermediate values of PGA.

Figure 2 – Table 11.8-1 from ASCE 7-16 (2017)

The PGA at the ground surface for Site Class C (PGA_M) is then used to estimate the peak transverse acceleration at the crest of the embankment, $PGA_{C,crest}$ = 0.300g as shown on Figure 3 and based on variations in recorded peak crest accelerations versus those recorded at the base of earth and rock fill dams by Idriss and on recorded values for Loma Prieta and other earthquakes by Holzer (1998).

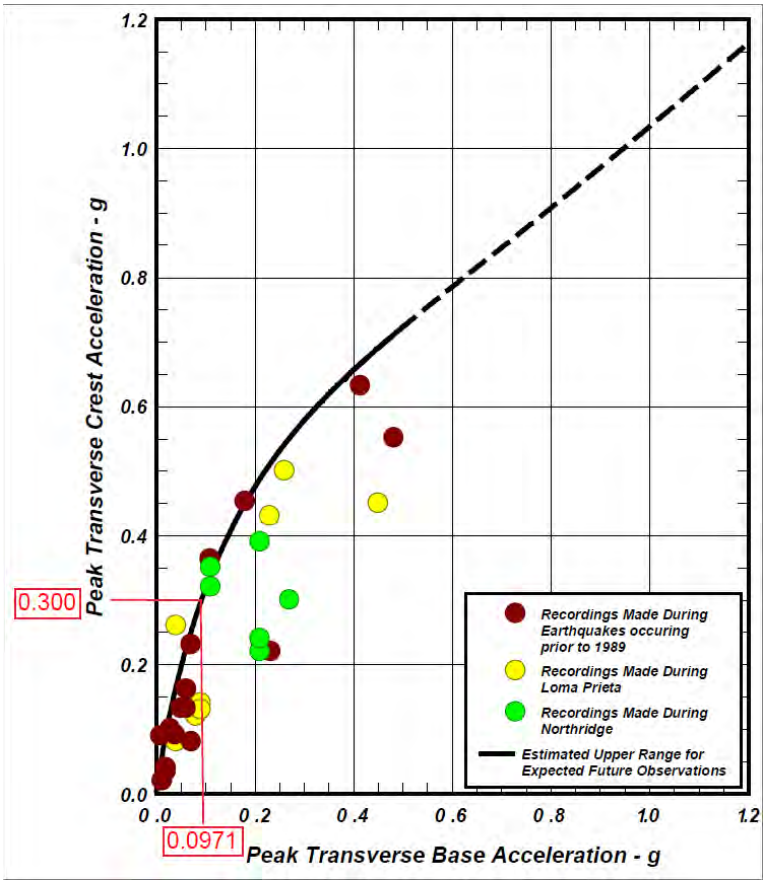

Figure 3 – Variations of Peak Transverse Crest Acceleration v. Peak Transverse Base Acceleration Based on Holzer (1998)

Makdisi and Seed (1977) note that the "maximum acceleration ratio" varies with the depth of the sliding mass relative to the embankment height. Figure 4 presents the relationship between maximum acceleration ratio (k_{max}/u_{max}) and depth of sliding mass (y/h). For deep-seated failure surfaces that involve the entire vertical profile of the embankment slope and extend from the crest to the toe, or below the toe, of the embankment into the foundation soils, the acceleration at the crest can be as low as approximately 34 percent of the maximum value:

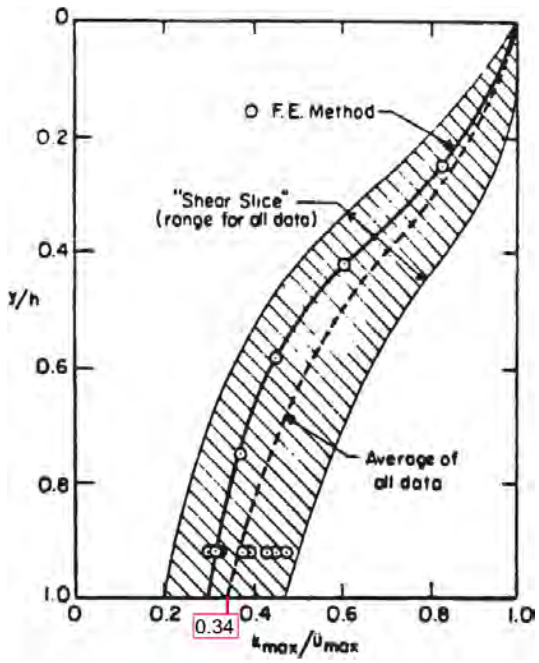

Figure 4 – Variation of "Maximum Acceleration Ratio" with depth of sliding mass after Makdisi and Seed (1977)

Therefore:

$$\frac{k_{max}}{u_{max}} = 0.34$$

Where: k_{max} = the maximum average acceleration for the potential sliding mass

u_{max} = the maximum crest acceleration

$$k_{max} = 0.34(u_{max})$$

$$k_{max,C} = 0.34(0.300g)$$

$$k_{max,C} = 0.102g$$

The pseudostatic analysis incorporates a horizontal seismic coefficient of 0.102g for the RWP embankment. Because it is unlikely the embankment would be exposed to the seismic load while the pond level had been at the maximum surcharge elevation long enough to develop steady-state phreatic conditions in the embankment after all three liners had been

compromised, the earthquake was assumed to occur with the storage pool at the long-term, maximum storage pool elevation (EL 5372.2 feet).

Liquefaction Triggering

The RWP was constructed using Lewis Shale (clay) and Pictured Cliffs Sandstone (fine-grained sand) excavated from the footprint and upstream pool. AECOM believes that the presence of clay will result in the proposed embankment not being susceptible to liquefaction during a seismic event. In addition, the native foundation (in-situ) Lewis Shale and Pictured Cliffs Sandstone materials are also not expected to be susceptible to liquefaction.

6 ANALYSIS RESULTS AND CONCLUSIONS

The safety factor assessment output figures are presented in Attachment C. Table 4 summarizes the results of the safety factor assessment.

Table 4 – Safety Factor Results

Loading Condition	Required Factor of Safety	Calculated Factor of Safety	Figure in Appendix C
Long-term, Maximum Storage Pool	1.50	3.40 (Upstream)	C03
		3.11 (Downstream)	C04
Maximum Surcharge Pool	1.40	4.36 (Upstream)	C05
		2.69 (Downstream)	C06
End-of-Construction	1.30	1.93 (Upstream)	C07
		1.77 (Downstream)	C08
Seismic	1.00	1.53 (Upstream)	C09
		1.11 (Downstream)	C10

All of the calculated factors of safety exceed the applicable required minimum factor of safety for the associated loading condition.

7 REFERENCES

1. AECOM, (2015). "Four Corners Power Plant Units 4 & 5 Selective Catalytic Reduction (SCR) Project – Geotechnical Engineering Investigation." Report No. 13-6-110. Prepared for Arizona Public Service Company. August 21.
2. AECOM, (2018a). "Bottom Ash Sluice Water Recycle System Upgrades (DRAFT) – Four Corners Power Plant – Arizona Public Service Company – Fruitland, New Mexico." Technical Memorandum. January 26.
3. AECOM, (2018b). "Geotechnical Recommendations Memo." May 29.
4. AECOM, (2018c). "Geotechnical Investigation for the Bottom Ash Sluice Water Recycle System – Sedimentation Tanks – Four Corners Power Plant – Arizona Public Service Company – Fruitland, New Mexico." Technical Memorandum. August 22.
5. Amec, (2003). "LS-1 and LS-2 Monitor Well Installation." October.
6. American Society of Civil Engineers (ASCE) (2017). *ASCE/SEI 7-16: Minimum Design Loads and Associated Criteria for Buildings and Other Structures*. Errata dated July 9, 2018.
7. Dames & Moore, (1990). *Raising Ash Dams 3 and 6 – Four Corners Steam Electric Station*. Prepared for Arizona Public Service Company. August 29.
8. Duncan, J. Michael, Stephen G. Wright, and Thomas L. Brandon, (2014). *Soil Strength and Slope Stability*. John Wiley & Sons, Inc. Hoboken, New Jersey. 2nd Ed.
9. GEO-SLOPE International, (2016). GeoStudio 2016, Version 8.16.2.14053, August 2016 Release.
10. International Code Council (ICC), Inc., (2017). *2018 International Building Code [IBC]*, August.
11. Hynes-Griffin, Mary E. and Arley G. Franklin, (1984). "Rationalizing the Seismic Coefficient Method." Miscellaneous Paper GL-84-13. Department of the [United States] Army, Waterways Experiment Station, Corps of Engineers. Vicksburg, Mississippi. July.
12. Holzer, Thomas L., (1998). "The Loma Prieta Earthquake of October 17, 1989, Earth Structures and Engineering Characterization of Ground Motion." USGS Professional Paper 1552-D, U.S. Government Printing Office.

13. Makdisi, F.I. and H. Bolton Seed, (1977). "A Simplified Procedure for Estimating Earthquake-Induced Deformations in Dams and Embankments." Report No. UCB/EERC-77/19. University of California, Berkeley. August.

14. Shafiee, A., H. R. Tavakoli, and M. K. Jafari, (2008). "Undrained Behavior of Compacted Sand-Clay Mixtures Under Monotonic Loading Paths." Journal of Applied Sciences 8 (18). Pgs 3108-3118.

15. State of New Mexico, (2018). New Mexico Administrative Code – Title 19, Chapter 25, Part 12.

16. United States Environmental Protection Agency (EPA), (2015). 40 CFR Parts 257 and 261 – Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule. Federal Register Vol. 80, No. 74. April 17.

17. United States Geological Survey (USGS), (2018). "Unified Hazard Tool – Conterminous US 2014 (v4.0.x)." https://earthquake.usgs.gov/hazards/interactive/. Accessed July 25, 2018.

18. URS Corporation, (2012). "Engineering Design Report – Lined Ash Impoundment 5280 Lift – Four Corners Power Plant – San Juan County, New Mexico." Prepared for Arizona Public Service. March.

8 ATTACHMENTS

FIGURE 5 RWP Slope Stability Analysis – Location of Maximum Section

ATTACHMENT A 2018 Test Pit Logs and Laboratory Data

ATTACHMENT B USGS Unified Hazard Tool

ATTACHMENT C SLOPE/W Output Figures

ANSI B 11" x 17"

Approved:

Project Management Initials: Designer: LMW Checked:

Last saved by: LEE.WRIGHT(2018-07-30) Last Plotted: 2018-07-30
Filename: \\PHOENIX\PROJECTS\ARIZONA_PUBLIC_SERVICE\60566008_FCPP_RETURN_WATER_POND_SG2\900_CAD_GIS\910_CAD\25-SKETCHES\SLOPE STABILITY\RETURN WATER POND PLAN.DWG

N

0 100 200

SCALE IN FEET

ACCESS ROAD

6TP-28

6TP-29

2+00

2+37

1+00

0+00

MAXIMUM SECTION

RWP-1

6TP-27

RETURN WATER POND
(RWP)

RWP-2

RWP-3

6TP-25

6TP-26

FHI FACILITY

RWP-4

ASH HAUL ROAD

DATUM INFORMATION

HORIZONTAL DATUM FOR THIS PROJECT IS BASED UPON THE NEW MEXICO STATE PLANE COORDINATE SYSTEM, WEST ZONE (3003), NORTH AMERICAN DATUM OF 1983 (NAD 83), US SURVEY FEET.
THE VERTICAL DATUM IS BASED UPON THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88).

LEGEND

ASH POND 6 TEST PIT (6TP-##)

PROPOSED TEST PIT (RWP-#)

AECOM

Figure 5
2018-07-23

RWP SLOPE STABILITY ANALYSIS
LOCATION OF MAXIMUM SECTION

AECOM PROJECT NO. 60566008
APS PROJECT NO. FCC06814
ARIZONA PUBLIC SERVICE
RETURN WATER POND

ATTACHMENT A

2018 Test Pit Logs and Laboratory Data

ATTACHMENT A1

2018 Test Pit Logs

AECOM
7720 N 16th Street, Suite 100
Phoenix, AZ 85020
602-371-1100
602-371-1615 (Fax)

TEST PIT LOG: RWP-1

SHEET 1 of 1
AECOM PROJECT #: 60566008

PROJECT: Return Water Pond SG2
CLIENT: Arizona Public Service
CLIENT PROJECT: FCC06814

CONTRACTOR: FHI Plant Services
DRILLER: Terry
FIELD ENGINEER: Dylan Curet

COORDINATES **N:** 2,069,554.377900
E: 2,530,072.438500
LOCATION: Four Corners Power Plant, NM

REFERENCE: N/A
STATION: N/A
OFFSET: N/A

EQUIPMENT: D-8 Dozer
BUCKET: 6.8 Cubic Yards

COMMENTS: Dozer equipped with a single ripper tooth. Excavation terminated due to inability to progress deeper without significantly extending the length of the test pit (at least 10 feet in length) and pushing materials to the opposite side of the pit.

SURFACE ELEV.: 5,384.00 FT
TOTAL DEPTH: 13 FT

START DATE: 04/10/2018 **TIME:** 07:28 AM
FINISH DATE: 04/10/2018 **TIME:** 11:00 AM

DEPTH BELOW SURFACE (FT)	ELEVATION (FT)	GRAPHIC	DESCRIPTION	USCS	SAMPLE NUMBER	SAMPLE MOISTURE (%)	SAMPLE DRY DENSITY (PCF)	SAMPLE MAX. DENSITY (PCF)	SAMPLE OPT. MOIST. (%)	REMARKS
0			CLAYEY SAND with GRAVEL, trace gypsum, dry, brown	SC						
3.0'			... some interbedded shale with little gypsum							
3.5'			SANDSTONE, dry, light brown, slightly weathered	SP						
4	5380		SHALE, dry to slightly moist, brown, moderately weathered	CL						
5.5'			SANDSTONE, dry to slightly moist, light brown, unweathered to slightly weathered	SP						
7.5'			SHALE, slightly moist, reddish-brown to brown, moderately weathered to highly weathered	CL	REP-1			114.9	14.9	7.5' to 9': Recovered representative bulk bucket sample. Sample tested as composite bulk sample with REP-4 from RWP-2 at 8.5' to 9.5'
9	5375									
10.5'			SANDSTONE, slightly moist, light brown, unweathered to slightly unweathered	SP						
12.0'			SHALE, slightly moist, whitish-brown to dark brown, moderately to slightly weathered, unweathered to slightly weathered sandstone at bottom of excavation	CL	REP-2					
13.0'										Excavation terminated at 13'
14	5370									No groundwater encountered
15										
16										

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TEST PIT LOG: RWP-2

SHEET 1 of 1
AECOM PROJECT #: 60566008

PROJECT: Return Water Pond SG2
CLIENT: Arizona Public Service
CLIENT PROJECT: FCC06814

CONTRACTOR: FHI Plant Services
DRILLER: Terry & Jeremy
FIELD ENGINEER: Dylan Curet

COORDINATES **N:** 2,069,211.884500 **REFERENCE:** N/A
E: 2,529,605.574400 **STATION:** N/A
LOCATION: Four Corners Power Plant, NM **OFFSET:** N/A

EQUIPMENT: John Deere 310SK
BUCKET: 1 Cubic Yard

COMMENTS: Refusal on unweathered sandstone layer.

SURFACE ELEV.: 5,390.00 FT
TOTAL DEPTH: 9.5 FT

START DATE: 04/10/2018 **TIME:** 11:10 AM
FINISH DATE: 04/10/2018 **TIME:** 12:30 PM

DEPTH BELOW SURFACE (FT)	ELEVATION (FT)	GRAPHIC	DESCRIPTION	USCS	SAMPLE NUMBER	SAMPLE MOISTURE (%)	SAMPLE DRY DENSITY (PCF)	SAMPLE MAX. DENSITY (PCF)	SAMPLE OPT. MOIST. (%)	REMARKS
0			SHALE, dry, light brown, trace gypsum, moderately weathered to slightly weathered	SC	REP-3			112.6	15.3	0' to 3.5': Recovered representative bulk bucket sample
3.0'			SANDSTONE, dry, light brown to brown, fine, breaks into angular fragments, highly weathered	SP						
4.0'	5385		SHALE, dry to slightly moist, brown to reddish brown, high plasticity, moderately weathered	CL						
6.0'			SANDSTONE, dry, whitish-brown, moderately hard, slightly weathered	SP						
8.0'			SHALE, dry, brown, some weak cementation, moderately weathered to slightly weathered, slightly weathered sandstone at bottom of excavation	SC	REP-4			114.9	14.9	8.5' to 9.5': Recovered representative bulk bucket sample. Sample tested as composite bulk sample with REP-1 from RWP-1 at 7.5' to 9'
9.5'	5380									Refusal on sandstone at 9.5'
	5375									No groundwater encountered

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602-371-1615 (Fax)

TEST PIT LOG: RWP-3

SHEET 1 of 1
AECOM PROJECT #: 60566008

PROJECT: Return Water Pond SG2
CLIENT: Arizona Public Service
CLIENT PROJECT: FCC06814

CONTRACTOR: FHI Plant Services
DRILLER: Terry
FIELD ENGINEER: Dylan Curet

COORDINATES **N:** 2,069,141.897400 **REFERENCE:** N/A
E: 2,529,248.297200 **STATION:** N/A
LOCATION: Four Corners Power Plant, NM **OFFSET:** N/A

EQUIPMENT: John Deere 310SK
BUCKET: 1 Cubic Yard

COMMENTS: Refusal on unweathered sandstone layer.

SURFACE ELEV.: 5,385.00 FT
TOTAL DEPTH: 8 FT

START DATE: 04/10/2018 **TIME:** 01:45 PM
FINISH DATE: 04/10/2018 **TIME:** 02:45 PM

DEPTH BELOW SURFACE (FT)	ELEVATION (FT)	GRAPHIC	DESCRIPTION	USCS	SAMPLE NUMBER	SAMPLE MOISTURE (%)	SAMPLE DRY DENSITY (PCF)	SAMPLE MAX. DENSITY (PCF)	SAMPLE OPT. MOIST. (%)	REMARKS
0			SHALE, dry, brown, very hard plates, completely weathered to slightly weathered shale, interbedded with less than 1" thick lenses of weak sandstone	SC						0' to 5': Recovered representative bulk bucket sample
2								114.7	15	
3					REP-7					
5	5380									
6			... increased sandstone interbedding frequency, material becoming increasingly hard							
8			8.0'		REP-8					7.5' to 8': Recovered representative bulk bucket sample Refusal on hard material at 8' No groundwater encountered
10	5375									
15	5370									

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Phoenix, AZ 85020
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TEST PIT LOG: RWP-4

SHEET 1 of 1
AECOM PROJECT #: 60566008

PROJECT: Return Water Pond SG2
CLIENT: Arizona Public Service
CLIENT PROJECT: FCC06814

CONTRACTOR: FHI Plant Services
DRILLER: Terry & Jeremy
FIELD ENGINEER: Dylan Curet

COORDINATES **N:** 2,068,768.980700 **REFERENCE:** N/A
E: 2,529,582.266300 **STATION:** N/A
LOCATION: Four Corners Power Plant, NM **OFFSET:** N/A

EQUIPMENT: John Deere 310SK
BUCKET: 1 Cubic Yard

COMMENTS: Refusal on unweathered sandstone layer.

SURFACE ELEV.: 5,398.00 FT
TOTAL DEPTH: 9.5 FT

START DATE: 04/10/2018 **TIME:** 12:35 PM
FINISH DATE: 04/10/2018 **TIME:** 01:35 PM

DEPTH BELOW SURFACE (FT)	ELEVATION (FT)	GRAPHIC	DESCRIPTION	USCS	SAMPLE NUMBER	SAMPLE MOISTURE (%)	SAMPLE DRY DENSITY (PCF)	SAMPLE MAX. DENSITY (PCF)	SAMPLE OPT. MOIST. (%)	REMARKS
1			SILTY SAND, mixed with fly ash, dry, gray, loose	SM	REP-5					0' to 2': Recovered representative bulk bucket sample
			... reddish-brown							
2			2.0'							
3	5395		SHALE, dry, brown, trace weak calcareous cementation, moderately weathered	CL						
4			4.0'							
5			SANDSTONE, dry, brown, thin and weak lenses interbedded with shale, moderately weathered to highly weathered	SP						
6			6.0'							
7			SHALE, dry, brown, strong calcareous cementation, slightly weathered to moderately weathered	CL						
			7.5'							
8	5390		SANDSTONE, dry, brown, thin lense of gypsum, highly weathered	SP						
			8.5'							
9			SHALE, dry, dark brown, moderately weathered to highly weathered	CL						
			9.0'							
			9.5'	SP	REP-6					9' to 9.5': Recovered representative bulk bucket sample
10			SANDSTONE, dry, dark brown, moderately to highly weathered							Refusal on sandstone at 9.5'
										No groundwater encountered
11										
12										
13	5385									
14										
15										
16										

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TEST PIT LOG: RWP-5

SHEET 1 of 1
AECOM PROJECT #: 60566008

PROJECT: Return Water Pond SG2
CLIENT: Arizona Public Service
CLIENT PROJECT: FCC06814

CONTRACTOR: FHI Plant Services
DRILLER: Terry
FIELD ENGINEER: Dylan Curet

COORDINATES **N:** 2,067,936.641400
E: 2,523,315.969000
LOCATION: Four Corners Power Plant, NM

REFERENCE: N/A
STATION: N/A
OFFSET: N/A

EQUIPMENT: John Deere 310SK
BUCKET: 1 Cubic Yard

COMMENTS:

SURFACE ELEV.: 5,119.00 FT
TOTAL DEPTH: 6 FT

START DATE: 04/10/2018 **TIME:** 02:56 PM
FINISH DATE: 04/10/2018 **TIME:** 03:21 PM

DEPTH BELOW SURFACE (FT)	ELEVATION (FT)	GRAPHIC	DESCRIPTION	USCS	SAMPLE NUMBER	SAMPLE MOISTURE (%)	SAMPLE DRY DENSITY (PCF)	SAMPLE MAX. DENSITY (PCF)	SAMPLE OPT. MOIST. (%)	REMARKS
1			SHALE, dry to slightly moist, brown, trace calcareous cementation, large nodules, highly weathered to completely weathered							0' to 3': Recovered representative bulk bucket sample
2					REP-9					
3			... light gray, small plates	CL						3' to 6': Recovered representative bulk bucket sample
4	5115									
5			... light brown shale, trace reddish-brown, some fine to coarse gravels		REP-10					
6			6.0'							Excavation terminated at 6' Groundwater not encountered
7										
8										
9	5110									
10										
11										
12										
13										
14	5105									
15										
16										

ATTACHMENT A2

Laboratory Data

GEOMAT INC.
915 Malta Avenue ◆ Farmington, NM 87401 ◆ Tel (505) 327-7928 ◆ Fax (505) 326-5721

LABORATORY REPORT

Client: AECOM
7720 N. 16th Street, Suite 100
Phoenix, Arizona 85020

Attn: **Lee Wright, P.E.**

Project: Return Water Pond Test Pits – AECOM Project No. 60566008

Location: Fruitland, New Mexico

Report Date: April 24, 2018
GEOMAT Project No: 181-2987
Page No: 1 of 1
Lab No: 6245

Sampled By: D. Curet/AECOM
Sampled Date: April 10, 2018
Requested By: L. Wright/AECOM

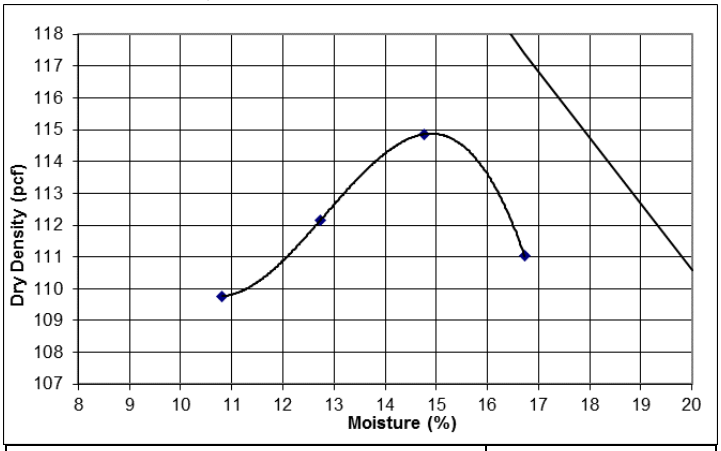
Sample Location: Combination of Test Pit RWP-1, Sample REP-1, depth 7.5'-9' and RWP-2, Sample REP-4, depth 8.5'-9.5'
Source: Test Pits RWP-1, REP-1 and RWP-2, REP-4
Material Description (Color, Symbol, Group): Test Pit Log: REP-1, Reddish Brown Shale and REP-4, Brown Shale. ASTM Classification: SC-Clayey Sand with Gravel

Sieve Analysis, ASTM C117, C136		
Sieve Size	% Passing	Specifications
6"		
5"		
4"		
3"		
2 ½"		
2"		
1 ½"		
1"	**100**	
¾"	**98**	
½"	**88**	
3/8"	**83**	
No. 4	**70**	
No. 8	**63**	
No. 10	**62**	
No. 16	**58**	
No. 30	**54**	
No. 40	**52**	
No. 50	**50**	
No. 100	**43**	
No. 200	**27**	

Plasticity Index, ASTM D4318		
	Results	Specifications
Liquid Limit (LL)	**39**	
Plastic Limit (PL)	**15**	
Plasticity Index (PI)	**24**	

Moisture-Density Relationship, ASTM D698 Method B	
Maximum Dry Density, pcf	**114.9**
Optimum Moisture Content, %	**14.9**

100% Saturation, SG = 2.75 Estimated



Description of Rammer	Manual
Preparation	Dry

Reviewed By: Nathan Compton

Distribution: AECOM – Lee Wright, P.E. (1)

Note: This is a summarized report of the referenced procedures and does not include all reporting requirements. Additional data can be provided at client's request.

GEOMAT INC.
915 Malta Avenue ◆ Farmington, NM 87401 ◆ Tel (505) 327-7928 ◆ Fax (505) 326-5721

LABORATORY REPORT

Client: AECOM
7720 N. 16th Street, Suite 100
Phoenix, Arizona 85020

Attn: **Lee Wright, P.E.**

Project: Return Water Pond Test Pits – AECOM Project No. 60566008

Location: Fruitland, New Mexico

Report Date: April 24, 2018
GEOMAT Project No: 181-2987
Page No: 1 of 1
Lab No: 6246

Sampled By: D. Curet/AECOM
Sampled Date: April 10, 2018
Requested By: L. Wright/AECOM

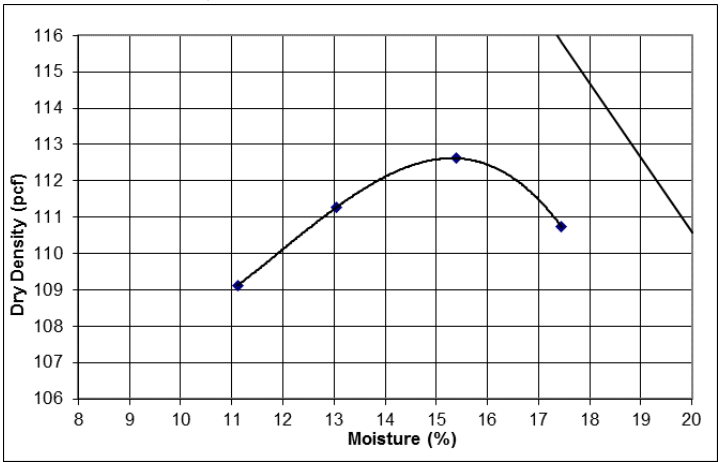
Sample Location: Test Pit RWP-2, Sample REP-3, depth 0'-3.5'
Source: Test Pit RWP-2, REP-3
Material Description (Color, Symbol, Group): Test Pit Log: Sandy Lean Clay. ASTM Classification: SC-Clayey Sand

Sieve Analysis, ASTM C117, C136		
Sieve Size	% Passing	Specifications
6"		
5"		
4"		
3"		
2 ½"		
2"		
1 ½"		
1"		
¾"	**100**	
½"	**94**	
3/8"	**93**	
No. 4	**88**	
No. 8	**83**	
No. 10	**83**	
No. 16	**79**	
No. 30	**75**	
No. 40	**71**	
No. 50	**65**	
No. 100	**46**	
No. 200	**26**	

Plasticity Index, ASTM D4318		
	Results	Specifications
Liquid Limit (LL)	**31**	
Plastic Limit (PL)	**15**	
Plasticity Index (PI)	**16**	

Moisture-Density Relationship, ASTM D698 Method A	
Maximum Dry Density, pcf	**112.6**
Optimum Moisture Content, %	**15.3**

100% Saturation, SG = 2.75 Estimated



Description of Rammer	Manual
Preparation	Dry

Reviewed By: Nathan Compton

Distribution: AECOM – Lee Wright, P.E. (1)

Note: This is a summarized report of the referenced procedures and does not include all reporting requirements. Additional data can be provided at client's request.

GEOMAT INC.
915 Malta Avenue ◆ Farmington, NM 87401 ◆ Tel (505) 327-7928 ◆ Fax (505) 326-5721

LABORATORY REPORT

Client: AECOM
7720 N. 16th Street, Suite 100
Phoenix, Arizona 85020

Attn: **Lee Wright, P.E.**

Project: Return Water Pond Test Pits – AECOM Project No. 60566008

Location: Fruitland, New Mexico

Report Date: April 24, 2018
GEOMAT Project No: 181-2987
Page No: 1 of 1
Lab No: 6247

Sampled By: D. Curet/AECOM
Sampled Date: April 10, 2018
Requested By: L. Wright/AECOM

Sample Location: Test Pit RWP-5, depth 0'-3.5'
Source: Test Pit RWP-5
Material Description (Color, Symbol, Group): Test Pit Log: Shale. ASTM Classification: CL-Sandy Lean Clay

Sieve Analysis, ASTM C117, C136		
Sieve Size	% Passing	Specifications
6"		
5"		
4"		
3"		
2 ½"		
2"		
1 ½"		
1"		
¾"		
½"		
3/8"	**100**	
No. 4	**99**	
No. 8	**99**	
No. 10	**99**	
No. 16	**97**	
No. 30	**95**	
No. 40	**94**	
No. 50	**92**	
No. 100	**86**	
No. 200	**59**	

Plasticity Index, ASTM D4318		
	Results	Specifications
Liquid Limit (LL)	**25**	
Plastic Limit (PL)	**15**	
Plasticity Index (PI)	**10**	

Moisture-Density Relationship, ASTM D698 Method A	
Maximum Dry Density, pcf	**114.7**
Optimum Moisture Content, %	**15.0**

100% Saturation, SG = 2.75 Estimated

Description of Rammer	Manual
Preparation	Dry

Reviewed By: Nathan Compton

Distribution: AECOM – Lee Wright, P.E. (1)

Note: This is a summarized report of the referenced procedures and does not include all reporting requirements. Additional data can be provided at client's request.

915 Malta Avenue
Farmington, New Mexico 87401
Tel (505) 327-7928
Fax (505) 326-5721

LETTER OF TRANSMITTAL

To:	AECOM	Date:	May 2, 2018
	7720 N. 16th St. Suite 100	Project:	Return Water Pond Test Pits – AECOM Project No. 60566008
	Phoenix, Arizona 85020	Project No.:	181-2987
Attn:	**Lee Wright, P.E.**		

We are:	For your:	The following:
X Transmitting	Review	**X** Laboratory Report
Returning	**X** Information & Files	Engineering Report
Separately	Approval	Constructions Drawings
	Signature	

Copies	Date	Description
1	4/20/18	Direct Shear Test Results, GEOMAT Lab No. 6245. Sample Location: Combination of Test Pit RWP-1, Sample REP-1, depth 7.5'-9' and RWP-2, Sample REP-4, depth 8.5'-9.5'
1	4/25/18	Direct Shear Test Results, GEOMAT Lab No. 6247. Sample Location: Test Pit RWP-5, depth 0'-3.5'

Delivery By:

Hand Delivery	Express Mail	Return Receipt
First Class Mail	Courier Service	
Regular Mail	**X** Other Email	

GEOMAT Inc.

By: Jana Nelson

Distribution: AECOM – Lee Wright (1)

TRAUTNER GEOTECH LLC
GEOTECHNICAL ENGINEERING, MATERIAL TESTING
AND ENGINEERING GEOLOGY

Direct Shear Test Results:

ASTM D-3080

Project: Geomat Misc. Testing 2018

Laboratory Number: 4165-A
Sample Date: 4/19/2018 (delivered)
Test Date: 4/20/2018
Technician: JT

Geomat Lab Number 6245
Type of Specimen: Remolded Square Shear Box
Width: 2.5 in
Height: 1.0 in

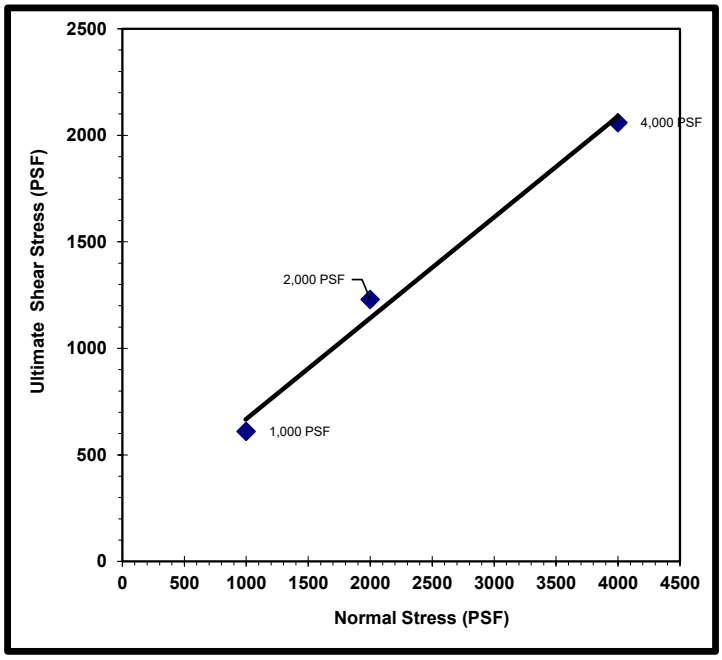
Summary of Sample Data: σ_n=4000 PSF	
Initial Moisture Content (%):	15.0
Intial Dry Density (PCF):	110.1
Final Moisture Content (%):	18.0
Final Dry Density (PCF):	110.6

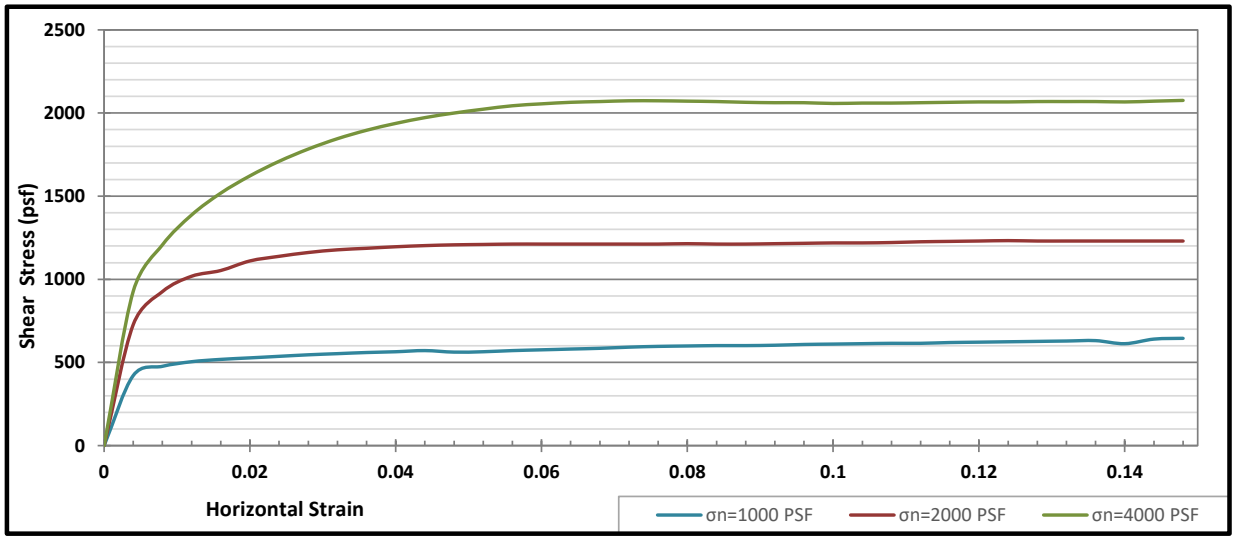
Summary of Sample Data: σ_n=2000 PSF	
Initial Moisture Content (%):	14.9
Intial Dry Density (PCF):	110.6
Final Moisture Content (%):	19.7
Final Dry Density (PCF):	106.9

Summary of Sample Data: σ_n=1000 PSF	
Initial Moisture Content (%):	14.6
Intial Dry Density (PCF):	109.7
Final Moisture Content (%):	20.7
Final Dry Density (PCF):	104.2

ESTIMATED STRENGTH PARAMETERS	
Angle of Internal Friction, ϕ (°):	**25**
Cohesion (PSF):	**200**

Direct Shear Test Results:			
Normal Stress, σ_n (PSF):	4000	2000	1000
Ultimate Shear Stress, τ_{ult} (PSF):	2060	1230	610





TRAUTNER GEOTECH LLC
GEOTECHNICAL ENGINEERING, MATERIAL TESTING
AND ENGINEERING GEOLOGY

Direct Shear Test Results:

ASTM D-3080

Project: Geomat Misc. Testing 2018

Laboratory Number: 4165-B
Sample Date: 4/19/2018 (delivered)
Test Date: 4/25/2018
Technician: JT

Geomat Lab Number 6247
Type of Specimen: Remolded Square Shear Box
Width: 2.5 in
Height: 1.0 in

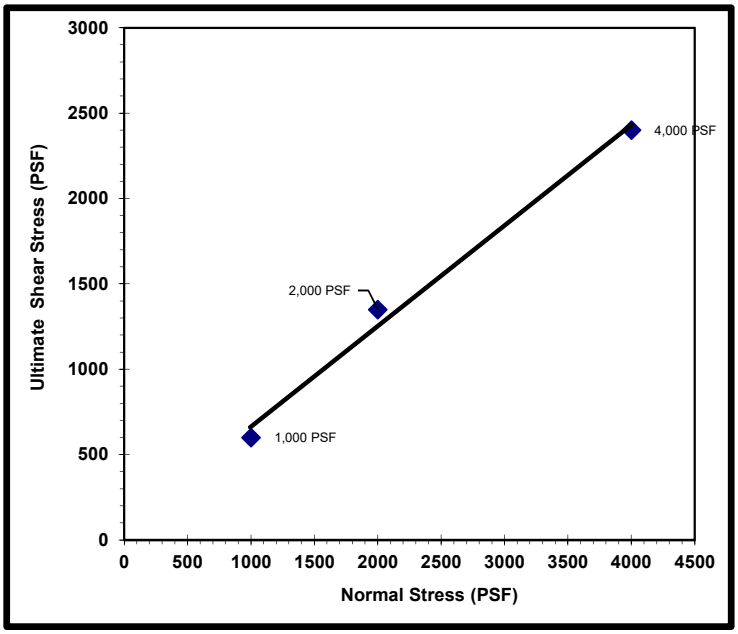
Summary of Sample Data: σ_n=4000 PSF	
Initial Moisture Content (%):	15.3
Intial Dry Density (PCF):	109.6
Final Moisture Content (%):	15.6

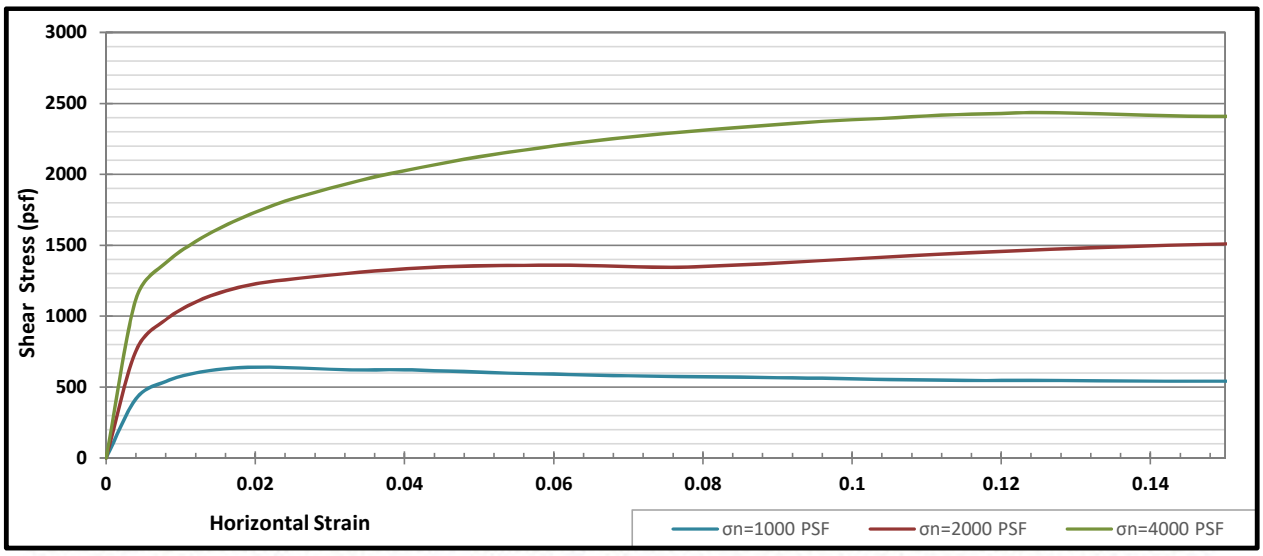
Summary of Sample Data: σ_n=2000 PSF	
Initial Moisture Content (%):	15.2
Intial Dry Density (PCF):	109.4
Final Moisture Content (%):	16.7

Summary of Sample Data: σ_n=1000 PSF	
Initial Moisture Content (%):	15.1
Intial Dry Density (PCF):	109.8
Final Moisture Content (%):	17.6

ESTIMATED STRENGTH PARAMETERS	
Angle of Internal Friction, ϕ (°):	**30**
Cohesion (PSF):	**75**

Direct Shear Test Results:			
Normal Stress, σ_n (PSF):	4000	2000	1000
Ultimate Shear Stress, τ_{ult} (PSF):	2400	1350	600





REPORT

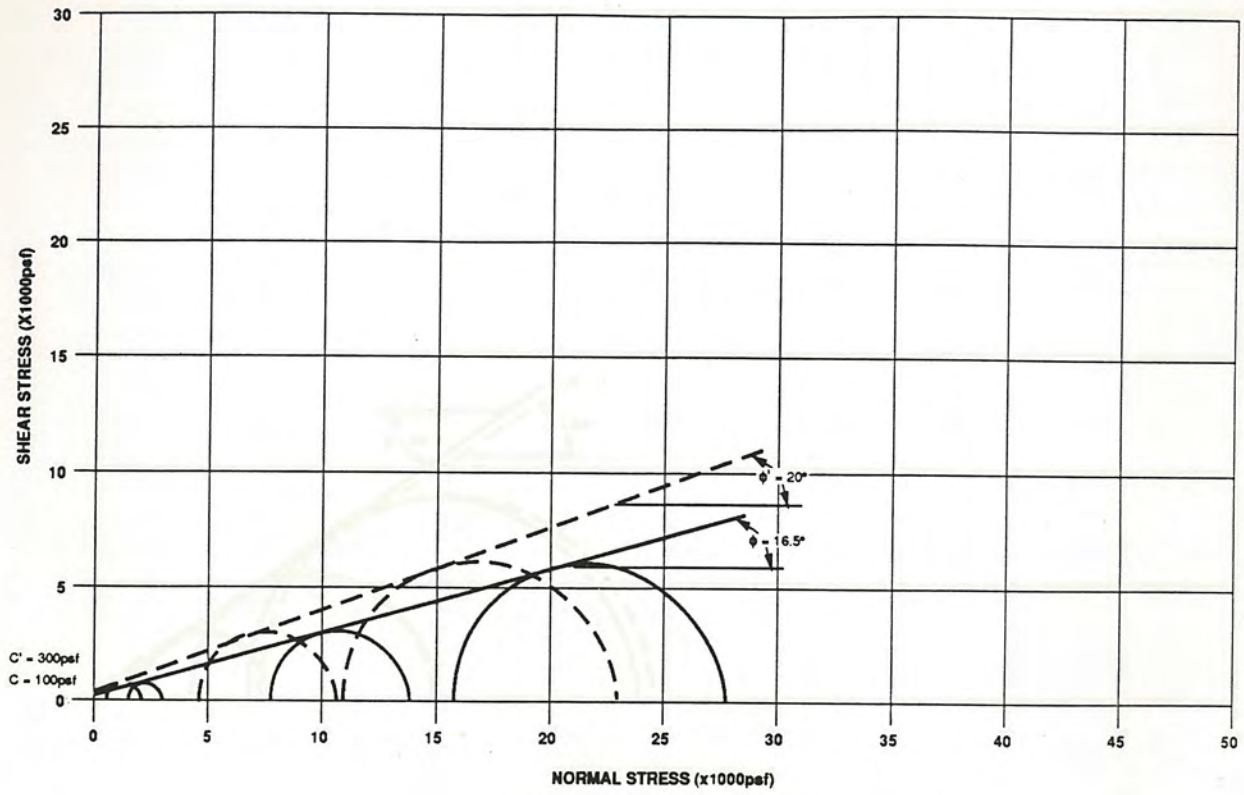
RAISING ASH DAMS 3 AND 6
FOUR CORNERS STEAM ELECTRIC STATION

FOR

ARIZONA PUBLIC SERVICE COMPANY

DAMES & MOORE

D&M Job No. 02353-105-022
August 29, 1990



MOHR ENVELOPE AT 2% AXIAL STRAIN

- - - - EFFECTIVE STRESS

——— TOTAL STRESS

MULTI-STAGE TX/CU/PP SAMPLE #6 BORING 15 @ 30'

TRIAXIAL COMPRESSION TEST DATA

COMPACTED SHALE

02353-105-022

BY **DAMES & MOORE** Plate A-12H

ATTACHMENT B

USGS Unified Hazard Tool

Unified Hazard Tool

Please do not use this tool to obtain ground motion parameter values for the design code reference documents covered by the U.S. Seismic Design Maps web tools (e.g., the International Building Code and the ASCE 7 or 41 Standard). The values returned by the two applications are not identical.

Input

Edition

Conterminous U.S. 2014 (v4.0.x)

Spectral Period

Peak ground acceleration

Latitude

Decimal degrees

36.68565

Time Horizon

Return period in years

2475

Longitude

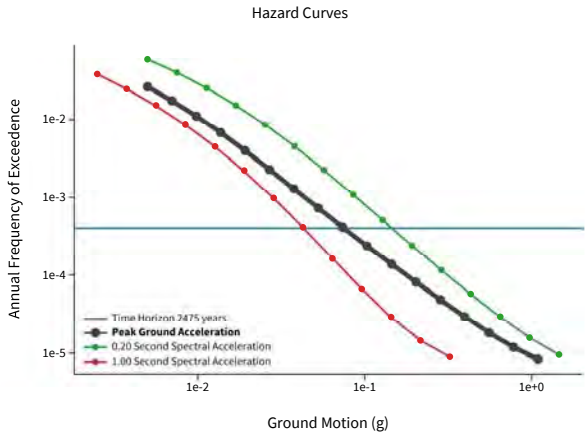
Decimal degrees, negative values for western long…

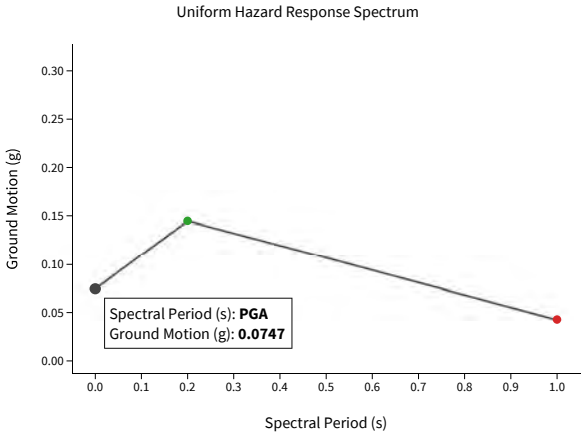
-108.49164

Site Class

760 m/s (B/C boundary)

Hazard Curve



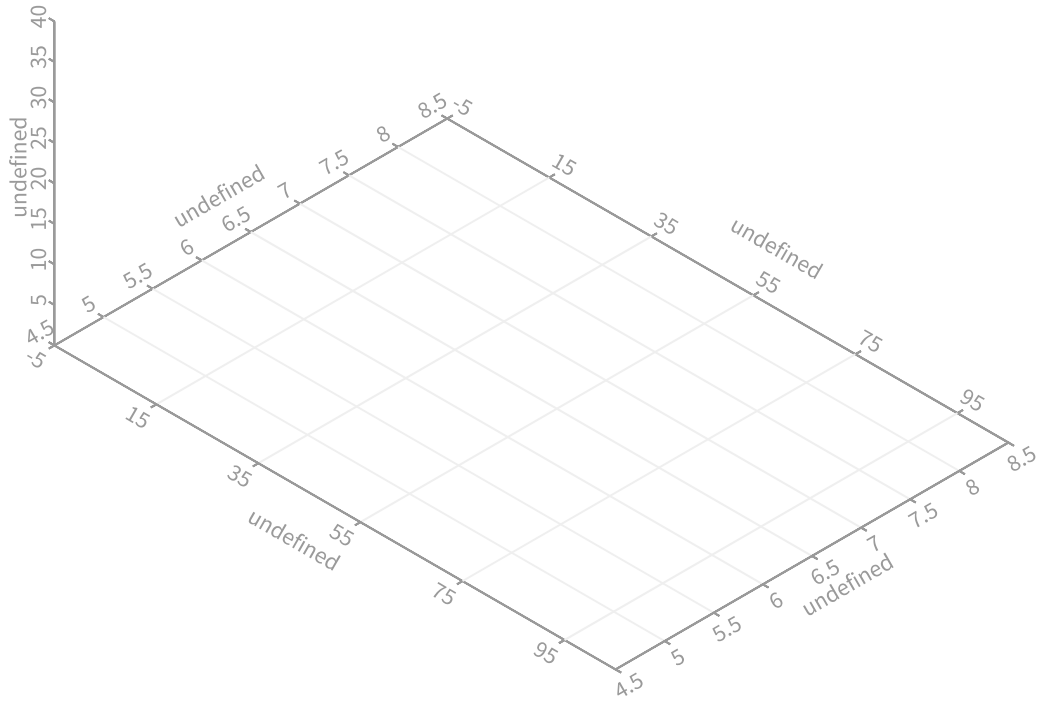


View Raw Data

Deaggregation

Component

Deaggregation calculations are not available for the selected edition.



ATTACHMENT C

SLOPE/W Output Figures

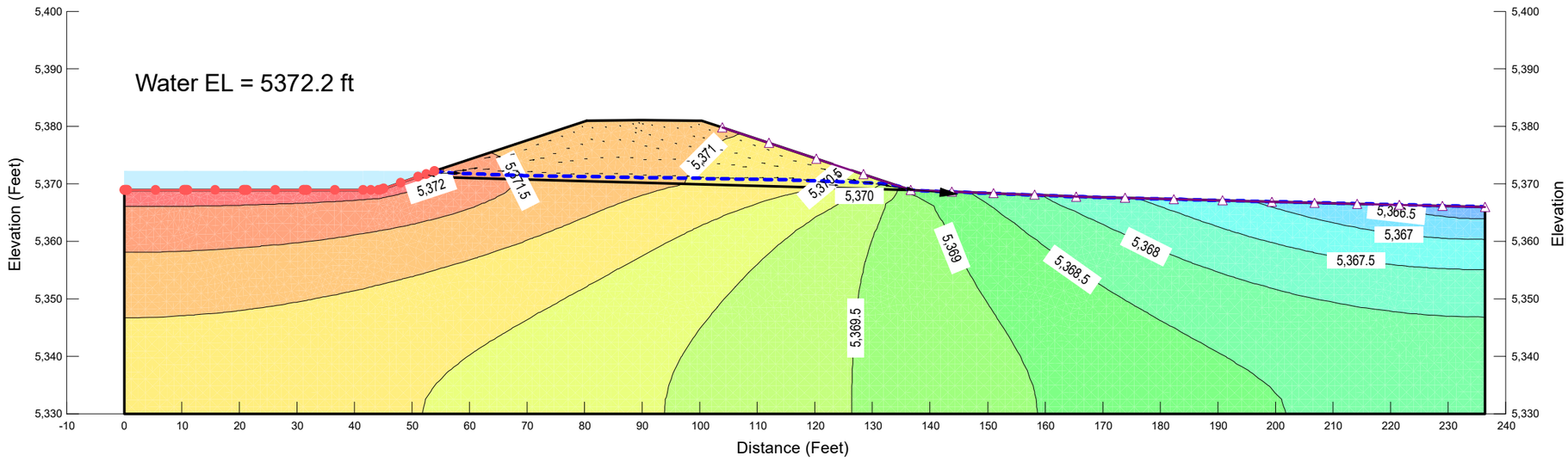
Slope Stability Analysis
Maximum Section
Return Water Pond

Four Corners Power Plant
Fruitland, New Mexico
Arizona Public Service

Note:
The results of the analysis shown here are based on available subsurface information, laboratory test results, and approximate soil properties. No warranties can be made regarding the continuity of subsurface conditions between the test pits.

C01) Steady-State Seepage - EL 5372.2
File Name: RWP - Maximum Section.gsz
Date: 2/22/2020
Method: Steady-State

Color	Name	Model	Sat Kx (ft/days)	Ky'/Kx' Ratio	K-Function
	Compacted Embankment	Saturated Only	2.835	0.1	
	Native Ground	Saturated / Unsaturated		0.1	Native Weathered Shale, Ksat = 2.835e-03 ft/d



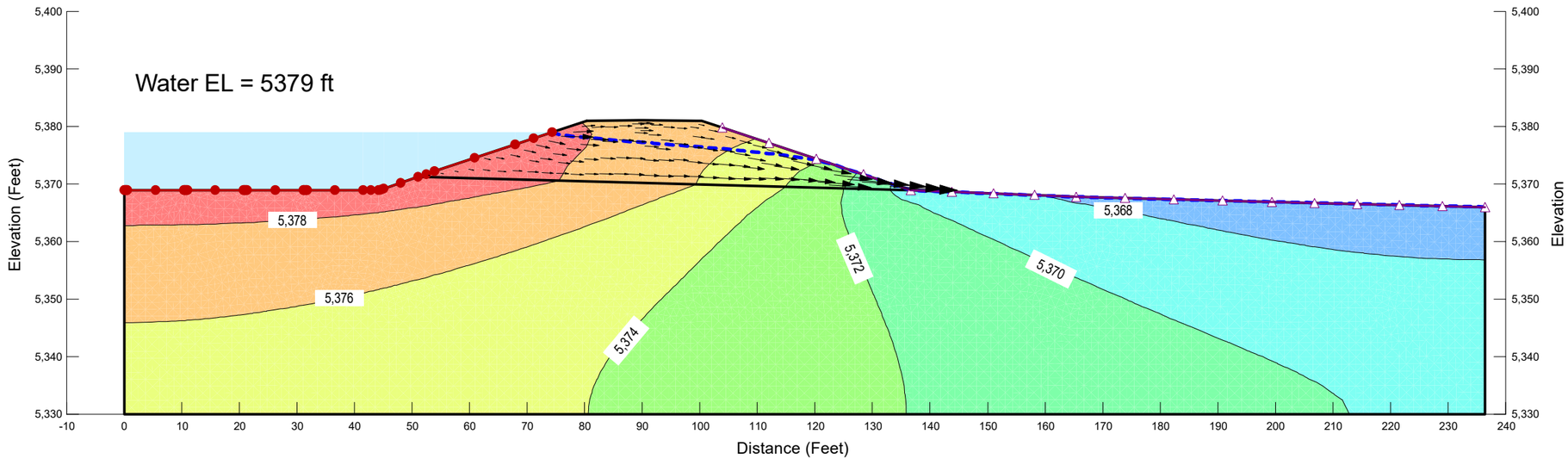
Slope Stability Analysis
Maximum Section
Return Water Pond

Four Corners Power Plant
Fruitland, New Mexico
Arizona Public Service

Note:
The results of the analysis shown here are based on available subsurface information, laboratory test results, and approximate soil properties. No warranties can be made regarding the continuity of subsurface conditions between the test pits.

C02) Steady-State Seepage - EL 5379
File Name: RWP - Maximum Section.gsz
Date: 2/22/2020
Method: Steady-State

Color	Name	Model	Sat Kx (ft/days)	Ky'/Kx' Ratio	K-Function
	Compacted Embankment	Saturated Only	2.835	0.1	
	Native Ground	Saturated / Unsaturated		0.1	Native Weathered Shale, Ksat = 2.835e-03 ft/d



Slope Stability Analysis
Maximum Section
Return Water Pond

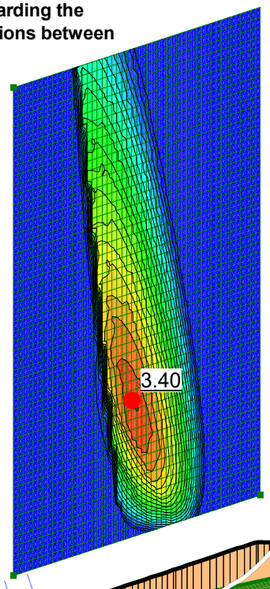
Four Corners Power Plant
Fruitland, New Mexico
Arizona Public Service

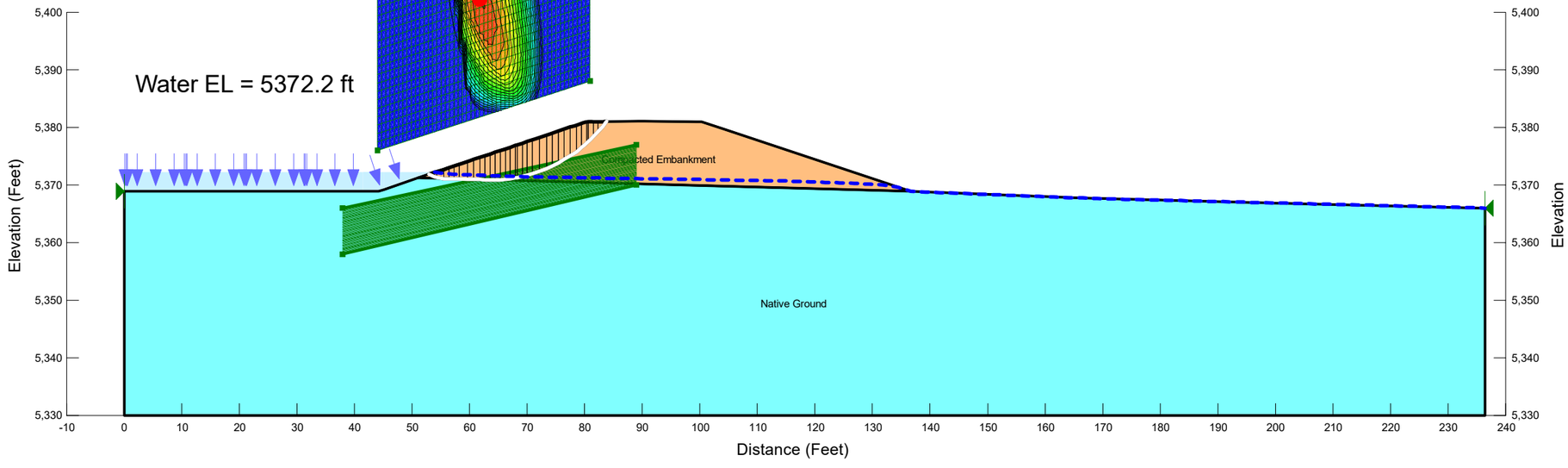
C03) RWP - Long-Term, Maximum Storage Pool - Upstream
File Name: RWP - Maximum Section.gsz
Date: 2/22/2020
Method: Spencer

Factor of Safety: 3.40

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Compacted Embankment	Mohr-Coulomb	125	200	25
	Native Ground	Mohr-Coulomb	120	500	30

Note:
The results of the analysis shown here are based on available subsurface information, laboratory test results, and approximate soil properties. No warranties can be made regarding the continuity of subsurface conditions between the test pits.





Slope Stability Analysis
Maximum Section
Return Water Pond

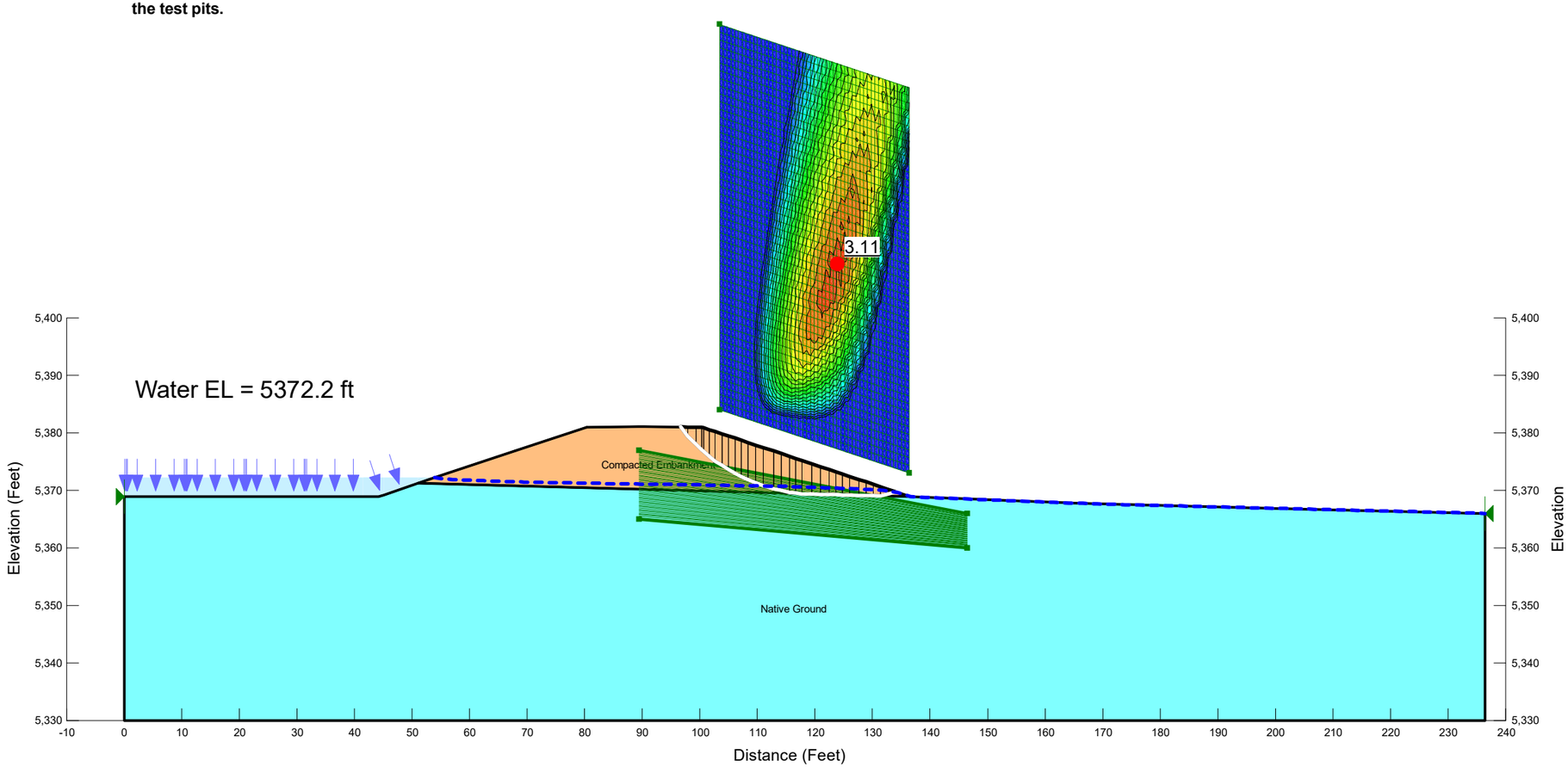
Four Corners Power Plant
Fruitland, New Mexico
Arizona Public Service

Note:
The results of the analysis shown here are based on available subsurface information, laboratory test results, and approximate soil properties. No warranties can be made regarding the continuity of subsurface conditions between the test pits.

C04) RWP - Long-Term, Maximum Storage Pool - Downstream
File Name: RWP - Maximum Section.gsz
Date: 2/22/2020
Method: Spencer

Factor of Safety: 3.11

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Compacted Embankment	Mohr-Coulomb	125	200	25
	Native Ground	Mohr-Coulomb	120	500	30



Slope Stability Analysis
Maximum Section
Return Water Pond

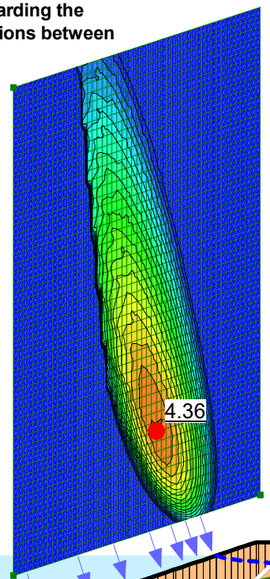
Four Corners Power Plant
Fruitland, New Mexico
Arizona Public Service

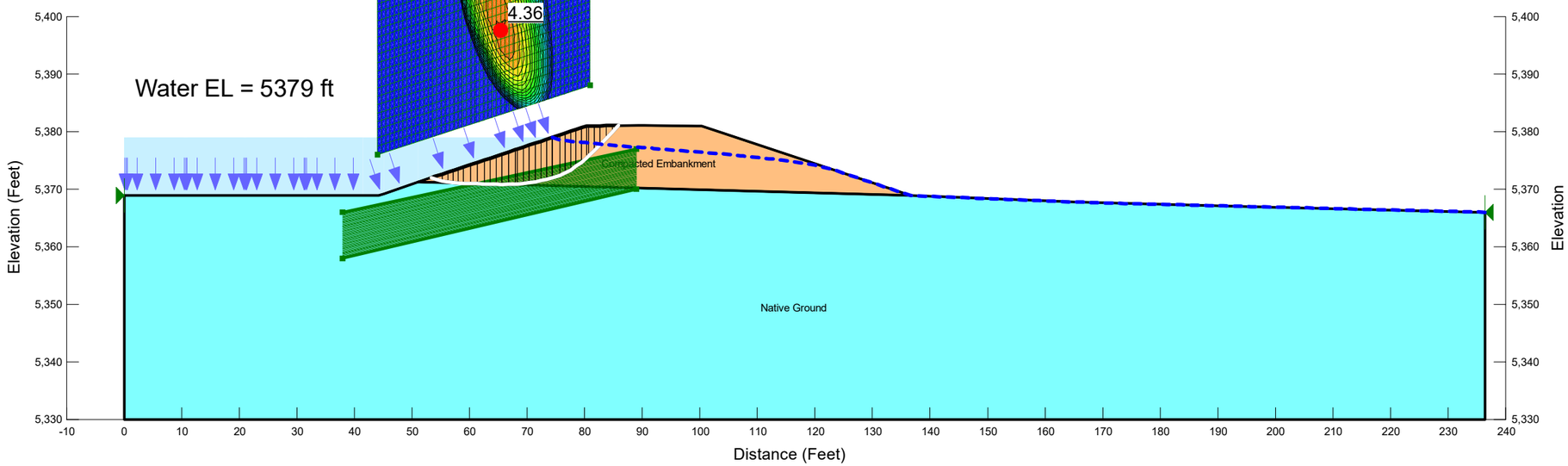
Note:
The results of the analysis shown here are based on available subsurface information, laboratory test results, and approximate soil properties. No warranties can be made regarding the continuity of subsurface conditions between the test pits.

C05) RWP - Maximum Surcharge Pool - Upstream
File Name: RWP - Maximum Section.gsz
Date: 2/22/2020
Method: Spencer

Factor of Safety: 4.36

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Compacted Embankment	Mohr-Coulomb	125	200	25
	Native Ground	Mohr-Coulomb	120	500	30





Slope Stability Analysis
Maximum Section
Return Water Pond

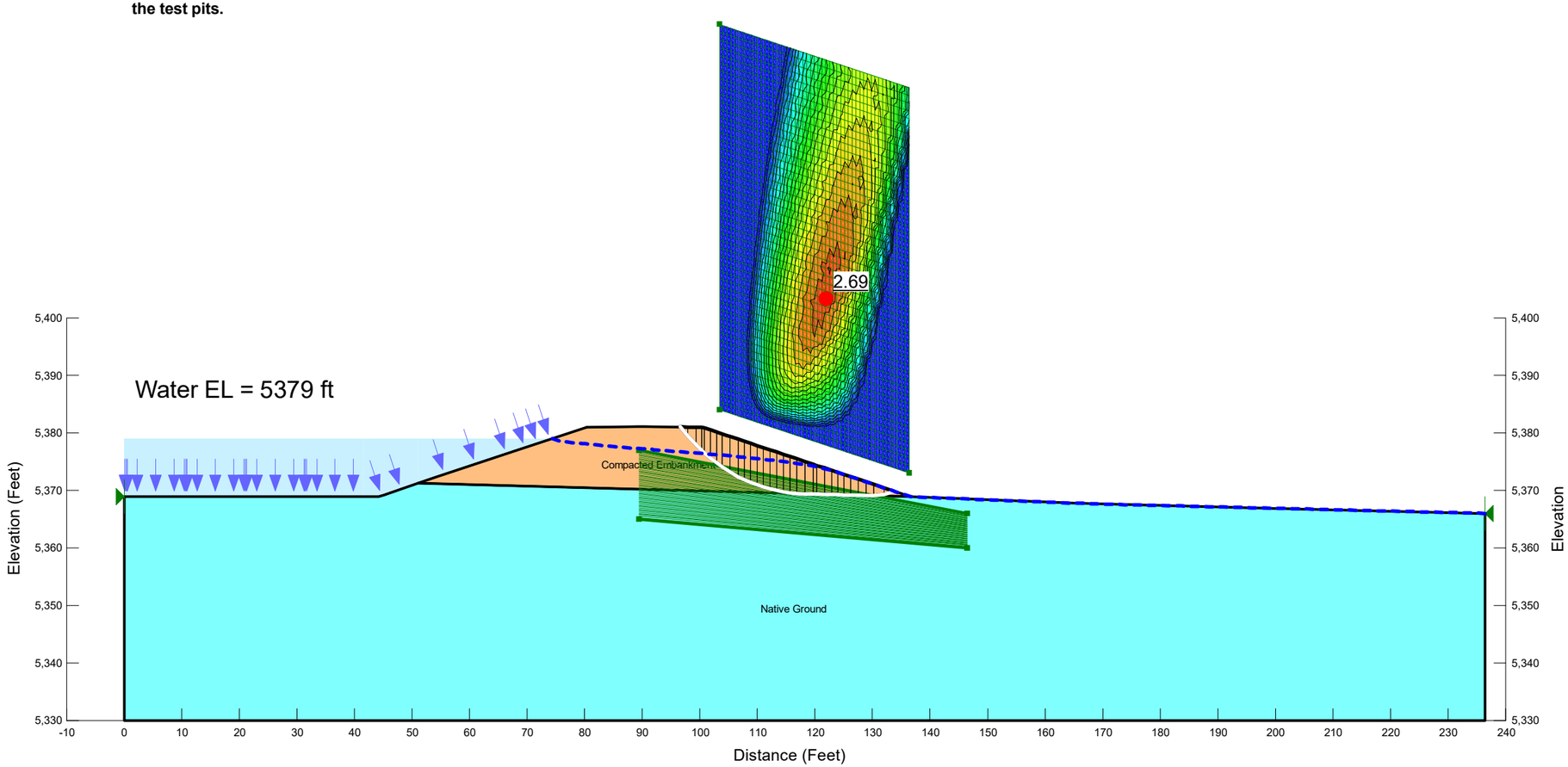
Four Corners Power Plant
Fruitland, New Mexico
Arizona Public Service

Note:
The results of the analysis shown here are based on available subsurface information, laboratory test results, and approximate soil properties. No warranties can be made regarding the continuity of subsurface conditions between the test pits.

C06) RWP - Maximum Surcharge Pool - Downstream
File Name: RWP - Maximum Section.gsz
Date: 2/22/2020
Method: Spencer

Factor of Safety: 2.69

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Compacted Embankment	Mohr-Coulomb	125	200	25
	Native Ground	Mohr-Coulomb	120	500	30



Slope Stability Analysis
Maximum Section
Return Water Pond

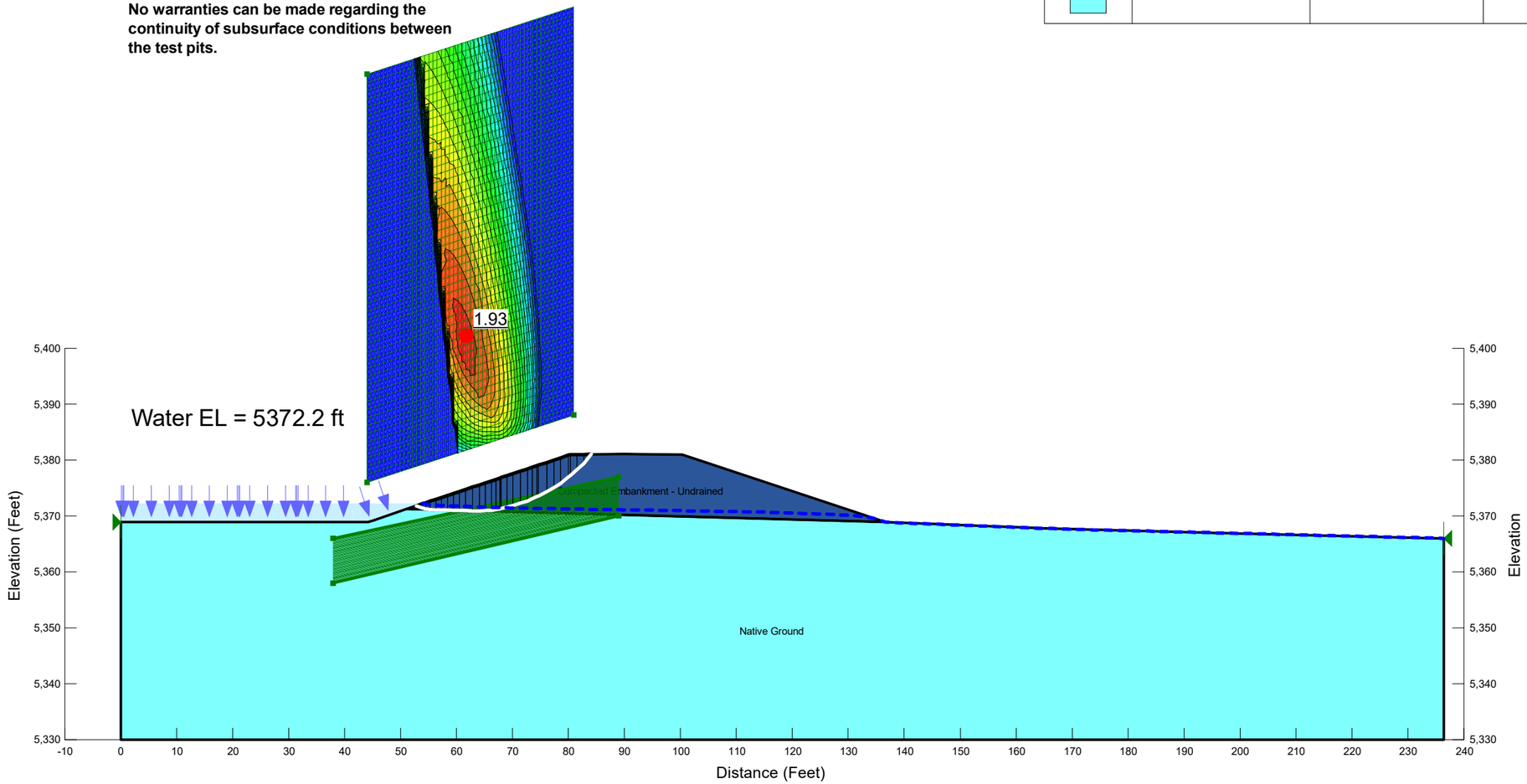
Four Corners Power Plant
Fruitland, New Mexico
Arizona Public Service

Note:
The results of the analysis shown here are based on available subsurface information, laboratory test results, and approximate soil properties. No warranties can be made regarding the continuity of subsurface conditions between the test pits.

C07) RWP - End-of-Construction Loading - Upstream
File Name: RWP - Maximum Section.gsz
Date: 2/27/2020
Method: Spencer

Factor of Safety: 1.93

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Compacted Embankment - Undrained	Mohr-Coulomb	125	100	16.5
	Native Ground	Mohr-Coulomb	120	500	30



Slope Stability Analysis
Maximum Section
Return Water Pond

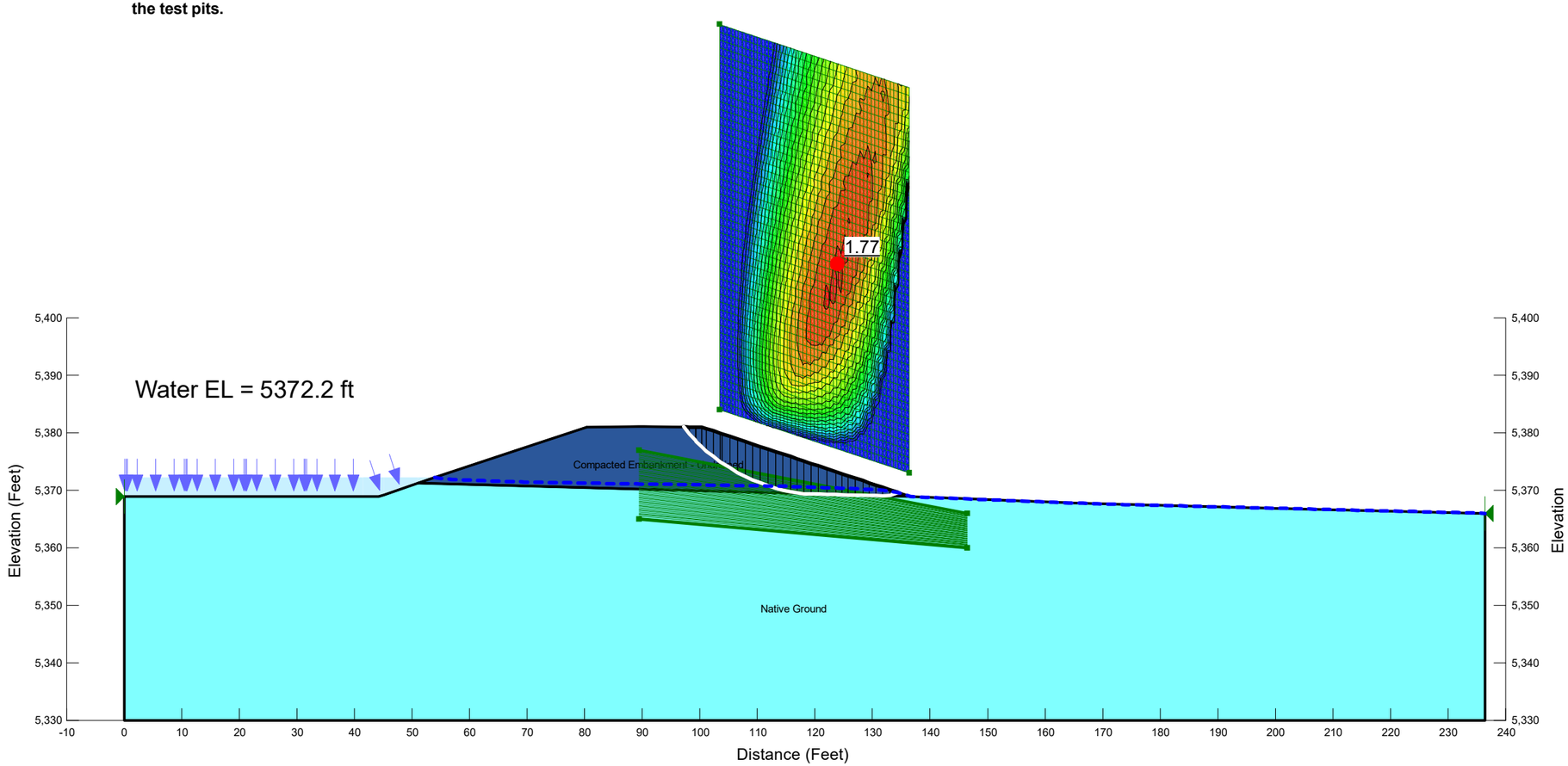
Four Corners Power Plant
Fruitland, New Mexico
Arizona Public Service

Note:
The results of the analysis shown here are based on available subsurface information, laboratory test results, and approximate soil properties. No warranties can be made regarding the continuity of subsurface conditions between the test pits.

C08) RWP - End-of-Construction Loading - Downstream
File Name: RWP - Maximum Section.gsz
Date: 2/27/2020
Method: Spencer

Factor of Safety: 1.77

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Compacted Embankment - Undrained	Mohr-Coulomb	125	100	16.5
	Native Ground	Mohr-Coulomb	120	500	30



Slope Stability Analysis
Maximum Section
Return Water Pond

Four Corners Power Plant
Fruitland, New Mexico
Arizona Public Service

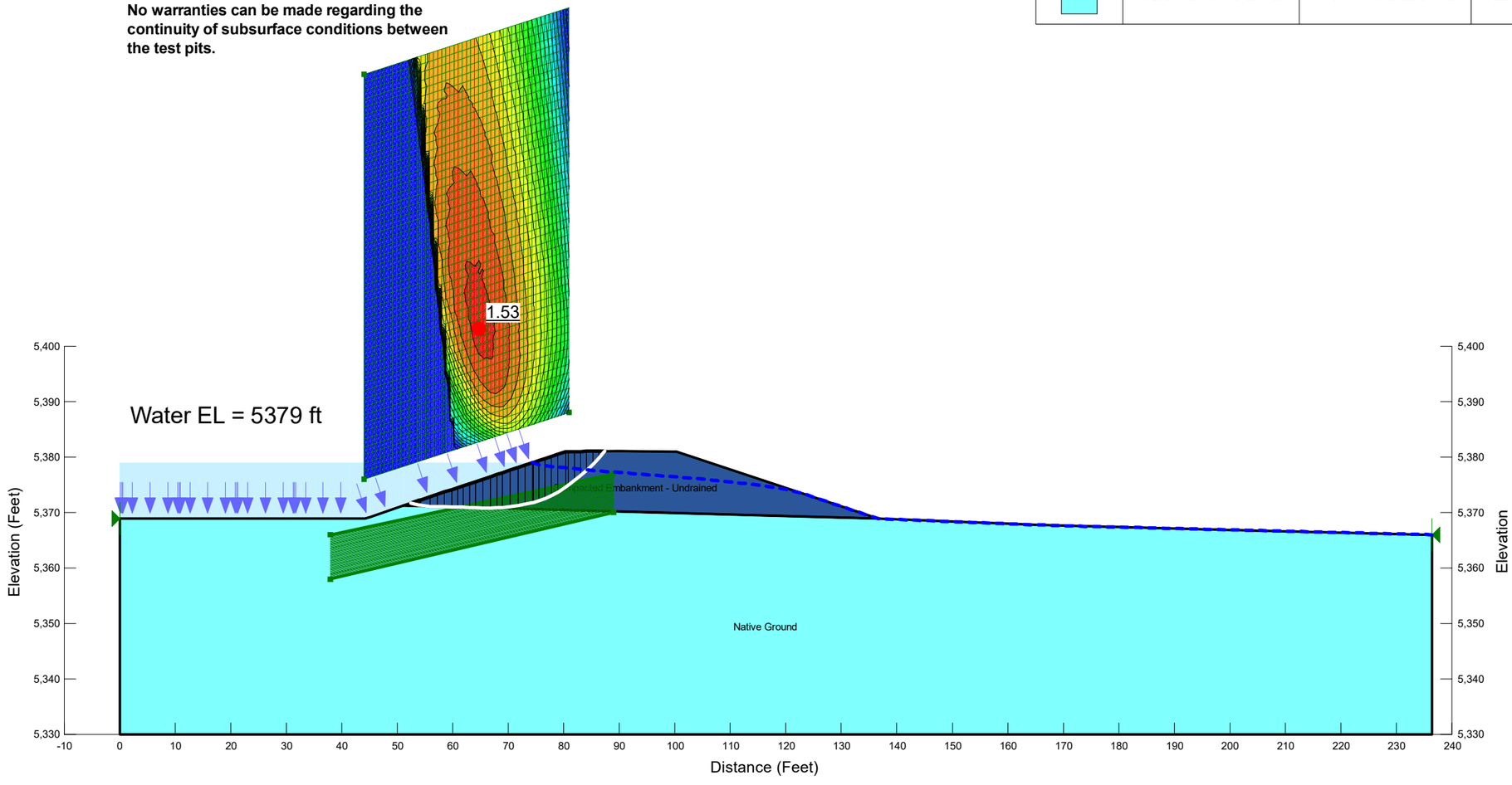
Horz Seismic Coef.: 0.102

Note:
The results of the analysis shown here are based on available subsurface information, laboratory test results, and approximate soil properties. No warranties can be made regarding the continuity of subsurface conditions between the test pits.

C09) RWP - Seismic Loading - Upstream (Full)
File Name: RWP - Maximum Section.gsz
Date: 2/27/2020
Method: Spencer

Factor of Safety: 1.53

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Compacted Embankment - Undrained	Mohr-Coulomb	125	100	16.5
	Native Ground	Mohr-Coulomb	120	500	30



Slope Stability Analysis
Maximum Section
Return Water Pond

Four Corners Power Plant
Fruitland, New Mexico
Arizona Public Service

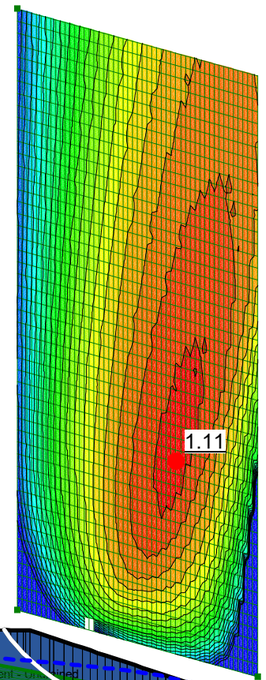
Horz Seismic Coef.: 0.102

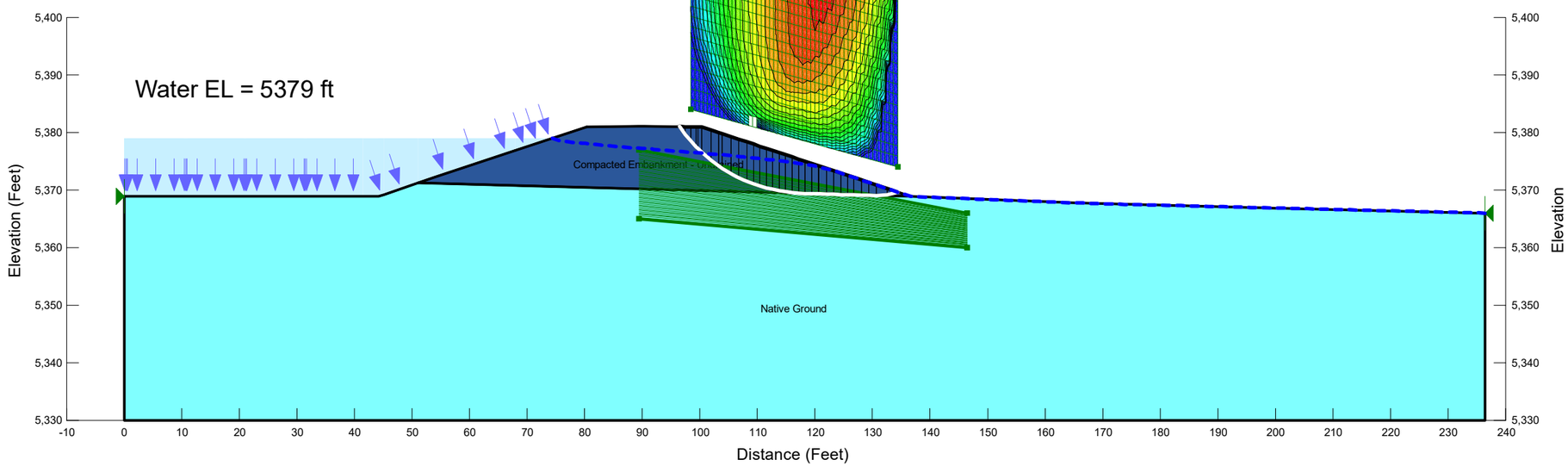
Note:
The results of the analysis shown here are based on available subsurface information, laboratory test results, and approximate soil properties. No warranties can be made regarding the continuity of subsurface conditions between the test pits.

C10) RWP - Seismic Loading - Downstream (Full)
File Name: RWP - Maximum Section.gsz
Date: 2/27/2020
Method: Spencer

Factor of Safety: 1.11

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	Compacted Embankment - Undrained	Mohr-Coulomb	125	100	16.5
	Native Ground	Mohr-Coulomb	120	500	30

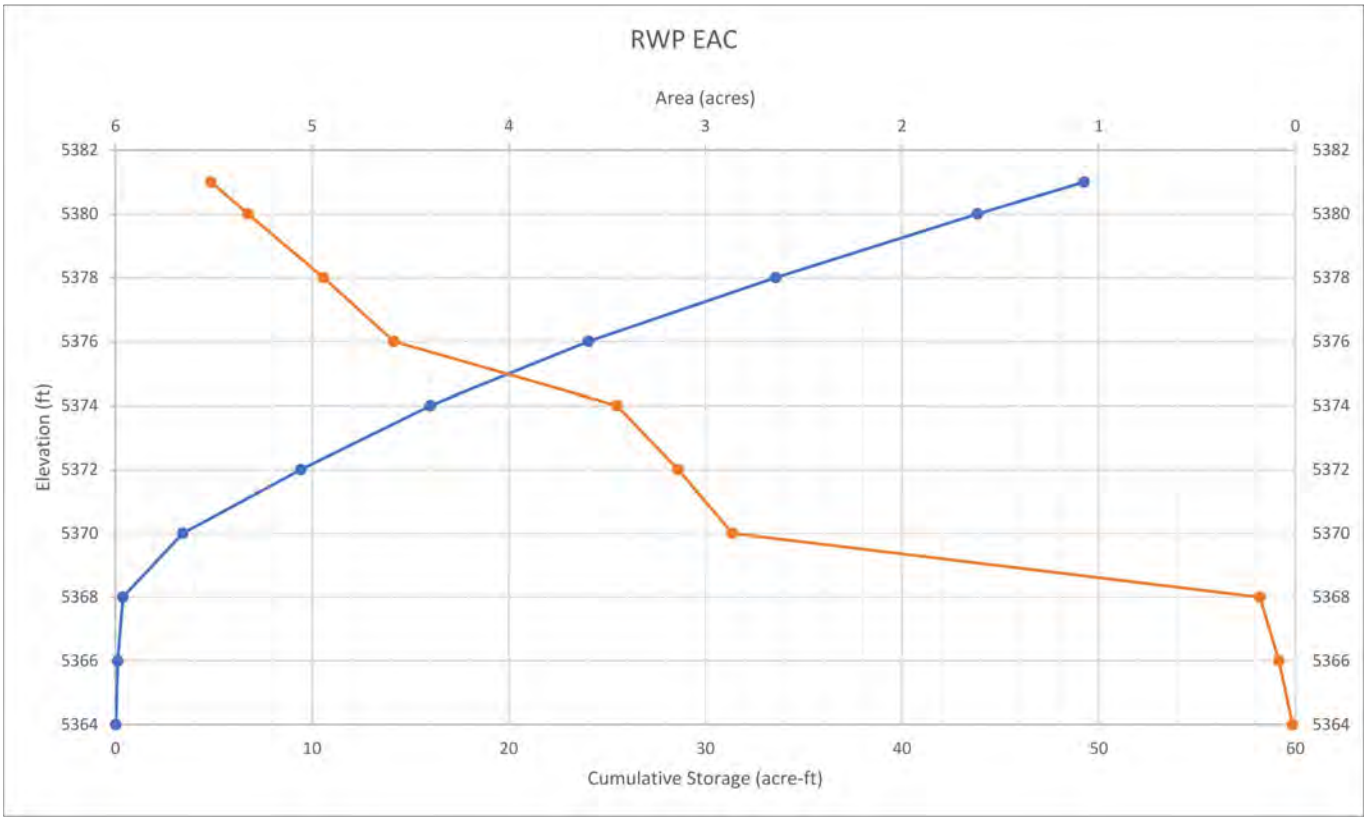




Appendix C.
Elevation-Area-Capacity Curves

Last saved by: LEE.WRIGHT(2020-02-24) Last Plotted: 2020-02-26
Filename: P:\PROJECTS\ARIZONA_PUBLIC_SERVICE\60596770_FC_RWP_SG3_ENG\900-CAD GIS\910 CAD\25 SKETCHES\FIGURE 3-2_ELEVATION-AREA-CAPACITY CURVE.DWG

RWP EAC			
Elevation (ft)	**Area (acres)**	**Storage (ft^3)**	**Cumulative Storage (acre-ft)**
5364	0.0141	0.0000	0.0141
5366	0.0836	4,257.3316	0.1118
5368	0.1804	11,500.7248	0.3759
5370	2.8629	132,566.3647	3.4192
5372	3.1389	261,439.7510	9.4210
5374	3.4496	286,994.2635	16.0095
5376	4.5845	349,962.3704	24.0435
5378	4.9425	414,993.7397	33.5704
5380	5.3262	447,302.3051	43.8391
5381	5.5147	236,113.7307	49.2595



FOUR CORNERS POWER PLANT
STRUCTURAL INTEGRITY REPORT
ARIZONA PUBLIC SERVICE
Project No. 60596770

ELEVATION-AREA-CAPACITY CURVE

AECOM

Appendix D.
Construction Specifications

FOR CONSTRUCTION

ARIZONA PUBLIC SERVICE
FOUR CORNERS POWER PLANT, UNITS 4 & 5
WA# FCC06814
RETURN WATER POND
INSTALLATION CONTRACT
AECOM PROJECT NO. 60566008

INDEX AND CERTIFICATION

SPECIFICATION INDEX

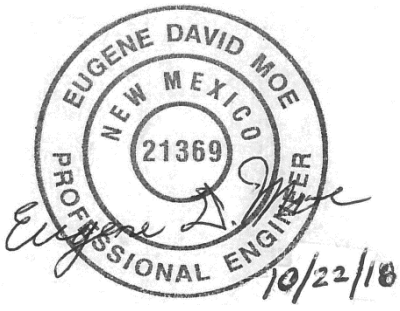
CERTIFICATIONS

Divisions 1, 2, 31, & 32

Divisions 3 & 5

Divisions 23& 40

Division 26



FOR CONSTRUCTION

ARIZONA PUBLIC SERVICE
FOUR CORNERS POWER PLANT, UNITS 4 & 5
WA# FCC06814
RETURN WATER POND
INSTALLATION CONTRACT
AECOM PROJECT NO. 60566008

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SECTION 01 11 00

SUMMARY OF WORK

PART 1 - GENERAL

1.01 SUMMARY

A. This section provides a summary of the scope of work for the Return Water Pond (RWP) project (Project).

1.02 PROJECT TEAM DEFINITIONS

A. "Owner" is defined as Arizona Public Service Company (APS) or its designated representative.

B. "Engineer" is defined as an AECOM Technical Services, Inc. (AECOM) representative appointed and authorized by Owner. Engineer will be a registered Professional Engineer (PE) in the State of New Mexico, or a designated representative under Engineer's supervision during construction.

C. "Engineer's On-Site Representative" is defined as a representative of Engineer on-site on a part-time or full-time basis to observe the Work and act as a liaison for communication between Contractor, Engineer, and Owner. Engineer's On-Site Representative may also be the Construction Quality Assurance (CQA) Representative.

D. "Construction Manager" (CM) is defined as a representative of Engineer on-site on a full-time basis to observe the Work and act as a liaison for communication between Contractor, Engineer, and Owner.

E. "Contractor" will be awarded the Project by Owner and will execute a contract agreement for the specified Work with Owner.

F. "Quality Control Team" is defined as a combination of Contractor's Quality Control (QC) Manager, Contractor's Surveyor, and Contractor's Independent QC Construction Materials Testing (CMT) Firm with QC CMT Firm Manager and QC Field Technicians all working under the direction of Contractor to perform on-site quality control on behalf of Contractor. Materials testing of on-site soils, cement treated base, geosynthetics, concrete, etc. will be performed as part of this team.

G. "Quality Control Manager" is an employee of Contractor and is the on-site representative of the QC Team. QC Manager is responsible for all activities and progress of QC Team and coordinates directly with QC CMT Firm Manager, QC Field Technicians, Engineer, CM, and designated Owner's Representative.

H. "QC CMT Firm Manager" will be an employee of QC CMT Firm and shall be a registered PE in the State of New Mexico. Duties include reviewing all laboratory test results and directly addressing any deficiencies that are encountered during testing and analysis of results. In addition, QC CMT Firm Manager will make periodic (bi-weekly, at a minimum) site visits to review testing procedures by QC Field Technicians.

I. "QC Field Technicians" assist QC CMT Firm Manager with the provision of monitoring, testing, inspecting and documentation of activities of Contractor.

J. "Construction Quality Assurance" is defined as a combination of Owner's Representative, CM, Engineer's On-Site Representative, Owner's Surveyor, and Owner's CQA CMT Firm with field technicians and laboratory, all working under direction of Owner and Engineer to perform on-site quality assurance tasks on behalf of Owner. CQA Team is responsible for review of Contractor's Work and review of QC Team to assure adherence to Specifications and QC Plan. Materials testing of on-site soils, cement treated base, geosynthetics, concrete, etc. will be performed as required and directed by Engineer and/or CM and Owner.

1.03 GENERAL SCOPE OF WORK

A. Work is defined by Contract Documents and consists of the following:

1. Composite lined pond with two lined cells consisting of:

a. Primary and secondary 60-mil high density polyethylene (HDPE) geomembrane liners,

b. Drainage geonet leak collection,

c. Geosynthetic clay liner (GCL),

d. Prepared subgrade (scarified, proof-rolled, and compacted).

2. Removal of two (2) pumps and motors at Pond 3 Pump-house (P3PH). Pumps and motors shall be salvaged and delivered to Owner's spare parts warehouse.

3. Installation and operation of a temporary pumping system (Godwin or equal) capable of pumping 250 gallons per minute (gpm) at 125 feet of head to pump water from the P3PH wet well to the Lined Decant Water Pond (LDWP). The pump discharge line shall be connected to the existing discharge pipe from the pump house to discharge directly into the LDWP. The temporary pumping system shall remain operational until the new pumps installed in the P3PH are operational.

4. Installation of two (2) new Owner furnished pumps and motors at P3PH. Pumps shall be reconnected to existing infrastructure within P3PH (pump mounts, pipe works, electric circuitry/panel, instrumentation and controls, etc).

5. Replacement of motor control center (MCC) at P3PH (5 sections) and installation of new pole mounted transformer for electrical service to P3PH.

6. Installation of new HDPE pipe (single-wall and double –wall) and flow control valves between P3PH discharge pipe works and RWP. Single-wall pipe shall be installed below ground and above ground as shown on the Drawings. Double-wall pipe is all above ground.

7. Re-use of return water piping on discharge side of LDWP booster pumps to convey flows from RWP to Plant (Process Liquor Tank).

8. Installation of two (2) new Owner furnished return water pumps, electrical rack, and appurtenances (RWP pump station) at RWP.

9. Installation of new pole mounted transformer for electrical service to RWP pump station.

10. Double tap or splice into LDWP booster pump discharge pipeline and install flow control valves and two (2) new HDPE pipelines (supply and return) for connecting P3PH discharge to RWP including:

    a. Supply water pipeine to RWP (inflow)

    b. Return water pipeline from RWP pump station (outflow).

11. Installation of concrete pad foundation and canopy for RWP pump station.

12. Freeze protection for above ground pipes and appurtenances at RWP pump station.

13. Installaton of four (4) new HDPE buried pipelines for extending existing thickener dump lines to RWP. Run new pipes into the existing clean out vault and install a blind flange at the end of each pipeline. Do not disconnect or demolision the existing thickener lines. The four (4) existing pipes shall remain operation during the construction period. The final connection at the existing clean out vault will be completed by others. Work includes installation of two (2) new cleanout concrete vaults, pipe, and appurtenances.

14. Installation of sideslope risers with pumps and appurtenances including control panel for level control and operation.

15. Installation of sewer lift station, force-main pipe and valves, and electrical rack.

16. Installation of leach field and force-main pipe.

1.04 PROJECT LOCATION

A. The Project is in Section 34, and 35, Township 29 North, Range 16 East. Plant is situated six miles southwest of Fruitland, New Mexico in San Juan County. Distances to site from major cities are as follows:

Farmington	18 miles
Albuquerque	229 miles

B. Transportation access and shipments to plant are made generally through highway access. Transportation access to Project site will include access along existing access roads, which are unpaved roads, and within developed laydown yards, which are also unpaved areas.

1. Highway Access – Plant is accessible from U.S. Highway 64 via a Plant access road near Fruitland, New Mexico.

2. Rail Access – Delivery by rail to Plant is not available.

3. Shipment Restrictions – Material shipments are restricted to twenty tons gross weight per delivery, unless special arrangements and routing are made.

1.05 SITE CONDITIONS

A. There are overhead utilities (poles and lines) in and around Project site and along access roads to Project site. Consideration shall be made during general site access, equipment mobilization and demobilization, and earthwork hauling to preserve functions of utilities. Coordination of interrupted service shall be made with Owner.

B. Site conditions and restrictions for Project are as follows:

1. Plant is in a desert location with conditions of fog, snow, 5 percent to 100 percent relative humidity, severe wind, dust, sandstorms, and temperatures ranging from -25^{o} F to 105^{o} F.

2. Elevation of the RWP site is approximately 5,373 feet above sea level.

1.06 CONTRACTOR'S USE OF PROPERTY

A. Contractor shall have access to site as directed by Owner and designated personnel of Plant.

B. Use of site is limited to performance of the Work and storage of materials related to this contract.

C. Contractor shall assume full responsibility for protection and safekeeping of equipment and materials on or off site that are related to this contract.

1.07 WORK SEQUENCE

A. Personnel from Plant, CQA personnel, and/or an Owner's representative will be on-site to monitor construction progress on at least a part-time basis. Work shall be closely coordinated by Contractor with other Work being performed at the site.

B. Notice to Proceed will be given after bid award to begin work under these Contract Documents.

C. Contractor shall be responsible for planning, scheduling, and otherwise executing the Work in a manner that meets requirements of Drawings and Specifications for this Project.

D. Contractor shall submit a Construction Work Plan in accordance with Contract. Construction Work Plan shall show construction activities and sequence to meet Schedule.

1.08 BROAD SCOPE OF WORK

A. This article describes the Project in general and provides work to be performed under this Contract. Contractor shall review entire set of Contract Documents to gain a thorough understanding of detailed Project requirements.

B. Contractor shall be responsible for obtaining and complying with all permits associated with Project including, but not necessarily limited to, the following:

1. Preparation of Storm Water Pollution Prevention Plan (SWPPP) including the submittal of Notice of Intent (NOI), and Notice of Termination (NOT) documents.

C. Contractor shall provide all labor, equipment, materials, and other items of expense for Work and construction of Project.

D. Contractor shall perform Work in accordance with Contract Documents, which includes, but is not limited to: Plant's Contractor Requirements, Drawings, these Specifications, subsequent addenda, approved shop drawings and submittals, requests for information (RFI's), and other change documents.

E. Construct Project as specified and shown on Drawings. This shall include, but is not limited to all hauling, excavation, spreading, and compaction of all earthen materials. This will also include all removal of obstructions, general excavating, grading and filling, slope and grade control, geosynthetics placement, temporary controls, pumps and appurtenances, pipe works, concrete pad and canopy, electrical systems, structures, and any related items necessary to complete the entire Project in accordance with the Contract Documents.

F. Unpaved roads that Contractor uses within Plant are responsibility of Contractor to maintain and provide dust control for.

G. Contractor shall perform, at a minimum, survey control and verification as required per Section 01 32 23, "Survey and Field Engineering."

H. Throughout construction, Contractor shall maintain one set of red-line (as-built) field drawings to show Project and components as-constructed. These drawings shall remain on-site during construction of project for periodic review by Owner, CM, and/or Engineer. Upon completion of each construction activity, red-line (as-built) drawings with revised survey data shall be submitted to Owner, CM, and/or Engineer for incorporation into Record Drawings.

I. Contractor shall be responsible for storage and handling of all construction materials unless otherwise directed by Owner.

J. Perform the required stormwater pollution prevention activities in accordance with Contractor's SWPPP and Owner's site-wide SWPPP.

1.09 CONTRADICTIONS

A. Specifications and Drawings may not be complete in every detail. Contractor shall comply with their manifest intent and general purpose, taken as a whole, and shall not make use of any errors or omissions therein to detriment of the Work. Should any conflict, error, omission or discrepancy appear on Drawings, Specifications, instructions, in Work done by others, or in site conditions, Contractor shall notify Owner and Engineer in writing at once, and a written response will be issued, which is to be followed. If Contractor proceeds with any of the Work in question prior to receiving such instructions, then required corrections shall be at Contractor's expense.

B. Contract Documents should be carefully reviewed in entirety upon Notice of Award and Contractor should carefully plan coordination of products and trades to identify contradictions, omissions, conflicts, or discrepancies as soon as possible. Contractor shall notify Engineer immediately upon discovery of any questions or conflicting information through a Request For Information (RFI's). It is the expectation that the majority of RFI's be submitted within four (4) weeks of Notice to Proceed. Delay caused due to review of RFI's will not be cause for a Claim if Contractor has not made a reasonable attempt to discover and notify Engineer of RFI's within this time period.

C. Contractor should consider value-adding proposals that may add benefit to Owner while reviewing Contract Documents. Contractor should propose Requests for Change as soon as a potential value-adding change is discovered to allow time for consideration and review.

D. Should any contradiction, either implied or real, exist between the Specifications and the Drawings, Contractor shall:

1. Stop all Work that concerns contradiction until contradiction is remedied or clarified by Engineer.

2. Notify the Owner and Engineer representatives immediately.

1.10 WORK NOT INCLUDED

A. CQA responsibilities identified in these Specifications and included in the CQA Plan (separate document) will be contracted separately by the Owner.

1.11 OWNER PROVIDED MATERIALS, FACILITIES AND SERVICES

A. Replacement pumps for P3PH and pumps for RWP pump station as referenced in Paragraph 1.03 of this specification. Contractor shall be responsible for installing pumps, and for testing, startup, and commissioning of pumps.

B. Water for construction purposes will be available from Morgan Lake, near the southwest corner of the lake. Contractor shall be responsible for construction of *a temporary pumping system (pump, pipe, and appurtenances) and a temporary portable water-truck loadout tower at Morgan Lake to be used by the Contractor for the duration of construction. The temporary pumping system and temporary water-truck loadout tower shall be removed by the Contractor once construction activities have been completed. The temporary pumping system and water-truck loadout plan must be approved by the Owner prior to installation.*~~any new conveyance piping from the existing submersible pump in Morgan Lake to Project site and any other construction water infrastructure deemed necessary by Contractor, and as approved by Owner.~~

C. Soil for use as fill material will be available upon request and is stockpiled near the Pond 6 cap. Contractor is responsible to excavate, process, screen, moisture condition and place soil materials excavated from site.

1.12 CHARACTER OF WORKERS

A. Contractor shall furnish and perform Work in an acceptable manner. All workmanship shall conform to detailed requirements specified herein. Where specific instructions are not given, Work shall be to best practices known to the trade. All Work shall be done by workmen, skilled and experienced in their appropriate trade. Contractor shall adhere to equipment manufacturer's instructions and recommendations.

B. Contractor shall at all times, employ sufficient labor and equipment for executing Work to fulfill completion in the manner required, and within the time required, by these Specifications.

C. All workers shall have sufficient skill and experience to properly perform Work assigned to them. Workers engaged in special-work or skilled-work shall have sufficient experience in such Work and in the operation of equipment required to perform all Work properly and satisfactorily. Contractor shall provide resumes of employees performing supervisory or skilled tasks upon request by Owner, CM, or Engineer.

D. Any person employed by Contractor or by any Subcontractor who, in opinion of the Owner, CM, or Engineer, does not perform Contractor's Work in a proper and skillful manner or is intemperate or disorderly shall, at written request of Owner, CM, or Engineer, be removed immediately by Contractor or Subcontractor employing such person and shall not be employed again in any portion of Project without the approval of Owner, CM, or Engineer. Should Contractor fail to remove such person or persons or fail to furnish suitable and sufficient personnel for proper execution of Work, CM or Engineer may suspend Work by written notice until compliance.

1.13 PROTECTION OF EXISTING PLANT, EQUIPMENT, AND PERSONNEL

A. Plant will remain in operation during construction. Contractor shall exercise extreme caution at all times to avoid damage to Owner's existing facilities or to in any way jeopardize their safety or continuity of operation.

B. Owner reserves the right to require Contractor to modify or eliminate any construction techniques or methods which may endanger personnel or adversely affect operation of any existing equipment.

C. Contractor shall take such precautions as necessary during excavation, demolition, and other work to avoid cutting or damaging any overhead conductors or underground utilities, including electric, gas and air piping, drain lines, water and sewer lines, and fire protection lines. Particular care shall be taken to avoid accidental contact with high voltage buried cables or overhead lines.

D. Contractor and all Subcontractors and their personnel working on site are required to attend Contractor Safety Orientation training. Safety training is required prior to any persons working on-site. Contractor shall coordinate training with their APS representative and notify Engineer of scheduled training date and time. Contractor shall coordinate to best of their ability to schedule most of their on-site workers for the same training session to minimize amount of training sessions required on APS' behalf. Safety Orientation training is good for the calendar year in which the training is completed. If Project spans more than one calendar year, Contractor will be required renew the training for all personnel working on site as described above.

1.14 CODES, STANDARDS, AND SPECIFICATIONS

A. Codes, standards, and specifications of generally recognized authorized bodies referred to in these Specifications are as fully a part of the Contract as if hereto attached or herein repeated. Unless otherwise indicated or specified, Work shall comply with all current editions and provisions of all applicable specifications, standards, and codes including, but not limited to, the following:

Abbreviation	**Organization**
AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
ANSI	American National Standards Institute
ASCE	American Society of Civil Engineers
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
AWS	American Welding Society
GSI	Geosynthetics Institute
IBC	International Building Code
OSHA	Occupational Safety and Health Administration
PPI	Plastic Pipes Institute

B. Where such codes, standards, and specifications are modified from time to time, latest edition shall govern and in case of conflict with any provisions specifically set forth in these Specifications, these Specifications shall govern.

C. Contractor shall be responsible for installation of all specified materials and compliance of aforesaid, with regulations of all applicable local, state, and national codes. Contractor shall also be responsible for all drawings, calculations, certifications, and documents required for verifying compliance with all regulations and codes applicable to the Work.

D. In event that apparently applicable and comparable but not identical codes, standards, or specifications have been published by more than one of the above sources and/or others for any item or part of the Work in the absence in specifications of a specific designated source having authority or preference then most stringent of such codes, standards, or regulations shall apply, unless otherwise approved in writing by Engineer prior to construction.

E. Contractor shall bring to attention of Engineer for resolution, any apparent conflicts between Drawings, Specifications, latest applicable codes, standards, and specifications.

1.15 CONTRACT DOCUMENTS

A. Contract Documents are defined as all documents so designated in the Agreement. Unless otherwise indicated in the Agreement, Contract Documents will be defined as Agreement, Drawings, Specifications, Addenda, and supplemental instructions and change documents.

B. Approved Shop Drawings, other Contractor submittals, reference project drawings, and reports and drawings of subsurface and physical conditions are not Contract Documents.

1.16 ELECTRONIC COMMUNICATION

A. Owner will provide Contractor, CM, Engineer, and other parties access to a website for electronic distribution of Project documents, including: Submittals, RFIs, Test Results, Change Orders, and other Project related documents.

B. Electronic submission of documents shall be as a Portable Document Format (PDF) file where appropriate, unless submission is specifically requested in a different format or where submission as a PDF would not be applicable. Drawings created in AutoCAD may be submitted as a DWF unless specifically requested otherwise.

1.17 CORRECTIVE ACTION

A. Contractor shall, upon receipt of a notice in writing of any non-compliance with foregoing provisions, take immediate corrective action. If Contractor fails or refuses to comply promptly, Owner, CM, or Engineer may issue an order stopping all or part of the Work until satisfactory corrective action has been taken. No part of the time lost due to any such stop order shall be made subject of a claim for extension of time or for excess costs of damages by Contractor, unless it was later determined that Contractor was in compliance.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

(Not Used)

END OF SECTION

SECTION 01 20 00

PRICE AND PAYMENT PROCEDURE

PART 1 - GENERAL

1.01 SUBMITTALS

A. Schedule of Estimated Payments

B. Schedule of Values

C. Application for Payments with list of Bid Items complete

D. Final Application for Payment.

1.02 SCHEDULE OF PAYMENTS

A. Prepare a Schedule of Estimated Payments for the Work. Schedule of Estimated Payments shall list expected times for completion of all or portions of Bid Items and expected dates and values for progress payments.

B. Take all measurements and compute quantities to estimate percent complete of each item listed in Bid Schedule. CM or Engineer may verify measurements, quantities, and percent complete.

C. Schedule of Estimated Payments shall include all equipment alternate additives, specified allowances, labor, tools, materials, products, bonds, insurance, start-up, close-out, environmental controls, permitting, overhead, profit, and all other items of expense for a complete and properly functional installation as shown on the Contract Documents.

D. An unbalanced or front-end loaded schedule will not be acceptable.

E. Summation of complete Schedule of Estimated Payments representing all the Work shall equal total Contract Price, including any bid alternatives awarded.

1.03 SCHEDULE OF VALUES

A. Prepare a Schedule of Values for each item in bid schedule. Schedule of Values shall list values for all Work for complete installation to serve as the basis for computing values for progress payments during construction.

B. Schedule of Values, Schedule of Payments, and Construction Schedule shall be consistent and be based on same major items of the Work where possible.

1.04 DEFECT ASSESSMENT

A. Replace the Work, or portions of the Work, not conforming to specified requirements. If, in opinion of Engineer, it is not practical to remove and replace the Work, Engineer will recommend to Owner an appropriate remedy or adjust payment.

B. Non-Payment for Rejected Products: Payment will not be made for rejected products for any of the following:

1. Products wasted or disposed of in a manner that is not acceptable.

2. Products determined as unacceptable before or after placement.

3. Products not completely unloaded from transporting vehicle.

4. Products placed beyond the lines and levels of required Work.

5. Products remaining on hand after completion of the Work.

6. Loading, hauling, and disposing of rejected products.

1.05 CHANGE/SUBSTITUTION PROCEDURES

A. Definitions:

1. *Change Order*—A document recommended by Engineer which is signed by Contractor and Owner and authorizes an addition, deletion, or revision in the Work or an adjustment in Contract Price or Contract Time, issued on or after effective date of Contract.

2. *Field Order*—Written order issued by Engineer which requires minor changes in the Work but which does not involve a change in Contract Price or Contract Time.

3. *Claim*—Demand or assertion by Owner or Contractor seeking an adjustment of Contract Price or Contract Time, or both, or other relief with respect to terms of Contract. Demand for money or services by a third party is not a Claim.

4. *Work Change Directive*—Written statement to Contractor by Engineer ordering an addition, deletion, or revision in the Work, or responding to differing or unforeseen subsurface or physical conditions under which the Work is to be performed or to emergencies. Work Change Directive will not change Contract Price or Contract Time but is evidence that parties expect that change, ordered or documented by a Work Change Directive, will be incorporated in a subsequently issued Change Order following negotiations by parties as to its effect, if any, on Contract Price or Contract Time.

B. Engineer will advise of minor changes in the Work not involving adjustment to Contract Price or Contract Time by issuing supplemental instructions, through submittal responses, or through a Field Order.

C. Engineer may issue a Work Change Directive including a detailed description of proposed change with supplementary or revised Drawings and specifications, and a change in Contract Time for executing the change. Contractor will prepare and submit estimate of change in Contract Price and Contract Time within 7 calendar days of receiving Work Change Directive.

D. Contractor may propose changes by submitting a Request for Change to Engineer, describing proposed change and its full effect on the Work. Include a statement describing reason for change, and effect on Contract Price and Contract Time with full documentation. Document requested substitutions.

E. Contractor shall notify Engineer within 24 hours of discovery of a potential Claim. Contractor shall submit detailed costs and schedule change requests within five (5) working days of discovery.

F. Unit Price Change Order: For contract unit prices and quantities, the Change Order will be executed on fixed unit price basis. For unit costs or quantities of units of work which are not pre-determined, changes in Contract Price or Contract Time will be computed as specified for Time and Material Change Order.

G. Time and Material Change Order: Submit itemized account and supporting data after completion of change, within time limits indicated in Conditions of the Contract. Engineer will determine change allowable in Contract Price and Contract Time as provided in Contract Documents.

H. Maintain detailed record of work done on Time and Material basis. Provide full information required for evaluation of proposed changes, and to substantiate costs for changes in the Work.

I. Document each quotation for change in cost or time with sufficient data to allow evaluation of quotation, including quotes, receipts, field logs, and timecards, where applicable.

J. Correlation of Contractor Submittals:

1. Promptly revise Schedule of Values and Application for Payment forms to record each authorized Change Order as separate line items and adjust Contract Price.

2. Promptly revise progress schedules to reflect change in Contract Time, revise sub-schedules to adjust times for other items of work affected by change, and resubmit.

3. Promptly enter changes in Project Record Documents.

1.06 PAYMENT

A. Partial payment for lump sum bid items only partially completed at time of application for payment will not be made unless otherwise noted in the Contract Documents or approved by Owner.

B. Payment for Unit Price bid items will be made based on number of units substantially completed in the opinion of Engineer unless otherwise noted in the Contract Documents or approved by Owner.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

(Not Used)

END OF SECTION

SECTION 01 31 13

PROJECT COORDINATION

PART 1 - GENERAL

1.01 SUMMARY DESCRIPTION

A. This section provides Contractor's minimum requirements for Project coordination.

B. Contractor shall, at all times, coordinate Work with Owner, CM, Engineer, and other Contractors working within the area of the Project.

1.02 SUBMITTALS

A. Contractor shall submit a Communication Plan for approval within 2 weeks of notice to proceed.

1.03 COMMUNICATION PLAN

A. Communication Plan shall provide a clear plan of the communication and distribution of submittals, RFI's, and QC data/submittals, to all of the Project Team.

B. Communication Plan shall identify all responsible people including contact information, titles, and specific responsibilities.

C. Engineer will approve Communication Plan if it provides a reasonable detailing of personnel, illustrates that Contractor has resources available for successful communication, and demonstrates Contractor's conformance with items described in this Section.

1.04 PROJECT SUPERINTENDENT

A. Each day during which Work under this contract is being performed at Project Site; Contractor shall have on site, during each shift, full-time, a competent superintendent and all other supervision necessary for performance of the Work without errors or delays and in a manner completely satisfactory to Owner, CM, and Engineer. Supervision shall be acceptable to Owner, CM, and Engineer; otherwise, supervision shall be replaced to satisfaction of same.

1.05 COORDINATION OF WORK

A. Work shall be closely coordinated by Contractor with others who will be performing other construction work and installing other construction items. It shall be responsibility of Contractor to perform the Work in conjunction with these other items of related work and as coordinated with or directed by Owner to avoid all possible interferences.

B. Contractor shall coordinate with the CQA Team to provide access to the Work to be inspected and/or tested. Contractor shall give at least 7-days' notice to CM, Engineer, and CQA Team prior to start/stop of major activities, major changes in Contractor's methods, or scheduling changes. Contractor shall give at least 24 hours' notice to CQA Team of individual Work activities requiring testing.

C. At least 48 hours of written notice shall be given to Owner on all work to be performed on or near the immediate vicinity of existing equipment or facilities. Every effort shall be made to minimize the interruption of normal Plant operations and traffic.

D. Contractor shall be responsible for maintaining a construction progress schedule using software approved by Owner. Contractor shall provide look-ahead schedules to Owner during construction progress meetings. Owner will outline requirements of look-ahead schedules during pre-construction meeting.

E. Functional testing, startup and commissioning shall be coordinated with representatives for Owner, CM, and Engineer. Contractor shall provide all functional testing, startup and commissioning as required per Section 01 78 25, "Plant Testing Startup and Commissioning'.

1.06 COMMUNICATION EQUIPMENT

A. Contractor shall have available a conference call service (call-in number) for all Special Ad-Hoc meetings requested by Contractor or for Contractor's communications with subcontractors and vendors not involving Owner, CM, or Engineer.

B. Contractor shall have a dedicated conference call phone at the trailer for use during meetings. Speakerphone function on a cell phone is unacceptable. If it is determined that Contractor provided conference call phone is incapable of providing uninterrupted, clear communication, Contractor shall provide an alternative conference call phone capable of uninterrupted, clear communication at no additional cost to Owner.

C. Contractor shall have on-site all tools necessary for receipt and delivery of electronic submittals and other communication, such as a high-volume scanner, copier, and printer; computers with word processing, spreadsheet, scheduling, and email software; and other office equipment as necessary.

D. Contractor shall have digital cameras to document and communicate Project conditions with off-site personnel, including Owner, CM, and Engineer.

E. Cell phone service availability at the site may be limited. Contractor shall have handheld radios for communication with Contractor's on-site personnel and with other contractors. Handheld radios shall be available for all vehicles that will be driving on haul road for coordination with vehicles of Ash Haul contractor.

1.07 CONTRACTOR'S RESPONSIBILITIES

A. Cooperate with Owner in verification of mobilization areas, areas for field offices, temporary utilities, water supply for construction, haul routes site access, material laydown areas, traffic, and parking facilities.

B. During construction, coordinate use of site and facilities with Owner.

C. Engineer's representative(s) will act as a liaison between Contractor and Owner. Communication between Contractor and Owner is to be passed through Engineer's representative. Engineer's representative will make final decisions regarding issues with input from Owner.

D. Comply with instructions from Owner for use of temporary utilities and construction facilities.

E. Submit Requests for Information to Engineer.

F. Participate in preconstruction meeting.

G. Participate in weekly site walks and office progress meetings as required.

H. Participate in pre-installation and/or pre-milestone activity conferences as necessary.

I. Provide CM, Engineer, and Owner opportunities to observe, inspect, and test Work in progress or completed. Contractor shall not cover complete Work without approval.

J. Contractor shall coordinate all field, technical, and administrative activities with representatives of Owner and Engineer. Daily communication and coordination with site representatives of Owner and Engineer is imperative.

K. Provide Owner and Engineer with opportunity and sufficient time to collect and test (field and laboratory) on-site materials to verify conformance with Specifications.

L. Communicate with and manage all subcontractors retained by Contractor on all applicable scopes of work. Share pertinent schedule and technical information with subcontractors to maintain a high quality of Work and expeditious construction. Invite Subcontractors and/or Suppliers' representatives to the various meetings (as applicable) so that they may participate in two-way communications on Work. Subcontractors and/or Suppliers' representatives shall attend weekly coordination meetings at request of Owner or Engineer.

M. Contractor shall coordinate with Engineer and Owner for the planning and execution of all milestone activities.

N. Contractor shall coordinate with Owner, Owner's Representative, and all other utility locating service Contractors for utility identification and marking.

O. Coordinate with Engineer and Owner and appropriate utility company(s) for temporary and permanent electrical equipment and service needs.

P. Contractor shall notify Owner 24 hours in advance of any need for Owner (or others) provided material or equipment. Contractor shall be responsible for removing such material from designated areas and delivering it to Contractor's Work site.

Q. Coordinate scheduling and sequencing aspects of the Project carefully to expedite Project while maintaining high quality. Coordination shall include, but is not limited to, the following:

1. Preparing Master Schedule.

2. Preparing Project Cost Tracking and Forecasting Reports.

3. Preparing Week Look-Ahead Schedules.

4. Daily Communication (safety tailgate or office trailer meetings).

5. Planning Contractor's equipment mobilization and Work.

6. Planning Subcontractor's mobilization and Work.

7. Thorough Progress Meetings.

8. Early identification of sequencing problems so they may be resolved expeditiously before they impact the schedule.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

(Not Used)

END OF SECTION

SECTION 01 31 19

PROJECT MEETINGS

PART 1 - GENERAL

1.01 SUMMARY DESCRIPTION

A. This section provides requirements for active participation of Project meetings, including preconstruction conference; progress meetings; construction foreman's meeting; functional testing, startup and commissioning meeting; health and safety meetings; and pre-installation conferences.

1.02 SUBMITTALS

A. Submit meeting minutes electronically for each meeting attended.

1.03 PRECONSTRUCTION CONFERENCE

A. Prior to start of the Work, a preconstruction conference will be arranged by Owner, CM, and Engineer. This conference shall be attended by Contractor and his major Subcontractors. Purpose of this conference is to acquaint Contractor with Owner's administrative requirements and policies, to give emphasis to those contract requirements considered most essential, to introduce Owner, Owner's Representative, and Contractor personnel, to reach agreement on timing and method of all procedures related to efficient progress of the Work, and to discuss any other items that may require clarification. Procedures and distribution of all correspondence and documents related to the Contract will also be established. Preconstruction conference will be held at a mutually agreed upon location and time. Minutes of this meeting will be recorded by Engineer and distributed electronically.

B. Preliminary Agenda:

1. Introduce Project Team and brief identification of roles and responsibilities.

2. Introduction and discussion of the Project.

3. Design overview and introduction.

4. Main construction components.

5. Unique construction activities, etc.

6. Specifications.

7. Discussion of expectations.

8. Mobilization and Temporary Facilities and Controls Plan.

9. Owner's outstanding contract, insurance, and pay application issues.

10. Drawings (sheet by sheet).

11. Use of site by Owner, Owner's Subcontractors, and Contractor.

12. Construction SWPPP Plan.

13. Temporary utilities to be provided by Contractor and Owner.

14. Utility identification and location.

15. Submittal procedures, submittal log sheet, and schedule of submittals.

16. Survey benchmark and Contractor's layout requirements.

17. Temporary Diversion and Control of Water Plan.

18. Security procedures.

19. Housekeeping requirements.

20. Procedures and processing of field decisions, submittals, substitutions, progress payments, change orders, and Project close-out.

21. Project schedule requirements.

22. CQA Plan.

23. CQA/QC testing responsibilities.

24. Procedures and responsibilities for maintaining as-built (red-line) Drawings.

25. Inspection and acceptance of Work procedures.

26. Health and Safety.

1.04 PROGRESS/AD HOC MEETINGS

A. Project progress meetings will be called weekly, a time and location to be established by CM to discuss progress and execution of the Work. Contractor and any Subcontractors, suppliers, installers, or testing agencies whose presence is necessary or requested shall attend these meetings.

B. Contractor shall submit appropriate documents prior to these meetings such as progress schedules, plans, shop Drawings, material information, and change order estimates and/or requests.

C. Each meeting will be held at mutually agreed time each week to be determined at a future date. Meetings will be held in the Contractor's trailer for parties on-site and as a conference call for parties in other locations. Contractor's trailer shall be equipped with a conference call phone, table, and seating for Contractor's employees plus any on-site Owner or Engineer representatives.

D. Contractor shall record draft minutes for each meeting and submit electronically within 5 days of meeting. CM and/or Engineer will review minutes for errors or omissions, and approve or return for revision. Revised meeting minutes shall be submitted within 5 days of receipt of comments.

1.05 CONSTRUCTION FOREMEN'S MEETING:

A. Construction foreman's meetings shall be conducted weekly in the Contractor's field office to discuss: health and safety; review agenda of Work progress since previous meeting; proposed progress and schedule for succeeding Work period; field observations, problems, and conflicts; problems which affect construction schedule; and coordination and shutdown requirements. Contractor's resident superintendent and Subcontractor's foreman shall attend these meetings.

1.06 HEALTH AND SAFETY MEETING:

A. Health and safety meetings shall be conducted biweekly (at a minimum) in the Contractor's field office to discuss: health and safety statistics, review Work progress since previous meeting; and new staff and training requirements. Contractor's resident superintendent, Subcontractor's foreman, Contractor's Health and Safety Manager, and Owner's Health and Safety Representative shall attend these meetings.

1.07 FUCTIONAL TESTING, STARTUP AND COMMISSIONING MEETING:

A. At least 3 months prior to start of functional testing, Contractor shall schedule a functional testing, startup and commissioning meeting with Owner, CM, and Engineer at a location to be selected by Owner, CM, and Engineer.

B. Contractor's Project Manager, Resident Superintendent, and Startup Manager shall be in attendance at meeting, along with any Subcontractors' or suppliers' representatives Contractor may desire to invite or at request of Engineer, and representatives for Owner, CM, and Engineer.

C. Agenda for meeting shall provide detailed testing and commissioning plans and schedules, requirements and schedules for training of Owner's staff, requirements and schedules for O&M data, and coordination and shutdown requirements.

D. Contractor shall record draft minutes for meeting and submit electronically within 5 days of meeting. Engineer will review minutes for errors or omissions, and approve or return for revision. Revised meeting minutes shall be submitted within 5 days of receipt of comments.

1.08 PRE-INSTALLATION / PRE-ACTIVITY CONFERENCE(S)

A. Prior to start of various key Work activities such as mobilization, grading, excavation, GCL installation, liner installations, pipe installation, pump and motor replacement, pump station installation, etc., Contractor shall participate in a pre-installation conference with Owner, CM, Engineer, and any appropriate Subcontractor supplier, manufacturer, or installer.

B. Contractor shall be prepared to provide updated schedule and sequence information, proposed equipment and methods to be used, and applicable QC procedures. Contractor shall demonstrate to Owner, CM, and Engineer readiness to conduct Work in accordance to Contract Documents.

C. Contractor shall record draft minutes for each meeting and submit electronically within 5 days of meeting. Engineer will review minutes for errors or omissions, and approve or return for revision. Revised meeting minutes shall be submitted within 5 days of receipt of comments.

1.09 SPECIAL AD HOC MEETINGS

A. Special Project meetings may be scheduled on an as needed basis to discuss a particular activity, plan, or change order issue. These meetings may be called by Owner, CM, Engineer, or Contractor at a time and place mutually agreed upon.

B. Contractor shall record draft minutes for each meeting and submit electronically within 5 days of meeting. Engineer will review minutes for errors or omissions, and approve or return for revision. Revised meeting minutes shall be submitted within 5 days of receipt of comments.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

(Not Used)

END OF SECTION

SECTION 01 32 13

PROJECT SCHEDULING AND SEQUENCINGS

PART 1 - GENERAL

1.01 SUMMARY DESCRIPTION

A. Section summarizes scheduling and sequencing requirements for the Project, which are described in more detail elsewhere in these Specifications, and other documents prepared for this Project.

1.02 SUBMITTALS

A. Contractor shall prepare and submit a preliminary progress schedule for the Work with bid documents.

B. Within 2 weeks of the Notice to Proceed, Contractor shall submit a detailed Project Progress Schedule in Critical Path Method (CPM) format. Contractor shall revise and resubmit schedule within 5 days of receipt of Owner's and Engineer's comments.

C. Contractor shall maintain and update Project Progress Schedule and submit on a weekly basis to show performance in relation to the target (original) schedule.

D. Contractor shall provide a 3-week "look ahead" schedule 24 hours prior to each weekly meeting.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

3.01 GENERAL

A. Bid Package provided by Owner includes a Milestone Target Schedule (considered preliminary) for Contractor to gain appreciation of Project scheduling and sequencing requirements. Contractor shall prepare a Construction Schedule that generally follows the intent of the Milestone Target Schedule, with Contractor's approach for construction factored in with its bid. Construction Schedule shall consist of sufficient detail to fully plan and communicate the Work tasks of the Project.

B. Contractor shall schedule Work and employ methodologies that generally support the "Summary of Work" as described in Section 01 11 00 and required construction sequencing identified and summarized in the Contract Documents.

C. Contractor shall engage in continuous communication and coordination of all Work, because activities (or inactivity) may directly or indirectly affect Contractor, Owner, Engineer, or other contractors.

D. Instruct recipient suppliers and Subcontractors to promptly report in writing problems anticipated by projections indicated in schedules.

3.02 SCHEDULES

A. Contractor shall prepare all schedules using MS Project Software, unless otherwise directed by Owner, and submittals shall be in color PDF format. MS Project files, or other scheduling software files, shall be provided upon request.

B. Relate progress schedule to the Project to extent required by Contract Documents and provide for expeditious and practicable execution of the Work.

C. Contractor shall incorporate time into schedule to allow Engineer to evaluate or inspect completed Work. Sufficient time should be allotted for a special site visit by personnel and office or lab evaluation. Contractor shall schedule other events or activities during this period so time and equipment is used as efficiently as possible.

D. Contractor shall revise and update complete Project Progress Schedule. Project Progress Schedule shall track percent complete and critical path.

E. Contractor shall revise and update “look-ahead” schedule and distribute prior to weekly progress meetings to discuss weekly details and schedule testing and inspections.

F. When preparing Contractor’s Schedule, Contractor shall ensure schedule allows for completion of Work in accordance with Contract Documents and allows for other time related items described in Contract Documents.

G. Show complete sequence of construction by activity, with dates for beginning and completion of each element of construction, duration, and bars showing progress and milestones.

H. Include subcontractors’ activities in schedule.

I. Include submittal dates for shop Drawings, product data, and samples, including Owner-furnished products, and dates that reviewed submittals shall be required from Owner and Engineer.

J. Indicate delivery data for products.

END OF SECTION

SECTION 01 32 23

SURVEYING AND FIELD ENGINEERING

PART 1 - GENERAL

1.01 SUMMARY DESCRIPTION

A. Work associated with this Section includes Contractor's land survey and construction staking efforts for purposes of construction in general accordance with approved Drawings and maintaining as-built records.

1.02 SUBMITTALS

A. Surveyor Qualifications

1. Contractor shall submit Surveyor's qualifications with bid.

2. Contractor shall also submit Surveyor's qualifications within 2 weeks of Notice to Proceed.

B. Preconstruction Survey

1. Contractor shall submit and receive approval of a preconstruction verification survey prior to mobilization.

C. Post-Construction Survey and As-Built Drawings

1. Contractor shall submit a post-construction survey within 2 weeks of Substantial Completion.

2. Contractor shall submit certification by land surveyor that elevations and locations of Work are in conformance with the Contract Documents.

D. Progress Surveys

1. Contractor shall submit monthly, progress surveys of completed Work.

2. Contractor shall submit subgrade surveys ahead of placement of geosynthetic materials.

1.03 SURVEY SUBMITTAL FORMAT

A. Contractor shall submit survey data with such promptness as to cause no delays of Project and allow Engineer a minimum of one week for verification.

B. All submitted survey data shall be in an organized format representative of industry standard practice.

C. All survey data shall be provided in coordinate system identified by the Drawings and coordinated with the Control Points shown on the Drawings.

D. Survey submittals shall include, at a minimum:

1. Lines and Points submitted in PDF or DWF format showing point numbers and elevations. Lines should connect related points where appropriate.

2. Points submitted in LandXML format, and also all points and linework submitted in Autocad 2016 format.

3. Field Notebooks.

4. GPS Reports.

E. Record drawings shall be prepared at a scale acceptable to Owner and Engineer.

1.04 SURVEYOR CERTIFICATION

A. All survey submittals shall be accompanied by a certification by Surveyor that provided information was surveyed under their supervision and direction. It shall also certify that survey submittals are accurate and complete to the best of their knowledge.

1.05 FIELD NOTEBOOKS

A. Field Notebooks shall be completed for each day that survey is performed and shall include, at a minimum, the following:

1. Survey personnel

2. Weather conditions

3. Equipment Used, including Model Numbers

4. Time and Date of Survey

5. Rubbings or Photos of Existing Survey Monuments

6. Base Station Data – Point, Location, Height, Model/Unit #, Start Time

7. Rover Data – Rod Type, H.I., Model/Unit#, etc.

8. Point Numbers collected, with additional descriptions for key points, as necessary.

9. Data from any Traverses performed – Instrument Point, H.I., Backsight Point, Horizontal Angle, Vertical Angle, etc.

10. Data from any Level Loops performed – Backsight H.I., Foresight H.I., etc.

11. Hand sketches of objects, control points, traverses, level loops, etc., if necessary.

B. All original field notes should be written in pencil and not contain any processed or 'resultant' data. However, processed data such as digital photos may be attached to field notebooks as supporting information. Digital field notebooks may be acceptable with approval from Engineer. Contractor shall submit a Request for Change with a proposed alternate field notebook template if use of digital field notebooks is requested.

C. All field notes must be recorded at time of survey.

1.06 GPS REPORTS

A. GPS reports shall include a raw or processed data report from the GPS equipment software, showing information such as point number, collected date and time, observation duration, latitude and longitude, elevation, Precision Dilution of Precision (PDOP), Root-Mean Square (RMS) error, Precision, Antenna Height, etc.

1.07 SCOPE OF WORK

A. Work associated with this Section includes Contractor's construction staking efforts for purposes of construction of Project in general accordance with approved Drawings and maintaining as-built recording.

B. Contractor shall furnish all materials, personnel, and equipment necessary to perform all surveying, staking, laying out of control lines and verifications of the accuracy of all existing control points which are delineated in the Contract Documents.

C. Contractor shall be responsible for establishing survey control for Project. Contractor shall coordinate with Owner to establish survey control for the site that is tied in to benchmarks at the Plant.

D. Contractor shall assume full responsibility for constructing Project to proper locations and grades in accordance with the Drawings. All lines, grades, elevations are to be set by Surveyor from existing references.

E. Contractor shall be responsible for field checking and verification of dimensions shown on the Drawings, for consulting with Owner regarding any discrepancies prior to performing any construction work, and for making required dimensional adjustment to suit (as approved in advance by Owner) at no cost to Owner.

F. Owner and/or Engineer reserve the right to perform any desired checking and correction of Contractor's surveys but this does not relieve Contractor of responsibility for adequate performance of the Work.

1.08 QUALIFICATIONS OF SURVEYOR

A. All survey work shall be performed by or under the direct supervision of a land surveyor registered in New Mexico and acceptable to Owner.

1.09 PRECONSTRUCTION SURVEY

A. Contractor shall perform a preconstruction verification survey of all areas which are included for expected disturbance in the Contract Documents or Contractor's Construction Work Plan. Preconstruction survey shall include:

1. Detailed survey of existing grade of Project area prior to construction, including: breaklines, tops, toes, existing survey monuments, established survey monuments, wells, piezometers, utilities, structures, piping, and other topographic features.

2. Detailed survey of expected borrow areas or stockpile areas. Areas determined at a later date for stockpile or borrow must be surveyed prior to disturbance.

1.10 PROGRESS SURVEYS

A. Progress surveys shall include, at a minimum:

1. Surveyed check point of all set grade stakes. Stakes set with written text, such as vertical cuts/fills or offsets, shall be noted in point description as such, and relevant text written on stake shall be included in point description or documented in the field notebook.

2. Top of pipe elevations of all piping.

3. Subgrade elevations of Project immediately prior to deployment of geosynthetic materials and/or and backfill.

4. Finish grade elevations of bottoms, tops, toes, etc.

5. Other spot elevations necessary to document compliance with grades and elevations shown or described in Contract Documents or ensure positive drainage is provided.

6. Final grade of any borrow or stockpile areas.

1.11 EXAMINATION

A. Contractor shall notify Owner and Engineer of any discrepancies discovered in surveying or layout.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

3.01 SURVEY REFERENCE POINTS

A. Datum and control points are shown on the Drawings.

B. Contractor shall establish and maintain a minimum of two permanent benchmarks for QC checks at locations approved by Owner.

C. Contractor shall locate and protect survey control points prior to starting site work and preserve all permanent reference points during construction.

D. Notify Owner if survey control points are damaged upon discovery. Also notify Owner of any damage caused by Contractor, then repair or replace survey control points at no additional cost to Owner.

E. Contractor shall report to Owner when any survey control point is lost or destroyed, or requires relocation because of necessary changes in grades or locations.

3.02 PROJECT SURVEY REQUIREMENTS

A. Provide instruments and other survey equipment that is accurate, suitable for surveys required in accordance with recognized professional standards, and in proper condition and adjustment at all times.

B. Perform work under direct supervision of a land surveyor registered in the State of New Mexico.

C. Owner may at any time use line and grade points and markers established by Contractor. Contractor's surveys are a part of the Work and may be checked by Owner or representatives of Owner at any time. Contractor is responsible for; 1) any lines, grades, or measurements, which do not comply with specified design criteria or proper tolerances, or which are otherwise defective, and 2) for any resultant defects in the Work. Contractor will be required to re-survey or check surveys to correct errors indicated by review of field notebooks or otherwise detected at no extra cost to Owner.

D. Locations of existing utilities shown on the Drawings are approximate and shall be field verified by Contractor prior to construction as required to complete the Work. Record Drawings of discovered utilities shall be submitted to Owner.

E. Contractor shall maintain a complete, accurate log of all control and survey work as it progresses.

3.03 QUALITY CONTROL

A. Surveyor shall record a point on a minimum of two known existing or established survey monuments prior to any survey being performed each day. If recorded points are not within a horizontal and vertical tolerance of 0.03 feet, equipment shall be restarted,

calibrated, adjusted, or otherwise reviewed for cause of inaccuracy. Surveyor shall repeat process until recorded points are within a tolerance of 0.03 feet.

B. Surveyor shall record a point at a minimum of same two known existing or established survey monuments after survey is complete for each day. If recorded points are not within a horizontal and vertical tolerance of 0.03 feet, Surveyor shall determine reason for inaccuracy and spot check with collected check-points for a minimum of 15% of the points established that day for inaccuracy. Surveyor shall resurvey or adjust any points or stakes surveyed that day, at discretion of Surveyor. Engineer reserves the right to require resurvey or re-staking of points if QC does not appear to be sufficiently performed or if Engineer believes Surveyor has not adequately addressed inaccuracies found.

C. At no time shall any QC points be deleted, except with proper documentation and reason.

D. Additional QC should be performed in accordance with industry standard practice. Alternate QC procedures may be proposed with a Request for Change to accommodate Surveyor's intended procedures and equipment.

3.04 SURVEYING ACCURACY AND TOLERANCES IN SETTING OF SURVEY STAKES

A. Tolerances applicable in setting survey stakes are set forth below. Such tolerances do not supersede stricter tolerances required by the Contract Documents, and do not otherwise relieve Contractor of responsibility for measurements in compliance therewith.

B. Positional Dilution of Precision (PDOP) shall not be greater than 3 for any surveyed or set points by GPS.

C. Tolerances shall be as follows:

Type of Mark	**Horizontal Position**	**Elevation**
Permanent reference points	±0.01 ft	±0.01 ft
Surveyed topography	±0.10 ft	±0.05 ft
Set Grade Stakes	±0.10 ft	±0.05 ft
Pipe Inverts/Tops	±0.02 ft	±0.02 ft

3.05 COORDINATION WITH ARIZONA PUBLIC SERVICE COMPANY

A. Keep Owner informed on progress of survey Work to allow Owner sufficient time and ample opportunity to verify survey Work without inconvenience or delay to Contractor.

3.06 AS-BUILTS

A. Contractor shall:

1. Maintain a complete and accurate log of control and survey Work and drawing markups.

2. Make field log and mark-up Drawings available for review by Engineer.

3. After Project completion, submit red-line Drawings marked up and digital survey data on disk.

4. Final as-built markup Drawings and digital files shall be prepared under direction, reviewed by, and stamped by a registered land surveyor (RLS) in the State of New Mexico.

END OF SECTION

SECTION 01 33 00

SUBMITTALS

PART 1 - GENERAL

1.01 SUMMARY DESCRIPTION

A. Submittals for this Project are generally described in this section, including submittal control, procedures for submission and review, and a brief description of the content and format of submittals.

B. Detailed submittal requirements will be specified in the technical specifications section.

1.02 SUBMITTALS

A. Within fourteen (14) days after receipt of Notice to Proceed, submit to Engineer a submittal log listing and scheduling all required submittal items.

B. Submittal Log will be acceptable to Engineer as to form and substance if it provides a reasonable listing of submittals and provides a workable arrangement for reviewing and processing required submittals. Submittal log shall be maintained by Contractor.

1.03 USE OF SUBMITTALS

A. Submittals are an expression of Contractor's interpretation of requirements in the Contract Documents and show how Contractor intends to fulfill these requirements. Submittals give Owner and Engineer an opportunity to correct misunderstandings Contractor might have about the Contract Documents.

B. Submittals may not be used to change requirements of the Contract, except where minor deviations in product data may be allowed at Owner's or Engineer's discretion.

C. Submittals will also be used to document products and installation procedures for record purposes, or to communicate Contractor's intentions for use by Owner and Engineer in coordinating other work.

D. Owner or Engineer response, or lack of response, does not constitute a waiver of requirement to comply with the Contract Documents.

1.04 GENERAL

A. All items within Contract Documents noted as "submit" shall be provided in accordance with this Section.

B. All products not specifically noted as "submit", but which are installed as part of the permanent installation shall be submitted in accordance with this Section. Shop drawings shall be provided for all products which are interrelated with connections or

which are required for a complete, functioning system but not specifically detailed in the Contract Documents.

C. All submittals noted within Contract Documents are required and regarded as essential to successful completion of Project. Exceptions to submittals are at Owner's or Engineer's discretion.

D. Submittals shall be organized and/or tabbed as appropriate for easy reference.

E. Submittals shall reference appropriate Specification section and its detailed content. Questions regarding any submittals shall be directed to Engineer for content and schedule of delivery.

F. Limit submittal items to one element of construction and type of product or equipment per submittal.

G. Contractor shall submit all shop drawings called for under the various sections of these Specifications. Shop drawings shall be completed and detailed. If approved by Engineer each copy of shop drawings will be identified as having received such approval by being so marked and dated. Make any corrections required by Engineer.

H. Contractor shall provide submittals at least 4 weeks prior to material procurement and/or delivery, but no later than 4 weeks after mobilization, unless otherwise stated within the Specifications.

I. No specific task shall commence prior to all submittals related to that task having been submitted and responded to with a remark of Furnish, which may include, but is not limited to, vendor supplied materials and/or imported materials.

J. Contractor shall submit electronically all vendor drawings, and all operating instructions, and O&M manuals for Contractor supplied material and equipment. All information provided by Contractor shall conform to detailed requirements specified herein, shall be delivered to Engineer as soon as practicable, and in no case later than the physical delivery of the material or equipment.

1.05 TRANSMITTAL FORM

A. A title page, cover letter, or standard transmittal form shall accompany each submittal.

B. All transmittal forms shall bear the following information:

1. Date

2. Contract Number

3. Project Title and Location

4. Contractor/Subcontractor's Name

5. Related Specification Section and Paragraph Numbers

6. Related Drawing and Detail Numbers

7. Submittal Control Number

C. Transmittal form shall include manufacturer, supplier, product generic name, product brand name, quantity intended for purchase, and intended use/location.

D. Submittals which include multiple products shall include a divider page between each product which lists the manufacturer, supplier, product generic name, product brand name, quantity intended for purchase, and intended use/location.

E. Each submittal shall note on transmittal form, divider page, or within submittal all deviations from Contract Documents. Minor deviations may be allowed by Engineer at Owner's and Engineer's discretion, however, all submittals with deviations not noted within submittal will be returned for correction without further review.

1.06 SUBMITTAL CONTROL NUMBER

A. Each submittal shall include a unique identifier as Submittal Control Number. Submittal Control Number shall be related Section number, followed by a dash, then followed by a two digit number unique to that submittal beginning at 01 and increasing sequentially.

B. Resubmittals shall include the same Submittal Control Number as original submittal, followed by a letter beginning at "A" and increasing sequentially.

C. For example, Submittal Control Number for the Submittal Log will be "013300-01". Submittal Control Number for a resubmittal of the Submittal Log will be "013300-01A", and a subsequent resubmittal will be "013300-01B".

1.07 SUBMITTAL FILE NAMING

A. Files submitted electronically shall be named as Submittal Control Number followed by an underscore (_), followed by the submittal title.

B. For example, Submittal Log file may be named:

1. "013300-01_Submittal Log.pdf"

1.08 SUBMITTAL ACTION

A. Submit electronically each submittal for review. One electronic copy will be returned to Contractor with one or more of the following standard stamped remarks:

1. No Exceptions Noted

a. Work covered by submittal may proceed provided it complies with the Contract Documents. Final acceptance will depend on that compliance.

2. Exceptions Noted

    a. Work covered by submittal may proceed provided it complies both with Engineer's notations and the Contract Documents. Final acceptance will depend on that compliance.

    b. Submittals marked Exception Noted do not require a resubmittal.

3. Review Not Completed

    a. Work covered by submittal is incomplete or requires corrections and/or clarifications in order for Engineer to fully review submittal.

    b. Submittal marked Review Not Complete may have partial Engineer review comments that need to be incorporated to complete submittal.

4. Review Not Required

    a. Submittals for informational purposes, record purposes, special processing, or other Contractor activity, will be returned marked Review Not Required.

    b. Submittals marked Review Not Required may not be reviewed for conformance with Contract Documents and do not constitute approval or acceptance of submitted information.

5. Make Corrections Noted

    a. Do not proceed with Work covered by submittal, including purchasing, fabrication, delivery, or other activity for submittal. Revise or prepare a new submittal for a product that complies with the Contract Documents.

    b. Submittals marked Make Corrections Noted require a resubmittal.

6. Resubmit

    a. Do not proceed with Work covered by submittal. Prepare additional information requested, or required by the Contract Documents, that indicates compliance with requirements and resubmit.

7. Do Not Resubmit

    a. Contractor may proceed with Work covered by submittal, and any additional information agreed upon with Engineer that indicates compliance with the Contract Documents; however, resubmittal is not required.

8. Submittal Not Complete

    a. Submittals marked Submittal Not Complete require additional information in order for Engineer to fully review submittal.

B. Submittals returned for correction or if not satisfactory and disapproved by Engineer, Contractor shall revise and resubmit submittal for approval within a maximum of 2 weeks after receipt of disapproved material.

C. Resubmittals shall be complete as a stand-alone submittal. Grossly incomplete submittals may be rejected immediately without further review.

D. Any Work completed prior to a submittal response of No Exceptions Noted or Exceptions Noted will be at the risk of Contractor and may require additional rework.

1.09 USE OF CONTRACT DOCUMENTS

A. All Shop Drawings or figures created by Contractor which make use of the Drawings or other provided documents, or otherwise edit content of those documents, shall mark through all APS or AECOM logos and Engineer's stamp with a thick red line.

1.10 PROJECT AS-BUILT DOCUMENTATION

A. Contractor shall furnish marked-up or red-line field drawings to Engineer for approval before submitting for final payment. These field drawings shall be maintained current by Contractor and readily accessible by Engineer or his designated representative.

B. Field drawings shall be scanned and submitted each month with Application for Payment.

C. Upon completion of Project, Contractor shall provide a set of red-lined "as-built" record drawings to Engineer which contains complete and accurate "as-built" survey information. Upon completion, the red-lined record drawings shall be reviewed and stamped by land surveyor who is registered in the State of New Mexico and has provided supervision and direction of survey Work.

D. Contractor shall describe and dimension, on field drawings and contract drawings, vertical and horizontal locations of all buried Work that has been installed as part of this Contract.

E. Contractor shall show on field drawings and contract drawings all deviations from the Contract Documents.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

3.01 CONTRACTOR'S REVIEW:

A. Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with Contract Documents prior to submission to Engineer. Contractor review shall verify the following:

1. Field measurements

2. Field construction criteria

3. Catalognumbers and similar data

4. Conformance with the Specifications

B. Review and acceptance of shop drawings, samples or product data by Engineer shall not relieve the Contractor from his responsibility with regard to fulfillment of the terms of the Contract. All risks of error and omission are assumed by Contractor and Engineer will not have responsibility for any such errors and omissions.

C. Approval Stamp: Stamp each submittal with a uniform, approval stamp as per Part 1.08 of this Specification.

3.02 ENGINEER’S ACTION:

A. Engineer’s review is for general conformance with the design concept and Contract Documents. Markings or comments shall not be construed as relieving Contractor from compliance with the contract plans and specifications or from departures therefrom. Contractor remains responsible for details and accuracy, for coordinating work with all other associated work and trades, for selecting fabrication processes, for techniques of assembly, and for performing work in a safe manner.

B. Submittals will be returned to Contractor under one of the action codes indicated in Part 1.08 of this Specification and defined on the transmittal form furnished by Engineer.

C. Resubmittals will be handled in the same manner as first submittals.

3.03 CERTIFICATES OF COMPLIANCE:

A. Certificates of Compliance as specified in the specifications shall include and mean certificates, manufacturer’s certificates, certifications, certified copies, letters of certification, and certificate of materials.

B. Contractor shall be responsible for providing Certificates of Compliance.

3.04 SCHEDULES:

A. Progress Payments shall be subject to meeting the "Schedule Requirements/Payment Milestones" of Table 01 33 00-1. No progress payment over the limits identified will be made until the milestones set in this table are satisfied.

Table 01 33 00-1

Section Number	Submittal	Schedule Requirement/ Payment Milestones
01 32 13	Project schedule is submitted and reaches no exceptions taken status.	Prior to 5% payment
01 33 00	Shop drawings are submitted and reaches no exceptions taken status.	Prior to 25% payment.
01 78 23	O&M Manual Content reaches no exceptions taken status.	Prior to 25% payment.
01 78 23	Initial O&M Manual	Prior to 50% payment
01 78 25	Plant Checkout Plan (Plant Testing, Startup, and Commissioning) reaches no exceptions taken status.	Prior to 60% payment.
01 78 23	Pre-Final O&M Manual reaches no exceptions taken status.	Prior to 75% payment.
01 78 25	Functional Completion Testing Certificates for each piece of equipment reaches no exceptions taken status.	Prior to 75% payment.
01 78 25	Startup Report and Certificates for each piece of equipment reaches no exceptions taken status.	Prior to 75% payment.
01 78 23	Final O&M Manual reaches no exceptions taken status.	Prior to 80% payment.
01 78 25	Commissioning Certificates for each piece of equipment reach no exceptions taken status.	Prior to 80% payment.
01 77 00	Record documentation is submitted and reaches no exceptions taken status.	Prior to 95% payment.
01 77 00	Punch list is completed and corrected.	Prior to 95% payment.

END OF SECTION

SECTION 01 35 29

HEALTH AND SAFETY

PART 1 - GENERAL

1.01 SUMMARY DESCRIPTION

A. Contractor shall complete construction activates in full compliance with any Owner, Four Corners Power Plant, Engineer, and OSHA safety standards and general safe practices in the industry for applicable Work on all aspects of this Project. In regards to areas of contradiction, the more stringent standard shall apply.

B. Contractor shall provide a Safety Manager (cannot be project supervisor) to ensure all Work is performed in a safe manner. Safety of Work is responsibility of all Contractors and Contractor representatives working on the Project.

1.02 SUBMITTALS

A. Contractor shall, prior to commencement of the Work, submit in writing to Owner and Engineer a proposed site specific safety program that ensures compliance with Owner requirements, OSHA Regulations, state and local regulations.

B. Contractor's site specific Health and Safety Plan shall specifically identify location and most expedient route to medical services, appropriate phone numbers and points of contact to obtain emergency transportation and medical support. Plan shall also address anticipated activities on the Project and types of materials/constituents of concern.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

3.01 GENERAL

A. All employees of Contractor and Subcontractors will be required to attend a Four Corners Power Plant safety orientation class prior to beginning of Work. Contractor shall make every effort to schedule all employees for one session. Contractor shall coordinate with their APS Vendor Supervisor to schedule any additional training sessions for new employees.

END OF SECTION

SECTION 01 43 00

QUALITY CONTROL

PART 1 - GENERAL

1.01 SUMMARY DESCRIPTION

A. Section covers Quality Assurance (QA) and Quality Control (QC) requirements for this contract.

B. Refer to “PROJECT TEAM DEFINITIONS” in Section 01 11 00 “Summary of Work” for role definitions.

C. QC inspection and testing will be sole responsibility of Contractor.

D. Inspections and tests of materials and other Work provided under this Contract for purpose of verifying their quality shall be performed by Contractor as specified herein, as specified by codes and standards referred to herein and as specified by equipment manufacturers.

E. QC required for Project focuses on resources and methods employed by Contractor and on responsibility of Contractor to execute the Work in general accordance with the Contract Documents.

F. Owner will also contract separately a Construction Quality Assurance (CQA) Consultant(s) to provide review and inspection of materials and to assure the QC is performed in accordance with Specifications. CQA Consultant shall provide overall quality of Work and shall be part of acceptance of Work. Scope of testing by the CQA Consultant will be described in the CQA Plan. Engineer will provide the CQA Plan to Contractor after Project award.

G. Inspection and testing by Owner in no way relieves Contractor from conformance with the Specifications, Drawings, Codes, other requirements, or from contractual obligations.

1.02 SUBMITTALS

A. Submit to Engineer or his designated representative for approval within five (5) working days after the receipt of the Notice to Proceed, a QC Plan that shall include procedures, instructions, methods, and corrective actions to be used including those for subcontractor’s Work. This document shall also include as a minimum:

1. QC organization (organizational chart specifically identifying responsible individuals and their organization that includes all relevant contact information).

2. Number and qualifications of personnel to be used for this purpose.

3. Authority and responsibilities of key personnel.

4. Specifically identified test methods and frequency of testing for each material and/or component of construction. Identify testing standard and provide a blank copy of report format.

5. Detail proposed method of documenting QC operation, inspection, and testing.

6. Detailed construction methods to be used to meet requirements set forth in the construction documents.

7. Submittals of QC data include but are not limited to: survey, soil compaction and material testing, and geosynthetics testing.

8. Specific submittals and QC provisions are identified in appropriate section.

B. Contractor shall submit a daily field report. Daily field report shall include, but is not limited to: weather conditions, field conditions, names and titles of personnel on site, topics discussed during daily safety meetings, construction activities, directives given or assigned, and expected construction activities for following day.

1. Daily field report shall include at least three photos showing the major items of work completed that day and a photo showing overall progress of the Work.

2. Additionally, report shall include photos of identified deficiencies or quality issues, and photos of any identified safety issues. Subsequent reports shall include photos showing resolution of quality or safety issues.

3. All photos should include a descriptive caption.

1.03 QUALITY CONTROL MANAGER

A. Contractor shall provide a full-time dedicated QC Manager to ensure Work product conforms to the requirements of the Contract Documents. Quality of Work is responsibility of Contractor and Contractor representatives working on Project and not just QC Team, which includes QC Construction Materials Testing (CMT) Firm.

B. QC Manager shall be skilled and knowledgeable in various trades to be performed as part of the Work.

C. Duties of QC Manager shall include, at a minimum: review of submittal comments, review of request for information (RFI) responses, review of manufacturer's instructions, development and review of QC procedures, documentation of QC tests, photography of installations, preparing daily QC Field Reports, attending all project meetings, and coordination of QC Team.

1.04 QUALITY CONTROL

A. QC refers to those actions taken by all parties involved in construction, including Contractor, those parties charged with procurement and installation of manufactured materials, and placement and compaction of soil materials, which provide a means to determine and sometimes quantify characteristics of products. Results of a QC program are compared to Specifications, Drawings and other contractual or regulatory requirements. During each aspect of handling of these materials, QC is provided by manufacturer, fabricator, or installer of materials, or supplier and earthworks contractor for soils, to ensure materials and workmanship conform to the Contract Documents. QC responsibility is retained by Contractor, suppliers, and manufacturers because these entities have the most direct control over qualifications of personnel, specialized experience or expertise, choice in type and quality of equipment, scheduling, sequencing, and workmanship that all factor into quality of finished Project.

B. Inspection and testing is to be performed prior to material being placed as part of the Work performed by Contractor, Subcontractor, supplier, or manufacturer. Contractor is obligated to comply with associated specification requirement and correction actions from failing results. Contractor is responsible for quality of Work by employing qualified operators and personnel, equipment, which is reliable, appropriately sized and type of equipment suitable for task. Contractor shall provide appropriate size of crew, adequate supervision, and coordination necessary to plan and execute Work, and appropriate means and methods.

C. Unless specifically authorized in writing, no construction shall be started until Contractor's QC Plan is approved by Engineer or Engineer's representative.

D. Contractor's quality of Work shall be inspected and tested by QC CMT Firm in accordance with testing frequencies listed in these Specifications.

E. Contractor shall establish and continuously provide a QC system to perform sufficient inspection and tests of all items of Work, including that of Subcontractors, to ensure conformance to applicable Specifications and Drawings with respect to materials, methods, workmanship, construction, finish, functional performance, and identification. QC system shall be established for all construction, except where the technical provisions of the Contract provide for specific QC inspections, tests or other means to be performed by Owner or his designated representative. Contractor's QC system shall specifically include surveillance and tests required in the Specifications.

F. Contractor's QC system is means by which Contractor assures that construction complies with the requirements of the Contract Documents. QC Plan shall be adequate to cover all construction operations and should be keyed to proposed construction sequence.

G. Contractor's job supervisory staff may be used for QC, supplemented as necessary by additional personnel for surveillance, special technicians, or testing facilities to provide capability for controls required by Specifications. Prior approval is required for facilities, equipment, and personnel used by Contractor in performing specified tests.

H. Contractor is subject to consequence of rejected Work and all QC inspections and tests shall be recorded by QC Manager or their designated representative including, but not limited to, specific items required in the Specifications. QC report to include a description of Project activities, QC tests, and records of corrective action taken shall be furnished by Contractor, his designated representative, or QC CMT firm with the daily field report.

I. If recurring deficiencies indicate that QC system is not adequate, such corrective actions will be taken as directed by Owner or Engineer.

J. In event Contractor fails to satisfactorily perform any required inspections and tests; to submit timely, complete, and factual reports and test data; or otherwise comply with QC provisions, Owner or his designated representative may provide these services from another source and all costs for providing these services will be deducted from payments due Contractor.

K. Results of QC tests are subject to verification by Owner's CQA Representative. Should a discrepancy between the QC results and Owner's CQA results occur, Owner's results and conclusions shall prevail.

L. Observation of Work in progress alone is not a basis of acceptance of Work. Results of inspection and testing on in-place material approved by Engineer or performed by Contractor's QC team and Owner's CQA Representative shall prevail.

M. Contractor shall be responsible to monitor QC over suppliers, manufacturers, products, services, site conditions, and workmanship to produce Work of specified quality.

N. Contractor shall comply fully with manufacturers' instructions. Should manufacturers' instructions conflict with the Contract Documents, Contractor must request clarification from Engineer before proceeding.

O. Contractor shall comply with specified standards as a minimum quality for the Work except when more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

P. Work shall be performed by persons qualified to produce workmanship of specified quality.

Q. Contractor shall employ its own testing program (type and frequency) to ensure itself that soil materials meet specification at any intermediate stage of Work. Proposed testing shall be outlined in Contractor's QC Plan.

R. Contractor's obligation for QC is not superseded or lessened by execution of CQA Plan and/or testing by CQA representative.

1.05 QUALITY ASSURANCE

A. CQA will be performed by Owner; Engineer, CQA Representative and/or third party laboratory retained by Owner in general accordance with the Specifications and CQA Plan. CQA inspections and testing does not replace Contractor's obligation, or methods, for QC.

B. CQA testing representative will be responsible for on-site and laboratory testing of soils and fill materials in accordance with CQA Plan.

C. Owner and Engineer will review Contractor's QC Plan and progress reports (and those of the Subcontractors).

D. Owner will conduct spot-checking of survey control points/data.

1.06 FIELD INSPECTION, SAMPLING, AND TESTING

A. Contractor shall make allowance for testing to be performed and divert equipment elsewhere during required CQA testing. Contractor shall provide adequate time for CQA testing when preparing schedules and Work production estimates.

B. Contractor shall maintain access at all times for Owner, Engineer, and/or CQA Representative to perform inspection, sampling, and testing.

C. All Work performed by Contractor shall meet approval of Engineer. Method and manner of doing the Work will be under control of Contractor.

D. Frequency of testing for material conformance and field installation are listed in respective sections of the Specifications.

1.07 NOTICES

A. Additional inspection and tests required due to defective Work or ill-timed notices may be initiated by Owner or his designated representative and will be at Contractor's expense. Contractor shall at no time deny CQA personnel, Engineer, or Owner access to any Work area, fabrication area, staging area, or any other area associated with the Work.

B. There is no provision for claims of delays due to CQA inspection, testing, or sampling. Should Contractor feel that delays are being incurred due to CQA inspection, testing, sampling, or other activities, Contractor shall notify Engineer in writing within 7 days of occurrence, documenting in detail date, time, and CQA activity of each occurrence. Should Engineer determine that CQA activities are causing delay to Work, corrective action will be taken.

C. If any Work should be covered up without prior approval or consent of Engineer, it must, if required by Engineer, be uncovered for examination. After uncovered Work has been observed and authorization given by Engineer, Work shall be recovered in accordance with the Specifications. Cost of uncovering and recovering the Work and

any consequential costs shall be born entirely by Contractor regardless of condition of the Work uncovered. If Work is found to be deficient, Contractor shall expose all Work that was covered prior to approval, correct any Work that is deficient, and proceed according to the Specifications. Cost of uncovering deficient Work, correcting deficient Work, and any consequential costs shall by borne entirely by Contractor.

D. Contractor shall cooperate with Engineer or independent third party laboratory to furnish samples of materials, design mixes, equipment, tools, storage, and assistance as required. Contractor shall also notify Engineer and independent third party twenty-four (24) hours prior to expected time for operations requiring services.

1.08 PROJECT COOPERATION

A. Provide representatives of Owner, Engineer, and CQA Team access to the Work at all times and at all locations where Work is in progress to observe and perform conformance testing in accordance with the CQA Plan.

B. Allow Owner or Engineer access and time to conduct CQA inspections, sampling and testing. Frequencies, time, and locations of CQA inspections, sampling, and testing will follow QC requirements in general, but will ultimately be at Owner or his designated representative's discretion. CQA Sampling or testing may include compaction of soils, soil material properties, and geosynthetic conformance and/or installation.

C. Allowing Owner or Engineer to perform CQA inspections and testing does not preclude Contractor from performing QC. Contractor maintains complete responsibility for quality of Work.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

(Not Used)

END OF SECTION

SECTION 01 50 00

TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.01 SUMMARY DESCRIPTION

A. This Section provides the requirements for temporary facilities and controls for the Project.

B. Temporary facilities and controls shall be provided to complete the required Work and to provide safety and protection of the environment.

C. This section includes the general requirements for Contractor's responsibility to divert storm water flows around Project area, control subsurface and surface seepage flows and storm water in excavations, borrow areas, and retention basins and protection of the completed Work. Contractor shall provide sufficient temporary equipment, supply, and labor to satisfy general intent of this Specification.

1.02 SUBMITTALS

A. Contractor shall prepare and submit a preliminary Construction Work Plan with bid documents generally indicating construction procedures, equipment, and materials proposed to accomplish the Work under this Contract.

B. Contractor shall update and resubmit the Construction Work Plan within 2 weeks of his receipt of the Notice to Proceed.

C. Submit shop drawings, product and performance data, and Manufacturer's certifications under provisions of Section 01 33 00 Submittals.

D. Submit to Engineer for approval within 2 weeks after the receipt of the Notice to Proceed, a Diversion and Storm Water Control Plan for the site. Diversion and Storm Water Control Plan shall identify and show the proposed schedule, layout, equipment and method for removing all water that enters excavations, so as to keep the excavations dry as to obtain satisfactory subgrade to allow construction of the Work. Diversion and Storm Water Control Plan shall show method of operation and a complete layout of all facilities including but not limited to temporary drainage ditches and pipes, wells, pumps, impoundments, earthen diversion works, and channels to be utilized.

E. Construct approved diversions and controls for protection of Work prior to its start.

F. Contractor is solely responsible for adequacy of diversion and control of water and for protection of Work.

1.03 CONSTRUCTION WORK PLAN

A. Updated Construction Work Plan shall provide more detail for construction procedures, equipment, and materials to be used for this Work.

B. Updated Construction Work Plan shall include details of sequencing and layouts showing proposed location of temporary construction facilities, material storage areas, dewatering structures, access roads, fuel and oil and gas facilities, material processing sites, stockpiles, power requirements, and various equipment and facilities to be used for the Work under this Contract.

C. Construction Work Plan shall include sequencing and methods for demolition of facilities and structures.

D. Construction Work Plan shall include temporary safety facilities such as signs, lighted barricades, traffic controls, flagmen, concrete barriers, berms, and high-intensity lighting.

E. Construction Work Plan shall include equipment and controls for preventing and minimizing generation of dust due to operations in construction and materials processing areas, along haul routes, equipment parking areas, and in waste areas. Plan may consist of water sprinkling or an equivalent service.

F. Make corrections to the preliminary Construction Work Plan as required upon receipt of the Notice to Proceed, incorporating any modifications to construction procedures developed during time interval.

1.04 ACCESS

A. Owner will provide general access to the site. Contractor shall not construct any staging areas, temporary facilities; haul roads, or access roads without approval of Owner. Coordinate with Owner and/or Engineer's Representative prior to constructing temporary roads (or widening existing) to resolve conflicts with Plant operations or design intent.

1.05 POWER

A. Provide and pay for power required for construction trailers, field office space, or any facilities and equipment utilized to conduct Work. Coordinate supply of power with Owner.

B. Contractor shall provide portable temporary electrical power generators as required for site work involving small tools, dewatering pumps, lighting, and welding equipment.

C. Contractor shall provide sufficient electric lighting so that all work may be done in a workmanlike manner when there is not sufficient daylight.

1.06 TEMPORARY HEAT

A. If temporary heat is required for protection of the Work, Contractor shall provide and install suitable heating apparatus, shall provide adequate and proper fuel, and shall maintain heat as required. Costs for temporary heating, cooling, and ventilating required to execute the Work shall be borne by Contractor.

1.07 CONSTRUCTION WATER

A. Water for construction purposes will be available from Morgan Lake, near the southwest corner of the lake. Contractor shall be responsible for construction of *a temporary pumping system (pump, pipe, and appurtenances) and a temporary portable water-truck loadout tower at Morgan Lake to be used by the Contractor for the duration of construction. The temporary pumping system and temporary water-truck loadout tower shall be removed by the Contractor once construction activities have been completed. The temporary pumping system and water-truck loadout plan must be approved by the Owner prior to installation.*~~any new conveyance piping from the existing submersible pump in Morgan Lake to Project site and any other construction water infrastructure deemed necessary by Contractor, and as approved by Owner.~~

1.08 POTABLE WATER

A. Contractor shall provide a potable water source at job trailer area for domestic use for employees and visitors of job trailer. This may include a 5-gallon water bottle dispenser or 20-ounce water bottles.

B. Contractor shall be required to maintain a potable water source within close proximity to each area of Work being performed for employees and visitors to Project area.

1.09 STORM WATER CONTROL

A. Provide for diversion and control of surface and subsurface water at the Site. Flows shall include water originating upstream of the Work as well as local seepage, run-on and runoff from adjacent hillside and existing stockpiles.

B. Contractor shall prepare a Diversion and Storm Water Control Plan that complies with Owner's requirements for diversion, containment, and control of site water. Submittals shall be in accordance with Section 01 33 00.

C. Contractor shall be responsible for maintenance of temporary control and dewatering equipment and activities when these activities are operational, including 24-hour oversight of such activities. Conduct routine inspections of effectiveness of temporary facilities and equipment maintenance (i.e. berms, pumps, etc.). Re-inspect all facilities immediately after storms to verify integrity of diversions and controls has not been compromised.

D. Contractor is responsible for understanding breadth and scope of diversion and, control of water, on this Project. Contractor shall also understand requirements of this

Specification as it relates to overall schedule duration of the Project (i.e. monsoon season, winter rains and snow, etc.).

E. Protect Work from water runoff and erosion resulting from precipitation. Protection shall include use of silt fences, sandbags, liner sheets, and berms, as necessary and be in compliance with Construction Storm Water Pollution Prevention Plan (SWPPP).

F. If precipitation or runoff damage occurs prior to acceptance by Owner, Contractor shall repair damaged Work in accordance to these Specifications at no cost to Owner.

G. Protection of Work from surface water (direct or runoff) shall take priority. Improperly protected Work that becomes damaged, compromised, or otherwise unusable shall be repaired or replaced at no cost to Owner.

H. Contractor shall be aware of precipitation events, which can reasonably be expected, and of drainage courses within and around the site.

I. Contractor shall employ a construction strategy and sequence of activities that minimize the adverse consequences of precipitation.

J. Contractor shall be required to manage accumulated water if construction activities create ponding areas. Managing these surface water accumulations and/or protecting the Work are required through the use of temporary sump pumps and pipes.

K. Use of berms or sandbags to divert water may be required to protect Work.

L. Streamflow records are relevant for flows occurring at the project site. Annual rainfall data from local or state Climatology offices or applicable United States Geological Surveys may be useful in evaluating potential time of year and magnitude of rainfall and runoff.

M. Protect all ongoing and completed work from operating and storm water flows.

N. Before construction activities begin, sufficient equipment shall be available on-site to assure that operation and adequacy of diversion, and/or control system can be continuously maintained. Contractor shall be responsible for providing sufficient remote power supply(s) (i.e. generator) where an electrical source is deemed not practical.

O. Contractor is required to own, rent, or purchase all necessary equipment and materials to satisfy the intent of this Specification.

P. Perform all permanent construction in areas free from water. During and after periods of rain, intermittent stream or flows may be expected. Contractor is solely responsible for protection of Work against damage or delay from water flow.

Q. Furnish, install, maintain, and operate all necessary equipment for removal of water from various parts of the Site.

R. Perform diversion control before execution of all Work.

S. Dispose of water in a manner that does not cause damage to public or private property and is consistent with regulatory and Owner requirements. Coordinate discharge points with Owner prior to diverting.

1.10 EROSION CONTROL

A. Surface drainage from cuts and fills within the construction limits, whether or not completed, and from borrow and waste disposal areas, shall be graded to control erosion. Temporary control measures shall be provided and maintained until permanent drainage facilities are completed and operative.

1.11 PROTECTION OF LAND AREAS

A. Except for any work or storage areas and access routes specifically assigned for use of Contractor under this Contract, land areas outside the limits of permanent Work performed under this Contract shall be preserved in their present conditions.

1.12 PROTECTION OF WATER RESOURCES

A. Contractor shall control the disposal of fuels, oils, bitumens, acids, or other harmful materials, both on and off work areas, and shall comply with applicable Federal, State, County and Municipal laws concerning pollution of rivers and streams while performing work under this Contract. Special measures shall be taken to prevent chemicals, fuels, oils, greases, and bituminous materials from entering public waters.

1.13 WASTE DISPOSAL

A. Any waste material resulting from Work under this Contract, which is dumped in unauthorized areas, shall be removed by Contractor, and area restored to condition of adjacent undisturbed areas. Where directed, contaminated ground shall be excavated, disposed of as approved, and replaced with suitable fill materials, all at expense of Contractor.

B. Contractor shall provide a means of collecting and removing all debris, trash, and construction wastes from the site. Owner is not responsible for providing a dumpster.

C. Waste material and construction debris shall be disposed of at an appropriate off-site landfill.

1.14 BURNING

A. Burning of materials will not be allowed on site without prior approval by Owner.

B. Air pollution restrictions applicable to this Project shall conform to all Federal, State, and County regulations.

1.15 WORK LIMITS

A. Confine apparatus, equipment, storage of materials, and operation of workmen to limits indicated by law, ordinances, permits, or as directed by Owner.

B. Avoid unreasonably encumbering premises with materials or equipment.

C. Avoid interfering with Owner's operations.

D. Do not conduct construction activities that present a hazard to Owner's personnel and equipment or to the public.

E. Use existing roads whenever possible. Widening and/or improving existing dirt access roads may be conducted upon approval of Owner.

F. Minimize construction of new roads.

G. Keep site neat, tidy, and free of waste materials or rubbish.

H. If existing facilities become damaged by Contractor, Contractor shall pay all expenses to repair or replace such facilities to satisfaction of Owner, at no cost to Owner.

1.16 JOB TRAILERS

A. Contractor shall provide one (1) job trailer for this Project at the Project site.

1. Job Trailer shall be designated for Contractor and subcontractors and include sufficient area for a conference table to accommodate approximately 20 people.

2. Job Trailer will be used for project meetings for on-site personnel, including representatives of Owner, CM, and Engineer.

3. Contractor shall provide conference call equipment within the conference room area provided in Job Trailer. It is Contractor's responsibility to procure and make available to all personnel assigned to Project, including Owner, CM, and Engineer's representative, a conference call service to be utilized for duration of Project.

B. Contractor shall provide one (1) job trailer, separate from the Contractor's trailer and for exclusive use by the Owner, CM, and Engineer, for this Project. Trailer shall be a minimum of 200 square feet of floor space, have a linoleum or tiled floor, and have at least one enclosed office room and one additional common room. Contractor shall meet following requirements for Owner/CM/Engineer job trailer:

1. Trailer shall be watertight and weatherproof.

2. Trailer shall include screened windows and a solid door with a lock and three keys.

3. Trailer shall be provided with electrical services for the duration of the Project.

4. Trailer shall have the necessary equipment to maintain a temperature of 72 degrees Fahrenheit under all conditions.

5. Trailer shall have sanitary facilities, and fresh drinking water (bottled or water cooler).

6. Trailer shall be equipped, at a minimum, with the following:

   a. Three (3) 30-inch by 60-inch desks with drawers, two (2) lockable file cabinets and three (3) padded office chairs.

   b. One (1) 42-inch by 72-inch drafting table with stool.

   c. One (1) 8-foot table.

   d. Six (6) additional chairs.

   e. One (1) 6-foot by 3-foot (minimum dimensions) steel utility shelving, assembled.

   f. One (1) 4-foot by 6-foot wall mounted dry erase board.

   g. One (1) clothes rack or closet with hangers.

   h. One (1) first aid kit.

   i. One (1) fire extinguisher, non-toxic, dry chemical, meeting U.L. for Classes A, B, and C fires.

   j. Two (2) wastepaper baskets.

   k. Two (2) recycle bins.

   l. One (1) refrigerator with a minimum of 3 cubic feet of freezer space.

   m. One (1) microwave oven.

7. Trailer shall be set up, equipped, and made ready for use prior to beginning of other Work on Project, and shall remain for at least seven (7) days after final acceptance of Work or until all field records pertinent to Project have been completed. Trailer shall be maintained in good condition and appearance by Contractor for duration of Project and shall then be removed upon satisfaction of above-listed requirements.

C. Contractor shall provide buildings or shelters for material and supply storage for protection against elements, theft or other damage at site as required. Provide buildings of sufficient size and so arranged or partitioned to provide security for their contents and provide ready access for inspection and inventory.

1.17 TEMPORARY LIGHTING

A. Contractor shall provide and maintain lighting for general construction purposes, as necessary.

B. Contractor shall provide and maintain lighting for general safety at 24-hour manned pump locations, hazards adjacent to access roads and as otherwise necessary.

1.18 TEMPORARY TOILETS

A. Provide adequate chemical toilet and hand washing facilities for all personnel and visitors. Number of facilities shall be a minimum of two or as required by federal and state Safety and Occupational Standards for total number of personnel on-site plus two Owner's or Engineer's representatives, whichever is greater.

B. Keep toilets in sanitary condition and schedule routine maintenance.

C. Remove toilet facilities upon completion of the Work and disinfect the premises.

1.19 PETROLEUM PRODUCTS

A. Contractor is responsible for providing their own fuel and dispensing equipment/service.

B. Store and dispense fuel, lubricating oils, and chemicals in such a manner as to prevent or contain spills, and prevent said materials from reaching local streams or groundwater. Portable fuel storage tanks shall have secondary containment sufficient to contain 125% of contents. Petroleum storage facilities shall be appropriately marked with signs and placards. Contractor is responsible for obtaining any necessary permits and preparing any necessary plans, such as Spill Prevention Control and Countermeasures (SPCC) Plan, associated with petroleum products.

C. Contractor shall fuel construction equipment from portable storage tanks and/or tanker trucks in a location and manner so as to prevent spill and run-off of fuel during fuel transfer.

D. In the event a petroleum product spill occurs, Contractor shall notify Owner immediately. Owner/Contractor shall then discuss requirements and responsibility for reporting spill to the appropriate authorities.

E. Dispose of waste in accordance with State and local regulations.

F. Keep Material Safety Data Sheets (MSDS) on file at the site for all petroleum products and other hazardous materials. All MSDS sheets must be submitted to Owner per the Four Corners Power Plant site specific procedures.

1.20 SITE SECURITY

A. Contractor is responsible for security of equipment and products on-site. Provide temporary fencing to secure Work area.

B. Contractor shall provide phone communications necessary for emergency contact.

1.21 PHONE

A. Contractor is responsible for provide land-line telephone service for entire period from start of construction to final completion. Coordinate supply of phone service with Owner.

1.22 RAIN GAUGE AND WEATHER MONITORING

A. Contractor is responsible for provide a rain gauge and weather monitoring equipment to track rain events for SWPPP compliance, for reporting weather conditions in daily field reports, or for other activities as necessary.

1.23 POST-CONSTRUCTION CLEAN-UP OR OBLITERATION

A. Contractor shall, unless otherwise instructed in writing by Owner, obliterate all signs of temporary construction facilities, such as haul roads, work areas, service areas, structures, stockpiles of excess or waste materials and other vestiges of construction prior to final acceptance of the Work.

1.24 CLEAN-UP

A. During the Work, Contractor shall be responsible on a daily basis sanitary and physical cleanliness of area affected by its Work. All debris, tools, hoses, ladders, and unused construction materials shall be gathered up by end of each shift, and wasted or stored in proper areas.

B. Because other Contractors are working concurrently and since Plant maintenance and overhaul Work is being done 24 hours a day, it is mandatory that these Work areas be kept continuously clean and orderly to prevent accidents or unwarranted use of material, tools, etc. that are for use in the Work.

C. Upon completion of the Work, area shall be cleared of all equipment, surplus material, and debris; such material shall be disposed of in manner approved by Owner.

D. Contractor's Work shall be subject to stoppage by Owner if Contractor does not correct any "housekeeping" deficiencies or violations to satisfaction of Owner within 24 hours of receipt from notification of such deficiencies or violations.

E. Contractor shall provide a means of collecting and removing all debris, trash, and construction rubble from the site. Owner is not responsible for providing a dumpster.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

(Not Used)

END OF SECTION

SECTION 01 57 23

CONSTRUCTION SWPPP

PART 1 - GENERAL

1.01 SUMMARY DESCRIPTION

A. This section summarizes general requirements of Construction Storm Water Pollution Prevention Plan (SWPPP). Contractor shall comply with terms and conditions of National Pollutant Discharge Elimination System (NPDES) General Permit for Storm water Discharges for Construction General Permit Activity (Construction General Permit) as regulated by Environmental Protection Agency (EPA). Under provisions of that permit, Contractor is designated as "Permittee" and responsible for providing necessary material and for taking appropriate measures to minimize pollutants in storm water runoff from the Project. Contractor shall obtain a permit for any discharge that is to Waters of the U.S., and comply with the requirements of permit. Intent of the Construction SWPPP on this Project will be to minimize potential of sediment (impacted and non-impacted) from leaving the site using reasonable engineering controls.

B. Contractor shall include all material, labor, equipment and other permits and incidental costs related to:

1. Preparing, updating and revising the SWPPP.

2. Installing and maintaining all structural and non-structural items chosen by Contractor to comply with the construction SWPPP.

3. Clean-up and disposal costs associated with clean-up and repair following storm events or Contractor caused spills on the Project.

4. Implementing and maintaining Best Management Practices (BMP) as approved by Engineer and Owner.

5. Filing the Notice of Intent (NOI) and Notice of Termination (NOT) in accordance with the NPDES General Permit.

C. All necessary SWPPP controls and BMPs must be implemented prior to commencement of any construction activity.

1.02 SUBMITTALS

A. Submit to Engineer and Owner, no later than ten (10) working days before submitting to EPA the following:

1. NOI to be covered by NPDES General Permit, including certifications of signature.

2. SWPPP for the Project, including certification of signature. Plan shall include Contractor's proposed temporary means for storm water control during all phases of construction and include storm water pumping/retention plans, and other site BMP's for pollution prevention.

B. Submit, at least 2 weeks prior to mobilization; completed and signed NOI form to EPA, Region 9.C. Submit to Engineer, as part of the Construction SWPPP a construction site inspection report template that includes the following:

1. Inspection scope.

2. Inspector qualifications.

3. Observations of SWPPP non-compliance and corrective steps taken.

4. Certificate of Compliance with SWPPP and the NPDES General Permit for Storm water Discharge in the event of no incidents.

C. Submit site inspection reports each month, at a minimum, throughout the Contract duration.

D. Submit to Engineer, upon Project completion the Notice of Termination (NOT) of coverage under NPDES General Permit.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

3.01 GENERAL

A. The SWPPP must be prepared and maintained according to current NPDES requirements to obtain NPDES permit coverage for storm water discharges.

B. Plan shall be implemented at beginning of the Project and maintained throughout Project until final acceptance is granted by Owner.

C. Contractor's work activities shall not interfere with or compromise SWPPP controls at any time.

D. Contractor's approach to Work and methodologies shall minimize downstream impact from sediment.

END OF SECTION

SECTION 01 57 26

DUST CONTROL

PART 1 - GENERAL

1.01 SUMMARY DESCRIPTION

A. Contractor shall conduct operations and maintain the Project site so as to minimize generation and dispersion of dust. Visible dust criterion may suggest safety and health hazards are present. Specific elevated air sampling results for particulate shall require implementation of dust control.

1.02 SUBMITTALS

A. Submit, within 2 weeks after receipt of Notice to Proceed, a Dust Control Plan. Plan shall include equipment, materials, and methods to control and suppress general dust particulates in accordance with the Contract Documents.

1.03 APPLICABLE STANDARDS

A. OSHA, Department of Labor; 29 CFR Part 1926 – Safety and Health Regulations for Construction.

PART 2 - PRODUCTS

2.01 WATER

A. Contractor shall provide a construction water supply source for dust control in accordance with Section 01 50 00, “Temporary Facilities and Controls”.

2.02 SUPPRESSANTS

A. Contractor shall obtain Engineer’s approval prior to use of any suppressant other than water for dust control. Contractor shall provide details of manufacturer recommendation as to rate of application (sample submittal, manufacturer technical literature).

PART 3 - EXECUTION

3.01 EARTHWORK

A. Contractor shall provide dust control during demolition activities.

B. When applying water for dust control, use equipment consisting of one or more hand held hoses, trucks equipped with spray bars, or truck-mounted water cannons with adjustable spray nozzle. Spray must provide complete coverage to wet the disturbed area. Other methods proposed for controlling the application of water shall be approved by Engineer.

C. If dust control measures are implemented and generation of dust persists, Contractor shall implement additional dust control measures in accordance with OSHA guidelines.

3.02 HAUL ROADS

A. Contractor shall implement dust control means to minimize or suppress airborne dust clouds created by operation of heavy equipment and trucks.

B. Dust Control of the Ash Haul Road will be the responsibility of the Ash Haul Contractor. All other site access roads used by Contractor shall be controlled for dust by Contractor.

C. Controls shall consist of one or more of the following controls:

1. Routine water application by mobile water trucks

2. Environmentally safe dust suppressants

3. Gravels

D. Contractor may use alternate methods of dust control upon approval by Engineer.

END OF SECTION

SECTION 01 60 00

PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY DESCRIPTION

A. This section covers procurement, documentation, and warranty information for all permanent materials and equipment furnished by Contractor.

1.02 SUBMITTALS

A. Product Data or Shop Drawings for all materials and equipment provided or installed shall be submitted according Section 01 33 00 Submittals.

B. Submit all Requests for Substitution within 14 days of Notice to Proceed.

1.03 SECTION INCLUDES

A. Transportation and Handling

B. Storage and Protection

C. Product Options

D. Substitutions

E. Spare Parts

1.04 TRANSPORTATION AND HANDLING

A. Transport and handle products in accordance with Manufacturer's instructions.

B. Promptly inspect shipments to assure that products comply with requirements, product quantities are correct, and products are undamaged.

C. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage.

D. Contractor has total responsibility to schedule, follow up, and prepare for delivery, off-loading, and storage of materials. Mishandled and/or damaged materials will be rejected by Owner at Contractor's expense.

1.05 STORAGE AND PROTECTION

A. Indoor storage for materials and equipment will not be provided by Owner. Contractor shall supply appropriate facilities for proper storage of all materials and equipment.

B. Store and protect products in accordance with Manufacturer's instructions, with seals and labels intact and legible.

C. For exterior storage of fabricated products, place on sloped supports, above ground.

D. Cover products subject to deterioration from ultraviolet light or weather with impervious sheet covering.

E. Provide ventilation to avoid condensation.

F. Store loose granular materials on solid flat surfaces in a well-drained area and prohibit mixing with foreign matter.

G. Arrange storage of products to allow access for inspection.

H. Periodically inspect to assure products are undamaged and are maintained under specified conditions.

I. Do not stack geosynthetic materials more than two high to maintain integrity of product and allow for safe inspection of lot/roll numbers.

1.06 PRODUCT OPTIONS

A. Products specified by reference standards or by description only:

1. Any product meeting those standards or description.

B. Products specified by naming one or more manufacturers:

1. Products of manufacturers named and meeting Specifications. No options or substitutions allowed.

C. Products specified by naming one or more manufacturers with a provision for substitutions:

1. Submit a Request for Substitution for any manufacturer not named.

1.07 SUBSTITUTIONS

A. Engineer will consider requests for substitutions only within fifteen (15) days after the Notice to Proceed.

B. Substitutions may be considered when a product becomes unavailable through no fault of Contractor.

C. Substitution Submittal Procedure:

1. Submit electronically a Request for Substitution for each item. Limit each request to one proposed substitution.

2. Submit shop drawings, product data, and certified test results attesting to proposed product equivalence. All deviations from Specifications or specified product(s) must be noted. Request for Substitutions that contain deviations from Specifications that are not noted may be rejected immediately without further review.

3. Submit statement from manufacturer on manufacturer's letterhead that product is suitable for intended purpose.

4. Engineer will respond, in writing, of decision to accept or reject request. Typically this response will be provided within 14 days of request.

1.08 SPARE PARTS:

A. Provide spare parts for Products as specified in individual technical specification sections.

B. Pack spare parts to protect them during storage. Tag spare parts and containers to clearly identify them in accordance with Contractor's parts numbering system as reviewed by Engineer's Representative. All parts shall be cross-referenced to their applicable Specification Section.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

(Not Used)

END OF SECTION

SECTION 01 71 13

MOBILIZATION

PART 1 - GENERAL

1.01 SUMMARY DESCRIPTION

A. This section provides general requirements for mobilization and demobilization to the Project site.

1.02 SUBMITTALS

A. Contractor shall prepare a written Mobilization Plan within 14 days of Notice to Proceed that includes equipment list and schedule for mobilization, laydown yards for materials and supplies, temporary trailers, construction water retention ponds and/or tanks, etc. Plan should include at least one drawing showing locations. Plan will be reviewed by Owner, CM, and Engineer for approval.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

3.01 GENERAL

A. Upon receipt of notice to proceed (within the time limit as required by Contract Agreement), Contractor shall furnish, mobilize, and materials, equipment, temporary facilities, and construction plants (of which are either explicitly identified in these Specifications or at Contractor's discretion and approach) as are necessary for successful completion of the Work. Mobilization as defined by the Contract shall also mean Contractor is on-site with sufficient quantity of labor and operators to commence Work.

B. Contractor shall also install, operate, and maintain temporary works and equipment throughout the period of construction. All applicable temporary works, such as sanitation facilities, shall fully comply with rules and regulations of Owner, plant, and/or government agency having jurisdiction. Equipment for clearing, grading, earthwork, and construction of access roads necessary for temporary works, if any, shall be included as mobilization.

C. As required by Owner, Contractor shall also obtain any permits (heavy haul, air emissions, dust, etc.) necessary to complete the Work prior to mobilization.

D. Contractor shall include as part of mobilization, all typical and special equipment that is reasonably identified as necessary to complete the work. Contractor shall exercise diligence in identifying and mobilizing correct piece(s) of equipment to perform work as intended and within schedule.

E. Contractor shall coordinate location of each temporary facility, equipment yard, and material laydown area with Owner prior to mobilization.

F. Contractor shall provide Owner with a list of all materials/chemical to be brought on-site along with chemical Safety Data Sheets (SDSs). All materials/chemicals shall be pre-approved by Owner prior to mobilization to the site.

G. Demobilization by Contractor or its subcontractors shall not be allowed until the punch list at the end of the project has been satisfied by Owner, CM, and Engineer and a final walk-through and acceptance of work has been conducted. Once Owner acceptance is obtained by Contractor, Contractor shall completely demobilize from the site within 14 days.

END OF SECTION

SECTION 01 77 00

CONTRACT CLOSEOUT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:

1. Substantial Completion procedures.

2. Starting and testing of systems.

3. Required record documents.

4. Final completion procedures.

5. Warranties.

6. Final cleaning.

7. Repair of the Work.

8. Specific closeout and special cleaning requirements for the Work in those Sections.

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00, “Submittals”.

1. Product Data: For cleaning agents.

2. Contractor's List of Incomplete Items: Initial submittal at Substantial Completion.

3. Certified List of Incomplete Items: Final submittal at Final Completion.

4. Certificate of Insurance: For continuing coverage.

5. Schedule of Maintenance Material Items: For maintenance material submittal items specified in other Sections.

1.04 SUBSTANTIAL COMPLETION PROCEDURES:

A. Contractor's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's punch list), indicating value of each item on the list and reasons why the Work is incomplete.

B. Submittals Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.

1. Submit closeout submittals specified in other Division 01 Sections, including project record (as-built) documents, operation and maintenance manuals, final completion construction photographic documentation, damage or settlement surveys, land surveys, and similar final record information.

2. Submit closeout submittals specified in individual Divisions 02 through 40 Sections, including specific warranties, maintenance service agreements, final certifications, and similar documents.

3. Submit maintenance material submittals specified in individual Divisions 02 through 40 Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Owner.

a. Schedule of Maintenance Material Items: Prepare and submit schedule of maintenance material submittal items, including name and quantity of each item and name and number of related Specification Section. Obtain Engineer's signature for receipt of submittals.

4. Submit test/adjust/balance records.

5. Submit changeover information related to Owner's operation and maintenance.

C. Procedures Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.

1. Advise Owner of pending insurance changeover requirements.

2. Complete startup and testing of systems and equipment.

3. Perform preventive maintenance on equipment used prior to Substantial Completion.

4. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems.

5. Terminate and remove temporary facilities from Project site, along with construction tools, and similar elements.

6. Remove labels that are not permanent labels.

7. Complete final cleaning requirements, including touchup painting.

8. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.

9. Provide complete set of Record (As-builts) Drawings to the Owner and Engineer.

D. Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of 10 days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Engineer, that must be completed or corrected before certificate will be issued.

1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

2. Results of completed inspection will form the basis of requirements for final completion.

1.05 STARTING OF SYSTEMS:

A. Conform to the requirements of Sections 01 78 23, “Operation and Maintenance Data” and 01 78 25, “Plant Testing Startup and Commissioning”.

B. Coordinate schedule for start-up of various equipment and systems. Notify Owner, CM, and Engineer 7 days prior to start-up of each item.

C. Verify each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, and for conditions which may cause damage. Verify tests, meter readings, and specified electrical characteristics agree with those required by equipment or system manufacturer. Verify wiring and support components for equipment are complete and tested.

D. Execute start-up under supervision of applicable manufacturer's representative in accordance with manufacturers’ instructions. When specified in individual specification Sections, require manufacturer to provide authorized representative to be present at site to inspect, check, approve equipment or system installation prior to start-up, to supervise placing equipment or system in operation, and to train the Owner’s staff.

E. Submit a written report in accordance with Section 01 33 00, “Submittals” that equipment or system has been properly installed and is functioning correctly.

1.06 DEMONSTRATION AND INSTRUCTIONS:

A. Conform to the requirements of Sections 01 78 23, “Operation and Maintenance Data” and 01 78 25, “Plant Testing Startup and Commissioning”.

B. Utilize operation and maintenance manuals as basis for instruction. Review contents of manual with Owner's personnel in detail to explain all aspects of operation and maintenance. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment at agreed time, at equipment location. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.

1.07 TESTING, ADJUSTING AND BALANCING:

A. Contractor shall appoint, employ, and pay for services required by independent firm(s) to perform testing, adjusting, and balancing of newly installed equipment. Adjust operating equipment to ensure smooth and unhindered operation.

B. Provide reports to Owner and Engineer indicating observations and results of tests and indicating compliance or non-compliance with requirements of Contract Documents.

1.08 PROJECT RECORDS DOCUMENTS

A. Contractor shall record any actual revisions to the Work and maintain one set of the following Project Record (as-builts) Documents on Site:

1. Contract drawings, specifications, and addenda.

2. Change orders, field orders, and other written notices.

3. Shop drawings, product data, and samples.

4. Records of surveying and layout Work.

5. Project record drawings.

B. Contractor shall record information on Project Record Documents concurrent with construction progress and store these documents separately from documents used for construction.

1. Owner will supply a set of Contract Drawings. Contractor shall mark thereon all revisions as the Work progresses in order to produce a set of as-bulit drawings. Contractor shall note any changes made during construction by any of Contractor's forces or those of any Subcontractors.

2. Contractor shall dimension the locations of buried or concealed Work, especially piping and conduit, with reference to exposed structures. Contractor shall dimension installed locations of concealed service lines on the Site or within structure by reference from the centre line of the service to the structure column

lines, or other main finished faces, or other structural points which are easily identified and located in the finished Work.

3. Certificates of Substantial Completion shall not be issued until as-built drawings are complete and submitted, and Contractor has satisfied all requirements for Substantial Completion of the Work.

C. For Project Record Documents and Record Shop Drawings, Contractor shall legibly mark each item to record actual construction including:

1. Field changes of dimensions and details. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements. Measured locations of internal utilities and appurtenances which are concealed in construction, referenced to visible and accessible features of the Work. Record location of concealed mechanical services and electrical main feeders, junction boxes and pullboxes.

2. Changes in the Work caused by Site conditions, or originated by Owner, Engineer, Contractor, Preselected Equipment Vendors, or Subcontractors and by addenda, supplemental drawings, Site instructions, supplementary instructions, change orders, correspondence, and directions of any regulatory authorities.

D. Upon completion of the Work, Contractor shall prepare two CD-ROM sets of Record Documents, Record Shop Drawings, and an index in an electronic format compatible with plant CD-ROM record standards. All record drawings are to be provided electronically in both AutoCAD (version 2016 or earlier) and Adobe Acrobat PDF (latest version). CD-ROM index shall identify the Owner's project number, project name, and Contract number and contents of each CD in the following format:

1. Index shall include the following columns of information for each Record Shop Drawing:

a. CD number.

b. Specification Section number.

c. Specification title.

d. Shop drawing transmittal number.

e. Shop drawing equipment description including Preselected Equipment Vendor and Supplier.

2. Index shall be generated using Microsoft Excel software. A copy of the electronic file shall be furnished to Owner.

3. Contractor shall remove Engineer seal from all documents.

E. Submit Record Documents to Engineer as defined in Section 01 33 00.

1.09 EQUIPMENT INVENTORY SPREADSHEET

A. As part of Owner's asset management program, Contractor shall complete all fields for equipment inventory file for each piece of equipment and device provided under this Contract, as a requirement for Substantial Completion. Owner will provide an electronic format of the equipment inventory spreadsheet on a CD to Contractor.

1.10 EQUIPMENT PREVENTATIVE MAINTENANCE SPREADSHEET

A. As part of Owner's asset management program, Contractor shall complete all fields for each piece of equipment and device provided under this Contract, as a requirement for Substantial Completion. Contractor shall transfer all of manufacturer's recommended preventative maintenance tasks and frequencies into the spreadsheet. Owner will provide an electronic format of the equipment inventory spreadsheet on a CD to Contractor.

1.11 PROTECTING INSTALLED CONSTRUCTION:

A. Protect installed Work and provide special protection where specified in individual specification sections. Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.

1.12 SPARE PARTS AND MAINTENANCE PRODUCTS:

A. Furnish spare parts, maintenance, and extra products in quantities specified in individual specification sections. Deliver to Project site and place in location as directed by Owner.

B. Coat parts to protect from moisture.

C. Crate in containers designed for prolonged storage suitable for handling with hoisting equipment containers: palletized.

D. Stencil on containers:

1. Manufacturer/supplier name.

2. Unit name.

3. Spare part name.

4. Manufacturer catalogue number.

5. Other identifying information.

6. Precautionary information.

1.13 FINAL COMPLETION PROCEDURES:

A. Submittals Prior to Final Completion: Before requesting final inspection for determining final completion, complete the following:

1. Submit a final Application for Payment according to Section 01 20 00 "Price and Payment Procedures".

2. Certified List of Incomplete Items: Submit certified copy of Engineer's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Engineer. Certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance. Submit completed punch list to Engineer as defined in Section 01 33 00.

3. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.

B. Inspection: Submit a written request for final inspection to determine acceptance a minimum of 10 days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.

1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.14 LIST OF INCOMPLETE ITEMS (PUNCH LIST):

A. Organization of List: Include name and identification of each location and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.

1. Organize items applying to each location by major element, including categories for equipment and piping systems. Include the following information at the top of each page:

a. Project name.

b. Date.

c. Name of Engineer.

d. Name of Contractor.

e. Page number.

2. Submit list of incomplete items in the following format:

a. MS Excel electronic file. Engineer will return annotated file.

1.15 SUBMITTAL OF PROJECT WARRANTIES:

A. Time of Submittal: Submit written warranties on request of Engineer for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated, or when delay in submittal of warranties might limit Owner's rights under warranty.

B. Organize warranty documents into an orderly sequence based on the table of contents of Contract Documents.

1. Bind warranties in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, with thickness as necessary to accommodate contents. Identify each binder on the front and spine with typed or printed title "WARRANTIES," Project name, and name of Contractor.

2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of product or installation, including name of product and name, address, and telephone number of Installer.

C. Provide copies of each warranty to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

PART 3 - EXECUTION

3.01 FINAL CLEANING:

A. General: Perform final cleaning in accordance with other Sections.

B. Construction Waste Disposal: Comply with waste disposal requirements in accordance with Section 01 50 00, "Temporary Facilities and Controls".

3.02 REPAIR OF THE WORK:

A. Complete repair and restoration operations before requesting inspection for determination of Substantial Completion.

B. Repair or remove and replace defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.

1. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that that already show evidence of repair or restoration.

    a. Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates. Remove paint applied to required labels and identification.

2. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.

3.03 ADJUSTING:

A. Adjust operating products and equipment to ensure smooth and unhindered operation.

END OF SECTION

SECTION 01 78 23

OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Section includes procedural requirements for providing, compiling, and submitting operation and maintenance data required for this project.

1.02 SUMMARY:

A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:

1. General contents of data.

2. Specific data for each equipment and system.

3. Assembly.

1.03 DEFINITIONS:

A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.

B. Subsystem: A portion of a system with characteristics similar to a system.

1.04 SUBMITTALS:

A. O&M Manual Content: Operations and maintenance manual submittal requirements are specified in individual Specification Sections for the Products for which they must be supplied. Submit reviewed manual content formatted and organized by this Section and as defined in Section 01 33 00. Engineer will comment on whether content of operations and maintenance submittals are acceptable. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.

B. Initial O&M Manual: Submit draft copy of each manual as defined in Section 01 33 00. Engineer will comment on whether general scope and content of manual are acceptable.

C. Pre-Final Manual Submittal: Submit 2 copies of each manual in final form prior to requesting inspection for Substantial Completion and as defined in Section 01 33 00. Engineer will return one copy with comments. Contractor to correct or revise each manual to comply with Engineer’s comments.

D. Submit four (4) copies of each corrected manual as a final manual within 15 days of receipt of Engineer’s comments and prior to commencing startup, commissioning, and/or training.

E. After acceptance, deliver one electronic copy to Engineer.

1.05 FORMAT (HARDCOPY):

A. Prepare data in the form of an O&M instructional manual.

B. Binders: Commercial quality, 8-1/2 x 11-inch three-hole post type binders with hardback, 3-inch maximum binder size. When multiple binders are used, correlate data into related consistent groupings. Three ring binders are not acceptable.

C. Arrange contents by Specification Section numbers and sequence of Table of Contents of this Project Manual.

D. Provide tabbed fly leaf for each separate product and system, with printed description of product and major component parts of equipment. Insert type tab labels must be secured or bonded to prevent the labels from falling out.

E. Text: Manufacturer's printed data, or typewritten data on 20 pound paper.

F. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages and insert into clear plastic envelopes that can be secured into the three-hole post binders.

1.06 FORMAT (ELECTRONIC DOCUMENTATION):

A. Contractor must provide Operation and Maintenance Manual information specific to the configuration of the project in electronic form. Documents should be formatted like a web site complete with index page and Table of Contents. The electronic format must be such that Owner is able to load files onto a server to provide online access via any standard web browser. Contractor shall make use of HTML (for text based documents) and PDF (for CAD type drawings) file formats. Complete document shall be provided on a CD.

B. Electronic O&M data must be organized in a logical manner to aid operations in troubleshooting and information retrieval.

1.07 QUALITY ASSURANCE:

A. Preparation of data shall be performed by personnel trained and experienced in O&M of described equipment, familiar with requirements of this section, skilled as technical writers to extent required to communicate essential data to Reader.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

3.01 GENERAL CONTENTS OF DATA:

A. Each individual manual shall contain equipment data pertaining to not more than one Specification section number as indicated in the Contract Documents.

B. Title Sheet: First page in data listing following:

1. Title: "OPERATION AND MAINTENANCE INSTRUCTIONS".

2. Title of Project: As shown on Contract Documents.

3. Name(s) of applicable structure(s) in which equipment is located.

4. Name of equipment as described in Contract Documents.

5. Contractor's name, address, and telephone number.

6. Subcontractor's name, address, and telephone number if equipment is provided by Subcontractor.

7. Contractor's or Subcontractor's purchase order number, manufacturer's shop order number or other such numbers required for parts and service ordering.

8. Manufacturer's name, address, and telephone number.

9. Name, address, and telephone number for local source of supply for parts and service.

C. Equipment List: Immediately following title sheet containing the following:

1. Table of Contents: Immediately following equipment list. Arrange in logical, systematic order and shall include as minimum each tabbed divider. Each page shall be numbered.

2. Tabbed Dividers: Insert tabbed section dividers between each major section

a. Provide title of section on each tab.

b. Provide table of contents for each tabbed section, arranged in systematic order.

3. Equipment Data Sheets: Provide catalog sheets showing configuration, manufacturer's specifications, models, options, and styles of equipment and major components being provided. Product data sheets will show project specific information with inapplicable information deleted by crossing out or removal. Include in tabbed section(s).

4. Text:

   a. Include only those sheets applicable to Project.

   b. Each sheet shall:

      (1) Identify specific equipment or part installed.

      (2) Identify text applicable to equipment or part installed.

      (3) Do not include inapplicable information or neatly strike it out.

5. Drawings:

   a. Supplement text with drawings to clearly illustrate following:

      (1) Equipment and components.

      (2) Relations of component parts of equipment and systems.

      (3) Control and flow diagrams.

   b. Actual drawings of equipment from manufacturer. "Typical" drawings are not acceptable, unless they accurately illustrate actual installation for this contract.

6. Specially written information, as required to supplement text for particular installation.

   a. Provide explanation of interrelationships of equipment and components, and effects one component has on another or entire system.

   b. Provide overall instructions and procedures for equipment tying in instructions and procedures for separate components into unified instructional package.

   c. Provide glossary of any special terms used by the manufacturer if applicable.

   d. Organize in consistent format under separate headings for different O&M procedures.

   e. Provide logical sequence of instructions in order of O&M action required for each procedure.

3.02 SPECIFIC DATA FOR EACH ITEM OF EQUIPMENT AND/OR SYSTEM:

A. For each item of equipment and system include:

1. Completed Equipment Data Form typewritten on copy of Form 01 78 23-1. An electronic copy of Form 01 78 23-1 will be provided to the contractor.

2. Description of equipment and component parts:

    a. Function

    b. Normal operating characteristics

    c. Limiting conditions.

    d. Performance curves

    e. Engineering data

    f. Test as applicable.

    g. Complete nomenclature and model number of replaceable parts including keyed labeled exploded diagram.

    h. Complete nameplate data.

    i. Owner’s tag (or asset) numbers for equipment as indicated on the Contract Drawings.

3. Operating Procedures:

    a. Startup and break-in.

    b. Normal operating instructions.

    c. Regulation and control

    d. Stopping and shutdown,

    e. Emergency instructions.

    f. Summer and winter operating instructions, as applicable.

    g. Special operating instructions.

4. Maintenance Procedures:

    a. Routine maintenance operations.

    b. Guide to troubleshooting.

    c. Disassembly, repair, and reassembly instructions.

    d. Alignment, adjusting, and checking instructions.

5. Servicing and Lubrication Schedule:

    a. List of lubricants required and quantity to be applied.

b. Schedule of lubrication.

c. Schedule for other routine maintenance.

6. Manufacturer's printed instructions regarding safety precautions for both (a) protection of personnel operating equipment and systems and (b) prevention of damage to equipment and systems.

7. Description of sequence of operation of controls.

8. Assembly drawings and diagrams required for maintenance.

9. Manufacturer's parts list and illustrations

a. Predicted life of parts subject to wear.

b. Items recommended to be stocked by Owner as spare parts and quantities of same.

10. Accepted control diagrams such as ladder diagrams, instrumentation loop diagrams, and electrical schematics.

11. Bill of material.

12. Other data as required under applicable Specification sections.

B. Each electric and electronic system, as applicable to equipment such as switchgear, motor control centers, panel boards, switchboards, starters, breakers, and relays shall include:

1. Description of System and Component Parts:

a. Function

b. Normal operating characteristics

c. Limiting conditions.

d. Performance curves

e. Engineering data

f. Rating tables

g. Tests, as applicable.

h. Complete nomenclature and model number of replaceable parts.

i. Complete nameplate data.

j. Owner's Tag (asset) numbers for equipment as indicated on Contract Drawings.

2. Circuit Directories of Panel Boards:

a. Electrical service.

b. Controls.

c. Communications.

3. Complete instrumentation, as applicable:

a. Loop diagrams

b. Tabulated listing of components in each control circuit or loop.

4. Operating Procedures:

a. Routine and normal operating instructions.

b. Sequences required.

c. Special operating instructions.

5. Maintenance Procedures:

a. Routine maintenance operations.

b. Guide to troubleshooting.

c. Disassembly, repair, and reassembly instructions.

d. Adjustment and checking instructions.

6. Manufacturer's printed instructions regarding safety precautions for both: (a) protection of personnel operating equipment and systems and (b) prevention of damage to equipment and systems.

7. List of original all of manufacturer's components, spare parts with diagram, and recommended quantities to be maintained in storage by Owner.

8. Other data as required under pertinent sections of Specifications.

C. Prepare and include additional data when need for such data becomes apparent during instruction of Owner's personnel. Differences between the equipment O&M manual and manufacturers training session shall result in training and/or O&M Manual being corrected.

3.03 ASSEMBLY:

A. Assemble in four (4) sets.

B. Remove bindings of individual manuals.

C. Insert index tabs labeled with the respective piece of equipment to separate individual manuals.

D. Provide a Table of Contents at the front of each volume showing equipment items in order in which they appear in the volume. Each equipment items shall include functional name, applicable specifications section, and the plan listing, if any.

E. Preventive maintenance schedule shall be bound in front of each section immediately following index tab sheet. Schedule shall be identified with respect to piece of equipment it is referring to.

F. Sheet Size: 8-1/2 x 11 sheets.

G. Drawings may be on 11 x 17-inch sheets folded to 8-1/2 x 11 inches.

H. Inscribe on covers and end of binder, title OPERATIONS AND MAINTENANCE INSTRUCTIONS, name of Project, Owner's project number, date of Contract, and volume number with subject matter of contents, and Engineer's name.

FORM 01 78 23-1 Page 1 of 4 EQUIPMENT DATA FORM				
PROJECT NAME				
CONTRACT NO.				
CONTRACTOR				
EQUIPMENT NO.			ASSET NO.*	
DESCRIPTION			MAINT. NO.*	
LOCATION				
MANUFACTURER				
PURCHASED FROM				
VENDOR ORDER NO.			PURCHASE $	
DATE OF PURCHASE				
LOCAL SUPPLIER				
ADDRESS				
PHONE NO.				
MODEL NO.				
NO. OF UNITS		SERIAL NOS.		
*By Owner				

FORM 01 78 23-1 Page 2 of 4
EQUIPMENT DATA FORM

NAMEPLATE DATA			
ELECTRIC MOTOR		PUMP/HVAC UNIT	
MANUFACTURER		MANUFACTURER	
TYPE	[ ] AC [ ] DC	TYPE	
HORSEPOWER		SIZE	
RPM		CAPACITY	
VOLTAGE		PRESSURE	
AMPERAGE		ROTATION	
PHASE		IMPELLER SIZE	
FRAME		IMPELLER MATERIAL	
DRIVE/REDUCER		OTHER (I&C)	
MANUFACTURER		MANUFACTURER	
	[ ] GEAR	TYPE	
	[ ] V-BELT [ ] CHAIN		
TYPE	[ ] VARIDRIVE	SIZE	
SERVICE FACTOR		CAPACITY	
RATIO		RANGE	

FORM 01 78 23-1 Page 3 of 4
EQUIPMENT DATA FORM

MAINTENANCE SUMMARY			
EQUIPMENT NO.		ASSET NO.*	
DESCRIPTION		MAINT. NO.*	
MAINTENANCE OPERATION:		FREQUENCY:	
List briefly each Maintenance Operation required and refer to specific information in Manufacturer's Manual, if applicable. Refer by symbol to "Lubricant List" for Lubrication Operation.		List required frequency of each maintenance operation.	
*By Owner			

FORM 01 78 23-1 Page 4 of 4
EQUIPMENT DATA FORM

LUBRICANT/RECOMMENDED SPARE PARTS LIST			
EQUIPMENT NO.		ASSET NO.*	
DESCRIPTION		MAINT. NO.*	

LUBRICANT LIST		
REFERENCE SYMBOL	LUBRICANT TYPE (MILITARY STANDARD)	RECOMMENDED LUBRICANT AND MANUFACTURER
List symbols in "Maintenance Operation" (Page 3).	List general lubricant type.	List specific lubricant name, viscosity, and manufacturer.

RECOMMENDED SPARE PARTS LIST				
PART NO. **	DESCRIPTION	UNIT	QUANTITY	UNIT COST

ADDITIONAL DATA AND REMARKS

* By Owner

** Identify parts provided by this contract with two asterisks.

Note: Attach additional sheets if necessary; identify each sheet at top with equipment number and description.

END OF SECTION

SECTION 01 78 25

PLANT TESTING, STARTUP AND COMMISSIONING

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide planning, functional completion testing, startup and commissioning as indicated and specified. Section includes:

1. Plant Checkout Plan

2. Functional Completion Testing

3. Startup

4. Commissioning

1.02 REFERENCES:

A. American Society of Mechanical Engineers (ASME): B31.1: Power Piping Code

1.03 DEFINITIONS:

A. Plant Checkout Plan (the Plan) incorporates all aspects of functional completion testing, startup, commissioning, and training to ensure facility operates properly and meets design intent and performance.

B. Functional Completion Testing is testing of equipment and unit process systems to confirm that construction and installation has been completed in anticipation of initial startup of equipment and unit process systems. Functional Completion Testing includes:

1. Physical Checkout shall be defined as process of physically inspecting products after they have been installed in the Work to determine if Products have been properly and completely installed, and are ready for Field and/or Functional Testing. Requirements for Physical Checkout are contained in pertinent technical spec(s) (if applicable) and in Paragraph 1.08 of this Section.

2. Field Testing shall be defined as testing that is performed by Contractor, with Supplier assistance, on Products after they have been installed in the Work, and after performance of physical checkout, for purpose of proving that tested Products meet requirements of pertinent technical specifications. Administrative and minimum technical requirements for field testing are specified in Paragraph 1.08 of this Section, while additional technical requirements are contained in PART 3 of pertinent technical specification(s). Test criteria are specified in Paragraph 1.08 of this Section.

C. Startup shall be defined as operation of equipment or unit process systems using clean water, air, or other fluids and gases as necessary to demonstrate operation of equipment or unit process systems with other equipment that is a part of process for Facility. Administrative and minimum technical requirements for startup are specified in Paragraph 1.09 of this Section, while additional technical requirements are contained in PART 3 of pertinent technical specification(s).

D. Commissioning shall be defined as operation of equipment or unit process systems using process liquids or process solids, plant support equipment, and plant utilities to demonstrate equipment or unit process systems are capable of processing water or wastewater at specified flows and conditions for a sustained period of operation as required by this section or equipment or unit process systems specifications. Administrative and minimum technical requirements for Commissioning are specified in Paragraph 1.10 of this Section, while additional technical requirements are contained in PART 3 of pertinent technical specification(s).

E. Testing and Checkout Coordinator shall be defined as person provided by Contractor to coordinate and oversee total spectrum of testing and inspection activities required by Contract Documents. Testing and Checkout Coordinator shall have been in responsible charge of two similar Projects in last four years.

1.04 ROLES AND RESPONSIBILITIES:

A. Contractor shall provide all outside services, materials, labor, supplies, test equipment and other items necessary to perform Plant Testing, Startup and Commissioning specified herein. In addition, Contractor shall arrange for and provide the participation or assistance of survey crews, quality control technicians, Supplier's representative(s), and required governmental agency representatives.

B. Contractor shall provide services of Supplier’s representative(s) as follows:

1. Assistance during installation as specified in PART 3 of pecifications in Division 2 through 40 and as specified herein.

2. Field Testing as specified in PART 3 of specifications in Divisions 2 through 40, and as specified herein.

3. Startup as specified in PART 3 of specifications in Divisions 2 through 40, and as specified herein.

4. Commissioning as specified in PART 3 of specifications in Divisions 2 through 40, and as specified herein.

C. Supplier's representative’s activities required by this Section are in addition to requirements for vendor training and other services specified elsewhere in Contract Documents. Timing for performance of these services is to be defined in Contractors Checkout Plan, specified herein.

D. Engineer will review and comment on Contractor's deliverables, participate in physical inspection activities, witness shop and field testing, witness functional testing, maintain permanent record of all testing results, and provide verification of conformance to specifications. Engineer's right to perform inspections, witness tests or monitor or assess the Work and activities does not relieve Contractor of its obligation to comply with requirements of Contract Documents nor does it imply completion of the Work.

1.05 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

1. Submit a Plant Checkout Plan for facility and a Functional Test Plan as defined in Section 01 33 00.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 43 00.

1. Preparation of plant checkout plan, functional completion testing and startup and commissioning shall be performed by personnel trained and experienced in O&M of the described equipment and familiar with requirements of this section.

1.07 PLANT CHECKOUT PLAN:

A. Contractor shall be responsible for preparing, coordinating, and executing the Plan.

1. Contractor shall use resources of equipment and unit process systems suppliers in this work, particularly for specific equipment and unit process systems.

2. An initial draft of the Plan shall be submitted as indicated here:

a. Initial draft Plan for Facility shall be completed and submitted by Contractor to Engineer for review as defined in Section 01 33 00. Engineer will require 45 days to review submittal and return with any exceptions noted.

b. Contractor shall incorporate Engineer's comments into revised Plan within 30 days of receiving comments, and reissue the Plan to Engineer and Owner.

c. Contractor shall regularly schedule meetings with Engineer and Owner to review and coordinate activities required by the Plan.

B. Contractor shall provide a dedicated field staff to support the Plan activities. A full-time Startup Manager shall be responsible for day to day activities and shall be primary contact with CM or Resident Engineer regarding Plan activities. Support staff shall include but not be limited to designated mechanical, electrical and instrumentation and control engineers and technicians, and operating staff.

C. The Plan shall define:

1. Logical and systematic performance of physical inspections, field and functional tests, startup, commissioning including:

   a. A chronological schedule of all testing and inspection activities.

   b. A checklist of all inspection and testing activities broken down by location, discipline, system, and device or item.

   c. All blank forms proposed by Contractor for verification or recording of the functional completion testing, startup, and commissioning.

   d. An index which cross references forms to their intended application(s).

   e. A list of all supplier certifications, including those required by applicable technical specifications. Provisions shall also be included for retesting, in event it is required.

2. A list of participants in functional completion testing, startup, and commissioning.

3. A list of special test equipment required for functional completion testing, startup, and commissioning.

4. Sources of test media (water, power, air. etc) for functional completion testing.

5. Proposed method of delivery of media to equipment to be tested during functional completion testing, startup, and commissioning.

6. Temporary or interim connections for sequencing of multiple units during functional completion testing, startup, and commissioning.

7. Ultimate disposal of test media after functional completion testing, startup, and commissioning.

D. Plan shall be reviewed by Engneer, modified or revised as necessary by Contractor, then re-reviewed by Engineer. Contractor shall continue to update the Plan, working in conjunction with Engineer, prior to start of the scheduled equipment checkout and functional testing activities as specified in Paragraph 1.08 herein. Each specific element of the plan must receive review or comment by Engineer, two weeks prior to actual commencement of testing as defined herein.

E. Contractor shall designate, in the Plan, a Testing and Checkout Coordinator, to coordinate and manage activities defined in the Plan.

1.08 FUNCTIONAL COMPLETION TESTING:

A. Functional Completion Testing shall be completed as construction and installation of equipment is completed to demonstrate that equipment is ready for equipment and unit process systems startup.

1. Functional Completion Testing shall be done in a coordinated manner based on the Plan prepared by Contractor. Owner's operating and maintenance staff shall be allowed to observe for purposes of familiarization and training. Additional witnesses, such as CM, may be present to represent Owner.

2. Functional Completion Testing procedures and documentation forms shall be developed by Contractor. Procedures shall include a listing of items inspected for Functional Completion Testing.

3. If any equipment or unit process systems do not meet Functional Completion Testing requirements, it shall be responsibility of Contractor and/or equipment suppliers to make necessary corrections or replacements and repeat test.

4. Equipment and unit process systems shall not be started up or put into service until Functional Completion Testing is completed as evidenced by a completed Functional Completion Testing certificate for equipment or subsystem.

5. Modifications to equipment and unit process systems required to meet Functional Completion Testing requirements shall be provided, and all retesting shall be performed at no additional cost to Owner.

6. A Functional Completion Testing Certificate shall be prepared by Contractor for each piece of equipment or unit process and submitted to Engineer and Owner for review.

1.09 STARTUP:

A. Startup activities for Facility shall not be initiated until the requirements of Functional Completion Testing are completed for equipment or unit process systems.

B. Requirements of this section shall be satisfactorily completed prior to beginning Commissioning for equipment and unit process systems.

C. Contractor shall be responsible for startup under direction of its Startup Manager. Owner's operating and maintenance staff shall be allowed to observe for purposes of familiarization and training. Additional witnesses, such as CM, may be present to represent Owner.

D. For equipment or unit process systems that do not meet the specified Startup requirements, it shall be the responsibility of Contractor and/or equipment or unit process systems suppliers to make necessary corrections or replacements and repeat Startup at no additional cost to Owner.

E. Startup Reports for each piece of equipment or unit process shall be completed and submitted by Contractor to Engineer and Owner for review as defined in Section 01 33 00.

F. Contractor shall not begin Commissioning until Startup certificate is completed and is submitted.

1.10 COMMISSIONING:

A. Commissioning activities for Facility shall not be initiated until requirements of Startup are completed for equipment or unit process systems.

B. Commissioning shall be used by Contractor and equipment or unit process suppliers to adjust, fine tune, modify and prepare tequipment or system for continuous operation.

1. Equipment shall not be operated without the guidance of qualified personnel having knowledge and experience necessary to conduct proper operation thereof and obtain valid results.

2. All required adjustments, tests, operation checks, and Startup and Commissioning activities shall be provided by qualified personnel.

3. Contractor shall be responsible for planning, supervising, and executing Startup and Commissioning of equipment and unit process systems with the assistance of equipment or unit process systems suppliers in accordance with the Plan.

C. For equipment or unit process systems that do not meet Commissioning requirements, it shall be responsibility of Contractor and/or equipment or unit process systems suppliers to make necessary corrections or replacements and repeat Commissioning at no additional cost to Owner.

D. Commissioning Certificates for each piece of equipment or unit process shall be completed and submitted by Contractor to Engineer and Owner for review as defined in Section 01 33 00.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

3.01 PLANT CHECKOUT PLAN:

A. Plan shall include the following items as a minimum:

1. Cover Sheet with Plant identification, title, date and other information as needed to properly identify the specific information for Facility.

2. Status and revisions sheet with appropriate dates and signatures spaces to document development and status of document.

3. Table of Contents including Appendix.

4. Equipment and systems descriptions with anticipated break down for individual startup activities. This section shall define individual "packages" for startup activities for equipment or unit process systems.

   a. Schedule of events for startup and other activities covered by the Plan. Schedule shall define dates for completing activities for equipment and unit process systems. Schedule shall be Contractor's best estimate of time sequence at time of issuance.

   b. Contractor shall submit monthly schedule updates to the Plan.

5. Sign-off sheets consisting of certification forms or completion reports required by specifications shall be included in the Plan. Standard forms shall be developed by Contactor for this purpose.

6. Reports, test results and other supporting data shall be collected by Contractor for documentation of specific details leading to certification or completion.

B. Following shall be included in functional completion testing, startup, and commissioning activities required by the Plan.

1. Four (4) Pumps and motors; two replacement pumps at Pond 3 Pump-house facility,and two pumps at Return Water Pond facility.

2. Two (2) Pumps and motors at sewer lift station facility.

3. Two (2) Pumps at the sideslope riser facilites.

4. All Valves and appurtenances associated with pumping systems.

5. All electrical systems associated with pumping systems.

3.02 FUNCTIONAL COMPLETION TESTING:

A. Provide 30 days written notice to Engineer for each functional completion test so that Engineer's Representative, may witness functional completion tests. Engineer's Representative may witness performance of any or all functional completion testing, at their option.

1. Testing shall be conducted in accordance with accepted Plan using applicable standard techniques reviewed by Engineer and Owner. Local and remote instrumentation may be used to record test data where it is determined devices have been calibrated and sufficient to obtain necessary data.

2. Contractor shall develop standard data sheets to document Functional Completion Testing requirements have been met for all equipment and unit process systems included in the Plan. As equipment testing is completed appropriate data sheet shall be completed and signed by responsible party and submitted to Engineer for review and acceptance. Data values shall be stated in the engineering units noted in equipment specifications.

3. A detailed Functional Completion Test plan shall be prepared and submitted to Engineer for review and comment as noted paragraph 1.08 above. Plan shall be prepared by Contractor in conjunction with equipment or subsystem supplier and shall become a part of overall Plan.

B. In event no reference to procedures is made, or no procedures for startup and commissioning are contained in a technical specification for following test parameters, the following shall be checkout requirements. Should these requirements conflict with Supplier's recommendations or in any way be less stringent than Supplier's requirements, they shall be superseded by Supplier's requirements for checkout testing.

1. Measurement of wearing ring clearances for all pumps requiring assembly, so equipped:

   a. Take two readings taken opposed to each other by 90 degrees.

   b. All measured clearances shall be within Supplier's specifications for new installations. Replace and recheck rings found to be out of round or out of specified tolerance.

2. Measurement of Impeller Bore for all pumps requiring assembly:

   a. Take two readings opposed to each other by 90 degrees.

   b. All measured clearances shall be within Supplier's specifications for new installations. Replace and recheck impellers found to be out of round or out of specified tolerance.

3. Measurement of shaft runout for all rotating equipment requiring assembly:

   a. Remove bearings from the shaft. Support shaft on pedestal rollers or in a lathe.

   b. Check each shoulder on the shaft.

   c. Take two readings for each shoulder, opposed to each other by 90 degrees.

   d. All measured clearances shall be within Supplier's specifications for new installations. Replace and recheck shafts found to be out of round or out of specified tolerance.

4. Vibration Measurements:

   a. Provide vibrational signature testing and documentation for each piece of direct drive or close coupled rotating equipment with a motor HP of 100 or above and a rated operating speed in excess of 1999 RPM.

   b. Unless specified otherwise, current edition of the Hydraulic Institute Standard, “Acceptable Field Vibration Limits” shall be the standard for vibrational testing.

   c. Take all specified vibrational readings in three directions: vertical, horizontal, and axial.

   d. Provide vibrational measurements in following engineering units:

      (1) Displacement in thousandths of an inch (mils), peak to peak.

      (2) Velocity in inches per second (ips), peak to peak.

      (3) Acceleration in feet per second per second (lg=32.3 ft/sec./sec.) zero to peak.

      (4) Spike energy in g-SE.

      (5) Vibrational readings shall be less than device rotating frequency, and within operating band specified by the Supplier.

      (6) Amplitude Allowable Maximums:

RPM	Amplitude inches peak to peak:
3,000 and above	0.001
1,500 - 2,999	0.002
1,000 - 1,499	0.0025
999 and below	0.003

5. Belt Drives:

   a. All belts shall ride within sheave and not slip to bottom of groove(s).

   b. Belt tension shall be in accordance with Supplier's recommendations.

   c. Pulley alignment shall be within Supplier's recommendations.

6. Gear Drives and Reducers:

   a. Check gears for lash at no less than three points around the gear.

   b. Rotate gears a full 360 degrees while checking alignment.

7. Coupling/Shaft Alignment:

    a. Perform all final alignments and checks with a dial indicator or a laser device. Feeler gauges and straight edges are not acceptable.

    b. Eliminate soft foot conditions prior to aligning.

    c. When checking for final soft foot, any displacement in excess of 0.002" must be corrected.

    d. When checking for pipe strain, any displacement in excess of 0.002" requires piping realignment.

    e. Alignments will not be regarded as final until the grout is set and all piping has been attached. Demonstrate that alignment is not changed by attachment of piping.

    f. Shim the driving element, never the driven element.

    g. Take bracket sag corrections into account when using a dial indicator. Bracket sag shall be determined on a rigid pipe.

    h. Mount a dial indicator to the driven element so that it can be rotated. Rotate both elements while aligning.

    i. When aligning three coupled elements, align gear reduction elements with the driven element first, then align the driver to the gear reduction element.

    j. Check all four alignments, i.e., angular alignment in the vertical and horizontal planes, and parallel alignment in the vertical and horizontal planes.

    k. Acceptable alignment accuracy for flexible couplings is +0.005 inches, or the Supplier's specifications, whichever is more stringent.

    l. Dial indicator must be perpendicular to the alignment surface.

    m. Number hold down nuts prior to tightening. Loosen in reverse order. Tighten in ascending order.

    n. Use only clean, deburred shims. Clean the machine base and feet from rust or burrs prior to alignment.

8. Measurement of Noise (dB):

    a. Eliminate noise sources generated by adjacent construction activity prior to testing and establish a background noise level prior to testing.

    b. Perform noise level testing on each installed device as required by technical specifications.

c. Maximum noise level exposure is 85 dBA over eight hours continuous for office, shop, and other areas where Owner's personnel will be performing their assigned duties.

9. Hydrostatic Testing:

a. AWWA C600 standards latest edition are the standards for all hydrostatic testing.

b. Visually inspect all welds prior to testing, for cracks, undercut on surface greater than 1/32-inches deep, lack of fusion on surface, reinforcement greater than Table 127.4.2 located in ANSI B31.1 Power Piping, and incomplete penetration (when accessible). Repair or rework as directed by Engineer’s Representative.

c. At no time during hydrostatic testing shall any part of piping system be subjected to a stress greater than 90 percent of its yield strength at test temperature.

d. After 10 minutes of full hydrostatic test pressures, make an examination for leakage of all joints, connections, and all regions of high stress, such as around openings and thickness transition sections.

e. Unless otherwise specified, minimum required hydrostatic test pressure shall be 1.5 times the design pressure as specified and as indicated.

f. Pressure holding time shall be 10 minutes plus time required to inspect for leakage.

g. Maximum pressure shall not exceed maximum rated pressure for any component in system being tested.

10. Electrical Equipment:

a. Testing standards for electrical components are those contained in Section 26 05 10 and pertinent technical specification(s).

C. Where required by equipment specifications, Contactor shall furnish an authorized, competent representative of equipment or unit process supplier to supervise and coordinate Functional Completion Testing program. Instrument readings and other test data shall be tabulated by Contractor.

D. Documentation Requirements:

1. Certificates are required for all Functional Completion Testing for equipment and unit process systems. Four copies of completed certificates shall be supplied for review by Engineer. Contents of certificate shall be at a minimum:

   a. Contractor Review Comments, and Approval Page. This page shall include Certification by preparer that he/she is person responsible for test data and data is authentic and accurate. This page shall include a listing and signature of all witnesses to the test.

   b. Equipment Suppliers Review Comments, and Approval Page. This page shall include Certification by equipment or unit process systems suppliers that equipment or unit process systems are properly installed and suitable for startup.

   c. Engineer Review Comments, and Approval Page.

   d. Process, Equipment, and P&IDs used in this Functional Completion Test

   e. Functional Completion Testing Schedule

   f. Test Descriptions/Procedures

      (1) Equipment or unit process systems tested.

      (2) Test dates.

      (3) Electrical Inspection and Tests

      (4) Test results.

      (5) Any repairs or corrections required to obtain acceptable test results.

      (6) Calibration sheet for instrumentation or devices used for testing but not part of plant installation.

      (7) Copies of calibration records for plant installed instrumentation

   g. Certify Mechanics and Installation. Inspection and certification to be conducted by equipment representative. Inspect and certify that each piece of equipment meets the following requirements:

      (1) Not damaged in transportation or installation.

      (2) Properly installed with no undue force imposed from piping or supports.

      (3) Is properly lubricated.

(4) Motor rotation is correct.

(5) Free of overheating.

(6) Free of vibration.

(7) Free of noise.

(8) Functions without overloading.

(9) Piping and other connections are completed.

(10) No leaks at equipment connections (static pressure testing).

h. Certify Electric Valve Mechanics and Installation

i. Inspect and certify that each valve meets the following requirements:

(1) Not damaged in transportation or installation.

(2) Properly installed with no undue force imposed from piping or supports.

(3) Is properly lubricated.

(4) Motor rotation is correct.

(5) Free of overheating.

(6) Free of vibration.

(7) Free of noise.

(8) Functions without overloading.

(9) Piping and other connections are completed.

(10) No leaks at equipment connections (static pressure testing).

j. Inspection and certification to be conducted by Contractor.

k. Instrumentation and Control Inspection and Tests

l. Inspect and certify instrumentation and control circuits for the following:

(1) Loop checks have been completed for all signal and control circuits.

(2) All instruments have been calibrated.

(3) All instrumentation tubing has been pressure tested and any leaks repaired.

(4) Manual modes function as intended.

(5) Protective interlocks function as intended.

(6) Remote modes function as intended.

(7) Automatic modes function as intended.

m. Instrumentation tests include the following:

(1) Complete loop checks for all signals and controls. Control panel operates process properly in automatic mode.

2. Tests certificates shall be submitted no later than 30 calendar days, after testing ends. Engineer and Owner shall have no more than 30 calendar days to complete a review and return with any exceptions noted.

3.03 STARTUP:

A. Provide 30 days written notice to Engineer's Representative for each startup procedure so that Engineer's Representative may witness each startup procedure. Engineer's Representative may witness the performance of any or all startup procedures, at their option.

B. Startup shall begin at conclusion of Functional Completion Testing, when equipment or unit process systems are subjected to full operation using a process flow substitute.

1. Startup activities shall be carried out with clean water as required to show equipment and unit process systems are functional. Process flows shall not be used for Startup.

2. Various vendors, equipment suppliers and manufacturers shall provide on-site supervision and assistance for Startup services for new facility.

C. Contractor shall coordinate all startup activities for equipment and unit process systems in accordance with the accepted Plan. Contractor shall develop a detailed Startup plan as part of that Plan that includes the following as a minimum:

1. Description of the overall, general startup process.

2. List of equipment and unit process systems included for Startup activities.

3. Detailed startup sequence of activities.

4. Equipment and system boundaries as shown using marked-up P&IDs.

5. Listing of staff and responsibilities for activities.

D. Startup Requirements: The following are minimum requirements for completion of Startup activities:

1. Startup shall show that equipment or unit process systems are suitable for continuous operation using clean water and that flows and operating parameters are in compliance with specified design conditions.

    a. Startup shall also demonstrate that local and remote instrumentation and controls are functioning properly and communicating with each other properly.

    b. Equipment or unit processes shall be operated for a minimum of 5 days without interruptions in service.

    c. If startup fails, Contractor will be responsible for redoing startup testing at no additional costs to the Owner.

E. Documentation Requirements:

1. A Startup certificate shall be prepared and submitted to Engineer for review and returned with any exceptions noted. Reports shall include, but not be limited to, the following:

2. Contents of certificate shall be at a minimum:

    a. Contractor Review Comments and Approval Page. This page shall include Certification by preparer that he/she is the person responsible for test data and data is authentic and accurate. This page shall include a listing and signature of all wittiness's to the test. Certification by Contractor that equipment or unit process systems were operated continuously for specified period and that equipment or unit process systems operated in compliance with specified operating conditions, parameters and performance; and that equipment or unit process systems are suitable for Commissioning.

    b. Equipment Suppliers Review Comments and Approval Page. This page shall include Certification by equipment or unit process systems suppliers that equipment or unit process systems have been started up properly and operated within the design parameters. Certification by equipment or unit process systems supplier that equipment or the unit process systems were operated continuously for specified period and that equipment or unit process systems operated in compliance with the specified operating conditions, parameters and performance; and that equipment or unit process systems are suitable for Commissioning.

    c. Engineer Review Comments, and Approval Page.

    d. Process, Equipment, and P&IDs Involved in this startup test.

    e. Startup Schedule.

f. Test Descriptions/Procedures.

(1) Equipment or unit process systems tested.

(2) Test dates.

(3) Electrical Inspection and Tests.

(4) Test results.

(5) Any repairs or corrections required to obtain acceptable test results.

(6) Calibration sheet for instrumentation or devices used for testing but not part of plant installation.

g. Appendix:

(1) A summary of all data used in calculations, including source, formulas with all terms defined.

(2) Calculations for all data submitted, fully defined.

(3) Copies of all raw field data sheets and notes.

(4) Production and/or operational data.

(5) Copies of calibration records for instrumentation.

3.04 COMMISSIONING:

A. Provide 30 days written notice to Engineer's Representative for each commissioning procedure so that Engineer's Representative, may witness teach commissioning procedure. Engineer's Representative may witness the performance of any or all commissioning procedures, at their option.

B. Commissioning shall begin at the conclusion of Startup Testing, wherein equipment or unit process systems are subjected to full operation using process flows.

1. On successful completion of Startup, process flows shall be used for commissioning equipment and unit process systems to show equipment and unit process systems function properly. Commissioning shall confirm proper operation of the equipment and unit process systems with process fluids, adjustments shall be made, and equipment or unit process systems shall be optimized and brought into compliance with design criteria.

2. Commissioning shall not be initiated with process flows until available flows are representative of that required for equipment or unit process systems for testing.

3. Various vendors, equipment suppliers and manufacturers shall provide on-site supervision and assistance for Commissioning services for new facility.

C. Contractor shall coordinate all Commissioning activities for equipment and unit process systems in accordance with the accepted Plan. Contractor shall develop a detailed Commissioning plan as part of that Plan that includes the following as a minimum:

1. Description of the overall, general Commissioning process.

2. List of equipment and unit process systems included for Commissioning activities.

3. Detailed Commissioning sequence of activities.

4. Equipment and system boundaries as shown using marked-up P&IDs.

5. Listing of staff and responsibilities for activities.

D. Commissioning Requirements: The following are minimum requirements for completion of Commissioning activities:

1. Commissioning shall show that equipment and unit process systems are capable of continuous operation using process liquids, chemicals, and utilities; and that flows, operating parameters and performance requirements have been demonstrated for a minimum of 7 days of continuous operation, or period required in equipment specifications, whichever is longer.

   a. Shutdowns that occur because of power outages, acts of God, failure of support systems not part of this contract will not be a cause of failure of seven days of continuous operation.

2. If the commissioning fails, Contractor will be responsible for redoing commissioning at no additional costs to Owner.

E. Documentation Requirements:

1. A Commissioning report shall be prepared and submitted to Engineer for review and return with any exceptions noted. Reports shall include, but not be limited to, the following:

   a. Contractor Review Comments and Approval Page. This page shall include Certification by preparer that he/she is the person responsible for test data and data is authentic and accurate. This page shall include a listing and signature of all wittiness's to the test. Certification by Contractor that equipment or unit process systems were operated continuously for specified period and that equipment or unit process systems operated in compliance with specified operating conditions, parameters, and performance.

b. Equipment Suppliers Review Comments and Approval Page. This page shall include Certification by equipment or unit process systems suppliers that equipment or unit process systems have been commissioned properly and operated within design parameters. Certification by equipment or unit process systems supplier that equipment or unit process systems were operated continuously for specified period and that equipment or unit process systems operated in compliance with specified operating conditions, parameters and performance.

c. Engineer Review Comments, and Approval Page.

d. Process, Equipment, and P&IDs Involved in this commissioning test.

e. Commissioning Schedule

(1) Test Descriptions/Procedures including equipment or unit process systems tested, test dates, electrical inspection and tests, test results, and any repairs or corrections required to obtain acceptable test results.

(2) Calibration sheet for instrumentation or devices used for testing but not part of plant installation.

f. Appendix:

(1) A summary of all data used in calculations, including source, formulas with all terms defined.

(2) Calculations for all data submitted, fully defined.

(3) Copies of all raw field data sheets and notes.

(4) Production and/or operational data.

(5) Copies of calibration records for instrumentation.

F. Commissioning Documentation and Reports

END OF SECTION

SECTION 02 41 00

GENERAL DEMOLITION

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide demolition and alterations of existing conditions as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. United States Environmental Protection Agency (USEPA):

1. 832: Storm Water Management for Construction Activities: Developing Pollution Prevention Plans and Best Management Practices.

1.03 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00.

1. Demolition Plan.

1.04 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 43 00.

B. Demolition Plan: Provide description of sequence, methods, and equipment used for demolition (including disposal).

1.05 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in Section 01 60 00.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

3.01 PREPARATION:

A. Survey Markers and Monuments:

1. Provide three reference points, established by a licensed land surveyor, for each survey marker or monument temporarily removed. Record locations and designations of survey markers and monuments prior to removal.

2. Store removed markers and monuments during demolition work and replace upon completion of work. Reestablish survey markers and monuments in conformance with recorded reference points. Forward letter to Engineer's Representative, signed by a licensed land surveyor, verifying reestablishment of survey markers and monuments.

B. Burning of demolition debris is prohibited.

C. Protect existing structures, equipment, and appurtenances to remain.

D. Obtain permission from Engineer's Representative before abandoning or removing existing structures, materials, equipment and appurtenances.

E. Provide fire extinguishers in areas where demolition work is performed by use of an open flame. Exercise necessary precautions for fire prevention.

F. Maintain circulation of traffic within area at all times during demolition operations.

G. Make necessary arrangements with and perform work required by utility companies and municipal departments for discontinuance or interruption of utility services due to demolition work.

H. Confine apparatus, storage of materials, demolition work, new construction, and operations of workmen to areas that will not interfere with continued use and operation of entire facility. Provide and maintain lights, barriers, and temporary passageways for free and safe access

I. Provide shoring or bracing where necessary to prevent settlement or displacement of existing or new structures. Do not overload floors.

3.02 DEMOLITION:

A. Clear site in preparation for construction in accordance with the requirements specified in Section 31 10 00. Site preparation will include demolition of existing structures, protection of above ground and below ground pipes and protection of underground utilities and facilities. Temporary fencing shall be erected around the construction site and lay-down area(s).

B. Demolition removes existing electrical conduit, raceways, conductors, etc. that are between equipment and panels.

C. Demolish and remove existing construction, utilities, equipment, and appurtenances.

D. Provide maximum practicable protection from inclement weather for materials, equipment, and personnel located in partially dismantled structures.

E. Protect persons and property throughout progress of work. Provide safe working conditions for personnel.

F. Wet down work during demolition operations to prevent dust from arising. Minimize spread of dust and airborne particles.

G. Complete demolition work on upper levels before disturbing supporting members on lower levels.

H. Cap or plug with concrete or non-shrink grout, pipes and other conduits which are abandoned in place.

I. Removed materials, equipment, and appurtenances, not designated for relocation, become property of Contractor and shall be disposed of offsite.

3.03 REPAIR/RESTORATION:

A. Repair or remove items that are damaged. Repair and install damaged items to condition at least equal to that which existed prior to start of work.

3.04 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 03 48 18

PRECAST REINFORCED CONCRETE VAULTS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section includes materials, design, and installation of factory-built precast reinforced concrete underground vaults and chambers.

1.02 REFERENCES:

A. American Association of State Highway and Transportation Officials (AASHTO):

1. HB: Standard Specifications for Highway Bridges.

2. M198: Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants

B. American Concrete Institute (ACI):

1. 318: Building Code Requirements for Structural Concrete and Commentary

C. ASTM International (ASTM):

1. A615: Standard Specification for General Requirements for Stainless Steel Wire and Wire Rods.

2. C33: Specification for Concrete Aggregates

3. C150: Specification for Portland Cement

4. C857: Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.

5. C858: Specification for Underground Precast Utility Chambers

1.03 SUBMITTALS:

A. Shop Drawings: Submit the following in accordance with Section 01 33 00.

1. Completely detailed shop drawings for precast concrete vaults. Indicate all dimensions, details, reinforcing steel, inserts, connections, openings and lifting devices. Mark each component for identification. Show mark on erection plan and place legibly on unit at time of manufacture.

2. Buoyancy Calculations.

B. Drawings of modifications or changes in features or details, which are necessitated by design requirements. Make such modifications without additional compensation.

C. Do not fabricate precast concrete vaults before shop drawings are accepted by the Engineer.

D. Certification, signed and sealed by a Professional Engineer registered in New Mexico where the vaults will be installed and employed by the vault manufacturer and stating:

1. Elements and connections are designed to withstand required loads and forces

2. Structure is not affected by buoyant forces.

3. Codes and specifications to which structural design conforms.

1.04 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 43 00.

B. Vault design and construction comply with the specified design load conditions, ASTM C858 and as specified herein.

1.05 DELIVERY, STORAGE AND HANDLING:

A. Comply with the requirements specified in Section 01 60 00.

B. Store vaults on clean blocking, off the ground and protected from rain and ground splatter.

PART 2 - PRODUCTS

2.01 PRECAST REINFORCED CONCRETE VAULTS:

A. Manufacturers:

1. Oldcastle Precast, Inc.

2. Shea Concrete Products Inc.

3. Vaughn Concrete Products/

B. Materials:

1. Minimum concrete compressive strength of 5,000 psi at 28 days conforming to Section 03 30 00.

2. Portland Cement: ASTM C150, Type II.

3. Coarse Aggregate and sand conforming to ASTM C33.

4. Steel reinforcement conforming to ASTM A615, Grade 60.

5. Water: Potable.

6. Provide air entraining and water reducing concrete admixtures as specified on Drawings.

7. Butyl rubber-based sealants conforming to AASHTO M198, Type B but with no bitumen content.

8. Non-Shrink Grout:

   a. BASF Chemical Company; Masterflow 713 Plus

   b. The Euclid Chemical Co.; Euco NS Grout

   c. Sika Corporation; SikaGrout 212

C. Design Criteria. Use design loads according to ASTM C857 or as indicated below, whichever produces the more severe conditions:

1. Design precast reinforced concrete vault to withstand earth and groundwater loads. Assume groundwater elevation to be at the top of the vault.

2. Design precast reinforced concrete vault to withstand internal hydrostatic and seismic loading. Assume internal fluid level to be at the top of the vault. Provide design based upon an equivalent fluid pressure.

3. Design precast reinforced concrete vault to withstand vehicle loading with an impact factor as prescribed in ASTM C857 but a minimum of 250 psf surcharge. Account for vehicle positions both above and alongside vault including directly on each manhole cover.

4. Design precast reinforced concrete vault ceiling to withstand additional concentrated loads from lifting hooks located directly above each valve, meter or other equipment. Provide lifting hook capable of supporting the load, but not less than 2,500 pounds each hook.

5. Design and install vaults to withstand hydrostatic uplift caused by a groundwater elevation at grade level or equal to the top of the vault, whichever produces the most severe condition. Use only the weight of the vault and hold-down slab to resist hydrostatic uplift with a minimum safety factory of 1.15. Do not include side friction of soil on walls.

6. Walls and floor slab: minimum of 6 inches in thickness. Cast lower wall section and floor slab together in one placement.

7. Precast reinforced concrete vault roof: minimum of 8 inches (200 mm) in thickness.

8. Design vault to withstand the load condition where the vault roof is removed while the structure is backfilled to grade and subject to live and dead loads.

9. Provide precast reinforced concrete vault as indicated on the drawings.

10. Fabricate precast reinforced concrete vault in sections for as required for installation.

11. Provide pipe sleeves with water stops, rubber pipe boots or other devices at pipe penetrations as indicated.

12. Provide reinforced concrete vertical entrance tube with inside dimensions as indicated.

2.02 BITUMINOUS WATERPROOFING MATERIAL:

A. Manufacturers:

1. Tnemec Company, Inc.; Series 46-465 H.B. Tnemecol

2. PPG Industries; Amercoat 78HB.

3. Carboline; Bitumastic 300M

B. Apply waterproofing to outside of walls, floor, and ceiling.

2.03 ENTRANCE HATCHES:

A. Manufacturers:

1. Bilco Co.

2. Halliday

3. Babcock-Davis Associates, Inc.

B. Provide aluminum hatches of the type and size indicated and as follows:

1. Fabricate hatch and frame with 1/4-inch (6 mm) extruded aluminum frame and 1/4- inch (6 mm) diamond checkered aluminum plate covers.

2. Reinforce cover, with aluminum bars and angles welded to underside of covers, to withstand AASHTO H-20 wheel loading.

3. Provide hatch with hinges, hold-open safety-lock bars and flush lift handles, factory assembled, and shipped complete for installation.

4. Provide stainless steel hardware throughout. Hinge covers to frames with heavy duty stainless steel concealed hinges and stainless steel pins. Attach hinges to covers and frames with countersunk/flathead stainless steel machine screws. Fit covers flush to frame.

5. Provide slam latch, flush mounted grip handle, and removable plug and key wrench.

6. Fabricate gutter type hatches with 1-1/2-inch (38 mm) drainage coupling in one corner of the channel frame.

7. Provide frost proof inner hatch.

8. Provide ladder-up safety post.

9. Provide drain PVC drain piping to location required by the Contract Drawings or as recommended by the Engineer.

2.04 LIFTING HOOKS:

A. Provide lifting hooks in the ceiling above pumps, valves and meters.

PART 3 - EXECUTION

3.01 PROTECTION:

A. Protect aluminum from contact with dissimilar metals, concrete, masonry or mortar.

B. Before coating application, clean contact surfaces, remove dirt, grease, oil, foreign substances.

3.02 FINISHES:

A. Finishes: Aluminum ladders to receive finish as specified or directed by the Engineer. Hatches to receive manufacturers' standard finish for aluminum.

3.03 INSTALLATION:

A. Install precast reinforced concrete vault, and related appurtenances in accordance with manufacturer's instructions.

B. Place precast reinforced concrete vault onto level prepared bedding as indicated. Provide uniform bearing over entire base of vault.

C. Seal all joints inside and out with specified sealant to ensure joints are waterproof.

D. Repair or replace damaged waterproofing.

E. Backfill vault excavation uniformily and in such a manner so as not to damage the waterproofing.

3.04 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 05 12 00

STRUCTURAL STEEL

PART 1 - GENERAL

1.01 DESCRIPTION:

A. The term "Structural Steel" is used as defined in accordance with the AISC Code of Standard Practice.

B. Provide structural steel as specified and as shown on contract drawings.

1.02 REFERENCES:

A. American Institute of Steel Construction (AISC):

1. 303: Code of Standard Practice for Steel Buildings and Bridges

2. 325: Manual of Steel Construction, 14th Edition

3. 326: Structural Steel Detailing Manual

4. 348: Specification for Structural Joints using ASTM A 325 or A 490 Bolts

5. 360-5: Specification for Structural Steel Buildings

B. ASTM International (ASTM):

1. A6/A6M: Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.

2. A36/A36M: Specification for Carbon Structural Steel.

3. A53: Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

4. A108: Standard Specification for Steel Bars, Carbon and Alloy, Cold-Finished

5. A123: Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

6. A143: Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedures for Detecting Embrittlement.

7. A153: Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

8. A194/A194M: Specification for Carbon and Alloy-Steel Nuts for Bolts for High-Pressure and High-Temperature Service.

9. A307: Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.

10. A325: Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.

11. A384: Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies.

12. A385: Practice for Providing High Quality Zinc Coatings (Hot-Dip).

13. A449: Specification for Quenched and Tempered Steel Bolts and Studs.

14. A500: Standard Specification for Steel for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.

15. A563: Specification for Carbon and Alloy Steel Nuts.

16. A572: Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.

17. A780: Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.

18. A992: Standard Specification for Steel for Structural Shapes for Use in Building Framing.

19. B695: Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.

20. F436: Specification for Hardened Steel Washers.

21. F1554: Standard Specification For Anchor Bolts, Steel, 36, 55, and 105 ksi Yield.

C. American Welding Society (AWS):

1. D1.1: Structural Welding Code – Steel

D. Occupational Safety and Health Administration (OSHA):

1. Safety and Health Standards for the Construction Industry, 29 CFR 1926 Subpart R Safety Standards for Steel Erection.

E. Governing Building Code:

1. International Building Code (IBC).

1.03 DESIGN CRITERIA:

A. Structural Connections: AISC Specification for Structural Steel Buildings. Design connections not fully detailed on the Drawings to resist the loads shown on the Contract Drawings or specified.

B. Where beam end reactions are not shown, design the connection for one-half the total allowable uniform load in kips for beams laterally supported at the given span, as determined by the tables for allowable loads on beams in the AISC Manual of Steel Construction, in addition to any axial loads identified on the Drawings.

C. Unless otherwise noted on Contract Drawings, design connections for ASTM A325 bolts, bearing-type connection with threads included in shear plane.

1.04 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

1. Submit in advance of fabrication complete information necessary for the fabrication of each component and part of the structural steel framing. Include the following:

a. Member size and length.

b. Bill of materials.

c. Material specifications.

d. Bolt hole size and bolt size.

e. Cuts, copes, and bevels.

f. Piece marks for field assembly.

g. Detail of each connection or typical connection.

h. Splices.

2. Submit erection drawings showing complete information necessary for the erection of each component part of the structural steel framing. Include the following:

a. Dimensions for alignment and elevations of each member.

b. Location of members and attachments by match-marking of piece numbers.

c. Type and location of each field connection.

d. Number of shear connectors on each member.

e. Detail of each field connection or typical connection.

f. Anchor blots and setting plans.

3. Do not develop shop drawings by using reproductions of contract drawings. Identify each shop drawing detail by contract drawing detail title.

4. All drawings shall be certified by a Professional Structural Engineer.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 43 00.

B. Steel fabricator shall have 5 years' experience minimum in structural steel fabrications.

C. Steel erector shall have 5 years' experience minimum in structural steel erection.

1.06 DELIVERY, STORAGE AND HANDLING:

A. Comply with the requirements in Section 01 60 00.

B. Load structural members in such a manner that they may be transported and unloaded without being over-stressed, deformed or otherwise damaged.

C. Protect structural steel members and packaged materials from corrosion and deterioration. Store material in a dry area.

D. Support materials stored outdoors above ground surfaces on wood runners and protected with acceptable effective and durable covers.

E. Do not place materials on the structure in a manner that might cause distortion or damage to the members or the supporting structures. Repair or replace damaged materials or structures as recommended by the Engineer.

1.07 FIELD MEASUREMENTS:

A. Verify dimensions and make any field measurements necessary and be fully responsible for accuracy and layout of the work.

B. Review the Contract Drawings and report any discrepancies to the Engineer for clarification prior to starting fabrication.

PART 2 - PRODUCTS

2.01 STRUCTURAL STEEL:

A. W shapes in conformance with ASTM A992 unless otherwise indicated or specified.

B. Angles, plates and bars in conformance with ASTM A36.

C. Steel pipe in conformance with ASTM A53, Grade B.

D. Hot-Dip Galvanized Carbon Steel in conformance with ASTM A123.

2.02 FASTENERS:

A. Carbon Steel Bolts, Nuts and Washers: ASTM A307, Grade A.

B. High-strength fasteners in conformance with ASTM A325, Type 1.

C. Nuts and washers ASTM A563 and F 436.

D. Hot-dip Galvanized Bolts, nuts and washers in conformance with ASTM A153.

E. Mechanically Galvanized Bolts, nuts and washers in conformance with ASTM B695.

2.03 WELDING:

A. Class E70XX electrodes.

B. Provide equipment for welding, electrodes, welding wire and fluxes capable of producing indicated welds when used by certified welders under AWS welding procedures. Provide welding materials that comply with requirements of AWS Structural Welding Code.

2.04 SHOP FABRICATION:

A. Fabricate each element and connection as indicated on the fabrication shop drawings accepted by the Engineer. Fabricate and shop assemble work to the greatest extent practical in conformance with following publications:

1. AISC Manual of Steel Construction

2. AISC Specification for Structural Joints

3. AISC Detailing Manual

4. AWS Structural Welding Code

2.05 CONNECTIONS:

A. Connect members with ASTM A325 high strength bolts unless otherwise specified or shown on contract drawings. Provide clean-cut holes without torn or ragged edges and remove outside burrs.

B. Welded Connections:

1. Weld connections indicated or specified.

C. Make connections with ASTM A307 carbon steel bolts when specified or shown in contract drawings.

D. Provide anchor rods with washer and heavy hex nuts. Provide hot-dip galvanized anchor rods, washers and heavy hex nuts with galvanized steel.

2.06 SHOP PAINTING:

A. Apply shop prime coat to structural steel, except to members or portions of members to be embedded in concrete, surfaces and edges to be field welded, and galvanized surfaces, unless otherwise specified. Provide surface preparation as described for the specified coating system.

B. Immediately after surface preparation, apply primer as specified in Section 09 91 10. Use painting methods that will result in full coverage of joints, corners, edges, and exposed surfaces.

2.07 GALVANIZE:

A. Provide hot-dip galvanizing, in conformance with ASTM A153, to bolts, nuts and washers that will be used with galvanized steel.

B. Complete fabrication and prepare surfaces of steel by removing weld spatter, flux, residue, burrs and metal surface defects before galvanizing. Clean weldments with power wire brush prior to galvanizing.

C. Provide steel dipped into solution of zinc chloride plus ammonium chloride immediately prior to galvanizing.

D. Tap bolt nuts after hot-dip galvanizing in conformance with ASTM A563.

E. Inspect galvanized material for compliance with these specifications. Mark the material with a clearly visible stamp indicating the name of the galvanizer, the ASTM number and the weight of zinc coating in ounces per sq. ft.

2.08 GALVANIZE TOUCH-UP:

A. Galvanize Touch-Up: Where galvanizing is damaged, touch-up abraded areas, using brushed-on method, with zinc-rich coating. Touch-up repair with zinc-rich coating of not less than 3 mil and not more than 6 mil dry film thickness.

B. Touch-up damaged galvanized surfaces with one of the following zinc rich coatings:

1. Endupor, zinc-rich coating by Dampney Manufacturing Co., Everett, MA

2. ZiRP, zinc-rich coating by Duncan Galvanizing Corp., Everett, MA

3. ZRC Cold Galvanizing Compound or ZRC Galvilite by ZRC Worldwide, Division of Norfolk Corp., Marshfield, MA;

4. Or acceptable equivalent product.

PART 3 - EXECUTION

3.01 ERECTION OF STRUCTURAL STEEL:

A. Conform to the IBC and referenced AISC standards. Brace and secure work until permanent connections are completed. Provide accessories and fasteners to secure the work in place whether or not shown or specified. Comply with OSHA requirements.

B. Splice members only where shown or specified. On exposed welded connections, remove erection bolts, fill holes with plug welds, and grind smooth at exposed surfaces. Comply with AISC specifications for bearing, adequacy of temporary connections, alignment, and the removal of paint on surfaces adjacent to field welds. Do not enlarge holes in members by burning or the use of drift pins, except in secondary bracing members. Ream holes that must be enlarged to place bolts. Do not use gas-cutting torches in the field for correcting fabrication errors in the structural framing.

3.02 DAMAGED MEMBERS:

A. During erection, straighten or replace members that are bent, twisted, or damaged. If heating is required in straightening, perform heating by methods that ensure uniform temperature throughout entire member. When required by the Engineer's Representative, remove members that are impaired strength and replace with new members at no additional cost to Owner.

3.03 MISFITS AT BOLTED CONNECTIONS:

A. Immediately notify the Engineer where misfits in erection bolting are encountered. Submit a method to remedy the misfit for review by the Engineer. The Engineer will determine whether the remedy is acceptable or if the member must be refabricated.

B. Do not enlarge incorrectly sized or misaligned holes in members by burning or by the use of drift pins. Notify the Engineer immediately and submit a proposed method of remedy for review by the Engineer's Representative.

3.04 ANCHOR BOLTS:

A. Install anchor bolts by using templates, setting drawings, and instructions provided by the fabricator. Verify positions of bolts prior to delivery of steel; report errors or deviation for adjustment. After anchor bolts have been embedded, protect threads by applying grease and by having the nuts screwed on until the metalwork is installed.

3.05 CONNECTIONS:

A. Securely bolt members to maintain steel in position during field welding and final bolting and accommodate dead loads, wind, and erection stresses.

B. Tighten high-strength bolted connections in accordance with AISC Specification for Structural Joints using ASTM A325 or A490 Bolts and manufacturer's specifications.

C. Common Bolts: Tighten ASTM A307 and nonslip critical bolts to snug tight plus one-quarter turn with upset bolt threads to preclude loosening, or use self-locking nuts.

D. Do not reuse galvanized high-strength bolts, nuts and washers.

3.06 CLEAN-UP:

A. Upon completion of the work, remove surplus materials, rubbish, and debris resulting from the operations, including disused equipment and implements of service, and leave the entire structure and site, insofar as the work of this section is concerned, in a neat, clean condition.

3.07 FIELD QUALITY CONTROL:

A. Inspection and testing, by the Owner, is not intended to relieve Contractor of responsibility. Defective material or workmanship, if found at any time prior to final acceptance of work, shall be rejected regardless of previous inspection.

3.08 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 05 50 00

MISCELLANEOUS METAL

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section includes metal fabrications not specifically included in other Sections and required for completion of work as shown on Contract Drawings and in accordance with Contract Documents.

B. Furnish labor, materials, equipment and incidentals necessary to install the products specified.

1.02 REFERENCES:

A. ASTM International (ASTM):

1. A6: General Requirements for Rolled Structural Steel Bars, Plates, Shapes and Sheet Piling.

2. A36: Standard Specification for Carbon Structural Steel.

3. A48: Standard Specification for Gray Iron Castings.

4. A53: Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

5. A108: Standard Specification for Steel Bars, Carbon, Cold Finished, Standard Quality.

6. A123/A123M: Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

7. A153: Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

8. A193/A193M: Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications.

9. A240: Standard Specification for heat-resisting chromium and chromium-nickel stainless steel plate, sheet, and strip for pressure vessels.

10. A307: Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.

11. A325: Structural Bolts, Steel, Heat Treated 120/105 ksi Minimum Tensile Strength.

12. A366: Standard Specification for Steel, Sheet, Carbon, Cold-Rolled, Commercial Quality.

13. A489: Standard Specification for Carbon Steel Lifting Eyes.

14. A500: Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.

15. A501: Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.

16. A502: Steel Structural Rivets.

17. A536: Standard Specification for Ductile Iron Castings.

18. A569: Steel, Carbon (0.15 Maximum, Percent) Hot-Rolled Sheet and Strip Commercial Quality.

19. A570: Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality.

20. A572: Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel

21. A576: Steel Bars, Carbon, Hot-Wrought, Special Quality.

22. A675: Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties.

23. A786: Rolled Steel Floor Plates.

24. A992: Standard Specification for Structural Shapes.

25. F436: Standard Specification for Hardened Steel Washers.

26. F844: Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use.

27. F1554: Standard Specification of Anchor Bolts, steel, 36, 55 and 105-ksi Yield Strength.

28. F2329: Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners.

B. American Institute of Steel Construction (AISC):

1. ANSI/AISC 360-5: Specification for Structural Steel Buildings

2. AISC Manual of Steel Construction, 14th Edition

C. American Welding Society (AWS):

1. A2.4: Standard Symbols for Welding, Brazing, and Nondestructive Examination.

2. D1.1: Structural Welding Code.

D. National Association of Architectural Metal Manufacturers (NAAMM):

1. MBG 531: Metal Bar Grating Manual.

2. MBG 533: Welding Specifications for Fabrication of Steel, Aluminum and Stainless Bar Grating.

E. International Code Council – Evaluation Services (ICC-ES):

1. ICC-ES Acceptance Criteria 193: Mechanical Anchors in Concrete Elements

2. ICC-ES Acceptance Criteria 308: Post-installed Adhesive Anchors in Concrete Elements

F. Submit the following shop drawings in accordance with Section 01 33 00.

1. Submit shop drawings and product data showing materials of construction and details of installation for all items furnished under this Section. Shop drawings shall show sizes of members, method of assembly, anchorage and connection to other members.

2. Test Reports:

a. Submit certified copies of mill test reports on each steel proposed for use showing the physical properties and chemical analysis.

3. Product Data:

a. Manufacturer’s catalog sheets on pre-manufactured items.

4. Miscellaneous Submittals:

a. Provide International Conference of Building Officials (ICBO) or other similar building code organization recommendations regarding safe allowable design loads for concrete anchors.

5. Stamped by Professional Engineer registered in State where the project is located.

1.03 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 43 00.

B. Design connections not detailed on the Drawings under direct supervision of a Professional Engineer experienced in design of this work and licensed in the State where the Project is located.

C. Adhesive Anchors:

1. Adhesive Anchor Installers shall be trained and certified by manufacturer.

D. Galvanized Coating:

1. Company specializing in hot-dip galvanizing after fabrication and following procedures of Quality Assurance Manual of the American Galvanizers Association.

1.04 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in Section 01 60 00.

B. Insofar as practical, factory assemble items specified herein. Package, ship and tag unassembled materials in a manner that will protect materials from damage and will facilitate identification and field assembly.

C. Protect painted coatings and hot-dip galvanized finishes from damage due to metal banding and rough handling. Use padded slings and straps.

D. Deliver items to be incorporated into the work of other trades in sufficient time to be checked prior to installation.

E. Store fabricated items in a dry area, not in direct contact with ground.

1.05 FIELD MEASUREMENTS:

A. The Contractor shall verify all dimensions and shall make any field measurements necessary and shall be fully responsible for accuracy and layout of the work.

B. The Contractor shall review the Contract Drawings and any discrepancies shall be reported to the Engineer for clarification prior to starting fabrication.

PART 2 - PRODUCTS

2.01 MISCELLANEOUS METAL SHAPES, CASTINGS, BOLTS AND ACCESSORIES:

A. Structural Steel Shapes:

1. W Shapes: ASTM A992, 50 ksi

2. HSS Round Shapes: ASTM A500, Grade B, 42 ksi

3. Pipe Shapes: ASTM A53, Grade B, 35 ksi

4. Plates and Bars: ASTM A36

5. Steel Sheets: ASTM A366

B. High Strength Bolts for Steel Members ASTM A325

C. Steel Washers ASTM F436

D. Plain Unhardened Steel Washers: ASTM F844

E. Anchor Bolts: ASTM F1554, Grade 36 standard headed bolts with heavy hex nuts, Grade A washers, hot-dip galvanized, unless otherwise specified.

F. Galvanizing: ASTM A123, Zn w/0.5 percent minimum Ni.

G. Galvanizing, hardware: ASTM A153, Zn w/0.5 percent minimum Ni.

2.02 POST INSTALLED ANCHORS:

A. Adhesive Anchors:

1. Products:

a. Hilti Corporation, HIT-HY 200 Adhesive Anchoring System

b. Powers Fasteners, PE1000+ Epoxy Adhesive Anchoring System

c. Simpson Strong Tie, SET-XP Epoxy-Tie or Acrylic-Tie

2. General:

a. Adhesive anchors shall be hot-dipped galvanized.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Upon receipt of material at job site, inspect all materials for shipping damage. Replace damaged items at no cost to Owner.

B. Examine supports for size, layout and alignment.

C. Correct defects considered detrimental to proper installation.

3.02 INSTALLATION:

A. Provide items such as bolts, shims, blocks, nuts, washers, and wedging pieces to complete installation.

B. Erect to lines and levels, plumb and true, and in correct relation to adjoining Work. Secure parts using concealed connections when practicable.

C. Plumb and true vertical members to tolerance of +/- 1/8 inch in 10 feet. Level horizontal members to tolerance of +/- 1/8 inch in 10 feet.

D. Use steel bolts to connect structural steel members.

E. Anchor Bolts and Concrete Anchors:

1. Preset anchor bolts using templates. Do not use concrete anchors in place of anchor bolts.

2. After anchor bolts are embedded, protect projecting threads by applying grease and having the nuts installed until the time of installation of equipment or metalwork.

3. Do not install concrete anchors until concrete has reached specified minimum compressive strength.

4. Install concrete anchors in accordance with anchor manufacturer recommendation. Embedment depth of anchor shall be as recommended by the anchor manufacturer, but not less than as shown on Contract Drawings.

5. Locate concrete anchors to clear reinforcing bars in concrete.

F. Weld headed anchor studs in accordance with manufacturer's recommendations.

G. Do not place new holes or enlarge unfair holes by use of cutting torch.

3.03 REPAIR AND PROTECTION:

A. Field repair of damaged galvanized coatings:

1. Clean and repair Zinc coating that has been burned by welding, abraded, or otherwise damaged after installation. Clean damage area by wire brushing and removing all traces of welding flux and loose or cracked zinc coating

2. Coat surfaces using zinc-rich paint.

B. Field repair of damaged primer.

1. Touch up abrasions in the shop primer immediately after erection. Paint areas left unprimed for welding with primer after welding.

3.04 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00

END OF SECTION

INFORMATION ONLY

SECTION 23 21 23

PUMP PROCUREMENT SPECIFICATION

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This Specification and all other documents referenced therein, shall define the minimum requirements for the design, materials, fabrication, tests, and inspection of the pumps. However, if there are discrepancies between the referenced documents and this Specification, the Supplier shall notify the Company.

1.2 APPLICABLE CODES AND STANDARDS

A. In this Specification, the term "code" refers to the document specified and used to design and build the pump. The latest edition and addenda of the following references and standards in effect when the Agreement/Order is issued, form a part of the requirements of this Specification.

B. AFBMA – Anti-Friction Bearing Manufacturers Association

C. ANSI – American National Standard Institute

D. ASTM – American Society for Testing and Materials

E. ASME – American Society of Mechanical Engineers

1. ASME B1.20.1 – Pipe Threads, General Purpose (Inch)

2. ASME B16.5 – Pipe Flanges and Flanged Fittings

3. ASME B31.1 – Power Piping

4. ASME B73.1 – Specification for Horizontal End Suction Centrifugal Pumps for Chemical Process

5. ASME B73.2 – Specification for Vertical Inline Pumps for the Chemical Process

F. HI – Hydraulic Institute Standards

1. Hydraulic Institute Standards for Centrifugal, Rotary, and Reciprocating Pumps

G. OSHA – Occupational Safety and Health Administration

1.3 DEFINITIONS

A. Buna-N: Nitrile rubber.

B. EPT: Ethylene propylene terpolymer.

1.4 ACTION SUBMITTALS

A. Product Data: For each pump, furnish a certified performance curve based on the specified fluid at its design service conditions (gpm, temperature, TDH, etc.) and final impeller dimensions. Indicate the pump's operating point on the curve.

1. Furnish detailed documents for all furnished accessories.

2. Furnish spare parts list (prices) for one year operation and maintenance.

B. Shop Drawings: For each pump.

1. Show pump layout and connections.

2. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.

3. Include diagrams for power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Documents: Furnish emergency and normal operation procedures and conformed maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra (spare) materials described below that match products furnished, and package them with protective covering for storage and identified with labels describing contents, and maintenance part number(s).

1. Mechanical Seals: One mechanical seal for each pump.

2. Recommended Commissioning spare parts for each pump.

PART 2 - PRODUCTS

2.1 SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS

A. Return Water pumps: RWP-PMP-001 and RWP-PMP-002.

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated, or an equivalent, Company-approved alternate:

1. Flowserve Corporation-Durco Mark 3 Unitized Self-Priming Pump.

C. Description: Factory-assembled and tested, centrifugal, overhung-impeller, separately coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal.

D. The construction of the centrifugal pumps shall be in full compliance with ASME B73.1 and B73.2 – Specification for Horizontal End Suction or Vertical Inline Centrifugal Pumps for Chemical Process and the specific requirements of HI Standards. Except that pumps shall be Self-Priming configuration.

E. Wetted components shall be compatible with the chemicals and chemical concentrations listed in Attachment 1A.

F. A rigid base mount for maximum resistance to loads shall support the horizontal pump, motor, and accessories.

G. Suction and discharge connections shall be flanged conforming to ASME B16.1 or ASME B16.5 as applicable. Gasketed surface of flanges shall be serrated finish in accordance with ASME B16.5, Section 6.4.4.1. Supplier to supply allowable flange loadings and nozzle loadings and they shall be within the limits defined in ASME Codes.

H. Pump Construction:

1. Casing: Radially split, CF8M Type 316 Stainless Steel, 2205 Duplex stainless steel (ASTM A 479/182 UNS 32205), super duplex or CD4MCuN, with threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and flanged connections. Provide integral mount on volute to support the casing and allow removal and replacement of impeller without disconnecting piping or requiring the realignment of pump and motor shaft.

2. Impeller: CF8M Type 316 Stainless Steel, CD4M/CD4MCuN; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For pumps not frequency-drive controlled, trim impeller to match specified performance.

3. Pump Shaft: Type 316 Stainless Steel or 2205 Duplex stainless steel (ASTM A 479/182 UNS 32205).

4. Seal: Pumps shall be supplied with mechanical seals (single or double). Supplier shall select and/or confirm materials and design for the mechanical seals to suit the pumping application, design service conditions, and pumped fluid.

5. Pump Bearings: Grease-lubricated ball bearings in cast-iron housing with grease fittings. Bearings shall have a minimum L10 life of 100,000 hours at design load.

I. Shaft Coupling: Flexible coupling shall be provided. Spacer type couplings shall be used when required to facilitate pump disassembly. Coupling service factor shall be as recommended by coupling manufacturer. Couplings shall be balanced by coupling manufacturer.

J. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.

K. Mounting Baseplate: Welded-steel frame (continuous, seam welded) with cross members and drip rim, factory fabricated from ASTM A 36/A 36M plate, channels and angles. Fabricate to mount pump casing/bearing housing, coupling guard, and motor.

L. Motor: Single speed, secured to mounting baseplate, with adjustable alignment. Furnish motor in accordance with Appendix "A" – Attachments section.

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application. The Supplier shall be responsible for appropriately sizing the motor. However, motors, excluding service factor, shall be non-overloading over the entire pump curve using design impeller diameter. Supplier shall inform Company in the event that this requirement will result in an increase of more than one motor frame size.

2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements.

a. Enclosure: Totally enclosed, fan cooled

b. Enclosure Materials: Cast iron or Cast aluminum.

c. Motor Bearings**:** Grease-lubricated ball bearings.

d. Unusual Service Conditions:

1) Ambient Temperature: 120 deg F.

2) Altitude: 5,330 ft above sea level.

3) High humidity.

e. Efficiency: Premium efficient.

f. NEMA Design: Class "B" temperature rise with Class "F" insulation.

g. Service Factor: 1.15.

M. Capacities and Characteristics:

1. Capacity: *90*~~450~~ gpm

2. Total Dynamic Head: *270*~~275~~ feet.

3. NPSHa: 6 psia

~~4. Maximum Operating Pressure: 120 psig.~~

~~5.~~*4. Maximum*~~Minimum~~ Allowable Working Pressure (Pump Casing): 285 psig

~~6.~~*5.* Maximum Fluid Temperature: 105 deg F.

~~7.~~*6.* Maximum Continuous Operating Temperature: 225 deg F.

~~8.~~*7.* Inlet and Outlet Size: TBD by Vendor.

~~9.~~*8.* Impeller Size: TBD by Vendor inches.

~~10.~~*9.* Motor Speed: 3550 rpm

~~11.~~*10.* Motor Horsepower: *TBD by Vendor*~~75~~ hp.

~~12.~~*11.* Electrical Characteristics:

a. Volts: 460

b. Phase: Three.

c. Hertz: 60.

d. Full-Load Amperes: *TBD by Vendor*~~56~~

~~13.~~*12.* Pumped Fluid: See Attachment 1A of this Specification.

2.2 SEPARATELY COUPLED, IN-LINE, VERTICAL CENTRIFUGAL PUMPS

A. Pond 3 Pump House Pumps: P3PH-PMP-001 and P3PH-PMP-002.

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated, or an equivalent, Company-approved alternate:

1. Flowserve Corporation-Durco Mark 3 In-Line Chemical Process Pumps.

C. Description: Factory-assembled and tested, centrifugal, overhung-impeller, separately coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for in-line mounting, with pump and motor shafts vertical.

D. The construction of the centrifugal pumps shall be in full compliance with ASME B73.1 and B73.2M – Specification for Horizontal End Suction or Vertical In-line Centrifugal Pumps for Chemical Process and the specific requirements of HI Standards.

E. Wetted components shall be compatible with the chemicals and chemical concentrations listed in Attachment 1B.

F. A rigid base mount for maximum resistance to loads shall support the In-line pump, motor, and accessories.

G. Suction and discharge connections shall be flanged conforming to ASME B16.1 or ASME B16.5 as applicable. Gasketed surface of flanges shall be serrated finish in accordance with ASME B16.5, Section 6.4.4.1. Supplier to supply allowable flange loadings and nozzle loadings and they shall be within the limits defined in ASME Codes.

H. Pump Construction:

1. Casing: Radially split, *ductile iron*~~cast iron~~, with threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and flanged connections. Provide integral mount on volute to support the casing and allow removal and replacement of impeller without disconnecting piping or requiring the realignment of pump and motor shaft.

2. Impeller: CF8M Type 316 Stainless Steel or CD4M/CD4MCuN; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For pumps not frequency-drive controlled, trim impeller to match specified performance.

3. Pump Shaft: Type 316 Stainless Steel or 2205 Duplex stainless steel (ASTM A 479/182 UNS 32205).

4. Seal: Pumps shall be supplied with mechanical seals (single or double). Supplier shall select and/or confirm materials and design for the mechanical seals to suit the pumping application, design service conditions, and pumped fluid.

5. Pump Bearings: Grease-lubricated ball bearings in cast-iron housing with grease fittings. Bearings shall have a minimum L10 life of 100,000 hours at design load.

I. Shaft Coupling: Flexible coupling shall be provided. Spacer type couplings shall be used when required to facilitate pump disassembly. Coupling service factor shall be as recommended by coupling manufacturer. Couplings shall be balanced by coupling manufacturer.

J. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.

K. Mounting Baseplate: Baseplate, fabricate of steel (continuous, seam welded) to mount pump casing, coupling guard, and motor in a vertical configuration.

L. Motor: Single speed, secured to mounting baseplate, with adjustable alignment. Furnish motor in accordance with Appendix "A" – Attachments section.

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application. The Supplier shall be responsible for appropriately sizing the motor. However, motors, excluding service factor, shall be non-overloading over the entire pump curve using design impeller diameter. Supplier shall inform Company in the event that this requirement will result in an increase of more than one motor frame size.

2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements.

   a. Enclosure: Totally enclosed, fan cooled

   b. Enclosure Materials: Cast iron or Cast aluminum.

   c. Motor Bearings**:** Grease-lubricated ball bearings.

d. Unusual Service Conditions:

1) Ambient Temperature: 120 deg F.

2) Altitude: 5,330 ft above sea level.

3) High humidity.

e. Efficiency: Premium efficient.

f. NEMA Design: Class "B" temperature rise with Class "F" insulation.

g. Service Factor: 1.15.

M. Capacities and Characteristics:

1. Capacity: 130 gpm

2. Total Dynamic Head: *475*~~500~~ feet.

3. NPSHa: 11 psia

~~4. Maximum Operating Pressure: 214 psig.~~

~~5.~~*4.* *Maximum*~~Minimum~~ Allowable Working Pressure (Pump Casing): 285 psig

~~6.~~*5.* Maximum Fluid Temperature: 105 deg F.

~~7.~~*6.* Maximum Continuous Operating Temperature: 225 deg F.

~~8.~~*7.* Inlet and Outlet Size: 3 x 1-1/2

~~9.~~*8.* Impeller Size: 10.38 inches.

~~10.~~*9.* Motor Speed: 3550 rpm

~~11.~~*10.* Motor Horsepower: 100 hp.

~~12.~~*11.* Electrical Characteristics:

a. Volts: 460

b. Phase: Three.

c. Hertz: 60.

d. Full-Load Amperes: 115.

~~13.~~*12.* Pumped Fluid: See Attachment 1B of this Specification.

PART 3 - EXECUTION

Not Used

Attachments:

1. Attachment 1A – Pumped Fluid Analysis Table – Return Water Pumps
2. Attachment 1B – Pumped Fluid Analysis Table – Pond 3 Pump House Pumps

ATTACHMENT 1A

PUMPED FLUID ANALYSIS TABLE – RETURN WATER PUMPS

Attachment 1A

Client/Location: APS - Four Corners	Date Sampled:	5/30/2018
Sample Name: Lined Water Impound	Date Received:	6/6/2018

Procedure	Results*	Reporting Limit	Method
pH	3.13	0.100	D-1293
Alkalinity "P" (as CaCO3)	---	2.000	D-1067-B
Alkalinity, Total (as CaCO3)	---	2.000	D-1067-B
Conductivity (µS)	47,710	0.100	D-1125-A
Calcium Hardness (as CaCO3)	1,024	6.113	Calc
Total Hardness (as CaCO3)	22,939	8.408	Calc
Chloride	5,725	1.000	D-512-B
Nitrate	95.00	0.100	Hach 8039
Phoshate	---	90.16	Calc
Silica	71.12	24.42	Calc
Sulfate	42,395	33.39	Calc

** Results reported as mg/L unless otherwise stated*

Element	Results*	Reporting Limit	Method
Aluminum (as Al)	22.44	13.49	EPA 200.7
Arsenic (as As)	---	4.475	EPA 200.7
Boron (as B)	496.0	22.97	EPA 200.7
Calcium (as Ca)	409.9	2.448	EPA 200.7
Chromium (as Cr)	---	0.345	EPA 200.7
Copper (as Cu)	---	1.483	EPA 200.7
Iron (as Fe)	2.556	0.376	EPA 200.7
Potassium (as K)	166.8	10.27	EPA 200.7
Magnesium (as Mg)	9,908	5.643	EPA 200.7
Manganese (as Mn)	3.461	0.337	EPA 200.7
Molybdenum (as Mo)	---	6.344	EPA 200.7
Sodium (as Na)	3,760	7.692	EPA 200.7
Nickel (as Ni)	---	1.474	EPA 200.7
Phosphorous (as P)	---	29.41	EPA 200.7
Lead (as Pb)	---	5.167	EPA 200.7
Sulfur (as S)	14,151	11.15	EPA 200.7
Selenium (as Se)	---	6.063	EPA 200.7
Silicon (as Si)	33.24	11.42	EPA 200.7
Zinc (as Zn)	---	1.623	EPA 200.7

** Results reported as mg/L unless otherwise stated*
--- Below Reporting Limit

ATTACHMENT 1B

PUMPED FLUID ANALYSIS TABLE – POND 3 PUMP HOUSE PUMPS

Attachment 1B

Client/Location: APS - Four Corners		Date Sampled:	11/2015 - 09/2016
Sample Name: Pond Seepage Pump House Discharge		Date Received:	---
Procedure	Results*	Reporting Limit	Method
pH	7.5	1.68	D-1293
Alkalinity "P" (as CaCO3)	---	2.000	D-1067-B
Alkalinity, Total (as CaCO3)	390	6.000	D-1067-B
Conductivity (µS)	---	0.100	D-1125-A
Calcium Hardness (as CaCO3)	430	2.0	Calc
Total Hardness (as CaCO3)	---	17.54	Calc
Chloride	920	200	D-512-B
Nitrate	33	0.100	Hach 8039
Phoshate	---	188.1	Calc
Silica	13	0.21	Calc
Sulfate	11,000	400	Calc
** Results reported as mg/L unless otherwise stated*			

Element	Results*	Reporting Limit	Method
Aluminum (as Al)	---	28.15	EPA 200.7
Arsenic (as As)	---	9.336	EPA 200.7
Boron (as B)	42	0.050	EPA 200.7
Calcium (as Ca)	---	5.107	EPA 200.7
Chromium (as Cr)	---	0.719	EPA 200.7
Copper (as Cu)	---	3.094	EPA 200.7
Iron (as Fe)	---	0.783	EPA 200.7
Potassium (as K)	46	0.50	EPA 200.7
Magnesium (as Mg)	1,100	20	EPA 200.7
Manganese (as Mn)	---	0.702	EPA 200.7
Molybdenum (as Mo)	---	13.23	EPA 200.7
Sodium (as Na)	3,400	5.0	EPA 200.7
Nickel (as Ni)	0.29	0.0020	EPA 200.7
Phosphorous (as P)	---	61.34	EPA 200.7
Lead (as Pb)	---	10.78	EPA 200.7
Sulfur (as S)	---	23.25	EPA 200.7
Selenium (as Se)	---	12.65	EPA 200.7
Silicon (as Si)	---	23.81	EPA 200.7
Zinc (as Zn)	---	3.386	EPA 200.7
** Results reported as mg/L unless otherwise stated* *--- Below Reporting Limit*			
Total Dissolved Solids	17,000 - 22,000	200	Calc

END OF SECTION

SECTION 26 05 10

ELECTRICAL WORK – GENERAL

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide complete and operational systems electric power systems, grounding systems and other specified systems, including the installation and wiring of miscellaneous equipment and devices. Perform all work and testing as indicated and specified.

1. Provide conduit, wiring and connections for power, control, lighting, instrumentation and alarms for equipment furnished by others unless otherwise specified and indicated.

2. Provide temporary circuits, overcurrent devices, conduit and wiring, and other equipment required during construction and change-over from existing to proposed electric system. Perform work at the convenience of the Owner.

3. Raceways supports and equipment anchoring shall be provided as specified in the Division 26 sections which form a part of the Contract Documents.

4. Disconnecting, removing, and relocating existing electrical equipment is a part of this Contract as indicated on the drawings or specified. Make equipment scheduled for removal free of shock hazard.

5. Provide electrical relocation work associated with the relocation of equipment for existing and new facilities, including disconnecting all existing wiring and conduits and providing new wiring and conduit to the relocated equipment. Make equipment scheduled for relocation free of electrical shock hazard.

6. The equipment enclosure classification of the plant areas are outdoors for the project. Provide all equipment, devices and material meeting the requirements for these area classifications unless otherwise noted or specified.

7. Install the electrical system in a manner that avoids conflicts with manholes, catch basins, etc. provided under other Divisions of the specifications

1.02 REFERENCES:

A. National Fire Protection Association (NFPA):

1. 70: National Electrical Code (NEC).

1.03 SEQUENCING AND SCHEDULING:

A. Coordinate electrical equipment installation with other disciplines.

B. Sequence, coordinate and integrate the installation of electrical materials and equipment for efficient flow of the work.

C. Sequencing and scheduling work at existing facilities:

1. Remove and demolish equipment and materials in such a sequence that the existing and proposed facility will function properly with no disruption of power to required facilities. Continuous service is required on all circuits and outlets affected by the work detailed in the contract, except where the Owner will permit an outage for a specific time. Obtain Owner's consent before removing any circuit from continuous service.

2. Coordinate electrical power outages to the electrical systems and equipment with the Owner. Where duration of proposed outage cannot be allowed by the Owner, phase the work to allow the system or equipment to be re-connected to the electrical power system within the time frame allowed by the Owner or provide temporary power connections as required to maintain service to the systems or equipment. The temporary power can be from a generator or another part of the facility not affected by the outage provided there is sufficient spare capacity.

1.04 QUALITY ASSURANCE:

A. Provide in accordance with Section 01 43 00 and as specified.

B. Install electrical work in conformance with latest rules and requirements of National Fire Protection Association Standard No. 70 (National Electrical Code) and in accordance with requirements of State and Local Codes.

1.05 QUALIFICATIONS OF ELECTRICAL SUBCONTRACTOR

A. The Electrical Subcontractor shall have been engaged in work of a similar nature to this contract for the past 5 years.

B. The Electrical Subcontractor shall have a minimum of five projects of equal or greater size with the type of equipment specified under this project.

1.06 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00:

1. The following defines a minimum for all Division 26 shop drawing and data submittals:

a. Submit shop drawings delineated by specification number with all information for one piece of equipment provided as one package.

b. Partial submittals will be returned without action.

c. Submit bills of material: Include a numbered list of all components, with manufacturer's name, catalog number, rating, and other identification. Place

item number or similar identification on all other drawings where item appears.

d. Submittal shall include:

(1) Manufacturer's drawings

(2) Panel layout

(3) Equipment layout

(4) Schematic diagram

(5) One line diagram

(6) Control sequence diagrams

(7) Interconnection diagrams

(8) Wiring diagrams

(9) Catalog data

e. Submit only completed drawings showing all local and remote devices associated with each item.

f. Mark shop drawings and data submitted showing only items applicable to specific contract.

g. Where additions and modifications are made to existing equipment, provide drawings which include both retained existing equipment and new work.

h. Submit time-current characteristic curves for all submitted protection devices such as circuit breakers and fuses.

i. Submit other documentary or descriptive information as required for each assembly to demonstrate compliance with the applicable contract documents.

2. Shop drawings and data are required for the following list:

a. Starting Equipment Data List -Submit blank list initially to verify acceptable format. Submit final list at completion of the project.

b. Conduit and Fittings

c. Wire and Cable

d. Ladder Type Cable Tray and Fittings

e. Wiring Devices

f. Transformers

g. Grounding Equipment and Devices

h. Panelboards

i. Lighting Fixtures and Accessories

j. Electric Heat Tracing

k. Control Stations

l. Enclosures

m. Control Panels

n. Safety Switches

o. Field Acceptance Test Reports

p. Record Drawings

1.07 NAMEPLATES AND LABELING:

A. Provide nameplates and labels as indicated on drawings.

1.08 INTERFERENCE AND ERRONEOUS LOCATIONS:

A. Locations of electrical equipment, devices, outlets, and similar items, as indicated, are approximate only. Exact locations shall be determined during construction.

B. Verify in field, all data and final locations of work installed under other sections of specifications, required for placing of electrical work.

C. In case of interference with other work or erroneous locations with respect to equipment or structures, furnish all labor and materials to complete the work.

1.09 APPROVAL AND MARKING EQUIPMENT:

A. Insure that devices and materials are listed and/or labeled by UL, wherever standards have been established by that organization. Where a UL listing is not available for equipment, submit certified test reports of a Nationally Recognized Testing Laboratory (NRTL), approved by the local inspecting authority, indicating that equipment is in conformance with local code requirements or any other applicable requirements. Tests and inspections for approval of equipment shall be performed at no additional cost to Owner.

B. Clearly mark equipment, devices and material with name or trademark of manufacturer and rating in volts and amperes and other pertinent information on a nameplate.

1.10 ELECTRIC SERVICE:

A. Electrical power system for the major equipment operates at 480 volt, 3-phase, 3 wire, 60 Hertz.

1. Provide electrical low voltage distribution system that operates on 208/120 volt, 3-phase and 60 Hertz obtained from the power system by dry-type transformer(s).

1.11 EQUIPMENT SPECIFIED ELSEWHERE:

A. Certain items of control equipment and other equipment are indicated on electrical drawings for connection, but are specified in other sections pertaining to plumbing, heating, ventilating and air conditioning, mechanical process, instrumentation, etc. Such items are not furnished as part of electrical work.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

3.01 REMOVAL AND RELOCATION OF MATERIAL AND EQUIPMENT:

A. Carefully dismantle and salvage electrical equipment, switches, fixtures, conduits, cables, wiring, boxes, as necessary to carry out proposed changes. Rehabilitate and relocate items of equipment as required and as indicated or specified.

1. Deliver material and equipment not indicated for reuse to Owner for his disposal.

B. Remove from site and dispose of material and equipment not indicated for reuse.

3.02 WORK IN EXISTING STRUCTURES:

A. In general, any or all existing electrical equipment and services are to remain in operation and shall not be disturbed unless otherwise noted in these Specifications and/or on the drawings or as required for the proper execution of the work.

B. In each area of the work, disconnect and carefully remove the existing electrical equipment and devices so noted. With the exception of items indicated as having to be re-used, all such existing equipment and devices shall be disposed of as specified herein. If not required by the Owner, remove them from the premises and site. All existing electrical equipment and devices indicated as not removed or abandoned are to be maintained in operation and any circuits disturbed by the construction shall be restored.

C. Maintain existing electrical services and systems to and in the buildings throughout the project and all “down-time” shall be scheduled at least two weeks in advance with the permission of the Engineer’s Representative and such scheduling shall be rigidly adhered to.

3.03 DEMOLITION:

A. Survey the existing electrical systems and equipment identified for removal with representatives from the other trades prior to performing any demolition work. Identify all conduit and equipment to be removed with tags or paint.

B. Where a piece of equipment is to be removed all associated ancillary components (e.g. solenoid valves, pressure switches, etc.) and associated wiring and conduit shall also be removed.

C. Equipment, building or structures scheduled for complete demolition shall be made safe from electrical shock hazard prior to demolition. Disconnect all electrical power, communications, alarm and signal system.

D. Equipment scheduled to be turned over to the Owner shall be carefully disconnected, removed and delivered to the Owner where indicated. Provide labor, hoisting and transportation of the equipment. All other miscellaneous electrical materials, devices, etc., associated with the equipment being turned over shall be demolished and removed from the site.

E. Remove electrical work associated with equipment scheduled for demolition except those portions to remain or be reused.

F. Unless otherwise specifically noted, remove unused exposed conduit and support systems back to point of concealment including abandoned circuit above accessible ceiling finishes. Removed unused wiring back to source (or nearest point of usage).

G. Disconnect abandoned outlets and removed devices. Removed abandoned outlets if conduit services them is abandoned or being removed. Provide blank covers for abandoned outlets which are not removed.

H. Disconnect and remove abandoned electrical equipment unless otherwise indicated or specified.

I. Disconnect and remove abandoned luminaries. Remove brackets, stems, hangers and other accessories.

J. Where electrical systems pass through the demolition areas to serve other portions of the premises, they shall remain or be suitably relocated and the system restored to normal operation.

K. The electrical and process equipment to be removed or relocated under this contract has been identified on the Drawings.

L. Trace out existing wiring that is to be relocated, or removed and perform the relocation or removed work as required for a complete operating and safe system.

M. Remove exposed conduits, wireways, outlet boxes, pull boxes and hangers made obsolete by the alterations, unless specifically designated to remain. Patch surfaces and provide blank covers for abandoned outlets which are removed.

N. All equipment, materials, controls, motor starters, branch and feeder breakers, panelboards, transformers, wiring, raceways, etc. furnished and installed to the temporarily keep circuits energized shall be removed when the permanent installation is fully operational.

3.04 PROTECTION OF ELECTRICAL EQUIPMENT:

A. Store equipment in compliance with manufacturer's recommendations and as specified herein.

B. Protect electrical equipment from the weather, especially from water dripping or splashing upon it, at all times during shipment, storage, and construction.

C. Do not store equipment outdoors.

D. Where equipment is installed or stored in moist areas, or unheated buildings, provide acceptable means to prevent moisture damage. Provide uniformly distributed source of heat in electrical equipment to prevent condensation and damage to electrical insulation systems.

3.05 DEFECTIVE OR DAMAGED EQUIPMENT:

A. Damaged equipment shall not be used. Equipment damaged in shipment, storage, installation or through other means shall be replaced without additional cost to the Owner.

B. All equipment showing signs of water damage shall be rejected regardless of dielectric test results.

C. All electrical equipment is considered "in storage" regardless of location until first energized. Manufacturer's recommendations for storage precautions, conditions and care shall be followed.

3.06 STARTING EQUIPMENT DATA LIST:

A. Obtain data from the equipment supplier shop drawing submittals or equipment nameplates, and prepare a complete tabulation of all motors over 1/3 hp, and related starting equipment, to be furnished on the project.

1. Include in tabulation firm the following information:

a. Name and identification of equipment.

b. Manufacturer.

c. Horsepower or kilowatt rating.

d. Voltage.

e. Phase.

f. Speed.

g. Full load current.

h. Locked rotor current or code letter.

i. Type of enclosure (open drip-proof, totally enclosed, fan cooled, etc.).

j. NEMA size of starter or contactor.

k. Overload heater size.

l. Type of starter (full-voltage, reduced-voltage, autotransformer, etc.).

m. Breaker trip setting or fuse size.

n. Voltage of starter operating coil.

o. If starter is at a motor control center, list motor control center number.

2. Final acceptance of the electrical system is contingent upon submittal of the complete tabulation.

3. Furnish six copies of the tabulation to the Engineer when a submission is made.

3.07 DRAWINGS AND SPECIFICATIONS:

A. Drawings and specifications are typical of work to be done and of the arrangement desired. Provide accessories and appurtenances which the Engineer deems functionally necessary for a complete installation, whether or not explicitly indicated or described.

3.08 AS-BUILT DRAWINGS:

A. The Contractor shall maintain a master set of as-built drawings showing the changes and deviations from the contract drawings.

B. A minimum of 30 days prior to application for Final Payment, submit two sets of drawings for approval that are marked to show the as-installed equipment, devices, raceway locations and wiring. The markings on the drawings are to be neat, clean and legible.

3.09 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 26 05 20

ELECTRIC WIRES AND CABLES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide wires and cables for complete electrical systems as indicated and specified.

1.02 REFERENCES:

A. ASTM International (ASTM):

1. B3: Soft or Annealed Copper Wire.

2. B8: Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.

B. Insulated Cables Engineers Association, Inc. (ICEA)/National Electrical Mfg's Association (NEMA):

1. S-61-4021/WC 5: Thermoplastic Insulated Wire & Cable.

C. National Fire Protection Association (NFPA):

1. 70: National Electrical Code (NEC).

D. Underwriters Laboratories, Inc. (UL):

1. 83: Thermoplastic-Insulated Wires and Cables.

1.03 SUBMITTALS:

A. Submit shop drawings in accordance with Section 01 33 00.

B. Submit shop drawings and manufacturers' product data in accordance with requirements of Section 26 05 10.

1.04 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in Section 01 60 00.

B. Deliver wire and cables in full reels protected against injury. Deliver reels with factory attached UL approved tags showing the manufacturers name and the type of insulation, size, and length of wire in each coil or reel.

C. Accept wire and cable on site in manufacturer's packaging. Inspect for damage.

D. Store and protect in accordance with manufacturer's instructions.

E. Protect from weather. Provide adequate ventilation to prevent condensation.

1.05 DESIGN CRITERIA:

A. Wire for lighting, single phase circuits shall be Type XHHW or THWN-THHN.

B. Wire for three phase circuits shall be Type XHHW.

C. Single conductor wire for control, indication and metering shall be Type THWN-THHN No. 12 or 14 AWG, stranded.

D. Multi-conductor control cable shall be used for the underground system and shall be No. 12 or 14 AWG, stranded with overall jacket.

E. Ground wires shall be Type THW, green. Bare ground wires shall be soft drawn copper, 98 percent conductivity.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. 600V Cable:

1. Okonite.

2. Southwire.

3. American Insulated Wire.

B. Control and Metering Wire:

1. Belden Wire and Cable.

2. Alpha Wire.

3. Coleman Cable.

2.02 MATERIALS AND COMPONENTS:

A. Furnish copper conductors. Material and stranding of conductors to conform to ASTM B3, and to ASTM B8, for the appropriate class.

B. Uncoated, soft or annealed copper wire conforming to ASTM B3.

C. Wires and Cables for Maximum 600-Volt Power Circuits: For No. 8 AWG gauge and smaller provide type THWN/THHN or RHW. Where used in lighting or receptacle branch circuits provide No. 12 AWG gauge and No. 10 AWG gauge as solid conductor. Provide other wire with Class C stranding. Provide No. 6 AWG gauge and larger as XHHW-2 with Class B stranding. Provide wires and cable conforming to UL 83.

D. Wires and Cables for Control, Indicating, Metering, or Alarm Circuits: Single and multi-conductor control cable, copper conductors, Class B or C stranding. Insulation; 600-volt polyethylene, polyvinylchloride. Continuous rating of 90C dry and 75C wet. Color coding conforming to Table K-2, ICEA/NEMA S-61-4021/WC 5.

E. Shielded Cable for Instrumentation Wiring: 7-strand copper conductors, size No. 16 AWG. Insulate conductors individually with color coded polyethylene or polyvinylchloride. Twist pairs with varying lay (if more than one pair) and cover with cable tape and copper or aluminum coated Mylar shielding tape and tinned copper drain wire. Jacket: polyvinylchloride. Cables: rated 600 volts and 90 degrees C.

PART 3 - EXECUTION

3.01 GENERAL:

A. Perform work in accordance with the National Electrical Code.

B. Provide power cable identification as follows:

System Voltage	Neutral	Phase A	Phase B	Phase C
240/120V	White	Black	Red	N/A
480/277V	Gray	Brown	Orange	Yellow

C. Use green to identify insulated ground conductors.

NOTE: Colored insulation, tapes or sleeves may be used to provide color coding. Insulated ground conductors must have green covering.

D. Permanently post means of identification of grounded and ungrounded conductors for each nominal voltage system at each panelboard and motor control center.

E. In power and multiconductor cables manufactured without a grounding conductor identify one of the multiconductors as the equipment grounding conductor at each cable end and at every point where the conductors are accessible.

3.02 INSTALLATION OF WIRING:

A. Unless otherwise indicated, use no conductor smaller than No. 12 AWG for power, No. 14 AWG for control, and No. 16 AWG for shielded applications.

B. Install conductors continuous from outlet to outlet and make no splices except within outlet or junction boxes.

C. Install cable in underground raceway system without splices. There shall be no splices between connection points unless otherwise indicated.

D. Pull all conductors contained within a single conduit at the same time.

E. Apply wire pulling compound to conductors being drawn through conduits. Use pulling compound, Minerallac No. 100, Y-er-Eas, Yellow 77, High Performance Polywater Cable Lubricant or acceptable equivalent.

F. Use no cable bend with radius of less than eight times its diameter.

G. Wires and cables installed without prior submittal review are subject to removal at no additional expense.

3.03 CONDUCTOR IDENTIFICATION:

A. Label each wire at both termination points. Carry individual conductor or circuit identification throughout, with circuit numbers or other identification clearly stamped on terminal boards and printed on directory cards in distribution cabinets and panelboards.

B. Identify each wire in junction boxes, cabinets, and terminal boxes where total number of control, indicating, and metering wires is three or more and no terminal board is provided, including all power wire. Where no termination is made use a plastic-coated, self-adhesive, wire marker and where termination is made use a, plastic, pre-printed sleeve wire marker.

C. In cases similar to above where terminal boards are provided for the control, indicating, and metering wires, identify all wires including motor leads and other power wires too large for connection to terminal boards, by sleeve wire markers as specified above.

D. In manholes and handholes, identify each power wire by laminated plastic tag located so it is easily seen. Control wires to be bundled and marked as listed in conduit and wire schedule.

3.04 CONNECTORS, TERMINAL LUGS AND BOARDS:

A. For wiring of circuits consisting of No. 10 or No. 12 AWG solid wires, such as for lighting branch circuits, use self-insulated pressure type connectors for all splices or joints.

B. Terminate all wires connected to terminal boards, terminal blocks, or to other similar terminals by means of ring and tongue, nylon self-insulated, tin-plated copper pressure terminals.

C. Terminal boards shall be 600 volts and rated for 125 percent of the ampacity of the connected circuit. They shall have screw terminals, with white marking strips for wire identification, of the 4-, 6-, 8-, or 12-pole type, as necessary.

D. Wire connections for which terminals are not supplied, for example, at solenoids or motor terminal junction boxes:

1. 10 AWG and smaller: Use self insulated pressure-type connectors.

2. 8 AWG and larger: Use insulated, mechanical type with set screw or follower bearing directly on the wire. Split bolt connectors are not acceptable.

E. Clearly and permanently mark terminal strips with ink or indelible pencil. Mark each wire consistently throughout entire system, using notation of wires given on manufacturer's wiring diagrams wherever possible.

3.05 FIELD TESTING:

A. Submit results of all cable tests on forms indicating cable size, voltage, and date with name of tester and witness.

3.06 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide a single, complete, integrated grounding system, including conductors, raceways, and connections, indicated and specified, and in accordance with the National Electrical Code Article 250 and the National Electrical Safety Code.

B. Include grounding of switchgear, substations, motor control centers, electric equipment enclosures etc., outdoor substations, transformers, switch structures, etc.; ground grid systems with ground rod and water pipe connections; structural steel, and lightning protection system.

C. Include grounding conductors completely inter-connecting water supply pipe, ground rods, ground grid, substation, switchgear and motor control center ground buses, other distribution equipment, and other groundable equipment.

1.02 REFERENCES:

A. American National Standards Institute (ANSI)/Institute of Electrical and Electronics Engineers (IEEE):

1. ANSI/IEEE C2: National Electrical Safety Code.

B. ASTM International (ASTM):

1. B3: Standard Specification for Soft or Annealed Copper Wire.

2. B8: Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.

C. Institute of Electrical and Electronics Engineers (IEEE):

1. Standard 81: Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potential of a Ground System.

D. National Fire Protection Association (NFPA):

1. 70: National Electrical Code.

E. Underwriters Laboratories (UL):

1. 467: Standard for Grounding and Bonding Equipment.

1.03 SUBMITTALS:

A. Submit shop drawings in accordance with Section 01 33 00

B. Submit shop drawings and manufacturers' product data in accordance with requirements of Section 26 05 10.

C. Submit catalog and dimensional data for the following:

1. Ground rods

2. Exothermic welding

3. Connecting hardware

D. Submit grounding system test results.

PART 2 - PRODUCTS

2.01 MANUFACTURER'S COMPLIANCE:

A. Manufacturer's acceptance contingent upon products' compliance with the specifications.

2.02 MANUFACTURERS:

A. Ground Rods:

1. ERICO Products Inc.

2. Galvan Electrical Products.

3. Nehring Electrical Works.

B. Exothermic Welding:

1. ERICO Products, Inc.

2. American Brass Mfg. Co.

3. Orgo-Thermit, Inc.

C. Connecting Hardware:

1. American Brass Mfg. Co.

2. Thomas and Betts

3. Anderson Electric Corp.

2.03 MATERIALS AND COMPONENTS:

A. Conductors:

1. Provide copper grounding conductors bare or insulated, sized as indicated. When not indicated on the drawing provide in accordance with the NEC. Provide protection of conductors in locations where physical damage would result from direct exposure.

2. Ground and bond wires for substations, main panels and distribution points, and ground rod connections shall be annealed bare copper conforming to ASTM B3, stranded, with 98 percent conductivity.

3. Equipment ground conductors run with circuit conductors and grounding electrode conductor shall be 600 volt with green insulation, unless noted otherwise on the Contract documents.

4. Unless noted otherwise, all conductors No. 8 AWG and larger shall be stranded, Class B in accordance with ASTM B8.

a. Uninsulated conductors shall be bare copper in accordance with ASTM B3.

B. Connectors and Fasteners:

1. Provide ground clamps which are UL listed for use with each application.

C. Ground Rods:

1. Ground rods shall conform to the requirements of NFPA 70 and UL Standard 467.

2. Ground rods shall be copper-clad steel rods not less than 3/4 inch in diameter and not less than 10 feet long per section.

3. Ground rods shall be clean and smooth with the following characteristics:

a. Cone-shaped point on the first section.

b. Die-stamped near the top with the name or trademark of the manufacturer and the length of the rod in feet.

PART 3 - EXECUTION

3.01 EXOTHERMIC WELDING:

A. Welding shall be by the exothermic process.

B. Within the welding procedure, include the proper mold and powder charge and conform to the manufacturer’s recommendations.

C. Welding processes shall be the exothermic fusion type that will make a connection without corroding or loosening.

D. The welding process shall join all strands and not cause the parts to be damaged or weakened.

E. Completed connection or joint shall be equal or larger in size than the conductors joined and have the same current-carrying capacity as the largest conductor.

F. Paint buried ground connection with a bitumastic paint.

3.02 INSTALLATION OF GROUNDING CONDUCTORS:

A. Install grounding conductors so that they will not be exposed to physical damage. Install connections firm and tight. Arrange conductors and connectors so no strain on connections.

B. Run grounding conductors associated with direct burial cables in common trenches above cables except as indicated otherwise.

C. Bury equipment grounding conductors 30 inches deep. Bring loops or taps up for connection to equipment or other items to be grounded.

D. Where raceways are used to contain and protect grounding conductors, install in accordance with Section 26 05 33.

E. Where bare grounding conductors are contained within metallic raceways, bond ends of raceways to conductors.

F. Install loop type, low impedance, grounding system interconnecting all components so at least two grounding connections are provided for each major item of electrical equipment. Ensure that severing of any single grounding conductor in this system does not remove grounding protection on any major item.

G. Connect structural steel to the external perimeter loop of grounding conductors installed around all sides of building foundation, buried at least 30 inches below grade. Connect to each vertical column by loop or tap. Connect two opposite points on external loop to two different points on grounding system.

H. Buried and concealed ground connections shall use exothermic welding.

I. Make accessible connections to structural members by exothermic welding process or by bolted connector. Connections to equipment or ground bus by bolted connectors.

3.03 INSTALLATION OF GROUND RODS:

A. Install ground rods where indicated. Install the top of the rod 12 inch below the ground surface.

B. Make connection to overall grounding system as indicated.

C. Ensure that final resistance of interconnected ground system is 10 ohms, or less. Measure ground resistance in normally dry conditions, and not less than 48 hours after rainfall.

3.04 EQUIPMENT GROUNDING:

A. Ground each piece of electrical equipment by means of a grounding conductor installed in raceway feeding that piece of equipment. Grounding conductors installed in conduit with insulated conductors to be furnished with green, 600 volt insulation. Ground conductors are in addition to and not to be considered as the neutral wire of the system.

B. Connect power transformer cases and neutrals to grounding system. Connect neutral ground connection at transformer terminal. Provide two separate, independent, diagonally opposite, connections for power transformers so removal of one connection will not impair continuity of other.

C. Connect a grounding conductor between panelboard and grounding system. Where a grounding bar is furnished with panelboard, connect grounding conductor to bar.

D. Conduits entering metal enclosures shall utilize bonding type locknuts and grounding bushings. Locknuts that gouge into the metal enclosures are not acceptable.

E. Where conduits are not effectively grounded by firm contact with a grounded enclosure, apply grounding bushings on at least one end of conduit run. Conduit connections shall be wrench tight.

F. Connect lightning arresters to ground system by suitable conductors. Where lightning arresters are furnished with electrical equipment and grounding connections are not inherently provided, ensure that suitable separate grounding conductor connects lightning arresters with system ground.

G. Ground wire fences. Unless otherwise indicated, provide grounding by buried outside peripheral ground loop; connections to each corner fence post and nearby ground rod; flexible connections to each gate; and at least two connections to grounding system from approximately opposite positions on fence.

H. Connect individual ground rods to the grounding loop using the direct burial grounding cable.

I. Bond individual cable tray sections with bonding jumpers.

3.05 FIELD TESTING:

A. Test grounding systems for ground resistance. Total resistance from any point on the ground network to the building counterpoise must not exceed 50 milliohms.

B. Ground resistance and counterpoise tests must be made during dry weather and no sooner than 48 hours after rainfall. Conditions of soil and weather shall be documented on test forms.

C. Conduct tests using the ratio method that measures the ratio of the resistance to earth of an auxiliary test electrode to the series resistance of the electrode under test and a second auxiliary electrode. Perform measurements in accordance with IEEE Standard 81.

D. Indicating instrument must be self-contained and include a direct-current generator, synchronized current and potential reversers, crossed-current and potential coils, direct-reading ohmmeter, series resistors, and range-selector switch. Calibrate direct-reading ohmmeter for ranges of 0 to 20 ohms and 0 to 200 ohms.

E. Place auxiliary grounding electrodes in accordance with instrument manufacturer's recommendations but not less than 50 feet apart, in accordance with IEEE Standard 81.

F. Perform continuity test on all power receptacles to ensure that the ground terminals are properly grounded to the facility ground system.

G. Furnish copies of test reports on ground system.

3.06 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide supports from building structure for electrical items by means of hangers, supports, anchors, sleeves, inserts, seals, and associated fastenings.

1.02 REFERENCES:

A. ASTM International (ASTM):

1. A123/A123M: Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

2. A653/A653M: Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

3. A924/A924M: Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.

4. E84: Standard Test Method for Surface Burning Characteristics of Building Materials.

5. E119: Standard Method for Fire Tests of Building Construction and Materials.

B. FM Global (FM):

1. Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.

C. National Fire Protection Association (NFPA):

1. 70: National Electrical Code (NEC).

D. Underwriters Laboratories, (UL): Applicable listings.

1. FRD: Fire Resistance Directory.

2. 263: Fire Tests of Building Construction and Materials.

3. 723: Test for Surface Burning Characteristics of Building Materials.

1.03 SUBMITTALS:

A. Submit the following shop drawings in accordance with Section 01 33 00.

B. Submit shop drawings and manufacturers' product data in accordance with the requirements of Section 26 05 10.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Steel or malleable iron.

B. Aluminum where indicated.

2.02 COATINGS:

A. Protect steel and malleable iron supports, support hardware, and fasteners with zinc coating.

B. Provide products for use outdoors.

C. Use PVC coating where indicated on Drawings.

2.03 MANUFACTURED SUPPORTING DEVICES:

A. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps.

B. Fasteners: Types, materials, and construction features as follows:

1. Expansion Anchors: Carbon steel wedge or sleeve type.

2. Toggle Bolts: All steel springhead type.

3. Powder-Driven Threaded Studs: Heat-treated steel, designed specifically for intended service.

4. Nuts, Washers, and Bolts: Stainless steel.

C. Conduit Sealing Bushings: Factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.

D. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Provide plugs with number and size of conductor gripping holes as required to suit individual risers.

E. U-Channel Systems: Channels, with 9/16 inch diameter holes, at minimum of 8 inch on center, in top surface. Provide fittings and accessories that mate and match with U-channel and are of same manufacture.

2.04 U-CHANNEL SYSTEMS:

A. Manufacturers, Stainless Steel/Galvanized Steel Channel.

1. Unistrut Corp.

2. Power-Strut.

3. B-Line Systems, Inc.

B. Provide Type 316 stainless steel channel outdoors with corresponding accessories.

C. Channels, with 9/16 inch diameter holes, at minimum of 8 inch on center, in top surface.

D. Provide fittings and accessories that mate and match with U-channel and are of same manufacture.

E. Provide hot-dipped galvanized after fabrication for steel channel and accessories.

F. Provide channel of the proper material to match equipment classifications.

2.05 FABRICATED SUPPORTING DEVICES:

A. Shop or field fabricate supports or manufacture supports assembled from U-channel components.

B. Brackets: Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install supporting devices to fasten electrical components securely and permanently in accordance with NEC requirements.

B. Coordinate with structural system and with other electrical installation.

C. Raceway Supports: Comply with NEC and following requirements:

1. Conform to manufacturer’s recommendations for selection and installation of supports.

2. Strength of each support shall be adequate to carry present and future load multiplied by safety factor of at least 4. Where this determination results in safety allowance of less than 200 lbs, provide additional strength until there is minimum of 200 lbs safety allowance in strength of each support.

3. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers only for 1 inch and smaller raceways

serving lighting and receptacle branch circuits above suspended ceilings only. For hanger rods with spring steel fasteners, use 1/4-inch diameter or larger threaded steel. Use spring steel fasteners that are specifically designed for supporting single conduits or tubing.

D. Vertical Conductor Supports: Install simultaneously with installation of conductors.

E. Fastening: Unless otherwise indicated, fasten electrical items and their supporting hardware securely to structure, including but not limited to conduits, raceways, cables, cable trays, busways, cabinets, panelboards, transformers, boxes, disconnect switches, and control components.

3.02 CHANNELS:

A. Support electrical components as required to produce same structural safety factors as specified for raceway supports.

B. Install metal U-channel racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices.

C. Install Type 316 stainless steel for mounting of electrical equipment in outdoor areas and on below grade, outside building and structure walls.

D. Install galvanized steel channels for interior building mounting of electrical equipment except for those locations listed above and unless otherwise indicated.

E. Install fiberglass channel in chemical areas with NEMA 4X enclosures.

3.03 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 26 05 33

RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide complete raceway systems, with matching accessories, fittings, boxes, and other hardware, as indicated and specified. When non-metallic raceway systems are specified, provide green insulated grounding conductor sized per National Electrical Code (NEC) requirements.

B. All raceway runs are indicated diagrammatically to outline general routing of raceway. Unless specifically identified for installation in concrete walls or slabs, raceways shall be run exposed with raceway supporting systems. Avoid interfering with pipes, ducts, structural members, or other equipment. Any installation deviations from the contract requirements shall be corrected at no cost to Owner.

C. Provide raceway systems in accordance with the following:

1. In NEMA 12 or NEMA 1 areas, use galvanized rigid steel raceway systems.

2. In NEMA 4 areas, and where subject to wetting or wash down, use galvanized rigid steel raceway systems.

3. In exterior building applications, use galvanized rigid steel raceway systems.

D. All raceway systems shall be installed in accordance with the criteria described in this section. Any proposed deviations from these requirements shall be submitted to the Engineer in writing for review and disposition.

1. Use Type 316 stainless steel support systems for exterior application and in NEMA 4 areas.

2. All NEMA 1 and NEMA 12 areas shall use hot dipped galvanized steel support systems.

E. Aluminum conduit and boxes are not acceptable products.

F. All raceways shall be supported to NEC requirements and to meet all applicable seismic criteria. Raceways 2 inch (50 mm) outside diameter or greater shall be independently supported in a manner to meet the criteria to resist failure during earthquake events. All hardware supports shall be specifically designed for the magnitude of the earthquake event as defined in Section 26 05 10.

1.02 REFERENCES:

A. National Fire Protection Association (NFPA):

1. 70: National Electrical Code (NEC).

B. Occupational Safety & Health Act (OSHA).

1. Regulation 1910.7

C. Underwriter's Laboratories, Inc. (UL):

1. 1: Electrical Flexible Metal Conduit

2. 6: Rigid Metal Electrical Conduit

3. 94: UL Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

4. 360: Electrical Liquid-Tight Flexible Steel

1.03 SUBMITTALS:

A. Submit shop drawings in accordance with Section 01 33 00.

B. Submit shop drawings and manufacturers' product data in accordance with the requirements of Section 26 05 10.

1.04 QUALITY ASSURANCE:

A. Provide in accordance with Section 01 43 00 and as specified.

B. Items provided under this section shall be listed and labeled by UL or other Nationally Recognized Testing laboratory (NRTL).

1. Term “NRTL” shall be as defined in OSHA Regulation 1910.7.

2. Terms “listed” and “labeled” shall be as defined in NFPA 70, National Electrical Code, Article 100.

C. Regulatory requirements:

1. National Electrical Code (NEC): Components and installation shall comply with National Fire Protection Association (NFPA) 70.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Rigid Metal Conduit, intermediate metal conduit and polyvinylchloride-coated rigid steel conduit.

1. Triangle/PWC, Inc.

2. Perma-Cote Industries.

3. Republic Steel Corporation.

4. Robroy Industries.

5. Allied Tube and Conduit.

B. Flexible Conduit:

1. American Flexible Conduit Company.

2. Anamet, Inc.

3. Electri-Flex Company.

4. International Metal Hose Company.

C. Boxes and Fittings:

1. O.Z./Gedney Company.

2. Crouse-Hinds Electrical Construction Materials.

3. Appleton Electric Company.

D. Support Systems:

1. Michigan Hanger Co., (O-Strut).

2. Thomas & Betts (Superstrut).

3. Unistrut Corp.

2.02 MATERIALS AND COMPONENTS:

A. Rigid Metal Conduit:

1. Provide galvanized rigid metal conduit, each with a coupling on one end and thread protector on other end.

2. Hot-dip galvanize rigid steel conduit over entire length, along interior and exterior surfaces, including threads. Conduit shall conform to UL 6.

B. Flexible-Metal Conduit:

1. Provide flexible-metal conduit for use in dry areas and match fittings, size, and material to rigid conduit to which it is connected. Flexible-metal conduit shall conform to UL 1.

2. Provide liquid-tight flexible-metal conduit for use in damp areas consisting of flexible-metal conduit, with liquid-tight, sunlight-resistant jacket extruded over the conduit. Provide stainless steel, braided flexible conduit in NEMA 4X, corrosive areas. On larger than 1-1/4 inch, furnish separate external ground wire. Liquid-Tight flexible-metal conduit shall conform to UL 360.

C. Boxes:

1. In NEMA 1 and NEMA 12 areas, provide standard, sheet-metal, outlet and junction boxes constructed of code-gauge, galvanized sheet steel. Size each box as required by the NEC.

2. Provide boxes containing fixture studs for hanging fixtures. Do not use shallow boxes unless building construction is such that it is impossible to use standard-depth boxes.

3. Provide cast boxes with covers or device plates suitable for the area classification. Use cover screws of stainless steel or high brass for iron boxes.

D. Fittings:

1. Provide cast-iron fittings of malleable iron or a mixture of gray iron and cast steel.

2. Provide suitable expansion fittings where conduits cross expansion joints. Equip these fittings with grounding straps, clamps, and copper bonding jumpers.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Perform all work in accordance with the NEC.

B. Use no conduit less than 3/4-inch in diameter (1 inch when located below grade), unless otherwise indicated.

C. Install raceways, boxes, enclosures, and cabinets as indicated, according to manufacturer’s printed instructions.

3.02 SEISMIC RESTRAINTS:

A. For conduits and other raceways installed in open areas, not adjacent to and secured to structural elements, and 2 inch outside diameter or greater, support such raceways using seismic restraints rated for the applicable project earthquake criteria.

B. Methods of Restraining Raceways:

1. Utilize threaded rod with rod stiffeners and transverse channel braces at approximately 45 degrees angle, at 15 feet on center, maximum, and on one side of rod support.

2. Utilize longitudinal bracing with channel braces at 30 feet on center, maximum.

3. Strap raceways directly to transverse channel braces, using pipe strap with both ends of strap bolted into the channel brace.

4. Do not rigidly brace raceways to different parts of a building that may respond differently during an earthquake. Seismic restraints shall not limit expansion and contraction of the raceway support system.

5. Provide flexible connections for conduits 2 inch outside diameter or greater than when terminating to fixed equipment to prevent loss of raceway integrity in the event of an earthquake.

3.03 INSTALLATION OF FITTINGS:

A. Install expansion fittings wherever conduits cross structural expansion joints. Keep the fittings in line with conduit, and install with regard to temperature so that full working range of expansion is available.

B. Do not install fittings to replace elbows and pull boxes, unless space or other problems make use of fittings necessary. Use oversize fittings whenever large cable is installed, in order to maintain proper bending radius.

C. Terminate ends of all floor conduits installed for future use with couplings and readily removable plugs set flush with finished floor surface. Cap spare wall conduits at wall where they enter building.

D. Equip ends of all conduits with conduit fittings. Fit conduits terminating at motor control center or power distribution equipment, or in box above or below, with grounding type bushings, or solidly ground by locknuts or other acceptable fittings. Connect each grounding bushing to ground bus by a bare or green-covered copper wire. Do not use ground wire smaller than 12 AWG. Install ground wire larger than 12 AWG when required by NEC. Where conduits terminate in unprotected areas or where bonding is required over expansion joint, flexible conduit or equivalent; use ground wires 6 AWG. copper or larger.

E. Terminate conduits entering gasketed sheet-metal boxes or gasketed sheet-metal equipment enclosures with gasketed hubs.

F. Terminate conduits entering nongasketed sheet-metal boxes or enclosures with double locknuts and insulated bushings, or with acceptable equivalent.

G. Join raceways with fittings listed for the purpose. Make joints tight. Use raceway fittings compatible with raceway and suitable for use and location. For intermediate steel conduit, use threaded rigid steel conduit fittings, except as otherwise indicated.

1. Make raceway terminations tight. Use bonding bushings or wedges at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.

2. Use insulating bushings to protect conductors.

3. Tighten set screws of threadless fittings with suitable tool.

3.04 INSTALLATION OF RACEWAYS:

A. Install exposed raceways parallel or at right angles to walls and ceiling beams. Make all changes in directions with listed bends, elbows, and pull boxes. Space parallel runs uniformly throughout. Secure in place by hangers and fasteners. Ground raceways by connection to properly grounded enclosures, bonding, or other means, to obtain permanent low resistance path to ground throughout installation. Ensure that raceway sections in single run and in parallel runs are of same type and finish.

1. Run parallel or banked raceways together, on common supports where practical.

2. Install raceways level and square and at proper elevations. Provide minimum 7 feet headroom.

B. Support conduits by hangers or pipe straps spaced according to NEC, but in no case more than 10 feet on centers.

C. Provide hot-dipped galvanized supports for galvanized conduit.

D. Stub-Up Connections: Extend conduits through concrete floor for connection to freestanding equipment with an adjustable top or coupling threaded inside for plugs, and set flush with the finished floor. Extend conductors to equipment with rigid steel conduit. Flexible metal conduit may be used 6 inches above the floor.

E. Do not use dissimilar metals in conjunction with each other. Use an insulation between adjoining surfaces so as to eliminate direct contact and any resultant electrolysis. Maintain electrical continuity of system. Use bituminous impregnated felt, heavy bituminous coatings, nonmetallic separators or washers, or other acceptable materials as insulation.

F. Install fittings to match raceway being used.

G. Install expansion fittings wherever conduits cross structural expansion joints at connections between buildings. Keep fittings in line with conduit, and install with regard to temperature so that full working range of expansion is available.

H. Provide separate raceways for all low voltage instrumentation raceways (50 volts and below) from control and power raceways.

I. Terminations: Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely, and install the locknuts with dished part against the box; use two locknuts, one inside and one outside the box.

J. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box, and tighten the chase nipple so no threads are exposed.

K. Install pull wires in all empty raceways. Use monofilament plastic line having not less than 200 lb tensile strength or equivalent polyester line. Leave not less than 12 inches of slack at each end of the pull wire.

L. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot water pipes. Install horizontal raceway runs above water and steam piping.

M. Complete raceway installation before beginning conductor installation.

N. Use temporary closures to prevent foreign matter from entering raceway.

O. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portion of bends is not visible above the finished slab.

P. Where metal conduits rise through floor slabs in wet areas, coat conduits for a distance of 6 inches above and below slab grade with brush coat of waterproof bituminous cement or pipewrap for a distance of 6 inches above and below slab grade.

3.05 BENDS:

A. Make all bends carefully to prevent distortion of circular cross section. Field bend conduit shall have an inside radius of not less than nine diameters.

B. Where bends of less than nine diameters are necessary, use standard factory elbows. Size conduit to permit cable-bending radius within the factory elbow of at least eight times cable diameter.

C. Allow no conduit greater than 50 feet to have more than two 90 degree bends or equivalent thereof between pulling points. For conduits less than 50 feet in length, allow only three 90 degree bends between pulling points.

3.06 CUTTING, THREADING AND CONNECTING:

A. Make all field cuts in conduits squarely, file cut ends, ream to remove rough edges and thread in accordance with NEC. No running thread permitted. Make all connections mechanically strong and tight, and with acceptable connectors. Where conduit surface coating is damaged or removed in the cutting, threading or reaming process, restore the surface to its original condition.

3.07 CONDUIT CLEANING:

A. Clean all conduit carefully before and after installation, ream ends free of burrs, and free inside surfaces from all imperfections likely to injure cable.

B. After installation of each complete new conduit run, snake the run with band to which is attached a tube cleaner with cylindrical mandrel of a diameter not less than 85 percent of nominal diameter of conduit. Remove and replace all conduit through which mandrel will not pass.

C. Use a sponge with steel brush to clean steel conduit and use a sponge with nylon brush to clean PVC conduits.

D. After cleaning, protect ends of all conduit with standard caps to prevent entrance of water, concrete, debris, or other foreign substance.

3.08 CONDUIT DRAINAGE:

A. Where practicable, pitch conduit to drain to outlet boxes, or install so as to avoid trapping moisture. Where dips are unavoidable in exposed conduits, install fitting with drain hole at low point.

3.09 INSTALLATION OF BOXES:

A. Unless otherwise indicated, install sheet metal boxes only in dry, accessible locations. Install cast-metal boxes in exterior concrete or masonry walls, in floor slabs, in basements, all other below grade locations and elsewhere as indicated. Cast metal boxes shall be used (unless otherwise indicated) where vapor-tight fixtures are required, for all surface mounting of wall switches and receptacles and for all outdoor use. Install pull boxes for motor control centers and large ceiling hung boxes where indicated.

B. Install boxes in conformance with all the requirements of NEC. Install boxes designed for type of construction involved. Support boxes in same manner as required for conduit. Size boxes to provide bending radius for wire or cable of at least eight times diameter or in accordance with NEC, whichever is larger.

C. Center all outlets in panels, or spaces and adjust to structural finish. Where specific locations are not indicated, locate outlets with respect to equipment served.

D. Place all outlet boxes, junction boxes and pull boxes, in accessible locations when they are installed above or behind plastered ceilings, furred spaces, or suspended ceilings. Install access panels of suitable size. Mark all access panels for all boxes so panels can be readily located in future. Mark, using metal tabs or plastic buttons which cannot mark ceilings or walls, appropriate for type of construction being used.

E. Assemble cast-metal boxes with threaded conduit hubs in such manner that conduit connections and gasketed covers are watertight. Close all unused threaded openings with pipe plugs and compound.

F. Provide cast boxes with covers and device plates suitable for the area classification. Install screws of stainless steel or high brass for iron boxes.

3.10 FLEXIBLE CONNECTIONS TO MOTORS AND EQUIPMENT:

A. At all motors and electrically operated equipment to which conduit connections are made, install with a complete connection between end of conduit and terminal box of motor or other equipment.

B. Install the conduits in locations permitting direct connection to motors.

C. Make connections between rigid raceway and motor or equipment subject to vibration and adjustment using flexible conduit. Make each connection with at least one quarter bend so that no vibration can be transmitted beyond flexible connection.

D. Install flexible metal conduit, fittings, and accessories in dry areas in accordance with requirements of NEC.

E. Install liquid-tight flexible metal conduit in damp and corrosive areas. Locate conduit to reduce the possibility of damage to the exterior coating. Use fittings that screw into flexible conduit and provide gaskets.

F. Use maximum of 6 feet of flexible conduit for recessed and semirecessed lighting fixtures and; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use liquid tight flexible conduit in wet or damp locations. Install liquid-tight flexible metal conduit in areas subject to wetting due to fire protection sprinklers or broken or ruptured water line. Locate conduit to reduce the possibility of damage to the exterior flexible conduit jacket. Use fittings that screw into flexible conduit and provide gaskets. Install separate ground conductor across flexible connections.

3.11 PROTECTION:

A. Provide protection and install in accordance with manufacturer printed instructions. The conduit and raceway equipment manufacturers, to ensure that coatings, finishes, and enclosures are without damage or deterioration at completion of project.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

3.12 FINAL SYSTEM ACCEPTANCE:

A. Upon completion of installation of system, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions and at no additional cost to the Owner.

B. Label all raceways and boxes in accordance with the requirements of Section 26 05 10.

3.13 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 26 05 53

ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.01 SUMMARY:

A. Section Includes:

1. Identification of electrical materials, equipment, and installations.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):

1. A13.1: Scheme for the Identification of Piping Systems

B. Institute of Electrical and Electronics Engineers (IEEE):

1. ANSI/IEEE C2: National Electrical Safety Code.

C. National Fire Protection Association (NFPA):

1. 70: National Electrical Code (NEC).

1.03 SUBMITTALS:

A. Submit shop drawings in accordance with Section 01 33 00.

1. Submit shop drawings and manufacturers' product data in accordance with the requirements of Section 26 05 10.

B. Product Data:

C. Submit for each type of product specified.

D. Samples: Submit for each color, lettering style, and or graphic representation required for identification materials; samples of labels and signs.

E. Miscellaneous: Schedule of identification nomenclature to be used for identification signs and labels.

1.04 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 43 00.

PART 2 - PRODUCTS

2.01 RACEWAY AND CABLE LABELS:

A. Manufacturer's Standard Products: Where more than one type is listed for specified application, selection is Installer's option, but provide single type for each application category. Use colors prescribed by ASME A13.1, NFPA 70, or as specified elsewhere.

B. Components and installation shall comply with NFPA 70.

C. Conform to ASME A13.1, Table 3, for minimum size of letters for legend and minimum length of color field for each raceway or cable size.

1. Color: Black legend on orange field.

2. Legend: Indicates voltage.

D. Adhesive Labels: Preprinted, flexible, self adhesive vinyl. Legend is over-laminated with clear, wear and chemical resistant coating.

E. Pre-tensioned, Wraparound Plastic Sleeves: Flexible, preprinted, color coded, acrylic bands sized to suit diameter of line it identifies and arranged to stay in place by pre-tensioned gripping action when placed in position.

F. Colored Adhesive Tape: Self adhesive vinyl tape not less than 3 mils thick by 1 to 2 inch wide.

G. Tape Markers: Vinyl or vinyl cloth, self adhesive, wraparound type with preprinted numbers and letters.

H. Aluminum, Wraparound Marker Bands: Bands cut from 0.014 inch thick aluminum sheet, with stamped or embossed legend, and fitted with slots or ears for permanently securing around wire or cable jacket or around groups of conductors.

I. Plasticized Card Stock Tags: Vinyl cloth with preprinted and field printed legends. Orange background, except as otherwise indicated, with eyelet for fastener.

J. Brass or Aluminum Tags: Metal tags with stamped legend, punched for fastener. Dimensions: 2 by 2 inch by 0.05 inch.

K. Comply with IEEE C2.

2.02 ENGRAVED NAMEPLATES AND SIGNS:

A. Manufacturer's Standard Products: Where more than one type is listed for specified application, selection is Installer's option, but provide single type for each application category. Use colors prescribed by ASME A13.1, NFPA 70, or as specified elsewhere.

B. Engraving stock, melamine plastic laminate, 1/16-inch minimum thick for signs up to 20 square inches, 1/8 inch thick for larger sizes.

1. Engraved Legend: Black letters on white face.

2. Punched for mechanical fasteners.

C. Baked Enamel Signs for Interior Use: Preprinted aluminum signs, punched for fasteners, with colors, legend, and size as indicated or as otherwise required for application. 1/4 inch grommets in corners for mounting.

D. Exterior, Metal Backed, Butyrate Signs: Wear resistant, non-fading, preprinted, cellulose acetate butyrate signs with 0.0396 inch, galvanized steel backing, with colors, legend, and size appropriate to application. 1/4-inch grommets in corners for mounting.

E. Fasteners for Plastic Laminated and Metal Signs: Self tapping stainless steel screws or No. 10/32 stainless steel machine screws with nuts, flat washers and lock washers.

2.03 MISCELLANEOUS IDENTIFICATION PRODUCTS:

A. Cable Ties: Fungus-inert, self extinguishing, 1 piece, self locking, Type 6/6 nylon cable ties with following features:

1. Minimum Width: 3/16-inch.

2. Tensile Strength: 50 lb minimum.

3. Temperature Range: -40 to 185 degrees F.

4. Color: As indicated where used for color coding.

B. Paint: Alkyd-urethane enamel. Primer as recommended by enamel manufacturer.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install identification devices according to manufacturer’s written instructions.

B. Install labels where indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment.

C. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and or designations used for electrical identification with corresponding designations used in Contract Documents or required by codes and standards. Use consistent designations throughout Project.

D. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.

E. Self Adhesive Identification Products: Clean surfaces of dust, loose material, and oily films before applying.

F. Install painted identification as follows:

1. Clean surfaces of dust, loose material, and oily films before painting.

2. Prime Surfaces: For galvanized metal, use single component, acrylic vehicle coating formulated for galvanized surfaces. For concrete masonry units, use heavy duty, acrylic resin block filler. For concrete surfaces, use clear, alkali resistant, alkyd binder type sealer.

3. Apply 1 intermediate and 1 finish coat of silicone alkyd enamel.

4. Apply primer and finish materials according to manufacturer's instructions.

G. Install Circuit Identification Labels on Boxes: Label externally as follows:

1. Exposed Boxes: Pressure sensitive, self adhesive plastic label on cover.

2. Concealed Boxes: Plasticized card stock tags.

3. Labeling Legend: Permanent, water proof listing of panel and circuit number or equivalent.

H. Identify Paths of Underground Electrical Lines: During trench backfilling, for exterior underground power, control, signal, and communications lines, install continuous underground plastic line marker located directly above line at 6 to 8 inch below finished grade. Where multiple lines installed in common trench or concrete envelope do not exceed an overall width of 16 inch, use single line marker.

1. Install line marker for underground wiring and in raceway.

I. Color Code Conductors: Secondary service, feeder, and branch circuit conductors throughout secondary electrical system.

1. Field applied, color coding methods may be used in lieu of factory coded wire for sizes larger than 10 AWG.

a. Colored, pressure sensitive plastic tape in half lapped turns for distance of 6 inch from terminal points and in boxes where splices or taps are made. Apply last 2 turns of tape with no tension to prevent possible unwinding. Use 1 inch wide tape in colors as specified. Adjust tape bands to avoid obscuring cable identification markings.

b. Colored cable ties applied in groups of 3 ties of specified color to each wire at each terminal or splice point starting 3 inch from terminal and spaced 3 inch apart. Apply with special tool or pliers, tighten to snug fit, and cut off excess length.

2. 240/120 Volt System: As follows:

a. Phase A: Black.

b. Phase B: Red.

c. Neutral: White.

d. Ground: Green.

3. 480/277 Volt - System: As follows:

a. Phase A: Brown

b. Phase B: Orange.

c. Phase C: Yellow.

d. Neutral: White.

e. Ground: Green.

J. Power Circuit Identification: Use metal tags or aluminum wraparound marker bands for cables, feeders, and power circuits in vaults, pull boxes, junction boxes, manholes, and switchboard rooms.

1. Legend: 1/4-inch steel letter and number stamping or embossing with legend corresponding to indicated circuit designations.

2. Fasten tags with nylon cable ties; fasten bands using integral ears.

K. Apply warning, caution, and instruction signs and stencils as follows:

1. Install warning, caution, and instruction signs where indicated or required to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved, plastic laminated instruction signs with accepted legend where instructions or explanations are needed for system or equipment operation. Install butyrate signs with metal backing for outdoor items.

2. Emergency Operating Signs: Install engraved laminate signs with white legend on red background with minimum 3/8-inch high lettering for emergency instructions on power transfer, load shedding, and or emergency operations.

L. Install identification as follows:

1. Apply equipment identification labels of engraved plastic laminate on each major unit of equipment, including central or master unit of each system. This includes communication, signal, and alarm systems, unless units are specified with their own self-explanatory identification. Except as otherwise indicated, provide single line of text with 1/2-inch high lettering on 1-1/2 inch high label; where 2 lines of text are required, use lettering 2 inch high. Use black lettering on white field. Apply labels for each unit of following categories of equipment.

   a. Panelboards, electrical cabinets, and enclosures.

   b. Motor starters.

   c. Push button stations.

   d. Control devices.

   e. Transformers.

2. Apply designation labels of engraved plastic laminate for disconnect switches, breakers, push buttons, pilot lights, motor control centers, and similar items for power distribution and control components above, except panelboards and alarm/signal components where labeling is specified elsewhere. For panelboards, provide framed, typed circuit schedules with explicit description and identification of items controlled by each individual breaker.

3.02 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 26 08 13

FIELD INSPECTION AND ACCEPTANCE TESTS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Perform electrical system tests to demonstrate that each component of each system is in proper working order and in accordance with applicable codes, manufacturer's instructions, drawings and specifications. Tests are in addition to, and no substitution for, factory tests of individual equipment.

1. Perform insulation and ground resistance tests before operating tests.

2. Determine proper rotation of motors before permanent connections are made.

B. Testing shall be performed to:

1. Provide initial acceptance tests and recorded data that can be used as a bench mark for future routine maintenance and trouble shooting by facility operating staff.

2. Ensure a successful start-up with a minimum of last minute interruptions and problems.

3. Determine the suitability of the equipment and systems for energization and placing into operating service.

4. Provide assurance that each system component is not only installed satisfactorily but performs, and will continue to perform, its function in the system with reasonable reliability throughout the life of the facility.

C. Provide all supervision and labor, materials, tools, test instruments or other equipment or services and expenses required to test, adjust, set, calibrate, functionally and operationally check all work and components of the various electrical systems and circuitry throughout the installation. Provide sufficient personnel to assist in any additional checks they may require for acceptance, start-up, run-in and placing the equipment and systems into continuous service.

D. The Contractor shall engage the services of competent nationally recognized independent electrical equipment testing firm to perform specified field inspections, tests, and adjustments. The testing firm shall not be a subsidiary, division, nor department of either the installing Contractor or the manufacturer of the equipment materials or systems being inspected and tested. The testing firm shall be a fully accredited member of the International Electrical Testing Association, Incorporated (NETA) and have the specialized experience and skill in the supervision and performance of all inspection and testing specified herein.

E. The testing firm shall perform the specified activities prior to the start-up and completion of the work identified in the Contract Documents.

F. The tests and inspections performed shall in no way relieve the Contractor of the responsibility for the performance of the tests, check outs, and inspections specified under other sections of the specification during construction.

G. The listings and descriptions of the tests, and checks described herein shall not be considered as complete and all inclusive. Additional normal standard construction (and sometimes repetitive) checks and tests may be necessary throughout the job, prior to final acceptance by the Owner.

H. Pay all costs for tests including expenses incident to retests occasioned by defects and failures of equipment to meet specifications.

1. Replace wiring and equipment found defective, or failing to meet specified requirements, without charge, unless written acceptance for repair is given by Engineer.

2. Unless otherwise specified, the Owner will supply electric power necessary for tests.

1.02 REFERENCES:

A. All inspections and tests shall be in accordance with the following applicable codes and standards latest revisions except as provided otherwise herein.

1. All Standard, Special and Supplemental Conditions of the Contract.

2. Association of Edison Illuminating Companies (AEIC).

3. American National Standards Institute (ANSI):

a. Z244-1: American National Standard for Personnel Protection

4. ASTM International (ASTM).

5. Insulated Cable Engineers Association (ICEA).

6. Institute of Electrical and Electronic Engineers (IEEE).

a. C2: National Electrical Safety Code

7. National Electrical Manufacturer's Association (NEMA).

8. International Electrical Testing Association (NETA):

a. ATS: Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

9. National Fire Protection Association (NFPA):

   a. 70: National Electrical Code

   b. 70B: Electrical Equipment Maintenance

   c. 70E: Electrical Safety Requirements for Employer Workplaces

   d. 101: Life Safety Code

10. Occupational Safety and Health Administration (OSHA):

   a. Part 1926; Subpart V, 1926.950 through 1926.960

11. State and Local Codes and Ordinances.

B. All inspections and tests shall utilize the following references:

1. Project Design Specifications

2. Project Design Drawings

3. Manufacturer's instruction manuals applicable to each particular apparatus

1.03 SUBMITTALS:

A. Submit shop drawings in accordance with Section 01 33 00.

1. Submit test plans and test data in accordance with the requirements of Section 26 05 10.

2. Submit evidence of NETA membership, experience and staff qualifications of the independent testing firm.

3. Submit in 3-ring notebook, test plans for each system and piece of equipment to be inspected and tested. Provide sample test data sheets with blanks identified where test data will be recorded, test instrument identification, calibration date, and blanks provided to identify the person performing the test and the person witnessing the test.

4. Submit test results.

1.04 SCHEDULING:

A. The Contractor shall be responsible for the preparation of proposed procedures and schedules for all inspections, tests, settings and calibrations specified or otherwise required prior to or during the check out for start-up and acceptance of all the electrical components, equipment and systems. This work shall be coordinated and to be compatible with both the work of other crafts and the project schedule. The above must be organized and submitted with all proposed testing and check out forms. The

procedures shall provide specific instructions for the checking and testing of each component in addition to the system functional checks. Tests and inspections shall be scheduled as the job progresses and may require repetition in grater detail at a later stage of construction. All procedures submitted shall include job safety rules proposed.

B. Equipment shall be inspected and tested to determine its condition. See other applicable sections of the specifications and contract documents for required checks and responsibilities.

C. At any stage of construction and when observed, any electrical equipment or system determined to be damaged, faulty, or requiring repairs shall be reported to the Engineer. Corrective action may require prior approval.

D. Prior to check out and testing for start-up, ensure that all equipment and wiring is properly and permanently identified with nameplates and other identification as specified elsewhere. Check and tighten all terminals and connection points, remove all shipping blocks and hardware, thoroughly clean all equipment, repair all damaged or scratched finishes, inspect for broken and missing parts and review and collect manufacturer's drawings and instructions for submittal to the Engineer. Make routine checks and tests as the job progresses and as necessary to insure that all wiring and equipment is properly installed and wired.

E. All testing and checkout work shall be performed with fully qualified personnel skilled in the particular tests being conducted. This is essential for obtaining and properly evaluating data while the tests are in progress and for insuring that important facts and questionable data are reported.

F. All inspections, tests, and calibrations shall be reported in writing on forms submitted for review under Submittals. The recorded data form shall have the signatures of the persons conducting the tests and authorized witnesses. The forms shall be designed to serve as the test and inspection checklist for inspection requirements. "As-found" and "as-left" test data shall be recorded and reported in writing.

G. The sequence of all tests and checks shall be such that the equipment can be energized immediately after the completion of the applicable tests.

H. When applicable electrical tests and inspections specified herein, or otherwise required are completed and results reported and reviewed then the Contractor may consider that portion of the electrical equipment system or installation electrically complete. The Contractor shall then affix appropriate dated completion or calibration labels to the tested equipment. The Contractor shall notify the Engineer’s Representative and Owner of electrical completion. If the Engineer’s Representative or Owner finds completed work unacceptable, the Contractor will be notified in writing of the unfinished or deficient work which shall be corrected by the Contractor. The Contractor shall notify the Engineer in writing when all exceptions have been corrected. If later in-service operation or further testing determines problems attributable to the Contractor, these shall be corrected by the Contractor or suitable arrangements shall be made to suit operating circumstances.

PART 2 - PRODUCTS

2.01 TESTING EQUIPMENT:

A. Calibration:

1. Furnish all material, test equipment, and power sources required for testing, calibrating and check out. All calibration and setting checks by the independent testing laboratory shall be performed with laboratory calibrated test instruments of appropriate accuracy. This test equipment shall have calibrations traceable to the National Bureau of Standards. Testing laboratory dated calibration labels shall be visible on all test equipment. Calibrations over 6 months old will not be acceptable on field test instruments. The accuracy of all test instruments shall be at least twice that of the accuracy of the equipment, device, relay or meter under test. All testing instruments shall be checked to insure satisfactory operation prior to proceeding with the tests. Serial and model numbers of the instruments used shall be recorded on the test forms.

2. Make necessary openings in circuits for testing instruments and place and connect all instruments, equipment, and devices, necessary for the tests. Upon completion of tests, remove instruments and instrument connections and restore all circuits to permanent condition.

2.02 TESTING:

A. Coordination:

1. Coordinate activities, and cooperate with others on project, to ensure that systems are energized when required, loads applied, and other requirements of Section are carried out on timely, coordinated basis.

2. Conduct tests in presence of Engineer’s Representative. Notify Engineer’s Representative seven calendar days or more in advance when any test to be performed, and do not start tests without Engineer’s Representative's permission.

3. Other Sections of specifications require services of one or more manufacturer's representatives, to ensure that equipment supplied has been installed properly and adjusted to proper working order. Advise representative of all applicable tests in this Section, so that work will be coordinated, and tests combined where feasible.

4. It is important that equipment warranties or guarantees not be voided by testing and checkout work. The checks and tests to normally be supplemental to and compatible with the manufacturer's installation instruction leaflets and literature. Where deviations are apparent, the manufacturer's review shall be obtained prior to testing. Reasonable cooperation shall be extended to permit witnessing by the manufacturer's representative if so requested. Where any questionable repairs, modifications, significant adjustments, tests or checks are to be made, the Contractor shall contact the Engineer to determine if the work should be performed by or with the manufacturer's representative.

PART 3 - EXECUTION

3.01 INSULATION TESTS OF EQUIPMENT, CABLE, AND CIRCUITS:

A. General:

1. Perform DC insulation tests of the type specified on electrical equipment, apparatus and cables under any one or more of the conditions described as follows: At the time equipment such as motors, generators, transformers, power circuit breakers and switches, switchgear, motor control centers, bus duct, and similar electrical equipment is :

a. Delivered to the site for care, storage, and/or installation,

b. Prior to energization and/or placing into service and acceptance by the Owner,

c. When damage to the insulation is suspected or known to exist,

d. After repairs or modifications to the equipment affecting the insulation,

2. Insulation tests are required to be performed by the testing firm at various stages of construction. The equipment, cable and systems that require testing, the maximum test voltages, and the type tests required shall be in accordance with the applicable paragraphs of NETA.

3. List each circuit and measured resistance as test data.

4. Maintain record of all insulation resistance values. Identify conductor, or equipment, date that value was taken and resistance value. Arrange information in suitable neat tabular form and submit to Engineer.

3.02 SPECIFIC TESTS AND INSPECTIONS BY THE CONTRACTOR:

A. General:

1. The following specific items of work shall be performed by the Contractor. The list is not all inclusive, nor does it define how the tests and checks are to be made. Refer to applicable sections of NETA and equipment specifications for additional details. The equipment and cable shall be deenergized and isolated as necessary to perform the tests.

2. The engagement of the independent testing firm in no way relieves the Contractor of the responsibility for, or diminishes the importance of, performance tests, checkouts, and inspections during the various stages of construction. The specific work of the independent test firm is defined in Paragraph 3.03.

3. The Contractor shall perform all tests and inspections as defined in the other sections of this specification. Tests and inspections required by these sections are not necessarily repeated under specific equipment in Paragraph 3.02

4. All equipment received for the job and for which the Contractor is responsible to be stored and cared for per the manufacturer's instructions. It is the Contractor's responsibility to obtain such information even where the instructions are not shipped with the equipment.

5. The Contractor shall assist the independent test laboratory in performing its work.

B. Equipment Test and Inspection During Construction and Prior to Acceptance Testing:

1. Motors (5 Hp and larger):

a. At the time of motor receipt, each motor shall be visually inspected for any physical damage and the motor meggered as described in Paragraph 1.e below.

b. All voltage motors shall be provided with adequate heating during storage. See Paragraph 3.01 for additional insulation tests for all motors of different voltages.

c. Before energizing any machine, visually inspect for serviceability. Check manufacturer's instruction manual for correct lubrication and ventilation. Verify that proper alignment has been performed. Check nameplate for electrical power requirements.

d. Test run all motors preferably uncoupled or unloaded, before placing into regular service. A check on the motor for rotation, speed, current and temperature rise to be made and results recorded. The proper color codes for phase identifications to be maintained. This may require lead swaps at the motor for proper rotation. A motor phase rotation meter shall be used prior to connection at motor to prevent later swaps.

e. Complete visual inspection and electrical test per NETA ATS. Section 7.15.1

2. Grounding Systems:

a. All grounding loops and major equipment grounds shall be tested to remote earth or directly referenced to an extremely low resistance (approximately 1 ohm) reference ground bench mark. Visual inspection of all systems, raceway and equipment grounds shall be made to determine the adequacy and integrity of the grounding. All ground testing results shall be properly recorded, witnessed, and submitted.

b. Ground tests shall be performed in accordance with NETA ATS, Section 8.13 using a J. G. Biddle Company low resistance, Null balance type, ground testing with ‘ohmmeter with test lead compensation in place. The test instrument shall be the type which compensates for potential and current rod resistances.

c. Test each ground rod and submit tabulation of results to Engineer. Include identification of electrode, date of reading and ground resistance value in results.

d. Test grounding system for continuity of connections and for resistance. Ensure that ground resistance of conduits, equipment cases, and supporting frames does not vary appreciably from that of system as whole and does not exceed 10 Ohms.

e. Where ground test results indicate the need for additional grounding conductors or rods that are not indicated on drawings or specified, additional grounding provisions shall be initiated to obtain the acceptable values. The Contractor shall be responsible for the proper installation of the grounding shown on drawings or specified and for the correction of improper installations as determined by inspections and tests.

3. Power Transformers:

a. At the time of equipment receipt, the exterior to be visually checked for any damage or any defects.

b. Perform complete inspection and electrical tests in accordance with NETA ATS, Section 7.2.

C. Wire and Cable:

1. Before energizing, the continuity and insulation resistance of every circuit external to equipment shall be measured with a megger from each wire to all others and ground and test results recorded on forms. Tests shall normally be conducted at voltages 500 volts or lower. High potential testing will normally be performed by the independent testing laboratory as described in Paragraph 3.03.

2. Insulation resistance measurements shall be taken of the following: (Refer to Paragraph 3.01 for additional information.)

a. Motor Feeders: With motors disconnected, measure and record insulation resistance from load side of contactors or circuit breakers. Repeat this test after motors are connected and just before energizing at lower voltage as limited by the maximum test voltage for the motor.

b. Motor Control Circuits (600 Volts): With push buttons and overcurrent devices connected, measure and record insulation resistance from phase to ground only. It will be necessary to lift the neutral ground on the control

transformers to perform this test. Also, isolate any control elements that should not be meggered.

c. Lighting Panel Feeders: Measure and record insulation resistance with circuit breakers, lighting transformers and panelboards connected, but with lighting branch circuit breakers or switches open.

d. Lighting Branch Circuits: Measure and record insulation resistance after all lampholders, receptacles, fixtures, etc., are connected but before lamping.

e. Feeder Circuits: Measure and record insulation resistance with connections to circuit breakers made up but with breakers open and loads not connected.

3. All cables and wires shall be checked for proper identification numbering and/or color coding.

3.03 SPECIFIC TESTS AND INSPECTIONS BY THE INDEPENDENT TESTING FIRM:

A. Thermographic (Infrared) Surveys:

1. After the equipment has been placed in service, infrared surveys shall be performed on all designated electrical system apparatus specified below. The survey shall be performed with all apparatus energized and under full or normal load conditions. The survey shall include all connections and joints. Access covers and doors shall be removed or opened from all apparatus for the purpose of the survey. The survey shall consist of an on-site inspection performed by competent field engineering personnel using portable, imaging-display infrared camera equipment to locate and recommend corrective measures for overheated electrical connections, splices, taps, conductors and other abnormally hot items of apparatus, or portions thereof, that are a part of the designated apparatus.

2. The infrared survey documentation shall include a survey summary as well as detailed inspection reports containing photographic records of significant problems found, problem cause(s), required corrective action(s) and recommendations as to how promptly corrective action(s) should be taken.

3. The infrared camera equipment used shall be of the fully portable, image display type with photographic camera attached unit, and be capable of measuring apparatus temperatures with an accuracy of plus or minus 0.25 degrees C. at 30 degree object temperature. The testing firm and its assigned field engineer shall be regularly engaged in this type of work, to have prior experience in the use of the infrared camera equipment for this kind of application and to also be experienced in the normal inspection and test, of the electrical apparatus to be surveyed.

B. Electrical system apparatus to be surveyed to include:

1. Low 480 volts voltage motor controls.

2. Small service transformers and power transformers.

3. Power distribution panels and centers.

4. Rotating equipment.

3.04 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 26 24 16

PANELBOARDS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide panelboards rated 600 volts or less and 1200 amperes or less.

B. Provide with circuit breakers and cabinets complete, as indicated and specified.

1.02 REFERENCES:

A. Federal Specifications (FS):

1. QQ-S-365B: General Requirements for Silver Plating, Electro Deposited

2. W-C-375B: Automatic Circuit Breakers.

3. W-P-115A: Panel, Power Distribution.

B. National Electrical Manufacturers Association (NEMA):

1. 250: Enclosures for Electrical Equipment (1000 volts maximum)

2. AB 1: Molded Case Circuit Breakers

3. PB 1: Panelboards

C. National Fire Protection Association (NFPA):

1. 70: National Electrical Code (NEC)

D. Underwriter's Laboratories, Inc. (UL):

1. 50: Cabinets and Boxes

2. 67: Panelboards

3. 86A: Wire Connectors and Soldering Lugs for Use with Copper Conductors

4. 489: Circuit Breakers, Molded Case and Circuit Breaker Enclosures

1.03 SUBMITTALS:

A. Submit shop drawings in accordance with Section 01 33 00

B. Submit shop drawings and manufacturer's product data in accordance with requirements of Section 26 05 10.

1.04 QUALITY ASSURANCE:

A. Provide in accordance with Section 01 43 00 and as specified.

B. All panelboards shall be designed, manufactured and assembled in accordance with the referenced standards.

C. Listing and Labeling: All panelboards shall be listed and labeled by Underwriter's Laboratories, Inc. (UL), or other nationally-recognized testing laboratory (NRTL).

D. Service Entrance panelboards shall be UL/NRTL-labeled as suitable for that purpose.

E. Single-source Responsibility: Provide panelboards products that are new, and from the same manufacturer for each building or job. Panelboard components shall be from the same manufacturer, or listed as an assembly thereof.

PART 2 - PRODUCTS

2.01 PANELBOARD MANUFACTURERS:

A. Manufacturers acceptable contingent upon products' compliance with the specifications:

1. Cutler-Hammer Products.

2. General Electric Company.

3. Siemens Corp.

4. Schneider Square D.

2.02 PANELBOARDS:

A. Factory assembled deadfront type panelboards.

B. Furnish panelboards complete with branch circuit breakers and a main circuit breaker or main lugs only as indicated.

C. Furnish panelboards with full capacity separate ground bus, separate insulated neutral bus and furnish panelboards connected to a 3 phase, 4 wire service or single phase, 3-wire service as indicated.

D. Provide panelboards with the voltage, frequency and current ratings as indicated conforming to NEMA Standard PB1, Federal Specification W-P-115A. U.L. 67, and the NEC.

E. Furnish the panelboard main and neutral buses, with minimum 98 percent conductivity rectangular copper bars provided with bolted type lugs as necessary.

F. Silver plate buses, connectors and terminals to a minimum thickness of 0.005-in., conforming to the requirements of Federal Spec. QQ-S-365B.

G. Prevent terminal lugs from turning per NEMA standard PB 1 and ensure they are suitable for the conductor material and size.

H. Provide main bus-bracing for each panel board adequate for 10,000 amperes symmetrical short circuit at 240 volts unless otherwise indicated.

I. Where the word “space” occurs on panel schedules, provide all necessary hardware in the space, including connection straps, mounting brackets, and filler plates so that only the addition of a future circuit breaker is required.

2.03 CIRCUIT BREAKERS:

A. Each circuit breaker shall be bolted into position in the panelboard, whether by direct bolted connection to the bus or by being bolted to the panelboard frame. Each circuit breaker shall be replaceable without disturbing adjacent units. Plug-on circuit breakers held in place only by spring force of the bus lug and the pressure of the deadfront are not acceptable.

B. Furnish frame sizes, trip settings and number of poles as indicated. Clearly and visibly mark circuit breakers with ampere trip rating. Furnish breakers meeting the requirements of F.S. W-C-375B and NEMA AB1.

C. Furnish all breakers with quick-make, quick-break, toggle mechanisms and thermal-magnetic, inverse time-limit overload and instantaneous short circuit protection on all poles, unless otherwise indicated. Automatic tripping indicated by the breaker handle assuming a clearly distinctive position from the manual ON and OFF position. Furnish breaker handle that is trip-free on overloads.

D. Do not use single pole breakers with handle ties or bails in lieu of multi-pole breakers.

E. For each panelboard, furnish quantity four handle lock devices for individual breakers to prevent the manual opening of the selected breakers. Turn devices over to Owner at completion of the project work.

F. Ensure that voltage and interrupting rating of all breakers in a panelboard is not less than voltage and short circuit rating of the panelboard main buses, as indicated. Furnish breakers suitable to operate satisfactorily at the frequency indicated.

G. Furnish ground fault interrupter (GFI) or ground fault equipment protector (GFEP) circuit breakers for certain circuits as indicated on the drawings or required by NEC.

H. Furnish single pole breakers with full module size. Do not install two pole breakers in a single module.

I. Furnish time-current characteristic curves and catalog information and data for each size of breaker furnished.

2.04 CABINETS:

A. Provide cabinets with NEMA enclosure type as indicated and without knockouts. Drill cabinets only for the exact conduit entrances and mounting bolts.

B. Finish cabinet fronts, trims and surface-mounted boxes in ANSI No. 61 or 49, light-gray enamel over a rust-inhibitive primer. Attach the fronts (exterior trims) to the boxes or interior trims, by quarter-turn, indicating trim clamps. Design cabinets for surface or flush mounting as indicated.

C. Unless otherwise specified, construct panelboard cabinets of code-gauge galvanized, sheet steel and equip with gutters of ample size for the risers and outgoing circuits. Ensure that the cabinets do not exceed 78 inch (in height.

D. Trims for branch circuit panelboards shall be supplied with a hinged door over all circuit breaker handles. Doors in panelboard trims shall not uncover any live parts. Doors shall have a semi flush cylinder lock and catch assembly. Door-in-door trim shall be provided. Both hinged trim and trim door shall utilize three point latching. No tools shall be required to install or remove trim. Trim shall be equipped with a door-actuated trim locking tab. Equip locking tab with provision for a screw such that removal of trim requires a tool, at the Owner’s option. Installation shall be tamper resistant with no exposed hardware on the panelboard trim.

E. Provide enclosure with the following side gutter dimensions:

1. Left side minimum 4-1/2 inch measured from inside lip of the box to the installed deadfront.

2. Right side; minimum 4-1/2 inch (measured from inside lip of the box to the installed deadfront. With the door-in-door cover in place; minimum 3-1/4 inch from installed outer door hinge to the installed deadfront.

2.05 FACTORY TESTING:

A. Standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of NEMA and UL standards.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Mount panelboards, plumb and rigid without distortion of the box. Mount such that the height of the top operating handle does not exceed 6 feet 7 inches from the floor.

B. Hang each door of the cabinet on semi- or fully-concealed hinges with a combination catch and lock.

C. On cabinets 48 inch high and over, install a 3 point catch assembly latching at top, bottom and approximate middle.

D. Verify all panelboard locks are keyed alike.

E. Provide typed directory card filled-out to clearly indicate the load served.

F. Door hinge to be on the side opposite escape route if applicable.

3.02 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 26 27 26

WIRING DEVICES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide field test, and place in operating condition, wiring devices as indicated and specified.

1.02 REFERENCES:

A. Federal Specifications (FS):

1. W-C-596-F: Plug, Electrical Connector, Receptacle, Electrical.

2. W-S-896-F: (1P-2P-3W) Switch, Toggle, Single Unit with wall plates.

B. National Electrical Manufacturers Association (NEMA):

1. WD 1: General Requirements for Wiring Devices

2. WD 6: Wiring Devices – Dimensional Requirements

C. National Fire Protection Association (NFPA):

1. 70: National Electrical Code (NEC).

D. Underwriters' Laboratories, Inc. (UL):

1. 20: General Use Snap Switches.

1.03 SUBMITTALS:

A. Submit shop drawings in accordance with Section 01 33 00

B. Submit shop drawings and manufacturer's product data in accordance with requirements of Section 26 05 10.

PART 2 - PRODUCTS

2.01 MANUFACTURER'S COMPLIANCE:

A. Manufacturer’s acceptance contingent upon products compliance with specifications.

B. Provide all devices with UL label.

2.02 MANUFACTURERS:

A. Allen-Bradley Co.

B. Appleton Electric Co.

C. Cooper Wiring Devices.

D. Eaton-Cutler Hammer, Inc.

E. Crouse-Hinds Co.

F. Hubbell Electrical Products.

G. Pass & Seymour, Legrand.

H. OZ Gedney.

I. Nelson Electric.

2.03 MATERIALS AND COMPONENTS:

A. Watertight Switches:

1. Provide watertight switches consisting of flush mounting switches in NEMA Type 4 gasketed cast metal boxes. Switch operable through shaft in matching cast metal cover, twenty-ampere, 120/277-volt switch enclosures:

a. Crouse-Hinds Type MC or MCC.

b. Appleton Cat. No. WDM 175 and WVG1

c. OZ Gedney Cat. No. WSP and WCT120

B. Special Receptacles:

1. Provide weatherproof devices rated 20 ampere, 125-volt, consisting of single receptacles with spring-loaded, soft-gasketed hinged covers with stainless steel spring. Covers as follows:

a. Hubbell Cat. No. 5206.

b. Bryant Electric Cat. No. 4510.

c. Crouse-Hinds Cat. No. WLRS-1.

C. Outlet Boxes and Enclosures:

1. Provide outlet boxes and enclosures conforming to Section 26 05 33 and enclosure schedule on the drawings unless otherwise indicated.

D. Device Plates:

1. Provide device plates suitable for type of outlet boxes and enclosures used. Plates for flush-mounting by device manufacturer. Plates for surface-mounting boxes by either device manufacturer or box manufacturer.

PART 3 - EXECUTION

3.01 GENERAL:

A. Perform all work in accordance with the NEC.

3.02 CONNECTION:

A. Securely and rigidly attach wiring devices in accordance with regulating agency, and as indicated, avoiding interference with other equipment.

B. Securely fasten nameplates using screws, bolts, or rivets and centered under or on the device, unless otherwise indicated.

3.03 GROUNDING:

A. Ground all devices in accordance with NEC.

B. Ground switches and their metal plates through switch mounting yoke, outlet box, and raceway system.

3.04 LABELING:

A. All wall plates to be engraved with the panelboard alpha-numeric identifier and circuit breaker number.

1. Characters to be 5/16 inch in size and black in color.

2. All engravings to match panelboard typed circuit breaker directories.

3.05 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 31 05 19.16

GEOMEMBRANES

PART 1 - GENERAL

1.01 SUMMARY:

A. This section details the technical requirements for the supply and installation of High Density Polyethylene (HDPE) geomembrane (liner). The material(s) furnished and installation performed shall be in strict accordance with these requirements and the Drawings.

1.02 REFERENCES:

A. ASTM International (ASTM):

1. D 792 – Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.

2. D 1004 – Standard Test Method for Tear Resistance (Graves Tear) of Plastic Film and Sheeting.

3. D 1505 – Standard Test Method for Density of Plastics by the Density-Gradient Technique.

4. D 1603 – Standard Test Method for Carbon Black in Olefin Plastics.

5. D 3895 – Standard Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry.

6. D 4218 – Standard Test Method for Determination of Carbon Black in Polyethylene Compounds By the Muffle-Furnace Technique.

7. D 4632 – Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.

8. D 5261 – Standard Test Method for Measuring Mass Per Unit Area of Geotextiles.

9. D 4833 – Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products.

10. D 5397 – Standard Text Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test.

11. D 5596 – Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics.

12. D 5721 – Standard Practice for Air-Oven Aging of Polyolefin Geomembranes.

13. D 5885 – Standard Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High Pressure Differential Scanning Calorimetry.

14. D 5994 – Standard Test Method for Measuring Core Thickness of Textured Geomembranes.

15. D 6241 - Standard Test Method for Static Puncture Strength of Geotextiles and Geotextile Related Products Using a 50-mm Probe.

16. D 6693 – Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes.

17. D 7238 – Standard Test Method for Effect of Exposure of Unreinforced Polyolefin Geomembrane Using Fluorescent UV Condensation Apparatus.

18. D 7466 – Standard Test Method for Measuring the Asperity Height of Textured Geomembranes.

B. GRI Standards - Geosynthetic Research Institute:

1. GM 13(a) – Standard Specification for Test Methods, Test Properties, and Testing Frequency for High Densty Polyethylene (HDPE) Smooth and Textured Geomembranes.

2. GM 19a – Seam Strength and Related Properties of Thermally Bonded Homogeneous Polyolefin Geomembranes/Barriers.

1.03 SUBMITTALS:

A. Submit liner Manufacturer and installer qualifications, product performance data, resin data, certification of acceptance for the liner foundation, and Quality Control (QC) and daily install reports in accordance with Section 01 33 00, ‘Submittals’ and this section.

B. Submit a summary of the Liner Subcontractor’s experience with the placement of 60 mil HDPE Geomembrane. At a minimum, Liner Subcontractor shall have 2 years of continuous installation experience with in excess of one million square feet of HDPE liner installed.

C. Liner Subcontractor shall provide Manufacturer’s Shop Drawing of the liner layout plan and details for the Owner’s review and approval prior to liner procurement. Submit two sets of full-sized, complete shop and illustration drawings. Detail all jointing and anchorage.

D. Liner Subcontractor’s approved construction layout drawings shall specify all components and details required to meet these Specifications. Responsibility of the Owner, Engineer’s Representative, Contractor, and Liner Subcontractor shall be clearly defined.

E. Provide Manufacturer testing results with the following frequency:

1. Density – Two per resin lot number.

2. Tensile Properties – One per 100,000 square feet of manufactured sheet unless otherwise approved by Engineer.

3. Carbon Black – Two per resin batch number thickness – one per 100,000 square feet of manufactured sheet unless otherwise approved by Engineer.

4. Volatile Loss – Certification by resin supplier with each resin batch.

F. Submit test results to the Owner for approval prior to delivery of the HDPE liner to the job site. Alternate testing methods may be used with prior approval by the Owner.

G. Submit to the Owner a peel strength value and the test procedure used to determine the peel strength 30 days before delivering liner to the site. This value will be used to evaluate field seam quality.

H. Submit copies of the quality control certificates for the resin used to produce the liner, welding rod, embedment anchors and stud liner.

I. Submit copies of the QC certificates showing the liner meets the requirements listed in Table 31 05 19.16-1.

1.04 GENERAL DEFINITIONS:

A. Field Seam – Seam welded during liner installation.

B. Factory Seam – Seam made during factory fabrication of the sheeting. Factory seams shall have tensile strength properties equal to or greater than the parent material. Bidders shall submit a sample of a factory seam with their bids.

C. Fish Mouth – Term used to describe the appearance of a bulge or gap along the weld line of a liner seam. Gap is formed when the welded length of one liner panel exceeds that of the adjoining panel; the excess material forms the fish mouth following seam welding.

D. Lot – A quantity of resin (usually the capacity of one rail car) used in the manufacture of geomembranes.

E. Panel – A single factory-fabricated section of the liner membrane.

F. Liner is constructed of High-Density Polyethylene (HDPE).

G. Liner – Initial solution barrier underlying the solution contained in the area fill and beneath the drainage layer.

H. Liner Subcontractor is also referred to in other contract documents as Liner Installer or Geosynthetics Installer.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Provide 60-mil textured (both sides) HDPE reflective white geomembrane materials that meets or exceeds the physical properties identified in Table 31 05 19.16-1.

B. HDPE liner material shall NOT be new-old stock (NOS) material. Liner rolls must have been manufactured within 18 months of the Owner's approval of the material submitted.

C. HDPE liner shall be free of holes, pinholes as verified by on-line electrical detection, bubbles, blisters, excessive contamination by foreign matter, and nicks and cuts on roll edges.

D. HDPE liner material is to be supplied in roll form. Each roll is to be identified with labels indicating product identification, roll number, thickness, length, width, and Manufacturer.

E. Extruded rod or bead shall be made from the same type resin as the geomembrane. Materials shall be free of contamination by moisture or foreign matter.

F. Contractor shall submit for review and approval samples and/or material date sheets for the liner materials, to include liner, neoprene, mastic and silicon seal.

G. Any material properties for the proposed HDPE liner which do not meet the requirements listed in Table 31 05 19.16-1 must have prior approval by Engineer.

Table 31 05 19.16-1 Material Properties High Density Polyethylene (HDPE)		
Property	**Test Method**	**60-mil Textured Liner**
Nominal Thickness, mils, minimum average		60
Thickness, mils, minimum Textured – lowest individual for 8 of 10	ASTM D 5994	54 With 10 mil min.avg. asperity height
Asperity Height, mils (min. avg.)	ASTM D 7466	16
Density (g/cc), minimum	ASTM D 1505/ ASTM D 792	0.940
Minimum Tensile Properties (each direction)	ASTM D 6693, Type IV	
1. Tensile Strength at Yield (lb/in. width)		126 min.
2. Tensile Strength at Break (lb/in. width)		90 min.
3. Elongation at Yield (percent)		12% min.
4. Elongation at Break (percent)		100% min.
Tear Resistance (lb)	ASTM D 1004	42 min.
Puncture Resistance (lb)	ASTM D 4833	90 min.
Stress Crack Resistance (hr)	ASTM D 5397 (App.)	500
Oxidative Induction Time (OIT) (min. avg.) (a or b) (a) Standard OIT (b) High Pressure OIT	 ASTM D 3895 ASTM D 5885	 100 min. 400 min.
Oven Aging at 85^{o} C (a or b) (a) Standard OIT (min. avg.) – % retained after 90 days (b) High Pressure OIT (min. avg.) – % retained after 90 days	ASTM D 5721 ASTM D 3895 ASTM D 5885	 55% 80%
UV Resistance (a) High Pressure OIT (min. avg.) – % retained after 1,600 hr	 ASTM D 5885	 50%
Carbon Black Content (percent)	ASTM D 1603/ D 4218	2.0-3.0%
Carbon Black Dispersion (within Category)	ASTM D 5596	9 of 10 views (Cat. 1 or 2). No more than 1 view (Cat. 3)
Roll Width (feet)		22.5

2.02 EQUIPMENT:

A. Use only welding material of a type recommended and supplied by the Manufacturer, delivered to the site in the original sealed containers, each with an indelible label bearing the brand name, Manufacturer's mark number, and complete directions as to proper storage.

B. Use welding equipment capable of continuously monitoring and controlling the temperature of the zone of contact where the machine is actually fusing the lining material to ensure that changes in environmental conditions will not affect the integrity of the weld.

C. An adequate number of welding machines shall be available to avoid delaying work.

D. Power sources to welding equipment must be capable of providing constant voltage under combined live load.

E. Provide sufficient equipment to perform the liner placement within the scheduled time.

F. Portable generators deployed atop installed liner materials shall be equipped with portable spill pads and cushioning materials to prevent any damage to the underlying liner materials.

PART 3 - EXECUTION

3.01 FOUNDATION PREPARATION:

A. Liner Subcontractor shall ensure foundation has been properly prepared for geosynthetic placement by walking the total area receiving geosynthetic materials and visually inspect for proper lines, grades, and anchorage throughout. Verify consistency with approved liner shop drawings prior to liner installation.

B. Liner Subcontractor shall ensure the Geosynthetic Clay Liner (GCL) has been placed in accordance with the Specifications and that the GCL surface is clear of all deleterious material, rock protrusions greater than 3/4-inch above the finished surface, or other objects that may puncture the geosynthetic materials from the foundation, underlayment, and anchor trenches prior to geosynthetic installation.

C. Liner Subcontractor shall ensure proper compaction and moisture treatment of the foundation has been performed in accordance with the provisions in Section 31 23 00, "Excavation and Fill" and is not soft and yielding prior to geosynthetic material deployment.

D. Liner Subcontractor, representative of Contractor, representative of Owner, and representative of CQA firm shall walk the entire area to receive geosynthetic materials and discuss completed foundation preparation, and Verify that underlying surfaces are ready to receive Work.

3.02 VERIFICATION OF UNDERLYING MATERIAL:

A. Subgrade:

1. Prior to installation of the GCL, Liner Subcontractor shall inspect and verify the subgrade conditions of the specified area as adequate for placement of the geosynthetic materials. Inspect and verify all foundation, underlayment, and anchor trenches are acceptable for proper liner installation. Subgrade Specifications are outlined in Section 31 23 00. Following the written certification (form and/or letter) of accepting the foundation, Liner Subcontractor assumes full responsibility for the approved area should foundation conditions be altered by occurrences outside the control of the General Contractor.

B. GCL:

1. Prior to the installation of the liner, Liner Subcontractor shall inspect and verify the GCL installation has been performed in accordance with these Specifications.

C. Liner:

1. Prior to installation of the Leak Collection and Recovery System (LCRS), free draining gravel, or piping, Liner Subcontractor shall inspect and verify liner system is ready to receive overlying material. Verify all repairs, field test results, and laboratory seam control tests meet or exceed the requirements of the Specifications prior to installation of the overlying materials. Obtain specific approval from the CQA representative prior to installation of the bottom ash operations layer, free draining gravel, or piping.

3.03 LINER INSTALLATION:

A. Liner Subcontractor shall be responsible for inspection of the sheet rolls at the job site. Should rolls show damage from transit, they will be so identified by the Lining Subcontractor and/or CQA representative and set aside.

B. During unrolling of the lining material, the Liner Subcontractor shall carry out visual inspection of the sheet surface. Any faulty areas shall be marked and repaired by the Lining Subcontractor in a manner approved by the Owner. Owner will make periodic, independent inspection of the liner, and any additional faulty areas discovered shall be repaired.

C. Liner Subcontractor shall lay out and overlap individual panels of liner material prior to welding with a minimum 4 to 6 inch overlap, using Manufacturer's trained technicians. Extreme care shall be taken by the installer in the preparation of the areas to be welded. Clean and prepare the area to be welded according to installation procedures provided by the material Manufacturer and subject to approval by the Owner.

D. Liner shall be placed with a sufficient amount of slack to compensate for the thermal expansion and contraction of the liner material relative to the geographic area where the liner is being placed. Any tensioned liner shall be removed and replaced to the approval of the Owner.

E. Assign each HDPE geomembrane panel a simple and logical identifying code. The coding system shall be subject to approval and shall be determined at the job site.

F. Fusion seam welds are to be performed by using a steel wedge heated to a temperature between 600°F and 850°F and pressing it onto the overlapped zone of the two liners to be joined. Extrudate (fillet) seams to be formed by extruding a ribbon of molten polymer over the edge of, or in between, the two surfaces to be joined.

G. All field production seams shall be fusion seams unless otherwise directed by the Drawings, Specifications, Engineer's Representative, or the Owner. All patches shall be extrusion welds unless otherwise directed by the Owner. All toe welds shall be performed using either a double-track fusion weld or a 2-inch solid wedge weld.

H. T-welds (where vertical and horizontal welds meet) shall be welded using either a continuous double-track fusion weld or a continuous 2-inch solid fusion weld. The vertical seam shall be welded first and the horizontal seam shall be continuous over the vertical seams. The welding operator shall release tension in the welding apparatus as needed to cross the vertical weld. The T-weld shall then be patched and extrudate welded as specified by the Owner.

I. Scrap liner slip sheets shall be used wherever liner materials come into direct contact with the subgrade soils to protect the underside of the liner from dirt accumulation. Because the sideslope liner will be fusion welded to the bottom liner, it is extremely important to keep the underside of the liner clean. Extrusion welds in lieu of cleaning the underside of the liner will NOT be permitted.

J. Liner Installer shall minimize number of field seams in corners, odd shaped geometric locations, and outside corners.

K. Use a sequential seam numbering system compatible with panel numbering system that is approved by the Owner.

L. Provide at least one Master Seamer who shall provide direct supervision over other welders as necessary.

M. All field seams shall be welded when the outside temperature is between 40 and 105 degrees Fahrenheit.

N. Tightly bond all welds on completion of the work. Replace or repair with an additional piece of HDPE liner any panel area showing injury due to excessive scuffing, puncture, or distress from any cause.

O. Allow no "fish mouths" within the seam area. Where "fish mouths" occur, cut and overlap the material and apply an overlap-extrusion weld.

P. Welding of liner material on which visible moisture is present will not be permitted.

Q. Lift the liner material into place; dragging the material across the prepared surface or other surface likely to scratch or scuff the liner material will not be permitted.

R. To the greatest extent possible, allow no horizontal seams on slopes steeper than 4:1.

S. Install liner anchorage as shown on the Drawings.

T. Coordinate liner installation activities with GCL, geotextile, and free draining gravel installation activities.

U. Install a minimum of two stainless steel bands at each pipe boot.

V. Liner Subcontractor shall coordinate materials and sequencing for all temporary (sand bags) and permanent anchorage of the liner with the Contractor and install permanent anchorage in accordance with Section 31 23 00.

W. Patches to the extrudate welds shall have their edges beveled prior to tacking to the patched area. All patches shall be a minimum of 6 inches larger in each direction than the overall area to be patched. Ground areas on the patches and the underlying liner shall be a maximum of 1/2-inch in width. HDPE extrudate must cover the entire ground area.

X. Prior to extrudate welding, a minimum of 6 inches of molten extrudate shall be extruded from the welding gun and wasted. Hot extrudate shall not be placed on the liner.

Y. Place ballast (commonly sand bags) on geomembrane, which will not damage geomembrane, to prevent wind uplift. Remove and dispose of all sandbags or other temporary ballast prior to bottom ash operations layer installation.

Z. Personnel working on geomembrane shall not engage in activities or wear shoes that could damage it. Smoking will not be permitted on the geomembrane.

3.04 QUALITY CONTROL:

A. FIELD SEAM TESTING

1. Contractor or Liner Subcontractor shall perform all testing and quality control in accordance with this Section, Section 01 43 00, and consistent with approved quality control plans.

2. The Liner Subcontractor shall perform destructive and on-site non-destructive testing on all welds to ensure watertight homogeneous seams.

3. The Liner Subcontractor’s quality control technician shall inspect each seam. Mark and repair in accordance with approved procedures any area showing a defect. The Liner Subcontractor will indicate on the field installation drawings the locations, types and correction for defects.

4. Each day, prior to liner welding, produce a test weld 3 feet in length with each welding machine. Perform test welding under the conditions that will exist for liner welding. Mark each test weld with date, ambient temperature, welding machine number, and seamer's name. Cut samples of the test welds 1-inch in width and perform peel and shear testing.

   The specimen passes when:

   a. The break is Film Tearing Bond (FTB).

   b. The break is ductile (elongating until failure).

   c. The strength of break is:

      i. 70 percent (wedge welder) or 65 percent (extrusion welder) of sheet minimum yield strength for peel adhesion test.

      ii. 90 percent of sheet minimum yield strength for bonded seam strength test.

      A break of the weld sheet interface is considered a non-FTB (failure) while a break through the weld is considered FTB if the break is ductile.

5. The Liner Subcontractor shall remove random weld samples from the installed welded sheeting for destructive shear and peel tests at locations designated by the Owner. Test a minimum of one sample per day or approximately one per 500 feet of weld, whichever is more, to determine seam tensile properties and peel strength. Frequency and location of samples will be specified by the CQA Consultant whereupon duplicate samples for quality assurance will be collected. This frequency may be increased or decreased if directed by the Owner and/or Engineer.

6. The Liner Subcontractor shall vacuum test the entire length of each extrusion weld seam or joint in accordance with ASTM D 5641.

7. The Liner Subcontractor shall mark, log and identify each type of repair to be made as a discrepant area.

8. The Owner retains the right to reject any field made seam for cause. Cause shall be defined to include poor workmanship, apparent sheet defects, defective welds or insufficient overlap. Any field seam rejected for such causes shall be repaired or replaced to the satisfaction of the Owner at no additional expense to the Owner.

9. Perform QC testing in the field on all pipe boot assemblies. Perform spark testing in accordance with ASTM D 7240, or air tests in accordance with ASTM D 5820, for each component of each boot as required.

10. The Lining Subcontractor shall pressure test the entire length of each fusion weld seam in accordance with ASTM D 5820. Upon completion of the test, the seam end opposite the needle shall be punctured to verify the entire seam was pressurized. The Liner Subcontractor shall close the needle hole and pressure release puncture with an extrusion weld.

B. REPAIRS

1. Any portion of the liner with a flaw, which fails a nondestructive or destructive test, where destructive tests were cut, or where nondestructive tests left cuts or holes, must be repaired in accordance with the Specifications. The CQA Field Manager must locate and record all repairs on the repair log and panel layout drawing. Repair techniques include the following:

   a. Patching, used to repair large holes, tears, large panel defects, undispersed raw materials, contamination by foreign matter, and destructive sample locations.

   b. Extrusion, used to repair small defects in the panels and seams. In general, this procedure should be used for defects less than ½ inch in the largest dimension.

   c. Capping, used to repair failed welds or to cover seams where welds or bonded sections cannot be nondestructively tested.

   d. Removal, used to replace areas with large defects where the preceding methods are not appropriate. Also used to remove excess material (wrinkles, fishmouths, intersections, etc.) from the installed liner. Areas of removal shall be patched or capped.

2. Repair procedures include the following:

   a. Abrade liner surfaces to be repaired (extrusion welds only) no more than one (1) hour prior to the repair.

   b. Clean and dry all surfaces at the time of repair.

   c. Verify the acceptance of the repair procedures, materials and techniques by the CQA Field Manager in advance of the specific repair.

   d. Extend patches or caps at least 6 inches beyond the edge of the defect, and round all corners of material to be patched and the patches to a radius of at least 3 inches. Bevel the top edges of patches prior to extrusion welding.

3. Failed Seam Procedures (from destructive testing):

   a. Resample and test 10 feet upstream and downstream of the failing destructive sample.

   b. If passing destructive tests are achieved, either reconstruct or cap the entire seam between two passing locations.

c. If failing destructive tests are recognized, continue to resample and test in 10-foot increments upstream and downstream of the weld until passing destructive tests are obtained.

d. If the seam ends prior to the 10-foot increment, the Liner Installer shall continue the measurement on the previous seam constructed using the equipment generating the failing test.

e. This sequential approach shall continue until passing destructive tests are obtained both upstream and downstream of the original failing destructive test.

f. The entire seam shall then be either reconstructed or capped between the passing destructive testing locations.

g. Any welding equipment deemed problematic by the Owner shall be replaced by certified equipment or calibrated and recertified by the Liner Installer prior to use on the Project.

C. Protect finished installation from wind and water damage.

D. Do not permit vehicle/equipment traffic on geotextile without prior approval by the Owner and/or Engineer's Representative.

3.05 WARRANTY AND GUARANTEE:

A. Obtain from the Manufacturer a written guarantee for a time period of at least 20 years after installation during which the liner materials under this project shall be free from defects. Such written guarantee shall provide for the total and complete repair or replacement of the defect or defective area of lining materials upon written notification and demonstration by the Owner of the specific non-conformance of the lining material with the Project Specifications. Such defects or non-conformance shall be repaired or replaced at no cost to the Owner within 30 days of notification or as approved by the Owner.

B. Obtain from the Installer/Subcontractor a written guarantee for a time period of at least two years after installation during which the workmanship using liner materials under this project shall be free from defects. Such written guarantee shall provide for the total and complete repair or replacement of the defect or defective area of installation, field repair, field testing, or other work using liming materials upon written notification and demonstration by the Owner of the specific non-conformance of the lining material installation with the Specifications. Such defects or non-conformance shall be repaired or replaced at no cost to the Owner within 30 days of notification or as approved by the Owner.

END OF SECTION

SECTION 31 05 19.19

GEONETS

PART 1 - GENERAL

1.01 SUMMARY:

A. This section covers requirements for material and installation of High Density Polyethylene (HDPE) biplanar geonet to be used as a drainage layer for a leak collection and removal system (LCRS) and installed between the inner and outer geomembrane liners.

1.02 REFERENCES:

A. ASTM International (ASTM):

1. D 1505 – Standard Test Method for Density of Plastics by the Density-Gradient Technique.

2. D 1603 – Standard Test Method for Carbon Black Content in Olefin Plastics.

3. D 4218 – Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds By the Muffle-Furnace Technique.

4. D 4716 – Standard Test Method for Determining the (In-plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head.

5. D 5199 – Standard Test Method for Measuring the Nominal Thickness of Geosynthetics.

6. D 6364 – Standard Test Method for Determining Short-Term Compressive Behavior of Geosynthetics.

7. D 7179 – Standard Test Method for Determining Geonet Breaking Forces.

B. GRI Standards - Geosynthetic Research Institute:

1. GRI-GN2 and GRI-GC13 – Standard Guide for Joining and Attaching Geonets and Drainage Composites.

1.03 DEFINITIONS:

A. Construction Quality Assurance (CQA) Contractor: Contractor who is responsible for all CQA work.

1.04 SUBMITTALS:

A. Geonet:

1. Copy of the raw material producers certificates describing the origin and identification of the raw materials.

2. Copy of the raw material producers quality control (QC) certificates.

3. Copy of the Manufacturer's QC certificates on tests performed on the material and a summary of results of the tests.

4. Certification that the properties of the manufactured material meets specification requirements and are guaranteed by the manufacturer.

B. Submit product samples and data specification sheets as per Section 01 33 00.

1.05 QUALIFICATIONS:

A. The Manufacturing Company specializing in the manufacture of products specified in this Section must have a minimum 2 years documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING:

A. A production certificate stating that each geonet conforms to the material properties published by the suppliers shall be provided with each shipment.

B. Geonet shall be protected from ultraviolet light exposure, precipitation or other inundation, dirt, puncture, cutting, or other damaging or deleterious conditions in accordance with the manufacture’s recommendations.

C. Geonet rolls shall be shipped and stored in relatively opaque and watertight wrappings.

D. Geonet may be cut to the appropriate dimension using a knife or suitable instrument.

1.07 MANUFACTURER’S WARRANTY:

A. Provide a 5-year manufacturer’s material warranty.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. HDPE Geonet- General Requirements:

1. HDPE geonet shall be a profiled geonet manufactured by extruding two sets of polyethylene strands to form a three dimensional structure in a diamond shape to provide planar water flow.

2. HDPE geonet formulation shall consist of a minimum of 97 percent of polyethylene resin, with the balance being carbon black and additives. No fillers, extenders, or other materials shall be mixed into the formulation.

3. Regrind or reworked polymer, which is previously processed HDPE geonet in chip form, is acceptable if it is the same formulation as the geonet being produced.

4. No amount of "recycled" or "reworked" material that has seen prior use in another product shall be added to the formulation.

B. Geonet Material Requirements: HDPE geonet shall meet the requirements of Table 31 05 19.19-1.

TABLE 31 05 19.19-1 – HDPE DRAINAGE NET MATERIAL REQUIREMENTS

Properties	Test Method	Value	Minimum Manufacturer Test Frequency
Thickness[1] (minimum)	ASTM D 5199	200 mil (min.)	1/50,000 ft^2
Transmissivity[2]	ASTM D 4716	9.6 gal/min/ft @ 10,000 psf	1/540,000 ft^2
Density	ASTM D 1505	0.94 g/cm^3	1/50,000 ft^2
Carbon Black	ASTM D 4218/ D 1603	2%	1/50,000 ft^2
Compressive Strength	ASTM D 6364	50,000 psf	1/540,000 ft^2
Tensile Strength – Machine Direction	ASTM D 7179	45 lb/in	1/50,000 ft^2

1. Thickness is nominal value.
2. Gradient of 0.1, water at 70^{o}F between steel plates for 15 minutes.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Upon delivery of the material to the project site, Contractor shall conduct a visual inspection of all rolls of geonet for damage or defects. This inspection shall be done without unrolling any rolls unless damage to the inside of a roll is found or suspected.

B. Any damage or defects shall be noted and immediately reported to the Owner. Any roll or portion thereof, which, in the judgment of the Owner, is seriously damaged, shall be removed from the project site and replaced with complying material at no additional cost to the Owner.

C. Verify field measurements and limits to receive geonet are as shown on Drawings.

3.02 STORAGE:

A. Provide on-site storage space in a location near the area to be lined such that on-site transportation and handling are minimized. Contractor shall be responsible for protecting stored material from theft and vandalism.

B. Rolls of geonet material shall be placed on a smooth surface free of rocks and standing water.

3.03 INSTALLATION:

A. General Requirements:

1. In the presence of wind, all drainage net shall be weighted with sandbags or the equivalent. Weights shall be installed during deployment and shall remain in place until replaced with the inner geomembrane or cover material.

2. Drainage net shall not be welded to the geomembrane.

3. Drainage net shall be cut using only scissors or other cutting tools approved by the Manufacturer that will not damage the underlying geomembrane. Care shall be taken not to leave tools in the drainage net.

4. All necessary precautions shall be taken to prevent damage to the underlying geomembrane during placement of the drainage net.

5. During placement of drainage net, care shall be taken not to entrap dirt or excessive dust that could cause clogging of the drainage system, and/or stones that could damage the adjacent geomembrane. If dirt or excessive dust is entrapped in the geonet, it shall be cleaned and all dirt removed prior to placement of the inner geomembrane. Care shall be taken in the handling of sandbags, to prevent rupture or damage of the sandbag.

B. Placement of Geonet:

1. On slopes, the drainage net shall be secured in the anchor trench and then rolled down the slope in such a manner as to continuously keep the net in tension. If necessary, the net shall be positioned by hand after unrolling to minimize wrinkles.

2. Drainage net shall be placed on side slopes with no horizontal seams along the slope and so that the long dimension is parallel to the slope.

3. No horizontal seam shall be located within 5 feet of the toe of a slope.

4. Drainage net shall be positioned on both the slopes and the bottom so that the core overlaps by a minimum of 4-inches.

5. When several layers of drainage net are installed care shall be taken to prevent the strands of one layer from penetrating the channels of the next layer.

6. Drainage net placed in the corners of the side slope shall be cut to eliminate excessive overlap of material.

7. When more than one layer of drainage net is installed the overlaps shall be staggered and the layers tied together.

C. Joining Geonet:

1. Adjacent panels of drainage net shall be joined using white or yellow self-locking straps. Metal fastening devices are not allowed.

2. Adjacent panels on slopes shall be joined on 5-foot centers.

3. Adjacent panels on the bottom shall be joined on 10-foot centers.

4. End seams on the base shall be joined on 12-inch centers.

5. Horizontal and end seams in anchor trenches shall be joined on 12-inch centers.

3.04 REPAIRS:

A. All holes or tears in the drainage net shall be repaired by placing a patch of drainage net over the tear which extends 2 feet beyond the edges of the hole or tear. The patch shall be secured to the original drainage net by tying every 12 inches. If the hole or tear width across the roll is more than 50% of the width of the roll, the damaged drainage net shall be removed and replaced.

3.05 PROTECTION:

A. Geomembrane Contractor shall be responsible for protection of the HDPE liner during installation of the drainage net. He shall be responsible for repair of any damage caused by installation of the drainage net.

B. Do not permit vehicle/equipment traffic on geotextile without prior approval by the Owner and/or Engineer's Representative.

3.06 CREST ANCHOR TRENCH:

A. Both geomembrane liners and the geonet shall be anchored in an anchor trench at the top of the slope as shown on the Drawings.

END OF SECTION

SECTION 31 05 19.23

GEOSYNTHETIC CLAY LINER

PART 1 - GENERAL

1.01 SUMMARY:

A. This specification details the technical requirements for the supply and installation of a reinforced Geosynthetic Clay Liner (GCL). The material(s) furnished and installation performed shall be in strict accordance with these requirements and the contract Drawings.

1.02 REFERENCES:

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. Use the latest revision date available unless otherwise indicated.

B. ASTM International (ASTM):

1. D 698 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft3 (600 kN-m/m3)).

2. D 3776 – Standard Test Method for Mass Per Unit Area (Weight) of Fabric.

3. D 5321 – Standard Test Method for Determining the Shear Strength of Soil-Geosynthetic and Geosynthetic-Geosynthetic Interface by Direct Sears.

4. D 5084 – Standard Test Method for Measurement of Hydraulic Conductivity of Standard Porous Materials Using a Flexible Wall Permeameter.

5. D 5261 – Standard Test Method for Measuring Mass per Unit Area of Geotextiles.

6. D 5887 – Standard Test Method for Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter.

7. D 5888 – Standard Guide for Storage and Handling of Geosynthetic Clay Liners.

8. D 5889 – Standard Practice for Quality Control of Geosynthetic Clay Liners.

9. D 5890 – Standard Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners.

10. D 5891 – Standard Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners.

11. D 5993 – Standard Test Method for Measuring Mass per Unit of Geosynthetic Clay Liner.

12. D 6102 – Standard Guide for Installation of Geosynthetic Clay Liners.

13. D 6243 – Standard Test Method for Determining the Internal and Interface Shear Strength of Geosynthetic Clay Liner by the Direct Shear Method.

14. D 6496 – Standard Test Method for Determining Average Bonding Peel Strength between Top and Bottom Layers of Needle-Punched Geosynthetic Clay Liners.

15. D 6768 – Standard Terminology Relating to Flax and Linen.

C. GRI Standards - Geosynthetic Research Institute:

1. GCL3 – Standard Specification for Test Methods, Required Properties, and Testing Frequency of Geosynthetic Clay Liners (GCL).

1.03 SUBMITTALS:

A. Contractor shall provide Manufacturer's Shop Drawings, product performance data, manufacturer quality control (QC) certificates, and samples of the geosynthetic clay liner (GCL) layout plan and details for the Owner's and Engineer Representative's review and approval in accordance with the provisions of Section 01 33 00.

B. Contractor shall procure no materials until the Owner or Engineer's Representative approves all material submittals.

1. Origin and identification of the bentonite.

2. List of properties and characteristics of the geotextiles.

3. Copies of the QC certificates for the Manufacture of the GCL

4. Certification that the GCL meets the properties identified in Table 31 05 19.23-1 listed in Section 2.01.G.

5. Signed certification that the delivered material meets or exceeds the above-listed properties.

6. Seaming procedure(s) for all horizontal (end to end) seams.

1.04 DELIVERY, STORAGE, AND HANDLING:

A. Packing and Shipping.

1. GCL shall be supplied in rolls wrapped individually in relatively impermeable and opaque protective covers.

2. GCL rolls shall be marked or tagged with the Manufacturer's name, product identification, roll number, roll dimension, and roll weight.

3. Offloading GCL shall be in strict accordance with Manufacturer's instructions using spreader bar or equal. PUSHING GCL ROLLS OFF TRUCKS OR DROPPING GCL ROLLS IS NOT PERMITTED AND ROLLS HANDLED IN THIS MANNER WILL BE REJECTED.

B. Storage and Protection.

1. Conform to the manufacturer's requirements and ASTM D 5888 unless otherwise specified.

2. Contractor shall provide on-site storage area for GCL rolls from time of delivery until installed.

3. After Contractor mobilization, store and protect GCL from dirt, water, ultraviolet exposure, and other sources of damage.

4. Preserve integrity and readability of GCL roll labels. Unidentifiable GCL rolls will be rejected.

1.05 MATERIAL WARRANTY:

A. Manufacturer shall provide a five (5) year warranty to the Owner against manufacturing defects. Warranty shall include defective product found to be not in compliance with the requirements of this section. Warranty shall include the supply of the replacement GCL material. Warranty shall not include the cost of re-installation, defects or failures due to improper installation.

1.06 WORKMANSHIP WARRANTY:

A. Installation Subcontractor shall provide a one (1) year warranty for the workmanship of the GCL installation in accordance with the requirements of these Contract Documents and the Manufacturer's instructions and recommendations. Warranty shall include repair of damaged or improperly installed GCL, or replacement of material found to be out of compliance with the specifications.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. GCL materials shall be:

1. CETCO Resistex 200 FLW9

~~1. GSE Bentoliner NSL.~~

~~2. CETCO Bentomat ST.~~

~~3. Or approved equal.~~

B. Active ingredient of the GCL shall be natural sodium bentonite. Bentonite shall be encapsulated between two geotextiles.

C. GCL shall be manufactured by mechanically bonding geotextiles using a needle punching process to enhance frictional and internal shear strength characteristics.

D. GCL material shall NOT be new-old stock (NOS) material. GCL rolls must have been manufactured within 18 months of the Owner's approval of the material. GCL rolls shall be a full roll width and a minimum of 100 feet in length.

E. Overlap Markings – A minimum overlap guideline and a construction match-line delineating the overlap zone shall be imprinted with non-toxic ink on both edges of the GCL panel to ensure the accuracy of the seam. These lines shall be used during CQA to ensure the minimum overlap is achieved. Minimum overlap guideline shall indicate where the edge of the panel must be placed in order to achieve the correct overlap for each panel.

F. All GCL's used shall be of the same type unless prior approval is obtained from the Owner.

G. Final GCL product shall have the minimum average roll value (MARV) properties identified in Table 31 05 19.23-1:

Table 31 05 19.23-1
Minimum Average Roll Value (MARV) Properties Geosynthetic Clay Liner (GCL)

Tested Property	Test Method	Frequency	Value
Cap Nonwoven, Mass/Unit Area	ASTM D 5261	1/*200,000 ft²* ~~25,000 yd²~~	*9.0* ~~5.9~~ oz/yd² MARV
Carrier *Scrim-reinforced Nonwoven* ~~Woven~~, Mass/Unit Area	ASTM D 5261	1/*200,000 ft²* ~~25,000 yd²~~	*6.0* ~~3.0~~ oz/yd² MARV
Swell Index	ASTM D 5890	1/100,000 lb	24 ml/2g min
Moisture Content	ASTM D 5993	1/*40,000 ft²* ~~5,000 yd²~~	35% max
Fluid Loss	ASTM D 5891	1/100,000 lb	18 ml max
Bentonite, Mass/Unit Area	ASTM D 5993	1/*40,000 ft²* ~~5,000 yd²~~	0.75 lb/ft² MARV
Tensile Strength	ASTM D 6768	1/*200,000 ft²* ~~25,000 yd²~~	*50* ~~23~~ lb/in MARV
Peel Strength	ASTM D 6496	1/*40,000 ft²* ~~5,000 yd²~~	*3.5* ~~2.1~~ lb/in MARV
Hydraulic Conductivity or Permeability	ASTM D 5887	1/*250,000 ft²* ~~30,000 yd²~~	*3* ~~5~~ x 10^{-9} cm/sec max

Table 31 05 19.23-1 Minimum Average Roll Value (MARV) Properties Geosynthetic Clay Liner (GCL)			
Tested Property	**Test Method**	**Frequency**	**Value**
~~Index Flux~~	~~ASTM D 5887~~	~~1/30,000 yd^2~~	~~1 x 10^{-6} cm^3/sec cm^2 max~~
Internal Shear Strength	ASTM D 6243	*1/1,000,000 ft^2* ~~Periodically~~	500 psf Typical

2.02 EXPERIENCE:

A. Manufacturer of the GCL shall have a minimum of two (2) years of continuous experience in the manufacture of similar GCL products. Manufacturer must demonstrate, by submitting a list of previous projects, a minimum of ten (10) million square feet of manufacturing experience of similar GCL products.

B. Installation Subcontractor for GCL shall have a minimum of one (1) year of experience installing GCL or similar products. Installation Subcontractor for GCL shall demonstrate by submitting a list of previous projects, a minimum of one (1) million square feet of GCL.

2.03 EXPERIENCE:

A. CQA Consultant shall perform quality assurance (QA) conformance testing for the GCL materials at a frequency of one (1) per lot of bentonite used in the GCL manufacturing process.

B. Conformance testing shall be performed for the following material properties:

1. Hydraulic Conductivity (ASTM D 5084).

2. Bentonite Mass per Unit Area (ASTM D 3776).

3. Direct Shear (ASTM D 5321).

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Contractor shall inspect all GCL received on-site for damage or defect prior to installation. Notify the Owner of any such damage, defect, and wetted or saturated material before installation.

3.02 SUBGRADE PREPARATION:

A. Subgrade shall be prepared in a manner consistent and in accordance with the requirements in Section 31 23 00 and ASTM D 6102.

B. GCL subgrade soils shall be within optimum to plus two (2) percent of the optimum moisture content (OMC) as determined by ASTM D 698 just prior to the deployment of the GCL materials. If the subgrade soils are at a moisture content less than the OMC, Contractor shall apply water to the subgrade soils receiving overlying GCL materials utilizing a water truck with spray bars at an application rate that achieves a uniform coating of the subgrade with water, acceptable to the Engineer. Care shall be taken by Contractor to not over-wet the subgrade to a point where rutting is realized by the GCL deployment equipment. If rutting, or other subgrade damage occurs during GCL deployment, Contractor shall be required to stop GCL placement, repair damaged subgrade in accordance with the Specifications, and allow ample time for the subgrade to dry to the moisture content requirements previously identified.

C. Subgrade shall be properly compacted so as not to settle and cause excessive strains in GCL or other geosynthetic materials.

D. Ensure that rutting or raveling is not caused by installation equipment.

E. Ensure a surface free of debris, roots, or angular stone protrusions larger than 1/2-inch or as specified by GCL installer, whichever is smaller.

F. Any voids remaining after the removal of protruding rocks shall be filled with clean sand or compacted structural fill.

G. Provide to Owner a subgrade acceptance form stating that area to receive GCL meets subgrade preparation specifications. Any damage to liner system caused by subgrade defects shall be repaired at Contractor's expense to meet approval of the Owner.

3.03 INSTALLATION:

A. GCL shall be installed in accordance with ASTM D 6102 and this specification. In the event of a conflict, the most stringent condition shall apply.

B. GCL Deployment shall, at a minimum, comply with the following:

1. Handle GCL in a manner to ensure it is not damaged during installation.

2. On slopes, anchor GCL securely and deploy it down slope in a controlled manner.

3. Weight GCL with sandbags, or equivalent approved by Engineer, as needed to ensure damage will not result from wind or other conditions. Remove all sandbags or other temporary ballast prior to liner installation.

4. Cut GCL with a hook blade, scissors, or other approved device. Protect adjacent materials from potential damage due to cutting of GCL.

5. Prevent damage to underlying layers during placement of GCL.

6. During GCL deployment, do not entrap in or beneath GCL, stones, trash, or moisture that could damage GCL.

7. Visually examine entire GCL surface. Ensure no potentially harmful foreign objects, such as needles, are present.

8. Do not place GCL in the rain or at times of impending rain.

9. Do not place GCL in areas of ponded water.

10. Replace GCL that is hydrated before placement of overlying geomembrane.

11. In general, only deploy GCL that can be covered during that day by geomembrane.

12. Add granular or powder bentonite to overlapped areas at rate of 1/4 lb per lineal foot.

13. On sideslopes, run GCL to bottom of slope as indicated on the Drawings.

14. Do not allow vehicles or other heavy objects on GCL without prior approval by Engineer. ATVs and other vehicles used for deployment of geomembrane liner will be allowed on a case-by-case basis if it can be demonstrated that vehicles will not damage GCL.

C. Overlaps:

1. On slopes, overlap GCL to Manufacturer's match line. Where no match line is present, overlap a minimum of 6-inches.

2. Horizontal seams on sideslopes shall be minimized. Contractor shall submit a seaming procedure for horizontal (end to end) seams and submit procedure to Owner for approval prior to installation of any GCL.

3. End-of-roll overlapped seams shall be constructed as per Manufacturer's recommendations and with a minimum overlap of 12-inches.

4. Apply granular or powder bentonite to overlapped area at a rate required 1/4 lb per lineal foot.

D. Defects and Repairs:

1. Repair all flaws or damaged areas by placing a patch of same materials extending at least one (1) foot beyond the flaw or damaged area.

2. For needle-punched GCL's, add granular or powder bentonite to the overlapped edges of the patch at a rate of 1/4 lb per lineal foot.

E. Interface with other products:

1. Ensure the following when deploying overlying materials:

a. GCL and underlying materials are not damaged.

b. Minimal slippage of GCL on underlying layers occurs.

c. No excess tensile stresses occur in GCL.

d. If necessary, approved adhesive can be used to keep overlap seams and patches in place during placement of overlying materials.

END OF SECTION

SECTION 31 10 00

SITE CLEARING

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide site clearing as indicated and in compliance with Contract Documents.

B. Section Includes:

1. Clearing and grubbing.

2. Removal of debris related to clearing and grubbing operations.

1.02 DEFINITIONS:

A. Clearing: Removal and disposal of above-ground items defined herein.

B. Grubbing: Removal and disposal of below-ground items defined herein.

1.03 SITE CONDITIONS:

A. Existing facilities, structures, and utilities are shown in accordance with available surveys and records. The indicated locations of underground utilities and structures are approximate. Other utilities may exist which are not indicated.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Verify survey benchmarks and intended elevations for the Work are as indicated.

B. Verify temporary erosion and sediment control measures are installed before commencing with any other work at the site.

C. Verify location and existence of all underground utilities and.

3.02 PREPARATION:

A. Protect bench marks, survey control points, and existing structures to remain from damage or displacement.

B. Protect trees and vegetation to remain. Do not cut or injure trees and vegetation outside easement lines and outside designated clearing areas.

C. Protect all underground utilities and structures that are to remain. If damage occurs, immediately notify the utility owner within the hour.

D. Protect site features to remain from damage by construction equipment and vehicular traffic.

E. Identify waste and salvage areas for stockpiling of removed materials and obtain Owner approval.

3.03 RESTORATION:

A. Existing surfaces, features, utilities, or structures that are to remain but are damaged during construction shall be restored to at least the condition in which they were found immediately before work began, unless noted otherwise.

3.04 CLEARING:

A. Remove and dispose of on site in approved areas:

1. Trees, snags, brush, shrubs, downed timber, decayed wood, and other vegetative growth.

2. Rocks, tiles, lumps of concrete, trash piles, debris, refuse**,** rubbish, and fencing. Remove all evidence of their presence from the surface.

B. Clear ground within limits of work, unless otherwise noted.

C. Manual cutting of trees, stumps, and stubs during clearing shall be as close to ground surface as practicable but no higher than 6 inches above ground for small trees (8 inches or less), and not higher than 12 inches above ground for larger trees (greater than 8 inches).

3.05 GRUBBING:

A. Remove and dispose of all stumps, buried logs, matted roots, roots larger than 2 inches, and organic materials off site.

B. Roots larger than 2 inches in diameter shall be removed to a depth of 12 inches, and roots larger than 1/2-inches in diameter to a depth of 6 inches.

C. Areas designated to receive pavement or structures shall be grubbed a depth of 18 inches. Measure depths of cut from existing ground surface or proposed finished grade, whichever is lower.

D. Depressions made by grubbing shall be filled with suitable material and compacted to conform to original adjacent grade.

3.06 BURNING:

A. Burning is not permitted on site.

3.07 CLEANING:

A. Promptly dispose of excess and unsuitable material off site.

B. Remove debris, junk, and trash from site.

C. Leave site in clean condition, ready for subsequent work.

D. Clean up spillage and wind-blown debris before entering public or private property, adjacent to site.

3.08 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 31 22 00

GRADING

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide grading as indicated and in compliance with Contract Documents.

B. Section Includes:

1. Rough grading.

2. Finish grading.

3. Stockpiling of subsoil.

4. Disposal of unsuitable and excess materials.

1.02 DEFINITIONS:

A. Unsuitable Material: Defined in Section 31 23 00.

B. Foundation Influence Zone (under foundations, pavements, or sidewalks): Area below base bounded by 1/2H:1V slope extending outward from 1 feet beyond outer edges.

1.03 SUBMITTALS:

A. Submit in accordance with Section 01 33 00.

1.04 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 43 00.

1.05 SITE CONDITIONS:

A. Existing Conditions:

1. Site topographic maps and other topographic data shown on Contract Drawings, or included in these Specifications are only for general information. Owner and CM are not responsible for their accuracy, completeness or usefulness and meaning. Make such additional investigations as required to become acquainted with site topography and sub-surface soil conditions for preparation of bid, and for successful execution of Work.

2. Excavated materials are considered unclassified until independent testing agency classifies material, regardless of materials encountered.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Verify survey benchmarks and intended elevations for the work are as indicated.

B. Identify areas loosened by frost action, softened by flooding or weather, or containing unsuitable material.

3.02 PREPARATION:

A. Remove material loosened by frost action, softened by flooding or weather, or containing unsuitable material. Replace and compact to same requirements as for specified fill in Section 31 23 00.

B. Identify required lines, levels, grades, and datum.

C. Stake and flag locations of known utilities.

D. Locate, identify, and protect from damage all above- and below-ground utilities to remain.

3.03 ROUGH GRADING:

A. General grading shall be performed to achieve drainage as shown on the Drawings and to the Owner or Engineer's approval. Contractor shall be responsible for providing the appropriate equipment in order to achieve the required slope for the borrow areas and diversion channels.

B. General grading shall be performed to provide positive slope towards drainage ditches, channels, road crossings, pipe inlets, and catchments and as shown on the Drawings in a manner sufficient until finish grading can be accomplished.

C. General rough grading shall be performed to provide positive slope away from roadways.

D. Subsoil removal and stockpiling:

1. Remove subsoil from areas that are to be excavated, landscaped, or graded.

2. Stockpile suitable subsoil on-site.

E. Provide for free drainage of construction site.

F. Benching Slopes: Horizontally bench existing slopes greater than 4H:1V to key fill material to slope for firm bearing.

G. Stability: Replace damaged or displaced subsoil to same requirements as for specified fill in Section 31 23 00.

H. Disc level surfaces.

I. Rough grade site to achieve lines and grades indicated with allowances for imported fill thicknesses.

J. Provide positive drainage away from buildings and structures.

3.04 FINISH GRADING:

A. Before finish grading:

1. Verify subgrade is contoured and compacted.

2. Verify backfill has been inspected.

B. Contractor shall perform finish grading to the lines and grades shown on the Drawings. Changes in the lines and grades shall be approved by Engineer prior to completion of Work.

C. Fine grade to eliminate uneven areas and depressions. Follow profiles and contours of subgrade and bring to finish grade as indicated.

3.05 STOCKPILING:

A. Location: As indicated or directed. Do not locate stockpiles over existing or new utilities unless directed.

B. Height: 8 feet maximum.

C. Slope: 2H:1V, maximum

D. Drainage: Grade to prevent standing water.

E. Provide erosion and sediment control around downhill-side of stockpile perimeter.

F. Immediately stabilize dormant stockpiles within 7 days. Stockpiles and portions of stockpiles that will not be actively used for at least 30 days shall be considered dormant.

3.06 EXCESS MATERIAL:

A. Excess grading material, suitable for backfilling or site grading, that is not necessary to complete the work at the project site belongs to the Owner and shall be delivered to an off-site designated location within 10 miles from project site.

B. Dispose off site, unsuitable materials and excess materials not received by Owner.

3.07 TOLERANCES:

A. Subgrade:

1. Elevation: 2 inches, from required elevation.

2. Grade: 1 inch per 10 feet.

B. Finish Grade:

1. Elevation: 1/2 inch, from required elevation.

3.08 FIELD QUALITY CONTROL:

A. See Section 31 23 00 for compaction and testing requirements.

3.09 CLEANING:

A. Remove unused stockpiles, grade area to prevent standing water, protect from erosion, and stabilize.

B. Leave site clean and raked, ready to receive landscaping.

3.10 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

B. Submit existing utility location information as part of record drawings. Include ticket numbers and original information from utility owners.

END OF SECTION

SECTION 31 23 00

EXCAVATION AND FILL

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section is intended to encompass all activities associated with the earthwork for this Project. Contractor's selection of heavy equipment, fleet size, schedule, sequence, and personnel qualifications shall be considered with the intent to execute Work in conformance with the requirements described herein.

B. Provide excavation and fill as indicated and in compliance with Contract Documents.

C. Section includes:

1. Excavation, subgrade preparation, and fill for site drainage, structures, liners, and features.

2. Embankments.

3. Soil and aggregate materials.

4. Compaction and testing.

1.02 REFERENCES:

A. American Association of State and Highway Transportation Officials (AASHTO) Publications:

1. M145: Standard Specification for Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes.

B. ASTM International (ASTM):

1. C33: Standard Specification for Concrete Aggregates.

2. C 136 Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.

3. C 117 Standard Test Method for Materials Finer than 75-μm (No. 200) Sieve in Mineral Aggregates by Washing.

4. D422: Test Method for Particle-Size Analysis of Soils.

5. D698: Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft3 (600 kN-m/m3)).

6. D1556: Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.

7. D2487: Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).

8. D4318: Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils.

9. D6938: Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

C. New Mexico State Department of Transportation Standard Specifications for Highway and Bridge Construction, 2014 Edition (NMDOT Spec's).

D. Occupational Safety and Health Administration (OSHA) Standards and Regulations:

1. 29 CFR 1926, Subpart P: Safety and Health Regulations for Construction, Excavations.

1.03 CLASSIFICATION OF EXCAVATION:

A. Excavation is part of the lump sum contract price for the entire project.

1.04 DEFINITIONS

A. Percent Compaction or Compaction Density: The field dry density of compacted material, expressed as a percentage of the maximum dry density.

B. Field Dry Density or Field Density: In-place density as determined by ASTM D1556 (Sand Cone Method) or ASTM D6938 (Nuclear Method).

C. Maximum Dry Density: Laboratory density as determined by ASTM D698 (Standard Proctor) and occurring at the optimum moisture content of the material being tested.

D. Proof Roll: Single pass of a drum or rubber tire roller, having a gross load between 25 to 50 tons. Rubber tire rollers shall have tires capable of operating at inflation pressures ranging from 90 to 150 psi.

1.05 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00.

1. Gradation analysis.

2. Materials Sources: Name of source, location, date of sample, sieve analysis, and laboratory compaction characteristics.

3. Test and Evaluation Reports:

a. Field density testing reports: Provide results from field density testing of prepared subgrade and compacted fill.

b. Grain-size analysis.

c. Laboratory compaction characteristics of soils.

d. Water content.

1.06 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 43 00.

B. Contractor shall be responsible for cost of testing and inspection conducted as a result of non-conforming work.

C. Provide testing in accordance with Part 3 of this section.

1. Employ an independent testing laboratory with the following qualifications: Accreditation by the American Associates of State Highway and Transportation Officials (AASHTO) Accreditation Program.

D. Protect excavations by shoring, bracing, sheet piling, underpinning or other methods required to prevent cave-in of loose soil. Protection shall be in accordance with OSHA 29 CFR 1926, Subpart P.

1.07 SAFETY:

A. Contractor shall provide necessary materials and equipment to shore and brace excavations to prevent slope failure, to prevent adjacent surface settlement, to provide safety, and to protect permanent structures from damage during construction as needed. If shoring is required, Contractor shall provide design calculations and details for review by Engineer and Owner.

B. All working conditions shall be in accordance with OSHA, in addition to other conditions as may be required by local jurisdiction having authority.

C. Contractor shall be solely responsible for the safety of temporary cuts. Lines shown on Drawings for temporary cuts indicate only of the need for such excavation and do not necessarily represent the safe slope to which the excavation must be made, which depends on Contractor's methods and site-specific conditions.

D. Contractor shall provide berms, fences, railing, etc. for all temporary and permanent excavations in accordance with OSHA requirements and local codes and regulations.

PART 2 - PRODUCTS

2.01 FILL MATERIALS:

A. Fill materials must be tested for compliance with the Specifications. All quality control (QC) testing shall be performed by Contractors construction materials testing (CMT) firm. Contractor maintains QC responsibility for meeting the Specifications by employing the appropriate screening techniques and equipment, moisture conditioning, fill procedures and

compaction methods, and equipment as outlined in Section 01 43 00. Contractor shall give the Owner at least five (5) working days' notice prior to using the proposed fill material to enable the CQA representative to sample and test the material.

B. Suitable Material: Material from on-site excavation and permitted off-site sources that meets all of the specified requirements for its intended use and is not unsuitable.

C. Unsuitable Material: Material that fails to meet requirements for suitable materials; or contains any of the following:

1. Organic clay, organic silt, or peat; as defined in ASTM D2487.

2. Vegetation, wood, roots, leaves, and organic, degradable material.

3. Stones or rock fragments over 6 inches in any dimension.

4. Porous biodegradable matter, excavated pavement, construction debris, rubbish, or refuse.

5. Soil materials that are too wet to be properly compacted and circumstances prevent soil materials that are in place drying prior to incorporation into the Work.

6. Ice, snow, frost, or frozen soil particles.

D. General Fill: Suitable, existing native soils, free of vegetation and debris.

E. Structural Fill: Suitable material that is classified by the Unified Soil Classification System (USCS) in accordance with ASTM D2487 as GW, GP, GM, GC, SW, SP, SM, SC, CL. Verify that the largest particles in the fill are no greater in dimension than one-half the thickness of the compacted lift thickness. Structural fill materials shall be free of organic matter, vegetation, construction debris, and other deleterious substances.

1. Plasticity Index: 10 or less.

2. Gradation: Table 31 23 00-1.

Table 31 23 00-1

Sieve Designation (Square Mesh)	**Percentage Passing (By Weight)**
6 inches	100
No. 3	30-70
No. 200	0-12

F. Granular Fill:

1. Aggregate Base Course: NMDOT, Type II.

a. Gradation: Table 31 23 00-2.

Table 31 23 00-2	
Sieve Designation (Square Mesh)	**Percentage Passing (By Weight)**
1 inch	100
3/4 inches	85-95
No. 4	40-70
No. 10	30-55
No. 200	6-15

2. Open Graded: Screened Gravel: ASTM C33, Coarse Aggregate, No. 67. Soil particles shall conform to the physical property requirements of ASTM C33.

G. Sand: ASTM C33, Fine Aggregate, No. 9, natural or manufactured sand, fine gravel, or crushed stone, not larger than 1/4 inch in size.

H. Free Draining Gravel:

1. Contractor shall provide non-angular Free Draining Gravel materials that are durable and free of organic or deleterious materials. Gravel shall have free-draining characteristics. Gravel material shall comply with ASTM C33 grading size No. 67, be washed and have a grain size distribution within the following limits when tested in accordance with ASTM C 136 and C117.

a. Gradation: Table 31 23 00-3.

Table 31 23 00-3	
Sieve Designation (Square Mesh)	**Percentage Passing (By Weight)**
1 inch	100
3/4 inches	90-100
3/8 inches	20-55
No. 4	0-10
No. 8	0-5

2.02 EQUIPMENT:

A. Compaction equipment shall be capable of consistently achieving the specified compaction requirements.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Verify that utilities have been properly disconnected, abandoned, capped, and/or protected. Contractor shall be responsible for verifying utility location using a private locating service before starting Work. Mark utilities at the surface with high visibility markings to prevent damage during construction activities. Contractor shall notify the Engineer and Owner of all identified utilities to be removed.

B. Upon discovery of any unknown utility or concealed conditions; stop affected Work and notify Engineer.

C. Immediately notify the Engineer if unexpected subsurface facilities or suspected hazardous materials are encountered during excavation. Discontinue affected work in area until notified to resume work.

D. Provide dewatering and diversion control to protect Work or adjacent structures or facilities from precipitation events as further described in Section 01 50 00. Employ diversion berms, swales, temporary pipes, sandbags, cover, riprap, or other materials and facilities at times when such precipitation events are likely. Perform borrow excavation and fill operations such that drainage is maintained at all times. No additional payment will be made beyond Contract price for site drainage or dewatering requirements.

E. Use equipment, tools, and machines to perform Work in accordance with the requirements covered by Specifications. Contractor shall maintain equipment, tools, and machines in satisfactory working condition. Compaction equipment shall be suitable for the soils to be compacted so as to consistently produce the required moistures and densities throughout the compacted soil mass as required by Specifications.

F. Excavation shall consist of the removal and appropriate disposal of every type of material encountered to the lines, grades, and elevations indicated. Material to be removed may include but is not limited to earth, hardpan, caliche, silt, clay, sand, gravel, cobbles, boulders, cemented alluvium, rock, slope wash talus and construction debris.

G. Contractor shall be solely responsible for the safety of temporary cuts and fills.

H. Verify that dewatering support systems are in place before commencing with excavation.

I. Verify that excavation safety and support systems meeting the requirements of OSHA 29 CFR 1926, Subpart P are in place before commencing with excavation.

1. Minimum slopes for laying back excavations or materials are contained in OSHA 29 CFR 1926, Subpart P; Appendices A and B.

2. Minimum requirements for shoring and bracing are contained in OSHA 29 CFR 1926, Subpart P; Appendix C.

J. Verify that fill materials submittals have been accepted by Engineer before commencing with work requiring the use of these materials.

K. Verify that erosion and sediment control measures are in place and functioning properly.

L. Dust control is required at excavated areas, borrow areas, laydown yards, stockpiles, screen plants, haul routes, disposal areas, and fill areas. Dust control is generally required at all locations where Contractors Work may generate visible dust. Prepare a Dust Control Plan as per Section 01 57 26 – Dust Control and submit per Section 01 33 00 – Submittals.

3.02 PREPARATION:

A. Underpin adjacent structures that could be damaged by excavation work.

B. Cut pavement where indicated on the Drawings with saw or pneumatic tools to prevent damage to remaining pavement. Dispose of large pieces of demolished pavement before proceeding with excavation.

C. Remove subsurface structures and related obstructions.

3.03 PROTECTION OF IN-PLACE CONDITIONS:

A. Support and protect from damage – existing pipes, poles, wires, fences, curbs, property line markers, and other features or structures which must be preserved in place to avoid being temporarily or permanently relocated.

B. Excavation near existing structures - discontinue digging by machinery when excavation approaches pipes, conduits, or other underground structures. Continue excavation by use of hand tools. Include such manual excavation in work to be done when incidental to normal excavation and under items involving normal excavation.

3.04 RESTORATION:

A. Begin restoration work within 24 hours of when damage occurred.

B. Existing surfaces, features, or utilities that are to remain but are damaged during construction shall be repaired or replaced to at least the condition in which they were found immediately before work began, unless noted otherwise.

3.05 EXCAVATION:

A. This section provides the requirements for general or mass excavation on the Project. Excavation is required to achieve depth and shape construction and at the borrow source to produce fill material.

B. Excavate to accommodate new structures and construction operations.

C. Excavate to lines and grades necessary to provide finish grades.

D. Excavations that are not shored and deeper than 4 feet shall have banks laid back to a minimum stable slope matching the angle of repose of the excavated material.

E. Workers shall have an adequate means of exit from excavations that are 4 feet or greater in depth. The means of exit shall not require more than 25 feet of lateral travel.

F. Establish limits of excavation to allow adequate working space for installing forms and for safety of personnel.

G. Carry out program of excavation, dewatering, and excavation support systems to eliminate possibility of undermining or disturbing foundations of existing structures or the work.

H. Preserve material below and beyond the lines of excavations.

I. Locate stockpiled excavated material at least 3 feet from edge of excavations to prevent cave-ins or bank slides. Deposit materials suitable for reuse in protected, maintained piles that are separate from other materials and readily available. Upon Project completion, restore all material storage areas to their original condition.

J. Excess excavation for the convenience of Contractor or over excavation performed by Contractor for any purpose or reason, except as may be ordered in writing by the Engineer, whether or not due to the fault of Contractor, is at the expense of the Contractor. Where required to complete the Work, refill excess excavation and over excavation with materials furnished and placed at the expense of and by Contractor. Such over excavation or earthwork associated with ramps and other work shall be the Contractor's responsibility.

K. Excavation shall consist of the removal and appropriate disposal of every type of material encountered to the lines, grades, and elevations indicated, including that which is rejected as not suitable for Structural Fill. Material to be removed may include but is not limited to earth, hardpan, caliche, silt, clay, sand, gravel, cobbles, boulders, cemented alluvium, rock, slopewash talus and construction debris.

L. Excavation shall be performed in a manner, which will not impair the finished surface or subgrade. Excavation or overcut made outside the lines indicated on the Drawings or staked in the field shall be refilled with materials approved by Owner, at the expense of Contractor, except where such overcut is directed or specified by Owner.

M. Conduct all excavation operations in such a manner that permanent improvements will not be damaged or subjected to settlement or horizontal movement. Repair any damage to permanent work due to settlement or horizontal movement resulting from excavation operations at Contractor's expense.

3.06 CHANNEL EXCAVATION REQUIREMENTS:

A. Channel excavation consists of the excavation of the drainage channel and shall be excavated in its entirety by Contractor as shown on the Drawings.

B. Finished grade of the channel area shall not include depressed areas that trap storm water, and shall generally be sloped to the east and west.

3.07 ANCHOR TRENCH EXCAVATION REQUIREMENTS:

A. Excavate the anchor trench to the lines and grades indicated on the Drawings.

B. Coordinate all planning, equipment, and methods for anchor trench excavation with Owner.

C. Contractor shall provide Owner and appropriate representatives the opportunity to witness anchor trench excavation, and observe the trench at various stages. Several days may be needed to complete a full evaluation. Comply with provisions in Section 01 33 00 – Submittals for progress schedules.

3.08 SUBGRADE PREPARATION:

A. The exposed surface shall be examined by an engineering geologist or soils engineer to determine that the proper bearing material has been exposed.

B. Contractor is responsible for QC measures and corrective actions in accordance with Section 01 43 00 – Quality Control and results of the CQA testing performed by Engineer. Contractor is also responsible at his/her expense, for corrective actions to address Work product that does not meet the Specifications.

C. Materials which are determined to be unsuitable by visual inspection shall be over-excavated below the foundation subgrade and backfilled with structural fill.

D. Compact subgrade and proof roll to identify soft spots or other deficiencies prior to filling operations or placing foundations. Correct deficiencies as specified for AUTHORIZED OVER-EXCAVATION and repeat proof roll procedure until successful.

E. Proof roll foundation subgrade prior to filling operation or placing foundation concrete. Continue until successful proof test is attained.

3.09 AUTHORIZED OVER-EXCAVATION:

A. If proof roll test fails then remove unsuitable material plus an additional 6 inches, and backfill with structural fill.

3.10 UNAUTHORIZED EXCAVATION:

A. Contractor is responsible for backfilling unauthorized excavations with structural fill.

3.11 FILL AND BACKFILL:

A. Fill activities shall not occur whenever atmospheric temperatures are expected to drop below freezing (32°F).

B. Obtain various fill materials from required excavation, and if required, effectively screen fill materials to produce a uniform fill material at the required gradations. Screening may be required for onsite soils to meet specified gradations. Materials shall be free of objectionable material.

C. Perform moisture-conditioning activities prior to placing and spreading a lift at the final destination to ensure uniform moisture content throughout. Condition the soil at the borrow source or at stockpiles/working pads that allow soil to be turned over, scarified, or otherwise blended for uniform moisture. Moisture conditioning at final destination of

each lift will be allowed only as a last resort to removal of the lift. Condition the soil to within the allowable plus and minus limits.

D. Distribution of materials shall be such that the fill is free from lenses, pockets, streaks, or layers of materials differing substantially in texture or gradation from the surrounding material. Combined borrow excavations and fill placement operation shall be such that the materials, when compacted in the fill, will be blended sufficiently to provide the best practicable distribution of the material, subject to the approval of the Engineer. Areas of rock nesting will be rejected.

E. Fill to lines and grades necessary to provide finish grades as shown on Drawings.

F. Use a placement method that does not disturb or damage other work or existing features.

G. Rollers shall not be permitted to operate within 2 feet of concrete structures, shotcrete channels, well pipes, or over buried structures until the compacted fill over the top of the buried structure has reached a depth of 2 feet. Do not operate heavy equipment over pipes and buried structures until at least 2 feet of fill material has been placed and compacted over the top of the buried structure or as directed by Owner. Operate compaction equipment so that structures are not damaged nor overstressed during compaction operations. Use mechanical tampers for compaction of fill material adjacent to structures where rolling equipment is impractical for use in compaction.

H. Structural Fill filling and backfill operations for sideslopes shall include excavation cuts or keys into the adjoining slope for every compacted lift. Keyed excavation cuts shall not exceed 1 foot vertically. Exceptions shall be at Owner or Engineer Representative's discretion.

I. Maintain fill materials within 3 percent of optimum moisture in accordance with ASTM D698 (Standard Proctor), to attain required compaction density.

J. Place and compact material in equal continuous layers.

K. General fill may be used in open areas, over lot fill, and areas which are not load bearing.

L. Use concrete fill where footing bearing surfaces are over-excavated or footing is otherwise not bearing on undisturbed soil.

M. Maximum compacted depth is 6 inches for aggregate materials and 8 inches for soil materials, unless noted otherwise.

3.12 SCARIFICATION AND COMPACTION:

A. Areas requiring scarification and recompaction of the subgrade soils have been shown on the Drawings. The areas shall be scarified a minimum depth of 12 inches, moisture conditioned, and recompacted. Where overexcavation is required to obtain an acceptable liner subgrade, Contractor shall scarify and recompact the final cut surface prior to the addition of fill materials.

B. Compact to density specified and indicated for various types of material. Control moisture content of material being placed as specified, or if not specified - at a level slightly lower than optimum.

C. Compaction Density: Provide densities in Table 31 23 00-4. The values listed are minimum percentages, unless noted otherwise.

Table 31 23 00-4

Area	Percentage of Maximum Dry Density as defined by ASTM D698 (Standard Proctor)
Scarified subgrades	95
General fill or open areas	95
Pond Berms or Embankment	100
Under pavement and slabs	98

3.13 LINER SUBGRADE PREPARATION:

A. Lined areas require scarification and recompaction of the subgrade soils as shown on the Drawings. The areas shall be scarified a minimum depth of 6 inches, moisture conditioned, and recompacted. Scarification and recompaction is only required in lined areas that are excavated to achieve grade. In areas where Structural Fill is required to achieve grade, scarification and recompaction is not required.

3.14 STRUCTURAL FILL SUBGRADE:

A. Structural Fill subgrade shall be reviewed and approved by Engineer's Representative. Structural Fill subgrade may require over-excavation if unsuitable materials are found. Depth of over-excavation shall be determined by the Engineer.

3.15 ANCHOR TRENCH BACKFILL:

A. Compaction may be achieved using hand operated whacker-type compaction equipment. CQA testing shall measure the success and consistency of the equipment and methods employed by Contractor. Contractor is responsible for failing tests and is subject to rework and changing the equipment and methods to achieve the performance specification for compaction.

B. Appreciable care shall be exercised to not damage the liner components when placing or compacting anchor trench backfill.

3.16 BACKFILLING AGAINST STRUCTURES:

A. Backfill shall not be placed against foundation walls until concrete has attained a compressive strength equal to the specified 28-day compressive strength.

3.17 EMBANKMENT FILL AND COMPACTION:

A. Begin filling in lowest section of work area. Grade surface of fill approximately horizontal but provide with sufficient longitudinal and transverse slope to allow for runoff of surface water from every point.

B. Install temporary dewatering sumps in low areas during filling operation where excessive amounts of rain runoff collect.

C. Reduce moisture content of fill material, if necessary, in source area by aerating it over during warm and dry atmospheric conditions. A large disc harrow with two to three foot diameter disks may be required for working soil in a drying operation.

D. Compact uniformly throughout. Keep fill surfaces sufficiently smooth and free from humps and hollows to allow for proper and uniform compaction. Do not permit hauling equipment to follow a single track on the same layer but direct equipment to spread out to prevent over compaction in localized areas. Take care in obtaining thorough compaction at edges of fill.

E. Slightly slope surface of fill to ensure drainage during periods of wet weather. Do not place fill while rain is falling or after a rain-storm until the CM or Engineer's Representative considers conditions satisfactory. During such periods and upon suspension of filling operations for periods in excess of 12 hours, roll smooth the surface of fill using a smooth wheel static roller to prevent excessive absorption of rainfall and surface moisture. Prior to resuming compaction operations, remove muddy material off surface to expose firm, compacted material, as determined by the CM or Engineer's Representative.

F. When fill is placed against an earlier fill or against in-situ material under and around structures, including around piping beneath structures or embankments, slope junction between two sections of fill at 1.5 to 1 (horizontal to vertical). Bench edge of existing fill 24 inches to form a serrated edge of compact stable material against which to place the new fill. Ensure that rolling extends over junction between fills.

G. Clean debris, remove loose material, and proof roll previously placed fill which has had time to become desiccated or littered with debris.

H. After spreading each loose lift to the required thickness and adjusting its moisture content, roll with sufficient number of passes to obtain the required compaction. One pass is defined as the required number of successive trips which by means of sufficient overlap will insure complete coverage and uniform compaction of an entire lift. Do not make additional passes until previous pass has been completed.

I. Fill surface shall be firm and hard when rolled. Reduce moisture content when fill material sinks and weaves under rollers and equipment. Spread out rolling operations over the maximum practicable area to minimize condition of sinking and weaving. Suspend fill operations on portions of embankment where inundations produce surface cracks.

J. Remove material which fails testing requirements and replace work.

3.18 FREE DRAINING GRAVEL:

A. Free Draining Gravel shall be spread uniformly over the geotextile and conveyance piping to the lines and grades indicated on Drawings. Hand placement shall be used to spread the gravel material to preserve the integrity of the geotextile, conveyance piping, and liner beneath, protecting it from undue stresses and abrasions. Do not drive equipment over the HDPE liner.

B. Compaction shall be performed using a hand-operated vibratory plate compactor with a minimum of two (2) passes.

C. Wheel barrows or other rubber-tire wagons shall be used if necessary to transport gravel materials across the liner. Type and ultimately weight (full stock capacity) of such hand pushed/pulled equipment shall be approved by Owner prior to use. Use of sacrificial HDPE liner slip sheets or plywood with rounded and protected corners may be used for high use or turn areas.

D. Maximum drop height of gravel materials shall be 3 feet.

E. Round-point hand shovels shall be used to minimize risk of puncture of the liner during time grading of the gravel.

F. Any damage to the liner or collection pipes shall be reported to Owner or Engineer's Representative. Fill operation shall cease in any and all areas of suspect damage to either liner or collection pipe.

3.19 FIELD QUALITY CONTROL:

A. See Section 01 43 00 for general requirements for field inspection and testing.

B. Samples of fill materials for laboratory testing shall be taken at scheduled and/or periodic intervals during construction as indicated in Tables 31 23 00-5 and -6. Samples shall be of such size, weight or volume to be representative of the material being placed, and shall be the size, weight or volume required for the specified laboratory testing procedures. Samples for moisture content tests shall be taken from the soil materials placed before and after compaction.

C. Sampling and testing of each type of material shall be the responsibility of the QC/CMT representatives.

D. Perform inspection at least once daily to confirm lift thickness and compaction effort for entire fill area.

E. Perform particle size distribution and gradation analyses using ASTM D422. Perform 1 test for every source and submit results to Engineer for acceptance. Repeat the moisture density test for every 5,000 cubic yard of material used.

F. Perform field density testing in accordance with ASTM D1556 or ASTM D6938.

G. Evaluate field density test results in relation to maximum dry density as determined by testing material in accordance with ASTM D698 (Standard Proctor).

H. Perform tests in accordance with ASTM D4318 to determine Liquid Limit, Plastic Limit and Plasticity Index and submit test results to Engineer for acceptance. Minimum of one test per 5,000 cubic yard of soil for use as fill material and whenever classification of material is in doubt as determined by the Engineer.

I. Location of field density tests shall be as recommended by the Engineer.

J. In the event compacted material does not meet specified in-place density, re-compact material and re-test area until specified results are obtained.

K. Required testing frequency of tests:

Table 31 23 00-5

Test		**Frequency of Tests**				
Reference	**Description**	**Subgrade (liner and foundation)**	**Structural Fill**	**Anchor Trench Backfill**	**Free Draining Gravel**	**Soil Cap Fill (Infiltration and Erosion Layer)**
ASTM D 2216/ ASTM D 4643	Laboratory Moisture Content (oven-dry)	1/200,000 sf and 1/10 nuclear density tests	1/10,000 cy and 1/10 nuclear density tests	1/1,000 lf and 1/10 nuclear density tests	N/A	1/10 nuclear density tests
ASTM D 422	Particle Size Analysis	1/200,000 sf and noticeable material change	1/10,000 cy and 1 per each noticeable material change	1/1,000 lf of trench and 1 per material type or change	N/A	1 per each Proctor
ASTM C 136	Particle Size Analysis	N/A	N/A	N/A	1 per material source or material change	N/A
ASTM D 698	Laboratory Compaction-Standard Proctor	1/200,000 sf and noticeable material change	1/10,000 cy and 1 per each noticeable material change	1/1,000 lf of trench and 1 per soil type	N/A	1/20,000 cy and 1 per each noticeable material change
ASTM D 1556	In-place density by sand cone method	1/10 nuclear density tests	1/10 nuclear density tests	1/10 nuclear density tests	N/A	1/10 nuclear density tests
ASTM D 6938	In-place density and moisture content by nuclear method	1/50,000 sf	1/1,000 cy	1 per 200 lf/lift or 1/day/lift	N/A	1/4,000 sy
ASTM D 4318	Atterberg Limits	1/200,000 sf and noticeable material change	1/10,000 cy and 1 per each noticeable material change	1/1,000 lf of trench and 1 per material type or change	N/A	1 per each Proctor

L. Frequency of field density tests:

Table 31 23 00-6	
Area	**Frequency**
Roadways	1 per lift for every 200 linear feet of roadway
Open Areas	1 per lift for each 10,000 square feet of open area
Under Structures	1 per lift for every 1,000 square feet of structure
Around Structures	1 per lift for every 1,500 square feet of structure
Embankment Fills	1 per lift for every 5,000 square feet of embankment
Regardless of the minimum testing frequency specified, field density tests shall be performed by the Contractor in sufficient number for the Contractor's quality control purposes to ensure that specified density is obtained.	

3.20 ADJUSTING:

A. Supply specified materials to build up low places when embankment or backfill settles below the finished grade at any time before substantial completion.

3.21 TOLERANCES:

A. Construct finished surfaces to plus or minus 1 inch of the elevations indicated.

B. Grade areas of cut and fill to plus or minus 0.20 foot of the grades indicated.

C. Complete embankment edges to plus or minus 6 inches of the slope lines indicated.

D. Provide the Engineer with adequate survey information to verify compliance with above tolerances.

3.22 PROTECTION:

A. Formulate excavation, backfilling, and filling schedule and procedures to eliminate possibility of undermining or disturbing foundations of partially and completed structures, pipelines and embankments or existing structures and pipelines.

3.23 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 31 23 33

TRENCHING AND BACKFILL

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide trenching and backfill as indicated and in compliance with Contract Documents.

B. Section includes:

1. Trench excavation width and safety.

2. Backfill materials and placement.

3. Utility identification using marking tape and trace wire

4. Soil and aggregate materials.

5. Compaction and testing.

1.02 REFERENCES:

A. ASTM International (ASTM):

1. C33: Specification for Concrete Aggregates.

2. D422: Test Method for Particle-Size Analysis of Soils.

3. D698: Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft3 (600 kN-m/m3)).

4. D1556: Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.

5. D2487: Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).

6. D4318: Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils.

7. D6938: Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

B. New Mexico State Department of Transportation Standard Specifications for Highway and Bridge Construction, 2014 Edition (NMDOT Spec's).

C. Occupational Safety and Health Administration (OSHA) Standards and Regulations:

1. 29 CFR 1926, Subpart P: Safety and Health Regulations for Construction, Excavations.

1.03 DEFINITIONS:

A. Percent Compaction or Compaction Density: The field dry density of compacted material, expressed as a percentage of the maximum dry density.

B. Field Dry Density or Field Density: In-place density as determined by ASTM D1556 (Sand Cone Method) or ASTM D6938 (Nuclear Method).

C. Maximum Dry Density: Laboratory density as determined by ASTM D698 (Standard Proctor) and occurring at the optimum moisture content of the soil being tested.

D. Pipe Embedment: Comprised of the following or combination thereof:

1. Foundation: Required only when the native trench bottom does not provide a firm working platform or the necessary uniform and stable support for the install pipe.

2. Bedding: Placed directly underneath the pipe and brings the trench bottom to grade. Provides a firm, stable, and uniform support of the pipe.

3. Haunching: From bottom of pipe to springline.

4. Initial Backfill: From top of bedding or foundation to 6 inches above top of pipe, unless noted otherwise.

5. Final Backfill: Above the initial backfill to a level below that required for the trench restoration area.

6. Backfill: Includes initial and final backfill.

1.04 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00.

1. Qualifications of Independent Testing Laboratory, four weeks prior to earthwork.

2. Temporary excavation and shoring drawings for worker protection in accordance with the General Provisions.

3. Gradation analysis.

4. Materials Sources: Name of source, location, date of sample, sieve analysis, and laboratory compaction characteristics.

5. Test and Evaluation Reports:

   a. Field density testing reports: Provide results from field density testing of prepared subgrade and compacted fill.

   b. Grain-size analysis.

   c. Laboratory compaction characteristics of soils.

   d. Water content.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 43 00.

B. Contractor shall be responsible for cost of testing and inspection conducted as a result of non-conforming work.

C. Provide testing in accordance with Part 3 of this section.

   1. Employ an independent testing laboratory with the following qualifications: Accreditation by the American Associates of State Highway and Transportation Officials (AASHTO) Accreditation Program.

D. Protect excavations by shoring, bracing, sheet piling, underpinning or other methods required to prevent cave-in of loose soil. Protection shall be in accordance with OSHA 29 CFR 1926, Subpart P.

PART 2 - PRODUCTS

2.01 BACKFILL MATERIALS:

A. Suitable Material: Material from on-site excavation and permitted off-site sources that meets all of the specified requirements for its intended use and is not unsuitable. Wet subgrade material which meets other requirements for suitable material is suitable.

B. Unsuitable Material: Material that fails to meet requirements for suitable materials; or contains any of the following:

   1. Organic clay, organic silt, or peat; as defined in ASTM D2487.

   2. Vegetation, wood, roots, leaves, and organic, degradable material.

   3. Stones or rock fragments over 6 inches in any dimension.

   4. Biodegradable matter, excavated pavement, construction debris, rubbish, or refuse.

   5. Ice, snow, frost, or frozen soil particles.

C. Bedding: ASTM C33, Fine Aggregate, No. 9, natural or manufactured sand, fine gravel, or crushed stone, not larger than 1/4 inch in size.

D. Granular Fill:

1. Aggregate Base Course: NMDOT, Type II

a. Gradation: Table 31 23 33-1.

Table 31 23 33-1

Sieve Designation (Square Mesh)	Percentage Passing (By Weight)
1 inch	100
3/4 inches	85-95
No. 4	40-70
No. 10	30-55
No. 200	6-15

2. Open Graded: Screened Gravel: ASTM C33, Coarse Aggregate, No. 67. Soil particles shall conform to the physical property requirements of ASTM C33.

E. Sand: ASTM C33, Fine Aggregate, No. 9, natural or manufactured sand, fine gravel, or crushed stone, not larger than 1/4 inch in size.

2.02 EQUIPMENT:

A. Compaction equipment shall be capable of consistently achieving the specified compaction requirements.

2.03 UTILITY IDENTIFICATION:

A. Marking Tape: Use type specifically manufactured for marking and locating underground utilities. Acid- and alkali-resistant polyethylene film, 6 inches wide with minimum thickness of 0.004 inch, minimum strength of 1,750 psi lengthwise and 1,500 psi crosswise. Provide tape manufactured with foil core at least 0.35-mil thick to enable detection by metal detection when tape is buried up to 3 feet deep. Tape shall bear continuous printed inscription describing specific utility.

B. Trace Wire: Continuous, single-strand copper wire, insulated, maximum 10 AWG. Clear plastic covering, imprinted with inscription describing specific utility in large letters.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Verify that dewatering support systems are in place before commencing with excavation.

B. Verify that excavation safety and support systems meeting the requirements of OSHA 29 CFR 1926, Subpart P are in place before commencing with excavation.

1. Minimum slopes for laying back excavations or materials are contained in OSHA 29 CFR 1926, Subpart P; Appendices A and B.

2. Minimum requirements for shoring and bracing are contained in OSHA 29 CFR 1926, Subpart P; Appendix C.

C. Verify that fill materials submittals have been accepted by Engineer before commencing with work requiring the use of these materials.

D. Verify that erosion and sediment control measures are in place and functioning properly.

E. Immediately notify the Engineer if unexpected subsurface facilities or suspected hazardous materials are encountered during excavation. Discontinue affected work in area until notified to resume work.

3.02 PREPARATION:

A. Underpin adjacent structures that could be damaged by excavation work.

B. Cut concrete with saw or pneumatic tools to prevent damage to remaining surface. Dispose of large pieces of demolished concrete before proceeding with excavation.

3.03 PROTECTION OF IN-PLACE CONDITIONS:

A. Support and protect from damage – existing pipes, poles, wires, fences, curbs, property line markers, and other features or structures which must be preserved in place to avoid being temporarily or permanently relocated.

B. Excavation Near Existing Structures:

1. Discontinue digging by machinery when excavation approaches pipes, conduits, or other underground structures. Continue excavation by use of hand tools. Include such manual excavation in work to be done when incidental to normal excavation and under items involving normal excavation.

3.04 RESTORATION:

A. Begin restoration work within 24 hours of when damage occurred.

B. Existing surfaces, features, or utilities that are to remain but are damaged during construction shall be repaired or replaced to at least the condition in which they were found immediately before work began, unless noted otherwise.

3.05 TRENCH EXCAVATION:

A. Provide competent person as required by OSHA 29 CFR 1926, Subpart P for Type C soils.

B. Sheet and brace trenches, excavations, and adjacent structures to comply with laws and regulations and to provide protection of life, property, and the Work. Where close sheeting is necessary, drive to prevent adjacent soil from entering excavation. Remove close sheeting only when removal would not damage property or the Work. Sheeting left in place shall be cut off 18 inches below ground surface.

C. Preserve material below and beyond the lines of excavations.

D. Locate stockpiled excavated material at least 3 feet from edge of excavations to prevent cave-ins or bank slides.

3.06 AUTHORIZED OVER-EXCAVATION:

A. Remove rock for a depth of 6 inches and backfill with bedding material.

3.07 UNAUTHORIZED EXCAVATION:

A. Contractor is responsible for backfilling unauthorized excavations with bedding material.

3.08 BACKFILL:

A. Fill to lines and grades necessary to provide finish grades.

B. Use a placement method that does not disturb or damage other work or existing features.

C. Maintain fill materials within 3 percent of optimum moisture in accordance with ASTM D698 (Standard Proctor), to attain required compaction density.

D. Place and compact material in equal continuous layers.

E. Maximum compacted depth is 6 inches for aggregate materials and 8 inches for soil materials, unless noted otherwise.

3.09 COMPACTION:

A. Compact to density specified and indicated for various types of material. Control moisture content of material being placed as specified, or if not specified - at a level slightly lower than optimum.

B. Compaction Density: Provide trench backfill densities according to Table 31 23 33-2. The values listed are minimum percentages, unless noted otherwise.

Table 31 23 33-2	
Area	**Percentage of Maximum Dry Density as defined by ASTM D698 (Standard Proctor)**
Trench Backfill (under slabs)	98
Trench Backfill (through embankment)	100
Trench Backfill (under exterior concrete slab)	95
Trench Backfill (in open areas)	95

3.10 UTILITY IDENTIFICATION:

A. Install marking tape over all site utilities 12 inches above top of buried pipes or utility lines.

B. Install trace wire at top center; pull wire taut to remove any slack.

C. Extend trace wire to utility boxes, manholes and junctions to allow for connection to subsurface location equipment.

3.11 FIELD QUALITY CONTROL:

A. See Section 01 43 00 for general requirements for field inspection and testing.

B. Compaction shall be deemed to comply with the specifications when no more than 1 test of any 3 consecutive tests falls below the specified relative compaction. The one test shall be no more than 3 percentage points below the specified compaction. The Contractor shall pay the costs for any retesting or additional testing of work not conforming to the specifications.

C. Perform particle size distribution and gradation analyses using ASTM. Perform 1 test for every source and submit results to Engineer for acceptance. Repeat the moisture density test for every 5,000 cubic yard of material used.

D. Perform field density testing in accordance with ASTM D1556 or ASTM D6938.

E. Evaluate field density test results in relation to maximum dry density as determined by testing material in accordance with ASTM D698 (Standard Proctor).

F. Perform tests in accordance with ASTM D4318 to determine Liquid Limit, Plastic Limit and Plasticity Index and submit test results to Engineer for acceptance. Minimum of one test per 5,000 cubic yard of soil for use as fill material and whenever classification of material is in doubt as determined by the Engineer.

G. Location of field density tests shall be as recommended by the Engineer's Representative.

H. Frequency of field density tests:

Table 31 23 33-3	
Area	**Frequency**
Trench (Structural Areas)	1 per lift for each 250 linear feet of trench
Trench (Non-Structural Areas)	1 per lift for each 500 linear feet of trench
Regardless of the minimum testing frequency specified, field density tests shall be performed by the Contractor in sufficient number for the Contractor's quality control purposes to ensure that specified density is obtained.	

I. Owner will retain the services of an independent testing laboratory to conduct confirmatory testing and inspection.

3.12 ADJUSTING:

A. Shrinkage:

1. Backfill to a height above finished grade which will allow for the shrinkage or consolidation of material. Initially, provide at all points, an excess of at least one percent of total height of backfill measured from stripped surface to top of finished surface.

2. Supply specified materials and build up low places, without additional cost if embankment or backfilling settles so as to be below the indicated level for proposed finished surface at any time before final acceptance of the work.

3.13 PROTECTION:

A. Formulate excavation, backfilling, and filling schedule and procedures to eliminate possibility of undermining or disturbing foundations of partially and completed structures, pipelines and embankments or existing structures and pipelines.

3.14 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 32 90 00

REVEGETATION

PART 1 - GENERAL

1.01 DESCRIPTION

A. This section describes requirements for establishment of permanent vegetative cover for aesthetics, transpiration, and prevention of erosion damage.

B. Soil preparation, application of amendments, seeding application, and measures are specified herein.

C. Seed mix design for revegetation includes warm and cool season grasses, and perennial shrubs.

1.02 SUBMITTALS

A. Contractor shall submit prior to beginning revegetation seed mix design from the Subcontractor/supplier to demonstrate conformance to mix described herein and a list of all material sources for seed, mulch, tackifier, and/or any soil amendments recommended to Engineer for review.

B. Contractor may also submit, for review by Engineer, any variation in specified method or materials of application contained herein. Particularly, Contractor may submit an alternate seed mix design for projected season of implementation.

1.03 REGULATORY REQUIREMENTS

A. Comply with product-specific requirements outlined on MSDS for safe application methods and personal protective equipment.

1.04 SEQUENCING AND SCHEDULING

A. Contractor to install vegetative cover after the berms or embankments are completed and before the month of July. Contractor shall seed in an effort to provide a permanent vegetative cover immediately following completion of finished grading.

IMPORTANT!
All areas shall be seeded as directed prior to the beginning of the wet season, July 1, 2018. Revegetation shall not be implemented in any other season without strong consideration for alternate seed mix design or artificial watering scheme.

B. Contractor shall apply seed mix by method of drill seeding per quantities outlined in paragraph 2.03, and cover by spreading straw or native grass mulch over area.

C. Contractor shall use straw or native grass mulch at an application rate of at least 2 tons/acre. Seed, straw, and mulch should be weed free and contain a minimum of viable seed associated with the mulch source (e.g., barley or wheat seeds). Long-stem mulch is preferred over shorter straw-length materials.

D. Straw or mulch will be crimped and stabilized using a tackifier emulsion. Contractor shall not drive over or disturb straw after it has been applied with tackifier. If Contractor disturbs any area of tackified straw, Contractor shall have to remove present straw, and reapply straw and tackifier at Contractors expense.

E. Contractor shall apply tackifier at a rate of at least 150 lbs/acre and be applied with a wood fiber mulch at a rate of 150 lbs/acre. Re-application of straw or mulch and tackifier will be required in areas that have been blown away and will be at Contractors expense.

F. In the event of erosion damage Contractor is to re-grade and reapply seed and mulch until construction of the Project is accepted by Owner.

1.05 QUALITY CONTROL

A. Contractor shall oversee Work performed by their personnel and that of its Subcontractors/suppliers to ensure conformity with the Specifications written herein as outlined in Contractor's Quality Control Plan:

PART 2 - PRODUCTS

2.01 EQUIPMENT

A. Before the Work begins, sufficient equipment shall be available on site to assure that operation of revegetation program can be continuously maintained:

2.02 SEED

A. Contractor shall mix the following seed in designated ratios prior to application.

Description	**PLS/acre**	**Type**
Western Wheatgrass (Pascorpyrum Smithii)	2.50	Grass
Indian Ricegrass (Achnatherum Hymenoides)	4.00	Grass
Blue Grama (Bouteloua Gracilis)	1.50	Grass
Antelope Bitterbrush (Purshia Tridentata)	0.10	Shrub
Four-wing Saltbush (Atriplex Canescens)	0.25	Shrub
Total:	**8.35**	

NOTE: Rate is in pounds of pure live seed (PLS) per acre.

PART 3 - EXECUTION

3.01 GENERAL

A. Contractor shall apply seed mixture in areas described in this Specification, and as approved by Engineer.

B. Contractor shall verify that all erosion rills that may have occurred between the time of completion of the embankmentsl and the scheduled start of revegetation are repaired with like fill material.

C. Following application of seed mixture, a straw mulch will be applied and tackified in place to facilitate the establishment of the vegetation.

D. Contractor to furnish, install and maintain all products and measures necessary to re-vegetate the embankment areas to prevent erosion. Methods, application equipment, seed mix, materials, and rates of application shall be that as reviewed and approved by Engineer. Substitutions or alternatives shall be approved prior to Work.

E. Coverage and rate of application of revegetation materials shall be uniform for the entire area(s) intended to receive such materials.

F. Double coverage, re-application, or heavier application rates shall be performed with strategic intent and approved by Engineer prior to Work.

G. Final stabilization of an area is considered sufficient when revegetated area has a uniform (evenly distributed, without large bare areas) perennial vegetative cover that is at least 70 percent of the native background vegetative cover.

H. If above success criterion is not met, Contractor will assess cause and select an appropriate remedy to address the situation. If necessary, local area where vegetation has not established will be re-graded, and seed and mulch will be reapplied to stabilize erosion problems. Contingency measures may include but will not necessarily be limited to reseeding, adjusting the seed mix and reapplying as necessary to localized problems, evaluating soil conditions and soil chemistry and adding amendments to areas as required, exploring mulch or other treatments, etc. Monitoring and implementation of contingency measures will continue until a permanent vegetative cover meeting the success criteria is obtained.

END OF SECTION

SECTION 40 02 00

INSTALLING OWNER FURNISHED EQUIPMENT

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section includes installation, testing, and field painting of four (4) Owner-furnished pumps: two (2) Flowserve separately coupled, base-mounted, end-suction centrifugal pumps (Return Water Pumps: RWP-PMP-001 and RWP-PMP-002) and two (2) Flowserve separately coupled, in-line, vertical centrifugal pumps (Pond 3 Pump house Pumps: P3PH-PMP-001 and P3PH-PMP-002). All miscellaneous parts and materials needed to install the owner furnished equipment is the responsibility of the Contractor.

1.02 REFERENCES:

A. Hydraulic Institute (HI):

1. HI 1.4 – Centrifugal Operations

2. HI 2.4 – Rotodynamic (Vertical) Operations

B. National Electrical manufacturers Association (NEMA):

1. MG-1: Motors and Generators

1.03 OWNER FURNISHED DATA:

A. Location layout, arrangement, dimensional drawings, mounting details for the equipment is provided in the contract documents for the project.

B. Assembly drawings for erecting the pumps in place shall be the responsibility of the Contractor. Contractor shall request assembly drawings from the equipment vendor/manufacturer for the installation.

C. Refer to contract documents for conduit, wiring diagrams showing field wiring, and terminal numbers and control features.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

3.01 INSTALLATION-GENERAL:

A. Contractor shall coordinate with the Owner and the pump vendor and manufacturer.

1. The Pump Vendor and Manufacturer contact information is as follows:

Dar Brainard
Pioneer Equipment Inc. (Flowserve Rep.)
3404 Vista Alameda NE, Suite A
Albuquerque, NM 87113
(505) 897-6822
darb@pioneerequip.com

B. Contractor shall contact vendor listed in Section 3.01 for applicable written installation instructions.

C. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

D. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

E. Examine foundations for suitable conditions where pumps are to be installed.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

G. Install expansion anchor bolt and mounting plates in locations where the pumps are installed on existing concrete per the equipment manufacturer's drawings and written instructions.

H. Assemble and install pieces of equipment requiring field installation.

I. Provide the manufacturer's recommended lubricants in drives and other mechanical equipment.

3.02 INSTALLING OWNER-FURNISHED PUMPS:

A. Comply with HI 1.4 and HI 2.4.

B. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.

C. Install equipment horizontal or vertical within 1 degree and according to the manufacturer's written instructions and the contract documents. Confirm that the pump cans and pumps are set to meet the alignment requirements established by the manufacturer.

D. Check to ensure that pump baseplates or soleplates have been provided with vertical leveling screws, as opposed to shims or wedges. Do not use shims and wedges.

E. Provide the manufacturer's recommended lubricants and operating fluids and verify that each piece of equipment contains the amount recommended by the manufacturer.

F. Verify that the installed pump is fully self-supporting before bolting pipe flanges, so that no strain is imparted on the flanges, pipes, or pipe supports from the pump assembly. Adjust the position of the pump assembly so that the pump flanges are plumb and aligned with the adjacent pipe flanges. Do not use temporary shims or jacking nuts for leveling, aligning, or supporting equipment.

G. When the alignment is correct, tighten the foundation bolts evenly but not too firmly. Then grout the unit to the foundation. The leveling pieces may be grouted in place. Do not tighten foundation bolts until the grout is hardened a minimum of 48 hours after pouring.

H. Provide continuous protection of the installed equipment from the elements, dust, debris, paint spatter, or other conditions that will adversely affect the unit's operation until such time as the equipment is scheduled for start-up testing.

3.03 MOUNTING AND ALIGNMENT DRIVERS FOR PUMPS:

A. Before mounting the driver on the discharge head/driver stand, check the register fit, if furnished, and the mounting face on the driver for acceptable tolerance on runout and squareness, respectively, using a dial indicator mounted on the driver shaft. See ANSI/NEMA MG-1. Next, check the squareness of the face of the driver coupling half, mounted on the shaft with a tight fit and seated against a split ring, using a dial indicator on a firm base.

B. With the driver bolted to the discharge head, mount a dial indicator on the driver shaft above the coupling half and sweep the bore of the stuffing box. If excess runout exists, some adjustment can be made at the driver mounting fit and the stuffing box mounting fit. Before installing any additional coupling parts, check the driver for correct rotation, as given in the manufacturer’s installation instructions.

C. Next, mount the pump half coupling, shaft adjusting nut, and coupling spacer if applicable, and raise the impeller in accordance with the manufacturer’s instructions. Then secure the coupling bolts. Make a final check of the shaft runout below the pump half coupling with a dial indicator. If the runout is within acceptable tolerances, check the tightness of the driver hold-down bolts. If dowels are used to secure the driver location, then redoweling is required after disassembly/reassembly, since tolerance buildup in the multiple joints results in alignment variation.

3.04 ELECTRICAL WORK:

A. Install electrical conduit, wire, and junction boxes to provide complete installation of the equipment in accordance with Division 26. Make terminations at the mechanical equipment locations.

3.05 PAINTING AND COATING:

A. Repair any damaged or defective coated areas.

B. Before priming, proved surfaces dry and free of dust, oil, grease, and other foreign material.

C. Prime in accordance with accepted manufacturer's written instructions.

D. Finish coat in accordance with accepted manufacturer's written instructions. Match color of adjacent surfaces.

3.06 PLACING EQUIPMENT IN SERVICE & FIELD TESTING:

A. After the equipment has been installed and is ready for field testing, notify the Engineer. Engineer's Representative will arrange a meeting with the Owner's representative for testing the equipment's operation. Contractor shall coordinate the meeting time with the equipment manufacturer's representative to be onsite for the testing.

B. Perform the following startup checks for each pump before starting:

1. Verify bearing lubrication.

2. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.

3. Verify that pump is rotating in the correct direction.

4. Prime pump by opening suction valves and closing drains, and prepare pump for operation.

5. Start motor.

C. The Contractor shall be present at the meeting with the Owner and the equipment supplier's representative.

D. Complete equipment testing, start up and commissioning per specification 01 78 25.

3.07 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 40 23 13.01

PROCESS VALVES AND APPURTENANCES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide all process valves and appurtenances as indicated and in compliance with Contract Documents.

1. Provide sizes and capacities as indicated or specified.

2. All necessary gaskets and bolting materials for all valves shall be provided and installed.

1.02 REFERENCES:

A. ASTM International (ASTM):

1. A536: Standard Specification for Ductile Iron Castings.

B. American Water Works Association (AWWA):

1. C508: Swing-Check Valves for Waterworks Service, 2-In. Through 24-In. NPS

1.03 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00:

1. Data, regarding valve characteristics and performance including Cv.

2. Shop drawing data for accessory items.

3. Manufacturer's literature as needed to supplement certified data, including pressure and temperature ratings, Body Materials, and Trim Materials.

4. Operating and maintenance instructions and parts lists.

5. Listing of reference installations as specified with contact names and telephone numbers.

6. Valve shop test results.

7. Qualifications of field service technician.

8. Shop and Field inspections reports.

9. List of recommended spare parts other than those specified.

10. Recommendations for short and long term storage.

11. Shop and field testing procedures and equipment to be used.

B. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations and clarifications from the specified requirements.

1. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.

2. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specification and justification are resubmitted with the entire package.

1.04 SPARE PARTS:

A. Comply with requirements specified in Section 01 60 00.

1.05 QUALITY ASSURANCE:

A. Comply with the requirements specified in Section 01 43 00.

B. Provide enclosures for the area classifications specified and indicated.

C. Contractor responsible for verifying outside diameter of pipe to be tapped.

D. Services of Manufacturer's Representative as stated in Section 01 43 00 and specified herein.

E. Manufacturer of valve shall have a minimum of five (5) operating installations with pumps of the size specified and in the same service as specified operating for not less than five (5) years.

F. If equipment proposed is heavier, taller, different laying length or requires more operating space than specified and indicated; provide all structural, architectural, mechanical, electrical and plumbing revisions at no additional cost to the Owner.

1. If equipment is heavier than specified, the Contractor shall provide all hoisting equipment sized to maintain the minimum safety factor between the specified maximum equipment weight and the lifting capacity of the hoisting equipment indicated and specified.

1.06 DELIVERY, STORAGE AND HANDLING:

A. Comply with the requirements specified in Section 01 60 00 and as specified.

PART 2 - MATERIALS

2.01 MANUFACTURERS:

A. Valves:

1. (Pond 3 Pump House) Carbon Steel and Alloy Steel Gate Valves shall be manufactured by the following:

a. 2-1/2 inches and larger: Class 300: Crane Figure 33.

b. 2 inches and Smaller: Class 600: Hancock, Newco, Edward-Vogt, R-P&C, Smith, Velan, or Waeco.

2. Class 150 Stainless-Steel Gate Valves shall be manufactured by the following:

a. 2-1/2 inches and larger: Crane Aloyco Figure 117.

b. 2 inches and Smaller: Crane, Jenkins, Newco, Pacific, Powell, Stockham, Velan, or Walworth.

2.02 SWING CHECK VALVES – 3-INCH AND LARGER:

A. Valves 3-inch and larger, AWWA C508 Swing Check Valves:

1. Manufacturers:

a. DeZurik-APCO CVS-6000A or approved equal

2. Minimum Working pressure:

Size	**Pressure**
3 to 12-inch (RWP Piping)	175 psi
3 to 12-inch (Pond 3 Pump house Piping)	250 psi

3. Valve Body:

a. ASTM A126 Class B cast iron or ASTM A536 Ductile Iron with integral flanges, faced and drilled per ANSI B16.1 Class 125/150 for RWP Piping, and Class 250/300 for Pond 3 Pump House Piping.

b. Provide full waterway type body with a net flow area not less than the nominal inlet pipe size when swung open a maximum of 25 degrees. When closed, the valve shall seat drop tight.

c. Provide a replaceable Type 316 stainless steel body seat.

4. Valve Disc:

a. ASTM A126 Class B cast iron or ASTM A536 Ductile Iron. Provide disc faced with a renewable resilient seat ring of a material suitable for the service specified and indicated. Provide Type 316 stainless follower ring and hardware.

5. Disc Arm:

a. Ductile iron or steel, suspended from and keyed to an austenitic stainless steel shaft located entirely above the waterway and supported at each end by bronze bushings.

b. Provide shaft to rotate freely without the need for external lubrication.

c. Provide the shaft sealed where it passes through the body by a stuffing box and adjustable packing. O-ring type shaft seals are not acceptable.

d. Provide valves with an outside lever and adjustable counterweight to initiate valve closure. Provide final closure dampened by means of a single, side-mounted bronze air-cushion assembly directly mounted to the valve body on machined pads.

e. Provide an adjustable amount of cushioning without the need for pre-charged air chambers. Commercial air cylinders which pivot and/or are attached with fabricated brackets are not acceptable.

2.03 AIR/VACUUM VALVES:

A. Manufacturers:

1. DeZurik-APCO or approved equal.

B. Valves: Fully automatic float operated valves designed to vent air within the pump discharge column on pump start-up and allow air to re-enter the column on pump shutdown or if a negative pressure occurs.

C. Provide with flanged inlet connections equivalent to the valve size. Provide Valves 6-inch and smaller with NPT outlet connections and valves larger than 6-inch with flanged outlet connections.

1. Flanges: ANSI Class 150

D. Provide valves with two (2) additional NPT connections for the addition of Air Release Valve, gauges, testing, and draining.

E. Provide valve body with a through flow area equal to the nominal valve size.

F. Provide valves with a bolted cover and flat gasket. Provide cover fitted to the valve body with a machined registered fit.

G. Provide guide shafts supported by bushings.

1. Provide float double guided and a resilient bumper.

H. Seats to provide drop tight shut off at full valve pressure rating.

1. Provide an anti-slam device.

I. Anti-Slam Device:

1. Provide for valves 6-inch and larger.

2. Flanged globe pattern spring operated device with a center guided disc and seat assembly.

3. Provide the disc with threaded ports to provide adjustment of flow rate.

4. Provide the device mounted on the valve inlet.

5. Seat and Disc: ASTM A351 Grade CF8M Stainless Steel.

J. Materials:

1. Valve Body, Cover and Baffle:

a. ASTM A126 Class B Cast Iron for Class 125 valves.

b. ASTM A536 Grade 65-45-12 Cast Ductile Iron for Class 300 valves.

2. Floats, Guide Shafts and Bushings: Type 316 stainless steel.

3. Seats: Buna-N.

4. Hardware: Type 316 stainless steel.

5. Springs: ASTM A313 Type 302 stainless steel.

2.04 GATE VALVES 3-INCH AND LARGER:

A. Resilient Seat Gate Valves:

1. Manufacturers-NRS Type Valves:

a. US Pipe.

b. American Cast Iron Pipe.

c. Kennedy Valve.

d. Mueller.

e. Seguro Valve.

B. General:

1. Provide resilient seat gate valves for all sizes indicated. Provide metallic seated valves conforming to AWWA C500 except as herein modified.

2. Provide resilient seated valves conforming to AWWA C509 except as modified herein.

C. Materials:

1. Body and Bonnet: ASTM A536 ductile iron.

2. Wedge: ASTM A536 ductile iron encapsulated with EPDM.

3. Provide all other materials as specified in AWWA C500 and C509. Working water pressure:

Valve Size	Pressure Rating
3 to 16-inch	250 psi

4. Exposed Valves: Flanged valves. Face-to-face dimensions to comply with ANSI B16.10, flanges to comply with ANSI B16.1.

5. Buried Valves: Mechanical joint or push-on joint ends, non-rising stem valves with operating nut in lieu of hand wheel. Provide gate boxes, steel extension stems or universal-joint operating rods with 2-in square operating nuts at upper end with coupling connected to valve stem to bring to operating nut to within 6 inches of ground surface.

6. Provide counterclockwise rotation to open valves.

7. Provide handwheels with arrow and word "open" to indicate open direction.

8. Provide geared operators for all valves 16-inch and larger. Gearing shall be steel with enclosed cases.

   a. Provide spur gears for buried valves with stems vertical

   b. Provide bevel gears where required by position of valve.

   c. Provide buried valves with totally enclosed gear cases to enclose both the gears and valve stuffing box and provide gasketed Type 316 stainless steel removable cover plates with Type 316 stainless steel fasteners to allow access to the stuffing box.

9. Chainwheels: Provide where required as specified herein. Provide beveled gear operator to mount chainwheel in vertical position. Provide valve mounted so that the arrow indicator will be visible from the floor level.

10. Provide conventional packing or double O rings in non-rising stem valves.

11. Valves capable of being repacked or O ring replaceable while under pressure.

12. Provide Type 316 stainless steel bolts and bronze nuts for stuffing box follower.

D. Provide all gate valves with all internal and external wetted parts coated with a fusion bonded epoxy in accordance with ANSI/AWWA C550.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Prior to installation, protect stored valves and appurtenances from damage due to exposure to sunlight, heat, dirt, debris, freezing and thawing, vandalism, etc.

B. Clean all debris, dirt, gravel, etc., from inside of piping before placing valves in place.

C. Erect and support valves in respective positions free from distortion and strain on appurtenances during handling and installation. Inspect material for defects in workmanship and material. Clean out debris and foreign material from valve openings and seats, test operating mechanisms to check functioning, and check nuts and bolts for tightness. Repair, valves and other equipment which do not operate easily or are otherwise defective at no additional cost to the Owner.

D. Set plumb and support valves in conformance with instructions of manufacturer. Shim valves mounted on face of concrete vertically and grout in place. Install valves in control piping for access.

E. Provide bolted split sleeve coupling or flexible type grooved coupling on downstream side of buried valves to assist in valve removal.

3.02 CHECK VALVES:

A. Install swing check valves horizontally or vertically (flow in upward direction) in pipelines unless otherwise indicated.

3.03 FIELD TESTING:

A. Pressure test valves with pipeline pressure testing.

B. Test functions of each valve.

C. Make all adjustments necessary to place valves in specified working order at time of above tests.

D. Remove all replace valves and appurtenances at no additional cost to the Owner with equipment that will meet all requirements specified and indicated if unable to demonstrate to the satisfaction of the Engineer that valves will perform the service specified, indicated and as submitted and accepted.

3.04 FIELD TOUCH-UP PAINTING:

A. After installation and accepted testing by the Engineer, apply touch-up paint to all scratched, abraided and damaged shop painted surfaces. Coating type and color shall match shop painting.

3.05 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 40 23 19.01

PIPE SUPPORTS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Design, and provide a complete system of pipe supports with inserts, bolts, nuts, restraining and hanger rods, washers, miscellaneous steel, sliding Teflon plates, and accessories as indicated and specified. The term pipe support includes hangers, guides, restraints, anchors and saddles.

B. Provide all support systems and the design of all support systems for all piping as specified herein. The Contractor shall provide pipe support locations, configurations and details through accepted shop drawing submittals stamped by a Registered Professional Engineer as specified herein.

C. The Contractor shall be responsible for the proper design, fabrication, location, shop drawings and installation of all pipe supports in accordance with the specified requirements.

D. Pipe support locations and types for piping 1/2-inch and larger shall be determined by the Contractor using the guidelines for support spacing specified herein and other criteria contained in this pipe support specification. Guidelines for pipe supports may need to be adjusted based upon field coordination, field routing, or other considerations outlined herein such as structural load limits. The Contractor may revise the pipe support locations and details through accepted shop drawing submittals stamped by a Registered Professional Engineer as specified herein. The Contractor is responsible for the proper design, installation and fabrication of all pipe supports in accordance with the specified requirements. For pipe supports 1/2-inch and larger pipe support shop drawings together with a marked up piping drawing showing support number, location and typical type shall be submitted by the Contractor for acceptance.

1. The Contractor shall be responsible for coordinating all pipe support designs for all trades to ensure compliance with all of the requirements of this specification, including but not limited to the total limitations specified herein.

E. Design and provide all temporary pipe supports required during installation and testing.

1.02 REFERENCES:

A. ASTM International (ASTM):

1. A36: Standard Specification for Carbon Structural Steel

2. A307: Standard Specification for Carbon Steel Externally Threaded Standard Fasteners

3. A312: Seamless and Welded Austenic Stainless Steel Pipe

4. A500: Cold Formed Welded and Seamless Carbon Steel Structural Tubing.

5. A572: Specification for Steel Plate.

6. E165: Practice for Liquid Penetrant Inspection Method.

7. E709: Practice for Magnetic Particle Examination.

B. American Welding Society (AWS):

1. D1.1: Structural Welding

C. Fluid Sealing Association: Technical Handbook.

D. Manufacturers' Standardization Society (MSS):

1. SP-58: Pipe Hangers and Supports - Materials and Design.

2. SP-69: Pipe Hangers and Supports - Selection and Application.

3. SP-89: Pipe Hangers and Supports - Fabrication and Installation Practices.

4. SP-90: Guidelines on Terminology for Pipe Hangers and Supports.

E. National Association of Expansion Joint Manufacturers: Standards of the Expansion Joint Manufacturers Association, Inc.

1.03 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00:

1. Pipe support drawings specified herein and including data for accessory items for acceptance prior to fabrication. The Contractor shall submit pipe support coordination drawings including all piping and pipe supports for all trades.

a. Detailed drawing of the device with dimensions.

b. A table of applied forces and moments.

c. A complete bill of materials.

d. A unique identification and revision level.

e. Stamp of a Registered Professional Engineer, registered in the state where this project is being constructed, experienced in pipe support design and pipe stress analysis as specified herein.

f. Detailed connections to existing structure.

g. Indicate all welds, both shop and field, by Standard Units of Measurement as specified in AWS D1.1.

2. Welding Procedure: Submit description required to illustrate each welding procedure to be performed in the specified work.

3. Welding Equipment: Submit descriptive data for welding equipment, including type, voltage and amperage.

4. Qualification for Welders: Provide certification that welders to be employed in work have satisfactorily passed AWS or ASME qualification tests. If recertification of welders is required, retesting is the Contractor's responsibility at no additional cost to the Owner.

5. Pipe support manufacturers' qualifications as specified herein.

   a. List of at least five (5) successful pipe support projects and current addresses and telephone numbers of persons in charge of representing the owner or the owner of those construction projects during the time of pipe support design, fabrication and installation.

   b. Qualification of manufacturers' Registered Professional Engineer, registered in the state where this project is being constructed, who stamps and seals shop drawings and designs.

6. Coordination drawings for pipe supports shall include as a minimum the following information.

   a. Coordination drawings shall include all pipe supports covered by specifications.

   b. These coordination drawings will be used by the Contractor to ensure that the pipe supports do not obstruct access, access for equipment operation or removal including all mechanical and electrical equipment, panels, valves, gauges, and instrumentation.

   c. The Contractor shall be responsible for including and coordinating the work of all subcontractors into the coordination drawings.

   d. Prepare reproducible coordination drawings, indicating equipment, piping, valves, expansion joints, ductwork, conduit, cable trays, junction boxes, lighting fixtures, sleeves, inserts, embedments, supports, hangers and appurtenances at not less than 1/4-inch scale. Drawings shall show beams, columns, ceiling heights, wall, floors, partitions and structural features as indicated on the contract drawings. Individual pipes and conduit 2-inches or less in diameter that will be field routed need not be shown on coordination drawings.

e. Coordination drawings shall include large-scale details as well as cross and longitudinal sections required to fully delineate all conditions. Particular attention shall be given to the location, size, and clearance dimensions of equipment items, shafts, operators and necessary maintenance access.

f. Make all minor changes in duct, pipe or conduit routings that do not affect the intended function, but items may not be resized or exposed items relocated without the approval of the Owner. No changes shall be made in any wall locations, ceiling heights, door swings or locations, window or other openings or other features affecting the function or aesthetic effect of the building. If conflicts or interferences cannot be resolved, the Owner shall be notified. Any problems of coordination that require architectural or structural changes of design shall be submitted to the Owner for resolution.

g. After the reproducible drawings have been coordinated and all changes have been made, the drawings shall be signed by the Contractor and all subcontractors indicating that all work on that drawing has been coordinated with all associated vendors and subcontractors and all conflicts have been resolved.

h. Relocation of any duct, pipe, conduit or other material that has been installed without proper coordination among all trades shall be performed at no additional cost to the Owner.

7. Written notification of any deviations from the requirements of this specification.

8. Support documentation and justification as specified.

9. Certificates of Design signed by a Registered Professional Engineer for all pipe supports.

10. Manufacturer's product data and specifications for shop painting.

B. A copy of the contract mechanical process, and structural drawings, with addenda that are applicable to the equipment specified in this section, marked to show all changes necessary for the equipment proposed for this specification section. If no changes are required, mark all drawings with "No changes required" or provide a statement that no changes are required.

1. Failure to include all drawings or a statement applicable to the equipment specified in this section will result in submittal return without review until a complete package is submitted.

2. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked and indexed to indicate requested deviations and clarifications from the specified requirements.

   a. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.

   b. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specifications and justifications are submitted in a complete package.

1.04 QUALITY ASSURANCE:

A. Provide in accordance with Section 01 43 00 and as specified.

B. Provide manufacturer's certification in writing, that materials meet or exceed minimum requirements as specified.

C. Welder Qualifications:

1. Quality and certify welding procedures, welders, and operators in accordance with ANSI B31.1, paragraph 127.5 for shop and project site welding of piping work.

D. Pipe supports: All supports and parts shall conform to the latest requirements of the Code for Pressure Piping ASME/ANSI B31.1 and Manufactures Standardization Society (MSS) Standard Practice SP-58, SP-69, SP-89 and SP-90 except as supplemented or modified by the requirements of this specification.

E. Structural Concrete: Conform to the requirements on the Drawings.

F. Conform to the requirements of the latest edition of the AISC Manual of Steel Construction for miscellaneous and supplementary steel. Tube steels are ASTM A500 Grade B, structural shapes A36, plates A-572 or equal. Stainless steel structural members shall conform to ASTM requirement Type 316L.

G. Pipe Support Manufacturer Qualifications:

1. Must possess a written quality assurance program.

2. Have a minimum of 5 years experience in the design and fabrication of pipe supports.

3. Have completed the design and fabrication of at least 5 successful pipe support projects of equal size, complexity, and systems as this project within the past 10 years.

4. Retains the services of a Registered Professional Engineer, registered in the state where this project is being constructed, with a minimum of ten years experience in the design of piping systems and pipe supports.

5. Manufacturers' Standardization Society (MSS) Member.

6. Have a field service technician on staff with at least 5 years experience in resolving field installation, interference and interface problems associated with the design, installation and manufacture of pipe supporting components.

H. Hanger inspections shall be performed in accordance with MSS-SP-89 and ASME B31.1.

1.05 DELIVERY, STORAGE AND HANDLING:

A. Comply with the requirements specified in Section 01 60 00.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Provide materials used in pipe supports, which are compatible with the pipes to which they are attached. Provide Type 316L stainless steel supports for all piping. Copper plated pipe supports are not acceptable.

B. Allowable materials: As indicated in ANSI B31.1 Appendix A and MSS-SP-58 Table 2.

C. Provide Type 316L stainless steel for pipe supports, hangers, guides, restraints, and anchors that are exterior or interior submerged, in potentially wetted areas in wet wells, channels, screening and grit removal areas and in chemically corrosive atmospheres.

D. Provide only new material. Previously used and/or scrap material is not acceptable.

E. Provide tube steels that are ASTM A500 Grade B, Structural shapes A-36, plates A-572 or equal.

F. Concrete anchor bolts - Hilti Kwik-Bolt II Stud Anchors, Rawl Bolt, Phillips Wedge Anchors, or equal. Expansion bolts shall be stainless steel.

2.02 DESIGN, LOCATION, AND TYPE OF PIPE SUPPORTS:

A. Design and provide pipe supports for piping 1/2-inch and larger to include the following loads:

1. Gravity Force: This force includes the weight of pipe, pipe contents (hydro load), valves, in-line equipment, insulation and any other weight imposed on the piping and/or pipe support.

2. Thermal Expansion Force: This force is developed by the restraint of free end displacement of the piping due to thermal growth.

3. Hydrostatic/Dynamic Forces: These forces are developed due to the internal pressure (positive and negative) during operation of the piping system. These forces include the forces due to water hammer, pressure pulses due to rapid valve closure, fluid discharge resulting from pump startup, operation of positive displacement pumps, etc.

4. Wind Loadings: Wind loadings.

B. Provide supports, guides, anchors, flexible couplings and expansion joints in accordance with the coupling and joint manufacturers' specifications and requirements.

C. For all pump suction and discharge nozzles provide an anchor located between the pump nozzles and the nearest expansion joint or non-rigid coupling.

D. Where possible, provide pipe supports, which are the manufacturers' standard products.

1. Provide pipe supports with individual means of adjustment for alignment.

2. Provide pipe supports complete with appurtenances including locking and adjusting nuts.

3. Hanger rods shall be subjected to tension only.

4. Where lateral or axial pipe movement occurs, provide hangers for the necessary swing without exceeding 4 degrees.

5. Provide concrete inserts capable of supporting the design loads.

6. Metal framing systems will be acceptable to support piping 2 inch and smaller.

7. Provide insulated piping supported using rigid load bearing insulation (baton board type) with 16 gauge shields to fit between the insulation and the support. Shields to encompass a minimum 1/3 of the pipe circumference and be 12 inch in length.

8. Provide load-bearing insulation capable of supporting the load, as a minimum on the bottom 60 degrees of the pipe support. Cope insulation and adjust to avoid interference of steel structures.

9. Provide supplementary steel as needed.

10. Do not support pipes from other pipe, conduits or metal stairs.

11. Chain, strap, T-bar, perforated bar and/or wire hangers are not acceptable.

12. Contact between piping and dissimilar metals such as hangers, building structural work or equipment subject to galvanic action is not acceptable.

13. All pipe supports located in fluid flow shall be supplied with double nutting.

E. Provide thrust anchors to resist thrust where required. Wall pipes may be used as thrust anchors if so designed. Welded attachments shall be of material comparable to that of the piping, and designed in accordance with governing codes.

F. Provide expansion joints where indicated and where required based on Contractor's design of the pipe support system. Indicate expansion joints on submittal drawings.

G. For piping 2-inch and smaller provide manufacturer’s standard supports and standard spacing guidelines

H. All outside above ground supports shall be Type 316L stainless steel as specified herein.

I. Provide pipe supports that do not overload or over stress the piping, equipment, or structure that they are supporting or to which they are attached. Allowable pipe stress to be within ANSI B31.1 code allowable.

J. The Contractor shall provide the services of a field service technician (preferably from the pipe support manufacturer) to field coordinate the locations of supports and resolve interferences and conflicts encountered during installation.

2.03 FABRICATION:

A. Provide pipe supports formed in accordance with paragraph 5.1 of MSS-SP-58.

B. Providing welding in accordance with Structural Welding Code.

C. Provide dimensional tolerances as specified in MSS-SP-89.

D. Provide threading and tapping in accordance with MSS-SP-89.

2.04 SHOP PAINTING:

A. Primer and Finish Paint: Shop apply to all exterior ferrous surfaces, high solids epoxy.

B. Ferrous surfaces which are not to be painted shall be given a shop applied coat of grease or rust resistant coating.

C. Provide additional shop paint coating for touch-up to all surfaces after installation and testing is completed and equipment accepted.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install items in accordance with manufacturers’ printed instructions and as indicated and specified herein.

B. Perform welding in accordance with Structural Welding Code:

1. Visually inspect welding while the operators are making the welds and again after the work is completed in accordance with AWS D1.1 Section 6.0. After the welding is completed, hand or power wire brush welds, and clean them before the Qualified Inspector makes the check inspection. The Qualified Inspector shall inspect welds with magnifiers under light for surface cracking, porosity, and slag inclusions; excessive roughness; unfilled craters; gas pockets; undercuts; overlaps; size and insufficient throat and concavity. The Qualified Inspector shall inspect the preparation of grove welds for throat opening and for snug positioning for back-up bars.

2. Nondestructive evaluation of welds connecting structural steel members subjected to critical stresses: Perform in accordance with the weld quality and standards of acceptance in AWS D1.1.

3. For weld areas containing defects exceeding the standards of acceptance in accordance with AWS D1.1, Section 3.7. Provide additional testing of the repaired area at no additional cost to the Owner.

4. Test Locations: As selected by the Owner.

5. Correct any deficiencies detected as directed by the Engineer at no additional cost to the Owner.

C. Proceed with the installation of the pipe supports only after required building structural work has been completed and concrete support structure has reached its 28-day compressive strength as specified on the Drawings.

D. Install pipe supports to comply with MSS-SP-89. Group parallel runs of horizontal piping to be supported together on trapeze type hangers.

E. Install pipe supports to provide indicated pipe slopes. Do not exceed maximum pipe deflection allowed by ANSI B31.1.

F. For exposed continuous pipe runs, install pipe supports of same type and style as installed for adjacent similar piping.

G. Install pipe supports to allow controlled movement of piping systems. Permit freedom of movement between pipe anchors, and facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

H. Piping to be free to move when it expands or contracts except where fixed anchors are indicated or required by the Contractor's pipe support systems. Where hanger rod swing length cannot be provided or where pipe movement based on expansion of 1 inch/100 feet, for each 100 degrees F change in temperature exceed 1/2-inch, provide sliding supports.

I. Prevent contact between dissimilar metals. Where concrete or metal support is used, place 1/8-inch thick Teflon, neoprene rubber, or plastic strip under piping at point of bearing. Cut to fit entire area of contact between pipe and pipe support.

J. Apply an anti-seize compound to nuts and bolts on all pipe supports.

K. Locate reinforcing steel in concrete structure with x-ray prior to drilling for embedment plates and anchor bolts. Avoid contact or interference with reinforcing steel.

3.02 INSTALLATION OF BUILDING ATTACHMENTS:

A. Support piping from structural framing, unless otherwise indicated.

B. Concrete Inserts:

1. Use existing embedded concrete items whenever possible.

2. Use expansion anchors only when existing embedded attachment points are not available or unsuitable. Attach to hardened concrete or completed masonry.

3.03 THRUST ANCHORS AND GUIDES:

A. Thrust Anchors:

1. Center thrust anchors between expansion joints and between elbows and expansion joints for suspended piping. Anchors must hold pipe rigid to force expansion and contraction movement to take place at expansion joints and/or elbows and to preclude separation of joints.

2. Restraining rod size and number shall be as indicated and adhere to manufacturers recommendations as a minimum.

B. Pipe guides: Provide adjacent to sliding expansion joints in accordance with recommendations of the National Association of Expansion Joint Manufacturers and the specific joint manufacturer.

3.04 PIPE SUPPORTS:

A. Provide minimum of two pipe supports for each pipe piece.

B. Where pipe connects to equipment, support pipe independently from the equipment. Do not use equipment to support piping.

C. Provide pipe supports so that there is no interference with maintenance or removal of equipment.

D. Unless otherwise indicated or authorized by the Engineer's Representative, place piping running parallel to walls approximately 1-1/2 inch out from face of wall and at least 3 inches below ceiling.

E. Pedestal pipe supports: adjustable with stanchion, saddle, and anchoring flange. Provide grout between baseplate and floor.

F. Support piping to prevent strain on valves, fittings, and equipment. Provide pipe supports at changes in direction or elevation, adjacent to flexible couplings, adjacent to non-rigid joints. Do not install pipe supports in equipment access areas or bridge crane runs.

G. Stacked horizontal runs of piping along walls may be supported by metal framing system attached to concrete insert channels.

H. Do not support piping from other piping.

I. Designs generally accepted as exemplifying good engineering practice, using stock or production parts, shall be utilized whenever possible.

J. Whenever possible, pipe attachments for horizontal piping shall be pipe clamps.

K. All rigid rod hangers shall provide a means of vertical adjustment after erection.

L. Where the piping system is subjected to shock loads, such as disturbances due to pump discharge or thrust due to actuation of safety valves, hanger design shall include provisions for rigid restraints or shock absorbing devices.

M. Hanger rods shall be subject to tensile loading only. At hanger locations where lateral or axial movement is anticipated suitable linkage shall be provided to permit rod swing.

N. Hanger spacing shall not exceed the spacing listed below:

1. In the case of concentrated loads the supports shall be placed as close as possible to the load to reduce the bending stress.

2. Where changes in direction of the piping system occur between supports, the total length between supports shall be kept to less than three-fourths of the full span. When practical, a support shall be placed immediately adjacent to any change in direction of the piping system.

O. Where practical, riser piping shall be supported independently of the connected horizontal piping. Pipe support attachments to the riser piping shall be riser clamp shear lugs. Welded attachments shall be of material comparable to that of the piping, and designed in accordance with governing codes. If friction is relied upon to support riser piping proper justification and documentation shall be submitted to ensure that enough friction force is provided to resist the applied loading.

P. Hanger components shall not be used for purposes other than for which they were designed. They shall not be used for rigging and erection purposes.

Q. All threads shall be UNC unless otherwise specified.

3.05 INSULATED PIPING:

A. Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed allowable pipe stresses.

B. Where vapor barriers are indicated on water piping, install coated protective shields.

3.06 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 40 23 19.05

PROCESS PIPING AND APPUTENANCES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. Provide and test process piping and appurtenances as indicated and in compliance with Contract Documents.

1.02 REFERENCES:

A. American Society of Mechanical Engineers (ASME):

1. B16.5: AN Standard for Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys

2. B16.9: Factory-Made Wrought Buttwelding Fittings

3. B16.11: Forged Fittings, Socket-Welding and Threaded

4. B16.21: Nonmetallic Flat Gaskets for Pipe Flanges

5. B16.36: Orfice Flanges

6. B16.39: Malleable Iron Threaded Pipe Unions Classes 150, 250, and 300

7. B16.47: Large Diameter Steel Flanges NPS 26 Through NPS 60 Metric/Inch Standard

8. B18.2.1: Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)

9. B18.2.2: Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch eries)

10. B31.1: Power Piping

B. ASTM International (ASTM):

1. A36: Standard Specification for Carbon Structural Steel

2. A53: Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

3. A105: Standard Specification for Carbon Steel Forgings for Piping Applications.

4. A106: Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service

5. A182: Standard Specificaiton for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.

6. A193: Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications

7. A194: Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both

8. A197: Standard Specification for Cupola Malleable Iron

9. A234: Standard Specification for Piping Fittings if Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.

10. A307: Standard Specification for Carbon Steel Externally Threaded Standard Fasteners

11. A312: Seamless and Welded Austenic Stainless Steel Pipe

12. A403: Standard Specification for Wrought Austenitic Stainless Steel Pipe Fittings.

13. A531: Standard Practice for Ultrasonic Examination of Turbine-Generator Steel Retaining Rings

14. A536: Standard Specification for Ductile Iron Castings

15. A563: Standard Specification for Carbon and Alloy Steel Nuts

16. B695: Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel

17. C177: Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus

18. D2000: Rubber Products in Automotive Applications

19. D2996: Standard Specification for Filament-Wound “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe

20. D3035: Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter

21. D3261: Standard Specfication for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethyene (PE) Plastic Pipe and Tubing

22. D3350: Standard Specification for Polyethylene Plastics Pipe and Fittings Materials

23. D5685: Standard Specification for “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pressure Pipe Fittings

24. E84: Standard Test Method for Surface Burning Characteristics of Building Materials

25. F2206: Standard Specification for Fabricated Fittings of Butt-Fused Polyethyene (PE)

26. F2329: Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners

27. F2620: Standard Practice for Heat Fusion Joining of Polyethyene Pipe and Fittings

C. American Welding Society (AWS):

1. B3.0: Welding Procedure and Performance Qualification

D. American Water Works Association (AWWA):

1. C104: Cement-Mortar Lining for Diuctile-Iron Pipe and Fittings

2. C110: Diuctile-Iron and Gray-Iron Fittings

3. C111: Rubber-Gasket Joints for Diuctile-Iron Presuure Pipe and Fittings

4. C115: Flanged Diuctile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges

5. C150: Thickness Design of Diuctile-Iron Pipe

6. C151: Diuctile-Iron Pipe, Centrifugally Cast

7. C153: Diuctile-Iron Compact Fittings

8. C213: Fusion-Bonded Epoxy Coatings and Linings for Steel Water Pipe and Fittings

9. C219: Bolted, Sleeve-Type Couplings for Plain-End Pipe

E. Expansion Joint Manufacturers Association Standards.

F. Fluid Sealing Association - Technical Handbook.

G. Manufacturer's Standardization Society (MSS):

1. SP-69: Pipe Hangers and Supports - Selection and Application

1.03 SUBMITTALS:

A. Submit the following in accordance with Section 01 33 00:

1. Submit manufacturer's certificates of conformance.

2. Submit certified copies of test reports.

3. Piping layouts in full detail, layout with spool piece numbers and spool piece detail sheets with bill of material.

4. Location of pipe hangers and supports.

5. Large scale details of wall penetrations and fabricated fittings.

6. Schedules of all pipe, fittings, special castings, flexible connectors, adapters, couplings, expansion joints, and other appurtenances.

7. Reports as required for welding certifications per ASME B31.1 Paragraph 127.6.

8. Catalog cuts of joints, couplings, harnesses, expansion joints, gaskets, fasteners and other accessories.

9. Wall thickness calculations for minimum wall thickness on OD/ID controlled pipe.

B. A copy of the contract mechanical process, civil, structural, electrical and instrumentation drawings, with addenda that are applicable to the equipment specified in this section, marked to show all changes necessary for the equipment proposed for this specification section. If no changes are required, mark all drawings with “No changes required”.

1. Failure to include all drawings applicable to the equipment specified in this section will result in submittal return without review.

C. A copy of this specification section with addenda and all referenced specification sections with addenda, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations and clarifications from the specified requirements.

1. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.

2. Failure to include a copy of the marked-up specification sections and or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specification and justification are resubmitted with the entire package.

1.04 QUALITY ASSURANCE:

A. Welder Qualifications:

1. Qualify and certify welding procedures, welders, and operators in accordance with ANSI B31.1, for shop and project site welding of piping work.

2. Qualification for welders: Welding shall be performed by welders holding current certification for the welding procedures in use.

3. Visually inspect welding while the operators are making the welds and again after the work is completed. After the welding is completed, hand or power wire brush welds and clean them before the inspector makes the check inspection. Inspect welds for defects exceeding tolerances allowed by code under which the weld was made. Repair all defects exceeding tolerance.

B. Job Conditions:

1. Coordinate dimensions and drillings of flanges with flanges for valves, pumps, and other equipment to be installed in piping system.

1.05 DELIVERY, STORAGE AND HANDLING:

A. Provide in accordance with Section 01 60 00.

B. During loading, transportation and unloading, prevent damage to pipes and coatings. Load and unload each pipe under control at all times. Under no circumstances will a dropped pipe be used unless inspected and accepted by Engineer's Representative. Place skids or blocks under each pipe in the shop and securely wedge pipe during transportation to protect pipe, lining, and coating.

C. Ship all random-length pipe to the jobsite with an Engineer approved method of identification for schedule and material.

D. Ship all gaskets to the jobsite tagged with size, material, and pressure rating.

E. Ship spare gaskets separately packaged and tagged as spare parts.

F. Ship all random length pipe to jobsite with protective end caps to prevent the entrance of dirt and debris.

G. Ship all pipe spool pieces to the Site piece marked for proper identification. Piece marks shall be on each end of the pipe spool.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Ship. Design, fabricate, and test Equipment and Materials in accordance with the manufacturer's procedures and the applicable codes and standards listed in ARTICLE 1.02, this Section.

B. All carbon steel materials shall be coated in to prevent rust during shipping, storage, and erection.

2.02 PIPE MATERIAL SPECIFICATIONS:

A. Piping, fittings, and components inside and from Pond 3 Pump-house to the new Return Water Pond shall be in accordance with piping material specifications 00PDH03 and 01CSS06. Piping and components shall have a minimum design/working pressure of 220 psig.

B. Piping, fittings, and components for the remaining piping systems shall be in accordance with piping material specifications 00PDH02 and 00SAS02. Piping and components shall have a minimum design/working pressure of 120 psig.

2.03 HDPE PIPE AND FITTINGS:

A. Manufacturers:

1. Independent Pipe Products

2. J-M Manufacturing

B. Provide iron pipe size high density polyethylene pipe and fittings.

1. Size range: 1-inch to 30-inch.

2. Working Pressure: Per paragraph 2.02A and 2.02B.

3. Joints:

a. Butt heat fusion.

b. Flanged: Provide at all equipment, valves, tanks and wall penetrations.

4. Flanged Connections: Van Stone type with HDPE flange and bolt ring as specified.

a. Bolt Torque: Install in accordance with Plasric Pipe Institute, Inc Technical Note #38.

5. Fittings:

a. 90 Degree Bends: Provide 5 piece HDPE segmented elbows.

b. 45 Degree Bends: Provide 3 piece HDPE segmented elbows.

c. Concentric Reducers: HDPE three section traditional type design, compact reducers are not acceptable.

d. For pump suction eccentric reducers provide flanged glass lined ductile iron or flanged Type 316L stainless steel as indicated.

e. Provide stiffeners where required.

C. Materials:

1. Pipe and Fittings: Material designation PE4710 in accordance with ASTM D3035.

2. Bolt Rings: Type 316 stainless steel ASTM A531 Grade CF8M.

3. Hardware: Type 316 stainless steel.

2.04 STEEL, STAINLESS-STEEL, AND ALLOY STEEL FITTINGS:

A. Steel pipe flanges shall be as follows:

1. Have surface finish in accordance with:

a. MSS SP-6 for flanges less than 24 inches.

b. MSS SP-44 for flanges 24-inches through 36-inches diameter in classes 150 to Class 900.

2. Flat face when connected to the following:

a. Class 125 cast-iron valves or fittings.

b. Fiberglass pipe or fittings.

c. HDPE pipe or fittings.

d. Equipment having flat face flanges.

2.05 DUCTILE IRON PIPE:

A. Thickness Design: AWWA C150.

B. Pipe: 14 to 20 inches in diameter: AWWA C151, Pressure Class 250 for mechanical and push on joints in buried and under bridge service.

C. Fittings: Ductile iron, AWWA C110 or C153, match wall thickness of adjacent pipe. All buried and under bridge fittings shall be restrained with EBAA Iron Mega-lug restraints or approved equal.

D. Joints: AWWA C111, rubber gasketed for push-on or mechanical joint and AWWA C115 for flanged joints. All buried and under bridge joints shall be restrained with EBAA Iron Mega-lug restraints or approved equal.

E. Interior Lining: Cement mortar, AWWA C104, minimum 40 mils thickness.

F. Exterior Coating:

1. Asphaltic coating, AWWA C151, for buried pipe and fittings.

2. Asphaltic coating, AWWA C151 for exposed pipe and fittings.

G. Bolts and Nuts (Aboveground):

1. Hex head bolts and nuts:

2. Bolts: ANSI B18.2.1.

3. Nuts: ANSI B18.2.2.

4. Number, size, and length: AWWA C115, Table 15.2.

5. Material: ASTM A307, low carbon steel.

6. Use studs with nuts on each end for pipe sizes 54 inches and larger.

7. Tee head bolts and hexagonal nuts: AWWA C111.

8. Number, size, and length: AWWA C111, Table 11.1.

9. Material: Low alloy steel or high strength cast iron in accordance with AWWA C111.

2.06 FLANGE BOLTING MATERIALS:

A. Flange Bolting Materials:

1. Shall as specified per the Piping Material Specifications.

2. Protective surface treatment of nuts and bolts shall be in accordance with the following:

a. Galvanized - Fasteners and associated hardware shall be hot-dip galvanized according to ASTM F2329 or mechanically deposited according to ASTM B695 with average thicknesses defined herein:

ASTM Standard Specification	Fastener and Nut Sizes 3/8 inch and Smaller	Fastener and Nut Larger than 3/8 inch
F2329	1.5 mils	1.7 mils
B695	Class 40	Class 50

2.07 GASKETS:

A. General: Shall as specified per the Piping Material Specifications.Pipe and fittings 2-inch and Larger: Provide filament wound fiberglass reinforced thermosetting resin pipe in accordance with ASTM D2996 and fittings in accordance with ASTM D5685.

2.08 PRESSURE GAUGES:

A. Gauges:

1. Non-liquid filled type.

2. Helical wound bourdon tube, Inconel X-750.

3. Welded parts: Type 316 stainless steel.

4. Bearings: Precision Sapphire Type.

5. 1/2-inch NPT bottom male thread connection.

6. Accuracy: 1/2 percent of scale range.

7. 4-1/2-inch diameter with ABS plastic case.

8. Provide external adjustment.

9. Pipe and Fittings: Schedule 40 or 80 threaded or socket welded, Type 316L stainless steel.

10. Pump Discharge Gauges: Provide gauges with range to cover the normal operating range, above the pump shutoff head and the range of pressures that will result from flushing.

B. Pipe and fittings: Type 316L stainless steel, provide as specified herein.

C. Ball valves: General service stainless steel ball valves.

D. Pressure Sensor Rings:

1. 1-inch and Larger: Provide sensor/isolators that fit inside the bolt circle of 150-lb (Class 150) or 300-lb (Class 300) ANSI flanges as required.

2. 3/4-inch and Smaller: Provide sensor/isolators full flange or threaded as specified and indicated. For chemical system provide full flange, threaded connections are not acceptable.

3. Face to face length of the sensor: Conform to Specification MSS SP-67.

4. Type: Flow through design with flexible sleeve around full circumference. The center section shall have a cavity behind the sleeve filled with silicone fluid to transfer pressure to the gauge.

5. Rigidly support all pressure instruments by a post at least 7/8 inch diameter welded to the isolator. On sensor rings with more than one instrument, provide all connections 1/2-inch NPT as a minimum, 1/4-inch NPT fittings are not acceptable.

6. Provide sensor/isolator rings that do not have any fill plugs or valves that can be inadvertently removed with the resultant loss of fill fluid. Pressure sensor/isolators using valves are not acceptable.

7. Provide liquid filled sensor/isolators permanently vacuum sealed at the factory with a modular seal consisting of a membrane and needle fitting to allow removal and replacement of pressure instruments without compromising the vacuum fill. Sensor/isolators using valves are not acceptable.

8. Provide the needle fitting with both 1/4-inch NPT threads and 1/2-inch NPT threads.

9. Provide the pressure sensor/isolator capable of operating under pressure with all pressure instruments removed with no loss of fill fluid and without the need for isolating valves.

10. Attach pressure instruments to the isolator with a hand tightened lock ring.

11. It shall be possible to remove or attach pressure instruments to the isolator without requiring the use of any tools.

12. Permanently fill the pressure sensor with high viscosity silicone instrument oil to damp out surges or pressure spikes without the requirement for a separate snubber.

13. Pressure rating: 200 psi minimum for all lines tested at 150 psi or less and 600 psi minimum per lines tested above 150 psi.

14. Provide gauges as specified herein. Provide all other types of instruments indicated and specified in accordance with Section 40 23 13.01.

15. Materials:

    a. Pressure sensor/isolator rings: Provide materials suitable for the service conditions specified and indicated, as a minimum provide the following:

Service	Body & Plates	Sleeve
Water	Type 316L Stainless Steel	Natural Rubber
Wastewater	Type 316L Stainless Steel	Natural Rubber

2.09 COUPLINGS-SLEEVE TYPE:

A. Manufacturers:

1. Romac

2. Smith Blair

3. Viking Johnson

4. Dresser

B. Provide couplings meeting AWWA C219

C. Couplings 12-inch and smaller:

1. End rings and center rings: ASTM A536 ductile iron, fusion bonded epoxy coated

2. Gaskets: Buna-N, NSF 61 approved

3. Hardware: Type 316 stainless steel

D. Couplings 14-inch and larger:

1. End rings and center rings: ASTM A36 steel, fusion bonded epoxy coated

2. Gaskets: Buna-N, NSF 61 approved

3. Hardware: Type 316 stainless steel

E. Bridles and tierods: Minimum 3/4-inch diameter, except where tierods replace flange bolts of smaller size, in which case fit with nut on each side of pair of flanges.

1. Provide as indicated

2.10 TRANSITION COUPLINGS:

A. Provide coupling in accordance with AWWA C219 as specified herein

B. Sizes: 2-inch through 24-inch.

C. Materials:

1. End rings and center rings: Ductile iron ASTM A536.

2. Gaskets: Virgin Styrene Butadiene Rubber(SBR) suitable for potable water and wastewater service, ASTM D2000 MBA 710.

3. Provide 5/8-inch, Type 316 Stainless steel bolts and nuts

D. Working Pressure: 250 psi.

E. Lining and Coating: Fusion bonded epoxy in accordance with AWWA C213.

2.11 DISMANTLING JOINTS:

A. Materials:

1. Flanged Spool: AWWA Class D steel ring flange compatible with ANSI class 125 and 150 bolt circles. Provide pipe of ASTM A36 plate 1 percent cold expanded to size.

2. End Ring and Body: ASTM A36 steel

3. Gaskets: ASTM D2000 Virgin NBR suitable for wastewater service

4. Bolts and Nuts: Type 316 stainless steel

5. Tie Rods: Type 316 stainless steel

B. Assembly Tolerance: 3 inches

C. Coating: Fusion bonded epoxy, NSF 61 certified

D. Pressure Rating: 150 psi working pressure

E. Manufacturers

1. Romac

2. Viking Johnson

2.12 INSULATION:

A. General:

1. Provide insulation where specified and indicated.

2. Provide pre-molded or pre-formed pipe insulation.

3. Provide insulation with a flame spread index of less than 25, and a smoke-developed index of less than 50 when tested in accordance with ASTM E84.

4. Provide insulation with a maximum thermal conductivity of 0.28 Btu-in/h-ft^2-degrees F at 75 degrees F mean temperature when tested in accordance with ASTM C177.

B. Insulation for above grade systems with an operating temperature below 130 degrees F.

1. Type: Pre-molded, Flexible Closed Cell Elastomeric Foam.

2. Provide self sealing lap for pipe sizes 6-inch and smaller. For pipe sizes above 6-inch and equipment provide Closed Cell Elastomeric Foam Sheets.

3. Manufacturers:

a. Armacell Engineered Foams, AP Armaflex FS SA and AP Armaflex.

4. Accessories:

a. Adhesive: Provide contact adhesive specifically designed for use with the insulation supplied.

b. Finish: Armaflex WB finish.

c. Pipe support inserts: Provide a pre-fabricated insert designed to prevent damage to the insulation at the pipe support attachment point.

d. Provide an aluminum or stainless steel outer jacket, a foam inner core with plastic support and self sealing closure, or acceptable equivalent product.

PART 3 - EXECUTION

3.01 INSTALLATION OF PIPE:

A. Install pipelines parallel to building walls wherever possible. Install piping to lines and grades indicated and support. Where temporary supports are used, provide temporary supports as specified in Section 40 23 19.01 to prevent shifting or distortion of pipe. Provide for expansion.

B. Slope piping toward low points and provide for draining at low points.

C. Before assembly, remove debris from inside pipes and fittings.

D. Before flanges pieces are assembled, remove rust resistant coating from machined surfaces, clean gaskets and smooth burrs. Make up flanged joints tight, and prevent strain upon valves or other pieces of equipment.

1. Bolt threads must fully engage the nuts. At a minimum the bolt must be flush with the nut and no more than 1/2-inch excess thread protruding from the nut.

E. Install tierods, pipe clamps or bridles when sleeve type couplings or fittings are used in piping system as indicated, and at changes in direction or other places to prevent joints from pulling apart under pressures indicated in the Process Pipe Schedule.

F. Examine pieces for damage. Do not install pieces that are damaged according to Engineer's Representative. If any damaged piece should be discovered after having been installed, remove and replace with a sound piece at no additional cost to the Authority.

G. Handle pipe with equipment such as nylon slings and padded skids, designed to prevent damage to the coating. Repair abrasions and injuries to the coating prior to the application of insulation or prior to the application of final field coating.

H. Support piping laid in trenches in trench on bed of selected backfill material which maintains desired line and grade.

I. Provide a minimum of 12-inch vertical clearance between buried pipelines and other pipelines or other utilities.

J. Use dielectric bushings or unions when ferrous pipes join nonferrous pipes carrying liquid either underground or elsewhere.

K. Welding in accordance with ASME B31.1 and AWS B3.0.

3.02 HDPE PIPING

A. All HDPE pipe joints shall be joined by thermal butt fusion per manufacturer's procedures and instructions. Extrusion welding or hot gas welding of HDPE is prohibited.

B. Installers shall be pre-qualified through sufficient training in butt fusion techniques according to ASTM F2620, Section 8 (Procedure 2).

C. A data logger shall be used to record time, pressure, and temperature for all heat fusion welds made for HDPE pipe joints and fittings.

D. HDPE pipe shall interface with other piping systems and equipment by means of HDPE flange adapters and coated metal back-up rings.

E. Sections of pipe having been discovered with cuts or gouges in excess of 10% of the pipe wall thickness shall be cut out and removed. The undamaged portions of the pipe shall be rejoined using the heat fusion joining method.

F. Fabricate and install all piping shown on the construction drawings, according to ASME B31.1, manufacturer's recommended procedures, and this specification. The piping shall be field located as indicated on the piping plan. The piping may be offset, lowered, or raised as required to avoid existing interferences.

G. All piping shall be erected to ensure proper draining capability. Localized low or high points without vents and drains shall not be accepted. Continuous slope shall be maintained on all gravity lines. If low points cannot be avoided on pressurized lines, a 1" ball valve with a threaded plug in the outlet shall be provided at the low point.

H. Flanges or unions for pipe 1 ½" or larger shall be provided at connections to all equipment. The connections shall be made without strain at the pipe connections.

I. Route pipe in an orderly manner, maintain gradient, and group pipes at common elevations whenever practical. Route pipe parallel and perpendicular to walls. Maintain headroom and neither interfere with use of space or take more space than necessary. Piping intended to be straight shall be straight. Deflections or deviations from a straight line or grade shall be accomplished by the use of approved fittings.

J. Do not install underground piping when the bedding is wet or frozen.

K. Verify that excavations are to the required grade and depth.

L. Trenching, backfill, and compaction for underground pipe shall be in accordance with Section 31 23 33, "Trenching and Backfill."

M. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Observe manufacturer's recommendations for installation of plastic pipe. Contractor is responsible for consulting with the manufacturer for thermal expansion design of the double contained piping system.

N. All piping shall be arranged so as not to interfere with the removal or maintenance of adjacent equipment, valves, or other devices. Piping shall not block access to manholes, access covers, etc.

O. Valves shall be installed at the locations shown on the construction drawings and placed to permit easy operation and access. Valves shall be installed upright where possible. All valves will be installed with their stems horizontal or above.

3.03 CONNECTIONS TO EXISTING PIPING:

A. Furnish all labor and material to complete connections to existing piping as indicated on the Contract Drawings.

B. Provide labor as required to complete these connecitons.

C. Field verify location of existing piping prior to fabrication of connecting pipe.

D. Connections to existing pipe in which no connection is provided shall be supplied by this Contract.

3.04 TEMPORARY PLUGS:

A. Close open ends of pipe with temporary plugs or caps when pipe installation is not in progress. Use watertight plugs for exterior, buried piping and if water or debris is in trench when work is resumed, do not remove until adequate provision has been made to prevent any water or debris entering pipe even if it necessitates dewatering trench.

3.05 PHYSICAL CHECKOUT, FIELD AND FUNCTIONAL TESTING:

A. Clean dirt, dust, oil, grease and other foreign material, before pressure and leakage tests.

B. Water for testing provided by the Contractor.

C. Pressure and Leakage Tests:

1. Test all piping systems in accordance with the requirements of pargraph 137 of ASME B31.1.

2. Furnish all necessary equipment and Materials required for testing including pumps, calibrated test gauges, temporary blank-off plates, special fittings, relief valves, temporary piping systems, gaskets, supports, anchors, and bracing materials required to conduct tests.

3. Provide temporary water supplies for filling and testing and provide temporary drain lines and hoses for disposal of water without flooding.

4. Protect plant equipment and materials from damage resulting from leaks in piping systems during testing.

5. Notify plant personnel when existing valves need to be operated.

6. Notify Engineer and proper authorities when systems are ready to test.

7. Perform hydrostatic tests in accordance with the requirements of ASME B31.1.

8. Hydrostatic test pressure at every point in the system shall be at least 1.5 times the system design pressure.

9. The temperature of the test media shall be at least 70 °F. Provide temporary heating equipment required.

10. Test pipelines in sections of acceptable length.

11. Fill section of pipe with water and expel air.

12. Pressure and leakage test consists of first raising pressure (based on elevation of lowest point of section under test and corrected to gage location) to pressure in psi numerically equal to test pressures indicated in the Process Pipe Schedule.

13. No visible leakage in joint is acceptable.

14. If unable to achieve and maintain specified pressure for one hour with no additional pumping, section has failed to pass test.

15. Clean fluid from leaks off equipment immediately after contact.

16. If section fails pressure and/or leakage test, locate, uncover, and repair or replace defective pipe, fitting, or joint, and conduct additional tests and repairs until section passes test at no additional cost and without any time extensions.

17. Drain all lines after hydrostatic tests.

D. Initial Service Leak Tests:

1. Perform Initial Service Test in accordance with the requirements of ASME B31.1.

2. Test Valves in the system for tightness and proper action.

3. Perform initial service test on all piping systems not specified to be hydrostatically tested.

E. Make piping connections to equipment with pipe in a free supported state and without application of vertical or horizontal forces to align piping with the equipment flanges.

F. Do not cover joints in underground piping with backfill material until piping has successfully passed pressure test.

G. Test pressures as indicated in Process Pipe Schedule.

H. Repair faulty joints even to extent of disassembling and remaking joint, remove defective pipe and fittings and replace in manner satisfactory to the Owner.

3.06 CONTRACT CLOSEOUT:

A. Provide in accordance with Section 01 77 00.

END OF SECTION

TEMP LIMIT:	33°F to 125°F		MATERIAL:	HDPE
CORROSION ALLOWANCE:	0.00”			
RATING CLASS	N/A		DESIGN CODE:	ASME B31.1

PIPING MATERIAL SPECIFICATION

00PDH02

TEMP LIMIT:	33°F to 125°F		MATERIAL:	HDPE
CORROSION ALLOWANCE:	0.00"			
RATING CLASS	N/A		DESIGN CODE:	ASME B31.1

1.0 Pipe:

First Size (NPS)	Second Size (NPS)	SCH/Press Rtg	End Prep	Description	Commodity Option	Notes
0.75 – 36		DR 9	PE (ASTM D3035)	Pipe, PE, HDPE, ASTM D3350 Cell CL of 445474C (PE4710), DR 9 per ASTM D3 035	Default	

2.0 Fittings:

First Size (NPS)	Second Size (NPS)	SCH/Press Rtg	End Prep	Description	Commodity Option	Notes
2.1	*45 Degree Elbow*					
0.75 – 8		DR 9	PE (ASTM D3261)	45 Degree Elbow, PE, HDPE, ASTM D3350 Cell CL of 445474C (PE4710), Molded per ASTM D3261, DR 9 per ASTMD3035	Default	1
2.2	*45 Deg N-Cut Mitered Elbos*					
2 – 8		EDR 9	PE (ASTM F2206)	45 Degree LR Elbow, PE, HDPE, ASTM D3350 Cell CL of 445474C (PE4710)	Fabricated	1, 4
10 – 36		EDR 9	PE (ASTM F2206)	45 Degree LR Elbow, PE, HDPE, ASTM D3350 Cell CL of 445474C (PE4710)	Default	1, 4
2.3	*90 Degree Elbow*					
0.75 – 8		DR 9	PE (ASTM D3261)	90 Degree Elbow, PE, HDPE, ASTM D3350 Cell CL of 445474C (PE4710), Molded per ASTM D3261, DR 9 per ASTM D3035	Default	1, 4
2.4	*90 Degree N-Cut Mitered Elbow*					
2 – 8		EDR 9	PE (ASTM F2206)	90 Degree LR Elbow, PE, HDPE, ASTM D3350 Cell CL of 445474C (PE4710)	Fabricated	1, 4
10 – 36		EDR 9	PE (ASTM F2206)	90 Degree LR Elbow, PE, HDPE, ASTM D3350 Cell CL of 445474C (PE4710)	Default	1, 4
2.5	*Cap*					
0.75 – 8		DR 9	PE (ASTM D3261)	Cap, PE, HDPE, ASTM D3350 Cell CL of 445474C (PE4710), Molded per ASTM D3261, DR 9 per ASTM D3035	Default	1
10 – 36		EDR 9	PE (ASTM F2206)	Cap, PE, HDPE, ASTM D3350 Cell CL of 445474C (PE4710), Fabricated with a Pressure Rating Equal to or Greater than DR 9 per ASTM F2206	Default	1
2.6	*Cross*					
0.75 – 36		EDR 9	PE (ASTM F2206)	Cross, PE, HDPE, ASTM D3350 Cell CL of 445474C (PE4710), Fabricated with a Pressure Rating Equal to or Greater than DR 9 per ASTM F2206	Default	1
2.7	*Lateral*					
0.75 – 36		EDR 9	PE (ASTM F2206)	Lateral, PE, HDPE, ASTM D3350 Cell CL of 445474C (PE4710), Fabricated with a Pressure Rating Equal to or Greater than DR 9 per ASTM F2206	Default	1
2.8	*Lateral – Reducing Lateral*					
1 – 36	0.75 – 34	EDR 9	PE (ASTM F2206)	Reducing Lateral, PE, HDPE, ASTM D3350 Cell CL of 445474C (PE4710), Fabricated with a Pressure Rating Equal to or Greater than DR 9 per ASTM F2206	Default	1
2.9	*Reducer - Concentric Reducer*					
1 – 8	0.75 – 6	DR 9	PE (ASTM D3261)	Concentric Reducer, PE, HDPE, ASTM D3350 Cell CL of 445474C (PE4710), Molded per ASTM D3261,DR 9 per ASTM D3035	Default	1
10 – 36	8 – 34	EDR 9	PE (ASTM F2206)	Concentric Reducer, PE, HDPE, ASTM D3350 Cell CL of 445474C (PE4710), Fabricated with a Pressure Rating Equal to or Greater than DR 9 per ASTM F2206.	Default	1
2.10	*Reducer – Eccentric Reducer*					
1 – 36	0.75 – 34	EDR 9	PE (ASTM F2206)	Eccentric Reducer, PE, HDPE, ASTM D3350 Cell CL of 445474C (PE4710), Fabricated with a Pressure Rating Equal to or Greater than DR 9 per ASTM F2206.	Default	1
2.11	*Tee*					
0.75 – 8		DR 9	PE (ASTM D3261)	Tee, PE, HDPE, ASTM D3350 Cell CL of 445474C (PE4710), Molded per ASTM D3261, DR 9 per ASTM D3035	Default	1
10 – 36		EDR 9	PE (ASTM F2206)	Tee, PE, HDPE, ASTM D3350 Cell CL of 445474C (PE4710), Fabricated with a Pressure Rating Equal to or Greater than DR 9 per ASTM F2206	Default	1
2.12	*Tee – Reducing Tee*					
1 – 36	0.75 – 34	EDR 9	PE (ASTM F2206)	Reducing Tee, PE, HDPE, ASTM D3350 Cell CL of 445474C (PE4710), Fabricated with a Pressure Rating Equal to or Greater than DR 9 per ASTM F2206	Default	1

TEMP LIMIT:	33°F to 125°F		MATERIAL:	HDPE
CORROSION ALLOWANCE:	0.00"			
RATING CLASS	N/A		DESIGN CODE:	ASME B31.1

3.0 Flanges:

First Size (NPS)	Second Size (NPS)	SCH/Press Rtg	End Prep	Description	Commodity Option	Notes
4.1	*Blind Flanges*					
2 – 24		CL150	FFFE	Blind Flange, CL150, FFFE, A105, ASME B16.5	Default	
26 – 36		CL150	FFFE	Blind Flange, CL150, FFFE, A105, ASME B16.47	Default	
4.2	*Flange*					
2 – 36			FFLFE x Loose flange, lap joint (ASTM D3261)	Flange Adapter, PE, HDPE, ASTM D3350 Cell CL of 445474C (PE4710), Molded per ASTM D3261, with Ductile Iron Convoluted Backup Ring drilled to ASME B16.5, CL150, Pressure rating equal to or greater than the piping	Default	2

4.0 Gaskets:

First Size (NPS)	Second Size (NPS)	SCH/Press Rtg	End Prep	Description	Commodity Option	Notes
2 – 10		150 psig	FFFE	Gasket, CL150, Garlock 3760 or Engineer Approved Equal, 1/16" thick	Default	3
2 – 10		150 psig / CL150	FFFE / FFLFE	Gasket, CL150, Garlock 3760 or Engineer Approved Equal, 1/16" thick	Default	3
2 – 10		200 psig	FFFE	Gasket, CL150, Garlock 3760 or Engineer Approved Equal, 1/16" thick	Default	3
2 – 10		200 psig / CL150	FFFE / FFLFE	Gasket, CL150, Garlock 3760 or Engineer Approved Equal, 1/16" thick	Default	3
2 – 10		CL150	FFLFE	Gasket, CL150, Garlock 3760 or Engineer Approved Equal, 1/16" thick	Default	3
2 – 10		CL150	FFFE / FFLFE	Gasket, CL150, Garlock 3760 or Engineer Approved Equal, 1/16" thick	Default	3
2 – 10		CL150B	FFTBE	Gasket, CL150, Garlock 3760 or Engineer Approved Equal, 1/16" thick	Default	3
2 – 10		CL150B / CL150	FFTBE / FFLFE	Gasket, CL150, Garlock 3760 or Engineer Approved Equal, 1/16" thick	Default	3
12 – 36		150 psig	FFFE	Gasket, CL150, Garlock 3760 or Engineer Approved Equal, 1/16" thick	Default	3
12 – 36		150 psig / CL150	FFFE / FFLFE	Gasket, CL150, Garlock 3760 or Engineer Approved Equal, 1/16" thick	Default	3
12 – 36		200 psig	FFFE	Gasket, CL150, Garlock 3760 or Engineer Approved Equal, 1/16" thick	Default	3
12 – 36		200 psig / CL150	FFFE / FFLFE	Gasket, CL150, Garlock 3760 or Engineer Approved Equal, 1/16" thick	Default	3
12 – 36		CL150	FFFE / FFLFE	Gasket, CL150, Garlock 3760 or Engineer Approved Equal, 1/16" thick	Default	3
12 – 36		CL150	FFLFE	Gasket, CL150, Garlock 3760 or Engineer Approved Equal, 1/16" thick	Default	3
12 – 36		CL150B	FFTBE	Gasket, CL150, Garlock 3760 or Engineer Approved Equal, 1/16" thick	Default	3
12 – 36		CL150B / CL150	FFTBE / FFLFE	Gasket, CL150, Garlock 3760 or Engineer Approved Equal, 1/16" thick	Default	3

5.0 Bolting:

First Size (NPS)	Second Size (NPS)	SCH/Press Rtg	End Prep	Description	Commodity Option	Notes
2 – 36		200 psig	FFFE	ASTM A307 Grade B, carbon steel stud-bolts threaded the entire length for FFFE Joint with 2 ASTM A563-A Heavy Nuts	Default	
2 – 36		CL150B / CL150	FFTBE / FFLFE	ASTM A307 Grade B, carbon steel stud-bolts threaded the entire length for FFFE Joint with 2 ASTM A563-A Heavy Nuts	Default	
2 – 36		CL150B	FFTBE	ASTM A307 Grade B, carbon steel stud-bolts threaded the entire length for FFFE Joint with 2 ASTM A563-A Heavy Nuts	Default	
2 – 36		150 psig / CL150	FFFE / FFLFE	ASTM A307 Grade B, carbon steel stud-bolts threaded the entire length for FFFE Joint with 2 ASTM A563-A Heavy Nuts	Default	
2 – 36		150 psig	FFFE	ASTM A307 Grade B, carbon steel stud-bolts threaded the entire length for FFFE Joint with 2 ASTM A563-A Heavy Nuts	Default	
2 – 36		200 psig / CL150	FFFE / FFLFE	ASTM A307 Grade B, carbon steel stud-bolts threaded the entire length for FFFE Joint with 2 ASTM A563-A Heavy Nuts	Default	
2 – 36		CL150	FFLFE	ASTM A307 Grade B, carbon steel stud-bolts threaded the entire length for FFFE Joint with 2 ASTM A563-A Heavy Nuts	Default	
2 – 36		CL150	FFFE / FFLFE	ASTM A307 Grade B, carbon steel stud-bolts threaded the entire length for FFFE Joint with 2 ASTM A563-A Heavy Nuts	Default	

TEMP LIMIT:	33°F to 125°F		MATERIAL:	HDPE
CORROSION ALLOWANCE:	0.00”			
RATING CLASS	N/A		DESIGN CODE:	ASME B31.1

6.0 Branch Table:

90 Degree Branch Connection Table

BRANCH	HEADER																					
	36	34	32	30	28	26	24	22	20	18	16	14	12	10	8	6	4	3	2	1 ½	1	¾
36	T																					
34	E	T																				
32	E	E	T																			
30	E	E	E	T																		
28	E	E	E	E	T																	
26	E	E	E	E	E	T																
24	E	E	E	E	E	E	T															
22	E	E	E	E	E	E	E	T														
20	E	E	E	E	E	E	E	E	T													
18	E	E	E	E	E	E	E	E	E	T												
16	E	E	E	E	E	E	E	E	E	E	T											
14	E	E	E	E	E	E	E	E	E	E	E	T										
12	E	E	E	E	E	E	E	E	E	E	E	E	T									
10	E	E	E	E	E	E	E	E	E	E	E	E	E	T								
8	E	E	E	E	E	E	E	E	E	E	E	E	E	E	T							
6	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	T						
4	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	T					
3	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	T				
2	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	T			
1 ½	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	T		
1	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	T	
¾	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	T

45 Degree Branch Connection Table

BRANCH	HEADER																					
	36	34	32	30	28	26	24	22	20	18	16	14	12	10	8	6	4	3	2	1 ½	1	¾
36	L																					
34	L	L																				
32	L	L	L																			
30	L	L	L	L																		
28	L	L	L	L	L																	
26	L	L	L	L	L	L																
24	L	L	L	L	L	L	L															
22	L	L	L	L	L	L	L	L														
20	L	L	L	L	L	L	L	L	L													
18	L	L	L	L	L	L	L	L	L	L												
16	L	L	L	L	L	L	L	L	L	L	L											
14	L	L	L	L	L	L	L	L	L	L	L	L										
12	L	L	L	L	L	L	L	L	L	L	L	L	L									
10	L	L	L	L	L	L	L	L	L	L	L	L	L	L								
8	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L							
6	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L						
4	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L					
3	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L				
2	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L			
1 ½	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L		
1	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	
¾	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L

TEMP LIMIT:	33°F to 125°F		MATERIAL:	HDPE
CORROSION ALLOWANCE:	0.00”			
RATING CLASS	N/A		DESIGN CODE:	ASME B31.1

7.0Notes:

1) Component shall have a pressure rating equal to or greater than DR 9 per ASTM D3035
2) When joining an adapter to a flanged butterfly valve, the inside diameter of the pipe flange shall be checked for valve disk rotation clearance
3) The gasket manufacturer shall be consulted to ensure the selected gasket can sustain the bolt load on the flange approval
4) IPS 2 to IPS 8 fabricated fittings shall be used to ensure sufficient radius on gravity drain systems which require cleanouts

8.0Legend:

E	Reducing Tee
FFLFE	Flat-Faced Lap-Flanged End
FFTBE	Flat-face thru-bolted End Without Bolt Holes
L	Lateral
PE	Plain End
T	Tee

TEMP LIMIT:	33°F to 125°F		MATERIAL:	HDPE
CORROSION ALLOWANCE:	0.00”			
RATING CLASS	N/A		DESIGN CODE:	ASME B31.1

PIPING MATERIAL SPECIFICATION

00PDH03

TEMP LIMIT:	33°F to 125°F		MATERIAL:	HDPE
CORROSION ALLOWANCE:	0.00"			
RATING CLASS	N/A		DESIGN CODE:	ASME B31.1

1.0 Pipe:

First Size (NPS)	Second Size (NPS)	SCH/Press Rtg	End Prep	Description	Commodity Option	Notes
0.75 – 36		DR 7.3	PE (ASTM D3035)	Pipe, PE, HDPE, ASTM D3350 Cell CL of 445474C (PE4710), DR 7.3 per ASTM D3035	Default	

2.0 Fittings:

First Size (NPS)	Second Size (NPS)	SCH/Press Rtg	End Prep	Description	Commodity Option	Notes
2.1	*45 Degree Elbow*					
0.75 – 8		DR 7.3	PE (ASTM D3261)	45 Degree Elbow, PE, HDPE, ASTM D3350 Cell CL of 445474C (PE4710), Molded per ASTM D3261, DR 7.3 per ASTMD3035	Default	1
2.2	*45 Deg N-Cut Mitered Elbos*					
2 – 8		EDR 7.3	PE (ASTM F2206)	45 Degree LR Elbow, PE, HDPE, ASTM D3350 Cell CL of 445474C (PE4710)	Fabricated	1, 4
10 – 36		EDR 7.3	PE (ASTM F2206)	45 Degree LR Elbow, PE, HDPE, ASTM D3350 Cell CL of 445474C (PE4710)	Default	1, 4
2.3	*90 Degree Elbow*					
0.75 – 8		DR 7.3	PE (ASTM D3261)	90 Degree Elbow, PE, HDPE, ASTM D3350 Cell CL of 445474C (PE4710), Molded per ASTM D3261, DR 7.3 per ASTM D3035	Default	1, 4
2.4	*90 Degree N-Cut Mitered Elbow*					
2 – 8		EDR 7.3	PE (ASTM F2206)	90 Degree LR Elbow, PE, HDPE, ASTM D3350 Cell CL of 445474C (PE4710)	Fabricated	1, 4
10 – 36		EDR 7.3	PE (ASTM F2206)	90 Degree LR Elbow, PE, HDPE, ASTM D3350 Cell CL of 445474C (PE4710)	Default	1, 4
2.5	*Cap*					
0.75 – 8		DR 7.3	PE (ASTM D3261)	Cap, PE, HDPE, ASTM D3350 Cell CL of 445474C (PE4710), Molded per ASTM D3261, DR 7.3 per ASTM D3035	Default	1
10 – 36		EDR 7.3	PE (ASTM F2206)	Cap, PE, HDPE, ASTM D3350 Cell CL of 445474C (PE4710), Fabricated with a Pressure Rating Equal to or Greater than DR 7.3 per ASTM F2206	Default	1
2.6	*Cross*					
0.75 – 36		EDR 7.3	PE (ASTM F2206)	Cross, PE, HDPE, ASTM D3350 Cell CL of 445474C (PE4710), Fabricated with a Pressure Rating Equal to or Greater than DR 7.3 per ASTM F2206	Default	1
2.7	*Lateral*					
0.75 – 36		EDR 7.3	PE (ASTM F2206)	Lateral, PE, HDPE, ASTM D3350 Cell CL of 445474C (PE4710), Fabricated with a Pressure Rating Equal to or Greater than DR 7.3 per ASTM F2206	Default	1
2.8	*Lateral – Reducing Lateral*					
1 – 36	0.75 – 34	EDR 7.3	PE (ASTM F2206)	Reducing Lateral, PE, HDPE, ASTM D3350 Cell CL of 445474C (PE4710), Fabricated with a Pressure Rating Equal to or Greater than DR 7.3 per ASTM F2206	Default	1
2.9	*Reducer - Concentric Reducer*					
1 – 8	0.75 – 6	DR 7.3	PE (ASTM D3261)	Concentric Reducer, PE, HDPE, ASTM D3350 Cell CL of 445474C (PE4710), Molded per ASTM D3261,DR 7.3 per ASTM D3035	Default	1
10 – 36	8 – 34	EDR 7.3	PE (ASTM F2206)	Concentric Reducer, PE, HDPE, ASTM D3350 Cell CL of 445474C (PE4710), Fabricated with a Pressure Rating Equal to or Greater than DR 7.3 per ASTM F2206.	Default	1
2.10	*Reducer – Eccentric Reducer*					
1 – 36	0.75 – 34	EDR 7.3	PE (ASTM F2206)	Eccentric Reducer, PE, HDPE, ASTM D3350 Cell CL of 445474C (PE4710), Fabricated with a Pressure Rating Equal to or Greater than DR 7.3 per ASTM F2206.	Default	1
2.11	*Tee*					
0.75 – 8		DR 7.3	PE (ASTM D3261)	Tee, PE, HDPE, ASTM D3350 Cell CL of 445474C (PE4710), Molded per ASTM D3261, DR 7.3 per ASTM D3035	Default	1
10 – 36		EDR 7.3	PE (ASTM F2206)	Tee, PE, HDPE, ASTM D3350 Cell CL of 445474C (PE4710), Fabricated with a Pressure Rating Equal to or Greater than DR 7.3 per ASTM F2206	Default	1
2.12	*Tee – Reducing Tee*					
1 – 36	0.75 – 34	EDR 7.3	PE (ASTM F2206)	Reducing Tee, PE, HDPE, ASTM D3350 Cell CL of 445474C (PE4710), Fabricated with a Pressure Rating Equal to or Greater than DR 7.3 per ASTM F2206	Default	1

TEMP LIMIT:	33°F to 125°F			MATERIAL:	HDPE
CORROSION ALLOWANCE:	0.00"				
RATING CLASS	N/A			DESIGN CODE:	ASME B31.1

3.0 Flanges:

First Size (NPS)	Second Size (NPS)	SCH/Press Rtg	End Prep	Description	Commodity Option	Notes
4.1	*Blind Flanges*					
2 – 24		CL150	FFFE	Blind Flange, CL150, FFFE, A105, ASME B16.5	Default	
26 – 36		CL150	FFFE	Blind Flange, CL150, FFFE, A105, ASME B16.47	Default	
4.2	*Flange*					
2 - 36			FFLFE x Loose flange, lap joint (ASTM D3261)	Flange Adapter, PE, HDPE, ASTM D3350 Cell CL of 445474C (PE4710), Molded per ASTM D3261, with Ductile Iron Convoluted Backup Ring drilled to ASME B16.5, CL150, Pressure rating equal to or greater than the piping	Default	2

4.0 Gaskets:

First Size (NPS)	Second Size (NPS)	SCH/Press Rtg	End Prep	Description	Commodity Option	Notes
2 – 10		150 psig	FFFE	Gasket, CL150, Garlock 3760 or Engineer Approved Equal, 1/16" thick	Default	3
2 – 10		150 psig / CL150	FFFE / FFLFE	Gasket, CL150, Garlock 3760 or Engineer Approved Equal, 1/16" thick	Default	3
2 – 10		220 psig	FFFE	Gasket, CL150, Garlock 3760 or Engineer Approved Equal, 1/16" thick	Default	3
2 – 10		220 psig / CL150	FFFE / FFLFE	Gasket, CL150, Garlock 3760 or Engineer Approved Equal, 1/16" thick	Default	3
2 – 10		CL150	FFLFE	Gasket, CL150, Garlock 3760 or Engineer Approved Equal, 1/16" thick	Default	3
2 – 10		CL150	FFFE / FFLFE	Gasket, CL150, Garlock 3760 or Engineer Approved Equal, 1/16" thick	Default	3
2 – 10		CL150B	FFTBE	Gasket, CL150, Garlock 3760 or Engineer Approved Equal, 1/16" thick	Default	3
2 – 10		CL150B / CL150	FFTBE / FFLFE	Gasket, CL150, Garlock 3760 or Engineer Approved Equal, 1/16" thick	Default	3
12 – 36		150 psig	FFFE	Gasket, CL150, Garlock 3760 or Engineer Approved Equal, 1/16" thick	Default	3
12 – 36		150 psig / CL150	FFFE / FFLFE	Gasket, CL150, Garlock 3760 or Engineer Approved Equal, 1/16" thick	Default	3
12 – 36		220 psig	FFFE	Gasket, CL150, Garlock 3760 or Engineer Approved Equal, 1/16" thick	Default	3
12 – 36		220 psig / CL150	FFFE / FFLFE	Gasket, CL150, Garlock 3760 or Engineer Approved Equal, 1/16" thick	Default	3
12 – 36		CL150	FFFE / FFLFE	Gasket, CL150, Garlock 3760 or Engineer Approved Equal, 1/16" thick	Default	3
12 – 36		CL150	FFLFE	Gasket, CL150, Garlock 3760 or Engineer Approved Equal, 1/16" thick	Default	3
12 – 36		CL150B	FFTBE	Gasket, CL150, Garlock 3760 or Engineer Approved Equal, 1/16" thick	Default	3
12 – 36		CL150B / CL150	FFTBE / FFLFE	Gasket, CL150, Garlock 3760 or Engineer Approved Equal, 1/16" thick	Default	3

5.0 Bolting:

First Size (NPS)	Second Size (NPS)	SCH/Press Rtg	End Prep	Description	Commodity Option	Notes
2 – 36		220 psig	FFFE	ASTM A307 Grade B, carbon steel stud-bolts threaded the entire length for FFFE Joint with 2 ASTM A563-A Heavy Nuts	Default	
2 – 36		CL150B / CL150	FFTBE / FFLFE	ASTM A307 Grade B, carbon steel stud-bolts threaded the entire length for FFFE Joint with 2 ASTM A563-A Heavy Nuts	Default	
2 – 36		CL150B	FFTBE	ASTM A307 Grade B, carbon steel stud-bolts threaded the entire length for FFFE Joint with 2 ASTM A563-A Heavy Nuts	Default	
2 – 36		150 psig / CL150	FFFE / FFLFE	ASTM A307 Grade B, carbon steel stud-bolts threaded the entire length for FFFE Joint with 2 ASTM A563-A Heavy Nuts	Default	
2 – 36		150 psig	FFFE	ASTM A307 Grade B, carbon steel stud-bolts threaded the entire length for FFFE Joint with 2 ASTM A563-A Heavy Nuts	Default	
2 – 36		220 psig / CL150	FFFE / FFLFE	ASTM A307 Grade B, carbon steel stud-bolts threaded the entire length for FFFE Joint with 2 ASTM A563-A Heavy Nuts	Default	
2 – 36		CL150	FFLFE	ASTM A307 Grade B, carbon steel stud-bolts threaded the entire length for FFFE Joint with 2 ASTM A563-A Heavy Nuts	Default	
2 – 36		CL150	FFFE / FFLFE	ASTM A307 Grade B, carbon steel stud-bolts threaded the entire length for FFFE Joint with 2 ASTM A563-A Heavy Nuts	Default	

TEMP LIMIT:	33°F to 125°F		MATERIAL:	HDPE
CORROSION ALLOWANCE:	0.00”			
RATING CLASS	N/A		DESIGN CODE:	ASME B31.1

6.0 Branch Table:

90 Degree Branch Connection Table

BRANCH	HEADER																					
	36	34	32	30	28	26	24	22	20	18	16	14	12	10	8	6	4	3	2	1 ½	1	¾
36	T																					
34	E	T																				
32	E	E	T																			
30	E	E	E	T																		
28	E	E	E	E	T																	
26	E	E	E	E	E	T																
24	E	E	E	E	E	E	T															
22	E	E	E	E	E	E	E	T														
20	E	E	E	E	E	E	E	E	T													
18	E	E	E	E	E	E	E	E	E	T												
16	E	E	E	E	E	E	E	E	E	E	T											
14	E	E	E	E	E	E	E	E	E	E	E	T										
12	E	E	E	E	E	E	E	E	E	E	E	E	T									
10	E	E	E	E	E	E	E	E	E	E	E	E	E	T								
8	E	E	E	E	E	E	E	E	E	E	E	E	E	E	T							
6	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	T						
4	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	T					
3	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	T				
2	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	T			
1 ½	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	T		
1	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	T	
¾	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	T

45 Degree Branch Connection Table

BRANCH	HEADER																					
	36	34	32	30	28	26	24	22	20	18	16	14	12	10	8	6	4	3	2	1 ½	1	¾
36	L																					
34	L	L																				
32	L	L	L																			
30	L	L	L	L																		
28	L	L	L	L	L																	
26	L	L	L	L	L	L																
24	L	L	L	L	L	L	L															
22	L	L	L	L	L	L	L	L														
20	L	L	L	L	L	L	L	L	L													
18	L	L	L	L	L	L	L	L	L	L												
16	L	L	L	L	L	L	L	L	L	L	L											
14	L	L	L	L	L	L	L	L	L	L	L	L										
12	L	L	L	L	L	L	L	L	L	L	L	L	L									
10	L	L	L	L	L	L	L	L	L	L	L	L	L	L								
8	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L							
6	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L						
4	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L					
3	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L				
2	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L			
1 ½	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L		
1	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	
¾	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L

TEMP LIMIT:	33°F to 125°F		MATERIAL:	HDPE
CORROSION ALLOWANCE:	0.00”			
RATING CLASS	N/A		DESIGN CODE:	ASME B31.1

7.0Notes:

1) Component shall have a pressure rating equal to or greater than DR 9 per ASTM D3035
2) When joining an adapter to a flanged butterfly valve, the inside diameter of the pipe flange shall be checked for valve disk rotation clearance
3) The gasket manufacturer shall be consulted to ensure the selected gasket can sustain the bolt load on the flange approval
4) IPS 2 to IPS 8 fabricated fittings shall be used to ensure sufficient radius on gravity drain systems which require cleanouts

8.0Legend:

E	Reducing Tee
FFLFE	Flat-Faced Lap-Flanged End
FFTBE	Flat-face thru-bolted End Without Bolt Holes
L	Lateral
PE	Plain End
T	Tee

TEMP LIMIT:	-20°F to 400°F		MATERIAL:	Stainless Steel
CORROSION ALLOWANCE:	0.00”			
RATING CLASS	150, ASME B16.5		DESIGN CODE:	ASME B31.1

PIPING MATERIAL SPECIFICATION

01SAS02

TEMP LIMIT:	-20°F to 400°F		MATERIAL:	Stainless Steel
CORROSION ALLOWANCE:	0.00"			
RATING CLASS	150, ASME B16.5		DESIGN CODE:	ASME B31.1

1.0 Pipe:

First Size (NPS)	Second Size (NPS)	SCH/Press Rtg	End Prep	Description	Commodity Option	Notes
0.5 – 2		40S	PE	Pipe, S-480, PE, SMLS, ASTM A312-TP304	Default	
2.5 – 30		10S	BE	Pipe, S-10S, BE, Welded, ASTM A312-TP304	Default	

2.0 Nipples:

First Size (NPS)	Second Size (NPS)	SCH/Press Rtg	End Prep	Description	Commodity Option	Notes
0.5 – 2		40S	PE	Nipple, S-40S, PE, 3" Long, SMLS, ASTM A312-TP304	Default	
0.5 – 2		40S	PE	Nipple, S-40S, PE, 4" Long, SMLS, ASTM A312-TP304	4" PE	
0.5 – 2		40S	PE	Nipple, S-40S, PE, 6" Long, SMLS, ASTM A312-TP304	6" PE	

3.0 Fittings:

First Size (NPS)	Second Size (NPS)	SCH/Press Rtg	End Prep	Description	Commodity Option	Notes
3.1	*45 Degree Elbow*					
0.5 – 2		CL3000	SWE	45 Degree Elbow, CL3000, SWE, ASTM A182-F304, ASME B16.11	Default	
3.2	*45 Degree LR Elbow*					
2.5 – 20		10S	BE	45 Degree LR Elbow, S-10S, BE, ASTM A403-WP304, ASME B16.9	Default	
3.3	*90 Degree Elbow*					
0.5 – 2		CL3000	SWE	90 Degree Elbow, CL3000, SWE, ASTM A182-F304, ASME B16.11	Default	
3.4	*90 Degree LR Elbow*					
2.5 – 20		10S	BE	90 Degree LR Elbow, S-10S, BE, ASTM A403-WP304, ASME B16.9	Default	
3.5	*90 Degree Reducing Elbow*					
3 – 20	2.5 – 18	10S	BE	Reducing 90 Degree LR Elbow, S-10S, BE, ASTM A403-WP304, ASME B16.9	Default	
3.6	*90 Degree SR Elbow*					
2.5 – 20		10S	BE	90 Degree SR Elbow, S-10S, BE, ASTM A403-WP304, ASME B16.9	Default	
3.7	*Cap*					
0.5 – 2		CL3000	SWE	Cap, CL3000, SWE, ASTM A105, ASME B16.11	Default	
2.5 – 20		STD	BE	Cap, S-STD, BE, ASTM A403-WP304, ASME B16.9	Default	
3.8	*Coupling*					
0.5 – 2		CL3000	SWE	Coupling, CL3000, SWE, ASTM A182-F304, ASME B16.11	Default	
3.9	*Coupling – Reducing Coupling*					
0.5 – 2		CL3000	SWE	Reducing Coupling, CL3000, SWE, ASTM A182, ASME B16.11	Default	
3.10	*Elbolet*					
2.5 – 20	0.5 – 2	CL3000	SWE	Elbolet, CL3000, SWE, ASTM A182-F304	Default	1
3.11	*Flatolet*					
2.5 – 20	0.5 – 2	CL3000	IRE x SWE	Flatolet, CL3000, IRE x SWE, ASTM A182-F304	Default	1
3.12	*Latrolet*					
2.5 – 20	0.5 – 2	CL3000	IRE x SWE	Latrolet, CL3000, IRE x SWE, ASTM A182-F304, MSS SP-97	Default	1
3.13	*Reducer - Concentric Swage*					
3 – 20	2.5 – 8	10S	BE	Reducer, S-10S, BE, ASTM A403-WP304, ASME B16.9	Default	
3.14	*Reducer – Concentric Swage*					
0.75 – 2	0.5 – 1.5	40S	PE	Concentric Swage, S-40S, PE, ASTM A403-WP304, ASME B16.9, MSS SP-95	Default	
2.5 – 4	0.5 – 2	10S x 40S	BE x PE	Concentric Swage, S-10S x S-40S, BE x PE, ASTM A403-WP304, ASME B16.9, MSS SP-95	Default	
3.15	*Reducer – Eccentric Reducer*					
3 – 20	2.5 – 8	10S	BE	Eccentric Reducer, S-10S, BE, ASTM A403-CF8M, ASME B16.9	Default	
3.17	*Sockolet*					
0.5 – 2		CL3000	IRE x SWE	Sockolet, CL3000, SWE, ASTM A182-F304, MSS SP-97	Default	1
3.18	*Tee*					
0.5 – 2		CL3000	SWE	Tee, CL3000, SWE, ASTM A182-F304, ASME B16.11	Default	
2.5 – 20		10S	BE	Tee, S-10S, BE, ASTM A403-WP304, ASME B16.9	Default	
3.19	*Tee – Reducing Tee*					
0.75 – 2	0.5 – 1.5	CL3000	SWE	Reducing Tee, CL3000, SWE, ASTM A182-F304, ASME B16.11	Default	
3 – 20	2.5 – 28	10S	BE	Reducing Tee, S-10S, BE, ASTM A403-WP304, ASME B16.9	Default	

TEMP LIMIT:	-20°F to 400°F		MATERIAL:	Stainless Steel	
CORROSION ALLOWANCE:	0.00"				
RATING CLASS	150, ASME B16.5		DESIGN CODE:	ASME B31.1	

3.20	*Thredolet*					
2.5 – 20	0.5 – 2	CL3000	IRE x FTE	Threadolet, CL3000, IRE x FTE, ASTM A182-F304, MSS SP-97	Default	1
3.21	*Weldolet*					
3 – 20	2.5 – 18	10S	IBE x BE	Weldolet, 10S, IRE x BE, ASTM A403-WP304, MSS SP-97	Default	1

4.0 Flanges:

First Size (NPS)	Second Size (NPS)	SCH/Press Rtg	End Prep	Description	Commodity Option	Notes
4.1	*Blind Flanges*					
0.5 – 20		CL150	RFFE	Blind Flange, CL150, RFFE, A182-F304, ASME B16.5	Default	2
0.5 – 20		CL300	RFFE	Blind Flange, CL300, RFFE, ASTM A182-F304, ASME B16.5	CL300	2
4.2	*Flange – Socket Weld*					
0.5 – 2		CL150	RFFE	Flange, SWE, Cl150, FFFE, ASTM A182-F304, ASME B16.5	Default	2
0.5 – 2		CL300	RFFE	Flange, SWE, Cl300, RFFE, ASTM A182-F304, ASME B16.5	CL300	2
4.3	*Flange –Weld Neck*					
2.5 – 20		CL150	RFFE	Flange, WN, CL150, RFFE, ASTM A182-F304, ASME B16.5	Default	2
2.5 – 20		CL150	FFFE	Flange, WN, CL150, FFFE, ASTM A182-F304, ASME B16.5	FFFE	2
2.5 – 20		CL300	RFFE	Flange, WN, CL300, RFFE, ASTM A182-F304, ASME B16.5	CL300	2

5.0 Gaskets:

First Size (NPS)	Second Size (NPS)	SCH/Press Rtg	End Prep	Description	Commodity Option	Notes
0.5 – 10		CL150	RFFE	Gasket, Ring Type PTFE, CL150, 1/16" thk, ASME B16.21	Default	
12 – 20		CL150	RFFE	Gasket, Ring Type PTFE, CL150, 1/8" thk, ASME B16.21	Default	
0.5 – 10		CL150	RFTBEHT	Gasket, Ring Type PTFE, CL150, 1/16" thk, ASME B16.21	Default	
12 – 20		CL150	RFTBEHT	Gasket, Ring Type PTFE, CL150, 1/8" thk, ASME B16.21	Default	

6.0 Bolting:

First Size (NPS)	Second Size (NPS)	SCH/Press Rtg	End Prep	Description	Commodity Option	Notes
0.5 – 30		CL150	RFFE	ASTM A193 Grade B7, alloy steel stud-bolts threaded the entire length for RFFE Joint with 2 Heavy Nuts ASTM A194-2H	Default	
0.5 – 30		CL300	FFFE	ASTM A193 Grade B7, alloy steel stud-bolts threaded the entire length for FFFE Joint with 2 Heavy Nuts ASTM A194-2H	Default	
3 – 20		CL150	RFTBEHT	ASTM A193 Grade B7, alloy steel stud-bolts threaded the entire length for RFTBEHT Joint with 2 Heavy Nuts ASTM A194-2H	RFTBEHT	
3 – 20		CL150	FFTBEHT	ASTM A193 Grade B7, alloy steel stud-bolts threaded the entire length for FFTBEHT Joint with 2 Heavy Nuts ASTM A194-2H	Default	

7.0 Branch Table:

90 Degree Branch Connection Table

TEMP LIMIT:	-20°F to 400°F	MATERIAL:	Stainless Steel
CORROSION ALLOWANCE:	0.00”		
RATING CLASS	150, ASME B16.5	DESIGN CODE:	ASME B31.1

20	T															
18	E	T														
16	E	E	T													
14	E	E	E	T												
12	E	E	E	E	T											
10	W	W	E	E	E	T										
8	W	W	W	E	E	E	T									
6	W	W	W	W	E	E	E	T								
4	W	W	W	W	W	W	E	E	T							
3	W	W	W	W	W	W	W	W	E	T						
2 ½	W	W	W	W	W	W	W	W	E	E	T					
2	S	S	S	S	S	S	S	S	S	S	S	T				
1 ½	S	S	S	S	S	S	S	S	S	S	S	E	T			
1	S	S	S	S	S	S	S	S	S	S	S	E	E	T		
¾	S	S	S	S	S	S	S	S	S	S	S	E	E	E	T	
½	S	S	S	S	S	S	S	S	S	S	S	E	E	E	E	T
	20	18	16	14	12	10	8	6	4	3	2 ½	2	1 ½	1	¾	½

HEADER

45 Degree Branch Connection Table

20	--															
18	--	--														
16	--	--	--													
14	--	--	--	--												
12	--	--	--	--	--											
10	--	--	--	--	--	--										
8	--	--	--	--	--	--	--									
6	--	--	--	--	--	--	--	--								
4	--	--	--	--	--	--	--	--	--							
3	--	--	--	--	--	--	--	--	--	--						
2 ½	--	--	--	--	--	--	--	--	--	--	--					
2	LO	LO	LO	LO	LO	LO	LO	LO	LO	LO	LO					
1 ½	LO	LO	LO	LO	LO	LO	LO	LO	LO	LO	LO					
1	LO	LO	LO	LO	LO	LO	LO	LO	LO	LO	LO					
¾	LO	LO	LO	LO	LO	LO	LO	LO	LO	LO	LO					
½	LO	LO	LO	LO	LO	LO	LO	LO	LO	LO	LO					
	20	18	16	14	12	10	8	6	4	3	2 ½	2	1 ½	1	¾	½

HEADER

TEMP LIMIT:	-20°F to 400°F		MATERIAL:	Stainless Steel
CORROSION ALLOWANCE:	0.00"			
RATING CLASS	150, ASME B16.5		DESIGN CODE:	ASME B31.1

8.0Notes:

5) Fitting shall be Bonney Forge®, WOI®, or Engineer approved equal
6) Flanged joints shall not be used above 400°F without Engineer approval
7) Soft Seat Ball valves shall only be used within the pressure-temperature ratings provided by the manufacturer

9.0Legend:

BE	Beveled End
BLE	Beveled Large End
E	Reducing Tee
FFFE	Flat-Faced Flanged End
FTE	Female Threaded end
IRE	Integral Reinforced End
L	Lateral
LO	Latrolet
MTE	Male Threaded End
P	Reinforcing Pad
PE	Plain End
PSE	Plain Small End
RFFE	Raised-Face Flanged End
RFTBE	Raised-Face Thru-Bolted End Without Bolt Holes
RFTBEH	Raised-Face Thru-Bolted End With Non-Threaded Bolt Holes
RFTBEHT	Raised-Face Thru-Bolted End With Threaded Bolt Holes
RL	Reducing Lateral
S	Sockolet
SWE	Socket welded end
T	Tee
TBE	Threaded Both Ends
W	Weldolet

TEMP LIMIT:	-20°F to 400°F		MATERIAL:	Carbon Steel
CORROSION ALLOWANCE:	0.00”			
RATING CLASS	300, ASME B16.5		DESIGN CODE:	ASME B31.1

PIPING MATERIAL SPECIFICATION

01CSS06

TEMP LIMIT:	-20°F to 400°F		MATERIAL:	Carbon Steel
CORROSION ALLOWANCE:	0.00"			
RATING CLASS	300, ASME B16.5		DESIGN CODE:	ASME B31.1

1.0 Pipe:

First Size (NPS)	Second Size (NPS)	SCH/Press Rtg	End Prep	Description	Commodity Option	Notes
0.5 – 2		80	PE	Pipe, S-80, PE, SMLS, ASTM A106-B	Default	
0.5 – 2		80	MTE	Pipe, S-80, MTE, SMLS, ASTM A106-B	MTE	
2.5 – 30		80	BE	Pipe, S-STD, BE, ERW, ASTM A53-B	Default	

2.0 Nipples:

First Size (NPS)	Second Size (NPS)	SCH/Press Rtg	End Prep	Description	Commodity Option	Notes
0.5 – 2		80	PE	Nipple, S-80, PE, 3" Long, SMLS, ASTM A106-B	Default	
0.5 – 2		80	MTE	Nipple, S-80, MTE, 3" Long, SMLS, ASTM A106-B	MTE	
0.5 – 2		80	PE x MTE	Nipple, S-80, PE x MTE, 3" Long, SMLS, ASTM A106-B	PE x MTE	
0.5 – 2		80	PE	Nipple, S-80, PE, 4" Long, SMLS, ASTM A106-B	4" PE	
0.5 – 2		80	MTE	Nipple, S-80, MTE, 4" Long, SMLS, ASTM A106-B	4" MTE	
0.5 – 2		80	PE x MTE	Nipple, S-80, PE x MTE, 4" Long, SMLS, ASTM A106-B	4" PE x MTE	
0.5 – 2		80	PE	Nipple, S-80, PE, 6" Long, SMLS, ASTM A106-B	6" PE	
0.5 – 2		80	MTE	Nipple, S-80, MTE, 6" Long, SMLS, ASTM A106-B	6" MTE	
0.5 – 2		80	PE x MTE	Nipple, S-80, PE x MTE, 6" Long, SMLS, ASTM A106-B	6" PE x MTE	

3.0 Fittings:

First Size (NPS)	Second Size (NPS)	SCH/Press Rtg	End Prep	Description	Commodity Option	Notes
3.1	*45 Degree Elbow*					
0.5 – 2		CL3000	SWE	45 Degree Elbow, CL3000, SWE, ASTM A105, ASME B16.11	Default	
3.2	*45 Degree LR Elbow*					
2.5 – 30		80	BE	45 Degree LR Elbow, S 80, BE, ASTM A234 WPB, ASME B16.9	Default	
3.3	*90 Degree Elbow*					
0.5 – 2		CL3000	SWE	90 Degree Elbow, CL3000, SWE, ASTM A105, ASME B16.11	Default	
3.4	*90 Degree LR Elbow*					
2.5 – 30		80	BE	90 Degree LR Elbow, S 80, BE, ASTM A234 WPB, ASME B16.9	Default	
3.5	*90 Degree Reducing Elbow*					
3 – 30	2.5 – 24	80	BE	Reducing 90 Degree LR Elbow, S-80, BE, ASTM A234-WPB, ASTM B16.9	Default	
3.6	*90 Degree SR Elbow*					
2.5 – 30		80	BE	90 Degree SR Elbow, S 80, BE, ASTM A234 WPB, ASME B16.9	Default	
3.7	*Cap*					
0.5 – 2		CL3000	SWE	Cap, CL3000, SWE, ASTM A105, ASME B16.11	Default	
0.5 – 2		CL2000	FTE	Cap, CL2000, FTE, ASTM A105, ASME B16.11	FTE	
2.5 – 30		80	BE	Cap, S-80, BE, ASTM A234 WPB, ASME B16.9	Default	
3.8	*Coupling*					
0.5 – 2		CL3000	SWE	Coupling, CL3000, SWE, ASTM A105, ASME B16.11	Default	
3.9	*Coupling – Reducing Coupling*					
0.75 – 2	0.5 – 1.5	CL3000	SWE	Reducing Coupling, CL3000, SWE, ASTM A105, ASME B16.11	Default	
3.10	*Elbolet*					
2.5 – 30	0.5 – 2	SPECIAL	IRE x SWE	Elbolet, S-80 x S-80, IRE x SWE, ASTM A105	Default	2
3.11	*Flatolet*					
2.5 – 30	0.5 – 2	SPECIAL	IRE x SWE	Flatolet, S-80 x S-80, IRE x SWE, ASTM A105	Default	2
3.12	*Lateral*					
0.5 – 2		CL3000	SWE	Lateral, CL3000, SWE, ASTM A105	Default	
2.5 – 30		80	BE	Lateral, S-80, BE, ASTM A234 WPB	Default	
3.13	*Lateral – Reducing Lateral*					
0.75 – 2	0.5 – 1.5	CL3000	SWE	Reducing Lateral, CL3000, SWE, ASTM A105	Default	
3 – 30	2.5 – 24	80	BE	Reducing Lateral, S-80, BE, ASTM A105	Default	
3.14	*Latrolet*					
2.5 – 30	0.5 – 2	SPECIAL	IRE x SWE	Latrolet, S-STD, x S-80, IRE x SWE, ASTM A105	Default	2

TEMP LIMIT:	-20°F to 400°F		MATERIAL:	Carbon Steel	
CORROSION ALLOWANCE:	0.00"				
RATING CLASS	300, ASME B16.5		DESIGN CODE:	ASME B31.1	

3.15	*Reducer - Concentric Swage*					
3 – 30	2.5 – 24	80	BE	Concentric Reducer, S-80, BE, ASTM A105, A234-WPB	Default	
3.16	*Reducer – Concentric Swage*					
0.75– 2	0.5 – 1.5	80	PE	Concentric Swage, S-80, PE, ASTM A234-WPB, MSS SP-95	Default	
2.5– 4	0.5 – 2	80 x 80	BE x PE	Concentric Swage, S-80 x S-80, BE x PE, ASTM A234-WPB, MSS SP-95	Default	
3.17	*Reducer – Eccentric Reducer*					
3 – 30	2.5 – 24	80	BE	Eccentric Reducer, S-80, BE, ASTM A234-WPB, ASME B16.9	Default	
3.18	*Reducer – Eccentric Swage*					
0.75 – 2	0.5 – 1.5	80	PE	Eccentric Swage, S-80, PE, ASTM A234-WPB, MSS SP-95	Default	
2.5 – 4	0.5 – 2	80 x 80	BE x PE	Eccentric Swage, S-STD x S-80, BE x PE, ASTM A234-WPB, MSS SP-95	Default	
3.19	*Sockolet*					
2.5 – 30	0.5 – 2	SPECIAL	IRE x SWE	Sockolet, S-80, x S-80, IRE x SWE, ASTM A105, MSS SP-97	Default	2
3.20	*Tee*					
0.5 – 2		CL3000	SWE	Tee, CL3000, SWE, ASTM A105, ASME B16.11	Default	
2.5 – 30		80	BE	Tee, S-80, BE, ASTM A234 WPB, ASME B16.9	Default	
3.21	*Tee – Reducing Tee*					
0.75 – 2	0.5 – 1.5	CL3000	SWE	Reducing Tee, CL3000, SWE, ASTM A105, ASME B16.11	Default	
3 – 30	2.5 – 28	STD	BE	Reducing Tee, S-STD, BE, ASTM A234 WPB, ASME B16.9	Default	
3.22	*Thredolet*					
2.5 – 30	0.5 – 2	SPECIAL	IRE x FTE	Threadolet, S-STD, x S-80, IRE x FTE, ASTM A105, MSS SP-97	Default	2
3.23	*Union*					
0.5 – 2		CL300	FTE	Union, CL300, FTE, ASTM A197, ASME B16.39	Default	
3.24	*Weldolet*					
6 – 30	2.5 – 28	80	IBE x BE	Weldolet, S-80, BE, ASTM A105, MSS SP-97	Default	1

4.0 Flanges:

First Size (NPS)	Second Size (NPS)	SCH/Press Rtg	End Prep	Description	Commodity Option	Notes
4.1	*Blind Flanges*					
0.5 – 24		CL150	RFFE	Blind Flange, CL150, RFFE, ASTM A105, ASME B16.5	Default	
0.5 – 24		CL150	FFFE	Blind Flange, CL150, FFFE, ASTM A105, ASME B16.5	150-FFFE	
0.5 – 24		CL300	RFFE	Blind Flange, CL300, RFFE, ASTM A105, ASME B16.5	300-RFFE	
26 – 30		CL150	RFFE	Blind Flange, CL150, RFFE, ASTM A105, ASME B16.47 Series A	Default	
26 – 30		CL150	FFFE	Blind Flange, CL150, FFFE, ASTM A105, ASME B16.47 Series A	150-FFFE	
26 – 30		CL300	RFFE	Blind Flange, CL300, RFFE, ASTM A105, ASME B16.47 Series A	300-RFFE	
4.2	*Flange –Weld Neck*					
2.5 – 24		CL150	RFFE x BE	Flange, WN, CL150, RFFE, ASTM A105, ASME B16.5	Default	
2.5 – 24		CL150	FFFE x BE	Flange, WN, CL150, FFFE, ASTM A105, ASME B16.5	150-FFFE	
2.5 – 24		CL300	RFFE x BE	Flange, WN, CL300, RFFE, ASTM A105, ASME B16.5	300-RFFE	
26 – 30		CL150	RFFE x BE	Flange, WN, CL150, RFFE, ASTM A105, ASME B16.47 Series A	Default	
26 – 30		CL150	FFFE x BE	Flange, WN, CL150, FFFE, ASTM A105, ASME B16.47 Series A	150-FFFE	
26 – 30		CL300	RFFE x BE	Flange, WN, CL300, RFFE, ASTM A105, ASME B16.47 Series A	300-RFFE	

TEMP LIMIT:	-20°F to 400°F		MATERIAL:	Carbon Steel
CORROSION ALLOWANCE:	0.00"			
RATING CLASS	300, ASME B16.5		DESIGN CODE:	ASME B31.1

5.0 Gaskets:

First Size (NPS)	Second Size (NPS)	SCH/Press Rtg	End Prep	Description	Commodity Option	Notes
0.5 – 30		CL150	RFFE	Gasket, EPDM, CL150, 0.0625" thick	Default	
0.5 – 30		CL300	RFFE	Gasket, EPDM, CL300, 0.0625" thick	Default	
1 - 24		CL300	RFFE (ASME B16.36)	Gasket, EPDM, CL300, 0.0625" thick	Default	

6.0 Bolting:

First Size (NPS)	Second Size (NPS)	SCH/Press Rtg	End Prep	Description	Commodity Option	Notes
0.5 – 30		CL150	RFFE	ASTM A193 Grade B7, alloy steel stud-bolts threaded the entire length for RFFE Joint with 2 Heavy Nuts ASTM A194-2H	Default	
0.5 – 30		CL150	FFFE	ASTM A193 Grade B7, alloy steel stud-bolts threaded the entire length for FFFE Joint with 2 Heavy Nuts ASTM A194-2H	Default	
0.5 – 30		CL300	RFFE	ASTM A193 Grade B7, alloy steel stud-bolts threaded the entire length for RFFE Joint with 2 Heavy Nuts ASTM A194-2H	CL300	
1 - 24		CL300	RFFE (ASME B16.36)	ASTM A193 Grade B7, alloy steel stud-bolts threaded the entire length for RFFE Joint with 2 Heavy Nuts ASTM A194-2H	Default	

7.0 Branch Table:

90 Degree Branch Connection Table

30	T																	
24	E	T																
20	E	E	T															
18	E	E	E	T														
16	E	E	E	E	T													
14	E	E	E	E	E	T												
12	E	E	E	E	E	E	T											
10	W	W	W	W	E	E	E	T										
8	W	W	W	W	W	W	W	E	T									
6	W	W	W	W	W	W	W	E	E	T								
4	W	W	W	W	W	W	W	W	W	E	T							
3	W	W	W	W	W	W	W	W	W	W	E	T						
2 ½	W	W	W	W	W	W	W	W	W	W	E	E	T					
2	S	S	S	S	S	S	S	S	S	S	S	S	S	T				
1 ½	S	S	S	S	S	S	S	S	S	S	S	S	S	S	E	T		
1	S	S	S	S	S	S	S	S	S	S	S	S	S	S	E	E	T	
¾	S	S	S	S	S	S	S	S	S	S	S	S	S	S	E	E	E	T
½	S	S	S	S	S	S	S	S	S	S	S	S	S	S	E	E	E	E
	30	24	20	18	16	14	12	10	8	6	4	3	2 ½	2	1 ½	1	¾	½

HEADER

45 Degree Branch Connection Table

TEMP LIMIT:	-20°F to 400°F	MATERIAL:	Carbon Steel
CORROSION ALLOWANCE:	0.00"		
RATING CLASS	300, ASME B16.5	DESIGN CODE:	ASME B31.1

30	L																	
24	RL	L																
20	RL	RL	L															
18	RL	RL	RL	L														
16	RL	RL	RL	RL	L													
14	RL	RL	RL	RL	RL	L												
12	RL	RL	RL	RL	RL	RL	L											
10	LO	LO	LO	LO	RL	RL	RL	L										
8	LO	LO	LO	LO	LO	LO	LO	RL	L									
6	LO	LO	LO	LO	LO	LO	LO	RL	RL	L								
4	LO	LO	LO	LO	LO	LO	LO	LO	LO	RL	L							
3	LO	LO	LO	LO	LO	LO	LO	LO	LO	LO	RL	L						
2 ½	LO	LO	LO	LO	LO	LO	LO	LO	LO	LO	LO	RL	L					
2	LO	LO	LO	LO	LO	LO	LO	LO	LO	LO	LO	LO	LO	L				
1 ½	LO	LO	LO	LO	LO	LO	LO	LO	LO	LO	LO	LO	LO	RL	L			
1	LO	LO	LO	LO	LO	LO	LO	LO	LO	LO	LO	LO	LO	RL	RL	L		
¾	LO	LO	LO	LO	LO	LO	LO	LO	LO	LO	LO	LO	LO	RL	RL	RL	L	
½	LO	LO	LO	LO	LO	LO	LO	LO	LO	LO	LO	LO	LO	RL	RL	RL	RL	L
	30	24	20	18	16	14	12	10	8	6	4	3	2 ½	2	1 ½	1	¾	½

HEADER

8.0 Notes:

1) Fitting shall be Bonney Forge®, WOI®, or Engineer approved equal
2) Fitting shall be designed by WFI® or Engineer approved equal to meet the requirements of ASME B31.1

9.0 Legend:

BE	Beveled End
E	Reducing Tee
FFFE	Flat Faced Flanged End
FFTBEHT	Flat Faced Thru Bolted End With Threaded Bolt Holes
FTE	Female Threaded end
IRE	Integral Reinforced End
L	Lateral
LO	Latrolet
MTE	Male Threaded End
PE	Plain End
RFFE	Raised Face Flanged End
RFTBE	Raised Face Thru Bolted End Without Bolt Holes
RFTBEH	Raised Face Thru Bolted End With Non Threaded Bolt Holes
RFTBEHT	Raised Face Thru Bolted End With Threaded Bolt Holes
RL	Reducing Lateral
S	Sockolet
SWE	Socket Welded End
T	Tee
W	Weldolet

Appendix E.
Operations & Maintenance Information

Granite Construction Company
P.O. BOX 27557
Tucson, AZ 85726

APS-FCPP Return Water Pond

CONTRACTOR TRANSMITTAL LETTER

To:	AECOM	**Date:**	9/11/2019
Attention:	Terry Stewart	**Granite Document No.:**	017823-03
Email:	terry.stewart@aecom.com	**Transmittal No(s).:**	T59_SM_017823-03-A
Phone:	480-708-1998	**Response Needed by:**	

Regarding: Final O&M Manual-A

Requested by:

Name:	Luke Plumb
Email:	luke.plumb@gcinc.com
Phone:	520-330-8258

We are sending you:

- ☒ Attached
- ☐ Shop Drawings
- ☐ Product Data
- ☐ Certifications
- ☐ Samples
- ☐ Billings
- ☐ Request for Information
- ☐ Change Order
- ☐ Other

Via:

- ☐ Hand Delivered
- ☒ Email
- ☐ Express Mail
- ☐ Regular Mail
- ☐ Fax

For your:

- ☒ Review & Approval
- ☐ Records

Copies	Date	Submittal No.	Specification No.	Description	Use Line Items
01	9/11/19	T59_SM_017823-03-A	01 78 23	Final O&M Manual-A	1.04

Remarks:

Please see attached documents regarding the final O&M Manual for the project.

Contractor's Stamp

GRANITE
For Review and Approval
09/11/2019

Architect's Stamp

Engineer's Stamp

Copies to:

Granite Construction Company

By: Luke Plumb

**** If enclosures are not as noted, kindly notify us at once**

Operation & Maintenance Instructions

Project: APS – Return Water Pond
(Four Corners Power Plant)

The Arizona Region Operations

Granite Construction Company • Arizona Region • Group 1

4115 E. Illinois Street
Tucson, AZ 85714

Phone (520) 748-8000 • Fax (520) 748-1862

graniteconstruction.com
Granite Construction Incorporated | NYSE: GVA

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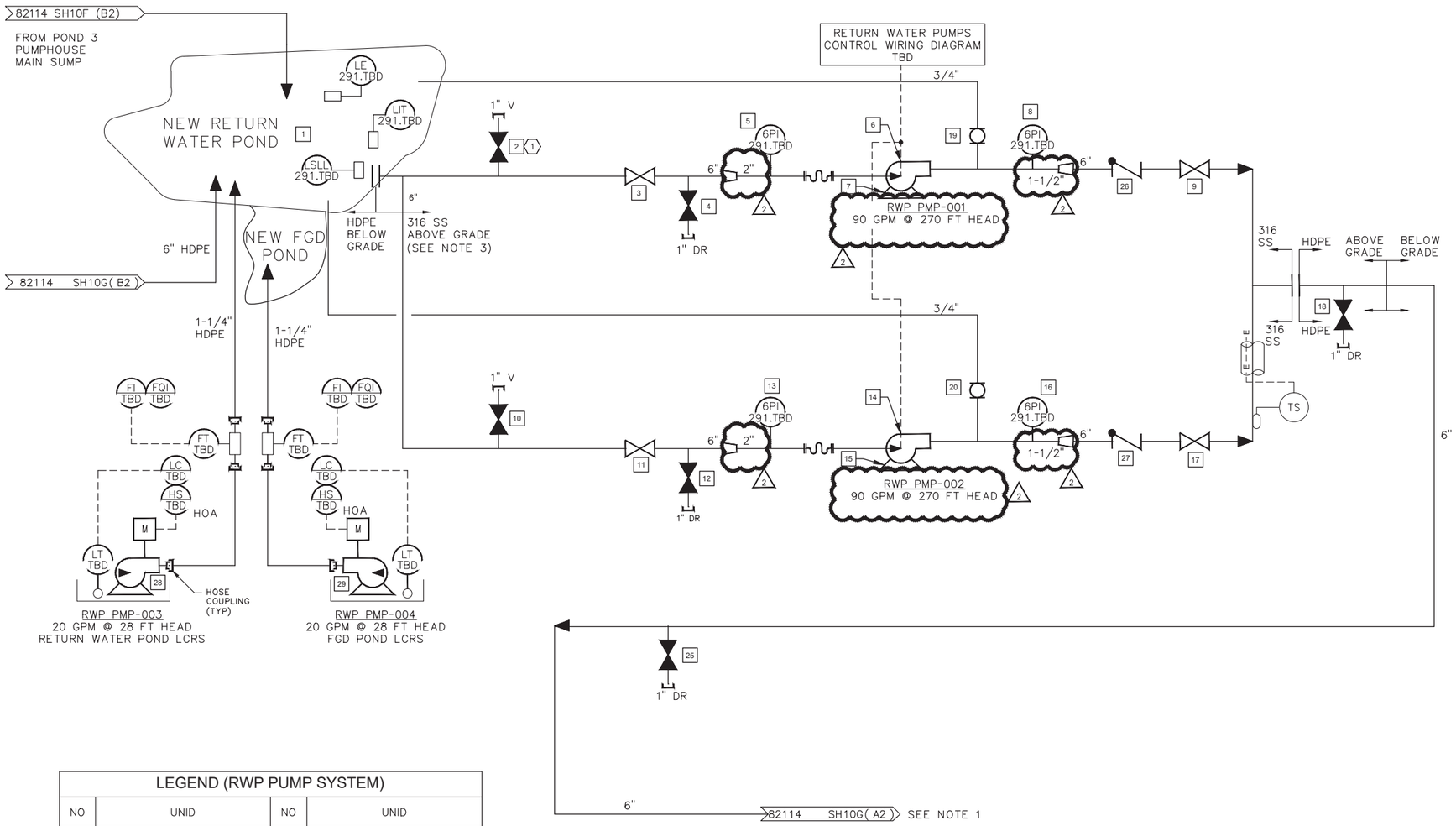


LEGEND (RWP PUMP SYSTEM)			
NO	UNID	NO	UNID
1	FC00CM-BP-RWP-POND-001	15	FC00CM-BP-RWP-MTR-002
2	FC00CM-BP-RWP-VLV-V001	16	FC00CM-BP-RWP-IND-PI291TBD
3	FC00CM-BP-RWP-VLV-V002	17	FC00CM-BP-RWP-VLV-V008
4	FC00CM-BP-RWP-VLV-V003	18	FC00CM-BP-RWP-VLV-V009
5	FC00CM-BP-RWP-IND-PI291TBD	19	FC00CM-BP-RWP-BV-001
6	FC00CM-BP-RWP-PMP-001	20	FC00CM-BP-RWP-BV-002
7	FC00CM-BP-RWP-MTR-001	21	NOT USED
8	FC00CM-BP-RWP-IND-PI391TBD	22	NOT USED
9	FC00CM-BP-RWP-VLV-V004	23	NOT USED
10	FC00CM-BP-RWP-VLV-V005	24	NOT USED
11	FC00CM-BP-RWP-VLV-V006	25	FC00CM-BP-RWP-VLV-V011
12	FC00CM-BP-RWP-VLV-V007	26	FC00CM-BP-RWP-CKV-002
13	FC00CM-BP-RWP-IND-PI291TBD	27	FC00CM-BP-RWP-CKV-003
14	FC00CM-BP-RWP-PMP-002	28	FC00CM-BP-RWP-PMP-003
		29	FC00CM-BP-RWP-PMP-004

CONSTRUCTION NOTES:

1. CONNECT TO 8" HDPE TO PLANT.

GENERAL CONSTRUCTION NOTES:

1. SEE FC-M-ADS-82114-10F-L FOR UNID LEGEND.
2. FOR STANDARD SYMBOLS, REFERENCE DRAWINGS, LEGEND AND GENERAL NOTES, SEE APS DRAWING G-76000.
3. ALL ABOVE GRADE EXTERIOR PIPING AND PUMPS HEAT TRACED AND INSULATED.

KEYED NOTES:

(1) EQUIPMENT/VALVE/INSTRUMENT NUMBER [2]. SEE LEGEND FOR UNID NUMBER

NO.	DATE	REVISION	DWN	CHD	EXD	RVWD	APVD	W.A.
2	12/17/18	REVISED PUMP FLOW & TDH & PIPE SIZES	DB	JM				
1	11/29/18	SWAP CHECK AND GATE VALVE LOCATIONS	DB	JM				

AECOM
7720 N. 16th Street Suite 100
Phoenix, Arizona 85020
(602) 371-1100

JOHN C McCONNELL NEW MEXICO PROFESSIONAL ENGINEER 12/17/18

FOUR CORNERS POWER PLANT
RETURN WATER POND

RETURN WATER POND P&ID

aps

SCALE NONE DATE 10/22/18

NMOC 811 Dial 8-1-1 or 1-800-321 2537

WORK SAFELY TODAY

DWN	EXD	APPROVED	W A
LDB	---	JACK MCCONNELL	FCC06814
CHD	RVWD	DRAWING APPROVED BY	
BCS	---		

UNIT	DISC	TYPE	SYS	SUBSYS	NUMBER	SHEET
FC45CM	M	02	WP	AP	200485	27

DRAWING: G:\910_CAD\20-SHEETS\APS_EDCS_Drawings\2_DRAWING_REVISIONS\FC45CM-M-02-WP-AP-200485-27.dwg

82114 SH 10H (E1) FROM SUMPS 9-17

82114 SH 10H (E1) FROM SUMPS 9-17

6" HDPE SDR11

6" HDPE SDR11

6" CARBON STEEL

PIPING ABANDONED IN PLACE 6x8

8"

ASH POND #6

N.C. 4-125-475

4-200-443

TO HALOPHYTE FARM (ABANDONED)

HALOPHYTE FARM VALVE PIT 4' C.M.P.

VALVE PIT 6C

82114 SH 10H (C3) FROM MANHOLE #1

82114 SH 10H (B3) FROM MANHOLE #2

82114 SH 10H (A3) FROM MANHOLE #3

4" HDPE SDR 17.0

FLOW TOTALIZERS

VALVE PIT 6B 4' C.M.P.

FLOW TOTALIZER

PIPING REMOVED

ASH POND INTERCEPT SUMP #6

DFADA 1 RETENTION BASIN

DFADA 2 RETENTION BASIN

DRY FLY ASH DISPOSAL AREA (DFADA) PHASE 1

DRY FLY ASH DISPOSAL AREA (DFADA) PHASE 2

DRY FLY ASH DISPOSAL AREA (DFADA) PHASE 3

6" HDPE

10" PVC EMERGENCY OVERFLOW

POND 3 TOE DRAIN DITCH

10" HDPE

6" HDPE

6x10

10x6

ORIFICE PLATE

ABANDONED IN PLACE HDPE (UNDERGROUND)

CARBON STEEL

3-125-280

4x3

3-200-442

12" PERFORATED HDPE SEEPAGE INLET PIPE

8" PERFORATED HDPE SEEPAGE INLET PIPE

12" HDPE SDR 17.0 DRAIN PIPE

GRADE BREAK

SEEPAGE SUMP #1

SEEPAGE SUMP #2

SEEPAGE SUMP #3

SEEPAGE SUMP #4

82114 SH 10H (C8) TO MANHOLE #1

82114 SH 10H (B8) TO MANHOLE #2

82114 SH 10H (A8) TO MANHOLE #3

82114 SH 10H (A8) TO MANHOLE #3

2" HDPE

4" C.S.

4-125-81 (2D)

4-125-280

4x1 1/2

P3PH PMP-001 130 GPM @475 FT HEAD

1 1/2-200-60

1 1/2-200-260

6x3

6-125-81 (2I)

4-125-81 (1D)

P3PH PMP-002 130 GPM @475 FT HEAD

6-125-81 (1I)

1 1/2" C.S.

1 1/2" DR

4"x1 1/2"

WET WELL

EXIST. 8" TO USE AS SLEEVE

4" C.S. BELOW GRADE

FOOTING DRAIN

CS

HDPE BELOW GRADE

DRY WELL

PUMPING STATION

DRYWELL SUMP PUMP A

DRYWELL SUMP PUMP B

ASH POND 3 PUMPHOUSE

TS

UG

ABOVE GRADE

4" HDPE

4" IN 8" HDPE (DOUBLE WALL PIPE) SEE NOTE 3

E

200485 SH27 (E8) TO NEW RWP

ORIFICE PLATE

4-125-475

4-125-81

6X4

VALVE PIT 3' C.M.P.

2" S.S.

4" PERFORATED CORRUGATED PVC SEEPAGE INLET PIPE

GRADE BREAK

NORTH INTERCEPT SUMP 7

NORTH INTERCEPT SUMP 8

DISCHARGE VAULT (5'X11' PRECAST)

S.S. 2" HDPE

FQ1 2000

FE 2000

FQ1 2100

FE 2100

6' C.M.P. 1073

2X3/4 3/4X2

HDPE PVC PVC HDPE

1 1/4-200-60

1 1/4-200-260

1 1/4X2

1 1/4" C.S.

CHACO WASH NORTHERN AREA WELLS

EXTRACTION WELL No. EW12

EXTRACTION WELL No. EW11

6' C.M.P. 1065

2X1 1X2

CHACO WASH SOUTHERN AREA WELLS

EXTRACTION WELL No. EW1

EXTRACTION WELL No. EW5

EXTRACTION WELL No. EW6

EXTRACTION WELL No. EW14

EXTRACTION WELL No. EW15

NOTES:

1. FOR STANDARD SYMBOLS, REFERENCE DRAWINGS, LEGEND & GENERAL NOTES, SEE APS DRAWING G-76000.

GENERAL CONSTRUCTION NOTES:

1. SEE FC-M-AOS-82114-10F-L FOR UNID LEGEND.
2. FOR STANDARD SYMBOLS, REFERENCE DRAWINGS, LEGEND AND GENERAL NOTES, SEE APS DRAWING G-76000.
3. ALL ABOVE GRADE EXTERIOR PIPING HEAT TRACED AND INSULATED BETWEEN THESE POINTS.

NO.	DATE	REVISION	DWN	CHD	EXD	RVWD	APVD	W.A.
10	08-03-16	REVISED SUMP IDENTIFICATION	AWF	KLP	CDW		AWG	FAC90385
9	01-05-16	AS BUILT MODIFICATIONS	KLP	AWF	JBH	CDW	AWG	FAC90385
8	2-20-14	AS BUILT	BNS	JDM	JBH		AWG	FCD05681
7	12-19-13	GENERAL REV FAC90386 MODS	BNS	JDM	JBH		AWG	FAC90371
6	9-10-04	ADDED ON/OFF PAGE CONNECTOR AND LINE No. 6"-DW-503-50	BW	PSS	TK	TLM	DDG	04-6379
5	5-20-99	CARBON CARRYOVER AS-BUILT	AD					04-6116
4	10-25-95	AS-BUILT & GENERAL REVISIONS	AGS					40-5160
3	9-22-94	GENERAL REVISION	AGS		OSTER		CAM	40-6044
2	7-15-93	GENERAL REVISION	AGS		OSTER		CAM	40-6044
1	4-22-93	CONSTRUCTABILITY REVIEW	AGS	RJM	OSTER	CHET	GF	40-6044

JOHN C McCONNELL NEW MEXICO 19047 PROFESSIONAL ENGINEER 12/17/18

FOR CONSTRUCTION

SEE FC-M-05-ADS-82114-10F-L FOR UNID LEGEND

NO.	DATE	REVISION	DWN	CHD	EXD	RVWD	APVD	W.A.
13	12/17/18	REVISED PUMP TDH	LDB	JMC	BCS			
12	11/29/18	SWAP GATE & CHECK VALVE LOCATIONS	LDB	JMC	BCS			
11	10/22/18	REPLACED PUMPS	LDB	JMC	BCS			

FOUR CORNERS COMMON
ASH POND 6/CHACO WASH
SEEPAGE INTERCEPT SYSTEM
P&ID

APS

SCALE NONE

DATE 3-23-93

DWN	APPROVED	W A
K. KOWACZ	CARL MARANO ENGINEERING SUPERVISOR	40-6050
CHD		
EXD J.D. MITCHELL		
RVWD		

UNIT	DISC	TYPE	SYS	NUMBER	SHEET
FC	M	02	ADS	82114	10F

DRAWING: C:\Users\adam_ford\Desktop\APS\FCPP\POND 6\FC-M-02-ADS-82114-10F\FC-M-02-ADS-82114-10F.dwg

1. Pond 3 Pump House Pumps and Motors 001 and 002

Pond Three Pump House

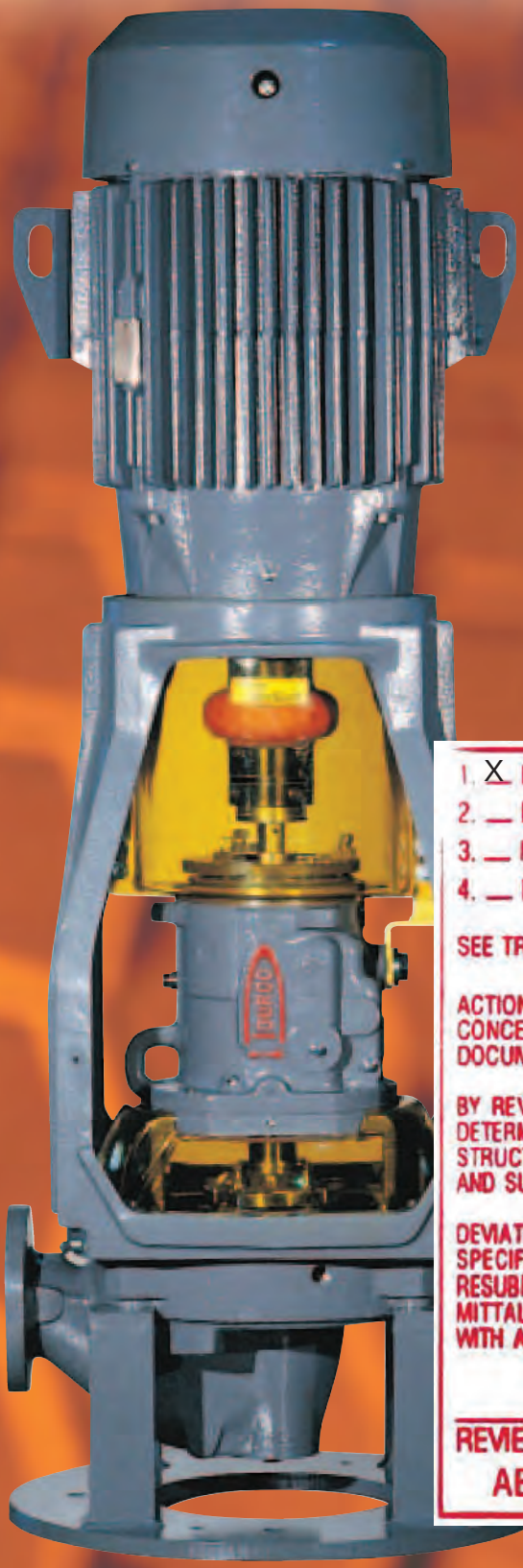
a. **127- FCOOCM-BP-AP-PMP-1066**
b. **128- FCOOCM-BP-AP-MTR-1066**
c. **116- FCOOCM-BP-AP-PMP-1067**
d. **117- FCOOCM-BP-AP-MTR-1067**

FLOWSERVE
Pump Division

PIONEER EQUIPMENT INC.

Mark III

In-Line Chemical Process Pumps



1. X NO EXCEPTIONS NOTED
2. __ EXCEPTIONS NOTED
3. __ REVIEW NOT COMPLETED
4. __ REVIEW NOT REQUIRED
5. __ MAKE CORRECTIONS NOTED
6. __ RESUBMIT
7. __ DO NOT RESUBMIT
8. __ SUBMITTAL NOT COMPLETE

SEE TRANSMITTAL FOR ADDITIONAL INFORMATION AS APPLICABLE.

ACTION SHOWN ABOVE IS ONLY FOR CONFORMANCE WITH THE DESIGN CONCEPT OF THE WORK AND THE INFORMATION IN THE CONTRACT DOCUMENTS.

BY REVIEW AND SUBMISSION, CONTRACTOR REPRESENTS THAT HE HAS DETERMINED AND VERIFIED MATERIALS, FIELD MEASUREMENTS AND CONSTRUCTION CRITERIA, SPECIFIED PERFORMANCE AND DESIGN CRITERIA AND SUBMIT DATA.

DEVIATIONS FROM CONTRACT DOCUMENTS ARE NOT REVIEWED UNLESS SPECIFICALLY REQUESTED IN WRITING BY CONTRACTOR. REVIEW ON RESUBMISSION WILL COVER ONLY DESIGNATED CHANGES ON THIS SUBMITTAL AND OTHER CHANGES CLEARLY IDENTIFIED BY CONTRACTOR WITH AN ENCIRCLEMENT.

1-4-19

REVIEWED BY
AECOM

DATE

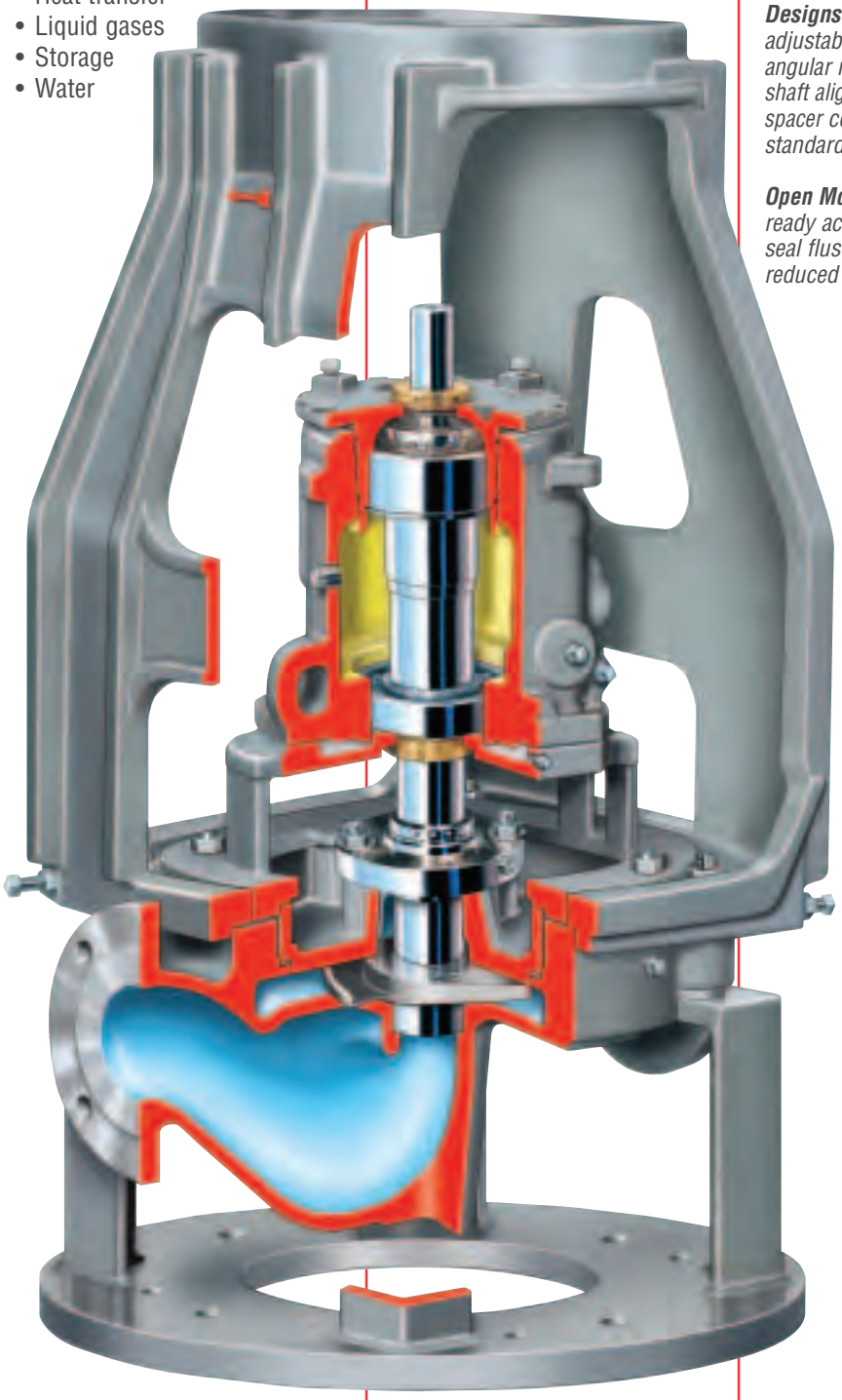
Mark III In-Line Process Pumps

Flowserve's Mark III In-Line ASME (ANSI) process pump delivers extended pump life, ease of maintenance and safety in addition to reliable, efficient performance. This space-saving pump has broad application in chemical and hydrocarbon processing as well as in general industry for services including:

- Chemical transfer
- Heat transfer
- Liquid gases
- Storage
- Water
- Washdown and cleaning
- Condensate return
- Light slurries

Operating Parameters

- Flows to 370 m^3/h (1630 gpm)
- Heads to 230 m (760 ft)
- Pressures to 24 bar (350 psi)
- Temperatures to 370°C (700°F)
- Motor sizes to 110 kW (150 hp)



C-Flange Adapter *is precision machined to provide fixed motor to pump angular shaft alignment within 0.001 mm/mm (0.001 in/in)*

Adjustable Parallel Alignment *of motor to pump shaft to within 0.05 mm (0.002 in) reduces coupling loads to improve pump, seal, motor and coupling life*

Broad Choice of Coupling Designs *due to precisely adjustable parallel and fixed angular motor to pump shaft alignment. Conventional spacer coupling type is standard*

Open Motor Adapter *permits ready access to seals and seal flush connections for reduced maintenance time*

Customer	: Pioneer Equipment Inc	Pump / Stages	: 2K3x1.5V-13RV M3V	/ 1
Customer reference	: AECOM	Based on curve no.	: MIII7315	
Item number	: P3PH-PMP-001/002	Flowserve reference	: 1407821115	
Service	: Pond 3 Pump House Pumps	Date	: December 28, 2018	

Operating Conditions

Capacity (rated/normal)	: 130.0 USgpm / -
Water capacity (CQ=1.00)	: -
Total developed head	: 475.00 ft
Water head (CH=1.00)	: -
NPSHa/NPSHa less margin	: 25.0 ft / -
Maximum suction pressure	: -

Liquid

Liquid type	: Other
Liquid description	: -
Temperature	: 105 °F
Density / Specific gravity	: - / 1.000
Solid Size - Actual / Limit	: - / 0.5940 in
Viscosity / Vapor pressure	: 1.00 cP / -

Materials / Specification

Material column code	: D/C
Pump specification	: ANSI B73.2M

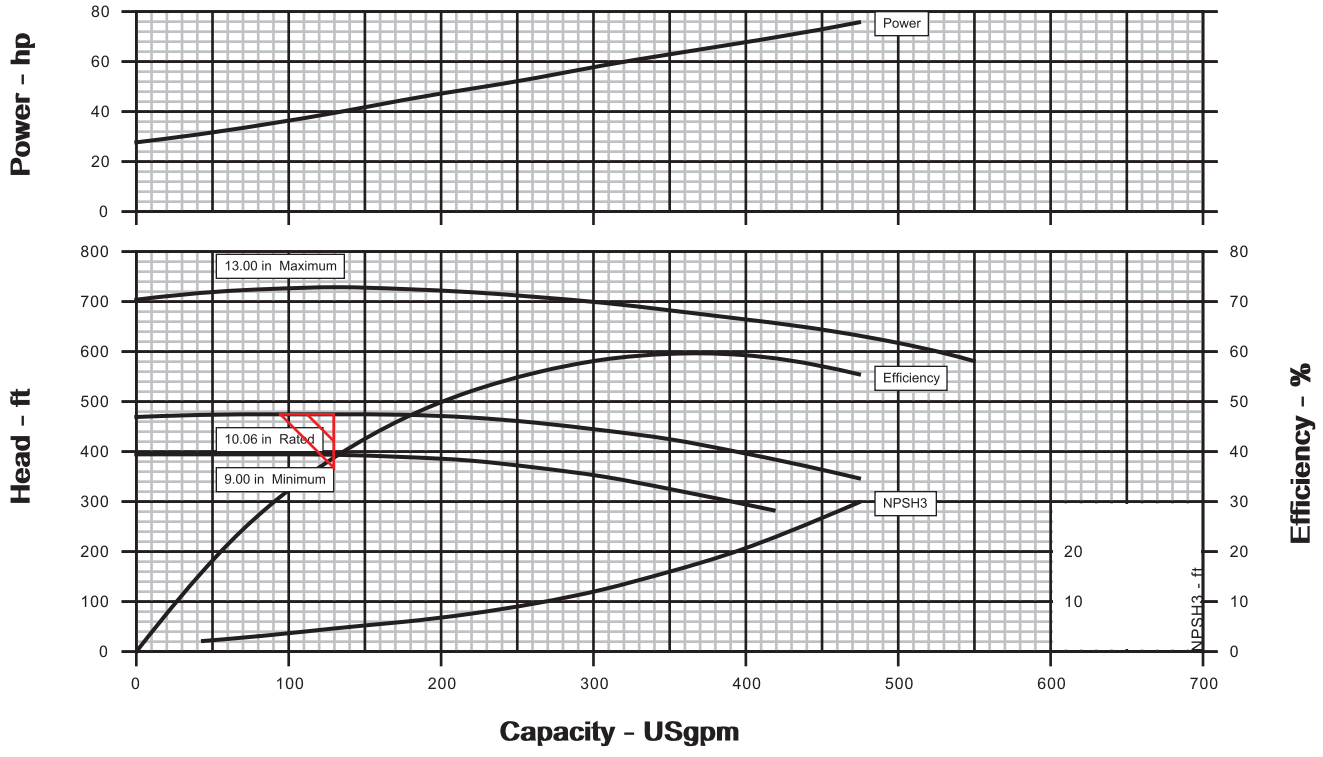
Other Requirements

Hydraulic selection : No specification
Construction : No specification
Test tolerance : ANSI/HI 14.6 Grade 1U
Driver Sizing : Max Power(MCSF to EOC) not using SF
Seal configuration : Single Seal

Performance

Hydraulic power	: 15.6 hp	Impeller diameter	
Pump speed	: 3550 rpm	Rated	: 10.06 in
Pump overall efficiency (CE=1.00)	: 39.4 %	Maximum	: 13.00 in
NPSH required (NPSH3)	: 4.5 ft	Minimum	: 9.00 in
Rated brake power	: 39.6 hp	Ns / Nss	: 593 / 6680 (US units)
		Minimum continuous flow	: 106.5 USgpm
Maximum brake power	: 75.5 hp	Maximum head at rated diameter	: 470.66 ft
Driver power rating	: 100 hp / 74.6 kW	Flow at BEP	: 367.3 USgpm
Casing working pressure	: 203.8 psig	Flow as % of BEP	: 35.4 %
(based on shut off @ cut dia/rated SG)		Efficiency at normal flow	: -
Maximum allowable	: 283.8 psig	Impeller diameter ratio (rated/max)	: 77.4 %
Hydrostatic test pressure	: 428.0 psig	Head rise to shut off	: -0.9 %
Estimated rated seal chamber pressure	: -	Total head ratio (rated / max) / (max / rated)	: 65.2 % / 153.5 %

CURVES ARE APPROXIMATE, PUMP IS GUARANTEED FOR ONE SET OF CONDITIONS; CAPACITY, HEAD, AND EFFICIENCY.



Construction Datash...

Customer	: Pioneer Equipment Inc	Pump / Stages	: 2K3x1.5V-13RV M3V / 1
Customer reference	: AECOM	Based on curve no.	: MIII7315
Item number	: P3PH-PMP-001/002	Flowserve reference	: 1407821115
Service	: Pond 3 Pump House Pumps	Date	: December 28, 2018

Construction

Nozzles	Size	Rating	Face	Position
Suction	3.00	150#	FF	Inline
Discharge	1.50	150#	FF	Inline

Casing mounting	: Inline
Casing split	: Radial
Impeller type	: Reverse Vane
Bearing type (radial)	: Single Row
Bearing number (radial)	: 6310-ZC3
Bearing type (thrust)	: Double Row
Bearing number (thrust)	: 5310-AZC3
Bearing lubrication	: Regreasable
Rotation (view from driver)	: CW per Hyd. Institute

Materials

Casing	: Carbon Steel
Impeller	: CD4MCuN
Seal chamber	: FML Box / Carbon Stl
Shaft	: 316 SS
Sleeve	: No Sleeve Req'd

Baseplate, Coupling and Guard

Baseplate type	: Pump Stand
Baseplate material	: Steel
Baseplate size	: See GA Drawing
Coupling manufacturer	: T.B. Woods
Coupling size	: Sureflex SC8/10H
Coupling / Shaft guard	: Steel
Shaft / seal guard	: PCY Seal Guard

Weights (Approx.)

Bareshaft pump (net)	: 494.0 lb
Baseplate (net)	: 82.0 lb
Driver (net)	: 1225.0 lb
Shipping gross weight/volume	: 2071.1 lb / 32739 cu.in

Testing

Hydrostatic test	: Non witnessed
Performance test	: Non witnessed
NPSH test	: None

Paint and Package

Pump paint	: FLS St'd PU Topcoat
Base grout surface prep	: N/A
Shipment type	: Domestic

Driver Information

Manufacturer	: ABB/Baldor
Power	: 100 hp / 74.6 kW
Service factor (requested / actual)	: 1.15 / 1.15
Synchronous speed	: 3600 rpm
Orientation / Mounting	: Vertical / Flange
Driver type	: NEMA
Frame-size / material	: 405TSC / CAST IRON
Enclosure	: TEFC-XEX
Hazardous area class	: N/A
Explosion 'T' rating	: N/A
Volts / Phase / Hz	: 230/460 / 3 / 60 Hz
Amps-full load/locked rotor	: - / -
Motor starting	: Direct on line (DOL)
Insulation	: F
Temperature rise	: 80 °C
Bearings	: Ball
Lubrication	: Grease
Motor mounted by	: Flowserve

Sound Pressure (dBA @ 1.0 m)

Driver, expected	: 77.0 dBA
Pump & driver, estimated	: 87.0 dBA

Seal Information

Arrangement	: Sgl Int O-Ring
Size	: -
Manufacturer / Type	: Flowserve / ISC2 Pusher
Material code (Man'f/API)	: C2CPX----EAXV- / BSTFX
Internal neck bushing	: Not Available

Gland

Gland material	: -
Flush	: .375" NPT
Vent	: .25" NPT
Drain	: .25" NPT
Auxiliary seal device	: Carbon Bushing

Piping

Seal flush plan	: None
Seal flush construction	: -
Seal flush material	: -
Aux seal flush plan	: None
Aux seal flush construction	: -
Aux seal flush material	: -

Notes

-

Mark IIIA Power End

Casing w/1/2" Plugged Drain (NPT)

Steel Pump Stand/CI Motor Adapter

-

No cust. insp. or documents required

FLOWSERVE

Full Page GA Drawing

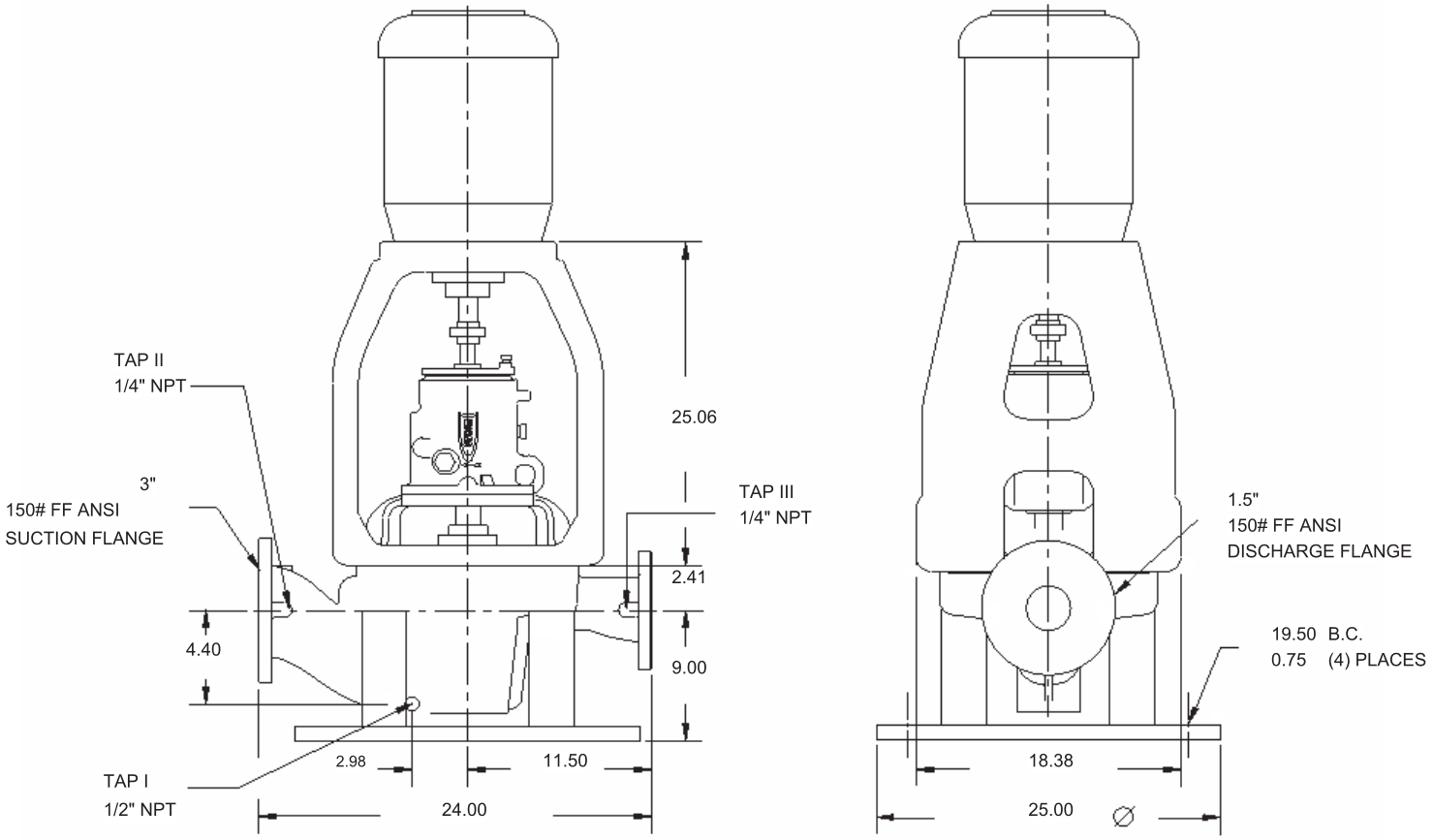
Dimensions certified for construction
when properly endorsed below.
Refer to factory for any "*" dimensions.
DO NOT SCALE DRAWING

NOTES:

1. Consult pump I.O.M. before installing the pump.
2. Installation dimensions are +/- .13" (3mm), unless otherwise noted.
3. Foundation bolts and piping should not be set rigidly before receipt of equipment.
4. All holes in flanges straddle centerlines.
5. Piping, foundations, and systems are the responsibility of others. Flowserve Pump Division data and comments are offered as an aid, but Flowserve Pump Division cannot assume responsibility for the system design or operation. It is recommended that a specialist skilled in this area be consulted to ensure a successful installation.

Pump Shaft Dia. at Seal: 1.875"

Pump Shaft Dia at Cplg: 1.125"



-

Customer	: Pioneer Equipment Inc	Pump size & type	: 2K3x1.5V-13RV M3V	Drawing number	: -
Item number	: P3PH-PMP-001/002	Pump speed / Stages	: 3550 rpm / 1	Date	: December 28, 2018
Service	: Pond 3 Pump House Pumps	Flow / Head	: 130.0 USgpm / 475.00 ft	Certified by / Date :	: -
Customer PO #	: -	Driver power / Frame	: 100 hp / 74.6 kW / 405TSC	Seal type	: ISC2 Pusher
Flowserve reference	: 1407821115	Volts / Phase / Hz	: 230/460 / 3 / 60 Hz	Seal flush plan	: None

Contact: Eric Lock

Address: Pioneer Equipment Inc
3738 E. Miami Ave.
Phoenix, AZ 85040

Phone: 602-437-4312

Scope of Supply

Customer:	Pioneer Equipment Inc	Pump / Stages:	2K3x1.5V-13RV M3V / 1
Cust / Proj Ref:	AECOM	Based on curve no.:	MIII7315
Item number:	P3PH-PMP-001/002	FLS # / Reference:	1407821115 /
Service:	Pond 3 Pump House Pumps	Date:	Dec 28, 2018

Qty	Description
2	2K3x1.5V-13RV M3V FPD - D/C
	Packaged by Chesapeake
	Safe (non explosive) atmosphere
	Casing - Carbon Steel (DS/WCB)
	Cover - Carbon Steel (DS/WCB)
	• Cover Gasket - TM
	Impeller - CD4M/CD-4MCuN
	• Impeller Gasket - TFR
	Bearing Housing - CI
	• Bearing Hsg Adapter - DCI2/7040
	• Motor Adapter CI
	Shaft - Standard
	• Shaft - 316 Stainless
	• No Sleeve Required
	• Stud B7 / Nut SR2H (Steel)
	Stud B8C1/Nut E8 (18-8)
	Casing - Standard
	• 150# FF ANSI Drilling
	• 1/2" NPT Casing Drain Tap (Plugged)
	• 1/4" NPT Suction Tap (Tap II)
	• 1/4" NPT Discharge Tap (Tap III)
	• Plastic Flange Covers
	ISO 1940 G6.3 Impeller Balance
	Power End - Standard Mk IIIA
	• Bearings - Regreaseable (Single Shield)
	• Oil Seals - TSSR
	304ss Nameplate w/US Customary Units
	Shaft Sealing Diameter - 1.875"
	Flowserve Single Cartridge Seal
	• Flowserve ISC Pusher w/o Pumping Ring
	• SilCar Rotary vs. SilCar Seat
	• Viton Elastomers
	• 316SS Metal Parts
	• 316SS Large Bore Gland
	Diamond coated SiC Seal faces

Feature quantities match pump quantity unless otherwise noted.

Proposal is valid for 60 days.

Customer:	Pioneer Equipment Inc	Pump / Stages:	2K3x1.5V-13RV M3V / 1
Cust / Proj Ref:	AECOM	Based on curve no.:	MIII7315
Item number:	P3PH-PMP-001/002	FLS # / Reference:	1407821115 /
Service:	Pond 3 Pump House Pumps	Date:	Dec 28, 2018

Qty	Description
	Seal Chamber - FML (Large Bore Taper design + Flow Modifiers)
	• Steel - Fasteners
	3.5" Spacer Coupling
	Coupling Service Factor ≥ 1.5
	• Woods Sure-Flex SC w/HYTREL [SC8/10H]
	• HYTREL Spacer
	Std. Steel Cplg Guard (Safety Yellow)
	Durcoshield Seal Guard
	• PCY Material Seal Guard
	• Pump Stand - Steel
	No Polyshield Baseplate Required
	• IPS Beacon 2 Not Provided
	10 Min Non-Wit Hydro Test-Csg & Cvr Only
	Performance Test - ANSI/HI 14.6 Grade 1U
	Performance Test - Standard
	• Non-Witnessed Performance Test
	Performance Test with Shop Motor
	Performance Test at Standard Speed
	Pump Coating - Manufacturer's Standard Polyurethane Top Coat
	• Pump Color - Quartz Grey (RAL 7039)
	• Baseplate Color - Same as Pump Color
	Coupling/Seal Guard Coating - Manufacturer's Standard
	• Coupling/Seal Guard Color - Signal Yellow (RAL 1003)
	Driver/Motor Coating - Manufacturer's Standard
	• Driver/Motor Color - Manufacturer's Standard
	• Flowserve Standard Warranty
	No Documentation Required
	Installation and Operations Manual
	• English - Language
	• 3 User Instruction Manuals
	Standard Domestic Packaging (6 Months)
	EXW - Ex-Works
2	Driver
	Driver Mounted by Factory
	• NEMA C-Face Motor
	• ABB/Baldor
	• TEFC-XEX Prem Eff Svr Duty (100 hp 3600 RPM 405TSC)
	• 230/460 volts - 3 phase
	• No Space Heaters

Feature quantities match pump quantity unless otherwise noted.

Proposal is valid for 60 days.

FLOWSERVE

ISC2 Series

Innovative standard cartridge seals

Sealing solutions for fluid handling applications
on shaft diameters up to 200 mm (8.000 inch)



Experience In Motion

FLOWSERVE

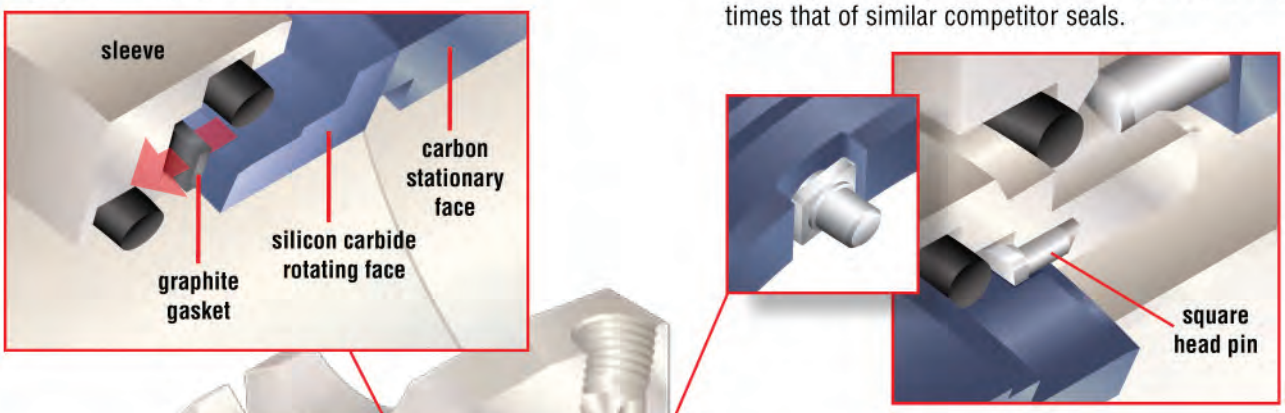
Advanced ISC2 seal design features enable superior rotating equipment reliability

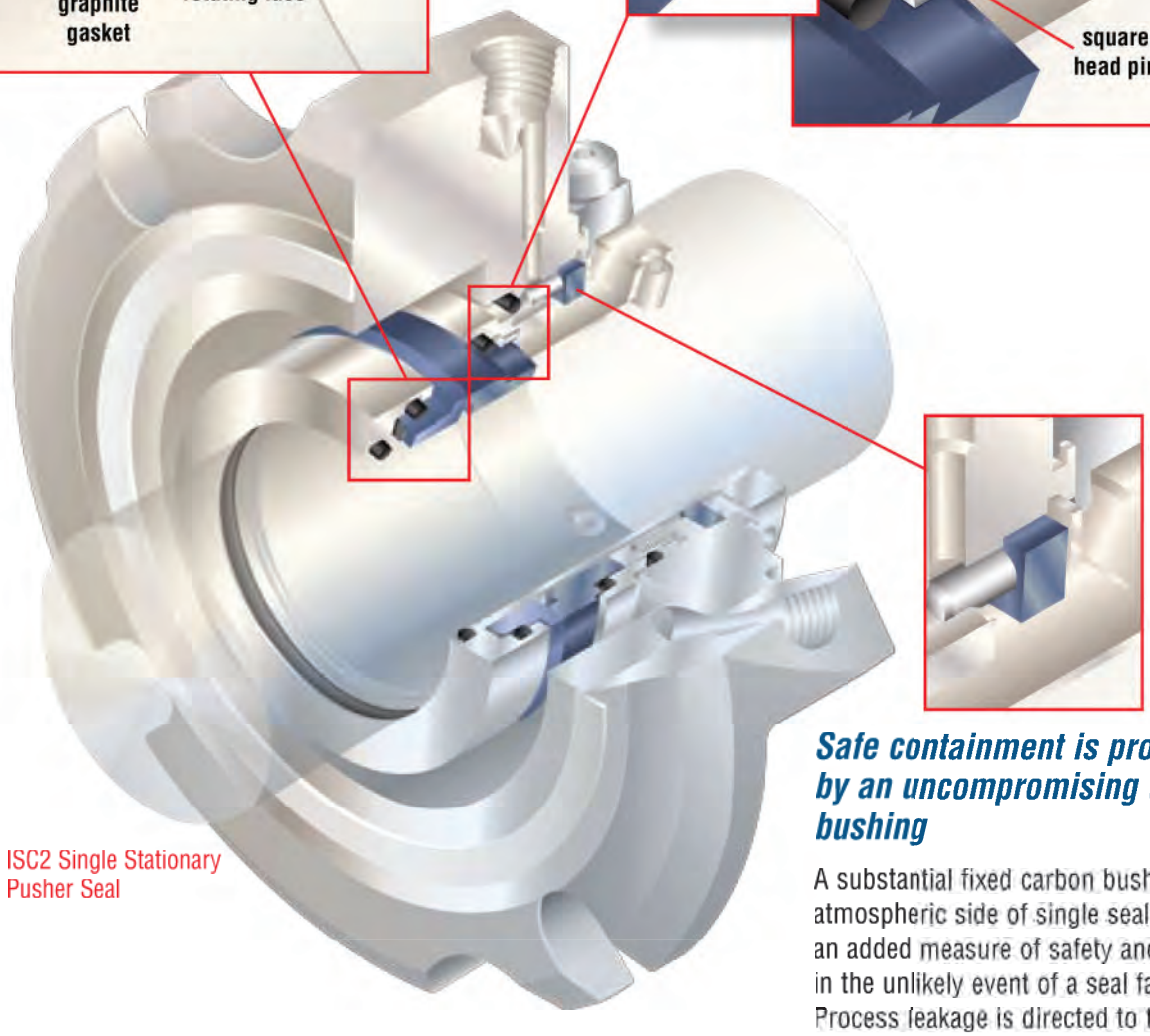
Tolerate dry running events with our exclusive thermal management technology

Thermally conductive and mechanically compliant graphite material dramatically improves heat transfer between the silicon carbide rotating seal face and the sleeve. The sleeve acts as a heat sink, lowering seal face operating temperatures and transforming cavitating and dry running bad actors into highly reliable installations.

Robust drive mechanisms deliver high torque loads with low seal face stress

Square-head drive pins self-align with the seal faces to distribute torque loads evenly over an area instead of a high-stress point load, reducing seal face fractures. The torque carrying capability of the ISC2 seal is three times that of similar competitor seals.





ISC2 Single Stationary Pusher Seal

Safe containment is provided by an uncompromising throttle bushing

A substantial fixed carbon bushing on the atmospheric side of single seals provides an added measure of safety and reliability in the unlikely event of a seal failure. Process leakage is directed to the drain for safe handling and disposal.

Materials of Construction

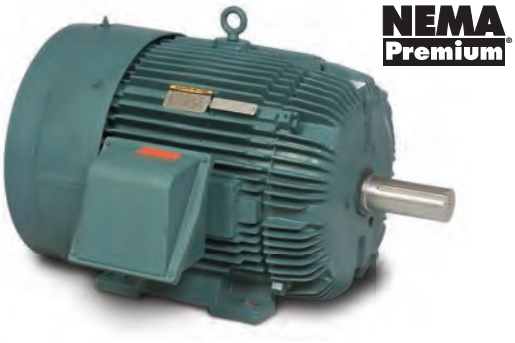
Metal Parts	316 Stainless Steel, Alloy C-276, Alloy 20, Titanium
Seal Faces	Premium Resin Carbon vs. Sintered Silicon Carbide *
	Sintered Silicon Carbide vs. Sintered Silicon Carbide
	Premium Resin Carbon vs. Tungsten Carbide
	Tungsten Carbide vs. Sintered Silicon Carbide
Metal Bellows	Alloy C-276
Elastomers	Fluoroelastomer, Perfluoroelastomer, EPDM, TFE-Propylene
Springs	Alloy C-276
Set Screws	17-4 H900 Stainless Steel

Operating Parameters

Pressure	
Pusher seal	0 to 20.6 bar (300 psig)
Metal bellows seal	0 to 13.8 bar (200 psig)
Temperature	-40 to 204°C (-40 to 400°F)
Maximum Speed	3600 rpm or 23 m/s (75 fps)
Seal Chamber Specifications	ASME B-73, EN 12 756, JIS, ISO 3069, API 682
Shaft Size	
Pusher seal	25 to 200 mm (1.000" to 8.000")
Metal bellows seal	25 to 95 mm (1.000" to 3.750")

* Diamond Coated for low temp and temporary dry run.

Severe Duty Super-E® ECP/XEX NEMA Premium® Efficient Motors



Baldor•Reliance Super-E, ECP motors have XEX designs that meet the demanding application requirements typically found in harsh processing environments. Features include cast iron construction, Oversized and rotatable cast iron conduit box, V-Ring shaft seal, Stainless steel nameplate and Corrosion resistant hardware and epoxy finish. Super-E electrical designs have 1.15 service factors and a Class F Insulation system that is Inverter Ready and meets NEMA MG 1 Part 31.4.4.2.

TEFC – Totally Enclosed Fan Cooled
Foot Mounted, 230/460 Volts, Three Phase, 1-125 Hp

Hp	kW	RPM	Frame	Catalog No.	Amps @ High V		F.L. Torque Lb. Ft.	Efficiency %			Power Factor %			Bearings		Volt Code	"C" Dim.	Conn. Diag. No.	Notes
					F.L.	L.R.		1/2	3/4	F.L.	1/2	3/4	F.L.	DE	ODE				
1	0.75	3450	143T	**ECP3580T**	1.4	12.1	1.5	80.6	84	84	65	77	83	6205	6205	E	12.88	CD0005	-
1	0.75	1765	143T	**ECP3581T**	1.5	15	3	84.4	87	87.5	48	60	70	6205	6205	E	12.88	CD0005	-
1	0.75	1150	145T	**ECP3582T**	1.8	9.6	4.5	82.3	84	82.5	42	55	63	6205	6205	E	12.88	CD0005	-
1 1/2	1.1	3450	143T	**ECP3583T**	2	20.1	2.3	81.3	84.3	85.5	68	78	83	6205	6205	E	12.88	CD0005	-
1 1/2	1.1	1760	145T	**ECP3584T**	2.1	18	4.5	86.8	88.4	88.5	54	67	76	6205	6205	E	12.88	CD0005	-
1 1/2	1.1	1170	182T	**ECP3667T**	2.5	16.2	6.8	84.8	86.9	87.5	44	56	64	6206	6206	E	15.93	CD0005	-
2	1.5	3450	145T	**ECP3586T**	2.5	30	3	83.8	86.2	86.5	70	80	85	6205	6205	E	12.88	CD0005	-
2	1.5	1755	145T	**ECP3587T**	2.8	25	6	86.9	88.5	88.5	54	67	75	6205	6205	E	12.88	CD0005	-
2	1.5	1165	184T	**ECP3664T**	3.2	20.9	9	96.9	88.5	88.5	48	60	68	6206	6206	F	15.93	CD0005	-
3	2.2	3500	182T	**ECP3660T**	3.4	32	4.5	87.5	89.1	88.5	83	89	92	6206	6206	E1	15.93	CD0005	-
3	2.2	1760	182T	**ECP3661T**	4.2	33	9	88.9	90.4	90.2	54	66	74	6206	6206	E1	15.93	CD0005	-
3	2.2	1165	213T	**ECP3764T**	4.5	30.9	13.5	89.5	90.4	90.2	52	64	70	6307	6307	E1	19.5	CD0005	-
5	3.7	3490	184T	**ECP3663T**	5.7	64.8	7.5	89.4	90.8	90.2	76	85	90	6206	6205	E1	15.93	CD0005	-
5	3.7	1750	184T	**ECP3665T**	6.6	54	14.9	90.3	91.2	89.5	60	73	80	6206	6206	E	15.93	CD0005	-
5	3.7	1160	215T	**ECP3768T**	7.3	51.9	22.8	90.3	91	90.2	54	65	72	6307	6307	E1	19.5	CD0005	-
7 1/2	5.6	3510	213T	**ECP3769T**	8.6	61.1	11.1	91.3	92.1	91.7	77	85	88	6307	6206	F	19.32	CD0005	-
7 1/2	5.6	1770	213T	**ECP3770T**	9.5	68	22.1	91.6	92.3	91.7	65	76	81	6307	6307	F	19.5	CD0005	-
7 1/2	5.6	1180	254T	**ECP2276T**	10.7	69.7	32.4	89.7	91.5	91.7	52	63	70	6309	6309	E1	24.69	CD0005	-
10	7.5	3500	215T	**ECP3771T**	11	120	15	92.7	92.9	92.4	82	89	92	6307	6307	F	19.5	CD0005	-
10	7.5	1760	215T	**ECP3774T**	12.5	88.5	29.8	92.9	93.1	92.4	67	78	82	6307	6307	F	19.5	CD0005	-
10	7.5	1180	256T	**ECP2332T**	14.2	93	44.4	90.2	91.6	91.7	55	66	72	6309	6309	E1	24.69	CD0180	-
15	11	3525	254T	**ECP2294T**	17.2	128	22.2	90.8	91.9	91.7	78	86	88	6309	6309	E1	24.69	CD0180	-
15	11	1765	254T	**ECP2333T**	18.5	122.9	44.6	91.9	92.6	92.4	66	77	82	6309	6309	E1	24.69	CD0005	-
15	11	1180	284T	**ECP4100T**	19.7	130.1	66.7	91.9	93	93	59	70	77	6311	6311	E1	27.93	CD0180	-
20	15	3540	256T	**ECP4106T**	22	165	29.8	91.5	92.2	92.4	83	91	92	6309	6309	E1	24.69	CD0180	-
20	15	1765	256T	**ECP2334T**	24	175	59	92.8	93.1	93	69	80	84	6309	6309	E1	24.69	CD0005	-
20	15	1180	286T	**ECP4102T**	26	171.6	89	92.5	93.3	93	61	72	78	6311	6311	F	27.93	CD0180	-
25	19	3510	284TS	**ECP4107T**	27	176	37.3	93.4	93.4	92.4	90	93	93	6311	6208	E1	24.66	CD0180	-
25	19	1770	284T	**ECP4103T**	30	186	74.2	92.3	93.5	93.6	73	81	85	6311	6311	E1	27.93	CD0005	-
25	19	1180	324T	**ECP4111T**	32	198	111	92.8	93.5	93	65	75	79	6312	6312	E1	30.27	CD0180	-
30	22	3520	286TS	**ECP4108T**	33	215	44.5	93.2	93.6	93	83	88	90	6311	6311	F	26.56	CD0180	-
30	22	1770	286T	**ECP4104T**	36	246	89	93.8	94.4	94.1	66	75	83	6311	6311	E1	27.93	CD0005	-
30	22	1180	326T	**ECP4117T**	39	243	133	92.5	93.2	93	62	73	78	6312	6312	E1	30.27	CD0005	-
40	30	3540	324TS	**ECP4109T**	45	326	59.5	92.3	93.4	93.6	80	87	90	6312	6312	F	28.66	CD0180	-
40	30	1775	324T	**ECP4110T**	46	320	118	93.9	94.6	94.5	73	81	84	6312	6312	E1	30.27	CD0180	-
40	30	1190	364T	**ECP4308T**	49.4	290	177	93.6	94.3	94.1	69	77	81	6313	6313	F	33.44	416820-2	-
50	37	3540	326TS	**ECP4114T**	56	403	74.1	94	94.5	94.1	80	87	89	6312	6312	E1	28.66	CD0180	-
50	37	1775	326T	**ECP4115T**	57	392	149	94.4	94.9	94.5	73	82	85	6312	6312	E1	30.27	CD0180	-
50	37	1185	365T	**ECP4312T**	61.7	345	221	93.9	94.4	94.1	70	78	81	6313	6313	F	33.44	416820-2	-
60	45	3560	364TS	**ECP4310T**	65.1	398	88.5	95.3	95.5	95	88	91	91	6313	6313	F	31.31	416820-2	-
60	45	1780	364T	**ECP4314T**	68	430	177	95.2	95.3	95	79	85	87	6313	6313	F	33.44	416820-2	-
60	45	1185	404T	**ECP4403T**	69	425	265	94.9	95.2	95	79	84	86	6316	6316	F	38.31	416820-2	-
75	56	3555	365TS	**ECP4313T**	80.7	494	111	95.1	95.4	95	91	92	92	6313	6313	F	31.31	416820-2	-
75	56	1780	365T	**ECP4316T**	85.9	542	221	95.7	95.8	95.4	77	84	86	6313	6313	F	33.44	416820-2	-
75	56	1185	405T	**ECP4404T**	86.9	541	332	95	95.3	95	73	82	85	6316	6316	F	38.31	416820-2	-
100	75	3565	405TS	**ECP4402T**	110	695	147	94.6	95.1	95	86	89	90	6313	6313	F	35.31	416820-2	-
125	93	3570	444TS	**ECP4412T**	138	820	184	93.9	94.7	95	83	87	86	6313	6313	F	40.98	416820-2	-
125	93	3570	444TS	**ECP4912T**	138	820	184	93.9	94.7	95	83	87	86	6313	6313	F	40.98	416820-2	99

NOTES: Volt Code: E = 208-230/460V, 60Hz; E1 = 230/460V, 60Hz, usable at 208V; F = 230/460V, 60 Hz
99 = Has F3 lead outlet hole and an arm mounted conduit box for easy F1 or F2 lead location.
See page 72 for Layout drawing. See page 93 for Connection Diagrams.
Efficiencies shown are nominal. Data subject to change without notice. Contact Baldor for certified data.

Shaded ratings are cast iron frames.

TEFC – Totally Enclosed Fan Cooled
Foot Mounted, 460 & 575 Volt, Three Phase, 1 - 400 Hp

NEMA Premium

Hp	kW	RPM	Frame	Catalog No.	Amps @ High V		F.L. Torque Lb. Ft.	Efficiency %			Power Factor %			Bearings		"C" Dim.	Conn. Diag. No.	Notes
					F.L.	L.R.		1/2	3/4	F.L.	1/2	3/4	F.L.	DE	ODE			
460 Volt, Ball Bearing Designs																		
1	0.75	3450	143T	**ECP3580T-4**	1.4	12.1	1.5	80.5	83.6	84	65	77	84	6205	6205	12.88	CD0006	-
1	0.75	3450	143T	**ENCP3580T-4**	1.3	11.2	1.5	80.5	83.9	84	73	83	87	6205	6203	11.38	CD0006	60
1	0.75	1765	143T	**ECP3581T-4**	1.5	15	3	84.4	87	87.5	48	60	70	6205	6205	12.88	CD0006	-
1	0.75	1765	143T	**ENCP3581T-4**	1.5	15	3	83.6	86.7	87.5	48	60	70	6205	6203	11.36	CD0006	60
1	0.75	1150	145T	**ECP3582T-4**	1.8	9.6	4.5	82.3	84	82.5	42	55	63	6205	6205	12.88	CD0006	-
1	0.75	850	182T	**ECP3687T-4**	2	9.3	6.1	74.1	78.4	78.5	38	48	59	6206	6206	15.93	CD0006	-
1 1/2	1.1	3450	143T	**ECP3583T-4**	2	20.1	2.3	81.3	84.3	85.5	68	78	83	6205	6205	12.88	CD0006	-
1 1/2	1.1	1760	145T	**ECP3584T-4**	2.1	18	4.5	86.5	88.3	88.5	54	67	76	6205	6205	12.88	CD0006	-
1 1/2	1.1	1170	182T	**ECP3667T-4**	2.5	16.2	6.8	85	87.1	87.5	44	56	65	6206	6206	15.93	CD0006	-
1 1/2	1.1	860	184T	**ECP3668T-4**	3.2	10.4	9.2	77.3	80.3	80	36	48	55	6206	6206	15.93	CD0006	-
2	1.5	3450	145T	**ECP3586T-4**	2.5	30	3	83.8	86.2	86.5	70	80	85	6205	6205	12.88	CD0006	-
2	1.5	1755	145T	**ECP3587T-4**	2.8	25	6	86.9	88.5	88.5	54	67	75	6205	6205	12.88	CD0006	-
2	1.5	1165	184T	**ECP3664T-4**	3.2	20.9	9	86.9	88.5	88.5	48	60	68	6206	6206	15.93	CD0006	-
2	1.5	865	213T	**ECP3772T-4**	3.8	18.3	12.1	82.3	85.4	85.5	38	48	56	6307	6307	19.5	CD0006	-
3	2.2	3500	182T	**ECP3660T-4**	3.4	34.5	4.5	87.5	89.1	88.5	83	89	92	6206	6206	15.93	CD0006	-
3	2.2	1760	182T	**ECP3661T-4**	4.1	31.9	9	89.2	90.4	90.2	56	67	75	6206	6206	15.93	CD0006	-
3	2.2	1165	213T	**ECP3764T-4**	4.5	31.5	13.5	88.4	89.8	89.5	53	64	70	6307	6307	19.5	CD0006	-
3	2.2	865	215T	**ECP3775T-4**	5.2	25.6	18.4	85.6	87	85.5	43	55	62	6307	6307	19.5	CD0006	-
5	3.7	3500	184T	**ECP3663T-4**	5.7	63.9	7.5	88.6	89.8	89.5	83	89	93	6206	6206	15.93	CD0006	-
5	3.7	1750	184T	**ECP3665T-4**	6.6	54	15	89.7	90.7	89.5	62	74	80	6206	6206	15.93	CD0006	-
5	3.7	1160	215T	**ECP3768T-4**	7.3	56.4	22.5	90.2	90.9	90.2	51	63	70	6307	6307	19.5	CD0006	-
5	3.7	880	254T	**ECP2280T-4**	8.4	49.7	30.1	87.8	89.8	87.5	48	59	66	6309	6309	24.69	CD0006	-
7 1/2	5.6	3525	213T	**ECP3769T-4**	8.6	86	11.2	90	91.4	91.7	79	87	90	6307	6307	19.5	CD0006	-
7 1/2	5.6	1770	213T	**ECP3770T-4**	9.5	68	22.1	91.6	92.3	91.7	65	76	81	6307	6307	19.5	CD0006	-
7 1/2	5.6	1180	254T	**ECP2276T-4**	10.7	70.1	33.3	90.6	91.8	91.7	53	65	71	6309	6309	24.69	CD0006	-
7 1/2	5.6	880	256T	**ECP2401T-4**	11.9	64.7	45.1	89.2	90.6	90.2	52	64	68	6309	6309	24.69	CD0006	-
10	7.5	3500	215T	**ECP3771T-4**	11	120	15	92.7	92.9	92.4	82	89	92	6307	6307	19.5	CD0006	-
10	7.5	1760	215T	**ECP3774T-4**	12.5	96.9	29.7	92.2	92.7	92.4	69	79	83	6307	6307	19.5	CD0006	-
10	7.5	1180	256T	**ECP2332T-4**	14.2	93	44.4	90.2	91.6	91.7	55	66	72	6309	6309	24.69	CD0006	-
10	7.5	880	284T	**ECP2402T-4**	14.4	71.5	59.6	90	90.9	90.2	53	66	72	6311	6311	27.93	CD0006	-
15	11	3525	254T	**ECP2394T-4**	17.2	128	22.2	90.8	91.9	91.7	78	86	88	6309	6309	24.69	CD0006	-
15	11	1765	254T	**ECP2333T-4**	18.5	122.9	44.6	91.9	92.6	92.4	66	77	82	6309	6309	24.69	CD0006	-
15	11	1180	284T	**ECP4100T-4**	19.8	130.1	66.7	91.9	93	93	59	70	77	6311	6311	27.93	CD0006	-
15	11	880	286T	**ECP2395T-4**	21.5	120	89.4	89.8	90.8	90.2	49	62	72	6311	6311	27.93	CD0006	-
20	15	3540	256T	**ECP4106T-4**	23	201	29.7	91.1	92.3	92.4	74	84	89	6309	6309	24.69	CD0006	-
20	15	1765	256T	**ECP2334T-4**	24	175	59	92.8	93.1	93	69	80	84	6309	6309	24.69	CD0006	-
20	15	1180	286T	**ECP4102T-4**	26	171.6	89	92.5	93.3	93	61	72	78	6311	6311	27.93	CD0006	-
20	15	880	324T	**ECP4112T-4**	28	160	119	89.4	90.7	91	59	68	74	6312	6312	30.27	CD0006	-
25	19	3530	284TS	**ECP4107T-4**	28	236	37.2	93	93.5	93	82	89	91	6309	6309	26.09	CD0006	-
25	19	1770	284T	**ECP4103T-4**	30	187.6	74.2	92.4	93.6	93.6	72	81	84	6311	6311	27.93	CD0006	-
25	19	1180	324T	**ECP4111T-4**	32	198	111	92.8	93.5	93	65	75	79	6312	6312	30.27	CD0006	-
30	22	3520	286TS	**ECP4108T-4**	33	215	44.5	93.2	93.6	93	83	88	90	6311	6311	26.56	CD0006	-
30	22	1770	286T	**ECP4104T-4**	36	246	89	93.8	94.4	94.1	66	75	83	6311	6311	27.93	CD0006	-
30	22	1180	326T	**ECP4117T-4**	39	243	133	92.5	93.2	93	62	73	78	6312	6312	30.27	CD0006	-
40	30	3540	324TS	**ECP4109T-4**	46	352	59.3	92.2	93.2	93	76	84	88	6312	6312	28.66	CD0006	-
40	30	1775	324T	**ECP4110T-4**	46	320	118	93.9	94.6	94.5	73	81	84	6312	6312	30.27	CD0006	-
40	30	1190	364T	**ECP4308T-4**	49.4	290	177	93.6	94.3	94.1	69	77	81	6313	6313	33.44	416820-36	-
50	37	3540	326TS	**ECP4114T-4**	56	403	74.1	93.7	94.4	94.1	80	87	89	6312	6312	28.66	CD0006	-
50	37	1775	326T	**ECP4115T-4**	57	392	149	94.4	94.9	94.5	73	82	85	6312	6312	30.27	CD0006	-
50	37	1185	365T	**ECP4312T-4**	61.7	345	221	93.9	94.4	94.1	70	78	81	6313	6313	33.44	416820-36	-
60	45	3560	364TS	**ECP4310T-4**	65.1	398	88.5	95.3	95.5	95	88	91	91	6313	6313	31.31	416820-36	-
60	45	1780	364T	**ECP4314T-4**	68	430	177	95.2	95.3	95	79	85	87	6313	6313	33.44	416820-36	-
60	45	1185	404T	**ECP4403T-4**	69	425	265	94.9	95.2	95	79	84	86	6316	6316	38.31	416820-36	-
75	56	3555	365TS	**ECP4313T-4**	80.7	494	111	95.1	95.4	95	91	92	92	6313	6313	31.31	416820-36	-
75	56	1780	365T	**ECP4316T-4**	85.9	542	221	95.7	95.8	95.4	77	84	86	6313	6313	33.44	416820-36	-
75	56	1185	405T	**ECP4404T-4**	86.9	541	332	95	95.3	95	73	82	85	6316	6316	38.31	416820-36	-
100	75	3565	405TS	**ECP4402T-4**	110	695	147	94.6	95.1	95	86	89	90	6313	6313	35.31	416820-36	-
100	75	1785	405T	**ECP4400T-4**	112	725	295	95.4	95.7	95.4	83	87	88	6316	6316	38.31	416820-36	-
100	75	1785	405TS	**ECP4400TS-4**	112	725	295	95.4	95.7	95.4	83	87	88	6316	6316	35.31	416820-36	-
100	75	1190	444T	**ECP4409T-4**	119	723	442	95	95.3	95	68	78	83	6318	6318	44.75	416820-36	-
100	75	1188	444T	**ECP4409T-4E**	115	725	442	94.7	95.2	95	77	84	86	6318	6318	44.62	416820-36	56
100	75	1190	444T	**ECP4909T-4**	119	723	442	95	95.3	95	68	78	83	6318	6318	44.75	416820-36	99

NOTES: 56 = Single Frame mounting holes in 447 and 449 frame
60 = Totally Enclosed Non-Ventilated Enclosure (TENV)
99 = Has F3 lead outlet hole and an arm mounted conduit box for easy F1 or F2 lead location.
See page 93 for Connection Diagrams. See page 72 for Dimensions. Efficiencies shown are nominal. Data subject to change without notice. Contact Baldor for certified data.

Shaded ratings are cast iron frames.

BALDOR • RELIANCE

Product Information Packet

FLOWSERVE CORP - (CHESAPEAKE

ECP4402T-4

100HP,3565RPM,3PH,60HZ,405TS,A40060M,TEF

Part Detail

Revision:	L	**Status:**	PRD/A	**Change #:**		**Proprietary:**	No
Type:	AC	**Elec. Spec:**	A40WG0061	**CD Diagram:**	416820-036	**Mfg Plant:**	
Mech. Spec:		**Layout:**	617429-502	**Poles:**	02	**Created Date:**	07-15-2013
Base:		**Eff. Date:**	03-06-2018	**Leads:**	3#2		

Specs

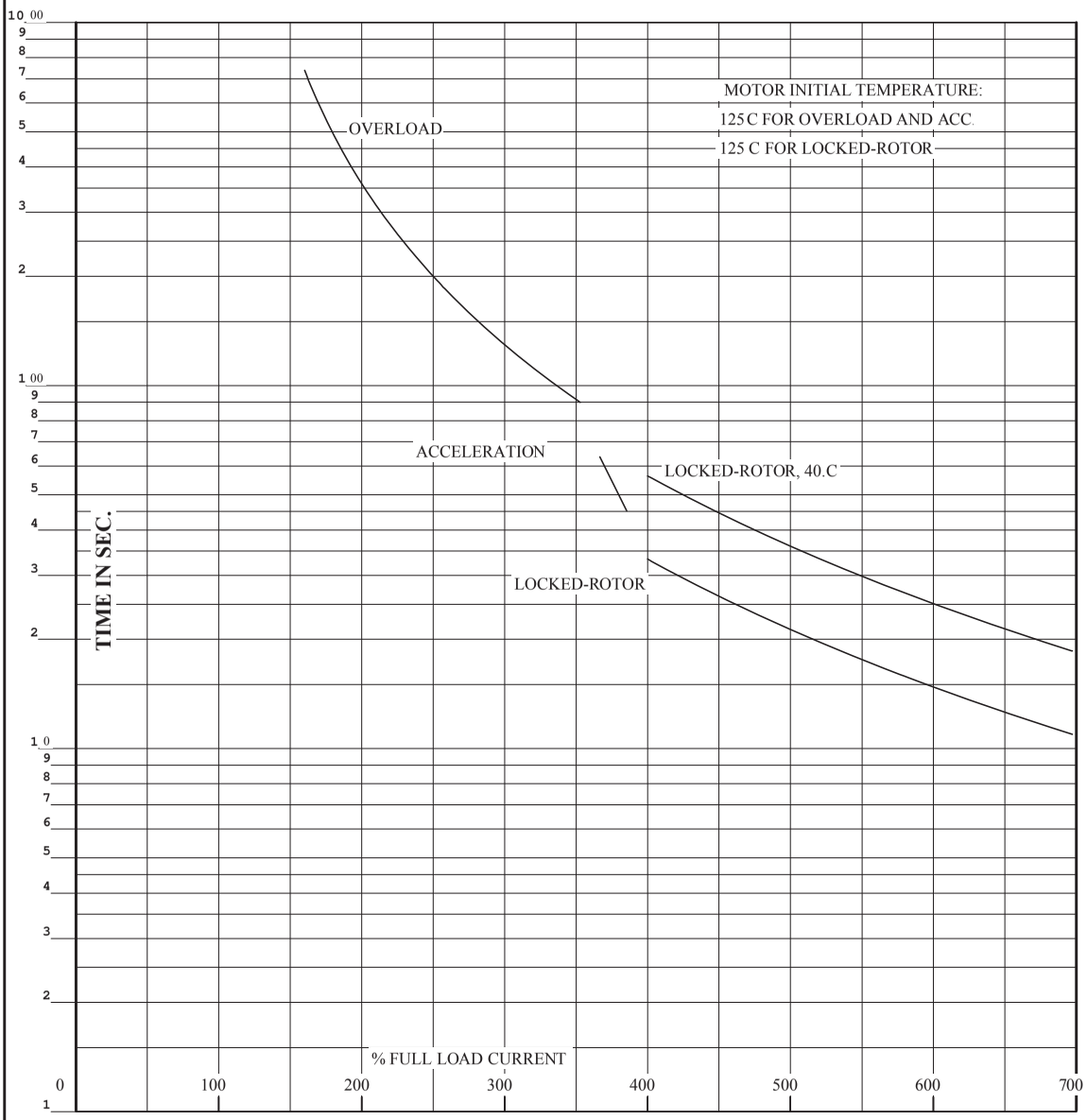
Catalog Number:	ECP4402T-4	**Heater Indicator:**	No Heater
Enclosure:	TEFC	**Insulation Class:**	F
Frame:	405TS	**Inverter Code:**	Inverter Ready
Frame Material:	Iron	**KVA Code:**	F
Output @ Frequency:	100.000 HP @ 60 HZ	**Lifting Lugs:**	Standard Lifting Lugs
Synchronous Speed @ Frequency:	3600 RPM @ 60 HZ	**Motor Lead Quantity/Wire Size:**	3 @ 2 AWG
Voltage @ Frequency:	460.0 V @ 60 HZ	**Motor Type:**	A40060M
XP Class and Group:	None	**Mounting Arrangement:**	F1
XP Division:	Division II	**Power Factor:**	90
Agency Approvals:	CSA EEV	**Pulley End Bearing Type:**	Ball
Auxillary Box:	No Auxillary Box	**Pulley Face Code:**	Standard
Base Indicator:	Rigid	**Shaft Ground Indicator:**	No Shaft Grounding
Bearing Grease Type:	Polyrex EM (-20F +300F)	**Shaft Rotation:**	Reversible
Constant Torque Speed Range:	6-60	**Shaft Slinger Indicator:**	Shaft Slinger
Current @ Voltage:	110.000 A @ 460.0 V	**Speed Code:**	Single Speed
Design Code:	B	**Motor Standards:**	NEMA
Drip Cover:	No Drip Cover	**Starting Method:**	Direct on line
Duty Rating:	CONT	**Thermal Device - Bearing:**	NONE (OLD)

Feedback Device:	NO FEEDBACK	**Thermal Device - Winding:**	None
		XP Temp Code:	T3

Nameplate NP3238

CAT NO	ECP4402T-4	SPEC NO.	P40G3906						
HP	100	AMPS	110	VOLTS	460	DESIGN	B		
FRAME	405TS	RPM	3565	HZ	60	AMB	40	SF	1.15
D.E. BRG.DATA	6313	O.D.E. BRG.DATA	6313	PH	3	DUTY	CONT	INSUL.CLASS	F
D.E. BRG.	65BC03J30X	TYPE	P	ENCL	TEFC	CODE	F		
O.D.E. BRG.	65BC03J30X	POWER FACTOR	90	NEMA NOM EFFICIENCY	95				
3/4 LOAD EFF.	95.1	MAX CORR KVAR	10.0	GUARANTEED EFFICIENCY	94.1				
TEMP CODE	T3	TEMP =	200						
CHP HZ	60-75	CT HZ	6-60	VT HZ	0-60				
INVERTER-TEMP-CODE	T3								
SER.NO.		MOTOR WEIGHT							

REL. S.O.	RPM 3565	S.F. 1.15	ROTOR 418142005PE
FRAME 405TS	VOLTS 460	NEMA DESIGN B	TEST S.O. TYPICAL DATA
HP 100	AMPS 110	CODE LETTER F	TEST DATE ---
TYPE P	DUTY CONT	ENCLOSURE TEFC	STATOR RES.@ 25 °C.0526
PHASE/HERTZ 3/60	AMB °C/INSUL 40/F	E/S 596930	OHMS (BETWEEN LINES)



THERMAL LIMIT CURVE

REMARKS: XE MOTOR-NEMA NOM. EFF. 95.0 %

GUARANTEED MIN. EFF. 94.5%

AMPERES SHOWN FOR 460 VOLT CONNECTION, IF OTHER VOLTAGE CONNECTIONS ARE AVAILABLE, THE AMPERES WILL VARY INVERSELY WITH THE RATED VOLTAGE.

BALDOR
A MEMBER OF THE ABB GROUP

DR. BY	W. L. SMITH
CK. BY	G. R. WEBB
APP. BY	D. M. BYRD
DATE	01/23/02

A-C MOTOR PERFORMANCE CURVES

A40WG0061-R001

ISSUE DATE 03/04/2014

Printed on 3/4/14 7:44 @ ragsun

REL. S.O.	FRAME	HP	TYPE	PHASE/ HERTZ	RPM	VOLTS
	405TS	100	P	3/60	3565	460

AMPS	DUTY	AMB °C/ INSUL.	S.F.	NEMA DESIGN	CODE LETTER	ENCL.
110	CONT	40/F	1.15	B	F	TEFC

E/S	ROTOR	TEST S.O.	TEST DATE	STATOR RES.@25 °C OHMS (BETWEEN LINES)
596930	418142005PE	---	---	.0526

PERFORMANCE

LOAD	HP	AMPERES	RPM	% POWER FACTOR	% EFFICIENCY
NO LOAD	0	25.6	3600	7.57	0
1/4	25.0	36.7	3591	69.7	91.7
2/4	50.0	57.7	3582	85.8	94.6
3/4	75.1	82.7	3572	89.3	95.1
4/4	100	110	3563	89.9	95.0
5/4	125	137	3552	90.2	94.6

SPEED TORQUE

	RPM	TORQUE % FULL LOAD	TORQUE LB.-FT.	AMPERES
LOCKED ROTOR	0	203	299	695
PULL UP	1545	182	269	632
BREAKDOWN	3408	256	377	387
FULL LOAD	3563	100	147	110

AMPERES SHOWN FOR 460. VOLT CONNECTION. IF OTHER VOLTAGE CONNECTIONS ARE AVAILABLE, THE AMPERES WILL VARY INVERSELY WITH THE RATED VOLTAGE

REMARKS: TYPICAL DATA
XE MOTOR-NEMA NOM. EFF. 95.0 %
GUARANTEED MIN. EFF. 94.5%

BALDOR
A MEMBER OF THE ABB GROUP

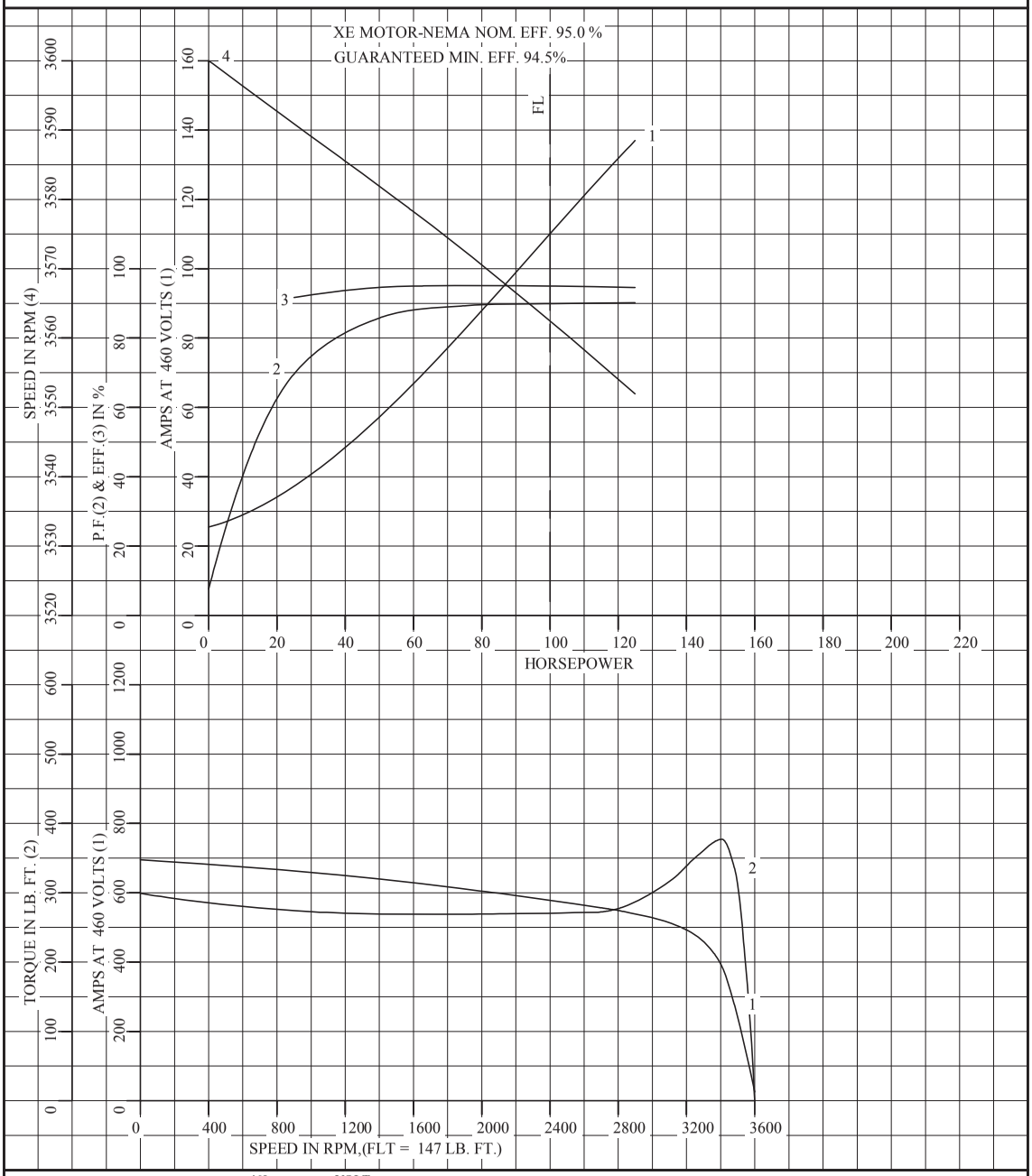
DR. BY W. L. SMITH
CK. BY G. R. WEBB
APP. BY D. M. BYRD
DATE 01/23/02

A-C MOTOR PERFORMANCE DATA

A40WG0061-R001
ISSUE DATE 03/04/20

Printed on 3/4/14 7:44 @ ragsun

REL S.O.		RPM	3565	S.F.	1.15	ROTOR	418142005PE
FRAME	405TS	VOLTS	460	NEMA DESIGN	B	TEST S.O.	TYPICAL DATA
HP	100	AMPS	110	CODE LETTER	F	TEST DATE	---
TYPE	P	DUTY	CONT	ENCLOSURE	TEFC	STATOR RES.@ 25 °C	.0526
PHASE/HERTZ	3/60	AMB °C/INSUL	40/F	E/S	596930		OHMS (BETWEEN LINES)



AMPERES SHOWN FOR 460 VOLT CONNECTION, IF OTHER VOLTAGE CONNECTIONS ARE AVAILABLE, THE AMPERES WILL VARY INVERSELY WITH THE RATED VOLTAGE.

BALDOR
A MEMBER OF THE ABB GROUP

DR. BY	W. L. SMITH
CK. BY	G. R. WEBB
APP. BY	D. M. BYRD
DATE	01/23/02

A-C MOTOR PERFORMANCE CURVES

A40WG0061-R001

ISSUE DATE 03/04/2014

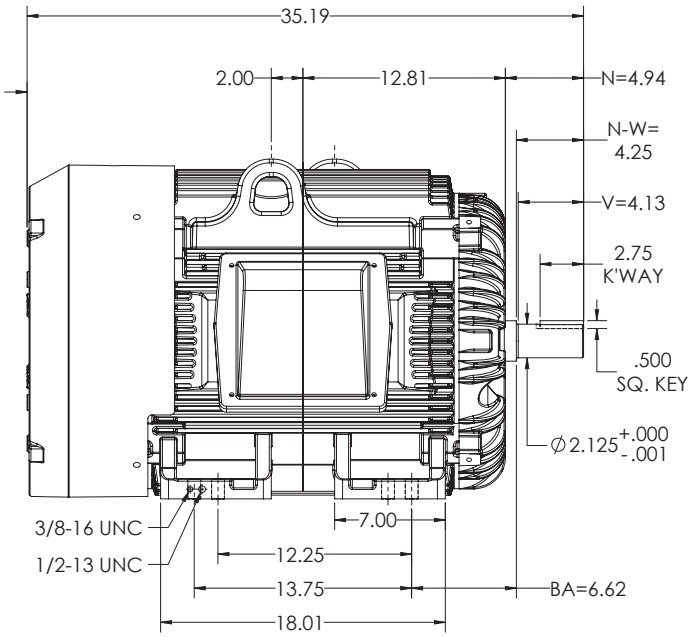
Printed on 3/4/14 7:44 @ ragsun

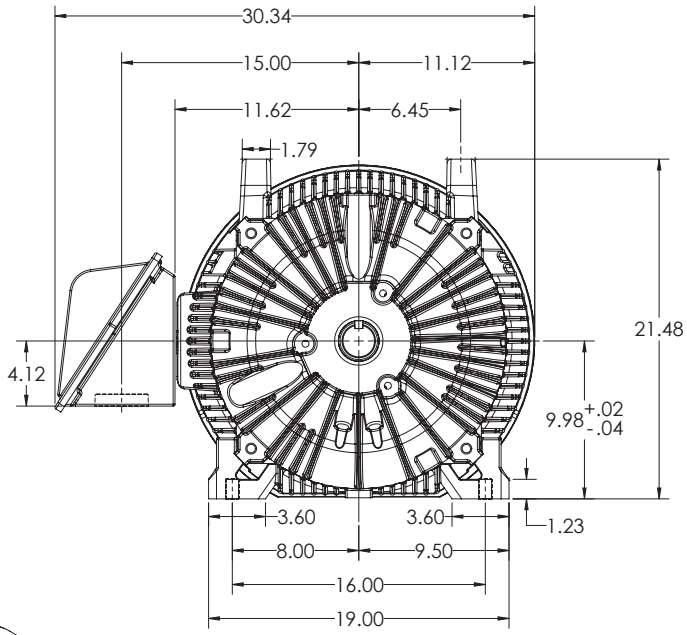
DUTY MASTER ALTERNATING CURRENT MOTORS

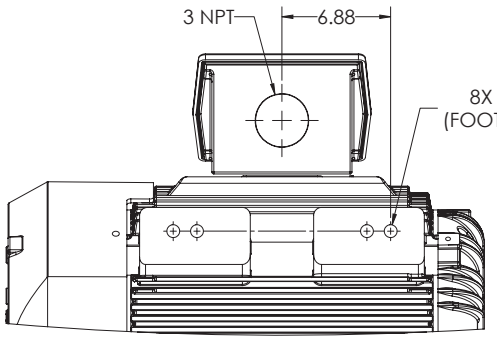
617429-502

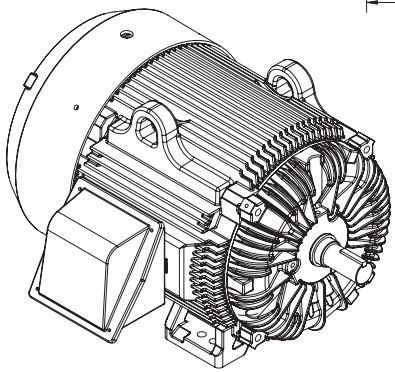
ENCLOSURE: TOTALLY ENCLOSED | SQUIRREL-CAGE INDUCTION | COOLING: FAN COOLED

MOUNTING: FOOT, F-1 | G405TS/G404TS FRAME MOUNTING | ENCLOSURE ENHANCEMENT: SEVERE DUTY









1 OBSTRUCTION MUST NOT ENCROACH ON AIR INLET.

IF MOUNTING CLEARANCE DETAILS ARE REQUIRED, CONSULT FACTORY.

MAX PERMISSIBLE SHAFT RUNOUT WHEN MEASURED AT END OF STANDARD SHAFT EXTENSION IS .003" T.I.R.

DIMENSIONS ARE IN INCHES; SEE SHEET 2 FOR DIMENSIONS IN MILLIMETERS.
WEIGHT (LBS): 1160, MOTOR WEIGHTS MAY VARY BY 15% DEPENDING ON RATING.
CUSTOMER IS RESPONSIBLE FOR DETERMINING THAT MOTOR PERFORMANCE IS SUITABLE IN THE APPLICATION.

REV. DESC: UPDATE DS QUALITY			
REV: C	VERSION: 03	REVISED: 09:15:12 06/28/2017	TDR: 000001033374
MODEL NO. 617429-502			REF:
BY: USJEDIL	Material:		C

BALDOR

G405TS/404TS TEFC F1 FOOT CAST IRON CONDUIT BOX/SEVERE DUTY

SHEET NUMBER 1 OF 2

617429-502

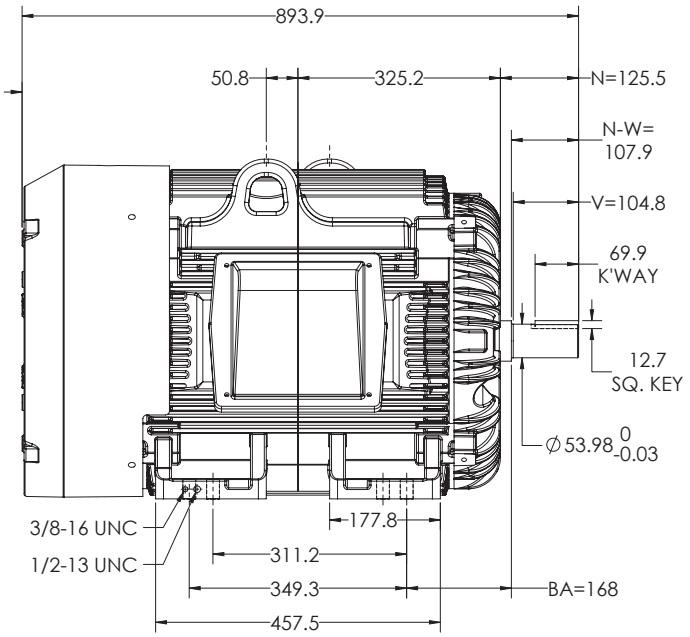
617429-502

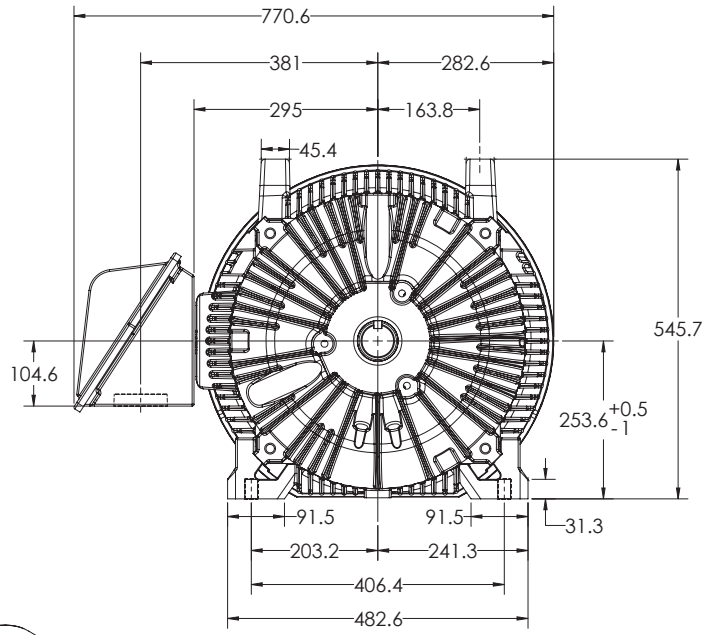
DUTY MASTER ALTERNATING CURRENT MOTORS

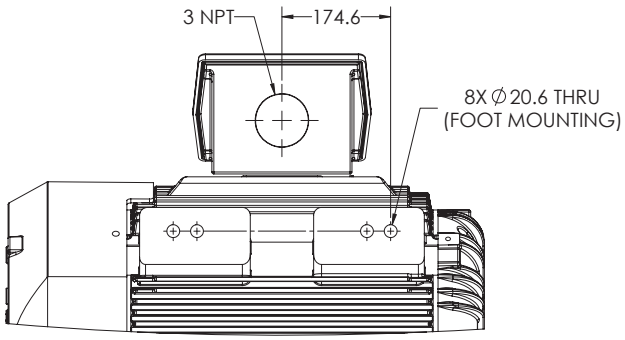
617429-502

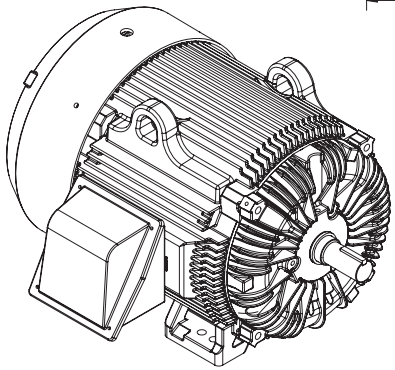
ENCLOSURE: TOTALLY ENCLOSED | SQUIRREL-CAGE INDUCTION | COOLING: FAN COOLED

MOUNTING: FOOT, F-1 | G405TS/G404TS FRAME MOUNTING | ENCLOSURE ENHANCEMENT: SEVERE DUTY









1 OBSTRUCTION MUST NOT ENCROACH ON AIR INLET.

IF MOUNTING CLEARANCE DETAILS ARE REQUIRED, CONSULT FACTORY.
MAX PERMISSIBLE SHAFT RUNOUT WHEN MEASURED AT END OF STANDARD SHAFT EXTENSION IS .08 T.I.R.

DIMENSIONS ARE IN MILLIMETERS.
WEIGHT (KGS): 530, MOTOR WEIGHTS MAY VARY BY 15% DEPENDING ON RATING.
CUSTOMER IS RESPONSIBLE FOR DETERMINING THAT MOTOR PERFORMANCE IS SUITABLE IN THE APPLICATION.

SHEET NUMBER 2 OF 2

617429-502

REV. DESC: UPDATE DS QUALITY			
REV: C	VERSION: 03	REVISED: 09:15:12 06/28/2017	TDR: 000001033374
MODEL NO. 617429-502			REF:
BY: USJEDIL	Material:		C

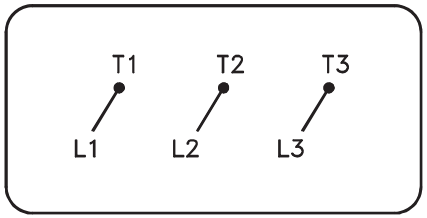
BALDOR

G405TS/404TS TEFC F1 FOOT CAST IRON CONDUIT BOX/SEVERE DUTY

617429-502

416820-036

A-C MOTOR
CONNECTION DIAGRAM
STANDARD 3 LEAD CONNECTED



(N.P. 1575-BA)

416820-036

REV. DESC: LOADED TO BUS, C/R 335225			BALDOR
REV. LTR: -	VERSION: 00	TDR: 000000538207	
FILE: \MGA\00000\682		REVISED: 11:54:06 04/30/2010	CONN DIAG - STANDARD 3 LEAD
MTL: -		BY: RAGRA	SH 1 of 1

Certificate of Approval

This is to certify that the Management System of:

Flowserve Corporation

3900 Cook Boulevard, Chesapeake, VA, 23323, United States

has been approved by LRQA to the following standards:

ISO 9001:2015

Chris Koci - Business Director - Certification

Issued by: Lloyd's Register Quality Assurance, Inc.

Current issue date: 1 November 2018
Expiry date: 31 October 2021
Certificate identity number: 10119320

Original approval(s):
ISO 9001 – 20 October 2000

Approval number(s): ISO 9001 – 0011996

The scope of this approval is applicable to:
Design and Manufacture of Industrial Pumps.

FLOWSERVE

Warranty

1. **WARRANTY:** Subject to the limitations in Section 2 herein, Seller warrants that the Equipment shall be free from defects in material, workmanship, and title. If it appears within twelve (12) months from the initial Equipment startup or until eighteen (18) months after shipment, whichever occurs first, that the Equipment or any part thereof does not conform to this warranty, and Buyer so notifies Seller within a reasonable time after discovery, Seller shall thereupon promptly correct such nonconformity by repair or replacement EXW Seller's factory or service center. Seller's sole obligation and Buyer's sole remedy under this warranty is repair or replacement at Seller's election. Seller's warranty obligation for Services shall be the earlier of either ninety (90) days from the date of initial startup or six (6) months after completion of the Service work. Seller shall not be responsible for any on-site costs, including removal and reinstallation of any warranted Equipment. Buyer agrees to provide Seller reasonable and clear access to its Equipment which may include removal of materials or structures not supplied by Seller as well as supplying any equipment, materials or structures which are necessary to provide reasonable access to the Equipment being repaired or replaced. All Equipment repaired or replaced will be re-warranted only for the remainder of the original warranty period. **THE EXPRESS WARRANTY SET FORTH HEREIN IS THE EXCLUSIVE WARRANTY OF SELLER, AND NO OTHER WARRANTY, EITHER EXPRESSED OR IMPLIED, INCLUDING WARRANTY OF MERCHANTABILITY OR FITNESS FOR PURPOSE, SHALL APPLY.** Seller is not responsible for repairs or alterations made by others without mutual written agreement between Seller and Buyer. Seller does not warrant the Equipment or any repair/replacement part against the effects of erosion, corrosion, or normal wear and tear due to operation or the environment. The warranty and remedies set forth herein are conditioned upon proper storage, installation, use and maintenance of the Equipment in all material respects, and in accordance with Seller's written recommendations. Replacement parts or repairs furnished under this warranty shall be subject to the warranty provisions herein for the remaining original warranty period.

2. **LIMITATION OF LIABILITY / EXCLUSION OF CONSEQUENTIAL LOSS:** The remedies set forth herein are exclusive, and the total liability of the Seller with respect to this Order, or any breach thereof, whether based on contract, warranty, tort (including negligence), indemnity, strict liability or otherwise, shall not exceed the Order price of the specific Equipment or Service which gives rise to the claim.

In all cases where Buyer claims damages allegedly arising out of defective or nonconforming Equipment or Services, Buyer's exclusive remedies and Seller's sole liability shall be those specifically provided for under Section 1 "Warranty".

IN NO EVENT, WHETHER ARISING BEFORE OR AFTER COMPLETION OF ITS OBLIGATIONS UNDER THE CONTRACT, SHALL SELLER BE LIABLE FOR SPECIAL, INDIRECT, CONSEQUENTIAL, INCIDENTAL OR PUNITIVE DAMAGES OF ANY KIND (INCLUDING BUT NOT LIMITED TO LOSS OF USE, REVENUE OR PROFITS, INVENTORY OR USE CHARGES, COST OF CAPITAL, OR CLAIMS OF CUSTOMERS) INCURRED BY THE BUYER OR ANY THIRD PARTY.

3. **GENERAL PROVISIONS:** (a) No Action, regardless of form, arising out of transactions under the Order, may be brought by the Buyer more than one (1) year after the cause of action has accrued. (b) Any modification to these Terms must be set forth in a written instrument signed by a duly authorized representative of Seller. (c) In the event Buyer has reason to believe the Equipment could be subject to a claim for damages or personal injury, Buyer shall immediately provide Seller with written notice of such claim, and shall provide Seller reasonable opportunity to inspect said Equipment and/or investigate the basis for such potential claim. (d) **UNLESS OTHERWISE SPECIFICALLY PROVIDED IN SELLER'S QUOTATION, EQUIPMENT AND SERVICES HEREUNDER ARE NOT INTENDED FOR USE IN ANY NUCLEAR OR NUCLEAR RELATED APPLICATIONS. IF SELLER'S QUOTATION EXPRESSLY STATE THAT THE EQUIPMENT AND SERVICES ARE INTENDED FOR NUCLEAR OR NUCLEAR RELATED APPLICATIONS, SELLER'S ADDENDUM (P-62) FOR NUCLEAR LIABILITY PROTECTION IS HEREBY INCORPORATED.** Buyer (i) accepts the Equipment and Services in accordance with the restriction set forth in the immediately preceding sentences, (ii) agrees to communicate such restriction in writing to any and all subsequent purchasers or users, and (iii) agrees to defend, indemnify and hold harmless Seller from any and all claims, losses, liability, suits, judgments and damages, including incidental and consequential damages, arising from the use of the Equipment or Services in any nuclear or nuclear related applications, whether the cause of action be based in tort, contract or otherwise, including allegations that the Seller's liability is based on negligence or strict liability.

2. Return Water Pond Pumps and Motors 001 and 002

Return Water Pond

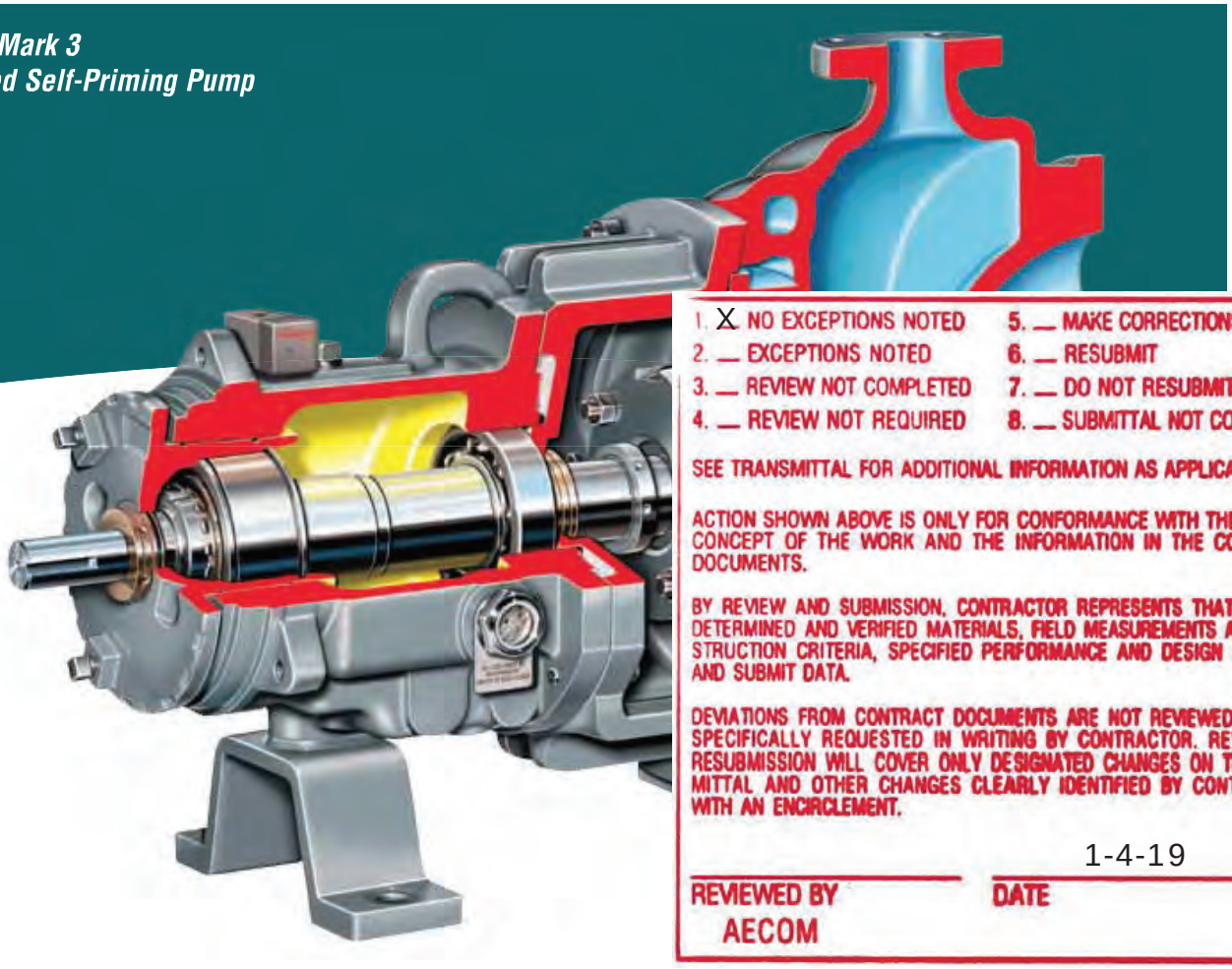
a. **06- FCOOCM-BP-RWP-PMP-001**
b. **07- FCOOCM-BP-RWP-MTR-001**
c. **14- FCOOCM-BP-RWP-PMP-002**
d. **15- FCOOCM-BP-RWP-MTR-002**

FLOWSERVE

APS FOUR CORNERS PO# 100598792
RETURN WATER POND PUMPS

PIONEER EQUIPMENT INC.

Durco Mark 3
Unitized Self-Priming Pump



1. X NO EXCEPTIONS NOTED
2. __ EXCEPTIONS NOTED
3. __ REVIEW NOT COMPLETED
4. __ REVIEW NOT REQUIRED
5. __ MAKE CORRECTIONS NOTED
6. __ RESUBMIT
7. __ DO NOT RESUBMIT
8. __ SUBMITTAL NOT COMPLETE

SEE TRANSMITTAL FOR ADDITIONAL INFORMATION AS APPLICABLE.

ACTION SHOWN ABOVE IS ONLY FOR CONFORMANCE WITH THE DESIGN CONCEPT OF THE WORK AND THE INFORMATION IN THE CONTRACT DOCUMENTS.

BY REVIEW AND SUBMISSION, CONTRACTOR REPRESENTS THAT HE HAS DETERMINED AND VERIFIED MATERIALS, FIELD MEASUREMENTS AND CONSTRUCTION CRITERIA, SPECIFIED PERFORMANCE AND DESIGN CRITERIA AND SUBMIT DATA.

DEVIATIONS FROM CONTRACT DOCUMENTS ARE NOT REVIEWED UNLESS SPECIFICALLY REQUESTED IN WRITING BY CONTRACTOR. REVIEW ON RESUBMISSION WILL COVER ONLY DESIGNATED CHANGES ON THIS SUBMITTAL AND OTHER CHANGES CLEARLY IDENTIFIED BY CONTRACTOR WITH AN ENCIRCLEMENT.

REVIEWED BY AECOM

DATE 1-4-19

The Durco Mark 3 Unitized Self-Priming pump is engineered to draw from liquid sources below ground level or from sources which have no positive pressure to naturally prime the pump. Conveniently located high and dry at ground level where installation is simple and maintenance is easily and more economically performed, the Mark 3 Self-Priming pump costs less to buy, install and maintain than submersible pumps.

The Mark 3 Self-Priming pump's compact design enables it to fit in tight clearance locations. It also can be mounted on a trailer for movement to various pumping areas, such as for wastewater lagoon service.

Operating Parameters

- Flows to 320 m^3/h (1400 gpm)
- Heads to 120 m (400 ft)
- Pressures to 20 bar (285 psi)
- Temperatures to 370°C (700°F)
- Static suction lift to 6 m (20 ft)

Features and Benefits

Unitized Casing has large priming chamber, air separator and volute in one integral component. This design eliminates the need for a separate priming tank.

Standard Reverse Vane Impeller is the only impeller design that offers repeatable pump performance throughout the life of the pump. Open impellers are available.

External Micrometer Impeller Adjustment accurately sets impeller clearance in 20 seconds, in the shop or in the field.

SealSentry Seal Chambers extend seal life and provide advanced self-flushing capability.

Back Pull-out Design allows removal of rotating element without removing casing, piping or motor.

Heavy-duty Pump End and Drive End Bearings are selected for long life and reliability.

6.2 PUMP INSTALLATION AND OPERATION

Installation of the self-priming pump is perhaps more critical than any other of the Durco centrifugal pumps. The suction piping must be as short as possible and be as close to the diameter of the pump's suction nozzle as is practical.

The pump works by removing the air contained in the suction piping. Once removed, it operates exactly the same as a flooded suction Standard pump. The longer the suction pipe, the greater the volume of air that has to be removed. The larger the diameter of the pipe, the greater the volume of air. The suction piping and the seal chamber/stuffing box must be airtight, for any leak will destroy the partial vacuum which is created by the impeller. This vacuum is what allows the liquid to enter the pump.

Initial priming liquid must be added to the pump casing until the liquid level has reached the bottom of the suction nozzle (See Figure 64). Once the initial prime is in place, the pump will automatically replenish itself and additional priming liquids are not normally necessary. If the pump sits idle in the hot sun for extended periods, additional priming liquid might have to be added to make up for evaporation losses. Another important dimension to check is the minimum submergence of the suction pipe into the sump, "S" as shown in Figure 64. See Figure 68 for the acceptable minimum values for "S".

The priming cycle begins pump operation. When the pump is turned on, the spinning impeller quickly moves the priming liquid out of the suction nozzle creating a partial vacuum in the suction line. The sump liquid begins to rise in the suction line, or the liquid in the tank car begins its ascent up the dip tube (See Figure 67). The liquid passes from the impeller and back into the casing where any entrained air is vented out the discharge nozzle. There must be a way for this air to vent. Our typical recommendation is to provide a small diameter air bleed line from discharge pipe to sump if the air is not able to freely vent out the discharge pipe as shown in Figure 66. The liquid falls to the bottom of the priming chamber where it passes through a bypass slot connecting the priming chamber with the volute. The liquid then returns to the impeller where it is mixed with air from the suction pipe. This mix of liquid and air is pumped to the priming chamber again until all of the air is removed from the suction piping. This process may take anywhere from 15 seconds to several minutes depending upon the amount of air to be removed.

Normal operation commences as soon as the suction piping and the priming chamber are void of air (See Figure 67). Liquid from the impeller then passes through the discharge passage and into the priming chamber. At the same time, liquid from the

FIGURE 64

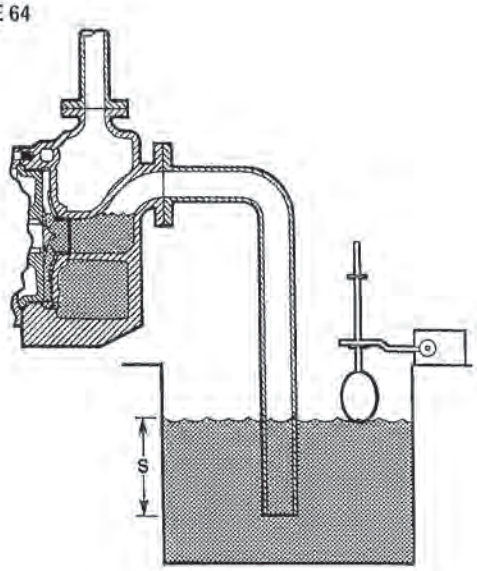


FIGURE 65

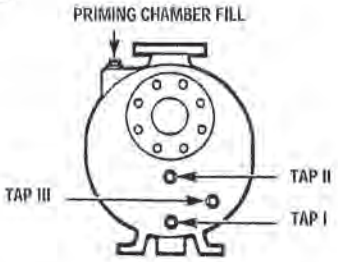
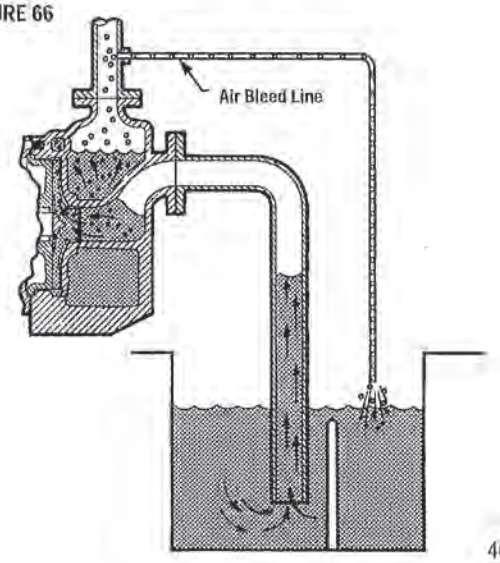
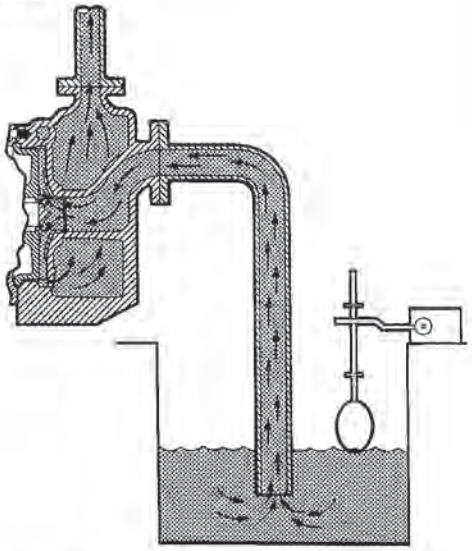


FIGURE 66



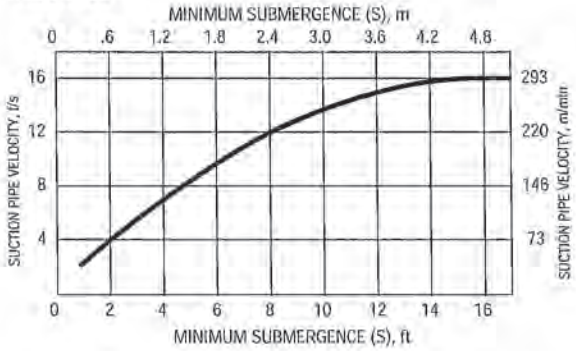
impeller also passes through the bypass slot in the bottom of the casing and into the priming chamber. These two flows join and pass out of the priming chamber through the discharge nozzle located at the top of the chamber.

FIGURE 67



Shut down occurs when the pump is turned off either by a float switch in the sump or manually by the pump operator. The liquid in the discharge piping falls back into the priming chamber and washes back through the impeller and suction nozzle. The backwash creates a siphon effect in the casing and suction nozzle until the liquid falls below the nozzle level and the siphon is broken. The inertia of the liquid flowing backwards pulls the level of the priming chamber to a lower level than achieved with the initial fill. Though the level is lower, there is still sufficient liquid in the priming chamber to allow the pump to reprime itself during the next pumping cycle.

FIGURE 68



It is usually recommended that a bypass line be installed from the casing Tap III (See Figure 65) to the seal chamber or the gland. The purpose of this line is to keep the seal faces wet during the priming cycle. The seal chamber is under negative pressure during priming cycle. It pulls liquid from the flood casing.

When possible, it is recommended that the suction piping be sloped slightly downward to the casing suction flange. This will ensure that no priming fluid is lost down the suction line while the pump is priming.

Special Note: The clearance between the outside diameter of the impeller and the casing cutwater is crucial. The clearance must be 1/8 in (3 mm) or less. If this close clearance is not maintained the pump may not prime.

Customer	: Pioneer Equipment Inc	Pump / Stages	: 2K2x1.5US-10ARV M3 / 1
Customer reference	: AECOM	Based on curve no.	: MII8060V
Item number	: RWP-PMP-001/002	Flowserve reference	: 1407821115
Service	: Return Water Pond Pumps	Date	: December 28, 2018

Operating Conditions

Capacity (rated/normal)	: 90.0 USgpm / -
Water capacity (CQ=1.00)	: -
Total developed head	: 270.00 ft
Water head (CH=1.00)	: -
NPSHa/NPSHa less margin	: 13.9 ft / -
Maximum suction pressure	: -

Liquid

Liquid type	: Other
Liquid description	: -
Temperature	: 105 °F
Density / Specific gravity	: - / 1.000
Solid Size - Actual / Limit	: - / 0.4060 in
Viscosity / Vapor pressure	: 1.00 cP / -

Materials / Specification

Material column code	: D4
Pump specification	: ANSI B73.1

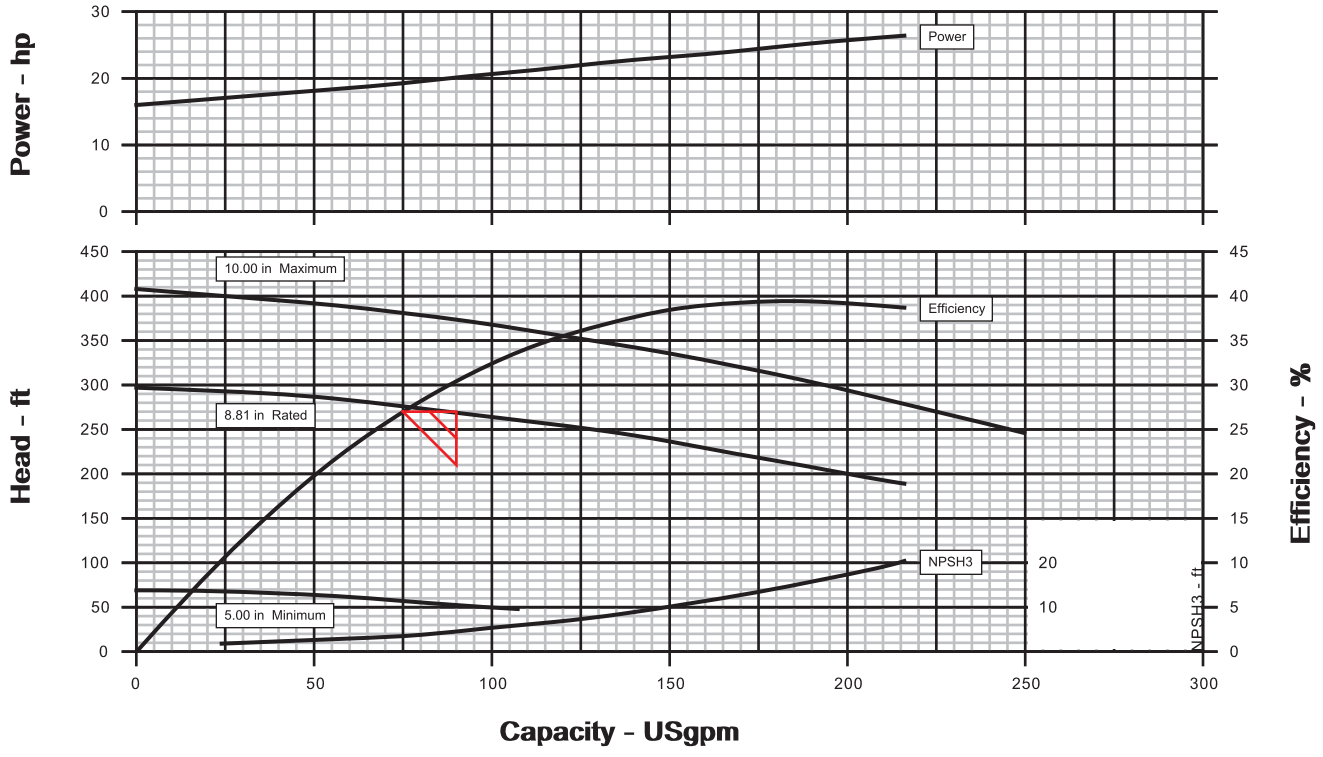
Other Requirements

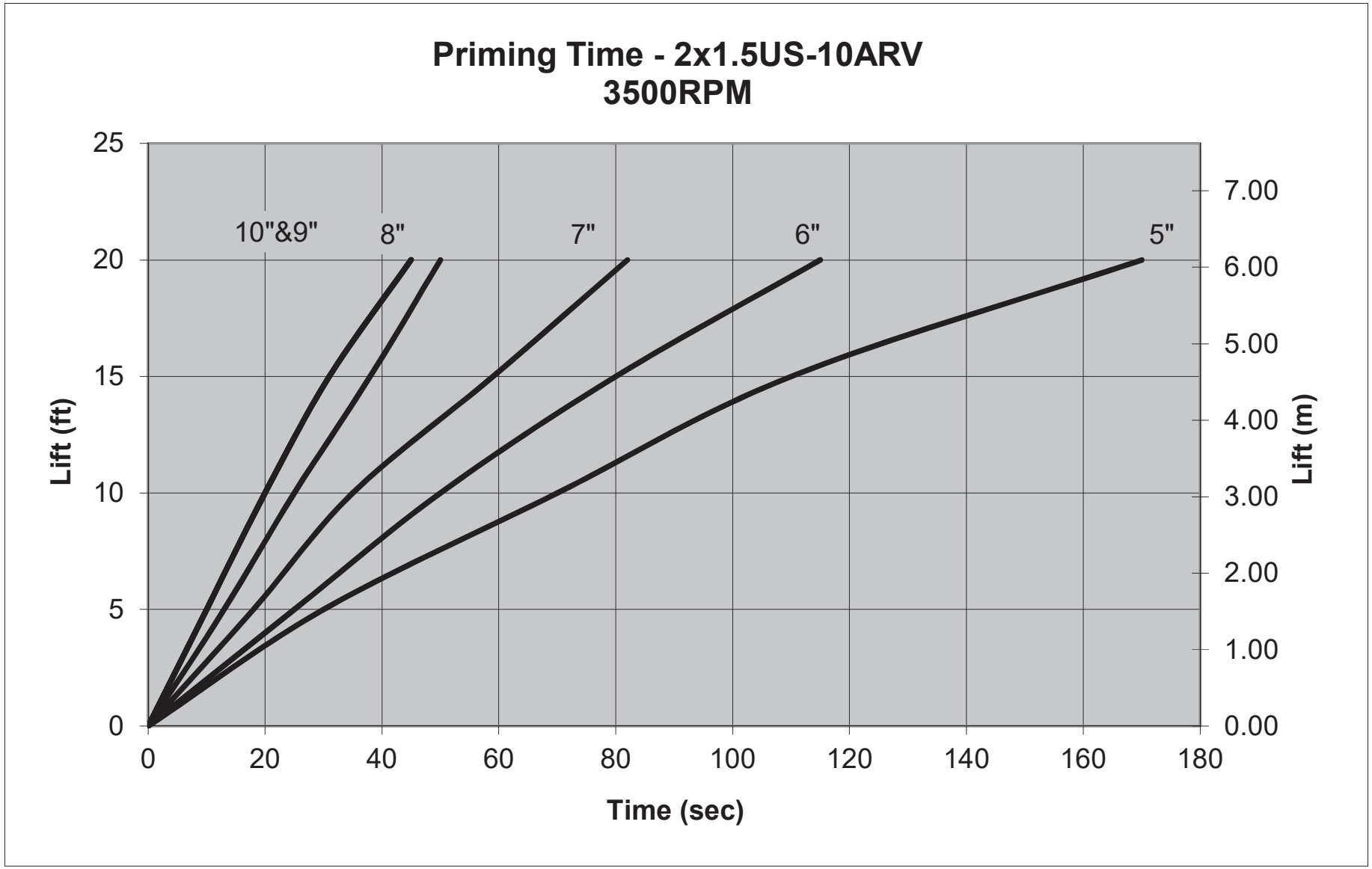
Hydraulic selection : No specification
Construction : No specification
Test tolerance : ANSI/HI 14.6 Grade 1U
Driver Sizing : Max Power(MCSF to EOC) not using SF
Seal configuration : Single Seal

Performance

Hydraulic power	: 6.14 hp	Impeller diameter	
Pump speed	: 3500 rpm	Rated	: 8.81 in
Pump overall efficiency (CE=1.00)	: 30.5 %	Maximum	: 10.00 in
NPSH required (NPSH3)	: 4.5 ft	Minimum	: 5.00 in
Rated brake power	: 20.1 hp	Ns / Nss	: 678 / 6400 (US units)
		Minimum continuous flow	: 17.0 USgpm
Maximum brake power	: 26.5 hp	Maximum head at rated diameter	: 297.39 ft
Driver power rating	: 30.0 hp / 22.4 kW	Flow at BEP	: 184.0 USgpm
Casing working pressure	: 128.7 psig	Flow as % of BEP	: 48.9 %
(based on shut off @ cut dia/rated SG)		Efficiency at normal flow	: -
Maximum allowable	: 273.0 psig	Impeller diameter ratio (rated/max)	: 88.1 %
Hydrostatic test pressure	: 413.0 psig	Head rise to shut off	: 10.1 %
Estimated rated seal chamber pressure	: 9.9 psig	Total head ratio (rated / max) / (max / rated)	: 72.4 % / 138.2 %

CURVES ARE APPROXIMATE, PUMP IS GUARANTEED FOR ONE SET OF CONDITIONS; CAPACITY, HEAD, AND EFFICIENCY.




Priming Time - 2x1.5US-10ARV
3500RPM
10"&9"
8"
7"
6"
5"
Lift (ft)
Lift (m)
Time (sec)
0
5
10
15
20
25
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
0
20
40
60
80
100
120
140
160
180

FLOWSERVE

Construction Datasheet

Customer	: Pioneer Equipment Inc	Pump / Stages	: 2K2x1.5US-10ARV M3 / 1
Customer reference	: AECOM	Based on curve no.	: MII8060V
Item number	: RWP-PMP-001/002	Flowserve reference	: 1407821115
Service	: Return Water Pond Pumps	Date	: December 28, 2018

Construction

Nozzles	Size	Rating	Face	Position
Suction	2.00	150#	FF	End
Discharge	1.50	150#	FF	Top

Casing mounting	: Foot
Casing split	: Radial
Impeller type	: Reverse Vane
Bearing type (radial)	: Single row
Bearing number (radial)	: 6310-ZC3
Bearing type (thrust)	: Double row
Bearing number (thrust)	: 5310-AZC3
Bearing lubrication	: Regreasable
Rotation (view from driver)	: CW per Hyd. Institute

Materials

Casing	: D4/CF8M
Impeller	: CD4M/CD-4MCuN
Seal chamber	: FML Box / (316SS)
Shaft	: 316 SS
Sleeve	: No Sleeve Req'd

Baseplate, Coupling and Guard

Baseplate type	: D Reinforced
Baseplate material	: Steel
Baseplate size	: 264
Coupling manufacturer	: T.B. Woods
Coupling size	: Sureflex SC8H
Coupling / Shaft guard	: Steel
Shaft / seal guard	: PCY Seal Guard

Weights (Approx.)

Bareshaft pump (net)	: 320.0 lb
Baseplate (net)	: 385.0 lb
Driver (net)	: 390.0 lb
Shipping gross weight/volume	: 1259.3 lb / 38545 cu.in

Testing

Hydrostatic test	: Non witnessed
Performance test	: -
NPSH test	: None

Paint and Package

Pump paint	: FLS St'd PU Topcoat
Base grout surface prep	: Flowserve St'd D14-3
Shipment type	: Domestic

Driver Information

Manufacturer	: ABB/Baldor
Power	: 30.0 hp / 22.4 kW
Service factor (requested / actual)	: 1.15 / 1.15
Synchronous speed	: 3600 rpm
Orientation / Mounting	: Horizontal / Foot
Driver type	: NEMA
Frame-size / material	: 286TS / CAST IRON
Enclosure	: TEFC-XEX
Hazardous area class	: N/A Safe Area
Explosion 'T' rating	: N/A Safe Area
Volts / Phase / Hz	: 230/460 / 3 / 60 Hz
Amps-full load/locked rotor	: 36.00 A / 212.50 A
Motor starting	: Direct on line (DOL)
Insulation	: F
Temperature rise	: 80 °C
Bearings	: Ball
Lubrication	: Grease
Motor mounted by	: FPD

Sound Pressure (dBA @ 1.0 m)

Driver, expected	: 71.0 dBA
Pump & driver, estimated	: 81.0 dBA

Seal Information

Arrangement	: Sgl Int O-Ring
Size	: 1.875 Inch
Manufacturer / Type	: Flowserve / ISC2 Pusher
Material code (Man'f/API)	: C2CPX----EAXV- / SBTFX
Internal neck bushing	: Not Available

Gland

Gland material	: 316SS Large Bore
Flush	: .375" NPT
Vent	: .25" NPT
Drain	: .25" NPT
Auxiliary seal device	: Carbon Bushing

Piping

Seal flush plan	: Other
Seal flush construction	: Hose
Seal flush material	: Other
Aux seal flush plan	: None
Aux seal flush construction	: -
Aux seal flush material	: -

Notes

-

Mark IIIA Power End

-

-

-

No cust. insp. or documents required

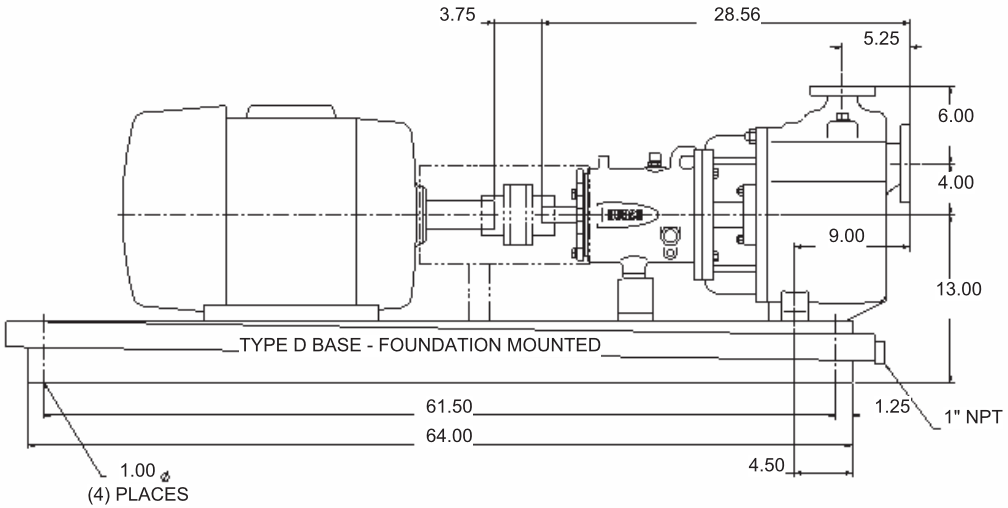
Full Page GA Drawing

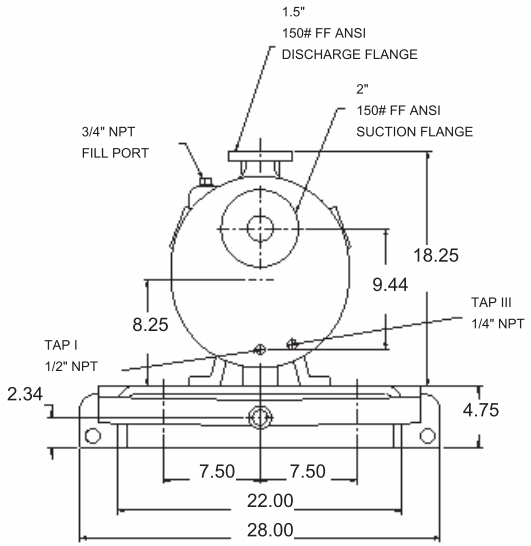
Dimensions certified for construction when properly endorsed below.
Refer to factory for any "*" dimensions.
DO NOT SCALE DRAWING

NOTES:
1. Consult pump I.O.M. before installing the pump.
2. Installation dimensions are +/- .13" (3mm), unless otherwise noted.
3. Foundation bolts and piping should not be set rigidly before receipt of equipment.
4. Allow a minimum of .75" (19mm) under baseplate for adjustment and grouting.
5. All holes in flanges straddle centerlines.
6. Piping, foundations, and systems are the responsibility of others. Flowserve Pump Division data and comments are offered as an aid, but Flowserve Pump Division cannot assume responsibility for the system design or operation. It is recommended that a specialist skilled in this area be consulted to ensure a successful installation.

Shaft Dia. at Seal: 1.875"

Shaft Dia at Cplg: 1.125"





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Customer	: Pioneer Equipment Inc	Pump size & type	: 2K2x1.5US-10ARV M3	Drawing number	: -
Item number	: RWP-PMP-001/002	Pump speed / Stages	: 3500 rpm / 1	Date	: December 28, 2018
Service	: Return Water Pond Pumps	Flow / Head	: 90.0 USgpm / 270.00 ft	Certified by / Date :	: -
Customer PO #	: -	Driver power / Frame	: 30.0 hp / 22.4 kW / 286TS	Seal type	: ISC2 Pusher
Flowserve reference	: 1407821115	Volts / Phase / Hz	: 230/460 / 3 / 60 Hz	Seal flush plan	: Other

Contact: Eric Lock

Address: Pioneer Equipment Inc
3738 E. Miami Ave.
Phoenix, AZ 85040

Phone: 602-437-4312

Scope of Supply

Customer:	Pioneer Equipment Inc	Pump / Stages:	2K2x1.5US-10ARV M3 / 1
Cust / Proj Ref:	AECOM	Based on curve no.:	MII8060V
Item number:	RWP-PMP-001/002	FLS # / Reference:	1407821115 /
Service:	Return Water Pond Pumps	Date:	Dec 28, 2018

Qty	Description
2	2K2x1.5US-10ARV M3 FPD - D4
	Packaging by Chesapeake
	Safe (non explosive) atmosphere
	Casing - 316SS (D4/CF8M)
	Cover - 316SS (D4/CF-8M)
	Cover Gasket - TM
	Impeller - CD4M/CD4MCuN
	Impeller Gasket - TFR
	Bearing Housing - CI
	Bearing Hsg Adapter - DCI2/7040
	Bearing Hsg Foot - CI
	Shaft - Standard
	• Shaft - 316 Stainless
	• Casing Studs B7TF / Nuts SRTF (Steel-TEF Coated)
	• Gland Studs B8C1/Nuts E8 (18-8)
	Casing - Standard
	150# FF ANSI Drilling
	• 1/2" NPT Casing Drain Tap (Plugged)
	• 1/4" NPT Suction Tap (Tap II)
	• 1/4" NPT Discharge Tap (Tap III)
	Plastic Flange Covers
	Impeller Balance ISO 1940 G6.3
	Power End Mark 3A
	• Bearings - Regreaseable (Single Shield)
	• Oil Seals - TSSR
	304ss Nameplate US Customary Units
	Shaft Sealing Diameter - 1.875"
	Flowserve Single Cartridge Seal
	• ISC2 Pusher w/o Pumping Ring
	• SilCar Rotary vs. SilCar Seat
	• Diamond coated SiC Seal faces
	• Viton Elastomers
	• 316SS Metal Parts
	• 316SS Large Bore Gland
	Seal Chamber - FML (Large Bore Taper design + Flow Modifiers)

Feature quantities match pump quantity unless otherwise noted.

Proposal is valid for 60 days.

Customer:	Pioneer Equipment Inc	Pump / Stages:	2K2x1.5US-10ARV M3 / 1
Cust / Proj Ref:	AECOM	Based on curve no.:	MII8060V
Item number:	RWP-PMP-001/002	FLS # / Reference:	1407821115 /
Service:	Return Water Pond Pumps	Date:	Dec 28, 2018

Qty	Description
	Bypass-1/4" TFE 303 Braided w/316SS Ftgs
	3.5" Coupling Spacer
	Coupling Service Factor ≥ 1.5
	• Woods Sure-Flex SC w/HYTREL [SC8H]
	• HYTREL Spacer
	Standard Coupling build
	Std. Steel Cplg Guard (Safety Yellow)
	Durcoshield Seal Guard
	• PCY Material Seal Guard
	Type D - Reinforced Foundation Baseplate
	• Opt 5 - Mach Top / End Cap / Full Drip
	• 264 Baseplate
	• Steel - Baseplate
	• Polybloc - Driver Mounting
	• Steel - Fasteners
	• Baseplate - Machined Top Surface
	• Baseplate - Lifting Holes (4)
	• Baseplate - End Caps
	• IPS Beacon 2 Not Provided
	No Radiography/ X-Ray
	10 Min Non-Wit Hydro Test-Csg & Cvr Only
	Performance Test - ANSI/HI 14.6 Grade 1U
	• Non-Witnessed Performance Test
	Performance Test with Shop Motor
	Performance Test at Standard Speed
	No Vibration Test Required
	Pump Coating - Manufacturer's Standard Polyurethane Top Coat
	Pump Color - Quartz Grey (RAL 7039)
	Baseplate Color - Same as Pump Color
	Coupling/Seal Guard Coating - Manufacturer's Standard
	Coupling/Seal Guard Color - Signal Yellow (RAL 1003)
	Driver/Motor Coating - Manufacturer's Standard
	Driver/Motor Color - Manufacturer's Standard
	• Flowserve Standard Warranty
	No Documentation Required
	• English - Language
	• 3 User Instruction Manuals
	Standard Domestic Packaging (6 Months)
	EXW - Ex-Works
2	Driver
	Driver Mounted by Factory
	NEMA Motor

Feature quantities match pump quantity unless otherwise noted.

Proposal is valid for 60 days.

Customer:	Pioneer Equipment Inc	Pump / Stages:	2K2x1.5US-10ARV M3 / 1
Cust / Proj Ref:	AECOM	Based on curve no.:	MII8060V
Item number:	RWP-PMP-001/002	FLS # / Reference:	1407821115 /
Service:	Return Water Pond Pumps	Date:	Dec 28, 2018

Qty	Description		
	• Motor Manufacturer • ABB/Baldor • TEFC PE Severe Duty XEX • Standard XEX (30.0 hp 3600 RPM 286TS) • 230/460 volts • No Space Heaters		

Feature quantities match pump quantity unless otherwise noted.

Proposal is valid for 60 days.

FLOWSERVE

ISC2 Series

Innovative standard cartridge seals

Sealing solutions for fluid handling applications
on shaft diameters up to 200 mm (8.000 inch)

Experience In Motion

FLOWSERVE

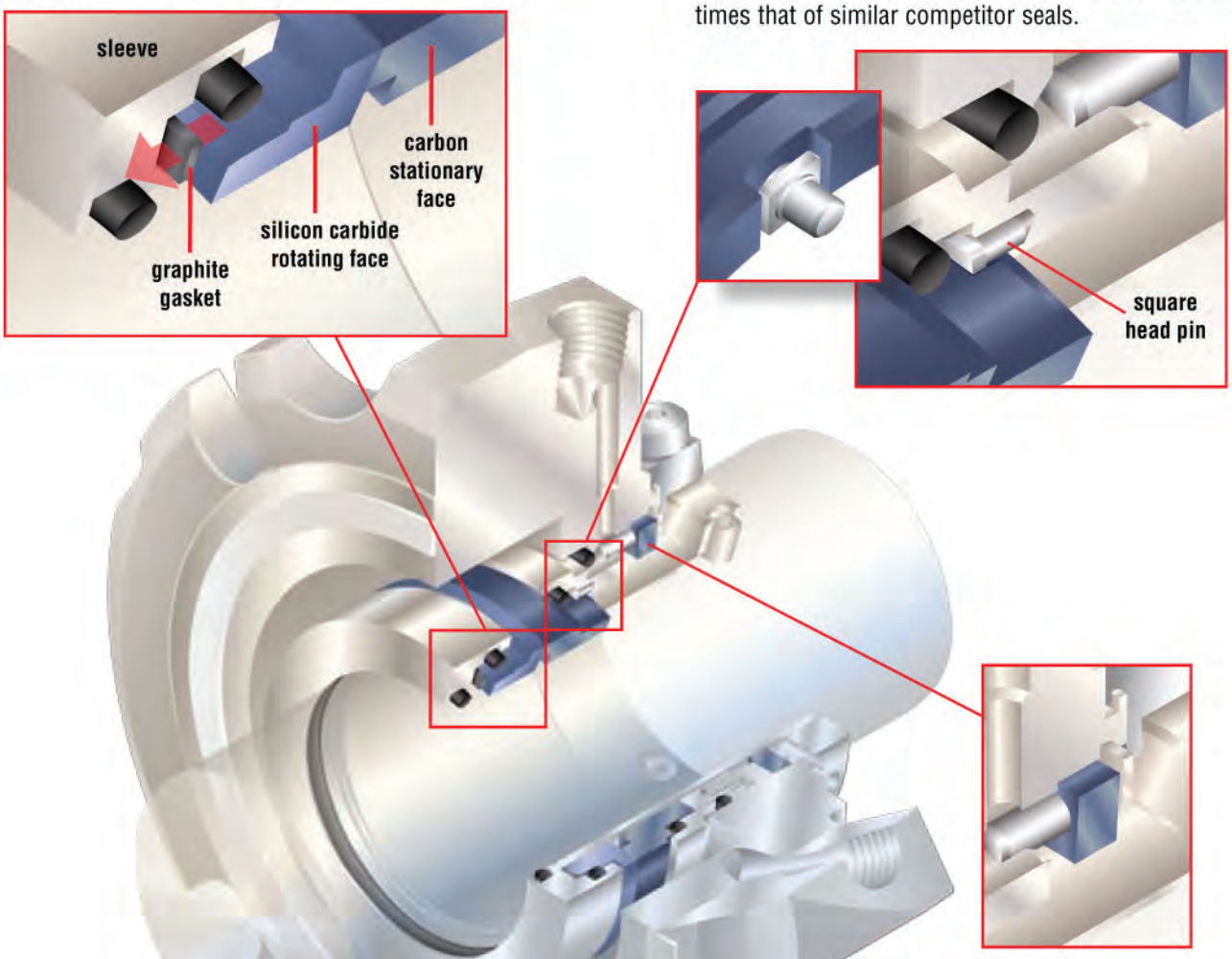
Advanced ISC2 seal design features enable superior rotating equipment reliability

Tolerate dry running events with our exclusive thermal management technology

Thermally conductive and mechanically compliant graphite material dramatically improves heat transfer between the silicon carbide rotating seal face and the sleeve. The sleeve acts as a heat sink, lowering seal face operating temperatures and transforming cavitating and dry running bad actors into highly reliable installations.

Robust drive mechanisms deliver high torque loads with low seal face stress

Square-head drive pins self-align with the seal faces to distribute torque loads evenly over an area instead of a high-stress point load, reducing seal face fractures. The torque carrying capability of the ISC2 seal is three times that of similar competitor seals.



ISC2 Single Stationary Pusher Seal

Safe containment is provided by an uncompromising throttle bushing

A substantial fixed carbon bushing on the atmospheric side of single seals provides an added measure of safety and reliability in the unlikely event of a seal failure. Process leakage is directed to the drain for safe handling and disposal.

Materials of Construction

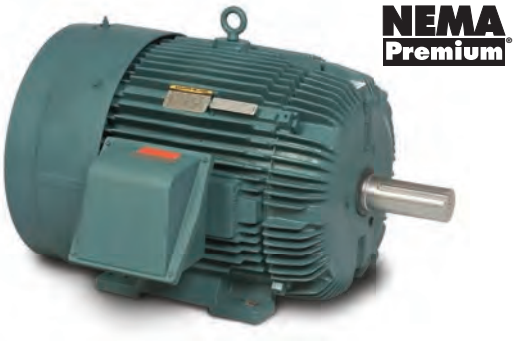
Metal Parts	316 Stainless Steel, Alloy C-276, Alloy 20, Titanium
Seal Faces	Premium Resin Carbon vs. Sintered Silicon Carbide * Sintered Silicon Carbide vs. Sintered Silicon Carbide Premium Resin Carbon vs. Tungsten Carbide Tungsten Carbide vs. Sintered Silicon Carbide
Metal Bellows	Alloy C-276
Elastomers	Fluoroelastomer, Perfluoroelastomer, EPDM, TFE-Propylene
Springs	Alloy C-276
Set Screws	17-4 H900 Stainless Steel

Operating Parameters

Pressure	
Pusher seal	0 to 20.6 bar (300 psig)
Metal bellows seal	0 to 13.8 bar (200 psig)
Temperature	-40 to 204°C (-40 to 400°F)
Maximum Speed	3600 rpm or 23 m/s (75 fps)
Seal Chamber Specifications	ASME B-73, EN 12 756, JIS, ISO 3069, API 682
Shaft Size	
Pusher seal	25 to 200 mm (1.000" to 8.000")
Metal bellows seal	25 to 95 mm (1.000" to 3.750")

* Diamond Coated for low temp and temporary dry run.

Severe Duty Super-E® ECP/XEX NEMA Premium® Efficient Motors



Baldor•Reliance Super-E, ECP motors have XEX designs that meet the demanding application requirements typically found in harsh processing environments. Features include cast iron construction, Oversized and rotatable cast iron conduit box, V-Ring shaft seal, Stainless steel nameplate and Corrosion resistant hardware and epoxy finish. Super-E electrical designs have 1.15 service factors and a Class F Insulation system that is Inverter Ready and meets NEMA MG 1 Part 31.4.4.2.

TEFC – Totally Enclosed Fan Cooled
Foot Mounted, 230/460 Volts, Three Phase, 1-125 Hp

Hp	kW	RPM	Frame	Catalog No.	Amps @ High V		F.L. Torque Lb. Ft.	Efficiency %			Power Factor %			Bearings		Volt Code	"C" Dim.	Conn. Diag. No.	Notes
					F.L.	L.R.		1/2	3/4	F.L.	1/2	3/4	F.L.	DE	ODE				
1	0.75	3450	143T	**ECP3580T**	1.4	12.1	1.5	80.6	84	84	65	77	83	6205	6205	E	12.88	CD0005	-
1	0.75	1765	143T	**ECP3581T**	1.5	15	3	84.4	87	87.5	48	60	70	6205	6205	E	12.88	CD0005	-
1	0.75	1150	145T	**ECP3582T**	1.8	9.6	4.5	82.3	84	82.5	42	55	63	6205	6205	E	12.88	CD0005	-
1 1/2	1.1	3450	143T	**ECP3583T**	2	20.1	2.3	81.3	84.3	85.5	68	78	83	6205	6205	E	12.88	CD0005	-
1 1/2	1.1	1760	145T	**ECP3584T**	2.1	18	4.5	86.8	88.4	88.5	54	67	76	6205	6205	E	12.88	CD0005	-
1 1/2	1.1	1170	182T	**ECP3667T**	2.5	16.2	6.8	84.8	86.9	87.5	44	56	64	6206	6206	E	15.93	CD0005	-
2	1.5	3450	145T	**ECP3586T**	2.5	30	3	83.8	86.2	86.5	70	80	85	6205	6205	E	12.88	CD0005	-
2	1.5	1755	145T	**ECP3587T**	2.8	25	6	86.9	88.5	88.5	54	67	75	6205	6205	E	12.88	CD0005	-
2	1.5	1165	184T	**ECP3664T**	3.2	20.9	9	96.9	88.5	88.5	48	60	68	6206	6206	F	15.93	CD0005	-
3	2.2	3500	182T	**ECP3660T**	3.4	32	4.5	87.5	89.1	88.5	83	89	92	6206	6206	E1	15.93	CD0005	-
3	2.2	1760	182T	**ECP3661T**	4.2	33	9	88.9	90.4	90.2	54	66	74	6206	6206	E1	15.93	CD0005	-
3	2.2	1165	213T	**ECP3764T**	4.5	30.9	13.5	89.5	90.4	90.2	52	64	70	6307	6307	E1	19.5	CD0005	-
5	3.7	3490	184T	**ECP3663T**	5.7	64.8	7.5	89.4	90.8	90.2	76	85	90	6206	6205	E1	15.93	CD0005	-
5	3.7	1750	184T	**ECP3665T**	6.6	54	14.9	90.3	91.2	89.5	60	73	80	6206	6206	E	15.93	CD0005	-
5	3.7	1160	215T	**ECP3768T**	7.3	51.9	22.8	90.3	91	90.2	54	65	72	6307	6307	E1	19.5	CD0005	-
7 1/2	5.6	3510	213T	**ECP3769T**	8.6	61.1	11.1	91.3	92.1	91.7	77	85	88	6307	6206	F	19.32	CD0005	-
7 1/2	5.6	1770	213T	**ECP3770T**	9.5	68	22.1	91.6	92.3	91.7	65	76	81	6307	6307	F	19.5	CD0005	-
7 1/2	5.6	1180	254T	**ECP2276T**	10.7	69.7	32.4	89.7	91.5	91.7	52	63	70	6309	6309	E1	24.69	CD0005	-
10	7.5	3500	215T	**ECP3771T**	11	120	15	92.7	92.9	92.4	82	89	92	6307	6307	F	19.5	CD0005	-
10	7.5	1760	215T	**ECP3774T**	12.5	88.5	29.8	92.9	93.1	92.4	67	78	82	6307	6307	F	19.5	CD0005	-
10	7.5	1180	256T	**ECP2332T**	14.2	93	44.4	90.2	91.6	91.7	55	66	72	6309	6309	E1	24.69	CD0180	-
15	11	3525	254T	**ECP2294T**	17.2	128	22.2	90.8	91.9	91.7	78	86	88	6309	6309	E1	24.69	CD0180	-
15	11	1765	254T	**ECP2333T**	18.5	122.9	44.6	91.9	92.6	92.4	66	77	82	6309	6309	E1	24.69	CD0005	-
15	11	1180	284T	**ECP4100T**	19.7	130.1	66.7	91.9	93	93	59	70	77	6311	6311	E1	27.93	CD0180	-
20	15	3540	256T	**ECP4106T**	22	165	29.8	91.5	92.2	92.4	83	91	92	6309	6309	E1	24.69	CD0180	-
20	15	1765	256T	**ECP2334T**	24	175	59	92.8	93.1	93	69	80	84	6309	6309	E1	24.69	CD0005	-
20	15	1180	286T	**ECP4102T**	26	171.6	89	92.5	93.3	93	61	72	78	6311	6311	F	27.93	CD0180	-
25	19	3510	284TS	**ECP4107T**	27	176	37.3	93.4	93.4	92.4	90	93	93	6311	6208	E1	24.66	CD0180	-
25	19	1770	284T	**ECP4103T**	30	186	74.2	92.3	93.5	93.6	73	81	85	6311	6311	E1	27.93	CD0005	-
25	19	1180	324T	**ECP4111T**	32	198	111	92.8	93.5	93	65	75	79	6312	6312	E1	30.27	CD0180	-
30	22	3520	286TS	**ECP4108T**	33	215	44.5	93.2	93.6	93	83	88	90	6311	6311	F	26.56	CD0180	-
30	22	1770	286T	**ECP4104T**	36	246	89	93.8	94.4	94.1	66	75	83	6311	6311	E1	27.93	CD0005	-
30	22	1180	326T	**ECP4117T**	39	243	133	92.5	93.2	93	62	73	78	6312	6312	E1	30.27	CD0005	-
40	30	3540	324TS	**ECP4109T**	45	326	59.5	92.3	93.4	93.6	80	87	90	6312	6312	F	28.66	CD0180	-
40	30	1775	324T	**ECP4110T**	46	320	118	93.9	94.6	94.5	73	81	84	6312	6312	E1	30.27	CD0180	-
40	30	1190	364T	**ECP4308T**	49.4	290	177	93.6	94.3	94.1	69	77	81	6313	6313	F	33.44	416820-2	-
50	37	3540	326TS	**ECP4114T**	56	403	74.1	94	94.5	94.1	80	87	89	6312	6312	E1	28.66	CD0180	-
50	37	1775	326T	**ECP4115T**	57	392	149	94.4	94.9	94.5	73	82	85	6312	6312	E1	30.27	CD0180	-
50	37	1185	365T	**ECP4312T**	61.7	345	221	93.9	94.4	94.1	70	78	81	6313	6313	F	33.44	416820-2	-
60	45	3560	364TS	**ECP4310T**	65.1	398	88.5	95.3	95.5	95	88	91	91	6313	6313	F	31.31	416820-2	-
60	45	1780	364T	**ECP4314T**	68	430	177	95.2	95.3	95	79	85	87	6313	6313	F	33.44	416820-2	-
60	45	1185	404T	**ECP4403T**	69	425	265	94.9	95.2	95	79	84	86	6316	6316	F	38.31	416820-2	-
75	56	3555	365TS	**ECP4313T**	80.7	494	111	95.1	95.4	95	91	92	92	6313	6313	F	31.31	416820-2	-
75	56	1780	365T	**ECP4316T**	85.9	542	221	95.7	95.8	95.4	77	84	86	6313	6313	F	33.44	416820-2	-
75	56	1185	405T	**ECP4404T**	86.9	541	332	95	95.3	95	73	82	85	6316	6316	F	38.31	416820-2	-
100	75	3565	405TS	**ECP4402T**	110	695	147	94.6	95.1	95	86	89	90	6313	6313	F	35.31	416820-2	-
125	93	3570	444TS	**ECP4412T**	138	820	184	93.9	94.7	95	83	87	86	6313	6313	F	40.98	416820-2	-
125	93	3570	444TS	**ECP4912T**	138	820	184	93.9	94.7	95	83	87	86	6313	6313	F	40.98	416820-2	99

NOTES: Volt Code: E = 208-230/460V, 60Hz; E1 = 230/460V, 60Hz, usable at 208V; F = 230/460V, 60 Hz
99 = Has F3 lead outlet hole and an arm mounted conduit box for easy F1 or F2 lead location.
See page 72 for Layout drawing. See page 93 for Connection Diagrams.
Efficiencies shown are nominal. Data subject to change without notice. Contact Baldor for certified data.

Shaded ratings are cast iron frames.

TEFC – Totally Enclosed Fan Cooled
Foot Mounted, 460 & 575 Volt, Three Phase, 1 - 400 Hp

NEMA Premium

Hp	kW	RPM	Frame	Catalog No.	Amps @ High V		F.L. Torque Lb. Ft.	Efficiency %			Power Factor %			Bearings		"C" Dim.	Conn. Diag. No.	Notes
					F.L.	L.R.		1/2	3/4	F.L.	1/2	3/4	F.L.	DE	ODE			
460 Volt, Ball Bearing Designs																		
1	0.75	3450	143T	**ECP3580T-4**	1.4	12.1	1.5	80.5	83.6	84	65	77	84	6205	6205	12.88	CD0006	-
1	0.75	3450	143T	**ENCP3580T-4**	1.3	11.2	1.5	80.5	83.9	84	73	83	87	6205	6203	11.38	CD0006	60
1	0.75	1765	143T	**ECP3581T-4**	1.5	15	3	84.4	87	87.5	48	60	70	6205	6205	12.88	CD0006	-
1	0.75	1765	143T	**ENCP3581T-4**	1.5	15	3	83.6	86.7	87.5	48	60	70	6205	6203	11.36	CD0006	60
1	0.75	1150	145T	**ECP3582T-4**	1.8	9.6	4.5	82.3	84	82.5	42	55	63	6205	6205	12.88	CD0006	-
1	0.75	850	182T	**ECP3687T-4**	2	9.3	6.1	74.1	78.4	78.5	38	48	59	6206	6206	15.93	CD0006	-
1 1/2	1.1	3450	143T	**ECP3583T-4**	2	20.1	2.3	81.3	84.3	85.5	68	78	83	6205	6205	12.88	CD0006	-
1 1/2	1.1	1760	145T	**ECP3584T-4**	2.1	18	4.5	86.5	88.3	88.5	54	67	76	6205	6205	12.88	CD0006	-
1 1/2	1.1	1170	182T	**ECP3667T-4**	2.5	16.2	6.8	85	87.1	87.5	44	56	65	6206	6206	15.93	CD0006	-
1 1/2	1.1	860	184T	**ECP3668T-4**	3.2	10.4	9.2	77.3	80.3	80	36	48	55	6206	6206	15.93	CD0006	-
2	1.5	3450	145T	**ECP3586T-4**	2.5	30	3	83.8	86.2	86.5	70	80	85	6205	6205	12.88	CD0006	-
2	1.5	1755	145T	**ECP3587T-4**	2.8	25	6	86.9	88.5	88.5	54	67	75	6205	6205	12.88	CD0006	-
2	1.5	1165	184T	**ECP3664T-4**	3.2	20.9	9	86.9	88.5	88.5	48	60	68	6206	6206	15.93	CD0006	-
2	1.5	865	213T	**ECP3772T-4**	3.8	18.3	12.1	82.3	85.4	85.5	38	48	56	6307	6307	19.5	CD0006	-
3	2.2	3500	182T	**ECP3660T-4**	3.4	34.5	4.5	87.5	89.1	88.5	83	89	92	6206	6206	15.93	CD0006	-
3	2.2	1760	182T	**ECP3661T-4**	4.1	31.9	9	89.2	90.4	90.2	56	67	75	6206	6206	15.93	CD0006	-
3	2.2	1165	213T	**ECP3764T-4**	4.5	31.5	13.5	88.4	89.8	89.5	53	64	70	6307	6307	19.5	CD0006	-
3	2.2	865	215T	**ECP3775T-4**	5.2	25.6	18.4	85.6	87	85.5	43	55	62	6307	6307	19.5	CD0006	-
5	3.7	3500	184T	**ECP3663T-4**	5.7	63.9	7.5	88.6	89.8	89.5	83	89	93	6206	6206	15.93	CD0006	-
5	3.7	1750	184T	**ECP3665T-4**	6.6	54	15	89.7	90.7	89.5	62	74	80	6206	6206	15.93	CD0006	-
5	3.7	1160	215T	**ECP3768T-4**	7.3	56.4	22.5	90.2	90.9	90.2	51	63	70	6307	6307	19.5	CD0006	-
5	3.7	880	254T	**ECP2280T-4**	8.4	49.7	30.1	87.8	89.8	87.5	48	59	66	6309	6309	24.69	CD0006	-
7 1/2	5.6	3525	213T	**ECP3769T-4**	8.6	86	11.2	90	91.4	91.7	79	87	90	6307	6307	19.5	CD0006	-
7 1/2	5.6	1770	213T	**ECP3770T-4**	9.5	68	22.1	91.6	92.3	91.7	65	76	81	6307	6307	19.5	CD0006	-
7 1/2	5.6	1180	254T	**ECP2276T-4**	10.7	70.1	33.3	90.6	91.8	91.7	53	65	71	6309	6309	24.69	CD0006	-
7 1/2	5.6	880	256T	**ECP2401T-4**	11.9	64.7	45.1	89.2	90.6	90.2	52	64	68	6309	6309	24.69	CD0006	-
10	7.5	3500	215T	**ECP3771T-4**	11	120	15	92.7	92.9	92.4	82	89	92	6307	6307	19.5	CD0006	-
10	7.5	1760	215T	**ECP3774T-4**	12.5	96.9	29.7	92.2	92.7	92.4	69	79	83	6307	6307	19.5	CD0006	-
10	7.5	1180	256T	**ECP2332T-4**	14.2	93	44.4	90.2	91.6	91.7	55	66	72	6309	6309	24.69	CD0006	-
10	7.5	880	284T	**ECP2402T-4**	14.4	71.5	59.6	90	90.9	90.2	53	66	72	6311	6311	27.93	CD0006	-
15	11	3525	254T	**ECP2394T-4**	17.2	128	22.2	90.8	91.9	91.7	78	86	88	6309	6309	24.69	CD0006	-
15	11	1765	254T	**ECP2333T-4**	18.5	122.9	44.6	91.9	92.6	92.4	66	77	82	6309	6309	24.69	CD0006	-
15	11	1180	284T	**ECP4100T-4**	19.8	130.1	66.7	91.9	93	93	59	70	77	6311	6311	27.93	CD0006	-
15	11	880	286T	**ECP2395T-4**	21.5	120	89.4	89.8	90.8	90.2	49	62	72	6311	6311	27.93	CD0006	-
20	15	3540	256T	**ECP4106T-4**	23	201	29.7	91.1	92.3	92.4	74	84	89	6309	6309	24.69	CD0006	-
20	15	1765	256T	**ECP2334T-4**	24	175	59	92.8	93.1	93	69	80	84	6309	6309	24.69	CD0006	-
20	15	1180	286T	**ECP4102T-4**	26	171.6	89	92.5	93.3	93	61	72	78	6311	6311	27.93	CD0006	-
20	15	880	324T	**ECP4112T-4**	28	160	119	89.4	90.7	91	59	68	74	6312	6312	30.27	CD0006	-
25	19	3530	284TS	**ECP4107T-4**	28	236	37.2	93	93.5	93	82	89	91	6309	6309	26.09	CD0006	-
25	19	1770	284T	**ECP4103T-4**	30	187.6	74.2	92.4	93.6	93.6	72	81	84	6311	6311	27.93	CD0006	-
25	19	1180	324T	**ECP4111T-4**	32	198	111	92.8	93.5	93	65	75	79	6312	6312	30.27	CD0006	-
30	22	3520	286TS	**ECP4108T-4**	33	215	44.5	93.2	93.6	93	83	88	90	6311	6311	26.56	CD0006	-
30	22	1770	286T	**ECP4104T-4**	36	246	89	93.8	94.4	94.1	66	75	83	6311	6311	27.93	CD0006	-
30	22	1180	326T	**ECP4117T-4**	39	243	133	92.5	93.2	93	62	73	78	6312	6312	30.27	CD0006	-
40	30	3540	324TS	**ECP4109T-4**	46	352	59.3	92.2	93.2	93	76	84	88	6312	6312	28.66	CD0006	-
40	30	1775	324T	**ECP4110T-4**	46	320	118	93.9	94.6	94.5	73	81	84	6312	6312	30.27	CD0006	-
40	30	1190	364T	**ECP4308T-4**	49.4	290	177	93.6	94.3	94.1	69	77	81	6313	6313	33.44	416820-36	-
50	37	3540	326TS	**ECP4114T-4**	56	403	74.1	93.7	94.4	94.1	80	87	89	6312	6312	28.66	CD0006	-
50	37	1775	326T	**ECP4115T-4**	57	392	149	94.4	94.9	94.5	73	82	85	6312	6312	30.27	CD0006	-
50	37	1185	365T	**ECP4312T-4**	61.7	345	221	93.9	94.4	94.1	70	78	81	6313	6313	33.44	416820-36	-
60	45	3560	364TS	**ECP4310T-4**	65.1	398	88.5	95.3	95.5	95	88	91	91	6313	6313	31.31	416820-36	-
60	45	1780	364T	**ECP4314T-4**	68	430	177	95.2	95.3	95	79	85	87	6313	6313	33.44	416820-36	-
60	45	1185	404T	**ECP4403T-4**	69	425	265	94.9	95.2	95	79	84	86	6316	6316	38.31	416820-36	-
75	56	3555	365TS	**ECP4313T-4**	80.7	494	111	95.1	95.4	95	91	92	92	6313	6313	31.31	416820-36	-
75	56	1780	365T	**ECP4316T-4**	85.9	542	221	95.7	95.8	95.4	77	84	86	6313	6313	33.44	416820-36	-
75	56	1185	405T	**ECP4404T-4**	86.9	541	332	95	95.3	95	73	82	85	6316	6316	38.31	416820-36	-
100	75	3565	405TS	**ECP4402T-4**	110	695	147	94.6	95.1	95	86	89	90	6313	6313	35.31	416820-36	-
100	75	1785	405T	**ECP4400T-4**	112	725	295	95.4	95.7	95.4	83	87	88	6316	6316	38.31	416820-36	-
100	75	1785	405TS	**ECP4400TS-4**	112	725	295	95.4	95.7	95.4	83	87	88	6316	6316	35.31	416820-36	-
100	75	1190	444T	**ECP4409T-4**	119	723	442	95	95.3	95	68	78	83	6318	6318	44.75	416820-36	-
100	75	1188	444T	**ECP4409T-4E**	115	725	442	94.7	95.2	95	77	84	86	6318	6318	44.62	416820-36	56
100	75	1190	444T	**ECP4909T-4**	119	723	442	95	95.3	95	68	78	83	6318	6318	44.75	416820-36	99

NOTES: 56 = Single Frame mounting holes in 447 and 449 frame
60 = Totally Enclosed Non-Ventilated Enclosure (TENV)
99 = Has F3 lead outlet hole and an arm mounted conduit box for easy F1 or F2 lead location.
See page 93 for Connection Diagrams. See page 72 for Dimensions. Efficiencies shown are nominal. Data subject to change without notice. Contact Baldor for certified data.

Shaded ratings are cast iron frames.

BALDOR® • RELIANCE

Product Information Packet

FLOWSERVE CORP - (CHESAPEAKE

ECP4108T-4

30HP,3525RPM,3PH,60HZ,286TS,1048M,TEFC,F

Part Detail

Revision:	C	**Status:**	PRD/A	**Change #:**		**Proprietary:**	No
Type:	AC	**Elec. Spec:**	10WGZ522	**CD Diagram:**	CD0006	**Mfg Plant:**	
Mech. Spec:	10H423	**Layout:**	10LYH423	**Poles:**	02	**Created Date:**	06-09-2016
Base:	RG	**Eff. Date:**	12-11-2017	**Leads:**	3#10		

Specs

Catalog Number:	ECP4108T-4	**Inverter Code:**	Inverter Duty
Enclosure:	TEFC	**KVA Code:**	G
Frame:	286TS	**Lifting Lugs:**	Standard Lifting Lugs
Frame Material:	Iron	**Locked Bearing Indicator:**	Locked Bearing
Output @ Frequency:	30.000 HP @ 60 HZ	**Motor Lead Quantity/Wire Size:**	3 @ 10 AWG
Synchronous Speed @ Frequency:	3600 RPM @ 60 HZ	**Motor Lead Exit:**	Ko Box
Voltage @ Frequency:	460.0 V @ 60 HZ	**Motor Lead Termination:**	Flying Leads
XP Class and Group:	None	**Motor Type:**	1048M
XP Division:	Not Applicable	**Mounting Arrangement:**	F1
Agency Approvals:	UR	**Power Factor:**	90
	CSA EEV	**Product Family:**	Super-E Chemical Processing
	CSA	**Pulley End Bearing Type:**	Ball
Auxillary Box:	No Auxillary Box	**Pulley Face Code:**	Standard
Auxillary Box Lead Termination:	None	**Pulley Shaft Indicator:**	Standard
Base Indicator:	Rigid	**Rodent Screen:**	None
Bearing Grease Type:	Polyrex EM (-20F +300F)	**Shaft Extension Location:**	Pulley End
Blower:	None	**Shaft Ground Indicator:**	No Shaft Grounding
Constant Torque Speed Range:	6	**Shaft Rotation:**	Reversible

Current @ Voltage:	34.000 A @ 460.0 V	**Shaft Slinger Indicator:**	Shaft Slinger
Design Code:	B	**Speed Code:**	Single Speed
Drip Cover:	No Drip Cover	**Motor Standards:**	NEMA
Duty Rating:	CONT	**Starting Method:**	Direct on line
Electrically Isolated Bearing:	Not Electrically Isolated	**Thermal Device - Bearing:**	NONE (OLD)
Feedback Device:	NO FEEDBACK	**Thermal Device - Winding:**	None
Front Face Code:	Standard	**Vibration Sensor Indicator:**	No Vibration Sensor
Front Shaft Indicator:	None	**Winding Thermal 1:**	None
Heater Indicator:	No Heater	**Winding Thermal 2:**	None
Insulation Class:	F	**XP Temp Code:**	T3

Nameplate NP3241

CAT.NO.	ECP4108T-4	P/N		ENCLOSURE	TEFC				
SPEC.	10H423Z522G1	CC	010A	FRAME	286TS	S/N			
HP	30	CLASS	F	HZ	60	DES	B		
RPM	3525	RPM MAX	5400	PH	3	KVA-CODE	G		
VOLT	460	MOTOR WEIGHT	396						
AMP	34	SER.F.	1.15	PF	90	ODE BRG	6311	DE BRG	6311
RATING	40C AMB-CONT	NEMA-NOM-EFF	91.7	GREASE	POLYREX EM				
				INV.TYPE	PWM				
TEMP CODE	T3	INVERTER-TEMP-CODE	200						
TEMP =	200	C HP FR	60	C HP TO	90				
CT HZ FROM	6	CT HZ TO	60						
HTR-VOLTS		HTR-AMPS		HTR-WATTS		MAX. SPACE HEATER TEMP.		VT HZ FROM	3	VT HZ TO	60

AC Induction Motor Performance Data

Record # 55456 - Typical performance - not guaranteed values

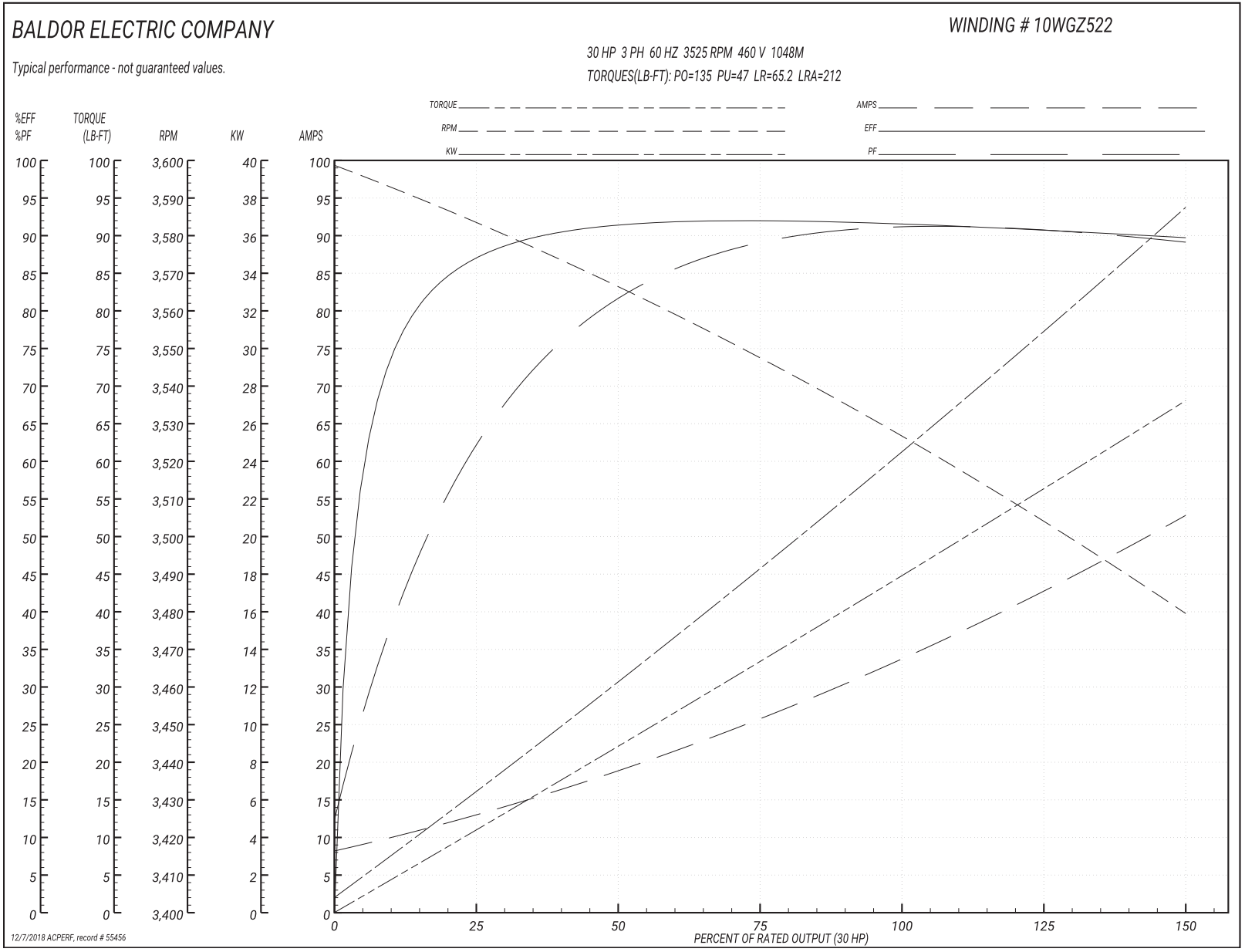
Winding: 10WGZ522-R001	**Type:** 1048M	**Enclosure:** TEFC

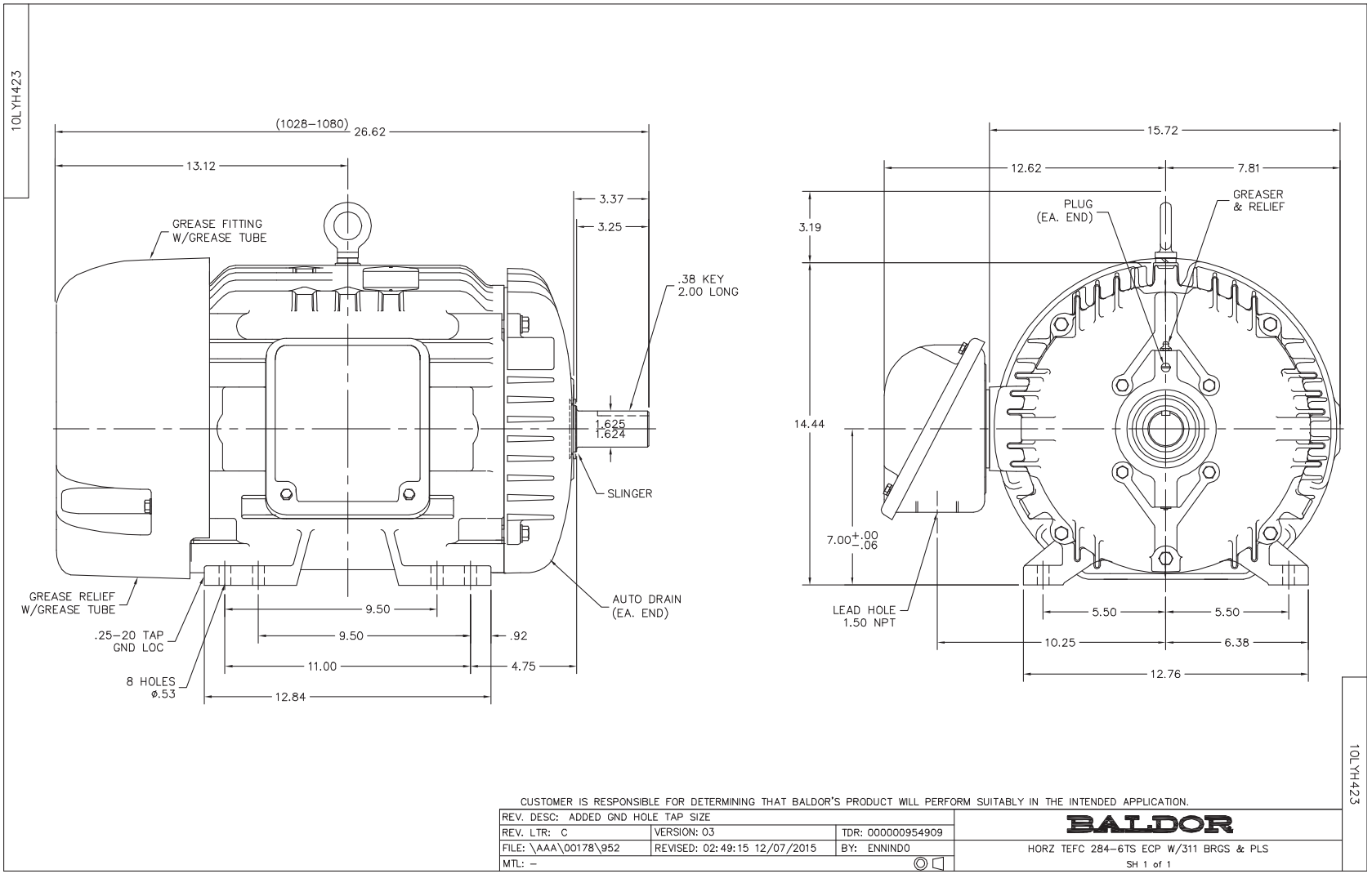
Nameplate Data				460 V, 60 Hz: Single Voltage Motor	
Rated Output (HP)	30			Full Load Torque	44.8 LB-FT
Volts	460			Start Configuration	direct on line
Full Load Amps	34			Breakdown Torque	135 LB-FT
R.P.M.	3525			Pull-up Torque	47 LB-FT
Hz	60	Phase	3	Locked-rotor Torque	65.2 LB-FT
NEMA Design Code	B	KVA Code	G	Starting Current	212 A
Service Factor (S.F.)	1.15			No-load Current	8.74 A
NEMA Nom. Eff.	91.7	Power Factor	90	Line-line Res. @ 25ºC	0.24052 Ω
Rating - Duty	40C AMB-CONT			Temp. Rise @ Rated Load	69°C
S.F. Amps				Temp. Rise @ S.F. Load	85°C
				Locked-rotor Power Factor	23.2

Load Characteristics 460 V, 60 Hz, 30 HP

% of Rated Load	25	50	75	100	125	150	S.F.
Power Factor	67	83	88	90	90	90	90
Efficiency	87	91.3	92	91.7	90.9	89.7	91.2
Speed	3583	3565.7	3547.3	3526.7	3504.4	3479.1	3513
Line amperes	12.4	18.7	26.1	34.1	43.1	52.5	39.5

Performance Graph at 460V, 60Hz, 30.0HP Typical performance - Not guaranteed values




10LYH423
(1028–1080) 26.62
13.12
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3.25
GREASE FITTING
W/GREASE TUBE
.38 KEY
2.00 LONG
1.625
1.624
SLINGER
GREASE RELIEF
W/GREASE TUBE
.25–20 TAP
GND LOC
8 HOLES
ø.53
9.50
9.50
.92
11.00
4.75
12.84
AUTO DRAIN
(EA. END)
15.72
12.62
7.81
PLUG
(EA. END)
GREASER
& RELIEF
3.19
14.44
7.00 +.00 −.06
LEAD HOLE
1.50 NPT
5.50
5.50
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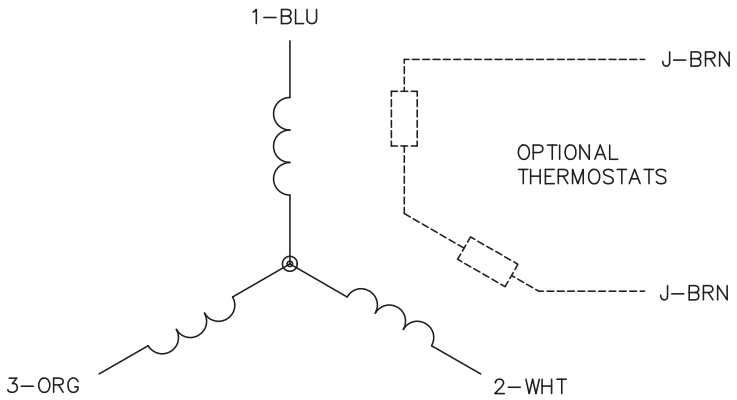
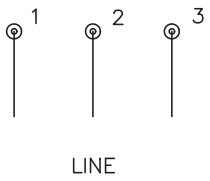
6.38
12.76
10LYH423
CUSTOMER IS RESPONSIBLE FOR DETERMINING THAT BALDOR'S PRODUCT WILL PERFORM SUITABLY IN THE INTENDED APPLICATION.
REV. DESC: ADDED GND HOLE TAP SIZE
REV. LTR: C
VERSION: 03
TDR: 000000954909
FILE: \AAA\00178\952
REVISED: 02:49:15 12/07/2015
BY: ENNIND0
MTL: –
BALDOR
HORZ TEFC 284–6TS ECP W/311 BRGS & PLS
SH 1 of 1

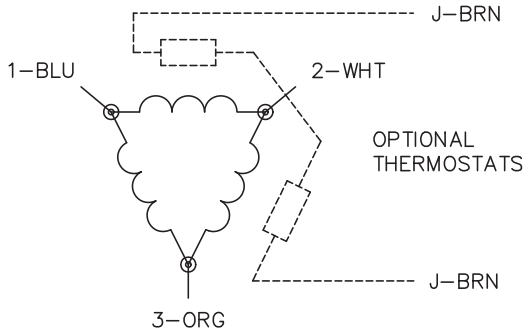
CD0006

TYPICAL WYE–CONNECTED MOTOR





TYPICAL DELTA–CONNECTED MOTOR



NOTES:

1. THREE LEAD MOTOR MAY BE EITHER WYE CONNECTED OR DELTA CONNECTED.
2. INTERCHANGE ANY TWO LINE LEADS TO REVERSE ROTATION.
3. OPTIONAL THERMOSTATS ARE PROVIDED WHEN SPECIFIED.
4. ACTUAL NUMBER OF INTERNAL PARALLEL CIRCUITS MAY VARY.
5. LEAD COLORS ARE OPTIONAL. LEADS MUST BE NUMBERED AS SHOWN.

CD0006

REV. DESC: REVISE TO SHOW OPTIONAL COLORS			BALDOR ELECTRIC Co.
REV. LTR: D	BY: JLP	REVISED: 01/21/99 4:02	TDR: 0171435
9000CD		FILE: AAA00005141	MDL: –
		MTL: –	3PH, SV, 3 LEADS, WYE OR DELTA CONNECTED

Certificate of Approval

This is to certify that the Management System of:

Flowserve Corporation

3900 Cook Boulevard, Chesapeake, VA, 23323, United States

has been approved by LRQA to the following standards:

ISO 9001:2015

Chris Koci - Business Director - Certification

Issued by: Lloyd's Register Quality Assurance, Inc.

Current issue date: 1 November 2018
Expiry date: 31 October 2021
Certificate identity number: 10119320

Original approval(s):
ISO 9001 – 20 October 2000

Approval number(s): ISO 9001 – 0011996

The scope of this approval is applicable to:
Design and Manufacture of Industrial Pumps.

FLOWSERVE

Warranty

1. **WARRANTY:** Subject to the limitations in Section 2 herein, Seller warrants that the Equipment shall be free from defects in material, workmanship, and title. If it appears within twelve (12) months from the initial Equipment startup or until eighteen (18) months after shipment, whichever occurs first, that the Equipment or any part thereof does not conform to this warranty, and Buyer so notifies Seller within a reasonable time after discovery, Seller shall thereupon promptly correct such nonconformity by repair or replacement EXW Seller's factory or service center. Seller's sole obligation and Buyer's sole remedy under this warranty is repair or replacement at Seller's election. Seller's warranty obligation for Services shall be the earlier of either ninety (90) days from the date of initial startup or six (6) months after completion of the Service work. Seller shall not be responsible for any on-site costs, including removal and reinstallation of any warranted Equipment. Buyer agrees to provide Seller reasonable and clear access to its Equipment which may include removal of materials or structures not supplied by Seller as well as supplying any equipment, materials or structures which are necessary to provide reasonable access to the Equipment being repaired or replaced. All Equipment repaired or replaced will be re-warranted only for the remainder of the original warranty period. **THE EXPRESS WARRANTY SET FORTH HEREIN IS THE EXCLUSIVE WARRANTY OF SELLER, AND NO OTHER WARRANTY, EITHER EXPRESSED OR IMPLIED, INCLUDING WARRANTY OF MERCHANTABILITY OR FITNESS FOR PURPOSE, SHALL APPLY.** Seller is not responsible for repairs or alterations made by others without mutual written agreement between Seller and Buyer. Seller does not warrant the Equipment or any repair/replacement part against the effects of erosion, corrosion, or normal wear and tear due to operation or the environment. The warranty and remedies set forth herein are conditioned upon proper storage, installation, use and maintenance of the Equipment in all material respects, and in accordance with Seller's written recommendations. Replacement parts or repairs furnished under this warranty shall be subject to the warranty provisions herein for the remaining original warranty period.

2. **LIMITATION OF LIABILITY / EXCLUSION OF CONSEQUENTIAL LOSS:** The remedies set forth herein are exclusive, and the total liability of the Seller with respect to this Order, or any breach thereof, whether based on contract, warranty, tort (including negligence), indemnity, strict liability or otherwise, shall not exceed the Order price of the specific Equipment or Service which gives rise to the claim.

In all cases where Buyer claims damages allegedly arising out of defective or nonconforming Equipment or Services, Buyer's exclusive remedies and Seller's sole liability shall be those specifically provided for under Section 1 "Warranty".

IN NO EVENT, WHETHER ARISING BEFORE OR AFTER COMPLETION OF ITS OBLIGATIONS UNDER THE CONTRACT, SHALL SELLER BE LIABLE FOR SPECIAL, INDIRECT, CONSEQUENTIAL, INCIDENTAL OR PUNITIVE DAMAGES OF ANY KIND (INCLUDING BUT NOT LIMITED TO LOSS OF USE, REVENUE OR PROFITS, INVENTORY OR USE CHARGES, COST OF CAPITAL, OR CLAIMS OF CUSTOMERS) INCURRED BY THE BUYER OR ANY THIRD PARTY.

3. **GENERAL PROVISIONS:** (a) No Action, regardless of form, arising out of transactions under the Order, may be brought by the Buyer more than one (1) year after the cause of action has accrued. (b) Any modification to these Terms must be set forth in a written instrument signed by a duly authorized representative of Seller. (c) In the event Buyer has reason to believe the Equipment could be subject to a claim for damages or personal injury, Buyer shall immediately provide Seller with written notice of such claim, and shall provide Seller reasonable opportunity to inspect said Equipment and/or investigate the basis for such potential claim. (d) **UNLESS OTHERWISE SPECIFICALLY PROVIDED IN SELLER'S QUOTATION, EQUIPMENT AND SERVICES HEREUNDER ARE NOT INTENDED FOR USE IN ANY NUCLEAR OR NUCLEAR RELATED APPLICATIONS. IF SELLER'S QUOTATION EXPRESSLY STATE THAT THE EQUIPMENT AND SERVICES ARE INTENDED FOR NUCLEAR OR NUCLEAR RELATED APPLICATIONS, SELLER'S ADDENDUM (P-62) FOR NUCLEAR LIABILITY PROTECTION IS HEREBY INCORPORATED.** Buyer (i) accepts the Equipment and Services in accordance with the restriction set forth in the immediately preceding sentences, (ii) agrees to communicate such restriction in writing to any and all subsequent purchasers or users, and (iii) agrees to defend, indemnify and hold harmless Seller from any and all claims, losses, liability, suits, judgments and damages, including incidental and consequential damages, arising from the use of the Equipment or Services in any nuclear or nuclear related applications, whether the cause of action be based in tort, contract or otherwise, including allegations that the Seller's liability is based on negligence or strict liability.

3. Return Water Pond and FGD LCRS Pumps 003 and 004

Return Water Pond

e. **28- FCOOCM-BP-RWP-PMP-003**
f. **29- FCOOCM-BP-RWP-PMP-004**

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MODELS: M 100T, M 106T, M 100S/T, M 106S/T, M 120T, M 126T

OPERATING INSTRUCTIONS, INSTALLATION & MAINTENANCE MANUAL INCLUDING SPARE PARTS LIST

Mody Pumps Inc.
2166 Zeus Court
Bakersfield, CA 93308
Tel.: (661) 392-7600 FAX.: (661) 392-7601
E-Mail: sales@modypump.com
http://www.modypump.com

LIFE IS PRECIOUS - THINK SAFETY

1. Most accidents can be avoided by using COMMON SENSE.
2. Please read the operation and maintenance instruction manual supplied with the pump. If you did not receive one, please call your local distributor before pump installation.
3. Do not wear loose apparel that may become entangled in the impeller or other moving parts.
4. Always use appropriate safety equipment, such as safety glasses, when working on the pump or piping.
5. Pumps build up heat and pressure during operation-allow time for pumps to cool before handling or servicing.
6. Only qualified service personnel should install, operate and repair pump.
7. Keep clear of suction and discharge openings. DO NOT insert fingers in pump with power connected.
8. Do not pump flammable or hazardous materials (gasoline, acids, alkalis, etc.)
9. Do not block or restrict discharge hose, as it may whip or burst catastrophically under pressure.
10. Make sure lifting handles/hooks are securely fastened each time before lifting.
11. Do not lift pump by the power cord under any circumstances.
12. Do not exceed manufacturer's recommendation for optimum performance, as this could cause the motor/pump to overheat and lead to premature wear or failure.
13. Secure the pump in its operating position so it does not tip over, fall or slide.
14. Keep away from impeller when power is connected.
15. Submersible Pumps are not approved for use in swimming pools, recreational water installations, decorative fountains or any installation where human contact with the pumped fluid is common.
16. Do not operate pump without adequate protection and safety devices in place.
17. Always replace safety devices that have been removed during service or repair.
18. To reduce risk of electrical shock, pump must be properly grounded in accordance with the National Electric Code and all applicable state and local codes and ordinances.
19. To reduce risk of electrical shock, always disconnect the pump from the power source before handling or servicing.
20. Any wiring of pumps should be performed by a qualified electrician.
21. Never operate a pump with a power cord that has frayed or brittle insulation.
22. Cable should be protected at all times to avoid punctures, cuts, and abrasions - inspect frequently.
23. Never handle connected - "hot" power cords with wet hands.
24. Never operate a pump with a plug-in type power cord without a ground fault circuit interrupter, adequate overload and short circuit protection.

IMPORTANT !!! MODY Pumps Inc. is not responsible for losses, injury, or death resulting from a failure to observe these safety precautions, misuse or abuse of pumps or equipment.

WARNING !!!

Mody Single Phase Pumps Must be Run Using a Capacitor Pump Panel.

Wiring Schematic is Attached.

Run Capacitor (Rc): 35mfd, 370-440v. MARS # 12243
Start Capacitor (Sc): 215-259mfd, 220-250v. Mars # 11052
Potential Relay 130v: 111-134v pickup, 15-40v Dropout. MARS # 19550
OR
Potential Relay 332v: 244-270v pickup, 40-90v Dropout. MARS # 19551

Warranty is void if pump is operated without suitable Control Panel.

DO NOT CONNECT POWER SUPPLY TO PUMP DIRECTLY

INTRODUCTION

THE *"mody"* MOTOR DRIVEN PORTABLE SUBMERSIBLE PUMPS HAVE BEEN DEVELOPED DUE TO A LONG FELT NEED OF HAVING A TRULY MAINTENANCE FREE PUMPSET FOR VARIOUS APPLICATIONS. THE PUMP IS A LIGHTWEIGHT, COMPACT UNIT ENABLING IT TO BE USED IN MOST SEA-CRAFT AND DIFFICULT LAND INSTALLATIONS. THE UNIT CONSISTS OF A VERTICAL CENTRIFUGAL PUMP WITH AN IN-BUILT SQUIRREL CAGE, INDUCTION ELECTRIC MOTOR WHICH IS AVAILABLE FOR VARIOUS ELECTRIC SUPPLY CONFIGURATIONS. THE PUMPED WATER IS USED AS A COOLING MEDIUM WHICH COOLS THE ELECTRIC MOTOR. THE PUMPSET CAN ALSO BE USED IN ANY POSITION THUS MAKING IT IDEAL FOR DEWATERING IN DIFFICULT LOCATIONS.

THE SERVICE LIFE OF A SUBMERSIBLE PUMP DEPENDS MAINLY ON TWO THINGS: THE DEPENDABILITY OF THE SEALING SYSTEM AND THE WEAR RESISTANCE OF THE PUMP WEAR PARTS.

ALL ***"mody"*** SUBMERSIBLE SUMP PUMPS INCORPORATE A UNIQUE SEALING SYSTEM. THE CONSTRUCTION CONSISTS OF TWO MECHANICAL SEALS, ARRANGED IN TANDEM, IMMERSED IN AN OIL BATH. THE COMPLETE PACKAGE IS A PRESSURE COMPENSATED SEALING DEVICE WHICH ENSURES A MINIMAL PRESSURE DIFFERENTIAL ACROSS THE SEAL FACES, IRRESPECTIVE OF THE DEPTH SETTING OF THE PUMP OR THE HEAD AGAINST WHICH THE PUMP IS OPERATING.

IN ***"mody"*** SUBMERSIBLE SUMP PUMPS, ALL WEAR PARTS ARE RUBBER LINED/COVERED AND ARE READILY REPLACEABLE AS NEEDED. BOTH WEAR AND ELECTRICITY CONSUMPTION ARE STILL FURTHER REDUCED WHEN THE PUMPS ARE FITTED WITH BUILT-IN LEVEL CONTROLS FOR AUTOMATIC STARTING AND STOPPING. **IT IS HOWEVER RECOMMENDED THAT IRRESPECTIVE OF TYPE OF PUMP, ADEQUATE MOTOR PROTECTION SWITCHGEAR SHOULD BE USED AT THE INSTALLATION. WE STRONGLY RECOMMEND THE USE OF SUITABLE CONTROL PANELS WHICH ARE AVAILABLE FROM US INCORPORATING ALL REQUIRED PROTECTION DEVICES.**

IT IS IN THE INTEREST OF THE USER THAT HE GO THROUGH THIS MANUAL IN DETAIL PRIOR TO USING THE PUMP. THE MANUAL WILL HELP HIM UNDERSTAND THE CONSTRUCTIONAL FEATURES AND TO OBTAIN TROUBLE FREE SERVICE FROM THE PUMP.

PURPOSE:

THE PUMP HAS BASICALLY BEEN DESIGNED AS A DEWATERING UNIT TO PUMP OUT FLOODED INSTALLATIONS OR ANY CONDITIONS THAT NEED DEWATERING OF UNWANTED FLUIDS. THE PUMP HAS BEEN DESIGNED TO HANDLE WATER CONTAMINATED WITH OIL AS WELL AS ABRASIVE PARTICLES NORMALLY ASSOCIATED WITH RAW WATER. THE MAXIMUM SIZE OF PARTICLES THAT CAN BE HANDLED IS APPROX. 0.4". **THE MAXIMUM SPECIFIC GRAVITY OF THE PUMPED FLUID SHOULD NOT EXCEED 1.1.**

TECHNICAL DATA

MOTOR

2-POLE SQUIRREL-CAGE AC MOTOR FOR 3-PHASE OR SINGLE PHASE ELECTRIC SUPPLY. MOTOR RATED 1.3 HP (M100T/M100S/T) AND 2 HP (M120T/M126T) ROTATING AT 3450 RPM (APPROX.) AT 60 HZ SUPPLY.

PUMP TYPE	HP	VOLTS	PHASE	HZ	F.L.AMPS	WEIGHT
M-100T	1.3	230/460	3	50/60	4/2	30 Lb.
M-106T	1.5	230/460	3	60	4/2	30 Lb.
M-100S/T	1.3	115/230	1	50/60	19/9	36 Lb.
M-106S/T	1.5	115/230	1	60	19/9	36 Lb.
M-120T	2.0	230/460	3	50/60	3.4	36 Lb.
M-126T	2.0	230/460	3	60	3.4	36 Lb.

CABLE

3 PHASE UNIT	50 Feet	14/4 SOOW CABLE.
1 PHASE UNIT	50 Feet	12/4 SOOW CABLE.

6 CORE CABLE AVAILABLE FOR THERMALS

DISCHARGE OUTLET

2" SS NPT. HOSE/BSPT TYPE OUTLET CAN BE SUPPLIED ON REQUEST.

MATERIALS

PUMP/MOTOR HOUSING	EPOXY COATED ALUMINUM EXTRUSIONS
IMPELLER	410SS NITRIDE HARDENED STAINLESS STEEL
RUBBER PARTS	NITRILE RUBBER
STRAINER	STAINLESS STEEL
HARDWARE	STAINLESS STEEL

SAFETY PRECAUTIONS:

1. ENSURE THAT THE INSULATION RESISTANCE OF THE MOTOR IS AT LEAST 1 MEG. OHM BEFORE ENERGIZING THE UNIT.

2. CHECK THAT THE AVAILABLE POWER SUPPLY (VOLTAGE, PHASE, FREQUENCY) MATCHES WITH THE DETAILS ON THE PUMP NAMEPLATE.

3. ENSURE THAT THE GROUND WIRE IN THE 4 CORE CABLE SUPPLIED WITH THE PUMP IS SECURELY EARTHED.

4. ENSURE DISCHARGE CONNECTION IS CORRECTLY AND SECURELY FITTED

5. ENSURE DELIVERY HOSE IS FREE FROM KINKS AND SHARP BENDS.

6. **DO NOT LIFT OR PULL THE PUMP UNDER ANY CIRCUMSTANCES BY MEANS OF THE CABLE.** THE PUMP MUST BE LOWERED/LIFTED FROM THE SPACE TO BE PUMPED BY USING A LIFTING ROPE ATTACHED TO THE HANDLE/EYEBOLT PROVIDED IN THE PUMP.

7. AT THE STARTING MOMENT THE PUMP SHALL MAKE A KICK WHICH IS OPPOSITE TO THE DIRECTION OF ROTATION OF THE IMPELLER. ENSURE THE KICK IS IN THE CORRECT DIRECTION (SEE THE ARROW ON THE PUMP). SHIFT ANY TWO PHASES IN THE MALE PLUG IF THE KICK IS WRONG. SINGLE PHASE UNITS THE DIRECTION OF ROTATION IS PRE-SET AT THE FACTORY.

8. DRY RUNNING OF THE PUMP IS NOT DESIRABLE. HOWEVER THE PUMP WILL NOT BE DAMAGED OR SUFFER ANY ILL EFFECTS IF IT IS RUN DRY FOR SHORT PERIODS (UPTO APPROX. 30 MINUTES).

9. THE MAXIMUM PUMP SUBMERGENCE RECOMMENDED IS 50 FEET.

10. THE MAXIMUM SPECIFIC GRAVITY OF PUMPED FLUID SHOULD NOT EXCEED 1.1.
PUMP IS DESIGNED TO OPERATE IN FLUIDS WITH pH from 5 – 8.

11. IF PUMP IS NOT USED AND LYING IN STORAGE FOR MORE THAN 30 DAYS PLEASE ENSURE THAT THE SEAL FACES ARE NOT GAUGE LOCKED – ROTATE THE IMPELLER/KICK START THE UNIT ONCE A MONTH. REFER TO INSTRUCTIONS ON DISASSEMBLY/REASSEMBLY OF MECH. SEALS IN THE EVENT THE FACES HAVE LOCKED.

12. ENSURE CORRECT OVERLOAD BREAKERS ARE INSTALLED IN POWER CIRCUIT BEFORE STARTING THE PUMP. (REFER TO AMP RATING ON NAMEPLATE).

FAULT FINDING IN THE UNIT.

TROUBLE GUIDE	CAUSE	REMEDY
PUMP DOES NOT START.	1.FUSES BLOWN. 2.CABLE DAMAGED 3.NO POWER. 4.BLOCKED IMPELLER. 6.STATOR WINDING BURNT.	1.REPLACE FUSES 2.SHORTEN/REPLACE CABLE 3.CHECK POWER SUPPLY. 4.CLEAN BOTTOM PARTS. 6.REPLACE STATOR/REWIND
PUMP STARTS BUT STOPS.	1.BLOCKED IMPELLER. 2.IMPELLER ROT.WRONG 3.CONNECTED FOR WRONG VOLTAGE. 4.VOLTAGE LOW/HIGH 5.CLOGGED STRAINER 6.PUMP RUNNING DRY 7.WATER TOO WARM (ABOVE 60 DEGREES C)	1.CLEAN BOTTOM PARTS. 2.SHIFT TWO PHASE CONN. 3.CHECK & RECONNECT. 4.CONTACT POWER CO. 5.CLEAN STRAINER 6.SWITCH OFF POWER 7.SWITCH OFF POWER
PUMP GIVES TOO LITTLE OUTPUT	1.IMPELLER ROT.BACKWARD. 2.PUMP WORN DOWN. 3.LONG HOSE AND DIAMETER TOO SMALL. 4.PRESSURE HEAD TOO HIGH 5.DISCHARGE HOSE TORN 6.LEAKING/CRACKED OUTLET	1.SHIFT TWO PHASE CONN. 2.REPLACE WEAR PARTS 3.CHECK PRESSURE LOSSES 4.USE PUMPS IN TANDEM. 5.USE NEW HOSE 6.REPL.OUTLET/GASKET.

OVERLOAD PROTECTION.

IT IS ESSENTIAL THAT A STARTER BE USED WHEN OPERATING THE PUMP. CHOOSE THE CORRECT RATING OF STARTER AS PER THE NAME PLATE OF THE PUMP. THE OVERLOAD SETTING ON THE STARTER RELAY SHOULD BE SET TO THE FULL LOAD CURRENT OF THE PUMP AS INDICATED ON THE NAME PLATE. FOR SINGLE PHASE PUMPS A PANEL BOARD IS NECESSARY.
SPECIAL CONTROL BOXES SUITABLE FOR THE PUMP ARE AVAILABLE WITH US INCORPORATING ALL PROTECTIONS NECESSARY.

LUBRICATION.

NO ROUTINE MAINTENANCE OR LUBRICATION IS NECESSARY. THE BEARINGS ARE GREASE LUBRICATED AND SEALED FOR LIFE. THE MECHANICAL SEAL AND OIL SEAL RUN IN AN OIL BATH. NO TOPPING UP IS NECESSARY BUT THE CONDITION OF THE OIL SHOULD BE CHECKED ONCE IN SIX MONTHS. THIS IS BY FAR THE EASIEST WAY TO ASCERTAIN THE INTEGRITY OF THE SEAL FACES. (REFER OVERHAUL INSTRUCTIONS)

GENERAL OVERHAUL(REFER DRG. DWE/005/00-SHEET 1&2)

THE PUMP SHOULD BE OVERHAULED EVERY ONE YEAR (APPROX. 2500 WORKING HOURS) UNDER NORMAL WORKING CONDITIONS. IF THE WATER BEING PUMPED CONTAINS A HIGH PERCENTAGE OF SLUDGE AND ABRASIVES IT IS ADVISABLE TO DO THE OVERHAUL EVERY SIX/EIGHT MONTHS (APROX. 2000 HRS). THE OVERHAUL INCLUDES REPLACEMENT OF SHAFT SEALS, WEAR COMPONENTS, CHECKING THE ELECTRICAL SYSTEM, AND GENERAL INSPECTION OF WEAR AND OTHER PARTS.

DISMANTLING (REFER DRG. DWE/005/00-- SHEET 1 & 2).

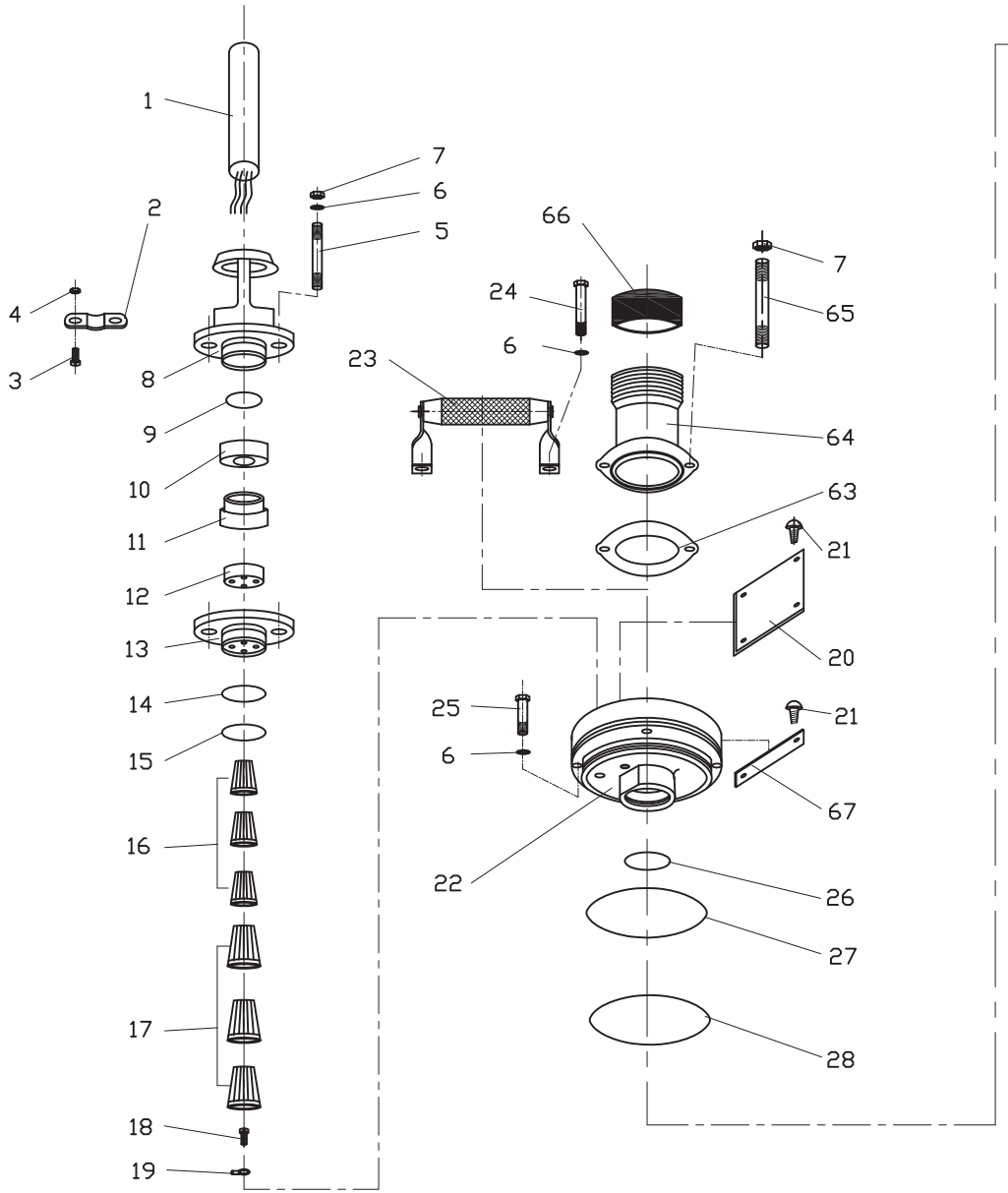
- BACK OFF THE TWO DISCHARGE OUTLET NUTS (7) AND LIFT OFF THE OUTLET (64). PUT ASIDE THE OUTLET GASKET (63).
- BACK OFF FOUR NOS. NUTS AND WASHERS(6,7) AND REMOVE THE STRAINER (62).
- BACK OFF FOUR NOS. NUTS (7) FROM THE STUD BOLT ASSY. (54) HOLDING THE DIFFUSER (61) AND REMOVE THE DIFFUSER.
- PULL OUT OUTER CASING (29) AND KEEP ASIDE.
- LOCK IMPELLER (58) BY MEANS OF IMPELLER LOCKING SPANNER (TOOL NO.T7001) TO PREVENT ROTATION AND UNSCREW IMPELLER NUT (60). REMOVE LOCK WASHER (59) AND SLIDE IMPELLER OFF SHAFT. THE RUBBER SLINGER WILL COME OFF WITH THE IMPELLER. (IF TOOL IS NOT AVAILABLE, YOU MAY USE A GOOD STRONG SCREWDRIVER FOR LOCKING THE IMPELLER)
- REMOVE IMPELLER KEY (56) AND REMOVE TRIMMING SPACERS (55) AND KEEP ASIDE.
- UNSCREW FOUR NOS. STUD BOLT ASSEMBLY (54) AND REMOVE WEAR PLATE (53).
- UNSCREW THE PHILLIPS SCREWS (52) HOLDING THE SAND GUARD (51) FROM SEAL HOUSING (47).
- UNSCREW OIL PLUG (41) AND REMOVE "O" RING (40) FROM CAVITY. DRAIN OUT THE OIL FROM THE OIL CHAMBER. THE CHAMBER CONTAINS APPROX. 150 ML OF OIL. CHECK IF THE OIL IS EMULSIFIED. IF SO, THE MECHANICAL SEAL IS WORN OUT AND NEEDS TO BE REPLACED. IF NO EMULSIFICATION HAS TAKEN PLACE THE MECHANICAL SEAL IS O.K. AND THE OIL CAN BE RE-USED.
- REMOVE CAP FOR CIRCLIP (50), CIRCLIP (45) AND SLIDE OUT COMPLETE MECHANICAL SEAL FROM THE ROTOR SHAFT. BE VERY CAREFUL WITH THE RUBBER BELLOWS AND THE TUNGSTEN CARBIDE SEAL FACE. LEAVE THE TUNGSTEN CARBIDE SEAT IN THE HOUSING UNLESS IT IS TO BE REPLACED.
- BY MEANS OF TWO SCREWDRIVERS LEVER OUT THE SEAL HOUSING FROM THE LOWER BEARING BRACKET (38)
- THE COMPLETE ROTOR WITH THE LOWER BEARING BRACKET AND BEARING CAN BE PULLED OUT OF THE STATOR CASING. USE TWO SCREWDRIVERS BETWEEN THE LOWER BEARING BRACKET AND THE STATOR CASING (30) AND PULL OUT THE COMPLETE ASSEMBLY.
- REMOVE CIRCLIP (45), AND TAKE OFF UPPER SEAL CAREFULLY.
- UNSCREW HEX. BOLT (39) AND LOOSEN BEARING COVER (36). THE ROTOR COMPLETE WITH LOWER BEARING (37), CAN BE REMOVED FROM THE LOWER BEARING BRACKET. THE STATIONARY MECHANICAL SEAL SEAT WILL REMAIN IN THE LOWER BEARING BRACKET. THE LOWER BEARING CAN NOW BE PRESSED OUT IF IT NEEDS TO BE REPLACED. EXAMINE UPPER BEARING FOR RADIAL OR AXIAL PLAY AND REPLACE IF NECESSARY.
- IF STATOR CHECKS OUT O.K. ELECTRICALLY AND THE CABLE IS O.K. DO NOT REMOVE THE TOP BRACKET FROM THE STATOR CASING. IF STATOR IS TO BE REWOUND THEN IT IS ESSENTIAL TO DISMANTLE GLAND ASSEMBLY.
- UNSCREW NUTS (4) AND REMOVE CABLE CLAMP (2). UNSCREW NUTS (7) AND PRY OFF CABLE GLAND (8). THE CABLE GROMMET (10) WILL COME OUT WITH THE GLAND. ALWAYS REPLACE CABLE GROMMET. REMOVE GLAND SPACER (11) AND PRY OUT CABLE GLAND BASE (13). REMOVE LEAD GROMMET (12) AND REPLACE. LOOSEN CABLE WIRES SO THAT ENOUGH SLACK EXISTS SO THAT THE TOP BRACKET CAN BE DISASSEMBLED.
- UNSCREW BOLTS (24) AND REMOVE HANDLE (23). THE TOP BRACKET (22) CAN BE REMOVED BY INSERTING TWO SCREWDRIVERS BETWEEN THE TOP BRACKET AND THE OUTER CASING AND PRYING THE SAME OUT OR TAPPING THE OUTLET WITH A RUBBER MALLET. DISCARD "O" RINGS.

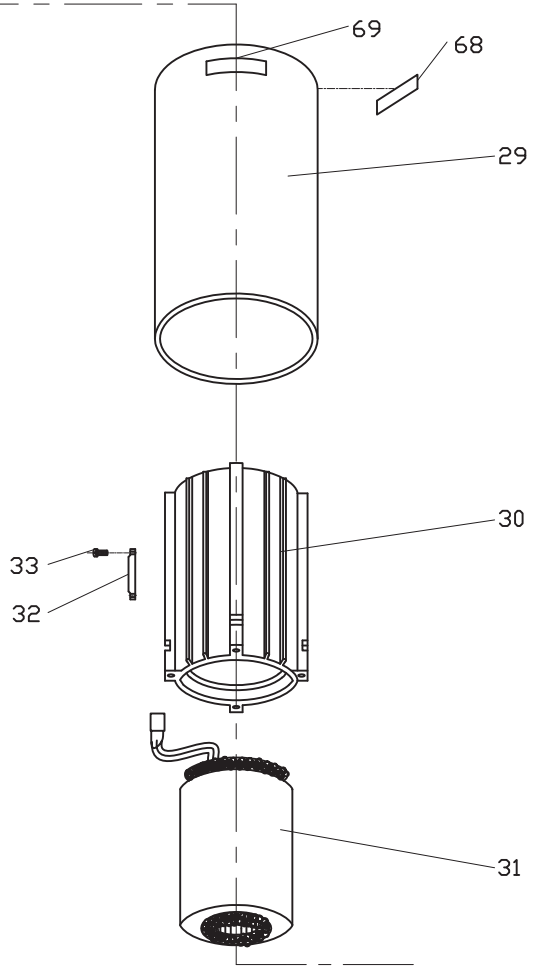
RE-ASSEMBLY(REFER DRG. NO. DW/005/00-- SHEET 1 & 2).

- THE REVERSE OF LAST TWO STEPS (OF THE DIS-ASSEMBLY PROCEDURE) CAN BE FOLLOWED FOR ASSEMBLY OF THE TOP BRACKET AND THE GLAND ASSEMBLY. REMEMBER TO FIT "O" RING (26) IN THE TOP BRACKET.
- FIT THE TOP BEARING ON THE ROTOR.
- SLIDE BEARING COVER (36) ON ROTOR SHAFT AND FIT LOWER BEARING ON ROTOR BY MEANS OF A HAND PRESS OR ANY OTHER SUITABLE METHOD.
- FIT MECHANICAL SEAL (44) ON ROTOR SHAFT AND LOCK THE ABOVE BY MEANS OF CIRCLIP (45).
- FIT LOWER BEARING BRACKET (47) ON LOWER BEARING ALIGNING THE TAPPED HOLES WITH THE HOLES IN THE BEARING COVER. FIT HEX BOLTS (39) AND TIGHTEN BEARING COVER AGAINST BEARING.
- THE COMPLETE ROTOR ASSEMBLY WITH THE LOWER BEARING BRACKET CAN NOW BE INSERTED INTO THE STATOR CASING. REMEMBER TO FIT THE "O" RING IN THE LOWER BEARING BRACKET BEFORE FITTING IN STATOR. ALIGN HOLES IN LOWER BEARING BRACKET WITH THE TAPPED HOLES IN THE STATOR CASING.
- FIT "O" RING IN SEAL HOUSING. FIT TUNGSTEN CARBIDE SEAL SEAT WITH SEAT CUP IN SEAL HOUSING AND PRESS HOME. ENSURE THE SEAT IS FITTING SQUARE IN CAVITY. FIT SEAL HOUSING IN LOWER BEARING BRACKET. ALIGN HOLES IN SEAL HOUSING WITH HOLES IN LOWER BEARING BRACKET.
- LIGHTLY OIL THE TUNGSTEN CARBIDE SEAT AND SLIDE MECHANICAL SEAL ON SHAFT. BE CAREFUL NOT TO DAMAGE THE BELLOWS OF THE SEAL. FIT CIRCLIP ON SHAFT AND LOCK THE SEAL. FIT SAND GUARD IN SEAL HOUSING.
- FIT WEAR PLATE IN RECESS OF SEAL HOUSING. FIT 4 STUD BOLTS (54) THROUGH THE HOLES IN THE LOWER BEARING BRACKET AND SEAL HOUSING AND SCREW THE SAME IN THE STATOR CASING. THE NUT (WELDED) WILL SEAT IN THE RECESS OF THE WEAR PLATE.
- FIT RUBBER SLINGER (57) ON IMPELLER HUB.
- SLIDE IMPELLER ON SHAFT AND ADJUST CLEARANCE BETWEEN THE IMPELLER AND WEAR PLATE BY MEANS OF THE TRIMMING SPACERS. THE IMPELLER SHOULD RUN FREE OF THE WEAR PLATE. PLACE THE LOCK WASHER AGAINST THE IMPELLER GUIDING THE TONGUE OF THE WASHER INTO THE IMPELLER KEYWAY. LOCK THE IMPELLER BY MEANS OF THE LOCKNUT (60) AND BEND THE WASHER OVER THE FLAT OF THE NUT.
- SLIDE THE OUTER CASING OVER THE WEAR PLATE AND LOWER BEARING BRACKET TILL IT SITS AGAINST THE RECESS GUIDE OF THE TOP BRACKET. ENSURE THE "O" RING IS FITTED IN THE TOP BRACKET BEFORE FITTING THE OUTER CASING.
- FIT THE DIFFUSER (61) THROUGH THE STUD BOLTS AND TIGHTEN AGAINST THE OUTER CASING BY MEANS OF THE NUTS (7). SEE THAT THE IMPELLER RUNS FREELY AND THE CLEARANCE BETWEEN THE DIFFUSER AND THE IMPELLER IS MINIMUM. IF ADJUSTMENT IS NECESSARY, THIS CAN BE DONE BY INCREASING THE TRIMMING SPACERS.
- PUT THE STRAINER ON THE STUD BOLTS AND TIGHTEN BY MEANS OF NUTS.
- MAKE THE ELECTRICAL CONNECTIONS AS REQUIRED AND THE EARTHING CONNECTION. FIT THE CABLE GLAND AND GLAND LOCK AND CLAMP THE CABLE. FIT THE OUTLET GASKET AND THE OUTLET (63). (ALWAYS REPLACE THE RUBBER PARTS OF THE CABLE GLAND ASSEMBLY --- DO NOT USE OLD RUBBER PARTS.)

RECOMMENDED SPARES FOR TWO YEARS OPERATION

SR. NO.	DESCRIPTION	PART NO.	RECOMMENDED QTY.
1.	MECHANICAL SEAL	535-032-00	4 NOS.
2.	"O" RING SET	375-100-66	2 SETS.
3.	CABLE GROMMET	260-034-66	2 NOS.
4.	CABLE LEAD GROMMET	260-016-66	2 NOS.
5.	UPPER BEARING	020-002-07	1 NO.
6.	LOWER BEARING	020-004-07	1 NO.
7.	IMPELLER (M100 60Hz)	300-060-22	1 NO.
8.	DIFFUSER	155-015-80	1 NO.
9.	WEAR PLATE	715-001-22	1 NO.
10.	LOCK WASHER	695-006-21	2 NOS.
11.	SLINGER	590-003-66	2 NOS.



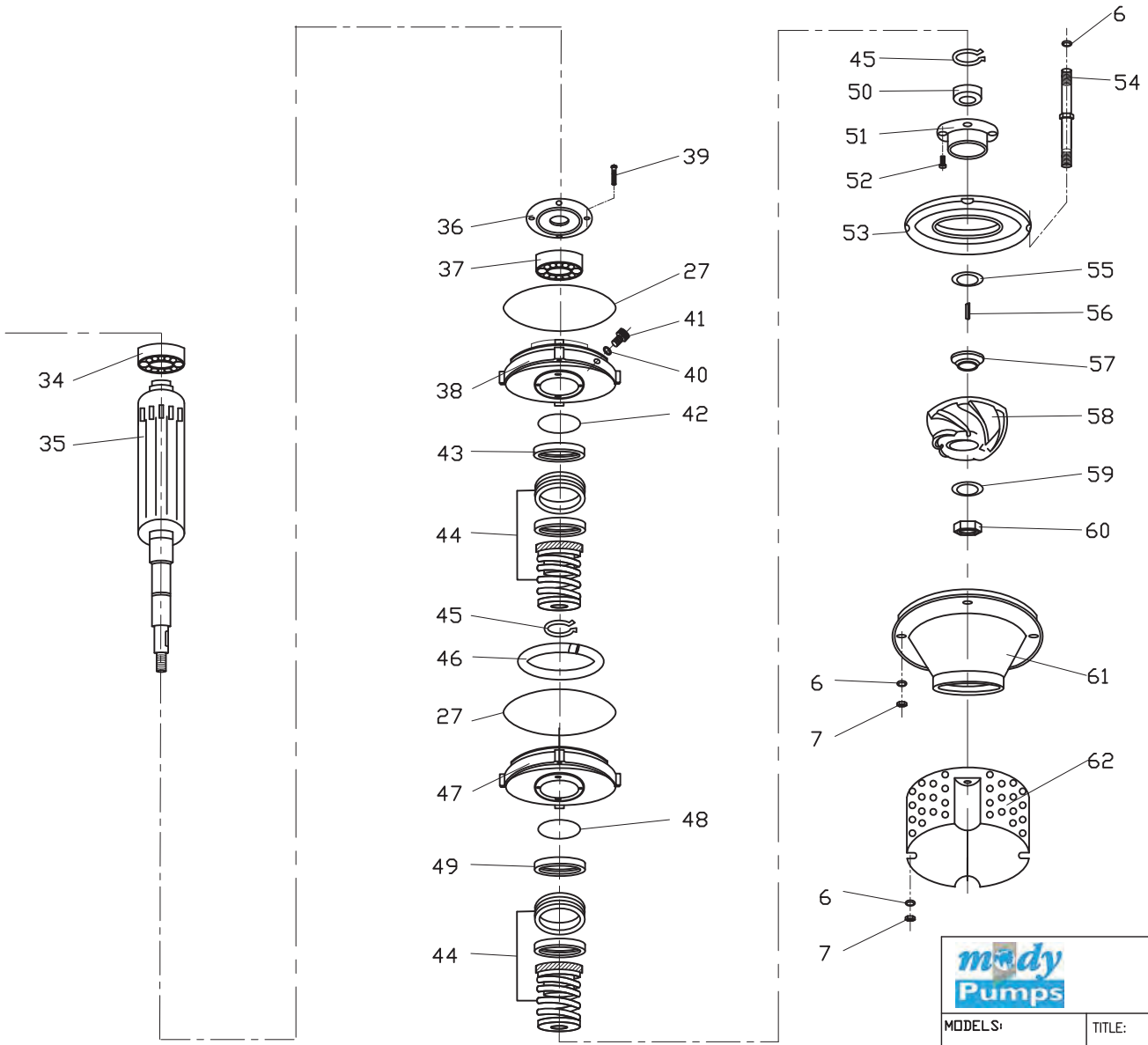


Mody Pumps Inc. 2166 Zeus Court Bakersfield, CA 93308 USA Tel.: 661-392-7600 Fax: 661-392-7601 www.modypump.com		NAME / DATE
	DRN.	BALAJI / 21/11/07
	CKD.	
	APPD.	

MODELS: M100T, M100ST, M106T, M106ST, M120T, M126T	TITLE: EXPLODED VIEW DRG. OF MODY SUBMERSIBLE PUMPS		
SCALE: NTS	QTY.: 1NO.	CODE No.: DWE\005\00	REV.: 0

DGN 02 06

SHEET 1 OF 2



Mody Pumps

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	NAME	DATE
DRN.	BALAJI	21/11/07
CKD.		
APPD.		

MODELS:
M100T, M100ST, M106T, M106ST, M120T, M126T

TITLE:
EXPLODED VIEW DRG. OF MODY SUBMERSIBLE PUMPS

SCALE	QTY.
NTS	1NO.

CODE No. DWE\005\00

REV. 0

DGN 02 06

SHEET 2 OF 2

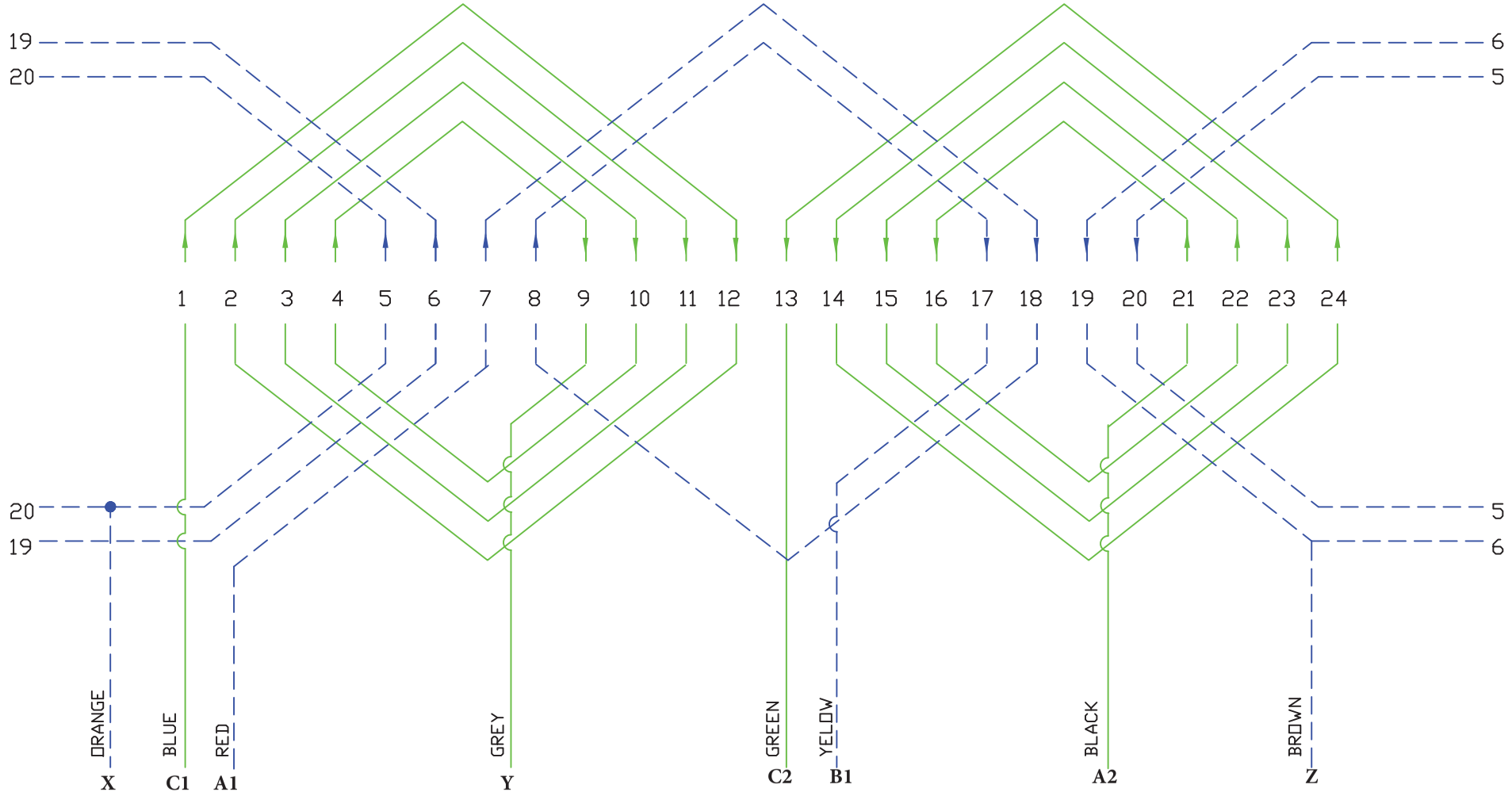
PUMP MODELS M100T/100ST/106T/106ST/120T/126T 1/2/2008

D.NO.	PART NO.	DESCRIPTION	QTY
1a	065-014-79	CABLE 100/106/120/126	50'
1b	065-015-79	CABLE 100ST/106ST (115V)	50'
1c	14/6	CABLE 6 CORE	50'
2	085-003-21	CABLE CLAMP	2
3	370-002-21	HEX NUT	2
4	525-022-21	CH.HD.SCREW	2
5	650-004-21	STUD	2
6	700-002-21	WASHER	18
7	370-005-21	HEX NUT	12
8	230-001-21	CABLE GLAND	1
9	380-007-66	"O" RING	2
10	260-034-66	CABLE GROMMET	1
11	600-011-40	CABLE GLAND SPACER	1
12	260-016-66	CABLE LEAD GROMMET	1
13	235-007-21	CABLE GLAND BASE	1
14	380-005-66	"O" RING	1
15	380-009-66	"O" RING	1
16	365-025-00	WIRE NUT CONNECTOR BLUE	3
17	365-026-00	WIRE NUT CONNECTOR ORANGE	3
18	525-007-40	EARTHING SCREW	1
19	740-001-46	EARTHING WIRE LUG	1
20	350-015-21	NAME PLATE	1
21	465-006-24	RIVET	6
22	035-005-30	TOP BRACKET	1
23	660-080-00	HANDLE	1
24	045-007-21	HEX HD.BOLT	2
25	045-006-21	HEX HD.BOLT	2
26	380-012-66	"O" RING	1
27	380-023-66	"O" RING	3
28	380-027-66	"O" RING	1
29A	400-001-33	OUTER CASING (M100T/106T)	1
29B	400-002-33	OUTER CASING (M100ST/M106ST)	1
29C	400-003-33	OUTER CASING (M120T/126T)	1
30A	625-001-33	STATOR CASING (M100T/106T)	1
30B	625-002-33	STATOR CASING (M100ST/106ST/120T/126T)	1
31A	619-002-00	BARE STATOR (M100T/106T)	1
31B	619-062-00	BARE STATOR 575V (M100T/106T)	1
31C	619-004-00	BARE STATOR (M100ST/106ST)	1
31D	619-006-00	BARE STATOR (M120T/126T)	1
32	010-001-26	ZINC ANODE	2
33	525-021-21	PH.PAN HD.SCREW	4
34	020-002-07	UPPER BEARING	1
35A	480-076-00	ROTOR COMPLETE (M100T/106T)	1
35B	480-071-00	ROTOR COMPLETE (M100ST/106ST/120T/126T)	1
36	037-001-30	BEARING COVER	1
37	020-004-07	LOWER BEARING	1

PUMP MODELS M100T/100ST/106T/106ST/120T/126T 1/2/2008

D.NO.	PART NO.	DESCRIPTION	QTY
38A	035-074-30	LOWER BEARING BRACKET	*
38B	660-083-00	LOWER BEARING BRACKET COMPLETE (38A, 42, 43)	1
39	045-001-21	HEX HD.BOLT	4
40	380-001-66	"O" RING	2
41	520-002-21	OIL PLUG	2
42	380-083-66	"O" RING	*
43	570-004-22	SEAL SEAT HOLDER	*
44	535-032-00	MECHANICAL SEAL	2
45	080-002-21	CIRCLIP	2
46	660-110-00	AIR VOLUME	1
47A	545-019-30	SEAL HOUSING	*
47B	660-079-00	SEAL HOUSING COMPLETE (47A, 48, 49)	1
48	380-012-66	"O" RING	*
49	570-002-22	SEAL SEAT HOLDER	*
50	600-076-21	CAP FOR CIRCLIP	1
51	515-010-21	SAND GUARD	1
52	525-025-21	PH.PAN HD.SCREW	3
53	715-001-22	WEAR PLATE	1
54	660-033-00	LOWER STUD ASSY	4
55	600-009-21	TRIMMING SPACER	AS REQD
56	320-002-22	KEY	1
57	590-003-66	SLINGER	1
58A	300-017-22	IMPELLER M100T/M100ST (50Hz)	1
58B	300-018-22	IMPELLER M100T/M100ST (60Hz)	1
58C	300-088-22	IMPELLER M106T/M106ST (60Hz)	1
58D	300-020-21	IMPELLER M120 (50Hz)	1
58E	300-021-22	IMPELLER M120 (60Hz)	1
58F	300-090-22	IMPELLER M126 (60Hz)	1
59	695-003-21	LOCK WASHER	1
60	365-037-21	DOME NUT	1
61	175-015-80	DIFFUSER	1
62	640-007-21	STRAINER	1
63	220-003-66	GASKET	1
64A	405-036-21	OUTLET 2" NPT SS	1
64B	405-009-21	OUTLET 2" HOSE SS	1
64C	405-033-21	OUTLET 2" BSPT SS	1
65	650-003-21	STUD	2
66	375-100-66	CAP FOR OUTLET	1
67	635-010-21	ROTATON ARROW	1
68	635-002-50	CAUTION STICKER	1
69	635-001-50	FINAL INSPECTION STICKER	1
70	375-100-66	"O" RING SET	1

MODY DUAL VOLTAGE 1 Ph, 115/230V WINDING DIAGRAM.



115 VOLT CONNECTION

JOIN : GREY AND GREEN - RUN WINDING-BLACK CABLE

JOIN : BLUE-BLACK-RED-ORANGE - COMMON-WHITE CABLE

JOIN : YELLOW-BROWN - START WINDING-RED CABLE

230 VOLT CONNECTION

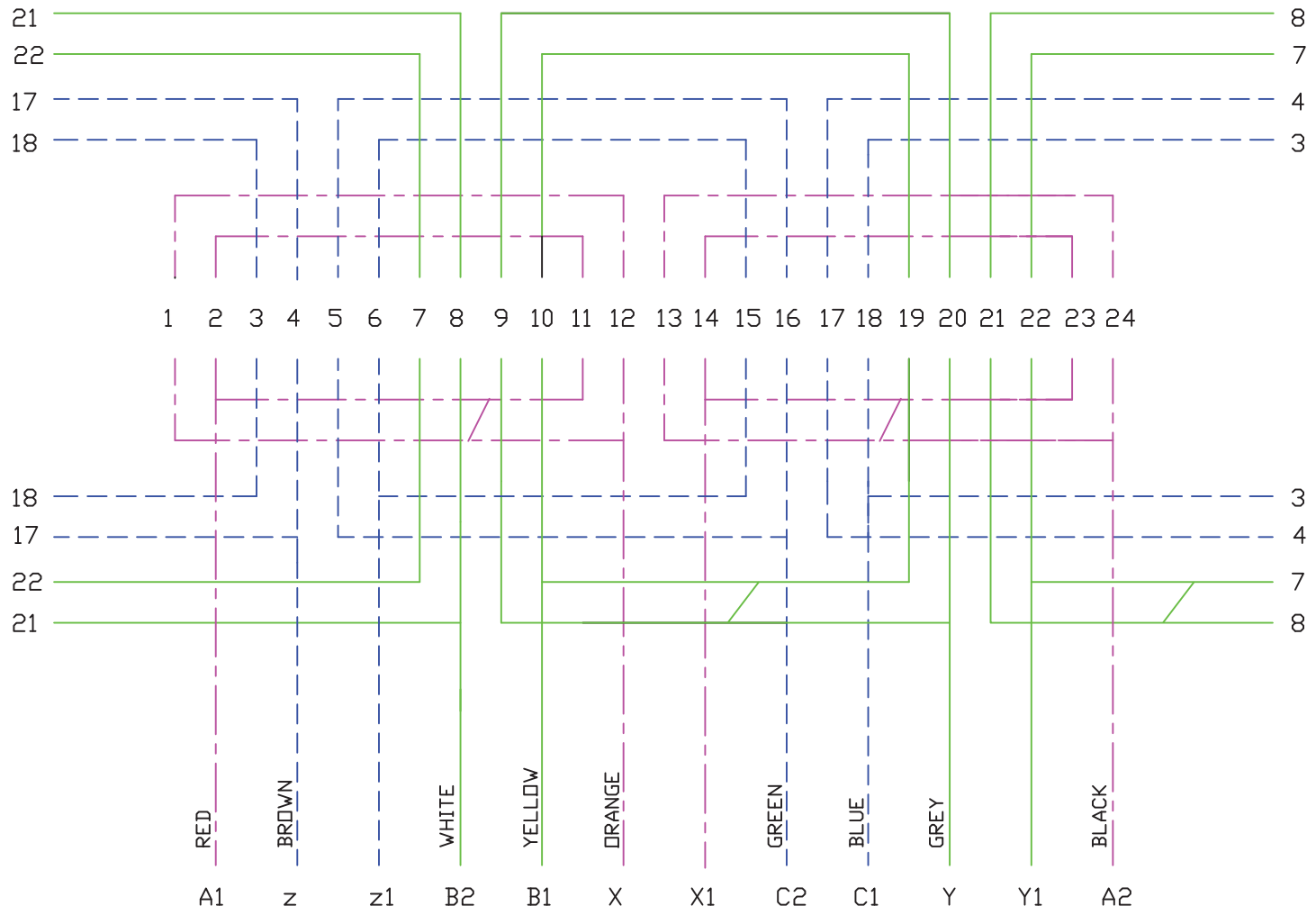
SHORT : YELLOW - ORANGE - PERMANENTLY
BLACK - GREY - PERMANENTLY

JOIN : BLUE-RED - COMMON-WHITE CABLE

JOIN : BROWN - START WINDING-RED CABLE

JOIN : GREEN - RUN WINDING-BLACK CABLE

MODY DUAL VOLTAGE, 3Ph-230/460v 9 LEAD WINDING DIAGRAM



460 VOLT CONNECTION

JOIN A2 X - BLACK AND ORANGE
B2 Y - WHITE AND GREY
C2 Z - GREEN AND BROWN

POWER TO A1(RED), B1(YELLOW), C1(BLUE)

230 VOLT CONNECTION

SHORT XYZ

JOIN A1 A2 - RED AND BLACK-POWER
B1 B2 - YELLOW AND WHITE-POWER
C1 C2 - BLUE AND GREEN-POWER

POINTS X1 Y1 Z1 ARE PERMANANTLY SHORT CIRCUITED

LIMITED WARRANTY

We warrant to our immediate customer and to the ultimate consumer that products of our manufacture will be free of defects in material and workmanship under normal use and service for the following time periods, when installed and maintained in accordance with our instructions.

PUMPS: One (1) year from date of installation or (18) months from date of shipment, whichever occurs first. As used herein, "the ultimate consumer" is defined as the purchaser who first uses the product after it's initial installation or, in the case for product designed for non-permanent installation, the first owner who uses the product. It is the purchaser's or any sub-vendor's obligation to make known to the ultimate consumer the terms and conditions of this warranty. This warranty gives you specific legal rights, and there may also be other rights which vary from state to state. In the event the product is covered by the Federal Consumer Product Warranties Law (1) the duration of any implied warranties associated with the product by virtue of said law is limited to the same duration as stated herein, (2) this warranty is a LIMITED WARRANTY, and (3) no claims of any nature whatsoever shall be made against us, until the ultimate consumer, his successor, or assigns, notifies us in writing of the defect, and delivers the product and/or defective part(s) freight prepaid to our facility or nearest authorized service station. Some states do not allow limitations on how long an implied warranty lasts, so the above limitation may not apply. **THE SOLE AND EXCLUSIVE REMEDY FOR BREACH OF ANY AND ALL WARRANTIES WITH RESPECT TO ANY PRODUCT SHALL BE TO REPLACE OR REPAIR AT OUR ELECTION, FOB POINT OF MANUFACTURE OR AUTHORIZED REPAIR STATION, SUCH PRODUCTS AND/OR PARTS AS PROVEN DEFECTIVE. THERE SHALL BE NO FURTHER LIABILITY, WHETHER BASED ON WARRANTY, NEGLIGENCE OR OTHERWISE.**

Unless expressly stated otherwise, guarantees in the nature of performance specifications furnished in addition to the foregoing material and workmanship warranties on a product manufactured by *Mody*, if any, are subject to laboratory tests corrected for field performance. Any additional guarantees, in the nature of performance specifications must be in writing and such writing must be signed by our authorized representative. Due to inaccuracies in field testing if a conflict arises between the results of field testing conducted by or for user, and laboratory tests corrected for field performance, the latter shall control. Components or accessories supplied by us but manufactured by others are warranted only to the extent of and by the terms and conditions of the original manufacturer's warranty.

RECOMMENDATIONS FOR SPECIAL APPLICATIONS OR THOSE RESULTING FROM SYSTEMS ANALYSES AND EVALUATIONS WE CONDUCT, WILL BE BASED ON OUR BEST AVAILABLE EXPERIENCE AND PUBLISHED INDUSTRY INFORMATION. SUCH RECOMMENDATIONS DO NOT CONSTITUTE A WARRANTY OF SATISFACTORY PERFORMANCE AND NO SUCH WARRANTY IS GIVEN.

This warranty shall not apply when damage is caused by (a) improper installation, (b) improper voltage, (c) lightning, (d) sand or other abrasive materials, (e) scale or corrosion build-up due to excessive chemical content. Any modification of the equipment will also void the warranty. We will not be responsible for loss, damage or labor cost due to interruption of service caused by defective parts. Neither will we accept charges incurred by others without our prior written approval. This warranty is void if our inspection reveals the product was used in a manner inconsistent with normal industry practice and/or our specific recommendations. The purchaser is responsible for communication of all necessary information regarding the application and use of the product. **UNDER NO CIRCUMSTANCES WILL WE BE RESPONSIBLE FOR ANY OTHER DIRECT OR CONSEQUENTIAL DAMAGES, INCLUDING BUT NOT LIMITED TO LOST PROFITS, LOST INCOME, LABOR CHARGES, DELAYS IN PRODUCTION, IDLE PRODUCTION, WHICH DAMAGES ARE CAUSED BY ANY DEFECTS IN MATERIAL, AND/OR WORKMANSHIP AND/OR DELAYS IN SHIPMENT. THIS WARRANTY IS EXPRESSLY IN LIEU OF ANY OTHER EXPRESS OR IMPLIED WARRANTY, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.**

No rights extended under this warranty shall be assigned to any person, whether by operation or otherwise, without our prior written approval.

Mody Pumps Inc.: *2166 Zeus Court, Bakersfield, CA 93308 Tel.: (661) 392-7600 Fax: (661) 392-7601*

4. Gate Valves

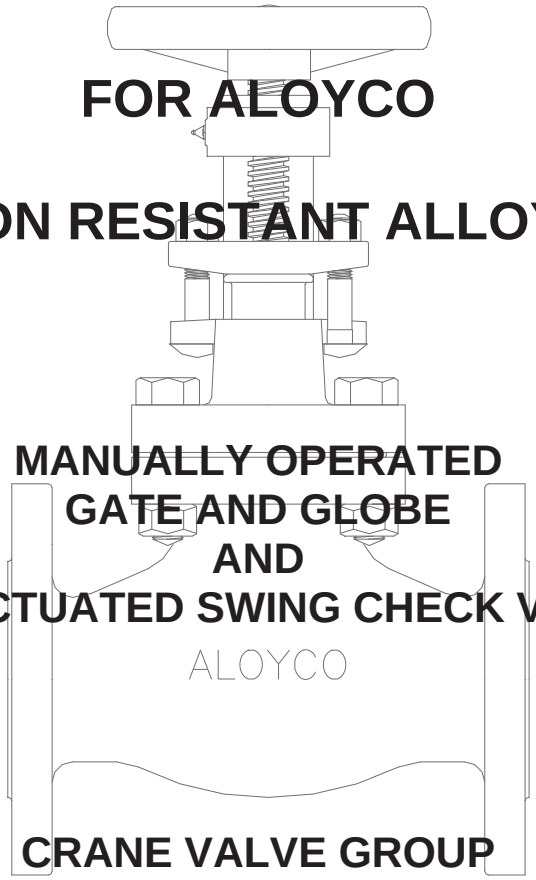
Return Water Pond

a. **03- FCOOCM-BP-RWP-VLV-V002**
b. **09- FCOOCM-BP-RWP-VLV-V004**
c. **11- FCOOCM-BP-RWP-VLV-V006**
d. **17- FCOOCM-BP-RWP-VLV-V008**

Pond 3 Pump House

e. **119- FCOOCM-BP-AP-VLV-1068**
f. **130- FCOOCM-BP-AP-VLV-1078**
g. **139- FCOOCM-BP-AP-VLV-1086**

INSTALLATION AND MAINTENANCE MANUAL



FOR ALOYCO

CORROSION RESISTANT ALLOY VALVES

MANUALLY OPERATED GATE AND GLOBE AND SELF ACTUATED SWING CHECK VALVES

CRANE VALVE GROUP

TABLE OF CONTENTS

INTRODUCTION

Aloyco Stainless Steel valves are built to high standards of Quality. Each valve is inspected and tested prior to it leaving the factory. It is imperative that the valves you purchased be properly installed, maintained and operated to assure satisfactory performance.

The purpose of this manual is to provide you information on installation, maintenance and operation of Aloyco valves. It is not intended to set specific maintenance intervals since these vary from service to service. It is also not to supersede any existing codes, or regulatory and safety requirements.

The illustrations contained in this manual are actual representation of a certain size, they do not necessarily represent all sizes in all details. Crane reserves the right to institute changes in material, design, and specifications without notice, in keeping with its policy of continuous product improvement.

Aloyco valves need very little maintenance, and at some facilities that translates into no maintenance at all. So a small problem, such as a gasket leak, grows into a major leak. Those facilities usually depend on a reactive valve maintenance program, that is correcting valve problems after they have occurred. However, the best approach is a Predictive Maintenance Program designed to determine the current status and condition of the valve and use that information to predict its remaining useful life. This requires you to identify sub-standard valve operation and to either repair or replace the sub-standard valve before failure occurs, thus allowing you to plan your downtime. Unplanned process down time and maintenance are very expensive.

You should use this manual as a guide in setting up your routine and preventive maintenance program specific to your application.

All work procedures should include the required safety equipment (i.e., eye protection, protective clothing, breathing apparatus, etc.) required to safely perform the work.

It is important to understand that the cautions and notices contained in this manual are not exhaustive. Crane could not possibly know, evaluate, and advise of all ways in which a service may be done and the resulting consequences. Crane assumes no responsibility for damage to valves, facilities or personnel, due to faulty installation, improper operation and repair or other conditions beyond our control.

When repair of a valve is necessary, Crane recommends the use of established repair procedures by a competent valve mechanic and the replacement of faulty or worn parts, with Aloyco authorized parts, as soon as possible.

In cases where external leakage is of concern Crane does not recommend or sanction the pressure injection of sealants into valves as an emergency repair procedure.

Should required maintenance exceed in-house capabilities, your local Crane Representative should be contacted for guidance. Valve Service Centers are operated by Crane specifically to assist in Emergency and normal reconditioning of valves. When reconditioned by a Crane Service Center, the valve has the same warranty as a new product.

Crane Service Center locations and phone numbers are listed on the back of this manual.

CHAPTER 1

DESCRIPTION AND OPERATION

1.1 General

This manual contains maintenance instructions together with pertinent illustrations for servicing corrosion resistant steel alloy, manually operated gate, globe and swing check valves. This manual is divided into two chapters; first covering general information pertaining to the types of valves included; second covering maintenance and service instructions for each group of valves in separate sections.

1.2 Descriptions

CAUTION

All gate and globe valves are supplied with PTFE gaskets and packing. All the check valves are supplied with PTFE gaskets. Not to be used on service temperatures exceeding 500 degrees F.

Gate Valves. (See Fig.1) The manually operated gate valves covered by this manual are of the bolted bonnet type, having either a split disc or a flexible or a solid wedge design depending on the size and pressure class. ½" – 2" Class 150 valves are supplied with fully trapped gasket between the body and the bonnet. 3" – 12" Class 150 valves are supplied with flat face gasket between the body and bonnet. All valves Class 300 and 600 are supplied with fully retained gasket between the body and the bonnet.

Globe Valves. (See Fig. 2) The manually operated globe valves covered by this manual are of the bolted type bonnet, having plug type swivel disc and rotating stem with a rising handwheel. The swivel disc is attached by a swivel nut and secured either with a lock weld or pins depending on the size, to prevent disengagement of the disc from the rotating stem during operation. Each globe valve is supplied with a fully trapped gasket between the bonnet and the valve body.

Swing Check Valves (See Fig. 3) The self actuated swing check valves covered by this manual are of the bolted cover type, the clapper arm and the disc being suspended from the cover. Each swing check valve is supplied with fully trapped gasket between the cover and the valve body.

Most check valves are allowed to have some leakage, according to API 598. Therefore, never rely on a swing check valve as positive stop valve.

1.3 Packaging

Gate and Globe Valves. Gate and globe valves are shipped in the closed position to prevent damage to the seating surface during handling and shipping and should be maintained in the closed position until they are installed. No internal blocking is used on the gate and globe valves

Swing Check Valves. These valves are shipped with the clapper arm and the disc blocked during handling and shipping.

CAUTION

The blocking must be removed through the valve waterway prior to installation.

1.4 Installation

Preparation for Installation. It is highly recommended that before you install a valve, you check the valve and determine it is in a satisfactory condition. Some suggested items are:

1) Look for special warning tags and the identification plate to assure the valve is correct for the intended service.
2) Remove the end caps and ensure that the valve is reasonably clean and free from foreign material.
3) Open and close the valve to ensure that no damage has occurred in transporting the valve.

Prior to installing the valve, clean out the dirt and foreign matter from inside the piping system.

Check for adequate clearance around the valve to ensure that it may be operated properly and that enough free space is available for maintenance of the valve.

The valve body is a rugged structure but it is not intended to be a means for aligning improperly fitted pipe. Care must be taken to ensure that any stresses caused by the improper pipe alignment are relieved elsewhere in the piping system. The valves should be supported, as necessary, to prevent unnecessary stresses induced by the connecting piping.

Installation. The following general rules should be followed when installing the valve in the pipeline.

a. Keep pipe ends free of dirt, spatter and grit. Check for any damage on the raised faces for the flanged end valves, for any thread damage for the threaded end valves, and any damage to the sockets for the socket end valves.

b. Handle the valve only with apparatus that will adequately support it using a safe and proper technique.

c. Install the valve using good piping practices (including the ones listed in the Manufacturers Standardization Society of the Valve and Fitting Industry Standard Practice MSS-SP-92 and as governed by applicable Industry Codes and Specifications. Assure that all bolting or welding (including preheat and post-weld heat treatment) associated with the installation of the valve in the piping system is in compliance with applicable codes and standards.

Gate and Globe Valves. The preferred installation for the gate and globe valves is with the valve in a horizontal line with the handwheel positioned vertically above the valve's centerline. When the stem points downward the bonnet acts as a pocket for debris and other foreign material in the line. Such material may interfere with the valve operation. Do not use split disc gate valves for steam service because the velocity will vibrate the disc and cause premature wear.

CAUTION

Split disc gate valves should never be installed with the stem pointed down because the weight of the disc will cause them to spread prematurely. This premature spread may not allow the disc to fully seat (close).

Globe valves are marked with either bridge wall markings, or flow arrows, because it is recommended that the valves be installed with the flow pressure under the disc. However, depending on your application, they may be installed with flow pressure over the disc.

Swing Check Valves. Swing check valves are normally used to prevent flow reversal. Since check valves have an allowable leakage rate per API 598, they are normally used in conjunction with gate valves which provides the positive stoppage of flow. The swing check valves can be installed in either horizontal lines or in vertical lines as required. When the valve is installed in the horizontal line, the valve cover must be up; when the valve is installed in a vertical line or for any angle from horizontal to vertical, they must be installed for upward flow only.

CAUTION

Flow through a swing check valve must open the disc to its full and stable position. Problems involving excessive wear of internal components, noisy operation or premature failure can occur from the use of check valves which are not in their fully open and stable position.

Swing check valves should not be installed immediately after pump discharges, elbows, tees, pulsation dampeners, or throttling valves, because the turbulence may cause disc motion and excessive wear or premature failure.

NOTE

A generally accepted practice is to install check valve a minimum of five times the pipe diameter away from pumps, elbows, tees, pulsation dampeners, or throttling valves.

A swing check valve should not immediately discharge into a tee or elbow.

1.5 Operation

Gate Valves. Opening and closing the gate valve is accomplished by operating the valve handwheel as desired. The gate valve disc moves down against or up and away from the seating surfaces in the valve body as the handwheel is rotated. The gate valve should not be used for the throttling purposes and should be operated only in the fully open or fully closed positions as erosion of the discs and seating surfaces, and stem "T-head" damage would result if the valve were operated in the partially open position.

CAUTION

Wrenches should not be used in the opening and closing of valves. This procedure can be dangerous as well as damaging the valve disc due to overloading of the stem and disc. In some cases, disc and stem separation has resulted or permanent distortion of the disc making the valve inoperable.

Globe Valves. Opening and closing of the globe valve is accomplished by operating the valve handwheel as desired.

The swivel disc and stem move down against or up away from the seating surface in the body. The globe valve can be used for throttling purposes as well as for on-off services. Since closure is accomplished by forcing the disc against the stream rather than across it, problems of chatter, erosion and excessive wear are minimized. In addition the short travel of the disc allows for fast closing time.

Swing Check Valves. Operations of the check valve to the open position is accomplished by self-actuating from line pressure against the disc. As line pressure diminishes, the weight of the disc causes the valve to close. The check valve operates primarily to prevent any reversal of flow in the installation.

1.6 Torque Application

The following procedures should be observed during replacement of the valve bolts (studs) and nuts on the body/bonnet joint, using applicable torque values given in Table 1.

a. ***Preparation***. Clean all bolts and nuts with solvent, rinse in demineralized water and dry with clean, lint-free cloths. Visually inspect all threads to ensure removal of all foreign material, corrosion products, burrs and previous lubrication. Lightly lubricate bolt threads, surfaces under the bolt heads and female threads of nuts with an antiseize compound. Install the bolts and nuts on the flanges and hand tighten the nuts against the flange faces. Using solvent and clean, lint-free wiping cloths, wipe off any excess lubricant than might adhere to the adjacent flange areas.

Table 1

Bolt Size (Dia.)	½ Torque (Ft-lbf)	Full Torque (ft-lbf)
5/16”	4-5	8-12
3/8”	6-8	12-18
½”	15-20	30-45
9/16”	25-30	45-68
5/8”	35-40	60-90
¾”	55-75	110-165
1”	140-180	260-390
1 ¼”	210-310	525-790

Torque values are based on bolts(studs) of ASTM A193 Grade B8 Class 2, with Grade 8 or 8F nuts to ASTM A194

b. ***Tightening Procedure***. Hand tighten nuts. Observe the tightening sequence shown in Figure 4 and, using a torque wrench with the required range, tighten each bolt to its valve listed in Table 1.

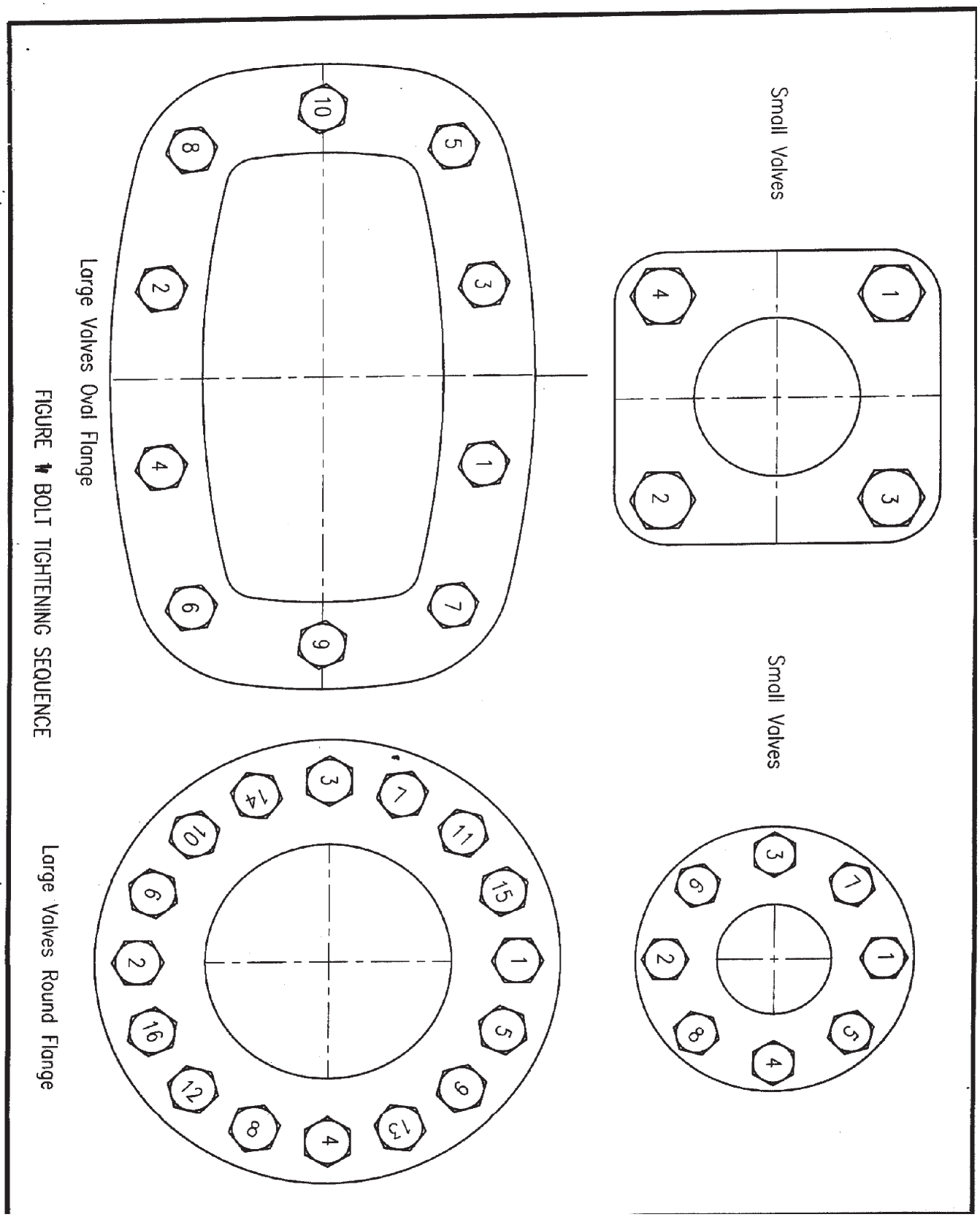
NOTE

Although ½ torque values are listed in Table 1, Aloyco strongly recommends using at least four (4) torque passes to arrive at final torque for bolts (studs) over 5/8” to ensure even pull down.

When all the bolts have been tightened to the 1/2 torque value, each bolt is tightened to the final torque value (Table 1) in the same sequence as previously used for initial torque.

All nuts should be evenly applied on stud and have full engagement.

Figure 4 Bolt Tightening Sequence



CHAPTER 2

MAINTENANCE

Section 1. GATE VALVES

2.1. General

This section covers necessary maintenance instructions for the manually operated gate valves, including routine maintenance, trouble shooting, disassembly, inspection, reassembly and recommended spare parts. Your Maintenance function should develop procedures to ensure that the valve is in maintained in a satisfactory and safe operating condition at all times.

2.2 Routine Maintenance

To ensure satisfactory valve operation, a routine maintenance check should be performed at regular intervals. The following actions should be taken:

1. Operate the valve through a complete cycle several times, checking for smoothness of action and absence of any leakage.
2. Close the valve and check for leakage using Sonic leak detection device.
3. Lubricate the exposed threads of the stems of the manually operated gate valves.
4. Using good grade of cup grease and a grease gun, apply the lubricant to the grease fitting on the yoke of the valves so equipped.
5. Check all the bonnet stud bolt nuts for proper torque values and tighten the nuts as necessary to meet requirements of Table 1.
6. Replace packing ring sets and the gasket if damaged or exposed to temperatures higher than maximum allowed.
7. Check the body and bonnet wall thickness using an Ultrasonic Thickness Tester. If under ASME B16.34 requirements, remove valve from service and either replace or repair, if economical.

2.3 Trouble Shooting

Following are the common troubles of the gate valve operation, together with the probable cause and recommended remedies. Observance of these procedures prior to valve disassembly will prevent unnecessary maintenance time and personnel involvement. Index numbers used in the listing refer to Figure 1.

Trouble:

Leakage at the body/bonnet joint

Probable cause:

1. Loose or improperly tightened bolt nuts (1).
2. Damaged or improperly seated gasket (26).

Remedy:

1. Tighten nuts in accordance with Table 1 and Figure 4, observing the entire sequence of tightening.

NOTE
Tightening should be performed with the valve depressurized.

2. Break the body bonnet joint and replace the gasket. (Refer to Table 1 and Figure 4 for bolt tightening procedure.)

CAUTION
Before attempting any disassembly, the line should be depressurized to prevent possibility of personnel injury or equipment damage. As an added safeguard, the valve should be opened and the body relieved of any residual pressure.

Trouble:

Leakage through valve seats.

Probable cause:

Worn or damaged seating surfaces on discs (4 and 5) or solid wedge (6) and/or body (28).

Remedy:

Disassemble valve and inspect all seating surfaces for wear and mechanical damage. Polish minor damage. Remachine or replace components if damage is heavy.

Trouble:

Leakage at the stuffing box.

Probable Cause:

1. Loose or improperly tightened gland studs nuts (14).
2. Gland follower (17) improperly seated.
3. Corrosion or mechanical damage of stem (7) in the stuffing box area.
4. Worn or damaged packing (25 and 25).

Remedy:

1. Tighten nuts, alternating at 1/4 turns, to torque value of 15 to 30 ft-lbf or just enough to stop any leakage. Do not tighten nuts excessively.
2. Reposition gland follower on the upper packing rings. It may be necessary to replace or to install additional packing rings. If leakage continues, replace the packing.

CAUTION

Crane does not recommend the practice of backseating the valve and repacking the valve under pressure. In the event that the backseat fails to seal properly a leak path to atmosphere is generated which constitutes a potential safety hazard to personnel.

3. Minor corrosion or damage can be polished out. Major damage necessitates stem replacement.

Trouble:

Rough or difficult valve operation.

Probable Cause:

1. Scored or otherwise damaged threads on the stem (7).
2. Damaged yoke bushing (13).
3. Excessively tight gland stud nuts (14).

Remedy:

1. Minor scoring or damage can be polished out. Major damage necessitates stem replacement.
2. Inspect bushing for damaged threads, galling or scoring. Polish out minor damage or replace the bushing for major damage.
3. Loosen nuts and then tighten to a torque value of 15 - 30 ft-lbf. In order to maintain even pulldown you should alternate tightening at 1/4 turn intervals.

2.4 Disassembly

CAUTION

Before attempting any disassembly, the line should be depressurized to prevent possibility of personnel injury or equipment damage. As an added safeguard, the valve should be opened and the body relieved of any residual pressure.

All internal parts of the gate valve are made accessible by removal of the bolted bonnet (3 Figure 1) from the valves body (28). The two discs (4 and 5) of a split disc valve are actuated by the disc arm (8) on the end of the stem(7) and will be lifted out of the body (28) when the bonnet (3) is removed. The solid or flexible wedge (6) of a gate valve is actuated by a stem foot on the end of the stem and will be lifted out of the body when the bonnet is removed.

NOTE

Match -mark the bonnet flange and body flange and disc to body before removing bonnet to ensure assembly of the parts in their original position.

CAUTION

Exercise care to prevent the disc or wedge from being dropped as they emerge from the valve body

Disassemble the gate valve in accordance with the following procedure: (see Figure 1)

1. Operate the valve to approximately one-quarter of open position. Remove the bonnet stud bolt nuts (1) and bonnet stud bolts (2) and lift the bonnet (3) of the body by raising the bonnet straight up. Use suitable hoist to lift the bonnet assembly on 6" valves and larger.

CAUTION

Exercise care to prevent the discs (4) and (5) of a double disc gate valve or the solid wedge (6) from being disengaged from the stem (7) as the discs or wedge emerge from the body. This is best accomplished on the double disc valve by taping the pair of discs together before lifting them clear of the body flange

2. On split disc type valves, after the discs are lifted clear of the body, remove from the disc arm (8) and carefully lay aside disc. Although there is no preferred orientation of the disc assembly in the body, the disc is fitted to the valve, therefore the disc should be replaced in the body in the same position from which they were removed, unless the disc and the body seating surfaces are to be remachined. Remove and discard used gasket (26).

3. On the wedge type valves, keep the solid wedge (6) centered on the stem foot until the wedge is clear of the body flange; then slip the wedge off the stem foot and carefully lay aside. The wedge should be replaced in the body in the same orientation as it was originally placed. Remove and discard used gasket (26).

4. Loosen gland stud nuts (14) and gland studs (15). Holding the stem (7) so it does not rotate, turn the handwheel (11) in the direction to close the valve until the stem threads become disengaged from the threads of the yoke bushing (13). Remove the stem by pulling it down through the stuffing box.

5a. For Class 150, 2" - 12"; Class 300, 2" - 2"; and Class 600, 2" - 1": loosen the yoke nut set screw (9) and remove the yoke bushing nut (13). Remove the handwheel (11), ID Tag, and the handwheel key (12) (sizes 3" and above) and withdraw the yoke bushing (13) through the bottom of the yoke boss. Remove gland stud nuts and gland studs (15) and remove the gland flange (16) and gland follower (17).

5b. For Class 300, 2.5" - 12"; and Class 600, 1.5" - 2": loosen the yoke bushing nut set screw (9) and remove the yoke bushing nut (13). Remove the handwheel (11), and ID Tag. Grind off the lock weld and withdraw the yoke bushing (13) from the bonnet yoke.

6. If the valve has a separate yoke, and the removal of the yoke (20) is necessary, remove the yoke bolt nuts (18) and yoke bolts (19) and remove the yoke from the bonnet (3).

7. Remove the packing rings set (5 rings). If a lantern ring was ordered, remove the upper packing rings (23), the lantern ring (24) and the lower packing rings (25) from the
bonnet (3). Do not remove the pipe nipple unless replacement is necessary.

2.5 Inspection

After disassembly of the gate valve, all parts should be inspected for evidence of wear, distortion or mechanical damage. Perform the inspections listed in Table 2 to assure satisfactory operation of the affected parts.

Table 2. Gate Valve Inspection

Step	Part	Inspect For	Remarks
1	Body Seats	Evidence of wear or mechanical damage which could prevent tight sealing.	Minor damage (less than 0.0005") can be corrected by lapping the seats with the body in the line. Major damage or wear will necessitate removal of the body from the line for replacement or remachining.
2	Disc or Wedge	Evidence of wear or mechanical damage to seating surface	Minor damage (less than 0.0005"), such as out-of-flatness, can be corrected by lapping g the seating surfaces. Major damage or wear will require remachining of the seating surfaces and many require replacement of the disc or wedge to ensure fit.
3	Stem Assembly	Evidence of wear or mechanical damage on stem area which passes through packing rings.	Remove minor damage by polishing; major damage will require stem replacement.
		Evidence of wear on stem threads.	Replace stem assembly if wear is excessive
4	Yoke Bushing	Evidence of wear on the stem thread on the I.D., O.D. and shoulder of bushing.	Replace yoke bushing if wear is evident.
5	Yoke Ends	Evidence of wear or roughness in bushing bore and adjacent machined areas.	Remove minor damage by polishing and major damage will require remachining or replacement of yoke.
6	Handwheel	Evidence of wear on underside surface which runs against yoke end.	Remove minor wear by polishing or remachining. Replace handwheel if extensive wear is evident.
7	Lantern Ring (if applicable)	Evidence of wear or roughness on the I.D. of the bore.	Polish out roughness or replace lantern ring.
8	Gland Follower	Evidence of wear or roughness on I.D.	Polish worn or rough areas or replace gland follower.

2.6 Reassembly

Reassembly of the gate valve is performed essentially in the reverse order of disassembly, observing the following special procedures. (See Figure 1)

1. Lubricate both the O.D. and the I.D. of the yoke bushing (13) with good grade of cup grease. Install the yoke bushing in the bushing bore in the yoke (20) from the underside of the bore. Position the handwheel key (12) in the key slot in the yoke bushing sizes (3" and above) and slide the handwheel (11) over the key and the bushing. Position the ID Tag. Secure the handwheel in the position with the yoke bushing nut (10) and tighten the nut with a wrench. Lock the yoke bushing nut in place by tightening the yoke nut set screw (9) with an Allen wrench. Using good grade of cup grease and a grease gun, apply lubrication to the grease fitting (21) on the handwheel end of the yoke.

CAUTION

When installing the top and bottom packing sets make sure that proper cup and cone installation sequence is used. The bottom ring and the top ring in the packing assembly is always a cone shaped ring.

2. Install the stem (7) through the bonnet (3), pushing the stem through the stuffing box far enough so that the bottom packing rings (25), lantern ring (24), top packing rings (23); gland follower (17) and gland flange (16) can be placed onto the stem in this order. Position the lower packing, the lantern ring and the upper packing in the stuffing box. Gently push the stem all the way until the end of the stem meets the bottom of the yoke bushing (13). Turn the handwheel (11) in the direction to open the valve to engage the stem thread in the yoke bushing; continue to turn the handwheel until the stem is approximately in the half open position.

3. Install the yoke bolts (19) through the yoke (20) and the yoke flange of the bonnet (3) and secure with the yoke bolt nuts (18).

4. Slide the gland follower (17) and the gland flange (16) into place on top of the packing rings Assemble the gland studs (15) through the gland flange into the yoke (20) and tighten the gland stud nuts (14) to torque value of 15 to 30 ft-lbf. In order to maintain even pulldown you should alternate tightening at 1/4 turn intervals.

NOTE
Tighten gland stud nuts evenly to avoid forcing the gland follower or gland flange against the stem.

5. Install the new gasket (26). Assemble two discs (4 and 5) to the disc arm (8) or the solid wedge (6) to the stem foot on the stem, making certain to hold the parts in place while carefully lowering the bonnet (3) over the body. As the discs or solid wedge is lowered in the body, guides in the body will guide the discs or wedge to the seat.

NOTE
Be certain that the discs or the wedge are installed in the same position as noted during disassembly.

6. Replace the bonnet stud bolts (2) through the bonnet and body flanges and assemble the bonnet stud bolt nuts (1) to both ends of the bolt studs. Following the procedures contained in Chapter 1, tighten the nuts in the sequence shown in Figure 4 to the torque values specified in Table 1.

2.7 Spare Parts.

The packing rings (25 and 23) and gasket (26) are the only recommended spare parts for a standard valve. If a lantern ring valve was ordered a spare lantern ring is recommended.

Figure 1 Typical Gate Valve Exploded View

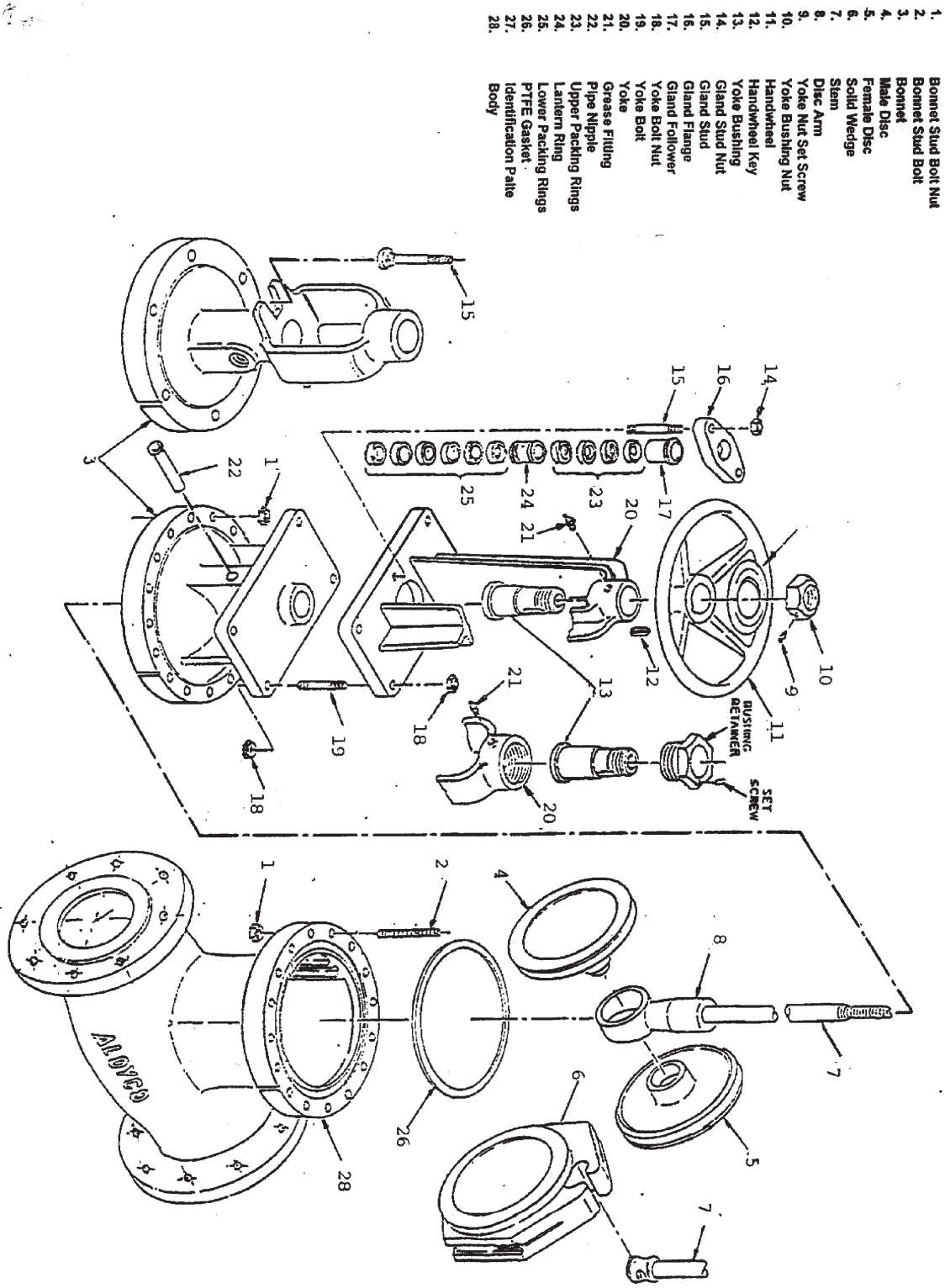


Figure 1. Typical Gate Valve Exploded View

Section 2. GLOBE VALVES

2.8 General

This section covers all necessary maintenance instructions for the manually operated globe valves, including routine maintenance, trouble shooting, disassembly, inspection, reassembly and recommended spare parts. Your Maintenance function should develop procedures to ensure that the valve is in maintained in a satisfactory and safe operating condition at all times.

2.9 Routine Maintenance

To ensure satisfactory valve operation, a routine maintenance check should be performed at regular intervals. The following actions should be taken:

1. Operate the valve through a complete cycle several times, checking for smoothness of action and absence of any leakage.
2. Close the valve and check for leakage using Sonic leak detection device.
3. Lubricate the exposed threads of the stems of the manually operated globe valves.
4. Check all the bonnet stud bolt nuts for proper torque values and tighten the nuts as necessary to meet requirements of Table 1.
5. Replace packing ring sets and the gasket if damaged or exposed to temperatures higher than maximum allowed.
6. Check the body and bonnet wall thickness using an Ultrasonic Thickness Tester. If under ASME B16.34 requirements, remove valve from service and either replace or repair, if economical.

2.10 Trouble Shooting

Following are the more common troubles of globe valve operation, together with the probable cause and recommended remedies. Observance of the remedial procedures prior to valve disassembly may prevent unnecessary maintenance time and personnel involvement. Index numbers used in the listing refer to Figure 2.

Trouble:

Leakage at the body/bonnet joint

Probable Cause:

1. Loose or improperly tightened bonnet stud bolt nuts.
2. Damaged or improperly seated gasket.

Remedy:

1. Tighten nuts in accordance with Table 1 and Figure 4, observing the entire sequence of tightening.

NOTE
Tightening should be performed with valve being depressurized.

2. Break the body/bonnet joint and replace the gasket. (Refer to Table 1 and Figure 4 for bolt tightening procedure.)

CAUTION
Before attempting any disassembly, the line should be depressurized to prevent possibility of personnel injury or equipment damage. As an added safeguard, the valve should be opened and the body relieved of any residual pressure.

Trouble:

Leakage through the valve seat.

Probable Cause:

Worn or damaged seating surface on disc (14) and/or on the body (26).

Remedy:

Disassemble the valve and inspect both seating surfaces for wear and mechanical damage. Polish out minor damage. Remachine the parts if damage is heavy.

Trouble:

Leakage at the stuffing box.

Probable Cause:

1. Loose or improperly tightened gland stud nuts (5).
2. Gland follower (8) improperly seated.
3. Corrosion or mechanical damage of stem (15), in the stuffing box area.

Remedy:

1. Tighten nuts, alternating at 1/4 turns, to a torque of 15 to 30 ft-lbf. Tighten nuts just enough to stop any leakage. Do not tighten excessively.

2. Reposition gland follower on the packing rings. It may be necessary to replace or install additional packing rings. If such is the case

then the valve should be depressurized and in fully open position before any repacking is attempted.

CAUTION

Crane does not recommend the practice of backseating the valve and repacking the valve under pressure. In the event that the backseat fails to seal properly a leak path to atmosphere is generated which constitutes a potential safety hazard to personnel.

3. Minor corrosion or damage can be polished out. Replace the stem if the damage is major.

Trouble:

Rough or difficult operation.

Probable Cause:

1. Scored or otherwise damaged threads on stem (15).
2. Damaged yoke bushing (17).
3. Excessively tight gland stud nuts (5).

Remedy:

1. Minor scoring or damage can be polished out. Replace if stem damage is major.
2. Inspect the bushing for damaged threads or scoring. Polish out minor damage or replace the bushing for major damage.
3. Loosen nuts and then tighten to a torque value of 15-30 ft-lbf. In order to maintain even pulldown you should alternate tightening at 1/4 turn intervals.

2.11 Disassembly

CAUTION

Before attempting any disassembly, the line should be depressurized to prevent possibility of personnel injury or equipment damage. As an added safeguard, the valve should be opened and the body relieved of any residual pressure.

All internal parts of the globe valve are made accessible by removal of the bolted bonnet (22) from the valve body (26). The assembled stem (15) and disc (14) will be lifted out of the body as a unit when the bonnet is removed.

NOTE

Place parts on a clean surface as they are removed from the valve. Exercise care to avoid damage to parts through contact with hard objects.

Disassemble the globe valve in accordance with the following procedure: (see Figure 2)

NOTE

Match -mark the bonnet flange and body flange before removing bonnet to ensure assembly of the parts in their original position.

1. Operate the valve to the fully-open position. Remove the bonnet stud bolt nuts (1) and bonnet stud bolts(2) and lift the bonnet (22) and associated parts off the body (26) by raising the bonnet straight up. Lift the bonnet assembly carefully to avoid striking the disc seating surface against the body chest and damaging the seating surface. Remove and discard the PTFE gasket. If the only purpose of the maintenance procedure is to examine the condition of the disc and body seating surfaces, no further disassembly is necessary. DO NOT use any tool on the stem surface as this will damage the surface.

2. Loosen the gland stud nuts (5) a minimum of two turns; then turn the handwheel (4) in the direction to close the valve until the handwheel is down to the yoke bushing (17).
Remove the handwheel nut (3) and the handwheel. Grasping the portion of the stem (15) extending below the bonnet (22) by hand, turn the stem until the threads are disengaged from the yoke bushing threads. Pull the stem
with disc (14) attached down through the stuffing box and out the underside of the bonnet.

3. Remove the gland stud nuts (5) and the gland studs (6) from the yoke (21) and lift off the gland flange (7) and the gland follower (8). Remove the packing rings (9 and 10) from the bonnet (22). Discard the packing rings.

4. Using the proper size punch drive out the swivel nut pin (12) and remove the swivel nut (13). In case of the welded assembly of the disc and swivel nut , cut the weld. Separate the disc (14) from the stem (15), exercising extreme care not to damage the stem surfaces and the disc seating surface at any time.

5. If replacement of the yoke bushing (17) is necessary, drill out the yoke nut pins (18) to depth sufficient to permit removal of the yoke bushing nut (16). In case of the tack weld, cut the weld. Drive the yoke bushing (17) down through the yoke bushing bore and remove the yoke bushing and the yoke nut pins from the underside of the bore. Discard the yoke bushing, yoke bushing nut and yoke nut pins.

6. In valves design with the separate yoke, if the removal of the yoke (21) is necessary, remove the yoke bolt nuts (19) and yoke bolts (20) and remove the yoke from the bonnet (22). Do not remove the leakoff pipe nipple (24) unless replacement is required.

2.12 Inspection

After disassembly of the globe valve, all parts should be inspected for evidence of wear, distortion or mechanical damage. Perform the inspections listed in Table 3 to assure satisfactory operation of the affected parts.

2.13 Reassembly

1. Reassembly of the globe valve is performed essentially in the reverse order of disassembly observing the following special procedures: (See Figure 2)

Install new yoke bushing (17) into the underside of the bore yoke (21) and seat bushing in the bore. Note location of holes for the yoke nut pins (18) and thread the yoke bushing nut (16) into the yoke bushing. Tighten nut with a wrench and drill holes for the yoke nut pins at the proper location to pick up previously drilled holes in the bushing end of the yoke. Install the yoke nut pins and drive them down until they are flush with the top of the yoke bushing. Using a center punch, stake the pins around their periphery to lock them in place.

Table 3. Globe Valve Inspection

Step	Part	Inspect For	Remarks
1	Body	Evidence of wear or mechanical damage which could prevent tight sealing	Minor damage (less than 0.0005”) can be corrected by lapping the seats with the body in the line. Major damage or wear will necessitate removal of the body from the line for replacement or remachining.
2	Disc	Evidence of wear or mechanical damage to seating surface	Minor damage (less than 0.0005”), such can be corrected by lapping the seating surface. Major damage or wear will require remachining of the seating surface and may require replacement of the disc
		Evidence of galling on the stem side of the disc, particularly where the bottom of the stem bears against the disc.	If galling is evident, remachine or replace the disc.
		Damaged thread on the disc which mate with disc swivel nut threads and may cause assembly difficulties.	Repair threads with thread chaser, or tap or replace the disc.
3	Swivel Nut	Damaged threads which mate with disc threads and may cause assembly difficulties.	Repair threads with thread chaser or tap or replace the swivel nut.
		Evidence of galling or wear in stem bore.	Minor damage can be polished out. Major damage requires replacement of the swivel nut.
4	Stem	Evidence of galling on bottom surface which bears against the disc.	Minor damage can be polished or repaired by machining taking a very light cut. Major damage requires replacement of the stem.
		Evidence of wear on stem area which passes through packing rings, particularly indications of a spiral being worn into the stem by rotation of the stem through the packing rings.	Minor damage can be polished out. Major damage requires replacement of the stem.
5	Yoke Bushing	Evidence of wear or roughness on threads in bushing O.D.	If thread wear or damage is evident replace the yoke bushing, yoke bushing nut, and yoke nut pins.
6	Lantern Ring (if applicable)	Evidence of wear or roughness on the I.D. of bore.	Polish out roughness or replace lantern ring.
7	Gland Follower	Evidence of wear or roughness on I.D.	Polish worn or rough areas or replace gland follower.

2. Assemble the disc (14) on the stem (15) and slide swivel nut (13) over the top of the stem and down to the stem foot. Engage the threads of the swivel nut and the disc and , using a wrench, tighten the swivel nut into the disc. Check to be sure that the disc and swivel nut rotate freely on the stem with minimum of side and end play.

3. Insert the swivel nut pin (12) and drive in to lock the swivel nut (13) in place. Stake each end of the swivel nut pin after installation. Check again that the swivel nut and disc (14) are free to rotate on the stem (15).

NOTE

If new parts are being installed, it will be necessary to drill a hole for the swivel nut pin. The hole must be drilled offset as in the original parts to avoid interference with the free rotation of the disc and swivel nut.

4. Push the stem (15) from the underside of the bonnet (22) through the stuffing box far enough so that the packing (11) lantern ring (if applicable) (10) , gland (8), and gland flange (7) can be placed onto the stem. Install the packing in the stuffing box. Lightly lubricate the stem threads and push the stem through the stuffing box until the stem threads contact the threads of the yoke bushing (17) in the yoke (21). Manually turn the stem in the clockwise direction to engage the stem and the bushing threads. Continue to turn the stem until it is far enough through he yoke bushing so that the handwheel (4) can be installed. Install the handwheel and secure in place with the handwheel nut (3), tightening the nut with the wrench.

5. Install the yoke bolts (20) through the yoke (21) and the yoke flange of the bonnet (22) and secure with the yoke bolt nuts (19).

6. With the packing rings installed, slide the gland follower (8) and gland flange (7) into place on top of the packing rings. Assemble the gland studs (6) through the gland flange into the yoke (21) and tighten the gland stud nuts (5) to torque value of 15 to 30 ft-lbf.

NOTE

Tighten gland stud nuts evenly to avoid forcing the gland follower or gland flange against the stem.

7. Install new PTFE gasket (23) in the recessed groove in the flange of the body (26). Turn the handwheel (4) to move the disc (14) into fully open position. Carefully lower the bonnet (22) and the assembled parts onto the body, making sure not to let the disc seating surface strike against the body chest as the bonnet is lowered into place.

NOTE

Make certain that the bonnet is installed on the body in the same position as was noted during disassembly.

2.14 Spare Parts.

The packing rings (9 and 11) and the gasket (23) are the only recommended spare parts.

Figure 2 Typical Globe Valve Exploded View

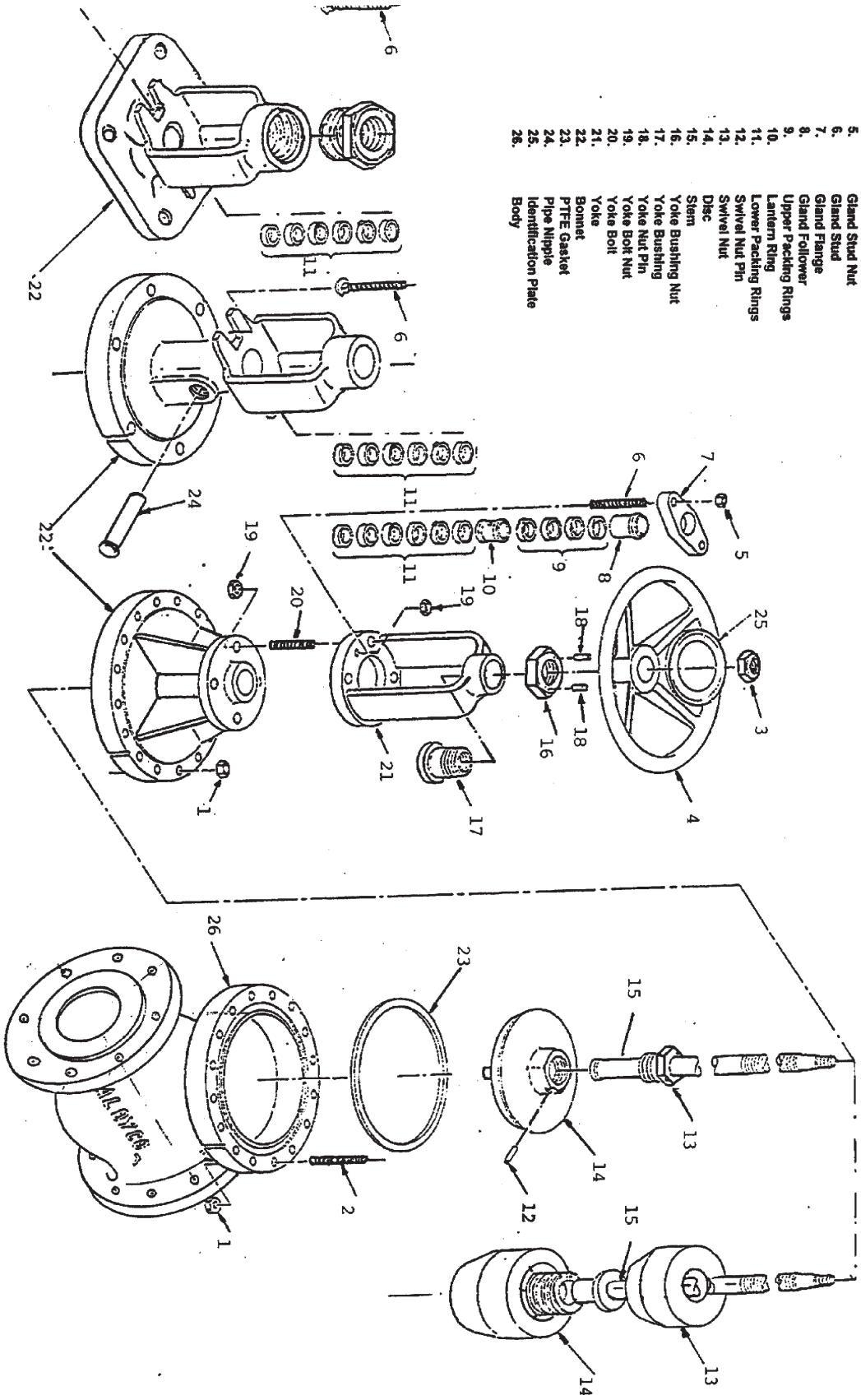


Figure 2. Typical Globe Valve Exploded View

Section 3. SWING CHECK VALVES

2.15 General.

This section covers all necessary maintenance instructions for the self-actuated swing check valves, including disassembly, inspection, lubrication, reassembly and trouble shooting. Your Maintenance function should develop procedures to ensure that the valve is in maintained in a satisfactory and safe operating condition at all times.

2.16 Routine Maintenance

One basic advantage of a swing check is its simplistic design. Other than a joint leak, valve fluttering, noisy operation and an occasional binding between the hinge pin and the disc arm little else can go wrong. To ensure satisfactory valve operation, a routine maintenance check should be performed at regular intervals. The following actions should be taken:

1. Inspect the valve for noisy or erratic operations. If this condition exist correct flow through the pipe.

NOTE
If correcting the flow fails to correct the condition then the valve will need to be disassembled, the most likely cause of the malfunction is process build-up around the hinge pivot point or galling between the moving parts.

2. If the system permits, depressurize the piping until the valve closes. Then pressurize the piping to assure if the valve opens.

NOTE
If the valve fails to open or close the valve needs to be disassembled and inspected to determine the cause of the malfunction.

CAUTION
Before attempting any disassembly, the line should be depressurized to prevent possibility of personnel injury or equipment damage.

3 Check all the cover stud bolt nuts for proper torque values and tighten the nuts as necessary to meet requirements of Table 1.

2.17 Trouble Shooting

Following is the list of more common troubles of swing check valve operation together with the probable cause and recommended remedies. Observance of the remedial procedures prior to valve disassembly may prevent unnecessary maintenance time and personnel involvement. Index numbers used in the listing refer to Figure 3.

NOTE
Place parts on a clean surface as they are removed from the valve. Exercise care to avoid damage to parts through contact with hard objects.

Trouble.
Leakage at cover body joint.

Probable Cause.

1. Loose or improperly tightened cover stud bolt nuts.

Remedy.

1. Tighten nuts in accordance with Table 1 and Figure 4.
2. Break the cover-body joint or replace gasket. (Refer to Table 1 and Figure 4 for bolt tightening procedure).

Trouble.

Leakage through seat.

Probable Cause

1 Worn or damaged seating surfaces on disc (7) and/or body (13).
2. Damaged or binding hinge pin (8) or hinge (9).
3. Disc (7) not free enough in the hinge (9) to align itself against the body seat.

Remedy.

1. Disassemble valve and check the seating surfaces for wear or mechanical damage. Polish out minor damage. Remachine or replace components if damage is heavy.
2. Check hinge pin for wear or out-off-roundness. Check hinge pin holes for roughness or wear. Polish out minor damage or replace parts with major damage.
3. Drive out disc nut pin (4) and loosen disc nut (5). Until disc (7) is sufficiently free. Lock nut in place with replacement disc nut pin.

2.18 Disassembly.

All internal parts are accessible by removal of the bolted cover (10). The hinge (9) and the disc (7) are suspended from the cover and will be lifted out of the valve when the cover is removed.

Disassemble the swing check valve in accordance with the following procedure: (see Figure 3)
1. Remove the cover stud bolt nuts (1) and cover stud bolts (2) and lift cover (10) from the body (13) taking care to prevent any damage to the disc seating surface. Lift cover straight up until cover pin (8) clears its locating hole; then shift cover laterally in the

downstream direction so as to move the disc (7) away from the seat in body (13). Lift cover and attached disc and hinge (9) clear of the valve body.

2. Push out the hinge pin (8) and remove and hinge and disc assembly from cover (10). The hinge pin should slide out easily.

3. If necessary for rework or replacement, remove the disc (7) from the hinge (9). Using hammer and punch, drive out the disc nut pin (4) and unscrew the disc nut (5). Remove the disc nut washer (if applicable) and withdraw the disc from the hinge.

4. Do not remove cover pin (11) unless replacement is necessary.

2.19 Inspection.

After disassembly of the swing check valve, all parts should be inspected for evidence of wear or distortion or mechanical damage. Perform the inspection listed in

Table 4. to assure satisfactory operation of the affected parts.

2.20 Reassembly

Reassembly of the swing check valve is performed essentially in the reverse order of disassembly, observing the following special procedures: (see Figure 3)

1. Assemble the disc (7) to the hinge (9) and install the disc nut washer (if applicable) and disc nut (5).

2. Tighten the disc nut (5) against the disc nuts washer (6) (if applicable) until the pin through holes in the nut and disc are aligned. Install the disc nut pin (4) and peen over the ends of the pin to lock the disc nut in place. Check that the disc is free fitting in the hinge (9) and that adequate movement between the disc and the hinge is present so that the disc can align itself freely against the body seat for closure.

3. Assemble the hinge (9) and the disc (7) to the cover (10) by inserting the hinge pin (8) through the cover hinge holes and the hinge. Check that the movement of the hinge on the hinge pin is free with no binding.

4. Place the PTFE gasket (3) in the gasket recess on the body cover flange.

5. If necessary, install replacement cover pin (11). Approaching the body from the downstream position, place cover (10) with the hinge and disc attached, on the body, in the same manner as removal, taking care to ensure that the cover pin is aligned with its locating hole. Lower cover into place gently to avoid damage to the seating surfaces.

6. Install cover stud bolts (2) and cover stud bolt nuts (1). Follow the procedure specified in Chapter 1 and tighten nuts to the torque values listed in Table 1 in the sequences in Figure 1.

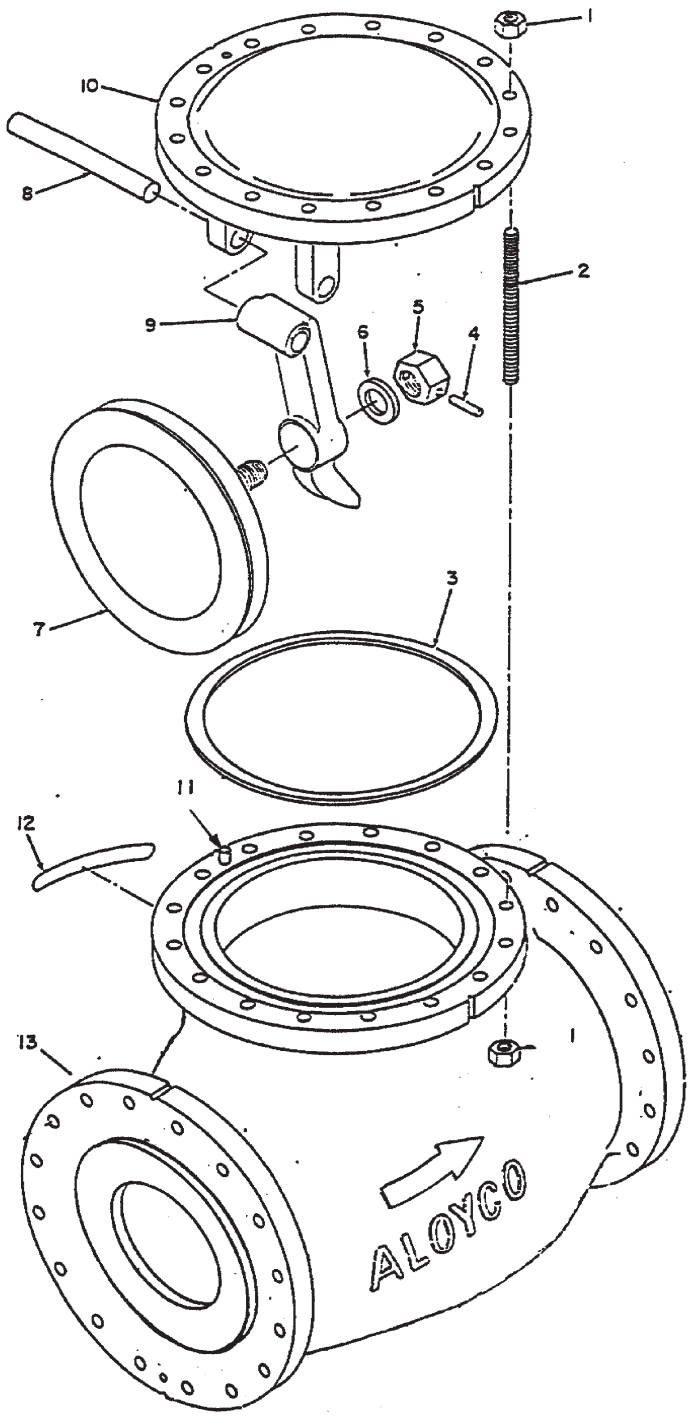
Table 4 Swing Check Valve Inspection

Step	Part	Inspect For	Remarks
1	Hinge Pin	Evidence of wear resulting in out-of-roundness, galling or roughness	Minor wear can be polished out. Major wear will necessitate hinge pin replacement
2	Hinge	Evidence of wear on hinge pin end resulting in out-of-roundness or roughness in hinge pin bore.	Minor wear can be polished out. Major wear will necessitate hinge replacement.
		Evidence of wear resulting from movement of the disc in the hinge	Minor wear can be polished out. Major wear will necessitate replacement.
3	Cover	Evidence of wear resulting in out-of-roundness or roughness in the hinge pin holes on the underside of the cover.	Minor wear can be polished out. Major wear will necessitate cover replacement.
4	Disc	Evidence of wear or damage on seating surface which could prevent tight seating.	Lap, grind or remachine disc seating surface to assure adequate seating or replace disc.
		Evidence of wear on surfaces which mate with hinge	Minor damage can be polished out. Major damage requires replacement of the disc.
5	Body	Evidence of wear or damage on body seat from hammering, sliding, etc. which could prevent tight seating.	Correct minor seating surface damage by lapping seat to obtain a flat surface with the body in line. If damage or wear is extensive, remove the body from the line for remachining of the seat or replacement of the body.

2.21 Spare Parts

The PTFE gasket (3) is the only recommended spare part for the swing check valve.

Figure 3 Typical Swing Check Valve Exploded View



1. Cover Stud Bolt Nut
2. Cover Stud Bolt
3. PTFE Gasket
4. Disc Nut Pin
5. Disc Nut
6. Disc Nut Washer
7. Disc
8. Hinge Pin
9. Hinge
10. Cover
11. Cover Pin
12. Identification Plate
13. Body

Figure 3 Typical Swing Check Valve Exploded View

Crane Service Center

CRANE VALVES
1202 HAHLO STREET
HOUSTON, TX
Ph: (713) 671-4600
Fax: (713) 671-4745

Cast Steel Gate Valves

- Gate valves provide complete shut off, providing the seats remain undamaged, and offer very little resistance to flow in the open position. Gate valves are best suited to infrequent valve operation, as any dirt in the system will cause scuffing of the seats, which slide relative to each other. Gate valves are not recommended for use in the partially open position because vibration and erosion of the disc may occur.
- Service temperature and pressure indicated on the identification plate or body marking should not be exceeded.
- Crane gate valves have not been designed as fire safe valves.
- Valves must be installed into a well-designed system and it is recommended that the system be inspected in accordance with the appropriate member state legislation. In the UK – The Pressure Equipment Directive 97/23/EC and The Pressure Systems Safety Regulations 2000.

STORAGE

• On receipt valves should be stored in a clean, dry environment until immediately prior to installation. Flange protectors should be left in place until the valve is ready to be installed.

INSTALLATION

Preparation

• Ensure valve is suitable for service conditions e.g. pressure, temperature, service media.

• When valves are to be installed remove the flange protectors and ensure valves are free of any foreign matter.

• If slinging the valve using rope, chain or wire (make sure breaking strain is correct for valve weight) only sling through yoke legs. Never sling through valve bore or under/through spokes of handwheel.

• The complete piping system must be flushed through prior to commissioning to ensure all foreign matter is removed. Subsequent valve failure is frequently caused by dirt and other matter left in the pipeline.

• The Installation shall be designed to provide adequate means of draining and venting to avoid harmful effects such as water hammer, vacuum collapse, corrosion and uncontrolled chemical reactions and to permit cleaning, inspection and maintenance in the correct manner.

• The product has not been designed to include corrosion, erosion or abrasion allowances. Any queries regarding service applications should be addressed to the

Crane Fluid Systems - Technical Sales Department.

• The valves have been designed for loadings, appropriate to its intended use and other reasonably foreseeable operating conditions. Loadings caused by traffic, wind and earthquake have not been taken into account.

• It is the responsibility of the installer to ensure that the valves do not exceed the allowable limits of pressure. However the equipment is designed to withstand a momentary pressure surge of up to 10% above the maximum working pressure.

The piping system shall be so designed to reduce the risk of fatigue due to vibration of pipes.

Valve Location

• Valves should be located to ensure ease and safety of operation and access allowed for subsequent maintenance of the valve.

• Valves should be located to allow access for gland adjustment and re-packing.

Piping Supports

These must be carefully aligned and at the correct distance between centres for the size and type of pipe. The following publications provide details of correct spans and installation details:

BS3974, Specification for Pipe Supports (Available from BSI)

DOI Directorate of M & E Engineering Services, M & E No. 3 (Available from HMSO)

Flange Joints

• Effective flange joints require compression of a gasket between mating flange faces. The mechanical forces required to maintain compression of the gasket over the full operational pressure and temperature range of the valve must be provided by the bolting. It is important that the correct bolting is used and that matching flanges and gaskets are equally suitable.

Assembly

• Make sure the mating faces are free of any defect that can lead to leakage. All flange faces must be clean and free of foreign bodies. The valve must be well supported. Take care to ensure alignment of the flanges. Use a suitable lubricant on bolt threads. Sequence the bolt tightening to ensure the contact between flanges and gasket is flat and parallel. Tighten bolts (not in rotation but by the cross over method) gradually and uniformly to avoid any tendancy to twist one flange relative to another.

OPERATION

Cast Steel gate valves are designed to seat with the Crane standard handwheel. Levers, wrenches or other tools should not generally be used to operate a valve. Excessive torque can cause damage to seating faces and/or stem/handwheel. With larger valves the use of a ‘pinch bar’ is acceptable providing the bar length does not exceed 1.5 x the handwheel diameter.

ROUTINE MAINTENANCE

• Check for leaks at gland. If gland is leaking tighten the gland nut(s). The gland nut(s) should be tightened only enough to prevent stuffing box leakage. Over-tightening can cause excessive wear on stem and packing and make valve difficult to operate. If leakage is still occurring add additional or new packing.
• Valves with rising stems are constructed so that packing can be replaced when the valve is fully open. It is strongly recommended that the pipeline be isolated when re-packing the stuffing box.
• Check for leaks at the body/bonnet joint. To remedy, tighten down the nuts on the bonnet bolts in the vicinity of the leak. If leakage still occurs renew the bonnet gasket. The pipeline must be sealed off before removing the valve bonnet to fit the new gasket.
• Lubricate the stem threads checking first that the working conditions permit the application of a lubricant.
• All valves are designed to permit inspection without removing the valve body from the pipeline. The portion of the pipeline on which the valve is installed must be sealed off and drained before any dismantling and inspection is carried out.
• It is important that if the disc is removed during routine maintenance that it is re-assembled in the valve body in the same position as it was before removal. The disc should be suitably marked to ensure this.
• Seat leakage can be caused by dirt on the seating faces or by foreign matter in the pipeline. To remove dirt, flush the valve seats by slowly seating the disc then slowly open the valve by one handwheel turn; repeat this procedure several times if required. If a leak is still evident, it will be necessary to remove the bonnet to inspect the sealing faces for damage.
• Occasionally operate valves that remain open or closed for long periods to ensure they are in good working order, thus avoiding the possibility of being inoperable in a time of emergency.

GENERAL CONSIDERATIONS

• Maximum operating pressure reduces as service temperature increases. Pressure and temperature limitations are shown by the valve body marking or on the identification plate, and must not be exceeded.
• Valves are not designed to operate under high shock loadings. Where pressure increases occur due to shock loading (water hammer), they should be added to the working pressure to obtain the total pressure acting on the valve. The total must not exceed the pressure rating of the valve. A pressure surge, or shock, is usually caused by the rapid closure of a check valve or quarter turn valve resulting in a sudden reduction in flow rate.
• It is bad practise to install valves with the hand wheels pointing downwards, as damage may be caused to the gland packing and stem seal, by debris in the system.
• The surfaces of valves in service may be subject to extreme temperatures; care should be taken when handling.

Fig No	PED Category by Size			Product Applications			
	Cat 1	Cat 2	Cat 3	Group 1 Gas	Group 2 Gas	Group 1 Liquid	Group 2 Liquid
47XUF	2 – 2.1/2	3 – 8	10 – 12	✓	✓	✓	✓
33XUF	-	2 – 4	5 – 12	✓	✓	✓	✓

The above products are not suitable for use with unstable fluids.

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A Crane Co company.

5. Check Valves- NIBCO

Return Water Pond

a. **26- FCOOCM-BP-RWP-CKV-002**
b. **27- FCOOCM-BP-RWP-CKV-003**

Pond 3 Pump House

c. **118- FCOOCM-BP-AP-CKV-1067**
d. **129- FCOOCM-BP-AP-CKV-1066**

NIBCO®
AHEAD OF THE FLOW®

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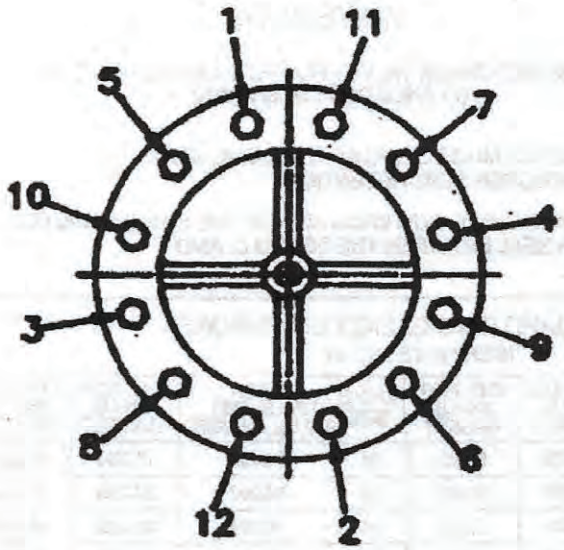
INSTALLATION, OPERATION & MAINTENANCE INSTRUCTIONS

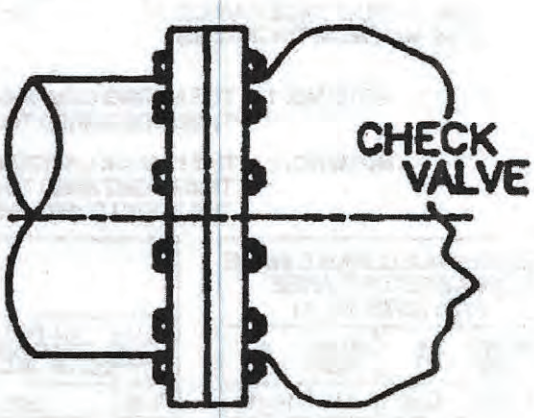
Review Date: 01/18/2012
Original Date: 04/07/1996

Operating, Maintenance and Installation Instructions for NIBCO® Flanged End and Wafer Style Check Valves (Series 910 & 960)

WARNING NOTICE:

1. Damage to the valve and/or internal leakage may result if pipe flanges other than those with standard flat faces, conforming to ANSI B16.5 or AWWA C207-86, are used. Flanges having an expanded inside diameter (often found on mortar lined pipe) cannot be used on the inlet side of the valve. A ring flange having a maximum inside diameter as shown in "A" dimension (see next page) must be inserted between the valve and mortar lined pipe flange.
2. Proper centering of ring gasket is important to prevent internal valve leakage.
3. The valve and adjacent piping must be supported and aligned to prevent stress from being transferred to the valve's flanges. The torquing of the flange bolts should then be done in several graduated steps, using the number sequence shown below. This even loading of the flange bolts will eliminate concentrated stresses which could fracture the valve's flange.



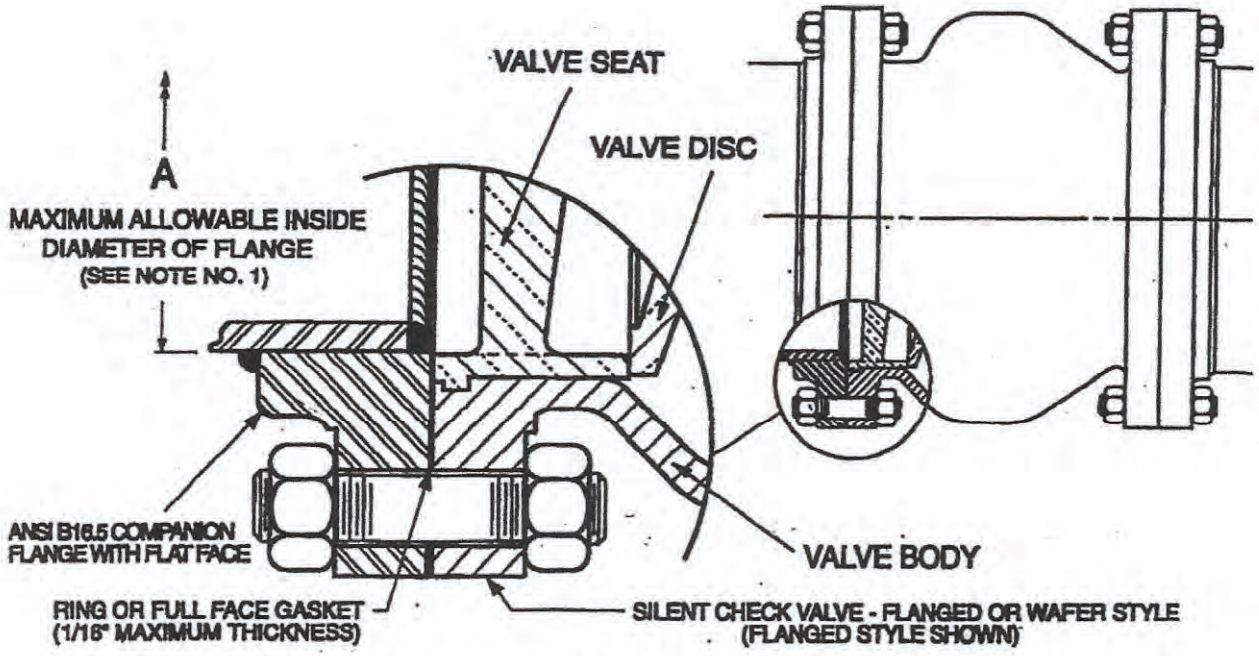


CAUTION: Only qualified personnel should undertake the procedures outlined in this document. NIBCO INC., its agents, representatives and employees assumes no liability for the use of these procedures. These procedures are offered as suggestions only.

SILENT CHECK VALVE INSTALLATION REQUIREMENTS

DAMAGE TO THE VALVE AND / OR INTERNAL LEAKAGE MAY RESULT IF PIPE FLANGES OTHER THAN THOSE WITH STANDARD FLAT FACES, CONFORMING TO ANSI B16.5 OR AWWA C207 ARE USED..

WARNING NOTICE: FLANGES HAVING AN EXPANDED INSIDE DIAMETER (OFTEN FOUND ON MORTAR LINED PIPE) CANNOT BE USED ON THE INLET SIDE OF THE VALVE. A RING FLANGE HAVING A MAXIMUM INSIDE DIAMETER, AS SHOWN IN "A" DIMENSION BELOW, MUST BE INSERTED BETWEEN THE VALVE AND MORTAR LINED PIPE FLANGE.



NOTE NO. 1 - THE MATING COMPANION FLANGE I.D. MUST OVERLAP THE VALVE SEAT. THIS IS REQUIRED TO PROVIDE PROPER SEAT RETENTION.

NOTE NO. 2 - THE FLANGE GASKET MUST BE PROPERLY CENTERED AND OF THE SIZE INDICATED. THIS IS REQUIRED TO ACHIEVE A SEAL BETWEEN THE SEAT O.D. AND THE BODY I.D. INTERFACE AREA.

MAXIMUM ALLOWABLE INSIDE DIAMETER OF FLANGE (SEE NOTE NO. 1)			
VALVE SIZE	A	VALVE SIZE	A
2 1/2	2.940	14	14.140
3	3.570	16	16.160
4	4.570	18	18.180
5	5.660	20	20.200
6	6.720	24	24.250
8	8.720	30	30.250
10	10.880	36	36.250
12	12.880	42	42.250

STANDARD RING GASKET DIMENSIONS (SEE NOTE NO. 2)							
VALVE SIZE	I.D. FOR 125 LB. AND 250 LB. GASKET	O.D. FOR 125 LB. GASKET	O.D. FOR 250 LB. GASKET	VALVE SIZE	I.D. FOR 125 LB. AND 250 LB. GASKET	O.D. FOR 125 LB. GASKET	O.D. FOR 250 LB. GASKET
2 1/2	2.875	4.875	5.125	14	14.000	17.750	19.125
3	3.500	5.375	5.875	16	16.000	20.250	21.250
4	4.500	6.875	7.125	18	18.000	21.625	23.500
5	5.562	7.750	8.500	20	20.000	23.875	25.750
6	6.625	8.750	9.875	24	24.000	28.250	30.500
8	8.625	11.000	12.125	30	30.000	34.750	37.500
10	10.750	13.375	14.250	36	36.000	41.250	44.000
12	12.750	16.125	16.625	42	42.000	48.000	50.750

For any technical enquiries please call NIBCO Technical Services.

6. 1” Vent/ Drain Valves

Return Water Pond

a. **02- FCOOCM-BP-RWP-VLV-V001**
b. **04- FCOOCM-BP-RWP-VLV-V003**
c. **10- FCOOCM-BP-RWP-VLV-V005**
d. **12- FCOOCM-BP-RWP-VLV-V007**
e. **18- FCOOCM-BP-RWP-VLV-V009**
f. **25- FCOOCM-BP-RWP-VLV-V011**

FNW™

INSTALLATION, OPERATION & MAINTENANCE INSTRUCTIONS

FIGURE 200A 2-PIECE BALL VALVE

INTRODUCTION

This instruction manual includes installation, operation and maintenance information for the figure 200A 2-piece 1000CWP, threaded end (NPT) ball valve.

INSTALLATION

WARNING
To avoid personal injury to your self, fellow workers, or damage to property from release of process fluid, before installation:

a. Shut off all operating lines to the valve site
b. Isolate the valve site completely from the process
c. Release process pressure
d. Drain the process fluid from the valve site

1. Remove the protective plastic cap from the threaded ends and clean or flush the valve.

2. Before installing the valve, inspect the valve body port and associated equipment for any damage that may have occurred and for any foreign matter that may have collected in shipping or storage. Make certain the body interior is clean.

3. Before installing the valve, inspect the pipe line and mating pipe threads, making sure the pipe is free of foreign material and the threads are clean and have no burrs or pits that could cause leakage.

4. Cycle the valve a couple of times before installation. Valves that are tested to MSS SP-110 may have water trapped between the ball and body cavity. This can be removed by partially opening the valve, exposing the cavity to the through port of the ball. Allow the water to drain out.

5. Use applicable sealant (e.g. - PTFE tape, high temperature pipe seal, etc.) to seal threaded ends on the pipeline.

6. To prevent distortion or damage to the valve, do not apply torque through the valve. When tightening the valve, always use a wrench on the end nearest the pipe being tightened. It is preferred that the pipe be screwed into the valve, holding the valve stationary at the end being connected. Do not use the handle to tighten the assembly as damage to the valve may occur.

7. Clean/flush the pipeline and leak test the system prior to using.

OPERATION

1. Ensure that the valve materials are compatible with the service and that the operating characteristics are below the valve maximums.

2. Fluids containing particles or coagulating agents are not acceptable as they can reduce the life of the seats and cause the torque to increase dramatically.

3. Care must be taken if throttling the valve (operation in partially open position). Critical pressure drops and high flow rates can decrease the life of, or damage, the seats. For optimum operation, open/close applications are recommended.

4. The valve comes standard with a locking device. Slide the locking plate up the lever before operating. Open and close the valve by turning the handle one-quarter turn (90°).

5. The valve is in the open position when the handle is parallel to the pipe, and in the closed position when perpendicular to the pipe.

MAINTENANCE

Valve parts are subject to normal wear and must be inspected and replaced as necessary. Inspection and maintenance frequency depends on the severity of the service conditions. This section includes instructions for packing adjustments, repacking, seat replacement and seating adjustment.

WARNING
To avoid personal injury, fellow workers, or damage to property from release of process fluids, before installation:

a. Shut off all operating lines to the valve.
b. Isolate the valve completely from the process.
c. Release process pressure.
d. Drain the process fluid from the valve.

1. Ball valves, if properly used, do not require internal lubrication or maintenance. However, a visual inspection should be part of a regular maintenance program. A higher frequency of inspection is recommended for valves operating under extreme conditions. Also, for proper operation it is recommended that the valve be opened and closed at least twice a year.

2. Before any maintenance, open and close the valve at least once to release the pressure completely from the valve body.

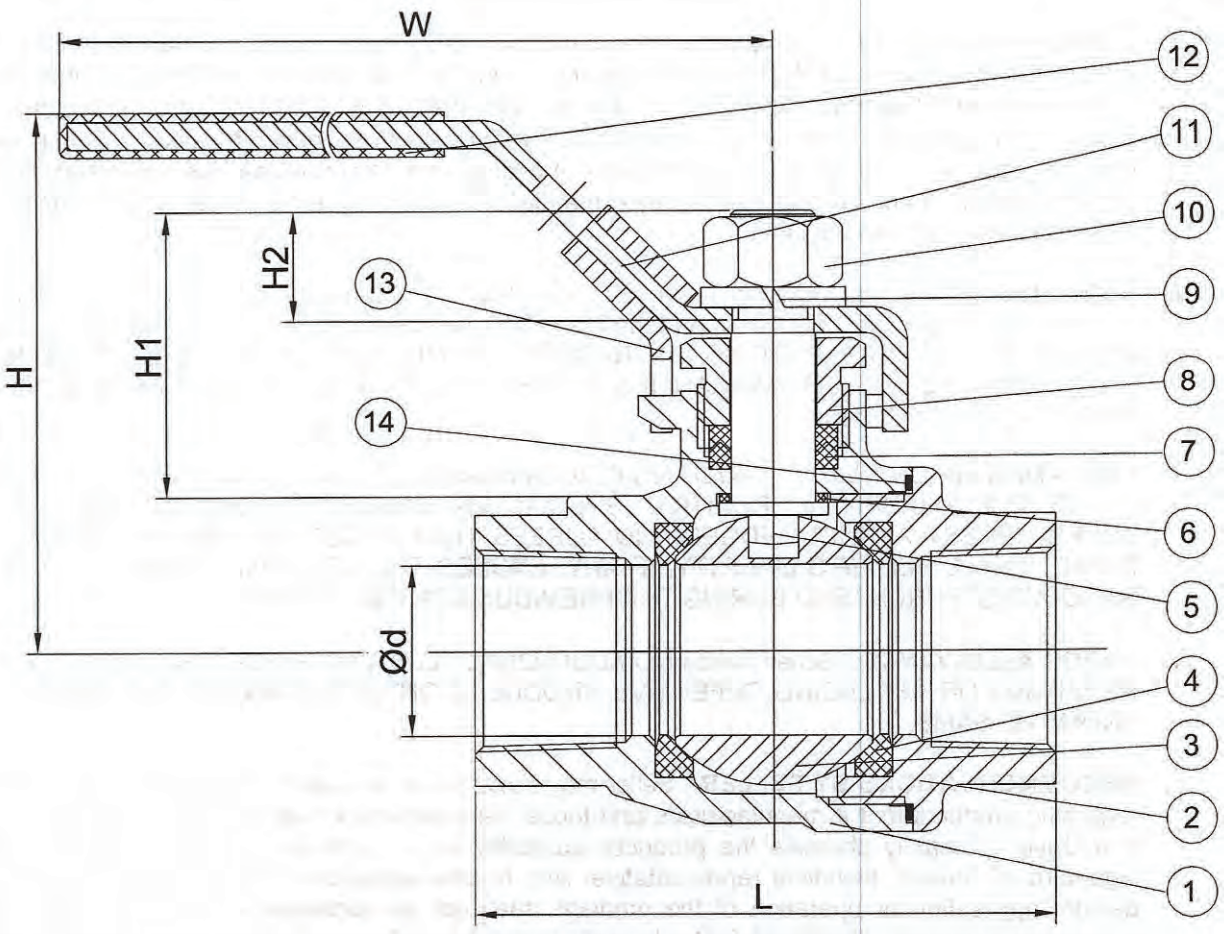
3. For stem packing leaks, with the lever locking device engaged, use a crescent wrench to turn the gland nut clockwise at 30° to 60° intervals until the leak stops. If the gland nut can not be turned clockwise any further, or if the stem packing continues to leak, it will have to be replaced or repaired. **NEVER REPLACE VALVE PACKING WHILE THE VALVE IS IN SERVICE.**

4. The valve can be rebuilt by using a "Soft Goods" repair kit from FNW.
   Disassembly
   A. Place the valve in a vise in the closed position. Do not over-tighten the vise or the valve may be deformed.
   B. Remove the stem nut (10), stem washer (9), handle (11), and gland (8).
   C. With a crescent or strap wrench, remove the end cap (2), seat (4), and the body gasket (14).
   D. Remove the ball (3) and seat (4).
   E. Push the stem (5) down through the body (1), and then remove the thrust washer (6) from the stem.
   F. Remove the packing (7) from the body.

   Assembly
   A. Rebuild the valve by using all the replacement parts of the rebuild kit.
   B. Ensure that all parts are clean and undamaged.
   C. Assemble the valve in reverse order of the disassembly instructions, except install the packing after the stem is inserted.

It is recommended to cycle and test the valve prior to resuming service. After reinstallation into the piping system, it may be necessary to adjust the stem nut/packing gland as described in step 3.

FIGURE 200A 2-PIECE BALL VALVE



Ref. No.	Description	Material	Qty
1	Body	ASTM A351 Gr. CF8M Stainless	1
2	End Cap	ASTM A351 Gr. CF8M Stainless	1
3	Ball	316SS Stainless	1
4	Seat	RTFE	2
5	Stem	316SS Stainless	1
6	Thrust Washer	PTFE	1
7	V-Ring Packing	PTFE	1 Set
8	Gland Nut	304SS Stainless	1
9	Stem Washer	304SS Stainless	1
10	Stem Nut	ASTM A194-8 Stainless	1
11	Handle	304SS Stainless	1
12	Handle Sleeve	Vinyl Plastic	1
13	Locking Device	304SS Stainless	1
14	Body Gasket	PTFE	1

WARRANTY

1. **LIMITED WARRANTY:** Subject to the limitations expressed herein, Seller warrants that products manufactured by Seller shall be free from defects in design, material and workmanship under normal use for a period of one (1) year from installation but in no case shall the warranty period extend longer than eighteen months from the date of sale. This warranty is void for any damage caused by misuse, abuse, neglect, acts of God, or improper installation. For the purpose of this section, "Normal Use" means in strict accordance with the installation, operation and maintenance manual. The warranty for all other products is provided by the original equipment manufacturer.

2. **REMEDIES:** Seller shall repair or replace, at its option, any non-conforming or otherwise defective product, upon receipt of notice from Buyer during the Manufacturer's warranty period at no additional charge. SELLER HEREBY DISCLAIMS ALL OTHER EXPRESSED OR IMPLIED WARRANTIES, INCLUDING, WITHOUT LIMITATION, ALL IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS OR FITNESS FOR A PARTICULAR PURPOSE.

3. **LIMITATION OF LIABILITY:** UNDER NO CIRCUMSTANCES SHALL EITHER PARTY BE LIABLE TO THE OTHER FOR INCIDENTAL, PUNITIVE, SPECIAL OR CONSEQUENTIAL DAMAGES OF ANY KIND. BUYER HEREBY ACKNOWLEDGES AND AGREES THAT UNDER NO CIRCUMSTANCES, AND IN NO EVENT, SHALL SELLER'S LIABILITY, IF ANY, EXCEED THE NET SALES PRICE OF THE DEFECTIVE PRODUCT(S) PURCHASED DURING THE PREVIOUS CONTRACT YEAR.

4. **LABOR ALLOWANCE:** Seller makes NO ADDITIONAL ALLOWANCE FOR THE LABOR OR EXPENSE OF REPAIRING OR REPLACING DEFECTIVE PRODUCTS OR WORKMANSHIP OR DAMAGE RESULTING FROM THE SAME.

5. **RECOMMENDATIONS BY SELLER:** Seller may assist Buyer in selection decisions by providing information regarding products that it manufacturers and those manufactured by others. However, Buyer acknowledges that Buyer ultimately chooses the product's suitability for its particular use, as normally signified by the signature of Buyer's technical representative. Any recommendations made by Seller concerning the use, design, application or operation of the products shall not be construed as representations or warranties, expressed or implied. Failure by Seller to make recommendations or give advice to Buyer shall not impose any liability upon Seller.

6. **EXCUSED PERFORMANCE:** Seller will make a good faith effort to complete delivery of the products as indicated by Seller in writing, but Seller assumes no responsibility or liability and will accept no back-charge for loss or damage due to delay or inability to deliver, caused by acts of God, war, labor difficulties, accidents, inability to obtain materials, delays of carriers, contractors or suppliers or any other causes of any kind whatever beyond the control of Seller. Under no circumstances shall Seller be liable for any special, consequential, incidental, or indirect damages, losses, or expense (whether or not based on negligence) arising directly or indirectly from delays or failure to give notice of delay.