Appendix C
Design Criteria

APPENDIX C

Design Criteria

In conformance with requirements from the 1996 Corrective Action Consent Agreement (CACA) (California Department of Toxic Substances Control 1996) and the 2013 Remedial Action/Remedial Design (RD/RA) Consent Decree (U.S. Department of the Interior [DOI] 2013), this appendix describes the design criteria for the groundwater remedy at the Topock Compressor Station (TCS). The design criteria are the technical parameters upon which the design is based, and are based on the translation of the identified applicable or relevant and appropriate requirements (ARARs) and the Environmental Impact Report (EIR; California Department of Toxic Substances Control [DTSC] 2011) mitigation measures (where applicable) into site-specific engineering parameters.

The design criteria are grouped into engineering disciplines (Civil [Section C.2], Structural [Section C.3], Geotechnical [Section C.4], Mechanical [including electrical] [Section C.5], Electrical [Section C.6], Instrumentation and Control [Section C.7], and Architectural [Section C.8]). In addition, this appendix describes PG&E Personnel Requirements (Section C.9) and design criteria for Health and Safety (Section C.10) and Noise (Section C.11).

This appendix includes five Attachments that contain a large amount of data; these Attachments are presented in PDF format on the CD-ROM version of the 90% Basis of Design (BOD) Report (enclosed within the report binders).

- Attachment A contains a detailed description of the in situ remediation design basis including carbon substrate selection and discussion of chemical reactions.
- Attachment B provides calculations in the following order:
  - Remedy-produced water pump calculations – recirculation; filter feed; conditioned water transfer
  - Remedy-produced water influent tank eductor sizing
  - Remedy-produced water caustic usage
  - Remedy project structural calculations related to the pipe bridges, Remedy-produced Water Conditioning Building, conditioned water storage, freshwater storage, the Contingent Freshwater Pre-injection Treatment Building, and L-300 load calculation
  - Freshwater supply and injection hydraulic network modeling calculations from EPANET software[1]
  - Hydraulic calculations for National Trails Highway In-situ Remediation Zone (NTH IRZ), Inner Recirculation Loop, and TCS Recirculation Loop wells
  - Structural design calculations for the MW-20 Bench Carbon Amendment Building
  - Fire suppression calculations for the MW-20 Bench and TW Bench Carbon Amendment Buildings
  - Sand separator collection system
- Attachment C summarizes information on existing site geology and geotechnical data in support of the groundwater remedy design and to propose areas where supplemental geotechnical investigation is needed to verify design parameters.
- Attachment D includes a bulletin on remediation well design and field approach.
- Attachment E includes a summary of the hydraulic analysis of the firewater system.

[1] Developed by the U.S. Environmental Protection Agency for hydraulic network modeling and drinking water quality analysis. For details, see http://www.epa.gov/nrmrl/wswrd/dw/epanet.html.

C.1 Codes and Standards

The Groundwater Remedy Project is generally being designed in accordance with the applicable standards, codes, ordinances and regulations, including but not limited to:

- American Association of State Highway Traffic Officials
- American Concrete Institute (ACI)
- American National Standards Institute (ANSI)
- American Petroleum Institute (API)
- American Railway Engineering and Maintenance of Way Association
- American Society for Testing and Materials (ASTM) International
- American Water Works Association Standard (AWWA)
- American Welding Society (AWS)
- Asphalt Institute
- Arizona Department of Transportation Policy for Accommodating Utilities on Highway Rights of Way
- Burlington Northern Santa Fe Railway (BNSF) Utility Accommodation Policy
- California Building Code (2013) as amended by San Bernardino County
- California Fire Code (2010)
- California Mechanical Code (2010)
- California Plumbing Code (2010)
- California Division of Occupational Safety and Health (Cal/OSHA)
- Crane Manufacturer's Association of America
- County of San Bernardino 2007 Development Code
- Illuminating Engineering Society of North America (IES) procedures
- International Energy Conservation Code (IECC)
- International Green Building Code
- Institute of Electrical and Electronic Engineers (IEEE)
- Instrument Society of America (ISA)
- Insulated Cable Engineers Association (ICEA)
- Minimum Design Loads for Building and Other Structures (American Society of Civil Engineers [ASCE] 7-10)
- Mohave County Regulations (including Drainage Design Manual for Mohave County)
- Mohave County Floodplain Administrator requirements
- National Association of Corrosion Engineers
- National Electrical Manufacturers Association (NEMA)
- National Electrical Code (NEC)
- National Electrical Safety Code (NESC)
- National Fire Protection Association (NFPA)
- National Sanitation Foundation
- Occupational Safety and Health Administration (OSHA)
- PG&E standards
- San Bernardino County Department of Public Health, Division of Environmental Services
- San Bernardino Fire Department/Certified Unified Program Agencies (CUPA) requirements
- San Bernardino County Floodplain regulations
- Uniform Fire Code (UFC) (Local Fire Code)
- Underwriters Laboratory (UL)

C.2 Civil

C.2.1 Site Datum

The topographic map (with 1-foot topographic contours) used in the design was based on an aerial survey conducted in 2011 by Toponex. Ground surveys were also conducted in localized areas to support the design. The following data were used to establish control for the project and conduct site survey work:

- Coordinates listed are 1983 State Plane Ground Coordinates, Zone 5 (NAD1983, State Plane, California, V, FIPS, 0405).
- The elevations are based on North American Vertical Datum of 1988 (NAVD88) in U.S. Survey feet.
- Units = International feet: 1 foot = 0.3048 meter.
- All bearing are grid bearings, distances are ground distances, and coordinates are ground coordinates.

C.2.2 Earthwork

This section describes the design criteria for the movement of soil and rock into forms and structures needed for the project.

- Grading, Paving and Access Roads

  Cut and grading will take place at the site to install new remedy facilities. Access roads are required to access certain project locations for construction and O&M. Access roads will be designed to the following standards (barring terrain or cultural, biological or natural resource constraints):

  - Maximum grade ≤ 10%, with the exception of the access road to IRL-4 and the access road east of Transwestern (TW) Bench
  - One way traffic width = 14 feet minimum
  - Two way traffic width = 20 feet minimum (Note that San Bernardino County Code Chapter 5 allows a variance for narrower fire access roads if turnouts [6 feet wide by 50 feet long] are provided about every 600 feet [County Standard 503.1]).
  - Cut slopes 1.5:1 (H:V) or flatter
  - Fill slopes 2:1 (H:V) or flatter
  - Out slope road (1/4 inch per foot) so that drainage flows perpendicular to road centerline
  - Roadside ditches (V shaped or trapezoidal) with a minimum top width of 2 feet
  - Per San Bernardino County requirements (Section 7 of San Bernardino County Department of Public Works – General Permit Conditions and Trench Specifications): 95% compaction of asphalt pavement, paving base material and the portion of backfill within 6 inches of paving base material. Below 6 inches, 90% compaction.
  - Pavement replacement will be in accordance with the California Department of Transportation's (Caltrans') *Flexible Pavement Structural Section Design Guide for California Cities and Counties* (latest edition).

- Utility trenches will be excavated to a minimum 3 feet deep and 2 feet wide. Utility trenches may include pipes (freshwater, extracted groundwater, carbon-amended water, remedy-produced water, clean in place (CIP), acid, coagulant, caustic, slurry, waste sump, utility, or spare pipes), as well as electrical and instrumentation conduits. Trench cutoff walls with drain systems may be installed at locations where pipe slopes exceed 8%-10% for long runs (300 to 500 feet) to help divert any potential water flow that may undermine the trench section. In areas where utility crossings exist there will be a minimum of 2 feet separation between utilities unless directed otherwise by the utility owner. The location and depth of utilities encountered during construction will be surveyed. The survey data, utility size, and material type will be recorded on as-built documents.

- Pipe and conduit bedding material will be free of rock(s), rubbish, debris, and other objectionable material, and minimum compaction will be 90% to 95% relative density, per American Society for Testing and Materials (ASTM) International D-1557 in areas sensitive to settlement. The minimum pipe bedding thickness will be 6 inches and the minimum pipe/conduit backfill zone thickness will be 3 inches. Bedding will be without voids, placed and compacted to the proper depth in 8-inch maximum lifts. The backfill will be placed to final grade to conform to the elevation of the adjoining surface elevation.
- A survey of aboveground and underground utilities will be conducted within all work areas prior to beginning intrusive site work and construction activities. This survey will include, but will not be limited to, the following activities:
  - Notify Underground Service Alert (USA) or “DigAlert” in California, or Arizona Blue Stake in Arizona
  - Geophysical survey to identify underground features
  - Excavation to expose and identify known or suspected utilities before excavation. It is Topock Compressor Station policy to minimize operational and safety risks by limiting subsurface intrusion as much as possible, and thus abandoned utilities are typically left in place. Because positive identification of all active and abandoned underground utilities prior to any intrusive activity within the station fence line is impossible, Compressor Station protocol requires all intrusive work be performed by hydro vacuum or hand excavation methods.

    As described during the October 24, 2011 site visit with the DTSC and the DOI, PG&E policy requires all excavations in the vicinity of existing infrastructure to be hand dug when within 3 feet of existing infrastructure; in more open areas. Hydro vacuum excavation may be used in lieu of hand digging. Depending on the location, density of utilities encountered, and available information regarding a specific location, hand excavation or clearing using the hydrovacuum may be required as deep as 10 feet below ground surface. No power equipment will be used until the excavation has been physically cleared for utilities. A station employee observes each excavation effort and determines when it is safe to proceed with more intrusive methods. PG&E does not have a written procedure for this requirement; however, it is policy and is understood and strictly followed by all station personnel.
- It is preferred that piping installed in utility corridors will be below ground. There are many reasons for this preference, including but not limited to the following:

  a) The National Electrical Safety Code (NESC) considers an above-ground, non-overhead, high voltage electrical supply line to be an example of non-Code compliant, therefore, medium and high voltage electrical lines will be place underground. In addition, aboveground low voltage electrical 480 volt power lines carry the risk of causing electrical injuries from contact, and long runs of exposed electrical conduit also present numerous design and O&M challenges.

     i. It is worth noting that along the Route 66 segment in the Upland Area, considerations were also given to the piping alignment (underground) to maintain usable road width in narrow stretches of the road. The California/San Bernardino County Fire Code (Chapter 5) requires 26 feet minimum width for vehicle access. Although variances are allowed if turnarounds are available every 600 feet (County Standard 503.1), additional grading and cut backs would be required to create these turnarounds in several narrow road sections or sections with steep ravine. Note that aboveground structures would also require drainage features which adds to the footprint.

  b) Placement of water lines underground (versus aboveground) will not only avoid increased visual impacts, but will also protect the health, safety, and free movement of humans and animals. Underground piping will also enhance the integrity of the remedy infrastructure (e.g., avoid being hit by vehicular traffic), and minimize remedy footprint and future O&M challenges.

c) Aboveground piping is inherently vulnerable as members of the public have been known to shoot pipes and large rocks or other debris may strike the pipe during a storm event. In addition, aboveground pipe will need periodic re-coating therefore, would require more maintenance compared to underground piping and as such, create more disturbance to nearby habitats as a result of maintenance activities.

d) However, in certain cases, aboveground installations will be necessary to protect sensitive resources (e.g., aerial crossings of Bat Cave Wash, crossing of the Colorado River on the Arched Bridge).

Belowground utility corridors may be constructed with direct burial, pre-cast concrete, or cast-in-place utility trenches with lids or buried directly in the soil. The installation option was selected based on the following criteria subject to constraints for the particular route (e.g., width of usable terrain):

- Directly buried electrical conduits may be installed beneath other electrical conduits.
- There must be at least 3 inches of clearance between directly buried water piping. The clearance between directly buried water piping may be increased up to 12 inches.
- The minimum spacing between directly buried electrical conduit shall be 3 inches or half the diameter of the conduit, whichever is greater.
- Tracer wire for locating non-metallic pipes or conduit will be installed in the trenches.

- Trenchless construction will be used underneath the I-40 highway. In this location, horizontal auger boring will be used. The method will be designed such that it complies with relevant guidelines prepared by the Arizona Department of Transportation (ADOT) (see also Section 5.3.2 of the Basis of Design Report for encroachment permits).
  - ADOT Policy for Accommodating Utilities on Highway Rights-of-Way, December 2009

  Pipes and conduit will be installed in steel casings when required by BNSF or ADOT. The need for cathodic protection will be evaluated on a case-by-case basis using site conditions and utility requirements. The casing will have centralizers and end caps 10 feet from the end of the casing. Identified spare pipes and conduits will be installed during construction. Exhibit C.1-1 lists minimum depth of cover for trenchless crossings. In some cases, concerns for pavement or railroad settlement or potential for drill fluid “frac-out” may require a thicker cover. Geotechnical borings may be required by ADOT or BNSF (see Section C.4). If drilling fluids are used, continuous monitoring for frac-out conditions will be performed to prevent harm to human health and the environment caused by the release of such fluids.

- Any earthwork in areas of sensitive habitat (including floodplain and riparian areas, wetlands, and waters of the US, as well as desert washes and desert riparian) will be subject to the substantive equivalents of Section 404 requirements and the California Department of Fish and Wildlife’s Avoidance and Minimization Measures under mitigation measure BIO-1 (see the Mitigation Monitoring and Reporting Program in the EIR [DTSC 2011]).

EXHIBIT C.1-1
Depth of Cover Design Criteria for Trenchless Crossings
Groundwater Remedy Basis of Design Report/Pre-Final (90%) Design
PG&E Topock Compressor Station, Needles, California

Transportation Agency	Minimum Depth Of Cover
ADOT	• 3 feet minimum[1] • 6 feet minimum for un-sleeved (uncased) crossings up to 48” diameter • 10 feet minimum for pipelines larger than 48”

[1]Source: Article 3.2.4 of ADOT Policy for Accommodating Utilities on Highway Rights-of-Way

C.2.3 Storm Drainage

Stormwater will be managed to protect new structures and facilities built as part of the remedy. This section describes the design criteria associated with stormwater drainage.

Surfaces will be graded to drain. Culverts or other drainage structures will be used to drain roadside ditches and protect stream crossings. Roof drainage from buildings will be collected in gutters and drain towards drainage systems. Stormwater captured within secondary containment will be managed at the remedy-produced water conditioning system. All drainage features and structures will be sized to meet San Bernardino County requirements for storm frequency and intensity.

- Rainfall intensity based on period equal to time of concentration for the basin being considered and 25-year recurrence interval.
- Minimum velocity for culverts is 2.0 feet per second. Maximum velocity for culverts is 10.0 feet per second.

During construction, erosion control measures will be implemented in accordance with San Bernardino County requirements and the construction Stormwater Pollution Prevention Plan (SWPPP). The erosion control measures will be tailored to the site to prevent sediment-laden water from leaving the site. The following erosion control measures may be used onsite as appropriate (for details, see the Construction/Remedial Action Work Plan [CH2M HILL 2014]):

- Site development considerations with construction scheduling
- Maintenance of buffer zones
- Disturbed-soil areas with decomposed granite
- Dust control on disturbed areas and access roads
- Diversion of runoff with earthen dikes, brow ditches, and berms to protect excavations
- Energy dissipaters, riprap channel protection, or outlet protection for discharge pipes, channels, and ditches
- Silt fence at limits of clearing
- Temporary sediment basins to protect existing drainage basins and culverts
- Check dams to control velocity along ditches and long longitudinal grades
- Stabilized construction entrance to all paved surfaces
- Materials management with material delivery, storage, and waste management
- Vehicle and equipment management with construction practices, cleaning, fueling, and maintenance

C.2.4 Site Security

In general, the security for remedial facilities located inside the Compressor Station will be provided for by the Compressor Station security system. Remedial facilities located outside of the Compressor Station will be equipped with security features/systems that are consistent with PG&E's current security standards. Such features, as determined necessary and in compliance with project and landowners' requirements, could include, but are not limited to, fencing to protect the equipment and provide safety for personnel and the public; locks to prevent unauthorized access; security devices and instrumentation; security communication systems; alarms to notify PG&E's security operations; and security cameras. Where appropriate, security features like cameras and card readers are noted on the 90% engineering plans/drawings (see Appendix D of this 90% BOD Report). Examples of security features to be installed at remedy facilities located at the TW Bench, MW-20 Bench, HNWR-1A well site, the North and South Aerial Crossings (crosses Bat Cave Wash) are described below. In compliance with the EIR mitigation measure CUL-1a-6, any additional phone calls and alarms associated with remedial activities will not be routed through PG&E's existing alarm system at the Compressor Station.

Transwestern Bench

- A perimeter fence will be installed with a motorized main gate and a personnel gate. The main gate will have a security card reader and camera to monitor and prevent unauthorized access.
- Perimeter cameras will be installed at the Operations Building.

- The Operations Building will have card readers at entrances.

MW-20 Bench

- Each new gate(s) will have a security card reader and camera.
- Additional perimeter cameras will be installed.
- A motorized gate with security card reader and camera will be installed.

HNWR-1A Well Site

- A perimeter fence will be installed along with a security camera to monitor and prevent unauthorized access.

North and South Aerial Crossings (Bat Cave Wash)

- Personnel gates with locks will be installed at each end of the 2 new aerial crossings.

C.2.5 Concrete Vaults

Concrete vaults will be installed to house mechanical and electrical equipment. Vaults will be precast concrete sections where possible. The vaults will vary in depth depending upon use and location, but to the extent possible they will be designed to be shallow enough that entry would not require a confined space entry procedure. Each vault will be equipped with a steel ladder with extension, conforming to California Division of Occupational Safety and Health (Cal/OSHA) standards. Well vaults will be designed for an H-20 loading in traffic areas and the lids will be supplied with spring assists for safe opening. Fall protection removable grating (live load 300 pounds per square foot [psf]) will be provided. For non-traffic areas, standard lids (300 psf) will be supplied. All vault lids will be equipped with security locks or other security devices (e.g., embedded locks or 5-point bolts).

C.2.6 Construction in 100-year Floodplain

The 100-year floodplain is defined in the Flood Insurance Rate Map (FIRM), Panel 5705 of 9400 for San Bernardino County, California and Unincorporated Areas, Revised August 28, 2008, and Panel 5675 of 6700 for Mohave County, Arizona and Unincorporated Areas, Revised November 18, 2009 (Map Number 04015C5675G). The base flood elevation shown on the current FIRM is 464 feet NAVD at River Mile (RM) 234 of the Colorado River. A review of the Mohave County Flood Insurance Study (FIS) shows that this elevation is specific to the California side of the river only, and is different from information found in the newer FIS for Mohave County, AZ.

The effective FIS for San Bernardino County lists a regulatory base flood elevation of 463.90 feet NAVD. This design uses the more conservative elevation of 464 feet NAVD as the base flood elevation for the project on the California side of the Colorado River. The vertical datum for all flood elevations shown on the San Bernardino County FIRM is NAVD88.

The effective FIS for Mohave County lists a regulatory base flood elevation of 465.3 feet NAVD. This is used as the base flood elevation for the project on the Arizona side of the Colorado River. The vertical datum for all flood elevations shown on the Mohave County FIRM is NAVD88.

In this 90% design, certain infrastructure (piping) cannot be located outside of the 100-year floodplain as defined by the above baseline flood elevation. PG&E are working with Mohave County Flood Administrator to ensure compliance with the county requirements for construction in the floodplain.

C.3 Structural

This section describes design criteria for physical structures made of wood, concrete, reinforced masonry, and steel. Detailed structural design criteria are shown in Exhibit C.3-1.

C.3.1 Concrete

Minimum requirements are listed below for structural concrete:

- Strength of poured-in-place concrete will be a minimum of 5,000 pounds per square inch (psi) at 28 days for all structures. Lower strengths of 3,000 psi will be used for non-critical structural elements and improvements at TCS evaporation ponds as indicated in the specifications. 2,000 psi will be used for concrete fill, pipe and conduit encasement.

- Cement will be clean, fresh, Type V, low alkali, Portland cement conforming to ASTM C150.
- Aggregate will be non-reactive.
- Cement content for all structures will be a minimum of 7.5 sacks per cubic yard of concrete.
- Slump of concrete will be as low as practicable to produce a dense, well consolidated concrete and not exceed 4” unless otherwise authorized by PG&E Project Engineer.
- Finish of formed surfaces will be smooth and free of fins, honeycomb, and segregation.
- When the surfaces have become sufficiently hardened, they will be kept continually moist for a period of not less than seven days. Curing compound conforming to ASTM C309 may be used in-lieu of wetting surfaces only where approved by the Engineer.
- In conformance with the EIR mitigation measures AES-1d and AES-2e, integral color concrete will be used in place of standard gray concrete.

EXHIBIT C.3-1
Structural Design Criteria
Groundwater Remedy Basis of Design Report/Pre-Final (90%) Design
PG&E Topock Compressor Station, Needles, California

Category	Criteria
General	
Governing Code	CBC (2013) as amended by San Bernardino County, IBC 2012, ASCE 7-10
Concrete: CODE and SPECIFICATION	ACI 318-11, Building Code Requirements for Reinforced Concrete ACI 350-06, Environmental Engineering Concrete Structures
Concrete Masonry Units: SPECIFICATIONS	CBC (2013)
Structural Steel: SPECIFICATIONS	AISC Steel Construction Manual , 14th Edition
Aluminum: SPECIFICATIONS	CBC (2013)
Concrete	
Strength	F’c = 5,000 psi for all structures (pipe bridge foundation and precast concrete containment trench), 3,000 psi for general structural concrete (pump pads, thrust blocks, valve vaults) and improvements at TCS evaporation ponds, and 2,000 psi for concrete fill, pipe/conduit encasement.
Reinforcing	ASTM A615, Grade 60, Type S
Prestressing Strand	ASTM A416
Welded Steel Wire Fabric	ASTM A185 or ASTM A497
Design	Strength Design or Alternate Method
Detailing	ACI-SP66 (04) Manual of Standard Practice for Detailing Concrete Structures
Color	Integral color concrete in place of standard gray color concrete (EIR mitigation measures AES-1d and AES-2e)
Reinforced Masonry	
Concrete Masonry Units	ASTM C90, Grade N, Type I (Unit Compressive Strength f’m = 1,900 psi at 28 days
Mortar for Unit Masonry	ASTM C270, Type M, Minimum Compressive Strength at 28 days = 2,500 psi.
Reinforcing	ASTM A615, Grade 60, Type S
Cold-Drawn Steel Wire	ASTM A 482
Grout	ASTM C476, Minimum Compressive Strength at 28 days = 3,000 psi.

EXHIBIT C.3-1
Structural Design Criteria
Groundwater Remedy Basis of Design Report/Pre-Final (90%) Design
PG&E Topock Compressor Station, Needles, California

Category	Criteria
Structural Steel	
Structural "W" Shapes	ASTM A992 (Fy = 50 ksi)
Structural channels. plates, angles, etc.	ASTM A36 (Fy = 36 ksi)
Structural Tubing	ASTM A500, Grade B (Fy = 46 ksi)
Steel Pipes	ASTM A53, Grade B
Stainless Steel	Alloy Types conforming to ASTM A-167 and ASTM A-276.
Plates and Shapes	Type 316 unless otherwise noted
Bolts, Nuts and Washers	Type 316
Welding	AWS E70 Electrodes
High Strength Bolts	ASTM A325N, Type 1, Min 3/4" Diameter
Other Bolts	ASTM A307, Grade A
Anchor Bolts	ASTM A36
Chemical Anchor Bolts	SS Type 316, Threaded Rod with Hilti HIT-HY200 Adhesive, or Equivalent
Expansion Anchors	SS Type 316 Hilti Kwik Bolt TZ, or Equivalent
Timber	
TBD	CBC (2013)
TBD	National Design Specification for Wood Construction

C.3.2 Reinforcing Steel (Minimum Requirements)

Minimum requirements for reinforcing steel are as follows:

- Reinforcing steel will be deformed, grade 60, conforming to ASTM A615, and be free from coating which will reduce the bond.
- Reinforcing steel will be sized in accordance with the Strength Design Method or Alternate method.
- Reinforcing steel splices will be in accordance with the requirements of ACI 318-11.

C.3.3 Dead Loads

Dead loads will consist of gravity loads induced by all structural elements, equipment, piping, and contained liquids.

C.3.4 Live Loads

Live loads for different structural elements are listed below:

- Roof live loads will be designed for a minimum live load of 20 psf.
- Stairs, walkways, and platforms will be designed for a minimum live load of 100 psf.
- Concrete floor on Grade and Grating will conform to the latest edition (2013) of the California Building Code (CBC), but will be a minimum live load of 500 psf, or Wheel Load of 16 kips.
- Elevated Concrete floor – 200 psf or Fork Lift load – 4 kips.

- Live load on aerial crossings (pipe bridges) will be:
  - A minimum concentrated load of 500 pounds at alternate panel point of trusses.
  - A minimum uniform live load of 25 pounds per square foot on walking surfaces.

C.3.5 Seismic Loads

The design will meet CBC (2013) and as amended by San Bernardino County and/or ASCE 7-10 "Minimum Design Loads for Buildings and Other Structures". In addition, the criteria have been updated to the site-specific location, from Needles, CA to the Compressor Station site. Specifically:

- CBC 2013, Site Class D
- Ss = 0.23 (Compressor Station site)
- S1 = 0.12 (Compressor Station site)
- I = 1.25 (importance Factor)

C.3.6 Wind Loads

The design will meet CBC (2013) and as amended by San Bernardino County and/or ASCE 7-10 "Minimum Design Loads for Buildings and Other Structures". Minimum Wind Load = 20 psf.

C.4 Geotechnical

A geotechnical data summary is included in Attachment C of this Appendix. The purpose of this geotechnical summary is to provide information on existing site geology and geotechnical data (CH2M HILL 2004, CH2M HILL 2009) in support of the groundwater remedy design and to propose areas where supplemental geotechnical investigation is needed to verify design parameters. Coordination with the Soil RFI/RI investigation program was conducted in planning of the supplemental geotechnical investigation to minimize the number of boreholes, thereby minimizing ground disturbance. Due to the limited amount of geotechnical data available at the time of this design, assumptions made during the design will be reviewed after receipt of supplemental geotechnical data, currently planned to be collected as part of the forthcoming Soil RFI/RI sampling effort (anticipated in early 2015). Any material changes to the design required by this supplemental information will be discussed with the agencies. It is important to note that as PG&E continues to engage in discussions with transportation agencies, counties, and other property owners/land managers to obtain institutional controls, access agreements, and permits, additional geotechnical data may be required to meet specific requirements of agencies and/or property owners/land managers.

The geotechnical design criteria presented in Exhibit C.4-1 are based on existing site-specific geologic information and geotechnical data to support foundation and trenching designs, as well as the trenchless crossing of I-40 in Arizona.

EXHIBIT C.4-1
Geotechnical Design Criteria
Groundwater Remedy Basis of Design Report/Pre-Final (90%) Design
PG&E Topock Compressor Station, Needles, California

Parameter	Criteria
Moist soil unit weight	120 pounds per cubic foot (pcf)
Shear strength parameters	Cohesionless Soils Friction angle: from 32 to 35 degrees for compacted fill Friction angle: from 28 to 30 degrees for native soils Cohesive Soils Undrained shear strength: from 800 to 1,000 pounds per square foot (psf)
Controlling earthquake magnitudes	Mean earthquake magnitude is 6.6 Modal earthquake magnitude is 7.9
Peak ground acceleration	For structure design is 0.10 g (design value for Site Class D) For liquefaction assessment is 0.15 g (for Site Class D)
Allowable bearing capacity	4,000 psf for CH2M HILL-designed structures on the TCS 2,000 psf for CH2M HILL designed structure outside the TCS
Allowable long-term settlement	1 inch
Sliding coefficient of friction	0.45
Lateral soil pressure equivalent fluid unit weight	Active pressure: 45 pcf Pressure at rest : 60 pcf. Passive resistance = 175 pcf
Temporary cut and fill slopes	2 Horizontal:1Vertical
Frost depth	8-10 inches

Additional Geotechnical Criteria

- Soil is corrosive to concrete structures and steel (resistivity > 1,000 ohm-centimeters, sulfate > 2,000 parts per million (ppm) and chloride > 500 ppm).
- Soil profile is classified as Site Class D (stiff soil site), as defined in the CBC (2010).
- Shallow foundations for buildings with support extending a minimum of 2 feet below lowest adjacent grade. Slabs and footings set on a minimum of 6” layer of granular base leveling course.
- Pipe design based on depth of fill, weight of fill, compaction of fill and modulus of soil reaction (E’ = 1,000 psi).
- Native onsite materials may be considered for backfill if they have an expansion index (EI) less than 50 and contain less than 8 percent fines, as determined by ASTM D4829 and D422.

C.5 Mechanical

This section describes the design criteria associated with key mechanical elements of the project. Mechanical design will follow the California Mechanical Code (2010) unless noted, and fire requirements per the California Fire Code (2010).

C.5.1 Piping

Based on experience with operation and maintenance of the IM facilities, the groundwater in the floodplain has high levels of total dissolved solids, chlorides, sulfate, and other minerals that have caused significant corrosion to iron-based piping material from mild carbon steel to Type 316 stainless steel. Therefore, piping will be designed and installed in accordance with best practices and past site experience for operation and maintenance, including use of flanged or union joints for serviceability and isolation valves for systems requiring routine maintenance.

In general, piping materials will be compatible with the characteristic of the conveying fluids and will be single-walled unless the pipe is used to convey: (1) groundwater or remedy-produced water that exhibits the hazardous waste characteristic; or (2) concentrated carbon substrate. In these cases, double-walled piping will be used. Double-walled pipe segments conveying either of the fluids described above will include appropriately designed leak detection systems. Low point sumps/traps with level switches and alarms will be the primary method of detecting leaks. Continuous leak detection systems may be used as an alternative to low point switches if switches are deemed impractical or incompatible with the installation. Pipeline segments installed in belowground concrete trenches (e.g., Pipeline A) will be designed with leak detection at low points (level switch with alarm). Drawing C-07-02 of Appendix D is a pipeline key map that shows the locations of the pipeline segments.

In the case of Pipeline H which connects to well IRL-4 located at the bottom of a wash, double walled pipe segments will be used to convey remedy produced water from the wellhead to a valve vault located on the plateau. As access to this well is difficult and via a steep slope, this containment design is to provide for safe operations during well rehabilitation where acids and chemicals are used. In the event of a leak, the secondary containment will drain to a concrete sump located at the wellhead. The concrete sump will be equipment with a level switch and alarm, as well as a sump pump.

Corrosion Control

For corrosion control, above ground and belowground steel pipe will be coated. Any steel pipe near the point where it emerges from the ground will be coated. Air-to-soil transition piping is any steel piping located 18" below ground or 6" above ground. Cathodic protection equipment will be applied as follows: 1) steel piping and structures will be cathodically protected underground; 2) plastic pipe (e.g., HDPE or CPVC or PVC) will be preferentially used when appropriate for corrosion resistance; and 3) steel pipe will be cement mortar-lined to prevent internal corrosion. Piping cathodic protection will conform to National Association of Corrosion Engineers SP0177-2007 Standard Recommended Practice - Mitigation of Alternating Current and Lightning Effects on Metallic Structures and Corrosion Control Systems.

In compliance with the EIR mitigation measures AES-1d and AES-2e, the external coatings used for wells, pipelines, storage tanks, structures, and utilities will consist of muted, earth tone colors that are consistent with the surrounding natural color palette, and matte finishes. Coating materials will be corrosion-resistant to protect the underlying surfaces.

Pressure Loss

For the freshwater and the remedy-produced water piping network, a hydraulic model built using the EPANET water supply program was used to simulate and optimize the piping design. Attachment B of this Appendix contains more details about the hydraulic modeling.

For the design of the in-situ remediation piping system, to ensure adequate distribution, the pressure loss in the branch distribution piping to each of the injection wells (including frictional losses and wellhead pressures from drop pipe frictional losses and pressure drop across the foot valve) will be designed to be 10 times higher than the pressure drop in the distribution header. The CIP loop conveyance piping will be designed to operate at a velocity of 3 to 5 feet per second (fps) and will have cleanouts at least every 400 feet.

C.5.2 Process Equipment

Primary process equipment (substrate dosing pumps, compliance related sensors, safety switches, etc.) will be designed for parallel operation or provide stand-by equipment to provide sufficient redundant capacity.

To the extent practical, all valving, instrumentation, manways, and access ladders for tanks will be located on the northern face (including northeastern face) of the remedial facilities to allow O&M personnel to work on the shady side during O&M activities.

C.5.3 Valves

Valves installed for throttling and flow control will include globe, needle, and diaphragm valves. Isolation valves will include; gate, ball, and butterfly valves. Other valves expected to be included in the remedy system include spring and swing check valves, pressure relief, air relief, variable orifice, foot, and combined air and vacuum relief valves. Carbon substrate storage tanks may include additional safety valves, including emergency ventilation and combination pressure/vacuum relief valves in accordance with applicable standards. Valves will meet PG&E and industry standards appropriate to the application and process conditions.

Exhibit C.5-1 lists potential valve types associated with the major equipment. Valves will meet industry standards appropriate to the application and process conditions.

EXHIBIT C.5-1
Potential Valve Type with Associated Device
Groundwater Remedy Basis of Design Report/Pre-Final (90%) Design
PG&E Topock Compressor Station, Needles, California

Equipment	Potential Valve Type
Fresh Water Injection Pumps	Pressure reducing, ball, swing check
Freshwater Extraction Well Pumps	Butterfly valve, swing check, and surge anticipation valve
Riverbank Extraction Pumps	Swing check, globe, butterfly, ball, gate
Transwestern Bench Extraction Pumps	Swing check, globe, ball
IRZ Pumps	Swing check, globe, ball, pressure reducing, pressure relief
East Ravine Pumps	Swing check, globe, ball
IRZ Backflush Pumps	Swing check, gate, ball, butterfly
Freshwater Backflush Pumps	Swing check, butterfly, flow control
Carbon Substrate Pumps	Pressure and vacuum relief, solenoid, swing check, motor operate valve, ball
Pipelines	Butterfly, motor-operated valve, combination air release, ball, and gate
Well Maintenance Reagent Pumps	Ball, swing check, solenoid, multi-port, motor-operated valve
Ethanol Storage and Transfer	Pressure and vacuum relief, swing check, solenoid, ball, emergency vent
Process Pumps (Submersible Sump Pumps, Air-operated Diaphragm Pumps, Metering Pumps, Centrifugal Pumps)	Butterfly, swing or other check, motor-operated valve, ball, solenoid, pneumatically actuated valve

C.5.4 Water Storage Tanks

Fixed steel tanks used for storing conditioned remedy-produced water will be designed in accordance with American Water Works Association Standard D-100 (2011). Foundations will be designed in accordance with the structural criteria described in Section C.3 above. Frac tanks used for storing remedy-produced water will be fabricated of welded steel and equipped with axles and wheels to enable them to be moved. Corrosion prevention measures will be applied to all tanks, including internal coatings. Permanent metal tank(s) will also have internal and external cathodic protection except for ethanol tanks mounted on saddle-type supports.

C.5.5 Secondary Containment

Secondary containment systems will be sized and designed in conformance with NFPA standards and California Fire Code (2010). In general, key design criteria are:

- Containment Volume
  - Secondary containment for a single container (tank) will be 110 percent of the primary container. Secondary containment for multiple containers will be 100 percent of the largest container's volume or 10 percent of the aggregate volumes of all containers, whichever is greater. In addition to the aforementioned, secondary containment systems open to rainfall will also be sized to accommodate spillage from the largest single tank at a minimum plus a 24-hr rainfall, as determined by a 25-yr storm. All secondary containment systems open to fire sprinkler discharge will also be sized to accommodate the discharge from all sprinkler heads over the secondary containment system for 20 minutes.
- Containment Construction and Drainage
  - Secondary containment will be constructed using materials capable of containing a spill or leak for at least as long as the period between monitoring inspections. Drainage can be accomplished through the use of one of the following methods:
    - Liquid-tight sloped or recessed floors in indoor locations or similar areas in outdoor locations
    - Liquid-tight floors in indoor locations or similar areas in outdoor locations provided with liquid- tight raised or recessed sills or dikes
    - Sumps and collection systems (e.g., collection sump)
    - Drainage systems leading to an approved location
    - Other approved engineered systems
  - Collection systems will be equipped with a monitoring system to monitor level in containment sumps. Upon detection of fluids in the sump an alarm will be initiated to alert the operators of a potential release.
- Overfill Protection
  - A means of providing overfill protection for primary container will be required. This may be an overfill prevention device and/or an attention getting high level alarm.
- Separation of Materials
  - Materials that in combination may cause a fire or explosion, or the production of a flammable, toxic, or poisonous gas, or the deterioration of a primary or secondary container will be separated in both the primary and secondary containment so as to avoid intermixing.

C.5.5.1 Remedy-produced Water Conditioning Plant and Associated Tank Farm Areas

The Remedy-produced Water Conditioning Plant will contain hazardous materials (caustic, acids, etc.) and the A-side Remedy portion of the plant will process water streams with known or suspected contamination. The conditioned water tank farm area will be equipped with the capability for local neutralization using caustic or acids. Therefore, these areas (see Figure 3.5-1) will be designed with the following secondary containment and monitoring systems:

- Area 1 – The influent storage tank farm area will have secondary containment constructed with concrete, coated with epoxy, and equipped with a collection sump and a sump pump that pumps to either the Influent

Storage Tanks or the Compressor Station Wastewater Tank.[2] The destination will be selected manually. A level switch mounted in the sump will issue an alarm when liquids are detected.

- Area 2 – The remedy-produced water conditioning system will have secondary containment constructed with concrete, coated with epoxy, and equipped with a sump and a sump pump that pumps to the Influent Storage Tanks or the TCS Cooling Tower Blowdown line (which connects to the Compressor Station Wastewater Tank). Sump monitoring will be accomplished via a level switch and alarm.
- Area 3 – The conditioned water tank farm area will have secondary containment constructed with concrete, coated with epoxy, and equipped with a sump and a sump pump that pumps to the TCS Cooling Tower Blowdown line or the Influent Storage Tanks. Sump monitoring will be accomplished via a level switch and alarm.

C.5.5.2 Truck Loading/Unloading Areas

There will be three truck loading/unloading stations with one at the MW-20 Bench, one at the Transwestern Bench, and one at the Compressor Station. Each truck loading/unloading area will be equipped with a secondary containment system constructed of epoxy-coated concrete, transfer pumps, pipes or hoses for connecting to the trucks, and sumps and sump pumps. The sumps will have level switches that will alarm in the event of a spill.

C.5.5.3 Equipment Decontamination Pads

Consistent with the EIR mitigation measure CUL-1a-9, the existing decontamination pad at the Transwestern Bench will be reused during remedy implementation. This pad will be repaired and equipped with a collection sump and a sump pump that pumps to the Remedy-produced Water Conditioning Plant at the Compressor Station.

Two new equipment decontamination pads will be installed for use by the project; one is located inside TCS adjacent to the Remedy-produced Water Conditioning Plant, and one is located at Moabi Regional Park within the main construction yard.

The new decontamination pad inside TCS will be constructed in the footprint of the Contingent Freshwater Pre-Injection Treatment System. It will be equipped with a collection sump and a sump pump that pumps to the influent tank farm of the water conditioning plant.

C.5.6 Septic and Plumbing System

The bathrooms in the Operations Building at the Transwestern Bench will be connected to a new leach field. The work will follow San Bernardino County Department of Public Health Environmental Services Division requirements (note that PG&E is currently seeking a variance from the setback requirement for the leach field; the outcome of this request for variance will be reported to the agencies).

Fresh water will be supplied for use in the onsite laboratory and sample preparation area in the Remedy-produced Water Conditioning Plant building. Washbasins or sinks in the laboratory will be drained to a double-contained tank specifically for storing the fluids. The contained fluids can be pumped to the Remedy-produced Water influent storage tanks or to the TCS wastewater tank, or be disposed of off-site.

The Remedy-produced Water Conditioning building will include rain water downspouts with spill out fittings to outside splash blocks for surface runoff, and plant water piping with wash-down hose bibs and connections for flushing of the chemical feed systems.

Information regarding emergency eyewashes and showers are provided below:

- The station located inside the Remedy-produced Water Conditioning Plant will be in the chemical storage area and near the sample room.

[2] The Wastewater Tank receives wastewater from the Oil/Water Separator and other sources of non-oily wastewater streams such as the cooling tower blowdown. Water from the Wastewater Tank is pumped directly to the TCS evaporation ponds.

- The stations at the MW-20 Bench and Transwestern Bench will be located inside the Carbon Amendment Buildings.

C.5.7 Fire Protection Equipment

The Remedy-produced Water Conditioning Plant at the Compressor Station and the Operations at the Transwestern Bench are unclassified, as described by NFPA 820; hence, only fire hydrants for fire protection are required. No fire and explosion hazard, materials of construction and ventilation requirements are listed in NFPA 820 for these facilities. The California Building Code 2013 does not require the buildings to be equipped with sprinklers; however, PG&E risk assessment requires a sprinkler system in both the Operations and Carbon Amendment buildings on the Transwestern Bench, as well as the Carbon Amendment building on the MW-20 Bench.

Portable fire extinguishers will be mounted in buildings in accordance with PG&E requirements and County Fire codes. Portable fire extinguishers will be ABC multipurpose dry chemical type UL-rated 20A:120B:C.

All electrical equipment will have Underwriters Laboratory approval where applicable. Areas of the electrical installation will be classified in accordance by Class, Division, and Group. Specifically, for the IRZ facilities at the MW-20 Bench and the Transwestern Bench, the following will apply:

- Class I, Division I within a 5-ft radius of the carbon storage tank vents.
- Class I, Division II within a 15-ft radius of the carbon storage tank vents (from vent elevation to ground).
- Class I, Division II from ground surface to 18-inches above grade within a 10-ft radius of the tank footprint.
- Class I, Division II within a 15-ft radius of the existing concrete decontamination pad at the Transwestern Bench.
- Class I, Division II within the carbon amendment building where there are pipes with >10% ethanol.

C.5.8 Heating, Ventilation, and Air Conditioning

The new heating, ventilation, and air conditioning (HVAC) systems in planned remedy facilities are independent of the existing Compressor Station HVAC system. The design criteria for makeup air and temperature control for the laboratory/office and motor control center (MCC) rooms are as follows:

- Office/ sampling room: Summer temperature <86 degrees F with no control for humidity. Makeup ventilation rate at 0.15 cubic feet per minute (cfm) per square foot or 15 cfm/person by code requirements.
- MCC Room: Summer temperature <90 degrees F with no control for humidity.

Wall-mounted ductless mini-split heat pumps will serve the rooms. A second, 100 percent capacity redundant unit will be installed for the Office/laboratory space. Wall mounted ductless mini-split heat pumps have two main components: an outdoor compressor/condenser and an indoor air-handling unit. Each unit will be capable of both cooling and heating the space. A conduit that houses the power cable, refrigerant tubing, suction tubing, and a condensate drain links the outdoor and indoor units. The indoor units will be mounted on the upper part of the room wall. Each unit will be sized per the heating and cooling requirements of each room.

For ventilation air in the Office/ sampling room space, a 60 cfm exhaust fan will be installed with either inlet door louvers or by undercutting the door to transfer outside air from the filter room.

Outside of the office/ sampling room and MCC room, the first and second floors of the remedy-produced water conditioning system will be naturally ventilated by constructing the building with no walls on three sides of the first floor (north, east and west), a wall on the north side with louvers, and a steel grating on the second floor adjacent to the filters and outside the MCC room and laboratory/office.

C.5.9 Air Pollution Control

Temporary and permanent mobile and fixed equipment emissions will comply with Clean Air Act - USC §§ 7401, et seq. (National Emission Standards for Hazardous Air Pollutants [NESHAP]); 40 Code of Federal Register (CFR) 61; 40 CFR 63 and local air district requirements (e.g., Mojave Desert Air Quality Control District).

C.5.10 Hazardous Materials Storage

The Hazardous Materials Division of the San Bernardino County Fire Department is the Administering Agency and the CUPA for San Bernardino County with responsibility for regulating hazardous materials handlers, hazardous waste generators, underground storage tank facilities, aboveground storage tanks, and stationary sources handling regulated substances. The handling and management of hazardous materials within the remedy facilities (e.g., the remedy-produced water conditioning facility) located within the Compressor Station will be incorporated into the existing Compressor Station Hazardous Materials Business Plan (HMBP). A separate HMBP will cover the handling and management of hazardous materials at remedy facilities located outside of the Compressor Station (e.g., MW-20 Bench, Transwestern Bench).

Chemicals that are anticipated to be used in remedy processes and stored on site are listed below with location:

- Potential chemicals to be used and stored in the Remedy-produced Water Conditioning System at the Compressor Station include the following:
  - 25% sodium hydroxide (caustic), to be stored in a 550-gallon tank
  - 19% hydrochloric acid, to be stored in a 550-gallon tank
  - A coagulant (e.g., Nalco Ultrion 8187) for aiding in settling solids in the Conditioning System
  - A flocculent addition (e.g., Nalco® 7878 Flocculant [anionic type]) to aid in the dewatering of the influent tank bottoms prior to pumping to the liquid phase separators (the need for this dewatering aid and flocculent type would have to be tested during operations)
  - Laboratory reagents (to be used in the sampling room located inside the conditioning building) and related waste
- Potential chemicals to be used and stored at the carbon amendment facilities include the following:
  - Carbon substrate (95% ethanol and 5% isopropyl alcohol) – one 15,000-gallon tank located at the MW-20 Bench and one 3,000-gallon tank located at the Transwestern Bench
  - Acids, caustics, and/or dispersants for use in the Clean-In-Place (CIP) systems at the MW-20 Bench and Transwestern Bench (330-gallon totes or smaller-volume drums). The potential chemicals are hydrochloric, glycolic (hydroxyacetic), and phosphoric acids, sodium hydroxide, and hydrogen peroxide

Potential chemicals to be used in well maintenance include hydrochloric acid, sulfamic acid, sulfuric acid, phosphoric acid, hydroxyacetic acid, acetic acid, citric acid, oxalic acid, ascorbic acid, hydrogen peroxide, sodium hypochlorite, sodium hydroxide, chlorine dioxide, potassium hydroxide, polyphosphate, Aqua Clear™ PFD, Rodine-103/Rodine 213, QC-21, CB4, NuWell 120, NuWell 130, nitrogen, and/or carbon dioxide. These materials will be brought on site during the well maintenance/rehabilitation activities, but will not be permanently stored on site.[3]

C.6 Electrical

In this section, the electrical design criteria and goals are described. Electrical systems and equipment will be designed to meet PG&E standards and the California Electrical Code (2010) unless specifically noted. The new Remedy electrical power distribution system will receive power from a single source; potential sources of power are under evaluation by PG&E. Regardless of its source, electrical power will be distributed to the project loads at

[3] For additional details, see the Operations and Maintenance Manual, Volume 1, Section 4, Exhibit 4.2-5.

the Transwestern Bench, the Remedy-produced Water Conditioning Plant at the Compressor Station, the MW-20 Bench, and three distribution locations for wells.

C.6.1 Safety, Availability, Reliability, and Efficiency

Of paramount importance is the need to minimize electrical hazards to operating personnel, including shock, arc flash, electrical fire, and combustion of explosive atmospheres. This is accomplished by applying electrical equipment within its ratings and in accordance with the electrical, fire, and life safety codes listed herein. Every 480 volt and above disconnect will have provisions for lock-out tag-out. This will provide safe working for equipment that may not be in view of the breaker handle. Where possible, the breaker handles will be in view of the connected load for additional safety.

A portable, rental backup generator of similar make and model of the existing generator (Isuzu Model 6WG1X) will be mobilized onsite as needed during project implementation to provide power. A connection panel is included in the 90% design (see BOD Report Appendix D, Drawing E-00-51, Detail 4) and space has been reserved for the portable rental generator (see Figure 3.5-1).

The power distribution system will include energy management features, such as real-time power and energy monitoring, which can be used in conjunction with process data to optimize process efficiency.

C.6.2 Distribution Voltage Selection

The project's standard distribution systems include the following:

- 12.47 kV, ungrounded delta, 3-phase, 3-wire
- 480Y/277 volts solidly grounded wye, 3-phase, 4-wire
- 240/120 volts solidly grounded wye, 1-phase, 3-wire
- 208/120 volts solidly grounded wye, 3-phase, 4-wire

The distribution voltages used throughout the project will be selected to reduce maximum load flows to levels below standard electrical equipment capacity ratings, to increase the distance that it may be transmitted, to reduce fault duty to levels standard electrical equipment withstand and interrupting ratings, and to minimize the cost of the electrical installation. Exhibit C.6-1 lists the equipment utilization voltages.

EXHIBIT C.6-1
Equipment Utilization Voltages
Groundwater Remedy Basis of Design Report/Pre-Final (90%) Design
PG&E Topock Compressor Station, Needles, California

Equipment	Volts	Phase
Fluorescent Lighting	120	Single, in office areas
Incandescent Lighting	120	Single
High-Intensity Discharge Lighting	120 or 240	Single
Other lighting	120	Single
Convenience Outlets	120	Single
Motor Control	120	Single
Motors, less than 1/2 horsepower (hp)	120	Single
Motors, 1/2 hp and above	480	Three

C.6.2.1 Voltage Drop

Total voltage drop from the transformer secondary to the point of utilization, including feeder, branch circuit, and transformation, will not exceed:

- Lighting - 3 percent
- Motors - 5 percent
- Receptacles - 5 percent
- Electric Heaters - 5 percent

Voltage dip calculations will be performed for motor starting whenever an individual motor exceeds 20 horsepower or if the motor is the longest or shortest distance from the transformer.

C.6.2.2 Demand Factors

The demand factors listed in Exhibit C.6-2 will be used for sizing power switchboards, MCCs, panelboards, and transformers. Connected load will be used for circuit and equipment sizing in accordance with NEC requirements. A 10 to 20 percent spare capacity will be provided at MCCs and panelboards. In accordance with the NEC, where it is unlikely that two or more coincident loads will be in use simultaneously, only the largest load(s) that will be in operation at one time will be used for calculating the total load of a feeder.

EXHIBIT C.6-2
Demand Factors
Groundwater Remedy Basis of Design Report/Pre-Final (90%) Design
PG&E Topock Compressor Station, Needles, California

Service	Demand Factor
Lighting	1.0 x Connected Load
Emergency Lighting	1.0 x Connected Load
Air Conditioning Equipment	1.0 x Connected Load
Ventilation Equipment	1.0 x Connected Load
Drainage Pumps and Ejectors	1.0 x Connected Load
Convenience Receptacles	180 VA each [a]
Process Loads	1 x Full Load Amps of loads plus 25% of largest motor

Notes:
a. Apply NEC demand factor of 50% for totals over 10 kW
VA = volt-amperes

C.6.2.3 Metering

Multifunction digital meters will be provided for the MCC in the Remedy-produced Water Conditioning Plant.

C.6.2.4 Branch Circuits

- Connected load and NEC requirements will be used for sizing branch circuit breakers and conductors.
- A minimum wire size of No. 12 American wire gauge (AWG) copper will be used for lighting and receptacle branch circuits. There will be NO common neutral for multiple lighting circuits.
- In general, lighting branch circuit loads will be limited to 1,500 watts. Lighting and receptacle branch circuits will not be combined, and the number of convenience receptacles on any one branch circuit will be limited to five duplex in process areas, and six duplex in office areas.
- The electrical design will include a circuit and raceway schedule providing unique names and termination location information for each power, control, and signal circuit.

C.6.2.5 Panelboards

- Branch circuits or feeders on the drawings will identify the panelboard and device protecting the individual circuit or feeder.
- Each panelboard will be equipped with a minimum of 20 percent spare breakers with spaces, bus work, and terminations to complete the standard size panelboard.
- Panelboard schedules will be prepared indicating circuit identification, protective device trip rating, number of poles, load in volt-amps by phase, rating of main lugs or main circuit breaker, neutral bus size, ground bus size, and the integrated short circuit rating of the panelboard.

C.6.2.6 Uninterruptible Power Supply

Uninterruptible power supply (UPS) will be provided for each control panel. The UPS output will be automatically selected through an automatic bypass relay.

C.6.2.7 Motor Control and Protection

Safety interlocks, such as emergency stop pushbuttons, will be hardwired directly to motor control circuits. Process controls and interlocks will be hardwired from Supervisory Control and Data Acquisition (SCADA) system programmable logic controllers (PLCs) to motor starters. Electrical metering data will be transmitted from intelligent motor overloads and relays to the SCADA system over an Ethernet network. Elementary (ladder-type) control diagrams will be prepared for each motor showing control wiring, pilot devices, auxiliary contacts, and external connections. A single diagram will be used for more than one motor having the same control.

In addition, the following guidelines will be used:

- Adjustable overload relays will be provided for all MCC-mounted and remote mounted constant-speed motor controllers. MCC-type construction will be used.
- MCCs located in the same room with the switchboard that powers them will not have a main circuit breaker. MCCs located in areas remote from the common MCC or switchboard that powers them will have a main circuit breaker.
- MCC enclosures will be NEMA 1 gasketed. Circuit breakers 225 amps and smaller and motor starters NEMA 4 and smaller will be the cubicle type with auto disconnect of control and motor power conductors.
- MCCs will include feeder circuit breakers and motor starters. Motor starters for motors up to 25 hp will be the full-voltage, non-reversing, combination type with a magnetic-only circuit breaker. Motor starters for motors larger than 25 hp will be the solid-state, soft-start, reduced-voltage, combination type with a magnetic-only circuit breaker.
- Motor starters will include an ON/OFF/AUTO or HAND/OFF/REMOTE selector switch, GREEN motor ON light, RED motor OFF light, and AMBER abnormal condition, fault, or alarm lights, as required. Lights will be the LED push-to-test type. These devices will be mounted on the front of the motor starter control center cubical.

C.6.2.8 Equipment Identification

Process and instrumentation diagram (P&ID) tag numbers will be used for motors, instrumentation and control devices, and other process equipment shown on electrical drawings. This same numbering method will be used to create unique tags for major electrical distribution equipment.

C.6.3 Electrical Equipment

This section discusses general guidelines for the selection and configuration of electrical equipment.

C.6.3.1 Distribution System Equipment

Equipment will be selected with adequate momentary and interrupting capacity for the point in the system where it is used. Series-rated criteria will not be used, except for self-contained equipment. Where practical, phase and ground fault protective devices and device settings will be selected that will function selectively to disconnect that portion of the system that is malfunctioning, and with as little disturbance to the rest of the system as possible.

Distribution equipment criteria include the following:

- 15 kV-class metal-clad switchgear will be specified to provide power distribution selection at the front end of the Remedy system.
- The switches will be interlocked, so only one power feed will be allowed to connect to the system at any given time. There will not be any provisions or need for paralleling systems.
- 15 kV-class cable will connect the transformers together through underground conduit.
- Sectionalizing equipment will allow for individual transformers to be isolated and replaced or repaired.
- The transformers will be distribution style, similar to those used for commercial buildings. The secondary voltage will be 480/277 volt.
- 480-volt MCCs with combination motor starters of the motor circuit protector (MCP) type rated for the available fault current.
  - Starters that are NEMA size 2 (25 hp) and larger will be the solid-state, soft-start type or adjustable-speed drives.
  - MCCs will be hardwired to the PLC for motor control.
  - Field-mounted, maintained, emergency stop push buttons will be hardwired directly to the motor starter.
  - MCCs will be sized to accept future loads and either allow for space in the structures, or floor space for future sections.
- 480-volt and 240/120-volt power distribution and lighting panelboards with molded case, bolt-in, circuit breakers with integrated short-circuit rating suitable for the available fault current.

C.6.3.2 Raceway Systems

Separate ductbanks will be used for the following systems:

- 12.47-kV power distribution
- 480-volt power wiring and 120-volt control wiring
- Communications systems, including Ethernet, low-voltage signal for fire alarm, telephone and data systems, and fiber optic cabling

Special consideration will be given to separation of raceways involving low-level process control signal wiring and power system wiring to minimize the possibility of interference. General guidelines for raceway sizing, selection, and installation are as follows:

- Conduit sizing will be based on Type THW insulation.
- The following minimum sizes will be used:
  - 3/4-inch minimum diameter for conduit not in ductbanks used within buildings or connected directly to the equipment or device.
  - 1-inch minimum diameter for conduit in ductbanks for field interconnection of equipment or buildings.
- Raceways will be a combination of concealed and exposed in process areas.

- Raceways will be concealed in walls and ceilings in control rooms, offices, and areas that have finished interiors.
- PVC-coated rigid galvanized steel conduit will be used for the transition from underground direct burial and under-slab PVC conduit and concrete-encased (in-floor slab) PVC and rigid galvanized steel conduit to exposed rigid galvanized steel conduit. The transition section will extend from 1 foot below grade or top of floor slab or the last foot of conduit in the floor slab, to 6 inches out of the floor slab, concrete encasement, or above grade.
- The number of conduit bends will be limited to an equivalent of 270 degrees on long runs without pull boxes.
- PVC-coated rigid galvanized steel conduit and fittings that are resistant to direct sunlight and include an interior urethane coating will be used in exposed corrosive interior and exterior areas. This conduit will also be used for underground direct-burial. Direct buried conduit will have a 3-inch red colored concrete cap.
- PVC Schedule 40 conduit and fittings will be used for under-slab and concrete-encased ductbanks.
- Rigid galvanized steel conduit and fittings will be used when exposed in interior non-corrosive process and non-process areas, pre-cast concrete utility trenches, and in non-corrosive areas outdoors.
- Flexible, nonmetallic, liquid-tight conduit 4 inches or smaller in size will be used for connections to motors, transformers, etc., as required. Fittings will be PVC-coated in wet or corrosive areas. Length of flexible conduit will be limited to 36 inches.
- Underground conduit routes will be identified with nonmetallic warning tape and tracer wire above underground direct-burial conduits.
- Raceways will be tagged with an engraved plastic or nonferrous metal embossed tag attached to the raceway with a stainless steel wiring. Raceway tags as defined in the plans and conduit schedule will be located at each terminus, pullbox, and at minimum intervals of every 50 feet on exposed raceways (in ceiling spaces and surface-mounted).
- Cable trays will be evaluated for use where appropriate.

C.6.3.3 Wire and Cable

- Stranded copper conductors will be used for all except lighting and receptacle wiring. Solid conductors No. 10 AWG and smaller will be used for lighting and receptacle wiring.
- A minimum conductor size of No. 12 AWG will be used for power and lighting branch circuits. Type THHN/THWN-2 insulation will be used for No. 10 AWG and smaller conductors (conduit will be sized for Type THW conductors). Type XHHW-2 insulation will be used for No. 8 AWG and larger conductors (conduit will be sized for THW conductors). Conductor ampacity ratings of 75°C will be used for sizing conductors.
- A minimum conductor size of No. 14 AWG will be used for individual 120-volt control circuits.
- A minimum conductor size of No. 14 AWG will be used for 120-volt control circuits routed in a common conduit with the power conductors to the motor circuit controls. Combining individual motor power and control conductors in a common conduit will be done up to a maximum power conductor size of No. 2 AWG.
- Power and control conductors will be color-coded. Conductors No. 8 AWG and smaller will have colored insulation. Conductors No. 6 AWG and larger will be color-coded with tape at each end and at accessible intermediate points.
- Conductors and control cables will be tagged with a permanent sleeve or nylon marker plate attached with a nylon strap. Conductor tags with an approved tag number will be provided by the Contractor and will be located in accessible locations at each termination.

- Under normal conditions, the maximum wire size will be limited to 500 kcmil. Parallel conductors will be used for circuits requiring greater capacity.
- The 120-volt control circuits will be combined in control cables containing multiple No. 14 AWG stranded copper conductors with type THHN insulation and a common PVC outer jacket.
- A 600-volt multi-circuit control cable will be used where grouping control circuits is practical, and the number of individual wires exceeds six conductors. When selecting control cable size, 25 percent spare (plus or minus 10 percent) conductors will be used.
- Multi-conductor control cable color-coding will be ICEA S-61-402 Appendix K, Method 1, Table K-2.
- Low-voltage analog signal circuits will be routed in 600-volt single twisted shielded pair instrumentation control cables. The cables will consist of No. 16 AWG stranded copper conductors with combination PVC/nylon insulation, drain wire, shield, and PVC outer jacket. Signal circuits may be combined in multi-twisted shielded pair instrumentation control cables with common overall shield. The cables will consist of No. 18 AWG minimum stranded copper conductors, with a combination PVC/nylon insulation, pair and common drain wires, pair and common shields, and PVC outer jacket. Instrumentation control cables will be in accordance with ICEA S-82-552. Low-voltage analog signal circuits will not be routed in the same control cable or conduit with 120-volt control or power circuits.
- Adequate separation of power and instrumentation and control (I&C) wiring will be provided to avoid signal interference.
- Shielded power cables will be used between adjustable-frequency drives and the driven motor.

C.6.3.4 Color Coding

Conductor insulation colors will be as shown in Exhibit C.6-3.

EXHIBIT C.6-3
System Color Coding
Groundwater Remedy Basis of Design Report/Pre-Final (90%) Design
PG&E Topock Compressor Station, Needles, California

System	Conductor	Color
All Systems	Ground	Green
208Y/120 Volts	Neutral	White
	Phase A	Black
	Phase B	Red
	Phase C	Blue
240/120 Volts	Neutral	White
	Phase L1	Black
	Phase L2	Red
480Y/277 Volts	Neutral	White
	Phase A	Brown
	Phase B	Orange
	Phase C	Yellow
12.47 kV	Phase A	Phase A
	Phase B	Phase B
	Phase C	Phase C

C.6.3.5 Circuit Identification

Circuit names will be assigned based on the device or equipment at the load end of the circuit. Circuits will be identified at each termination and in accessible manholes and pull boxes. Plastic sleeves for conductor No. 3 AWG or smaller and plastic marker plates for larger conductors will be used. For lighting circuits, the panel and circuit number will be identified for each fixture.

C.6.3.6 Enclosures

NEMA 1 enclosures will be used for equipment in electrical rooms and finished areas, while NEMA 12 enclosures will be used for electrical equipment in dry industrial locations. NEMA 3R enclosures will be used for outside and in wet locations, and NEMA 4X enclosures will be used for corrosive locations. NEMA 4 enclosures will be used for underground and in wet locations.

C.6.3.7 Fiber Optic Cabling

Where used, fiber optic cabling will be installed either in conduit (4-inch-diameter minimum with three 1 ¼-inch inner ducts), or in a cable tray. Routing of the raceway system will provide for large-radius turns to prevent breaking of the fiber optic cable.

C.6.3.8 Convenience Receptacles

General-service duplex receptacles will not be spaced more than 25 feet apart in process areas. Receptacles will be surface-mounted on walls or columns. Weatherproof receptacles will be installed in damp areas or areas subject to washdown.

Outlet-mounted ground-fault circuit-interrupters (GFCIs) will be provided where required by the NEC. Panelboard or feed-through-type devices will not be used.

C.6.3.9 Low Voltage AC Induction Motors

Enclosures for both horizontal and vertical motors 25 hp and smaller will be totally enclosed, fan-cooled (TEFC) severe-duty for indoor and outdoor locations. In wet and/or corrosive locations, chemical industry severe-duty (CISD-TEFC) motors will be used. Motors larger than 25 hp will be open drip-proof, unless TEFC or CISD-TEFC is required for specific conditions (evaluated on a case-by-case basis considering cost and required physical protection). Submerged motors will be totally submersible, air- or oil-sealed. Bearings will be rated for 100,000-hour Anti-Friction Bearings Manufacturers’ Association (AFBMA) B-10 life.

Alternating current (AC) induction motors will be the premium efficiency type with the following:

- Motors will have a 1.15 service factor at 50 degrees Celsius ambient, except where inverter-duty rated.
- NEMA design letter to fit the application (usually NEMA design B), and locked rotor kV-amps kVA Code G or lower.
- Motor windings will be copper wire.
- Motors 15 hp and larger located in damp or wet areas will be provided with 115-volt space heaters to prevent moisture condensation.
- TEFC motors will be equipped with weep holes and drain plugs to withdraw condensed moisture.
- Motors operated by variable frequency drives (VFDs) will be specified with special provisions for inverter duty operation.

C.6.4 Electrical Systems Analysis

An analysis of the fault current was done during the 90% design. Maximum fault current was analyzed with sufficient accuracy to establish the required interrupting ratings of circuit protective devices specified.

During construction, a final load flow, short circuit, coordination, and arc flash hazard analysis will be performed by the Project Engineer, based on actual equipment purchased, to establish protective device settings that will result in reasonable selectivity of device operation for both three-phase and ground faults, while minimizing the arc flash hazard to workers. The following protective device characteristics will be specified:

- Protective relay model, pickup, and time delay settings
- Circuit breaker model, frame size, trip unit, trip settings, and time delay settings
- Current transformer ratios

Arc flash labels will be placed on the installed electrical equipment.

C.6.5 Grounding System

An integrated grounding system will be installed throughout the new remedial facilities and interconnected with the existing grounding system at the Compressor Station. A lightning protection system will be connected to the facility ground ring as well as to any exposed metallic surfaces.

Grounding electrode ground mats or embedded rods and cables will be designed for a maximum resistance to ground of 25 ohms. Where more than one rod is required, rods will be installed at least 20 feet apart. A minimum of No. 4/0 AWG stranded bare copper cable will be used for interconnecting to ground rods and footing rebar.

A lightning protection system will be designed with air terminals and separate grounding system on buildings or structures used for operations and maintenance and chemical storage, including shade structures. Shade structures, if isolated from electrical equipment, may not be required to have lightning protection.

Equipment Grounding

A separate ground conductor sized in accordance with NEC requirements will be installed in raceways for power feeders and branch circuit raceways for motor control, lighting, and receptacle loads.

Shields of shielded instrumentation cables will be grounded to the ground bus at the power supply for the analog or low-voltage discrete signal circuit. Shielded instrumentation cables will not be grounded at more than one point.

C.6.6 Hazardous and Corrosive Area Definition

Area classification are shown on the drawings at the 90% design stage.

C.6.7 Energy Efficiency and Lighting

Energy efficiency will be a factor in equipment selection. Motors will be specified to be Premium Efficient per latest NEMA MG 1 standard where possible. Lighting equipment and facilities for safe operations will be designed to be energy efficient and comply with California Title 24 and county lighting ordinances. In compliance with EIR mitigation measure CUL-1a-7, to minimize construction and operations-related lighting impacts, the lighting for the remedy will include the following features: (1) shrouding/shielding for portable lights during construction and operational activities; (2) installation of portable lights at the lowest allowable height and in the smallest number feasible to maintain adequate night lighting for safety; and (3) shielding and orientation of lights such that off-site visibility of light sources, glare, and light from construction activities are minimized to the extent feasible. In addition, no additional permanent poles will be installed for lighting.

C.6.7.1 General Lighting Requirements

Since CUL-1a-7 is not meant to replace or subsume any actions required by the County or state or federal entities with regard to lighting required for minimum security and safety purposes, the following specifications will also be met:

- Construction Industry 29 CFR 1926.56 (lighting safety requirements)
- General Industry 29 CFR 1910.120 (HAZWOPER) (lighting safety requirements)
- San Bernardino County Code Title 8 Section § 83.07.040 Glare and Outdoor Lighting - Mountain and Desert Regions

- Mohave County Outdoor Light Control Ordinance 87-1
- Specific requirements from land owners, if feasible and is not in conflicting with the mitigation measures and county codes

The San Bernardino County lighting requirements are divided into two categories: residential and commercial/industrial. Remedy facilities are located both on and outside of PG&E-owned land, as follows:

- PG&E parcel (zoned industrial) – Compressor Station and Transwestern Bench
- Outside of PG&E parcel (zoned recreational) – Federally-owned land (including MW-20 Bench), the Havasu National Wildlife Refuge, and Fort Mojave Indian Tribe-owned land

PG&E will apply industrial requirements on the PG&E parcel and residential requirements outside of the PG&E parcel. The rationale for installing lights outside of the PG&E parcel is as follows:

Well Sites

- Nighttime access is not necessary; therefore no permanent lights will be installed. No new permanent light poles will be installed.
- Portable or truck-mounted lights can be brought in the event that an emergency or unforeseen condition occurs and plugged in locally.
- At the freshwater supply well site (HNWR-1A), security camera poles will have lights to allow for remote viewing of the well site during night time.

MW-20 Bench

- Similar to the IM-3 Brine Storage Facilities located at the MW-20 bench, nighttime access is not normally required. Exterior lights will be installed but activated manually.
- No new permanent light poles will be installed.

In both Mohave and San Bernardino Counties, the lighting requirements are intended to reduce glare or other light emissions on adjacent properties. Exhibit C.6-4 lists San Bernardino County shielding requirements for different types of fixtures in residential and commercial areas.

Fixtures prohibited by the County Code will not be used on the project. Fixtures planned for use in the remedy project are listed in Exhibit C.6-5. Fixtures used at the Compressor Station will comply with County requirements and follow PG&E standards for energy efficiency and lighting at operating facilities.

EXHIBIT C.6-4
Shielding Requirements For Outdoor Lighting In the Mountain Region and Desert Region
Groundwater Remedy Basis of Design Report/Pre-Final (90%) Design
PG&E Topock Compressor Station, Needles, California

Fixture Lamp Type	Residential Area Shielded	Commercial/Industrial Area Shielded
Low pressure sodium	Fully	Fully
High pressure sodium	Prohibited except fully shielded on streets	Fully
Metal halide	Prohibited	Fully
Fluorescent	Fully	Fully
Quartz	Prohibited	Fully
Incandescent > 60 watts	Fully	Fully
Incandescent 60 watts or less	No requirement	No requirement
Glass tubes filled with neon, argon, or krypton	No requirement	No requirement
Mercury vapor	Prohibited	Fully
Halogen	Prohibited	Fully
Searchlights for advertising purposes	Prohibited	Prohibited
Laser source light or similar light intensity light for advertising purposes	Prohibited when projected above the horizontal	Prohibited when projected above the horizontal

Source: San Bernardino County Development Code, Ch. 83.07.040 Table 83-7. Note that LED lights (a low energy form) may be suitable for the Remedy. This technology is not covered in the County Code.

EXHIBIT C.6-5
Planned Fixtures for Remedy and Associated County Requirements For Outdoor Lighting
Groundwater Remedy Basis of Design Report/Pre-Final (90%) Design
PG&E Topock Compressor Station, Needles, California

Fixture Lamp Type	Shielding Requirement	Type Used in Remedy Project?
Low pressure sodium	Fully	Indoors/Outdoors
Fluorescent	Fully	Indoors
Incandescent > 60 watts	Fully	Indoors
Incandescent 60 watts or less	No requirement	Indoors
LED	No requirement (not covered in the County Code)	Indoors

Source: San Bernardino County Development Code, Ch. 83.07.040 Table 83-7.

The amount of light or the illumination level is based on having sufficient light to do the expected tasks safely. OSHA sets standards for construction activities as shown on Exhibit C.6-6.

EXHIBIT C.6-6
Minimum Illumination Intensities
Groundwater Remedy Basis of Design Report/Pre-Final (90%) Design
PG&E Topock Compressor Station, Needles, California

Level (foot-candles)	Area of Operation
5	General construction area lighting.
3	General construction areas, concrete placement, excavation and waste areas, access ways, active storage areas, loading platforms, refueling, and field maintenance areas.
5	Indoors: warehouses, corridors, hallways, and exit ways.
5	Tunnels, shafts, and general underground work areas. (Exception: minimum of 10 foot-candles is required at tunnel and shaft heading during drilling, mucking, and scaling. Bureau of Mines approved cap lights shall be acceptable for use in the tunnel heading.)
10	General construction plant and shops (e.g., batch plants, screening plants, mechanical and electrical equipment rooms, carpenter shops, rigging lofts and active store rooms, mess halls, and indoor toilets and workrooms.)
30	First aid stations, infirmaries, and offices.

Source: Safety Lighting Levels During Construction – OSHA 29 CFR 1926.56(a) Table D-3.

For activities and areas not included under the OSHA standard, the ANSI/IES has established recommended illumination levels under Recommended Practice RP-07-01 (see Exhibit C.6-7).

EXHIBIT C.6-7
Recommended Illumination Levels per ANSI/IES RP-07-01
Groundwater Remedy Basis of Design Report/Pre-Final (90%) Design
PG&E Topock Compressor Station, Needles, California

Category	Description	Level
A	Public spaces	3 fc (30 lux)
B	Simple orientation for short visits	5 fc (50 lux)
C	Working space where simple visual tasks are performed	10 fc (100 lux)
D	Performance of visual tasks of high contrast and large size	30 fc (300 lux)
E	Performance of visual tasks of high contrast and small size, or tasks of low contrast and large size	50 fc (500 lux)
F	Performance of visual tasks of low contrast and small size	100 fc (1,000 lux)
G	Performance of visual tasks of critical importance	300 – 1,000 fc (3,000 – 10,000 lux)

Notes:
fc=foot-candles
1 fc ≈ 10 lux

C.6.7.2 Lighting Calculations

The recommended illumination level (foot-candles) for each space will be calculated in accordance with IES procedures. The following assumptions will be made, unless specific information is available:

Reflectances for finished rooms:

- Ceilings: 80 percent reflectance
- Walls: 50 percent reflectance
- Floors: 20 percent reflectance

Reflectances for unfinished rooms:

- Ceilings: 50 percent reflectance
- Walls: 30 percent reflectance
- Floors: 10 percent reflectance

Maintenance factor (light loss factor):

- Fluorescent lighting: 0.80

C.6.7.3 Emergency Lighting System

- Emergency illumination will be provided in appropriate spaces, as required by code to provide life safety, property, and equipment protection.
- Adequate lighting levels will be provided to maintain safe building egress and critical process plant functions. Emergency lighting will be located near MCCs and any equipment locations that need to be monitored on a continuing basis.
- In large process areas, emergency standby lighting units with a battery pack and two lamps and lighted exit signs with a battery pack will be provided. The battery pack will power the lights for at least 90 minutes.

C.6.7.4 Explosion-Proof Luminaires

Any room or space listed as a hazardous atmosphere area will have explosion-proof-type luminaires UL listed for installation in the hazardous area classifications, as required by Article 500 of the NEC.

C.6.7.5 Nighttime Construction Lighting

The first step will be to determine whether nighttime construction work is required. Nighttime construction-related activities will be limited to work that cannot be disrupted or suspended until the following day, such as, but not limited to, well drilling and development or decommissioning activities. If nighttime construction is required, the following principles will be applied:

- Identify the active area for construction and the applicable lighting standards. Only areas of active construction may be illuminated.
- Obtain portable lighting (including solar-powered). Lights must include shielding/shrouding (e.g., downward facing fixtures with cutoff shields to reduce light diffusion). No permanent poles will be installed for nighttime lighting.
- Install the minimum lighting feasible to maintain adequate night lighting for safety at the lowest allowable height. Orient the lights such that off-site visibility of light sources, glare, and construction activities is limited.
- Assign a responsible member of the construction crew, such as foreman or crew boss, to extinguish the lighting as soon as the nighttime construction work is completed.

C.6.8 Communications

Fiber optic cable or conventional copper wire will be used for sending signals via cable. Wireless communications devices like radio, satellite, or cellular, may be used as appropriate.

C.6.9 Existing Utilities

A utility survey was conducted in early 2012, and utility potholing were conducted in 2013 and 2014 to support the remedy design. A survey of aboveground and underground utilities will be conducted within all work areas prior to beginning intrusive site work and construction activities, including maintaining a minimum 25-foot right-of-way for the L300 gas pipelines located near occupied buildings. Existing engineering drawings have been reviewed to identify areas of potential conflict, but are for planning purposes only, not solely relied upon. See also Section C.2.2, Earthwork.

C.7 Instrumentation and Control

The I&C system for the project will utilize a stand-alone Remedy SCADA system and local PLCs. The Remedy SCADA system will be located at the Operations Building (Transwestern Bench) and will provide monitoring, supervisory control, alarming, and control functions. The Remedy SCADA includes hardware (e.g., servers, PCs, touch screen panels) and software. Historian software will collect, archive and distribute project-wide raw data and provide access to historical data.

In general, emergency shutdown of equipment due to alarm conditions (low discharge flow, high discharge pressure, motor overload, pump seal water failure, high level vault alarms, etc.) will be hardwired and will occur remotely or be executed locally. These alarm conditions will require manual reset at the SCADA or the local digital controller. In conformance with the EIR mitigation measure CUL-1a-6, all additional phone calls and alarms associated with remediation activities or facilities will not be routed through PG&E's existing alarm system utilized at the Compressor Station. The notification system for remediation-related alerts and/or phone calls will not introduce additional noise to the project area, to the maximum extent feasible, provided there is ongoing compliance with applicable safety regulations or standards of the Federal Energy Regulatory Commission, Occupational Safety and Health Administration, and other agencies.

There are 6 control nodes equipped with a PLC to control equipment in the field. Node PLCs will have operator interface terminals. The operator interface will include sufficient access to modify system set-points, parameters, alarms limits, and indication of associated process variables and instruments. This data will also be available to the Remedy SCADA system for full remote control, alarming, trending, archiving, etc.

Each PLC switch will be connected to the Operations Building's gigabit capable Ethernet backbone switch. The fiber cable will be run from the Operations Building communication panel to remote communication panels and onto each remote PLC. The fiber cable will be multimode or single mode as applicable, consisting of 12 fibers per cable. All fiber cables will be color coded, labeled and terminated at a fiber interconnect panel.

The system has been designed to allow for isolation/removal of components that could fail from operational sequencing, thereby minimizing downtime. Full redundancy of the Remedy SCADA system was determined to be unnecessary. System outage in individual area is expected to be repaired and put back into service within two to three days given an appropriate inventory of parts and skilled staff availability.

Power Distribution to Instrument Power Panel

All control power for each node PLC will be supplied by a control panel. The control panel shall be fed from the area primary distribution transformer. All I&C power for field devices or panels will be sourced from the control.

Uninterruptible Power Supply

The UPS will be double conversion "true online" and configured with an automatic bypass switch for battery maintenance. The UPS will provide power to the PLC, 24-volt DC power supply, Digital Input/Digital Output (DI&DO) cards, and analyzer power.

Power System Monitoring/Control from SCADA

Power distribution panels, motor control centers, and communications panels will be supplied with digitally networked power metering devices for remote energy monitoring and control. Primary distribution equipment and selected secondary equipment will be supplied with electrically actuated circuit breakers or contactors which will be available for remote position monitoring and alarming as well as remote manual and automatic control via the SCADA system. Automatic sequencing for restarting of equipment after restoration of power will be provided through SCADA.

C.8 Architectural

Building and all infrastructure components will conform to the following. Specifics for the Remedy-produced Water Conditioning Plant, Transwestern Bench Operations Building, and Transwestern Carbon Amendment Building are noted:

All Buildings (Water Conditioning, TW Bench Operations, TW Bench Carbon Amendment):

- Exterior finishes: In conformance with the EIR mitigation measure AES-1d and AES-2e, the color of the wells, pipelines, reagent storage tanks, control structures, and utilities shall consist of muted, earth-tone colors that are consistent with the surrounding natural color palette. Matte finishes shall be used to prevent reflectivity along the view corridor. Integral color concrete should be used in place of standard gray concrete.
- The design, location, and physical appearance and character of new construction at the Topock Compressor Station will be consistent with existing buildings in scale, form, materials, and architectural detail.
- In keeping with the Secretary of the Interior's Standards for the Rehabilitation of Historic Buildings, the new construction will be differentiated from existing historic architecture on the property, but will be compatible with the historic materials, features, size, scale and proportion, and massing to protect the integrity of the Topock Compressor Station and its environment.
- Floors: In process areas these will be reinforced cast-in-place concrete and aluminum grates where required for liquid containment. In containment areas, a chemical resistant polymer coating will be applied to concrete floor and containment basin surfaces. Six-inch housekeeping pads at equipment locations.
- Doors and frames: Heavy-gauge hollow metal doors and frames will be used. Hardware to be of heavy gauge and made of stainless steel where practical. Windows: Aluminum framed windows with a clear anodized finish. Energy efficient insulated tempered glass with a low-E coating. Extensive use of day lighting through windows.
- Louvers: Aluminum drainable louver with a clear anodized finish.
- Fire protection: Fire extinguishers as required per building and fire codes including NFPA 10. Pedestrian doors: Field finished with polyurethane and epoxy finish coating.

Specific design features for the Remedy-produced Water Conditioning Plant:

- Doors from the exterior into the facility and the interior door into the groundwater sampling equipment room will receive a tempered glass window.
- Interior finishes: Epoxy paint over gypsum board and concrete masonry unit (CMU). Clear sealer at concrete not covered with polymer containment coating. All paint to be off-white to promote a bright space where light can reach areas behind equipment.
- Overhead sectional doors: An 18-foot wide by 12-foot high heavy-gauge steel overhead sectional door with perforations to allow for air movement. Overhead door to be manually operated.
- Exterior wall assemblies: Exposed concrete on the lower floor. Insulated metal siding on the upper floor with Kynar finishes to match existing adjacent buildings.
- Structural steel framing: Steel framing to be finished with an epoxy primer and polyurethane finish coating at the upper floor of the remedy building. Exposed steel structure of the lower floor of the remedy building to hot-dip galvanized.

- Interior walls and ceilings: Metal studs with Batt insulation where separating conditioned and non-conditioned spaces. Wall to be built on a concrete curb and receive moisture resistant gypsum board on both sides. Epoxy paint over gypsum board in laboratory room and MCC room, insulation above structural metal deck at metal roof, painted concrete at lower floor ceiling to improve light reflectivity.
- Cabinetry: Wood cabinets with chemical-resistant countertops and stainless steel pulls.
- Floors: Smooth texture and finished with a clear surface sealer to increase the durability of the concrete surface and to maintain a clean, dust-free environment.
- Roof: Insulated metal roof with continuous ridge vent and Kynar light colored finishes to match existing adjacent buildings.
- Fire Protection: portable fire extinguishers.

Specific design features for the TW Bench Operations Building:

- Floors: Operations building to have a utilitarian – level polished concrete floor to minimize life cycle costs.
- Roof: Standing seam metal similar to Remedy Produced Water Conditioning Plant.
- Fire Protection: In addition to portable fire extinguishers, an automatic fire sprinkler system is provided.
- Interior wall finish to be semi-gloss sheen over gypsum board. Clear sealer at ground and polished concrete. All paint to be off-white to promote a bright space where light can reach areas behind equipment. Cabinetry to be of plastic laminate covered wood overlay construction with plastic laminate countertops.
- Structural steel framing to be of hot-dip galvanized steel when exposed.

Specific design features for the TW Bench Carbon Amendment Building:

- Floors: Process areas to receive chemical resistant polymer coatings.
- Roof: Standing seam metal similar to Remedy Produced Water Conditioning Plant.
- Structural steel framing to be of hot-dip galvanized steel.
- Fire Protection: In addition to portable fire extinguishers, an automatic fire sprinkler system is provided.
- Interior surfaces to be epoxy paint over CMU. Clear sealer at concrete not covered with polymer chemical containment coating. All paint to be off-white to promote a bright space where light can reach areas behind equipment.

C.9 PG&E Personnel Requirements

PG&E personnel will perform the following activities during construction:

- PG&E personnel, or their designee, will lead TCS-specific safety and biological and cultural sensitivity training for contractors and employees.
- Serve as liaison and primary contact for any agency, tribal, or other third party personnel inspecting and/or monitoring construction and O&M activities.
- Serve as liaison and primary contact for community, stakeholders, agencies, Tribes, members of the press, and others requesting site tours or project-related information.
- Initiate communications with/notifications to agencies, land owners, and others, as required, in the event of emergencies or contingency triggers.
- Attend stand-up tailboard (safety) meetings before the start of work each day to review safety policies and specific hazards likely to be encountered in the day’s activities.
- Sign waste manifest forms and compliance documents that require PG&E certification.

- Monitor for compliance with PG&E safety standards and requirements and contract specifications, terms, and conditions.

C.10 Health and Safety

The project falls under federal Occupational Safety and Health Administration (OSHA) Hazardous Waste Operations and Emergency Response (HAZWOPER) requirements (29 CFR 1910.120) so these procedures must be followed in addition to California and Arizona state requirements.

These requirements are embodied in the project-specific health and safety plan(s) for construction and O&M. In addition, health and safety work plans will be prepared or amended by construction, drilling and other service contractors working on the project. Existing health and safety plans will be reviewed and amended, as needed, to suit new project requirements and/or conditions. PG&E personnel similarly work under PG&E's own health and safety requirements. These health and safety plans will be available onsite and will describe such things as training, site control, medical surveillance, safety personnel roles and responsibilities, personnel protective equipment, exposure monitoring and air sampling programs, heat and cold stress, and site work rules and procedures.

Project-specific health and safety plans for construction and O&M activities are provided in the Construction/Remedial Action Work Plan and Volume 5 of the O&M Manual.

C.11 Noise

- A design margin of 3 to 5 A-weighted decibels (dB[A]) will be considered in all noise design criteria.
- In conformance with the EIR mitigation measures NOISE-3 and CUL-1a-10, the operational noise design criteria for the project will be per San Bernardino County Development Code 83.01.080 for acceptable exterior noise standards for place of worship, which is 55 dB(A) Leq daytime (7 a.m.-10 p.m.) and 45 dB(A) Leq nighttime (10 p.m.-7 a.m.) (Leq is the equivalent average hourly noise level) (see page 4.9-24 of the EIR [DTSC 2011]). The noise measurement locations will be at the edge of the Maze closest to the subject facilities and at the short-term ambient noise measurement locations (ST-1, ST-2, and ST-3) in Exhibit 4.9-2 of the certified EIR (DTSC 2011).
- For remedy facilities in Arizona, the operational noise design criteria will be 60 dB daytime and 50 dB nighttime average at closest residences (per current Mohave General Plan, Exhibit V-5, Maximum Noise Levels for Various Land Use (Freilich, Leitner & Carlisle 2010).
- For remedy facilities on the Refuge, the operational noise design criteria will be 60 dB.
- For remedy facilities located on the Compressor Station and within PG&E property, the operational noise design criteria will be consistent with the noise environment at the Station, per San Bernardino County Development Code 83.01.080 for industrial land use, 70 dB(A).
- The construction noise criteria will conform to San Bernardino Development Code and Mojave County standards, as well as the EIR mitigation measures NOISE-1, -2, and -3. Per San Bernardino County Code Division 3 Chapter 83.01.080, temporary construction, maintenance, repair, or demolition activities between 7:00 a.m. and 7:00 p.m., except Sundays and federal holidays, are exempt from noise limits.

C.12 References

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Attachment A
Carbon Substrate Selection and Degradation Pathways Design Bulletin
(*on CD-ROM only*)

ARCADIS	TOPIC: **Carbon Substrate Selection and Degradation Pathways Design Bulletin**	
Revision 2 (8/1/12)	REPORT SECTION: Appendix C	BULLETIN No.:

1. Purpose

The objective of this Design Bulletin is to detail the basis of design for the selection and usage of carbon substrates and their degradation pathways for the In-Situ Reactive Zone (IRZ) at the Pacific Gas & Electric (PG&E) Topock site. There is a wide spectrum of organic carbon substrates available for anaerobic in-situ reactive zone (IRZ) applications including fermentable soluble substrates such as molasses, lactate, and whey; alcohols such as ethanol and methanol; semi-soluble substrates such as emulsified vegetable oil; and solids such as chitin and bark mulch.

Selection of the appropriate substrate depends on the balance between the mode of delivery, the substrate properties, and the rate of carbon utilization. Substrates considered for use in the Topock Compressor Station final remedy will be discussed in this appendix, as well as general degradation pathways. Some information on carbon substrate dosing design is also provided in this appendix to supplement the thorough treatment of the dosing design in the groundwater modeling Appendix B.

2. References

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ARCADIS 2009. *Upland In-Situ Pilot Test, Final Completion Report.* Pacific Gas and Electric Company Topock Compressor Station, Needles, California. March 3.

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3. Definitions

C-1	Single carbon compounds
CH_4	Methane
$C_2H_3O_2^-$	Acetate
C_2H_6O	Ethanol
$C_3H_5O_3^-$	Lactate
$C_3H_5O_2^-$	Propionate

$C_{12}H_{22}O_{11}$	Lactose
CO_2	Carbon dioxide
$Cr(III)$	Trivalent chromium
$Cr(VI)$	Hexavalent chromium
$Cr(OH)_3$	Chromium hydroxide
e^-	Electrons
$Fe(II)$	Ferrous iron
$Fe(III)$	Ferric Iron
$Fe(OH)_3$	Ferrihydrite
H^+	Hydronium ion
H_2	Hydrogen
H_2O	Water
H_2S	Hydrogen sulfide
HS^-	Bisulfide ion
$Mn(IV)$	Tetravalent manganese
$Mn(II)$	Divalent manganese
MnO_2	Manganese dioxide
NO_3^-	Nitrate
NO_2^-	Nitrite
N_2	Nitrogen
O_2	Oxygen
SO_4^{2-}	Sulfate

4. Carbon Substrate Selection

Based on the results of the preliminary evaluation, the carbon substrates that were carried forward into remedy design included ethanol (used in the Uplands In-Situ Pilot Test [ARCADIS 2009]), sodium lactate (used in the Floodplains In-Situ Pilot Test [ARCADIS, 2007]), emulsified vegetable oil, and liquid whey. Each of these carbon substrates were evaluated in the Final Environmental Impact Report (FEIR, DTSC, 2011). The selection of the appropriate substrate depended on the balance between the mode of delivery, the substrate properties, and the rate of carbon utilization.

It is anticipated that for most of the final remedy operational period, substrates that are soluble with short biodegradation half lives (i.e., 5 to 20 days), like lactate and ethanol, will be used to facilitate effective distribution and establishment of reducing conditions across the IRZ, with the highest degree of distribution control, given the utilization of the carbon substrates and by-products (discussed below) to completion (i.e. to complete degradation to carbon dioxide and methane). During the 60% design stage, ethanol was selected for use in the ongoing design and for initial use in the final remedy based on additional considerations including substrate cost and PG&E's greater experience and past successes with ethanol (e.g., at the PG&E Hinkley Compressor Station site). However, carbon substrate selection may change over the lifetime of the project as substrate costing varies. In addition, alternative substrates could be useful for certain situations that arise over the life of the project. For example, emulsified vegetable oil may be used during future operational stages of the remedy if a low dosage, slow release reservoir of carbon would be advantageous.

5. Organic Carbon Degradation Pathways

Within an active IRZ, periodic injection activities support the development of a diverse microbial community that utilizes the augmented organic carbon supply via a complex network of degradation pathways. In general, there are two types of processes by which organic carbon substrates are consumed: respiratory processes and fermentation processes. Regardless of the carbon substrate used and the complex network of degradation pathways stimulated, the resultant end products of degradation will include carbon dioxide, methane, and biomass. Eventually, biomass will also decay into carbon dioxide and methane. The following provides an overview of the various degradation pathways that will be stimulated within the IRZs, identifies the typical intermediates that may form, and includes several balanced oxidation-reduction reactions. This list may not be inclusive, considering the complex microbial ecology that will develop within the IRZ, but is intended to provide a basic framework for understanding the carbon degradation pathways.

In respiratory processes, organic carbon substrates are oxidized to carbon dioxide, releasing electrons that in turn reduce terminal electron acceptors (oxygen, nitrate, hexavalent chromium, iron, manganese, and sulfate). In fermentation processes, the organic carbon substrates are both oxidized and reduced via the metabolic pathways. The general pathways and intermediates for organic carbon degradation are shown on Figure 1. As shown on the figure, in the respiratory pathways coupled to reduction of oxygen, nitrate, chromium, iron, manganese and sulfate, the carbon substrate is completely oxidized to carbon dioxide. Consequently, total organic carbon concentrations return to ambient concentrations following IRZ injections.

Fermentation reactions produce additional intermediates such as fatty acids, alcohols, lactate, succinate, and hydrogen from primary fermentation of more complex organic carbon substrates, and acetate and single carbon (C-1) compounds, like formate, from less complex substrates or the intermediates of primary fermentation.

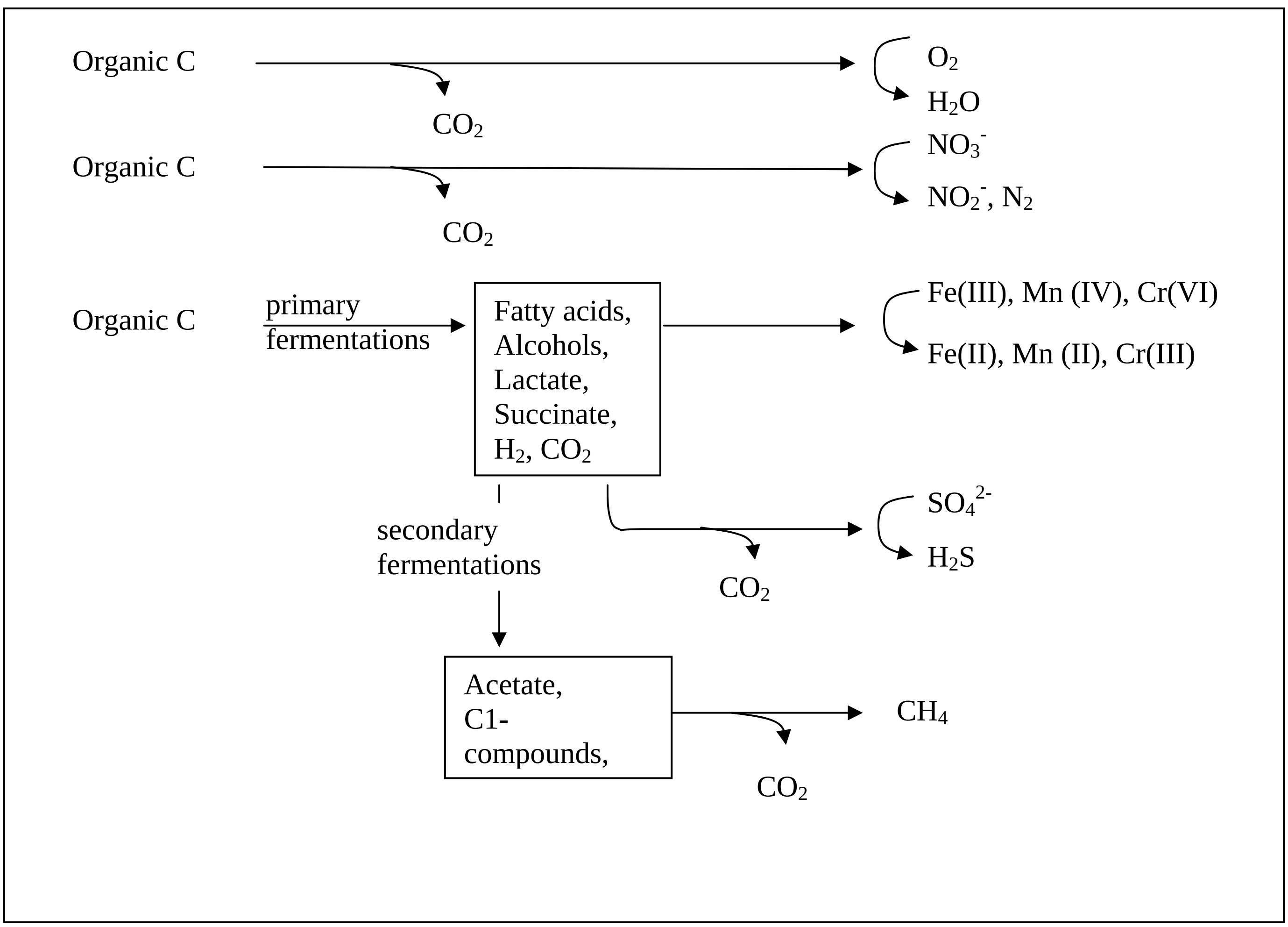

Figure 1: General Degradation Pathways for Organic Carbon Substrates (adapted from Lengeler et al., 1999)

For the IRZs that are part of the final groundwater remedy at the Topock Compressor Station, several organic carbon substrates were considered. For the purposes of this discussion, however, only the four most likely substrates are considered, ethanol, lactate, liquid whey, and emulsified vegetable oil (EVO). For reference, liquid whey is composed primarily of the disaccharide lactose, and EVO is a triglyceride.

EVO is a slightly different substrate than the others being discussed, because it is delivered as a separate phase oil that will sorb to aquifer soils. The triglycerides are first hydrolyzed, releasing glycerol and long chain fatty acids (IES, 2006). As the long chain fatty acids are degraded by beta-oxidation, smaller molecules are generated which more easily dissolve into groundwater, such as butyric acid, and acetate (IES, 2006), as shown on Figure 2.

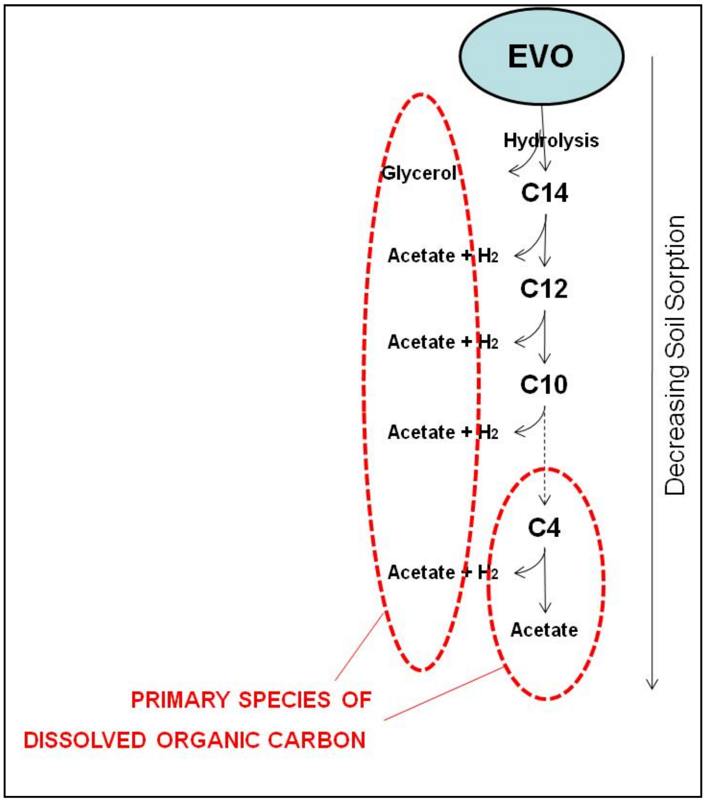

Figure 2. Degradation and Dissolution of EVO.

In the next few sections, the general breakdown pathways and balanced reactions for the respiration and fermentation of the various organic carbon substrates are presented. For the purpose of EVO, acetate will be discussed as an example of a dissolved organic compound.

a. Respiratory Processes

In respiratory processes, the oxidation of organic carbon substrates to carbon dioxide is coupled to the reduction of a terminal electron acceptor. Respiratory processes stimulated within an IRZ include aerobic respiration, denitrification, chromium reduction, iron reduction, manganese reduction, and sulfate reduction. The following discussion will provide an overview of the reactions for these respiratory processes.

The following are balanced oxidation half-reactions that release electrons for ethanol, lactate, lactose (from whey), and acetate (a degradation intermediate and one of the primary dissolved constituents released from EVO).

Ethanol	$1/12\ C_2H_6O + 1/4\ H_2O \rightarrow 1/6\ CO_2 + H^+ + e^-$	(1)
Lactate	$1/12\ C_3H_5O_3^- + 1/4\ H_2O \rightarrow 1/4\ CO_2 + 11/12\ H^+ + e^-$	(2)
Lactose	$1/48\ C_{12}H_{22}O_{11} + 13/48\ H_2O \rightarrow 1/4\ CO_2 + H^+ + e^-$	(3)
Acetate	$1/8\ C_2H_3O_2^- + 1/4\ H_2O \rightarrow 1/4\ CO_2 + 7/8\ H^+ + e^-$	(4)

The release of electrons from the oxidation of each substrate is coupled to the reduction of the various terminal electron acceptors. Below are the reduction half reactions for the various terminal electron acceptors. Note, for iron and manganese reduction (Reaction 8 and 9), various mineral phase reactants are possible and one example of each is shown. Similarly for chromium (Reaction 7), several mineral phase products are possible and one example is shown, chromium hydroxide.

Oxygen	$1/4\ O_2 + H^+ + e^- \rightarrow 1/2\ H_2O$	(5)
Nitrate	$1/5\ NO_3^- + 6/5\ H^+ + e- \rightarrow 1/10\ N_2 + 3/5\ H_2O$	(6)
Chromium	$1/3\ Cr^{6+} + H_2O + e^- \rightarrow 1/3\ Cr(OH)_3 + H^+$	(7)
Iron	$Fe(OH)_3 + 3H^+ + e^- \rightarrow Fe^{2+} + 3H_2O$	(8)
Manganese	$1/2\ MnO_2 + 2H^+ + e^- \rightarrow 1/2\ Mn^{2+} + H_2O$	(9)
Sulfate	$1/8\ SO_4^{2-} + 9/8\ H^+ + e^- \rightarrow 1/8\ HS- + 1/2\ H_2O$	(10)

For each substrate being considered, bacteria within the IRZ would couple the oxidation of the organic carbon substrate with the reduction of various electron acceptors. For example, balanced reactions for the coupling of ethanol oxidation with oxygen, iron and sulfate reduction (Reactions 11, 12 and 13, respectively) are as follows:

Ethanol/Oxygen	$1/12\ C_2H_6O + 1/4\ O_2 \rightarrow 1/6\ CO_2 + 1/4\ H_2O$	(11)
Ethanol/Iron	$1/12\ C_2H_6O + Fe(OH)_3 + 2H^+ \rightarrow Fe^{2+} + 2\ 3/4\ H_2O + 1/6\ CO_2$	(12)
Ethanol/Sulfate	$1/12\ C_2H_6O + 1/8\ SO_4^{2-} + 1/8\ H^+ \rightarrow 1/8\ HS- + 1/4\ H_2O + 1/6\ CO_2$	(13)

The utilization of electron acceptors in the system will generally be governed by the principles of thermodynamic equilibrium and redox kinetics. Dissolved oxygen and nitrate are thermodynamically more favorable electron acceptors than Cr(VI), while Cr(VI) is thermodynamically a more favorable electron acceptor than manganese oxides, iron oxides, and sulfate. However, given the relative availability of the electron acceptors and spatial heterogeneities of the subsurface aquifer environment, many of these reactions can occur simultaneously under field conditions. For example, iron and manganese reduction can proceed concurrently and sulfate reduction can begin before iron oxides are depleted, depending on the strength of the reducing environment. The strength of the reducing environment can be tuned by adjusting the concentration of organic carbon injected. To a large extent, this can help minimize the reduction of manganese, iron, and sulfate while still achieving adequate Cr(VI) reduction and removal. However, in order to create a reducing environment sufficient for the sustained removal of Cr(VI), some manganese, iron, and sulfate reduction will occur. Some iron reduction is actually desirable, as it provides stored Cr(VI) reduction capacity within the aquifer. In fact, abiotic pathways, such as reduction by Fe(II), may be faster than direct biotic mechanisms for Cr(VI) reduction (e.g., Wielinga et al., Environmental Science and Technology, 2001). Iron reduction is expected to occur under active Cr(VI) reducing conditions, producing mixed Fe/Cr precipitates that sequester Cr(VI). Thus, it is anticipated that both Cr(VI) reduction mechanisms will occur simultaneously. These principles are discussed in more detail in Appendix B of the Basis of Design (BOD)/60% Design Report.

The oxidation-reduction (redox) reactions fostered in the IRZ may temporarily mobilize certain naturally-occurring metals within the treatment zone, including manganese and arsenic. An adaptive operations approach, outlined in Volume 2 of the Operations and Maintenance Manual will be used to balance carbon dosing to treat

Cr(VI) while minimizing manganese and arsenic generation.

b. Fermentative Processes

Fermentative conditions will also develop within the IRZ, as indicated by increased methane concentrations in groundwater in IRZs at the PG&E Hinkley Site (ARCADIS 2010). As shown in Figure 1, various organic intermediates and hydrogen can be produced from the fermentation of the organic carbon substrates, but the ultimate end products of reaction are carbon dioxide and methane.

For example, fatty acids have been monitored during IRZ implementation at Hinkley. The most prominent fatty acids detected in IRZ groundwater during both lactate and ethanol applications have been acetate and propionate (ARCADIS 2010). The production of acetate and propionate from lactate and ethanol are well documented fermentation processes.

Propionibacteria produce acetate and propionate from the fermentation of lactate (Lengeler et al., 1999) as follows:

$$3\ C_3H_5O_3^- \rightarrow C_2H_3O_2^- + CO_2 + 2\ C_3H_5O_2^- + H_2O \qquad (14)$$

Ethanol ferments to produce acetate and propionate as follows (Schink et al., 1987):

$$3\ C_2H_6O + 2\ HCO_3^- \rightarrow C_2H_3O_2^- + 2\ C_3H_5O_2^- + H^+ + 3\ H_2O \qquad (15)$$

Finally, the products of fermentation will be used by methanogens to make methane. Acetoclastic methanogens will produce methane from acetate (Lengeler et al., 1999):

$$C_2H_3O_2^- + H^+ \rightarrow CH_4 + CO_2 \qquad (16)$$

Hydrogenotrophic methanogens will produce methane from carbon dioxide and hydrogen (Lengeler et al., 1999):

$$CO_2 + 4\ H_2 \rightarrow CH_4 + 2\ H_2O \qquad (17)$$

6. Dosing Design

The primary design consideration for carbon substrate dosing is the adequate (lateral) distribution of the substrate in the subsurface while minimizing byproduct (reduced manganese and arsenic) production. Concentrations of total organic carbon will be highest at the injection point and will decrease with distance, and the arsenic and manganese generated is a consequence of that distribution of organic carbon, as discussed in detail in Appendix B of the BOD/60% Design Report. As such, the hydraulic, fate and transport, and geochemical models, as well as pilot test data, are being used to guide reagent dosing design, as discussed in Appendix B (BOD/60% Design Report). To optimize the tradeoff between organic carbon distribution and byproduct generation, design parameters such as well spacing, recirculation flow rates, and injection concentrations can be varied. The first step of this process was taken with the reactive transport modeling that supported the IRZ design (Appendix B, BOD/60% Design Report). This optimization process will continue during operation as monitoring data are collected, evaluated, and used to modify operations of the system.

The semi-soluble substrate, EVO is a special case and is discussed further in this section. As EVO is injected, significant portions of the oil will be retained on the soil. The amount of oil that will be retained per unit volume of aquifer varies with soil type as documented in the Protocol for Enhanced In Situ Bioremediation (IES, 2006) and is a lower bound on the amount of oil that will be required to achieve distribution within a given target volume. However, the amount of EVO required to achieve sufficient distribution can be up to an order of magnitude greater than the amount of oil retention reported in the literature, based on field implementation at a number of sites (Schnobrich et al., 2011). In practice, the required EVO loading must be evaluated on a case-by-case basis to confirm the site-specific degree of droplet retention and to ensure sufficient organic carbon distribution for treatment within the targeted area.

Attachment B
Calculations (*on CD-ROM only*)

- Remedy-produced water pump calculations – Recirculation; filter feed; conditioned water transfer
- Remedy-produced water conditioning process - Eductor sizing
- Remedy-produced water conditioning process - Caustic usage
- Remedy-produced water conditioning building – Structural calculations
- Freshwater injection/remedy-produced water collection/conditioned remedy water distribution and disposal hydraulic network modeling calculations from EPANET software
- Hydraulic calculations for NTH IRZ, Inner Recirculation Loop, and TCS Recirculation Loop Wells
- Structural calculations for the MW-20 Bench Carbon Amendment Building
- Fire suppression calculations for carbon amendment buildings
- Sand separator system

Remedy-produced Water Pump Calculations—Recirculation; Filter Feed; Conditioned Water Transfer

PMP 201-204
Influent Tank Recirculation Pump 1 through 4

DESIGN DATA

DGN FLOW	492.4	GPM	FROM
SG @DT	1.0		TNK-201
DEN @ DT	62.4	Lb/ft3	
VISC. @ D T	1	cP	TO
VAP P @ D T	0.7	PSIA	TNK-201
DGN TEMP	150.0	F	

PUMP SUCTION INPUT DATA CONDITIONS

MINIMUM SYSTEM INITIAL PRES.		14.7	psia
STATIC HEAD (+) OR LIFT (-)		1.0	ft
EQUIPMENT LOSS			psia
MISC LOSS		0.0	psia

PUMP DISCHARGE INPUT DATA CONDITIONS

MAX. SYSTEM TERMINAL PRES.		14.7	psia
STATIC HEAD DIFFERENCE		1.0	ft
EQUIPMENT LOSS (2) Eductors		30.0	psi
EQUIPMENT LOSS		0.0	psi
MISCELLANEOUS LOSS		0.0	psi
MISCELLANEOUS LOSS		0.0	psi
ALLOWED CONTROL VALVE PRES. DROP		0.0	psi

RESULTS

CORRECTED DIFFERENTIAL HEAD		82	ft
CORRECTED DIFFERENTIAL PRESS		35.1	psi
MIN. PUMP CASING DESIGN PRESSURE		42.5	psig
DESIGN SUCTION PRES.		14.2	psia
CORRECTED DISCHARGE PRESS.		49.3	psia
CORRECTED NPSHa		28.7	ft

(yellow)	Required Input
(green)	Optional Input

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PUMP CALCULATION SHEET

Pump2K Version 1.2

PROJECT NO. :	435062.00	BY:	RCH	DATE:	
CLIENT:	PG&E	CHECKED:	WLR/JP	DATE:	
EQUIPMENT NO(S):	PMP-201-204	REVISION NO.:	0	DATE:	13-Jul-12 BY: RCH
SERVICE:	Remedy Water	FLUID:	Remedy Water	PFD #:	G-1201
LOCATION:	Influent Tank Farm	NO. PUMPS REQ'D:	4	P&ID #:	I-1101-1104

DESIGN DATA			NORMAL OPERATING DATA	
DGN FLOW, GPM	492.4	PUMPS FROM:	NORMAL FLOW,GPM	0
SG, DESIGN TEMP	0.98604	TNK-201	SG, NORMAL TEMP	0
DEN @ D T, LB/FT3	61.528896		DEN @ N T, LB/FT3	0
VISC. @ D T, CP	1	PUMPS TO:	VISC. @ N T, CP	0
VAP P @ D T, PSIA	0.65	TNK-201	VAP P @ N T, PSIA	0
DGN TEMP, DEG F	150		NORM. TEMP, DEG F	0

INPUT:	SUCTION PIPING DATA			DISCHARGE PIPING DATA		
NOMINAL SIZE, IN.	6.00	<-enter piping & fitting data		6.00	<-enter piping & fitting data	
SCHEDULE	40			40		
ACTUAL I.D., IN.	6.065			6.065		
FITTINGS	NO.	K *	DP, PSI	NO.	K *	DP, PSI
ELBOWS, 90 LR	4	0.24	0.19	8	0.24	0.37
ELBOWS, 45 LR		0.18	0.00		0.18	0.00
TEES, THRU	1	0.58	0.12	3	0.58	0.35
TEES, BRANCH		0.94	0.00	2	0.94	0.37
BALL VALVES		0.18	0.00		0.18	0.00
BUTTERFLY VALVES	1	0.29	0.06	4	0.29	0.23
GATE VALVES		0.12	0.00		0.12	0.00
GLOBE VALVES		4.67	0.00		4.67	0.00
CHECK VALVES		1.75	0.00	1	1.75	0.35
PLUG VALVES		0.30	0.00		0.30	0.00
PIPE ENTRANCE	1	0.50	0.10			
PIPE EXIT				1	1.00	0.20
OTHER			0.00			0.00
LIN. FT OF PIPE	58		0.39	80		0.54
OTHER, EQ FT			0.00			0.00
CONTINGENCY, %	20%			20%		
CONTINGENCY, FT	11.6		0.08	16		0.11
TOTAL EQ FT	137			371		
DP TOTAL, PSI			0.93			2.52

	CALCULATED SUCTION DATA	CALCULATED DISCHARGE DATA
PIPE I.D., IN	6.065	6.065
X-SECT AREA,FT2	0.2006	0.2006
DGN FLOW, LB/HR	242,763	242,763
VELOCITY, FT/SEC	5.46	5.46
REYNOLDS NUM	252,577	252,577
DARCY FRI FACT	0.01733	0.01733
FRICT DP, PSI/100'	0.68	0.68

* CALCULATION OF K FACTOR BASED ON 2-K METHOD.

NOTES:

Updated to add analyzers on inlet to eductors. Change eductor to 30 dp and add inlet stream of chemicals to pump suction (T). Added 25 gph to flow for chemicals and updated flow for 3' -30 dP

PUMP SUCTION CONDITIONS

MINIMUM SYSTEM INITIAL PRES., PSIA		14.7
STATIC HEAD (+) OR LIFT (-), FT		1
STATIC HEAD (+) OR LIFT (-), PSI		0.4
LINE FRICTION LOSS, PSI		0.9
EQUIPMENT LOSS, PSI		0.0
MISC LOSS, PSI	0	0.0
DESIGN SUCTION PRES., PSIA		14.2

PUMP DISCHARGE CONDITIONS

MAX. SYSTEM TERMINAL PRES., PSIA		14.7
STATIC HEAD DIFFERENCE, FT		1
STATIC HEAD DIFFERENCE, PSI		0.4
TOTAL FIXED LOSSES, PSIA		15.1
LINE FRICTION LOSS, PSI		2.5
EQUIPMENT LOSS, PSI	(2) Eductors	30.0
EQUIPMENT LOSS, PSI	0	0.0
MISCELLANEOUS LOSS, PSI	0	0.0
MISCELLANEOUS LOSS, PSI	0	0.0
TOTAL VARIABLE LOSS, PSI		32.5
TOTAL FIXED AND VARIABLE LOSS, PSIA		47.6
ALLOWED CONTROL VALVE PRES. DROP , PSI		0.0
DISCHARGE PRESSURE, PSIA		47.6
CORRECTED DISCHARGE PRESSURE, PSIA		**49.3**

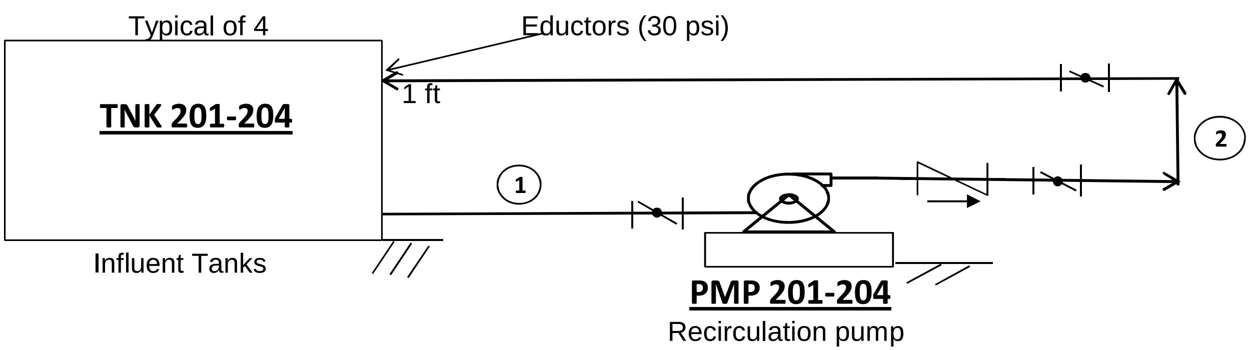
DIFFERENTIAL HEAD AND POWER CALCULATION

DESIGN SUCTION PRESSURE, PSIA	14.2
TOTAL DIFFERENTIAL PRESSURE, PSI	33.5
TOTAL DIFFERENTIAL HEAD, FT	78
OVERALL LOSS SAFETY FACTOR, % (e.g., 10 %)	5%
CORRECTED DIFFERENTIAL HEAD, FT	**82**
CORRECTED DIFFERENTIAL PRESS, PSI	**35.1**
HYDRAULIC HORSEPOWER, HP	10.1
PUMP EFFICIENCY, % (e.g., 50%)	50%
BRAKE HORSEPOWER, BHP (water only)	20.2
MIN. PUMP CASING DESIGN PRESSURE, PSIG	42.5

NET POSITIVE SUCTION HEAD CALCULATION (NPSHa)

MINIMUM SYSTEM INITIAL PRESSURE, PSIA	14.7
MINIMUM STATIC HEAD, PSI	0.4
LINE FRICTION LOSS AT DESIGN FLOW, PSI	0.9
OTHER LOSSES, NET, PSI	0.0
LIQUID VAPOR PRESSURE, PSIA	0.7
NET POSITIVE SUCTION HEAD AVAILABLE, PSIA	13.5
NET POSITIVE SUCTION HEAD AVAILABLE, FT.	32
NPSHa SAFETY FACTOR, FT.	3
CORRECTED NPSHa, FT.	**28.7**

Job Name:	Topock 60% Design	**Sheet No.:**	3 of 3
Subject:	Pump Calculation	**Date:**	8/3/2012
Job No.:	435062	**Computed By:**	RCH
		Checked By:	JP



Section 1: Suction
6" pipe
1 entrance
1 butterfly
4 elbows
58'
1' static lift

Section 2: Discharge
6" pipe
1 exit
1 check
4 butterfly
2 branch T
eductors (30 psi)
8 elbows
80'
3 thru T

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JOB NO.: 415087.01.05.02

SHEET NO.: 1

DATE: 10 05 2011

JOB NAME: TOPOCK GROUNDWATER TREATMENT

COMPUTED BY CHRIS ABDULJABBAR

SUBJECT: Pump Calculation

CHECKED BY: JOHN PORCELLA

REVISION HISTORY:

Rev. No.	Date	By	Approved	Notes
1	10/05/11	C. Abduljabbar	John Porcella	Prelim. sizing for determining elec. load.
2	07/30/12	R Harris	John Porcella	processes
3	08/01/14	J Porcella	John Porcella	Update to include revised equipment layouts

OWNER:

CH2M HILL Energy and Chemicals **Discipline:** Process

CH2MHILL

PUMP CALCULATION SHEET

Pump2K Version 1.2

PROJECT NO. :	435062.01.13.04	BY:	J. Porcella	DATE:	23-Aug-14
CLIENT:	PG&E	CHECKED:	W. Farmer	DATE:	28-Aug-14
EQUIPMENT NO(S):	PMP-310/320	REVISION NO.:	3	DATE:	03-Sep-14 BY: JP
SERVICE:	Remedy Water	FLUID:	Groundwater	PFD #:	
LOCATION:	Influent Tank Farm	NO. PUMPS REQ'D:	2	P&ID #:	I-12-01 & I-14-01

DESIGN DATA			NORMAL OPERATING DATA	
DGN FLOW, GPM	35	PUMPS FROM:	NORMAL FLOW,GPM	20
SG, DESIGN TEMP	0.9962	Influent Tank Farm	SG, NORMAL TEMP	0.9962
DEN @ D T, LB/FT3	62.16288		DEN @ N T, LB/FT3	62.16288
VISC. @ D T, CP	0.813	PUMPS TO:	VISC. @ N T, CP	0.813
VAP P @ D T, PSIA	0.6	Filters & Conditioned Water Tank Farm	VAP P @ N T, PSIA	0.6
DGN TEMP, DEG F	85		NORM. TEMP, DEG	85

INPUT:	SUCTION PIPING DATA			DISCHARGE PIPING DATA		
NOMINAL SIZE, IN.	2.00	<-enter piping & fitting data		2.00	<-enter piping & fitting data	
SCHEDULE	40			40		
ACTUAL I.D., IN.	2.067			2.067		
FITTINGS	NO.	K *	DP, PSI	NO.	K *	DP, PSI
ELBOWS, 90 LR	3	0.31	0.07	10	0.31	0.23
ELBOWS, 45 LR		0.23	0.00		0.23	0.00
TEES, THRU	5	0.74	0.28	0	0.74	0.00
TEES, BRANCH	2	1.20	0.18	5	1.20	0.45
BALL VALVES	2	0.23	0.03	7	0.23	0.12
BUTTERFLY VALVE	1	0.38	0.03	1	0.38	0.03
GATE VALVES		0.15	0.00	0	0.15	0.00
GLOBE VALVES		5.96	0.00	0	5.96	0.00
CHECK VALVES		2.25	0.00	1	2.25	0.17
PLUG VALVES		0.39	0.00	0	0.39	0.00
PIPE ENTRANCE	1	0.50	0.04			
PIPE EXIT				1	1.00	0.07
OTHER			0.00			0.00
LIN. FT OF PIPE	55		0.55	615		6.14
OTHER, EQ FT			0.00			0.00
CONTINGENCY, %	20%			20%		
CONTINGENCY, FT	11.0		0.11	123		1.23
TOTAL EQ FT	129			845		
DP TOTAL, PSI			1.29			8.44

	CALCULATED SUCTION DATA	CALCULATED DISCHARGE DATA
PIPE I.D., IN	2.067	2.067
X-SECT AREA,FT2	0.0233	0.0233
DGN FLOW, LB/HR	17,434	17,434
VELOCITY, FT/SEC	3.34	3.34
REYNOLDS NUM	65,463	65,463
DARCY FRI FACT	0.02296	0.02296
FRICT DP, PSI/100'	1.00	1.00

* CALCULATION OF K FACTOR BASED ON 2-K METHOD.

NOTES:

See "Key assumptions" worksheet.

PUMP SUCTION CONDITIONS

MINIMUM SYSTEM INITIAL PRES., PSIA		14.7
STATIC HEAD (+) OR LIFT (-), FT		0
STATIC HEAD (+) OR LIFT (-), PSI		0.0
LINE FRICTION LOSS, PSI		1.3
EQUIPMENT LOSS, PSI		
MISC LOSS, PSI		
DESIGN SUCTION PRES., PSIA		13.4

PUMP DISCHARGE CONDITIONS

MAX. SYSTEM TERMINAL PRES., PSIA		14.7
STATIC HEAD DIFFERENCE, FT		4
STATIC HEAD DIFFERENCE, PSI		1.7
TOTAL FIXED LOSSES, PSIA		16.4
LINE FRICTION LOSS, PSI		8.4
EQUIPMENT LOSS, PSI	GAC Vessels	2.5
EQUIPMENT LOSS, PSI	Cartridge Filters	2.5
MISCELLANEOUS LOSS, PSI	Flow meter	2.0
MISCELLANEOUS LOSS, PSI	Static mixer	1.0
TOTAL VARIABLE LOSS, PSI		16.4
TOTAL FIXED AND VARIABLE LOSS, PSIA		32.9
ALLOWED CONTROL VALVE PRES. DROP , PSI		
DISCHARGE PRESSURE, PSIA		32.9
CORRECTED DISCHARGE PRESSURE, PSIA		**33.8**

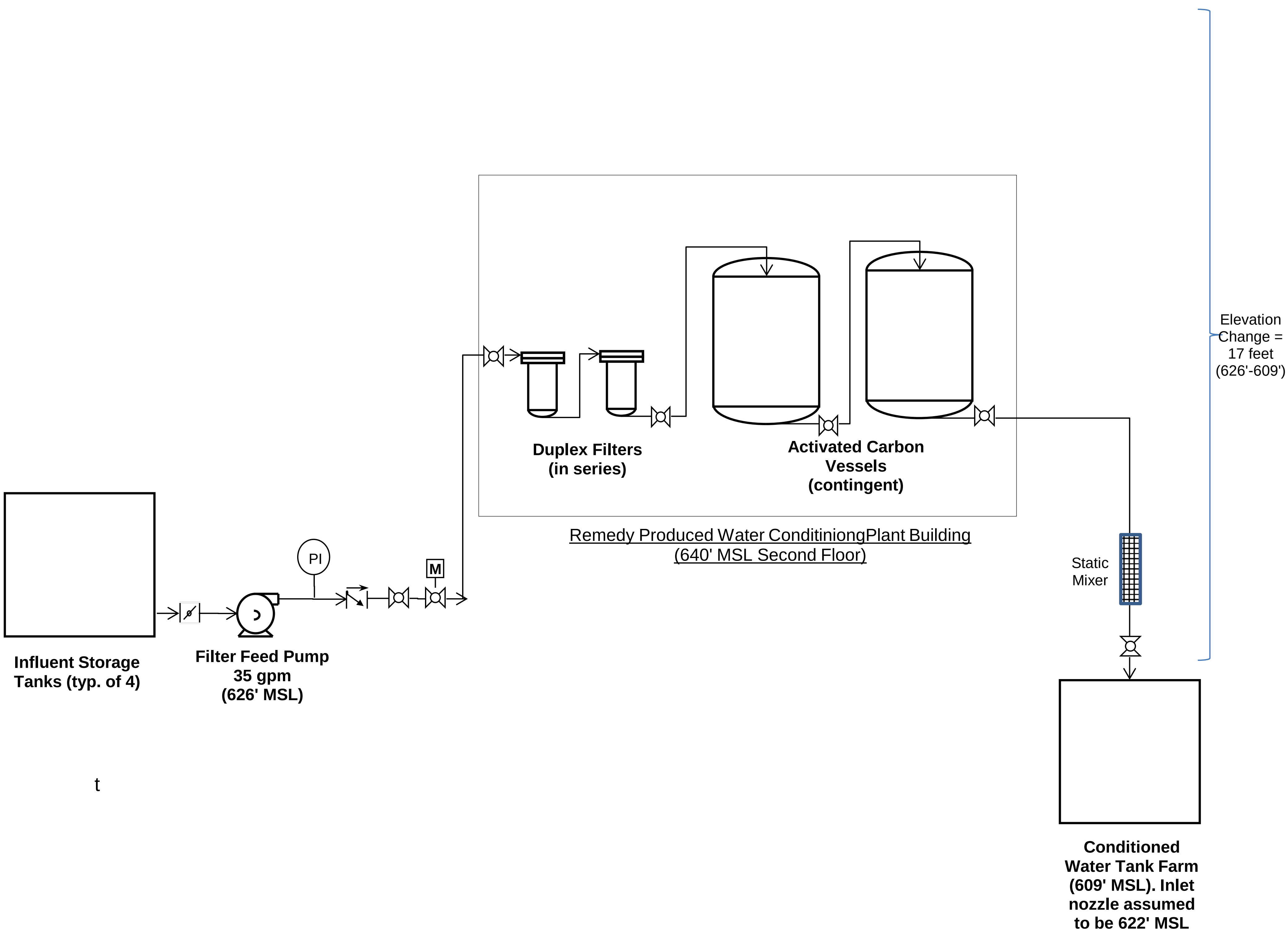
DIFFERENTIAL HEAD AND POWER CALCULATION

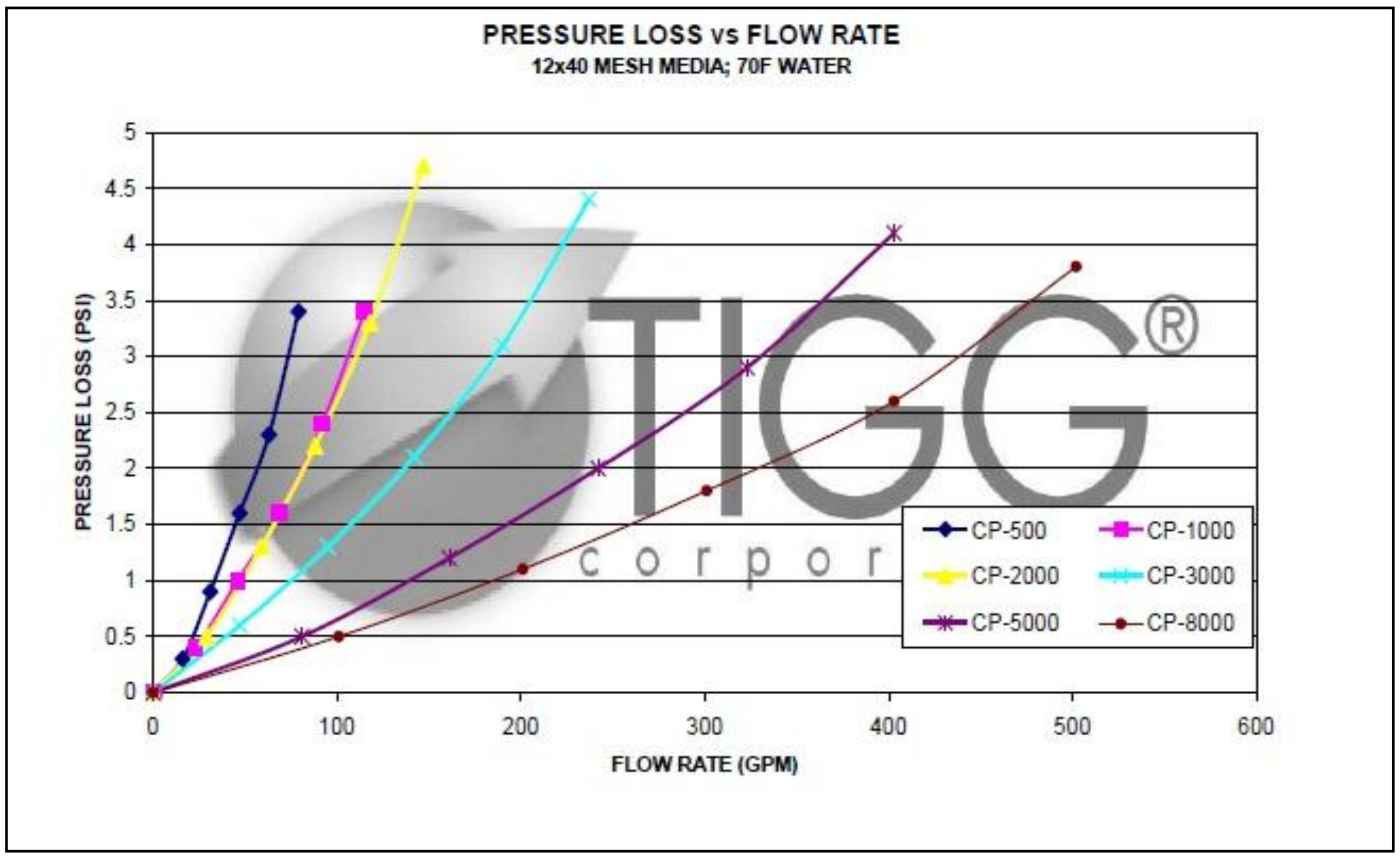
DESIGN SUCTION PRESSURE, PSIA	13.4
TOTAL DIFFERENTIAL PRESSURE, PSI	19.5
TOTAL DIFFERENTIAL HEAD, FT	45
OVERALL LOSS SAFETY FACTOR, % (e.g., 10 %)	5%
CORRECTED DIFFERENTIAL HEAD, FT	**47**
CORRECTED DIFFERENTIAL PRESS, PSI	**20.3**
HYDRAULIC HORSEPOWER, HP	0.4
PUMP EFFICIENCY, % (e.g., 50%)	50%
BRAKE HORSEPOWER, BHP (water only)	0.8
MIN. PUMP CASING DESIGN PRESSURE, PSIG	24.7

NET POSITIVE SUCTION HEAD CALCULATION (NPSHa)

MINIMUM SYSTEM INITIAL PRESSURE, PSIA	14.7
MINIMUM STATIC HEAD, PSI	0.0
LINE FRICTION LOSS AT DESIGN FLOW, PSI	1.3
OTHER LOSSES, NET, PSI	0.0
LIQUID VAPOR PRESSURE, PSIA	0.6
NET POSITIVE SUCTION HEAD AVAILABLE, PSIA	12.8
NET POSITIVE SUCTION HEAD AVAILABLE, FT.	30
NPSHa SAFETY FACTOR, FT.	3
CORRECTED NPSHa, FT.	**26.7**

Job Name:	TOPOCK GROUNDWATER TREATMENT	Sheet No	2
Subject:	Pump Calculation	Date:	10 05 2011
Job No.:	415087.01.05.02	Computed By:	CHRIS ABDULJABBAR
		Checked By:	JOHN PORCELLA





2

Figure -1-CARBON VESSEL PRESSURE DROP CURVE

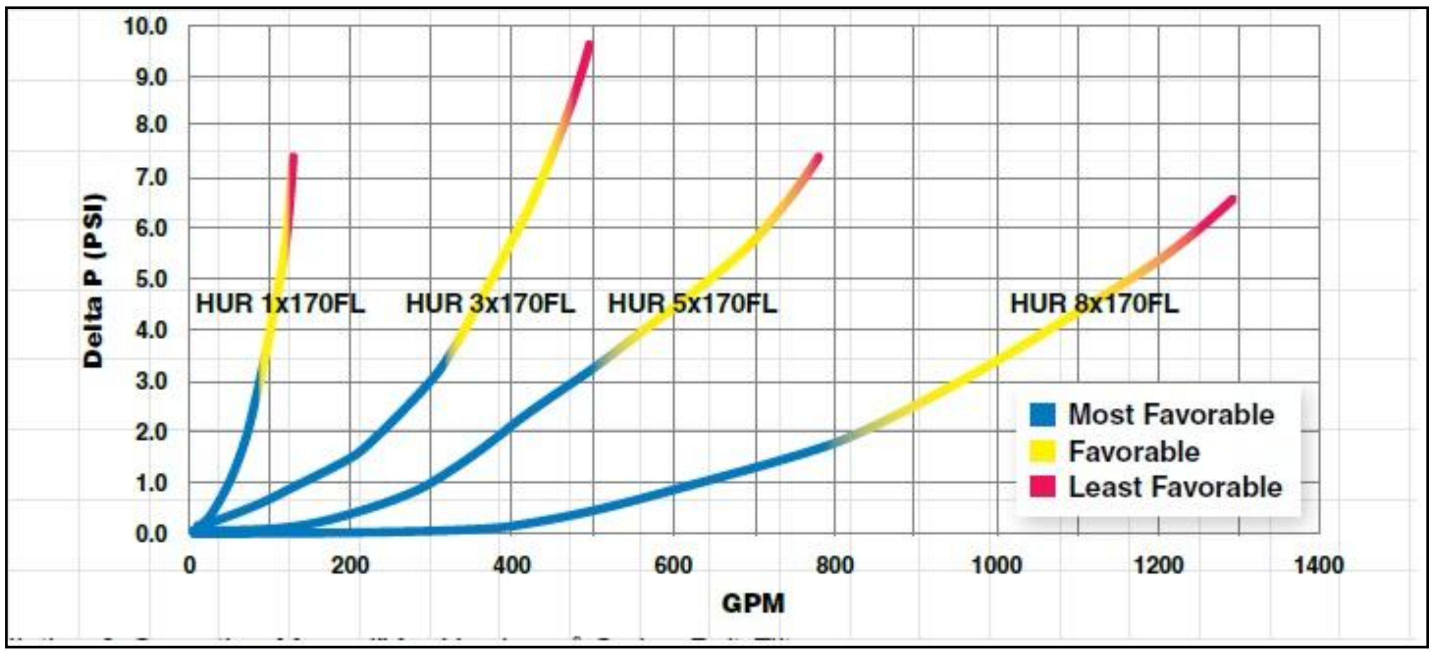


Figure -2-CARTRIDGE FILTER PRESSURE DROP CURVE

Technical Specifications

Model Number	Pipe Dia. MNPT Ends	Number of Elements	Length	Weight	Max. Working Pressure (PSI @ 75°F)	Typical Flow (GPM)	Pressure Loss (PSI)
3/8-40C-4-6-2	3/8"	6	6-1/2"	1.3 oz	310	.4 - 3	.25 - 11.25
3/8-40C-4-12-2	3/8"	12	11"	2.1 oz	310	.4 - 3	.50 - 22.5
1/2-40C-4-6-2	1/2"	6	7"	2.1 oz	300	.65 - 5	.25 - 10
1/2-40C-4-12-2	1/2"	12	12"	3.3 oz	300	.65 - 5	.50 - 20
3/4-40C-4-6-2	3/4"	6	9"	3.7 oz	240	1.5 - 12	.25 - 11
3/4-40C-4-12-2	3/4"	12	15"	5.8 oz	240	1.5 - 12	.50 - 22
1-40C-4-6-2	1"	6	11"	6.5 oz	220	2.5 - 16	.30 - 11.75
1-40C-4-12-2	1"	12	18"	9.9 oz	220	2.5 - 16	.60 - 23.5
1.25-40C-4-6-2	1-1/4"	6	14"	12.2 oz	180	4 - 32	.25 - 13.5
1.25-40C-4-12-2	1-1/4"	12	25"	18.3 oz	180	4 - 32	.50 - 27
1.5-40C-4-6-2	1-1/2"	6	15"	14.8 oz	170	6 - 40	.25 - 12.25
1.5-40C-4-12-2	1-1/2"	12	28"	25.4 oz	170	6 - 40	.50 - 24.5
2-40C-4-6-2	2"	6	19"	25 oz	140	9 - 60	.25 - 9.25
2-40C-4-12-2	2"	12	35"	43 oz	140	9 - 60	.50 - 18.5

309 Cary Point DriveCary, IL, 60013
Phone 847-516-3700 | Fax 847-516-3724 | Toll Free 1-800-782-8427

Pressure loss shown is shown as a linear function of flowrate at 0.0278 psi/gpm. For 35 gpm this is 0.97 psi.

Figure -3-STATIC MIXER PRESSURE DROP CHART (see 2" 6 element unit)

CH2MHILL	**Job Name:** TOPOCK GROUNDWATER TREATMENT	**Sheet No.:** 4	
	Subject: Pump Calculation	**Date:** 10 05 2011	
	Job No.: 415087.01.05.02	**Computed By:** CHRIS ABDULJABBAR	
		Checked By: JOHN PORCELLA	

Assumptions:

1. Process piping will be Schedule 80 CPVC. Schedule 40 steel assumed for calculation.
2. Pump location will be 615 feet from Tank Farm.
3. Filter pressure drop based on Harmsco HUR 1x170 curves (see separate sheet) with a combined value of 2.5 psi. Assume 0.5 psi for 20 micron cartridge and 2 psi for 5 micron cartridge.
4. Activated carbon vessel are assumed to be conditionally needed. Vessel pressure drop based on TIGG pressure drop curves for CP-500 vessels (2 in series) with a combined value of 2.5 psi.
5. Pump elevation 626' MSL, Filter housing height 644 MSL. Conditioned Water Tank Nozzle elevation 609' + 13' = 622' MSL.

Results:

This spreadsheet shows a TDH of 41 feet. However, the local high point is in the Remedy Produced Water Conditioning Building which has a peak elevation of 644 ft MSL. A separate spreadsheet (PDF follows this page) shows a TDH of 47 feet TDH. Therefore this value is used for pump selection

PUMP CALCULATION SHEET

CH2MHILL

Pump2K Version 1.2

PROJECT NO. :	435062.01.13.04	BY:	J. Porcella	DATE:	23-Aug-14
CLIENT:	PG&E	CHECKED:	W. Farmer	DATE:	28-Aug-14
EQUIPMENT NO(S):	PMP-310/320	REVISION NO.:	3	DATE:	03-Sep-14 BY: JP
SERVICE:	Remedy Water	FLUID:	Groundwater	PFD #:	
LOCATION:	Influent Tank Farm	NO. PUMPS REQ'D:	2	P&ID #:	I-12-01 & I-14-01

DESIGN DATA			NORMAL OPERATING DATA	
DGN FLOW, GPM	35	PUMPS FROM:	NORMAL FLOW,GPM	20
SG, DESIGN TEMP	0.9962	Influent Tank Farm	SG, NORMAL TEMP	0.9962
DEN @ D T, LB/FT3	62.16288		DEN @ N T, LB/FT3	62.16288
VISC. @ D T, CP	0.813	PUMPS TO:	VISC. @ N T, CP	0.813
VAP P @ D T, PSIA	0.6	Filters & Conditioned Water Tank Farm	VAP P @ N T, PSIA	0.6
DGN TEMP, DEG F	85		NORM. TEMP, DEG F	85

INPUT:	SUCTION PIPING DATA			DISCHARGE PIPING DATA		
NOMINAL SIZE, IN.	2.00	<-enter piping & fitting data		2.00	<-enter piping & fitting data	
SCHEDULE	40			40		
ACTUAL I.D., IN.	2.067			2.067		
FITTINGS	NO.	K *	DP, PSI	NO.	K *	DP, PSI
ELBOWS, 90 LR	3	0.31	0.07	10	0.31	0.23
ELBOWS, 45 LR		0.23	0.00		0.23	0.00
TEES, THRU	5	0.74	0.28	0	0.74	0.00
TEES, BRANCH	2	1.20	0.18	5	1.20	0.45
BALL VALVES	2	0.23	0.03	7	0.23	0.12
BUTTERFLY VALVES	1	0.38	0.03	1	0.38	0.03
GATE VALVES		0.15	0.00	0	0.15	0.00
GLOBE VALVES		5.96	0.00	0	5.96	0.00
CHECK VALVES		2.25	0.00	1	2.25	0.17
PLUG VALVES		0.39	0.00	0	0.39	0.00
PIPE ENTRANCE	1	0.50	0.04			
PIPE EXIT				1	1.00	0.07
OTHER			0.00			0.00
LIN. FT OF PIPE	55		0.55	166		1.66
OTHER, EQ FT			0.00			0.00
CONTINGENCY, %	20%			20%		
CONTINGENCY, FT	11.0		0.11	33		0.33
TOTAL EQ FT	129			307		
DP TOTAL, PSI			1.29			3.06

	CALCULATED SUCTION DATA	CALCULATED DISCHARGE DATA
PIPE I.D., IN	2.067	2.067
X-SECT AREA,FT2	0.0233	0.0233
DGN FLOW, LB/HR	17,434	17,434
VELOCITY, FT/SEC	3.34	3.34
REYNOLDS NUM	65,463	65,463
DARCY FRI FACT	0.02296	0.02296
FRICT DP, PSI/100'	1.00	1.00

* CALCULATION OF K FACTOR BASED ON 2-K METHOD.

NOTES:

See "Key assumptions" worksheet.

PUMP SUCTION CONDITIONS		
MINIMUM SYSTEM INITIAL PRES., PSIA		14.7
STATIC HEAD (+) OR LIFT (-), FT		0
STATIC HEAD (+) OR LIFT (-), PSI		0.0
LINE FRICTION LOSS, PSI		1.3
EQUIPMENT LOSS, PSI		
MISC LOSS, PSI		
DESIGN SUCTION PRES., PSIA		13.4

PUMP DISCHARGE CONDITIONS		
MAX. SYSTEM TERMINAL PRES., PSIA		14.7
STATIC HEAD DIFFERENCE, FT		18
STATIC HEAD DIFFERENCE, PSI		7.8
TOTAL FIXED LOSSES, PSIA		22.5
LINE FRICTION LOSS, PSI		3.1
EQUIPMENT LOSS, PSI	GAC Vessels	2.5
EQUIPMENT LOSS, PSI	Cartridge Filters	2.5
MISCELLANEOUS LOSS, PSI	Flow meter	2.0
MISCELLANEOUS LOSS, PSI	Static mixer	0.0
TOTAL VARIABLE LOSS, PSI		10.1
TOTAL FIXED AND VARIABLE LOSS, PSIA		32.5
ALLOWED CONTROL VALVE PRES. DROP , PSI		
DISCHARGE PRESSURE, PSIA		32.5
CORRECTED DISCHARGE PRESSURE, PSIA		**33.7**

DIFFERENTIAL HEAD AND POWER CALCULATION	
DESIGN SUCTION PRESSURE, PSIA	13.4
TOTAL DIFFERENTIAL PRESSURE, PSI	19.1
TOTAL DIFFERENTIAL HEAD, FT	44
OVERALL LOSS SAFETY FACTOR, % (e.g., 10 %)	10%
CORRECTED DIFFERENTIAL HEAD, FT	**47**
CORRECTED DIFFERENTIAL PRESS, PSI	**20.2**
HYDRAULIC HORSEPOWER, HP	0.4
PUMP EFFICIENCY, % (e.g., 50%)	50%
BRAKE HORSEPOWER, BHP (water only)	0.8
MIN. PUMP CASING DESIGN PRESSURE, PSIG	24.3

NET POSITIVE SUCTION HEAD CALCULATION (NPSHa)	
MINIMUM SYSTEM INITIAL PRESSURE, PSIA	14.7
MINIMUM STATIC HEAD, PSI	0.0
LINE FRICTION LOSS AT DESIGN FLOW, PSI	1.3
OTHER LOSSES, NET, PSI	0.0
LIQUID VAPOR PRESSURE, PSIA	0.6
NET POSITIVE SUCTION HEAD AVAILABLE, PSIA	12.8
NET POSITIVE SUCTION HEAD AVAILABLE, FT.	30
NPSHa SAFETY FACTOR, FT.	3
CORRECTED NPSHa, FT.	**26.7**

This calculation extends to local high point in the Remedy Produced Water Conditioning Building. See also previous page.

CH2MHILL

JOB NO.: 415087.01.05.02
SHEET NO.: 1
DATE: 10 05 2011

JOB NAME: TOPOCK GROUNDWATER TREATMENT
COMPUTED BY CHRIS ABDULJABBAR
SUBJECT: Pump Calculation
CHECKED BY: JOHN PORCELLA

REVISION HISTORY:

Rev. No.	Date	By	Approved	Notes
1	10/05/11	C. Abduljabbar	John Porcella	Prelim. sizing for determining elec. load.
2	06/30/12	R Harris	John Porcella	Update to include changed Conditioned Water Storage Tank Location
3	09/03/14	J. Porcella	John Porcella	Update to include changed Conditioned Water Storage Tank Location

OWNER:
CH2M HILL Energy and Chemicals **Discipline:** Process

CH2MHILL

PUMP CALCULATION SHEET

Pump2K Version 1.2

PROJECT NO. :	435062.01.13.04	BY:	J. Porcella	DATE:	23-Aug-14
CLIENT:	PG&E	CHECKED:	W. Farmer	DATE:	28-Aug-14
EQUIPMENT NO(S):	PMP-320/340	REVISION NO.:	3	DATE:	03-Sep-14 BY: JP
SERVICE:	Remedy Water	FLUID:	Groundwater	PFD #:	
LOCATION:	Influent Tank Farm	NO. PUMPS REQ'D:	2	P&ID #:	I-12-02 & I-14-02

DESIGN DATA			NORMAL OPERATING DATA	
DGN FLOW, GPM	35	PUMPS FROM:	NORMAL FLOW,GPM	20
SG, DESIGN TEMP	0.9962	Influent Tank Farm	SG, NORMAL TEMP	0.9962
DEN @ D T, LB/FT3	62.16288		DEN @ N T, LB/FT3	62.16288
VISC. @ D T, CP	0.813	PUMPS TO:	VISC. @ N T, CP	0.813
VAP P @ D T, PSIA	0.6	Filters & Conditioned	VAP P @ N T, PSIA	0.6
DGN TEMP, DEG F	85	Water Storage Tank	NORM. TEMP, DEG F	85

INPUT:	SUCTION PIPING DATA			DISCHARGE PIPING DATA		
NOMINAL SIZE, IN.	2.00	<-enter piping		2.00	<-enter piping	
SCHEDULE	40	& fitting data		40	& fitting data	
ACTUAL I.D., IN.	2.067			2.067		
FITTINGS	NO.	K *	DP, PSI	NO.	K *	DP, PSI
ELBOWS, 90 LR	1	0.31	0.02	10	0.31	0.23
ELBOWS, 45 LR		0.23	0.00		0.23	0.00
TEES, THRU	4	0.74	0.22	4	0.74	0.22
TEES, BRANCH	1	1.20	0.09	1	1.20	0.09
BALL VALVES	1	0.23	0.02	1	0.23	0.02
BUTTERFLY VALVES		0.38	0.00	1	0.38	0.03
GATE VALVES		0.15	0.00	2	0.15	0.02
GLOBE VALVES		5.96	0.00	1	5.96	0.45
CHECK VALVES		2.25	0.00	2	2.25	0.34
PLUG VALVES		0.39	0.00	0	0.39	0.00
PIPE ENTRANCE	1	0.50	0.04			
PIPE EXIT				1	1.00	0.07
OTHER			0.00			0.00
LIN. FT OF PIPE	50		0.50	405		4.04
OTHER, EQ FT			0.00			0.00
CONTINGENCY, %	40%			40%		
CONTINGENCY, FT	20.0		0.20	162		1.62
TOTAL EQ FT	109			714		
DP TOTAL, PSI			1.09			7.13

	CALCULATED SUCTION DATA	CALCULATED DISCHARGE DATA
PIPE I.D., IN	2.067	2.067
X-SECT AREA,FT2	0.0233	0.0233
DGN FLOW, LB/HR	17,434	17,434
VELOCITY, FT/SEC	3.34	3.34
REYNOLDS NUM	65,463	65,463
DARCY FRI FACT	0.02296	0.02296
FRICT DP, PSI/100'	1.00	1.00

* CALCULATION OF K FACTOR BASED ON 2-K METHOD.

NOTES:

See "Key assumptions" worksheet.

PUMP SUCTION CONDITIONS

MINIMUM SYSTEM INITIAL PRES., PSIA		14.7
STATIC HEAD (+) OR LIFT (-), FT		2
STATIC HEAD (+) OR LIFT (-), PSI		0.9
LINE FRICTION LOSS, PSI		1.1
EQUIPMENT LOSS, PSI		
MISC LOSS, PSI		
DESIGN SUCTION PRES., PSIA		14.5

PUMP DISCHARGE CONDITIONS

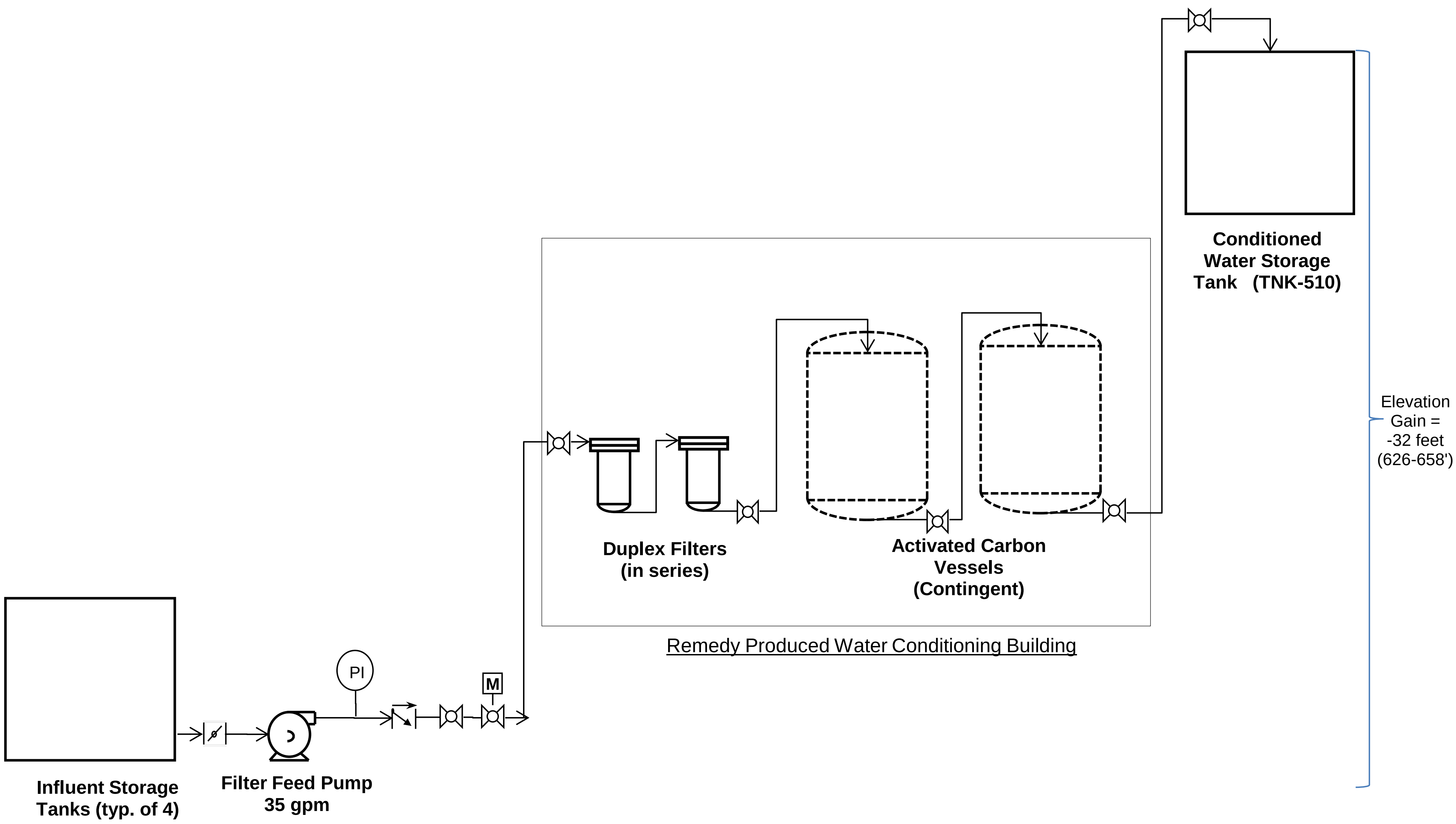
MAX. SYSTEM TERMINAL PRES., PSIA		14.7
STATIC HEAD DIFFERENCE, FT		35
STATIC HEAD DIFFERENCE, PSI		15.1
TOTAL FIXED LOSSES, PSIA		29.8
LINE FRICTION LOSS, PSI		7.1
EQUIPMENT LOSS, PSI	GAC Vessels	2.5
EQUIPMENT LOSS, PSI	Cartridge Filters	2.5
MISCELLANEOUS LOSS, PSI	Flow meter	2.0
MISCELLANEOUS LOSS, PSI		0.0
TOTAL VARIABLE LOSS, PSI		14.1
TOTAL FIXED AND VARIABLE LOSS, PSIA		43.9
ALLOWED CONTROL VALVE PRES. DROP , PSI		
DISCHARGE PRESSURE, PSIA		43.9
CORRECTED DISCHARGE PRESSURE, PSIA		**45.4**

DIFFERENTIAL HEAD AND POWER CALCULATION

DESIGN SUCTION PRESSURE, PSIA	14.5
TOTAL DIFFERENTIAL PRESSURE, PSI	29.5
TOTAL DIFFERENTIAL HEAD, FT	68
OVERALL LOSS SAFETY FACTOR, % (e.g., 10 %)	10%
CORRECTED DIFFERENTIAL HEAD, FT	**72**
CORRECTED DIFFERENTIAL PRESS, PSI	**30.9**
HYDRAULIC HORSEPOWER, HP	0.6
PUMP EFFICIENCY, % (e.g., 50%)	50%
BRAKE HORSEPOWER, BHP (water only)	1.3
MIN. PUMP CASING DESIGN PRESSURE, PSIG	38.0

NET POSITIVE SUCTION HEAD CALCULATION (NPSHa)

MINIMUM SYSTEM INITIAL PRESSURE, PSIA	14.7
MINIMUM STATIC HEAD, PSI	0.9
LINE FRICTION LOSS AT DESIGN FLOW, PSI	1.1
OTHER LOSSES, NET, PSI	0.0
LIQUID VAPOR PRESSURE, PSIA	0.6
NET POSITIVE SUCTION HEAD AVAILABLE, PSIA	13.9
NET POSITIVE SUCTION HEAD AVAILABLE, FT.	32
NPSHa SAFETY FACTOR, FT.	3
CORRECTED NPSHa, FT.	**29.2**



Conditioned
Water Storage
Tank (TNK-510)
Elevation
Gain =
-32 feet
(626-658')
Duplex Filters
(in series)
Activated Carbon
Vessels
(Contingent)
Remedy Produced Water Conditioning Building
PI
M
Influent Storage
Tanks (typ. of 4)
Filter Feed Pump
35 gpm

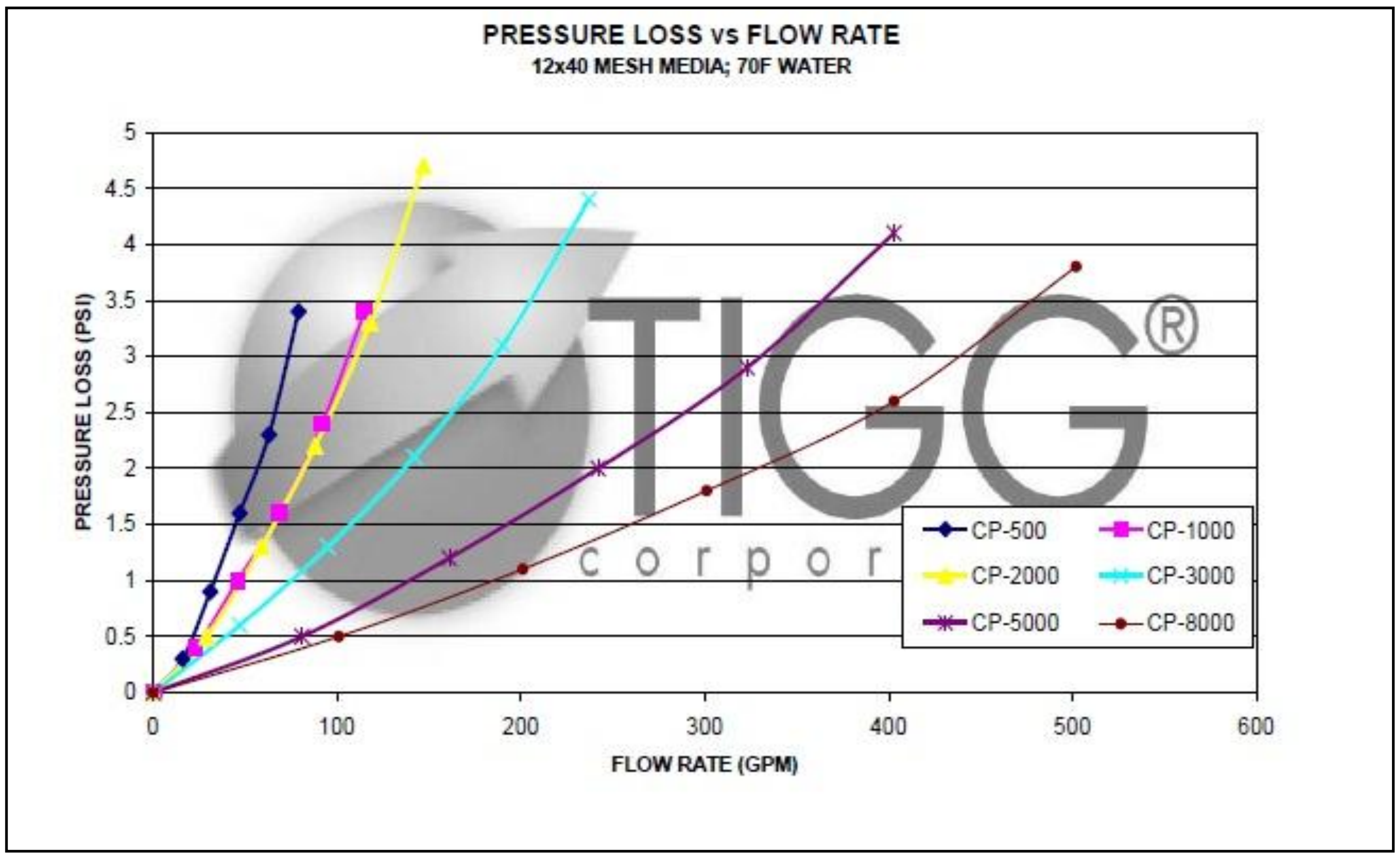


Figure -1-CARBON VESSEL PRESSURE DROP CURVE

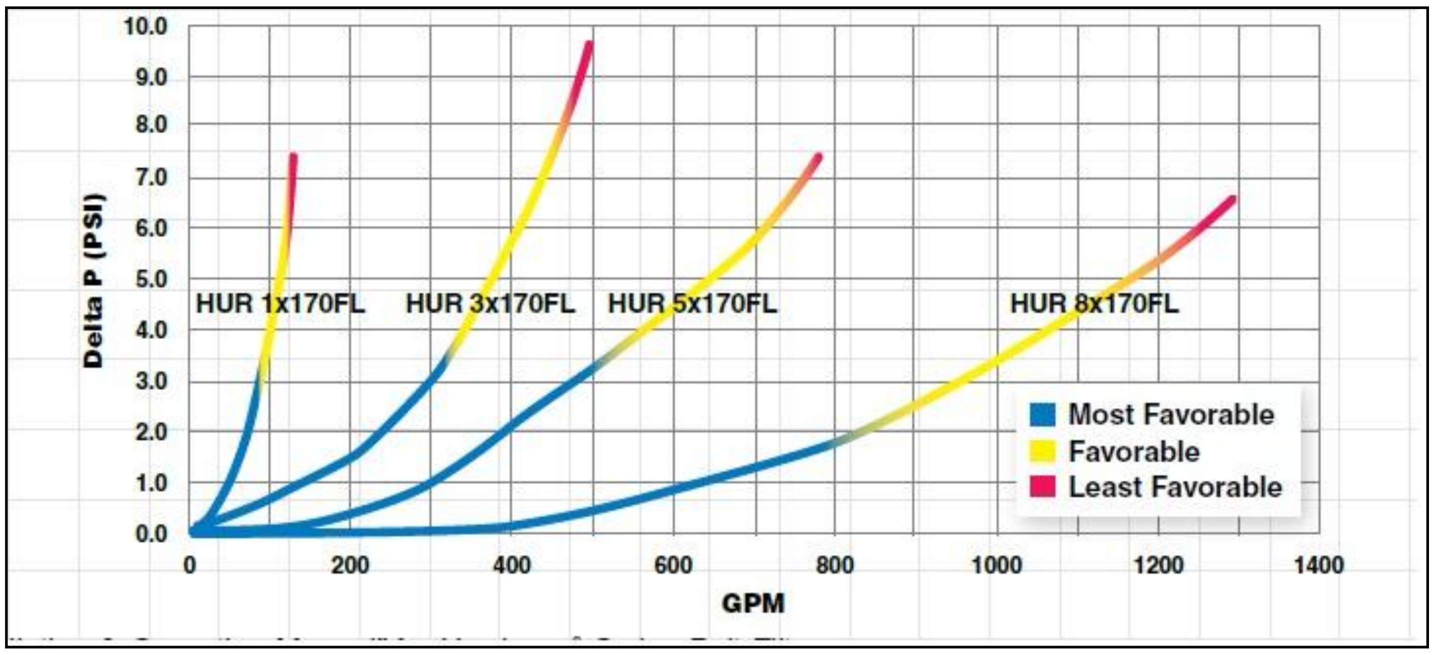


Figure -2-CARTRIDGE FILTER PRESSURE DROP CURVE

CH2MHILL

Job Name:	TOPOCK GROUNDWATER TREATMENT	**Sheet No.:**	4
Subject:	Pump Calculation	**Date:**	10 05 2011
Job No.:	415087.01.05.02	**Computed By:**	CHRIS ABDULJABBAR
		Checked By:	JOHN PORCELLA

Assumptions:

1. Process piping will be Schedule 80 CPVC. Schedule 40 steel assumed for calculation.
2. Pump location will be approx. 400 feet from Conditioned Water Storage Tank (TNK-510). Additional distance included for pipes going between 1st and 2nd floors and to enter TNK-510.
3. Filter pressure drop based on Harmsco HUR 1x170 curves (see separate sheet) with a combined value of 2.5 psi. Assume 0.5 psi for 20 micron cartridge and 2 psi for 5 micron cartridge.
4. Activated carbon vessel are assumed to be conditionally needed. Vessel pressure drop based on TIGG pressure drop curves for CP-500 vessels (2 in series) with a combined value of 2.5 psi.

CH2MHILL

JOB NO.: 435062.01.13.04

SHEET NO.: 1

DATE: 10 05 2011

JOB NAME: TOPOCK GROUNDWATER TREATMENT

COMPUTED BY CHRIS ABDULJABBAR

SUBJECT: Pump Calculation

CHECKED BY: JOHN PORCELLA

REVISION HISTORY:

Rev. No.	Date	By	Approved	Notes
1	10/05/11	C. Abduljabbar	John Porcella	Prelim. sizing for determining elec. load.
2	07/30/12	R Harris	John Porcella	Update to include revised equipment layouts
3	08/01/14	J Porcella	John Porcella	Update to include revised equipment layouts

OWNER:

CH2M HILL Energy and Chemicals **Discipline:** Process

CH2MHILL

PUMP CALCULATION SHEET

Pump2K Version 1.2

PROJECT NO. :	435062.01.13.04	BY:	J. Porcella	DATE:	23-Aug-14	
CLIENT:	PG&E	CHECKED:	W. Farmer	DATE:	28-Aug-14	
EQUIPMENT NO(S):	PMP-405/406	REVISION NO.:	3	DATE:	03-Sep-14	BY: JP
SERVICE:	Remedy Water	FLUID:	Groundwater	PFD #:		
LOCATION:	Conditioned Water Tank Farm	NO. PUMPS REQ'D:	2	P&ID #:	I-14-01	

DESIGN DATA / NORMAL OPERATING DATA

DESIGN DATA			NORMAL OPERATING DATA	
DGN FLOW, GPM	35	PUMPS FROM:	NORMAL FLOW,GPM	20
SG, DESIGN TEMP	0.9962	Conditioned Water Tank Farm	SG, NORMAL TEMP	0.9962
DEN @ D T, LB/FT3	62.16288		DEN @ N T, LB/FT3	62.16288
VISC. @ D T, CP	0.813	PUMPS TO:	VISC. @ N T, CP	0.813
VAP P @ D T, PSIA	0.6	See Key Assumptions	VAP P @ N T, PSIA	0.6
DGN TEMP, DEG F	85		NORM. TEMP, DEG F	85

INPUT: SUCTION PIPING DATA / DISCHARGE PIPING DATA

INPUT:	SUCTION PIPING DATA			DISCHARGE PIPING DATA		
NOMINAL SIZE, IN.	2.00	<-enter piping		2.00	<-enter piping	
SCHEDULE	40	& fitting data		40	& fitting data	
ACTUAL I.D., IN.	2.067			2.067		
FITTINGS	NO.	K *	DP, PSI	NO.	K *	DP, PSI
ELBOWS, 90 LR	3	0.31	0.07	6	0.31	0.14
ELBOWS, 45 LR		0.23	0.00	6	0.23	0.10
TEES, THRU	2	0.74	0.11	2	0.74	0.11
TEES, BRANCH	2	1.20	0.18	5	1.20	0.45
BALL VALVES	1	0.23	0.02	2	0.23	0.03
BUTTERFLY VALVE	2	0.38	0.06	0	0.38	0.00
GATE VALVES		0.15	0.00	0	0.15	0.00
GLOBE VALVES		5.96	0.00	0	5.96	0.00
CHECK VALVES		2.25	0.00	1	2.25	0.17
PLUG VALVES		0.39	0.00	0	0.39	0.00
PIPE ENTRANCE	1	0.50	0.04			
PIPE EXIT				1	1.00	0.07
OTHER			0.00			0.00
LIN. FT OF PIPE	70		0.70	400		3.99
OTHER, EQ FT			0.00			0.00
CONTINGENCY, %	25%			25%		
CONTINGENCY, FT	17.5		0.17	100		1.00
TOTAL EQ FT	135			608		
DP TOTAL, PSI			1.35			6.07

CALCULATED SUCTION DATA / CALCULATED DISCHARGE DATA

	CALCULATED SUCTION DATA	CALCULATED DISCHARGE DATA
PIPE I.D., IN	2.067	2.067
X-SECT AREA,FT2	0.0233	0.0233
DGN FLOW, LB/HR	17,434	17,434
VELOCITY, FT/SEC	3.34	3.34
REYNOLDS NUM	65,463	65,463
DARCY FRI FACT	0.02296	0.02296
FRICT DP, PSI/100'	1.00	1.00

* CALCULATION OF K FACTOR BASED ON 2-K METHOD.

NOTES:

See "Key assumptions" worksheet.

PUMP SUCTION CONDITIONS

MINIMUM SYSTEM INITIAL PRES., PSIA		14.7
STATIC HEAD (+) OR LIFT (-), FT		0
STATIC HEAD (+) OR LIFT (-), PSI		0.0
LINE FRICTION LOSS, PSI		1.3
EQUIPMENT LOSS, PSI		
MISC LOSS, PSI		
DESIGN SUCTION PRES., PSIA		13.4

PUMP DISCHARGE CONDITIONS

MAX. SYSTEM TERMINAL PRES., PSIA		14.7
STATIC HEAD DIFFERENCE, FT		27
STATIC HEAD DIFFERENCE, PSI		11.6
TOTAL FIXED LOSSES, PSIA		26.3
LINE FRICTION LOSS, PSI		6.1
EQUIPMENT LOSS, PSI		0.0
EQUIPMENT LOSS, PSI		0.0
MISCELLANEOUS LOSS, PSI	Flow meter	2.0
MISCELLANEOUS LOSS, PSI		0.0
TOTAL VARIABLE LOSS, PSI		8.1
TOTAL FIXED AND VARIABLE LOSS, PSIA		34.4
ALLOWED CONTROL VALVE PRES. DROP , PSI		
DISCHARGE PRESSURE, PSIA		34.4
CORRECTED DISCHARGE PRESSURE, PSIA		**35.4**

DIFFERENTIAL HEAD AND POWER CALCULATION

DESIGN SUCTION PRESSURE, PSIA	13.4
TOTAL DIFFERENTIAL PRESSURE, PSI	21.1
TOTAL DIFFERENTIAL HEAD, FT	49
OVERALL LOSS SAFETY FACTOR, % (e.g., 10 %)	10%
CORRECTED DIFFERENTIAL HEAD, FT	**51**
CORRECTED DIFFERENTIAL PRESS, PSI	**22.0**
HYDRAULIC HORSEPOWER, HP	0.4
PUMP EFFICIENCY, % (e.g., 50%)	50%
BRAKE HORSEPOWER, BHP (water only)	0.9
MIN. PUMP CASING DESIGN PRESSURE, PSIG	26.6

NET POSITIVE SUCTION HEAD CALCULATION (NPSHa)

MINIMUM SYSTEM INITIAL PRESSURE, PSIA	14.7
MINIMUM STATIC HEAD, PSI	0.0
LINE FRICTION LOSS AT DESIGN FLOW, PSI	1.3
OTHER LOSSES, NET, PSI	0.0
LIQUID VAPOR PRESSURE, PSIA	0.6
NET POSITIVE SUCTION HEAD AVAILABLE, PSIA	12.8
NET POSITIVE SUCTION HEAD AVAILABLE, FT.	30
NPSHa SAFETY FACTOR, FT.	3
CORRECTED NPSHa, FT.	**26.6**

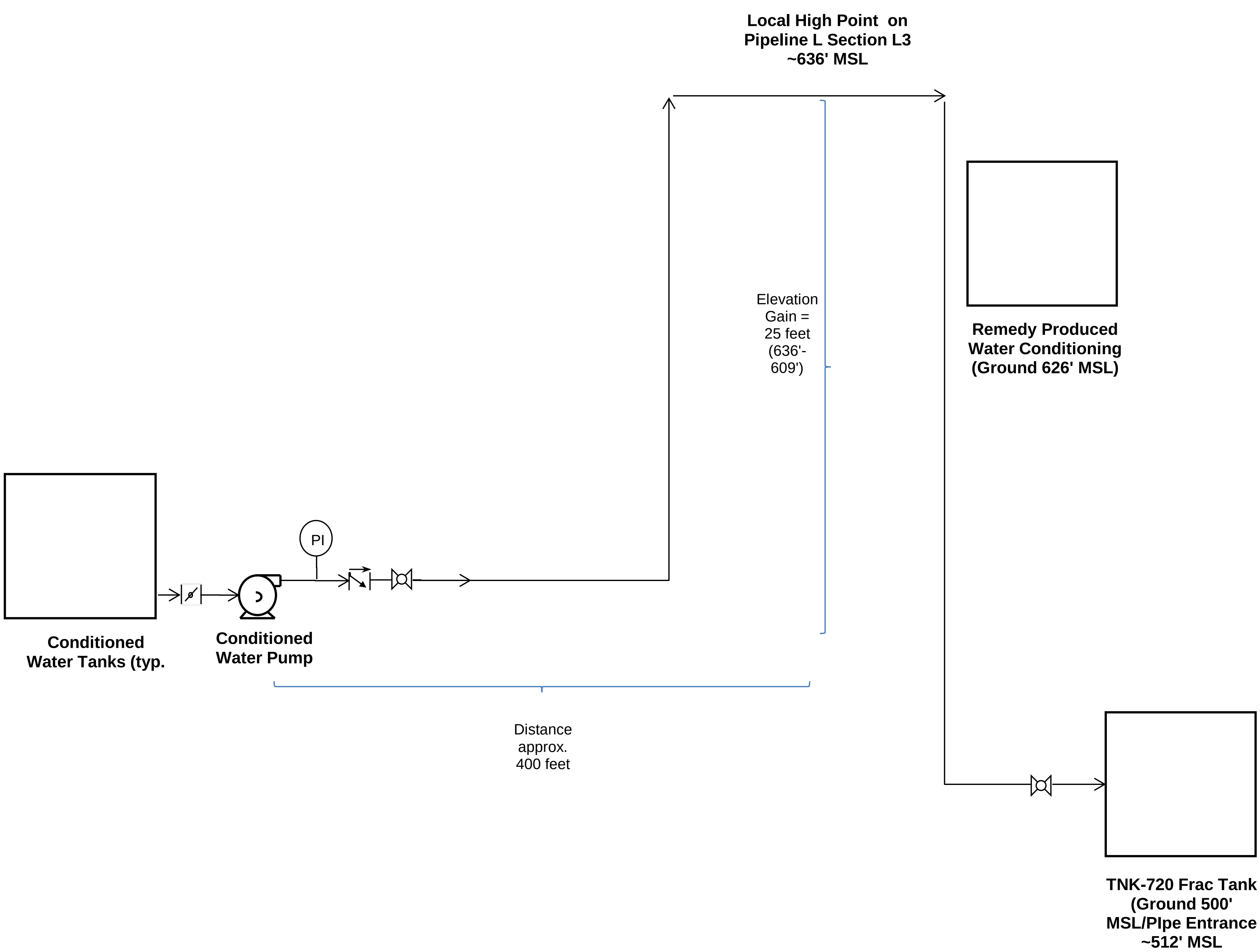
CH2MHILL

Job Name: TOPOCK GROUNDWATER TREATMENT **Sheet No** 2

Subject: Pump Calculation **Date:** 10 05 2011

Job No.: 435062.01.13.04 **Computed By:** CHRIS ABDULJABBAR

Checked By: JOHN PORCELLA



CH2MHILL

Job Name: TOPOCK GROUNDWATER TREATMENT	**Sheet No.:** 3
Subject: Pump Calculation	**Date:** 10 05 2011
Job No.: 435062.01.13.04	**Computed By:** CHRIS ABDULJABBAR
	Checked By: JOHN PORCELLA

Assumptions:

1. Process piping will be Schedule 80 CPVC. Schedule 40 steel assumed for calculation.
2. Pump location in Conditioned Water Tank Farm (609' MSL) approx. 530 feet from Remedy Produced Water Conditioning Bldg. (626' MSL)
3. Water destination is TNK-720 at MW-20 Bench located at Elevation 500' MSL. High point on pipeline is located on the Compressor Station Tank Farm is at 636' MSL on Pipeline L. Station entrance elevation approximately 615' MSL. Therefore, once water flows past high point (approx. 400'') it is largely controlled by gravity and the calculation can be terminated . Due to the elevation difference an air vacuum release valve was added at the high point.

Remedy-produced Water Conditioning Process—Eductor Sizing

CH2MHILL Lockwood Greene

— CALCULATION SHEET —

COMPUTED BY:	**R. Harris**		
REVISION No.:		DATE:	**02-Jul-2012**
REV. COMMENT			
CHECKED BY:	**W.L. Ross**		
LOCATION:	**Needles, CA**		
PROJECT NAME	**Topock Groundwater Remediation**		
PROJECT No:	**435062**		

CLIENT: **PG&E**

SUBJECT: **Influent Tank Eductor and Recirc Pump Sizing**

Eductor Sizing Basis:

Tank Diameter is 8'

Tank Volume: 21,000 gal

Tank Volume: 2,807 ft^3

Assume 30 minute mix and 3 tank turnovers *check of mix time = 25.7 minutes*

Induced flow = 2100 gpm

Volume for 3 Tank Turnovers = 63,000 per 2 eductors (or 31,500 gal/eductor)

Eductor Sizing:

Scenarios: 2", 3", and 4" Eductors
20 psi, 30 psi, 40 psi, and 50 psi drop across Eductors

Eductor Size*	DP*	Max Plume*	Motive Liq. In*	Out of Eductor*	Complete Mix**
2 in	20 psi	23 ft	87.2 gpm	436 gpm	1200 gpm
3 in	20 psi	34 in	201 gpm	1003 gpm	1200 gpm
2 in	30 psi	34 in	107 gpm	534 gpm	1200 gpm
3 in	**30 psi**	**51 in**	**246 gpm**	**1228 gpm**	**1200 gpm**
4 in	30 psi	60 in	427 gpm	2136 gpm	1200 gpm
2 in	40 psi	48 in	123 gpm	616 gpm	1200 gpm
3 in	40 psi	73 in	283 gpm	1417 gpm	1200 gpm
3 in	50 psi	99 in	317 gpm	1585 gpm	1200 gpm
4 in	40 psi	95 in	493 gpm	2448 gpm	1200 gpm

* Data from www.jrgjt.com

** Complete mix assumed after 3 tank turnovers per Bill Ross.

Tank width is 8ft (96")

Using a 3" eductor

Nozzles Needed = 2

Pump to handle 492 gpm at 82 psi

Check Mix time =

Based on data above, we can use two 3" nozzles per tank.

Recirculation pump to handle 492 gpm at 82 psi (See pump Calc)

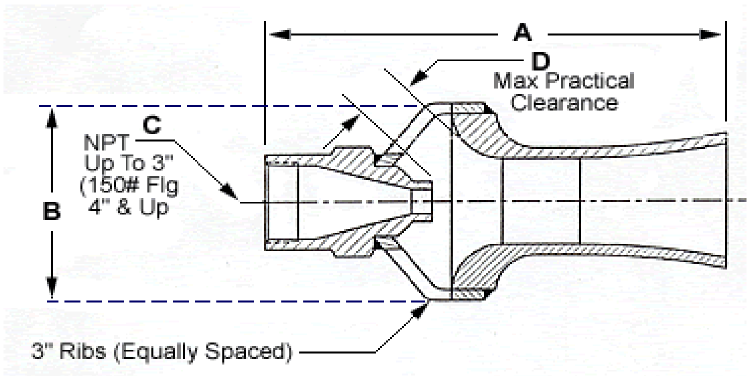
CH2MHILL Lockwood Greene

— CALCULATION SHEET —

COMPUTED BY	R. Harris		
REVISION No.:		DATE:	02-Jul-2012
REV. COMMENT			
CHECKED BY:	W.L. Ross		
LOCATION:	Needles, CA		
PROJECT NAME	Topock Groundwater Remediation		
PROJECT No:	435062		

CLIENT: PG&E

SUBJECT: Influent Tank Eductor and Recirc Pump Sizing



* Data from www.jrgjt.com

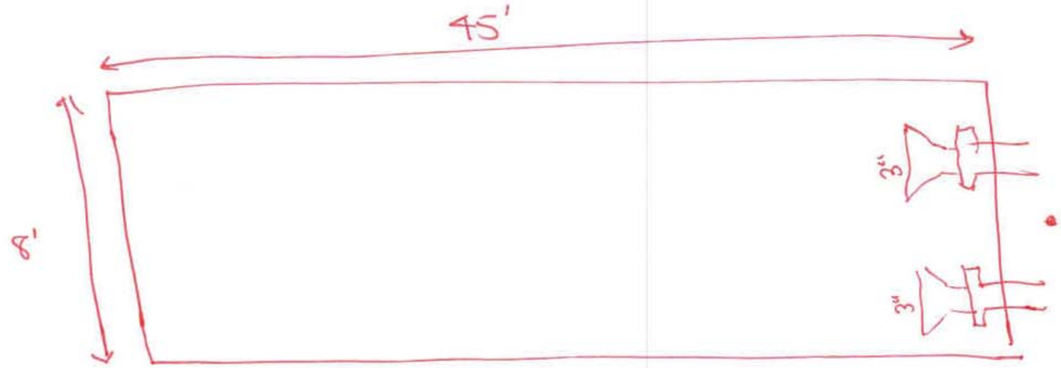
Based on data above, we can use two 3" nozzle. Vendor to clarify Dimension B for PVC eductor and Tank nozzle sizes.
for outboard access.

Size IPS		Pressure Difference, PSI											
		10	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**	**120**	**140**
	Motive Flow (GPM)	7.1	10.0	12.3	14.2	15.8	17.4	18.7	20.1	21.3	22.4	24.6	26.5
3/8" mnpt	Outlet Flow (GPM)	35	50	61	71	79	87	88	90	91	92	94	96
	Max. Plume Length	4	8	12	16	22	29	36	43	50	58	72	86
	Motive Flow (GPM)	15.4	21.8	26.7	30.8	34.5	37.8	40.8	43.6	46.3	48.8	53.4	57.7
3/4" mnpt	Outlet Flow (GPM)	77	109	134	154	172	189	192	195	197	200	204	209
	Max. Plume Length	5	11	17	24	33	42	53	64	74	85	106	127
	Motive Flow (GPM)	30.8	43.6	53.4	61.6	68.9	75.5	81.5	87.2	92.5	97.5	107	115
1-1/2" fnpt	Outlet Flow (GPM)	154	218	267	306	345	378	384	389	395	400	409	417
	Max. Plume Length	7.5	16	24	34	46	60	75	90	105	120	150	180
	Motive Flow (GPM)	61.6	87.2	107	123	138	151	163	174	185	195	214	231
2" fnpt	Outlet Flow (GPM)	308	436	534	616	689	755	767	778	789	799	818	835
	Max. Plume Length	11	23	34	48	65	85	106	12	148	170	212	255
	Motive Flow (GPM)	142	201	246	283	317	347	375	401	426	449	491	531
3" fnpt	Outlet Flow (GPM)	708	1,003	1,228	1,417	1,585	1,737	1,764	1,790	1,815	1,836	1,880	1,920
	Max. Plume Length	16	34	51	73	99	129	161	193	225	257	322	386
	Motive Flow (GPM)	246	349	427	493	551	604	652	698	740	780	856	920
4" flg	Outlet Flow (GPM)	1232	1744	2136	2448	2760	3024	3072	3112	3160	3200	3272	3336
	Max. Plume Length	22	41	60	95	132	164	196	228	260	295	360	424
6" flg	Motive Flow (GPM)	493	698	854	986	1102	1208	1304	1395	1480	1560	1712	1840
	Outlet Flow (GPM)	2464	3488	4272	4896	5520	6048	6144	6224	6320	6400	6544	6672
8" flg	Motive Flow (GPM)	986	1395	1709	1971	2205	2416	2608	2790	2960	3120	3424	3680
	Outlet Flow (GPM)	4928	6976	8544	9792	11040	12096	12384	12448	12640	12800	13088	13344
10" flg	Motive Flow (GPM)	1971	2790	3418	3942	4410	4832	5216	5581	5920	6240	6848	7360
	Outlet Flow (GPM)	9856	13952	17088	19584	22080	24192	24576	24896	25344	25600	26176	26688

**** Pressure is in PSI and Plume Length shown in Feet**

Option 2

Portable Frac Tanks
(sloped bottom)



- (2) 3" (30 psi) eductors
- side mounted ~1' from bottom of tank on 8' side
- requires 492 gpm @ ~76' (10hp) recirc pump

Remedy-produced Water Conditioning Process—Caustic Usage

Calculation Cover Sheet

ES-P04-03-F03 Calculation Sign Off Form

CH2MHILL

Project Name/Title:	PG&E Topock Final Groundwater Remedy Design	Project Number:	415087.01.05.02
Document Name:	Basis of Design Report - Appendix C	Preparer Name:	John Porcella
Project Manager:	Christina Hong	Design Manager:	John Porcella

Calculation Title:	Remedy WW Treatment Plant - Caustic Feed Usage					
Calculation Identifier:						
Date Prepared	Rev. No.	Preparer Signature/Date		Checker Signature/Date		*For Professional Seal When Required*
26-Oct	1	John Porcella	26-Oct-11	Ken Martins	10-Nov-11	
4/4/2013	2	John Porcella	4-Apr-13			
STC/SME Signature/Date						
LTR Signature/Date (if required)						

Comments:

Total usage revised to 13,840 gal/year based on increase in flow from 0.7 million gallons per year to 0.78 million gallons per year.

Information Requiring Confirmation:

Problem Statement

Calculate caustic usage to neutralize first flush well rehabilitation water to 1) calculate caustic usage

Given/Assumptions

1. 700,000 gallons per year of first flush water (Table F-1)
2. First flush water is pH 2.1 and final pH is 7.0
3. Hydrochloric acid (32%) is used for acidifying well water from ambient conditions to dissolve precipitated minerals
4. Ambient concentrations based on IW-3 backwash water chemical analysis of samples collected 10/5/11 ("Raw Data")

Method

Use Stream Analyzer by OLI Systems to perform pH adjustment (http://www.olisystems.com/new-streamanalyzer.shtml)
Uses electrolyte thermodynamic equations to calculate equilibrium concentrations.
Results shown on "Stream Analyzer Modeling" worksheet
Screenshot 1 - Starting conditions
Screenshots 2/3 - acidifying process in two different pH ranges (pH on y-axis; ratio of acid volume (L) to million liters of water)
Screenshots 4/5 - neutralizing process in two different pH ranges (pH on y-axis; ratio of NaOH volume (L) to million liters of water)

Caustic Usage

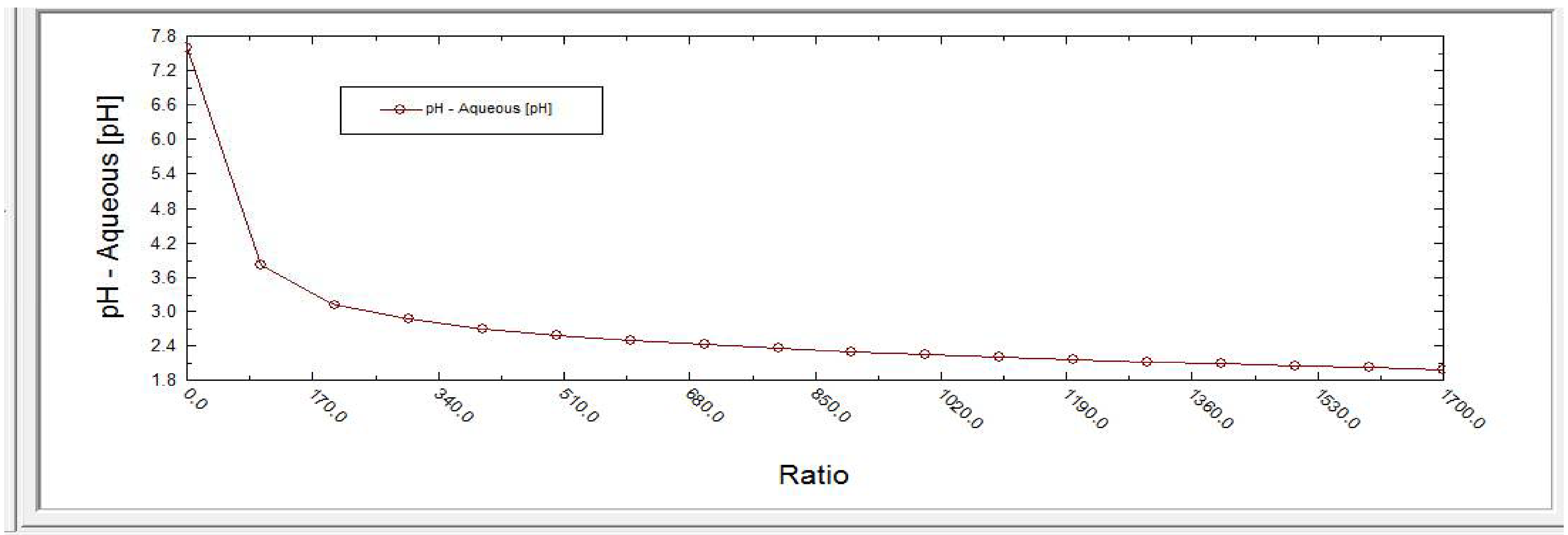
1850 L	25% caustic		
to			
1e6 L	well water		
700,000	gallons/year first flush water		
3.7854	L/gal		
2,649,788	Liters/year first flush water		
4,902	Liters/year of 25% caustic		
1,295	gal/year of 25% caustic		
1.15	specific gravity 25% caustic		
8.34	lbs/gal		
12,420	lbs/year caustic		
Rev. 2	Total Flow	780,000	gallons/year first flush water
		13,840	lbs/year caustic

SCREEN SHOT #1

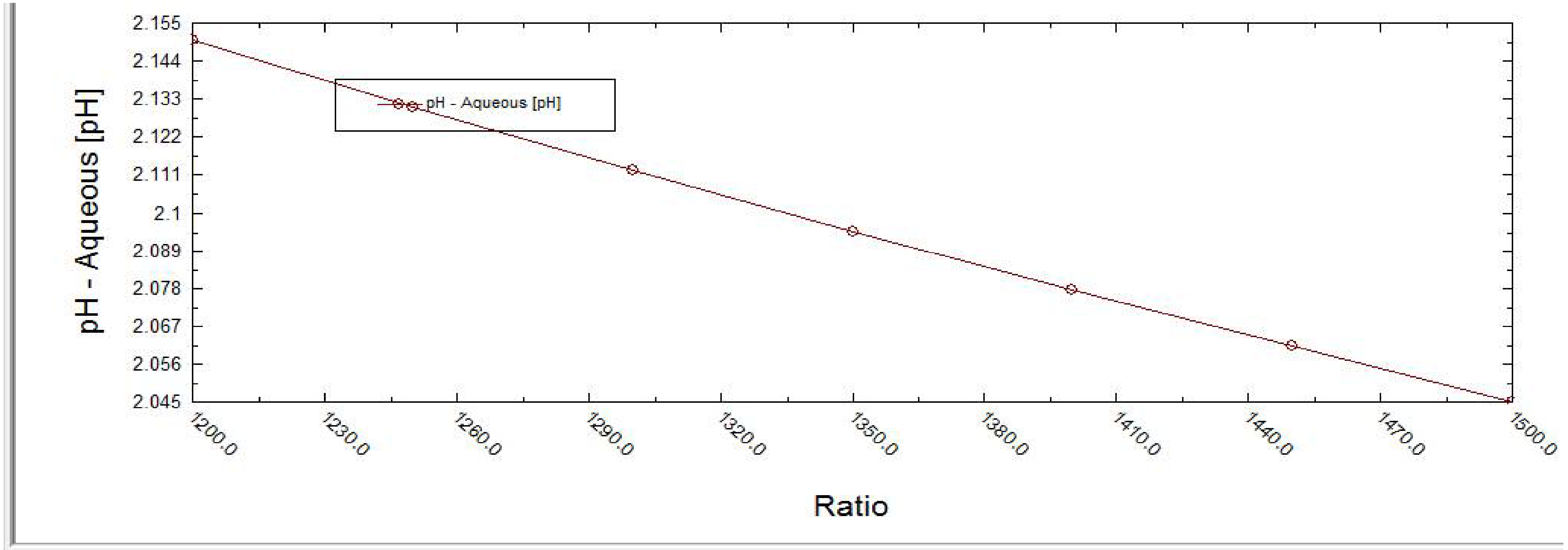
Description | Reconciliation | Molecular Basis | Report

Variable	Unit	Value
Known: pH - Aqueous	pH	7.60000
pH Acid Titrant: Carbon dioxide		
pH Base Titrant: Sodium hydroxide		
Neutrals		
Water		
Carbon dioxide	mg/L	0.0
Sodium hydroxide	mg/L	0.0
Cations		
Calcium ion(+2)	mg/L	95.0000
Magnesium ion(+2)	mg/L	22.0000
Sodium ion(+1)	mg/L	940.000
Strontium ion(+2)	mg/L	3.20000
Potassium ion(+1)	mg/L	10.0000
Anions		
Chloride ion(-1)	mg/L	2200.00
Nitrate ion(-1)	mg/L	2.60000
Sulfate ion(-2)	mg/L	490.000
Bicarbonate ion(-1)	mg/L	40.0000

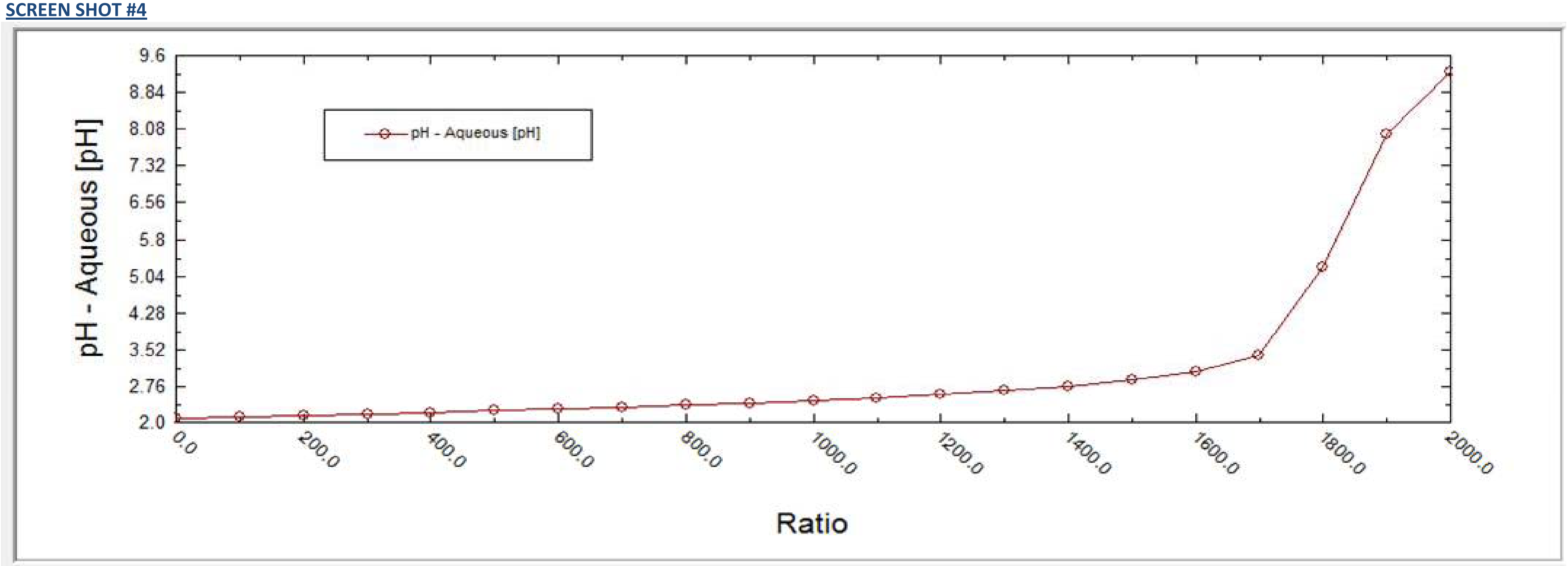
SCREEN SHOT #2



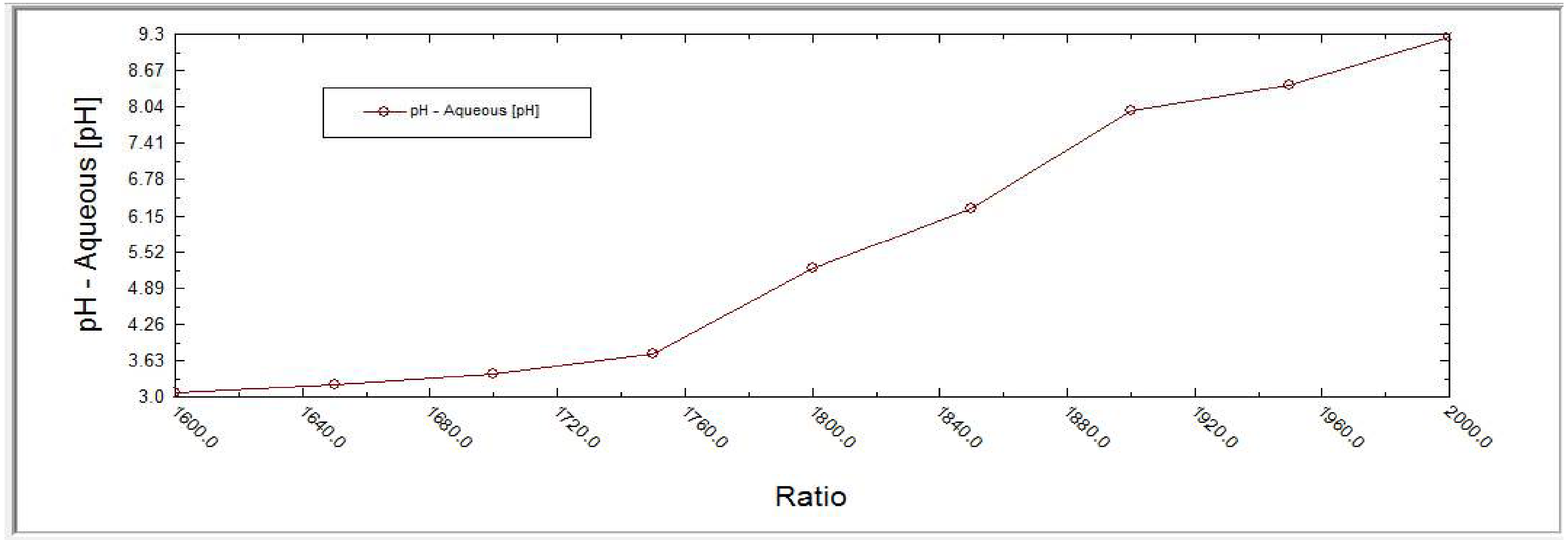
SCREEN SHOT #3



SCREEN SHOT #4



SCREEN SHOT #5



Method	Analyte	Final Result	Final Validation Flag	Reporting Limit	Units
E120.1	EC	7200		0.1	µmhos/cm
E180.1	Turbidity	0.1		0.1	NTU
E218.6	Hexavalent Chromium	1	U	1	ug/L
E300.0	Chloride	2200		250	mg/L
E300.0	Fluoride	5	U	5	mg/L
E300.0	Nitrate as N	2.6		1	mg/L
E300.0	Nitrogen, Nitrite	25	U	25	mg/L
E300.0	Sulfate	490		50	mg/L
E365.3	Phosphorus, Total (As P)	0.02	U	0.02	mg/L
SM2320B	Alkalinity	40		5	mg/L
SM2320B	Alkalinity, Bicarbonate (As CaCO3)	40		5	mg/L
SM2320B	Alkalinity, Carbonate (As CaCO3)	5	UJ	5	mg/L
SM2320B	Alkalinity, Hydroxide (As CaCO3)	5	U	5	mg/L
SM2540C	Total Dissolved Solids	3700		50	mg/L
SM2540D	Suspended Solids (Residue, Non-Filterable)	10	U	10	mg/L
SM4500-HB	pH	7.6	H=	0.1	pH Units
SM4500NH3C	Nitrogen, Ammonia (As N)	0.1	U	0.1	mg/L
SM5310C	Total Organic Carbon	1	U	1	mg/L
SW6010B	Aluminum	50	U	50	ug/L
SW6010B	Antimony	10	U	10	ug/L
SW6010B	Barium	7.6		3	ug/L
SW6010B	Beryllium	1	U	1	ug/L
SW6010B	Boron	740		100	ug/L
SW6010B	Cadmium	3	U	3	ug/L
SW6010B	Calcium	95000		500	ug/L
SW6010B	Chromium	1	U	1	ug/L
SW6010B	Cobalt	3	U	3	ug/L
SW6010B	Copper	5	U	5	ug/L
SW6010B	Iron	20	U	20	ug/L
SW6010B	Iron, dissolved	20	U	20	ug/L
SW6010B	Lead	10	U	10	ug/L
SW6010B	Magnesium	22000		100	ug/L
SW6010B	Manganese	10	U	10	ug/L
SW6010B	Manganese, dissolved	10	U	10	ug/L
SW6010B	Molybdenum	9.2		5	ug/L
SW6010B	Nickel	5	U	5	ug/L
SW6010B	Potassium	10000		5000	ug/L
SW6010B	Silver	3	U	3	ug/L
SW6010B	Sodium	940000		50000	ug/L
SW6010B	Strontium	3200		2500	ug/L
SW6010B	Vanadium	3	U	3	ug/L
SW6010B	Zinc	10	U	10	ug/L
SW6020A	Arsenic	0.12		0.1	ug/L
SW6020A	Selenium	2.8		0.5	ug/L
SW6020A	Thallium	0.5	U	0.5	ug/L
SW7470A	Mercury	0.2	U	0.2	ug/L

Remedy Project Structural Calculations — related to the pipe bridges, Remedy-produced Conditioning Building, Conditioned water storage, Freshwater storage, Contingent Freshwater Pre-injection Treatment Building, and L-300 Load

TOPOCK GROUNDWATER REMEDIATION PROJECT

STRUCTURAL CALCULATIONS

90% Design Submittal

Date: August 27, 2014

TABLE OF CONTENT

TAB NO. 1

1. INFLUENT TANK FARM
2. CONDITIONED WATER TANK FARM

JIX A - CALCULATION COVER SHEET

CALCULATION ID NUMBER	
REVISION NUMBER	
JOB NUMBER	~~WW-PEB-2171-048462~~

TITLE	Topock Influent tank farm & Conditioned Water Tank Farm Canopy

PAGE	Description
1 To 3.	Influent Tank Farm Design
4 to 8	Canopy Roof Truss (infl diaph. truss)
9 To 12	Interior Frame Typical (Frame N).
13 To 17	Exterior Frame Typical (Frame N2)
18 To 20	Interior Frame w/ distributed load on col. (Frame N3)
21 to 35	Water Conditioned Tank farm double canopy & Mom. frames
36	Calc. for frames
37	Calc. for Double Canopy
A1, A2	Data Tanks

Revised dates 1 4/09/14 2 5/08/14

	initial	date
PREPARED	KD	9/05/12
TITLE		
REVIEWED		
TITLE		

REVISION NOTES	

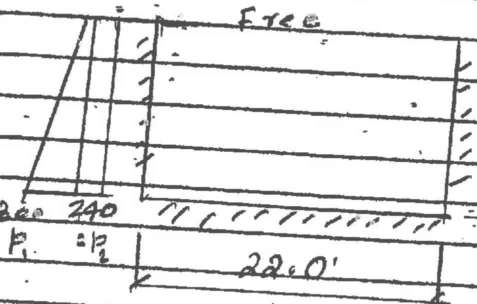
E2 Consulting Engineers, Inc. 1900 Powell Street, Suite 250 Eneryville, CA 94608	Designed By: KD	Date: 8/31/14
	Checked By: KJ	Date: 6/12/14
Project No. WW-PEB-2174-0432062	Revised By:	Date:
		Sheet No. 1

Project Description Topock Influent Tank Farm/Water Conditioning Tank Farm

Ref. Dwgs. Elv. plan, Fdn plan & Section A (CH2M Hill)
See Appendix-A for Tank data
Objective
1. Design supporting walls to take surcharge & earth loads
2. Design Fdn. for all loads
3. Design conc. slab on Grade for equipment loads

$p_1 = wh = 60 \times 5 = 300$
$p_2 = 4 \times 60 = 240$

$\frac{a}{b} = \frac{11}{5} = 2.2 > 1.5$



~~Design as a cantiver wall~~
for vertical Reinforcement

$M_{max} = .3 \times \frac{5}{2} \times \frac{5}{3} + .24 \times 5 \times \frac{5}{2} = 4.25'^{k}$

$M_{u\,max} = 4.25 \times 1.7 \times 1.3 = 9.39'^{k}$

$V_{u\,max} = \left[\frac{.3 \times 5}{2} + .24 \times 5\right] \times 1.7 \times 1.2 = 1.95 \times 2.21 = 4.31^{k}$

$d_r = (4310)/.85 \times 12 \times 141 = 3''$

$d = 12 - 2 - .5 = 9.5''$ $b = 12''$ $F = .09$

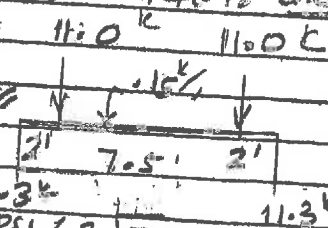
Vert. Reinf. $\frac{M_u}{F} = \frac{9.39}{.09} = 104$ $A_s = .0021 \times 12 \times 9.5 = .24\ in^2$

#5 @ 12" c/c Vert. ea. face

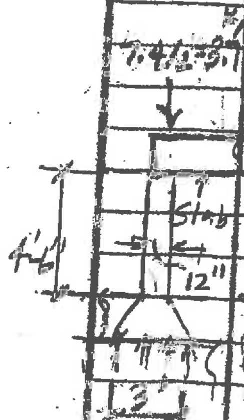
Horiz. Reinf. $M_{u_h} = [.0857 \times .3 \times 5 + .3304 \times .24 \times 5^2] \times 1.7 \times 1.3 = 5.8'^{k}$

$\frac{M_u}{F} = \frac{5.8}{.09} = 65$ $A_{sh} = .0017 \times 12 \times 9.5 = .193\ in^2$ #4 @ 12" ok
Assume

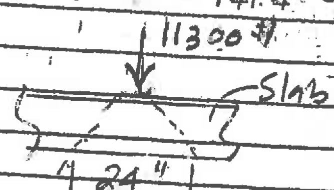
Top slab (24" slab width for wheel load)
Total wt/ax = (21000 × 16 + 18000)/24 = 73#/□'
Axle load = 22k (For wall design)
Load/wheel = 11k for slab design



12" Slab $v_u = \frac{1.4(300) + 1.7(11000)}{.85 \times 24 \times 9.5} = 98.7\ PSI < 2\sqrt{5000} = 141.4\ PSI$
$d = 12 - 2.5 = 9.5''$



P = Soil press = (3.7 wall + slab 1.2) / 3×1 = 1.96 k/ft² < 2.0 KSF



SLAB REINF

$M_u = 11.3 \times 2 \times 1.6 = 36.2'^{k}$

$d = 9.5''$ $b = 24''$ $F = .18$ $\frac{M_u}{F} = \frac{36.2}{.18} = 201$

$A_s = .0048 \times 24 \times 9.5 = 1.09\ in^2$ #6 @ 10" $A_{sa} = .44 \times \frac{12}{10} \times 2 = 1.06\ in^2 \approx 1.09$ ok

Use 12" Tk Slab w/ #6 @ 10" in short dir.
#6 @ 16" in Long dir.

E2 Consulting Engineers, Inc.
1900 Powell Street, Suite 250
Emeryville, CA 94608

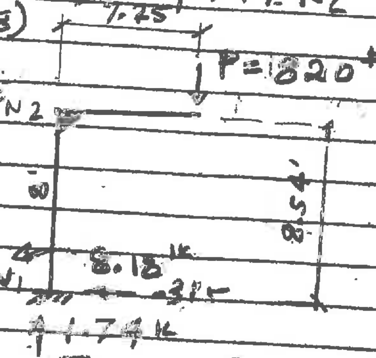
Designed By: KD		Date: 4/03/14	
Checked By: KJ		Date: 6/12/14	
Revised By:		Date:	
Project No.	WW-PEB-2174-04321	Sheet No.	2
Project Description	Topock Influent Tank Farm Canopy		

Frames @ Canopy (8'-10" spcg.) Interior Fr. 'N', Exterior Fr. N2

See Roof plan (pg-3) & Truss calc.'s (pgs. 4 To 8)

Two Frames Frame N, & Frame N1

Vert. loads (@ INTERIOR)



$P_{DL+LL} = (6+20) \times 8.83 \times 3.5$

$= [(6 \times 8.83)1.1 + 20 \times 8.83] \times 3.5$

$= 185 + 618 = 803^{\#}$ USE $820^{\#}$

Lateral loads

Wind: $P_W = 20 \times 8.83 \times 4.0 = 706^{\#}$ USE $700^{\#}$

Comb. ASCE 7-10: USE combinations for ASD - ASCE 7-10

2. D + L

6a. D + .75 L + .75 (.6 W)

7. .6 D + .6 W

Exterior Frame-N: See Computer output pgs 9 To 12. Ext. frame (pgs 13 To 17)

See computer output for corresponding combination.

Seismic: $V = F \times \frac{S_{DS}}{R} \times W$ $R = 3.5$ $\Omega = 3.0$

$= 1 \times \frac{.406}{3.5} \times W = .116\,W$

Roof: $W = 7 \times 8.83 \times 6 + 7 \times 8.83 \times 15 = 1298^{\#}$

$V = .116 \times 1298 = 151^{\#} < 700^{\#}$ Wind Governs

Assume: Frame N (Interior Fr.) only takes vert. load, horizontal loads transferred by truss (pg. 4), to Exterior Frame N2 (See sketch pg. 9). For Load combinations see computer output for Frame N & N1

Max. defl. = .48" = l/213 (Horiz. Frame N) Δ_{max} = .375 = l/232 (Horiz. N1)

Frame N: Max. vert defl. = .959" = $\frac{2 \times 7.25 \times 12}{.959} = \frac{l}{181} < \frac{l}{180}$ OK

Frame N2: Δ_{max} = .857"

Stresses are very low. HSS 6x6x6 for all members

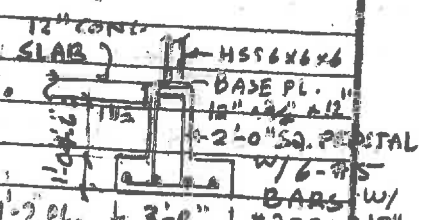
See Computer Calc.'s for code check

Base pl.

MAX. P = 1.74k 12" 3/4" x 12" Base pl.

$f_p = \frac{P}{A} + \frac{M}{S} = \frac{1.74}{14 \times 14} + \frac{8.18 \times 12}{\frac{1}{6} \times 14 \times 14^2} = .21$

$t_p = 2 \times 4.0 \sqrt{\frac{.21}{36}} = .61" < .75"$ USE 14 x 3/4 x 1'-2 PL.



Anchor Bolts

4 7/8" Φ 307 A-B.'s Max. Ten/Bolt = $\frac{8.18 \times 12}{2 \times 11}$ = 4.4k < 6.3k (14.5)

Emb. = 12" Max Shear/Bolt = .315/4 = .1k < 4k ok

Footing 8'-10" col. Spacing: M_o = .4 x 4 + 8.18 = 9.78'k Say 10'k P_{max} = 2.05 + .015 x 7 x 8.83 = 3k (siding)

$p = \left[\frac{3.0}{3 \times 8.83} + \left(.15 \times 1 \times \frac{2}{3} + .15 \times 3 \times 1\right)\right] + \frac{10}{\frac{1}{6} \times 8.83 \times 3^2} = .113 + .25 + .76 = 1.15$ (4/3)

USE 1' TK x 3'-0" W x Cont. ftg. w/ #5 @ 12" Ea. Way

Attn: Vinod 4/09/14

2 Consulting Engineers, Inc. 1900 Powell Street, Suite 250 Emeryville, CA 94608	Designed By:	KD	Date: 4/07/14
	Checked By:	KJ	Date: 5/12/14
	Reviewed By:		Date:
Project No.	WW-PGE-2174		Sheet No. 3
Project Description:	Topock Influent Tank Farm Canopy		

Reference:

X-Bracing (See pg-3)

Max. $P_{Br.} = 2.7^k$ (See pg.-6 computer output)

Try HSS 4 x 2 x 3 $A = 2.06 in^2$ $r = .804"$

$l_{max} = \sqrt{7.0^2 + 8.50^2} = 11.01'$

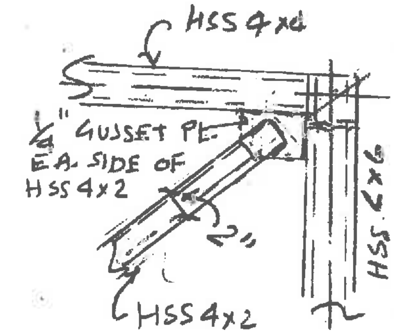
$\frac{Kl}{r_{min.}} = \frac{11.01 \times 12}{.804} = 164 < 300$

F_a (Ten.) $= .6 \times 46 \times 2.06 = 56.8^k > 2.7^k$ OK

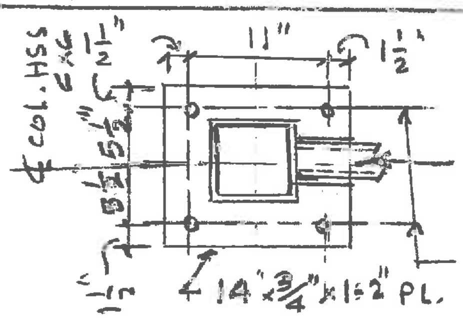
For Single Bracing HSS 4x2x3

F_a (Comp.) $= 5.29 \times 2.06 = 10.9^k > 2.7^k$

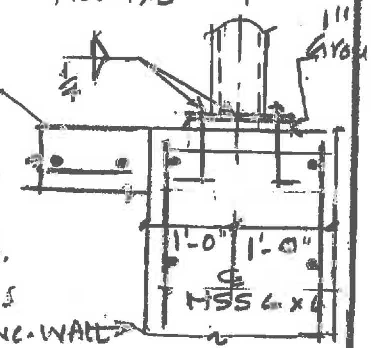
USE HSS 4x2x3 Single Bracing



Base pl. & Anchor Bolts (See pg. 2)



PLAN AT BASE PL.



ELEV. AT BRACE

PLAN AT PEDSTAL

EZ Consulting Engineers, Inc. 1900 Powell Street, Suite 250 Emeryville, CA 94608	Designed By: KD	Date: 5/12/14
	Checked By: KJ	Date: 5/12/14
	Reviewed By:	Date:
Project No. WW-PGE-2174		Sheet No. 3A

Project Description: Topock Influent Tank farm Canopy

Reference:

Block Wall Design (Infill Wall Spanning Vertically)

Seismic Loads (⊥ar to walls)

Assume the structure to be rigid - 8" TK walls (wt. 77 psf/ft²)

$V = .3 S_{DS} W I_e$ $\quad S_{DS} = .406 \quad W = 77$ PSF/ $\quad I_e = 1.25$

$= .3 \times .406 \times 77 \times 1.25$

$= 11.72$ PSF < 20 PSF (wind)

Wind governs — higher than vertical span = 8' say ok.

$P_W = .02 \times 8.83 = .177^{k/'}$ (on columns)

(See Frame N3 for Results)

Block Wall (8" TK Grouted @ 16" o/c) wt. of wall = 66 PSF/

$M_W = (.02 \times 8.83^2)/8 = .195^{'k} = 2.34^{''k} = 2340^{\#''}$ $\quad P_{DL} = 66 \times 8 = 528^{\#}$ USE $550^{\#}$

$V_W = 20 \times 8.83 \times .50 = 88.3$ #/

$f_a = \frac{550}{7.63 \times 12} = 6.0$ PSI $\quad F_a = .25 f'_m \left[1 - \left(\frac{h'}{140r}\right)^2\right]$ $\quad r = \frac{d}{\sqrt{12}} = \frac{8.63}{\sqrt{12}} = 2.49''$

$= .25 \times 1500 \left[1 - \left(\frac{8 \times 12}{140 \times 2.49}\right)^2\right]$

$= 345.4$ PSI

$\frac{f_a}{F_a} = \frac{6}{345.4} = .017$

8" TK wall w/ #5 @ 16" vert. & horiz. Reinf. $\quad \rho = \frac{A_s}{bd} = \frac{.31 \times .75}{8 \times 3.8} = .00765$

$n = \frac{E_s}{E_m} = \frac{29000 \times 10^{-3}}{900 \times 1500} = 21.5 \quad n\rho = 21.5 \times .00765 = .1644$

$k = .4312 \quad j = .856 \quad \frac{2}{kj} = 5.41 \quad f_b = \frac{2M}{kjbd^2} = \frac{2 \times 2340 \times 5.41}{12 \times 3.8^2}$

$= 146.1$ PSI < 500

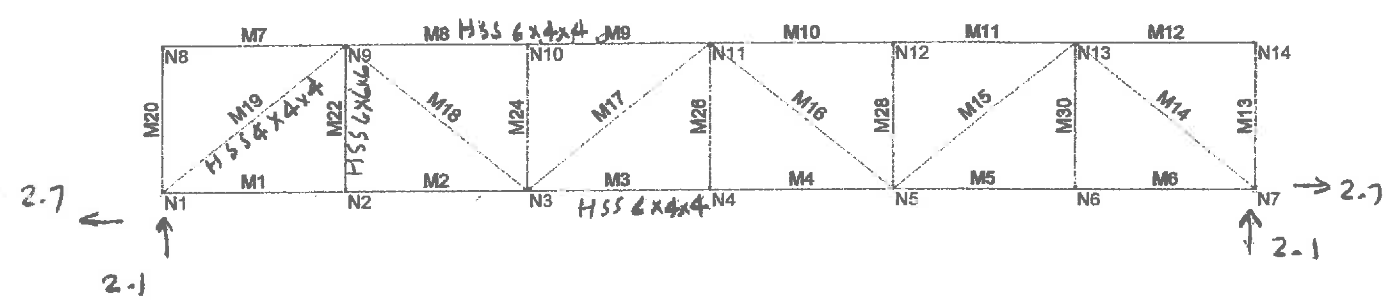
$f_s = \frac{M}{A_s j d} = \frac{2340 \times 1}{.2325 \times .856 \times 3.8} = 3094$ PSI < 24000 ok

$\frac{f_a}{F_a} + \frac{f_b}{F_b} = .017 + \frac{146.1}{500} = .309 < 1.0$

USE 8" Blk wall w/ #5 @ 16" Horiz & Vert. Reinf.

Min. As horiz. $= .002 \times 12 \times 3.8 = .0912$ in² < .2325 in²

wind load → w Bond Bm $= .02 \times 8 = .16^{k/'}$ $\quad M = \frac{.16 \times 8.83^2}{8} = 1.56^{'k}$ 2-#5 in Bond Bm ok by insp.



Results for LC 1, wind ns

e-2	influent farm truss	SK - 2
		June 12, 2014 at 11:52 AM
		infldiaph.truss.r2d

Hot Rolled Steel Properties

	Label	E [ksi]	G [ksi]	Nu	Therm (\1E5 F)	Density[k/ft^3]	Yield[ksi]
1	A36 Gr.36	29000	11154	.3	.65	.49	46
2	A572 Gr.50	29000	11154	.3	.65	.49	50
3	A992	29000	11154	.3	.65	.49	50
4	A500 Gr.B RND	29000	11154	.3	.65	.49	42
5	A500 Gr.B Rect	29000	11154	.3	.65	.49	46
6	A53 Gr.B	29000	11154	.3	.65	.49	35

Hot Rolled Steel Section Sets

	Label	Shape	Type	Design List	Material	Design Rules	A [in2]	I (90,270) [i...	I (0,180) [in4]
1	HR1A	HSS6x6x6	Beam	Tube	A500 Gr.B Rect	Typical	7.58	39.5	39.5
2	HR2	HSS6x4x4	Beam	Tube	A500 Gr.B Rect	Typical	4.3	11.1	20.9
3	HR3	HSS4x4x4	HBrace	Wide Flange	A500 Gr.B Rect	Typical	3.37	7.8	7.8

Joint Coordinates and Temperatures

	Label	X [ft]	Y [ft]	Temp [F]
1	N1	0	0	0
2	N2	8.83	0	0
3	N3	17.66	0	0
4	N4	26.49	0	0
5	N5	35.32	0	0
6	N6	44.15	0	0
7	N7	52.98	0	0
8	N8	0	7.25	0
9	N9	8.83	7.25	0
10	N10	17.66	7.25	0
11	N11	26.49	7.25	0
12	N12	35.32	7.25	0
13	N13	44.15	7.25	0
14	N14	52.98	7.25	0

Joint Boundary Conditions

	Joint Label	X [k/in]	Y [k/in]	Rotation[k-ft/rad]	Footing
1	N1	Reaction	Reaction		
2	N7	Reaction	Reaction		

Member Primary Data

	Label	I Joint	J Joint	Rotate(deg)	Section/Shape	Type	Design List	Material	Design Rules
1	M1	N1	N2		HR2	Beam	Tube	A500 Gr.B ...	Typical
2	M3	N3	N4		HR2	Beam	Tube	A500 Gr.B ...	Typical
3	M4	N4	N5		HR2	Beam	Tube	A500 Gr.B ...	Typical
4	M5	N5	N6		HR2	Beam	Tube	A500 Gr.B ...	Typical
5	M6	N6	N7		HR2	Beam	Tube	A500 Gr.B ...	Typical
6	M7	N8	N9		HR2	Beam	Tube	A500 Gr.B ...	Typical
7	M8	N9	N10		HR2	Beam	Tube	A500 Gr.B ...	Typical
8	M9	N10	N11		HR2	Beam	Tube	A500 Gr.B ...	Typical
9	M10	N11	N12		HR2	Beam	Tube	A500 Gr.B ...	Typical
10	M11	N12	N13		HR2	Beam	Tube	A500 Gr.B ...	Typical
11	M12	N13	N14		HR2	Beam	Tube	A500 Gr.B ...	Typical
12	M13	N14	N7		HR1A	Beam	Tube	A500 Gr.B ...	Typical
13	M14	N7	N13		HR3	HBrace	Wide Flange	A500 Gr.B ...	Typical
14	M15	N13	N5		HR3	HBrace	Wide Flange	A500 Gr.B ...	Typical

Member Primary Data (Continued)

	Label	I Joint	J Joint	Rotate(deg)	Section/Shape	Type	Design List	Material	Design Rules
15	M16	N5	N11		HR3	HBrace	Wide Flange	A500 Gr.B ...	Typical
16	M17	N11	N3		HR3	HBrace	Wide Flange	A500 Gr.B ...	Typical
17	M18	N3	N9		HR3	HBrace	Wide Flange	A500 Gr.B ...	Typical
18	M19	N9	N1		HR3	HBrace	Wide Flange	A500 Gr.B ...	Typical
19	M20	N1	N8		HR1A	Beam	Tube	A500 Gr.B ...	Typical
20	M22	N9	N2		HR1A	Beam	Tube	A500 Gr.B ...	Typical
21	M2	N2	N3		HR2	Beam	Tube	A500 Gr.B ...	Typical
22	M24	N3	N10		HR1A	Beam	Tube	A500 Gr.B ...	Typical
23	M26	N11	N4		HR1A	Beam	Tube	A500 Gr.B ...	Typical
24	M28	N5	N12		HR1A	Beam	Tube	A500 Gr.B ...	Typical
25	M30	N13	N6		HR1A	Beam	Tube	A500 Gr.B ...	Typical

Joint Loads and Enforced Displacements (BLC 1 : wind ns)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N1	L	Y	.35
2	N2	L	Y	.7
3	N3	L	Y	.7
4	N4	L	Y	.7
5	N5	L	Y	.7
6	N6	L	Y	.7
7	N7	L	Y	.35

Joint Loads and Enforced Displacements (BLC 2 : wind ew)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N1	L	X	.254
2	N8	L	X	.254

Basic Load Cases

	BLC Description	Category	X Gravity	Y Gravity	Joint	Point	Distributed
1	wind ns	None			7		
2	wind ew	None			2		

Load Combinations

	Description	Solve	PD...	SR...	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor
1	wind ns	Yes	Y		1	1														
2	wind ew	Yes	Y		2	1														

Joint Reactions (By Combination)

	LC	Joint Label	X [k]	Y [k]	MZ [k-ft]
1	1	N1	-2.699	-2.1	0
2	1	N7	2.699	-2.1	0
3	1	Totals:	0	-4.2	
4	1	COG (ft):	X: 26.49	Y: 0	
5	2	N1	-.381	-.035	0
6	2	N7	-.127	.035	0
7	2	Totals:	-.508	0	
8	2	COG (ft):	NC	NC	

Joint Deflections

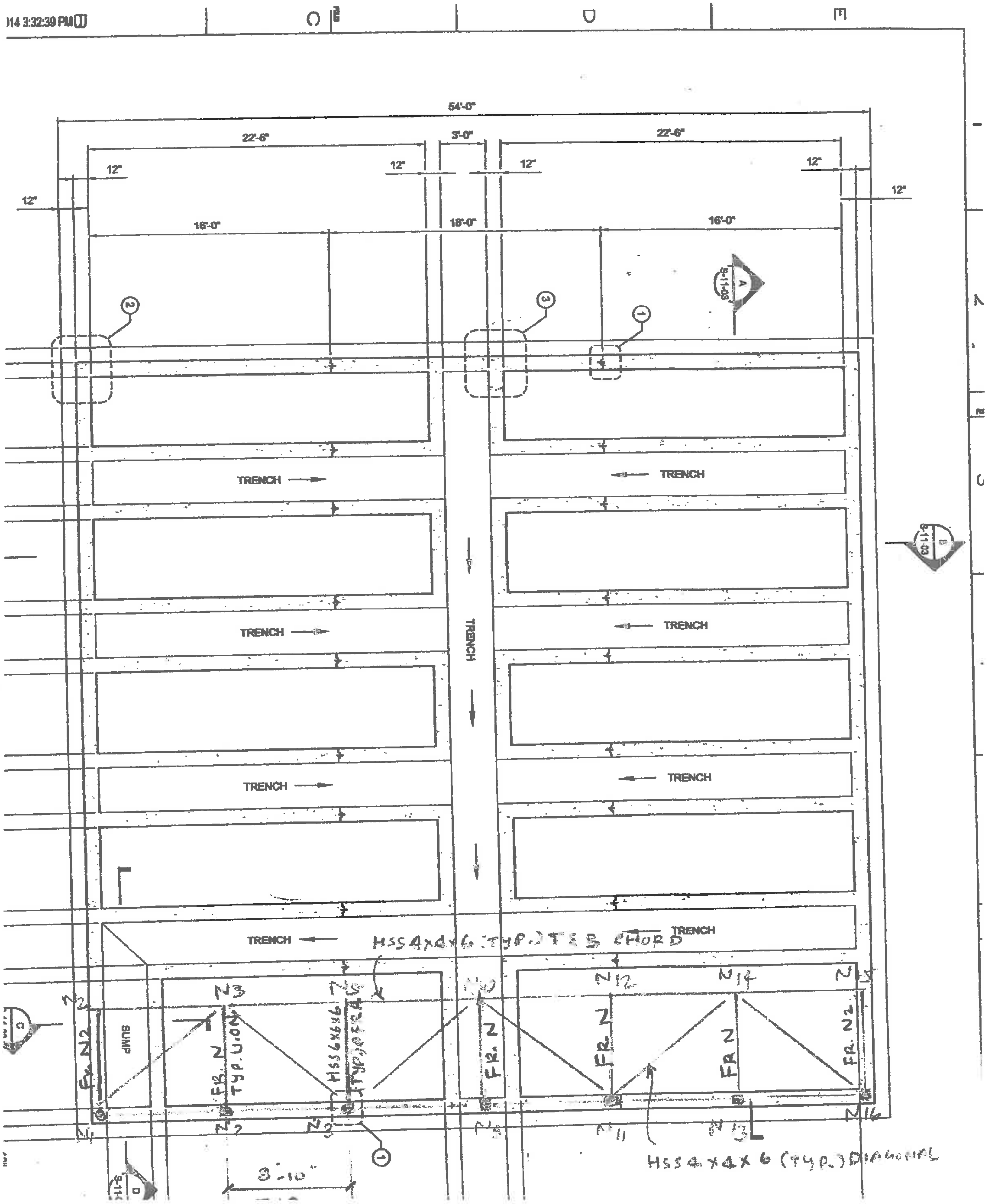
	LC	Joint Label	X [in]	Y [in]	Rotation [rad]
1	1	N1	0	0	1.259e-4
2	1	N2	0	.013	1.275e-4
3	1	N3	0	.025	6.888e-5
4	1	N4	0	.028	0
5	1	N5	0	.025	-6.888e-5
6	1	N6	0	.013	-1.275e-4
7	1	N7	0	0	-1.259e-4
8	1	N8	-.006	0	0
9	1	N9	-.006	.013	1.286e-4
10	1	N10	-.003	.025	6.859e-5
11	1	N11	0	.027	0
12	1	N12	.003	.025	-6.859e-5
13	1	N13	.006	.013	-1.286e-4
14	1	N14	.006	0	0
15	2	N1	0	0	-4.042e-6
16	2	N2	0	0	-3.427e-6
17	2	N3	0	0	-2.837e-7
18	2	N4	0	0	1.209e-6
19	2	N5	0	0	2.022e-6
20	2	N6	0	0	2.218e-6
21	2	N7	0	0	5.647e-7
22	2	N8	0	0	0
23	2	N9	0	0	-3.426e-6
24	2	N10	0	0	-2.825e-7
25	2	N11	0	0	1.209e-6
26	2	N12	0	0	2.022e-6
27	2	N13	0	0	2.218e-6
28	2	N14	0	0	0

Member AISC 13th(360-05): ASD Steel Code Checks

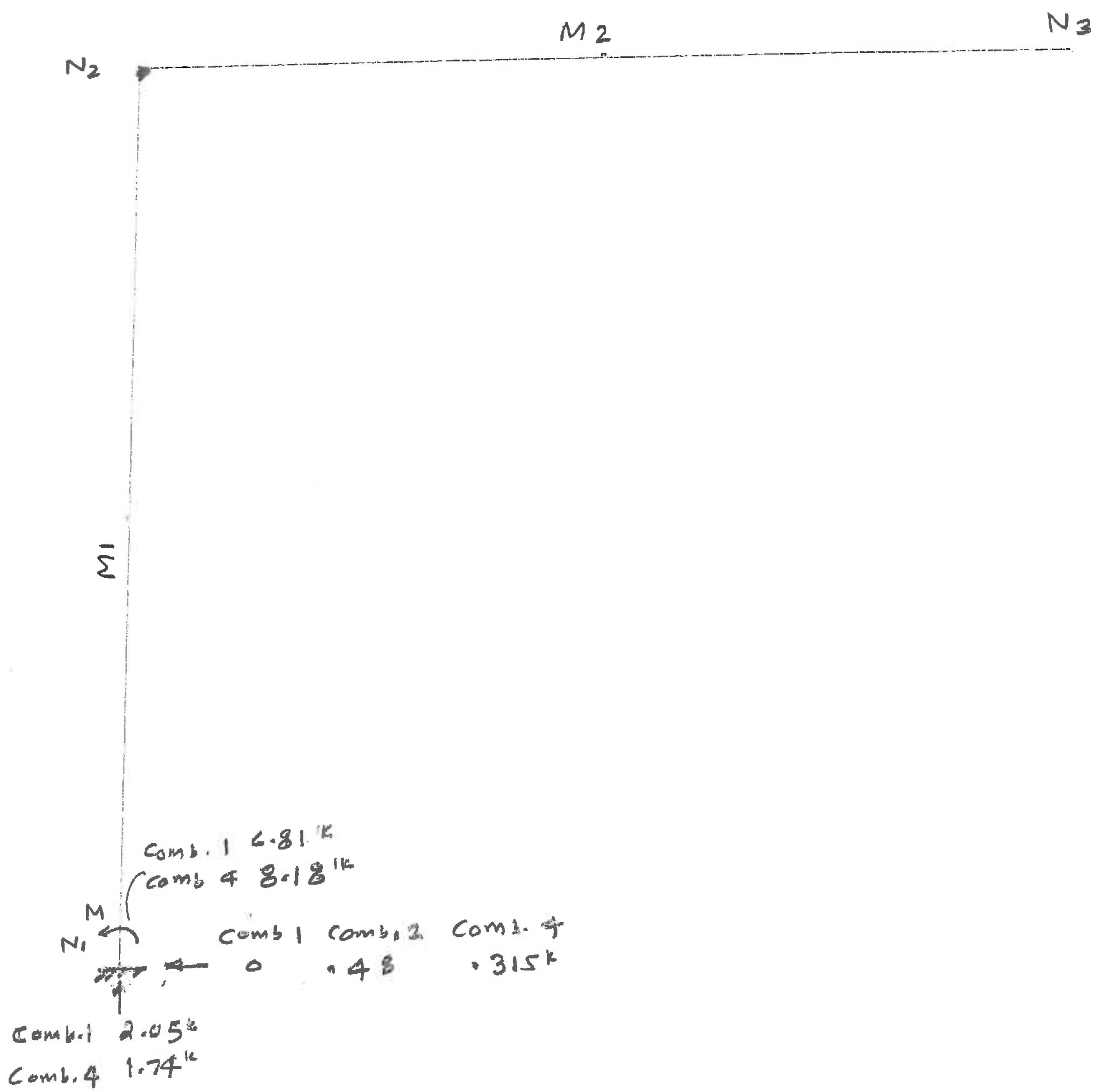
	LC	Member	Shape	UC Max	Loc[ft]	Shear UC	Loc[ft]	Pnc/om [k]	Pnt/om [k]	Mn/om [k-ft]	Cb	Eqn
1	1	M1	HSS6x4x4	.002	8.83	.000	0	88.399	118.443	19.58	1.667	H1-1b
2	1	M3	HSS6x4x4	.009	0	.000	0	88.399	118.443	19.58	1.52	H1-1b
3	1	M4	HSS6x4x4	.009	8.83	.000	0	88.399	118.443	19.58	1.52	H1-1b
4	1	M5	HSS6x4x4	.005	0	.000	0	88.399	118.443	19.58	1.696	H1-1b
5	1	M6	HSS6x4x4	.002	0	.000	0	88.399	118.443	19.58	1.667	H1-1b
6	1	M7	HSS6x4x4	.000	8.83	.000	0	88.399	118.443	19.58	1.667	H1-1b
7	1	M8	HSS6x4x4	.018	8.83	.000	0	88.399	118.443	19.58	1.795	H1-1b
8	1	M9	HSS6x4x4	.018	0	.000	0	88.399	118.443	19.58	1.645	H1-1b
9	1	M10	HSS6x4x4	.018	8.83	.000	0	88.399	118.443	19.58	1.645	H1-1b
10	1	M11	HSS6x4x4	.018	0	.000	0	88.399	118.443	19.58	1.795	H1-1b
11	1	M12	HSS6x4x4	.000	0	.000	0	88.399	118.443	19.58	1.667	H1-1b
12	1	M13	HSS6x6x6	.000	0	.000	0	189.355	208.79	36.267	1	H1-1b
13	1	M14	HSS4x4x4	.015	0	.000	0	53.755	92.826	10.765	1	H1-1b
14	1	M15	HSS4x4x4	.015	0	.000	0	53.755	92.826	10.765	1	H1-1b
15	1	M16	HSS4x4x4	.003	0	.000	0	53.755	92.826	10.765	1	H1-1b
16	1	M17	HSS4x4x4	.003	0	.000	0	53.755	92.826	10.765	1	H1-1b
17	1	M18	HSS4x4x4	.015	0	.000	0	53.755	92.826	10.765	1	H1-1b
18	1	M19	HSS4x4x4	.015	0	.000	0	53.755	92.826	10.765	1	H1-1b
19	1	M20	HSS6x6x6	.000	0	.000	0	189.355	208.79	36.267	1	H1-1b
20	1	M22	HSS6x6x6	.002	0	.000	0	189.355	208.79	36.267	1	H1-1b
21	1	M2	HSS6x4x4	.005	8.83	.000	0	88.399	118.443	19.58	1.696	H1-1b
22	1	M24	HSS6x6x6	.000	0	.000	0	189.355	208.79	36.267	1	H1-1b
23	1	M26	HSS6x6x6	.002	0	.000	0	189.355	208.79	36.267	1	H1-1b
24	1	M28	HSS6x6x6	.000	0	.000	0	189.355	208.79	36.267	1	H1-1b

Member AISC 13th(360-05): ASD Steel Code Checks (Continued)

	LC	Member	Shape	UC Max	Loc[ft]	Shear UC	Loc[ft]	Pnc/om [k]	Pnt/om [k]	Mn/om [k-ft]	Cb	Eqn
25	1	M30	HSS6x6x6	.002	0	.000	0	189.355	208.79	36.267	1	H1-1b
26	2	M1	HSS6x4x4	.000	8.83	.000	0	88.399	118.443	19.58	1.667	H1-1b
27	2	M3	HSS6x4x4	.000	0	.000	0	88.399	118.443	19.58	2.157	H1-1b
28	2	M4	HSS6x4x4	.000	8.83	.000	0	88.399	118.443	19.58	2.185	H1-1b
29	2	M5	HSS6x4x4	.001	0	.000	0	88.399	118.443	19.58	2.251	H1-1b
30	2	M6	HSS6x4x4	.001	0	.000	0	88.399	118.443	19.58	1.667	H1-1b
31	2	M7	HSS6x4x4	.001	8.83	.000	0	88.399	118.443	19.58	1.667	H1-1b
32	2	M8	HSS6x4x4	.001	8.83	.000	0	88.399	118.443	19.58	1.434	H1-1b
33	2	M9	HSS6x4x4	.001	0	.000	0	88.399	118.443	19.58	2.157	H1-1b
34	2	M10	HSS6x4x4	.001	8.83	.000	0	88.399	118.443	19.58	2.185	H1-1b
35	2	M11	HSS6x4x4	.001	0	.000	0	88.399	118.443	19.58	2.251	H1-1b
36	2	M12	HSS6x4x4	.000	0	.000	0	88.399	118.443	19.58	1.667	H1-1b
37	2	M13	HSS6x6x6	.000	0	.000	0	189.355	208.79	36.267	1	H1-1b
38	2	M14	HSS4x4x4	.001	0	.000	0	53.755	92.826	10.765	1	H1-1b
39	2	M15	HSS4x4x4	.000	0	.000	0	53.755	92.826	10.765	1	H1-1b
40	2	M16	HSS4x4x4	.001	0	.000	0	53.755	92.826	10.765	1	H1-1b
41	2	M17	HSS4x4x4	.000	0	.000	0	53.755	92.826	10.765	1	H1-1b
42	2	M18	HSS4x4x4	.001	0	.000	0	53.755	92.826	10.765	1	H1-1b
43	2	M19	HSS4x4x4	.000	0	.000	0	53.755	92.826	10.765	1	H1-1b
44	2	M20	HSS6x6x6	.000	0	.000	0	189.355	208.79	36.267	1	H1-1b
45	2	M22	HSS6x6x6	.000	0	.000	0	189.355	208.79	36.267	1	H1-1b
46	2	M2	HSS6x4x4	.000	8.83	.000	0	88.399	118.443	19.58	1.434	H1-1b
47	2	M24	HSS6x6x6	.000	0	.000	0	189.355	208.79	36.267	1	H1-1b
48	2	M26	HSS6x6x6	.000	0	.000	0	189.355	208.79	36.267	1	H1-1b
49	2	M28	HSS6x6x6	.000	0	.000	0	189.355	208.79	36.267	1	H1-1b
50	2	M30	HSS6x6x6	.000	0	.000	0	189.355	208.79	36.267	1	H1-1b

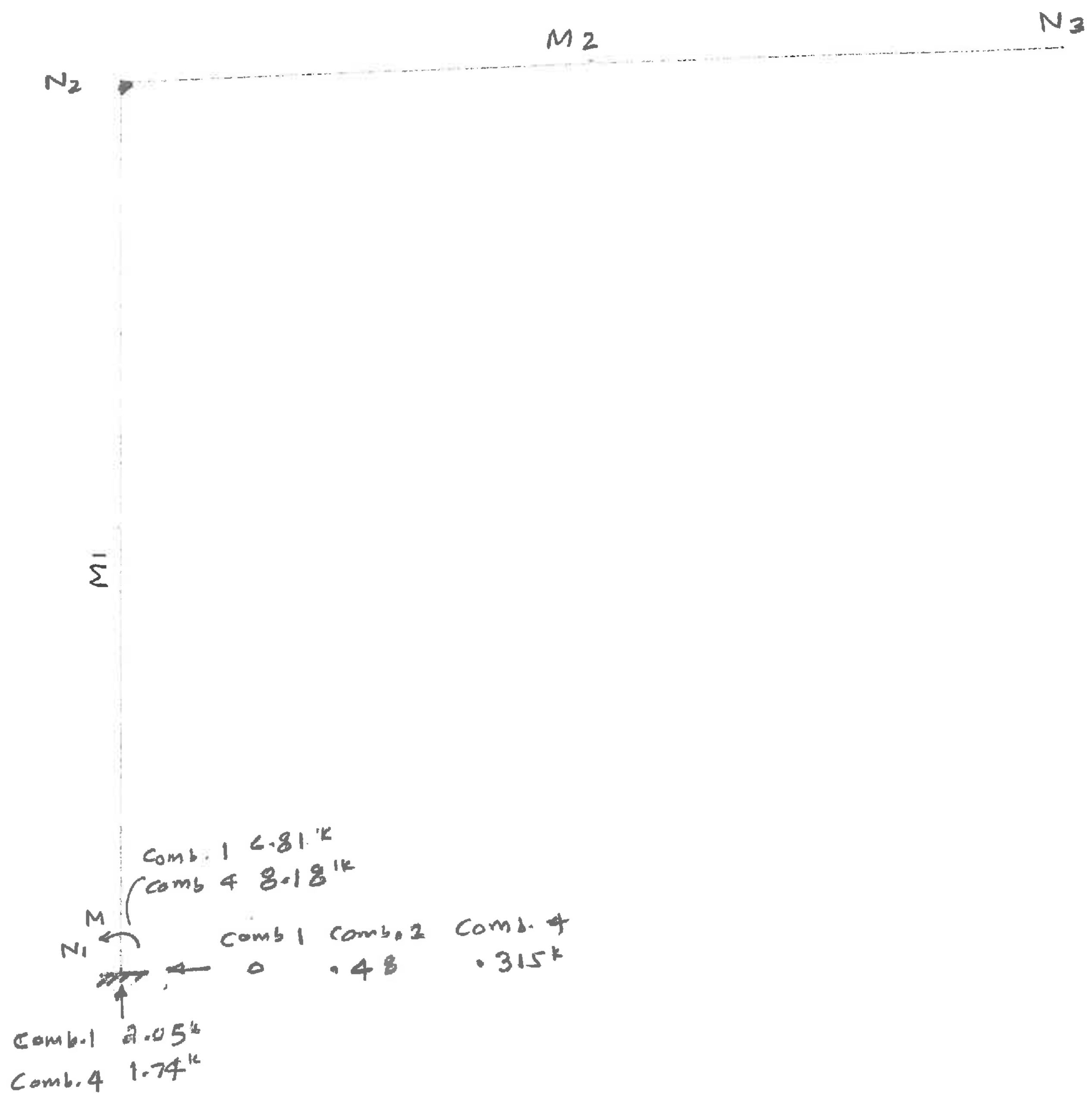


14 3:32:39 PM
C
D
E
54'-0"
22'-6"
3'-0"
22'-6"
12"
16'-0"
18'-0"
16'-0"
TRENCH
SUMP
HSS 4x4x6 (TYP.) T & B CHORD
HSS 4x4x6 (TYP.) DIAGONAL
HSS 6x6x6 (TYP.) 0.0.
FR. N TYP. U.O.N.
FR. N
FR. N2
N1
N2
N3
N5
N10
N11
N12
N13
N14
N15
N16
8'-10"



e2		SK - 1
kd	topock Influent Farm canopy	Apr 2, 2014 at 11:37 AM
ww-peg-2174-043062	FRAME N, Interior column	topockifc.frameN.r2d

Assumption - Block wall spanning vertically



e2	topock Influent Farm canopy FRAME N, Interior column	SK - 1
kd		Apr 2, 2014 at 11:37 AM
ww-peg-2174-043062		topockifc.frameN.r2d

Assumption - Block wall spanning vertically

Hot Rolled Steel Properties

	Label	E [ksi]	G [ksi]	Nu	Therm (\1E5 F)	Density[k/ft^3]	Yield[ksi]
1	A36 Gr.36	29000	11154	.3	.65	.49	36
2	A572 Gr.50	29000	11154	.3	.65	.49	50
3	A992	29000	11154	.3	.65	.49	50
4	A500 Gr.42	29000	11154	.3	.65	.49	42
5	A500 Gr.46	29000	11154	.3	.65	.49	46

Hot Rolled Steel Section Sets

	Label	Shape	Type	Design List	Material	Design Rules	A [in2]	I (90,270) [i...	I (0,180) [in4]
1	HR2	HSS6x6x6	Beam	Tube	A500 Gr.46	Typical	7.58	39.5	39.5

Joint Coordinates and Temperatures

	Label	X [ft]	Y [ft]	Temp [F]
1	N1	0	0	0
2	N2	0	8	0
3	N3	7.25	8.54	0

Joint Boundary Conditions

	Joint Label	X [k/in]	Y [k/in]	Rotation[k-ft/rad]	Footing
1	N1	Reaction	Reaction	Reaction	

Member Primary Data

	Label	I Joint	J Joint	Rotate(deg)	Section/Shape	Type	Design List	Material	Design Rules
1	M1	N1	N2		HR2	Beam	Tube	A500 Gr.46	Typical
2	M2	N2	N3		HR2	Beam	Tube	A500 Gr.46	Typical

Joint Loads and Enforced Displacements (BLC 1 : dl)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N3	L	Y	-.2
2	N2	L	Y	-.2

Joint Loads and Enforced Displacements (BLC 2 : ll)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N3	L	Y	-.63
2	N2	L	Y	-.63

Joint Loads and Enforced Displacements (BLC 3 : wind)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N2	L	X	.7

Joint Loads and Enforced Displacements (BLC 4 : -wind)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N2	L	X	-.7

Joint Loads and Enforced Displacements (BLC 5 :)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N3	L	Y	-.32
2	N2	L	Y	-.32

Basic Load Cases

	BLC Description	Category	X Gravity	Y Gravity	Joint	Point	Distributed
1	dl	None		-1	2		
2	ll	None			2		
3	wind	None			1		
4	-wind	None			1		
5		None			2		

Load Combinations

	Description	Solve	PD...	SR...	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor
1	dl+ll	Yes	Y		1	1	2	1												
2	dl+wind	Yes	Y		1	.6	3	.6												
3	dl-wind	Yes	Y		1	.6	4	.6												
4	dl+ll+wind	Yes	Y		1	1	2	.75	3	.45										
5	-ll+dl+wind	Yes	Y		1	1	5	1	4	.5										

Joint Reactions

	LC	Joint Label	X [k]	Y [k]	MZ [k-ft]
1	1	N1	0	2.054	6.812
2	1	Totals:	0	2.054	
3	1	COG (ft):	X: 3.261	Y: 7.841	
4	2	N1	-.42	.476	4.65
5	2	Totals:	-.42	.476	
6	2	COG (ft):	X: 2.683	Y: 7.16	
7	3	N1	.42	.476	-2.085
8	3	Totals:	.42	.476	
9	3	COG (ft):	X: 2.683	Y: 7.16	
10	4	N1	-.315	1.739	8.179
11	4	Totals:	-.315	1.739	
12	4	COG (ft):	X: 3.195	Y: 7.763	
13	5	N1	.35	1.434	1.68
14	5	Totals:	.35	1.434	
15	5	COG (ft):	X: 3.103	Y: 7.656	

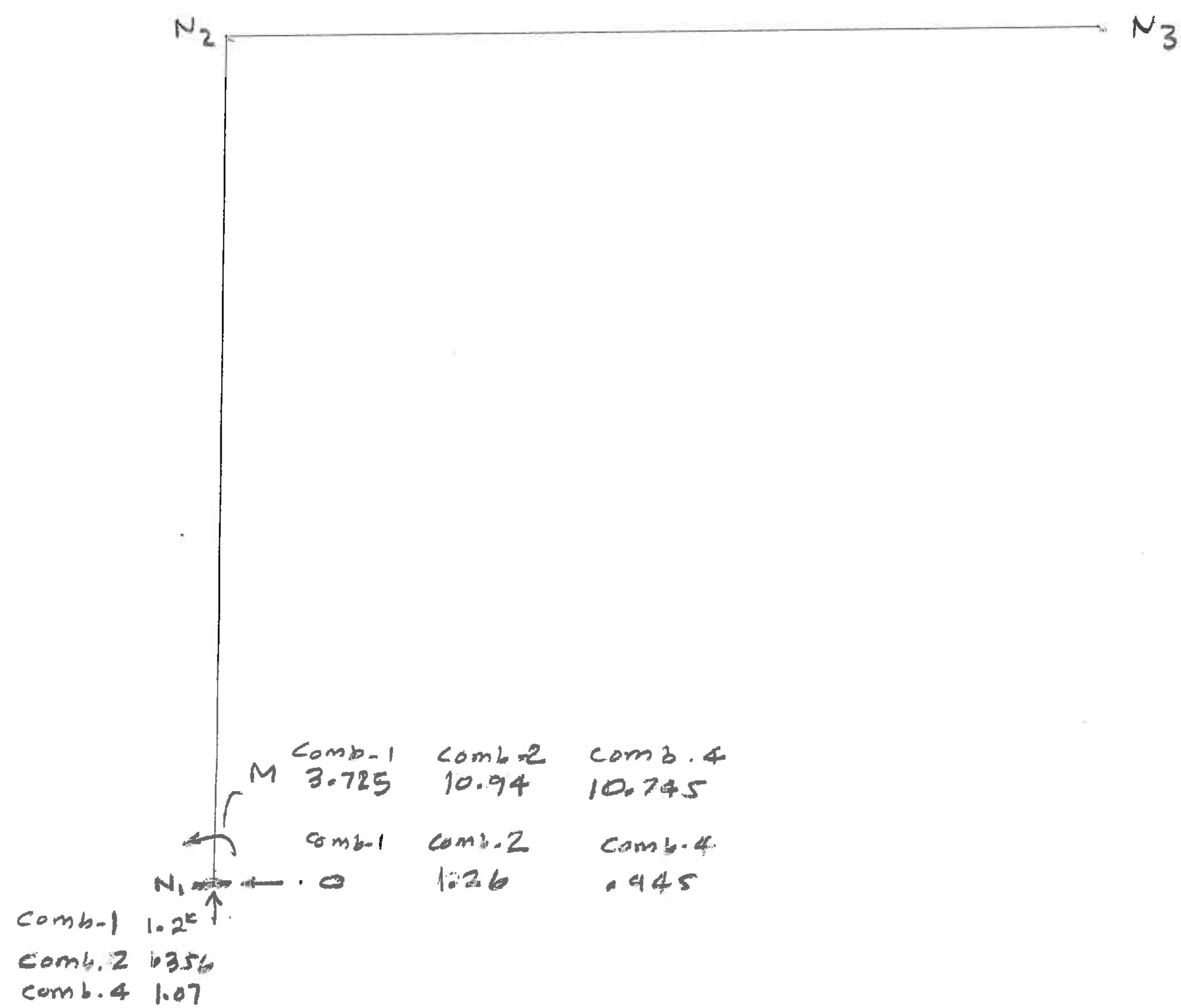
Joint Deflections (By Combination)

	LC	Joint Label	X [in]	Y [in]	Rotation [rad]
1	1	N1	0	0	0
2	1	N2	.409	0	-8.497e-3
3	1	N3	.48	-.959	-1.22e-2
4	2	N1	0	0	0
5	2	N2	.214	0	-3.726e-3
6	2	N3	.241	-.364	-4.379e-3
7	3	N1	0	0	0
8	3	N2	-.059	0	5.076e-4
9	3	N3	-.06	.005	-1.446e-4
10	4	N1	0	0	0
11	4	N2	.442	0	-8.637e-3
12	4	N3	.511	-.932	-1.168e-2
13	5	N1	0	0	0
14	5	N2	.156	0	-3.855e-3
15	5	N3	.192	-.479	-6.269e-3

Member AISC 13th(360-05): ASD Steel Code Checks

	LC	Member	Shape	UC Max	Loc[ft]	Shear UC	Loc[ft]	Pnc/om [k]	Pnt/om [k]	Mn/om [k-ft]	Cb	Eqn
1	1	M1	HSS6x6x6	.193	0	.000	0	185.372	208.79	36.267	1.006	H1-1b
2	1	M2	HSS6x6x6	.185	0	.018	0	189.253	208.79	36.267	1.716	H1-1b
3	2	M1	HSS6x6x6	.130	0	.007	0	185.372	208.79	36.267	1.409	H1-1b
4	2	M2	HSS6x6x6	.035	0	.004	0	189.253	208.79	36.267	1.832	H1-1b
5	3	M1	HSS6x6x6	.059	0	.007	0	185.372	208.79	36.267	1.832	H1-1b
6	3	M2	HSS6x6x6	.035	0	.004	0	189.253	208.79	36.267	2.195	H1-1b
7	4	M1	HSS6x6x6	.230	0	.006	0	185.372	208.79	36.267	1.832	H1-1b
8	4	M2	HSS6x6x6	.154	0	.015	0	189.253	208.79	36.267	1.147	H1-1b
9	5	M1	HSS6x6x6	.126	8	.006	0	185.372	208.79	36.267	1.726	H1-1b
10	5	M2	HSS6x6x6	.123	0	.012	0	189.253	208.79	36.267	1.742	H1-1b

(13)



e2	topock Influent Farm canopy	SK - 1
kd	Frame N2 Exterior column	Apr 2, 2014 at 12:08 PM
ww-peg-2174-043062		topockifc.frameN1.r2d

Assumption Block wall spanning Vertically & Lateral loads applied directly @ Joints

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Hot Rolled Steel Properties

	Label	E [ksi]	G [ksi]	Nu	Therm (\1E5 F)	Density[k/ft^3]	Yield[ksi]
1	A36 Gr.36	29000	11154	.3	.65	.49	36
2	A572 Gr.50	29000	11154	.3	.65	.49	50
3	A992	29000	11154	.3	.65	.49	50
4	A500 Gr.42	29000	11154	.3	.65	.49	42
5	A500 Gr.46	29000	11154	.3	.65	.49	46

Hot Rolled Steel Section Sets

	Label	Shape	Type	Design List	Material	Design Rules	A [in2]	I (90,270) [i...	I (0,180) [in4]
1	HR2	HSS6x6x6	Beam	Tube	A500 Gr.46	Typical	7.58	39.5	39.5
2	HR3	HSS6x6x6	Beam	Tube	A500 Gr.46	Typical	7.58	39.5	39.5

Joint Coordinates and Temperatures

	Label	X [ft]	Y [ft]	Temp [F]
1	N1	0	0	0
2	N2	0	8	0
3	N3	7.25	8.54	0

Joint Boundary Conditions

	Joint Label	X [k/in]	Y [k/in]	Rotation[k-ft/rad]	Footing
1	N1	Reaction	Reaction	Reaction	

Member Primary Data

	Label	I Joint	J Joint	Rotate(deg)	Section/Shape	Type	Design List	Material	Design Rules
1	M1	N1	N2		HR3	Beam	Tube	A500 Gr.46	Typical
2	M2	N2	N3		HR2	Beam	Tube	A500 Gr.46	Typical

Joint Loads and Enforced Displacements (BLC 1 : dl)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N3	L	Y	-.1
2	N2	L	Y	-.1

Joint Loads and Enforced Displacements (BLC 2 : ll)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N3	L	Y	-.315
2	N2	L	Y	-.315

Joint Loads and Enforced Displacements (BLC 3 : wind)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N2	L	X	2.1

Joint Loads and Enforced Displacements (BLC 4 : -wind)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N2	L	X	-2.1

Joint Loads and Enforced Displacements (BLC 5 : -ll)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N3	L	Y	.315

Joint Loads and Enforced Displacements (BLC 5 : -ll) (Continued)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
2	N2	L	Y	.315

Basic Load Cases

	BLC Description	Category	X Gravity	Y Gravity	Joint	Point	Distributed
1	dl	None		-1	2		
2	ll	None			2		
3	wind	None			1		
4	-wind	None			1		
5	-ll	None			2		

Load Combinations

	Description	Solve	PD...	SR...	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor
1	dl+ll	Yes	Y		1	1	2	1												
2	dl+wind	Yes	Y		1	.6	3	.6												
3	dl-wind	Yes	Y		1	.6	4	.6												
4	dl+ll+wind	Yes	Y		1	1	2	.75	3	.45										
5	-ll+dl+wind	Yes	Y		1	1	5	.5	4	.5										

Joint Reactions

	LC	Joint Label	X [k]	Y [k]	MZ [k-ft]
1	1	N1	0	1.224	3.725
2	1	Totals:	0	1.224	
3	1	COG (ft):	X: 3.014	Y: 7.55	
4	2	N1	-1.26	.356	10.942
5	2	Totals:	-1.26	.356	
6	2	COG (ft):	X: 2.365	Y: 6.786	
7	3	N1	1.26	.356	-9.252
8	3	Totals:	1.26	.356	
9	3	COG (ft):	X: 2.365	Y: 6.786	
10	4	N1	-.945	1.066	10.745
11	4	Totals:	-.945	1.066	
12	4	COG (ft):	X: 2.924	Y: 7.444	
13	5	N1	1.05	.279	-8.145
14	5	Totals:	1.05	.279	
15	5	COG (ft):	X: .943	Y: 5.11	

Joint Deflections (By Combination)

	LC	Joint Label	X [in]	Y [in]	Rotation [rad]
1	1	N1	0	0	0
2	1	N2	.224	0	-4.661e-3
3	1	N3	.263	-.524	-6.64e-3
4	2	N1	0	0	0
5	2	N2	.46	0	-7.408e-3
6	2	N3	.51	-.669	-7.812e-3
7	3	N1	0	0	0
8	3	N2	-.358	0	5.286e-3
9	3	N3	-.391	.435	4.882e-3
10	4	N1	0	0	0
11	4	N2	.497	0	-8.716e-3
12	4	N3	.561	-.857	-1.037e-2
13	5	N1	0	0	0
14	5	N2	-.325	0	4.954e-3

Joint Deflections (By Combination) (Continued)

	LC	Joint Label	X [in]	Y [in]	Rotation [rad]
15	5	N3	-.357	.428	4.934e-3

Member AISC 13th(360-05): ASD Steel Code Checks

	LC	Member	Shape	UC Max	Loc[ft]	Shear UC	Loc[ft]	Pnc/om [k]	Pnt/om [k]	Mn/om [k-ft]	Cb	Eqn
1	1	M1	HSS6x6x6	.106	0	.000	0	185.372	208.79	36.267	1.004	H1-1b
2	1	M2	HSS6x6x6	.102	0	.011	0	189.253	208.79	36.267	1.758	H1-1b
3	2	M1	HSS6x6x6	.303	0	.022	0	185.372	208.79	36.267	1.585	H1-1b
4	2	M2	HSS6x6x6	.023	0	.003	0	189.253	208.79	36.267	1.931	H1-1b
5	3	M1	HSS6x6x6	.256	0	.022	0	185.372	208.79	36.267	1.774	H1-1b
6	3	M2	HSS6x6x6	.023	0	.003	0	189.253	208.79	36.267	1.932	H1-1b
7	4	M1	HSS6x6x6	.299	0	.017	0	185.372	208.79	36.267	1.396	H1-1b
8	4	M2	HSS6x6x6	.086	0	.009	0	189.253	208.79	36.267	1.776	H1-1b
9	5	M1	HSS6x6x6	.225	0	.018	0	185.372	208.79	36.267	1.703	H1-1b
10	5	M2	HSS6x6x6	.007	0	.002	0	189.253	208.79	36.267	2.725	H1-1b

Note: Calc's based on Block wall spanning horizontally apply loads to col. (as distributed load), Based on results columns not affected with respect to size and outputs for Frame N & N2 are OK (18)

Hot Rolled Steel Properties

	Label	E [ksi]	G [ksi]	Nu	Therm (\1E5 F)	Density[k/ft^3]	Yield[ksi]
1	A36 Gr.36	29000	11154	.3	.65	.49	36
2	A572 Gr.50	29000	11154	.3	.65	.49	50
3	A992	29000	11154	.3	.65	.49	50
4	A500 Gr.42	29000	11154	.3	.65	.49	42
5	A500 Gr.46	29000	11154	.3	.65	.49	46

Hot Rolled Steel Section Sets

	Label	Shape	Type	Design List	Material	Design Rules	A [in2]	I (90,270) [i...	I (0,180) [in4]
1	HR2	HSS6x6x6	Beam	Tube	A500 Gr.46	Typical	7.58	39.5	39.5

Joint Coordinates and Temperatures

	Label	X [ft]	Y [ft]	Temp [F]
1	N1	0	0	0
2	N2	0	8	0
3	N3	7.25	8.54	0

Joint Boundary Conditions

	Joint Label	X [k/in]	Y [k/in]	Rotation[k-ft/rad]	Footing
1	N1	Reaction	Reaction	Reaction	

Member Primary Data

	Label	I Joint	J Joint	Rotate(deg)	Section/Shape	Type	Design List	Material	Design Rules
1	M1	N1	N2		HR2	Beam	Tube	A500 Gr.46	Typical
2	M2	N2	N3		HR2	Beam	Tube	A500 Gr.46	Typical

Joint Loads and Enforced Displacements (BLC 1 : dl)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N3	L	Y	-.2
2	N2	L	Y	-.2

Joint Loads and Enforced Displacements (BLC 2 : ll)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N3	L	Y	-.63
2	N2	L	Y	-.63

Joint Loads and Enforced Displacements (BLC 5 : .5 ll)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N3	L	Y	-.32
2	N2	L	Y	-.32

Member Distributed Loads (BLC 3 : wind)

	Member Label	Direction	Start Magnitude[k/ft,F]	End Magnitude[k/ft,F]	Start Location[ft,%]	End Location[ft,%]
1	M1	x	.177	.177	0	8

Member Distributed Loads (BLC 4 : -wind)

Member Label	Direction	Start Magnitude[k/ft,F]	End Magnitude[k/ft,F]	Start Location[ft,%]	End Location[ft,%]

Member Distributed Loads (BLC 4 : -wind) (Continued)

	Member Label	Direction	Start Magnitude[k/ft,F]	End Magnitude[k/ft,F]	Start Location[ft,%]	End Location[ft,%]
1	M1	X	-.177	-.177	0	8

Basic Load Cases

	BLC Description	Category	X Gravity	Y Gravity	Joint	Point	Distributed
1	dl	None		-1	2		
2	ll	None			2		
3	wind	None					1
4	-wind	None					1
5	.5 ll	None			2		

Load Combinations

	Description	Solve	PD...	SR...	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor
1	dl+ll	Yes	Y		1	1	2	1												
2	dl+wind	Yes	Y		1	.6	3	.6												
3	dl-wind	Yes	Y		1	.6	4	.6												
4	dl+ll+wind	Yes	Y		1	1	2	.75	3	.45										
5	.5 ll+dl- col w...	Yes	Y		1	1	5	1	4	.75										
6	.5ll +dl+col w...	Yes	Y		1	1	5	1	3	.75										

Joint Reactions (By Combination)

	LC	Joint Label	X [k]	Y [k]	MZ [k-ft]
1	1	N1	0	2.054	6.812
2	1	Totals:	0	2.054	
3	1	COG (ft):	X: 3.281	Y: 7.841	
4	2	N1	0	-.373	1.278
5	2	Totals:	0	-.373	
6	2	COG (ft):	X: -3.423	Y: -.032	
7	3	N1	.85	.476	-2.122
8	3	Totals:	.85	.476	
9	3	COG (ft):	X: 2.683	Y: 7.16	
10	4	N1	0	1.102	5.621
11	4	Totals:	0	1.102	
12	4	COG (ft):	X: 5.043	Y: 9.94	
13	5	N1	1.062	1.434	.23
14	5	Totals:	1.062	1.434	
15	5	COG (ft):	X: 3.103	Y: 7.656	
16	6	N1	0	.372	4.482
17	6	Totals:	0	.372	
18	6	COG (ft):	X: 11.966	Y: 18.095	

Joint Deflections (By Combination)

	LC	Joint Label	X [in]	Y [in]	Rotation [rad]
1	1	N1	0	0	0
2	1	N2	.409	0	-8.497e-3
3	1	N3	.48	-.959	-1.22e-2
4	2	N1	0	0	0
5	2	N2	.077	0	-1.607e-3
6	2	N3	.09	-.179	-2.259e-3
7	3	N1	0	0	0
8	3	N2	-.026	0	-1.815e-4
9	3	N3	-.022	-.055	-8.339e-4
10	4	N1	0	0	0

Joint Deflections (By Combination) (Continued)

	LC	Joint Label	X [in]	Y [in]	Rotation [rad]
11	4	N2	.338	0	-7.029e-3
12	4	N3	.397	-.792	-1.008e-2
13	5	N1	0	0	0
14	5	N2	.14	0	-3.833e-3
15	5	N3	.176	-.477	-6.247e-3
16	6	N1	0	0	0
17	6	N2	.27	0	-5.617e-3
18	6	N3	.317	-.632	-8.031e-3

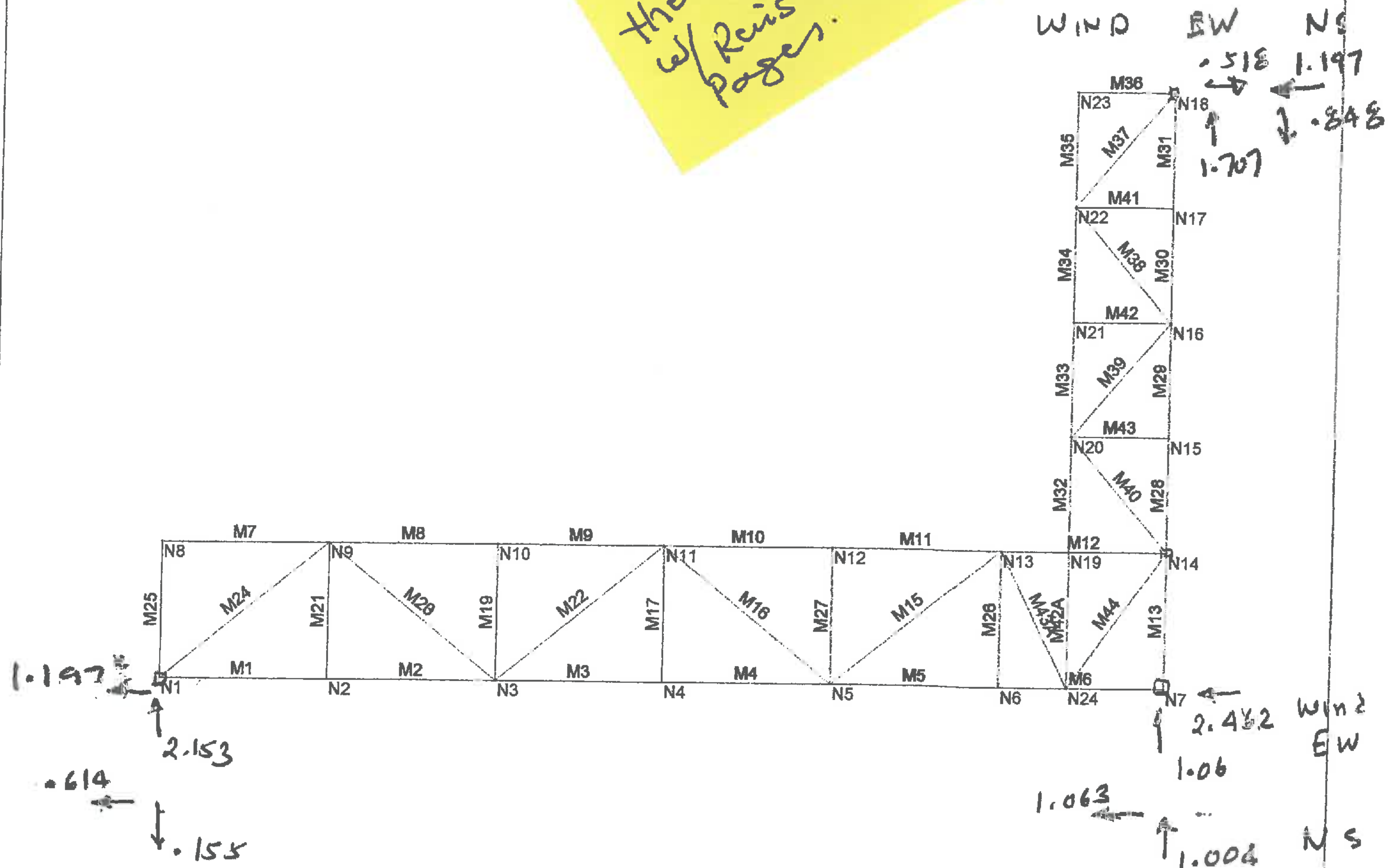
Member AISC 13th(360-05): ASD Steel Code Checks (By Combination)

	LC	Member	Shape	UC Max	Loc[ft]	Shear UC	Loc[ft]	Pnc/om [k]	Pnt/om [k]	Mn/om [k-ft]	Cb	Eqn
1	1	M1	HSS6x6x6	.193	0	.000	0	185.372	208.79	36.267	1.006	H1-1b
2	1	M2	HSS6x6x6	.185	0	.018	0	189.253	208.79	36.267	1.716	H1-1b
3	2	M1	HSS6x6x6	.036	8	.000	0	185.372	208.79	36.267	1	H1-1b
4	2	M2	HSS6x6x6	.035	0	.004	0	189.253	208.79	36.267	1.832	H1-1b
5	3	M1	HSS6x6x6	.060	0	.015	0	185.372	208.79	36.267	2.189	H1-1b
6	3	M2	HSS6x6x6	.035	0	.004	0	189.253	208.79	36.267	1.832	H1-1b
7	4	M1	HSS6x6x6	.158	0	.000	0	185.372	208.79	36.267	1.004	H1-1b
8	4	M2	HSS6x6x6	.154	0	.015	0	189.253	208.79	36.267	1.726	H1-1b
9	5	M1	HSS6x6x6	.126	7.917	.019	0	185.372	208.79	36.267	1.277	H1-1b
10	5	M2	HSS6x6x6	.123	0	.012	0	189.253	208.79	36.267	1.742	H1-1b
11	6	M1	HSS6x6x6	.126	8	.000	0	185.372	208.79	36.267	1.003	H1-1b
12	6	M2	HSS6x6x6	.123	0	.012	0	189.253	208.79	36.267	1.742	H1-1b

(21)

Arbitrary
N ←

Replaced these pages w/ Revised pages.



Total Load to be Resisted by Blk wall

EW Dir. V = 4.92 k
NS Dir. V = 2.874 k

} Design walls in EW Dir for Max V = 4.92 k

e2	Conditioned water Tank farm. ~~Influent~~ farm double canopy roof	SK - 1
		June 11, 2014 at 12:46 PM
		inflcanopy.diaph.r2d

Hot Rolled Steel Properties

	Label	E [ksi]	G [ksi]	Nu	Therm (\1E5 F)	Density[k/ft^3]	Yield[ksi]
1	A36 Gr.36	29000	11154	.3	.65	.49	36
2	A572 Gr.50	29000	11154	.3	.65	.49	50
3	A992	29000	11154	.3	.65	.49	50
4	A500 Gr.B RND	29000	11154	.3	.65	.49	42
5	A500 Gr.B Rect	29000	11154	.3	.65	.49	46
6	A53 Gr.B	29000	11154	.3	.65	.49	35

Hot Rolled Steel Section Sets

	Label	Shape	Type	Design List	Material	Design Rules	A [in2]	I (90,270) [i...	I (0,180) [in4]
1	HR1	HSS4x4x6	Beam	Tube	A500 Gr.B Rect	Typical	4.78	10.3	10.3
2	HR2	HSS6x6x6	Beam	Tube	A500 Gr.B Rect	Typical	7.58	39.5	39.5
3	HR3	HSS6x4x6	Beam	Tube	A500 Gr.B Rect	Typical	6.18	14.9	28.3

Joint Coordinates and Temperatures

	Label	X [ft]	Y [ft]	Temp [F]
1	N1	0	0	0
2	N2	8.5	0	0
3	N3	17	0	0
4	N4	25.5	0	0
5	N5	34	0	0
6	N6	42.5	0	0
7	N7	51	0	0
8	N8	0	6.917	0
9	N9	8.5	6.917	0
10	N10	17	6.917	0
11	N11	25.5	6.917	0
12	N12	34	6.917	0
13	N13	42.5	6.917	0
14	N14	51	6.917	0
15	N15	51	12.75	0
16	N16	51	18.583	0
17	N17	51	24.416	0
18	N18	51	30.249	0
19	N19	46	6.917	0
20	N20	46	12.75	0
21	N21	46	18.583	0
22	N22	46	24.416	0
23	N23	46	30.249	0
24	N24	46	0	0

Joint Boundary Conditions

	Joint Label	X [k/in]	Y [k/in]	Rotation[k-ft/rad]	Footing
1	N1	Reaction	Reaction		
2	N7	Reaction	Reaction		
3	N18	Reaction	Reaction		

Member Primary Data

	Label	I Joint	J Joint	Rotate(deg)	Section/Shape	Type	Design List	Material	Design Rules
1	M1	N1	N2		HR1	Beam	Tube	A500 Gr.B ...	Typical
2	M2	N2	N3		HR1	Beam	Tube	A500 Gr.B ...	Typical
3	M3	N3	N4		HR1	Beam	Tube	A500 Gr.B ...	Typical

Member Primary Data (Continued)

	Label	I Joint	J Joint	Rotate(deg)	Section/Shape	Type	Design List	Material	Design Rules
4	M4	N4	N5		HR1	Beam	Tube	A500 Gr.B ...	Typical
5	M5	N5	N6		HR1	Beam	Tube	A500 Gr.B ...	Typical
6	M6	N6	N7		HR1	Beam	Tube	A500 Gr.B ...	Typical
7	M7	N8	N9		HR1	Beam	Tube	A500 Gr.B ...	Typical
8	M8	N9	N10		HR1	Beam	Tube	A500 Gr.B ...	Typical
9	M9	N10	N11		HR1	Beam	Tube	A500 Gr.B ...	Typical
10	M10	N11	N12		HR1	Beam	Tube	A500 Gr.B ...	Typical
11	M11	N12	N13		HR1	Beam	Tube	A500 Gr.B ...	Typical
12	M12	N13	N14		HR3	Beam	Tube	A500 Gr.B ...	Typical
13	M13	N14	N7		HR1	Beam	Tube	A500 Gr.B ...	Typical
14	M15	N13	N5		HR1	Beam	Tube	A500 Gr.B ...	Typical
15	M16	N5	N11		HR1	Beam	Tube	A500 Gr.B ...	Typical
16	M17	N11	N4		HR2	Beam	Tube	A500 Gr.B ...	Typical
17	M19	N10	N3		HR2	Beam	Tube	A500 Gr.B ...	Typical
18	M20	N3	N9		HR1	Beam	Tube	A500 Gr.B ...	Typical
19	M21	N9	N2		HR1	Beam	Tube	A500 Gr.B ...	Typical
20	M22	N11	N3		HR1	Beam	Tube	A500 Gr.B ...	Typical
21	M24	N9	N1		HR1	Beam	Tube	A500 Gr.B ...	Typical
22	M25	N1	N3		HR2	Beam	Tube	A500 Gr.B ...	Typical
23	M26	N6	N13		HR2	Beam	Tube	A500 Gr.B ...	Typical
24	M27	N5	N12		HR2	Beam	Tube	A500 Gr.B ...	Typical
25	M28	N14	N15		HR1	Beam	Tube	A500 Gr.B ...	Typical
26	M29	N15	N16		HR1	Beam	Tube	A500 Gr.B ...	Typical
27	M30	N16	N17		HR1	Beam	Tube	A500 Gr.B ...	Typical
28	M31	N17	N18		HR1	Beam	Tube	A500 Gr.B ...	Typical
29	M32	N19	N20		HR1	Beam	Tube	A500 Gr.B ...	Typical
30	M33	N20	N21		HR1	Beam	Tube	A500 Gr.B ...	Typical
31	M34	N21	N22		HR1	Beam	Tube	A500 Gr.B ...	Typical
32	M35	N22	N23		HR1	Beam	Tube	A500 Gr.B ...	Typical
33	M36	N23	N18		HR3	Beam	Tube	A500 Gr.B ...	Typical
34	M37	N18	N22		HR1	Beam	Tube	A500 Gr.B ...	Typical
35	M38	N22	N16		HR1	Beam	Tube	A500 Gr.B ...	Typical
36	M39	N16	N20		HR1	Beam	Tube	A500 Gr.B ...	Typical
37	M40	N20	N14		HR1	Beam	Tube	A500 Gr.B ...	Typical
38	M41	N17	N22		HR3	Beam	Tube	A500 Gr.B ...	Typical
39	M42	N16	N21		HR3	Beam	Tube	A500 Gr.B ...	Typical
40	M43	N15	N20		HR3	Beam	Tube	A500 Gr.B ...	Typical
41	M42A	N19	N24		HR2	Beam	Tube	A500 Gr.B ...	Typical
42	M43A	N13	N24		HR1	Beam	Tube	A500 Gr.B ...	Typical
43	M44	N24	N14		HR1	Beam	Tube	A500 Gr.B ...	Typical

Joint Loads and Enforced Displacements (BLC 1 : wind - ns)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N7	L	X	.3
2	N14	L	X	.6
3	N15	L	X	.564
4	N16	L	X	.564
5	N17	L	X	.564
6	N18	L	X	.282

$\Sigma V = 2.874^k$

Joint Loads and Enforced Displacements (BLC 2 : wind - ew)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N1	L	Y	-.41
2	N2	L	Y	-.82
3	N3	L	Y	-.82
4	N4	L	Y	-.82

Joint Loads and Enforced Displacements (BLC 2 : wind - ew) (Continued)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
5	N5	L	Y	-.82
6	N6	L	Y	-.58
7	N24	L	Y	-.41
8	N17	L	Y	-.24

Σ V = 4.92 k

Member Distributed Loads

Member Label	Direction	Start Magnitude[k/ft,F]	End Magnitude[k/ft,F]	Start Location[ft,%]	End Location[ft,%]
No Data to Print ...					

Basic Load Cases

	BLC Description	Category	X Gravity	Y Gravity	Joint	Point	Distributed
1	wind - ns	None			6		
2	wind - ew	None			8		

Load Combinations

	Description	Solve	PD...	SR...	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor
1	wind ns	Yes	Y		1	1														
2	wind ew	Yes	Y		2	1														

Joint Reactions

	LC	Joint Label	X [k]	Y [k]	MZ [k-ft]
1	1	N1	-.614	-.155	0
2	1	N7	-1.063	1.004	0
3	1	N18	-1.197	-.848	0
4	1	Totals:	-2.874	0	
5	1	COG (ft):	NC	NC	
6	2	N1	1.944	2.153	0
7	2	N7	-2.462	1.06	0
8	2	N18	.518	1.707	0
9	2	Totals:	0	4.92	
10	2	COG (ft):	X: 25.498	Y: 1.191	

Joint Deflections

	LC	Joint Label	X [in]	Y [in]	Rotation [rad]
1	1	N1	0	0	-7.749e-7
2	1	N2	0	0	5.61e-6
3	1	N3	0	.001	4.033e-6
4	1	N4	0	.002	1.144e-6
5	1	N5	0	.002	-5.297e-6
6	1	N6	0	0	-1.509e-5
7	1	N7	0	0	-1.434e-5
8	1	N8	0	0	-1.448e-6
9	1	N9	0	0	5.267e-6
10	1	N10	0	.001	4.075e-6
11	1	N11	0	.002	1.125e-6
12	1	N12	.001	.002	-5.164e-6
13	1	N13	.002	0	-1.623e-5
14	1	N14	.002	0	-2.113e-5
15	1	N15	.005	0	-1.252e-5
16	1	N16	.005	0	8.008e-6

Joint Deflections (Continued)

	LC	Joint Label	X [in]	Y [in]	Rotation [rad]
17	1	N17	.003	0	2.889e-5
18	1	N18	0	0	3.288e-5
19	1	N19	.002	0	-1.93e-5
20	1	N20	.004	0	-1.487e-5
21	1	N21	.005	0	8.703e-6
22	1	N22	.003	-.001	2.611e-5
23	1	N23	0	-.001	1.918e-5
24	1	N24	0	0	-1.544e-5
25	2	N1	0	0	-8.049e-5
26	2	N2	0	-.012	-9.378e-5
27	2	N3	0	-.02	-3.837e-5
28	2	N4	.001	-.021	8.263e-6
29	2	N5	.002	-.017	5.186e-5
30	2	N6	.001	-.007	6.427e-5
31	2	N7	0	0	4.926e-5
32	2	N8	.006	0	-6.242e-5
33	2	N9	.006	-.011	-8.596e-5
34	2	N10	.003	-.02	-3.993e-5
35	2	N11	0	-.021	8.883e-6
36	2	N12	0	-.017	4.793e-5
37	2	N13	-.003	-.007	9.529e-5
38	2	N14	-.003	0	1.486e-5
39	2	N15	-.003	0	7.071e-6
40	2	N16	-.002	0	-9.104e-6
41	2	N17	0	0	-1.166e-5
42	2	N18	0	0	-2.617e-7
43	2	N19	-.003	-.003	6.338e-5
44	2	N20	-.003	-.001	-4.25e-7
45	2	N21	-.002	0	-8.222e-6
46	2	N22	0	0	-1.073e-5
47	2	N23	0	0	4.182e-6
48	2	N24	.001	-.003	6.034e-5

Member AISC 14th(360-10): ASD Steel Code Checks

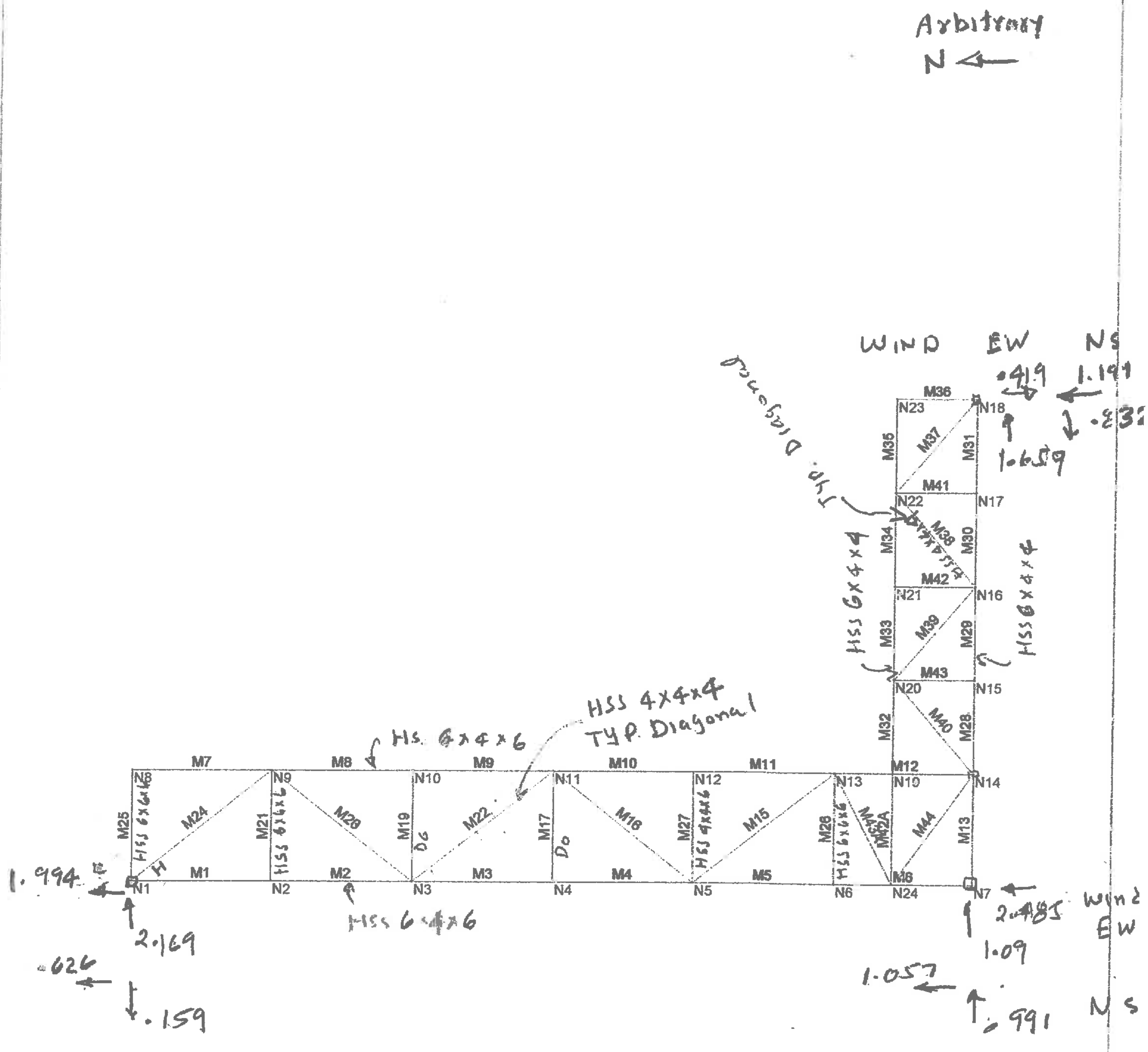
	LC	Member	Shape	UC Max	Loc[ft]	Shear UC	Loc[ft]	Pnc/om [k]	Pnt/om [k]	Mn/om [k-ft]	Cb	Eqn
1	1	M1	HSS4x4x6	.002	8.5	.000	0	95.152	131.665	14.668	1.006	H1-1b
2	1	M2	HSS4x4x6	.002	8.5	.000	0	95.152	131.665	14.668	2.252	H1-1b
3	1	M3	HSS4x4x6	.000	8.5	.000	0	95.152	131.665	14.668	1.726	H1-1b
4	1	M4	HSS4x4x6	.001	8.5	.000	0	95.152	131.665	14.668	2.21	H1-1b
5	1	M5	HSS4x4x6	.002	8.5	.000	0	95.152	131.665	14.668	1.24	H1-1b
6	1	M6	HSS4x4x6	.005	3.542	.000	3.542	95.152	131.665	14.668	2.132	H1-1b
7	1	M7	HSS4x4x6	.000	8.5	.000	0	95.152	131.665	14.668	1.667	H1-1b
8	1	M8	HSS4x4x6	.002	8.5	.000	0	95.152	131.665	14.668	2.257	H1-1b
9	1	M9	HSS4x4x6	.002	8.5	.000	0	95.152	131.665	14.668	1.701	H1-1b
10	1	M10	HSS4x4x6	.003	8.5	.000	0	95.152	131.665	14.668	2.211	H1-1b
11	1	M11	HSS4x4x6	.003	8.5	.000	0	95.152	131.665	14.668	1.399	H1-1b
12	1	M12	HSS6x4x6	.004	8.5	.000	3.542	127.34	170.228	27.315	2.102	H1-1b
13	1	M13	HSS4x4x6	.006	6.917	.000	0	106.185	131.665	14.668	2.234	H1-1b
14	1	M15	HSS4x4x6	.001	0	.000	0	76.738	131.665	14.668	1	H1-1b
15	1	M16	HSS4x4x6	.002	0	.000	0	76.738	131.665	14.668	1	H1-1b
16	1	M17	HSS6x6x6	.000	6.917	.000	0	191.023	208.79	36.267	2.272	H1-1b
17	1	M19	HSS6x6x6	.000	0	.000	0	191.023	208.79	36.267	2.27	H1-1b
18	1	M20	HSS4x4x6	.002	0	.000	0	76.738	131.665	14.668	1	H1-1b
19	1	M21	HSS4x4x6	.000	6.917	.000	0	106.185	131.665	14.668	2.265	H1-1b
20	1	M22	HSS4x4x6	.001	0	.000	0	76.738	131.665	14.668	1	H1-1b
21	1	M24	HSS4x4x6	.001	0	.000	0	76.738	131.665	14.668	1	H1-1b

Member AISC 14th(360-10): ASD Steel Code Checks (Continued)

	LC	Member	Shape	UC Max	Loc[ft]	Shear UC	Loc[ft]	Pnc/om [k]	Pnt/om [k]	Mn/om [k-ft]	Cb	Eqn
22	1	M25	HSS6x6x6	.000	0	.000	0	191.023	208.79	36.267	1.667	H1-1b
23	1	M26	HSS6x6x6	.000	0	.000	0	191.023	208.79	36.267	2.179	H1-1b
24	1	M27	HSS6x6x6	.000	6.917	.000	0	191.023	208.79	36.267	2.266	H1-1b
25	1	M28	HSS4x4x6	.003	5.833	.000	0	112.991	131.665	14.668	2.234	H1-1b
26	1	M29	HSS4x4x6	.002	5.833	.000	0	112.991	131.665	14.668	1.82	H1-1b
27	1	M30	HSS4x4x6	.002	0	.000	0	112.991	131.665	14.668	2.067	H1-1b
28	1	M31	HSS4x4x6	.003	0	.000	0	112.991	131.665	14.668	2.256	H1-1b
29	1	M32	HSS4x4x6	.003	5.833	.000	0	112.991	131.665	14.668	2.254	H1-1b
30	1	M33	HSS4x4x6	.008	5.833	.000	0	112.991	131.665	14.668	1.957	H1-1b
31	1	M34	HSS4x4x6	.008	0	.000	0	112.991	131.665	14.668	2.183	H1-1b
32	1	M35	HSS4x4x6	.001	0	.000	0	112.991	131.665	14.668	1.667	H1-1b
33	1	M36	HSS6x4x6	.001	5	.000	0	153.96	170.228	27.315	1.667	H1-1b
34	1	M37	HSS4x4x6	.007	0	.000	0	100.98	131.665	14.668	1	H1-1b
35	1	M38	HSS4x4x6	.002	0	.000	0	100.98	131.665	14.668	1	H1-1b
36	1	M39	HSS4x4x6	.001	0	.000	0	100.98	131.665	14.668	1	H1-1b
37	1	M40	HSS4x4x6	.006	0	.000	0	100.98	131.665	14.668	1	H1-1b
38	1	M41	HSS6x4x6	.003	0	.000	0	153.96	170.228	27.315	2.241	H1-1b
39	1	M42	HSS6x4x6	.000	5	.000	0	153.96	170.228	27.315	2.218	H1-1b
40	1	M43	HSS6x4x6	.003	5	.000	0	153.96	170.228	27.315	2.245	H1-1b
41	1	M42A	HSS6x6x6	.001	6.917	.000	0	191.023	208.79	36.267	2.201	H1-1b
42	1	M43A	HSS4x4x6	.001	0	.000	0	100.495	131.665	14.668	1	H1-1b
43	1	M44	HSS4x4x6	.002	0	.000	0	94.897	131.665	14.668	1	H1-1b
44	2	M1	HSS4x4x6	.003	0	.000	0	95.152	131.665	14.668	2.241	H1-1b
45	2	M2	HSS4x4x6	.003	8.5	.000	0	95.152	131.665	14.668	1.984	H1-1b
46	2	M3	HSS4x4x6	.006	0	.000	0	95.152	131.665	14.668	1.261	H1-1b
47	2	M4	HSS4x4x6	.007	0	.000	0	95.152	131.665	14.668	1.759	H1-1b
48	2	M5	HSS4x4x6	.010	0	.000	0	95.152	131.665	14.668	2.252	H1-1b
49	2	M6	HSS4x4x6	.014	8.5	.001	0	95.152	131.665	14.668	3.686	H1-1b
50	2	M7	HSS4x4x6	.001	8.5	.000	0	95.152	131.665	14.668	1.667	H1-1b
51	2	M8	HSS4x4x6	.020	8.5	.000	0	95.152	131.665	14.668	2.173	H1-1b
52	2	M9	HSS4x4x6	.018	0	.000	0	95.152	131.665	14.668	1.526	H1-1b
53	2	M10	HSS4x4x6	.014	0	.000	0	95.152	131.665	14.668	1.722	H1-1b
54	2	M11	HSS4x4x6	.016	0	.000	0	95.152	131.665	14.668	2.183	H1-1b
55	2	M12	HSS6x4x6	.010	3.453	.002	0	127.34	170.228	27.315	2.376	H1-1b
56	2	M13	HSS4x4x6	.006	6.917	.000	0	106.185	131.665	14.668	1.069	H1-1b
57	2	M15	HSS4x4x6	.009	0	.000	0	76.738	131.665	14.668	1	H1-1b
58	2	M16	HSS4x4x6	.007	0	.000	0	76.738	131.665	14.668	1	H1-1b
59	2	M17	HSS6x6x6	.002	0	.000	0	191.023	208.79	36.267	2.256	H1-1b
60	2	M19	HSS6x6x6	.001	0	.000	0	191.023	208.79	36.267	2.242	H1-1b
61	2	M20	HSS4x4x6	.005	0	.000	0	76.738	131.665	14.668	1	H1-1b
62	2	M21	HSS4x4x6	.005	6.917	.000	0	106.185	131.665	14.668	2.251	H1-1b
63	2	M22	HSS4x4x6	.001	0	.000	0	76.738	131.665	14.668	1	H1-1b
64	2	M24	HSS4x4x6	.018	0	.000	0	76.738	131.665	14.668	1	H1-1b
65	2	M25	HSS6x6x6	.001	0	.000	0	191.023	208.79	36.267	1.667	H1-1b
66	2	M26	HSS6x6x6	.006	6.917	.001	0	191.023	208.79	36.267	2.208	H1-1b
67	2	M27	HSS6x6x6	.001	0	.000	0	191.023	208.79	36.267	2.243	H1-1b
68	2	M28	HSS4x4x6	.003	0	.000	0	112.991	131.665	14.668	2.224	H1-1b
69	2	M29	HSS4x4x6	.002	0	.000	0	112.991	131.665	14.668	1.9	H1-1b
70	2	M30	HSS4x4x6	.005	0	.000	0	112.991	131.665	14.668	2.261	H1-1b
71	2	M31	HSS4x4x6	.005	5.833	.000	0	112.991	131.665	14.668	1.922	H1-1b
72	2	M32	HSS4x4x6	.014	0	.001	0	112.991	131.665	14.668	2.173	H1-1b
73	2	M33	HSS4x4x6	.005	0	.000	0	112.991	131.665	14.668	1.39	H1-1b
74	2	M34	HSS4x4x6	.006	0	.000	0	112.991	131.665	14.668	2.262	H1-1b
75	2	M35	HSS4x4x6	.000	0	.000	0	112.991	131.665	14.668	1.667	H1-1b
76	2	M36	HSS6x4x6	.000	5	.000	0	153.96	170.228	27.315	1.667	H1-1b
77	2	M37	HSS4x4x6	.003	0	.000	0	100.98	131.665	14.668	1	H1-1b
78	2	M38	HSS4x4x6	.004	0	.000	0	100.98	131.665	14.668	1	H1-1b

Member AISC 14th(360-10): ASD Steel Code Checks (Continued)

	LC	Member	Shape	UC Max	Loc[ft]	Shear UC	Loc[ft]	Pnc/om [k]	Pnt/om [k]	Mn/om [k-ft]	Cb	Eqn
79	2	M39	HSS4x4x6	.003	0	.000	0	100.98	131.665	14.668	1	H1-1b
80	2	M40	HSS4x4x6	.004	0	.000	0	100.98	131.665	14.668	1	H1-1b
81	2	M41	HSS6x4x6	.001	0	.000	0	153.96	170.228	27.315	2.259	H1-1b
82	2	M42	HSS6x4x6	.001	0	.000	0	153.96	170.228	27.315	2.261	H1-1b
83	2	M43	HSS6x4x6	.001	5	.000	0	153.96	170.228	27.315	2.202	H1-1b
84	2	M42A	HSS6x6x6	.008	0	.000	0	191.023	208.79	36.267	2.26	H1-1b
85	2	M43A	HSS4x4x6	.011	0	.000	0	100.495	131.665	14.668	1	H1-1b
86	2	M44	HSS4x4x6	.001	0	.000	0	94.897	131.665	14.668	1	H1-1b



Total Load to be Resisted by Blk Wall

EW Dir. $V = 4.92^k$ } Design walls in EW Dir for Max $V = 4.92^k$

NS Dir. $V = 2.874^k$

e2	Conditioned water Tank farm. ~~Influent~~ farm double canopy roof	SK - 1
		June 11, 2014 at 12:46 PM
		inflcanopy.diaph.r2d

Hot Rolled Steel Properties

	Label	E [ksi]	G [ksi]	Nu	Therm (\1E5 F)	Density[k/ft^3]	Yield[ksi]
1	A36 Gr.36	29000	11154	.3	.65	.49	36
2	A572 Gr.50	29000	11154	.3	.65	.49	50
3	A992	29000	11154	.3	.65	.49	50
4	A500 Gr.B RND	29000	11154	.3	.65	.49	42
5	A500 Gr.B Rect	29000	11154	.3	.65	.49	46
6	A53 Gr.B	29000	11154	.3	.65	.49	35

Hot Rolled Steel Section Sets

	Label	Shape	Type	Design List	Material	Design Rules	A [in2]	I (90,270) [i...	I (0,180) [in4]
1	HR1	HSS4x4x4	HBrace	Wide Flange	A500 Gr.B Rect	Typical	3.37	7.8	7.8
2	HR2	HSS6x6x6	Beam	Tube	A500 Gr.B Rect	Typical	7.58	39.5	39.5
3	HR3	HSS6x4x6	Beam	Tube	A500 Gr.B Rect	Typical	6.18	14.9	28.3

Joint Coordinates and Temperatures

	Label	X [ft]	Y [ft]	Temp [F]
1	N1	0	0	0
2	N2	8.5	0	0
3	N3	17	0	0
4	N4	25.5	0	0
5	N5	34	0	0
6	N6	42.5	0	0
7	N7	51	0	0
8	N8	0	6.917	0
9	N9	8.5	6.917	0
10	N10	17	6.917	0
11	N11	25.5	6.917	0
12	N12	34	6.917	0
13	N13	42.5	6.917	0
14	N14	51	6.917	0
15	N15	51	12.75	0
16	N16	51	18.583	0
17	N17	51	24.416	0
18	N18	51	30.249	0
19	N19	46	6.917	0
20	N20	46	12.75	0
21	N21	46	18.583	0
22	N22	46	24.416	0
23	N23	46	30.249	0
24	N24	46	0	0

Member Primary Data

	Label	I Joint	J Joint	Rotate(deg)	Section/Shape	Type	Design List	Material	Design Rules
1	M1	N1	N2		HR3	Beam	Tube	A500 Gr.B ...	Typical
2	M2	N2	N3		HR3	Beam	Tube	A500 Gr.B ...	Typical
3	M3	N3	N4		HR3	Beam	Tube	A500 Gr.B ...	Typical
4	M4	N4	N5		HR3	Beam	Tube	A500 Gr.B ...	Typical
5	M5	N5	N6		HR3	Beam	Tube	A500 Gr.B ...	Typical
6	M6	N6	N7		HR3	Beam	Tube	A500 Gr.B ...	Typical
7	M7	N8	N9		HR3	Beam	Tube	A500 Gr.B ...	Typical
8	M8	N9	N10		HR3	Beam	Tube	A500 Gr.B ...	Typical
9	M9	N10	N11		HR3	Beam	Tube	A500 Gr.B ...	Typical
10	M10	N11	N12		HR3	Beam	Tube	A500 Gr.B ...	Typical

Member Primary Data (Continued)

	Label	I Joint	J Joint	Rotate(deg)	Section/Shape	Type	Design List	Material	Design Rules
11	M11	N12	N13		HR3	Beam	Tube	A500 Gr.B ...	Typical
12	M12	N13	N14		HR3	Beam	Tube	A500 Gr.B ...	Typical
13	M13	N14	N7		HR3	Beam	Tube	A500 Gr.B ...	Typical
14	M15	N13	N5		HR1	HBrace	Wide Flange	A500 Gr.B ...	Typical
15	M16	N5	N11		HR1	HBrace	Wide Flange	A500 Gr.B ...	Typical
16	M17	N11	N4		HR2	Beam	Tube	A500 Gr.B ...	Typical
17	M19	N10	N3		HR2	Beam	Tube	A500 Gr.B ...	Typical
18	M20	N3	N9		HR1	HBrace	Wide Flange	A500 Gr.B ...	Typical
19	M21	N9	N2		HR2	Beam	Tube	A500 Gr.B ...	Typical
20	M22	N11	N3		HR1	HBrace	Wide Flange	A500 Gr.B ...	Typical
21	M24	N9	N1		HR1	HBrace	Wide Flange	A500 Gr.B ...	Typical
22	M25	N1	N8		HR2	Beam	Tube	A500 Gr.B ...	Typical
23	M26	N6	N13		HR2	Beam	Tube	A500 Gr.B ...	Typical
24	M27	N5	N12		HR2	Beam	Tube	A500 Gr.B ...	Typical
25	M28	N14	N15		HR3	Beam	Tube	A500 Gr.B ...	Typical
26	M29	N15	N16		HR3	Beam	Tube	A500 Gr.B ...	Typical
27	M30	N16	N17		HR3	Beam	Tube	A500 Gr.B ...	Typical
28	M31	N17	N18		HR3	Beam	Tube	A500 Gr.B ...	Typical
29	M32	N19	N20		HR3	Beam	Tube	A500 Gr.B ...	Typical
30	M33	N20	N21		HR3	Beam	Tube	A500 Gr.B ...	Typical
31	M34	N21	N22		HR3	Beam	Tube	A500 Gr.B ...	Typical
32	M35	N22	N23		HR3	Beam	Tube	A500 Gr.B ...	Typical
33	M36	N23	N18		HR3	Beam	Tube	A500 Gr.B ...	Typical
34	M37	N18	N22		HR1	HBrace	Wide Flange	A500 Gr.B ...	Typical
35	M38	N22	N16		HR1	HBrace	Wide Flange	A500 Gr.B ...	Typical
36	M39	N16	N20		HR1	HBrace	Wide Flange	A500 Gr.B ...	Typical
37	M40	N20	N14		HR1	HBrace	Wide Flange	A500 Gr.B ...	Typical
38	M41	N17	N22		HR3	Beam	Tube	A500 Gr.B ...	Typical
39	M42	N16	N21		HR3	Beam	Tube	A500 Gr.B ...	Typical
40	M43	N15	N20		HR3	Beam	Tube	A500 Gr.B ...	Typical
41	M42A	N19	N24		HR2	Beam	Tube	A500 Gr.B ...	Typical
42	M43A	N13	N24		HR1	HBrace	Wide Flange	A500 Gr.B ...	Typical
43	M44	N24	N14		HR1	HBrace	Wide Flange	A500 Gr.B ...	Typical

Joint Loads and Enforced Displacements (BLC 1 : wind - ns)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N7	L	X	.3
2	N14	L	X	.6
3	N15	L	X	.564
4	N16	L	X	.564
5	N17	L	X	.564
6	N18	L	X	.282

Joint Loads and Enforced Displacements (BLC 2 : wind - ew)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N1	L	Y	-.41
2	N2	L	Y	-.82
3	N3	L	Y	-.82
4	N4	L	Y	-.82
5	N5	L	Y	-.82
6	N6	L	Y	-.58
7	N24	L	Y	-.41
8	N17	L	Y	-.24

Basic Load Cases

	BLC Description	Category	X Gravity	Y Gravity	Joint	Point	Distributed
1	wind - ns	None			6		
2	wind - ew	None			8		

Load Combinations

	Description	Solve	PD...	SR...	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor
1	wind ns	Yes	Y		1	1														
2	wind ew	Yes	Y		2	1														

Joint Reactions

	LC	Joint Label	X [k]	Y [k]	MZ [k-ft]
1	1	N1	-.626	-.159	0
2	1	N7	-1.057	.991	0
3	1	N18	-1.191	-.832	0
4	1	Totals:	-2.874	0	
5	1	COG (ft):	NC	NC	
6	2	N1	1.994	2.169	0
7	2	N7	-2.485	1.092	0
8	2	N18	.491	1.659	0
9	2	Totals:	0	4.92	
10	2	COG (ft):	X: 25.498	Y: 1.191	

Joint Deflections (By Combination)

	LC	Joint Label	X [in]	Y [in]	Rotation [rad]
1	1	N1	0	0	-1.146e-6
2	1	N2	0	0	2.937e-6
3	1	N3	0	0	2.965e-6
4	1	N4	0	.001	5.98e-7
5	1	N5	0	.002	-4.363e-6
6	1	N6	0	0	-1.321e-5
7	1	N7	0	0	-1.215e-5
8	1	N8	0	0	-4.248e-6
9	1	N9	0	0	2.41e-6
10	1	N10	0	0	3.057e-6
11	1	N11	0	.001	5.91e-7
12	1	N12	.001	.002	-4.409e-6
13	1	N13	.002	0	-1.289e-5
14	1	N14	.002	0	-2.558e-5
15	1	N15	.005	0	-1.607e-5
16	1	N16	.005	0	7.139e-6
17	1	N17	.003	0	3.136e-5
18	1	N18	0	0	3.931e-5
19	1	N19	.002	0	-2.013e-5
20	1	N20	.004	0	-2.012e-5
21	1	N21	.005	0	8.523e-6
22	1	N22	.003	-.001	2.802e-5
23	1	N23	0	-.001	8.593e-6
24	1	N24	0	0	-1.035e-5
25	2	N1	0	0	-8.707e-5
26	2	N2	0	-.012	-8.056e-5
27	2	N3	0	-.02	-3.823e-5
28	2	N4	.001	-.021	9.148e-6
29	2	N5	.002	-.017	5.392e-5

Joint Deflections (By Combination) (Continued)

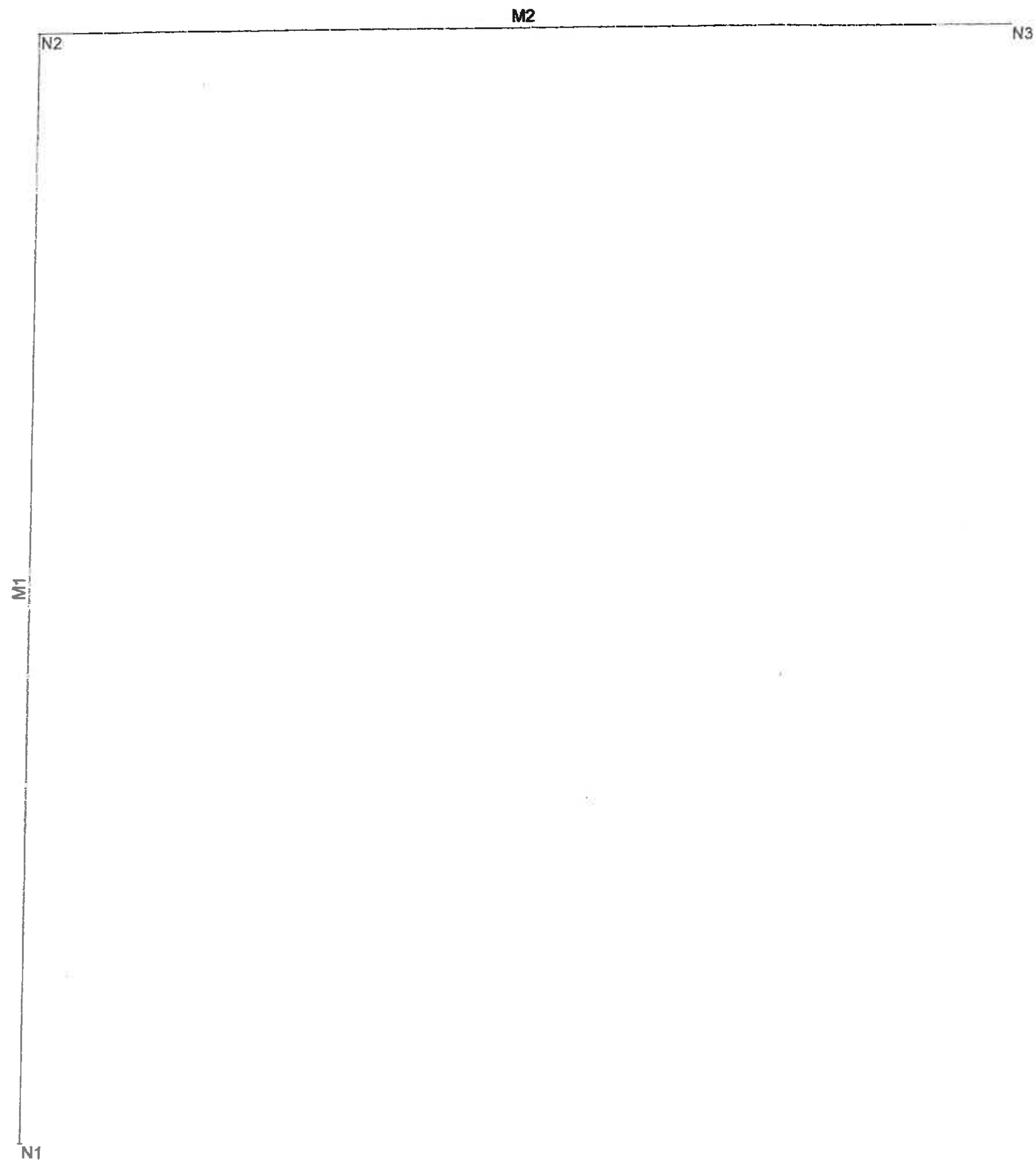
	LC	Joint Label	X [in]	Y [in]	Rotation [rad]
30	2	N6	.001	-.007	7.81e-5
31	2	N7	0	0	3.84e-5
32	2	N8	.004	0	-3.741e-5
33	2	N9	.004	-.011	-7.297e-5
34	2	N10	.003	-.02	-3.967e-5
35	2	N11	0	-.021	9.994e-6
36	2	N12	0	-.017	5.035e-5
37	2	N13	-.002	-.007	9.46e-5
38	2	N14	-.002	0	1.205e-5
39	2	N15	-.002	0	4.772e-6
40	2	N16	-.002	0	-7.576e-6
41	2	N17	0	0	-9.04e-6
42	2	N18	0	0	5.35e-7
43	2	N19	-.002	-.002	5.157e-5
44	2	N20	-.002	-.001	-3.615e-6
45	2	N21	-.002	0	-6.242e-6
46	2	N22	0	0	-7.863e-6
47	2	N23	0	0	1.201e-5
48	2	N24	0	-.003	6.713e-5

Member AISC 14th(360-10): ASD Steel Code Checks

	LC	Member	Shape	UC Max	Loc[ft]	Shear UC	Loc[ft]	Pnc/om [k]	Pnt/om [k]	Mn/om [k-ft]	Cb	Eqn
1	1	M1	HSS6x4x6	.001	0	.000	0	127.34	170.228	27.315	1.973	H1-1b
2	1	M2	HSS6x4x6	.002	0	.000	0	127.34	170.228	27.315	2.272	H1-1b
3	1	M3	HSS6x4x6	.000	8.5	.000	0	127.34	170.228	27.315	2.099	H1-1b
4	1	M4	HSS6x4x6	.001	8.5	.000	0	127.34	170.228	27.315	2.212	H1-1b
5	1	M5	HSS6x4x6	.002	8.5	.000	0	127.34	170.228	27.315	1.531	H1-1b
6	1	M6	HSS6x4x6	.004	8.5	.000	3.542	127.34	170.228	27.315	2.128	H1-1b
7	1	M7	HSS6x4x6	.000	8.5	.000	0	127.34	170.228	27.315	1.667	H1-1b
8	1	M8	HSS6x4x6	.002	0	.000	0	127.34	170.228	27.315	2.264	H1-1b
9	1	M9	HSS6x4x6	.001	8.5	.000	0	127.34	170.228	27.315	2.024	H1-1b
10	1	M10	HSS6x4x6	.003	8.5	.000	0	127.34	170.228	27.315	2.212	H1-1b
11	1	M11	HSS6x4x6	.003	8.5	.000	0	127.34	170.228	27.315	1.499	H1-1b
12	1	M12	HSS6x4x6	.006	8.5	.000	3.542	127.34	170.228	27.315	2.094	H1-1b
13	1	M13	HSS6x4x6	.005	6.917	.000	0	140.458	170.228	27.315	2.18	H1-1b
14	1	M15	HSS4x4x4	.001	0	.000	0	56.155	92.826	10.765	1	H1-1b
15	1	M16	HSS4x4x4	.002	0	.000	0	56.155	92.826	10.765	1	H1-1b
16	1	M17	HSS6x6x6	.000	6.917	.000	0	191.023	208.79	36.267	2.273	H1-1b
17	1	M19	HSS6x6x6	.000	0	.000	0	191.023	208.79	36.267	2.271	H1-1b
18	1	M20	HSS4x4x4	.002	0	.000	0	56.155	92.826	10.765	1	H1-1b
19	1	M21	HSS6x6x6	.000	6.917	.000	0	191.023	208.79	36.267	2.26	H1-1b
20	1	M22	HSS4x4x4	.001	0	.000	0	56.155	92.826	10.765	1	H1-1b
21	1	M24	HSS4x4x4	.001	0	.000	0	56.155	92.826	10.765	1	H1-1b
22	1	M25	HSS6x6x6	.000	0	.000	0	191.023	208.79	36.267	1.667	H1-1b
23	1	M26	HSS6x6x6	.000	6.917	.000	0	191.023	208.79	36.267	2.262	H1-1b
24	1	M27	HSS6x6x6	.000	0	.000	0	191.023	208.79	36.267	2.272	H1-1b
25	1	M28	HSS6x4x6	.003	5.833	.000	0	148.478	170.228	27.315	2.228	H1-1b
26	1	M29	HSS6x4x6	.002	5.833	.000	0	148.478	170.228	27.315	1.483	H1-1b
27	1	M30	HSS6x4x6	.002	0	.000	0	148.478	170.228	27.315	1.661	H1-1b
28	1	M31	HSS6x4x6	.003	0	.000	0	148.478	170.228	27.315	2.236	H1-1b
29	1	M32	HSS6x4x6	.004	5.833	.000	0	148.478	170.228	27.315	2.273	H1-1b
30	1	M33	HSS6x4x6	.006	5.833	.000	0	148.478	170.228	27.315	1.551	H1-1b
31	1	M34	HSS6x4x6	.007	0	.000	0	148.478	170.228	27.315	2.153	H1-1b
32	1	M35	HSS6x4x6	.002	0	.000	0	148.478	170.228	27.315	1.667	H1-1b
33	1	M36	HSS6x4x6	.002	5	.000	0	153.96	170.228	27.315	1.667	H1-1b
34	1	M37	HSS4x4x4	.009	0	.000	0	72.509	92.826	10.765	1	H1-1b

Member AISC 14th(360-10): ASD Steel Code Checks (Continued)

	LC	Member	Shape	UC Max	Loc[ft]	Shear UC	Loc[ft]	Pnc/om [k]	Pnt/om [k]	Mn/om [k-ft]	Cb	Eqn
35	1	M38	HSS4x4x4	.003	0	.000	0	72.509	92.826	10.765	1	H1-1b
36	1	M39	HSS4x4x4	.002	0	.000	0	72.509	92.826	10.765	1	H1-1b
37	1	M40	HSS4x4x4	.008	0	.000	0	72.509	92.826	10.765	1	H1-1b
38	1	M41	HSS6x4x6	.004	0	.000	0	153.96	170.228	27.315	2.254	H1-1b
39	1	M42	HSS6x4x6	.000	5	.000	0	153.96	170.228	27.315	2.22	H1-1b
40	1	M43	HSS6x4x6	.004	5	.000	0	153.96	170.228	27.315	2.251	H1-1b
41	1	M42A	HSS6x6x6	.002	6.917	.000	0	191.023	208.79	36.267	2.155	H1-1b
42	1	M43A	HSS4x4x4	.001	0	.000	0	72.185	92.826	10.765	1	H1-1b
43	1	M44	HSS4x4x4	.003	0	.000	0	68.434	92.826	10.765	1	H1-1b
44	2	M1	HSS6x4x6	.004	8.5	.000	0	127.34	170.228	27.315	2.258	H1-1b
45	2	M2	HSS6x4x6	.004	8.5	.000	0	127.34	170.228	27.315	2.164	H1-1b
46	2	M3	HSS6x4x6	.005	0	.000	0	127.34	170.228	27.315	1.131	H1-1b
47	2	M4	HSS6x4x6	.006	0	.000	0	127.34	170.228	27.315	1.715	H1-1b
48	2	M5	HSS6x4x6	.009	0	.000	0	127.34	170.228	27.315	2.225	H1-1b
49	2	M6	HSS6x4x6	.011	3.453	.002	0	127.34	170.228	27.315	2.725	H1-1b
50	2	M7	HSS6x4x6	.002	8.5	.000	0	127.34	170.228	27.315	1.667	H1-1b
51	2	M8	HSS6x4x6	.016	8.5	.000	0	127.34	170.228	27.315	2.199	H1-1b
52	2	M9	HSS6x4x6	.014	0	.000	0	127.34	170.228	27.315	1.393	H1-1b
53	2	M10	HSS6x4x6	.012	0	.000	0	127.34	170.228	27.315	1.651	H1-1b
54	2	M11	HSS6x4x6	.014	0	.000	0	127.34	170.228	27.315	2.183	H1-1b
55	2	M12	HSS6x4x6	.012	3.453	.003	0	127.34	170.228	27.315	2.764	H1-1b
56	2	M13	HSS6x4x6	.005	0	.000	0	140.458	170.228	27.315	1.022	H1-1b
57	2	M15	HSS4x4x4	.013	0	.000	0	56.155	92.826	10.765	1	H1-1b
58	2	M16	HSS4x4x4	.010	0	.000	0	56.155	92.826	10.765	1	H1-1b
59	2	M17	HSS6x6x6	.003	0	.000	0	191.023	208.79	36.267	2.262	H1-1b
60	2	M19	HSS6x6x6	.002	0	.000	0	191.023	208.79	36.267	2.263	H1-1b
61	2	M20	HSS4x4x4	.008	0	.000	0	56.155	92.826	10.765	1	H1-1b
62	2	M21	HSS6x6x6	.006	6.917	.001	0	191.023	208.79	36.267	2.252	H1-1b
63	2	M22	HSS4x4x4	.002	0	.000	0	56.155	92.826	10.765	1	H1-1b
64	2	M24	HSS4x4x4	.024	0	.000	0	56.155	92.826	10.765	1	H1-1b
65	2	M25	HSS6x6x6	.003	0	.000	0	191.023	208.79	36.267	1.667	H1-1b
66	2	M26	HSS6x6x6	.008	6.917	.001	0	191.023	208.79	36.267	2.249	H1-1b
67	2	M27	HSS6x6x6	.003	0	.001	0	191.023	208.79	36.267	2.261	H1-1b
68	2	M28	HSS6x4x6	.003	0	.000	0	148.478	170.228	27.315	2.217	H1-1b
69	2	M29	HSS6x4x6	.002	0	.000	0	148.478	170.228	27.315	1.975	H1-1b
70	2	M30	HSS6x4x6	.004	0	.000	0	148.478	170.228	27.315	2.263	H1-1b
71	2	M31	HSS6x4x6	.004	5.833	.000	0	148.478	170.228	27.315	2.057	H1-1b
72	2	M32	HSS6x4x6	.012	0	.001	0	148.478	170.228	27.315	2.163	H1-1b
73	2	M33	HSS6x4x6	.003	5.833	.000	0	148.478	170.228	27.315	1.052	H1-1b
74	2	M34	HSS6x4x6	.005	0	.000	0	148.478	170.228	27.315	2.263	H1-1b
75	2	M35	HSS6x4x6	.000	0	.000	0	148.478	170.228	27.315	1.667	H1-1b
76	2	M36	HSS6x4x6	.001	5	.000	0	153.96	170.228	27.315	1.667	H1-1b
77	2	M37	HSS4x4x4	.004	0	.000	0	72.509	92.826	10.765	1	H1-1b
78	2	M38	HSS4x4x4	.005	0	.000	0	72.509	92.826	10.765	1	H1-1b
79	2	M39	HSS4x4x4	.004	0	.000	0	72.509	92.826	10.765	1	H1-1b
80	2	M40	HSS4x4x4	.005	0	.000	0	72.509	92.826	10.765	1	H1-1b
81	2	M41	HSS6x4x6	.002	0	.000	0	153.96	170.228	27.315	2.264	H1-1b
82	2	M42	HSS6x4x6	.002	0	.000	0	153.96	170.228	27.315	2.263	H1-1b
83	2	M43	HSS6x4x6	.003	5	.000	0	153.96	170.228	27.315	2.228	H1-1b
84	2	M42A	HSS6x6x6	.009	6.917	.001	0	191.023	208.79	36.267	2.23	H1-1b
85	2	M43A	HSS4x4x4	.014	0	.000	0	72.185	92.826	10.765	1	H1-1b
86	2	M44	HSS4x4x4	.002	0	.000	0	68.434	92.826	10.765	1	H1-1b



Results for LC 1, dl+ll

e2	Water conditioning topock Influent Farm double canopy	SK - 1
kd		June 12, 2014 at 5:31 PM
ww-peg-2174-043062		topockifcdblew.frame.r2d

Hot Rolled Steel Properties

	Label	E [ksi]	G [ksi]	Nu	Therm (\1E5 F)	Density[k/ft^3]	Yield[ksi]
1	A36 Gr.36	29000	11154	.3	.65	.49	36
2	A572 Gr.50	29000	11154	.3	.65	.49	50
3	A992	29000	11154	.3	.65	.49	50
4	A500 Gr.42	29000	11154	.3	.65	.49	42
5	A500 Gr.46	29000	11154	.3	.65	.49	46

Hot Rolled Steel Section Sets

	Label	Shape	Type	Design List	Material	Design Rules	A [in2]	I (90,270) [i...	I (0,180) [in4]
1	HR1A	HSS6x6x6	Column	Wide Flange	A500 Gr.46	Typical	7.58	39.5	39.5
2	HR2	HSS6x6x4	Beam	Tube	A500 Gr.46	Typical	5.24	28.6	28.6

Joint Coordinates and Temperatures

	Label	X [ft]	Y [ft]	Temp [F]
1	N1	0	0	0
2	N2	0	8	0
3	N3	7	8.139	0

Joint Boundary Conditions

	Joint Label	X [k/in]	Y [k/in]	Rotation[k-ft/rad]	Footing
1	N1	Reaction	Reaction	Reaction	

Member Primary Data

	Label	I Joint	J Joint	Rotate(deg)	Section/Shape	Type	Design List	Material	Design Rules
1	M1	N1	N2		HR1A	Column	Wide Flange	A500 Gr.46	Typical
2	M2	N2	N3		HR2	Beam	Tube	A500 Gr.46	Typical

Joint Loads and Enforced Displacements (BLC 1 : dl)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N3	L	Y	-.2
2	N2	L	Y	-.2

Joint Loads and Enforced Displacements (BLC 2 : ll)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N3	L	Y	-.595
2	N2	L	Y	-.595

Joint Loads and Enforced Displacements (BLC 3 : wind)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N2	L	X	.7

Joint Loads and Enforced Displacements (BLC 4 : -wind)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N2	L	X	-.7

Joint Loads and Enforced Displacements (BLC 5 : -ll)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N2	L	Y	.595

Joint Loads and Enforced Displacements (BLC 5 : -ll) (Continued)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
2	N3	L	Y	.595

Basic Load Cases

	BLC Description	Category	X Gravity	Y Gravity	Joint	Point	Distributed
1	dl	None		-1	2		
2	ll	None			2		
3	wind	None			1		
4	-wind	None			1		
5	-ll	None			2		

Load Combinations

	Description	Solve	PD...	SR...	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor
1	dl+ll	Yes	Y		1	1	2	1												
2	dl+wind	Yes	Y		1	.6	3	.6												
3	dl-wind	Yes	Y		1	.6	4	.6												
4	dl+ll+wind	Yes	Y		1	1	2	.75	3	.45										
5	-ll+dl+wind	Yes	Y		1	1	5	.5	4	1										

Joint Reactions (By Combination)

	LC	Joint Label	X [k]	Y [k]	MZ [k-ft]
1	1	N1	0	1.921	6.093
2	1	Totals:	0	1.921	
3	1	COG (ft):	X: 3.124	Y: 7.632	
4	2	N1	-.42	.439	4.472
5	2	Totals:	-.42	.439	
6	2	COG (ft):	X: 2.512	Y: 6.921	
7	3	N1	.42	.439	-2.261
8	3	Totals:	.42	.439	
9	3	COG (ft):	X: 2.512	Y: 6.921	
10	4	N1	-.315	1.624	7.564
11	4	Totals:	-.315	1.624	
12	4	COG (ft):	X: 3.055	Y: 7.552	
13	5	N1	.7	.136	-5.847
14	5	Totals:	.7	.136	
15	5	COG (ft):	X: -1.803	Y: 1.903	

Joint Deflections (By Combination)

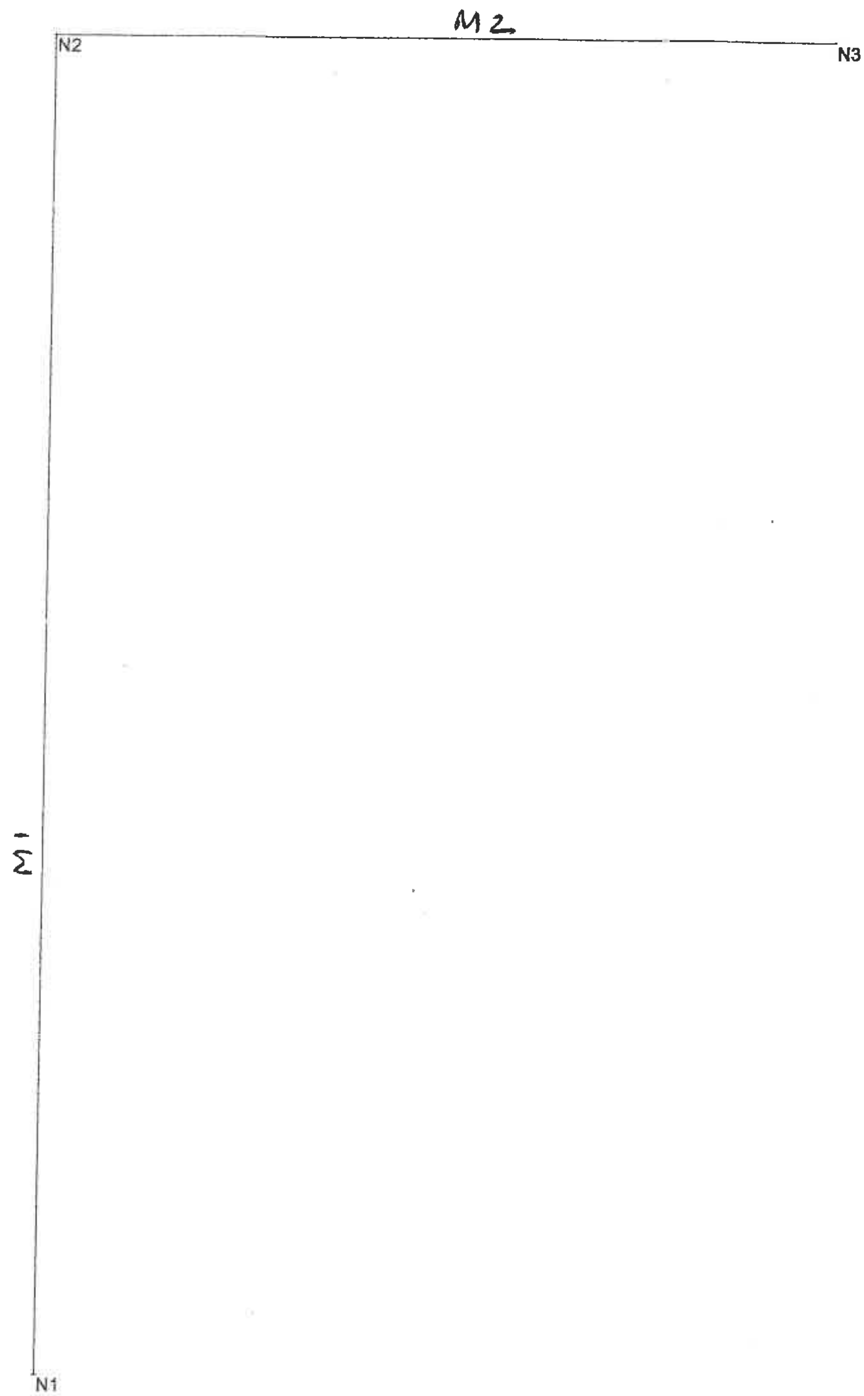
	LC	Joint Label	X [in]	Y [in]	Rotation [rad]
1	1	N1	0	0	0
2	1	N2	.366	0	-7.603e-3
3	1	N3	.384	-.893	-1.205e-2
4	2	N1	0	0	0
5	2	N2	.203	0	-3.504e-3
6	2	N3	.21	-.339	-4.275e-3
7	3	N1	0	0	0
8	3	N2	-.07	0	7.286e-4
9	3	N3	-.07	.016	-4.234e-5
10	4	N1	0	0	0
11	4	N2	.405	0	-7.874e-3
12	4	N3	.422	-.871	-1.153e-2
13	5	N1	0	0	0
14	5	N2	-.242	0	3.829e-3

Joint Deflections (By Combination) (Continued)

	LC	Joint Label	X [in]	Y [in]	Rotation [rad]
15	5	N3	-.249	.337	4.126e-3

Member AISC 13th(360-05): ASD Steel Code Checks (By Combination)

	LC	Member	Shape	UC Max	Loc[ft]	Shear UC	Loc[ft]	Pnc/om [k]	Pnt/om [k]	Mn/om [k-ft]	Cb	Eqn
1	1	M1	HSS6x6x6	.173	0	.000	0	185.372	208.79	36.267	1.006	H1-1b
2	1	M2	HSS6x6x4	.234	0	.023	0	132.309	144.335	25.709	1.702	H1-1b
3	2	M1	HSS6x6x6	.125	0	.007	0	185.372	208.79	36.267	1.431	H1-1b
4	2	M2	HSS6x6x4	.043	0	.005	0	132.309	144.335	25.709	1.787	H1-1b
5	3	M1	HSS6x6x6	.064	0	.007	0	185.372	208.79	36.267	2.172	H1-1b
6	3	M2	HSS6x6x4	.043	0	.005	0	132.309	144.335	25.709	1.787	H1-1b
7	4	M1	HSS6x6x6	.213	0	.006	0	185.372	208.79	36.267	1.16	H1-1b
8	4	M2	HSS6x6x4	.193	0	.019	0	132.309	144.335	25.709	1.709	H1-1b
9	5	M1	HSS6x6x6	.162	0	.012	0	185.372	208.79	36.267	1.621	H1-1b
10	5	M2	HSS6x6x4	.010	1.532	.002	7.001	132.309	144.335	25.709	1.18	H1-1b



Results for LC 1, dl+ll

e2	water conditioning	SK - 1
kd	topock ~~Influent~~ Farm double canopy	June 13, 2014 at 3:12 PM
ww-peg-2174-043062		topockifcdblew.frame1.r2d

Company : e2
Designer : kd
Job Number : ww-peg-2174-043062 topock Influent Farm double canopy

June 16, 2014
10:01 AM
Checked By: [handwritten initials]

Hot Rolled Steel Properties

	Label	E [ksi]	G [ksi]	Nu	Therm (\1E5 F)	Density[k/ft^3]	Yield[ksi]
1	A36 Gr.36	29000	11154	.3	.65	.49	36
2	A572 Gr.50	29000	11154	.3	.65	.49	50
3	A992	29000	11154	.3	.65	.49	50
4	A500 Gr.42	29000	11154	.3	.65	.49	42
5	A500 Gr.46	29000	11154	.3	.65	.49	46

Hot Rolled Steel Section Sets

	Label	Shape	Type	Design List	Material	Design Rules	A [in2]	I (90,270) [i...	I (0,180) [in4]
1	HR1A	HSS6x4x6	Column	Tube	A500 Gr.46	Typical	6.18	14.9	28.3
2	HR2	HSS4x4x6	Beam	Tube	A500 Gr.46	Typical	4.78	10.3	10.3

Joint Coordinates and Temperatures

	Label	X [ft]	Y [ft]	Temp [F]
1	N1	0	0	0
2	N2	0	8.625	0
3	N3	5	8.625	0

Joint Boundary Conditions

	Joint Label	X [k/in]	Y [k/in]	Rotation[k-ft/rad]	Footing
1	N1	Reaction	Reaction	Reaction	

Member Primary Data

	Label	I Joint	J Joint	Rotate(deg)	Section/Shape	Type	Design List	Material	Design Rules
1	M1	N1	N2		HR1A	Column	Tube	A500 Gr.46	Typical
2	M2	N2	N3		HR2	Beam	Tube	A500 Gr.46	Typical

Joint Loads and Enforced Displacements (BLC 3 : wind)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N2	L	X	.5

Joint Loads and Enforced Displacements (BLC 4 : -wind)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N2	L	X	-.5

Member Distributed Loads (BLC 1 : dl)

	Member Label	Direction	Start Magnitude[k/ft,F]	End Magnitude[k/ft,F]	Start Location[ft,%]	End Location[ft,%]
1	M2	Y	-.04	-.04	0	5

Member Distributed Loads (BLC 2 : ll)

	Member Label	Direction	Start Magnitude[k/ft,F]	End Magnitude[k/ft,F]	Start Location[ft,%]	End Location[ft,%]
1	M2	Y	-.12	-.12	0	5

Member Distributed Loads (BLC 5 : -ll)

	Member Label	Direction	Start Magnitude[k/ft,F]	End Magnitude[k/ft,F]	Start Location[ft,%]	End Location[ft,%]
1	M2	Y	.12	.12	0	5

Basic Load Cases

	BLC Description	Category	X Gravity	Y Gravity	Joint	Point	Distributed
1	dl	None		-1			1
2	ll	None					1
3	wind	None			1		
4	-wind	None			1		
5	-ll	None					1

Load Combinations

	Description	Solve	PD...	SR...	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor
1	dl+ll	Yes	Y		1	1	2	1												
2	dl+wind	Yes	Y		1	.6	3	.6												
3	dl-wind	Yes	Y		1	.6	4	.6												
4	dl+ll+wind	Yes	Y		1	1	2	.75	3	.45										
5	-ll+dl+wind	Yes	Y		1	1	5	.5	4	1										

Joint Reactions

	LC	Joint Label	X [k]	Y [k]	MZ [k-ft]
1	1	N1	0	1.063	2.232
2	1	Totals:	0	1.063	
3	1	COG (ft):	X: 2.073	Y: 7.889	
4	2	N1	-.3	.278	3.016
5	2	Totals:	-.3	.278	
6	2	COG (ft):	X: 1.52	Y: 6.935	
7	3	N1	.3	.278	-2.169
8	3	Totals:	.3	.278	
9	3	COG (ft):	X: 1.52	Y: 6.935	
10	4	N1	-.225	.913	3.803
11	4	Totals:	-.225	.913	
12	4	COG (ft):	X: 2.003	Y: 7.768	
13	5	N1	.5	.163	-4.362
14	5	Totals:	.5	.163	
15	5	COG (ft):	X: -.287	Y: 3.818	

Joint Deflections

	LC	Joint Label	X [in]	Y [in]	Rotation [rad]
1	1	N1	0	0	0
2	1	N2	.218	0	-4.195e-3
3	1	N3	.218	-.353	-6.408e-3
4	2	N1	0	0	0
5	2	N2	.211	0	-3.252e-3
6	2	N3	.211	-.215	-3.675e-3
7	3	N1	0	0	0
8	3	N2	-.129	0	1.653e-3
9	3	N3	-.129	.08	1.229e-3
10	4	N1	0	0	0
11	4	N2	.308	0	-5.326e-3
12	4	N3	.308	-.404	-7.162e-3
13	5	N1	0	0	0
14	5	N2	-.287	0	4.17e-3
15	5	N3	-.287	.252	4.217e-3

Member AISC 13th(360-05): ASD Steel Code Checks

	LC	Member	Shape	UC Max	Loc[ft]	Shear UC	Loc[ft]	Pnc/om [k]	Pnt/om [k]	Mn/om [k-ft]	Cb	Eqn
1	1	M1	HSS6x4x6	.086	0	.000	0	126.25	170.228	27.315	1.005	H1-1b
2	1	M2	HSS4x4x6	.150	0	.026	0	117.669	131.665	14.668	2.326	H1-1b
3	2	M1	HSS6x4x6	.112	0	.005	0	126.25	170.228	27.315	1.524	H1-1b
4	2	M2	HSS4x4x6	.029	0	.005	0	117.669	131.665	14.668	2.326	H1-1b
5	3	M1	HSS6x4x6	.081	0	.005	0	126.25	170.228	27.315	1.915	H1-1b
6	3	M2	HSS4x4x6	.029	0	.005	0	117.669	131.665	14.668	2.326	H1-1b
7	4	M1	HSS6x4x6	.143	0	.004	0	126.25	170.228	27.315	1.262	H1-1b
8	4	M2	HSS4x4x6	.125	0	.021	0	117.669	131.665	14.668	2.326	H1-1b
9	5	M1	HSS6x4x6	.160	0	.009	0	126.25	170.228	27.315	1.655	H1-1b
10	5	M2	HSS4x4x6	.003	0	.001	0	117.669	131.665	14.668	2.326	H1-1b

E2 Consulting Engineers, Inc. 1900 Powell Street, Suite 250 Emeryville, CA 94608	Designed By:	KD	Date: 6/16/14
	Checked By:	KS	Date: 6/16/14
	Reviewed By:		Date:
Project No. WW-PGE-2174			Sheet No. 36
Project Description: Water Conditioned Tank Farm double Canopy.			

Reference:

Frames @ Double Canopy (L shaped) Only Interior Frame

Frame EW Dir. (pgs 28 to 31)

Vertical grav. load

$P_{(DL+LL)} = (6+20) \times 8.50 \times 3.5$
$= 180 + 595 = 775$ # USE 795 #

Lateral Load

$P_W = 20 \times 8.50 \times 4.0 = 680$ # USE 700 #

wind Governs by insp.

For Load combinations see computer printout.

Results (See computer printouts)

Max DL+LL Defl. = .893" $\frac{2 \times 7 \times 12}{.893} = 188 < \frac{l}{180}$ ok

HSS 6x6x6 ok for column & beam

Horiz. Defl. (LC-4 DL+LL+wind) = .422 = $\frac{l}{227} < \frac{l}{200}$ ok

Base pl. (Try 14"x14"x 3/4" PL.)

Max. $P = 1.92^k$ USE 2.2^k $\frac{P}{A} + \frac{M}{S} = \frac{2.2}{14 \times 14} + \frac{6.1 \times 12}{\frac{1}{6} \times 14 \times 14^2} = .16$
$M = 6.093^k$ USE $6.1^{'k}$

$t_p = 2 \times 4 \times \sqrt{\frac{.16}{36}} = .53"$

Try 4 - 7/8"Φ A.B.'s (A-307) $T = \frac{6.1 \times 12}{2 \times 11} = 3.33^k$

$V = .7/4 = .175^k$

$\frac{T}{T_A} + \frac{V}{V_A} = \frac{3.33}{6.3} + \frac{.175}{4} = .572 < 1.0$ (LC-5)

USE 14" x 3/4" x 1'-2" Base pl. w/ 4 - 7/8"Φ x12" (Emb.) A.B.'s

Footing 3'-0" W x 1'-0" TK Ftg. w/ #5 @ 12" (Same as Influent Farm)

Frame 1 NS Dir. (pgs 32 to 35)

$W_{(DL+LL)} = (6+20) \times 5.84 = 35 + 117 = 152$ #/' USE $.16^{k/'}$

$P_W = 20 \times 5.84 \times 4.31 = 503$ # USE $.5^k$

Results

$\Delta_{DL+LL} = .353" = l/170$ ok $\Delta^{(Vert.)}_{(LC-4)} = .404$ $\Delta^{(Horiz)}_{(LC4)} = .308$ $l/336$ ok

HSS 6x6x6 & HSS 6x6x4 (Bm.) ok

E2 Consulting Engineers, Inc. 1900 Powell Street, Suite 250 Emeryville, CA 94608	Designed By:	KD.	Date: 6/16/19
	Checked By:	Ky	Date: 6/16/19
	Reviewed By:		Date:
Project No. WW-PGE-2174			Sheet No. 37
Project Description:	Conditioned Water Tank Farm / Blk wall & Bracing		

Reference:

Block Wall

Parallal to wall

Max Shear = 4.92^k (wind NS Dir.)

$v/_{l}$ (NS) $= \frac{4920}{.8 \times 51} = 120.6$ #/'

$V_{EW} = 2.874^k$

$v/_{l}$ (EW) $= \frac{2874}{.8 \times 30} = 120$ #/'

$F_v = \frac{120.6}{12} = 10.05$ PSI $< 1.0\sqrt{1500} = 38.72$ PSI OK

Perpendicular to wall

Refer to Pg 3A Influent Farm Tank

$V_w = 88.3$ #/' $F_v = \frac{88.3}{12 \times 3.8} = 1.94$ PSI very small OK

X-Bracing

Max $P_{Br.} = 2.153^k$ Try HSS 4×2×3 $A = 2.06^{in^2}$ $r = .804''$

$l_{max.} = \sqrt{7.0^2 + 8.14^2} = 10.74'$ $\frac{Kl}{r} = \frac{10.74 \times 12}{.804} = 160 < 300$

$F_a = .6 \times 46 \times 2.06 = 56.8^k > 2.153^k$ OK

(Tens) $F_a = 5.2 \times 2.06 = 10.7^k > 2.153^k$ OK

USE HSS 4×2×3 Single Bracing

Tom Appendix-A
707-974-0660
pg. A-1

DenBeste Manufacturing, Inc.
31162 Shelby Lane
Shafter, CA 92362
Tel (661) 746-2079

Portable Liquid Storage Tank, 21,000 Gallon Capacity

Features:

- All 1/4" Steel Plate Construction
- Smooth Interior Walls
- Contoured Full Drain Bottoms
- Static Liquid Level Gauges
- Integrated Stairways with Larger Walkways and Platforms
- Safety Harness Clips for Worker Safety
- Lifting Eyes for Difficult Tank Placement
- ABS Braking Systems
- Multiple Options Available

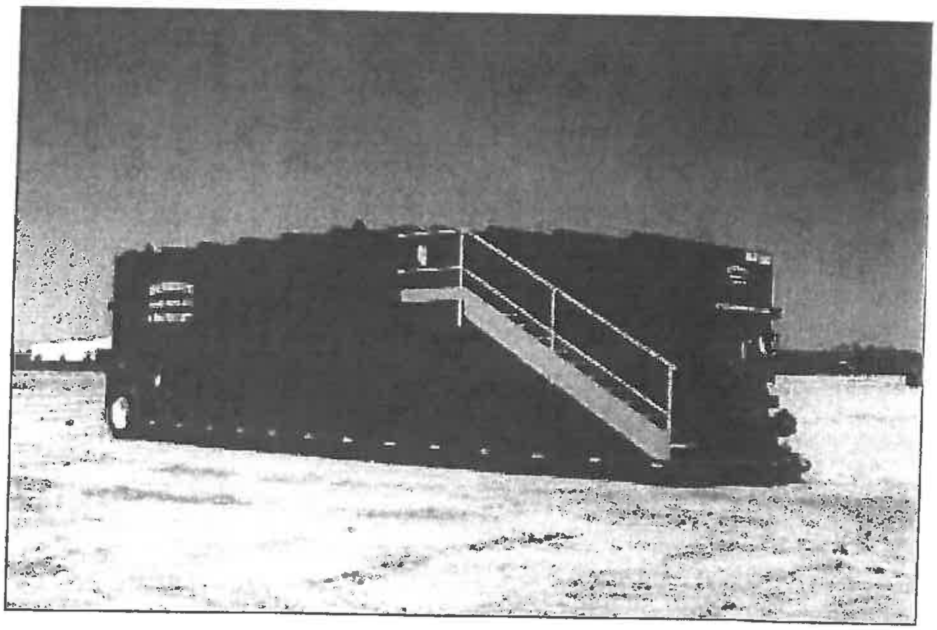
Specifications:

Length:	45 ft. (540 inches)
Width:	8 ft. 5 inches (102 inches)
Height:	11 ft. (133 inches)
Capacity:	500.9 bbl (21,037 Gals)
Operating Specs:	Max Pressure Rating 1 P.S.I. / Max Vacuum Rating 0.25 P.S.I.
Side Wall:	1/4" A36 Steel Plate
Floor:	1/4" A36 Steel Plate
Roof:	1/4" A36 Steel Plate
Exterior Supports:	6" x 3" x 3/16" Formed Channel Sides and Roof
Main Rails:	12" x 3" - 20.7 # Structural Channel
Manways:	3 – 20" Manways, Located in Front, Top & Rear. 1 – 26" Manway on the Side. Equipped with Buna-N Gaskets
Relief Valve:	Blaylock Pressure / Vacuum Valve Model LL10 16 oz / in? Pressure – 0.4 oz / in? Vacuum
Metering Gauge:	2 – 8" Stainless Steel Float Balls
Drain Valves:	4" Butterfly Valves Front and Rear
Fill Lines:	3" Sch 80 Front Fill Line W/Cap 3" Sch 80 Rear Fill Line W/Cap
Gel Line:	4" Gel line with Butterfly Valve
Manifold:	8" Front Manifold with Hammer Lock Fittings
Suspension:	Spring – 22.5 K Capacity
Axle:	5" rd, 77.5" track, 22.5K Capacity
Wheels & Tires:	8.25 x 22.5 Steel Wheels with 11R22.5 – 14 ply tires
Lights:	D.O.T. Approved Lights
Blast:	Interior – SSPC-SP10 Exterior – SSPC- SP6

A-2

Interior Paint:	**100% Solids Epoxy – Gray (25 to 30 mils) Carboline Phenoline # 309**
Exterior Paint:	**Polyurethane 6 – 9 Mils**

- **Maximum specific gravity of fluid to be stored in tank is S.G. 1.92 or 16 pounds per gallon**
- **Maximum fluid temperature to be stored in tank is to be no greater than 180° F. Minimum fluid temperature is to be no less than -40° F.**
- **Steel tanks are not rated for either pressure or vacuum. All tanks must be vented.**
- **Minimum PH value to be stored in "coated" tank is 3. Maximum PH value to be stored in "coated" tank is 12.**



21,000 Gallon Closed Top Tank, Vapor Secure, Epoxy Lined Tank

TAb: #2

REMEDY PRODUCED WATER
CONDITIONING PLANT

APPENDIX A - CALCULATION COVER SHEET

CALCULATION ID NUMBER	
REVISION NUMBER	
JOB NUMBER	~~WW-PEB-2174-043002~~

TITLE	Topock Water Conditioning Plant, Needles, CA

PAGE NO.	Item
1	Design Criteria & Loads
2 To 5	Roof Framing
6 To 9	Concrete Floor Framing
10, 11	Basement Concrete walls. For Earth Loads
12 To 17	Lateral loads and Analysis upper steel Frames
18 To 22	Lateral loads, Analysis, Shear Walls, Lower building
23 To 25	Footings & Retaining wall (Future Bldg.)
17A To 17G	Appendix to page 17 (Anchor Bolts)
26 - 26-6	Steel Moment Frame
27 - 27-6	Col. line-B Braced Frame
28 - 28-5	Col. line-A Braced Frame
29 - 29-6	Concrete Moment Frame line (4)

	Initial	date
PREPARED	KD	3/06/14
TITLE	KJ	6/25/~~14~~
REVIEWED		
TITLE		

REVISION NOTES	

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Designed By:	KD	Date:	5/30/12
Checked By:	KJ	Date:	6/25/14
Revised By:		Date:	
Project No.	WW-PEB-2174-043062	Sheet No.	1

Project Description: Topock Ground water Remediation proj., Designs Criteria

All Buildings including
- Water treatment & maintenance facility (water conditioning plant)
- Hazardous waste storage & operations Bldg.

References
AWAA Standard D-100-11 For Tank Design
IBC 2009/CBC 2010 As amended by San Bernardino County
ASCE 7-10 For Loads & load Combinations
ACI 318-11 For Concrete
AISC 13nth Edition For Steel
Moments & Reactions for Rectangular plates, U.S Dept of interior

Seismic Data *
~~S_S = .434~~(.22) ~~S_1 = .205~~(.12) ~~F_a = 1.4, F_v = 2.0~~ (2.318)
~~S_{MS} = $F_a \times S_S$ = 1.4 × .434 = .608~~ ~~S_{M1} = $F_v S_1$ = 2 × .205 = .41~~(.28
~~S_{DS} = .667 × .608 = .406~~(.247) ~~S_{D1} = .667 × .41 = .273~~ (.187)
~~Seismic category - D (Table 1613.5.6 IBC)~~ Occupancy Type III (Table 1604.5, IBC)
Table 1.5.1 ASCE 7-10

Concrete Data
f'_c = ~~5.0~~ ksi f_y = 60 ksi

~~Structural Steel~~
~~F_y = 50 ksi (WF shapes) F_y = 36 ksi (for channels, plates etc)~~

Soil Data
~~No Soil Report available.~~
Allow. Bearing Pressure for ftg = 2.0 k/ft²   Friction Factor = .35
~~Capacity of drilled piers axial = 30k~~
~~uplift = 25k~~
~~lateral = 13k~~

* ~~Seismic Data in Bracket is new Revised Data. It has been used for lower Concrete Bldg. Upper Steel Bldg uses higher Seismic factors~~

Design Loads Floor

1ST Flr	DL 12" Conc. Slab	=	150	PSF
	LL	=	500	
	TL		650	PSF
2nd Flr	DL 12" Conc. Slab	=	150	PSF
	LL	=	200	
	TL		350	PSF

In addition The floors shall be checked for concentrated loads from equipments, Cranes or trucks

Misc. All Basement walls
Design for 60 pcf at rest press.
Design for 2'-0" Soil Surcharge (For trucks)

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Project No. WW-PEG-2124-043062		Sheet No. 2
Project Description: Topock Water Conditioning Plant Roof Framing		

Roof Loads

DL = 10.0 PSF
Mech. etc. = 20.0 (USE 50% of this for Seismic DL)
LL = 20.0
TL = 50.0 PSF

Decking

For Roof purlins @ 5'-0" w/ $1\frac{1}{2}$" HSB 36 Deck by Verco (22 GA.) or EQ

Allow load = 120 PSF > 50 PSF ok

~~USE 22GA. $1\frac{1}{2}$" Decking~~

purlins P-1
Between (4) & (5)

$l = 29.5'$ $\omega_{TL} = (.05) \times 5 + .02 = .27^{k/l}$

$R = .27 \times \frac{29.5}{2} = 3.93^k$

$M = \frac{.27 \times 29.5^2}{8} = 29.37^{1k}$ $S_x = \frac{29.37 \times 12}{.6 \times 50} = 11.75 \text{ in}^3$

Try W 12x19 $I_x = 130 \text{ in}^4$

$\Delta_{TL} = \frac{5}{384} \times \frac{.27 \times 29.5^4}{29000 \times 130} \times 1728 = 1.22" = \frac{l}{290} < \frac{l}{240}$

USE W 12x19 purlins w/ 1/3 span filler strut inbetween purlin

Purlins P-2 (Bet.'n (3) & (4))

$l = 21.5'$ P-2 $W_{TL} = .27^{k/l}$ $R = .27 \times 21.5 \times .5 = 2.9^k$

$M = \frac{.27 \times 21.5^2}{8} = 15.6^{1k}$ Try W 12x14 $I = 88.6$

$\Delta_{TL} = \frac{5}{384} \times \frac{.27 \times 21.5^4}{29000 \times 130} \times 1728 = .344" = \frac{l}{749} < \frac{l}{240}$ ok

USE W 12x19

$l_x = 21.5$ $l_y = 17.5$ Purlins P-3 @ (A) & (B)

$W_y = .02 \times 4 = .08^{k/l}$ $M_y = \frac{.08 \times 17.5^2}{8} = 3.06^{1k}$

$W_x = .05 \times 2.5 + .02 + .01 \times 7 = .22^{k/l}$ $M_x = \frac{.22 \times 29.5^2}{8} = 23.93^{1k}$

W 12x22 $S_x = 25.4 \text{ in}^3$ $S_y = 2.31$ $f_{bx} + f_{by} = \frac{23.93 \times 12}{25.4} + \frac{3.06 \times 12}{2.31} = 11.31 + 15.9 = 27.22^{ksi} < 30^{ksi}$

~~W 12x22 o.k.~~

USE W 12x40 @ Braced Frame (See pg 16)

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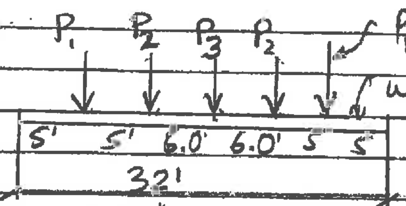
Checked By: KJ	**Date:** 6/25/14	
Revised By:	**Date:**	
Project No. WW-PEG-2124-043062		**Sheet No.** 3

Project Description Topock Water Conditioning plant Roof framing

Roof
Girders

Col. line ④

$l = 32'$



$P_1 = 3.93 + 2.9 = 6.83^k$

$P_3 = 3.93 \times \frac{6}{5} + 2.9 \times \frac{6}{5} = 8.2^k$

$P_2 = 3.93 \times \frac{5.5}{5} + 2.9 \times \frac{5.5}{5} = 7.51^k$

$R = 19.56^k$ $R = 19.56^k$ $w_{TL} = .01 \times \frac{14}{2} + .07 = .14^{k/'}$

$R = 6.83 + 7.51 + \frac{8.2}{2} + .14 \times 16 = 19.56^k$

$M_{max} = 19.56 \times 16 - 6.83 \times 11 - 7.51 \times 6 - \frac{.14 \times 16^2}{2} = 174.85^{'k}$

Try W 18×60 $S = 108\ in^3$ $I = 984\ in^4$

$f_{bx} = \frac{175 \times 12}{108} = 12^{ksi} < 50^{ksi}$ $w_{eq.} = \frac{175 \times 8}{(32)^2} = 1.367^{k/'}$

$\Delta_{TL} = \frac{5}{384} \times \frac{1.367 \times 32^4}{29000 \times 984} \times 1728 = 1.13'' = \frac{l}{340} < \frac{l}{240}$ ok

USE W 18×60

Col. line ⑤

Girder ($l = 32'$)

P_1', P_2' & P_3' are 58% of P_1, P_2, P_3 for interior girders.

Design for 60% of Moment for girders col. line ② & ③

$M_x = .6 \times 175 = 105^{'k}$ $P_y = .02 \times 16 \times 7 = 2.24^k$

Also Design for My due to wind $w_y = .02 \times 7 = .14^{k/'}$

$M_y = \frac{.14 \times 32^2}{8} = 17.92^{'k}$ OR $M_y = \frac{P_y l}{4} = \frac{2.24 \times 32}{4} = 17.92^{'k}$

W 18×60 $S_y = 13.3\ in^3$ $I_y = 50.1\ in^4$

$f_b = f_{bx} + f_{by} = \frac{105 \times 12}{108} + \frac{17.92 \times 12}{13.3} = 11.67 + 16.17 = 27.84^{ksi} < 30^{ksi}$

$\Delta_{TL} = \frac{105}{175} \times 1.13 = 0.68''$

USE W 18×60

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Designed By: KD	Date: 6/25/12		
Checked By: KJ	Date: 6/25/14		
Revised By:	Date:		
Project No.	WW-PEA-2124-C43062	Sheet No.	4

Project Description Topock water conditioning plant Roof Framing

Girt G-1A Line ③ ⑤

$l = 16.0'$ Try MC 10 Girts @ 4'-3" o/c

$w_W = .02 \times 4.25 = .085^{k/'}$

$M_W = (.085 \times 16^2)/8 = 2.72^{'k}$ $R = .085 \times 8 = .68^k$

MC 10x22 For $l_u = 16$ $M_A = (28.4)/1.67 = 17.0^{'k} >> 2.72^{'k}$ OK

Lines Ⓐ & Ⓑ G-1B

$l = 21.5'$ $M_W = (.085 \times 21.5^2)/8 = 4.91^{'k}$ USE MC 10x22 $M_A = 12^{'k} > 4.91^{'k}$

G-1

$l = 29.5'$ $M_W = \frac{.085 \times 29.5^2}{8} = 9.25^{'k}$ $R = .085 \times \frac{29.5}{2} = 1.254^k$

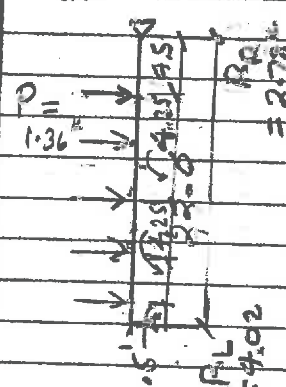
Try MC 10x28.5 $l_u = 29.5'$ $M_A = \frac{24.4}{1.67} = 14.6^{'k} > 9.25^{'k}$ OK

USE MC 10x28.5' for $l = 29.5'$

USE MC 10x22 for $l = 21.5'$ And $l = 16'$

Middle Column @ lines ③ & ⑤

$h = 22.0'$ Try W 10x22 Col. $S_x = 23.2 \text{ in}^3$



$P = .68 \times 2 = 1.36^k$

$R_L \times 22 = 1.36(4.5 + 8.75 + 13 + 17.25 + 21.5)$

$R_L = 4.02^k$ $R_R = 6.8 - 4.02 = 2.78^k$

$\bar{M}_{max} = 2.78 \times 8.75 - 1.36 \times 4.25 = 18.55^{'k}$ Say $19^{'k}$

$f_{bx} = (19 \times 12)/23.2 = 9.82^{ksi} < .6 \times 50$ OK

Col. does not take vertical loads

See Conn. below to beam above

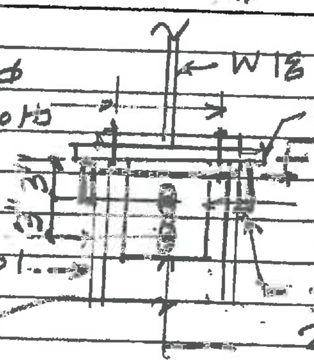
P_{max} due to weight of siding + framing

$= .015 \times 16 \times 20 = 4.8^k$ Say 5^k $f_a = \frac{5}{6.49} = .77^{ksi}$ small

5^k is transferred to W10 thru Girts

USE W x 10 x 45

See pg. 16 (Mom. Fr. Analysis)



L 8x6x3/8 Ea. Side LLV Vert. welded to col

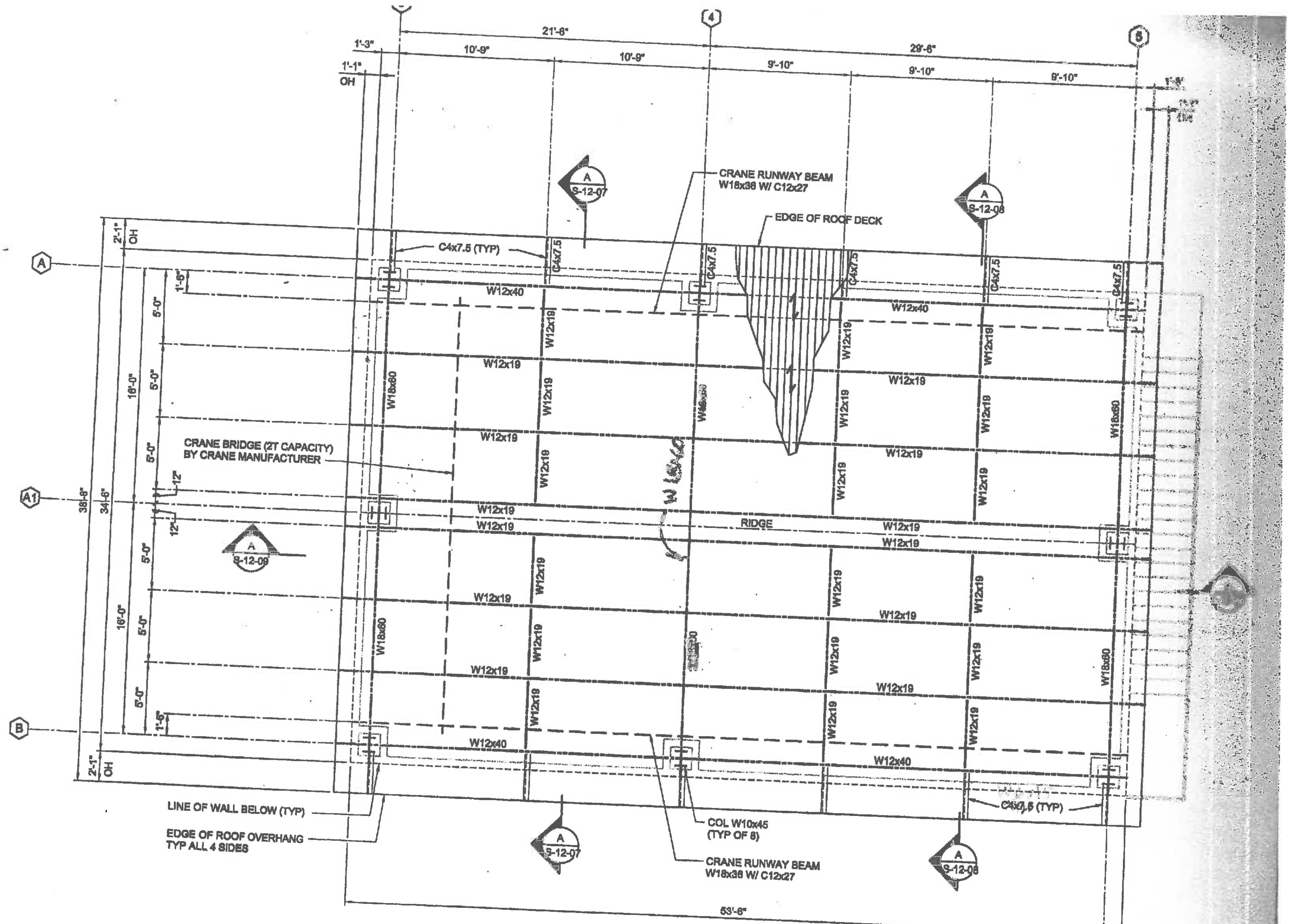
W/ 2 - 7/8" x 1 1/2" Vert. holes

3"x6"x1/2" PL. EA. SIDE WELDED TO CAP PL.

2 - 3/4" φ A-325 Bolts

For Mom. frame columns see pg. 15 and 16 (W 10x45)

See Sect. A / S-12-13 for Alternate Detail



A
A1
B
4
5
21'-6"
29'-6"
1'-3"
1'-1"
OH
10'-9"
10'-9"
9'-10"
9'-10"
9'-10"
1'-8"
38'-8"
34'-6"
2'-1"
OH
2'-1"
OH
16'-0"
16'-0"
5'-0"
5'-0"
5'-0"
5'-0"
5'-0"
5'-0"
1'-6"
1'-6"
12"
12"
53'-6"
CRANE RUNWAY BEAM
W18x38 W/ C12x27
EDGE OF ROOF DECK
C4x7.5 (TYP)
C4x7.5
W12x40
W12x19
W18x60
RIDGE
CRANE BRIDGE (2T CAPACITY)
BY CRANE MANUFACTURER
A
S-12-07
A
S-12-08
A
S-12-09
LINE OF WALL BELOW (TYP)
EDGE OF ROOF OVERHANG
TYP ALL 4 SIDES
COL W10x45
(TYP OF 8)

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	Checked By:	Ky	Date: 6/27/14
	Reviewed By:		Date:
Project No.	WW-PEG-2124.04362		Sheet No. 6
Project Description:	Topock Remedy Bldg.		

Reference:

2nd floor Structural Slab (Clear Span = 5.5')

Note: All Conc. beams except conc. frame @ line ④ are designed for $M = \frac{w\ell^2}{8}$ (Including the slab)

$w_u = (1.4 \times .15 + 1.7 \times .2) = .21 + .34 = .55^{k/\prime}$

$M_u = \frac{.55 \times 5.5^2}{8} = 2.08^{\prime k}$ $R = .55 \times \frac{5.5}{2} = 1.51^k$

Calculate capacity (Mom. & Shear) for slab, Try #5@12"

$f_y = 60^{ksi}$, $f'_c = 5^{ksi}$

$\phi M_n = A_s f_y (d - \frac{a}{2})$ $a = \frac{A_s f_y}{.85 f'_c b} = \frac{.31 \times 60}{.85 \times 5 \times 12} = .365$

$= \frac{.31 \times 60}{12} (10 - \frac{.365}{2})$ $d = 12 - 1.5 - .5 = 10''$

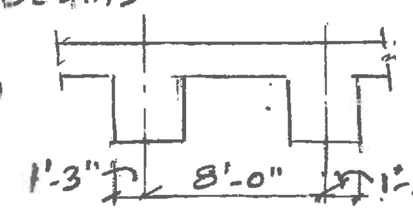
$= 15.22^{\prime k} > 2.08^{\prime k}$ ok

$\phi V_n = .85 \times 2\sqrt{5000} \times 12 \times 10 \times 10^{-3} = 14.42^k > 1.51 \times \frac{5.5}{2} = 4.15^k$ ok

USE 12" Conc. slab w/ #5 @ 12" o/c

Beams

B-1 (Int. Bm)



B-1 $\ell_c = 29.5 - 1.25 - .75 = 27.5'$

$w_u = 1.4 (.15 \times 5.5 + .15 \times 2.5 \times 3.5)$
$+ 1.7 (.2 \times 5.5)$
$= 1.4 (2.1375) + 1.7 (1.1) =$
$= 2.993 + 1.87 = 4.863^{k/\prime}$

$M_u = \frac{4.863 \times 27.5^2}{8} = 459.7^{\prime k}$ $b = 30$, $d = 36 - 1.5 - .5 = 34''$, $F = 2.89$

$\frac{M_u}{F} = \frac{459.7}{2.89} = 159$ $A_s = .003 \times 30 \times 34 = 3.06^{in^2}$

USE 5-#8 T & B

$V_u = 4.863 \times 27.5 \times .5 = 66.87^k$

$V @ dist\ d = 66.87 - 4.863 \times \frac{34}{12} = 53.1^k$

$V_n = 2\sqrt{5000} \times 30 \times 34 \times 10^{-3} = 144.25^k$ No Stirrups Reqd.

$Min.\ A_v = \frac{50 b_w S}{f_y} = \frac{50 \times 30 \times 12}{60000} = .3^{in^2}$ USE 36" x 30" Bm. w/ 5-#8 @ T&B w/ #4 Stirrups @ 16" o/c ($d/2 = 17"$)

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	Reviewed By:		Date:
Project No.	NW-PEB-2174-043062		Sheet No. 7
Project Description:	Topock Remedy Bldg.		

Reference:

B-1B (Ext. Bm.)

B-1A ($\ell_c = 27.5'$)

$w_{u_1} = 1.4\,(.15 \times \frac{5.5}{2} + .15 \times 2.5 \times 3.0) + 1.7\,(.2 \times \frac{5.5}{2})$

$= .577 + 1.575 + .935 = 3.087^{k/\prime}$ Say $3.1^{k/\prime}$

$M_{u_1} = \frac{3.10 \times 27.5^2}{8} = 293^{\prime k}$ $\quad \frac{M_u}{F} = \frac{293}{2.89} = 101$

$A_s = .0019 \times 30 \times 34 = 1.94\ in^2$ 5-#7 Bars @ T & B

$< 3.0\ in^2$ ok

$V_{u_1} = 3.1 \times 27.5 \times .5 = 42.62^k$

$\phi V_{n_1} = .85 \times 2\sqrt{5000} \times 30 \times 34 \times 10^{-3} = .85 \times 144.25 = 122.6^k > 42.62$

No Stirrups Reqd., USE Min. #4 @ 16" o/c

B-2 Int. Bm.

B-2 ($\ell_c = 21.5 - 2.5 = 19'$)

$w_{u_2} = 4.86^{k/\prime}$ (Same as B-1)

$M_{u_2} = \frac{4.86 \times 19^2}{8} = 219.3^{\prime k}$ $\quad \frac{M_u}{F} = \frac{219.3}{2.89} = 75.9$

$A_s = .0017 \times 30 \times 34 = 1.73\ in^2$ 5-#7 Bars T & B

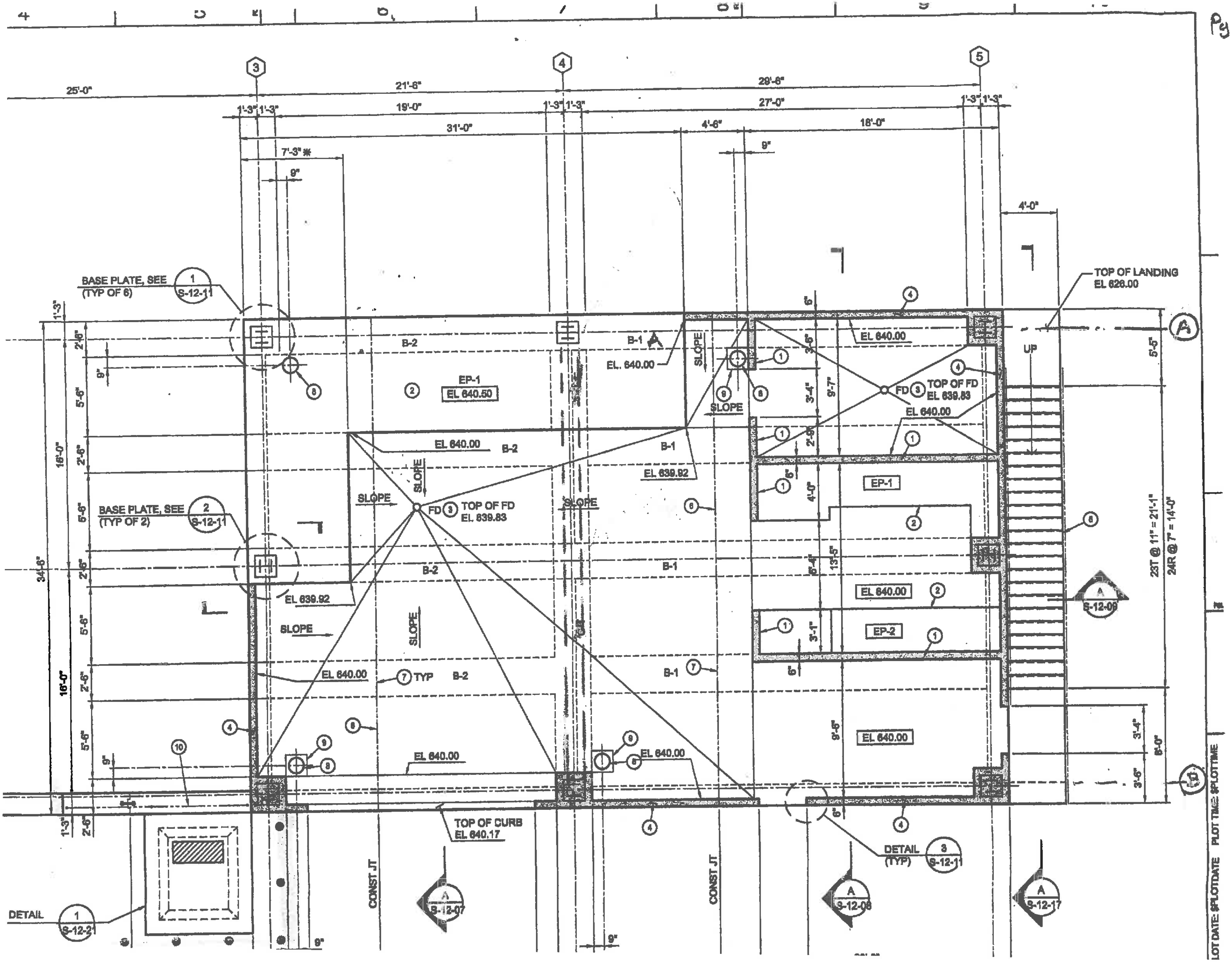
$V_{u_2} = 4.86 \times 21.5 \times .5 = 52.25^k$

$\phi V_{n_2} = 122.6^k$ (Same as B-1B)

$> 52.25^k$

No Stirrups Reqd. USE Min. #4 @ 16" o/c

Pg. 9.



25'-0"
21'-6"
29'-6"
1'-3" 1'-3"
19'-0"
27'-0"
31'-0"
4'-6"
18'-0"
7'-3" *
9"
4'-0"
BASE PLATE, SEE (TYP OF 6) 1 S-12-11
BASE PLATE, SEE (TYP OF 2) 2 S-12-11
TOP OF LANDING EL 626.00
UP
B-1
B-2
EL. 640.00
EL 640.00
EL 639.92
EP-1 EL 640.50
EP-1
EP-2
FD 3 TOP OF FD EL 639.83
SLOPE
7 TYP
13'-5"
9'-7"
9'-6"
34'-6"
16'-0"
23T @ 11" = 21'-1"
24R @ 7" = 14'-0"
A S-12-09
TOP OF CURB EL 640.17
CONST JT
DETAIL 1 S-12-2
DETAIL (TYP) 3 S-12-11
A S-12-07
A S-12-08
A S-12-17
LOT DATE: $PLOTDATE PLOT TIME: $PLOTTIME

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	Checked By: KJ	Date: 6/25/14
	Revised By:	Date:
Project No. WW-PEG-2124-043062		Sheet No. 10

Project Description Basement Wall Design / Concrete Wall Supports

Wall W-1 @ line-B

South wall (Bet'n line (3) & (5))

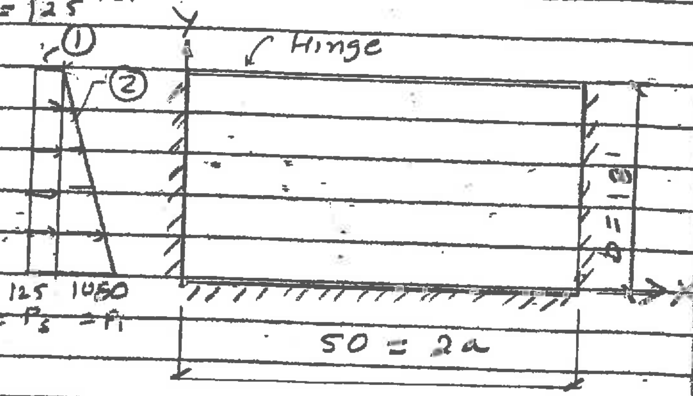
Assume wall hinged on Top, two sides & bottom fixed

For wall designation see sketch pg. 21

P_S = Surcharge = 250 x .50 = 125 psf

P_1 = .5 x 120 x 18 = 1080 psf

$\frac{a}{b} = \frac{25}{18} = 1.39$ Say 1.50



Loading Type — Calculate Mom. & Reactions

(1)

M_{1x} = .0531 x .125 x 18² = 2.15 ᵏ

R_{1x} = .5302 x .125 x 18 = 1.193

M_{1y} = .1194 x .125 x 18² = 4.84 ᵏ

R_{1y} = .6252 x .125 x 18 = 1.407

(2)

M_{2x} = .0262 x 1.08 x 18² = 9.17 ᵏ

R_{2x} = .2208 x 1.08 x 18 = 4.292 ᵏ

M_{2y} = .0637 x 1.08 x 18² = 22.29 ᵏ

R_{2y} = .3997 x 1.08 x 18 = 7.77 ᵏ

M_{Tx} = 2.15 + 9.17 = 11.32 ᵏ

M_{ux} = 1.7(11.32) = 19.24 ᵏ

M_{Ty} = 4.84 + 22.29 = 27.13 ᵏ

M_{uy} = 1.7 (27.12) = 46.10 ᵏ

R_{Tx} = 1.193 + 4.292 = 5.485 ᵏ

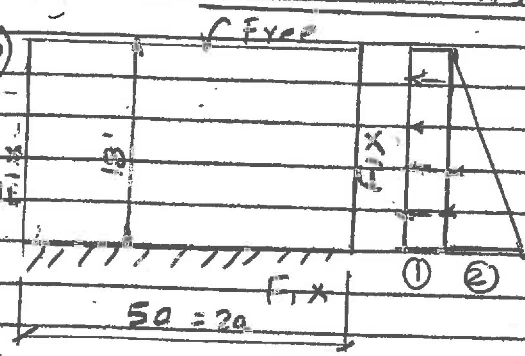
R_{Ty} = 1.407 + 7.77 = 9.177 ᵏ

R_{uy} = 1.7 (9.177) = 15.6 ᵏ

$d_y = \frac{15600}{.85 \times 141 \times 12}$ = 10.85" 15" Tk wall ok USE 18" Tk Walls

Wall W-2

South wall (Future Bldg. bet'n (1) & (3))



$\frac{a}{b} = \frac{25.0}{18} = 1.39$ USE 1.5

(1) & (2)

M_{1x} = .3304 x .125 x 18² = 13.38 ᵏ

M_{2x} = .0857 x 1.08 x 18² = 29.99

R_{1x} = 1.6267 x .125 x 18 = 3.66

R_{1y} = 1.0123 x .125 x 18 = 2.28

M_{1y} = .3508 x .125 x 18² = 14.21

M_{2y} = .1262 x 1.08 x 18² = 44.16

R_{2x} = .3127 x 1.08 x 18 = 6.08

R_{2y} = .5047 x 1.08 x 18 = 9.81

M_{Tx} = 13.38 + 29.99 = 43.37 ᵏ M_{Ty} = 44.16 + 14.21 = 58.37 ᵏ

R_{Tx} = 3.66 + 6.08 = 9.74 R_{Ty} = 9.81 + 2.28 = 12.09 ᵏ

M_{uy} = 1.7 x 58.37 = 99.23 ᵏ R_{uy} = 1.7 x 12.09 = 20.553 ᵏ

$d_y = \frac{20.553}{.85 \times 12 \times .141}$ = 14.3" USE 24" Tk Walls

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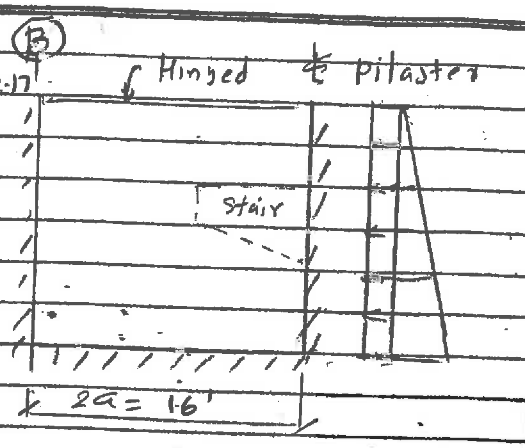
Project No. WW-PEG-2124-043062		Sheet No. 11

Project Description: Basement Wall Design

Wall W-3 — East Wall (Col-line 5) See Dwg. 5-12-17

$\frac{a}{b} = \frac{8}{18} = .44$ USE .50



(1)

$M_{1x} = .0572 \times .125 \times 18^2 = 2.32^{1k}$

$R_{1x} = .4751 \times .125 \times 18 = 1.069^{k}$

$M_{1y} = .0512 \times .125 \times 18^2 = 2.07^{1k}$

$R_{1y} = .4525 \times .125 \times 18 = 1.02^{k}$

(2)

$M_{2x} = .0269 \times 1.08 \times 18^2 = 9.413^{1k}$

$R_{2x} = .2450 \times 1.08 \times 18 = 4.763^{k}$

$M_{2y} = .0320 \times 1.08 \times 18^2 = 11.20^{1k}$

$R_{2y} = .3225 \times 1.08 \times 18 = 6.269$

$M_{Tx} = 2.32 + 9.413 = 11.733^{1k}$ $\quad M_{Ty} = 2.07 + 11.20 = 13.27^{1k}$

$M_{uy} = 13.27 \times 1.7 = 22.56^{1k}$ $\quad R_{uy} = (1.02 + 6.27) \times 1.7 = 12.39^{k}$

$d_r = \frac{12390}{.85 \times 141 \times 12} = 8.62'' < 15.0''$ (Used) OK

Reinforcements

W-1 Line B

$d = 18 - 2 - .50 = 15.5''$ $\quad b = 12''$ $\quad F = .24$

Max $M_{uy} = 46.10^{1k}$ $\quad k_n = \frac{46.10}{.24} = 192$

$f'_c = 5^{ksi}$ $\quad f_y = 60^{ksi}$

$A_{s_v} = .0038 \times 12 \times 15.5 = .707\ in^2$ #8 @ 12" o/c Vert. outside face

$M_{u_x} = 1.7 \times 11.32 = 19.24^{1k}$ say 20^{1k} $\quad k_n = \frac{20.0}{.225} = 89$

for b = 12 & d = 18 - 2 - 1 = 15"

$A_{s_h} = .0017 \times 12 \times 15.0 = .31\ in^2$ 2-#6 @ 15" o/c

$A_{sm}(min) = .0025 \times 12 \times 15 = .45^{in^2} < 2 \times .44 \times \frac{12}{15} = .704^{in^2}$ (towards earth)

USE 18" TK walls w/ #8 @ 12" Vert. bars outside face

#8 @ 12" vert. bars inside face

#6 @ 15" Horiz. bars ea. face

(Line-5)

W-3

$d = 18 - 2 - .50 = 15.5$ $\quad b = 12''$ $\quad F = .24$

Vert. → Rebars: $k_n = \frac{22.56}{.24} = 94$ $\quad A_{s_v} = .0018 \times 12 \times 15.5 = .335\ in^2$

#6 @ 12" Vert. outside face

Horiz. → Rebars: $d = 18 - 2 - 1 = 15''$ $\quad b = 12''$ $\quad F = .225$ $\quad M_{ux} = 1.7 \times 9.413 = 16.0^{1k}$

$k_n = (16)/.225 = 71$ $\quad A_{s_h} = .0017 \times 12 \times 15 = .306\ in^2$ #7 @ 15"

USE #8 @ 12" ea. face vert. bars & #6 @ 15" horiz. bars —

W-2 (line B) → See Calc. pg. 24A

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Project No. WW-PEG-2124-043062		Sheet No. 12

Project Description: Lateral Loads, Topock Water Conditioning plant

	Lateral Loads
Seismic	~~Moment frames above El. 14'-0" are primarily single story frames carrying 20 PSF Dead Load from Roof~~
	Lower portion from El. 14'-0" to El. 0'-0" shall be analysed as separate building from above using different seismic factors. All forces from above including vertical loads & horizontal shear acting at el. 14'-0"
	Slope of Roof is 4:1
12.3.3.4	Design forces for all connections & collectors shall be ~~1.25 times the seismic force for above frames (over el. 14'-0")~~
	Redundancy factor ρ
	ρ = 1.3 for all moment & Braced frames
	Load Combinations (ASCE 7-10.)
	For Mom. Frames & Braced frames Combinations w/ Allowable Stress Design
12.4.3.2	Comb. 5 – $(1.0 + .14 S_{DS}) D + .7 \Omega_o Q_E$ OR $(1+.057)D + 2.1 Q_E$
Mom. Fr's	Comb. 8 – $(.6 - .14 S_{DS}) D + .7 \Omega_o Q_E$ OR $(.6-.057)D + 2.1 Q_E$
	Ordinary Moment frames N S Dir
Table 12.2-1	$R = 3.5$ $\Omega_o = 3$ $C_d = 3$ $\delta_x = \frac{C_d \delta_{xe}}{I} = \frac{3}{1.25} \delta_{xe} = 2.40 \delta_{xe}$
	Braced Frames
Table 12.2-1	$R = 3.25$ $\Omega_o = 2$ $C_d = 3.25$
Braced Fr's	Comb. 5 $(1+.057)D + 1.4 Q_E = 1.057 D + 1.4 Q_E$
	Comb. 8 : $(.6 - .057) D + 1.4 Q_E = .543 D + 1.4 Q_E$
	Using Equivalent Lateral procedure
	$V = C_s W$; $I = 1.25$ $R = 3.5$ (Ordinary Mom. Fr.)
	$C_s = \frac{S_{DS}}{(R/I)} = \frac{.406}{(3.5/1.25)} = .145$ $C_{s\,max} = \frac{.5 S_{D1}}{T(R/I)}$
(Mom. Fr)	$T = C_t h_n^{x} = .028 \times (21)^{.8} = .32$ $T_{Br. Fr} = .02 \times (21)^{.75} = .196$ sec
	$C_{s\,max} = \frac{.5 \times .271}{.32 (2.8)} = .152$ (Mom. Fr's) $C_{s\,max} = \frac{.5 \times .271}{.196 (3.25/1.25)} = .265$ (For Braced Frame)
N S Dir	$W = .02 \times 25 \times 35 + .75 \times 4.0 + .01 \times 10.5 \times 25 = 23.12$
	$V_{NS} = .152 \times 23.12 \times 1.3 = 4.6^k$ USE 4.6^k / Mom. Fr. Say 5^k
E W Dir	$V_{EW} = .265 \times 23.12 \times 1.3 = 9.1^k$ USE 9.1^k / Br. Fr.
Wind See P3.14 for Wind pressure calc.	$V_{NS} = .034 (\frac{21}{2} + 5.4) \times 25 = 9.5 = P_W$ $V_{EW} = .024 \times 23.7 (\frac{34}{2}) = 4.83^k = P_W$
	Design for seismic in both directions & check w/ wind loads applied in separate load cases See pg. 14

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Project No.	WW-PEG-2124-043062		Sheet No. 13
Project Description	Lateral Loads Topock W.C. plant		

Lateral Loads Contd.

Seismic — Lower Structure is concrete slab & beam at 2nd flr and concrete shear walls under 2nd flr resisting lateral loads. Shear walls shall be designed to carry loads from
- Moment Frames & braced frames (all lateral loads)
- Columns supporting Roof DL & LL as well as Crane loads

From Table 12.2-1 Get design factors for Ordinary Reinforced concrete shear walls

$S_{DS} = .247,\ S_{D1} = .187 \quad S_{MS} = .37\ \&\ S_{M1} = .28$

$R = 4 \quad \Omega_o = 2.50 \quad C_d = 4$

$V = C_s W \qquad C_s = \frac{S_{DS}}{(R/I)} = \frac{.2406}{(4/1.25)} = .0773$

$C_{s\,max.} = \frac{.5 S_{D1}}{T(R/I)} = \frac{.5 \times .187}{T \times 3.2} = \frac{.0292}{T} = \frac{.0292}{.1448} = .202$

Sect. 12.8.2.1 — $T_a = C_t h_n^x = .02 \times 14^{.75} = .1448$ USE $T = .1448$ sec. (Eq. 12.8-7)

Slab / Walls / Bms

$W = .15 \times 1 \times 50 \times 34 + .15 \times 34 \times 3 \times \frac{14}{2} \times 1.5 + .15 \times 50 \times 3 \times 3 \times 2.5 + 255 + 160.7 + 168.2 = 585^k$

$V = .202\ W = .202 \times 505 \times 1.10 = 112.2^k$

~~$V_{Tot.}$ = Upper struct Shear + Lower struct. Shear~~

Line A — $V_{Tot.} = 5.0 \times 2 + 112.2 = 122.2^k$ (Mom. Fr.'s) USE 125^k

For Conc. Structure combinations w/ Strength Design

12.4.3.2 — 5 $(1.2 + .2 S_{DS})D + \Omega_o Q_E = (1.2 + .2 \times .406) \times D + 2.5 Q_E$

7 $(.9 - .2 S_{DS}) D + \Omega_o Q_E = (.9 - .2 \times .406) \times D + 2.5 Q$

Final equations are

Use for Shear Walls:
- Comb. 5 $(1.2 + .0812)D + 2.5 Q_E = 1.281 D + 2.5 Q_E$
- Comb. 7 $(.9 - .0812) D + 2.5 Q_E = 0.819 D + 2.5 Q_E$

Calculate T_a based on Eq. 12.8-9 ASCE 7-10

Walls line ③ — $D_1 = 17$, $h_n = 14$, $A_b = 7$, Fdn Area $A_b = 76.5$, Bldg Area $A_b = 1700$

$T_a = \frac{.0019}{\sqrt{C_w}} \times h_n$ (Eq. 12.8-10) $\qquad C_w = \frac{100}{A_B} \sum_{i=1}^{n} \left(\frac{h_n}{h_i}\right)^2 \frac{A_i}{\left[1 + .83\left(\frac{h_i}{D_i}\right)^2\right]}$ — Shear Area

$= \frac{.0019 \times 14}{\sqrt{6.384}} \qquad = \frac{100}{2 \times 34 \times 10.5} \left[\frac{1.5 \times 17 + 1.5 \times 34}{\left(1 + .83\left(\frac{14}{17}\right)^2\right)}\right]$

$= .0105$ sec. $\qquad = 6.384$

$T = .0105 \times 1.5 = .016$ sec. Too small use other method

$T_a = .1 N = .1 \times 1 = .1$ sec. $T = C_u T_a = 1.5 \times .1 = .15$ sec. (Eq. 12.8-8) (Table 12.8-1)

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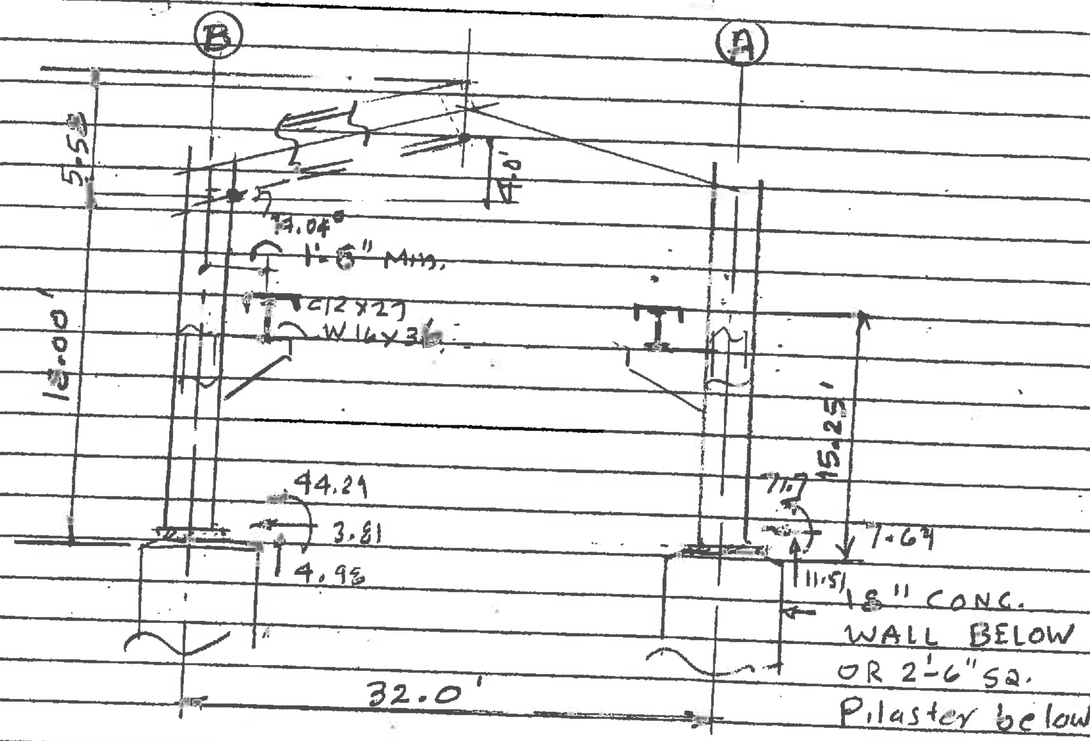
Project No. WW-PEG-2174-043062		Sheet No. 14

Project Description Frame @ Col. line (3) Load Combinations



Following Load combinations for Frame Design considered

$Q_E = Q_p$ = Seismic P_W = wind

Include Roof DL DL = .02 x 25 = .50 k/'

1. ~~D + L Q_E~~ See pg. 12 for Seismic (Q_E) & Wind (P_W)
2. ~~1.057 D + 2.1 Q_E~~ Q_E = 5.0 (Mom. Fr.), Q_E = 9.1 k (Br. Fr.)
3. .543 D + 2.1 Q_E
4. Roof D + WIND P_W P_W = 5 k (Br. Fr.), P_W = 10.0 (Mom. Fr.)
5. Roof D + .75 L + .75 P_W
6. Roof. D + Crane (D+L) + 2.1 Q_E

Assume crane is not operating during earthquake. Hence no impact nor horiz. loads due to operation

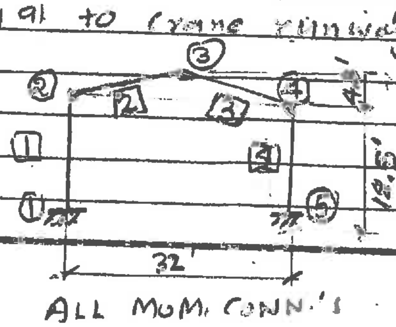
Crane Loads (2 T capacity) Single Girder/Wheel Crane

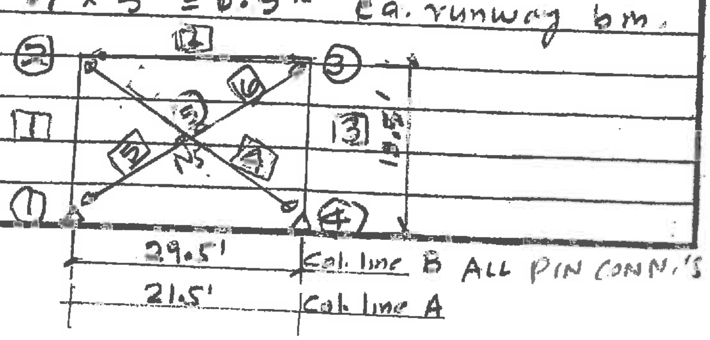
Assume DL = 1 k (including bridge girder & crane)

Crane D+L = 1 + 4 = 5 k

⊥ar to crane runway = .2 x 5 = 1.0 k 0.5 k ea. beam

∥al to crane runway = .1 x 5 = 0.5 k ea. runway bm.





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	Sheet No. 15

Project No. WW-PEG-2174-043062

Project Description Crane Runway Design.

Single Bridge (Girder) $l = 32 - 2 \times 1.5 = 29'$

$P = (1.0 + 4) \times 1.25 = 6.25^k$ $\quad R_{(max.)} = \frac{6.25 \times 27.5}{29} = 5.93^k$

$M = \frac{6.25 \times 29}{4} = 45.3^{1k}$

for $l_u = 27.5'$ Bm W 14x48 $M_A = \frac{86}{1.67} = 51.5^{1k}$

Try W 14x61 $I_x = 640$ $I_y = 107$

$S_x = 92.1$ $S_y = 21.5$

$\Delta_A = \frac{29 \times 12}{600} = 0.58''$ $\quad \Delta_a = \frac{Pl^3}{48EI} = \frac{6.25 \times 29^3}{48 \times 29000 \times 640} \times 1728 = .30'' < .58''$

Note: Crane Bridge Girder size for reference only however it shall be designed by Crane Manufacturer.

Crane Runway Beam

Max. Span = 29.5' $\quad P_{max} = 5.93^k$ Say 6^k

$M_{x\,max} = \frac{6 \times 29.5}{4} = 44.25^{1k}$ $\quad R_{(Max)} = 6^k$ $\quad M_{y\,max} = \frac{1.2 \times 29.5}{4} = 8.85^{1k}$

C 12x20.7

W16x36

Try W 16x36 W/ C 12x20.7 CH. (AISC - pg. 1-112)

$I = 610\ in^4$, $S_{1\,(Bot.)} = 62.8$ $\quad S_{2\,(Top)} = 123$ $\quad S_y = 25.6$ $\quad I_y = 153$

$r = 6.34$

$A = 16.69\ in^2$

$f_{bx\,(Bot)} = \frac{44.25 \times 12}{62.8} = 8.45^{ksi}$ $\quad f_{by\,(Top)} = \frac{8.85 \times 12}{25.6} = 4.15^{ksi}$

$f_{bx} + f_{by} = 8.45 + 4.15 = 12.6^{ksi} < .6F_y$ ok

$\Delta_{max} = \frac{6 \times (29.5)^3}{48 \times 29000 \times 670} \times 1728 = .285'' < \frac{l}{600} = .59''$ ok

Crane col (WIND + Crane) pg. 3 Crane (Roof DL only)

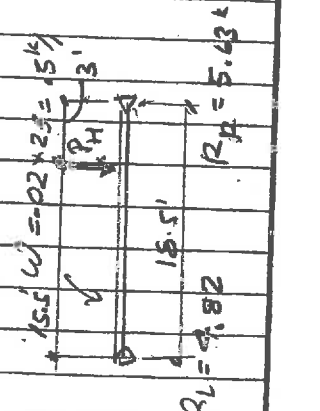
Vert. $P_{max} = 6^k + \frac{20}{2} = 16^k = P_V$

Horiz. $P_H = .2 \times 6 = 1.2^k$ $\quad W_W = .5^k/'$

$R_R = \frac{.5 \times 18.5}{2} + \frac{1.2 \times 15.5}{18.5} = 5.63^k$ $\quad R_L = 4.82^k$

$M_{max} = \frac{4.82 \times 9.64}{2} = 23.23^{1k}$

$P_D = 16^k$



Include Crane LL: Crane col. - W10x45
See Computer output for various Combinations.

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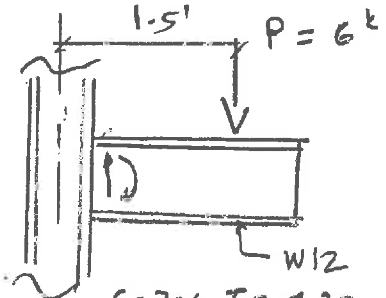
	Checked By:	KJ	Date: 6/25/14
	Reviewed By:		Date:
Project No.	WW-P&S-2174		Sheet No. 15A
Project Description:	Crane Runway Design, Misc. Supports		

Reference:

Crane Runway Bm. Support



$S_x = 70.6$, $I_x = 425$

$S_y = 19.2$, $I_y = 95.8$

$M_{max} = 1.5 \times 6 = 9^{'k}$

(W12)

$\Delta_{xx} = \dfrac{PL^3}{3EI} = \dfrac{6 \times 1.5^3}{3 \times 29000 \times 425} \times 1728 = .001''$ very small

$f_{bx} = \dfrac{9 \times 12}{70.6} = 1.53^{ksi}$ very small

Δ_{yy} all small ok by insp.

W 12x53 ok

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Project No. WW-PEG-2124-043062		Sheet No. 16

Project Description Topock W.C. plant, Frames sizes & checks (outputs)

N-S Dir — Typical Mom. Fr.

(Topockgwr. mom. fr.)

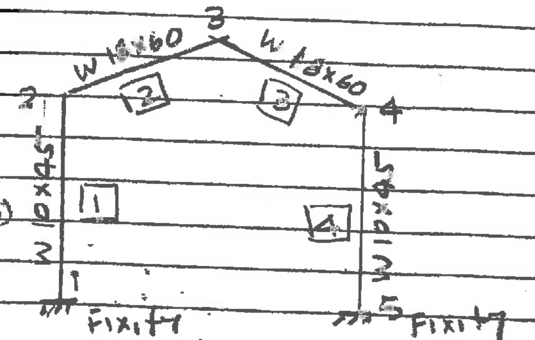
For size checks see page 26

Steel code checks (outputs)

Displacement (see Joint deflections)

Max. Defl. (JT. 4, load case 6)

$= 1.26'' = \delta_{xe}$ = Defl. by elastic an.



Max. Defl. $\delta_e = 2.4\,\delta_{xe}$ (pg. 12)

$= 2.4 \times 1.26 = 3.024'' < .015 \times 18.5 \times 12 = 3.33''$ (Table 12-12-1 ASCE 7/10)

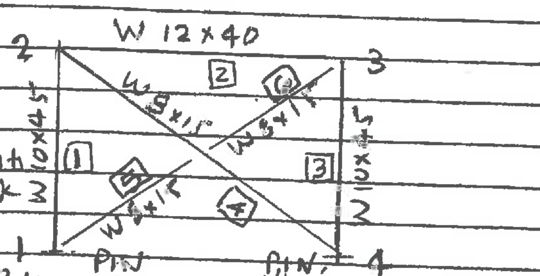
Assume $\rho = 1.0$ for Drift Calculations.

~~Design pilaster below for~~

Mom. Fr. only — $M = 71.7^{k}$ $V_{max} = 7.69^{k}$ $R_{max} = 11.51^{k}$

(Topock wcp. braced frame A)

E-W Dir — Braced Frames



Line A — $V_{max} = 19.26^{k}$ $R_{max} = 21.18^{k}$

$R_{uplift} = 16.62^{k}\downarrow$ 12-1¼" φ A-36 Bolts & 24"x24" Base pl. ok

Line B — $V_{max} = 19.28^{k}$ $R_{max} = 16.62^{k}$

$R_{uplift} = 12.11^{k}$ 12-1¼" φ A 36 A.B.'s w/ 24x24x1½" pl. ok (See page 22)

Wind Loads (see chapter 28, Part-2)

Sect. 28.5 — Risk catagory II V = 110 mph

Table 28.6.1 (pg. 304) Exp C, V = 110 mph $P_{S30} = 17.5$ psf ($\theta = 18.4°$)

Wind Press. — $P_W = P_S = \lambda K_{zt} P_{S30}$ (Eq. 28.6-1 pg. 306)

$P_{S30} = 17.5$ (Table 28.3.1) $\lambda = 1.35$ (pg. 305) (mean ht. 25') $K_{zt} = 1.0$

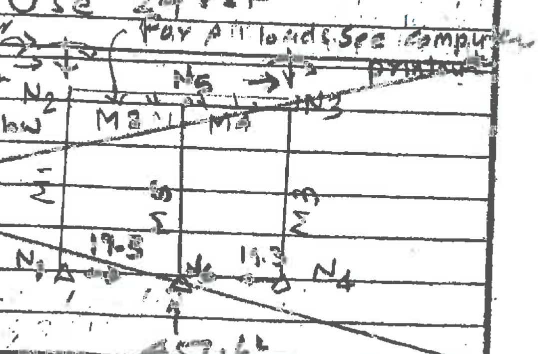
$P_S = 1.35 \times 1 \times 17.5 = 23.6$ PSF Use 24 PSF

~~See output for Mom. Fr. w/ Comb Stiffness — Topock conc. Frame (4) — Stiffness of Fr. = 1/Δ = 1/.378 = 2.6 (Load comb. -5) → see note below~~

~~Max. Reactions (DL+LL) R = 25^k, V = 19.3^k~~

~~Comb-3 DL+Seis. V_max = 97.6^k R_max = 103.3^k 147.1^k~~

~~Note: Δ = 100/Σ... = .829" Converted to reflect defl. for 100^k load~~



USE SHEAR WALLS @ COL. LINES ③, ④ & ⑤ See Calc's pg. 18

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Project No. WW-PEG-2174-043063		Sheet No. 17
Project Description: Topock Steel Mom. fr. Base pl. & Anchor Bolts		

Loads from pg. -26 computer output for Stl Mom. frame
Also see Braced frame line-B

Load comb (5): $P_{max} = 22.55^k$ $M_{max} = 70.46^{'k}$ $V_{max} = 8.32^k$

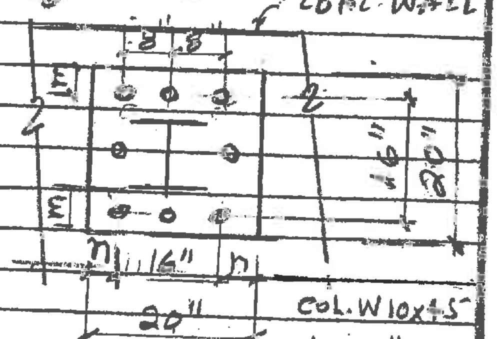
Base pl. (20" x 20" x 1" tk trial size)

$\frac{P}{A} = \frac{22.6}{20 \times 20} = .0565^{ksi}$ $\frac{M}{S} = \frac{70.46 \times 12}{1/6 \times 20 \times 20^2} = .634^{ksi}$

$f_p = .0565 + .634 = .69^{ksi}$

$n = \frac{B - .8 b_f}{2} = \frac{20 - .8 \times 8}{2} = 6.8"$

$m = \frac{N - .95 d}{2} = \frac{20 - .95 \times 10}{2} = 5.25"$



$t_{min} = 2 m \sqrt{\frac{f_p}{F_y}}$ $F_y = 36^{ksi}$

↓ is used since this comp'n occurs in that direction

$= 2 \times 5.25 \sqrt{.69/36} = 1.45"$ (See calc's below for 24" x 24" pl.) *

$f'_c = 5^{ksi}$
$f_y = 60^{ksi}$

Anchor Bolts

Steel Mom. Frame

Max. Ten./Bolt $= T = \frac{70.46 \times 12}{16 \times 3} = 17.62^k$

Max Shear/Bolt $= V = \frac{8.32}{8} = 1.04^k$

Try $1\frac{1}{4}" \phi \times 18"$ A-36 Anchor Bolts [Table 3, 5, 6 Attached)

Allow. $T_a = 19.6^k$ for $E_d = 8.4"$ & $S_{dc} = 19.8$ c/c bolts

$V_a = 10.2^k$ $m_t = 4.3$ = Edge dist. for tens.

Due to overlapping cones since $S_d = 8" < 19.8"$ (Arbitrary)
Increase embedment to 18" & Reduce cone area to 80%

$\frac{V}{V_a} + \frac{T}{T_a} = \frac{1.04}{10.2 \times .8} + \frac{17.62}{19.8 \times .8} = 1.23 \approx 1.2$ (20% increase for seismic or wind loads OK)

USE 24" x 24" x $1\frac{1}{2}$" Base pl. w/ 8-$1\frac{1}{4}" \phi \times 18"$ A.B.'s or

* $f_p = \frac{22.6}{24 \times 24} + \frac{70.46 \times 12}{1/6 \times 24 \times 24^2} = .406^{ksi}$ $t_{min} = 2 \times 7.25 \sqrt{\frac{.406}{36}} = 1.54"$

$1\frac{1}{2}"$ Tk pl OK

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Project No. WW-PEG-2124-043062

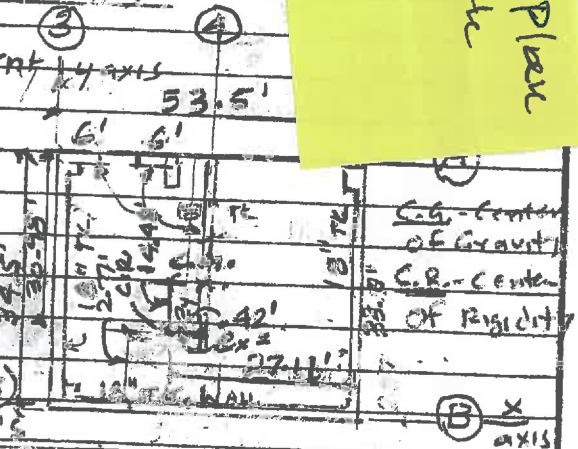
Project Description: Lateral Analysis, Topock W.C. plant, S[illegible]

Re do Plan Sketch

Lateral Analysis (Lower Building)

Assume portion bet'n ③ & Ⓐ is built now - Referred to as current Bldg

N S DIR. Distribute Shears



Diaph. @ 2nd Flr. is rigid diaph.
Assume C.G. of Floor in the center of floor in both direction
See charts for values of Δ_F
See attachments
Compute V_d and V_T (Torsional shears)
R_x & R_y are stiffness in x & y dir's

Wall line	Ht.	d (Length)	h/d	Δ_F	R	ΣR
3	13'	34.5'	.377	.119	8.40	
5	13'	34.5	.377	.119	8.40	
4	13'	34.5	.377	.119	8.40	25.20 (ΣR_y)
A	13	6.0	2.17	1.673	.598	
A	13	6.0	2.17	1.673	.598	
B	13	53.5	.243	.073	13.70	
						14.896 (ΣR_x)

Locate C.R. of Floor w.r.t. front wall & Left wall (line 3)

$\bar{X} = \frac{8.40 \times 52.25 + 8.4 \times 26.25}{25.20} = 26.33'$ (From Y axis) $e_x = \frac{53.5}{2} - 26.33 = .42'$

$\bar{Y} = \frac{2 \times .598 \times 34.5}{14.896} = 2.77'$ (From x axis) $e_y = \frac{34.5}{2} - 2.77 = 14.48'$

Torsional Moments

$T_{NS} = V_T \times e_x = 125 \times .42 = 52.5^{1k}$ (pg 13) $\frac{T_{NS}}{J} = \frac{52.5}{13202} = .04$

$T_{EW} = 125 \times 14.48 = 1810^{1k}$ $\frac{T_{EW}}{J} = \frac{1810}{13202} = .137$

Torsional Shears

$J = x_R y_R^2 + y_R x_R^2 = .598(30.98)^2 \times 2 + 13.7 \times (2.02)^2 + 8.4 \times .42^2 + 8.40(26.33)^2 + 8.40(27.11)^2 = 130202\ ft^2$

Wall ③ $V_{T3} = .04 \times 8.4 \times 26.33 = 8.85^k$

$V_{T5} = .04 \times 8.4 \times 27.11 = 9.11^k$ $V_{T4} = .04 \times 8.4 \times .42 = .14^k$

Wall Ⓐ $V_{TA} = .137 \times .598 \times 30.98 = 2.54^k$ $V_{TB} = .137 \times 13.7 \times 2.02 = 3.79$

Formula for shears: NS Dir. $V_T = \frac{T_{NS}}{J} \times R_y x_R$ EW Dir. $V_T = \frac{T_{EW}}{J} \times R_x y_R$

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Project Description: Lateral Analysis, Shear Walls Topock W.C. plant

Lateral Analysis Shear Walls

For ΣR_x & ΣR_y & V_T see pg. 17

Wall direct Shears + Torsional Shear = V.

Wall Line	Wall R_x or R_y	$R_x/\Sigma R_x$ or $R_y/\Sigma R_y$	V_d Direct Shear	V_T Torsional pg. 18	$V = Q_E$	$V' = 2.5 Q_E / .8 0 l$	v ksi
(3)	8.4	.333	41.63	8.85	50.48	5.72	.044
(4)	8.41	.334	41.75	.14	41.89	4.73	.036
(5)	8.41	.333	41.63	9.11	50.74	5.75	.044
(A)	.598	.04	5.0	2.54	7.54	4.91	.038
(B)	13.72	.92	115.0	3.79	118.79	8.67	.067

for shear & torsion $\phi = .75$ ACI 9.3.2.3

ACI 11.9-5 — $\lambda = 1.0$

Allow. Shear $V_{all} = 2\lambda\sqrt{f'_c}\,hd$ $hd = .8 l_w$

$= 2\times1\sqrt{5000}\times.8l$

$d = 18-2.5 = 15.5''$

$v = \frac{V_u}{\phi} = \frac{2.5V/l}{.8\times.75\times12\times18} = 0.00772\,V'$ where V → kips, l → ft

Allow. $V_c = 2\sqrt{5000} = 141.42$ psi $>$ v (Table above) ok

11.9.9.1 No shear reinforcement reqd.

R 11.9.9 $\frac{h_w}{l_w} = \frac{14}{53} = .26 < .5$ provide vert. Reinf. equal to horiz. reinf.

Min. vert. reinf. $= .0025\times12\times18 = .54$ in²

#6 @ 18" ea. face $A_{s_a} = .44\times\frac{12}{18}\times2 = .587$ in²

Min horiz. reinf. $= .0025\times12\times18 = .54$

#6 @ 18" ea. face $A_{s_a} = .587 > .54$ in² ok

Provide Reinf. based on overturning for short walls

DL on walls + Seismic as per Combinations 5 & 7 page 13

Line (4) — See comb.n pg. 13

$M_o = 2.5\times7.54\times14 = 263.9^{1k}$ $M_R = .819(.225\times14\times\frac{6^2}{2})$

$M_o - M_R = 263.9 - .9\times56.7 = 213.32$ $= 56.7^{1k}$

$P_{uplift} = (213.3)/.8\times6 = 44.2^k$ $P_c = \frac{263.9}{.8\times6} + 1.28(\times.225\times14\times6 = 47.1^k$

Line (3)

$M_o = 2.5\times50.48\times14 = 1766.8^{1k}$ $M_R = .819(.225\times14\times\frac{33^2}{2}) = 1404.7^{1k}$

$P_u = \frac{(1766.8 - .9\times1404.7)}{.8\times33.0} = 19.04^k$ $P_c = \frac{1766.8}{.8\times33} + 1.28\times.225\times14\times3 = 79.0^k$

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Project No. WN-PEG-2124-043062		Sheet No. 20

Project Description Lateral Analyses, Shear Wall Columns Topock W.C. plant

Line (A) Pilasters

Try pilaster 18"x 24" as conc. wall

Line (A) See pg. 18 for forces

$\phi P_n = .55\phi f_c' A_g \left[1 - \left(\frac{k l_c}{32 h}\right)^2\right]$ $l_c = 14'$ $k = 2$

$= .55 \times .7 \times 5 \times 18 \times 24 \left[1 - \left(\frac{2 \times 14 \times 12}{32 \times 18}\right)^2\right]$ $h = 18"$ $A_g = 18" \times 24"$

$= .55 \times .7 \times 5 \times 18 \times 24 [1 - .34]$

$= 548.62^k > 67 + 12 = 79^k$ (Roof)

USE 6-#6 vert. Bars in 18"x24" pilaster

6-#6 Ten. cap. $= .90 \times 6 \times .44 \times 60 = 142.6^k > 44.2^k$

Line (3) See pg 19 — To accomodate Base pl. frm from above 30" width is required so Try 30"x30" pilasters

$\phi P_n = .55 \times .7 \times 5 \times 30 \times 30 \left[1 - \left(\frac{2 \times 14 \times 12}{32 \times 30}\right)^2\right]$

$= 1732.5 [1 - (.34)^2]$ (Roof DL + Seis.)

$= 1520.3^k > 79.0 + 12 = 91^k$

9-#8 Bars for pilaster.

Ten. Cap. $= .9 \times 9 \times .79 \times 60 = 384 > 19^k$ (pg. 19)

Min. A for col. $= .01 \times 30 \times 30 = 9.0^{in^2}$ 12-#8 Bars req'd.

USE 12-#8 BARS for 30"x30" col. w/ #4 Ties @ 12" o/c

Line (5) See pg 11 — $M_0 = 2.5 \times 50.74 \times 14 = 1775.9$ $M_R = .819(.225 \times 14 \times 33) \frac{}{2} = 1404.7^{k}$

$P_u = \frac{(1775.9 - .9 \times 1404.7)}{.8 \times 33.0} = 19.04^k$

$P_c = 79 + 12 = 91^k$ (See pg. 19 for Line (3))

Ten. is very small

USE 30"30" pilaster OR column w/ 12-#8 BARS

See Details 4/S-12-11 And 2/S-12-16, provide #4 Ties @ 12"

(See pg. 11) Other Reinf. - for shear wall also a Retaining Wall (pg. 11)

~~2-#6 @ 12" vert~~ Reinf. ~~2-#6 @ 15" horiz. bars~~

2-#6 @ 15" vert. bars

Line (B) (see pg. 10) See page 10 & 11 for Basement Retaining Wall Calc's

~~9-#8 Bars in pilaster 30"x30"~~ Vert. Reinf. - Rest #9 @ 12" (O.F.)

~~7# @ 15" Horiz. Reinf. ea. face (E.F.)~~   #9 @ 15" (E.F.)

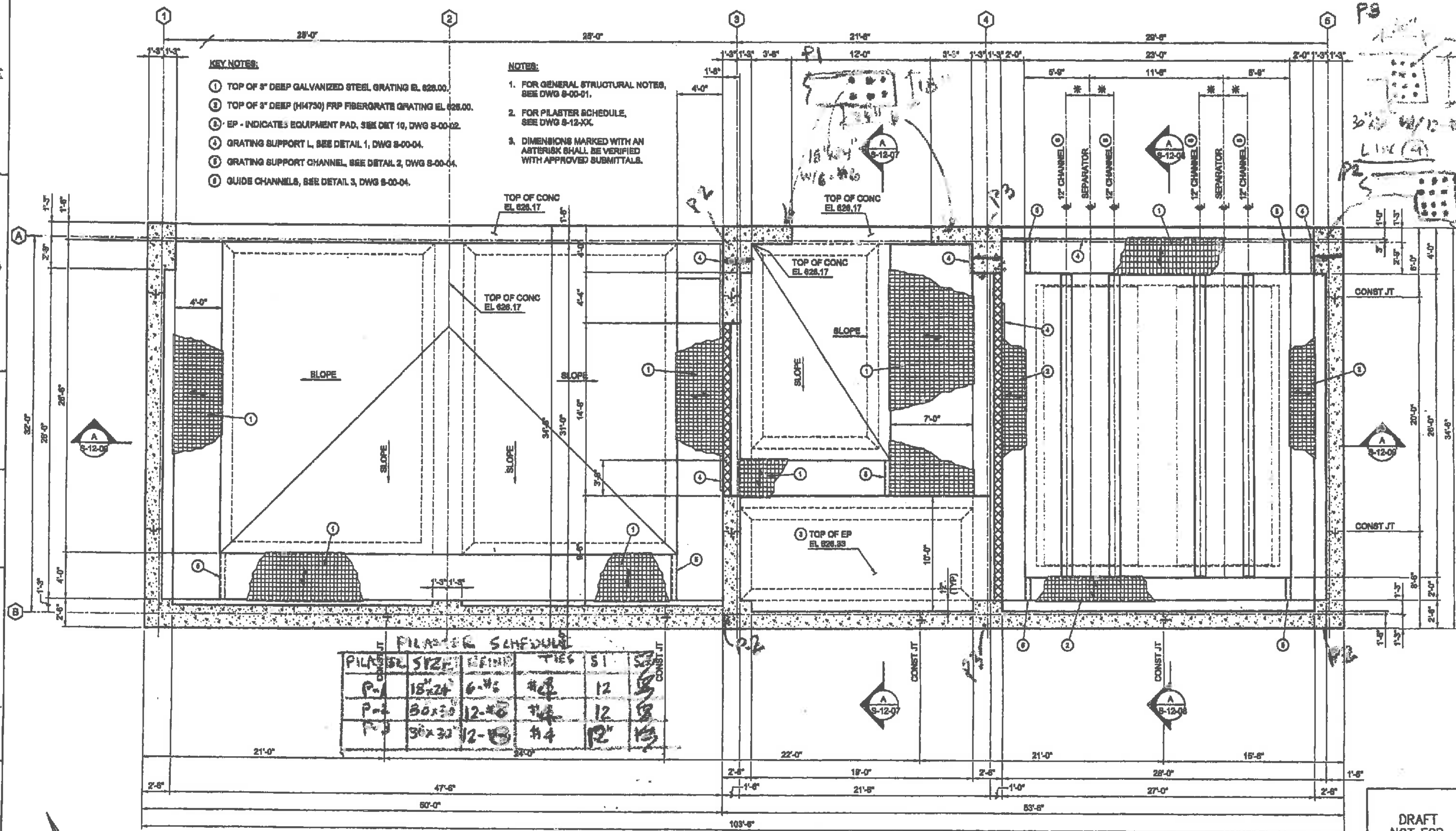
pg-21

KEY NOTES:

1. TOP OF 3" DEEP GALVANIZED STEEL GRATING EL 626.00.
2. TOP OF 3" DEEP (HI4730) FRP FIBERGRATE GRATING EL 626.00.
3. EP - INDICATES EQUIPMENT PAD, SEE DET 10, DWG S-00-02.
4. GRATING SUPPORT L, SEE DETAIL 1, DWG S-00-04.
5. GRATING SUPPORT CHANNEL, SEE DETAIL 2, DWG S-00-04.
6. GUIDE CHANNELS, SEE DETAIL 3, DWG S-00-04.

NOTES:

1. FOR GENERAL STRUCTURAL NOTES, SEE DWG S-00-01.
2. FOR PILASTER SCHEDULE, SEE DWG S-12-XX.
3. DIMENSIONS MARKED WITH AN ASTERISK SHALL BE VERIFIED WITH APPROVED SUBMITTALS.



PILASTER SCHEDULE

PILASTER	SIZE	REINF	TIES	S1	S2
P-1	18"x24"	6-#6	#4	12	[illegible]
P-2	30x30	12-#8	#4	12	18
P-3	30"x30"	12-#8	#4	12"	18

FIRST FLOOR PLAN

1/4" = 1'-0"

DRAFT NOT FOR CONSTRUCTION

CH2MHILL.

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REVISIONS

TOPOCK GROUNDWATER REMEDIATION PROJECT
REMEDY - PRODUCED WATER CONDITIONING PLANT
FIRST FLOOR PLAN
GAS TRANSMISSION & DISTRIBUTION
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

DSGN KJD · DRN WTH · CHKD VMB · DATE 4/5/13

S-12-02

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Project No. WW-PEB-2124-043062		Sheet No. 23

Project Description Topock W.C. plant, Foundation Design

Footings (Concrete frame columns)

Max $P_u = 243.5^k$ Say 250^k $P = \frac{250}{1.6} = 156.2^k$

Allow. Soil press = 4^{KSF} $A_r = \frac{156.2}{4} = 39.06\ ft^2$

Size Reqd = $\sqrt{39.06} = 6.25$ ft.

Try 7-0" SQ. Ftg. Conc. Col. Size = 2.5' SQ.

WT. OF FTG = $7.0 \times 7.0 \times 2 \times .15 = 14.7^k$

$p = \frac{(156.3+14.7)}{7.0 \times 7.0} = 3.5^{KSF}$ ok

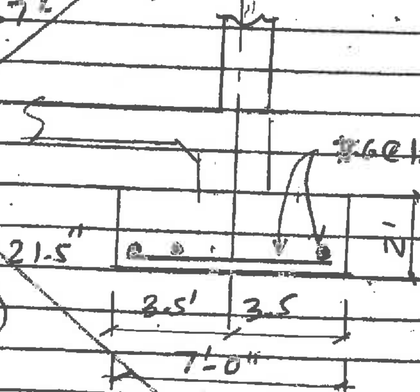
7'-0" SQ. FTG. Preferred.

$M_u = \frac{3.5 \times 1.6 \times 2.25^2}{2} = 14.2^{1k}$ @ Face of col.

Try #6 @ 12" o/c $d = 24 - 3.5 = 21.5"$

$\phi M_n = .9 \times .44 \times \frac{60}{12} (21.5 - \frac{.44 \times 60}{5 \times 12 \times 2})$

$= 42^{1k} > 14.2$ ok



Check Shear

$v = \frac{3.5 \times 1.6 \times 2.25 \times 10^3}{12 \times 21.5 \times .85} = 57.5^{PSI} < 2\sqrt{5000} = 141.4^{PSI}$

Punching Shear @ dist. d/2 $= \frac{250000}{4 \times 21.5 \times 21.5 \times .85} = 159.1^{PSI} < 4 \times \sqrt{5000}$ ok

USE 7'0" SQ. FTG. W/ #6@12" Ea Way

Footings (Shear Walls Lines ③, ④, ⑤) COL. LINE A (current)

$Max\ P_{Footing} = \frac{P}{2} + .15 \times 2.5 \times 4 \times 8.5 + .15 \times 2 \times 8.5 \times 8.5 = 91 + 12.75 + 21.7 = 125.5^k$ (pg. 20) (Pedestal) (Ftg.) USE 130^k

Soil press. $p = \frac{130}{5 \times 6} = 3.6^{KSF} < 4$ KSF ok.

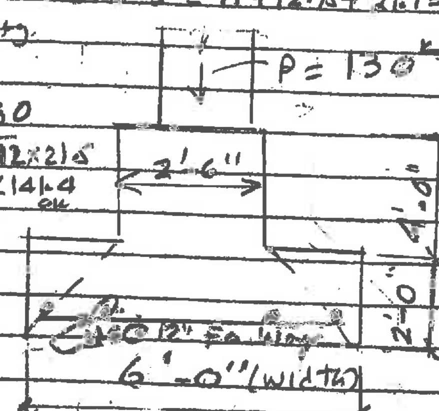
$V_u = 3.60 \times 1.6 \times 1.75 = 10.08^k$ $v_u = \frac{10080}{.85 \times 12 \times 21.5} = 46.2 < 141.4$ ok

$M_u = 3.6 \times 1.6 \times 1.75^2 \times .5 = 8.82^{1k}$

$= 8.82^{1k}$

$\phi M_n = .9 \times .44 \times \frac{60}{12} (21.5 - \frac{.44 \times 60}{5 \times 12 \times 2})$

$= 42^{1k} > 8.82^{1k}$



USE 6'-0" Continuous Ftg. Min. W/ #6@12" Ea. Way

See Fdn. plan.

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Project Description: Topock W-a plant Fdn Design

Footings (Shear wall line A)

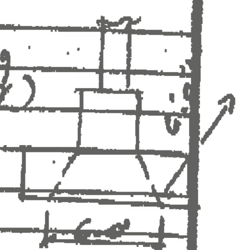
Assume Cantilever Ret. wall for future building

Ref. Dwg S12-07: Max. P_c @ pilaster = 103.6^k (18"x24" pilaster)

Try 6'-0" wide x 6'-0" long Ftg.

$P = \frac{(103.6)/1.4}{6.0 \times 6.0} = 2.06^{KSF} < 4.0^{KSF}$

#6 @ 12" Ea. Way @ bottom of Ftg.



Col. line 'B' Wall A: Footing & Cantilevered Retaining Wall (OTM Design)

Level Backfill

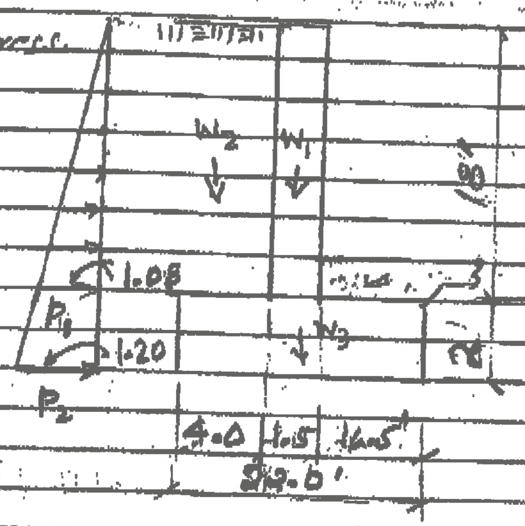
Design for 60 pcf lateral press.

Conc. f'_c = 5 ksi, fy = 60 ksi

$P_1 = 60 \times 18 = 1080$ PSF

$P_2 = 60 \times 20 = 1200$ PSF

No Surcharge on the wall



Stability

$W_1 = 18 \times 1.5 \times .15 = 4.05^k$

$W_2 = 18 \times 4.0 \times .11 = 7.92^k$

$W_3 = 22.0 \times 2.0 \times .15 = 6.60$

$\Sigma W = 18.57^k$

@ FTG: $M_o = 1.08 \times \frac{18}{2}(\frac{18}{3}+2) = 77.76^{1k}$

@ STEM: $M_{oc} = 1.08 \times \frac{18}{2} \times .5 \times 18 \times .333 = 58.32^{1k}$ | $V_s = 1.08 \times 18 \times .5 = 9.72$

M_R is very large OK by insp.

Soil press is also ok by insp

STEM Design: $M_{us} = 1.7 \times 58.32 = 99.15^{1k}$ $V_{us} = 1.7 \times 9.72 = 16.52^k$ d = 18-2-.5 = 15.5"

Try #9 @ 8" o/c vert. Reinf $v_u = \frac{16520}{.85 \times 15.5 \times 12} = 104.5^{psi} < 2\sqrt{5000} = 141.4^{psi}$ ok

$\phi M_n = .9 A_s f_y (d - \frac{a}{2})$ $a = \frac{A_s f_y}{f'_c b} = \frac{1.5 \times 60}{5 \times 12} = 1.5''$ #9 @ 8" vert.

$= .9 \times 1.5 \times \frac{60}{12}(15.5 - \frac{1.5}{2})$

$= 99.56^{1k} > 99.15^{1k}$ USE #9 @ 8" Soil Side & #~~8 @ 12~~ #6 @ 8" Far Side

Horiz Reinf: Min. $A_s = .0025 \times 18 \times 12 = .54^{in^2}$ #5 @ 12" Ea. Face A_{s} = 2 x .31 = .62 in² ok

Sliding: Sliding Resist. = $P_f + P_p$ = .35 x 18.57 + .3 x 6 x 6/2 = 6.49 + 5.4 = 11.89^k > 9.72

Footing Reinf.: M_u = 1.4 [(.11 x 18 + .15 x 2) x 4²/2] x 25.54^{1k} A_s = .0025 x 12 x 15 = .27 in² (Dusa.D) USE #6 @ 12" @ T & B EA. WAY @ Footing

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Project No. WW-PEB-2124-003061		Sheet No. 25
Project Description: Topock W.C. plant, Ret-Wall Design		

STEM

$V_S = 1.08 \times 18 \times .5 + .12 \times 18 = 11.88^k$

$M_{as} = 77.76^{1k}$ $M_{us} = 1.7 \times 77.76 = 132.2^{1k}$

$V_S = 11.88^k$ $V_{us} = 1.7 \times 11.88 = 20.2^k$

$v_u = \frac{V_{us} = 20200}{.85 \times 21.5 \times 12}$ $d = 24 - 2.5 = 21.5''$

$= 92.1^{PSI} < 2\sqrt{5000} = 141.4^{PSI}$

Try #9 @ 8" Vert. Reinf. $A_{sa} = 1 \times \frac{12}{8} = 1.5\ in^2$

$\phi M_n = .9 A_s f_y (d - \frac{a}{2})$ $a = \frac{A_s f_y}{f'_c b} = \frac{1.50 \times 60000}{5000 \times 12} = 1.50''$

$= .9 \times 1.5 \times \frac{60}{12}(21.5 - \frac{1.50}{2})$

$= 140.06^{1k} > 132.2^{1k}$

#9 @ 8" - soil face vert. #8 @ 12" inside face vert.

Horiz. Reinf. (See pg 10 for Moment $M_{1x} + M_{2x}$)

$M_{ux} = 1.7(13.38 + 29.99) = 73.73^{k}$ $\frac{M_u}{F} = \frac{73.73}{.441} = 167$ $A_s = .0032 \times 12 \times 21 = .80\ in^2$

USE #8 @ 12" @ Ea. face $\approx .79\ in^2$ OK

Check Sliding

$V_S = 11.88^k/_l$ (pg. 24)

friction factor = .35

P_f = Sliding Resist. = $\mu W = .35 \times 18.27 = 6.395^k/_l$

P_p = passive Resist = $.3 \times 6 \times 6 \times .5 = 5.4^k/_l$

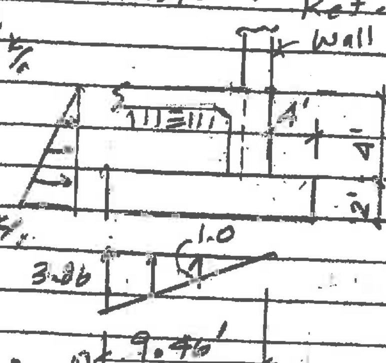
$P_f + P_p$ = Sliding + Frict. Resist. = $6.395 + 5.4 = 11.795^k/_l$

Add Frict. Resist. of slab on Grade

P_{fs} = Frict. Resist. of slab = $.35 \times 26 \times .15 = 1.365^k/_l$

Total Resist = $11.795 + 1.365 = 13.160^k/_l$

$F.S. = \frac{13.16}{11.88} = 1.11$ Say OK (w Surcharge) $F.S. = (13.16)/9.72 = 1.35$ (w/o Surcharge)



Footing Reinf. ($d = 24 - 3 - .5 = 20.5''$)

M_u (BOT.) $= 1.7\left[\frac{3.86 \times 7}{2} \times \frac{2}{3} \times 7 + \frac{1.0 \times 7^2}{2}\right]$

$= 1.7(46.713 + 24.5) = 1.7(71.213) = 121.06^{1k}$

$\frac{M_u}{F} = \frac{121.06}{.42} = 288$ $A_s = .0054 \times 12 \times 20.5 = 1.33\ in^2$

#9 @ 8" @ bot.

DL only: M_u (TOP) $= 1.4\left[(.11 \times 18 + .15 \times 2) \times \frac{4^2}{2}\right] = 1.4(18.24) = 25.54^{1k}$

$\frac{M_u}{F} = \frac{25.54}{.42} = 61$ $A_s = .0015 \times 12 \times 20.5 = .37\ in^2$

#6 @ 12" o/c

USE #9 @ 8" @ bot. & #6 @ 12" @ Top

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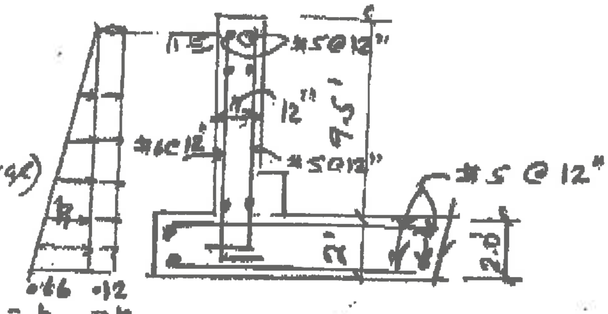
Project No.	WW PE8 - 2174	Sheet No.	25
Project Description:	Topock Tank Area Retaining Walls		

Reference: See sketch pg. 25A for Reference

Walls 'B' & 'C' Design



WALL 'B'

$p_1 = 60 \times 9 = 540$ PSF

$p_2 = 60 \times 11 = 660$ PSF

$p_3 = 60 \times 2 = 120$ PSF (surcharge)

STEM

$Mo_1 = .54 \times \frac{9}{2} \times \frac{9}{3} + .12 \times 9 \times 4.5$

$= 7.29 + 4.86 = 12.15^{k}$

FTG.

$Mo_2 = .66 \times 11.5 \times .5 \times \frac{11.5}{3} + .12 \times 11.5 \times \frac{11.5}{2} = 14.55 + 7.94 = 22.49^{k}$

Since Ftg is continuous mat No overturning Factor of Safety need to be calculated & soil press. is also ok by insp.

STEM Reinf.

$M_{olu} = 1.7 \times 12.15 = 20.66^{k}$ $d = 18 - 2 - .5 = 15.5''$ (#6 @ 12")

$\phi M_n = .9 \times .44 \times \frac{60}{12}\left(15.5 - \frac{.5 A_s f_y}{.85 f'_c b}\right)$ $\frac{A_s f_y}{.85 f'_c b} = \frac{.44 \times 60}{.85 \times 5 \times 12} = .52''$

$= 30.18^{k} > 20.66^{k}$

Vert. Reinf - USE #6 @ 12" Soil Side & #5@12" (#6@12") far side

Min. Horiz. Reinf = $.0025 \times 12 \times 12 = .36$ in² #4 @ 12" Ea. Face

Footing min. A = $.002 \times 24 \times 12 = .576$ in² #6 @ 12" Ea. way $A_{sa} = 2 \times .2 = .4$ in²; T&B $A_{sa} = 2 \times .31 = .62$ in² $> .576$ in²

Wall 'C' Ht. of Stem 10.5' Ht. for design = 10'

Wall 'C' is similar to wall 'B' except Overturning design is required.

Stem wall Reinf. - Same as wall 'B'. Vert. Reinf. #6@12" Soil side & #5@12" Horiz. Reinf. #4 @ 12" Ea. Face

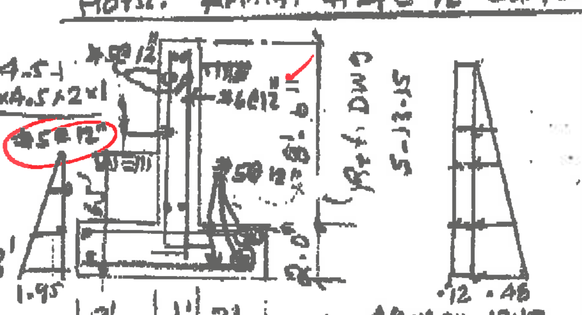
$Mo_2 = .48 \times \frac{10}{2} \times \frac{10}{3} + .12 \times 10 \times \frac{10}{2} = 14.0^{k}$

$M_R = .15 \times 8.5 \times 1 \times 3 + .15 \times 6 \times 2.0 \times 3 + .11 \times 8 \times 3 \times 4.5 + .11 \times 4.5 \times 2 \times 1$

$= 1.275 \times 3 + 1.80 \times 3 + 2.64 \times 4.5 + .99 \times 1$

$= 22.10^{k}$

$F.S. = (22.1/14.0) = 1.58 > 1.50$



#6@12" (#5@12")

$\bar{X} = \frac{M_R - M_o}{\Sigma W} = \frac{22.1 - 14}{6.7} = 1.21'$ $3\bar{x} = 3.63'$

$p = \frac{2 \times \Sigma W}{3 \times \bar{X} \times b} = \frac{2 \times 6.7}{3.63 \times 1} = 3.69$ KSF ≤ 4.0 KSF ok

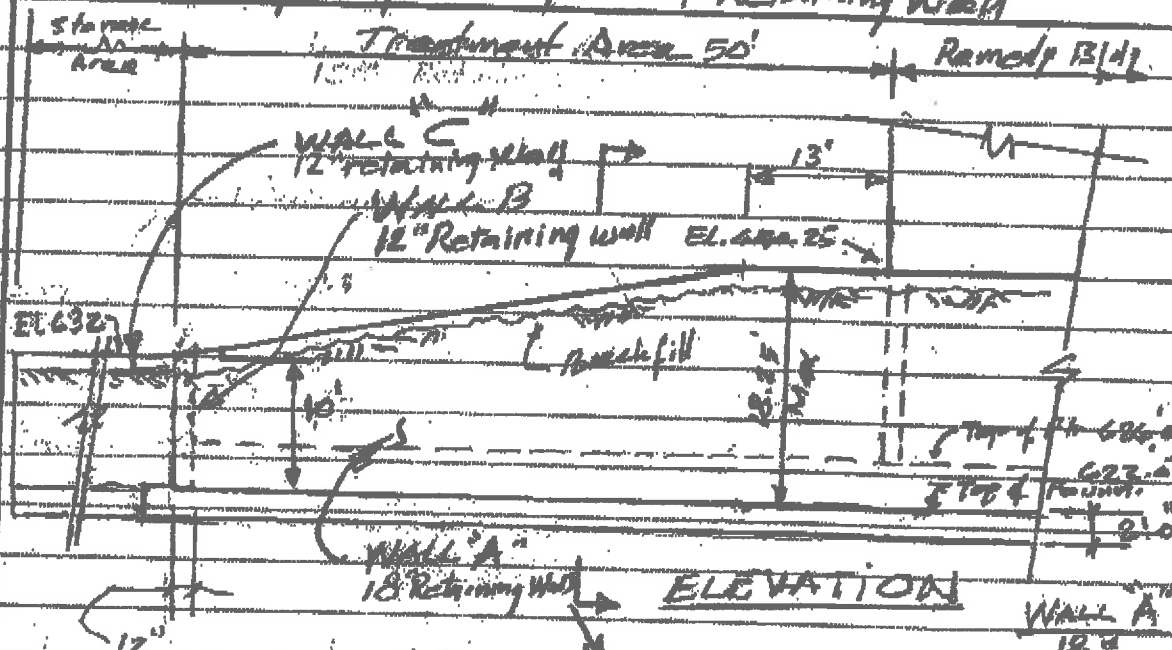
$V = \frac{.48 \times 10}{2} + .12 \times 10 = 3.6^{k}$

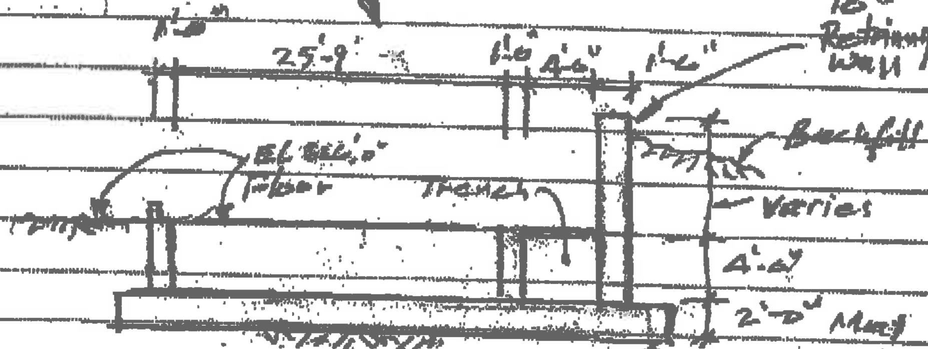
Sliding Resist = $P_f + P_p = .35 \times 6.7 + .3 \times 6.5 \times 6.5 = 2.35 + 6.33 = 8.68^{k} > 3.6^{k}$ OK

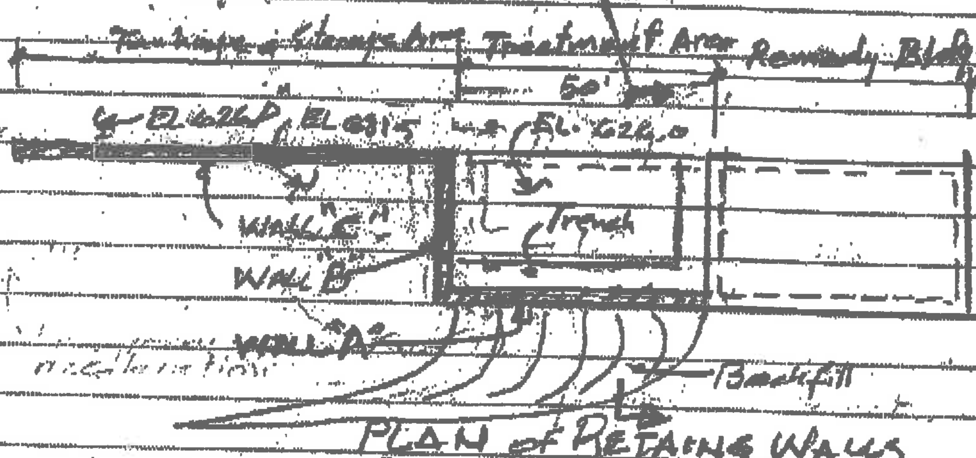
Ftg. Reinf. $M_u = (3.7 + .64) \times 3^2/2 \times 1.7 = 16.60^{k}$ #5 @ 12" Ea. way @ Bot.

25A

E2 Consulting Engineers, Inc. 1900 Powell Street, Suite 250 Emeryville, CA 94608	Designed By: KJ		Date: 6/18/14
	Checked By:		Date:
	Reviewed By:		Date:
Project No.	PGE 2174		Sheet No. 2 of 6
Project Description:	Topock Ground Water Remediation Remedy Bldg Tankage Area Retaining Wall		
Reference:			







17 A

TABLE 3 ALLOWABLE LOADS - WORKING STRESS DESIGN

Steel Type	D(in.) =>	1/2	5/8	3/4	7/8	1	1-1/8	1-1/4	1-3/8	1-1/2	1-3/4	2	2-1/4	2-1/2	2-3/4	3
A36	Ta (kips)	2.9	4.6	6.8	9.4	12.3	15.5	19.6	23.5	28.6	38.5	50.6	65.8	81.0	99.8	120.9
	Va (kips)	1.5	2.4	3.5	4.9	6.4	8.0	10.2	12.2	14.8	20.0	26.3	34.2	42.1	51.9	62.8
A307	Ta (kips)	2.6	4.1	6.0	8.3	10.9	13.7	17.4	20.9	25.4	34.2	45.0	58.5	72.0	88.7	107.5
	Va (kips)	1.3	2.1	3.1	4.3	5.7	7.1	9.1	10.8	13.2	17.8	23.4	30.4	37.4	46.1	55.8
A449	Ta (kips)	7.3	11.7	17.3	23.9	31.4	34.8	44.2	52.9	64.2	62.0	81.6	106.0	130.5	160.8	194.8
	Va (kips)	3.8	6.1	9.0	12.4	16.3	18.1	22.9	27.5	33.4	32.2	42.4	55.1	67.8	83.5	101.2
A325	Ta (kips)	7.3	11.7	17.3	23.9	31.4	34.8	44.2	52.9	64.2	-	-	-	-	-	-
	Va (kips)	3.8	6.1	9.0	12.4	16.3	18.1	22.9	27.5	33.4	-	-	-	-	-	-
A354 Gr. BC	Ta (kips)	8.7	13.9	20.5	28.3	37.2	46.8	59.4	71.1	86.5	116.5	153.3	199.3	245.3	274.5	322.4
	Va (kips)	4.5	7.2	10.6	14.7	19.3	24.3	30.9	36.9	44.9	60.5	79.6	103.5	127.4	142.6	172.7
A354 Gr. BD	Ta (kips)	10.4	16.5	24.4	33.8	44.3	55.8	70.9	84.8	103.1	138.9	182.8	237.7	292.5	318.9	386.2
	Va (kips)	5.0	7.9	11.7	16.2	21.2	26.8	34.0	40.7	49.4	66.6	87.7	114.0	140.3	165.7	200.6
A490	Ta (kips)	10.4	16.5	24.4	33.8	44.3	55.8	70.9	84.8	103.1	-	-	-	-	-	-
	Va (kips)	5.0	7.9	11.7	16.2	21.2	26.8	34.0	40.7	49.4	-	-	-	-	-	-
A540 fut=115 psi	Ta (kips)	-	-	-	-	-	-	-	-	-	-	-	182.8	225.0	277.3	335.8
	Va (kips)	-	-	-	-	-	-	-	-	-	-	-	95.0	116.9	144.0	174.4
A540 fut=120 psi	Ta (kips)	8.4	13.3	19.7	27.3	35.8	45.1	57.2	68.5	83.3	112.2	147.7	192.0	236.3	291.2	352.8
	Va (kips)	4.4	6.9	10.2	14.2	18.6	23.4	29.7	35.6	43.3	58.3	76.7	99.7	122.7	151.3	183.2
A540 fut=135 psi	Ta (kips)	9.6	15.3	22.5	31.2	40.9	51.5	65.4	78.3	95.2	128.3	168.8	219.4	270.0	332.8	403.0
	Va (kips)	5.0	7.9	11.7	16.2	21.2	26.8	34.0	40.7	49.4	66.6	87.7	114.0	140.3	172.9	209.3
A540 fut=145 psi	Ta (kips)	10.3	16.4	24.2	33.5	43.9	55.3	70.3	84.1	102.2	137.8	181.3	235.6	290.0	357.4	432.8
	Va (kips)	5.0	7.9	11.7	16.2	21.2	26.8	34.0	40.7	49.4	66.6	87.7	114.0	140.3	172.9	209.3
A540 fut=155 psi	Ta (kips)	11.0	17.5	25.9	35.8	47.0	59.1	75.1	89.9	109.3	147.3	193.8	251.9	310.0	382.1	462.7
	Va (kips)	5.0	7.9	11.7	16.2	21.2	26.8	34.0	40.7	49.4	66.6	87.7	114.0	140.3	172.9	209.3
A540 fut=165 psi	Ta (kips)	11.7	18.6	27.6	38.1	50.0	62.9	79.9	95.7	116.3	156.8	206.3	268.1	330.0	406.7	492.5
	Va (kips)	5.0	7.9	11.7	16.2	21.2	26.8	34.0	40.7	49.4	66.6	87.7	114.0	140.3	172.9	209.3

17 B

TABLE 5. MINIMUM REQUIREMENTS FOR EMBEDMENT AND SPACING FOR DUCTILE DESIGN
(c) f'c = 5,000 PSI

Steel Type	D (in.) ->	1/2	5/8	3/4	7/8	1	1-1/8	1-1/4	1-3/8	1-1/2	1-3/4	2	2-1/4	2-1/2	2-3/4	3
A36	Ed (in.)	3.4	4.3	5.2	6.2	7.0	7.9	8.9	9.8	10.8	12.4	14.3	16.3	18.1	20.1	22.2
	Sde (in.)	7.6	9.6	11.6	13.7	15.7	17.6	19.8	21.7	23.9	27.8	31.9	36.3	40.3	44.7	49.2
A307	Ed (in.)	3.5	4.4	5.3	6.3	7.2	8.1	9.1	10.0	11.0	12.6	14.6	16.7	18.5	20.6	22.7
	Sde (in.)	7.7	9.7	11.8	13.9	15.9	17.9	20.2	22.1	24.3	28.2	32.4	36.9	41.0	45.5	50.0
A449 or A325	Ed (in.)	5.0	6.4	7.8	9.1	10.5	10.9	12.3	13.5	14.9	15.9	18.2	20.8	23.1	25.6	28.2
	Sde (in.)	10.9	13.7	16.7	19.6	22.5	23.6	26.6	29.1	32.1	34.5	39.6	45.1	50.1	55.6	61.2
A354 Gr.BC	Ed (in.)	5.2	6.5	7.9	9.3	10.7	12.0	13.5	14.8	16.3	19.0	21.7	24.8	27.5	29.2	32.2
	Sde (in.)	11.1	14.0	17.0	20.0	23.0	25.8	29.0	31.8	35.0	40.6	46.6	53.2	59.0	62.6	69.1
A354 Gr.BD or A490	Ed (in.)	5.7	7.2	8.7	10.3	11.8	13.2	14.9	16.3	18.0	20.9	24.0	27.3	30.3	32.5	35.8
	Sde (in.)	12.2	15.4	18.7	21.9	25.1	28.2	31.8	34.8	38.3	44.5	51.1	58.2	64.6	69.3	76.2
A540 fut=115 psi	Ed (in.)	-	-	-	-	-	-	-	-	-	-	-	23.7	26.3	29.2	32.1
	Sde (in.)	-	-	-	-	-	-	-	-	-	-	-	51.0	56.6	62.8	69.1
A540 fut=120 psi	Ed (in.)	5.0	6.4	7.8	9.1	10.5	11.7	13.2	14.5	16.0	18.5	21.2	24.2	26.9	29.9	32.9
	Sde (in.)	10.9	13.7	16.7	19.6	22.5	25.2	28.4	31.1	34.3	39.8	45.7	52.1	57.8	64.2	70.6
A540 fut=135 psi	Ed (in.)	5.4	6.8	8.3	9.7	11.1	12.5	14.1	15.4	17.0	19.7	22.6	25.8	28.6	31.8	35.0
	Sde (in.)	11.5	14.6	17.7	20.8	23.9	26.8	30.2	33.0	36.4	42.2	48.5	55.2	61.3	68.0	74.9
A540 fut=145 psi	Ed (in.)	5.6	7.1	8.6	10.1	11.6	13.0	14.6	16.0	17.7	20.4	23.5	26.8	28.7	33.0	36.4
	Sde (in.)	12.0	15.1	18.4	21.6	24.7	27.7	31.3	34.2	37.7	43.8	50.2	57.2	63.5	70.5	77.6
A540 fut=155 psi	Ed (in.)	5.8	7.3	8.9	10.5	12.0	13.5	15.2	16.6	18.3	21.2	24.3	27.7	30.8	34.2	37.7
	Sde (in.)	12.4	15.6	19.0	22.3	25.6	28.7	32.3	35.4	39.0	45.3	51.9	59.2	65.7	72.9	80.2
A540 fut=165 psi	Ed (in.)	6.0	7.6	9.2	10.6	12.4	13.9	15.7	17.2	18.9	21.9	25.1	28.7	31.8	35.4	39.0
	Sde (in.)	12.8	16.1	19.6	23.0	26.4	29.6	33.3	36.5	40.2	46.7	53.6	61.1	67.7	75.2	82.7

NOTES:

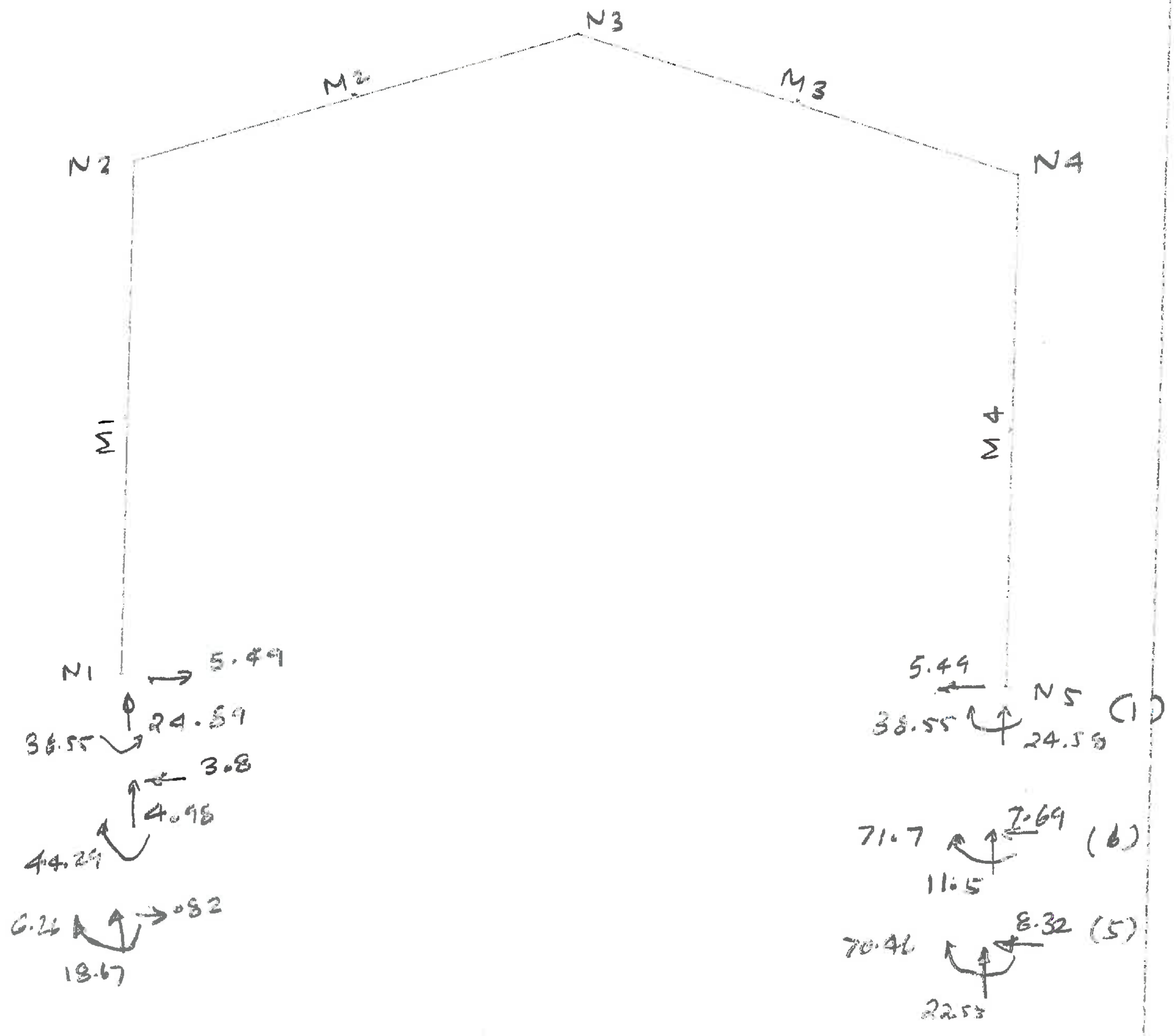
17 C

TABLE 6. MINIMUM EDGE DISTANCES FOR TENSION AND SHEAR WITHOUT ADDITIONAL REINFORCEMENT FOR AN INDIVIDUAL BOLT

(c) f'c = 5,000 PSI

Steel type	(in.) =>	1/2	5/8	3/4	7/8	1	1-1/8	1-1/4	1-3/8	1-1/2	1-3/4	2	2-1/4	2-1/2	2-3/4	3
A36	m_t (in.)	1.7	2.1	2.5	3.0	3.4	3.8	4.3	4.7	5.2	6.0	6.9	7.9	8.8	9.7	10.7
	m_v (in.)	4.4	5.6	6.8	8.0	9.2	10.3	11.6	12.7	14.0	16.2	18.6	21.2	23.5	26.1	28.7
A307	m_t (in.)	1.7	2.1	2.6	3.0	3.5	3.9	4.4	4.8	5.3	6.1	7.0	8.0	8.9	9.9	10.9
	m_v (in.)	4.5	5.7	6.9	8.1	9.3	10.4	11.8	12.9	14.2	16.5	18.9	21.6	23.9	26.6	29.2
A449 or A325	m_t (in.)	2.4	3.0	3.6	4.3	4.9	5.1	5.8	6.3	7.0	7.5	8.6	9.8	10.9	12.1	13.3
	m_v (in.)	6.4	8.0	9.8	11.5	13.2	13.8	15.6	17.0	18.8	20.2	23.2	26.6	29.3	32.5	35.8
A354 Gr.BC	m_t (in.)	2.4	3.1	3.7	4.4	5.0	5.6	6.3	6.9	7.6	8.9	10.2	11.6	12.9	13.7	15.1
	m_v (in.)	6.5	8.2	10.0	11.7	13.4	15.1	17.0	18.9	20.5	23.8	27.3	31.1	34.5	36.8	40.4
A354 Gr.BD or A490	m_t (in.)	2.7	3.3	4.1	4.8	5.5	6.2	6.9	7.6	8.4	9.7	11.1	12.7	14.1	15.1	16.6
	m_v (in.)	7.1	9.0	10.9	12.9	14.7	16.5	18.6	20.4	22.5	26.1	29.9	34.1	37.8	40.6	44.6
A540 fut=115 psi	m_t (in.)	-	-	-	-	-	-	-	-	-	-	-	11.1	12.3	13.7	15.1
	m_v (in.)	-	-	-	-	-	-	-	-	-	-	-	29.8	33.1	36.8	40.4
A540 fut=120 psi	m_t (in.)	2.4	3.0	3.6	4.3	4.9	5.5	6.2	6.8	7.5	8.7	10.0	11.4	12.6	14.0	15.4
	m_v (in.)	6.4	8.0	9.8	11.5	13.2	14.8	16.6	18.2	20.1	23.3	26.7	30.5	33.8	37.5	41.3
A540 fut=135 psi	m_t (in.)	2.5	3.2	3.9	4.5	5.2	5.8	6.6	7.2	7.9	9.2	10.6	12.1	13.4	14.8	16.3
	m_v (in.)	6.8	8.5	10.4	12.2	14.0	15.7	17.7	19.3	21.3	24.7	28.4	32.3	35.9	39.6	43.8
A540 fut=145 psi	m_t (in.)	2.6	3.3	4.0	4.7	5.4	6.1	6.8	7.5	8.2	9.5	11.0	12.5	13.9	15.4	16.9
	m_v (in.)	7.0	8.8	10.7	12.6	14.5	16.2	18.3	20.0	22.1	25.6	29.4	33.5	37.2	41.3	45.4
A540 fut=155 psi	m_t (in.)	2.7	3.4	4.1	4.9	5.6	6.3	7.1	7.7	8.5	9.9	11.3	12.9	14.3	15.9	17.5
	m_v (in.)	7.2	9.1	11.1	13.1	15.0	16.8	18.9	20.7	22.8	26.5	30.4	34.6	38.4	42.7	47.0
A540 fut=165 psi	m_t (in.)	2.8	3.5	4.3	5.0	5.8	6.5	7.3	8.0	8.8	10.2	11.7	13.3	14.8	16.4	18.1
	m_v (in.)	7.5	9.4	11.5	13.5	15.4	17.3	19.5	21.4	23.5	27.3	31.4	35.7	39.7	44.0	48.5

For load comb. See pg. 2 of this output



e-2	topock water conditioning structure steel mom.frame	SK - 1
kd		July 27, 2012 at 9:23 AM
ww-peg-2174-043062		topockgwr.momfr.r2d

Joint Loads and Enforced Displacements (BLC 3 : gl-seismic)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^...
1	N2	L	X	2.5
2	N4	L	X	2.5

Joint Loads and Enforced Displacements (BLC 4 : P wind)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^...
1	N2	L	X	5
2	N4	L	X	5

Joint Loads and Enforced Displacements (BLC 5 : P crane)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^...
1	N2	L	X	.5
2	N4	L	X	.5

Joint Loads and Enforced Displacements (BLC 6 : M crane)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^...
1	N2	L	M	-6.75

Basic Load Cases

	BLC Description	Category	X Gravity	Y Gravity	Joint	Point	Distributed
1	d	None					2
2	l	None					2
3	gl-seismic	None			2		
4	P wind	None			2		
5	P crane	None			2		
6	M crane	None			1		

Member Primary Data

	Label	I Joint	J Joint	Rotate(deg)	Section/Shape	Type	Design List	Material	Design Rules
1	M1	N1	N2		W10X45	Column	Wide Flange	A572 Gr.50	Typical
2	M2	N2	N3		W18X60	Beam	Wide Flange	A572 Gr.50	Typical
3	M3	N3	N4		W18X60	Beam	Wide Flange	A572 Gr.50	Typical
4	M4	N4	N5		W10X45	Column	Wide Flange	A572 Gr.50	Typical

Joint Boundary Conditions

	Joint Label	X [k/in]	Y [k/in]	Rotation[k-ft/rad]	Footing
1	N1	Reaction	Reaction	Reaction	
2	N5	Reaction	Reaction	Reaction	

Hot Rolled Steel Section Sets

	Label	Shape	Type	Design List	Material	Design Rules	A [in2]	I (90,270) [i...	I (0,180) [in4]
1	HR1A	W10X45	Column	Wide Flange	A572 Gr.50	Typical	13.3	53.4	248
2	HR2	W18X60	Beam	Wide Flange	A572 Gr.50	Typical	17.6	50.1	984

Member AISC 13th(360-05): ASD Steel Code Checks

	LC	Member	Shape	UC Max	Loc[ft]	Shear UC	Loc[ft]	Pnc/om [k]	Pnt/om [k]	Mn/om [...	Cb	Eqn
1	1	M1	W10X45	.543	18.5	.078	0	162.302	398.204	136.976	2.194	H1-1b
2	1	M2	W18X60	.379	15.312	.148	0	187.409	526.946	301.27	1.484	H1-1b
3	1	M3	W18X60	.379	1.392	.146	16.53	187.409	526.946	301.318	1.484	H1-1b

Member AISC 13th(360-05): ASD Steel Code Checks (Continued)

	LC	Member	Shape	UC Max	Loc[ft]	Shear UC	Loc[ft]	Pnc/om [k]	Pnt/om [k]	Mn/om [...	Cb	Eqn
4	1	M4	W10X45	.542	0	.078	0	162.302	398.204	136.976	2.194	H1-1b
5	2	M1	W10X45	.304	0	.048	0	162.302	398.204	136.976	2.191	H1-1b
6	2	M2	W18X60	.234	9.918	.034	0	187.409	526.946	215.148	1.059	H1-1b
7	2	M3	W18X60	.236	16.704	.069	16.53	187.409	526.946	306.886	2.501	H1-1b
8	2	M4	W10X45	.533	0	.103	0	162.302	398.204	136.976	2.267	H1-1b
9	3	M1	W10X45	.337	0	.061	0	162.302	398.204	136.976	2.221	H1-1b
10	3	M2	W18X60	.175	4.872	.020	16.53	187.409	526.946	215.852	1.063	H1-1b
11	3	M3	W18X60	.193	16.704	.044	16.53	187.409	526.946	306.886	2.408	H1-1b
12	3	M4	W10X45	.456	18.5	.089	0	162.302	398.204	136.976	2.264	H1-1b
13	4	M1	W10X45	.201	0	.028	0	162.302	398.204	136.976	2.166	H1-1b
14	4	M2	W18X60	.196	11.31	.036	0	187.409	526.946	223.128	1.099	H1-1b
15	4	M3	W18X60	.188	16.704	.061	16.53	187.409	526.946	306.886	2.237	H1-1b
16	4	M4	W10X45	.424	0	.080	0	162.302	398.204	136.976	2.26	H1-1b
17	5	M1	W10X45	.204	18.5	.011	0	162.302	398.204	136.976	1.38	H1-1b
18	5	M2	W18X60	.385	13.746	.110	0	187.409	526.946	255.808	1.26	H1-1b
19	5	M3	W18X60	.311	16.704	.135	16.53	187.409	526.946	306.886	1.696	H1-1b
20	5	M4	W10X45	.700	0	.120	0	162.302	398.204	136.976	2.235	H1-1b
21	6	M1	W10X45	.339	0	.054	0	162.302	398.204	136.976	2.194	H1-1b
22	6	M2	W18X60	.253	8.7	.028	0	187.409	526.946	211.352	1.041	H1-1b
23	6	M3	W18X60	.250	16.704	.069	16.53	187.409	526.946	306.886	2.592	H1-1b
24	6	M4	W10X45	.565	0	.110	0	162.302	398.204	136.976	2.27	H1-1b

Joint Coordinates and Temperatures

	Label	X [ft]	Y [ft]	Temp [F]
1	N1	0	0	0
2	N2	0	18.5	0
3	N3	16	23.3	0
4	N4	32	18.5	0
5	N5	32	0	0

Hot Rolled Steel Properties

	Label	E [ksi]	G [ksi]	Nu	Therm (\1E5 F)	Density[k/ft^3]	Yield[ksi]
1	A36 Gr.36	29000	11154	.3	.65	.49	36
2	A572 Gr.50	29000	11154	.3	.65	.49	50
3	A992	29000	11154	.3	.65	.49	50
4	A500 Gr.42	29000	11154	.3	.65	.49	42
5	A500 Gr.46	29000	11154	.3	.65	.49	46

Load Combinations

	Description	Solve	PDe...	SR...	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor
1	d+l	Yes	Y		1	1	2	1												
2	d+gl	Yes	Y		1	1.057	3	2.1												
3	d1+gl	Yes	Y		1	.543	3	2.1												
4	d+Pw	Yes	Y		1	1	4	.75												
5	d+.75l+.75Pw	Yes	Y		1	1	2	.75	4	.75										
6	d+Pc+gl	Yes	Y		1	1	3	2.1	5	1	6	1								

Joint Reactions (By Combination)

	LC	Joint Label	X [k]	Y [k]	MZ [k-ft]
1	1	N1	5.493	24.894	-38.549
2	1	N5	-5.493	24.576	38.542
3	1	Totals:	0	49.47	

Joint Reactions (By Combination) (Continued)

	LC	Joint Label	X [k]	Y [k]	MZ [k-ft]
4	1	COG (ft):	X: 15.897	Y: 20.9	
5	2	N1	-3.33	5.921	39.204
6	2	N5	-7.17	11.509	66.308
7	2	Totals:	-10.5	17.43	
8	2	COG (ft):	X: 15.897	Y: 20.9	
9	3	N1	-4.272	1.673	45.461
10	3	N5	-6.228	7.281	59.387
11	3	Totals:	-10.5	8.954	
12	3	COG (ft):	X: 15.897	Y: 20.9	
13	4	N1	-1.925	6.264	24.844
14	4	N5	-5.575	10.226	50.469
15	4	Totals:	-7.5	16.49	
16	4	COG (ft):	X: 15.897	Y: 20.9	
17	5	N1	.82	18.574	6.261
18	5	N5	-8.32	22.551	70.464
19	5	Totals:	-7.5	41.225	
20	5	COG (ft):	X: 15.897	Y: 20.9	
21	6	N1	-3.808	4.983	44.291
22	6	N5	-7.692	11.507	71.697
23	6	Totals:	-11.5	16.49	
24	6	COG (ft):	X: 15.897	Y: 20.9	

Load Combination Design

	Description	ASIF	CD	ABIF	Service	Hot Rolled	Cold Form...	Wood	Concrete	Masonry	Footings	Aluminum
1	d+l					Yes	Yes	Yes	Yes	Yes	Yes	Yes
2	d+ql					Yes	Yes	Yes	Yes	Yes	Yes	Yes
3	d1+ql					Yes	Yes	Yes	Yes	Yes	Yes	Yes
4	d+Pw					Yes	Yes	Yes	Yes	Yes	Yes	Yes
5	d+.75l+.75Pw					Yes	Yes	Yes	Yes	Yes	Yes	Yes
6	d+Pc+ql					Yes	Yes	Yes	Yes	Yes	Yes	Yes

Joint Deflections (By Combination)

	LC	Joint Label	X [in]	Y [in]	Rotation [rad]
1	1	N1	0	0	0
2	1	N2	-.261	-.018	-5.875e-3
3	1	N3	0	-.899	-5.875e-3
4	1	N4	.261	-.018	2.512e-7
5	1	N5	0	0	5.876e-3
6	2	N1	0	0	0
7	2	N2	.968	-.004	-3.715e-3
8	2	N3	1.061	-.316	7.555e-4
9	2	N4	1.151	-.008	4.172e-4
10	2	N5	0	0	0
11	3	N1	0	0	0
12	3	N2	1.006	-.001	-2.7e-3
13	3	N3	1.054	-.162	7.507e-4
14	3	N4	1.1	-.005	-5.769e-4
15	3	N5	0	0	0
16	4	N1	0	0	0
17	4	N2	.67	-.005	-3.13e-3
18	4	N3	.757	-.299	5.393e-4
19	4	N4	.843	-.007	7.766e-4
20	4	N5	0	0	0
21	5	N1	0	0	0
22	5	N2	.553	-.013	-6.092e-3

Joint Deflections (By Combination) (Continued)

	LC	Joint Label	X [in]	Y [in]	Rotation [rad]
23	5	N3	.771	-.749	5.495e-4
24	5	N4	.988	-.016	3.695e-3
25	5	N5	0	0	0
26	6	N1	0	0	0
27	6	N2	1.082	-.004	-4.031e-3
28	6	N3	1.174	-.313	8.788e-4
29	6	N4	1.263	-.008	1.955e-4
30	6	N5	0	0	0

Member Section Forces

	LC	Member Label	Sec	Axial[k]	Shear[k]	Moment[k-ft]
1	1	M1	1	24.894	-5.539	-38.549
2			2	24.894	-5.539	-12.93
3			3	24.894	-5.539	12.69
4			4	24.894	-5.539	38.309
5			5	24.894	-5.539	63.928
6	1	M2	1	12.414	22.33	63.928
7			2	10.614	16.33	-16.798
8			3	8.814	10.33	-72.468
9			4	7.014	4.33	-103.08
10			5	5.306	-1.361	-108.67
11	1	M3	1	5.215	1.666	-108.67
12			2	7.015	-4.334	-103.098
13			3	8.815	-10.334	-72.47
14			4	10.615	-16.334	-16.785
15			5	12.323	-22.026	63.924
16	1	M4	1	24.576	5.539	63.924
17			2	24.576	5.539	38.308
18			3	24.576	5.539	12.691
19			4	24.576	5.539	-12.925
20			5	24.576	5.539	-38.542
21	2	M1	1	5.921	3.371	39.204
22			2	5.921	3.371	23.614
23			3	5.921	3.371	8.023
24			4	5.921	3.371	-7.568
25			5	5.921	3.371	-23.159
26	2	M2	1	3.541	5.125	-23.159
27			2	2.906	3.011	-40.148
28			3	2.272	.897	-48.31
29			4	1.638	-1.217	-47.643
30			5	1.036	-3.222	-38.159
31	2	M3	1	2.642	-2.134	-38.159
32			2	3.276	-4.248	-24.832
33			3	3.911	-6.362	-2.676
34			4	4.545	-8.476	28.309
35			5	5.146	-10.482	68.11
36	2	M4	1	11.509	7.266	68.11
37			2	11.509	7.266	34.506
38			3	11.509	7.266	.901
39			4	11.509	7.266	-32.703
40			5	11.509	7.266	-66.308
41	3	M1	1	1.673	4.284	45.461
42			2	1.673	4.284	25.646
43			3	1.673	4.284	5.831
44			4	1.673	4.284	-13.984
45			5	1.673	4.284	-33.799

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Member Section Forces (Continued)

	LC	Member Label	Sec	Axial[k]	Shear[k]	Moment[k-ft]
46	3	M2	1	1.417	1.322	-33.799
47			2	1.091	.236	-37.053
48			3	.766	-.85	-35.771
49			4	.44	-1.936	-29.955
50			5	.131	-2.966	-19.609
51	3	M3	1	1.742	-2.408	-19.609
52			2	2.068	-3.494	-7.284
53			3	2.394	-4.58	9.576
54			4	2.72	-5.666	30.971
55			5	3.029	-6.696	56.895
56	3	M4	1	7.281	6.286	56.895
57			2	7.281	6.286	27.825
58			3	7.281	6.286	-1.246
59			4	7.281	6.286	-30.317
60			5	7.281	6.286	-59.387
61	4	M1	1	6.264	1.955	24.844
62			2	6.264	1.955	15.802
63			3	6.264	1.955	6.761
64			4	6.264	1.955	-2.281
65			5	6.264	1.955	-11.322
66	4	M2	1	3.548	5.481	-11.322
67			2	2.948	3.481	-30.034
68			3	2.348	1.481	-40.394
69			4	1.748	-.519	-42.401
70			5	1.179	-2.417	-36.067
71	4	M3	1	2.318	-1.382	-36.067
72			2	2.918	-3.382	-26.12
73			3	3.518	-5.382	-7.821
74			4	4.118	-7.382	18.831
75			5	4.687	-9.279	53.824
76	4	M4	1	10.226	5.637	53.824
77			2	10.226	5.637	27.75
78			3	10.226	5.637	1.677
79			4	10.226	5.637	-24.396
80			5	10.226	5.637	-50.469
81	5	M1	1	18.674	-.746	6.261
82			2	18.674	-.746	9.709
83			3	18.674	-.746	13.158
84			4	18.674	-.746	16.607
85			5	18.674	-.746	20.056
86	5	M2	1	9.743	16.615	20.056
87			2	8.243	11.615	-38.89
88			3	6.743	6.615	-76.956
89			4	5.243	1.615	-94.141
90			5	3.82	-3.128	-90.472
91	5	M3	1	4.934	-.591	-90.472
92			2	6.434	-5.591	-77.562
93			3	7.934	-10.591	-43.771
94			4	9.434	-15.591	10.9
95			5	10.857	-20.335	86.425
96	5	M4	1	22.551	8.48	86.425
97			2	22.551	8.48	47.202
98			3	22.551	8.48	7.98
99			4	22.551	8.48	-31.242
100			5	22.551	8.48	-70.464
101	6	M1	1	4.983	3.847	44.291
102			2	4.983	3.847	26.499

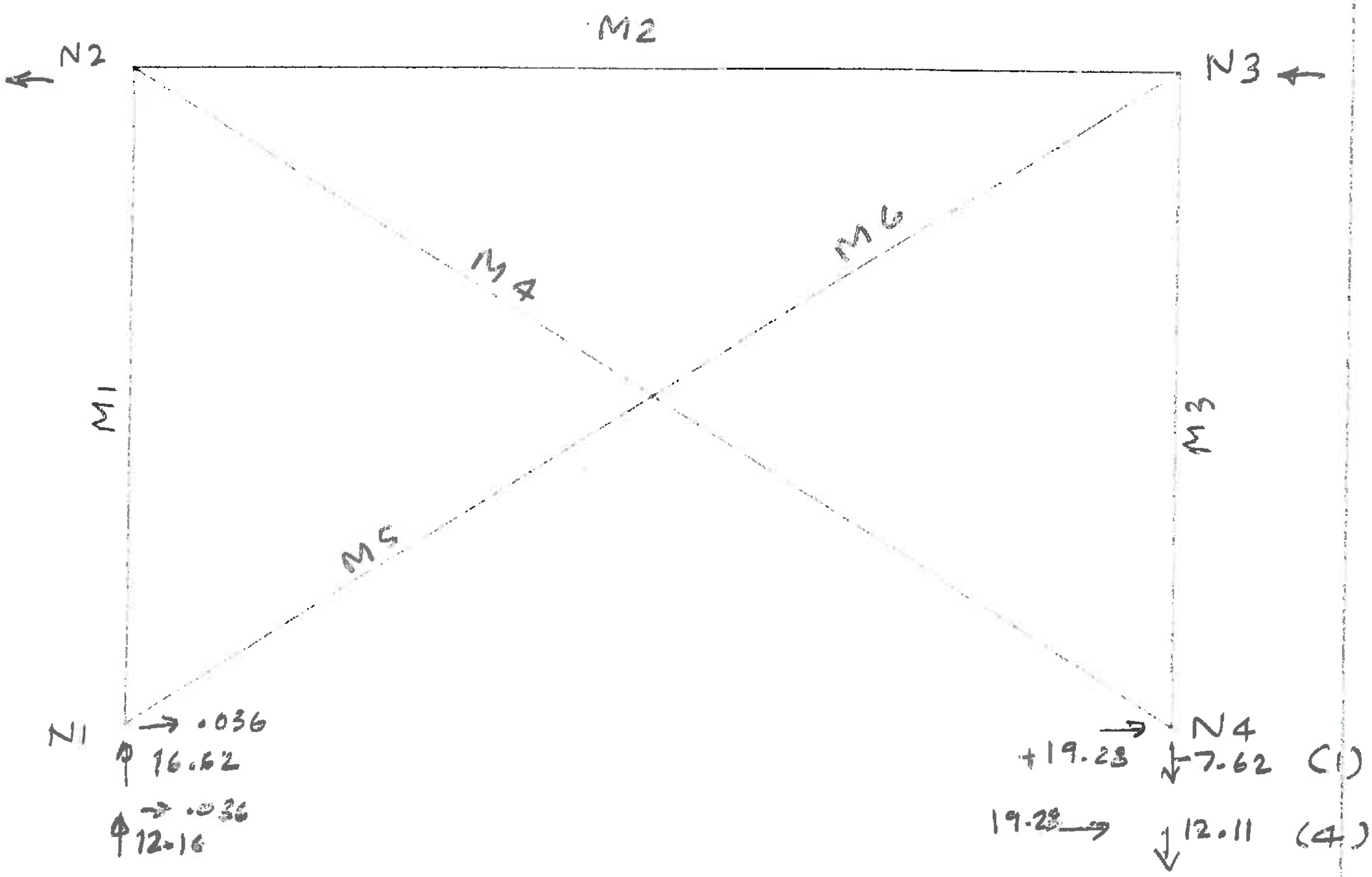
Member Section Forces (Continued)

	LC	Member Label	Sec	Axial[k]	Shear[k]	Moment[k-ft]
103			3	4.983	3.847	8.707
104			4	4.983	3.847	-9.085
105			5	4.983	3.847	-26.877
106	6	M2	1	3.292	4.22	-33.627
107			2	2.692	2.22	-47.074
108			3	2.092	.22	-52.168
109			4	1.492	-1.78	-48.91
110			5	.923	-3.677	-37.311
111	6	M3	1	2.797	-2.577	-37.311
112			2	3.397	-4.577	-22.374
113			3	3.997	-6.577	.916
114			4	4.597	-8.577	32.558
115			5	5.167	-10.474	72.542
116	6	M4	1	11.507	7.797	72.542
117			2	11.507	7.797	36.482
118			3	11.507	7.797	.422
119			4	11.507	7.797	-35.637
120			5	11.507	7.797	-71.697

Material Takeoff

	Material	Size	Pieces	Length[ft]	Weight[K]
1	Hot Rolled Steel				
2	A572 Gr.50	W10X45	2	37	1.7
3	A572 Gr.50	W18X60	2	33.4	2
4	Total HR Steel		4	70.4	3.7

Col line (B) - Braced Frame



E2	~~Frame A~~ Frame B	SK - 1
kd	topock wcs braced frame	July 27, 2012 at 9:14 AM
ww-peg-2174-043062		topockwcp. braced frame A.r2d

Joint Coordinates and Temperatures

	Label	X [ft]	Y [ft]	Temp [F]
1	N1	0	0	0
2	N2	0	18.5	0
3	N3	29.5	18.5	0
4	N4	29.5	0	0
5	N5	14.75	9.25	0

Member Primary Data

	Label	I Joint	J Joint	Rotate(deg)	Section/Shape	Type	Design List	Material	Design Rules
1	M1	N1	N2		W10x45	Column	Wide Flange	A572 Gr.50	DR1
2	M2	N2	N3		W12x40	Beam	Wide Flange	A572 Gr.50	DR1
3	M3	N3	N4		W10x45	Column	Wide Flange	A572 Gr.50	DR1
4	M4	N4	N2		W6x15	VBrace	Wide Flange	A572 Gr.50	DR1
5	M5	N1	N5		W6x15	VBrace	Wide Flange	A572 Gr.50	DR1
6	M6	N5	N3		W6x15	VBrace	Wide Flange	A572 Gr.50	DR1

Joint Loads and Enforced Displacements (BLC 1 : d)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N2	L	Y	-5
2	N3	L	Y	-8

Joint Loads and Enforced Displacements (BLC 2 : Pcr)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N2	L	Y	-5
2	N3	L	Y	-5

Joint Loads and Enforced Displacements (BLC 3 : ql)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N2	L	X	-4.6
2	N3	L	X	-4.6

Joint Loads and Enforced Displacements (BLC 4 : Pw)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N2	L	X	-2.5
2	N3	L	X	-2.5

Hot Rolled Steel Section Sets

	Label	Shape	Type	Design List	Material	Design Rules	A [in2]	I (90,270) [i...	I (0,180) [in4]
1	HR1A	W12x40	Beam	Wide Flange	A572 Gr.50	DR1	11.7	44.1	307
2	HR2	W10x45	Column	Wide Flange	A572 Gr.50	DR1	13.3	53.4	248
3	HR3	W6x15	VBrace	Wide Flange	A572 Gr.50	DR1	4.43	9.32	29.1

Basic Load Cases

	BLC Description	Category	X Gravity	Y Gravity	Joint	Point	Distributed
1	d	None			2		
2	Pcr	None			2		
3	ql	None			2		
4	Pw	None			2		

Load Combinations

	Description	Solve	PD...	SR...	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor
1	d+Pcr+ql	Yes	Y		DL	1.057	2	.9	3	2.1										
2	d+Pcr+ql	Yes	Y		DL	.543	2	.9	3	2.1										
3	d+PwPcr	Yes	Y		DL	1	2	.9	4	.75										
4	d+ql	Yes	Y		DL	.543	3	2.1												
5	d+Pw	Yes	Y		DL	1	4	.75												

Joint Reactions (By Combination)

	LC	Joint Label	X [k]	Y [k]	MZ [k-ft]
1	1	N1	.036	16.62	0
2	1	N4	19.284	-7.62	0
3	1	Totals:	19.32	9	
4	1	COG (ft):	X: 14.75	Y: 18.5	
5	2	N1	.036	16.62	0
6	2	N4	19.284	-7.62	0
7	2	Totals:	19.32	9	
8	2	COG (ft):	X: 14.75	Y: 18.5	
9	3	N1	.006	6.853	0
10	3	N4	3.744	2.147	0
11	3	Totals:	3.75	9	
12	3	COG (ft):	X: 14.75	Y: 18.5	
13	4	N1	.038	12.116	0
14	4	N4	19.282	-12.116	0
15	4	Totals:	19.32	0	
16	4	COG (ft):	NC	NC	
17	5	N1	.006	2.352	0
18	5	N4	3.744	-2.352	0
19	5	Totals:	3.75	0	
20	5	COG (ft):	NC	NC	

Joint Deflections

	LC	Joint Label	X [in]	Y [in]	Rotation [rad]
1	1	N1	0	0	0
2	1	N2	-.117	-.012	0
3	1	N3	-.127	-.003	0
4	1	N4	0	0	0
5	1	N5	-.027	.043	1.728e-4
6	2	N1	0	0	0
7	2	N2	-.117	-.012	0
8	2	N3	-.127	-.003	0
9	2	N4	0	0	0
10	2	N5	-.027	.043	1.728e-4
11	3	N1	0	0	0
12	3	N2	-.024	-.005	0
13	3	N3	-.026	-.003	0
14	3	N4	0	0	0
15	3	N5	-.005	.008	4.091e-5
16	4	N1	0	0	0
17	4	N2	-.115	-.009	0
18	4	N3	-.125	0	0
19	4	N4	0	0	0
20	4	N5	-.027	.043	1.636e-4
21	5	N1	0	0	0
22	5	N2	-.022	-.002	0
23	5	N3	-.024	0	0

Joint Deflections (Continued)

	LC	Joint Label	X [in]	Y [in]	Rotation [rad]
24	5	N4	0	0	0
25	5	N5	-.005	.008	3.176e-5

Load Combination Design

	Description	ASIF	CD	ABIF	Service	Hot Rolled	Cold Form...	Wood	Concrete	Masonry	Footings	Aluminum
1	d+Pcr+ql					Yes	Yes	Yes	Yes	Yes	Yes	Yes
2	d+Pcr+qi					Yes	Yes	Yes	Yes	Yes	Yes	Yes
3	d+PwPcr					Yes	Yes	Yes	Yes	Yes	Yes	Yes
4	d+qi					Yes	Yes	Yes	Yes	Yes	Yes	Yes
5	d+Pw					Yes	Yes	Yes	Yes	Yes	Yes	Yes

Member Section Forces

	LC	Member Label	Sec	Axial[k]	Shear[k]	Moment[k-ft]
1	1	M1	1	16.589	0	0
2			2	16.589	0	0
3			3	16.589	0	0
4			4	16.589	0	0
5			5	16.589	0	0
6	1	M2	1	9.664	0	0
7			2	9.664	0	0
8			3	9.664	0	0
9			4	9.664	0	0
10			5	9.664	0	0
11	1	M3	1	4.5	0	0
12			2	4.5	0	0
13			3	4.5	0	0
14			4	4.5	0	0
15			5	4.5	0	0
16	1	M4	1	-22.78	.016	0
17			2	-22.78	.016	-.14
18			3	-22.806	-.016	-.281
19			4	-22.806	-.016	-.14
20			5	-22.806	-.016	0
21	1	M5	1	.058	0	0
22			2	.058	0	0
23			3	.058	0	0
24			4	.058	0	0
25			5	.058	0	0
26	1	M6	1	0	0	0
27			2	0	0	0
28			3	0	0	0
29			4	0	0	0
30			5	0	0	0
31	2	M1	1	16.589	0	0
32			2	16.589	0	0
33			3	16.589	0	0
34			4	16.589	0	0
35			5	16.589	0	0
36	2	M2	1	9.664	0	0
37			2	9.664	0	0
38			3	9.664	0	0
39			4	9.664	0	0
40			5	9.664	0	0
41	2	M3	1	4.5	0	0
42			2	4.5	0	0

Member Section Forces (Continued)

	LC	Member Label	Sec	Axial[k]	Shear[k]	Moment[k-ft]
43			3	4.5	0	0
44			4	4.5	0	0
45			5	4.5	0	0
46	2	M4	1	-22.78	.016	0
47			2	-22.78	.016	-.14
48			3	-22.806	-.016	-.281
49			4	-22.806	-.016	-.14
50			5	-22.806	-.016	0
51	2	M5	1	.058	0	0
52			2	.058	0	0
53			3	.058	0	0
54			4	.058	0	0
55			5	.058	0	0
56	2	M6	1	0	0	0
57			2	0	0	0
58			3	0	0	0
59			4	0	0	0
60			5	0	0	0
61	3	M1	1	6.848	0	0
62			2	6.848	0	0
63			3	6.848	0	0
64			4	6.848	0	0
65			5	6.848	0	0
66	3	M2	1	1.876	0	0
67			2	1.876	0	0
68			3	1.876	0	0
69			4	1.876	0	0
70			5	1.876	0	0
71	3	M3	1	4.5	0	0
72			2	4.5	0	0
73			3	4.5	0	0
74			4	4.5	0	0
75			5	4.5	0	0
76	3	M4	1	-4.422	.004	0
77			2	-4.422	.004	-.031
78			3	-4.426	.004	-.062
79			4	-4.426	-.004	-.031
80			5	-4.426	-.004	0
81	3	M5	1	.009	0	0
82			2	.009	0	0
83			3	.009	0	0
84			4	.009	0	0
85			5	.009	0	0
86	3	M6	1	0	0	0
87			2	0	0	0
88			3	0	0	0
89			4	0	0	0
90			5	0	0	0
91	4	M1	1	12.085	0	0
92			2	12.085	0	0
93			3	12.085	0	0
94			4	12.085	0	0
95			5	12.085	0	0
96	4	M2	1	9.66	0	0
97			2	9.66	0	0
98			3	9.66	0	0
99			4	9.66	0	0

Member Section Forces (Continued)

	LC	Member Label	Sec	Axial[k]	Shear[k]	Moment[k-ft]
100			5	9.66	0	0
101	4	M3	1	0	0	0
102			2	0	0	0
103			3	0	0	0
104			4	0	0	0
105			5	0	0	0
106	4	M4	1	-22.772	.016	0
107			2	-22.772	.016	-.136
108			3	-22.797	.016	-.272
109			4	-22.797	-.016	-.136
110			5	-22.797	-.016	0
111	4	M5	1	.057	0	0
112			2	.057	0	0
113			3	.057	0	0
114			4	.057	0	0
115			5	.057	0	0
116	4	M6	1	0	0	0
117			2	0	0	0
118			3	0	0	0
119			4	0	0	0
120			5	0	0	0
121	5	M1	1	2.348	0	0
122			2	2.348	0	0
123			3	2.348	0	0
124			4	2.348	0	0
125			5	2.348	0	0
126	5	M2	1	1.875	0	0
127			2	1.875	0	0
128			3	1.875	0	0
129			4	1.875	0	0
130			5	1.875	0	0
131	5	M3	1	0	0	0
132			2	0	0	0
133			3	0	0	0
134			4	0	0	0
135			5	0	0	0
136	5	M4	1	-4.421	.003	0
137			2	-4.421	.003	-.026
138			3	-4.425	-.003	-.053
139			4	-4.425	-.003	-.026
140			5	-4.425	-.003	0
141	5	M5	1	.008	0	0
142			2	.008	0	0
143			3	.008	0	0
144			4	.008	0	0
145			5	.008	0	0
146	5	M6	1	0	0	0
147			2	0	0	0
148			3	0	0	0
149			4	0	0	0
150			5	0	0	0

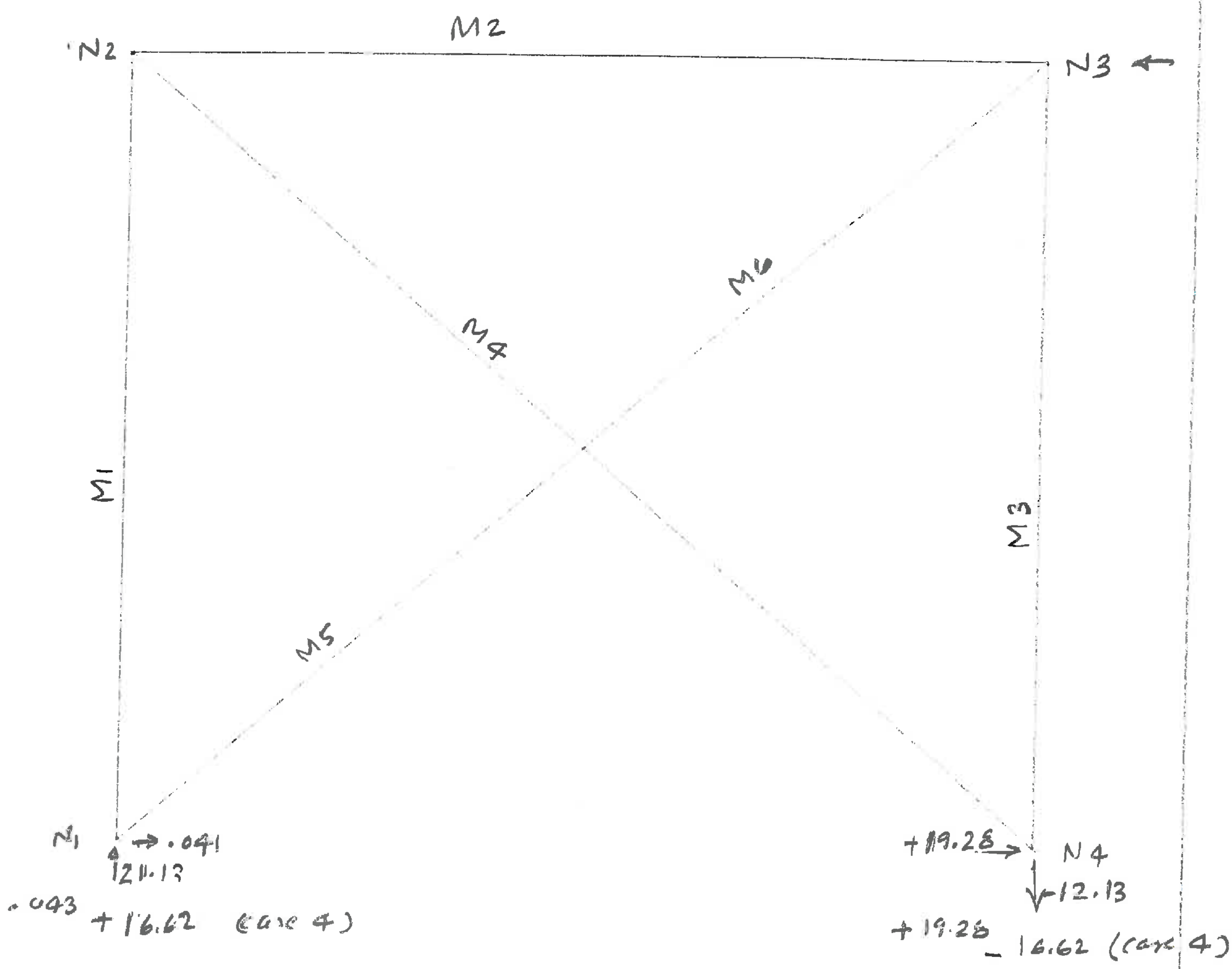
Member AISC 13th(360-05): ASD Steel Code Checks

	LC	Member	Shape	UC Max	Loc[ft]	Shear UC	Loc[ft]	Pnc/om [k]	Pnt/om [k]	Mn/om [k-ft]	Cb	Eqn
1	1	M1	W10x45	.051	0	.000	0	162.302	398.204	107.502	1	H1-1b
2	1	M2	W12x40	.091	0	.000	0	52.895	350.299	58.061	1	H1-1b

Member AISC 13th(360-05): ASD Steel Code Checks (Continued)

	LC	Member	Shape	UC Max	Loc[ft]	Shear UC	Loc[ft]	Pnc/om [k]	Pnt/om [k]	Mn/om [k-ft]	Cb	Eqn
3	1	M3	W10x45	.014	0	.000	0	162.302	398.204	107.502	1	H1-1b
4	1	M4	W6x15	.117	17.41	.001	17.41	8.023	132.635	9.084	1.316	H1-1b
5	1	M5	W6x15	.001	0	.000	0	32.093	132.635	15.745	1	H1-1b
6	1	M6	W6x15	.000	0	.000	0	32.093	132.635	15.745	1	H1-1a
7	2	M1	W10x45	.051	0	.000	0	162.302	398.204	107.502	1	H1-1b
8	2	M2	W12x40	.091	0	.000	0	52.895	350.299	58.061	1	H1-1b
9	2	M3	W10x45	.014	0	.000	0	162.302	398.204	107.502	1	H1-1b
10	2	M4	W6x15	.117	17.41	.001	17.41	8.023	132.635	9.084	1.316	H1-1b
11	2	M5	W6x15	.001	0	.000	0	32.093	132.635	15.745	1	H1-1b
12	2	M6	W6x15	.000	0	.000	0	32.093	132.635	15.745	1	H1-1b
13	3	M1	W10x45	.021	0	.000	0	162.302	398.204	107.502	1	H1-1a
14	3	M2	W12x40	.018	0	.000	0	52.895	350.299	58.061	1	H1-1b
15	3	M3	W10x45	.014	0	.000	0	162.302	398.204	107.502	1	H1-1b
16	3	M4	W6x15	.024	17.41	.000	0	8.023	132.635	9.084	1.316	H1-1b
17	3	M5	W6x15	.000	0	.000	0	32.093	132.635	15.745	1	H1-1b
18	3	M6	W6x15	.000	0	.000	0	32.093	132.635	15.745	1	H1-1a
19	4	M1	W10x45	.037	0	.000	0	162.302	398.204	107.502	1	H1-1b
20	4	M2	W12x40	.091	0	.000	0	52.895	350.299	58.061	1	H1-1b
21	4	M3	W10x45	.000	0	.000	0	162.302	398.204	107.502	1	H1-1b
22	4	M4	W6x15	.116	17.41	.001	0	8.023	132.635	9.084	1.316	H1-1b
23	4	M5	W6x15	.001	0	.000	0	32.093	132.635	15.745	1	H1-1b
24	4	M6	W6x15	.000	0	.000	0	32.093	132.635	15.745	1	H1-1b
25	5	M1	W10x45	.007	0	.000	0	162.302	398.204	107.502	1	H1-1a
26	5	M2	W12x40	.018	0	.000	0	52.895	350.299	58.061	1	H1-1b
27	5	M3	W10x45	.000	0	.000	0	162.302	398.204	107.502	1	H1-1b
28	5	M4	W6x15	.022	17.41	.000	17.41	8.023	132.635	9.084	1.316	H1-1b
29	5	M5	W6x15	.000	0	.000	0	32.093	132.635	15.745	1	H1-1b
30	5	M6	W6x15	.000	0	.000	0	32.093	132.635	15.745	1	H1-1a

Col. line-(A) Braced frame



d + Pc + qx.

E2	LINE A	SK - 1
kd	topock wcs braced frame	July 27, 2012 at 8:59 AM
ww-peg-2174-043062		topockwcp. braced frame.r2d

Joint Coordinates and Temperatures

	Label	X [ft]	Y [ft]	Temp [F]
1	N1	0	0	0
2	N2	0	18.5	0
3	N3	21.5	18.5	0
4	N4	21.5	0	0
5	N5	10.75	9.25	0

Member Primary Data

	Label	I Joint	J Joint	Rotate(deg)	Section/Shape	Type	Design List	Material	Design Rules
1	M1	N1	N2		W10x45	Column	Wide Flange	A572 Gr.50	DR1
2	M2	N2	N3		W12x40	Beam	Wide Flange	A572 Gr.50	DR1
3	M3	N3	N4		W10x45	Column	Wide Flange	A572 Gr.50	DR1
4	M4	N4	N2		W6x15	VBrace	Wide Flange	A572 Gr.50	DR1
5	M5	N1	N5		W6x15	VBrace	Wide Flange	A572 Gr.50	DR1
6	M6	N5	N3		W6x15	VBrace	Wide Flange	A572 Gr.50	DR1

Joint Loads and Enforced Displacements (BLC 1 : d)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N2	L	Y	-5
2	N3	L	Y	-8

Joint Loads and Enforced Displacements (BLC 2 : Pcr)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N2	L	Y	-5
2	N3	L	Y	-5

Joint Loads and Enforced Displacements (BLC 3 : ql)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N2	L	X	-4.6
2	N3	L	X	-4.6

Joint Loads and Enforced Displacements (BLC 4 : Pw)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N2	L	X	-2.5
2	N3	L	X	-2.5

Hot Rolled Steel Section Sets

	Label	Shape	Type	Design List	Material	Design Rules	A [in2]	I (90,270) [i...	I (0,180) [in4]
1	HR1A	W12x26 40	Beam	Wide Flange	A572 Gr.50	DR1	7.65	17.3	204
2	HR2	W10x45	Column	Wide Flange	A572 Gr.50	DR1	13.3	53.4	248
3	HR3	W6x15	VBrace	Wide Flange	A572 Gr.50	DR1	4.43	9.32	29.1

Basic Load Cases

	BLC Description	Category	X Gravity	Y Gravity	Joint	Point	Distributed
1	d	None			2		
2	Pcr	None			2		
3	ql	None			2		
4	Pw	None			2		

Load Combinations

	Description	Solve	PD...	SR...	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor
1	d+Pcr+ql	Yes	Y		DL	1.057	2	.9	3	2.1										
2	d+Pcr+ql	Yes	Y		DL	.543	2	.9	3	2.1										
3	d+PwPcr	Yes	Y		DL	1	2	.9	4	.75										
4	d+ql	Yes	Y		DL	.543	3	2.1												
5	d+Pw	Yes	Y		DL	1	4	.75												

Joint Reactions (By Combination)

	LC	Joint Label	X [k]	Y [k]	MZ [k-ft]
1	1	N1	.041	21.13	0
2	1	N4	19.279	-12.13	0
3	1	Totals:	19.32	9	
4	1	COG (ft):	X: 10.75	Y: 18.5	
5	2	N1	.041	21.13	0
6	2	N4	19.279	-12.13	0
7	2	Totals:	19.32	9	
8	2	COG (ft):	X: 10.75	Y: 18.5	
9	3	N1	.009	7.728	0
10	3	N4	3.741	1.272	0
11	3	Totals:	3.75	9	
12	3	COG (ft):	X: 10.75	Y: 18.5	
13	4	N1	.043	16.623	0
14	4	N4	19.277	-16.623	0
15	4	Totals:	19.32	0	
16	4	COG (ft):	NC	NC	
17	5	N1	.008	3.227	0
18	5	N4	3.742	-3.227	0
19	5	Totals:	3.75	0	
20	5	COG (ft):	NC	NC	

Joint Deflections

	LC	Joint Label	X [in]	Y [in]	Rotation [rad]
1	1	N1	0	0	0
2	1	N2	-.124	-.015	0
3	1	N3	-.132	-.003	0
4	1	N4	0	0	0
5	1	N5	-.028	.032	2.72e-4
6	2	N1	0	0	0
7	2	N2	-.124	-.015	0
8	2	N3	-.132	-.003	0
9	2	N4	0	0	0
10	2	N5	-.028	.032	2.72e-4
11	3	N1	0	0	0
12	3	N2	-.026	-.006	0
13	3	N3	-.028	-.003	0
14	3	N4	0	0	0
15	3	N5	-.005	.006	6.291e-5
16	4	N1	0	0	0
17	4	N2	-.121	-.012	0
18	4	N3	-.129	0	0
19	4	N4	0	0	0
20	4	N5	-.028	.032	2.594e-4
21	5	N1	0	0	0
22	5	N2	-.024	-.002	0
23	5	N3	-.025	0	0

Joint Deflections (Continued)

	LC	Joint Label	X [in]	Y [in]	Rotation [rad]
24	5	N4	0	0	0
25	5	N5	-.005	.006	5.035e-5

Load Combination Design

	Description	ASIF	CD	ABIF	Service	Hot Rolled	Cold Form...	Wood	Concrete	Masonry	Footings	Aluminum
1	d+Pcr+gl					Yes	Yes	Yes	Yes	Yes	Yes	Yes
2	d+Pcr+gl					Yes	Yes	Yes	Yes	Yes	Yes	Yes
3	d+PwPcr					Yes	Yes	Yes	Yes	Yes	Yes	Yes
4	d+gl					Yes	Yes	Yes	Yes	Yes	Yes	Yes
5	d+Pw					Yes	Yes	Yes	Yes	Yes	Yes	Yes

Member Section Forces

	LC	Member Label	Sec	Axial[k]	Shear[k]	Moment[k-ft]
1	1	M1	1	21.078	0	0
2			2	21.078	0	0
3			3	21.078	0	0
4			4	21.078	0	0
5			5	21.078	0	0
6	1	M2	1	9.664	0	0
7			2	9.664	0	0
8			3	9.664	0	0
9			4	9.664	0	0
10			5	9.664	0	0
11	1	M3	1	4.499	0	0
12			2	4.499	0	0
13			3	4.499	0	0
14			4	4.499	0	0
15			5	4.499	0	0
16	1	M4	1	-25.463	.027	0
17			2	-25.463	.027	-.19
18			3	-25.475	-.027	-.38
19			4	-25.475	-.027	-.19
20			5	-25.475	-.027	0
21	1	M5	1	.08	0	0
22			2	.08	0	0
23			3	.08	0	0
24			4	.08	0	0
25			5	.08	0	0
26	1	M6	1	0	0	0
27			2	0	0	0
28			3	0	0	0
29			4	0	0	0
30			5	0	0	0
31	2	M1	1	21.078	0	0
32			2	21.078	0	0
33			3	21.078	0	0
34			4	21.078	0	0
35			5	21.078	0	0
36	2	M2	1	9.664	0	0
37			2	9.664	0	0
38			3	9.664	0	0
39			4	9.664	0	0
40			5	9.664	0	0
41	2	M3	1	4.499	0	0
42			2	4.499	0	0

Member Section Forces (Continued)

	LC	Member Label	Sec	Axial[k]	Shear[k]	Moment[k-ft]
43			3	4.499	0	0
44			4	4.499	0	0
45			5	4.499	0	0
46	2	M4	1	-25.463	.027	0
47			2	-25.463	.027	-.19
48			3	-25.475	-.027	-.38
49			4	-25.475	-.027	-.19
50			5	-25.475	-.027	0
51	2	M5	1	.08	0	0
52			2	.08	0	0
53			3	.08	0	0
54			4	.08	0	0
55			5	.08	0	0
56	2	M6	1	0	0	0
57			2	0	0	0
58			3	0	0	0
59			4	0	0	0
60			5	0	0	0
61	3	M1	1	7.719	0	0
62			2	7.719	0	0
63			3	7.719	0	0
64			4	7.719	0	0
65			5	7.719	0	0
66	3	M2	1	1.876	0	0
67			2	1.876	0	0
68			3	1.876	0	0
69			4	1.876	0	0
70			5	1.876	0	0
71	3	M3	1	4.5	0	0
72			2	4.5	0	0
73			3	4.5	0	0
74			4	4.5	0	0
75			5	4.5	0	0
76	3	M4	1	-4.942	.006	0
77			2	-4.942	.006	-.043
78			3	-4.944	-.006	-.086
79			4	-4.944	-.006	-.043
80			5	-4.944	-.006	0
81	3	M5	1	.013	0	0
82			2	.013	0	0
83			3	.013	0	0
84			4	.013	0	0
85			5	.013	0	0
86	3	M6	1	0	0	0
87			2	0	0	0
88			3	0	0	0
89			4	0	0	0
90			5	0	0	0
91	4	M1	1	16.574	0	0
92			2	16.574	0	0
93			3	16.574	0	0
94			4	16.574	0	0
95			5	16.574	0	0
96	4	M2	1	9.66	0	0
97			2	9.66	0	0
98			3	9.66	0	0
99			4	9.66	0	0

Member Section Forces (Continued)

	LC	Member Label	Sec	Axial[k]	Shear[k]	Moment[k-ft]
100			5	9.66	0	0
101	4	M3	1	0	0	0
102			2	0	0	0
103			3	0	0	0
104			4	0	0	0
105			5	0	0	0
106	4	M4	1	-25.454	.026	0
107			2	-25.454	.026	-.182
108			3	-25.465	-.026	-.364
109			4	-25.465	-.026	-.182
110			5	-25.465	-.026	0
111	4	M5	1	.076	0	0
112			2	.076	0	0
113			3	.076	0	0
114			4	.076	0	0
115			5	.076	0	0
116	4	M6	1	0	0	0
117			2	0	0	0
118			3	0	0	0
119			4	0	0	0
120			5	0	0	0
121	5	M1	1	3.22	0	0
122			2	3.22	0	0
123			3	3.22	0	0
124			4	3.22	0	0
125			5	3.22	0	0
126	5	M2	1	1.875	0	0
127			2	1.875	0	0
128			3	1.875	0	0
129			4	1.875	0	0
130			5	1.875	0	0
131	5	M3	1	0	0	0
132			2	0	0	0
133			3	0	0	0
134			4	0	0	0
135			5	0	0	0
136	5	M4	1	-4.941	.005	0
137			2	-4.941	.005	-.035
138			3	-4.943	-.005	-.071
139			4	-4.943	-.005	-.035
140			5	-4.943	-.005	0
141	5	M5	1	.011	0	0
142			2	.011	0	0
143			3	.011	0	0
144			4	.011	0	0
145			5	.011	0	0
146	5	M6	1	0	0	0
147			2	0	0	0
148			3	0	0	0
149			4	0	0	0
150			5	0	0	0

Member AISC 13th(360-05): ASD Steel Code Checks

	LC	Member	Shape	UC Max	Loc[ft]	Shear UC	Loc[ft]	Pnc/om [k]	Pnt/om [k]	Mn/om [k-ft]	Cb	Eqn
1	1	M1	W10x45	.065	0	.000	0	162.302	398.204	107.502	1	H1-1b
2	1	M2	W12x40	.049	0	.000	0	99.582	350.299	87.847	1	H1-1b

Member AISC 13th(360-05): ASD Steel Code Checks (Continued)

	LC	Member	Shape	UC Max	Loc[ft]	Shear UC	Loc[ft]	Pnc/om [k]	Pnt/om [k]	Mn/om [k-ft]	Cb	Eqn
3	1	M3	W10x45	.014	0	.000	0	162.302	398.204	107.502	1	H1-1b
4	1	M4	W6x15	.129	14.182	.001	14.182	12.092	132.635	11.431	1.316	H1-1b
5	1	M5	W6x15	.001	0	.000	0	48.369	132.635	18.975	1	H1-1b
6	1	M6	W6x15	.000	0	.000	0	48.369	132.635	18.975	1	H1-1a
7	2	M1	W10x45	.065	0	.000	0	162.302	398.204	107.502	1	H1-1b
8	2	M2	W12x40	.049	0	.000	0	99.582	350.299	87.847	1	H1-1b
9	2	M3	W10x45	.014	0	.000	0	162.302	398.204	107.502	1	H1-1b
10	2	M4	W6x15	.129	14.182	.001	14.182	12.092	132.635	11.431	1.316	H1-1b
11	2	M5	W6x15	.001	0	.000	0	48.369	132.635	18.975	1	H1-1b
12	2	M6	W6x15	.000	0	.000	0	48.369	132.635	18.975	1	H1-1a
13	3	M1	W10x45	.024	0	.000	0	162.302	398.204	107.502	1	H1-1b
14	3	M2	W12x40	.009	0	.000	0	99.582	350.299	87.847	1	H1-1b
15	3	M3	W10x45	.014	0	.000	0	162.302	398.204	107.502	1	H1-1b
16	3	M4	W6x15	.026	14.182	.000	14.182	12.092	132.635	11.431	1.316	H1-1b
17	3	M5	W6x15	.000	0	.000	0	48.369	132.635	18.975	1	H1-1b
18	3	M6	W6x15	.000	0	.000	0	48.369	132.635	18.975	1	H1-1b
19	4	M1	W10x45	.051	0	.000	0	162.302	398.204	107.502	1	H1-1a
20	4	M2	W12x40	.049	0	.000	0	99.582	350.299	87.847	1	H1-1b
21	4	M3	W10x45	.000	0	.000	0	162.302	398.204	107.502	1	H1-1b
22	4	M4	W6x15	.128	14.182	.001	14.182	12.092	132.635	11.431	1.316	H1-1b
23	4	M5	W6x15	.001	0	.000	0	48.369	132.635	18.975	1	H1-1b
24	4	M6	W6x15	.000	0	.000	0	48.369	132.635	18.975	1	H1-1a
25	5	M1	W10x45	.010	0	.000	0	162.302	398.204	107.502	1	H1-1b
26	5	M2	W12x40	.009	0	.000	0	99.582	350.299	87.847	1	H1-1b
27	5	M3	W10x45	.000	0	.000	0	162.302	398.204	107.502	1	H1-1b
28	5	M4	W6x15	.025	14.182	.000	14.182	12.092	132.635	11.431	1.316	H1-1b
29	5	M5	W6x15	.000	0	.000	0	48.369	132.635	18.975	1	H1-1b
30	5	M6	W6x15	.000	0	.000	0	48.369	132.635	18.975	1	H1-1a

APPENDIX A - CALCULATION COVER SHEET

CALCULATION ID NUMBER	
REVISION NUMBER	
JOB NUMBER	WW- PGE - 2174

TITLE	Topock - Remediation - Switchgear Canopy

Page	content
1	General
2	Lateral Analysis for frames & Loads
3.	Roof Framing
4	Foundation
–	Attachment - A, Mom. Fr. Line - A
–	Attach. - B Mom. Frame line - B
–	Attach. - C Braced Fr.'s Line ① & ④

	initial	date
PREPARED	KD	7/16/14
TITLE		
REVIEWED		
TITLE		

REVISION NOTES	

2 Consulting Engineers, Inc. 1900 Powell Street, Suite 250 Emeryville, CA 94608	Designed By:	KD	Date: 7/15/14
	Checked By:		Date:
	Reviewed By:		Date:
			Sheet No. 1

roject No.	WW-PGE-3174
roject Description:	Topock Remediation - Switchgear Canopy

eference:

General References

1. CBC 2010
2. ASCE 7-10
3. ACI 318-11

Seismic Data

$S_s = .23$ $S_{ms} = 1.6 \times .23 = .368$

$S_1 = .12$ $S_{m1} = F_v S_1 = 2.318 \times .12 = .28$

$S_{DS} = .267$ $S_{D1} = .187$

Soil Bearing press. = 4000 PSF

Conc. Data

$f'_c = 5.0$ KSI $F_y = 60$ KSI

Related Dwgs.

S-12-21 TO S-12-25

Loads

Roof DL = 10 PSF LL = 20 PSF TL = 30 PSF

Siding DL = 15 PSF

2 Consulting Engineers, Inc. 1900 Powell Street, Suite 250 Emeryville, CA 94608	Designed By:	KD	Date: 7/11/14
	Checked By:		Date:
	Reviewed By:		Date:
Project No. WW-PGE-2174			Sheet No. 2
Project Description: Topock - Remediation - Switchgear Enclosure			

Reference:

Lateral Analysis

Seismic — Using Equivalent Lateral Procedure

$V = C_s W$ $S_{DS} = .247$ $R = 3.5$ $\Omega = 3.0$ (Mom. Fr.)

Wt. W — Deck + Frame = 12 PSF Siding = 15 PSF $R = 3.25$ (Braced Fr.)

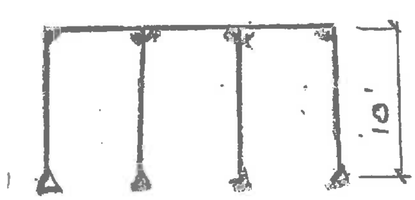
$W = 12 \times 22 \times .012 + 2 \times 6 \times 12 \times .015$ (Roof, Siding)
$= 5.33^k$

$C_s = \frac{S_{DS}}{(R/I)} = \frac{.247}{(3.25/1.25)} = .095$ (Br. Fr.) $C_{s\,max} = \frac{.5\,S_{D1}}{T(R/I)} = \frac{.5 \times .187}{.204(2.8)}$
$= .164$ (Mom. Fr.)

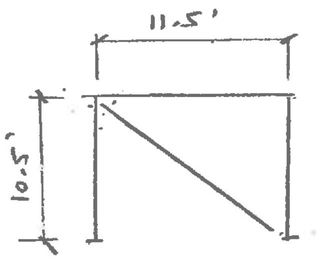
$T = C_t h_n^x = .028 \times (12)^{.8} = .204$ (Mom. Fr.) $C_{s\,max} = \frac{.5 \times .187}{.129 \times 2.6} = .279$ (Br. Fr.)
$T = .02 \times (12)^{.75} = .129$ (Br. Frames)
$V = .279 \times 5.33 = 1.49^k$ USE $.75^k$/Frame for Br. Fr.
$V = .164 \times 5.33 = .87^k$ USE $.44^k$/Frame for Mom. Fr.

Wind — $V_{EW} = .02(12) \times 6 = 1.44^k$ P/Mom. Frame $= .75^k$/Frame
$V_{NS} = .02(22) \times 6 = 2.64^k$ P/Br. Frame $= 1.35^k$/Frame

Wind governs in both directions.



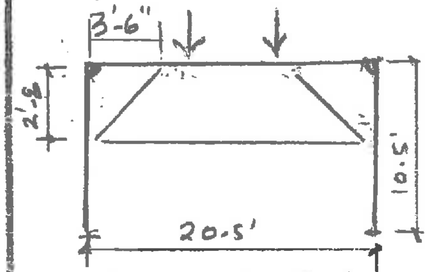
FRAME LINE-B



FRAME LINES ① & ④

Basic Loads

1 DL
2 LL (Wind Down)
3 Wind Horiz.
4 Seismic



FRAME LINE-A

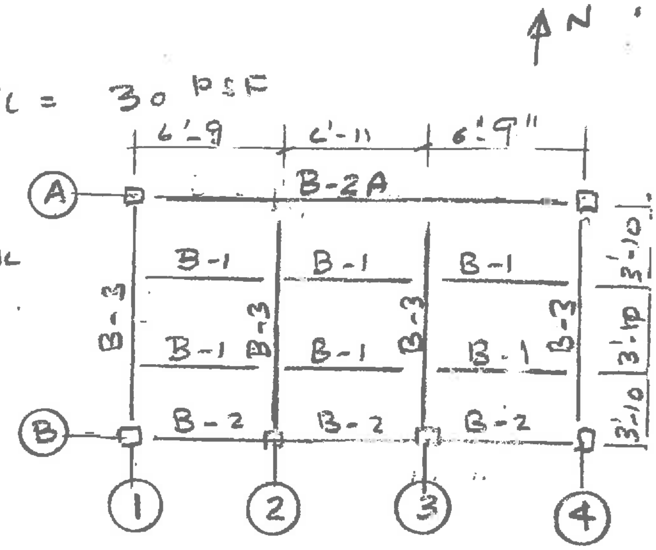
Load Combination

1. DL + LL (Wind Down) ① + ②
2. DL + Wind Horiz. ① + .6 ③
3. DL + Seismic ① + .7 ④
4. DL + Wind up + Wind Horiz. ① + (-.5) ② + .45 ③
5. DL + Wind Down + Wind Horiz. ① + ② + .45 ③

Max. Defl. for Frame Line A = .507 = ℓ/249 < ℓ/200 ; .60 Δ Line B = .473" = ℓ/266 <

:2 Consulting Engineers, Inc. **1900 Powell Street, Suite 250** **Emeryville, CA 94608**	**Designed By:** KD **Checked By:** **Reviewed By:**		**Date:** 7/10/14 **Date:** **Date:**
Project No.	WW - PGE - 2174		**Sheet No.** 3
Project Description:	Topock - Remediation - Switchgear Enclosure		

Reference:



Roof Loads

$DL = 10^{PSF}$ $LL = 20^{PSF}$ $TL = 30^{PSF}$

B-1, B-2: $\ell = 7'$

$w_{TL} = (.01 + .02) \times 3.75 = .113^{k/'}$

$M = \frac{.113 \times 7^2}{8} = .692^{'k}$ $R = .395^{k}$

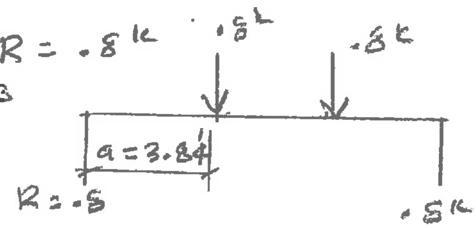
$S_x = \frac{.692 \times 12}{27.6} = .309^{in^3}$

HSS 4x4x4 $S = 3.90^{in^3}$ $I = 7.8^{in^4}$ $A = 3.37^{in}$

B-3: $\ell = 11.52'$

$P = 2 \times .395 = .79^{k}$ say $.8^{k}$

$M = .8 \times \frac{11.66}{2} - .8 \times 1.875 = 3.164^{'k}$ $R = .8^{k}$



$S_x = \frac{3.164 \times 12}{27.6} = 1.375\ in^3 < 8.58^{in^3}$

$\Delta = \frac{Pa}{24EI}(3\ell^2 - 4a^2)$

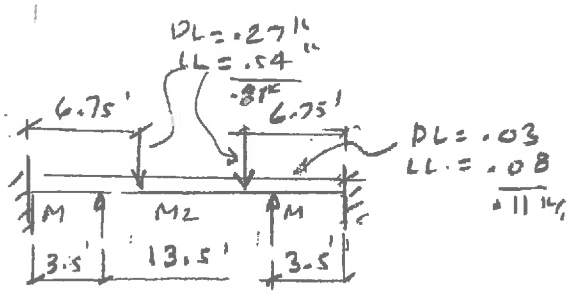
$= \frac{.8 \times 3.84 (3 \times 11.52^2 - 4 \times 3.84^2) \times 1728}{24 \times 29000 \times 10.3}$

$= .251'' = \frac{\ell}{550} < \frac{\ell}{180}$ ok

USE HSS 4x4x6 $I = 20.9$

B-2A (DL+LL): See computer output (Memb. M2) (Attach. - A)

	LC-1	LC-5
Max Design check =	.196	1.203



USE HSS6x4x4

Col. & Base plates

Col.: Column size is governed by displacement @ Top of frame. See sht. for frame deflections @ top HSS 4x4x6 is ok

Base Pl: Max $P_{DL+LL} = 3.5^{k}$ $V = .25 \times 2 = .5^{k}$ Loads are Very Small

USE 12"x12"x3/4" PL w/ 4-3/4"Φ A-307 Bolts.

Consulting Engineers, Inc. 1900 Powell Street, Suite 250 Emeryville, CA 94608	Designed By:	KD	Date: 7/15/14
	Checked By:		Date:
	Reviewed By:		Date:
Project No. WW-PGE-2174			Sheet No. 4
Project Description: Topock - Remediation Switchgear Enclosure			

Reference:

Foundation

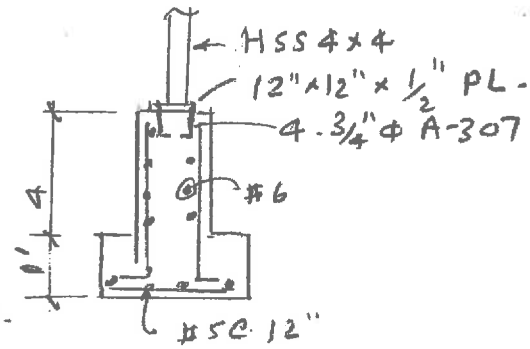
Pedestal

Max. $P = 4^k$ Max $V = .5^k$

Try 1'-6" SQ PEDSTAL

$M = .5 \times 4 = 2^{'k}$ $V = .5^k$

18" SQ. PED. W/ 8-#6 Bars ok by insp.



Footing

$M = .5 \times 5 = 2.5^{'k}$ $P = 4^k + 1.5 \times 1.5 \times 4 \times .15 + 2.5 \times 2.5 \times 1 \times .15 = 6.3^k$

$S_{FTG.} = \frac{1}{6} \times 2.5 \times 2.5^2 =$

$\frac{P}{A} + \frac{M}{S} = f_p = \frac{6.3}{2.5 \times 2.5} \pm \frac{2.5}{2.6} = 1.0 \pm .96 = 1.96^{ksf}$ (Max. $< 4^{ksf}$

USE 2'-6" SQ. FTG. W/ 4-#5 Bars Ea. Way

Slab on Grade

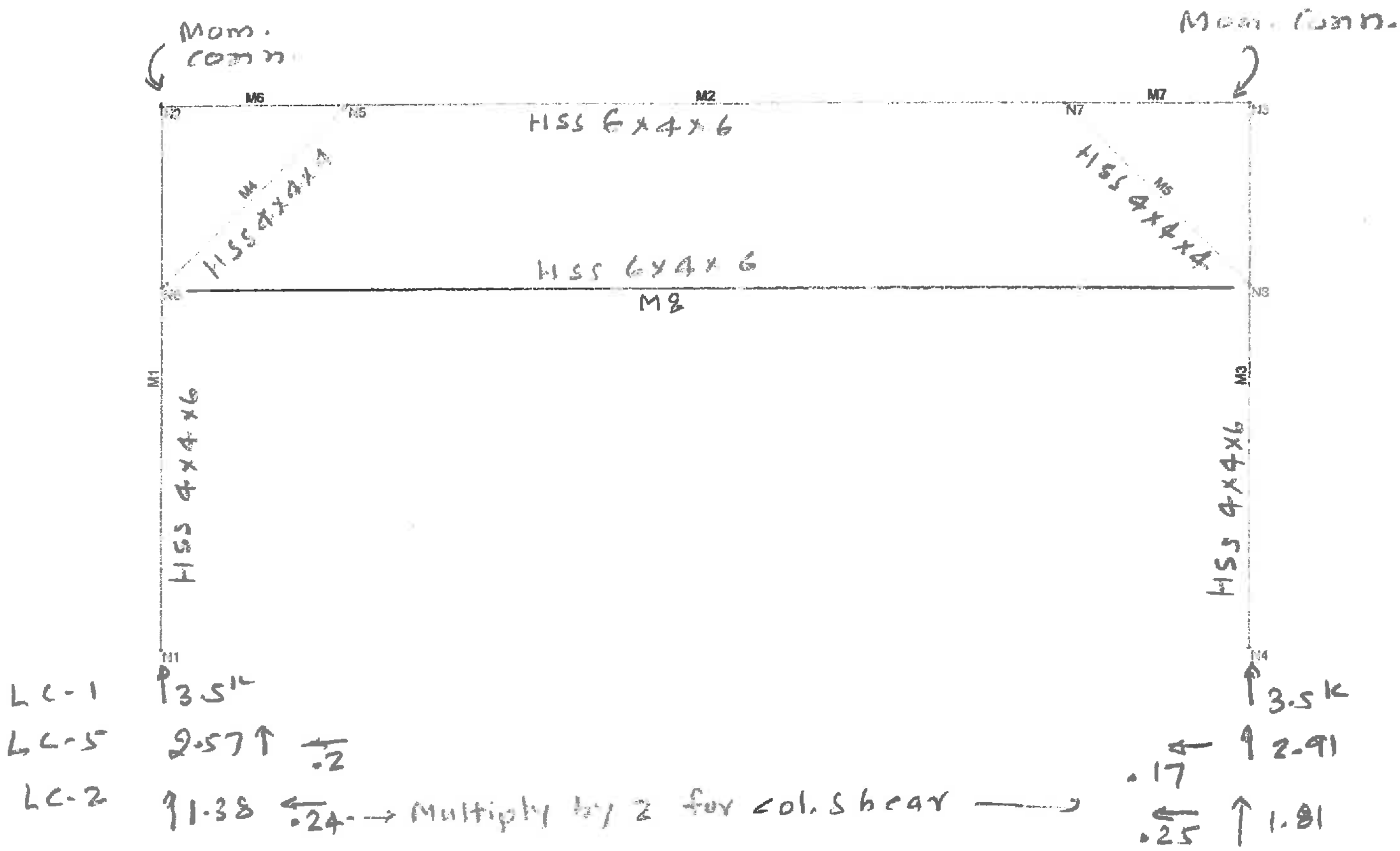
12" TK Slab w/ #5 @ 12" Ea. Way

Gr. Bm. (12" x 30")

$w = .015 \times 11 + .15 \times 1 \times 2.5 = .54^{k/'}$

USE 12" x 2'-6" deep Gr. Bm. w/ #5 @ 12" Ea Face

& #4 Stirrups @ 18" o/c ok by Insp.



Results for LC 1, dl+ll

E 2	Switchgear topock moment frame line A	SK - 2
		July 13, 2014 at 10:16 PM
		topockswithgear.momfrb.r2d

Global

Display Sections for Member Calcs	5
Max Internal Sections for Member Calcs	97
Include Shear Deformation?	Yes
Merge Tolerance (in)	.12
P-Delta Analysis Tolerance	0.50%
Include P-Delta for Walls?	Yes
Automaticly Iterate Stiffness for Walls?	Yes
Maximum Iteration Number for Wall Stiffness	3
Gravity Acceleration (ft/sec^2)	32.2
Wall Mesh Size (in)	12
Eigensolution Convergence Tol. (1.E-)	4
Dynamic Solver	Accelerated Solver

Hot Rolled Steel Code	AISC 14th(360-10): ASD
Adjust Stiffness?	Yes(Iterative)
RISAConnection Code	None
Cold Formed Steel Code	AISI S100-10: ASD
Wood Code	AF&PA NDS-12: ASD
Wood Temperature	< 100F
Concrete Code	ACI 318-11
Masonry Code	ACI 530-11: ASD
Aluminum Code	AA ADM1-10: ASD - Building

Number of Shear Regions	4
Region Spacing Increment (in)	4
Concrete Stress Block	Rectangular
Use Cracked Sections?	Yes
Bad Framing Warnings?	No
Unused Force Warnings?	Yes
Min 1 Bar Diam. Spacing?	No
Concrete Rebar Set	REBAR_SET_ASTMA615
Min % Steel for Column	1
Max % Steel for Column	8

Hot Rolled Steel Properties

	Label	E [ksi]	G [ksi]	Nu	Therm (\1E5 F)	Density[k/ft^3]	Yield[ksi]
1	A36 Gr.36	29000	11154	.3	.65	.49	36
2	A572 Gr.50	29000	11154	.3	.65	.49	50
3	A992	29000	11154	.3	.65	.49	50
4	A500 Gr.B RND	29000	11154	.3	.65	.49	42
5	A500 Gr.B Rect	29000	11154	.3	.65	.49	46
6	A53 Gr.B	29000	11154	.3	.65	.49	35

Hot Rolled Steel Section Sets

	Label	Shape	Type	Design List	Material	Design Rules	A [in2]	I (90,270) [i...	I (0,180) [in4]
1	HR1A	HSS4x4x6	Column	Tube	A500 Gr.B Rect	Typical	4.78	10.3	10.3
2	HR2	HSS6x4x4	Beam	Tube	A500 Gr.B Rect	Typical	4.3	11.1	20.9
3	HR3	HSS4x4x4	HBrace	Tube	A500 Gr.B Rect	Typical	3.37	7.8	7.8

Joint Coordinates and Temperatures

	Label	X [ft]	Y [ft]	Temp [F]
1	N1	0	0	0
2	N2	0	10.5	0
3	N3	20.5	10.5	0

Joint Coordinates and Temperatures (Continued)

	Label	X [ft]	Y [ft]	Temp [F]
4	N4	20.5	0	0
5	N5	3.5	10.5	0
6	N6	0	7.83	0
7	N7	17	10.5	0
8	N8	20.5	7.83	0

Joint Boundary Conditions

	Joint Label	X [k/in]	Y [k/in]	Rotation[k-ft/rad]	Footing
1	N1	Reaction	Reaction		
2	N4	Reaction	Reaction		

Member Primary Data

	Label	I Joint	J Joint	Rotate(deg)	Section/Shape	Type	Design List	Material	Design Rules
1	M1	N1	N2		HR1A	Column	Tube	A500 Gr.B ...	Typical
2	M2	N5	N7		HR2	Beam	Tube	A500 Gr.B ...	Typical
3	M3	N3	N4		HR1A	Column	Tube	A500 Gr.B ...	Typical
4	M4	N5	N6		HR3	HBrace	Tube	A500 Gr.B ...	Typical
5	M5	N7	N8		HR3	HBrace	Tube	A500 Gr.B ...	Typical
6	M6	N2	N5		HR2	Beam	Tube	A500 Gr.B ...	Typical
7	M7	N7	N3		HR2	Beam	Tube	A500 Gr.B ...	Typical
8	M8	N6	N8		HR2	Beam	Tube	A500 Gr.B ...	Typical

Joint Loads and Enforced Displacements (BLC 1 : dl)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N2	L	Y	-.5
2	N3	L	Y	-.5

Joint Loads and Enforced Displacements (BLC 2 : ll)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N2	L	Y	-.54
2	N3	L	Y	-.54

Joint Loads and Enforced Displacements (BLC 3 : wind horiz)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N2	L	X	.11
2	N6	L	X	.3
3	N3	L	X	.11
4	N8	L	X	.3

Joint Loads and Enforced Displacements (BLC 4 : seismic)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N2	L	X	.21
2	N3	L	X	.21

Member Point Loads (BLC 1 : dl)

	Member Label	Direction	Magnitude[k,k-ft]	Location[ft,%]
1	M2	Y	-.27	3.25
2	M2	Y	-.27	10.25

Member Point Loads (BLC 2 : ll)

	Member Label	Direction	Magnitude[k,k-ft]	Location[ft,%]
1	M2	Y	-.54	3.25
2	M2	Y	-.54	10.25

Member Distributed Loads (BLC 1 : dl)

	Member Label	Direction	Start Magnitude[k/ft,F]	End Magnitude[k/ft,F]	Start Location[ft,%]	End Location[ft,%]
1	M2	Y	-.03	-.03	0	13.5
2	M6	Y	-.03	-.03	0	3.5
3	M7	Y	-.03	-.03	0	3.5

Member Distributed Loads (BLC 2 : ll)

	Member Label	Direction	Start Magnitude[k/ft,F]	End Magnitude[k/ft,F]	Start Location[ft,%]	End Location[ft,%]
1	M2	Y	-.08	-.08	0	13.5
2	M6	Y	-.08	-.08	0	3.5
3	M7	Y	-.08	-.08	0	3.5

Basic Load Cases

	BLC Description	Category	X Gravity	Y Gravity	Joint	Point	Distributed
1	dl	None		-1	2	2	3
2	ll	None			2	2	3
3	wind horiz	None			4		
4	seismic	None			2		

Load Combinations

	Description	Solve	PD...	SR...	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor
1	dl+ll	Yes	Y		1	1	2	1												
2	dl+wind horiz	Yes	Y		1	1	3	.6												
3	dl+seismic	Yes	Y		1	1	4	.7												
4	dl+wind up	Yes	Y		1	1	3	.45	2	-.5										
5	dl+ll+wind ho.	Yes	Y		1	1	3	.45	2	.6										

Joint Reactions

	LC	Joint Label	X [k]	Y [k]	MZ [k-ft]
1	1	N1	.02	3.499	0
2	1	N4	-.02	3.499	0
3	1	Totals:	0	6.997	
4	1	COG (ft):	X: 10.25	Y: 10.11	
5	2	N1	-.241	1.384	0
6	2	N4	-.251	1.814	0
7	2	Totals:	-.492	3.197	
8	2	COG (ft):	X: 10.25	Y: 9.647	
9	3	N1	-.141	1.442	0
10	3	N4	-.153	1.756	0
11	3	Totals:	-.294	3.197	
12	3	COG (ft):	X: 10.25	Y: 9.647	
13	4	N1	-.185	.492	0
14	4	N4	-.184	.805	0
15	4	Totals:	-.369	1.297	
16	4	COG (ft):	X: 10.25	Y: 8.397	
17	5	N1	-.171	2.571	0
18	5	N4	-.198	2.906	0
19	5	Totals:	-.369	5.477	

Joint Reactions (Continued)

	LC	Joint Label	X [k]	Y [k]	MZ [k-ft]
20	5	COG (ft):	X: 10.25	Y: 10.002	

Joint Deflections

	LC	Joint Label	X [in]	Y [in]	Rotation [rad]
1	1	N1	0	0	1.601e-4
2	1	N2	.002	-.003	1.897e-5
3	1	N3	-.002	-.003	-1.897e-5
4	1	N4	0	0	-1.601e-4
5	1	N5	.002	-.015	-1.305e-3
6	1	N6	-.004	-.003	-2.084e-4
7	1	N7	-.002	-.015	1.305e-3
8	1	N8	.004	-.003	2.084e-4
9	2	N1	0	0	-6.586e-3
10	2	N2	.507	-.001	-8.613e-4
11	2	N3	.505	-.001	-8.71e-4
12	2	N4	0	0	-6.698e-3
13	2	N5	.506	-.044	-9.633e-4
14	2	N6	.474	-.001	-1.941e-3
15	2	N7	.505	.032	-6.163e-5
16	2	N8	.477	-.001	-1.795e-3
17	3	N1	0	0	-4.044e-3
18	3	N2	.32	-.001	-6.606e-4
19	3	N3	.318	-.001	-6.704e-4
20	3	N4	0	0	-4.157e-3
21	3	N5	.319	-.034	-8.206e-4
22	3	N6	.295	-.001	-1.315e-3
23	3	N7	.318	.022	8.106e-5
24	3	N8	.298	-.001	-1.169e-3
25	4	N1	0	0	-4.824e-3
26	4	N2	.368	0	-6.295e-4
27	4	N3	.368	0	-6.251e-4
28	4	N4	0	0	-4.833e-3
29	4	N5	.368	-.028	-3.954e-4
30	4	N6	.346	0	-1.362e-3
31	4	N7	.367	.027	-3.477e-4
32	4	N8	.346	0	-1.352e-3
33	5	N1	0	0	-5.06e-3
34	5	N2	.396	-.002	-6.652e-4
35	5	N3	.393	-.002	-6.919e-4
36	5	N4	0	0	-5.298e-3
37	5	N5	.396	-.041	-1.364e-3
38	5	N6	.368	-.002	-1.613e-3
39	5	N7	.393	.019	5.624e-4
40	5	N8	.373	-.002	-1.305e-3

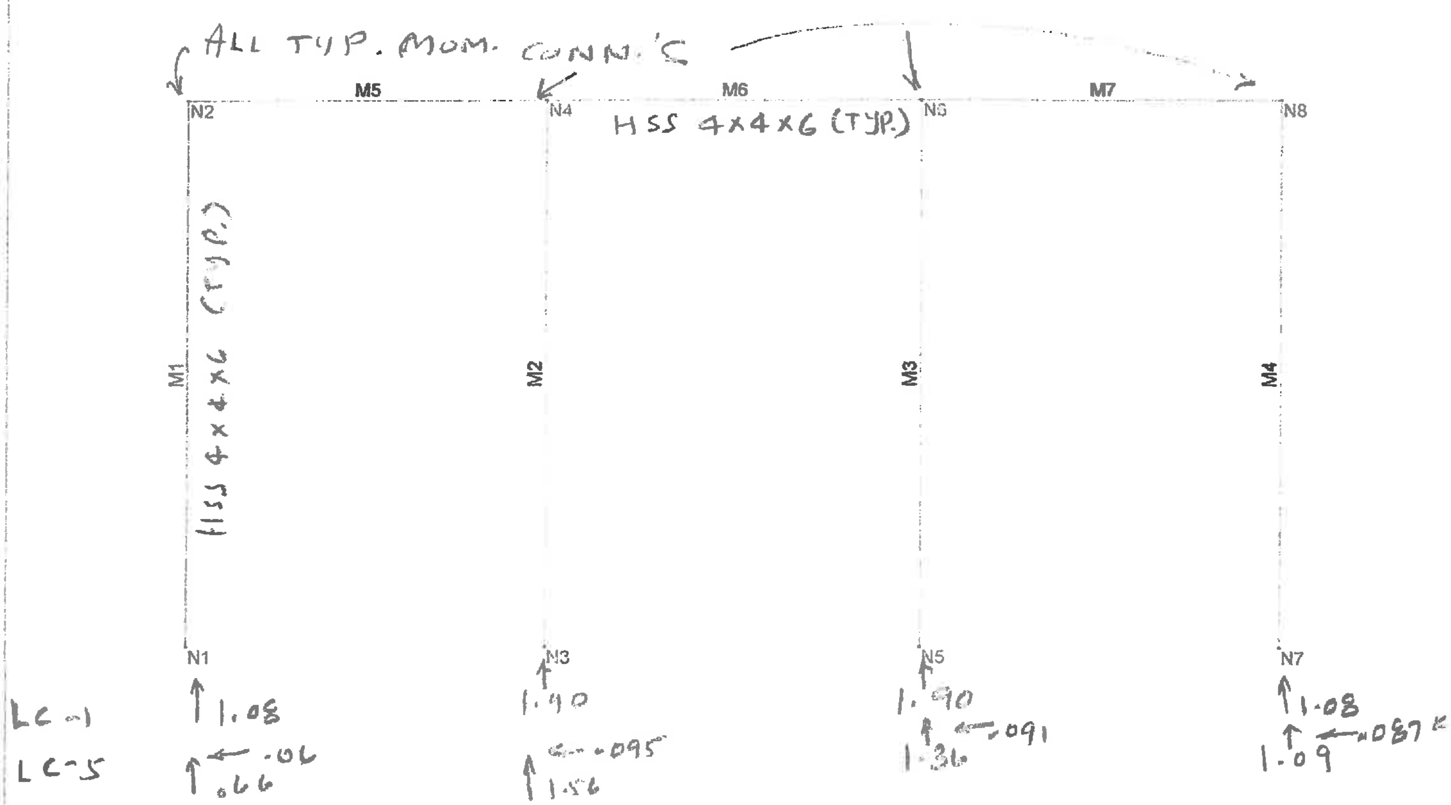
Member AISC 14th(360-10): ASD Steel Code Checks

	LC	Member	Shape	UC Max	Loc[ft]	Shear UC	Loc[ft]	Pnc/om [k]	Pnt/om [k]	Mn/om [k-ft]	Cb	Eqn
1	1	M1	HSS4x4x6	.032	7.766	.007	7.875	80.21	131.665	14.668	2.598	H1-1b
2	1	M2	HSS6x4x4	.196	0	.040	0	59.773	118.443	19.58	1.549	H1-1b
3	1	M3	HSS4x4x6	.032	2.734	.007	0	80.21	131.665	14.668	2.598	H1-1b
4	1	M4	HSS4x4x4	.030	2.247	.001	4.402	85.595	92.826	10.765	1.136	H1-1b
5	1	M5	HSS4x4x4	.030	2.247	.001	4.402	85.595	92.826	10.765	1.136	H1-1b
6	1	M6	HSS6x4x4	.166	3.5	.031	3.5	113.122	118.443	19.58	1.977	H1-1b
7	1	M7	HSS6x4x4	.166	0	.031	0	113.122	118.443	19.58	1.977	H1-1b
8	1	M8	HSS6x4x4	.055	10.25	.004	0	27.57	118.443	19.58	1.136	H1-1b

Member AISC 14th(360-10): ASD Steel Code Checks (Continued)

	LC	Member	Shape	UC Max	Loc[ft]	Shear UC	Loc[ft]	Pnc/om [k]	Pnt/om [k]	Mn/om [k-ft]	Cb	Eqn
9	2	M1	HSS4x4x6	.141	7.766	.029	7.875	80.21	131.665	14.668	1.362	H1-1b
10	2	M2	HSS6x4x4	.142	13.5	.019	13.5	59.773	118.443	19.58	2.315	H1-1b
11	2	M3	HSS4x4x6	.151	2.734	.033	0	80.21	131.665	14.668	1.363	H1-1b
12	2	M4	HSS4x4x4	.004	2.247	.001	0	85.595	92.826	10.765	1.136	H1-1b
13	2	M5	HSS4x4x4	.020	2.247	.001	0	85.595	92.826	10.765	1.136	H1-1b
14	2	M6	HSS6x4x4	.037	0	.009	0	113.122	118.443	19.58	2.362	H1-1b
15	2	M7	HSS6x4x4	.137	0	.026	0	113.122	118.443	19.58	2.188	H1-1b
16	2	M8	HSS6x4x4	.045	10.25	.004	0	27.57	118.443	19.58	1.136	H1-1b
17	3	M1	HSS4x4x6	.086	7.766	.016	7.875	80.21	131.665	14.668	1.362	H1-1b
18	3	M2	HSS6x4x4	.122	13.5	.018	13.5	59.773	118.443	19.58	2.323	H1-1b
19	3	M3	HSS4x4x6	.096	2.734	.021	0	80.21	131.665	14.668	1.364	H1-1b
20	3	M4	HSS4x4x4	.006	2.247	.001	4.402	85.595	92.826	10.765	1.136	H1-1b
21	3	M5	HSS4x4x4	.018	2.247	.001	4.402	85.595	92.826	10.765	1.136	H1-1b
22	3	M6	HSS6x4x4	.021	0	.004	0	113.122	118.443	19.58	1.889	H1-1b
23	3	M7	HSS6x4x4	.115	0	.022	0	113.122	118.443	19.58	2.172	H1-1b
24	3	M8	HSS6x4x4	.045	10.25	.004	0	27.57	118.443	19.58	1.136	H1-1b
25	4	M1	HSS4x4x6	.102	7.875	.022	7.875	80.21	131.665	14.668	1.363	H1-1b
26	4	M2	HSS6x4x4	.058	13.5	.005	13.5	59.773	118.443	19.58	2.268	H1-1b
27	4	M3	HSS4x4x6	.104	2.734	.023	0	80.21	131.665	14.668	1.363	H1-1b
28	4	M4	HSS4x4x4	.007	2.155	.001	0	85.595	92.826	10.765	1.136	H1-1b
29	4	M5	HSS4x4x4	.009	2.247	.001	0	85.595	92.826	10.765	1.136	H1-1b
30	4	M6	HSS6x4x4	.055	3.5	.011	0	113.122	118.443	19.58	2.174	H1-1b
31	4	M7	HSS6x4x4	.060	0	.012	0	113.122	118.443	19.58	2.186	H1-1b
32	4	M8	HSS6x4x4	.040	10.25	.004	0	27.57	118.443	19.58	1.136	H1-1b
33	5	M1	HSS4x4x6	.114	7.766	.019	7.875	80.21	131.665	14.668	1.361	H1-1b
34	5	M2	HSS6x4x4	.203	13.5	.034	13.5	59.773	118.443	19.58	1.993	H1-1b
35	5	M3	HSS4x4x6	.132	2.734	.029	0	80.21	131.665	14.668	1.364	H1-1b
36	5	M4	HSS4x4x4	.017	2.247	.001	4.402	85.595	92.826	10.765	1.136	H1-1b
37	5	M5	HSS4x4x4	.029	2.247	.001	4.402	85.595	92.826	10.765	1.136	H1-1b
38	5	M6	HSS6x4x4	.067	3.5	.011	3.5	113.122	118.443	19.58	1.63	H1-1b
39	5	M7	HSS6x4x4	.185	0	.035	0	113.122	118.443	19.58	2.14	H1-1b
40	5	M8	HSS6x4x4	.051	10.25	.004	0	27.57	118.443	19.58	1.136	H1-1b

Attach. - B



Results for LC 1, dl+ll

E 2	Topock Switchgear Moment Frame lineB	SK - 1
		July 14, 2014 at 1:23 PM
		topoclswitchgear.momfrlineB.r2d

Hot Rolled Steel Properties

	Label	E [ksi]	G [ksi]	Nu	Therm (\1E5 F)	Density[k/ft^3]	Yield[ksi]
1	A36 Gr.36	29000	11154	.3	.65	.49	36
2	A572 Gr.50	29000	11154	.3	.65	.49	50
3	A992	29000	11154	.3	.65	.49	50
4	A500 Gr.B RND	29000	11154	.3	.65	.49	42
5	A500 Gr.B Rect	29000	11154	.3	.65	.49	46
6	A53 Gr.B	29000	11154	.3	.65	.49	35

Hot Rolled Steel Section Sets

	Label	Shape	Type	Design List	Material	Design Rules	A [in2]	I (90,270) [i...	I (0,180) [in4]
1	HR1A	HSS4x4x6	Column	Tube	A500 Gr.B Rect	Typical	4.78	10.3	10.3
2	HR2	HSS4x4x6	Beam	Tube	A500 Gr.B Rect	Typical	4.78	10.3	10.3

Joint Coordinates and Temperatures

	Label	X [ft]	Y [ft]	Temp [F]
1	N1	0	0	0
2	N2	0	10.5	0
3	N3	6.75	0	0
4	N4	6.75	10.5	0
5	N5	13.75	0	0
6	N6	13.75	10.5	0
7	N7	20.5	0	0
8	N8	20.5	10.5	0

Joint Boundary Conditions

	Joint Label	X [k/in]	Y [k/in]	Rotation[k-ft/rad]	Footing
1	N1	Reaction	Reaction		
2	N3	Reaction	Reaction		
3	N5	Reaction	Reaction		
4	N7	Reaction	Reaction		

Member Primary Data

	Label	I Joint	J Joint	Rotate(deg)	Section/Shape	Type	Design List	Material	Design Rules
1	M1	N1	N2		HR1A	Column	Tube	A500 Gr.B ...	Typical
2	M2	N3	N4		HR1A	Column	Tube	A500 Gr.B ...	Typical
3	M3	N5	N6		HR1A	Column	Tube	A500 Gr.B ...	Typical
4	M4	N7	N8		HR1A	Column	Tube	A500 Gr.B ...	Typical
5	M5	N2	N4		HR2	Beam	Tube	A500 Gr.B ...	Typical
6	M6	N4	N6		HR2	Beam	Tube	A500 Gr.B ...	Typical
7	M7	N6	N8		HR2	Beam	Tube	A500 Gr.B ...	Typical

Joint Loads and Enforced Displacements (BLC 1 : dl)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N4	L	Y	-.27
2	N6	L	Y	-.27
3	N2	L	Y	-.27
4	N8	L	Y	-.27

Joint Loads and Enforced Displacements (BLC 2 : ll)

Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...

Joint Loads and Enforced Displacements (BLC 2 : ll) (Continued)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N3	L	Y	-.54
2	N6	L	Y	-.54
3	N2	L	Y	-.27
4	N8	L	Y	-.27

Joint Loads and Enforced Displacements (BLC 3 : wind horiz)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N2	L	X	.375
2	N8	L	X	.375

Joint Loads and Enforced Displacements (BLC 4 : seismic)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N2	L	X	.21
2	N8	L	X	.21

Member Distributed Loads (BLC 1 : dl)

	Member Label	Direction	Start Magnitude[k/ft,F]	End Magnitude[k/ft,F]	Start Location[ft,%]	End Location[ft,%]
1	M5	Y	-.03	-.03	0	6.75
2	M6	Y	-.03	-.03	0	7
3	M7	Y	-.03	-.03	0	6.75

Member Distributed Loads (BLC 2 : ll)

	Member Label	Direction	Start Magnitude[k/ft,F]	End Magnitude[k/ft,F]	Start Location[ft,%]	End Location[ft,%]
1	M5	Y	-.08	-.08	0	6.75
2	M6	Y	-.08	-.08	0	7
3	M7	Y	-.08	-.08	0	6.75

Basic Load Cases

	BLC Description	Category	X Gravity	Y Gravity	Joint	Point	Distributed
1	dl	None		-1	4		3
2	ll	None			4		3
3	wind horiz	None			2		
4	seismic	None			2		

Load Combinations

	Description	Solve	PD...	SR...	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor
1	dl+ll	Yes	Y		1	1	2	1												
2	dl+wind	Yes	Y		1	1	3	.6												
3	dl+seismic	Yes	Y		1	1	3	.7												
4	dl+wind up	Yes	Y		1	1	3	.45	2	-.5										
5	dl+ll+wind ho...	Yes	Y		1	1	3	.45	2	.6										

Member Section Forces

	LC	Member Label	Sec	Axial[k]	Shear[k]	Moment[k-ft]
1	1	M1	1	1.076	-.016	0
2			2	1.033	-.016	.042
3			3	.99	-.016	.085
4			4	.948	-.016	.127
5			5	.905	-.016	.169
6	1	M2	1	1.372	.003	0

Member Section Forces (Continued)

	LC	Member Label	Sec	Axial[k]	Shear[k]	Moment[k-ft]
7			2	1.329	.003	-.007
8			3	1.287	.003	-.015
9			4	1.244	.003	-.022
10			5	1.201	.003	-.029
11	1	M3	1	1.906	-.003	0
12			2	1.863	-.003	.008
13			3	1.821	-.003	.016
14			4	1.778	-.003	.025
15			5	1.735	-.003	.033
16	1	M4	1	1.078	.016	0
17			2	1.035	.016	-.043
18			3	.992	.016	-.086
19			4	.95	.016	-.13
20			5	.907	.016	-.173
21	1	M5	1	.016	.365	.169
22			2	.016	.152	-.267
23			3	.016	-.061	-.343
24			4	.016	-.274	-.06
25			5	.016	-.487	.583
26	1	M6	1	.013	.444	.554
27			2	.013	.223	-.03
28			3	.013	.002	-.227
29			4	.013	-.219	-.037
30			5	.013	-.44	.54
31	1	M7	1	.016	.485	.572
32			2	.016	.272	-.067
33			3	.016	.059	-.346
34			4	.016	-.154	-.267
35			5	.016	-.367	.173
36	2	M1	1	.295	.097	0
37			2	.252	.097	-.255
38			3	.209	.097	-.51
39			4	.167	.097	-.764
40			5	.124	.097	-1.019
41	2	M2	1	.908	.129	0
42			2	.865	.129	-.339
43			3	.822	.129	-.678
44			4	.78	.129	-1.017
45			5	.737	.129	-1.356
46	2	M3	1	.654	.127	0
47			2	.611	.127	-.333
48			3	.569	.127	-.667
49			4	.526	.127	-1
50			5	.483	.127	-1.333
51	2	M4	1	.855	.109	0
52			2	.812	.109	-.286
53			3	.77	.109	-.572
54			4	.727	.109	-.858
55			5	.684	.109	-1.145
56	2	M5	1	.129	-.146	-1.019
57			2	.129	-.224	-.707
58			3	.129	-.302	-.263
59			4	.129	-.38	.313
60			5	.129	-.458	1.02
61	2	M6	1	.004	.009	-.336
62			2	.004	-.072	-.28
63			3	.004	-.153	-.083

Member Section Forces (Continued)

	LC	Member Label	Sec	Axial[k]	Shear[k]	Moment[k-ft]
64			4	.004	-.234	.256
65			5	.004	-.315	.736
66	2	M7	1	-.12	-.102	-.597
67			2	-.12	-.18	-.359
68			3	-.12	-.258	.01
69			4	-.12	-.336	.512
70			5	-.12	-.414	1.145
71	3	M1	1	.248	.114	0
72			2	.205	.114	-.3
73			3	.163	.114	-.6
74			4	.12	.114	-.9
75			5	.077	.114	-1.2
76	3	M2	1	.929	.15	0
77			2	.886	.15	-.395
78			3	.844	.15	-.79
79			4	.801	.15	-1.185
80			5	.758	.15	-1.58
81	3	M3	1	.633	.148	0
82			2	.59	.148	-.389
83			3	.547	.148	-.779
84			4	.505	.148	-1.168
85			5	.462	.148	-1.557
86	3	M4	1	.902	.126	0
87			2	.859	.126	-.331
88			3	.816	.126	-.662
89			4	.774	.126	-.994
90			5	.731	.126	-1.325
91	3	M5	1	.149	-.193	-1.2
92			2	.149	-.271	-.808
93			3	.149	-.349	-.286
94			4	.149	-.427	.369
95			5	.149	-.505	1.155
96	3	M6	1	.004	-.017	-.425
97			2	.004	-.098	-.325
98			3	.004	-.179	-.083
99			4	.004	-.26	.3
100			5	.004	-.341	.826
101	3	M7	1	-.141	-.149	-.732
102			2	-.141	-.227	-.415
103			3	-.141	-.305	.033
104			4	-.141	-.383	.613
105			5	-.141	-.461	1.325
106	4	M1	1	.118	.075	0
107			2	.075	.075	-.197
108			3	.032	.075	-.395
109			4	-.01	.075	-.592
110			5	-.053	.075	-.79
111	4	M2	1	.579	.095	0
112			2	.536	.095	-.249
113			3	.494	.095	-.498
114			4	.451	.095	-.747
115			5	.408	.095	-.995
116	4	M3	1	.125	.095	0
117			2	.082	.095	-.248
118			3	.039	.095	-.496
119			4	-.003	.095	-.744
120			5	-.046	.095	-.992

Member Section Forces (Continued)

	LC	Member Label	Sec	Axial[k]	Shear[k]	Moment[k-ft]
121	4	M4	1	.53	.077	0
122			2	.488	.077	-.202
123			3	.445	.077	-.403
124			4	.402	.077	-.605
125			5	.359	.077	-.807
126	4	M5	1	.094	-.188	-.79
127			2	.094	-.199	-.463
128			3	.094	-.209	-.119
129			4	.094	-.22	.243
130			5	.094	-.23	.623
131	4	M6	1	0	-.092	-.372
132			2	0	-.103	-.201
133			3	0	-.114	-.011
134			4	0	-.125	.198
135			5	0	-.136	.427
136	4	M7	1	-.094	-.182	-.566
137			2	-.094	-.193	-.25
138			3	-.094	-.203	.085
139			4	-.094	-.214	.437
140			5	-.094	-.224	.807
141	5	M1	1	.661	.067	0
142			2	.619	.067	-.175
143			3	.576	.067	-.35
144			4	.533	.067	-.525
145			5	.491	.067	-.7
146	5	M2	1	1.233	.1	0
147			2	1.19	.1	-.262
148			3	1.147	.1	-.525
149			4	1.105	.1	-.787
150			5	1.062	.1	-1.05
151	5	M3	1	1.359	.096	0
152			2	1.316	.096	-.251
153			3	1.274	.096	-.502
154			4	1.231	.096	-.753
155			5	1.188	.096	-1.003
156	5	M4	1	1.091	.091	0
157			2	1.048	.091	-.239
158			3	1.005	.091	-.478
159			4	.963	.091	-.717
160			5	.92	.091	-.956
161	5	M5	1	.104	.059	-.7
162			2	.104	-.101	-.665
163			3	.104	-.26	-.361
164			4	.104	-.419	.212
165			5	.104	-.578	1.052
166	5	M6	1	.009	.214	.003
167			2	.009	.049	-.228
168			3	.009	-.116	-.169
169			4	.009	-.281	.178
170			5	.009	-.446	.814
171	5	M7	1	-.082	.148	-.19
172			2	-.082	-.011	-.306
173			3	-.082	-.17	-.154
174			4	-.082	-.329	.267
175			5	-.082	-.488	.956

Joint Reactions

	LC	Joint Label	X [k]	Y [k]	MZ [k-ft]
1	1	N1	.016	1.076	0
2	1	N3	-.003	1.912	0
3	1	N5	.003	1.906	0
4	1	N7	-.016	1.078	0
5	1	Totals:	0	5.972	
6	1	COG (ft):	X: 10.25	Y: 8.95	
7	2	N1	-.096	.295	0
8	2	N3	-.125	.908	0
9	2	N5	-.124	.654	0
10	2	N7	-.105	.855	0
11	2	Totals:	-.45	2.712	
12	2	COG (ft):	X: 10.25	Y: 9.177	
13	3	N1	-.113	.248	0
14	3	N3	-.145	.929	0
15	3	N5	-.145	.633	0
16	3	N7	-.121	.902	0
17	3	Totals:	-.525	2.712	
18	3	COG (ft):	X: 10.25	Y: 9.177	
19	4	N1	-.075	.118	0
20	4	N3	-.093	.309	0
21	4	N5	-.094	.125	0
22	4	N7	-.075	.53	0
23	4	Totals:	-.338	1.082	
24	4	COG (ft):	X: 10.25	Y: 9.805	
25	5	N1	-.064	.661	0
26	5	N3	-.095	1.557	0
27	5	N5	-.091	1.359	0
28	5	N7	-.087	1.091	0
29	5	Totals:	-.338	4.668	
30	5	COG (ft):	X: 10.25	Y: 9.003	

Joint Deflections

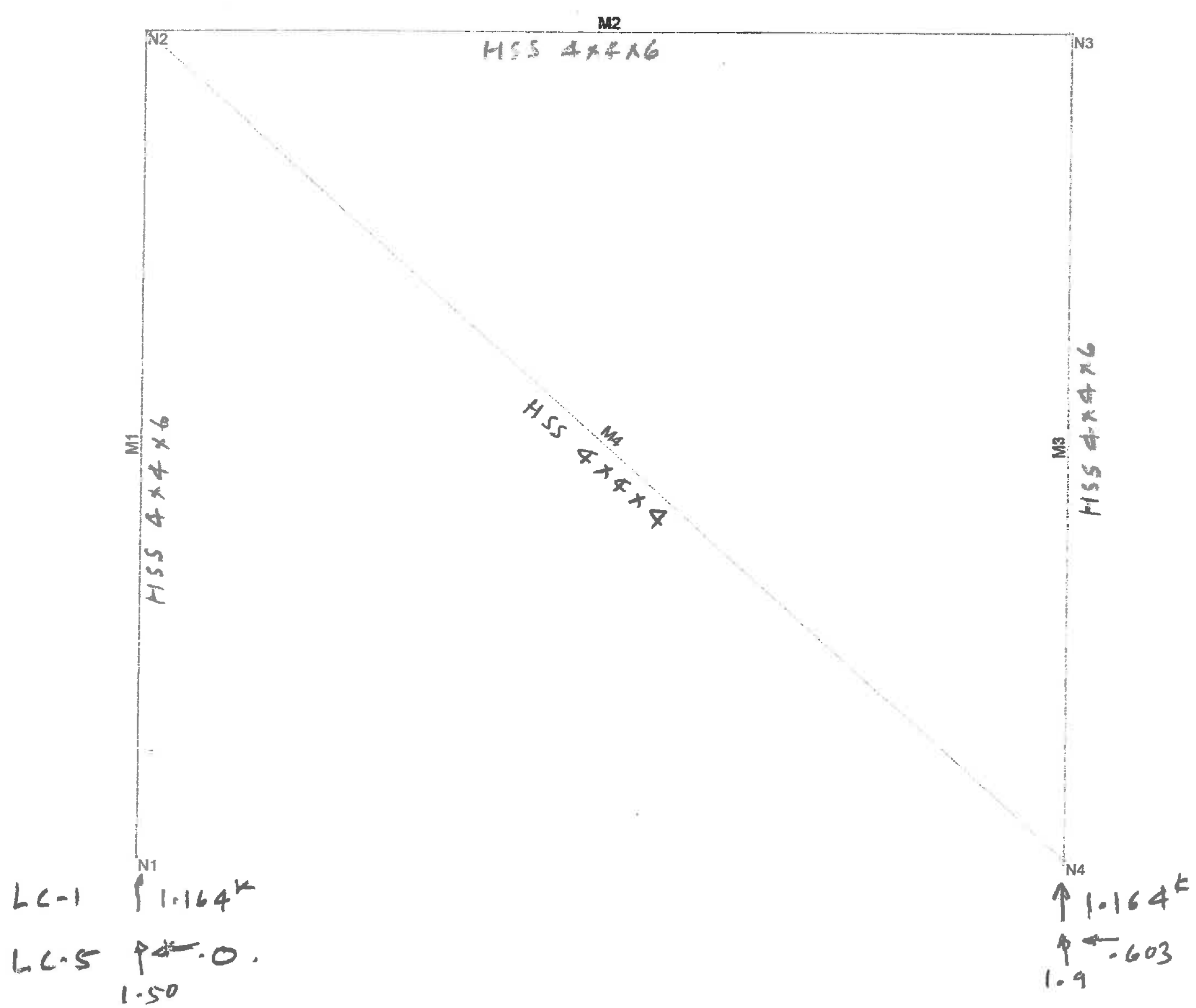
	LC	Joint Label	X [in]	Y [in]	Rotation [rad]
1	1	N1	0	0	1.794e-4
2	1	N2	0	-.001	-3.566e-4
3	1	N3	0	0	-2.942e-5
4	1	N4	0	-.001	6.33e-5
5	1	N5	0	0	3.59e-5
6	1	N6	0	-.002	-6.781e-5
7	1	N7	0	0	-1.8e-4
8	1	N8	0	-.001	3.665e-4
9	2	N1	0	0	-4.292e-3
10	2	N2	.406	0	-1.068e-3
11	2	N3	0	0	-4.645e-3
12	2	N4	.406	0	-3.553e-4
13	2	N5	0	0	-4.622e-3
14	2	N6	.406	0	-4.033e-4
15	2	N7	0	0	-4.424e-3
16	2	N8	.406	0	-8.026e-4
17	3	N1	0	0	-5.018e-3
18	3	N2	.473	0	-1.223e-3
19	3	N3	0	0	-5.418e-3
20	3	N4	.473	0	-4.185e-4
21	3	N5	0	0	-5.394e-3
22	3	N6	.473	0	-4.665e-4

Joint Deflections (Continued)

	LC	Joint Label	X [in]	Y [in]	Rotation [rad]
23	3	N7	0	0	-5.15e-3
24	3	N8	.473	0	-9.585e-4
25	4	N1	0	0	-3.209e-3
26	4	N2	.3	0	-7.11e-4
27	4	N3	0	0	-3.425e-3
28	4	N4	.3	0	-2.757e-4
29	4	N5	0	0	-3.422e-3
30	4	N6	.3	0	-2.822e-4
31	4	N7	0	0	-3.227e-3
32	4	N8	.3	0	-6.751e-4
33	5	N1	0	0	-3.196e-3
34	5	N2	.31	0	-9.816e-4
35	5	N3	0	0	-3.563e-3
36	5	N4	.31	-.001	-2.423e-4
37	5	N5	0	0	-3.515e-3
38	5	N6	.31	-.001	-3.402e-4
39	5	N7	0	0	-3.465e-3
40	5	N8	.31	-.001	-4.417e-4

Member AISC 14th(360-10): ASD Steel Code Checks

	LC	Member	Shape	UC Max	Loc[ft]	Shear UC	Loc[ft]	Pnc/om [k]	Pnt/om [k]	Mn/om [k-ft]	Cb	Eqn
1	1	M1	HSS4x4x6	.017	10.5	.000	0	80.21	131.665	14.668	1.667	H1-1b
2	1	M2	HSS4x4x6	.009	10.5	.000	0	80.21	131.665	14.668	1.667	H1-1b
3	1	M3	HSS4x4x6	.013	10.5	.000	0	80.21	131.665	14.668	1.667	H1-1b
4	1	M4	HSS4x4x6	.017	10.5	.000	0	80.21	131.665	14.668	1.667	H1-1b
5	1	M5	HSS4x4x6	.040	6.75	.014	6.75	107.28	131.665	14.668	1.913	H1-1b
6	1	M6	HSS4x4x6	.038	0	.013	0	105.635	131.665	14.668	2.778	H1-1b
7	1	M7	HSS4x4x6	.039	0	.014	0	107.28	131.665	14.668	1.875	H1-1b
8	2	M1	HSS4x4x6	.070	10.5	.003	0	80.21	131.665	14.668	1.667	H1-1b
9	2	M2	HSS4x4x6	.097	10.5	.004	0	80.21	131.665	14.668	1.667	H1-1b
10	2	M3	HSS4x4x6	.094	10.5	.004	0	80.21	131.665	14.668	1.667	H1-1b
11	2	M4	HSS4x4x6	.082	10.5	.003	0	80.21	131.665	14.668	1.667	H1-1b
12	2	M5	HSS4x4x6	.070	6.75	.013	6.75	107.28	131.665	14.668	1.914	H1-1b
13	2	M6	HSS4x4x6	.050	7	.009	7	105.635	131.665	14.668	2.434	H1-1b
14	2	M7	HSS4x4x6	.078	6.75	.012	6.75	107.28	131.665	14.668	2.594	H1-1b
15	3	M1	HSS4x4x6	.082	10.5	.003	0	80.21	131.665	14.668	1.667	H1-1b
16	3	M2	HSS4x4x6	.112	10.5	.004	0	80.21	131.665	14.668	1.667	H1-1b
17	3	M3	HSS4x4x6	.109	10.5	.004	0	80.21	131.665	14.668	1.667	H1-1b
18	3	M4	HSS4x4x6	.095	10.5	.004	0	80.21	131.665	14.668	1.667	H1-1b
19	3	M5	HSS4x4x6	.082	0	.015	6.75	107.28	131.665	14.668	1.954	H1-1b
20	3	M6	HSS4x4x6	.056	7	.010	7	105.635	131.665	14.668	2.416	H1-1b
21	3	M7	HSS4x4x6	.091	6.75	.014	6.75	107.28	131.665	14.668	2.536	H1-1b
22	4	M1	HSS4x4x6	.054	10.5	.002	0	80.21	131.665	14.668	1.667	H1-1b
23	4	M2	HSS4x4x6	.070	10.5	.003	0	80.21	131.665	14.668	1.667	H1-1b
24	4	M3	HSS4x4x6	.068	10.5	.003	0	80.21	131.665	14.668	1.667	H1-1b
25	4	M4	HSS4x4x6	.057	10.5	.002	0	80.21	131.665	14.668	1.667	H1-1b
26	4	M5	HSS4x4x6	.054	0	.007	6.75	107.28	131.665	14.668	2.16	H1-1b
27	4	M6	HSS4x4x6	.029	7	.004	7	105.635	131.665	14.668	2.309	H1-1b
28	4	M7	HSS4x4x6	.055	6.75	.007	6.75	107.28	131.665	14.668	2.284	H1-1b
29	5	M1	HSS4x4x6	.051	10.5	.002	0	80.21	131.665	14.668	1.667	H1-1b
30	5	M2	HSS4x4x6	.078	10.5	.003	0	80.21	131.665	14.668	1.667	H1-1b
31	5	M3	HSS4x4x6	.076	10.5	.003	0	80.21	131.665	14.668	1.667	H1-1b
32	5	M4	HSS4x4x6	.071	10.5	.003	0	80.21	131.665	14.668	1.667	H1-1b
33	5	M5	HSS4x4x6	.072	6.75	.017	6.75	107.28	131.665	14.668	1.963	H1-1b
34	5	M6	HSS4x4x6	.056	7	.013	7	105.635	131.665	14.668	2.589	H1-1b
35	5	M7	HSS4x4x6	.065	6.75	.014	6.75	107.28	131.665	14.668	2.529	H1-1b



Results for LC 1, dl+ll

E 2	topock switchgear braced frames LINES ① & ④	SK - 1
		July 14, 2014 at 4:21 PM
		topock switchgear braced fr lines 1 ...

Hot Rolled Steel Properties

	Label	E [ksi]	G [ksi]	Nu	Therm (\1E5 F)	Density[k/ft^3]	Yield[ksi]
1	A36 Gr.36	29000	11154	.3	.65	.49	36
2	A572 Gr.50	29000	11154	.3	.65	.49	50
3	A992	29000	11154	.3	.65	.49	50
4	A500 Gr.B RND	29000	11154	.3	.65	.49	42
5	A500 Gr.B Rect	29000	11154	.3	.65	.49	46
6	A53 Gr.B	29000	11154	.3	.65	.49	35

Hot Rolled Steel Section Sets

	Label	Shape	Type	Design List	Material	Design Rules	A [in2]	I (90,270) [i...	I (0,180) [in4]
1	HR1A	HSS4x4x6	Beam	Tube	A500 Gr.B Rect	Typical	4.78	10.3	10.3
2	HR2	HSS4x4x4	HBrace	Wide Flange	A500 Gr.B Rect	Typical	3.37	7.8	7.8

Joint Coordinates and Temperatures

	Label	X [ft]	Y [ft]	Temp [F]
1	N1	0	0	0
2	N2	0	10.5	0
3	N3	11.5	10.5	0
4	N4	11.5	0	0

Joint Boundary Conditions

	Joint Label	X [k/in]	Y [k/in]	Rotation[k-ft/rad]	Footing
1	N1	Reaction	Reaction		
2	N4	Reaction	Reaction		

Member Primary Data

	Label	I Joint	J Joint	Rotate(deg)	Section/Shape	Type	Design List	Material	Design Rules
1	M1	N1	N2		HR1A	Beam	Tube	A500 Gr.B ...	Typical
2	M2	N2	N3		HR1A	Beam	Tube	A500 Gr.B ...	Typical
3	M3	N3	N4		HR1A	Beam	Tube	A500 Gr.B ...	Typical
4	M4	N4	N2		HR2	HBrace	Wide Flange	A500 Gr.B ...	Typical

Joint Loads and Enforced Displacements (BLC 3 : wind horiz)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N2	L	X	.67
2	N3	L	X	.67

Joint Loads and Enforced Displacements (BLC 4 : seismic)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N2	L	X	.35
2	N3	L	X	.35

Member Point Loads (BLC 1 : dl)

	Member Label	Direction	Magnitude[k,k-ft]	Location[ft,%]
1	M2	Y	-.27	3.83
2	M2	Y	-.27	7.67

Member Point Loads (BLC 2 : ll)

	Member Label	Direction	Magnitude[k,k-ft]	Location[ft,%]
1	M2	Y	-.54	3.83
2	M2	Y	-.54	7.67

Basic Load Cases

	BLC Description	Category	X Gravity	Y Gravity	Joint	Point	Distributed
1	dl	None		-1		2	
2	ll	None				2	
3	wind horiz	None			2		
4	seismic	None			2		

Load Combinations

	Description	Solve	PD...	SR...	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor
1	dl+ll	Yes	Y		1	1	2	1												
2	dl+wind horiz	Yes	Y		1	1	3	.6												
3	dl+seismic	Yes	Y		1	1	4	.7												
4	dl+ll+wind ho...	Yes	Y		1	1	3	.45	2	-.5										
5	dl+ll+wind ho...	Yes	Y		1	1	3	.45	2	.6										
~~6~~		~~Yes~~	~~Y~~		~~1~~	~~1~~	~~3~~	~~.45~~	~~2~~	~~.6~~										

Duplicate

Joint Reactions (By Combination)

	LC	Joint Label	X [k]	Y [k]	MZ [k-ft]
1	1	N1	0	1.164	0
2	1	N4	0	1.164	0
3	1	Totals:	0	2.327	
4	1	COG (ft):	X: 5.75	Y: 9.327	
5	2	N1	0	-.111	0
6	2	N4	-.804	1.358	0
7	2	Totals:	-.804	1.247	
8	2	COG (ft):	X: 5.75	Y: 8.31	
9	3	N1	0	.176	0
10	3	N4	-.49	1.071	0
11	3	Totals:	-.49	1.247	
12	3	COG (ft):	X: 5.75	Y: 8.31	
13	4	N1	0	-.197	0
14	4	N4	-.603	.904	0
15	4	Totals:	-.603	.707	
16	4	COG (ft):	X: 5.75	Y: 6.639	
17	5	N1	0	.397	0
18	5	N4	-.603	1.498	0
19	5	Totals:	-.603	1.895	
20	5	COG (ft):	X: 5.75	Y: 9.059	
21	6	N1	0	.397	0
22	6	N4	-.603	1.498	0
23	6	Totals:	-.603	1.895	
24	6	COG (ft):	X: 5.75	Y: 9.059	

Joint Deflections

	LC	Joint Label	X [in]	Y [in]	Rotation [rad]
1	1	N1	0	0	7.103e-6
2	1	N2	0	0	7.103e-6
3	1	N3	0	0	7.103e-6
4	1	N4	0	0	7.103e-6

Joint Deflections (Continued)

	LC	Joint Label	X [in]	Y [in]	Rotation [rad]
5	2	N1	0	0	-2.366e-5
6	2	N2	.003	0	-2.366e-5
7	2	N3	.003	0	-2.684e-5
8	2	N4	0	0	-2.684e-5
9	3	N1	0	0	-1.304e-5
10	3	N2	.002	0	-1.304e-5
11	3	N3	.002	0	-1.497e-5
12	3	N4	0	0	-1.497e-5
13	4	N1	0	0	-1.864e-5
14	4	N2	.002	0	-1.864e-5
15	4	N3	.003	0	-2.102e-5
16	4	N4	0	0	-2.102e-5
17	5	N1	0	0	-1.473e-5
18	5	N2	.002	0	-1.473e-5
19	5	N3	.002	0	-1.711e-5
20	5	N4	0	0	-1.711e-5
21	6	N1	0	0	-1.473e-5
22	6	N2	.002	0	-1.473e-5
23	6	N3	.002	0	-1.711e-5
24	6	N4	0	0	-1.711e-5

Member AISC 14th(360-10): ASD Steel Code Checks (By Combination)

	LC	Member	Shape	UC Max	Loc[ft]	Shear UC	Loc[ft]	Pnc/om [k]	Pnt/om [k]	Mn/om [k-ft]	Cb	Eqn
1	1	M1	HSS4x4x6	.007	0	.000	0	80.21	131.665	14.668	1	H1-1b
2	1	M2	HSS4x4x6	.230	5.75	.027	0	72.657	131.665	14.668	1.136	H1-1b
3	1	M3	HSS4x4x6	.007	10.5	.000	0	80.21	131.665	14.668	1	H1-1b
4	1	M4	HSS4x4x4	.024	7.624	.003	15.572	33.574	92.826	10.765	1.136	H1-1b
5	2	M1	HSS4x4x6	.001	10.5	.000	0	80.21	131.665	14.668	1	H1-1b
6	2	M2	HSS4x4x6	.090	5.75	.011	0	72.657	131.665	14.668	1.136	H1-1b
7	2	M3	HSS4x4x6	.003	10.5	.000	0	80.21	131.665	14.668	1	H1-1b
8	2	M4	HSS4x4x4	.040	7.624	.003	15.572	33.574	92.826	10.765	1.136	H1-1b
9	3	M1	HSS4x4x6	.001	0	.000	0	80.21	131.665	14.668	1	H1-1b
10	3	M2	HSS4x4x6	.090	5.75	.011	0	72.657	131.665	14.668	1.136	H1-1b
11	3	M3	HSS4x4x6	.003	10.5	.000	0	80.21	131.665	14.668	1	H1-1b
12	3	M4	HSS4x4x4	.034	7.624	.003	15.572	33.574	92.826	10.765	1.136	H1-1b
13	4	M1	HSS4x4x6	.001	10.5	.000	0	80.21	131.665	14.668	1	H1-1b
14	4	M2	HSS4x4x6	.019	5.75	.003	0	72.657	131.665	14.668	1.136	H1-1b
15	4	M3	HSS4x4x6	.002	10.5	.000	0	80.21	131.665	14.668	1	H1-1b
16	4	M4	HSS4x4x4	.036	7.624	.003	15.572	33.574	92.826	10.765	1.136	H1-1b
17	5	M1	HSS4x4x6	.002	0	.000	0	80.21	131.665	14.668	1	H1-1b
18	5	M2	HSS4x4x6	.175	5.75	.020	0	72.657	131.665	14.668	1.136	H1-1b
19	5	M3	HSS4x4x6	.005	10.5	.000	0	80.21	131.665	14.668	1	H1-1b
20	5	M4	HSS4x4x4	.036	7.624	.003	15.572	33.574	92.826	10.765	1.136	H1-1b
21	6	M1	HSS4x4x6	.002	0	.000	0	80.21	131.665	14.668	1	H1-1b
22	6	M2	HSS4x4x6	.175	5.75	.020	0	72.657	131.665	14.668	1.136	H1-1b
23	6	M3	HSS4x4x6	.005	10.5	.000	0	80.21	131.665	14.668	1	H1-1b
24	6	M4	HSS4x4x4	.036	7.624	.003	15.572	33.574	92.826	10.765	1.136	H1-1b

TAB NO. 3

*1. FUTURE FRESH WATER PRE-INJECTION TREATMENT SYSTEM BUILDING.

*2. OUTDOOR CHEMICAL STORAGE AREA

3. Remedy Freshwater Storage Tank (10,000 gal.).

*4. BACKWASH TANK

*5. Treated Water Tank

* 60% Design Level.

ENDIX A - CALCULATION COVER SHEET

CALCULATION ID NUMBER	
REVISION NUMBER	
JOB NUMBER	~~WW PGE 2174~~

TITLE	Topock Fresh Water Treatment System Bldg.

Pg. No.	CONTENT
1	General & Data
2	Lateral Loads
3,4	Moment Frame & Braced Frame
5,6,7	Treatment Vessel Tank Design
8	Foundation for TFWB (Topock Fresh Water Bldg.)
Appendix	A-1 (Moment Frame) 5 pages
Appendix	A-2 (Braced Frame) 6 pages
Appendix	A-3 Data for Vessel tank / Filteration Equip

	initial	date
PREPARED	KD	5/07/14
TITLE		
REVIEWED		
TITLE		

REVISION NOTES	

Engineers, Inc.
400 Powell Street, Suite 250
Emeryville, CA 94608

Designed By:	KD	Date:	4/23/14
Checked By:	KJ	Date:	6/27/14
Reviewed By:		Date:	
No.	WW-P&E-2174	Sheet No.	1

Description: Topock Fresh Water Treatment System Bldg

Reference:

GENERAL

References

1. AWAA Standard D-100-11 For tank Design
2. CBC 2010
3. ASCE 7-10 For Seismic, Wind, Loads etc.
4. ACI 318-11 Conc. Design

Seismic Data

$S_S = .23$ $S_{MS} = 1.6 \times .23 = .368$ USE .37

$S_1 = .12$ $S_{M1} = F_v S_1 = 2.318 \times .12 = .279$ USE .28

$S_{DS} = .247$ $S_{D1} = .187$

Wind - 20 PSF

Soil Bearing = 4000 PSF

Conc. Data

$f_c' = 5.0$ KSI $f_y = 60$ KSI

Floor Loads

DL - 5" Conc Slab + Deck + Misc.	=	75 PSF
Piping	=	25
Σ DL	=	100 PSF
LL	=	100
TL	=	200 PSF

Roof Loads

DL - Deck + FRMG.	=	6
LL	=	20
TL		26 PSF

Tank Data

See APPENDIX A-3

Equipment on 2nd Flr.

See Appendix A-3

Engineers, Inc. 00 Powell Street, Suite 250 Emeryville, CA 94608	Designed By: KD	Date: 4/24/14	
	Checked By: KJ	Date: 6/27/14	
	Reviewed By:	Date:	
No. WN-PGE-2174		Sheet No. 2	
Project Description: Topock Fresh Water treatment system Bldg.			

Reference:

Seismic Loads

Using Equivalent Lateral Procedure

Sect. 12.8 Ref-3 — $V = C_s W$ $I = 1.25$ $R = 3.5$ (Ordinary Mom. Fr.'s) $R = 3.25$ (Braced Frames)

NS Dir. Mom. Fr.'s — $W = (.006 \times 14.5 \times 32.5 + .085 \times 14.5 \times 28.5) \times 1.05 = (2.83 + 35.13) \times 1.05 = 39.85^k$ USE 40^k

EW Dir. Br. Fr.'s — $W = (.006 \times 47 \times 32.5 + .085 \times 45 \times 28.5) \times 1.05 = (9.17 + 109.0) \times 1.05 = 124.1^k$ USE 124^k

$C_s = \frac{S_{DS}}{(R/I)} = \frac{.247}{(3.5/1.25)} = .088$ $C_{s\,max} = \frac{.5 S_{D1}}{T(R/I)}$

Table 12-8.2, Sect 12.8.2.1 Ref-3 — $T_{NS} = C_t h_n^x = .028 \times (28)^{.8} = .403$ $T_{EW} = .02 (28)^{.75} = .243$ sec.

$C_{s\,max}$ Br. Fr. $= \frac{.5 \times .187}{.243 \times 2.6} = .148 > .088$ $C_{s\,max}$ Mom. Fr. $= \frac{.5 \times .187}{.403 \times 2.8} = .083$ USE .088 ok

$V_{NS} = .088 \times 40 = 3.52^k$ (Mom. Fr.'s) $V_{EW} = \frac{.247}{(3.25/1.25)} \times W = .095 \times 124 = 11.8^k$ (Br. Fr.'s) USE 12^k

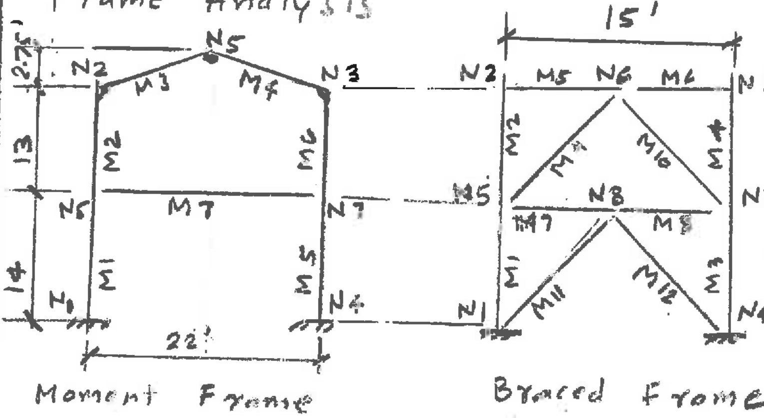
Wind Loads

NS Dir. — $V_{NS} = .01 (9.25) \times 14.5 + .01 (6.5) \times 14.5 = 2.28^k$ USE $2.5^k < 3^k$

EW Dir. — $V_{EW} = .01 (8.0) \times 26 + .01 (6.5) \times 26 = 3.77^k$ USE $4.0^k < 5^k$

Seismic Loads are higher, design for several combinations.

Sect. 12.8.3 — Frame Analysis



Distribute Seismic Force

$C_{vx} = (w_x h_x^k) / \sum_{i=1}^{n} w_i h_i^k$ $K = 1$

$= (2.83 \times 28) / 2.83 \times 28 + 35.13 \times 14$

$= .139$

Roof NS Dir — $V_R = .139 \times 3.52 = .49^k$ Say .50

$V_F = 3.52 - .5 = 3.02^k$

Wind N-S — $V_r = 1.5^k$ $V_f = 1^k$

Wind EW — $V_r = 2.4^k$ $V_f = 1.6^k$

g Engineers, Inc. 1900 Powell Street, Suite 250 Emeryville, CA 94608	Designed By:	KD	Date: 4/28/14
	Checked By:	KJ	Date: 4/27/14
	Reviewed By:		Date:
ct No. WW-PGE-2174			Sheet No. 3
ect Description:	Topock Fresh Water Treatment System Bldg.		

Reference:

<u>Second Floor Loads on Moment Fr. member</u>

B-1 ($l = 12'$)

$\omega_{TL} = (.10 \times 4.33 + .10 \times 4.33) = .433 + .433 = .866^{k/}$

$R = 5.20^k$

B-1A ($l = 7.0$)

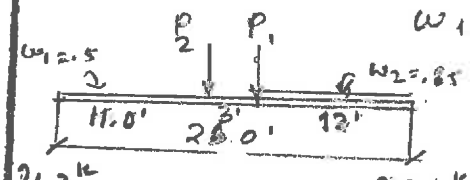
$\omega_{TL} = .1 \times 5 + .1 \times 5 = 1.0^{k/}$ $R = 1 \times 3.5 = 3.5^k$

B-1B ($l = 3.0$) $\omega_{TL} = .866^{k/}$ $R = 1.3^k$

B-1C ($l = 11.0$) $\omega_{TL} = .1 \times 3 + .1 \times 3 = .6^{k/}$ $R = 3.3^k$

B-3 ($l = 26'$) $\omega_2 = .1 \times 4.25 + .1 \times 4.25 = .85^{k/}$

$\omega_1 = .1 \times 2.5 + .1 \times 2.5 = .50^{k/}$



$P_1 = 9.75 \times 2 = 19.5^k$ (B-2) $P_2 = 5.6^k \times 2 = 11.2^k$ (B-2A)

$R_L \times 26 = .85 \times 12 \times 6 + 19.5 \times 12 + 11.2 \times 13 + .5 \times 11 \times 20.5$

$R_L = 21.3^k$ $R_R = 46.4 - 21.3 = 25.1^k$

$F_y = 50^{ksi}$

W 16x57 $M_R = 254^{1k}$) 165.5^{1k}

$M_{max} = 25.1 \times 12 - .85 \times 12^2 \times .5 = 240^{1k}$

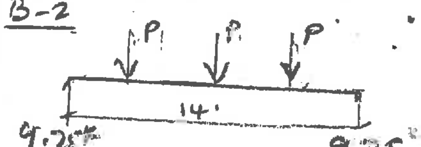
$\Delta_{TL} = \frac{5}{384} \times \frac{2.84 \times 26^4}{29000 \times 954} \times 1728 = .605'' ok$

$\omega_{eq.} = \frac{240 \times 8}{26^2} = 2.84^{k/}$ USE $\omega_{DL} = 1.30 \times .85 = 1.3^{k/}$, $\omega_{LL} = 1.45$

Adustment for piping loads 10PSF

See computer printout for deflections (App A-1)

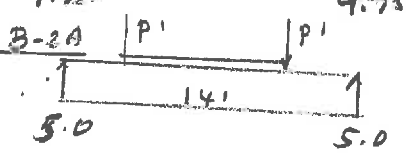
B-2



$P = 5.20^k$ (B-1) $+ 1.3$ (B-1B) $= 6.50^k$

$R = .5 \times 6.50 \times 3 = 9.75^k$

B-2A



$P' = 3.3$ (B-1C) $+ 1.3$ (B-1B) $= 4.7^k$

$\omega = .075 \times 1.5 + .075 \times 1.5 = .225^{k/}$

$R = 4 + .225 \times 9.4 \times .5 = 5.6^k$

Note: This page Calc's are done to Substantiate the floor loads used in computer analysis of moment frame.

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Project No.	WW-PGE-2174	Sheet No.	4

Project Description: Topock Fresh Water Treatment Bldg.

Reference:

Moment Frame Load combinations (See computer printout) NS' DIR APPENDIX A-1

Basic Loads:

DL
Roof
Memb's M3 & M4
$.006 \times 14.5 = .087^{k/'}$ USE $.1^{k/'}$

FLOOR
Memb. M7
See Note pg. 3 USE DL = $1.0^{k/'}$

LL
Memb's M3 & M4
$.02 \times 14.5 = .29^{k/'}$

Memb. M7
$.1 \times 14.5 = 1.45^{k/'}$

Seismic Loads (See page 2)
P_S JT. N2 & N3 $= \frac{.44}{2} = .22^k$
P_S JT. N6 & N7 $= \frac{2.56}{2} = 1.28^k$

Wind Loads
P_W JT. N2 & $N_3 = \frac{1.5}{2} = .75^k$
P_W JT N_6 & $N_7 = \frac{1}{2} = .5^k$

Braced Frames IN EW DIR (See Computer output Appendix A-2)

Roof

DL
Memb's. M5, M6
$.006 \times 6.25 + .04 = .08^{k/'}$

LL ↓ $.02 \times 6.25 = .125^{k/'}$
↑ $.01 \times 6.25 = .063$

Floor
Memb's M7, M8
$.085 \times 7.25 = .62^{k/'}$
$.10 \times 7.25 = .725^{k/'}$

Seismic
P_S JT. N2, N3 $= \frac{.14 \times 6}{2} = .42^k$
P_S JT. N5, N7 $= \frac{.86 \times 6}{2} = 2.58^k$

Wind
P_W JT. N2, N3 $= \frac{.6 \times 4.0}{2} = 1.20^k$
P_W JT N5, N7 $= \frac{.4 \times 4.0}{2} = .80^k$

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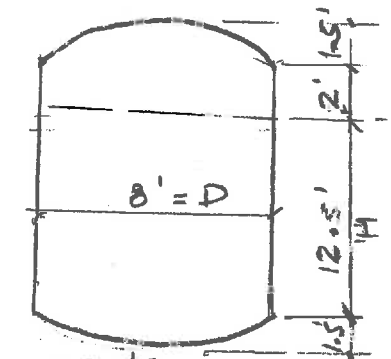
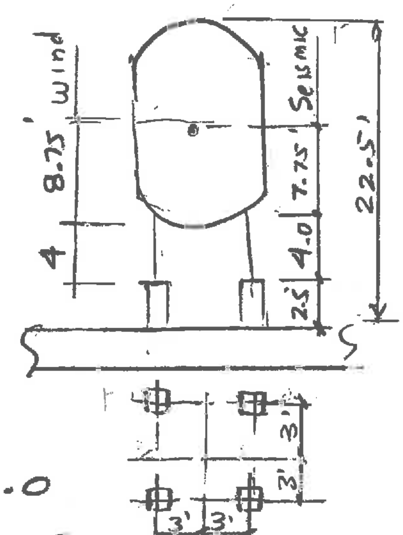
Project No. WW-PGE-2174			Sheet No.
Project Description:	Topock Freshwater Treatment Bldg / Treatment vessel tank		

Reference: Seismic Loads





Impulsive Components

$A_i = \frac{S_{ai} I_E}{1.4 \times R_I}$ $I_E = 1.25$ $R_I = 3.0$

For $T_1 < T_s$ $S_{ai} = S_{DS}$

$= \frac{.247 \times 1.25}{1.4 \times 3.0} = .074$ $T_1 = C_t h_n^x = .02 \times 17^{.75} = .167 < .757$

Impulsive   USE $A_i = .074\ g$ $T_S = \frac{.187}{.247} = .757$ $T_L = 12$ sec.

Eq. 13-16 $A_{i\,min.} = \frac{.36 \times .12 \times 1.25}{3.0} = .018$

$V_i = A_i (W_s + W_r + W_f + W_i)$

W_T = wt. of contents $= 49 HD^2 = 49 \times 13.5 \times 8^2 \times 10^{-3} = 42.34^k$

wt. of Tank shell $= \frac{\pi}{4}(8.03125^2 - 8.0^2) \times 14.5 \times .49 + \pi \times 8 \times .03125 \times .49 \times 2$

$= 3.56 + .78 = 4.33^k$

Total Wt. $= 42.34 + 4.33 = 46.67^k$ USE 47^k

$V_i = .074 \times 47 = 3.48^k$

Convective $A_c = \frac{S_{ac} I_E}{1.4 R_I} =$ $I_E = 1.25$ $R_I = 1.5$ $S_{ac} = \frac{1.5 \times .187}{T_c}$

Eq. 13-18

$T_c = 2\pi \sqrt{\frac{8}{3.68\ g \tanh\left(\frac{3.68 \times 14}{8}\right) 6.44}} = 2\pi \sqrt{\frac{8}{3.68 \times 32.2 \times .9999}} = 1.633$

$S_{ac} = \frac{1.5 \times .187}{1.633} = .172$ $A_c = \frac{.172 \times 1.25}{1.4 \times 1.5} = .1024$

$V = .1024 \times 47 = 4.81^k$ USE $A_c = .1024\ g$

$M = .1024\,(42.34 \times 11.75 + 4.66 \times 12) = (497.5 + 55.9) \times .1024 = 56.67^{\prime k}$ (water, shell)

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Project No.			Sheet No. 6
Project Description:	Topock Freshwater Treatment Bldg / Treatment Vessel Tank		

Reference:

Calculate Uplift on bolts (DL + Water + Seismic) Tank Full

Design $M_{OTM} = 1.5 \times 56.67 + 1.5 \times 4.81 \times 2 = 99.44^{1k}$ @ FTG.

Resisting $M_{RM} = 46.67 \times 5.5 = 256.7^{1k}$ @ FTG. F.S. $= \frac{256.7}{99.44} = 2.58 > 1.5$ ok

No tension in Bolts, Design only for shear

$V_{MAX} = \frac{5^k}{4} = 1.25^k$ $P_{MAX} = \frac{47}{4} = 11.75^k$ / PIER

Base Pl.

$p = \frac{11.75}{12 \times 12} = .082^{ksi}$ $M = \frac{.082 \times 6^2}{2} = 1.48^{1k}$

Try ¾" Pl. $S = \frac{1}{6} \times 1" \times .75^2 = .09375$

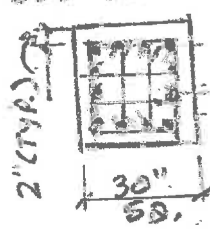
$f_b = \frac{1.48}{.09375} = 15.79^{ksi} < 27^{ksi}$ OK

PIER OR PEDESTAL

$M = 56.67^{1k}$ $P = 47^k$

Max P / PEDSTAL (comp.) $= \frac{47}{4} + \frac{56.67}{6 \times 2}$ (PED.) $= 11.75 + 4.75 = 16.5^k$ / PED. USE 20^k (w conc. PED WT.)

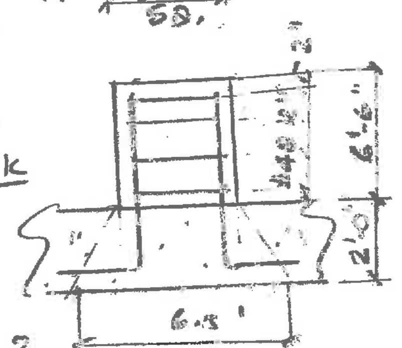
30"x30" PEDISTALS W/ 12-#6 BARS



M/PED. $= \frac{5}{4} \times 6.5 \times 1.7 = 13.81^{1k}$

30"x30" SQ. x 6'-6" High PEDESTAL W/ 12-#6 BARS W/ #4 TIES @ 12" o/c

Ten. $T = \frac{13.81 \times 12}{4 \times 24"} = 1.73^k$ / BAR #6 BARS ok



w/ DL + LL + Seismic

f_p (soil press) $= \frac{P}{A} + \frac{M}{S}$ $P = 16.5 + .15 \times 2.5^2 \times 2.5 = 18.84^k$ USE 20^k

$M_o = 99.5^{1k}$ $S = \frac{1}{6} \times 6.5 \times 5.5^2 = 38.73\ ft^3$

Since Ftg is very large, Tributary

$f_p = \frac{20}{6.5 \times 5.5} + \frac{99.5 \times .5}{38.73} = .47 + 1.28 = 1.75\ ksf < 4\ ksf$ ok

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Project No.			Sheet No. 7
Project Description:	Topock FWTB/Treatment Vessel Tank		

Reference:

Wind Loads (Check w/ Tank Empty)

G = 1.0 Wind Vel. = 100 mph $q_z = .00256 \times 1.09 \times 1.15 \times 100^2 = 32$ PSF

$P_W = q_z G C_f = 32 \times 1 \times .6 = 19.2$ PSF USE $P_W = 20$ PSF

$P_W = .02 \times 8 \times 17.5 = 2.8^k$ $M_{max} = 2.8 \times 12.75 = 35.7'^k$ (Morm)

$P_{DL} = 4.33^k$ Resisting $M = 4.33 \times 2.91 = 12.6'^k$

$P_u = \frac{35.7 \times 1.5 - 12.6}{5.82 \times 2} = 3.52^k$ $V/PED. = \frac{2.8}{4} = .7^k$

(@ Bolt w/ 2 PED's)

$= \frac{35.7 \times 1.5 - 12.6}{(5.82/.707)} = 4.97^k$

1" ϕ A.B. $T_{ALL} = 10.9^k$ P_u (@ Bolt w/ single PED. acting)

(Emb. = 12") $V_{ALL} = 5.7^k$

$\frac{T}{T_{ALL}} + \frac{V}{V_{ALL}} = \frac{4.97}{10.9} + \frac{1.4}{5.7} = .70 < 1.33$ ok

$M/PED = .7 \times 0.5 \times 1.7 + \frac{35.7}{2} \times 1.7 = 38.1'^k$

$f_p = \frac{P}{A} + \frac{M}{S} =$ $P_{DL} = 4.33 + .15 \times 2.5^2 \times 2.5 = 6.67^k$ USE 7^k

$M = 38.1'^k$

$S = 1/6 \times 5.5 \times 6.5^2 = 38.73$ ft³

$= \frac{7 \times 1.4}{6.5 \times 5.5} + \frac{38.1}{38.73}$

$= .274 + .984 = 1.26$ KSF

Dowels in Pedestal

Ten $T = \frac{38.10}{4 \times 24} \times 12 = 4.76^k$ $T_A = .9 \times 60 \times .44 = 23.76^k$ ok

Footing Reinf.

@ Face of Ped. $M_{u\,DL+Seis.} = 1.75 \times \frac{2.5^2}{2} = 5.47'^k$ Try #5 @ 12" Ea. way @ T & B

$M_{u\,DL+wind} = 1.26 \times \frac{2.5^2}{2} = 3.94'^k$ $d = 24 - 2.5 = 21.5"$

$\phi M_n = .9 \times .31 \times \frac{60}{12}(21.5 - \frac{a}{2})$ $a = \frac{.31 \times 60}{.85 \times 5 \times 12} = .365$

$= 29.73'^k > 3.94'^k$

Wind + DL: Mu betw'n pedestals $= 1.26 \times \frac{6^2}{10} = 4.54'^k < 29.73'^k$

USE #5 @ 12" Ea. way @ T & B w/ Mat Ftg.

Seismic + DL: $M_u = \frac{1.75 \times 6^2}{10} = 6.3'^k < 29.73'^k$

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Project No.		**Sheet No.**	8

Project Description: Topock FWTB Foundation

Reference:

1. Foundation for columns
2. foundation for All FWTB Tanks
3. Foundation for Retaining Wall.
4. Base pl. & Anchor Bolts

1 Footings columns

Max $P = 10.69 + 38.78 = 49.47^k$ USE 50^k
(Br. Fr. / Mom. Fr)

$A_{FTG\ REQ.} = \frac{50}{4.0} = 12.5\ ft^2 \quad b_r = \sqrt{12.5} = 3.53'$ min.

USE 4'-0 SQ. FTG. W/ 5-#4 Ea. Way
ON COL. Line A (Remedy Bldg) USE 9'-0" W x cont. Mat. Fdn. ok by insp.

2 & 3 Footing for Tanks & Columns & Retaining Wall

Combine all Footings to provide Mat Foundation

Total DL + LL on Mat FDN. = 2 × 50 (Int. col.) + 2 × (25 + 10) (Ext. col.) + 3 × 47 (Tanks) + 15 (FTG) = 326^k

$p = \frac{326 \times 1.10}{11 \times 48} = .68^{ksf} < 4.0^{ksf}$ (1.10 For Soil + misc.)

Retaining Wall Ftg. adjacent to Mat Ftg. & to be made continuous with Mat Ftg.

Rebars in Mat Ftg.

Min. A_s on top & Bot. together in both dir. = .01 × 24 × 12 = 2.88 in^2/1 Mat

USE #8 @ 12" Ea. Way @ T & B $\quad A_{sa} = .79 \times 4 = 3.16\ in^2 > 2.88\ in^2$

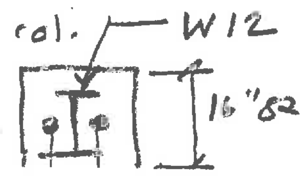
4 Base pl. & A.B.'s

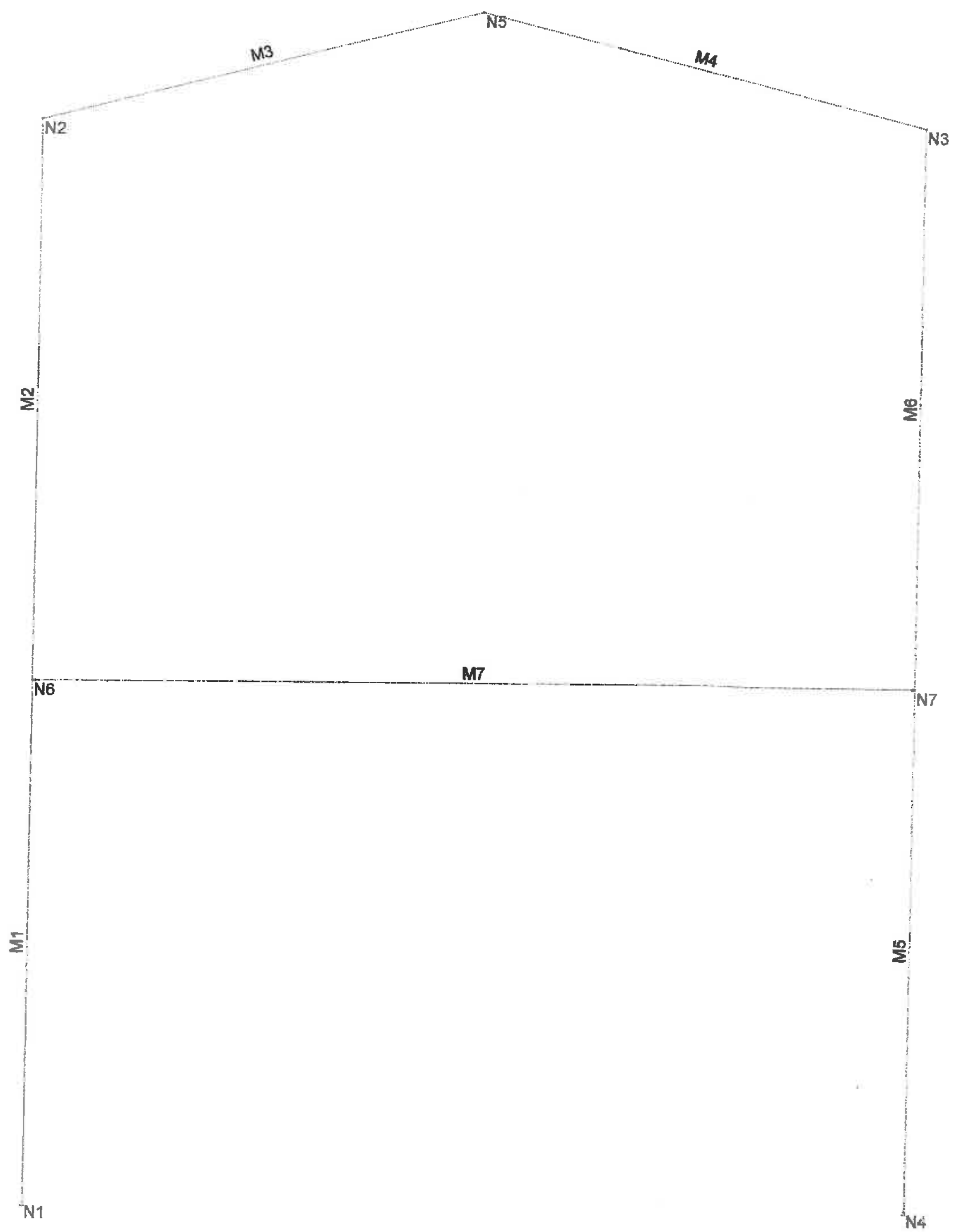
Max. comp.'n $P = 38.8^k \quad f_p = \frac{39}{16 \times 16} = .152^{ksi} \quad t_r = 2 \times 4 \sqrt{\frac{.152}{36}} = .52''$

USE 16"×16"×3/4" Base pl. Try 2-1"φ A.B.'s

Max shear $V = 1.4^k$ (dl + seismic) No uplift on col.

2-1"φ A.B.'s A-307 ok by insp. Emb = 15"





Results for LC 1, dl+wind

e2	topock ~~electrical panel canopy~~ frwb mom. fr.	SK - 2
kd		Apr 27, 2014 at 7:44 PM
ww-peg-2174-043062		topocfwtb.momfrA.r2d

Hot Rolled Steel Properties

	Label	E [ksi]	G [ksi]	Nu	Therm (\1E5 F)	Density[k/ft^3]	Yield[ksi]
1	A36 Gr.36	29000	11154	.3	.65	.49	36
2	A572 Gr.50	29000	11154	.3	.65	.49	50
3	A992	29000	11154	.3	.65	.49	50
4	A500 Gr.42	29000	11154	.3	.65	.49	42
5	A500 Gr.46	29000	11154	.3	.65	.49	46

Hot Rolled Steel Section Sets

	Label	Shape	Type	Design List	Material	Design Rules	A [in2]	I (90,270) [i...	I (0,180) [in4]
1	HR1A	W12x53	Beam	Wide Flange	A572 Gr.50	Typical	15.6	95.8	425
2	HR2	W16x67	Beam	Wide Flange	A572 Gr.50	Typical	19.6	119	954

Joint Coordinates and Temperatures

	Label	X [ft]	Y [ft]	Temp [F]
1	N1	0	0	0
2	N2	0	27	0
3	N3	26	27	0
4	N4	26	0	0
5	N5	13	29.75	0
6	N6	0	13	0
7	N7	26	13	0

Joint Boundary Conditions

	Joint Label	X [k/in]	Y [k/in]	Rotation[k-ft/rad]	Footing
1	N1	Reaction	Reaction		
2	N4	Reaction	Reaction		

Member Primary Data

	Label	I Joint	J Joint	Rotate(deg)	Section/Shape	Type	Design List	Material	Design Rules
1	M1	N1	N6		HR1A	Beam	Wide Flange	A572 Gr.50	Typical
2	M2	N6	N2		HR1A	Beam	Wide Flange	A572 Gr.50	Typical
3	M3	N2	N5		HR1A	Beam	Wide Flange	A572 Gr.50	Typical
4	M4	N5	N3		HR1A	Beam	Wide Flange	A572 Gr.50	Typical
5	M5	N4	N7		HR1A	Beam	Wide Flange	A572 Gr.50	Typical
6	M6	N7	N3		HR1A	Beam	Wide Flange	A572 Gr.50	Typical
7	M7	N6	N7		HR2	Beam	Wide Flange	A572 Gr.50	Typical

Joint Loads and Enforced Displacements (BLC 4 : wind horiz)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N2	L	X	.75
2	N3	L	X	.75
3	N6	L	X	.5
4	N7	L	X	.5

Joint Loads and Enforced Displacements (BLC 5 : seismic)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N2	L	X	.25
2	N3	L	X	.25
3	N6	L	X	1.51
4	N7	L	X	1.51

Member Distributed Loads (BLC 1 : dl)

	Member Label	Direction	Start Magnitude[k/ft,F]	End Magnitude[k/ft,F]	Start Location[ft,%]	End Location[ft,%]
1	M4	Y	-.1	-.1	0	13.4
2	M3	Y	-.1	-.1	0	13.4
3	M7	Y	-1.2	-1.2	0	26

Member Distributed Loads (BLC 2 : ll wind down)

	Member Label	Direction	Start Magnitude[k/ft,F]	End Magnitude[k/ft,F]	Start Location[ft,%]	End Location[ft,%]
1	M3	Y	-.29	-.29	0	13.4
2	M4	Y	-.29	-.29	0	13.4

Member Distributed Loads (BLC 3 : ll wind up)

	Member Label	Direction	Start Magnitude[k/ft,F]	End Magnitude[k/ft,F]	Start Location[ft,%]	End Location[ft,%]
1	M3	Y	-.145	-.145	0	13.4
2	M4	Y	-.145	-.145	0	13.4

Member Distributed Loads (BLC 6 : ii flr)

	Member Label	Direction	Start Magnitude[k/ft,F]	End Magnitude[k/ft,F]	Start Location[ft,%]	End Location[ft,%]
1	M7	Y	-1.45	-1.45	0	26

Basic Load Cases

	BLC Description	Category	X Gravity	Y Gravity	Joint	Point	Distributed
1	dl	None		-1			3
2	ll wind down	None					2
3	ll wind up	None					2
4	wind horiz	None			4		
5	seismic	None			4		
6	ll flr	None					1

Load Combinations

	Description	Solve	PD...	SR...	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor
1	dl+wind	Yes	Y		1	1	4	.6												
2	dl+seismic	Yes	Y		1	1	5	.7												
3	dl+wind up	Yes	Y		1	1	3	1	4	.45										
4	dl+ll+wind	Yes	Y		1	1	2	.75	4	.45	6	.75								
5	dl+ rf ll+ flrll	Yes	Y		1	1	2	.75	6	.75										
6	dl+flr ll	Yes	Y		1	1	6	1												
7	dl + seismic...	Yes	Y		1	1	5	.525	6	.75										

Joint Reactions

	LC	Joint Label	X [k]	Y [k]	MZ [k-ft]
1	1	N1	-.918	18.53	0
2	1	N4	-.582	21.339	0
3	1	Totals:	-1.5	39.869	
4	1	COG (ft):	X: 13	Y: 14.605	
5	2	N1	-1.406	18.288	0
6	2	N4	-1.058	21.581	0
7	2	Totals:	-2.464	39.869	
8	2	COG (ft):	X: 13	Y: 14.605	
9	3	N1	-.873	20.786	0
10	3	N4	-.252	22.937	0
11	3	Totals:	-1.125	43.722	
12	3	COG (ft):	X: 13	Y: 15.818	
13	4	N1	-.949	35.754	0
14	4	N4	-.176	38.17	0
15	4	Totals:	-1.125	73.924	
16	4	COG (ft):	X: 13	Y: 15.068	
17	5	N1	-.378	36.962	0
18	5	N4	.378	36.962	0
19	5	Totals:	0	73.924	
20	5	COG (ft):	X: 13	Y: 15.068	
21	6	N1	-.156	38.784	0
22	6	N4	.156	38.784	0
23	6	Totals:	0	77.569	
24	6	COG (ft):	X: 13	Y: 13.825	
25	7	N1	-1.093	32.686	0
26	7	N4	-.755	35.458	0
27	7	Totals:	-1.848	68.144	
28	7	COG (ft):	X: 13	Y: 13.939	

Joint Deflections

	LC	Joint Label	X [in]	Y [in]	Rotation [rad]
1	1	N1	0	0	-5.476e-3
2	1	N2	1.262	-.007	-1.533e-3

Joint Deflections (Continued)

	LC	Joint Label	X [in]	Y [in]	Rotation [rad]
3	1	N3	1.286	-.009	-9.09e-4
4	1	N4	0	0	-5.357e-3
5	1	N5	1.274	-.065	5.513e-4
6	1	N6	.79	-.006	-4.162e-3
7	1	N7	.79	-.007	-4.429e-3
8	2	N1	0	0	-7.378e-3
9	2	N2	1.636	-.006	-1.743e-3
10	2	N3	1.66	-.009	-1.119e-3
11	2	N4	0	0	-7.26e-3
12	2	N5	1.649	-.065	6.461e-4
13	2	N6	1.054	-.006	-5.404e-3
14	2	N7	1.055	-.007	-5.671e-3
15	3	N1	0	0	-4.262e-3
16	3	N2	.952	-.008	-1.542e-3
17	3	N3	.998	-.01	-3.273e-4
18	3	N4	0	0	-4.032e-3
19	3	N5	.975	-.12	4.22e-4
20	3	N6	.604	-.007	-3.029e-3
21	3	N7	.605	-.008	-3.549e-3
22	4	N1	0	0	-4.906e-3
23	4	N2	1.084	-.014	-1.805e-3
24	4	N3	1.141	-.015	-2.948e-4
25	4	N4	0	0	-4.619e-3
26	4	N5	1.112	-.152	4.741e-4
27	4	N6	.693	-.012	-3.425e-3
28	4	N7	.694	-.013	-4.072e-3
29	5	N1	0	0	-1.433e-4
30	5	N2	-.028	-.015	-7.551e-4
31	5	N3	.028	-.015	7.551e-4
32	5	N4	0	0	1.433e-4
33	5	N5	0	-.152	0
34	5	N6	0	-.013	3.234e-4
35	5	N7	0	-.013	-3.234e-4
36	6	N1	0	0	-5.915e-5
37	6	N2	-.012	-.014	-3.118e-4
38	6	N3	.012	-.014	3.118e-4
39	6	N4	0	0	5.915e-5
40	6	N5	0	-.071	0
41	6	N6	0	-.013	1.335e-4
42	6	N7	0	-.013	-1.335e-4
43	7	N1	0	0	-6.265e-3
44	7	N2	1.383	-.012	-1.517e-3
45	7	N3	1.406	-.014	-8.925e-4
46	7	N4	0	0	-6.146e-3
47	7	N5	1.395	-.069	5.439e-4
48	7	N6	.893	-.011	-4.551e-3
49	7	N7	.894	-.012	-4.818e-3

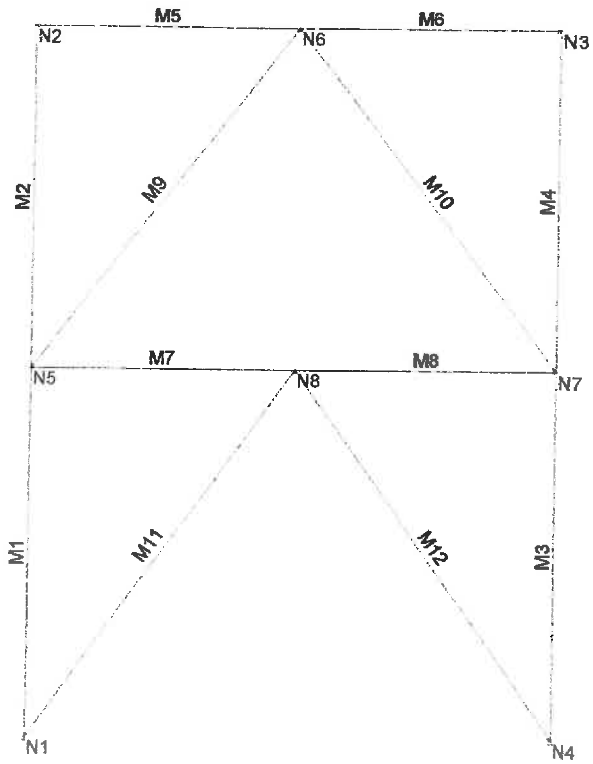
Member AISC 13th(360-05): ASD Steel Code Checks

	LC	Member	Shape	UC Max	Loc[ft]	Shear UC	Loc[ft]	Pnc/om [k]	Pnt/om [k]	Mn/om [k-ft]	Cb	Eqn
1	1	M1	W12x53	.097	13	.013	0	349.575	467.066	194.361	1.667	H1-1b
2	1	M2	W12x53	.077	0	.002	0	333.761	467.066	185.689	1.06	H1-1b
3	1	M3	W12x53	.066	3.184	.018	13.288	345.071	467.066	194.128	1.092	H1-1b
4	1	M4	W12x53	.129	13.288	.039	13.288	345.071	467.066	194.361	2.333	H1-1b
5	1	M5	W12x53	.080	13	.009	0	349.575	467.066	194.361	1.667	H1-1b
6	1	M6	W12x53	.132	14	.013	0	333.761	467.066	194.361	1.318	H1-1b

Member AISC 13th(360-05): ASD Steel Code Checks (Continued)

	LC	Member	Shape	UC Max	Loc[ft]	Shear UC	Loc[ft]	Pnc/om [k]	Pnt/om [k]	Mn/om [k-ft]	Cb	Eqn
7	1	M7	W16x67	.460	13	.128	26	183.746	586.826	232.786	1.136	H1-1b
8	2	M1	W12x53	.132	13	.019	0	349.575	467.066	194.361	1.667	H1-1b
9	2	M2	W12x53	.109	0	.005	0	333.761	467.066	194.361	1.125	H1-1b
10	2	M3	W12x53	.079	1.661	.021	13.288	345.071	467.066	194.361	1.138	H1-1b
11	2	M4	W12x53	.145	13.288	.042	13.288	345.071	467.066	194.361	2.251	H1-1b
12	2	M5	W12x53	.116	13	.015	0	349.575	467.066	194.361	1.667	H1-1b
13	2	M6	W12x53	.149	14	.009	0	333.761	467.066	194.361	1.189	H1-1b
14	2	M7	W16x67	.460	13	.128	26	183.746	586.826	232.786	1.136	H1-1b
15	3	M1	W12x53	.096	13	.012	0	349.575	467.066	194.361	1.667	H1-1b
16	3	M2	W12x53	.072	0	.010	0	333.761	467.066	194.361	1.544	H1-1b
17	3	M3	W12x53	.069	8.858	.031	0	345.071	467.066	194.361	1.115	H1-1b
18	3	M4	W12x53	.139	13.288	.056	13.288	345.071	467.066	194.361	2.586	H1-1b
19	3	M5	W12x53	.058	13	.005	0	349.575	467.066	194.361	1.667	H1-1b
20	3	M6	W12x53	.144	14	.018	0	333.761	467.066	194.361	1.477	H1-1b
21	3	M7	W16x67	.461	13	.128	26	183.746	586.826	232.786	1.136	H1-1b
22	4	M1	W12x53	.130	13	.014	0	349.575	467.066	194.361	1.667	H1-1b
23	4	M2	W12x53	.087	0	.013	0	333.761	467.066	194.361	1.65	H1-1b
24	4	M3	W12x53	.082	9.135	.040	0	345.071	467.066	194.361	1.14	H1-1b
25	4	M4	W12x53	.164	13.288	.068	13.288	345.071	467.066	194.361	2.62	H1-1b
26	4	M5	W12x53	.083	13	.005	0	349.575	467.066	194.361	1.667	H1-1b
27	4	M6	W12x53	.170	14	.022	0	333.761	467.066	194.361	1.484	H1-1b
28	4	M7	W16x67	.856	13	.238	26	183.746	586.826	232.786	1.136	H1-1b
29	5	M1	W12x53	.077	13	.005	0	349.575	467.066	194.361	1.667	H1-1b
30	5	M2	W12x53	.087	14	.017	0	333.761	467.066	194.361	2.115	H1-1b
31	5	M3	W12x53	.083	0	.054	0	345.071	467.066	194.361	1.807	H1-1b
32	5	M4	W12x53	.083	13.288	.054	13.288	345.071	467.066	194.361	1.807	H1-1b
33	5	M5	W12x53	.077	13	.005	0	349.575	467.066	194.361	1.667	H1-1b
34	5	M6	W12x53	.087	14	.017	0	333.761	467.066	194.361	2.115	H1-1b
35	5	M7	W16x67	.856	13	.238	26	183.746	586.826	232.786	1.136	H1-1b
36	6	M1	W12x53	.065	13	.002	0	349.575	467.066	194.361	1.667	H1-1b
37	6	M2	W12x53	.036	14	.007	0	333.761	467.066	194.361	2.115	H1-1b
38	6	M3	W12x53	.034	0	.022	0	345.071	467.066	194.361	1.807	H1-1b
39	6	M4	W12x53	.034	13.288	.022	13.288	345.071	467.066	194.361	1.807	H1-1b
40	6	M5	W12x53	.065	13	.002	0	349.575	467.066	194.361	1.667	H1-1b
41	6	M6	W12x53	.036	14	.007	0	333.761	467.066	194.361	2.115	H1-1b
42	6	M7	W16x67	.987	13	.274	0	183.746	586.826	232.786	1.136	H1-1b
43	7	M1	W12x53	.139	13	.017	0	349.575	467.066	194.361	1.667	H1-1b
44	7	M2	W12x53	.095	0	.005	0	333.761	467.066	194.361	1.166	H1-1b
45	7	M3	W12x53	.065	3.322	.018	13.288	345.071	467.066	193.565	1.089	H1-1b
46	7	M4	W12x53	.127	13.288	.039	13.288	345.071	467.066	194.361	2.336	H1-1b
47	7	M5	W12x53	.122	13	.013	0	349.575	467.066	194.361	1.667	H1-1b
48	7	M6	W12x53	.131	14	.009	0	333.761	467.066	194.361	1.206	H1-1b
49	7	M7	W16x67	.855	13	.238	26	183.746	586.826	232.786	1.136	H1-1b

App A-2 15



e2	twrb Br. Frame	SK - 2
kd	topock ~~electrical panel canopy~~	Apr 29, 2014 at 10:06 AM
ww-peg-2174-043062		topock[illegible]c.bracefr.r2d

Hot Rolled Steel Properties

	Label	E [ksi]	G [ksi]	Nu	Therm (\1E5 F)	Density[k/ft^3]	Yield[ksi]
1	A36 Gr.36	29000	11154	.3	.65	.49	36
2	A572 Gr.50	29000	11154	.3	.65	.49	50
3	A992	29000	11154	.3	.65	.49	50
4	A500 Gr.42	29000	11154	.3	.65	.49	42
5	A500 Gr.46	29000	11154	.3	.65	.49	46

Joint Coordinates and Temperatures

	Label	X [ft]	Y [ft]	Temp [F]
1	N1	0	0	0
2	N2	0	27.	0
3	N3	15	27.	0
4	N4	15	0	0
5	N5	0	14.	0
6	N6	7.5	27.	0
7	N7	15	14.	0
8	N8	7.5	14.	0

Joint Boundary Conditions

	Joint Label	X [k/in]	Y [k/in]	Rotation[k-ft/rad]	Footing
1	N1	Reaction	Reaction		
2	N4	Reaction	Reaction		

Member Primary Data

	Label	I Joint	J Joint	Rotate(deg)	Section/Shape	Type	Design List	Material	Design Rules
1	M1	N1	N5	90	HR1a	Column	Wide Flange	A572 Gr.50	Typical
2	M2	N5	N2	90	HR1a	Column	Wide Flange	A572 Gr.50	Typical
3	M3	N4	N7	90	HR1a	Column	Wide Flange	A572 Gr.50	Typical
4	M4	N7	N3	90	HR1a	Column	Wide Flange	A572 Gr.50	Typical
5	M5	N2	N6		HR3	Beam	Wide Flange	A572 Gr.50	Typical
6	M6	N6	N3		HR3	Beam	Wide Flange	A572 Gr.50	Typical
7	M7	N5	N8		HR3	Beam	Wide Flange	A572 Gr.50	Typical
8	M8	N8	N7		HR3	Beam	Wide Flange	A572 Gr.50	Typical
9	M9	N5	N6		HR2	Beam	Wide Flange	A572 Gr.50	Typical
10	M10	N7	N6		HR2	Beam	Wide Flange	A572 Gr.50	Typical
11	M11	N1	N8		HR2	Beam	Wide Flange	A572 Gr.50	Typical
12	M12	N4	N8		HR2	Beam	Wide Flange	A572 Gr.50	Typical

Joint Loads and Enforced Displacements (BLC 4 : wind horiz)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N2	L	X	1.2
2	N3	L	X	1.2
3	N5	L	X	.8
4	N7	L	X	.8

Joint Loads and Enforced Displacements (BLC 5 : seismic)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N3	L	X	.43
2	N2	L	X	.43
3	N5	L	X	2.58
4	N7	L	X	2.58

Joint Reactions (By Combination)

	LC	Joint Label	X [k]	Y [k]	MZ [k-ft]
1	1	N1	.322	1.761	0
2	1	N4	-2.722	8.739	0
3	1	Totals:	-2.4	10.5	
4	1	COG (ft):	X: 7.5	Y: 15.486	
5	2	N1	-.586	.794	0
6	2	N4	-3.628	9.706	0
7	2	Totals:	-4.214	10.5	
8	2	COG (ft):	X: 7.5	Y: 15.486	
9	3	N1	.619	2.161	0
10	3	N4	-2.419	7.394	0
11	3	Totals:	-1.8	9.555	
12	3	COG (ft):	X: 7.5	Y: 14.347	
13	4	N1	1.957	7.414	0
14	4	N4	-3.757	12.648	0
15	4	Totals:	-1.8	20.063	
16	4	COG (ft):	X: 7.5	Y: 15.689	
17	5	N1	2.857	10.031	0
18	5	N4	-2.857	10.031	0
19	5	Totals:	0	20.063	
20	5	COG (ft):	X: 7.5	Y: 15.689	
21	6	N1	3.298	10.687	0
22	6	N4	-3.298	10.688	0
23	6	Totals:	0	21.375	
24	6	COG (ft):	X: 7.5	Y: 14.73	
25	7	N1	1.273	5.986	0
26	7	N4	-4.434	12.671	0
27	7	Totals:	-3.161	18.656	
28	7	COG (ft):	X: 7.5	Y: 14.836	

Joint Deflections (By Combination)

	LC	Joint Label	X [in]	Y [in]	Rotation [rad]
1	1	N1	0	0	-4.147e-5
2	1	N2	.011	0	-2.623e-5
3	1	N3	.011	-.002	-2.484e-5
4	1	N4	0	0	-4.283e-5
5	1	N5	.007	0	-3.357e-5
6	1	N6	.011	-.002	-6.45e-6
7	1	N7	.007	-.002	-3.35e-5
8	1	N8	.006	-.004	-6.45e-6
9	2	N1	0	0	-8.279e-5
10	2	N2	.013	0	8.344e-7
11	2	N3	.013	-.001	2.225e-6
12	2	N4	0	0	-8.415e-5
13	2	N5	.011	0	-3.943e-5
14	2	N6	.013	-.002	-2.758e-6
15	2	N7	.012	-.001	-3.936e-5
16	2	N8	.011	-.004	-2.758e-6
17	3	N1	0	0	-3.147e-5
18	3	N2	.008	0	-1.93e-5
19	3	N3	.008	-.001	-1.9e-5
20	3	N4	0	0	-3.176e-5
21	3	N5	.005	0	-2.516e-5
22	3	N6	.008	-.001	-4.838e-6
23	3	N7	.005	-.001	-2.514e-5
24	3	N8	.005	-.004	-4.838e-6

Joint Deflections (By Combination) (Continued)

	LC	Joint Label	X [in]	Y [in]	Rotation [rad]
25	4	N1	0	0	-3.014e-5
26	4	N2	.008	-.002	-2.066e-5
27	4	N3	.008	-.003	-1.764e-5
28	4	N4	0	0	-3.309e-5
29	4	N5	.005	-.002	-2.523e-5
30	4	N6	.008	-.003	-4.838e-6
31	4	N7	.005	-.003	-2.508e-5
32	4	N8	.005	-.008	-4.838e-6
33	5	N1	0	0	1.474e-6
34	5	N2	0	-.002	-1.51e-6
35	5	N3	0	-.002	1.51e-6
36	5	N4	0	0	-1.474e-6
37	5	N5	0	-.002	-7.339e-8
38	5	N6	0	-.003	0
39	5	N7	0	-.002	7.339e-8
40	5	N8	0	-.008	0
41	6	N1	0	0	6.786e-7
42	6	N2	0	-.002	-6.953e-7
43	6	N3	0	-.002	6.953e-7
44	6	N4	0	0	-6.786e-7
45	6	N5	0	-.002	-3.379e-8
46	6	N6	0	-.003	0
47	6	N7	0	-.002	3.379e-8
48	6	N8	0	-.009	0
49	7	N1	0	0	-6.193e-5
50	7	N2	.01	-.002	4.533e-7
51	7	N3	.01	-.002	1.844e-6
52	7	N4	0	0	-6.329e-5
53	7	N5	.009	-.002	-2.959e-5
54	7	N6	.01	-.002	-2.069e-6
55	7	N7	.009	-.002	-2.952e-5
56	7	N8	.008	-.008	-2.069e-6

Member Distributed Loads (BLC 1 : dl)

	Member Label	Direction	Start Magnitude[k/ft,F]	End Magnitude[k/ft,F]	Start Location[ft,%]	End Location[ft,%]
1	M5	Y	-.08	-.08	0	7.5
2	M6	Y	-.08	-.08	0	7.5
3	M7	Y	-.62	-.62	0	7.5
4	M8	Y	-.62	-.62	0	7.5

Member Distributed Loads (BLC 2 : ll wind down)

	Member Label	Direction	Start Magnitude[k/ft,F]	End Magnitude[k/ft,F]	Start Location[ft,%]	End Location[ft,%]
1	M5	Y	-.125	-.125	0	7.5
2	M6	Y	-.125	-.125	0	7.5

Member Distributed Loads (BLC 3 : ll wind up)

	Member Label	Direction	Start Magnitude[k/ft,F]	End Magnitude[k/ft,F]	Start Location[ft,%]	End Location[ft,%]
1	M5	Y	.063	.063	0	7.5
2	M6	Y	.063	.063	0	7.5

Member Distributed Loads (BLC 6 : flr ll)

	Member Label	Direction	Start Magnitude[k/ft,F]	End Magnitude[k/ft,F]	Start Location[ft,%]	End Location[ft,%]
1	M7	Y	-.725	-.725	0	7.5
2	M8	Y	-.725	-.725	0	7.5

Basic Load Cases

	BLC Description	Category	X Gravity	Y Gravity	Joint	Point	Distributed
1	dl	None					4
2	ll wind down	None					2
3	ll wind up	None					2
4	wind horiz	None			4		
5	seismic	None			4		
6	flr ll	None					2

Load Combinations

	Description	Solve	PD...	SR...	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor
1	dl+wind	Yes	Y		1	1	4	.6												
2	dl+seismic	Yes	Y		1	1	5	.7												
3	dl+wind up	Yes	Y		1	1	3	1	4	.45										
4	dl+ll+wind	Yes	Y		1	1	2	.75	4	.45	6	.75								
5	dl+ rf+flr ll	Yes	Y		1	1	2	.75	6	.75										
6	dl + flr ll	Yes	Y		1	1	6	1												
7	dl+seis+flr ll	Yes	Y		1	1	5	.525	6	.75										

Member AISC 13th(360-05): ASD Steel Code Checks (By Combination)

	LC	Member	Shape	UC Max	Loc[ft]	Shear UC	Loc[ft]	Pnc/om [k]	Pnt/om [k]	Mn/om [k-ft]	Cb	Eqn
1	1	M1	W12x53	.002	14	.000	0	333.761	467.066	72.605	1	H1-1b
2	1	M2	W12x53	.001	0	.000	0	349.575	467.066	72.605	1	H1-1b
3	1	M3	W12x53	.006	14	.000	0	333.761	467.066	72.605	1	H1-1b
4	1	M4	W12x53	.001	0	.000	0	349.575	467.066	72.605	1	H1-1b
5	1	M5	W12x30	.006	7.5	.006	7.5	200.717	263.174	107.535	1.709	H1-1b
6	1	M6	W12x30	.006	0	.006	0	200.717	263.174	107.535	1.709	H1-1b
7	1	M7	W12x30	.038	7.5	.044	7.5	200.717	263.174	107.535	1.764	H1-1b
8	1	M8	W12x30	.039	0	.044	0	200.717	263.174	107.535	1.764	H1-1b
9	1	M9	LL4x4x6x0	.003	0	.000	0	40.038	171.257	12.018	1	H1-1b
10	1	M10	LL4x4x6x0	.023	0	.000	0	40.038	171.257	12.018	1	H1-1b

Member AISC 13th(360-05): ASD Steel Code Checks (By Combination) (Continued)

	LC	Member	Shape	UC Max	Loc[ft]	Shear UC	Loc[ft]	Pnc/om [k]	Pnt/om [k]	Mn/om [k-ft]	Cb	Eqn
11	1	M11	LL4x4x6x0	.010	0	.000	0	35.752	171.257	12.018	1	H1-1b
12	1	M12	LL4x4x6x0	.081	0	.000	0	35.752	171.257	12.018	1	H1-1b
13	2	M1	W12x53	.004	14	.000	0	333.761	467.066	72.605	1	H1-1b
14	2	M2	W12x53	.002	0	.000	0	349.575	467.066	72.605	1	H1-1b
15	2	M3	W12x53	.006	14	.000	0	333.761	467.066	72.605	1	H1-1b
16	2	M4	W12x53	.002	0	.000	0	349.575	467.066	72.605	1	H1-1b
17	2	M5	W12x30	.005	7.5	.006	7.5	200.717	263.174	107.535	1.709	H1-1b
18	2	M6	W12x30	.005	0	.006	0	200.717	263.174	107.535	1.709	H1-1b
19	2	M7	W12x30	.041	7.5	.044	7.5	200.717	263.174	107.535	1.764	H1-1b
20	2	M8	W12x30	.040	0	.044	0	200.717	263.174	107.535	1.764	H1-1b
21	2	M9	LL4x4x6x0	.001	0	.000	0	40.038	171.257	12.018	1	H1-1b
22	2	M10	LL4x4x6x0	.013	0	.000	0	40.038	171.257	12.018	1	H1-1b
23	2	M11	LL4x4x6x0	.004	0	.000	0	35.752	171.257	12.018	1	H1-1b
24	2	M12	LL4x4x6x0	.215	0	.000	0	35.752	171.257	12.018	1	H1-1a
25	3	M1	W12x53	.002	14	.000	0	333.761	467.066	72.605	1	H1-1b
26	3	M2	W12x53	.000	0	.000	0	349.575	467.066	72.605	1	H1-1b
27	3	M3	W12x53	.005	14	.000	0	333.761	467.066	72.605	1	H1-1b
28	3	M4	W12x53	.000	0	.000	0	349.575	467.066	72.605	1	H1-1b
29	3	M5	W12x30	.002	7.5	.001	7.5	200.717	263.174	107.535	1.709	H1-1b
30	3	M6	W12x30	.002	0	.001	0	200.717	263.174	107.535	1.709	H1-1b
31	3	M7	W12x30	.038	7.5	.044	7.5	200.717	263.174	107.535	1.743	H1-1b
32	3	M8	W12x30	.037	0	.044	0	200.717	263.174	107.535	1.743	H1-1b
33	3	M9	LL4x4x6x0	.003	0	.000	0	40.038	171.257	12.018	1	H1-1b
34	3	M10	LL4x4x6x0	.015	0	.000	0	40.038	171.257	12.018	1	H1-1b
35	3	M11	LL4x4x6x0	.018	0	.000	0	35.752	171.257	12.018	1	H1-1b
36	3	M12	LL4x4x6x0	.072	0	.000	0	35.752	171.257	12.018	1	H1-1b
37	4	M1	W12x53	.006	14	.000	0	333.761	467.066	72.605	1	H1-1b
38	4	M2	W12x53	.001	0	.000	0	349.575	467.066	72.605	1	H1-1b
39	4	M3	W12x53	.009	14	.000	0	333.761	467.066	72.605	1	H1-1b
40	4	M4	W12x53	.001	0	.000	0	349.575	467.066	72.605	1	H1-1b
41	4	M5	W12x30	.011	7.5	.012	7.5	200.717	263.174	107.535	1.709	H1-1b
42	4	M6	W12x30	.011	0	.012	0	200.717	263.174	107.535	1.709	H1-1b
43	4	M7	W12x30	.069	7.5	.083	7.5	200.717	263.174	107.535	1.768	H1-1b
44	4	M8	W12x30	.070	0	.083	0	200.717	263.174	107.535	1.768	H1-1b
45	4	M9	LL4x4x6x0	.000	0	.000	0	40.038	171.257	12.018	1	H1-1b
46	4	M10	LL4x4x6x0	.025	0	.000	0	40.038	171.257	12.018	1	H1-1b
47	4	M11	LL4x4x6x0	.058	0	.000	0	35.752	171.257	12.018	1	H1-1b
48	4	M12	LL4x4x6x0	.222	0	.000	0	35.752	171.257	12.018	1	H1-1a
49	5	M1	W12x53	.007	14	.000	0	333.761	467.066	72.605	1	H1-1b
50	5	M2	W12x53	.001	0	.000	0	349.575	467.066	72.605	1	H1-1b
51	5	M3	W12x53	.007	14	.000	0	333.761	467.066	72.605	1	H1-1b
52	5	M4	W12x53	.001	0	.000	0	349.575	467.066	72.605	1	H1-1b
53	5	M5	W12x30	.010	7.5	.012	7.5	200.717	263.174	107.535	1.709	H1-1b
54	5	M6	W12x30	.010	0	.012	0	200.717	263.174	107.535	1.709	H1-1b
55	5	M7	W12x30	.068	7.5	.083	7.5	200.717	263.174	107.535	1.768	H1-1b
56	5	M8	W12x30	.068	0	.083	0	200.717	263.174	107.535	1.768	H1-1b
57	5	M9	LL4x4x6x0	.011	0	.000	0	40.038	171.257	12.018	1	H1-1b
58	5	M10	LL4x4x6x0	.011	0	.000	0	40.038	171.257	12.018	1	H1-1b
59	5	M11	LL4x4x6x0	.085	0	.000	0	35.752	171.257	12.018	1	H1-1b
60	5	M12	LL4x4x6x0	.085	0	.000	0	35.752	171.257	12.018	1	H1-1b
61	6	M1	W12x53	.007	14	.000	0	333.761	467.066	72.605	1	H1-1b
62	6	M2	W12x53	.000	0	.000	0	349.575	467.066	72.605	1	H1-1b
63	6	M3	W12x53	.007	14	.000	0	333.761	467.066	72.605	1	H1-1b
64	6	M4	W12x53	.000	0	.000	0	349.575	467.066	72.605	1	H1-1b
65	6	M5	W12x30	.005	7.5	.006	7.5	200.717	263.174	107.535	1.709	H1-1b
66	6	M6	W12x30	.005	0	.006	0	200.717	263.174	107.535	1.709	H1-1b
67	6	M7	W12x30	.078	7.5	.096	7.5	200.717	263.174	107.535	1.749	H1-1b

Member AISC 13th(360-05): ASD Steel Code Checks (By Combination) (Continued)

	LC	Member	Shape	UC Max	Loc[ft]	Shear UC	Loc[ft]	Pnc/om [k]	Pnt/om [k]	Mn/om [k-ft]	Cb	Eqn
68	6	M8	W12x30	.078	0	.096	0	200.717	263.174	107.535	1.749	H1-1b
69	6	M9	LL4x4x6x0	.005	0	.000	0	40.038	171.257	12.018	1	H1-1b
70	6	M10	LL4x4x6x0	.005	0	.000	0	40.038	171.257	12.018	1	H1-1b
71	6	M11	LL4x4x6x0	.098	0	.000	0	35.752	171.257	12.018	1	H1-1b
72	6	M12	LL4x4x6x0	.098	0	.000	0	35.752	171.257	12.018	1	H1-1b
73	7	M1	W12x53	.006	14	.000	0	333.761	467.066	72.605	1	H1-1b
74	7	M2	W12x53	.001	0	.000	0	349.575	467.066	72.605	1	H1-1b
75	7	M3	W12x53	.008	14	.000	0	333.761	467.066	72.605	1	H1-1b
76	7	M4	W12x53	.001	0	.000	0	349.575	467.066	72.605	1	H1-1b
77	7	M5	W12x30	.005	7.5	.006	7.5	200.717	263.174	107.535	1.709	H1-1b
78	7	M6	W12x30	.005	0	.006	0	200.717	263.174	107.535	1.709	H1-1b
79	7	M7	W12x30	.071	7.5	.083	7.5	200.717	263.174	107.535	1.751	H1-1b
80	7	M8	W12x30	.071	0	.083	0	200.717	263.174	107.535	1.751	H1-1b
81	7	M9	LL4x4x6x0	.000	0	.000	0	40.038	171.257	12.018	1	H1-1b
82	7	M10	LL4x4x6x0	.011	0	.000	0	40.038	171.257	12.018	1	H1-1b
83	7	M11	LL4x4x6x0	.038	0	.000	0	35.752	171.257	12.018	1	H1-1b
84	7	M12	LL4x4x6x0	.262	0	.000	0	35.752	171.257	12.018	1	H1-1a

APP - A-3

22

Vinod Badani

From: Alfred.Voegels@CH2M.com
Sent: Tuesday, April 08, 2014 11:51 AM
To: John.Porcella@CH2M.com; vinod.badani@e2.com
Cc: Nathan.Betts@CH2M.com; Doug.Sunseri@CH2M.com; Rob.VanderArk@ch2m.com
Subject: RE: TOPOCK-Fresh Water Pre-Injection treatment

Hi Vinod, when could we expect updated structural sketches? No rush, just planning workload. Thanks.

From: Porcella, John/BAO
Sent: 4/8/2014 11:24 AM
To: vinod.badani@e2.com
Cc: Betts, Nathan/LAS; Sunseri, Doug/SEA; Voegels, Alfred/PDX
Subject: RE: TOPOCK-Fresh Water Pre-Injection treatment

Hi Vinod –

1. Treatment vessels - I estimate for

- 8' dia x 12.5 ' side shell ~ 17' overall vessel height,
- supported on 30" concrete pier supports,
- 22.5 feet overall height floor to top of head.

All dimensions scaled from Doug's drawings, about 45,000 pounds fully loaded (water, media, internals).

2. Filter skids - see attachments
   - "SPECIFICATION HUR 8x170FL-1.pdf" for single unit weight.
   - FP817-D-6-P.pdf is plan drawing for 2 filter skid package. Filters mounted on steel skid frame. One skid each pre-filter and post filter.

2. The chemical storage area – not final, but pretty close as shown on "ChemStorage Layout". It looks like we have allocated more space than we really need. Marty PDF'd the cad files the hypochlorite tablet vendor provided in case you want to look at that ("Binder2.pdf").

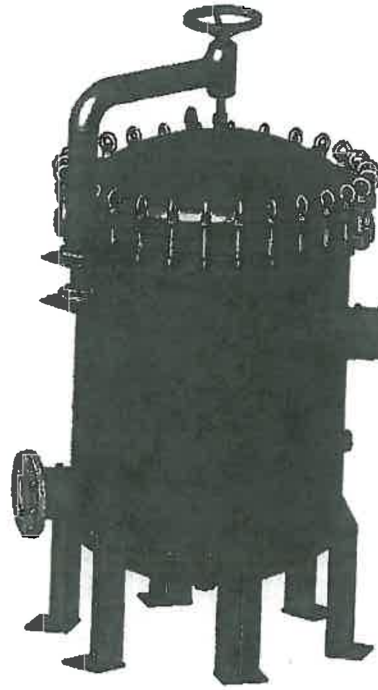
Feel free to call to discuss.

Thanks.

From: Vinod Badani [mailto:vinod.badani@e2.com]
Sent: Monday, April 07, 2014 12:14 PM
To: Porcella, John/BAO
Cc: Betts, Nathan/LAS .
Subject: TOPOCK-Fresh Water Pre-Injection treatment

John:
Can you[provide me with weight of Treatment Vessels?
I know it is 8-feet in diameter with 10 feet side wall (16-feet overall height. Mounted 18-inches to 2 feet above floor.
Also need total weights for Filter skids.
Any progress on Chemical storage Building? I need you to verify size to make it sure this will house all equipment+ need information for containment requirements.

PRODUCT SPECIFICATION
Harmsco® Model #: HUR 8X170FL



Description: Tangential Entry, Up-Flow Cartridge Filter Housing with; Swing Bolt Closure, Davit Cover Lift, and Flanged Connections.

Details:

1. Stainless steel construction, all wetted metallic components are ASTM A-240.
2. Swing bolt style housing closure. Swing bolts are ASTM A-193 B8.
3. NSF Certified using Genuine Harmsco® Hurricane® replacement filter cartridges.*
4. Tangential inlet and the integral inner-can, create a centrifugal flow that induces pre-filtration by heavy particulate separation.
5. Patented "Up-Flow" design that;
   a. Self purges housing of air.
   b. Eliminates by-pass contamination during servicing.
   c. Improves efficiency by creating an even flow distribution across filtering media.
6. Strong, durable construction.
7. Utilizes eight (8) Genuine Harmsco® Hurricane® HC/170 filter cartridges, available in many micron ratings. *
   Note: Harmsco® Hurricane® HC/170 filter cartridges available include: Activated Carbon, High Temperature, SureSafe™, Poly-Mesh, Poly-Pleat™ & more. **
8. Inlet & Outlet are NPS 6 Flanges ANSI/ASME B16.5 Class 150
9. Drains (Qty 2) are 1-1/2" Female NPT (FPT) Couplings, Class 1000
10. Vent is ½" Female NPT (FPT) Coupling, Class 1000
11. Gauge Ports (Qty 2) are ¼" Female NPT (FPT) Couplings, Class 1000
12. Closure Gasket is EPDM 70 Durometer O-ring.
13. Electro-polish finish.
14. Pressure Rating - 150 P.S.I.G.
15. Temperature Rating – Up to 140°F
    Note: Higher temperatures are possible, check cartridge specifications. **
16. Flow Rate – 1,200 GPM Maximum. See Pressure Drop vs. Flow Rate Curve, page 2.
17. One person can perform maintenance.

Requirements:

Floor Load:
Dry weight = 1,600 lbs.
Volume = 232 US gallons x 8.337 lbs./US gallon (water) = 1,935 lbs.
Total weight = 1,600 + 1,935 = 3,535 lbs. (housing + water)
Floor contact area = 1.164 ft².
Floor Load = 3,535 lbs. divided by 1.164 ft² = **3,100 pounds per square foot** (approx.)
Note: Piping shall conform to all applicable codes and be independently supported. If floor strength is suspect, use appropriate measures to adequately distribute load.

Floor Space: 14 ft² (does not include Cover/Davit swing position), See Installation Diagram, page 3.
Service Height: 104-1/2", See Installation Diagram, page 3.
Bonding: Housing shall be bonded in accordance with all applicable codes. A grounding lug is provided.

Recommended Spare Parts:
Closure Gasket O-ring: PN 368-E
Set of 8 Harmsco® Hurricane® HC/170 replacement cartridges

* The use of any filter cartridges other than Genuine Harmsco® Hurricane® filter cartridges in this filter housing voids certifications by NSF International.
** Contact a Harmsco® sales representative for Harmsco® Hurricane® HC/170 filter cartridge specifications.

This product is manufactured under one or more of the following patents: U.S. NO. 4,187,179; 3,720,322; CANADA NO. 977,693; GT. BRIT. NO. 1,372,014; W. GERMANY NO. 2,261,817; FRANCE NO. 7,246,864; EUROPEAN NO. 0,191,844, Other patents pending.
Notice: The information contained in this publication is considered accurate, and is intended to be used as a guide. This information is subject to change without notification. Contact Harmsco® Filtration Products for the latest, most up to date, specifications. Harmsco® Filtration Products does not assume any liability for the accuracy and completeness of the data in this publication. Temperature ratings, flow rates and chemical resistance can be affected by a number of unknown factors. End users should perform their own tests to determine suitability for each application.

Harmsco. FILTRATION PRODUCTS
Economical Solutions to Liquid Filtration Challenges

www.harmsco.com
sales@harmsco.com
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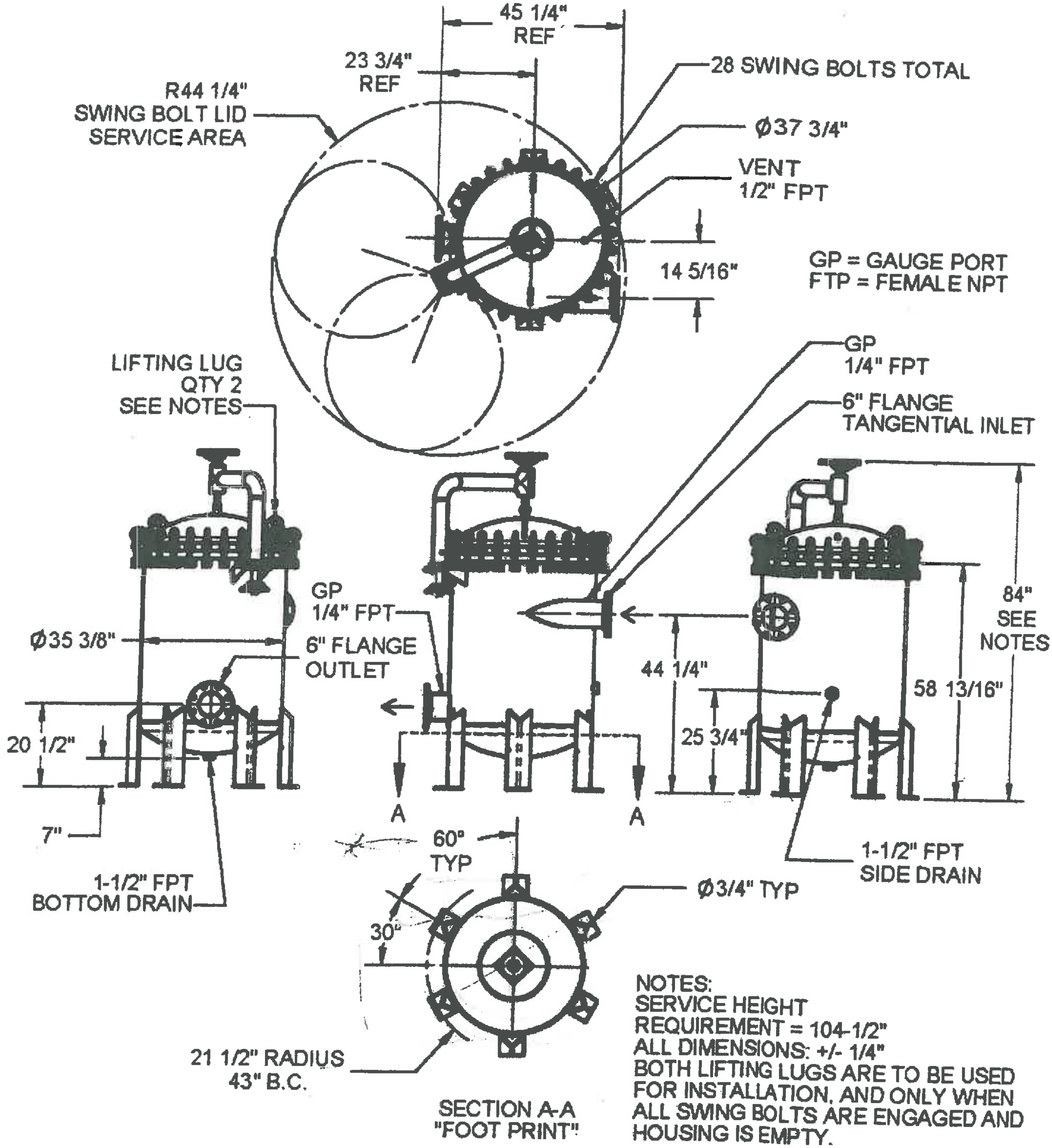
561-848-9628

Harmsco® Filtration Products
Installation Diagram
Hurricane® 8 X 170 Swing Bolt Housing



NOTES:
SERVICE HEIGHT REQUIREMENT = 104-1/2"
ALL DIMENSIONS: +/- 1/4"
BOTH LIFTING LUGS ARE TO BE USED FOR INSTALLATION, AND ONLY WHEN ALL SWING BOLTS ARE ENGAGED AND HOUSING IS EMPTY.

MODEL #: HUR 8X170FL

Revised: 3-4-09
File Name: SPECIFICATION HUR 8X170FL (pg. 3 of 3)

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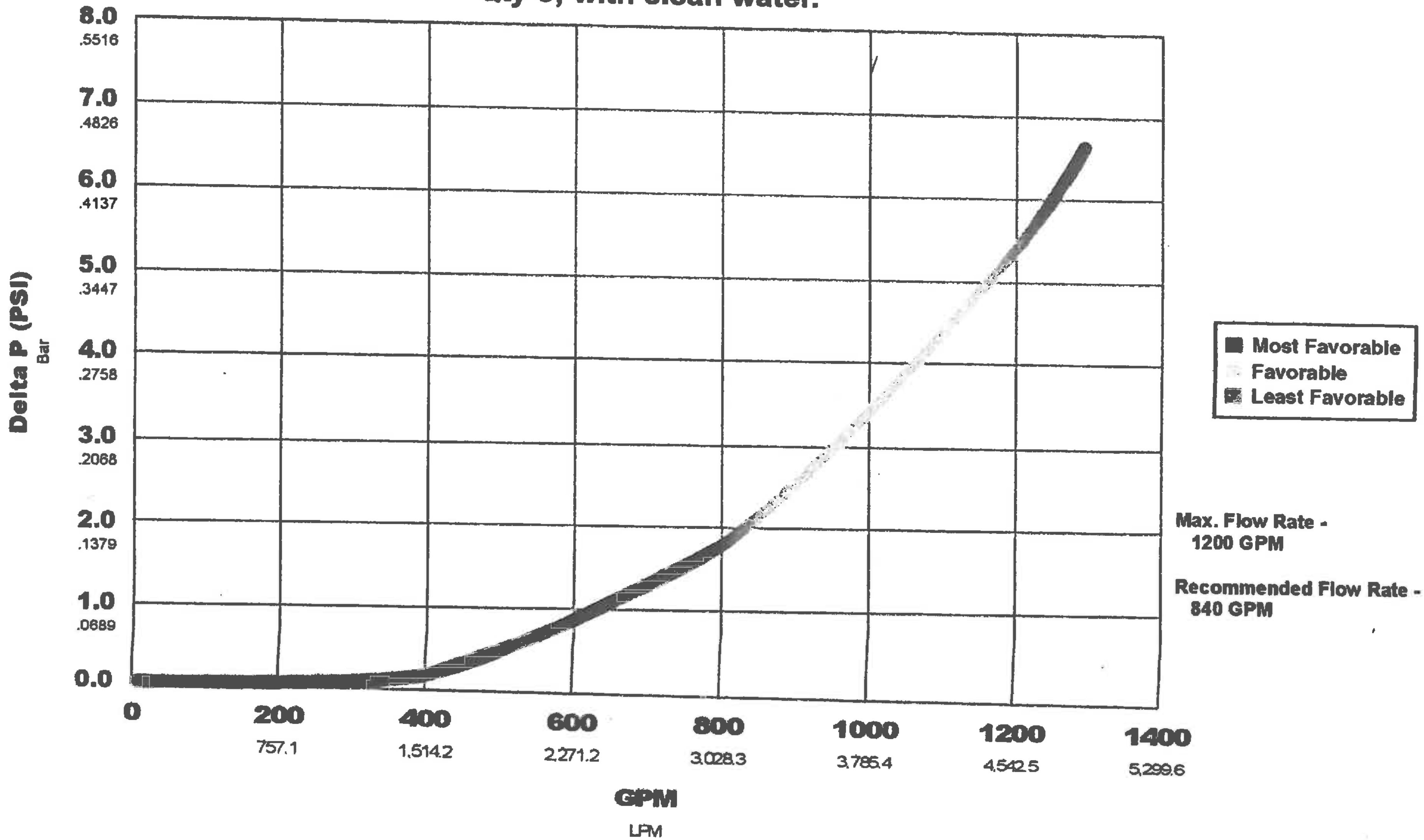
Pressure Drop vs. Flow Rate Curve

Harmsco® HUR 8X170FL
Hurricane® HC/170-20 Cartridges
Qty 8; with clean water.



Max. Flow Rate - 1200 GPM

Recommended Flow Rate - 840 GPM

Revised: 3-4-09
File Name: SPECIFICATION HUR 8X170FL (pg. 2 of 3)

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E2 Consulting Engineers, Inc. 1900 Powell Street, Suite 250 Emeryville, CA 94608	Designed By:	KD	Date: 5/15/14
	Checked By:	KJ	Date: 6/25/14
	Reviewed By:		Date:
Project No. WW-PGE-2174			Sheet No. 1
Project Description: Topock Chemical Storage Area Bldg.			

Reference:

General References

1. CBC 2010
2. ASCE 7-10
3. ACI 318-11

Seismic Data

$S_S = .23 \quad S_{MS} = 1.6 \times .23 = .368$

$S_1 = .12 \quad S_{M1} = F_v S_1 = 2.318 \times .12 = .28$

$S_{DS} = .267 \quad S_{D1} = .187$

Soil Bearing press. = 4000 psf

Conc. Data

$f'_c = 5.0$ ksi $\quad F_y = 60$ ksi

E2 Consulting Engineers, Inc. 1900 Powell Street, Suite 250 Emeryville, CA 94608	Designed By:	KD	Date:	5/14/14
	Checked By:	KJ	Date:	6/25/14
	Reviewed By:		Date:	
Project No.	WW-PGE-2174		Sheet No.	2
Project Description:	Topock Chemical Storage Area Bldg.			

Reference:

Seismic Loads

Using Equivalent Lateral procedure

$V = C_s W$ $I = 1.25$ $R = 3.5$ (OMF)
$R = 3.25$ (Braced Frame)

$W = (.01 \times 32 \times 16 + .015 \times 6 \times 28 \times 2) = 10.2^k$

Mom. Fr. $T = C_t h_n^x = .028 (14)^{.8} = .231 \text{ sec.}$ $C_{s_{max}} = \frac{.5 S_{D1}}{T(R/I)} = \frac{.5 \times .187}{.231 \times 2.8} = .145$

$C_s = \frac{S_{DS}}{(R/I)} = \frac{.247}{(3.5/1.25)} = \frac{.247}{2.8} = .088$
USE .10

Br. Fr. $T = .02 (12)^{.75} = .129 \text{ sec.}$

$C_{s_{max}} = \frac{.5 \times .187}{.129 \times 2.6} = .278$ $C_s = \frac{.247}{2.6} = .095$ USE .10

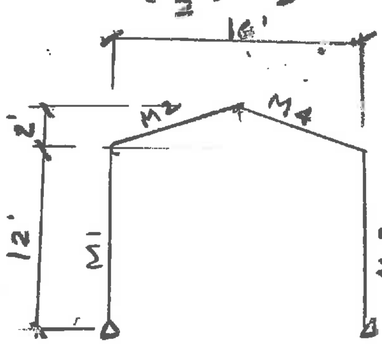
$V = .1 \times 10.2 = 1.02^k$

USE $.51^k$ for Mom. Frame & Braced Frame

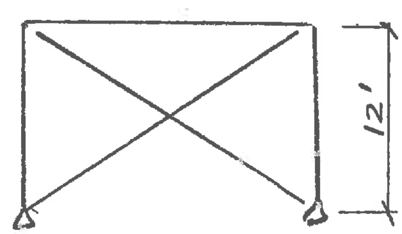
Wind Loads

Mom Fr. $V = .02 \left(\frac{14}{2}\right)(14) = 1.96^k > .51^k$ Wind Governs

Br. Fr. $V = .02 \times \left(\frac{12}{2}\right)\left(\frac{16}{2}\right) = 1.04^k > .51^k$ Wind Governs



Mom. Fr.



Braced Fr.

Note: See pages 5 to 8 for computerized Mom. fr. design. (RISA-2d)

2 Consulting Engineers, Inc. 1900 Powell Street, Suite 250 Emeryville, CA 94608	Designed By:	KD	Date: 5/14/14
	Checked By:	KJ	Date: 5/25/14
	Reviewed By:		Date:
roject No.	UIW-PGE-2174		Sheet No. 3
roject Description:	Topock Chemical Storage Area Bldg.		

eference:

Roof Loads on Mom. Frame

B-1 (l=14') purlin

$w_{TL} = (.01 \times 3.5 + .02 \times 3.5) = .035 + .07 = .105^{k/'}$ USE $.12^{k/'}$

$R = .12 \times 7 = .84^{k}$ $M = \frac{.12 \times 14^2}{8} = 2.94^{'k}$

W 8x10 $M_R = 21^{'k}$ (50 ksi)

$\Delta_{TL} = \frac{5}{384} \times \frac{.12 \times 14^4}{29000 \times 30.8} \times 1728 = .116'' = \frac{l}{1448} < \frac{l}{240}$ ok

B-2 (l = 16') Girder @ Mom. Frame

$w_{TL} = (.01 + .02) \times 14 = .14 + .28 = .42^{k/'}$ USE $.45^{k/'}$

$R = .45 \times 8 = 3.6^{k}$ $M = \frac{.45 \times 16^2}{8} = 14.4^{'k}$

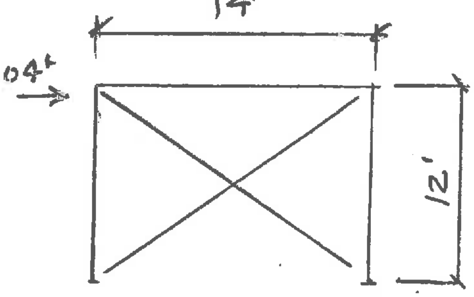
W 10x22 $M_R = 64^{'k}$ $I = 118\ in^4$

See computer printout

Braced Frame

Max. $P_w = 1.04^{k}$ $P_{seis.} = .51^{k}$

X Br. $l = \sqrt{12^2 + 14^2} = 18.43'$ USE 18'



Try ㄱㄱ 4x4x1/4 $r = 1.25$

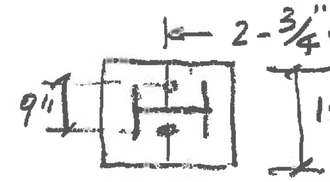
$\frac{Kl}{r} = \frac{18 \times 12}{1.25} = 172.8 < 200$

Cap Ten. = $3.88 \times .6 \times 46 = 107^{k}$

Cap. Comp. = 19^{k} USE ㄱㄱ 4x4x1/4

Base pl. (12"x12"x5/8")

$f_p = \frac{4+1}{12 \times 12} = .035$ ksi. $t = 2 \times 3.7 \sqrt{\frac{.035}{36}} = .23''$



USE 12"x5/8"x1'-0" PL. w/ 2- 3/4"Φ x12" A.B.'s (uplift= .33k) ok by insp.

E2 Consulting Engineers, Inc. 1900 Powell Street, Suite 250 Emeryville, CA 94608	Designed By:	KD	Date: 5/15/14
	Checked By:	KJ	Date: 5/25/14
	Reviewed By:		Date:
Project No. WW-PGE-2174			Sheet No. 4
Project Description: Topock Chemical Storage Area Bldg			

Reference:

Foundation

Column Footings (Try 3'-0" Sq. Ftg.)

Max P = 5 (Roof) + 1 (Siding+Misc) + .15 × 2 × 3² = 8.7ᵏ USE 9ᵏ

$A_{Ftg} = \frac{9.0}{4} = 2.25$ br = 1.5'

USE 2'-6" SQ. Ftg. w/ 3-#5 Bars Ea. Way & #5 Dowels @ 24" into Ftg.

$p = \frac{9}{2.5 \times 2.5} = 1.44^{ksf}$ ok

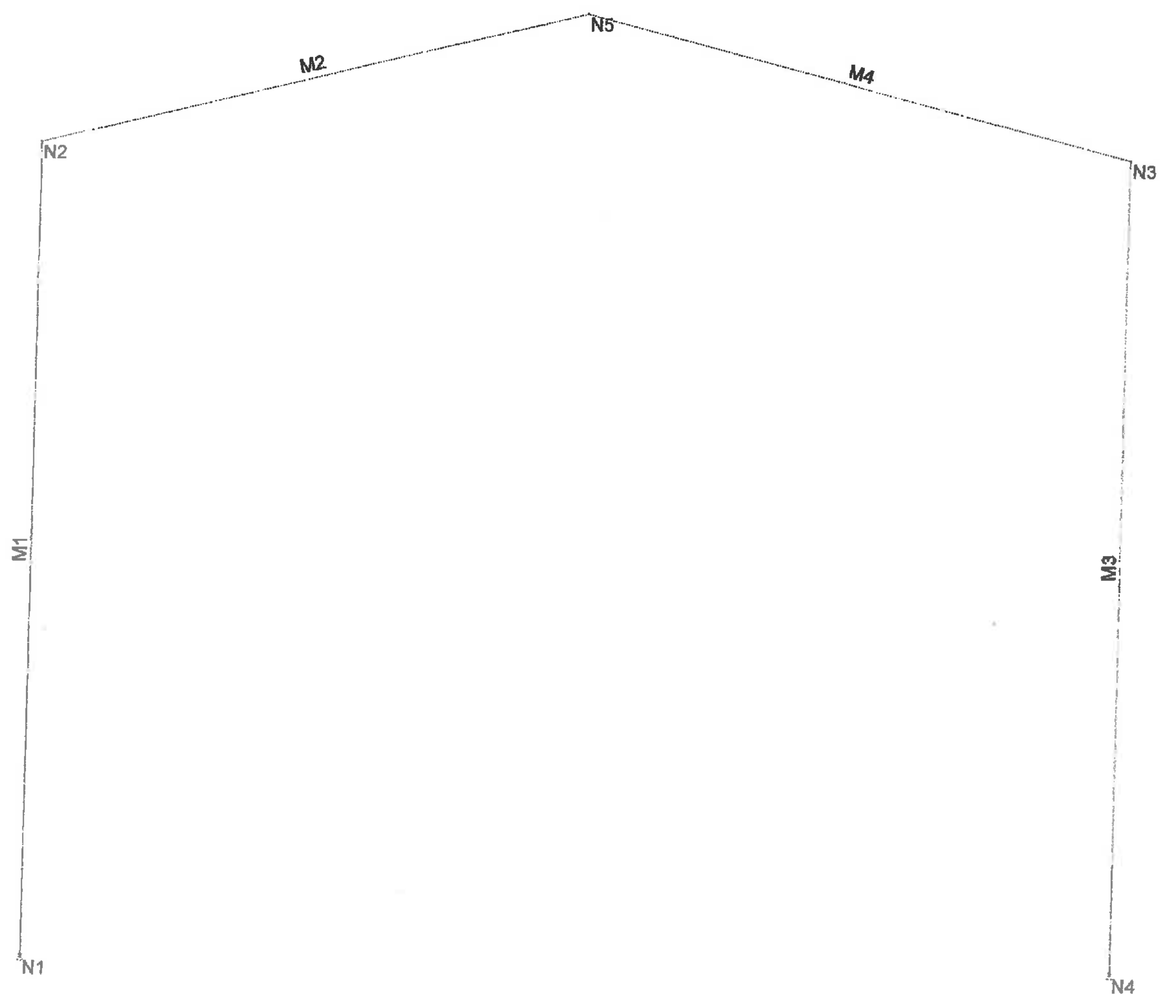
Slab on Grade (12" Tk Slab)

DL slab = 150^{PSF}
LL slab = 125
375 PSF

12" Slab w/ #5 @ 12" Ea. Way @ BOT

Min. $A_s = .002 \times 12 \times 12 = .288\ in^2$ $A_{sa} = .31\ in^2$ ok

⑤



Results for LC 1, dl+wind

e2	topock chemical storage moment frame	SK - 1
kd		May 14, 2014 at 5:22 PM
ww-peg-2174-043062		topoccsmf.ewdir.r2d

Hot Rolled Steel Properties

	Label	E [ksi]	G [ksi]	Nu	Therm (\1E5 F)	Density[k/ft^3]	Yield[ksi]
1	A36 Gr.36	29000	11154	.3	.65	.49	36
2	A572 Gr.50	29000	11154	.3	.65	.49	50
3	A992	29000	11154	.3	.65	.49	50
4	A500 Gr.42	29000	11154	.3	.65	.49	42
5	A500 Gr.46	29000	11154	.3	.65	.49	46

Hot Rolled Steel Section Sets

	Label	Shape	Type	Design List	Material	Design Rules	A [in2]	I (90,270) [i...	I (0,180) [in4]
1	HR1A	W10x22	Column	Wide Flange	A572 Gr.50	Typical	6.49	11.4	118
2	HR2	W10x22	Beam	Wide Flange	A572 Gr.50	Typical	6.49	11.4	118

Joint Coordinates and Temperatures

	Label	X [ft]	Y [ft]	Temp [F]
1	N1	0	0	0
2	N2	0	12	0
3	N3	16	12	0
4	N4	16	0	0
5	N5	8	14	0

Joint Boundary Conditions

	Joint Label	X [k/in]	Y [k/in]	Rotation[k-ft/rad]	Footing
1	N1	Reaction	Reaction		
2	N4	Reaction	Reaction		

Member Primary Data

	Label	I Joint	J Joint	Rotate(deg)	Section/Shape	Type	Design List	Material	Design Rules
1	M1	N1	N2		HR1A	Column	Wide Flange	A572 Gr.50	Typical
2	M2	N2	N5		HR2	Beam	Wide Flange	A572 Gr.50	Typical
3	M3	N3	N4		HR1A	Column	Wide Flange	A572 Gr.50	Typical
4	M4	N3	N5		HR2	Beam	Wide Flange	A572 Gr.50	Typical

Joint Loads and Enforced Displacements (BLC 4 : wind horiz)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N2	L	X	-.98
2	N3	L	X	-.98

Joint Loads and Enforced Displacements (BLC 5 : seismic)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N2	L	X	-.26
2	N3	L	X	-.26

Member Distributed Loads (BLC 1 : dl)

	Member Label	Direction	Start Magnitude[k/ft,F]	End Magnitude[k/ft,F]	Start Location[ft,%]	End Location[ft,%]
1	M2	Y	-.14	-.14	0	8.246
2	M4	Y	-.14	-.14	0	8.246

7

Member Distributed Loads (BLC 2 : ll wind down)

	Member Label	Direction	Start Magnitude[k/ft,F]	End Magnitude[k/ft,F]	Start Location[ft,%]	End Location[ft,%]
1	M2	Y	-.28	-.28	0	8.246
2	M4	Y	-.28	-.28	0	8.246

Member Distributed Loads (BLC 3 : ll wind up)

	Member Label	Direction	Start Magnitude[k/ft,F]	End Magnitude[k/ft,F]	Start Location[ft,%]	End Location[ft,%]
1	M2	Y	-.14	-.14	0	8.246
2	M4	Y	-.14	-.14	0	8.246

Basic Load Cases

	BLC Description	Category	X Gravity	Y Gravity	Joint	Point	Distributed
1	dl	None					
2	ll wind down	None					2
3	ll wind up	None					2
4	wind horiz	None			2		2
5	seismic	None			2		

Load Combinations

	Description	Solve	PD...	SR...	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor
1	dl+wind	Yes	Y		1	1	4	1												
2	dl+seismic	Yes	Y		1	1	5	1												
3	dl+wind up	Yes	Y		1	1	3	1	4	.75										
4	dl+ll+wind	Yes	Y		1	1	2	.75	4	.75										
5	dl+ll	Yes	Y		1	1	2	1												

Joint Reactions (By Combination)

	LC	Joint Label	X [k]	Y [k]	MZ [k-ft]
1	1	N1	1.14	2.636	0
2	1	N4	.82	-.328	0
3	1	Totals:	1.96	2.309	
4	1	COG (ft):	X: 8	Y: 13	
5	2	N1	.429	1.548	0
6	2	N4	.091	.761	0
7	2	Totals:	.52	2.309	
8	2	COG (ft):	X: 8	Y: 13	
9	3	N1	1.069	3.43	0
10	3	N4	.401	1.188	0
11	3	Totals:	1.47	4.618	
12	3	COG (ft):	X: 8	Y: 13	
13	4	N1	1.154	4.011	0
14	4	N4	.316	1.761	0
15	4	Totals:	1.47	5.772	
16	4	COG (ft):	X: 8	Y: 13	
17	5	N1	.51	3.463	0
18	5	N4	-.51	3.463	0
19	5	Totals:	0	6.927	
20	5	COG (ft):	X: 8	Y: 13	

Joint Deflections (By Combination)

	LC	Joint Label	X [in]	Y [in]	Rotation [rad]
1	1	N1	0	0	0
2	1	N2	-.631	-.003	1.409e-3

Joint Deflections (By Combination) (Continued)

	LC	Joint Label	X [in]	Y [in]	Rotation [rad]
3	1	N3	-.614	0	2.165e-3
4	1	N4	0	0	0
5	1	N5	-.623	-.036	-7.849e-4
6	2	N1	0	0	0
7	2	N2	-.174	-.001	9.728e-5
8	2	N3	-.156	0	8.508e-4
9	2	N4	0	0	0
10	2	N5	-.165	-.036	-2.082e-4
11	3	N1	0	0	0
12	3	N2	-.488	-.003	5.97e-4
13	3	N3	-.453	-.001	2.105e-3
14	3	N4	0	0	0
15	3	N5	-.471	-.072	-5.936e-4
16	4	N1	0	0	0
17	4	N2	-.494	-.004	4.142e-4
18	4	N3	-.451	-.002	2.3e-3
19	4	N4	0	0	0
20	4	N5	-.473	-.09	-5.961e-4
21	5	N1	0	0	0
22	5	N2	-.026	-.003	-1.131e-3
23	5	N3	.026	-.003	1.131e-3
24	5	N4	0	0	0
25	5	N5	0	-.108	0

Member AISC 13th(360-05): ASD Steel Code Checks (By Combination)

	LC	Member	Shape	UC Max	Loc[ft]	Shear UC	Loc[ft]	Pnc/om [k]	Pnt/om [k]	Mn/om [k-ft]	Cb	Eqn
1	1	M1	W10x22	.230	12	.024	0	81.967	194.311	64.87	1.667	H1-1b
2	1	M2	W10x22	.217	0	.051	0	129.265	194.311	64.87	2.089	H1-1b
3	1	M3	W10x22	.152	0	.017	0	81.967	194.311	64.87	1.667	H1-1b
4	1	M4	W10x22	.152	0	.030	8.246	129.265	194.311	64.87	1.296	H1-1b
5	2	M1	W10x22	.089	12	.009	0	81.967	194.311	64.87	1.667	H1-1b
6	2	M2	W10x22	.082	0	.030	0	129.265	194.311	64.87	2.554	H1-1b
7	2	M3	W10x22	.022	0	.002	0	81.967	194.311	64.87	1.667	H1-1b
8	2	M4	W10x22	.050	5.068	.014	0	129.265	194.311	59.317	1.072	H1-1b
9	3	M1	W10x22	.222	12	.022	0	81.967	194.311	64.87	1.667	H1-1b
10	3	M2	W10x22	.206	0	.066	0	129.265	194.311	64.87	2.441	H1-1b
11	3	M3	W10x22	.082	0	.008	0	81.967	194.311	64.87	1.667	H1-1b
12	3	M4	W10x22	.123	3.865	.024	8.246	129.265	194.311	57.648	1.042	H1-1b
13	4	M1	W10x22	.242	12	.024	0	81.967	194.311	64.87	1.667	H1-1b
14	4	M2	W10x22	.223	0	.077	0	129.265	194.311	64.87	1.667	H1-1b
15	4	M3	W10x22	.071	0	.007	0	81.967	194.311	64.87	2.508	H1-1b
16	4	M4	W10x22	.134	4.638	.033	0	129.265	194.311	64.87	1.667	H1-1b
17	5	M1	W10x22	.116	12	.010	0	129.265	194.311	58.345	1.054	H1-1b
18	5	M2	W10x22	.106	7.903	.066	0	81.967	194.311	64.87	1.667	H1-1b
19	5	M3	W10x22	.116	0	.010	0	129.265	194.311	64.87	1.647	H1-1b
20	5	M4	W10x22	.106	7.903	.066	0	81.967	194.311	64.87	1.667	H1-1b
								129.265	194.311	64.87	1.647	H1-1b

NDIX A - CALCULATION COVER SHEET

CALCULATION ID NUMBER	
REVISION NUMBER	
JOB NUMBER	~~WW-PSE-2174~~

TITLE	Tanks outside 12'Φ x 17' Steel, 10'Φ x 21' FRP, 10'Φ x 18' CRP. / Adjacent to chemical Storage Area

Pg. No.	CONTENT
1	General Data & Wind Loads For 12'Φ x 17' Steel Tank
2 To 5	Tank Design, Impulsive & Convective Forces, Sloshing ht.
6 To 8	Annular Ring & Ring Wall Fdn. Design.
9	General Data, Wind loads for Fiberglass FRP & CRP Tanks
10 To 11	10'Φ x 21' FRP Tank Impulsive & Convective Forces, Sloshing ht.
12 To 13	10'Φ x 21' FRP Tank Ring wall Fdn.
14	10'Φ x 18' CRP Tank Impulsive & convective Forces
15	CRP Tank Anchor Bolts & Pedestals
16	CRP Tank Base pl. & Fdn Design.
A-1, A-2	Attachments.

	initial	date
PREPARED	KD	4/15/14
TITLE		
REVIEWED		
TITLE		

REVISION NOTES	

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	Checked By:	KJ	Date: 6/25/14
	Reviewed By:		Date:
. No. WW-PGE-2174			Sheet No. 1
ct Description: Topock 12'd x 17' Steel Tank			

Reference:

Design References

1. AWAA Standard D-100-11
2. IBC 2009 / CBC 2010
3. ACI 318-11
4. Nuclear Reactors & Earthquakes (TID 7024) Chap-6

Design Data

Concrete $f_c' = 5^{ksi}$ $f_y = 60^{ksi}$ - Anchor Bolts - A-307

Tank Data

Height = 13+1+3 = 17' Height of water = 13'

Dia. of tank = 12' = D

Sec. 3.7 Min t for shell = $\frac{2.6 h_p D G}{S E} = \frac{2.6 \times 14 \times 12 \times 1}{15000 \times .86} = .05''$ USE 3/16" (Table 16)

(.85 3/t)

Seismic Data

Site Class - D

Seismic coefficents (See structural Dwg. S-00-01)

$S_S = .23$ $F_a = 1.6$ $S_{ms} = F_a \times S_S = 1.6 \times .23 = .368$ Say .37

$S_1 = .12$ $F_v = 2.318$ $S_{m1} = F_v \times S_1 = 2.318 \times .12 = .279$ Say .28

$S_{DS} = .37 \times .667 = .247$ $S_{D1} = .28 \times .667 = .187$

Soil Data (No Soil Report)

Allow. Soil Press. = 1 x 1.2 = 1200 PSF

Wind Data. Code AWAA D-100-11 (Sect. 3.1.4) Exposure-C

Assume G: Gust Factor = 1.0 Wind Vel. = 100 mph

$q_z = .00256\, k_z I V^2 = .00256 \times 1.09 \times 1.15 \times 100^2 = 32$ PSF

$P_W = q_z G C_f = 32 \times 1 \times .6 = 19.2$ PSF > 30 x .6 = 18 PSF

USE P_W = 20 PSF

Total $P_W = 20 \times 12 \times 17.5 = 4200^{\#} = 4.20^k$

$V_{max} = 4.32^k$ $M_{max} = 4.20 \times 8.75 = 36.75^{'k}$

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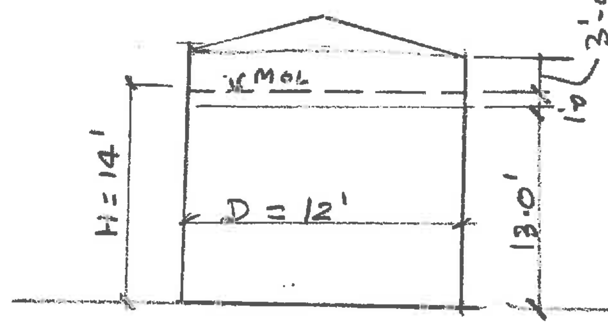
Project No. WW-PGE-2174			Sheet No. 2
Project Description: Topock 12'Φ×17' Tank			

Reference:

Design of Tank for Seismic Loads



Impulsive Components

Eq. 13-18 $A_i = \frac{S_{ai} I_E}{1.4 \times R_I}$ $I_E = 1.25$ (Table 24) $R_I = 3.0$ (Table 28)

$= \frac{.247 \times 1.25}{1.4 \times 3.0} = .074$ For $T_i \leq T_s$ $S_{ai} = S_{DS}$

$T_i = C_t h_n^x = .02 \times 17^{.75} = .167 < .757$

$A_{i_{min}} = \frac{.36 S_1 I_E}{R_I}$ $T_S = \frac{S_{D1}}{S_{DS}} = \frac{.187}{.247} = .757$ $T_L = 12$ sec.

$= \frac{.36 \times .12 \times 1.25}{3.0} = .018$ USE $A_i = .074$ g

Eq. 13-20 $V_i = A_i (W_s + W_r + W_f + W_i)$ $M_i = A_i (W_s X_s + W_r \times H_t + W_i X_i)$

W_T = wt of contents = $49 H D^2 = 49 \times 14 \times 12^2 \times 10^{-3} = 98.8^k$

$\frac{D}{H} = \frac{12}{14} = .86 < 3.33$ $\frac{W_1}{W_T} = .82$ $\frac{W_2}{W_T} = .2$

$\frac{X_1}{H} = .42$ $\frac{X_2}{H} = .78$

Ref.-1 $X_1 = .42 \times 14 = 5.88'$, $X_2 = .78 \times 14 = 10.92'$ } From Charts Figures A.5 & A.6 (pg. 194)

$W_1 = W_T \times .82 = 98.8 \times .82 = 81.02^k$ $W_2 = 98.8 \times .2 = 19.76^k$

W_r = wt. of Roof = $\frac{\pi}{4}(12)^2 \times .01 = 1.13^k$

W_s = wt. of shell = $\frac{\pi}{4}(12.03125^2 - 12.0^2) \times 17 \times .49 = 4.91^k$ say 5^k

Total wt. = $W_t = W_1 + W_r + W_s = 81.02 + 1.13 + 5 = 87.15^k$ USE 88^k

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Project No. WW-PGE-2174			Sheet No. 3
Project Description: Topock 12'ϕ×17' Tank			

Reference:

12' ϕ Water Tank contd.

Total Wt. = 88^k = Wt

Note: Floor wt. not included since it is at ground level.

V_1 = shear due to impulsive forces

$= A_i (W_t) = .074 \times 88 = 6.51^k$

M_i = Moment due to impulsive forces

$= .074 (W_s X_s + W_r H_t + W_1 X_1)$

$= .074 (5.07 \times 8.5 + 1.13 \times 17.25 + 81.02 \times 5.88)$

$= .074 (42.50 + 19.49 + 476.40) = .074 \times 488.13 = 36.14^{1k}$

M_{imf} & M_{imf} Not used since Tank is on Ring Fdn.
(Eq. 13-33) (Eq. 13-32)

Convective Forces (Sloshing Effects)

Eq. 13-18 $A_c = \dfrac{S_{ac} I_E}{1.4 R_I}$ $I_E = 1.25$ $R_I = 1.5$

(See calc. below)
$S_{ac} = \dfrac{k S_{D1}}{T} = .14 < S_{DS}$ (Eq. 13-12) $T_c < T_L$
$= .247$

Eq. 13-22 $T_c = 2\pi \sqrt{\dfrac{D}{3.68\, g \tanh\left(\dfrac{3.68 H}{D}\right)}} = 2\pi \sqrt{\dfrac{12}{3.68 \times 32.2 \times .999627}}$

$= 2.0$ sec.

$\tanh\left(\dfrac{3.68 \times 14}{12}\right) = \tanh(4.293) = .999627$

$S_{ac} = \dfrac{1.5 \times .187}{T_c} = \dfrac{1.5 \times .187}{2.0} = .14025$

$A_c = \dfrac{.14025 \times 1.25}{1.4 \times 1.50} = .0835$

Eq. 13-30 $X_c = \left[1 - \dfrac{\cosh\left[\frac{3.67H}{D}\right] - 1}{\frac{3.67H}{D} \sinh\left[\frac{3.67H}{D}\right]}\right] H$

$H = 14$ $D = 12$ $\dfrac{H}{D} = 1.167$

$\cosh(4.282) = 36.1994$

$\sinh(4.282) = 36.1856$

$= \left[1 - \dfrac{\cosh(4.282) - 1}{4.282 \sinh(4.282)}\right] 14$

$= \left[1 - \dfrac{36.1994 - 1}{4.282 \times 36.1856}\right] \times 14$

$= 10.81'$

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Project No. WW-PGE-2174			Sheet No. 5
Project Description: Topock 12"Φ x 17' Tank			

Reference:

Sloshing Wave Height

Eq. 13-52 $d = .5 D A_f$

$A_f = \frac{k S_{D1} I_E}{T_c}$ $T_c = 2.0$ sec.

$S_{D1} = .187$ $I_E = 1.25$ (Seis. Group II) $k = 1.50$

$A_f = \frac{1.5 \times .187 \times 1.25}{2.0} = .1753$ OR $A_f = \frac{1.5 \times .187 \times 1.5}{2.0} = .21$ (Seismic Gr. III)

$d = .5 \times 12 \times .1753 = 1.052' < 3.0'$ ok
(Group II)

$d = .5 \times 12 \times .2104 = 1.262' < 3.0'$ ok
(Group III)

Since we have assumed Group II for Seismic Calc's according to table-29, there is no requirement for freeboard. Hence the tank height can be reduced to 15' OR 16' (H+2')

Anchor Bolts

$V_{max} = V_f = 6.64^k$ (pg. 4) $M_{max} = M_s = 40^k$ (pg. 4)

$V_A = \tan 30 (W_s + W_r + W_T)(1 - .4 A_v)$ $A_v = .14 S_{DS} = .14 \times .247 = .035$

$= .577 (29.67 + 1.13 + 81.02)(1 - .4 \times .035)$

$= 63.7^k > 6.64^k$ Min. Anchor Bolts to be @ 6'-0" o/c

Uplift

$P_s = \left[\frac{4 M_s}{D A_c} - W'\right] \times \frac{1}{N} + \frac{.035 \times W'}{N}$ $N_{(min)} = \frac{\pi D}{6} = 7$ A.B.'s USE 8 A.B.'s

$= \left[\frac{4 \times 40.1}{12} - 6.13\right] \times \frac{1}{8} + \frac{.035 \times 6.13}{8}$ $W' = W_r + W_s = 5 + 1.13 = 6.13^k$

$= .905 + .027 = .932^k$

USE 8-1"Φ A.B.'s Cap. = 1" x 1'-6" (Emb.) A.B. = $12.1^k > .932^k$ (conc.)

Conc $f'_c = 4$ ksi

T cap. of Steel A.B. = $.5 \times 58 \times 1.06 = 17.57^k$

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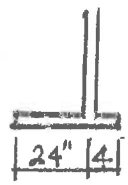
Project No.	WW-PGE-2174		Sheet No. 6
Project Description:	Topock 12'ø x 17' Tank		

Reference:

Annular Ring



$W_L = 7.9 t_b \sqrt{F_y G} < 1.28\ HDG$

$W_L = 7.9 \times .1875 \times \sqrt{36000 \times 14 \times 1} = 1051.6\ \#/$

$1.28\ HDG = 1.28 \times 14 \times 12 \times 1 = 215\ \#/$

$\text{Reqd. } L = .216 \times .1875 \sqrt{\frac{36000}{14 \times 1}} = 2.053'$

$> .035 D = .035 \times 12 = .42'$

USE 2'-4"

For $J < .785$

Eq. 13-39 $\sigma_c = \left[w_t (1 + .4 A_v) + \frac{1.273\ M_s}{D^2} \right] \times \frac{1}{12 t_s}$ $\quad w_t = \frac{W_s}{\pi D} + w_{rs}$

$= \left[w_t (1 + .4 \times .035) + \frac{1.273 \times 40.1 \times 10^3}{12^2} \right] \frac{1}{12 \times .1875}$ $\quad = \frac{5000}{\pi \times 12} + \frac{1180}{\pi \times 12}$

$= 230.83\ PSI$ Small ok $\quad = 162.6\ \#/$

Eq. 13-3[illegible] Value of $J = \frac{M_s}{D^2 \left[w_t (1 - .4 A_v) + w_L \right]}$

$= \frac{40.0 \times 10^3}{12^2 \left[162.6 (1 - .4 \times .035) + 1051.6 \right]}$

$= .23 < .785$ Eq. 13-39 is ok to use

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Project No.	WW-PGE-2174		Sheet No.	7
Project Description:	Topock 12' Φ x 17' Tank			

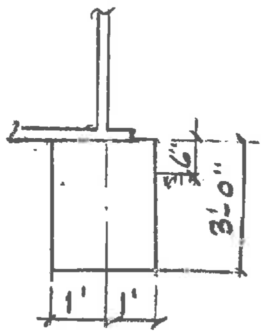
Reference:

Ring Wall Foundation

Try 2'-0" wide x 3'-0" deep foundation

Ring wall outside Dia = $d = 2\left(\frac{12}{2}+1\right) = 14'$

Ring wall Inside Dia. = $d_1 = 2\left(\frac{12}{2}-1\right) = 10'$



Try Footing Width = 2'-0"

Footing Depth = 3'-0"

$$A = \frac{\pi}{4}\left[14^2 - 10^2\right] = 122.5 \text{ ft}^2$$

$$S = \frac{\pi}{32}\left[\frac{14^4 - 10^4}{14}\right] = 199.4 \text{ ft}^3$$

Total Weight = $W = W_1' + W_2' + W_3'$

$W_1' = W_r + W_s = 1.13 + 5 = 6.13^k$

$W_2' = W_L \pi D = .215 \times \pi \times 12 = 8.11^k$

W_3' = Wt. of Ftg = $.15\left[A \times 3\right] = .15\left[122.5 \times 3\right] = 55.12^k$

$\Sigma W = 6.13 + 8.11 + 55.12 = 69.37^k$

$$q_1 = \frac{69.37}{122.5} = .566 \text{ KSF}$$

M_d = OTM @ Base of Ftg. = $M_s + V_f \times 3 = 40.0 + 6.64 \times 3 = 60.0^{1K}$

$$q_2 = \frac{60.0}{199.4} = .301 \text{ KSF}$$

DL + Seis. $q_1 + q_2 = .566 + .301 = .867 \text{ KSF} < 1.2 \text{ KSF}$

DL + LL ok by insp.

USE 2'-0" wide x 3'-0" deep Ftg. (Ring Fdn.)

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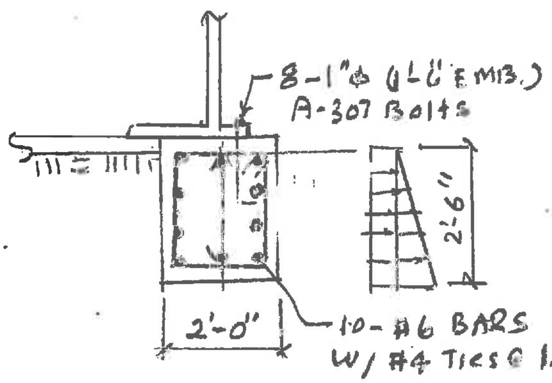
Project No.	WW-PGE-2174		Sheet No. 8
Project Description:	Topock 12' φ x 17' Tank		

Reference:

Ring Wall Foundation (contd.)

Hoop Tension



Soil Active Press = P_a

$P_a = k_a w h'$ $\quad h' = 2.5'$

$= .5 \times 120 \times 2.5$ $\quad k_a = .50$

$= 150 \ \#/'$ $\quad w = 120$ PSF/'

Surcharge

$P_s = w_H \times H \times .5$ $\quad w_H = 62.4$ PSF/'

$= 62.4 \times 14 \times .50$ $\quad H = 14'$

$= 436.8 \ \#/'$

Hoop Tension $T_H = w_p h' R$

$w_p = \left[\frac{P_a}{2} + P_s \right] = \frac{150}{2} + 436.8 = 511.8 \ \#/'$ Say $512 \ \#/'$

$T_H = 512 \times 2.5 \times \frac{12}{2} = 7680\# = 7.68^k$

$T_{HU} = 1.7 \times 7.68 = 13.056^k$ Say 13.1^k

$A_{sr} = \frac{13.1}{.9 \times 60} = .243 \ in^2$ $\quad$ Min. $A_s = .002 \times 36 \times 24 = 1.73 \ in^2$

10-#5 BARS ok. $\quad A_{s_a} = 10 \times .31 = 3.10 \ in^2 > 1.73 \ in^2$

USE 2'-0" W x 3'-6" TK Ftg. w/ 10-#6 BARS

Shear Reinf. Try #4 @ 12" o/c (3-legs)

$A_v = \frac{50 b_w s}{f_y} = \frac{50 \times 42 \times 12}{60000} = .42 \ in^2 < .2 \times 3 = .6 \ in^2$

#4 Stirrups @ 12" o/c ok

USE 10-#6 Bars w/ #4 stirrups @ 12"

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Project No. WW-PGE-2174			Sheet No. 1
Project Description:	Topock 10'ø x 21' Fiberglass Tank		

Reference:

Design References

1. AWAA Standard D-100-11
2. IBC 2009 / CBC 2010
3. ACI 318-11
4. Nuclear Reactors & Earthquakes (TID 7024) Chap-6

Design Data

Concrete $f'_c = 5^{KSI}$ $f_y = 60^{KSI}$ - Anchor Bolts - A-307

Tank Data

FRP Tank: Height $H_t = 17+1+3 = 21'$ Height of Water = 17'

Capacity of Tank = 10000 gallons (See pg 2 for required Ht.)

CRP Tank: Height $H_t = 15+1+2 = 18'$

Capacity of Tank = 10000 gallons (See pg. 6)

See Attachments A-1 & A-2 For Dimensions etc.

Seismic Data

Site Class - D

Seismic Coefficents (See structural Dwg. S-00-01)

$S_S = .23$ $F_a = 1.6$ $S_{MS} = F_a \times S_S = 1.6 \times .23 = .368$ Say .37

$S_1 = .12$ $F_v = 2.318$ $S_{M1} = F_v \times S_1 = 2.318 \times .12 = .279$ Say .28

$S_{DS} = .37 \times .667 = .247$ $S_{D1} = .28 \times .667 = .187$

Soil Data (No Soil Report)

Allow. Soil Press. = 4.0 KSF

Wind Data. Code AWAA D-100-11 (Sect. 3.1.4) Exposure C

Assume G = Gust Factor = 1.0 Wind vel. = 100 mph

$q_z = .00256\, K_z I V^2 = .00256 \times 1.09 \times 1.15 \times 100^2 = 32^{PSF}$

$P_W = q_z G C_f = 32 \times 1 \times .6 = 19.2^{PSF} > 30 \times .6 = 18^{PSF}$

USE $P_W = 20^{PSF}$

Total $P_W = 20 \times 10 \times 21.0 = 4200^{\#} = 4.20^k$

$V_{max} = 4.20^k$ $M_{max} = 4.20 \times 10.50 = 44.1^{'k}$

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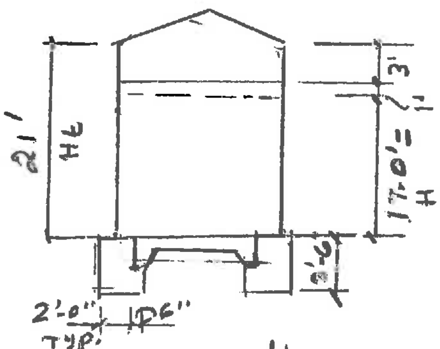
	Checked By:	KJ	Date: 6/25/14
	Reviewed By:		Date:
Project No. WW-PGE-2174			Sheet No. 10
Project Description: Topock 10'Ø x 21' Fiberglass Tank (FRP Tank)			

Reference:

10'Ø x 19'-0" (Water level), Fibreglass Tank



Cap. of Tank = 10000 gallons.

Ht. of water = H, $\frac{\pi}{4} \times 10^2 \times H = .1336 \times 10000$ H = 17'

1'-0" Freeboard

3'-0" Assumed sloshing

See pg. 9 for Tank Seismic & wind data

Impulsive Forces (Reference-1)

Eq. 13-18 $A_i = \frac{S_{ai} I_E}{1.4 R_I} = \frac{.247 \times 1.25}{1.4 \times 3.0} = .074$

$T_1 \leq T_S$ $S_{ai} = S_{DS}$ $T_1 = C_t h_n^x = .02 \times 21^{.75} = .196 < T_S$ $T_S = \frac{S_{D1}}{S_{DS}} = \frac{.187}{.247} = .757$

$A_{i\,min} = \frac{.36 S_1 I_E}{R_I} = \frac{.36 \times .12 \times 1.25}{3.0} = .018$ USE $A_i = .074\,g$

Eq. 13-20 $V_i = A_i (W_s + W_r + W_f + W_i)$, $M_i = A_i (W_s X_s + W_r H_t + W_i X_i)$

W_T = wt. of Contents $= 49 H D^2 = 49 \times 17 \times 10^2 \times 10^{-3} = 83.3^k$

$\frac{D}{H} = \frac{10}{21} = .4762 < 3.33$ $X_i = \left[.5 - .094 \frac{D}{H}\right] H = [.5 - .094 \times .476]\,21 = 9.56'$

Eq. 13-29

Eq. 13-25 $W_i = \left[1 - 0.218 \frac{D}{H}\right] W_T = [1 - .218 \times .476] \times 83.3 = .896 \times 83.3 = 74.65^k$

W_s = wt. of shell $= 3^k$ W_r = wt. of Roof $= 1^k$

Total Weight $= W_t = W_i + W_r + W_s = 74.65 + 4 = 78.65$ USE 79^k

$V_1 = A_i (W_t) = .074 \times 79 = 5.85^k$

$M_i = .074 (W_s X_s + W_r H_t + W_i X_i) = .074 (3 \times 21 \times .5 + 1 \times 21.5 + 75 \times 9.56)$

$= .074 (31.5 + 21.5 + 717) = 57^{'k}$

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Project No. WW-PGE-2174			Sheet No. 11
Project Description: Topock 10'Φ x 21' Fiberglass Tank			

Reference:

Convective Forces (Sloshing)

Eq. 13-18 $A_c = \frac{S_{ac} I_E}{1.4 R_I}$ $S_{ac} = \frac{K S_{D1}}{T} = \frac{1.5 \times .187}{T} = \frac{.2805}{1.825} = .1537 < S_{DS} = .247$

Eq. 13-22 $T_c = 2\pi\sqrt{\frac{D}{3.68 g \tanh\left(\frac{3.68 H}{D}\right)}} = 2\pi\sqrt{\frac{10}{3.68 \times 32.2 \times \tanh(6.256)}} = 1.825$ sec.

$\tanh \times \left(\frac{3.68 \times 17}{10}\right) = \tanh(6.256) = .99999$

$A_c = \frac{.1537 \times 1.25}{1.4 \times 1.5} = .0915$

$X_c = \left[1 - \frac{\cosh\left(3.67 \frac{H}{D}\right) - 1}{\frac{3.67 H}{D} \sinh\left[3.67 \frac{H}{D}\right]}\right] H$

$= \left[1 - \frac{\cosh(6.239) - 1}{6.239 \sin(6.239)}\right] \times 17 = \left[1 - \frac{256.1739 - 1}{6.239 \times 256.1739}\right] \times 17 = 14.286'$

256.17

$X_c = 14.286'$

Sloshing Wave Ht.

$d = .5 D A_f$ $A_f = \frac{K S_{D1} I_E}{T_c} = \frac{1.5 \times .187 \times 1.25}{1.825} = .1921$ (Group II)

$= .5 \times 10 \times .1921$ $A_f = .1921$

$= .96'$

Uplift on Tank

$P_s = \left[\frac{4 M_s}{D A_c} - W'\right] \times \frac{1}{N} + \frac{.035 \times W'}{N}$ $N = \frac{\pi D}{6} = 6$

$= \left[\frac{4 \times 57}{10} - 4\right] \times \frac{1}{6} + \frac{.035 \times 4}{6} = 3.16^k$

1"Φ x 1'-6 (Emb.) A.B.'s @ 6'-0" o/c Cap. = $12.1^k > 3.16^k$

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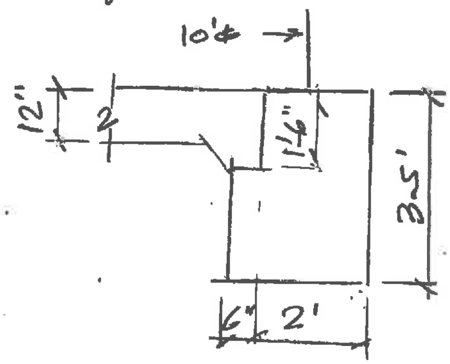
Project No.	WW-PHE-2174		Sheet No. 12
Project Description:	Topock 10' ϕ x 21' Fiberglass Tank		

Reference:

Ring Wall Foundation w/ Ledge for slab under the Tank'
(See pg-10 for sketch)

Ring wall outside Dia = 12'   Ring wall Inside dia. = 8'



Try Footing Width = 2'-6"
Footing Depth = 3'-2"

$A = \frac{\pi}{4}\left[12^2 - 8^2\right] = 62.83\ ft^2$

$S = \frac{\pi}{32}\left[\frac{12^4 - 8^4}{12}\right] = 136.14\ ft^3$

Total weight $W_t = 79^k$

$W_1' = W_r + W_S = 1 + 3 = 4^k$

$W_2' = W_L \pi D = 1.28 \times 17 \times 10 \times 10^{-3} \times \pi \times 10$
$= 6.84^k$

$W_3' =$ wt. of Ftg. $= .15 \times 62.83 \times 3.5$
$= 33^k$

$\Sigma W = 4 + 6.8 + 33 = 45.8^k$ Say 46^k

$q_1 = \frac{46}{62.83} = .73\ ^{KSF}$

$M_d =$ OTM @ Base of Ftg. $= M_S + V_f \times 3.5 = 57 + .0915 \times 79 \times 3.5$
$= 57 + 7.23 \times 3.5 = 82.3^k$

$q_2 = \frac{82.3}{136.14} = .605$

$P_{(DL + Seis.)} = .73 + .605 = 1.335\ ^{KSF} < 4\ ^{KSF}$

$P_{(DL + LL)} = \frac{79}{62.83} = 1.26\ ^{KSF} < 4\ ^{KSF}$

$P_{(DL + LL + wind)} = \frac{79}{62.83} + \frac{44.1}{136.14} = 1.58\ ^{KSF} < 4\ ^{KSF}$

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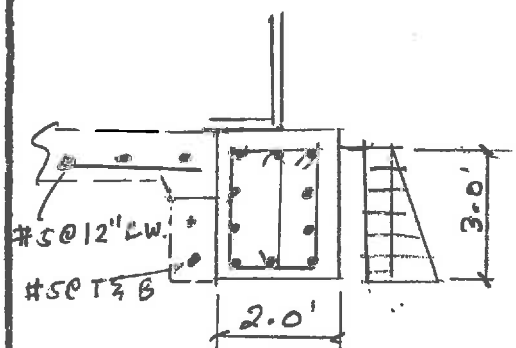
	Checked By:	KJ	Date: 6/25/14
	Reviewed By:		Date:
			Sheet No. 13

Project No.	WW-PGE-2174
Project Description:	Topock 10' ⌀ x 21' Fiberglass Tank

Reference:

Ring Wall Fdn - Contd.

Hoop Tension



Soil Active Press = P_a

$P_a = k_a w h'$ $h' = 3.0'$

$= .5 \times 120 \times 3$ $K_a = .50$

$= 180$ #/' $w = 120$ PSF/'

Surcharge

$P_s = w_H \times H \times .5$ $w_H = 62.4$ PSF/'

$= 62.4 \times 17 \times .50$ $H = 17'$

$= 530.4$ #/'

Hoop Tension $T_H = w_p h' R$

$w_p = \left[\frac{P_a}{2} + P_s\right] = \frac{180}{2} + 530.4 = 620.4$

$T_H = 620.4 \times 3.0 \times \frac{10}{2} = 9306^{\#} = 9.306^k$

$T_{Hu} = 1.7 \times 9.306 = 15.82^k$

$A_{sr} = \frac{15.82}{.9 \times 60} = .293 \text{ in}^2$ Min. $A_s = .002 \times 42 \times 24 = 2.02 \text{ in}^2$

USE 10 - #6 bars $A_{sa} = 10 \times .44 = 4.4 \text{ in}^2 > 2.02$

Shear Reinf. Try #4 @ 12"

$A_v = \frac{50 b_w s}{f_y} = \frac{50 \times 42 \times 12}{60000} = .42 \text{ in}^2 < .2 \times 3 = .6 \text{ in}^2$

USE 10 - #6 Bars w/ #4 Stirrups @ 12" o/c

Conc. Slab on Grade

Min. Reinf. $= .002 \times 12 \times 12 = .288 \text{ in}^2$

USE #5 @ 12" Ea. Way

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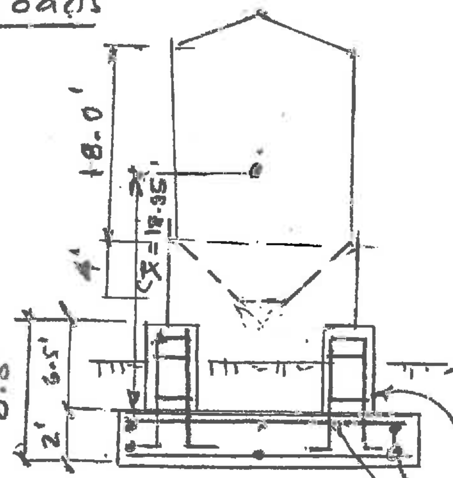
Project No.	WW-PGE-2174		Sheet No. 14
Project Description:	Topock 10"Φ CRP Tank (Fiberglass Tank)		

Reference:

Seismic Loads



Cap. of Tank = 10000 Gallons

$\left(\frac{\pi}{4}\times 10^2 \times H + \frac{\pi}{4}\times 10^2 \times \frac{5}{2}\right) = .1336 \times 10000$

Solving for H

$78.54H + 196.0 = 1336 \quad H = 14.5'$

USE 15'

C.G. (Mom. @ Top of FTG.)

$78.5 \times (7.5+5+6.5) + 12.23 \times (3.67+6.5)$

$= 85.73 \times \bar{X}$

$\bar{X} = 18.85'$

Impulsive Forces

$A_i = \frac{S_{ai} I_E}{1.4 R_I}$ $\quad I_E = 1.25 \quad R_I = 3.0$

For $T < T_s$ $\quad S_{ai} = S_{DS}$

$T_1 = C_t h_n^x$

$= \frac{.247 \times 1.25}{1.4 \times 3.0}$

$= .074$

$V_i = A_i (W_s + W_r + W_i)$

$W_1 = 49 H D^2 = 49 \times 15.0 \times 10^2 + 196 \times 62.4$ (cylindrical, conical)

$= 73500 + 12230 = 85730^{\#}$

$= .074(5 + 85.73)$

$W_s + W_r = 3 + 2 = 5^k$

$= 6.71^k$

Convective Force (See sect. 13.2-9.1 for elevated tanks)

Eq. 13-18 $A_c = \frac{S_{ac} I_E}{1.4 R_I}$ $\quad S_{ac} = \frac{1.5 \times .187}{T_c} = .154$

$T_c = 2\pi \sqrt{\frac{D}{3.68\, g \tanh\left(\frac{3.68 H}{D}\right)}}$

$= 2\pi \sqrt{\frac{10}{3.68 \times 32.2 \tanh(5.52)}}$

$= 1.823$

$= \frac{.154 \times 1.25}{1.4 \times 1.5} = .0915$

$V = .0915 \times 91 = 8.327^k$

$M = (85.73 \times 18.85 + 3 \times 20.5 + 1 \times 30 + 1 \times 10.17) \times .0915 = 157.2^{lk}$

Design OTM $M_o = 1.5 \times 157.2 + 1.5 \times 8.3 \times 2 = 260.7^{lk}$

Resisting Mom. $= M_R = 85.73 \times (3.75 + 3.25) = 643^{lk}$

$F.S. = \frac{643.0}{260.7} = 2.46$ OK

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	Reviewed By:		Date:
Project No.	WW-PGE-2174		Sheet No. 15
Project Description:	Topock 10'Ø FRP Tank		

Reference:

Anchor Bolts & Pedestals

Bolts — check uplift w/ Tank empty + wind

$P_W = 20$ PSF $P_W = .02 \times 10 \times 18 + .02 \times 10 \times 4 = 3.6 + .8 = 4.4^k$

$M_W = 3.6 \times 21 + .8 \times 12.17 = 75.6 + 9.74 = 85.34^{1k}$ (OTM)

$P_{DL} = 5^k$ $M_R = 5 \times (3.75 + 3.25) = 35.00^{1k}$

$P_u = \frac{85.34 \times 1.5 - 35.0}{7.5 \times 2} = 6.2^k$ $V/PED. = \frac{4.4}{4} = 1.1^k$

(@ Bolt w/ 2 PED.'s)

$P_u = (85.34 \times 1.5 - 35)/(7.5/.707) = 8.77^k$

(@ Bolt w/ single ped acting)

1"Φ A-B. $T_{All} = 10.9^k$ $V_{All} = 5.7^k$

$\frac{T}{T_{All}} + \frac{V}{V_{All}} = \frac{8.77}{10.9} + \frac{2.2}{5.7} = 1.19 < 1.33$ USE $1\frac{1}{4}$"Φ × 16" (EMB.) A-307 Bolts

$M/ped. = 1.1 \times 6.5 \times 1.7 + 85.34 \times .5 \times 1.7 = 84.69^{1k}$

$f_p = \frac{P}{A} + \frac{M}{S}$ $P_{DL} = 5 + .15 \times 2.5^2 \times 6.5 = 11.09^k$

$M = 84.69^{1k}$ $S = \frac{1}{6} \times 14 \times 14^2 = 457.33$

$= \frac{11.09}{14 \times 14} + \frac{84.69}{457.33}$

$= .242$ KSF

Dowels in Pedestal

Ten $T = \frac{84.69 \times 12}{4 \times 24} = 14.12^k$ $T_A = .9 \times 60 \times .79 = 42.66^k$/Dowel

USE 2'-6" SQ. Pedestal w/ 12 - #7 BARS OR 18 - #8 BARS

Comp in Pedestal (DL + LL + Seismic OR Tank full + Seismic)

$M_s = 157.2^{1k}$ (See pg. 14) (OTM @ Top of Ped.) $P_s/PED. = \frac{157.2}{7.5 \times 2} + \frac{86}{4} = 10.48 + 21.5 = 32$

$M/PED = \frac{8.33 \times 6.5}{4} = 13.54^{1k}$

Conc. col. $f_c = 5$ ksi, $f_y = 60$ ksi, $\gamma = .75$

$P_u = [1.4 \times 10.5 + 1.4(.15 \times 2.5^2 \times 6.5)] + 1.7 \times 21.5 = 59.8^k$

$M_u = 1.7 \times 13.54 = 23.02^{1k}$ $\rho = \frac{A_s}{bd} = \frac{8 \times .79}{30 \times 27.5} = .008$ $\frac{P_u}{A_g} = 2.69$ for $\frac{e}{h} = \frac{23 \times 12}{2.69 \times 60}$ ...

$P_u = 2.06 \times 30 \times 30 = 1854^k > 60^k$

USE 30" × 30" PEDESTAL w/ 12 #7 BARS & #4 TIES @ 12" o/c

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Project No.	WW-PEG-2174		Sheet No. 16
Project Description:	Topock 10'Φ GRP Tank		

Reference:

Base Plate (DL+LL+ Seismic or Tank Full + Seismic)

P./PED. = 32^k (pg. 15) Try 12"×12" × 1" TK PL

$S_{pl.} = \frac{1}{6} \times 1" \times 1.0^2 = .1666 \ in^3$

$p = \frac{32}{12 \times 12} = .222^{ksi}$ $M_{pl.} = \frac{.222 \times 6^2}{2} = 4^{"k}$

$f_b = \frac{4}{.1666} = 24^{ksi} < 27^{ksi}$

USE Base pl. 12" × 1" × 1'-0"

Footing Reinf.

Total P = 86^k + 4 ($.15 \times 2.5^2 \times 6.5$) + $.15 \times 14^2 \times 2.0 = 169.2^k$
(pg. 14)

Mo = 157.2 + 8.33×2 = $173.86^{'k}$
(@ Base Ftg)

$\frac{P}{A} + \frac{M}{S} = \frac{169.2}{14 \times 14} + \frac{173.86}{\frac{1}{6} \times 14 \times 14^2} = .86 + .38 = 1.24^{ksf} < 4^{ksf}$ ok

Mu @ Face of pedstal = $1.6 \times 1.24 \times \frac{2^2}{2} = 2.90^{'k}$ Mu btw'n Ped's = $\frac{1.24 \times 1.6 \times 7.5^2}{10} = 11.16^{'k}$

d = 24 − 3.5 = 21.5" b = 12" Try #5 @ 12"

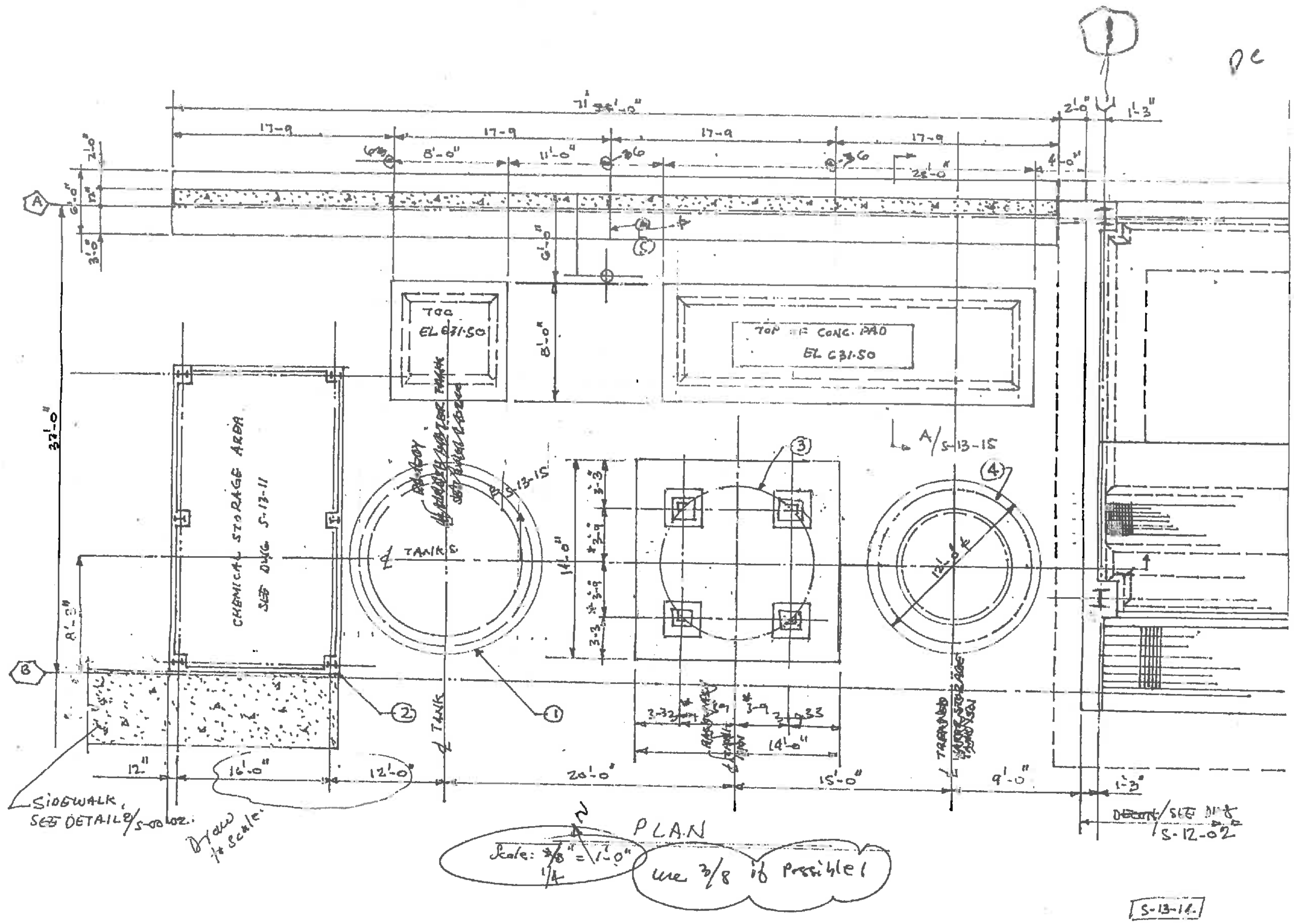
$\phi M_n = .9 \times .31 \times \frac{60}{12} (d - \frac{a}{2})$ $a = \frac{.31 \times 60}{.85 \times 5 \times 12} = .365$

$= .9 \times .31 \times 5 (21.5 - \frac{.365}{2}) = 29.73^{'k} > 11.16^{'k}$

Vu ok by insp.

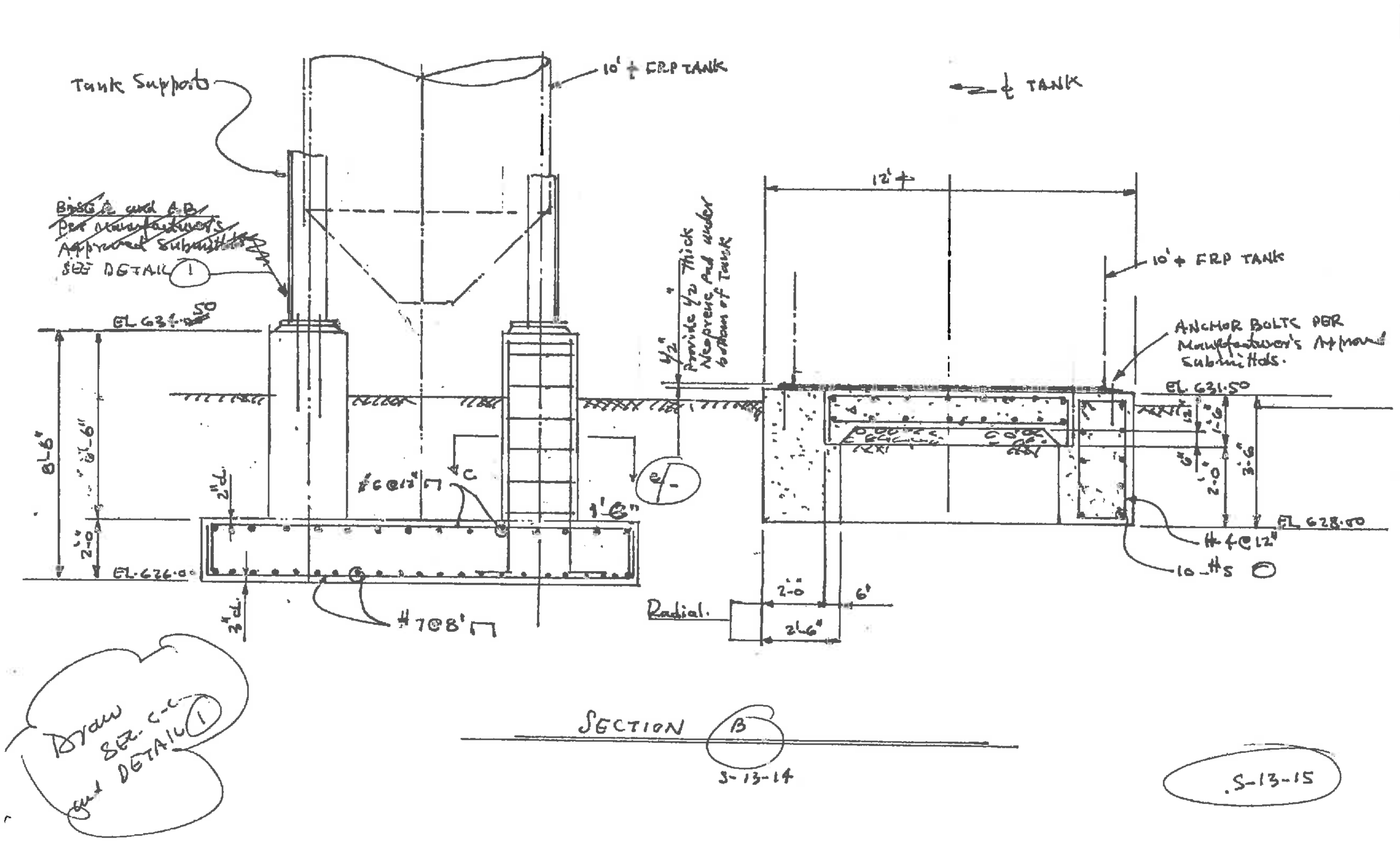
USE 14'×14' SQ. × 2'-0" TK FTG. w/ #5 @ 12" @ T & B

A-1



CHEMICAL STORAGE AREA
SEE DWG S-13-11
TOC
EL 631.50
TOP OF CONC. PAD
EL 631.50
A/S-13-15
TANKS
TANK
PLAN
Scale: 3/8" = 1'-0"
1/4
use 3/8 if Possible!
SIDEWALK,
SEE DETAIL B/S-00-02.
Draw to scale.
S-13-11
S-12-02
37'-0"
17-9
8'-0"
11'-0"
4'-0"
2'-0"
1'-3"
14'-0"
12'-0"
16'-0"
20'-0"
15'-0"
9'-0"
12"

A-2


Tank Supports
10' ⌀ FRP TANK
← ℄ TANK
12' ⌀
10' ⌀ FRP TANK
Base Pl. and A.B. Per Manufacturer's Approved Submittals
SEE DETAIL 1
EL 631.50
1/2"
Provide 1/2 Thick Neoprene Pad under bottom of Tank
ANCHOR BOLTS PER Manufacturer's Approved Submittals.
EL 631.50
8'-6"
6'-6"
2'-0"
EL 626.00
2"cl.
3"cl.
#6@12"
C
C
1'-6"
#7@8'
3'-6"
2'-0"
EL 628.00
#4@12"
10-#5
Radial.
2'-0"
6'
2'-6"
SECTION B
S-13-14
S-13-15
Draw Sec. C-C and DETAIL 1

User–Specified Input

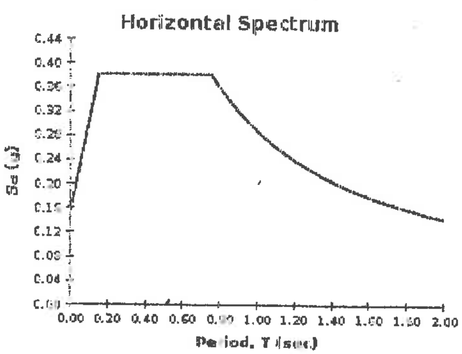
Building Code Reference Document ASCE 41-13 Retrofit Standard, BSE-2N
(which utilizes USGS hazard data available in 2008)

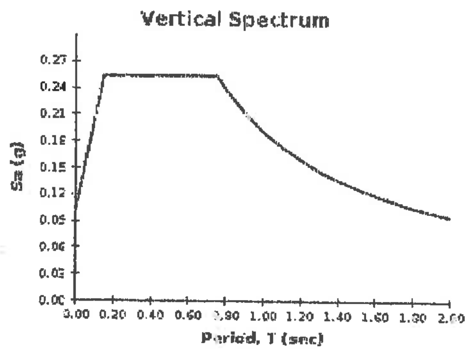
Site Coordinates 34.78039°N, 114.58276°W

Site Soil Classification Site Class D – "Stiff Soil"

USGS–Provided Output

$S_{S,BSE-2N}$	0.238 g	$S_{XS,BSE-2N}$	0.381 g
$S_{1,BSE-2N}$	0.125 g	$S_{X1,BSE-2N}$	0.287 g





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Tab. # 4

1. CONDITIONED WATER TANK (40,^{K} gallons).
2. Retaining wall.

VINOD / EZ

NO. OF PAGES - 11

A - CALCULATION COVER SHEET

CALCULATION ID NUMBER	
REVISION NUMBER	
JOB NUMBER	~~WW PEB-2194-043012~~

TITLE	Topock Groundwater Remediation Project, Water Tank

	initial	date
PREPARED		
TITLE		
REVIEWED		
TITLE		

REVISION NOTES	

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Designed By:	KD	Date:	3/29/12
Checked By:	KJ	Date:	6/25/14
Revised By:		Date:	
Project No.	WW-PEG-2174-485062-01.02.02	Sheet No.	1

Project Description: Topock Groundwater Remediation Project, Ref.'s & Data

Design References

1. AWWA Standard D-100-11 (Rev. of ANSI/AWWA D100-05)
2. IBC 2009 / CBC 2010
3. ACI 318-11
4. Nuclear Reactors & Earthquakes (TID 7024) Chap.-6

Design Data

Concrete $f_c' = 4.0^{ksi}$ $f_y = 60^{ksi}$
Anchor Bolts A-307

Tank Data

Total Height = 16' Height of water = H = 12.5'
Dia. of Tank = 25' = D
Min t for shell $= \frac{2.6 h_p D G}{SE} = \frac{2.6 \times 12.5 \times 25 \times 1}{15000 \times .66} = .05''$ Use .25"
(Table 15)

Seismic Data (See attachment - 1)

Site class - D (Assumed w/o any Soil Info.)
Seismic coefficients based on general area in Needles, CA.

$S_s = .23$
$S_1 = .12$
$F_a = 1.6$
$F_v = 2.318$

$S_s = .434$ $S_1 = .135$ $F_a = 1.4$ $F_v = 2.3$
$S_{MS} = F_a \times S_s = 1.4 \times .434 = .608$ (.23)
$S_{M1} = F_v \times S_1 = 2.3 \times .135 = .311$ (.322) .368 S_{M1}
.279
$S_{DS} = .667 \times .608 = .406$ (.322) .214 $S_{D1} = .667 \times .311 = .207$

Soil Data (No Soil Report)

Allow. Soil press. = 1 × 1.2 = 1200 PSF

Wind Data - Code AWWA D100-11

Assume G = Gust factor = 1.0 V = wind vel. = 100 m/hr.

$P_W = q_z G C_f$ | $q_z = .00256 K_z I V^2$
$= 32 \times 1.0 \times .6$ | $= .00256 \times 1.09 \times 1.15 \times 100^2 = 32^{PSF}$
$= 19.2^{PSF} > 30 C_f$

However Use 25 PSF = P_W
Total wind $P_W = 25 \times 25 \times 16 = 10000^{\#} = 10^k$
$V_{max} = 10^k$ $M_{max} = 10 \times 8 = 80^{'k}$ (Overturning)

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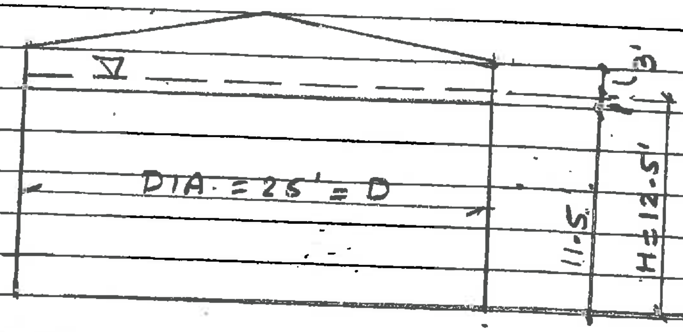
Project No. WW-PEG-2174-43052		Sheet No. 2
Project Description Topock Groundwater Remediation Proj.		

Design of 25' Dia Water Tank (Ref. #1 pg. 1)



Impulsive Components

$A_i = \frac{S_{ai} I_E}{1.4 \times R_I} = \frac{.406 \times 1.25}{1.40 \times 3.0} = .121\ g$

Table 24 (Group II)
$I_E = 1.25$ $R_I = 3.0$ (Table-28) (Impulsive)
$S_{ai} = S_{DS}$ (For $T_i \le T_s$) $R_I = 1.5$ (convective)

$T_1 = C_t h_n^x = .02 \times 16^{.75} = .16$ sec. $< .51$ Sec.

$T_L = 12$ sec. $T_S = \frac{S_{D1}}{S_{DS}} = \frac{.207}{.406} = .51$ sec

Min. $A_i = \frac{.36 S_1 \times I_E}{R_i} = \frac{.36 \times .311 \times 1.25}{3.0} = .047$ USE $A_i = .121$ G

Eq. 13-20 $V_i = A_i (W_s + W_r + W_f + W_i)$

$M_i = A_i (W_s X_s + W_r \times H_t + W_i X_i)$

Weights

W_T = wt. of contents = $49 HD^2 = 49 \times 12.5 \times 25^2 \times 10^{-3} = 382.8^k$

$\frac{D}{H} = \frac{25}{12.5} = 2 < 3.33$ $\frac{W_1}{W_T} = .55$ $\frac{X_1}{H} = .35$

$\frac{W_2}{W_T} = .43$ $\frac{X_2}{H} = .62$

$X_1 = .35 H = .35 \times 12.5 = 4.38'$

$W_1 = .55 \times W_T = .55 \times 382.8 = 210.5^k$ (Effective weight)

$X_2 = .62 H = .62 \times 12.5 = 7.75'$

$W_2 = .43 W_T = .43 \times 382.8 = 164.6^k$

$W_r = \frac{\pi}{4} (25)^2 \times .01 = 4.91^k$ = wt. of Roof

$W_s = \frac{\pi}{4} (25.042^2 - 25^2) \times 16 \times .49 = 12.84$ = wt. of shell

Total wt. $W = W_1 + W_r + W_s = 210.5 + 4.91 + 12.84 = 228.25^k$ Say 229

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Project No. WWW-PEA-2174-43052		Sheet No. 3

Project Description Topock Groundwater Remediation press.

(25' Dia. Water Tank contd.)

Total $W = 229^k$

Note: Floor weight not included since it is at ground level.

Shear V_i (due to impulsive forces)

Eq. 13-20 $= A_i (W_i + W_r + W_s) = .121 \times 229 = 27.7^k$

partial Eq. 13-23 Moment M_i (due to impulsive forces

$= A_i (W_s \times X_s + W_r \times H_t + W_i \times X_i)$

$= .121 (12.84 \times 8 + 4.91 \times 16 + 210.5 \times 4.38)$

$= .121 (102.72 + 78.56 + 922) = 133.5^{1k}$

Adjust & Calculate effective impulsive weight to include varying bot. press. if supported on pile fdn. (Sect. A-135.3)

Eq. 13-22 $X_i = .375 H = .375 \times 12.5 = 4.69'$

$$X_{imf} = .375 \left[1 + 1.333 \left\{ \frac{.866 \frac{D}{H}}{\tanh(.866 \times \frac{D}{H})} - 1 \right\} \right] H$$

$$= .375 \left[1 + 1.333 \left\{ \frac{.866 \times 2}{\tanh(1.732)} - 1 \right\} \right] 12.5$$

$\tanh(1.732) = .939$

$= .375 [26.572] = 9.96'$

Partial Eq. 13-32 Moment $M_{imf} = .121 (102.72 + 78.56 + 210.5 \times 9.96)$

$= 264.77^k$

? To be used if supported on pile fdn. or MAT FDN. See Sect. A.13.5.3

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Project No. WW-PEG-2174-435062		Sheet No. 4

Project Description: Topock Groundwater Remediation Proj.

(25' DIA. TANK CONTD.)

Convective Forces (Sloshing Effect)

$$A_c = \frac{S_{ac} I_E}{1.4 R_i} \qquad I_E = 1.25 \qquad R_I = 1.5$$

$$S_{ac} = \frac{K S_{D1}}{T_c} \leq S_{DS} \quad \text{(Eq. 13-12)} \qquad T_c \leq T_L$$

First mode of sloshing effect given by

$$T_c = 2\pi \sqrt{\frac{D}{3.68 g \tanh\left(\frac{3.68 H}{D}\right)}}$$

$$\tanh\left(\frac{3.68 \times 12.5}{25}\right) = \tanh(1.84) = .9508$$

$$T_c = 2\pi \sqrt{\frac{25}{3.68 \times 32.2 \times .9508}} = 2.96 \text{ sec.} < 12 \text{ sec.}$$

Eq. 13-12 $$S_{ac} = \frac{1.5 \times .207}{2.96} = .1049$$

$$A_c = \frac{.1049 \times 1.25}{1.4 \times 1.5} = .0625$$

Eq. 13-30 $$X_c = \left[1 - \frac{\cosh\left[\frac{3.67H}{D}\right] - 1}{\frac{3.67H}{D} \sinh\left[\frac{3.67H}{D}\right]}\right] H$$

Substitute $H = 12.5$, $D = 25$

$$= \left[1 - \frac{\cosh(1.835) - 1}{1.835 \sinh(1.835)}\right] 12.5$$

$$= \left[1 - \frac{3.2124 - 1}{1.835 \times 3.0528}\right] \times 12.5 = 7.5634'$$

$$W_c = .230 \frac{D}{H} \tanh\left[\frac{3.67 \times H}{D}\right] W_T$$

$H = 12.5$ $D = 25$

$W_T = 49 \pi H D^2 = 382.8^k$

$$= .230 \times 2 \tanh[1.835] \times 382.8$$

$$= .230 \times 2 \times .9503 \times 382.8 = 167.34^k$$

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Project Description	Topock Groundwater Remediation Project.		

Eq. 13-35 Height from bot. of shell to the c.G. of effective convective weight W_c adjusted for varying bot. press.

$$= X_{cmf} = \left[1 - \frac{\cosh\left[\frac{3.67H}{D}\right] - 1.937}{\frac{3.67H}{D}\sinh\left[\frac{3.67H}{D}\right]}\right] H \qquad H = 12.5 \quad D = 25$$

$$= \left[1 - \frac{\cosh(1.835) - 1.937}{1.835 \sinh(1.835)}\right] 12.5$$

$$= \left[1 - \frac{3.2124 - 1.937}{1.835 \times 3.0528}\right] \times 12.5 = 9.654'$$

Eq. 13-32 $M_{cmf} = \sqrt{A_i (W_s X_s + W_r H_t + W_i X_{imf})^2 + [A_c W_c X_{cmf}]^2}$

Moment due to convective (sloshing)

$= A_c W_c X_{cmf}$ $\qquad A_c = .0625$ (pg. 4)

$= .0625 \times 167.34 \times 9.654$ $\qquad X_{cmf} = 9.654'$

$= 100.97$ $\qquad W_c = 167.34$ (pg. 4)

$$M_{cmf} = \sqrt{(264.77)^2 + (100.97)^2}$$

$$= 283.37^{1k}$$

Moment to be used if supported on pile or Mat Fdn. (Sect. 13.5.3.2.2)

Eq. 13-23 $M_s = \sqrt{[A_i (W_s X_s + W_r H_t + W_i X_i)]^2 + [A_c W_c X_c]^2}$

$$= \sqrt{(133.5)^2 + (.0625 \times 167.34 \times 7.5634)^2}$$

$$= \sqrt{17822.25 + 6257.4} = 155.18^{1k}$$

USE 160^{1k}

M_s is Design overturning moment @ bot. of shell (w/o bot varying press effect) for Ring Fdn.

Eq. 13-31 V_f = Design shear @ top of Ring Fdn

$$= \sqrt{[A_i (W_s + W_r + W_f + W_i)]^2 + (A_c W_c)^2}$$

$$= \sqrt{[.121 (229)]^2 + [.0625 \times 167.34]^2} = 29.62^k$$

USE 30^k

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Project No. WW-PEB-2174-435062		Sheet No. 6

Project Description Topock Groundwater Remediation Project

Uplift Check

Eq. 13-36 J = overturning Ratio

$$= \frac{M_s}{D^2 [w_t(1-.4 A_v) + w_L]}$$

Sect. 13.5.4.3
$A_v = 1.4 S_{DS} = .14 \times .406 = .057$
$M_s = 160^{1k}$
$D = 25'$

Eq 13-41 $w_t = \frac{W_s}{\pi D} + w_{rs}$

$= \frac{12840}{\pi D} + 100$

$= 163.5 + 100 = 263.5$ #/'

$W_s = 12.84$
$w_{rs} = \frac{5}{\pi D} = .064$ k/' $= 64$ #/' say 100#/'

Eq 13-37 $w_L = 7.9 t_b \sqrt{F_y H G} \le 1.28 HDG$

$1.28 HDG = 1.28 \times 12.5 \times 25 \times 1 = 400$ #/'

Eq. 13.38 Required Annulus width = $L = .216 t_b \sqrt{\frac{F_y}{HG}} \le .035 D$

$= .216 \times .25 \sqrt{\frac{36000}{12.5 \times 1}}$

$= 2.9'$ say 3'

$.035 \times 25 = .875'$

$$J = \frac{160 \times 10^3}{25^2 [263.5(1-.40 \times .057) + 400]} = .389 < .785$$

Sloshing Wave Height

Eq. 13-52

$d = .5 D A_f$

A_f when $T_c < 4 = \frac{K S_{D1} I_E}{T_c}$ $T_c = 2.96$ sec (pg. 4)

$S_{D1} = .207$ $I_E = 1.25$ $K = 1.5$

$A_f = \frac{1.5 \times .207 \times 1.25}{2.96} = .1311$

$d = .5 \times 25 \times .1311 = 1.64' < 3'$ ok

Wind loads (See pg. 1)

Max $M_w = P_w \times 16 \times .5 = 10 \times 8 = 80^{1k} < 160^{1k}$ (Seismic)

Seismic loads govern the design of the Tank

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Project No. WW-PEB-2174-43062		Sheet No. 8

Project Description Topock Groundwater Remediation Proj.

Ring Wall Foundation

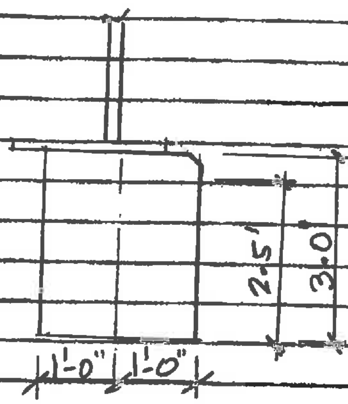
Try 2'-0" wide × 3'-0" deep foundation

~~Ring wall outside dia = d = 2(25/2 + 1) = 27'~~

~~Ring wall Inside dia. = d_1 = 2(12.5 − 1) = 23'~~

Width = 2.0'

Depth = 3.0'



$$A = \frac{\pi}{4}\left[27^2 - 23^2\right] = 157.08\ ft^2$$

$$S = \frac{\pi}{32}\left[\frac{27^4 - 23^4}{27}\right] = 914.84\ ft^3$$

Calculate W

$W_1' = W_r + W_s = 5 + 13 = 18^k$

$W_2' = W_L \times \pi \times D = .4 \times \pi \times 25 = 31.42^k$

W_3' = Weight of Ftg

$= .15 \left\{\frac{\pi}{4}\left[27^2 - 23^2\right]\right\} 3.0 = 70.7^k$

$\sum W = 18 + 31.42 + 70.7 = 120.11^k$ USE 125^k

~~Assume wt. of water is supported by slab or Ground~~

$q_1 = \frac{125}{157.08} = .796^{KSF}$

$M_{OTM} = 160^{1k}$ $M_d = 160 + 30 \times 3.0 = 250^{1k}$

$q_2 = \frac{250}{914.84} = .273^{KSF}$

DL+Seis. $q_1 + q_2 = .796 + .274 = 1.07^{KSF} < 1.2^{KSF} \times 1.33$ OK

~~Assume LL = .016 × $\frac{\pi}{4}$ × 25² = 7.85^k~~ q_3 = ~~$\frac{7.85}{157.08}$~~ $= .05^{KSF}$

DL + LL $q_1 + q_3 = .796 + .05 = .846^{KSF} < 1.2^{KSF}$ OK

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Project No. WW-PEB-2174-435062		Sheet No. 7

Project Description Topock Groundwater Remediation Project

Annular Ring

Eq. 13-37

$W_L = 7.9\, t_b \sqrt{F_y H G} < 1.28\ HDG$

$W_L = 7.9 \times .25 \sqrt{36000 \times 12.5 \times 1} = 1325\ \#/'$

$1.28\ HDG = 1.28 \times 15 \times 160$ (3.5) $= 400\ \#/'$ (480)

Eq. 13-38 Require L (Annulus width)

$= .216 \times .25 \sqrt{\dfrac{36000}{12.5 \times 1}} = 2.9' > .035 \times 25 = .875'$

USE 3'-0"

For J < .785

Eq. 13-39 $\sigma_c = \left[W_t (1 + .4 A_v) + \dfrac{1.273\ M_s}{D^2} \right] \dfrac{1}{12\, t_s}$

$= \left[263.5 (1 + .4 \times .057) + \dfrac{1.273 \times 160 \times 10^3}{(25)^2} \right] \times \dfrac{1}{12 \times .25}$

$= [595.4] \times \dfrac{1}{12 \times .25} = 198.5$ PSI Small ok

Anchor Bolts

AWWA-D-100-11

$V_{max} = V_f = 30^k$ (pg. 5)

$M_{max} = M_s = 160'^k$

$V_A = \tan 30 (W_s + W_r + W_1)(1 - .4 A_v)$

$= .577 (229)(1 - .4 \times .057) = .577 \times 229 \times .977$

$= 129.1^k >> 30^k$

Min. Anchor Bolts to be provided

Min. SPA. = 6'

$\pi D = \pi \times 25 = 78.5'$

No. of Anchor Bolts $= \dfrac{78.5}{6} = 13$ USE 14 - 1"φ x 18" A-307 A-B.'s

Eq. 3-42 $P_s = \dfrac{4\ M_s}{N\ D_{ac}} - \dfrac{W'}{N} = \left[\dfrac{4 \times 160}{25} - .057 \times 18 \times 9 \right] \times \dfrac{1}{14}$ ($W_r + W_s$)

(Design uplift) $= 1.76^k$ ok

Sect. 3.3.3.2 Ten. Cap. of 1" x 1'-6" (Emb.) A.B. = $.5 \times 58 \times .606 = 17.57^k$

Cap. of Conc. = 12.1^k for Emb. = 18" Root tensile "

Sect. 3.8.5 Min. Dia. = 1" Allowance .25" for corrosion USE Root Area for 3/4 φ = .334

Ten. Cap. = $.5 \times 58 \times .334 = 9.7^k > 1.76^k$ ok

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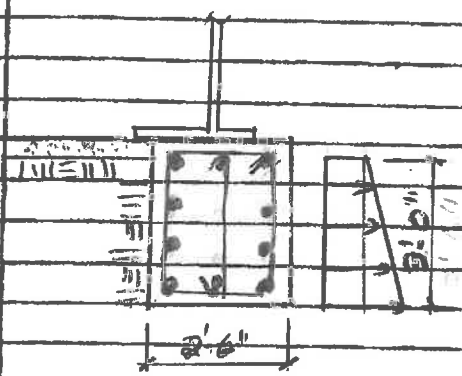
Project No. WW-PEB-2174-43062		Sheet No. 9

Project Description Topock Groundwater Remediation Proj.

Ring Wall Foundation (contd.)

Hoop Tension



Soil Active Press

$= P_a = K_a w b'$ $b' = 3.0"$

$K_a = .50$

$= .5 \times 120 \times 3.0$ $w = 120$ PSF/'

$= 255$ #/'

Surcharge

$P_s = w_H \times H \times .5$ $w_H = 62.4$ PSF/'

$= 62.4 \times 12.5 \times .5$ $H = 12.5$

$= 390$ #/'

Hoop Ten. $T_H = w_p b' R$

$w_p = \left[\frac{P_a}{2} + P_s\right] = \frac{255}{2} + 390 = 518$ #/'

↓ AV.

$T_H = 518 \times 3.0 \times \frac{25}{2} = 19425$ # $= 19.43^k$

$T_{H_u} = 1.7 \times 19.43 = 33.03^k$

$A_{s_r} = \frac{33.03}{.9 \times 60} = .61$ in²

Min. $A_s = .002 \times 36 \times 36 = 2.59$ in²

USE 10 - #6 Bars. $A_{s_a} = 10 \times .44 = 4.40$ in² > 2.59 in²

USE 2'-6" W × 3'-0" TK Ftg. W/ 10 - #6 Bars

W/ #4 Stirrups @ 18" o/c OR #5 stirrups @ 24" o/c

for Shear Reinf.

$A_v = \frac{50 b_w s}{f_y} = \frac{50 \times (36) \times 18}{60000} = .54$ in² < .2 × 3 = .6 in²

Alternate #5 Stirrups @ 24" o/c

$A_v = \frac{50 \times 36 \times 24}{60000} = .72$ in² < .31 × 3 = .93 in²

Attachment 1

USGS.gov
NSHMP_HazardApp.Jar

Conterminous 48 States
2003 NEHRP Seismic Design Provisions
Zip Code = 92363 (Needles, CA)
Spectral Response Accelerations Ss and S1
Ss and S1 = Mapped Spectral Acceleration Values
Data are based on a 0.05 deg grid spacing

Period (sec)	Centroid Sa (g)	
0.2	0.225	(Ss)
1.0	0.135	(S1)

Period (sec)	Maximum Sa (g)	
0.2	0.434	(Ss)
1.0	0.205	(S1)

Period (sec)	Minimum Sa (g)	
0.2	0.204	(Ss)
1.0	0.131	(S1)

Conterminous 48 States
2003 NEHRP Seismic Design Provisions
Zip Code = 86436 (Topock, AZ)
Spectral Response Accelerations Ss and S1
Ss and S1 = Mapped Spectral Acceleration Values
Data are based on a 0.05 deg grid spacing

Period (sec)	Centroid Sa (g)	
0.2	0.221	(Ss)
1.0	0.131	(S1)

Period (sec)	Maximum Sa (g)	
0.2	0.230	(Ss)
1.0	0.134	(S1)

Period (sec)	Minimum Sa (g)	
.2	.204	(Ss)
1.0	.131	(S1)

APPENDIX A - CALCULATION COVER SHEET

CALCULATION ID NUMBER	
REVISION NUMBER	
JOB NUMBER	

TITLE	Topock Ground Water Remediation Project Water Storage Tank Retaining Wall

CONTENT STRUCTURAL DESIGN CALCULATIONS

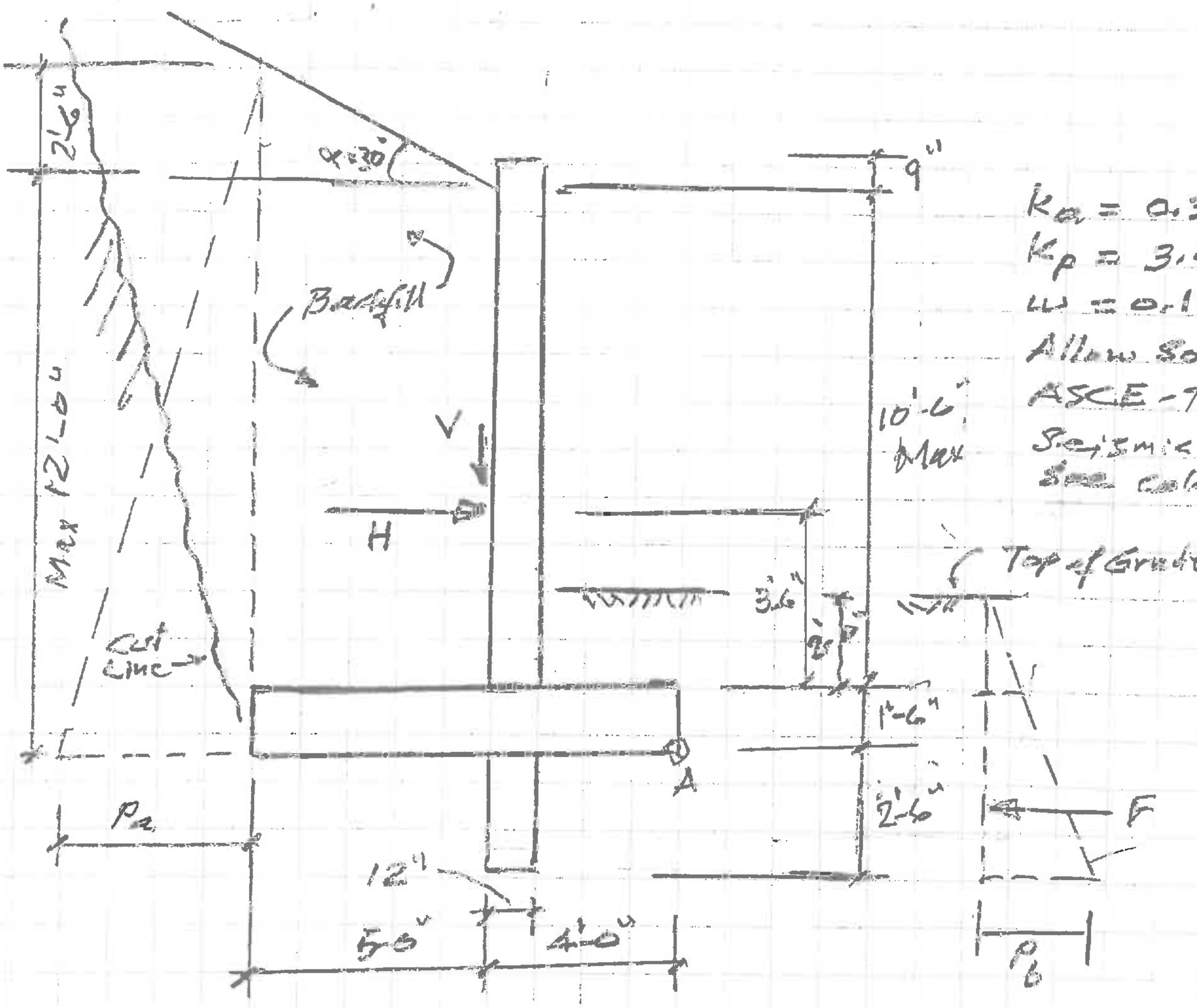
Page 1 - Reference Project related Dwgs & Design Data
2 - Retaining Wall Between station 40 TO 70
3 - " " " " 15 TO 35 & 65 TO 85
4 - " " " " 0 TO 15 & 85 TO 92
5 - Retaining Wall Plan, Elevation & Sections
6 - Retaining Wall Deflection

	initial	date
PREPARED	[illegible]	4/23/14
TITLE		
REVIEWED		
TITLE		

REVISION NOTES	

TOPOCK GROUND WATER REMEDIATION PROJECT
WATER STORAGE TANK RETAINING WALL

Date: 12/23/14
By: KJ
Sht 1 of 6



$K_a = 0.33$
$K_p = 3.0$
$w = 0.11$ k/ft³
Allow Soil bearing = 2.0 ksf
ASCE-7-10
Seismic site class D
See calculation Below

Retaining wall max height at stations 35 TO 65

In absence of dynamic soil report follow ASCE 7-10 requirement for nonbuilding 15.6.1 Earth retaining structure & equation 11.8-1

$PGA_M = F_{PGA} \times PGA = 1.2 \times 0.3 = 0.36$

- PGA_M: Peak ground acceleration
- F_{PGA}: Site coefficient Select 1.2 for site D
- PGA: Table 22-7 peak ground acceleration Select .30

Reference Civil Dwgs:
C-10-10 Existing site grading
Dwg — Tank Retaining wall Plan
Dwg — Tank Retaining wall Elevation

Date: 4/23/14
By: KJ
Sht 2 of 6

Retaining Wall Between Station 40 to 70

$p = 145 \times 0.11 \times 0.33 = 0.526$ k/□'

$H = 0.526 \times \frac{14.5}{2} \times 1.36 = 5.2$ k/ft ← Seismic acceleration factor

$V = H \times \tan 30° = 5.2 \times 0.58 = 3.0^k$

$M_{OT} = 5.2^k \times 5' = 26^{k'}$

Vert. weight on base of footing

W = Backfill $= 5' \times 12' \times 0.11 = 6.6^k$
Wall Stem $= 11.25 \times 1 \times 0.15 = 1.7$
Footing $= 9' \times 1.5 \times 0.15 = 2.0$
Grading $= 2' \times 3' \times 0.11 = 0.7$
Shear Key $= 1 \times 2.5 \times 0.15 = 0.4$
Wt Soil on wall $= 3.4 \times 0.3 = 0.9$ (Friction on face of wall)
$R = 12.1^k$

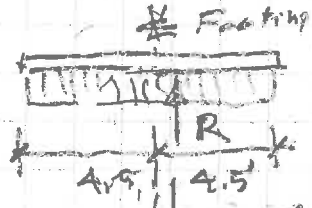
$M_r = 6.6 \times 6.5 = 43.0^{k'}$
$1.7 \times 3.5 = 6.0$
$2.0 \times 4.5 = 9.0$
$0.7 \times 1.5 = 1.0$
$0.4 \times 3.5 = 14.0$
$0.9 \times 4.0 = 3.6$
Total $= 76.6^{k'}$

$SF_{OT} = \frac{76.6}{26} = 2.9 > 2$ ok

$SF_{sliding} = \frac{12.1 \times 0.3 + 5.0}{5.2} = 1.7 > 1.5$ ok

$F = \omega \frac{h^2}{2} \times k_p = 0.11 \times \frac{6^2}{2} \times 3 = 5.9$
Deduct for Upper Soil use 5^k

Location of R under footing $= \frac{Mr - M_{OT}}{R}$



$= \frac{76.6 - 26}{12.1} = 4.2'$

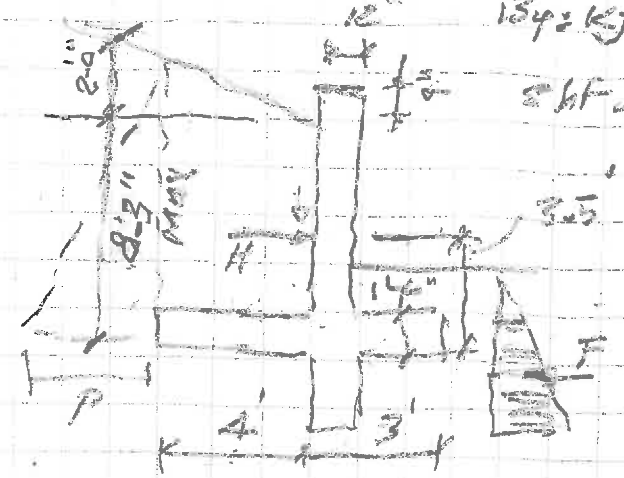
$e = 4.5 - 4.2 = 0.3$ negligible

Max Bearing pressure $= \frac{2R}{9 \times 1} = \frac{2 \times 12.1}{9} = 2.68^{ksf} \approx 2 \times 1.33 = 2.66^{ksf}$ ok

Reinf.
Base of Stem $= 5.2 \times 3.5 = 18.2^{k'}$
Select from ACI Table for 12" slab #4@12 EF As = 0.44 ok
Dowels into Footing. All other bars #5@12 per Min. Flex reinf. ok

Date: 4/23/[illegible]
By: KJ

Stations 18 to 35 & 65 to 85



$P = 10.5 \times 0.11 \times 0.33 = 0.381$ k/ft'

$H = 0.381 \times \frac{10.5}{2} \times 1.36 = 2.7$ k/' ← Seismic

$V = 2.7 \times 0.58 = 1.6^k$

$M_{OT} = 2.7 \times 3.5 = 9.5$ 'k

Vertical weight on base of footing:

W = Backfill $= 4' \times 8.5' \times 0.11 = 3.7^k$
Wall Stem $= 7.5 \times 1 \times 0.15 = 1.1$
Footing $= 7' \times 1.5' \times 0.15 = 1.6$
Grading $= 2' \times 2' \times 0.11 = 0.5$
Shearkey $= 1 \times 2.5 \times 0.15 = 0.4^k$
Wt soil on wall $= 1.6 \times 0.3 = 0.5$

$R = 7.8^k$

$M_r = 3.7 \times 5 = 18.5$ 'k
$1.1 \times 2.5 = 2.8$
$1.6 \times 3.5 = 5.6$
$0.5 \times 1 = 0.5$
$0.3 \times 2.5 = 0.8$
$0.5 \times 3 = 1.5$
Total $= 29.7$

$SF_{OT} = \frac{29.7}{9.5} = 3.1 > 2$ ok

$F = 0.11 \times \frac{4.5^2}{2} \times 3 = 3.3$

$SF_{sliding} = \frac{7.8 \times 0.3 + 3.3}{2.7} = 2.1 > 1.5$ ok

Location of R under footing $= \frac{M_{OT} - M_r}{R}$

$= \frac{29.7 - 9.5}{7.8} = 2.6$

$e = 3.5' - 2.6 = 0.9'$ negligible

Max bearing Pressure $= \frac{2R}{7 \times 1} = \frac{7.7 \times 2}{7} = 2.2$ ksf $< 2 \times 1.33$ ksf ok

Reinf. #6 @ 12" wall all others #5 @ 12" ok by reference to previous wall design

Date: 4/28/1[illegible]
By: KJ
Sht 4

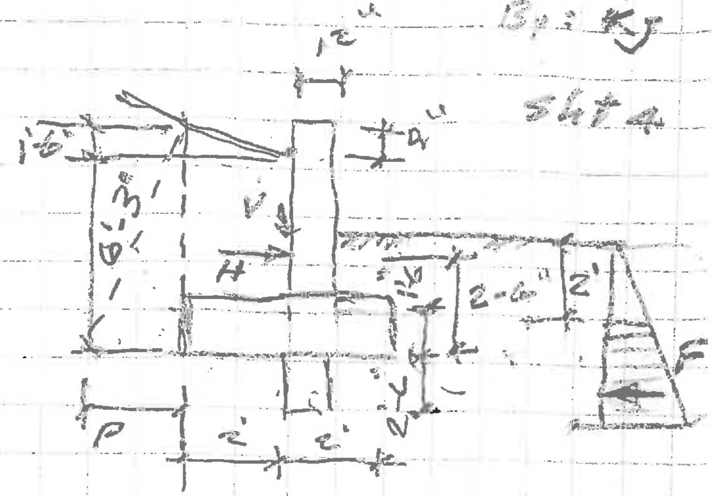
Station: 0 to 15 & 85 to 92

$p = 7.75 \times 0.11 \times 0.33 = 0.28$ k/ft'

$H = 0.28 \times \frac{7.75}{2} \times 1.36 = 1.48$ ← seismic

$V = 1.48 \times 0.57 = 0.84$ k

$M_{OT} = 1.48 \times 2.5 = 3.7$ 'k



Vert. weigh on footing base

W = Backfill = 2 × 7' × 0.11 = 1.5 k (1.5 Ave)
Wall stem = 7 × 1' × 0.15 = 1.0
Footing = 4 × 1.5 × 0.15 = 0.9
Grading = 1 × 2 × 0.11 = 0.2
Shear key = 1 × 2.5 × 0.15 = 0.4
wt soil on wall = 0.84 × 0.3 = 0.3

R = 4.3

Mr = 1.5 × 3 = 4.5 'k
= 1 × 1.5 = 1.5
= 0.9 × 2 = 1.8
= 0.2 × 0.5 = 0.1
= 0.4 × 1.5 = 0.6
= 0.3 × 2 = 0.6

9.1 'k

$SF_{OT} = \frac{M_r}{M_{OT}} = \frac{9.1}{3.7} = 2.5 > 2.0$ ok

$SF_{sliding} = \frac{4.3 \times 0.3 + 3}{1.48} = 2.9 > 2.0$ ok ← F see previous sht

Location of R under footing @ $\frac{M_r - M_{OT}}{4.3} = \frac{9.1 - 3.7}{4.3} = 1.25'$

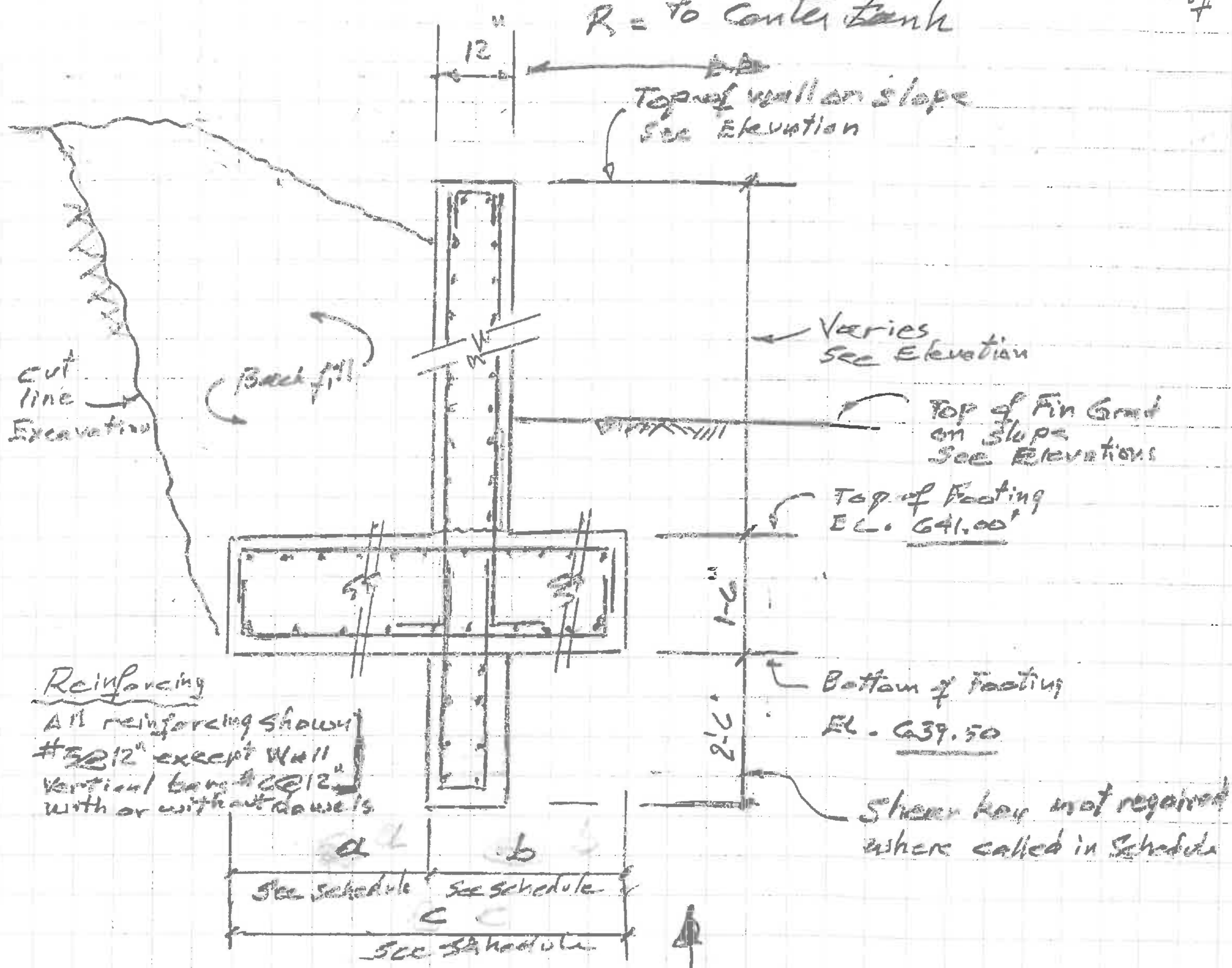
$e = 2 - 1.25 = 0.75$ negligible

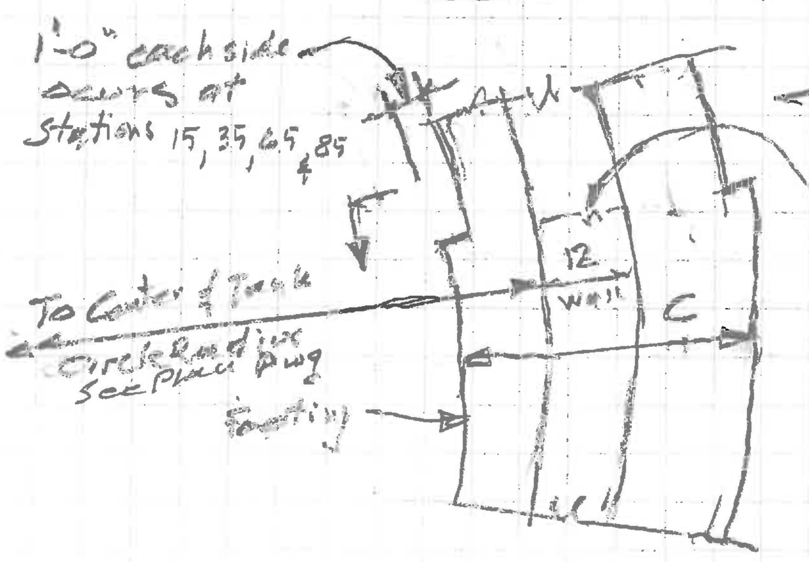
Max bearing pressure $= \frac{2R}{4 \times 1} = \frac{2 \times 4.3}{4} = 2.15$ ksf $< 2 \times 1.33$ ksf ok

Reinforcing same as previous sht ok by inspection

Date: 4/23/1?
By: KJ

sht 5 of 6





Construction (CJ) for Wall only
at station 15, 35, 65 & 85

stations	a	b	c
35 to 65	4	5	9'
15 to 35 & 65 to 85	3	4	7
0 to 15 & 85 to 92	2	3	5

No shear key bet 85-2 & 0-5

PARTIAL PLAN

Date: 4/23/14
By: KJ
sht 6 of 6

Check Wall deflection for highest Wall

$$\Delta = \frac{WL^3}{15EI}$$

$$W_{Tot} = 0.526 \times \frac{(10.5')}{2} = 2.76^{k}$$

$$I = \frac{d^4}{12} = \frac{12''^4}{12} = 12^{3''}$$

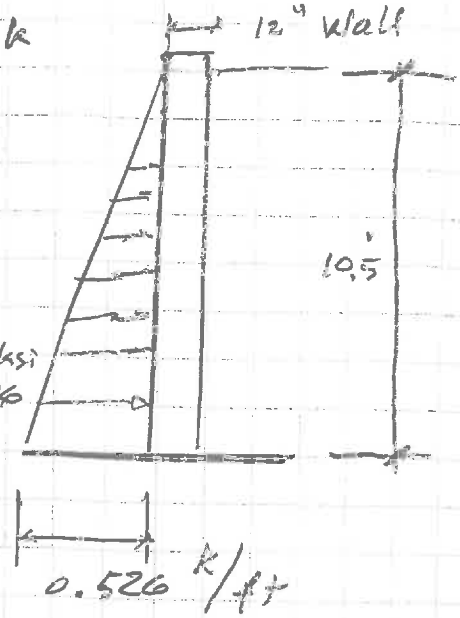
$$E = 0.033\, W_{conc}^{1.5} \times \sqrt{f'_c}$$

$$0.033 \times 150^{1.5} \sqrt{5000}$$

$$0.033 \times 1837 \times 70.7 = 4286 \text{ ksi}$$

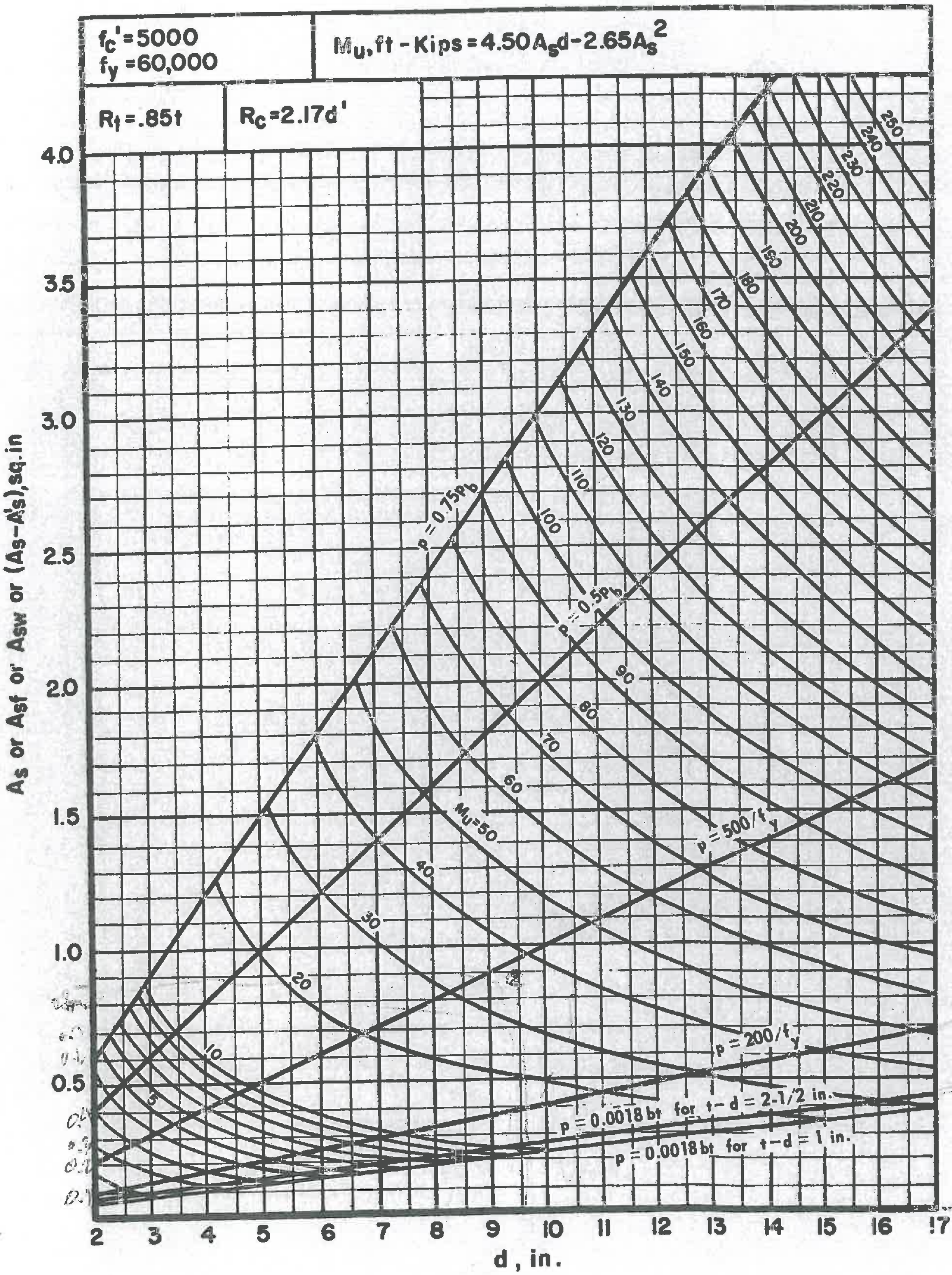
$$\Delta = \frac{2.76 \times 10.5^{3} \times 12^{3}}{15 \times 4286 \times 12^{3}}$$

$$= 0.05''$$

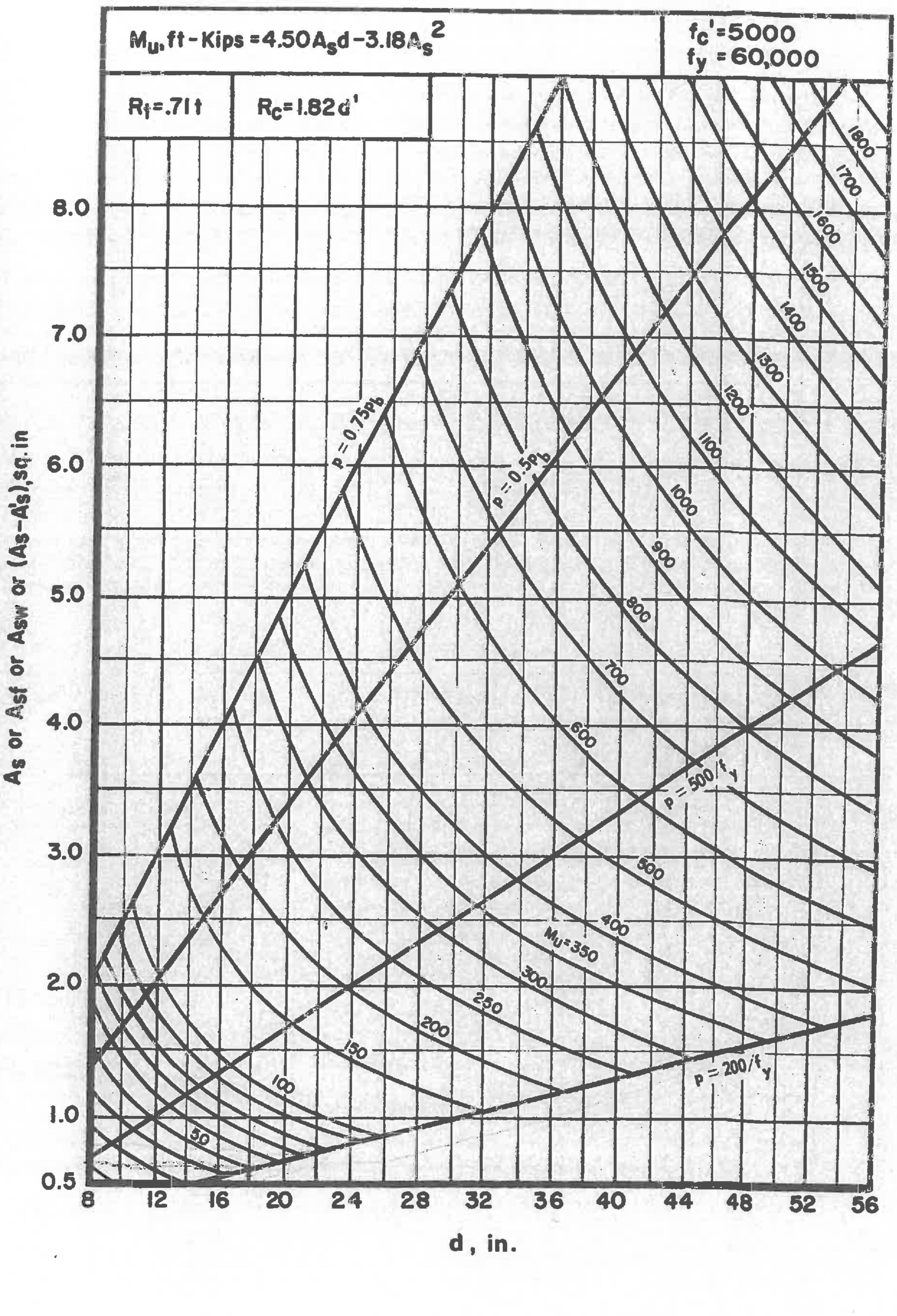


Effect of wall horiz arch neglected on conservative side

Flexure 7.8.1 **Resisting moments M_u, ft-kips, for sections 12 inches wide, slabs**

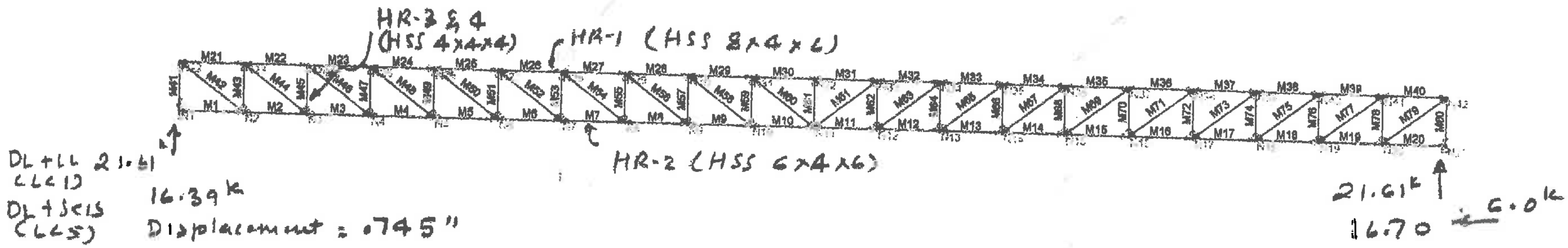


Flexure 7.8.2 Resisting moments M_u, ft-kips, for sections 10 inches wide, beams



TAB-NO. 5

1. Pipeline A-Bridge
2. Pipeline I-Bridge
3. Foundation Design
4. Appendix



Note: See pg. (2) for Loads & Combinations
See pg (33) for Results - check

Results for LC 1,

e2	PIPELINE A - BRIDGE	SK - 2
kd	topock 180' pipe bridge	June 24, 2014 at 1:27 PM
ww-peg-2174-043062		180pb.topock.r2d

E2 Consulting Engineers, Inc. 1900 Powell Street, Suite 250 Eneryville, CA 94608	Designed By: KD	Date: 3/12/14
	Checked By:	Date:
	Revised By:	Date:
Project No. WW-PGE - 2174		Sheet No.

Project Description Topock 200' Pipe Bridge Line I, Line A

(2)

Loads

Line I

DL — 6" Sch. 40 (3 pipes) & 1 - 2" ϕ pipe

Wt. of pipes = 3×19 + 4 = 61#

Wt. of Water = 3×π×6.0²×62.4 / 144×4 = 37.5

92.5# USE 100#

pipe DL + water = 100 #/'

Wt of Grating (5 PSF) = 5×3×2 = 30

Total DL = 130 #/'

DL Ea. Truss = 100/2 = 50 #/' Joint DL = .05×10 = .5k

Line A — 2-6"ϕ, 1-8"ϕ, 2-4"ϕ   6"ϕ   8"ϕ   2-4"ϕ grating

Wt. of water + pipes = 100×2 + (50+22) + 30 = 282 #/' DL/Truss = 80 #/'

Joint DL @ Line A = .10×9 = .90k

Several Combinations of basic loads cases

See page of Computer output

Comb. 1 DL + LL

2 DL

3 DL + Alt ST. LL

4 DL + LL on Half Truss Left

5 Seismic

6 DL + LL on Half Truss Right

LL — Live Load = 25 PSF over entire bridge truss

Joint LL @ Truss = 25×3×10 = 750# (LINE A)

OR = 25×3×9 = 675# (LINE I)

Seismic Line - I

(Pipe wt.) (wt. of Truss) (DL) (LL)

line I — DL + .25LL = .05×200 + .100×200 + .075×.25×200 = 30 + 3.75 = 33.75k

line A — DL + .25LL = .10×180 + .080×180 + .075×.25×180 = 32.4 + 3.38 = 35.8k

Ref. — Using equivalent lateral procedure

ASCE 7/10 — V = CsW where Cs = SDS / (R/Ie)   SDS = .406

Table 12.2.1 pg. 77 — V = .406 / (3/1.25) × W = .169W   R = 3 (See Table 12.2.1 pg. 77)   I = 1.25

line I — V = .169 × 33.75 = 5.7k   Apply 2.0k at N22, N42 & N1 Each

V = .169 × 35.8 = 6.05k   Apply 2.0k @ N22, N42 & N1 Each

(Line A)

Global

Display Sections for Member Calcs	5
Max Internal Sections for Member Calcs	97
Include Shear Deformation?	Yes
Merge Tolerance (in)	.12
P-Delta Analysis Tolerance	0.50%
Include P-Delta for Walls?	Yes
Automaticly Iterate Stiffness for Walls?	Yes
Maximum Iteration Number for Wall Stiffness	3
Gravity Acceleration (ft/sec^2)	32.2
Wall Mesh Size (in)	12
Eigensolution Convergence Tol. (1.E-)	4
Dynamic Solver	Accelerated Solver

Hot Rolled Steel Code	AISC 13th(360-05): ASD
Adjust Stiffness?	Yes(Iterative)
RISAConnection Code	None
Cold Formed Steel Code	AISI S100-07: ASD
Wood Code	AF&PA NDS-05/08: ASD
Wood Temperature	< 100F
Concrete Code	ACI 318-08
Masonry Code	ACI 530-05: ASD
Aluminum Code	AA ADM1-05: ASD - Building

Number of Shear Regions	4
Region Spacing Increment (in)	4
Concrete Stress Block	Rectangular
Use Cracked Sections?	Yes
Bad Framing Warnings?	No
Unused Force Warnings?	Yes
Min 1 Bar Diam. Spacing?	No
Concrete Rebar Set	REBAR_SET_ASTMA615
Min % Steel for Column	1
Max % Steel for Column	8

Hot Rolled Steel Section Sets

	Label	Shape	Type	Design List	Material	Design Rules	A [in2]	I (90,270) [i...	I (0,180) [in4]
1	HR2	HSS6x4x6	Beam	Tube	A500 Gr.46	Typical	6.18	14.9	28.3
2	HR1	HSS8x4x6	Beam	Tube	A500 Gr.46	Typical	7.58	19.6	58.7
3	HR3	HSS4x4x4	Beam	Tube	A500 Gr.46	Typical	3.37	7.8	7.8
4	HR4	HSS4x4x4	Beam	Tube	A500 Gr.46	Typical	3.37	7.8	7.8

Design Size and Code Check Parameters

	Label	Max Depth[in]	Min Depth[in]	Max Width[in]	Min Width[in]	Max Bending Chk	Max Shear Chk
1	Typical					1	1

Joint Coordinates and Temperatures

	Label	X [ft]	Y [ft]	Temp [F]
1	N1	0	0	0
2	N2	9	0	0
3	N3	18	0	0
4	N4	27	0	0
5	N5	36	0	0
6	N6	45	0	0
7	N7	54	0	0

Joint Coordinates and Temperatures (Continued)

	Label	X [ft]	Y [ft]	Temp [F]
8	N8	63	0	0
9	N9	72	0	0
10	N10	81	0	0
11	N11	90	0	0
12	N12	99	0	0
13	N13	108	0	0
14	N14	117	0	0
15	N15	126	0	0
16	N16	135	0	0
17	N17	144	0	0
18	N18	153	0	0
19	N19	162	0	0
20	N20	171	0	0
21	N21	180	0	0
22	N22	0	7	0
23	N23	9	7	0
24	N24	18	7	0
25	N25	27	7	0
26	N26	36	7	0
27	N27	45	7	0
28	N28	54	7	0
29	N29	63	7	0
30	N30	72	7	0
31	N31	81	7	0
32	N32	90	7	0
33	N33	99	7	0
34	N34	108	7	0
35	N35	117	7	0
36	N36	126	7	0
37	N37	135	7	0
38	N38	144	7	0
39	N39	153	7	0
40	N40	162	7	0
41	N41	171	7	0
42	N42	180	7	0

Joint Boundary Conditions

	Joint Label	X [k/in]	Y [k/in]	Rotation[k-ft/rad]	Footing
1	N1		Reaction		
2	N21	Reaction	Reaction		

Member Primary Data

	Label	I Joint	J Joint	Rotate(deg)	Section/Shape	Type	Design List	Material	Design Rules
1	M1	N1	N2		HR2	Beam	Tube	A500 Gr.46	Typical
2	M2	N2	N3		HR2	Beam	Tube	A500 Gr.46	Typical
3	M3	N3	N4		HR2	Beam	Tube	A500 Gr.46	Typical
4	M4	N4	N5		HR2	Beam	Tube	A500 Gr.46	Typical
5	M5	N5	N6		HR2	Beam	Tube	A500 Gr.46	Typical
6	M6	N6	N7		HR2	Beam	Tube	A500 Gr.46	Typical
7	M7	N7	N8		HR2	Beam	Tube	A500 Gr.46	Typical
8	M8	N8	N9		HR2	Beam	Tube	A500 Gr.46	Typical
9	M9	N9	N10		HR2	Beam	Tube	A500 Gr.46	Typical
10	M10	N10	N11		HR2	Beam	Tube	A500 Gr.46	Typical
11	M11	N11	N12		HR2	Beam	Tube	A500 Gr.46	Typical
12	M12	N12	N13		HR2	Beam	Tube	A500 Gr.46	Typical

Member Primary Data (Continued)

	Label	I Joint	J Joint	Rotate(deg)	Section/Shape	Type	Design List	Material	Design Rules
13	M13	N13	N14		HR2	Beam	Tube	A500 Gr.46	Typical
14	M14	N14	N15		HR2	Beam	Tube	A500 Gr.46	Typical
15	M15	N15	N16		HR2	Beam	Tube	A500 Gr.46	Typical
16	M16	N16	N17		HR2	Beam	Tube	A500 Gr.46	Typical
17	M17	N17	N18		HR2	Beam	Tube	A500 Gr.46	Typical
18	M18	N18	N19		HR2	Beam	Tube	A500 Gr.46	Typical
19	M19	N19	N20		HR2	Beam	Tube	A500 Gr.46	Typical
20	M20	N20	N21		HR2	Beam	Tube	A500 Gr.46	Typical
21	M21	N22	N23		HR1	Beam	Tube	A500 Gr.46	Typical
22	M22	N23	N24		HR1	Beam	Tube	A500 Gr.46	Typical
23	M23	N24	N25		HR1	Beam	Tube	A500 Gr.46	Typical
24	M24	N25	N26		HR1	Beam	Tube	A500 Gr.46	Typical
25	M25	N26	N27		HR1	Beam	Tube	A500 Gr.46	Typical
26	M26	N27	N28		HR1	Beam	Tube	A500 Gr.46	Typical
27	M27	N28	N29		HR1	Beam	Tube	A500 Gr.46	Typical
28	M28	N29	N30		HR1	Beam	Tube	A500 Gr.46	Typical
29	M29	N30	N31		HR1	Beam	Tube	A500 Gr.46	Typical
30	M30	N31	N32		HR1	Beam	Tube	A500 Gr.46	Typical
31	M31	N32	N33		HR1	Beam	Tube	A500 Gr.46	Typical
32	M32	N33	N34		HR1	Beam	Tube	A500 Gr.46	Typical
33	M33	N34	N35		HR1	Beam	Tube	A500 Gr.46	Typical
34	M34	N35	N36		HR1	Beam	Tube	A500 Gr.46	Typical
35	M35	N36	N37		HR1	Beam	Tube	A500 Gr.46	Typical
36	M36	N37	N38		HR1	Beam	Tube	A500 Gr.46	Typical
37	M37	N38	N39		HR1	Beam	Tube	A500 Gr.46	Typical
38	M38	N39	N40		HR1	Beam	Tube	A500 Gr.46	Typical
39	M39	N40	N41		HR1	Beam	Tube	A500 Gr.46	Typical
40	M40	N41	N42		HR1	Beam	Tube	A500 Gr.46	Typical
41	M41	N1	N22		HR3	Beam	Tube	A500 Gr.46	Typical
42	M42	N22	N2		HR4	Beam	Tube	A500 Gr.46	Typical
43	M43	N2	N23		HR3	Beam	Tube	A500 Gr.46	Typical
44	M44	N23	N3		HR4	Beam	Tube	A500 Gr.46	Typical
45	M45	N3	N24		HR3	Beam	Tube	A500 Gr.46	Typical
46	M46	N24	N4		HR4	Beam	Tube	A500 Gr.46	Typical
47	M47	N4	N25		HR3	Beam	Tube	A500 Gr.46	Typical
48	M48	N25	N5		HR4	Beam	Tube	A500 Gr.46	Typical
49	M49	N5	N26		HR3	Beam	Tube	A500 Gr.46	Typical
50	M50	N26	N6		HR4	Beam	Tube	A500 Gr.46	Typical
51	M51	N6	N27		HR3	Beam	Tube	A500 Gr.46	Typical
52	M52	N27	N7		HR4	Beam	Tube	A500 Gr.46	Typical
53	M53	N7	N28		HR3	Beam	Tube	A500 Gr.46	Typical
54	M54	N28	N8		HR4	Beam	Tube	A500 Gr.46	Typical
55	M55	N8	N29		HR3	Beam	Tube	A500 Gr.46	Typical
56	M56	N29	N9		HR4	Beam	Tube	A500 Gr.46	Typical
57	M57	N9	N30		HR3	Beam	Tube	A500 Gr.46	Typical
58	M58	N30	N10		HR4	Beam	Tube	A500 Gr.46	Typical
59	M59	N10	N31		HR3	Beam	Tube	A500 Gr.46	Typical
60	M60	N31	N11		HR4	Beam	Tube	A500 Gr.46	Typical
61	M61	N11	N33		HR4	Beam	Tube	A500 Gr.46	Typical
62	M62	N33	N12		HR3	Beam	Tube	A500 Gr.46	Typical
63	M63	N12	N34		HR4	Beam	Tube	A500 Gr.46	Typical
64	M64	N34	N13		HR3	Beam	Tube	A500 Gr.46	Typical
65	M65	N13	N35		HR4	Beam	Tube	A500 Gr.46	Typical
66	M66	N35	N14		HR3	Beam	Tube	A500 Gr.46	Typical
67	M67	N14	N36		HR4	Beam	Tube	A500 Gr.46	Typical
68	M68	N36	N15		HR3	Beam	Tube	A500 Gr.46	Typical
69	M69	N15	N37		HR4	Beam	Tube	A500 Gr.46	Typical

Member Primary Data (Continued)

	Label	I Joint	J Joint	Rotate(deg)	Section/Shape	Type	Design List	Material	Design Rules
70	M70	N37	N16		HR3	Beam	Tube	A500 Gr.46	Typical
71	M71	N16	N38		HR4	Beam	Tube	A500 Gr.46	Typical
72	M72	N38	N17		HR3	Beam	Tube	A500 Gr.46	Typical
73	M73	N17	N39		HR4	Beam	Tube	A500 Gr.46	Typical
74	M74	N39	N18		HR3	Beam	Tube	A500 Gr.46	Typical
75	M75	N18	N40		HR4	Beam	Tube	A500 Gr.46	Typical
76	M76	N40	N19		HR3	Beam	Tube	A500 Gr.46	Typical
77	M77	N19	N41		HR4	Beam	Tube	A500 Gr.46	Typical
78	M78	N41	N20		HR3	Beam	Tube	A500 Gr.46	Typical
79	M79	N20	N42		HR4	Beam	Tube	A500 Gr.46	Typical
80	M80	N42	N21		HR3	Beam	Tube	A500 Gr.46	Typical
81	M81	N11	N32		HR3	Beam	Tube	A500 Gr.46	Typical

Joint Loads and Enforced Displacements (BLC 1 : dl)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...	
1	N22	L	Y	-.36	= .45
2	N23	L	Y	-.72	= .96
3	N24	L	Y	-.72	
4	N25	L	Y	-.72	
5	N26	L	Y	-.72	
6	N27	L	Y	-.72	
7	N28	L	Y	-.72	
8	N29	L	Y	-.72	
9	N30	L	Y	-.72	
10	N31	L	Y	-.72	Revised
11	N32	L	Y	-.72	
12	N33	L	Y	-.72	
13	N34	L	Y	-.72	
14	N35	L	Y	-.72	
15	N36	L	Y	-.72	
16	N37	L	Y	-.72	
17	N38	L	Y	-.72	
18	N39	L	Y	-.72	
19	N40	L	Y	-.72	
20	N41	L	Y	-.72	-.96
21	N42	L	Y	-.36	-.45

Joint Loads and Enforced Displacements (BLC 2 : ll)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N22	L	Y	-.338
2	N23	L	Y	-.675
3	N24	L	Y	-.675
4	N25	L	Y	-.675
5	N26	L	Y	-.675
6	N27	L	Y	-.675
7	N28	L	Y	-.675
8	N29	L	Y	-.675
9	N30	L	Y	-.675
10	N31	L	Y	-.675
11	N32	L	Y	-.675
12	N33	L	Y	-.675
13	N34	L	Y	-.675
14	N35	L	Y	-.675
15	N36	L	Y	-.675
16	N37	L	Y	-.675
17	N38	L	Y	-.675

Joint Loads and Enforced Displacements (BLC 2 : II) (Continued)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
18	N39	L	Y	-.675
19	N40	L	Y	-.675
20	N41	L	Y	-.675
21	N42	L	Y	-.338

Joint Loads and Enforced Displacements (BLC 3 : I alternate joint)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N23	L	Y	-.675
2	N25	L	Y	-.675
3	N27	L	Y	-.675
4	N29	L	Y	-.675
5	N31	L	Y	-.675
6	N33	L	Y	-.675
7	N35	L	Y	-.675
8	N37	L	Y	-.675
9	N39	L	Y	-.675
10	N41	L	Y	-.675

Joint Loads and Enforced Displacements (BLC 4 : I half truss only)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N22	L	Y	-.338
2	N23	L	Y	-.675
3	N24	L	Y	-.675
4	N25	L	Y	-.675
5	N26	L	Y	-.675
6	N27	L	Y	-.675
7	N28	L	Y	-.675
8	N29	L	Y	-.675
9	N30	L	Y	-.675
10	N31	L	Y	-.675
11	N32	L	Y	-.675

Joint Loads and Enforced Displacements (BLC 5 : seismic)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N1	L	X	2
2	N22	L	X	2
3	N42	L	X	2

Joint Loads and Enforced Displacements (BLC 6 : I half truss on right)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N33	L	Y	-.675
2	N34	L	Y	-.675
3	N35	L	Y	-.675
4	N36	L	Y	-.675
5	N37	L	Y	-675
6	N38	L	Y	-.675
7	N39	L	Y	-.675
8	N40	L	Y	-.675
9	N41	L	Y	-.675
10	N42	L	Y	-.338

Basic Load Cases

	BLC Description	Category	X Gravity	Y Gravity	Joint	Point	Distributed
1	dl	None		-1	21		
2	ll	None			21		
3	l alternate joint	None			10		
4	l half truss only	None			11		
5	seismic	None			3		
6	l half truss on right	None			10		

Load Combinations

	Description	Solve	PD...	SR...	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor
1	d+l	Yes	Y		1	1	2	1												
2	d	Yes	Y		1	1														
3	l alt. jt. +d	Yes	Y		1	1			3	1										
4	d+l half truss...	Yes	Y		1	1			4	1										
5	d+seismic	Yes	Y		1	1	2	.25	5	1										
6	d+l half truss...	Yes	Y		1	1	2	.25	5	1										

Load Combination Design

	Description	ASIF	CD	ABIF	Service	Hot Rolled	Cold Form...	Wood	Concrete	Masonry	Footings	Aluminum
1	d+l					Yes	Yes	Yes	Yes	Yes	Yes	Yes
2	d					Yes	Yes	Yes	Yes	Yes	Yes	Yes
3	l alt. jt. +d					Yes	Yes	Yes	Yes	Yes	Yes	Yes
4	d+l half truss ...					Yes	Yes	Yes	Yes	Yes	Yes	Yes
5	d+seismic					Yes	Yes	Yes	Yes	Yes	Yes	Yes
6	d+l half truss ...					Yes	Yes	Yes	Yes	Yes	Yes	Yes

Joint Reactions (By Combination) (See next page for Revised printout)

	LC	Joint Label	X [k]	Y [k]	MZ [k-ft]
1	1	N1	0	20.315	0
2	1	N21	0	20.315	0
3	1	Totals:	0	40.63	
4	1	COG (ft):	X: 90	Y: 5.977	
5	2	N1	0	13.564	0
6	2	N21	0	13.564	0
7	2	Totals:	0	27.129	
8	2	COG (ft):	X: 90	Y: 5.468	
9	3	N1	0	16.939	0
10	3	N21	0	16.939	0
11	3	Totals:	0	33.879	
12	3	COG (ft):	X: 90	Y: 5.774	
13	4	N1	0	18.794	0
14	4	N21	0	15.423	0
15	4	Totals:	0	34.217	
16	4	COG (ft):	X: 81.121	Y: 5.786	
17	5	N1	0	15.096	0
18	5	N21	-6	15.407	0
19	5	Totals:	-6	30.504	
20	5	COG (ft):	X: 90	Y: 5.638	
21	6	N1	0	15.096	0
22	6	N21	-6	15.407	0
23	6	Totals:	-6	30.504	
24	6	COG (ft):	X: 90	Y: 5.638	

Joint Reactions

	LC	Joint Label	X [k]	Y [k]	MZ [k-ft]
1	1	N1	0	21.611	0
2	1	N21	0	21.611	0
3	1	Totals:	0	43.221	
4	1	COG (ft):	X: 90	Y: 6.12	
5	2	N1	0	14.86	0
6	2	N21	0	14.86	0
7	2	Totals:	0	29.72	
8	2	COG (ft):	X: 90	Y: 5.721	
9	3	N1	0	18.235	0
10	3	N21	0	18.235	0
11	3	Totals:	0	36.47	
12	3	COG (ft):	X: 90	Y: 5.958	
13	4	N1	0	20.089	0
14	4	N21	0	16.719	0
15	4	Totals:	0	36.808	
16	4	COG (ft):	X: 81.747	Y: 5.967	
17	5	N1	0	16.392	0
18	5	N21	-6	16.703	0
19	5	Totals:	-6	33.096	
20	5	COG (ft):	X: 90	Y: 5.851	
21	6	N1	0	16.392	0
22	6	N21	-6	16.703	0
23	6	Totals:	-6	33.096	
24	6	COG (ft):	X: 90	Y: 5.851	

Joint Deflections

	LC	Joint Label	X [in]	Y [in]	Rotation [rad]
1	1	N1	-1.032	0	0
2	1	N2	-1.032	-1.415	0
3	1	N3	-1.016	-2.78	0
4	1	N4	-.986	-4.062	0
5	1	N5	-.943	-5.232	0
6	1	N6	-.889	-6.263	0
7	1	N7	-.826	-7.135	0
8	1	N8	-.756	-7.829	0
9	1	N9	-.68	-8.333	0
10	1	N10	-.599	-8.636	0
11	1	N11	-.516	-8.733	0
12	1	N12	-.433	-8.636	0
13	1	N13	-.353	-8.333	0
14	1	N14	-.277	-7.829	0
15	1	N15	-.206	-7.135	0
16	1	N16	-.143	-6.263	0
17	1	N17	-.09	-5.232	0
18	1	N18	-.047	-4.062	0
19	1	N19	-.016	-2.78	0
20	1	N20	0	-1.415	0
21	1	N21	0	0	0
22	1	N22	-.028	-.024	0
23	1	N23	-.041	-1.437	0
24	1	N24	-.066	-2.801	0
25	1	N25	-.1	-4.08	0
26	1	N26	-.144	-5.247	0
27	1	N27	-.195	-6.276	0
28	1	N28	-.253	-7.146	0

Joint Deflections (Continued)

	LC	Joint Label	X [in]	Y [in]	Rotation [rad]
29	1	N29	-.315	-7.838	0
30	1	N30	-.38	-8.339	0
31	1	N31	-.448	-8.64	0
32	1	N32	-.516	-8.736	0
33	1	N33	-.585	-8.64	0
34	1	N34	-.652	-8.339	0
35	1	N35	-.718	-7.838	0
36	1	N36	-.78	-7.146	0
37	1	N37	-.837	-6.276	0
38	1	N38	-.888	-5.247	0
39	1	N39	-.932	-4.08	0
40	1	N40	-.967	-2.801	0
41	1	N41	-.991	-1.437	0
42	1	N42	-1.004	-.024	0
43	2	N1	-.709	0	0
44	2	N2	-.708	-.971	0
45	2	N3	-.697	-1.909	0
46	2	N4	-.677	-2.789	0
47	2	N5	-.647	-3.592	0
48	2	N6	-.61	-4.3	0
49	2	N7	-.567	-4.899	0
50	2	N8	-.519	-5.376	0
51	2	N9	-.466	-5.721	0
52	2	N10	-.411	-5.929	0
53	2	N11	-.354	-5.996	0
54	2	N12	-.297	-5.929	0
55	2	N13	-.242	-5.721	0
56	2	N14	-.19	-5.376	0
57	2	N15	-.141	-4.899	0
58	2	N16	-.098	-4.3	0
59	2	N17	-.061	-3.592	0
60	2	N18	-.032	-2.789	0
61	2	N19	-.011	-1.909	0
62	2	N20	0	-.971	0
63	2	N21	0	0	0
64	2	N22	-.019	-.017	0
65	2	N23	-.028	-.987	0
66	2	N24	-.045	-1.923	0
67	2	N25	-.069	-2.801	0
68	2	N26	-.099	-3.603	0
69	2	N27	-.134	-4.309	0
70	2	N28	-.173	-4.906	0
71	2	N29	-.216	-5.381	0
72	2	N30	-.261	-5.725	0
73	2	N31	-.307	-5.932	0
74	2	N32	-.354	-5.997	0
75	2	N33	-.401	-5.932	0
76	2	N34	-.448	-5.725	0
77	2	N35	-.493	-5.381	0
78	2	N36	-.535	-4.906	0
79	2	N37	-.575	-4.309	0
80	2	N38	-.61	-3.603	0
81	2	N39	-.64	-2.801	0
82	2	N40	-.664	-1.923	0
83	2	N41	-.681	-.987	0
84	2	N42	-.69	-.017	0
85	3	N1	-.872	0	0

Joint Deflections (Continued)

	LC	Joint Label	X [in]	Y [in]	Rotation [rad]
86	3	N2	-.872	-1.195	0
87	3	N3	-.858	-2.347	0
88	3	N4	-.832	-3.43	0
89	3	N5	-.796	-4.417	0
90	3	N6	-.751	-5.288	0
91	3	N7	-.698	-6.023	0
92	3	N8	-.638	-6.61	0
93	3	N9	-.574	-7.034	0
94	3	N10	-.506	-7.291	0
95	3	N11	-.436	-7.372	0
96	3	N12	-.366	-7.291	0
97	3	N13	-.298	-7.034	0
98	3	N14	-.234	-6.61	0
99	3	N15	-.174	-6.023	0
100	3	N16	-.121	-5.288	0
101	3	N17	-.076	-4.417	0
102	3	N18	-.039	-3.43	0
103	3	N19	-.014	-2.347	0
104	3	N20	0	-1.195	0
105	3	N21	0	0	0
106	3	N22	-.024	-.02	0
107	3	N23	-.035	-1.215	0
108	3	N24	-.055	-2.364	0
109	3	N25	-.085	-3.446	0
110	3	N26	-.122	-4.43	0
111	3	N27	-.165	-5.299	0
112	3	N28	-.213	-6.032	0
113	3	N29	-.266	-6.617	0
114	3	N30	-.321	-7.039	0
115	3	N31	-.378	-7.294	0
116	3	N32	-.436	-7.373	0
117	3	N33	-.493	-7.294	0
118	3	N34	-.551	-7.039	0
119	3	N35	-.606	-6.617	0
120	3	N36	-.658	-6.032	0
121	3	N37	-.707	-5.299	0
122	3	N38	-.75	-4.43	0
123	3	N39	-.787	-3.446	0
124	3	N40	-.816	-2.364	0
125	3	N41	-.837	-1.215	0
126	3	N42	-.848	-.02	0
127	4	N1	-.882	0	0
128	4	N2	-.882	-1.243	0
129	4	N3	-.867	-2.44	0
130	4	N4	-.839	-3.559	0
131	4	N5	-.8	-4.574	0
132	4	N6	-.751	-5.461	0
133	4	N7	-.694	-6.203	0
134	4	N8	-.631	-6.784	0
135	4	N9	-.563	-7.194	0
136	4	N10	-.492	-7.425	0
137	4	N11	-.419	-7.475	0
138	4	N12	-.35	-7.357	0
139	4	N13	-.283	-7.067	0
140	4	N14	-.22	-6.612	0
141	4	N15	-.163	-6.002	0
142	4	N16	-.113	-5.251	0

Joint Deflections (Continued)

	LC	Joint Label	X [in]	Y [in]	Rotation [rad]
143	4	N17	-.07	-4.373	0
144	4	N18	-.036	-3.386	0
145	4	N19	-.013	-2.313	0
146	4	N20	0	-1.175	0
147	4	N21	0	0	0
148	4	N22	-.004	-.022	0
149	4	N23	-.016	-1.264	0
150	4	N24	-.039	-2.459	0
151	4	N25	-.071	-3.575	0
152	4	N26	-.111	-4.588	0
153	4	N27	-.157	-5.473	0
154	4	N28	-.209	-6.212	0
155	4	N29	-.264	-6.791	0
156	4	N30	-.322	-7.199	0
157	4	N31	-.381	-7.427	0
158	4	N32	-.439	-7.477	0
159	4	N33	-.498	-7.361	0
160	4	N34	-.555	-7.073	0
161	4	N35	-.609	-6.619	0
162	4	N36	-.66	-6.011	0
163	4	N37	-.707	-5.262	0
164	4	N38	-.748	-4.385	0
165	4	N39	-.783	-3.401	0
166	4	N40	-.81	-2.329	0
167	4	N41	-.829	-1.193	0
168	4	N42	-.839	-.019	0
169	5	N1	-.745	0	0
170	5	N2	-.746	-1.067	0
171	5	N3	-.735	-2.097	0
172	5	N4	-.713	-3.064	0
173	5	N5	-.682	-3.945	0
174	5	N6	-.642	-4.721	0
175	5	N7	-.596	-5.377	0
176	5	N8	-.543	-5.898	0
177	5	N9	-.487	-6.276	0
178	5	N10	-.427	-6.501	0
179	5	N11	-.366	-6.571	0
180	5	N12	-.305	-6.492	0
181	5	N13	-.245	-6.258	0
182	5	N14	-.19	-5.873	0
183	5	N15	-.138	-5.345	0
184	5	N16	-.093	-4.686	0
185	5	N17	-.055	-3.909	0
186	5	N18	-.025	-3.03	0
187	5	N19	-.005	-2.07	0
188	5	N20	.003	-1.051	0
189	5	N21	0	0	0
190	5	N22	.011	-.018	0
191	5	N23	0	-1.084	0
192	5	N24	-.02	-2.112	0
193	5	N25	-.047	-3.077	0
194	5	N26	-.081	-3.957	0
195	5	N27	-.121	-4.731	0
196	5	N28	-.165	-5.385	0
197	5	N29	-.214	-5.905	0
198	5	N30	-.264	-6.28	0
199	5	N31	-.316	-6.504	0

Joint Deflections (Continued)

	LC	Joint Label	X [in]	Y [in]	Rotation [rad]
200	5	N32	-.369	-6.572	0
201	5	N33	-.421	-6.495	0
202	5	N34	-.473	-6.262	0
203	5	N35	-.523	-5.879	0
204	5	N36	-.571	-5.354	0
205	5	N37	-.614	-4.696	0
206	5	N38	-.653	-3.921	0
207	5	N39	-.686	-3.044	0
208	5	N40	-.712	-2.086	0
209	5	N41	-.73	-1.069	0
210	5	N42	-.739	-.019	0
211	6	N1	-.745	0	0
212	6	N2	-.746	-1.067	0
213	6	N3	-.735	-2.097	0
214	6	N4	-.713	-3.064	0
215	6	N5	-.682	-3.945	0
216	6	N6	-.642	-4.721	0
217	6	N7	-.596	-5.377	0
218	6	N8	-.543	-5.898	0
219	6	N9	-.487	-6.276	0
220	6	N10	-.427	-6.501	0
221	6	N11	-.366	-6.571	0
222	6	N12	-.305	-6.492	0
223	6	N13	-.245	-6.258	0
224	6	N14	-.19	-5.873	0
225	6	N15	-.138	-5.345	0
226	6	N16	-.093	-4.686	0
227	6	N17	-.055	-3.909	0
228	6	N18	-.025	-3.03	0
229	6	N19	-.005	-2.07	0
230	6	N20	.003	-1.051	0
231	6	N21	0	0	0
232	6	N22	.011	-.018	0
233	6	N23	0	-1.084	0
234	6	N24	-.02	-2.112	0
235	6	N25	-.047	-3.077	0
236	6	N26	-.081	-3.957	0
237	6	N27	-.121	-4.731	0
238	6	N28	-.165	-5.385	0
239	6	N29	-.214	-5.905	0
240	6	N30	-.264	-6.28	0
241	6	N31	-.316	-6.504	0
242	6	N32	-.369	-6.572	0
243	6	N33	-.421	-6.495	0
244	6	N34	-.473	-6.262	0
245	6	N35	-.523	-5.879	0
246	6	N36	-.571	-5.354	0
247	6	N37	-.614	-4.696	0
248	6	N38	-.653	-3.921	0
249	6	N39	-.686	-3.044	0
250	6	N40	-.712	-2.086	0
251	6	N41	-.73	-1.069	0
252	6	N42	-.739	-.019	0

Member AISC 13th(360-05): ASD Steel Code Checks

	LC	Member	Shape	UC Max	Loc[ft]	Shear UC	Loc[ft]	Pnc/om [k]	Pnt/om [k]	Mn/om [k-ft]	Cb	Eqn
1	1	M1	HSS6x4x6	.009	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1b
2	1	M2	HSS6x4x6	.086	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1b
3	1	M3	HSS6x4x6	.303	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1a
4	1	M4	HSS6x4x6	.425	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1a
5	1	M5	HSS6x4x6	.531	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1a
6	1	M6	HSS6x4x6	.620	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1a
7	1	M7	HSS6x4x6	.693	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1a
8	1	M8	HSS6x4x6	.750	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1a
9	1	M9	HSS6x4x6	.791	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1a
10	1	M10	HSS6x4x6	.815	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1a
11	1	M11	HSS6x4x6	.815	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1a
12	1	M12	HSS6x4x6	.791	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1a
13	1	M13	HSS6x4x6	.750	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1a
14	1	M14	HSS6x4x6	.693	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1a
15	1	M15	HSS6x4x6	.620	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1a
16	1	M16	HSS6x4x6	.531	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1a
17	1	M17	HSS6x4x6	.425	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1a
18	1	M18	HSS6x4x6	.303	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1a
19	1	M19	HSS6x4x6	.086	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1b
20	1	M20	HSS6x4x6	.009	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1b
21	1	M21	HSS8x4x6	.092	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1b
22	1	M22	HSS8x4x6	.330	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
23	1	M23	HSS8x4x6	.465	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
24	1	M24	HSS8x4x6	.582	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
25	1	M25	HSS8x4x6	.682	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
26	1	M26	HSS8x4x6	.763	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1a
27	1	M27	HSS8x4x6	.826	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
28	1	M28	HSS8x4x6	.871	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1a
29	1	M29	HSS8x4x6	.898	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
30	1	M30	HSS8x4x6	.907	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
31	1	M31	HSS8x4x6	.907	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
32	1	M32	HSS8x4x6	.898	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
33	1	M33	HSS8x4x6	.871	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
34	1	M34	HSS8x4x6	.826	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1a
35	1	M35	HSS8x4x6	.763	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
36	1	M36	HSS8x4x6	.682	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1a
37	1	M37	HSS8x4x6	.582	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1a
38	1	M38	HSS8x4x6	.465	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1a
39	1	M39	HSS8x4x6	.330	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1a
40	1	M40	HSS8x4x6	.092	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1b
41	1	M41	HSS4x4x3	.369	0	.000	0	58.347	71.066	8.424	1	H1-1a
42	1	M42	HSS4x4x3	.482	5.582	.002	0	42.116	71.066	8.424	1.136	H1-1a
43	1	M43	HSS4x4x3	.347	0	.000	0	58.347	71.066	8.424	1	H1-1a
44	1	M44	HSS4x4x3	.433	5.582	.002	11.402	42.116	71.066	8.424	1.136	H1-1a
45	1	M45	HSS4x4x3	.311	0	.000	0	58.347	71.066	8.424	1	H1-1a
46	1	M46	HSS4x4x3	.383	5.582	.002	0	42.116	71.066	8.424	1.136	H1-1a
47	1	M47	HSS4x4x3	.275	0	.000	0	58.347	71.066	8.424	1	H1-1a
48	1	M48	HSS4x4x3	.333	5.582	.002	11.402	42.116	71.066	8.424	1.136	H1-1a
49	1	M49	HSS4x4x3	.239	0	.000	0	58.347	71.066	8.424	1	H1-1a
50	1	M50	HSS4x4x3	.284	5.582	.002	11.402	42.116	71.066	8.424	1.136	H1-1a
51	1	M51	HSS4x4x3	.203	0	.000	0	58.347	71.066	8.424	1	H1-1a
52	1	M52	HSS4x4x3	.234	5.582	.002	11.402	42.116	71.066	8.424	1.136	H1-1a
53	1	M53	HSS4x4x3	.084	0	.000	0	58.347	71.066	8.424	1	H1-1b
54	1	M54	HSS4x4x3	.100	5.701	.002	0	42.116	71.066	8.424	1.136	H1-1b
55	1	M55	HSS4x4x3	.066	0	.000	0	58.347	71.066	8.424	1	H1-1b
56	1	M56	HSS4x4x3	.075	5.701	.002	11.402	42.116	71.066	8.424	1.136	H1-1b

Member AISC 13th(360-05): ASD Steel Code Checks (Continued)

	LC	Member	Shape	UC Max	Loc[ft]	Shear UC	Loc[ft]	Pnc/om [k]	Pnt/om [k]	Mn/om [k-ft]	Cb	Eqn
57	1	M57	HSS4x4x3	.048	0	.000	0	58.347	71.066	8.424	1	H1-1b
58	1	M58	HSS4x4x3	.050	5.701	.002	11.402	42.116	71.066	8.424	1.136	H1-1b
59	1	M59	HSS4x4x3	.029	0	.000	0	58.347	71.066	8.424	1	H1-1b
60	1	M60	HSS4x4x3	.026	5.701	.002	11.402	42.116	71.066	8.424	1.136	H1-1b
61	1	M61	HSS4x4x3	.026	5.701	.002	0	42.116	71.066	8.424	1.136	H1-1b
62	1	M62	HSS4x4x3	.029	7	.000	0	58.347	71.066	8.424	1	H1-1b
63	1	M63	HSS4x4x3	.050	5.701	.002	0	42.116	71.066	8.424	1.136	H1-1b
64	1	M64	HSS4x4x3	.048	7	.000	0	58.347	71.066	8.424	1.136	H1-1b
65	1	M65	HSS4x4x3	.075	5.701	.002	0	42.116	71.066	8.424	1	H1-1b
66	1	M66	HSS4x4x3	.066	7	.000	0	58.347	71.066	8.424	1.136	H1-1b
67	1	M67	HSS4x4x3	.100	5.701	.002	0	42.116	71.066	8.424	1	H1-1b
68	1	M68	HSS4x4x3	.084	7	.000	0	58.347	71.066	8.424	1.136	H1-1b
69	1	M69	HSS4x4x3	.234	5.82	.002	11.402	42.116	71.066	8.424	1	H1-1b
70	1	M70	HSS4x4x3	.203	7	.000	0	58.347	71.066	8.424	1.136	H1-1a
71	1	M71	HSS4x4x3	.284	5.82	.002	11.402	42.116	71.066	8.424	1	H1-1a
72	1	M72	HSS4x4x3	.239	7	.000	0	58.347	71.066	8.424	1.136	H1-1a
73	1	M73	HSS4x4x3	.333	5.82	.002	0	42.116	71.066	8.424	1	H1-1a
74	1	M74	HSS4x4x3	.275	7	.000	0	58.347	71.066	8.424	1.136	H1-1a
75	1	M75	HSS4x4x3	.383	5.82	.002	11.402	42.116	71.066	8.424	1	H1-1a
76	1	M76	HSS4x4x3	.311	7	.000	0	58.347	71.066	8.424	1.136	H1-1a
77	1	M77	HSS4x4x3	.433	5.82	.002	0	42.116	71.066	8.424	1	H1-1a
78	1	M78	HSS4x4x3	.347	7	.000	0	58.347	71.066	8.424	1.136	H1-1a
79	1	M79	HSS4x4x3	.482	5.82	.002	11.402	42.116	71.066	8.424	1	H1-1a
80	1	M80	HSS4x4x3	.369	7	.000	0	58.347	71.066	8.424	1.136	H1-1a
81	1	M81	HSS4x4x3	.019	0	.000	0	58.347	71.066	8.424	1	H1-1a
82	2	M1	HSS6x4x6	.008	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1b
83	2	M2	HSS6x4x6	.062	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1b
84	2	M3	HSS6x4x6	.210	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1a
85	2	M4	HSS6x4x6	.294	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1a
86	2	M5	HSS6x4x6	.366	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1a
87	2	M6	HSS6x4x6	.428	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1a
88	2	M7	HSS6x4x6	.478	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1a
89	2	M8	HSS6x4x6	.517	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1a
90	2	M9	HSS6x4x6	.545	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1a
91	2	M10	HSS6x4x6	.562	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1a
92	2	M11	HSS6x4x6	.562	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1a
93	2	M12	HSS6x4x6	.545	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1a
94	2	M13	HSS6x4x6	.517	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1a
95	2	M14	HSS6x4x6	.478	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1a
96	2	M15	HSS6x4x6	.428	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1a
97	2	M16	HSS6x4x6	.366	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1a
98	2	M17	HSS6x4x6	.294	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1a
99	2	M18	HSS6x4x6	.210	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1a
100	2	M19	HSS6x4x6	.062	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1b
101	2	M20	HSS6x4x6	.008	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1b
102	2	M21	HSS8x4x6	.065	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1b
103	2	M22	HSS8x4x6	.228	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
104	2	M23	HSS8x4x6	.321	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
105	2	M24	HSS8x4x6	.402	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
106	2	M25	HSS8x4x6	.470	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
107	2	M26	HSS8x4x6	.526	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
108	2	M27	HSS8x4x6	.569	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
109	2	M28	HSS8x4x6	.600	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
110	2	M29	HSS8x4x6	.618	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
111	2	M30	HSS8x4x6	.625	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
112	2	M31	HSS8x4x6	.625	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1a
113	2	M32	HSS8x4x6	.618	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1a

Member AISC 13th(360-05): ASD Steel Code Checks (Continued)

	LC	Member	Shape	UC Max	Loc[ft]	Shear UC	Loc[ft]	Pnc/om [k]	Pnt/om [k]	Mn/om [k-ft]	Cb	Eqn
114	2	M33	HSS8x4x6	.600	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1a
115	2	M34	HSS8x4x6	.569	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1a
116	2	M35	HSS8x4x6	.526	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1a
117	2	M36	HSS8x4x6	.470	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1a
118	2	M37	HSS8x4x6	.402	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1a
119	2	M38	HSS8x4x6	.321	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1a
120	2	M39	HSS8x4x6	.228	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1a
121	2	M40	HSS8x4x6	.065	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1b
122	2	M41	HSS4x4x3	.253	0	.000	0	58.347	71.066	8.424	1	H1-1a
123	2	M42	HSS4x4x3	.335	5.582	.002	0	42.116	71.066	8.424	1.136	H1-1a
124	2	M43	HSS4x4x3	.237	0	.000	0	58.347	71.066	8.424	1	H1-1a
125	2	M44	HSS4x4x3	.301	5.582	.002	11.402	42.116	71.066	8.424	1.136	H1-1a
126	2	M45	HSS4x4x3	.212	0	.000	0	58.347	71.066	8.424	1	H1-1a
127	2	M46	HSS4x4x3	.267	5.582	.002	11.402	42.116	71.066	8.424	1.136	H1-1a
128	2	M47	HSS4x4x3	.094	0	.000	0	58.347	71.066	8.424	1	H1-1b
129	2	M48	HSS4x4x3	.233	5.582	.002	11.402	42.116	71.066	8.424	1.136	H1-1a
130	2	M49	HSS4x4x3	.081	0	.000	0	58.347	71.066	8.424	1	H1-1b
131	2	M50	HSS4x4x3	.107	5.701	.002	11.402	42.116	71.066	8.424	1.136	H1-1b
132	2	M51	HSS4x4x3	.069	0	.000	0	58.347	71.066	8.424	1	H1-1b
133	2	M52	HSS4x4x3	.090	5.701	.002	0	42.116	71.066	8.424	1.136	H1-1b
134	2	M53	HSS4x4x3	.056	0	.000	0	58.347	71.066	8.424	1	H1-1b
135	2	M54	HSS4x4x3	.073	5.701	.002	11.402	42.116	71.066	8.424	1.136	H1-1b
136	2	M55	HSS4x4x3	.044	0	.000	0	58.347	71.066	8.424	1	H1-1b
137	2	M56	HSS4x4x3	.056	5.701	.002	11.402	42.116	71.066	8.424	1.136	H1-1b
138	2	M57	HSS4x4x3	.031	0	.000	0	58.347	71.066	8.424	1	H1-1b
139	2	M58	HSS4x4x3	.039	5.701	.002	0	42.116	71.066	8.424	1.136	H1-1b
140	2	M59	HSS4x4x3	.019	0	.000	0	58.347	71.066	8.424	1	H1-1b
141	2	M60	HSS4x4x3	.022	5.701	.002	0	42.116	71.066	8.424	1.136	H1-1b
142	2	M61	HSS4x4x3	.022	5.701	.002	11.402	42.116	71.066	8.424	1.136	H1-1b
143	2	M62	HSS4x4x3	.019	7	.000	0	58.347	71.066	8.424	1	H1-1b
144	2	M63	HSS4x4x3	.039	5.701	.002	11.402	42.116	71.066	8.424	1.136	H1-1b
145	2	M64	HSS4x4x3	.031	7	.000	0	58.347	71.066	8.424	1	H1-1b
146	2	M65	HSS4x4x3	.056	5.701	.002	11.402	42.116	71.066	8.424	1.136	H1-1b
147	2	M66	HSS4x4x3	.044	7	.000	0	58.347	71.066	8.424	1	H1-1b
148	2	M67	HSS4x4x3	.073	5.701	.002	0	42.116	71.066	8.424	1.136	H1-1b
149	2	M68	HSS4x4x3	.056	7	.000	0	58.347	71.066	8.424	1	H1-1b
150	2	M69	HSS4x4x3	.090	5.701	.002	11.402	42.116	71.066	8.424	1.136	H1-1b
151	2	M70	HSS4x4x3	.069	7	.000	0	58.347	71.066	8.424	1	H1-1b
152	2	M71	HSS4x4x3	.107	5.701	.002	0	42.116	71.066	8.424	1.136	H1-1b
153	2	M72	HSS4x4x3	.081	7	.000	0	58.347	71.066	8.424	1	H1-1b
154	2	M73	HSS4x4x3	.233	5.82	.002	11.402	42.116	71.066	8.424	1.136	H1-1a
155	2	M74	HSS4x4x3	.094	7	.000	0	58.347	71.066	8.424	1	H1-1b
156	2	M75	HSS4x4x3	.267	5.82	.002	0	42.116	71.066	8.424	1.136	H1-1a
157	2	M76	HSS4x4x3	.212	7	.000	0	58.347	71.066	8.424	1	H1-1a
158	2	M77	HSS4x4x3	.301	5.82	.002.	11.402	42.116	71.066	8.424	1.136	H1-1a
159	2	M78	HSS4x4x3	.237	7	.000	0	58.347	71.066	8.424	1	H1-1a
160	2	M79	HSS4x4x3	.335	5.82	.002	11.402	42.116	71.066	8.424	1.136	H1-1a
161	2	M80	HSS4x4x3	.253	7	.000	0	58.347	71.066	8.424	1	H1-1a
162	2	M81	HSS4x4x3	.012	0	.000	0	58.347	71.066	8.424	1	H1-1b
163	3	M1	HSS6x4x6	.009	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1b
164	3	M2	HSS6x4x6	.075	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1b
165	3	M3	HSS6x4x6	.256	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1a
166	3	M4	HSS6x4x6	.360	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1a
167	3	M5	HSS6x4x6	.448	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1a
168	3	M6	HSS6x4x6	.525	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1a
169	3	M7	HSS6x4x6	.586	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1a
170	3	M8	HSS6x4x6	.635	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1a

Member AISC 13th(360-05): ASD Steel Code Checks (Continued)

	LC	Member	Shape	UC Max	Loc[ft]	Shear UC	Loc[ft]	Pnc/om [k]	Pnt/om [k]	Mn/om [k-ft]	Cb	Eqn
171	3	M9	HSS6x4x6	.668	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1a
172	3	M10	HSS6x4x6	.690	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1a
173	3	M11	HSS6x4x6	.690	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1a
174	3	M12	HSS6x4x6	.668	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1a
175	3	M13	HSS6x4x6	.635	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1a
176	3	M14	HSS6x4x6	.586	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1a
177	3	M15	HSS6x4x6	.525	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1a
178	3	M16	HSS6x4x6	.448	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1a
179	3	M17	HSS6x4x6	.360	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1a
180	3	M18	HSS6x4x6	.256	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1a
181	3	M19	HSS6x4x6	.075	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1a
182	3	M20	HSS6x4x6	.009	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1b
183	3	M21	HSS8x4x6	.079	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1b
184	3	M22	HSS8x4x6	.279	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
185	3	M23	HSS8x4x6	.394	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
186	3	M24	HSS8x4x6	.492	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
187	3	M25	HSS8x4x6	.577	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
188	3	M26	HSS8x4x6	.644	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
189	3	M27	HSS8x4x6	.699	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
190	3	M28	HSS8x4x6	.735	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
191	3	M29	HSS8x4x6	.760	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
192	3	M30	HSS8x4x6	.766	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
193	3	M31	HSS8x4x6	.766	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1a
194	3	M32	HSS8x4x6	.760	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1a
195	3	M33	HSS8x4x6	.735	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1a
196	3	M34	HSS8x4x6	.699	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1a
197	3	M35	HSS8x4x6	.644	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1a
198	3	M36	HSS8x4x6	.577	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1a
199	3	M37	HSS8x4x6	.492	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1a
200	3	M38	HSS8x4x6	.394	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1a
201	3	M39	HSS8x4x6	.279	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1a
202	3	M40	HSS8x4x6	.079	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1b
203	3	M41	HSS4x4x3	.311	0	.000	0	58.347	71.066	8.424	1	H1-1a
204	3	M42	HSS4x4x3	.412	5.582	.002	0	42.116	71.066	8.424	1.136	H1-1a
205	3	M43	HSS4x4x3	.295	0	.000	0	58.347	71.066	8.424	1	H1-1a
206	3	M44	HSS4x4x3	.363	5.582	.002	11.402	42.116	71.066	8.424	1.136	H1-1a
207	3	M45	HSS4x4x3	.259	0	.000	0	58.347	71.066	8.424	1	H1-1a
208	3	M46	HSS4x4x3	.329	5.582	.002	0	42.116	71.066	8.424	1.136	H1-1a
209	3	M47	HSS4x4x3	.234	0	.000	0	58.347	71.066	8.424	1	H1-1a
210	3	M48	HSS4x4x3	.279	5.582	.002	0	42.116	71.066	8.424	1.136	H1-1a
211	3	M49	HSS4x4x3	.099	0	.000	0	58.347	71.066	8.424	1	H1-1b
212	3	M50	HSS4x4x3	.245	5.582	.002	11.402	42.116	71.066	8.424	1.136	H1-1a
213	3	M51	HSS4x4x3	.087	0	.000	0	58.347	71.066	8.424	1	H1-1b
214	3	M52	HSS4x4x3	.105	5.701	.002	11.402	42.116	71.066	8.424	1.136	H1-1b
215	3	M53	HSS4x4x3	.069	0	.000	0	58.347	71.066	8.424	1	H1-1b
216	3	M54	HSS4x4x3	.088	5.701	.002	11.402	42.116	71.066	8.424	1.136	H1-1b
217	3	M55	HSS4x4x3	.056	0	.000	0	58.347	71.066	8.424	1	H1-1b
218	3	M56	HSS4x4x3	.064	5.701	.002	0	42.116	71.066	8.424	1.136	H1-1b
219	3	M57	HSS4x4x3	.038	0	.000	0	58.347	71.066	8.424	1	H1-1b
220	3	M58	HSS4x4x3	.047	5.701	.002	11.402	42.116	71.066	8.424	1.136	H1-1b
221	3	M59	HSS4x4x3	.025	0	.000	0	58.347	71.066	8.424	1	H1-1b
222	3	M60	HSS4x4x3	.022	5.701	.002	11.402	42.116	71.066	8.424	1.136	H1-1b
223	3	M61	HSS4x4x3	.022	5.701	.002	0	42.116	71.066	8.424	1.136	H1-1b
224	3	M62	HSS4x4x3	.025	7	.000	0	58.347	71.066	8.424	1	H1-1b
225	3	M63	HSS4x4x3	.047	5.701	.002	11.402	42.116	71.066	8.424	1.136	H1-1b
226	3	M64	HSS4x4x3	.038	7	.000	0	58.347	71.066	8.424	1	H1-1b
227	3	M65	HSS4x4x3	.064	5.701	.002	11.402	42.116	71.066	8.424	1.136	H1-1b

Member AISC 13th(360-05): ASD Steel Code Checks (Continued)

	LC	Member	Shape	UC Max	Loc[ft]	Shear UC	Loc[ft]	Pnc/om [k]	Pnt/om [k]	Mn/om [k-ft]	Cb	Eqn
228	3	M66	HSS4x4x3	.056	7	.000	0	58.347	71.066	8.424	1	H1-1b
229	3	M67	HSS4x4x3	.088	5.701	.002	0	42.116	71.066	8.424	1.136	H1-1b
230	3	M68	HSS4x4x3	.069	7	.000	0	58.347	71.066	8.424	1	H1-1b
231	3	M69	HSS4x4x3	.105	5.701	.002	0	42.116	71.066	8.424	1.136	H1-1b
232	3	M70	HSS4x4x3	.087	7	.000	0	58.347	71.066	8.424	1	H1-1b
233	3	M71	HSS4x4x3	.245	5.82	.002	0	42.116	71.066	8.424	1.136	H1-1a
234	3	M72	HSS4x4x3	.099	7	.000	0	58.347	71.066	8.424	1	H1-1b
235	3	M73	HSS4x4x3	.279	5.82	.002	11.402	42.116	71.066	8.424	1.136	H1-1a
236	3	M74	HSS4x4x3	.234	7	.000	0	58.347	71.066	8.424	1	H1-1a
237	3	M75	HSS4x4x3	.329	5.82	.002	11.402	42.116	71.066	8.424	1.136	H1-1a
238	3	M76	HSS4x4x3	.259	7	.000	0	58.347	71.066	8.424	1	H1-1a
239	3	M77	HSS4x4x3	.363	5.82	.002	11.402	42.116	71.066	8.424	1.136	H1-1a
240	3	M78	HSS4x4x3	.295	7	.000	0	58.347	71.066	8.424	1	H1-1a
241	3	M79	HSS4x4x3	.412	5.82	.002	0	42.116	71.066	8.424	1.136	H1-1a
242	3	M80	HSS4x4x3	.311	7	.000	0	58.347	71.066	8.424	1	H1-1a
243	3	M81	HSS4x4x3	.013	0	.000	0	58.347	71.066	8.424	1	H1-1b
244	4	M1	HSS6x4x6	.009	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1b
245	4	M2	HSS6x4x6	.080	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1b
246	4	M3	HSS6x4x6	.279	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1a
247	4	M4	HSS6x4x6	.390	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1a
248	4	M5	HSS6x4x6	.484	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1a
249	4	M6	HSS6x4x6	.562	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1a
250	4	M7	HSS6x4x6	.624	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1a
251	4	M8	HSS6x4x6	.670	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1a
252	4	M9	HSS6x4x6	.699	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1a
253	4	M10	HSS6x4x6	.712	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1a
254	4	M11	HSS6x4x6	.689	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1a
255	4	M12	HSS6x4x6	.658	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1a
256	4	M13	HSS6x4x6	.616	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1a
257	4	M14	HSS6x4x6	.563	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1a
258	4	M15	HSS6x4x6	.498	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1a
259	4	M16	HSS6x4x6	.423	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1a
260	4	M17	HSS6x4x6	.336	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1a
261	4	M18	HSS6x4x6	.238	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1a
262	4	M19	HSS6x4x6	.069	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1b
263	4	M20	HSS6x4x6	.009	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1b
264	4	M21	HSS8x4x6	.085	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1b
265	4	M22	HSS8x4x6	.304	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
266	4	M23	HSS8x4x6	.427	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
267	4	M24	HSS8x4x6	.531	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
268	4	M25	HSS8x4x6	.618	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
269	4	M26	HSS8x4x6	.686	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
270	4	M27	HSS8x4x6	.737	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
271	4	M28	HSS8x4x6	.769	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
272	4	M29	HSS8x4x6	.784	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1a
273	4	M30	HSS8x4x6	.780	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1a
274	4	M31	HSS8x4x6	.780	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1a
275	4	M32	HSS8x4x6	.758	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
276	4	M33	HSS8x4x6	.724	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
277	4	M34	HSS8x4x6	.678	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1a
278	4	M35	HSS8x4x6	.619	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1a
279	4	M36	HSS8x4x6	.547	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1a
280	4	M37	HSS8x4x6	.464	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1a
281	4	M38	HSS8x4x6	.368	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1a
282	4	M39	HSS8x4x6	.259	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1a
283	4	M40	HSS8x4x6	.073	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1b
284	4	M41	HSS4x4x3	.343	0	.000	0	58.347	71.066	8.424	1	H1-1a

Member AISC 13th(360-05): ASD Steel Code Checks (Continued)

	LC	Member	Shape	UC Max	Loc[ft]	Shear UC	Loc[ft]	Pnc/om [k]	Pnt/om [k]	Mn/om [k-ft]	Cb	Eqn
285	4	M42	HSS4x4x3	.447	5.582	.002	0	42.116	71.066	8.424	1.136	H1-1a
286	4	M43	HSS4x4x3	.321	0	.000	0	58.347	71.066	8.424	1	H1-1a
287	4	M44	HSS4x4x3	.398	5.582	.002	0	42.116	71.066	8.424	1.136	H1-1a
288	4	M45	HSS4x4x3	.285	0	.000	0	58.347	71.066	8.424	1	H1-1a
289	4	M46	HSS4x4x3	.348	5.582	.002	0	42.116	71.066	8.424	1.136	H1-1a
290	4	M47	HSS4x4x3	.249	0	.000	0	58.347	71.066	8.424	1	H1-1a
291	4	M48	HSS4x4x3	.299	5.582	.002	11.402	42.116	71.066	8.424	1.136	H1-1a
292	4	M49	HSS4x4x3	.213	0	.000	0	58.347	71.066	8.424	1	H1-1a
293	4	M50	HSS4x4x3	.249	5.582	.002	0	42.116	71.066	8.424	1.136	H1-1a
294	4	M51	HSS4x4x3	.088	0	.000	0	58.347	71.066	8.424	1	H1-1b
295	4	M52	HSS4x4x3	.107	5.701	.002	11.402	42.116	71.066	8.424	1.136	H1-1b
296	4	M53	HSS4x4x3	.070	0	.000	0	58.347	71.066	8.424	1	H1-1b
297	4	M54	HSS4x4x3	.082	5.701	.002	11.402	42.116	71.066	8.424	1.136	H1-1b
298	4	M55	HSS4x4x3	.052	0	.000	0	58.347	71.066	8.424	1	H1-1b
299	4	M56	HSS4x4x3	.058	5.701	.002	11.402	42.116	71.066	8.424	1.136	H1-1b
300	4	M57	HSS4x4x3	.034	0	.000	0	58.347	71.066	8.424	1	H1-1b
301	4	M58	HSS4x4x3	.033	5.701	.002	0	42.116	71.066	8.424	1.136	H1-1b
302	4	M59	HSS4x4x3	.015	0	.000	0	58.347	71.066	8.424	1	H1-1b
303	4	M60	HSS4x4x3	.022	5.82	.002	11.402	42.116	71.066	8.424	1.136	H1-1b
304	4	M61	HSS4x4x3	.043	5.701	.002	0	42.116	71.066	8.424	1.136	H1-1b
305	4	M62	HSS4x4x3	.035	7	.000	0	58.347	71.066	8.424	1	H1-1b
306	4	M63	HSS4x4x3	.060	5.701	.002	11.402	42.116	71.066	8.424	1.136	H1-1b
307	4	M64	HSS4x4x3	.048	7	.000	0	58.347	71.066	8.424	1	H1-1b
308	4	M65	HSS4x4x3	.077	5.701	.002	11.402	42.116	71.066	8.424	1.136	H1-1b
309	4	M66	HSS4x4x3	.060	7	.000	0	58.347	71.066	8.424	1	H1-1b
310	4	M67	HSS4x4x3	.094	5.701	.002	11.402	42.116	71.066	8.424	1.136	H1-1b
311	4	M68	HSS4x4x3	.073	7	.000	0	58.347	71.066	8.424	1	H1-1b
312	4	M69	HSS4x4x3	.111	5.701	.002	0	42.116	71.066	8.424	1.136	H1-1b
313	4	M70	HSS4x4x3	.085	7	.000	0	58.347	71.066	8.424	1	H1-1b
314	4	M71	HSS4x4x3	.241	5.82	.002	0	42.116	71.066	8.424	1.136	H1-1a
315	4	M72	HSS4x4x3	.097	7	.000	0	58.347	71.066	8.424	1	H1-1b
316	4	M73	HSS4x4x3	.276	5.82	.002	0	42.116	71.066	8.424	1.136	H1-1a
317	4	M74	HSS4x4x3	.220	7	.000	0	58.347	71.066	8.424	1	H1-1a
318	4	M75	HSS4x4x3	.310	5.82	.002	11.402	42.116	71.066	8.424	1.136	H1-1a
319	4	M76	HSS4x4x3	.244	7	.000	0	58.347	71.066	8.424	1	H1-1a
320	4	M77	HSS4x4x3	.344	5.82	.002	11.402	42.116	71.066	8.424	1.136	H1-1a
321	4	M78	HSS4x4x3	.269	7	.000	0	58.347	71.066	8.424	1	H1-1a
322	4	M79	HSS4x4x3	.378	5.82	.002	0	42.116	71.066	8.424	1.136	H1-1a
323	4	M80	HSS4x4x3	.285	7	.000	0	58.347	71.066	8.424	1	H1-1a
324	4	M81	HSS4x4x3	.019	0	.000	0	58.347	71.066	8.424	1	H1-1b
325	5	M1	HSS6x4x6	.015	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1b
326	5	M2	HSS6x4x6	.062	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1b
327	5	M3	HSS6x4x6	.220	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1a
328	5	M4	HSS6x4x6	.312	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1a
329	5	M5	HSS6x4x6	.393	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1a
330	5	M6	HSS6x4x6	.460	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1a
331	5	M7	HSS6x4x6	.516	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1a
332	5	M8	HSS6x4x6	.558	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1a
333	5	M9	HSS6x4x6	.588	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1a
334	5	M10	HSS6x4x6	.606	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1a
335	5	M11	HSS6x4x6	.604	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1a
336	5	M12	HSS6x4x6	.584	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1a
337	5	M13	HSS6x4x6	.551	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1a
338	5	M14	HSS6x4x6	.506	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1a
339	5	M15	HSS6x4x6	.449	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1a
340	5	M16	HSS6x4x6	.379	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1a
341	5	M17	HSS6x4x6	.296	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1a

Member AISC 13th(360-05): ASD Steel Code Checks (Continued)

	LC	Member	Shape	UC Max	Loc[ft]	Shear UC	Loc[ft]	Pnc/om [k]	Pnt/om [k]	Mn/om [k-ft]	Cb	Eqn
342	5	M18	HSS6x4x6	.105	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1b
343	5	M19	HSS6x4x6	.051	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1b
344	5	M20	HSS6x4x6	.031	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1b
345	5	M21	HSS8x4x6	.078	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1b
346	5	M22	HSS8x4x6	.265	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
347	5	M23	HSS8x4x6	.368	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
348	5	M24	HSS8x4x6	.457	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
349	5	M25	HSS8x4x6	.532	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
350	5	M26	HSS8x4x6	.593	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
351	5	M27	HSS8x4x6	.640	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
352	5	M28	HSS8x4x6	.673	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
353	5	M29	HSS8x4x6	.693	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
354	5	M30	HSS8x4x6	.698	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
355	5	M31	HSS8x4x6	.698	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1a
356	5	M32	HSS8x4x6	.690	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1a
357	5	M33	HSS8x4x6	.668	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1a
358	5	M34	HSS8x4x6	.632	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1a
359	5	M35	HSS8x4x6	.582	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1a
360	5	M36	HSS8x4x6	.519	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1a
361	5	M37	HSS8x4x6	.441	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1a
362	5	M38	HSS8x4x6	.349	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1a
363	5	M39	HSS8x4x6	.244	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1a
364	5	M40	HSS8x4x6	.066	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1b
365	5	M41	HSS4x4x3	.280	0	.000	0	58.347	71.066	8.424	1	H1-1a
366	5	M42	HSS4x4x3	.370	5.582	.002	0	42.116	71.066	8.424	1.136	H1-1a
367	5	M43	HSS4x4x3	.263	0	.000	0	58.347	71.066	8.424	1	H1-1a
368	5	M44	HSS4x4x3	.332	5.582	.002	11.402	42.116	71.066	8.424	1.136	H1-1a
369	5	M45	HSS4x4x3	.235	0	.000	0	58.347	71.066	8.424	1	H1-1a
370	5	M46	HSS4x4x3	.294	5.582	.002	11.402	42.116	71.066	8.424	1.136	H1-1a
371	5	M47	HSS4x4x3	.208	0	.000	0	58.347	71.066	8.424	1	H1-1a
372	5	M48	HSS4x4x3	.256	5.582	.002	0	42.116	71.066	8.424	1.136	H1-1a
373	5	M49	HSS4x4x3	.090	0	.000	0	58.347	71.066	8.424	1	H1-1b
374	5	M50	HSS4x4x3	.218	5.582	.002	0	42.116	71.066	8.424	1.136	H1-1a
375	5	M51	HSS4x4x3	.076	0	.000	0	58.347	71.066	8.424	1	H1-1b
376	5	M52	HSS4x4x3	.097	5.701	.002	11.402	42.116	71.066	8.424	1.136	H1-1b
377	5	M53	HSS4x4x3	.062	0	.000	0	58.347	71.066	8.424	1	H1-1b
378	5	M54	HSS4x4x3	.078	5.701	.002	11.402	42.116	71.066	8.424	1.136	H1-1b
379	5	M55	HSS4x4x3	.048	0	.000	0	58.347	71.066	8.424	1	H1-1b
380	5	M56	HSS4x4x3	.059	5.701	.002	0	42.116	71.066	8.424	1.136	H1-1b
381	5	M57	HSS4x4x3	.034	0	.000	0	58.347	71.066	8.424	1	H1-1b
382	5	M58	HSS4x4x3	.040	5.701	.002	0	42.116	71.066	8.424	1.136	H1-1b
383	5	M59	HSS4x4x3	.020	0	.000	0	58.347	71.066	8.424	1	H1-1b
384	5	M60	HSS4x4x3	.021	5.701	.002	0	42.116	71.066	8.424	1.136	H1-1b
385	5	M61	HSS4x4x3	.025	5.701	.002	11.402	42.116	71.066	8.424	1.136	H1-1b
386	5	M62	HSS4x4x3	.023	7	.000	0	58.347	71.066	8.424	1	H1-1b
387	5	M63	HSS4x4x3	.044	5.701	.002	0	42.116	71.066	8.424	1.136	H1-1b
388	5	M64	HSS4x4x3	.037	7	.000	0	58.347	71.066	8.424	1	H1-1b
389	5	M65	HSS4x4x3	.063	5.701	.002	11.402	42.116	71.066	8.424	1.136	H1-1b
390	5	M66	HSS4x4x3	.051	7	.000	0	58.347	71.066	8.424	1	H1-1b
391	5	M67	HSS4x4x3	.082	5.701	.002	0	42.116	71.066	8.424	1.136	H1-1b
392	5	M68	HSS4x4x3	.065	7	.000	0	58.347	71.066	8.424	1	H1-1b
393	5	M69	HSS4x4x3	.101	5.701	.002	11.402	42.116	71.066	8.424	1.136	H1-1b
394	5	M70	HSS4x4x3	.079	7	.000	0	58.347	71.066	8.424	1	H1-1b
395	5	M71	HSS4x4x3	.225	5.82	.002	11.402	42.116	71.066	8.424	1.136	H1-1a
396	5	M72	HSS4x4x3	.093	7	.000	0	58.347	71.066	8.424	1	H1-1b
397	5	M73	HSS4x4x3	.263	5.82	.002	0	42.116	71.066	8.424	1.136	H1-1a
398	5	M74	HSS4x4x3	.213	7	.000	0	58.347	71.066	8.424	1	H1-1a

Member AISC 13th(360-05): ASD Steel Code Checks (Continued)

	LC	Member	Shape	UC Max	Loc[ft]	Shear UC	Loc[ft]	Pnc/om [k]	Pnt/om [k]	Mn/om [k-ft]	Cb	Eqn
399	5	M75	HSS4x4x3	.301	5.82	.002	11.402	42.116	71.066	8.424	1.136	H1-1a
400	5	M76	HSS4x4x3	.241	7	.000	0	58.347	71.066	8.424	1	H1-1a
401	5	M77	HSS4x4x3	.339	5.82	.002	11.402	42.116	71.066	8.424	1.136	H1-1a
402	5	M78	HSS4x4x3	.269	7	.000	0	58.347	71.066	8.424	1	H1-1a
403	5	M79	HSS4x4x3	.377	5.82	.002	11.402	42.116	71.066	8.424	1.136	H1-1a
404	5	M80	HSS4x4x3	.286	7	.000	0	58.347	71.066	8.424	1	H1-1a
405	5	M81	HSS4x4x3	.014	0	.000	0	58.347	71.066	8.424	1	H1-1b
406	6	M1	HSS6x4x6	.015	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1b
407	6	M2	HSS6x4x6	.062	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1b
408	6	M3	HSS6x4x6	.220	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1a
409	6	M4	HSS6x4x6	.312	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1a
410	6	M5	HSS6x4x6	.393	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1a
411	6	M6	HSS6x4x6	.460	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1a
412	6	M7	HSS6x4x6	.516	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1a
413	6	M8	HSS6x4x6	.558	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1a
414	6	M9	HSS6x4x6	.588	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1a
415	6	M10	HSS6x4x6	.606	4.5	.002	9	122.941	170.228	27.315	1.136	H1-1a
416	6	M11	HSS6x4x6	.604	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1a
417	6	M12	HSS6x4x6	.584	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1a
418	6	M13	HSS6x4x6	.551	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1a
419	6	M14	HSS6x4x6	.506	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1a
420	6	M15	HSS6x4x6	.449	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1a
421	6	M16	HSS6x4x6	.379	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1a
422	6	M17	HSS6x4x6	.296	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1a
423	6	M18	HSS6x4x6	.105	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1b
424	6	M19	HSS6x4x6	.051	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1b
425	6	M20	HSS6x4x6	.031	4.5	.002	0	122.941	170.228	27.315	1.136	H1-1b
426	6	M21	HSS8x4x6	.078	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1b
427	6	M22	HSS8x4x6	.265	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
428	6	M23	HSS8x4x6	.368	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
429	6	M24	HSS8x4x6	.457	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
430	6	M25	HSS8x4x6	.532	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
431	6	M26	HSS8x4x6	.593	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
432	6	M27	HSS8x4x6	.640	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
433	6	M28	HSS8x4x6	.673	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
434	6	M29	HSS8x4x6	.693	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
435	6	M30	HSS8x4x6	.698	4.5	.001	9	154.145	208.79	43.154	1.136	H1-1a
436	6	M31	HSS8x4x6	.698	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1a
437	6	M32	HSS8x4x6	.690	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1a
438	6	M33	HSS8x4x6	.668	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1a
439	6	M34	HSS8x4x6	.632	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1a
440	6	M35	HSS8x4x6	.582	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1a
441	6	M36	HSS8x4x6	.519	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1a
442	6	M37	HSS8x4x6	.441	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1a
443	6	M38	HSS8x4x6	.349	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1a
444	6	M39	HSS8x4x6	.244	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1a
445	6	M40	HSS8x4x6	.066	4.5	.001	0	154.145	208.79	43.154	1.136	H1-1b
446	6	M41	HSS4x4x3	.280	0	.000	0	58.347	71.066	8.424	1	H1-1a
447	6	M42	HSS4x4x3	.370	5.582	.002	0	42.116	71.066	8.424	1.136	H1-1a
448	6	M43	HSS4x4x3	.263	0	.000	0	58.347	71.066	8.424	1	H1-1a
449	6	M44	HSS4x4x3	.332	5.582	.002	11.402	42.116	71.066	8.424	1.136	H1-1a
450	6	M45	HSS4x4x3	.235	0	.000	0	58.347	71.066	8.424	1	H1-1a
451	6	M46	HSS4x4x3	.294	5.582	.002	11.402	42.116	71.066	8.424	1.136	H1-1a
452	6	M47	HSS4x4x3	.208	0	.000	0	58.347	71.066	8.424	1	H1-1a
453	6	M48	HSS4x4x3	.256	5.582	.002	0	42.116	71.066	8.424	1.136	H1-1a
454	6	M49	HSS4x4x3	.090	0	.000	0	58.347	71.066	8.424	1	H1-1b
455	6	M50	HSS4x4x3	.218	5.582	.002	0	42.116	71.066	8.424	1.136	H1-1a

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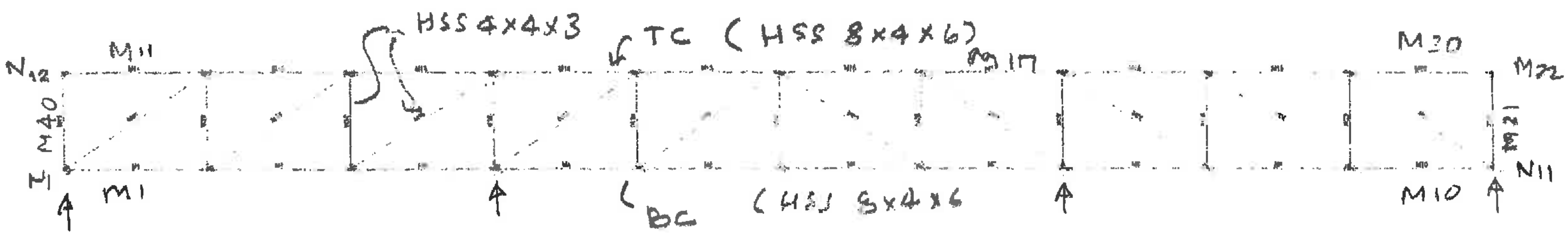
Member AISC 13th(360-05): ASD Steel Code Checks (Continued)

	LC	Member	Shape	UC Max	Loc[ft]	Shear UC	Loc[ft]	Pnc/om [k]	Pnt/om [k]	Mn/om [k-ft]	Cb	Eqn
456	6	M51	HSS4x4x3	.076	0	.000	0	58.347	71.066	8.424	1	H1-1b
457	6	M52	HSS4x4x3	.097	5.701	.002	11.402	42.116	71.066	8.424	1.136	H1-1b
458	6	M53	HSS4x4x3	.062	0	.000	0	58.347	71.066	8.424	1	H1-1b
459	6	M54	HSS4x4x3	.078	5.701	.002	11.402	42.116	71.066	8.424	1.136	H1-1b
460	6	M55	HSS4x4x3	.048	0	.000	0	58.347	71.066	8.424	1	H1-1b
461	6	M56	HSS4x4x3	.059	5.701	.002	0	42.116	71.066	8.424	1.136	H1-1b
462	6	M57	HSS4x4x3	.034	0	.000	0	58.347	71.066	8.424	1	H1-1b
463	6	M58	HSS4x4x3	.040	5.701	.002	0	42.116	71.066	8.424	1.136	H1-1b
464	6	M59	HSS4x4x3	.020	0	.000	0	58.347	71.066	8.424	1	H1-1b
465	6	M60	HSS4x4x3	.021	5.701	.002	0	42.116	71.066	8.424	1.136	H1-1b
466	6	M61	HSS4x4x3	.025	5.701	.002	11.402	42.116	71.066	8.424	1.136	H1-1b
467	6	M62	HSS4x4x3	.023	7	.000	0	58.347	71.066	8.424	1	H1-1b
468	6	M63	HSS4x4x3	.044	5.701	.002	0	42.116	71.066	8.424	1.136	H1-1b
469	6	M64	HSS4x4x3	.037	7	.000	0	58.347	71.066	8.424	1	H1-1b
470	6	M65	HSS4x4x3	.063	5.701	.002	11.402	42.116	71.066	8.424	1.136	H1-1b
471	6	M66	HSS4x4x3	.051	7	.000	0	58.347	71.066	8.424	1	H1-1b
472	6	M67	HSS4x4x3	.082	5.701	.002	0	42.116	71.066	8.424	1.136	H1-1b
473	6	M68	HSS4x4x3	.065	7	.000	0	58.347	71.066	8.424	1	H1-1b
474	6	M69	HSS4x4x3	.101	5.701	.002	11.402	42.116	71.066	8.424	1.136	H1-1b
475	6	M70	HSS4x4x3	.079	7	.000	0	58.347	71.066	8.424	1	H1-1b
476	6	M71	HSS4x4x3	.225	5.82	.002	11.402	42.116	71.066	8.424	1.136	H1-1a
477	6	M72	HSS4x4x3	.093	7	.000	0	58.347	71.066	8.424	1	H1-1b
478	6	M73	HSS4x4x3	.263	5.82	.002	0	42.116	71.066	8.424	1.136	H1-1a
479	6	M74	HSS4x4x3	.213	7	.000	0	58.347	71.066	8.424	1	H1-1a
480	6	M75	HSS4x4x3	.301	5.82	.002	11.402	42.116	71.066	8.424	1.136	H1-1a
481	6	M76	HSS4x4x3	.241	7	.000	0	58.347	71.066	8.424	1	H1-1a
482	6	M77	HSS4x4x3	.339	5.82	.002	11.402	42.116	71.066	8.424	1.136	H1-1a
483	6	M78	HSS4x4x3	.269	7	.000	0	58.347	71.066	8.424	1	H1-1a
484	6	M79	HSS4x4x3	.377	5.82	.002	11.402	42.116	71.066	8.424	1.136	H1-1a
485	6	M80	HSS4x4x3	.286	7	.000	0	58.347	71.066	8.424	1	H1-1a
486	6	M81	HSS4x4x3	.014	0	.000	0	58.347	71.066	8.424	1	H1-1b

Material Takeoff

	Material	Size	Pieces	Length[ft]	Weight[K]
1	Hot Rolled Steel				
2	A500 Gr.46	HSS4x4x3	41	375	3.3
3	A500 Gr.46	HSS6x4x6	20	180	3.8
4	A500 Gr.46	HSS8x4x6	20	180	4.6
5	Total HR Steel		81	735	11.7

ATTH. A-5 (23)



e2	180' topock ~~200~~' pipe bridge TOP DIAPH. TRUSS	SK - 1
kd		Mar 20, 2014 at 1:36 PM
ww-peg-2174-043062		topockhbt3A.pipebridge180.r2d

Hot Rolled Steel Section Sets

	Label	Shape	Type	Design List	Material	Design Rules	A [in2]	I (90,270) [i...	I (0,180) [in4]
1	HR1A	HSS4x4x3	Beam	Tube	A500 Gr.46	Typical	2.58	6.21	6.21
2	HR2	HSS8x4x6	Beam	Tube	A500 Gr.46	Typical	7.58	19.6	58.7

Joint Coordinates and Temperatures

	Label	X [ft]	Y [ft]	Temp [F]
1	N1	0	0	0
2	N2	18	0	0
3	N3	36	0	0
4	N4	54	0	0
5	N5	72	0	0
6	N6	90	0	0
7	N7	108	0	0
8	N8	126	0	0
9	N9	144	0	0
10	N10	162	0	0
11	N11	180	0	0
12	N12	0	12	0
13	N13	18	12	0
14	N14	36	12	0
15	N15	54	12	0
16	N16	72	12	0
17	N17	90	12	0
18	N18	108	12	0
19	N19	126	12	0
20	N20	144	12	0
21	N21	162	12	0
22	N22	180	12	0

Joint Boundary Conditions

	Joint Label	X [k/in]	Y [k/in]	Rotation[k-ft/rad]	Footing
1	N1	Reaction	Reaction		
2	N11	Reaction	Reaction		
3	N4		Reaction		
4	N8		Reaction		

Member Primary Data

	Label	I Joint	J Joint	Rotate(deg)	Section/Shape	Type	Design List	Material	Design Rules
1	M1	N1	N2	90	HR2	Beam	Tube	A500 Gr.46	Typical
2	M2	N2	N3	90	HR2	Beam	Tube	A500 Gr.46	Typical
3	M3	N3	N4	90	HR2	Beam	Tube	A500 Gr.46	Typical
4	M4	N4	N5	90	HR2	Beam	Tube	A500 Gr.46	Typical
5	M5	N5	N6	90	HR2	Beam	Tube	A500 Gr.46	Typical
6	M6	N6	N7	90	HR2	Beam	Tube	A500 Gr.46	Typical
7	M7	N7	N8	90	HR2	Beam	Tube	A500 Gr.46	Typical
8	M8	N8	N9	90	HR2	Beam	Tube	A500 Gr.46	Typical
9	M9	N9	N10	90	HR2	Beam	Tube	A500 Gr.46	Typical
10	M10	N10	N11	90	HR2	Beam	Tube	A500 Gr.46	Typical
11	M11	N12	N13	90	HR2	Beam	Tube	A500 Gr.46	Typical
12	M12	N13	N14	90	HR2	Beam	Tube	A500 Gr.46	Typical
13	M13	N14	N15	90	HR2	Beam	Tube	A500 Gr.46	Typical
14	M14	N15	N16	90	HR2	Beam	Tube	A500 Gr.46	Typical
15	M15	N16	N17	90	HR2	Beam	Tube	A500 Gr.46	Typical

Member Primary Data (Continued)

	Label	I Joint	J Joint	Rotate(deg)	Section/Shape	Type	Design List	Material	Design Rules
16	M16	N17	N18	90	HR2	Beam	Tube	A500 Gr.46	Typical
17	M18	N19	N20	90	HR2	Beam	Tube	A500 Gr.46	Typical
18	M19	N20	N21	90	HR2	Beam	Tube	A500 Gr.46	Typical
19	M20	N21	N22	90	HR2	Beam	Tube	A500 Gr.46	Typical
20	M21	N22	N11		HR1A	Beam	Tube	A500 Gr.46	Typical
21	M22	N11	N21		HR1A	Beam	Tube	A500 Gr.46	Typical
22	M23	N21	N10		HR1A	Beam	Tube	A500 Gr.46	Typical
23	M24	N10	N20		HR1A	Beam	Tube	A500 Gr.46	Typical
24	M25	N20	N9		HR1A	Beam	Tube	A500 Gr.46	Typical
25	M26	N9	N19		HR1A	Beam	Tube	A500 Gr.46	Typical
26	M27	N19	N8		HR1A	Beam	Tube	A500 Gr.46	Typical
27	M28	N8	N18		HR1A	Beam	Tube	A500 Gr.46	Typical
28	M29	N18	N7		HR1A	Beam	Tube	A500 Gr.46	Typical
29	M30	N7	N17		HR1A	Beam	Tube	A500 Gr.46	Typical
30	M31	N17	N6		HR1A	Beam	Tube	A500 Gr.46	Typical
31	M32	N5	N17		HR1A	Beam	Tube	A500 Gr.46	Typical
32	M33	N16	N5		HR1A	Beam	Tube	A500 Gr.46	Typical
33	M34	N4	N16		HR1A	Beam	Tube	A500 Gr.46	Typical
34	M35	N15	N4		HR1A	Beam	Tube	A500 Gr.46	Typical
35	M36	N3	N15		HR1A	Beam	Tube	A500 Gr.46	Typical
36	M37	N14	N3		HR1A	Beam	Tube	A500 Gr.46	Typical
37	M38	N2	N14		HR1A	Beam	Tube	A500 Gr.46	Typical
38	M39	N13	N2		HR1A	Beam	Tube	A500 Gr.46	Typical
39	M40	N1	N13		HR1A	Beam	Tube	A500 Gr.46	Typical
40	M41	N1	N12		HR1A	Beam	Tube	A500 Gr.46	Typical
41	m17	N18	N19		HR2	Beam	Tube	A500 Gr.46	Typical

Joint Loads and Enforced Displacements (BLC 1 : seismic)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N12	L	Y	-.2
2	N13	L	Y	-.4
3	N14	L	Y	-.4
4	N15	L	Y	-.4
5	N16	L	Y	-.4
6	N17	L	Y	-.4
7	N18	L	Y	-.4
8	N19	L	Y	-.4
9	N20	L	Y	-.4
10	N21	L	Y	-.4
11	N1	L	Y	0
12	N2	L	Y	0
13	N3	L	Y	0
14	N4	L	Y	0
15	N5	L	Y	0
16	N6	L	Y	0
17	N7	L	Y	0
18	N8	L	Y	0
19	N9	L	Y	0
20	N10	L	Y	0
21	N11	L	Y	0
22	N22	L	Y	-.2

Basic Load Cases

	BLC Description	Category	X Gravity	Y Gravity	Joint	Point	Distributed
1	seismic	None			22		

Load Combinations

	Description	Solve	PD...	SR...	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor
1	seismic	Yes	Y		1	1														

Joint Reactions (By Combination)

	LC	Joint Label	X [k]	Y [k]	MZ [k-ft]
1	1	N1	.491	.553	0
2	1	N11	-.491	.553	0
3	1	N4	0	1.447	0
4	1	N8	0	1.447	0
5	1	Totals:	0	4	
6	1	COG (ft):	X: 90	Y: 12	

Joint Deflections

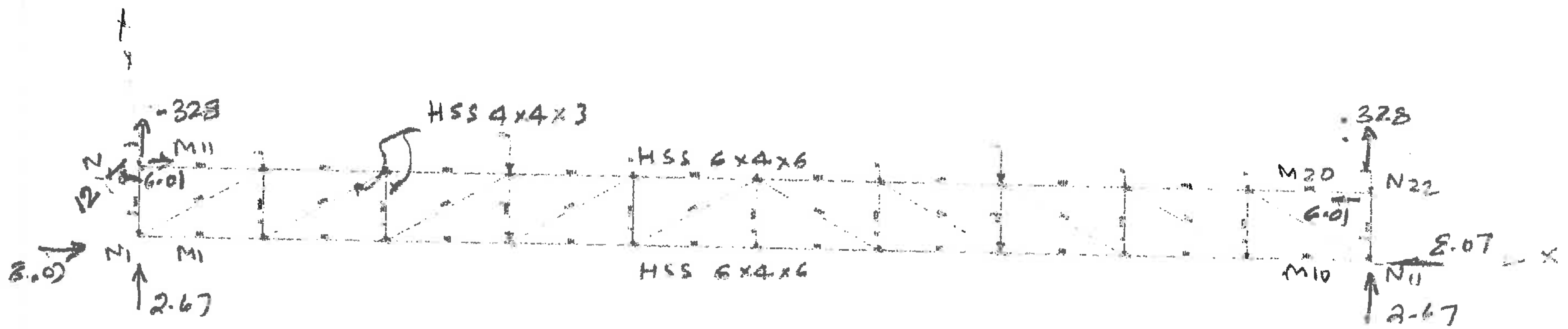
	LC	Joint Label	X [in]	Y [in]	Rotation [rad]
1	1	N1	0	0	0
2	1	N2	0	-.006	0
3	1	N3	0	-.006	0
4	1	N4	0	0	0
5	1	N5	0	-.009	0
6	1	N6	0	-.012	0
7	1	N7	0	-.009	0
8	1	N8	0	0	0
9	1	N9	0	-.006	0
10	1	N10	0	-.006	0
11	1	N11	0	0	0
12	1	N12	.001	0	0
13	1	N13	.001	-.006	0
14	1	N14	0	-.007	0
15	1	N15	0	-.002	0
16	1	N16	0	-.009	0
17	1	N17	0	-.012	0
18	1	N18	0	-.009	0
19	1	N19	0	-.002	0
20	1	N20	0	-.007	0
21	1	N21	-.001	-.006	0
22	1	N22	-.001	0	0

Member AISC 13th(360-05): ASD Steel Code Checks (By Combination)

	LC	Member	Shape	UC Max	Loc[ft]	Shear UC	Loc[ft]	Pnc/om [k]	Pnt/om [k]	Mn/om [k-ft]	Cb	Eqn
1	1	M1	HSS8x4x6	.000	0	.000	0	63.144	208.79	26.397	1	H1-1b
2	1	M2	HSS8x4x6	.000	0	.000	0	63.144	208.79	26.397	1	H1-1b
3	1	M3	HSS8x4x6	.006	0	.000	0	63.144	208.79	26.397	1	H1-1b
4	1	M4	HSS8x4x6	.000	0	.000	0	63.144	208.79	26.397	1	H1-1b
5	1	M5	HSS8x4x6	.001	0	.000	0	63.144	208.79	26.397	1	H1-1b
6	1	M6	HSS8x4x6	.001	0	.000	0	63.144	208.79	26.397	1	H1-1b
7	1	M7	HSS8x4x6	.000	0	.000	0	63.144	208.79	26.397	1	H1-1b
8	1	M8	HSS8x4x6	.006	0	.000	0	63.144	208.79	26.397	1	H1-1b
9	1	M9	HSS8x4x6	.000	0	.000	0	63.144	208.79	26.397	1	H1-1b

Member AISC 13th(360-05): ASD Steel Code Checks (By Combination) (Continued)

	LC	Member	Shape	UC Max	Loc[ft]	Shear UC	Loc[ft]	Pnc/om [k]	Pnt/om [k]	Mn/om [k-ft]	Cb	Eqn
10	1	M10	HSS8x4x6	.000	0	.000	0	63.144	208.79	26.397	1	H1-1b
11	1	M11	HSS8x4x6	.000	0	.000	0	63.144	208.79	26.397	1	H1-1b
12	1	M12	HSS8x4x6	.004	0	.000	0	63.144	208.79	26.397	1	H1-1b
13	1	M13	HSS8x4x6	.004	0	.000	0	63.144	208.79	26.397	1	H1-1b
14	1	M14	HSS8x4x6	.001	0	.000	0	63.144	208.79	26.397	1	H1-1b
15	1	M15	HSS8x4x6	.005	0	.000	0	63.144	208.79	26.397	1	H1-1b
16	1	M16	HSS8x4x6	.005	0	.000	0	63.144	208.79	26.397	1	H1-1b
17	1	M18	HSS8x4x6	.004	0	.000	0	63.144	208.79	26.397	1	H1-1b
18	1	M19	HSS8x4x6	.004	0	.000	0	63.144	208.79	26.397	1	H1-1b
19	1	M20	HSS8x4x6	.000	0	.000	0	63.144	208.79	26.397	1	H1-1b
20	1	M21	HSS4x4x3	.003	0	.000	0	39.809	71.066	8.424	1	H1-1b
21	1	M22	HSS4x4x3	.023	0	.000	0	13.85	71.066	8.424	1	H1-1b
22	1	M23	HSS4x4x3	.001	0	.000	0	39.809	71.066	8.424	1	H1-1b
23	1	M24	HSS4x4x3	.001	0	.000	0	13.85	71.066	8.424	1	H1-1b
24	1	M25	HSS4x4x3	.006	0	.000	0	39.809	71.066	8.424	1	H1-1b
25	1	M26	HSS4x4x3	.006	0	.000	0	13.85	71.066	8.424	1	H1-1b
26	1	M27	HSS4x4x3	.011	0	.000	0	39.809	71.066	8.424	1	H1-1b
27	1	M28	HSS4x4x3	.039	0	.000	0	13.85	71.066	8.424	1	H1-1b
28	1	M29	HSS4x4x3	.001	0	.000	0	39.809	71.066	8.424	1	H1-1b
29	1	M30	HSS4x4x3	.013	0	.000	0	13.85	71.066	8.424	1	H1-1b
30	1	M31	HSS4x4x3	.000	0	.000	0	39.809	71.066	8.424	1	H1-1b
31	1	M32	HSS4x4x3	.013	0	.000	0	13.85	71.066	8.424	1	H1-1b
32	1	M33	HSS4x4x3	.001	0	.000	0	39.809	71.066	8.424	1	H1-1b
33	1	M34	HSS4x4x3	.039	0	.000	0	13.85	71.066	8.424	1	H1-1b
34	1	M35	HSS4x4x3	.011	0	.000	0	39.809	71.066	8.424	1	H1-1b
35	1	M36	HSS4x4x3	.006	0	.000	0	13.85	71.066	8.424	1	H1-1b
36	1	M37	HSS4x4x3	.006	0	.000	0	39.809	71.066	8.424	1	H1-1b
37	1	M38	HSS4x4x3	.001	0	.000	0	13.85	71.066	8.424	1	H1-1b
38	1	M39	HSS4x4x3	.001	0	.000	0	39.809	71.066	8.424	1	H1-1b
39	1	M40	HSS4x4x3	.023	0	.000	0	13.85	71.066	8.424	1	H1-1b
40	1	M41	HSS4x4x3	.003	0	.000	0	39.809	71.066	8.424	1	H1-1b
41	1	m17	HSS8x4x6	.001	0	.000	0	63.144	208.79	43.154	1	H1-1b



e2	
kd	180' topock ~~200'~~ pipe bridge BOT DIAPH TRUSS
ww-peg-2174-043062	

SK
Ma
topo

Company : e2
Designer : kd
Job Number : ww-peg-2174-043062 topock 180' pipe bridge

Hot Rolled Steel Section Sets

	Label	Shape	Type	Design List	Material	Design Rules
1	HR1A	HSS4x4x3	Beam	Tube	A500 Gr.46	Typical
2	HR2	HSS6x4x6	Beam	Tube	A500 Gr.46	Typical

Joint Coordinates and Temperatures

	Label	X [ft]	Y [ft]	Temp [F]
1	N1	0	0	0
2	N2	18	0	0
3	N3	36	0	0
4	N4	54	0	0
5	N5	72	0	0
6	N6	90	0	0
7	N7	108	0	0
8	N8	126	0	0
9	N9	144	0	0
10	N10	162	0	0
11	N11	180	0	0
12	N12	0	12	0
13	N13	18	12	0
14	N14	36	12	0
15	N15	54	12	0
16	N16	72	12	0
17	N17	90	12	0
18	N18	108	12	0
19	N19	126	12	0
20	N20	144	12	0
21	N21	162	12	0
22	N22	180	12	0

Joint Boundary Conditions

	Joint Label	X [k/in]	Y [k/in]	Rotation[k-ft/rad]	Footing
1	N1	Reaction	Reaction		
2	N11	Reaction	Reaction		
3	N22	Reaction	Reaction		
4	N12	Reaction	Reaction		

Member Primary Data

	Label	I Joint	J Joint	Rotate(deg)	Section/Shape	Type	Design List	Material	Design Rules
1	M1	N1	N2		HR2	Beam	Tube	A500 Gr.46	Typical
2	M2	N2	N3		HR2	Beam	Tube	A500 Gr.46	Typical
3	M3	N3	N4		HR2	Beam	Tube	A500 Gr.46	Typical
4	M4	N4	N5		HR2	Beam	Tube	A500 Gr.46	Typical
5	M5	N5	N6		HR2	Beam	Tube	A500 Gr.46	Typical
6	M6	N6	N7		HR2	Beam	Tube	A500 Gr.46	Typical
7	M7	N7	N8		HR2	Beam	Tube	A500 Gr.46	Typical
8	M8	N8	N9		HR2	Beam	Tube	A500 Gr.46	Typical
9	M9	N9	N10		HR2	Beam	Tube	A500 Gr.46	Typical
10	M10	N10	N11		HR2	Beam	Tube	A500 Gr.46	Typical
11	M11	N12	N13		HR2	Beam	Tube	A500 Gr.46	Typical
12	M12	N13	N14		HR2	Beam	Tube	A500 Gr.46	Typical
13	M13	N14	N15		HR2	Beam	Tube	A500 Gr.46	Typical
14	M14	N15	N16		HR2	Beam	Tube	A500 Gr.46	Typical
15	M15	N16	N17		HR2	Beam	Tube	A500 Gr.46	Typical

Basic Load Cases

	BLC Description	Category	X Gravity	Y Gravity	Joint	Point	Distributed
1	seismic	None			22		

Load Combinations

	Description	Solve	PD	SR...	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor
1	seismic	Yes	Y		1	1														

Joint Reactions (By Combination)

	LC	Joint Label	X [k]	Y [k]	MZ [k-ft]
1	1	N1	8.066	2.672	0
2	1	N11	-8.066	2.672	0
3	1	N22	6.012	.328	0
4	1	N12	-6.012	.328	0
5	1	Totals:	0	6	
6	1	COG (ft):	X: 90	Y: 6	

Joint Deflections

	LC	Joint Label	X [in]	Y [in]	Rotation [rad]
1	1	N1	0	0	0
2	1	N2	-.005	-.042	0
3	1	N3	-.007	-.093	0
4	1	N4	-.005	-.142	0
5	1	N5	-.003	-.161	0
6	1	N6	0	-.166	0
7	1	N7	.003	-.161	0
8	1	N8	.005	-.142	0
9	1	N9	.007	-.093	0
10	1	N10	.005	-.042	0
11	1	N11	0	0	0
12	1	N12	0	0	0
13	1	N13	.007	-.037	0
14	1	N14	.01	-.089	0
15	1	N15	.009	-.14	0
16	1	N16	.005	-.161	0
17	1	N17	0	-.166	0
18	1	N18	-.005	-.161	0
19	1	N19	-.009	-.14	0
20	1	N20	-.01	-.089	0
21	1	N21	-.007	-.037	0
22	1	N22	0	0	0

Member AISC 13th(360-05): ASD Steel Code Checks

	LC	Member	Shape	UC Max	Loc[ft]	Shear UC	Loc[ft]	Pnc/om [k]	Pnt/om [k]	Mn/om [k-ft]	Cb	Eqn
1	1	M1	HSS6x4x6	.047	0	.000	0	48.002	170.228	27.315	1	H1-1b
2	1	M2	HSS6x4x6	.014	0	.000	0	48.002	170.228	27.315	1	H1-1b
3	1	M3	HSS6x4x6	.005	0	.000	0	48.002	170.228	27.315	1	H1-1b
4	1	M4	HSS6x4x6	.006	0	.000	0	48.002	170.228	27.315	1	H1-1b
5	1	M5	HSS6x4x6	.006	0	.000	0	48.002	170.228	27.315	1	H1-1b
6	1	M6	HSS6x4x6	.006	0	.000	0	48.002	170.228	27.315	1	H1-1b
7	1	M7	HSS6x4x6	.006	0	.000	0	48.002	170.228	27.315	1	H1-1b
8	1	M8	HSS6x4x6	.005	0	.000	0	48.002	170.228	27.315	1	H1-1b
9	1	M9	HSS6x4x6	.014	0	.000	0	48.002	170.228	27.315	1	H1-1b

Member Primary Data (Continued)

	Label	I Joint	J Joint	Rotate(deg)	Section/Shape	Type	Design List	Material	Design Rules
16	M16	N17	N18		HR2	Beam	Tube	A500 Gr.46	Typical
17	M18	N19	N20		HR2	Beam	Tube	A500 Gr.46	Typical
18	M19	N20	N21		HR2	Beam	Tube	A500 Gr.46	Typical
19	M20	N21	N22		HR2	Beam	Tube	A500 Gr.46	Typical
20	M21	N22	N11		HR1A	Beam	Tube	A500 Gr.46	Typical
21	M22	N11	N21		HR1A	Beam	Tube	A500 Gr.46	Typical
22	M23	N21	N10		HR1A	Beam	Tube	A500 Gr.46	Typical
23	M24	N10	N20		HR1A	Beam	Tube	A500 Gr.46	Typical
24	M25	N20	N9		HR1A	Beam	Tube	A500 Gr.46	Typical
25	M26	N9	N19		HR1A	Beam	Tube	A500 Gr.46	Typical
26	M27	N19	N8		HR1A	Beam	Tube	A500 Gr.46	Typical
27	M28	N8	N18		HR1A	Beam	Tube	A500 Gr.46	Typical
28	M29	N18	N7		HR1A	Beam	Tube	A500 Gr.46	Typical
29	M30	N7	N17		HR1A	Beam	Tube	A500 Gr.46	Typical
30	M31	N17	N6		HR1A	Beam	Tube	A500 Gr.46	Typical
31	M32	N5	N17		HR1A	Beam	Tube	A500 Gr.46	Typical
32	M33	N16	N5		HR1A	Beam	Tube	A500 Gr.46	Typical
33	M34	N4	N16		HR1A	Beam	Tube	A500 Gr.46	Typical
34	M35	N15	N4		HR1A	Beam	Tube	A500 Gr.46	Typical
35	M36	N3	N15		HR1A	Beam	Tube	A500 Gr.46	Typical
36	M37	N14	N3		HR1A	Beam	Tube	A500 Gr.46	Typical
37	M38	N2	N14		HR1A	Beam	Tube	A500 Gr.46	Typical
38	M39	N13	N2		HR1A	Beam	Tube	A500 Gr.46	Typical
39	M40	N1	N13		HR1A	Beam	Tube	A500 Gr.46	Typical
40	M41	N1	N12		HR1A	Beam	Tube	A500 Gr.46	Typical
41	m17	N18	N19		HR2	Beam	Tube	A500 Gr.46	Typical

Joint Loads and Enforced Displacements (BLC 1 : seismic)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N12	L	Y	-.326
2	N13	L	Y	-.1
3	N14	L	Y	-.1
4	N15	L	Y	-.824
5	N16	L	Y	-.1
6	N17	L	Y	-.1
7	N18	L	Y	-.1
8	N19	L	Y	-.824
9	N20	L	Y	-.1
10	N21	L	Y	-.1
11	N1	L	Y	-.326
12	N2	L	Y	-.1
13	N3	L	Y	-.1
14	N4	L	Y	-.824
15	N5	L	Y	-.1
16	N6	L	Y	-.1
17	N7	L	Y	-.1
18	N8	L	Y	-.824
19	N9	L	Y	-.1
20	N10	L	Y	-.1
21	N11	L	Y	-.326
22	N22	L	Y	-.326

Member AISC 13th(360-05): ASD Steel Code Checks (Continued)

	LC	Member	Shape	UC Max	Loc[ft]	Shear UC	Loc[ft]	Pnc/om [k]	Pnt/om [k]	Mn/om [k-ft]	Cb	Eqn
10	1	M10	HSS6x4x6	.047	0	.000	0	48.002	170.228	27.315	1	H1-1b
11	1	M11	HSS6x4x6	.018	0	.000	0	48.002	170.228	27.315	1	H1-1b
12	1	M12	HSS6x4x6	.007	0	.000	0	48.002	170.228	27.315	1	H1-1b
13	1	M13	HSS6x4x6	.008	0	.000	0	48.002	170.228	27.315	1	H1-1b
14	1	M14	HSS6x4x6	.038	0	.000	0	48.002	170.228	27.315	1	H1-1b
15	1	M15	HSS6x4x6	.043	0	.000	0	48.002	170.228	27.315	1	H1-1b
16	1	M16	HSS6x4x6	.043	0	.000	0	48.002	170.228	27.315	1	H1-1b
17	1	M18	HSS6x4x6	.008	0	.000	0	48.002	170.228	27.315	1	H1-1b
18	1	M19	HSS6x4x6	.007	0	.000	0	48.002	170.228	27.315	1	H1-1b
19	1	M20	HSS6x4x6	.018	0	.000	0	48.002	170.228	27.315	1	H1-1b
20	1	M21	HSS4x4x3	.000	0	.000	0	39.809	71.066	8.424	1	H1-1b
21	1	M22	HSS4x4x3	.306	0	.000	0	13.85	71.066	8.424	1	H1-1a
22	1	M23	HSS4x4x3	.016	0	.000	0	39.809	71.066	8.424	1	H1-1b
23	1	M24	HSS4x4x3	.280	0	.000	0	13.85	71.066	8.424	1	H1-1a
24	1	M25	HSS4x4x3	.014	0	.000	0	39.809	71.066	8.424	1	H1-1b
25	1	M26	HSS4x4x3	.254	0	.000	0	13.85	71.066	8.424	1	H1-1a
26	1	M27	HSS4x4x3	.008	0	.000	0	39.809	71.066	8.424	1	H1-1b
27	1	M28	HSS4x4x3	.020	0	.000	0	13.85	71.066	8.424	1	H1-1b
28	1	M29	HSS4x4x3	.001	0	.000	0	39.809	71.066	8.424	1	H1-1b
29	1	M30	HSS4x4x3	.007	0	.000	0	13.85	71.066	8.424	1	H1-1b
30	1	M31	HSS4x4x3	.001	0	.000	0	39.809	71.066	8.424	1	H1-1b
31	1	M32	HSS4x4x3	.007	0	.000	0	13.85	71.066	8.424	1	H1-1b
32	1	M33	HSS4x4x3	.001	0	.000	0	39.809	71.066	8.424	1	H1-1b
33	1	M34	HSS4x4x3	.020	0	.000	0	13.85	71.066	8.424	1	H1-1b
34	1	M35	HSS4x4x3	.008	0	.000	0	39.809	71.066	8.424	1	H1-1b
35	1	M36	HSS4x4x3	.254	0	.000	0	13.85	71.066	8.424	1	H1-1a
36	1	M37	HSS4x4x3	.014	0	.000	0	39.809	71.066	8.424	1	H1-1b
37	1	M38	HSS4x4x3	.280	0	.000	0	13.85	71.066	8.424	1	H1-1a
38	1	M39	HSS4x4x3	.016	0	.000	0	39.809	71.066	8.424	1	H1-1b
39	1	M40	HSS4x4x3	.306	0	.000	0	13.85	71.066	8.424	1	H1-1a
40	1	M41	HSS4x4x3	.000	0	.000	0	39.809	71.066	8.424	1	H1-1b
41	1	m17	HSS6x4x6	.038	0	.000	0	48.002	170.228	27.315	1	H1-1b

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E2 Consulting Engineers, Inc. 1900 Powell Street, Suite 250 Eneryville, CA 94608	Designed By: KD	Date: 3/21/14
	Checked By:	Date:
	Revised By:	Date:
Project No.		Sheet No.

Project Description Topock 180' pipe bridge Line A

Bridge Trusses

Main Truss - 180' Long, Line A (180 pb. topock. r2d)

A Unity check

A.1 Top chord (HSS 8x4x6) Memb. 30, 31

DL+LL UC Max = .907 < 1.0 ok

A.2 BOT. chord (HSS 6x4x6) Memb 10, 11)

DL+LL UC Max = .815

A.3 Diagonals (HSS 4x4x4) Memb. 42

DL+LL UC Max = .482

A.4 Verticals (HSS 4x4x4) Memb 41, 80

UC Max = .369

B. Deflection Check

Comb 1 DL+LL Δ_{max} = 8.736

Comb 2 Δ_{DL} = 7.373 provide camber $\frac{l}{300} = \frac{180 \times 12}{300} = 7.2''$

Net DL+LL Defl. = 8.736 - .9 x 7.373 = 2.10'' = $\frac{l}{1028}$

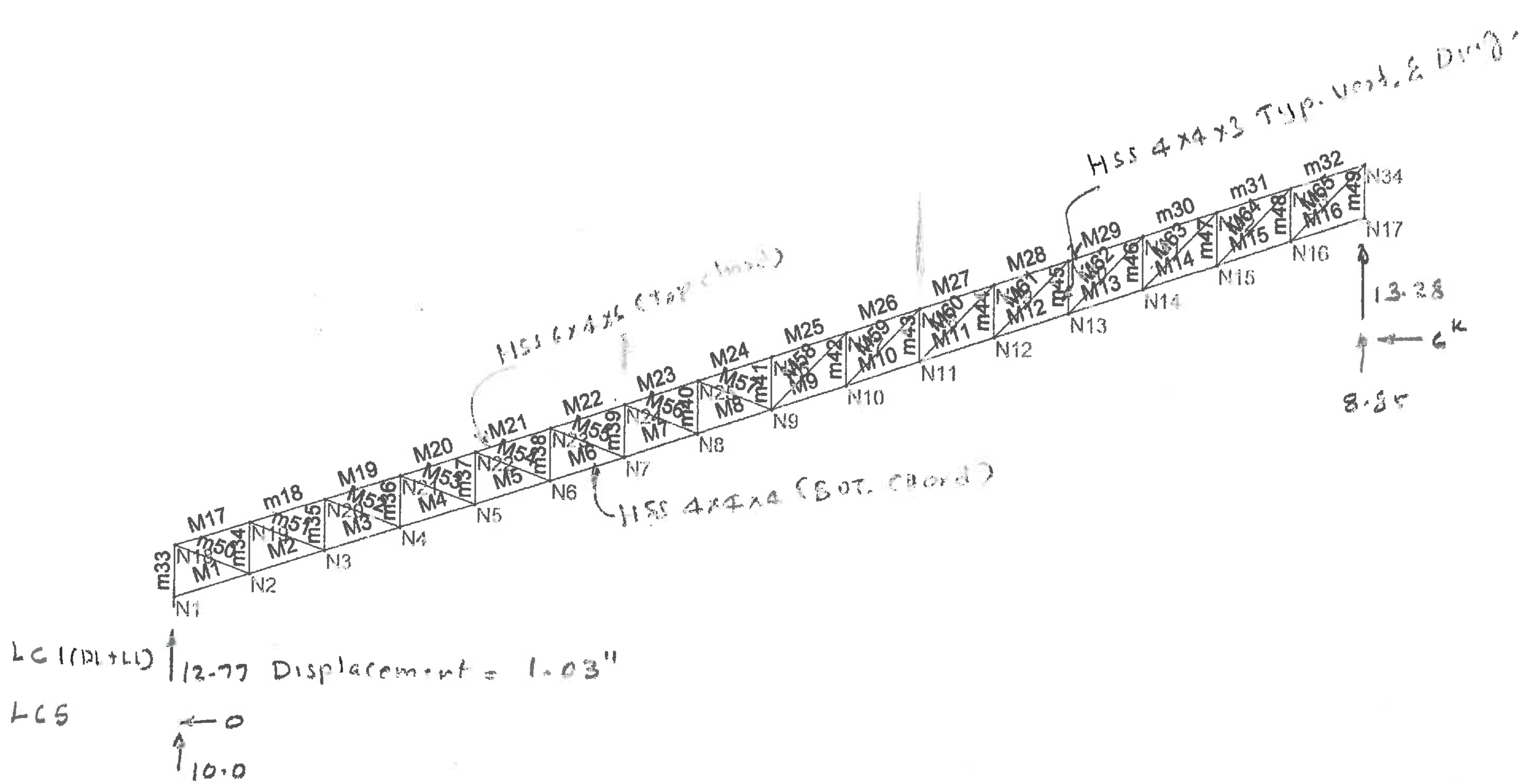
C Support Forces (Reactions)

Max R_{N1} = 21.611^k = R_{N21} H_{N21} = 0 (DL+LL)

H_{N21} = 6^k (seismic)

Max movement @ N_1 = .97'' (Roller)

Top chord Truss LINE A



Results for LC 1, d+l

e2	*PIPELINE I - BRIDGE*	SK - 1
kd	topock 160' pipe bridge, 3: 1 slop[e	Aug 6, 2014 at 10:34 PM
ww-peg-2174-043062		200pb7.topock.r2d

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Hot Rolled Steel Properties

	Label	E [ksi]	G [ksi]	Nu	Therm (\1E5 F)	Density[k/ft^3]	Yield[ksi]
1	A36 Gr.36	29000	11154	.3	.65	.49	36
2	A572 Gr.50	29000	11154	.3	.65	.49	50
3	A992	29000	11154	.3	.65	.49	50
4	A500 Gr.42	29000	11154	.3	.65	.49	42
5	A500 Gr.46	29000	11154	.3	.65	.49	46

Hot Rolled Steel Section Sets

	Label	Shape	Type	Design List	Material	Design Rules	A [in2]	I (90,270) [i...	I (0,180) [in4]
1	HR2	HSS4x4x4	Beam	Tube	A500 Gr.46	Typical	3.37	7.8	7.8
2	HR1	HSS8x4x6	Beam	Tube	A500 Gr.46	Typical	6.18	14.9	28.3
3	HR3	HSS4x4x3	Beam	Tube	A500 Gr.46	Typical	2.58	6.21	6.21

Joint Coordinates and Temperatures

	Label	X [ft]	Y [ft]	Temp [F]
1	N1	0	0	0
2	N2	10	3.333	0
3	N3	20	6.666	0
4	N4	30	9.999	0
5	N5	40	13.332	0
6	N6	50	16.665	0
7	N7	60	19.998	0
8	N8	70	23.331	0
9	N9	80	26.664	0
10	N10	90	29.997	0
11	N11	100	33.33	0
12	N12	110	36.663	0
13	N13	120	39.996	0
14	N14	130	43.329	0
15	N15	140	46.662	0
16	N16	150	49.995	0
17	N17	160	53.328	0
18	N18	0	7	0
19	N19	10	10.333	0
20	N20	20	13.666	0
21	N21	30	16.999	0
22	N22	40	20.332	0
23	N23	50	23.665	0
24	N24	60	26.998	0
25	N25	70	30.331	0
26	N26	80	33.664	0
27	N27	90	36.997	0
28	N28	100	40.33	0
29	N29	110	43.663	0
30	N30	120	46.996	0
31	N31	130	50.329	0
32	N32	140	53.662	0
33	N33	150	56.995	0
34	N34	160	60.328	0

Joint Boundary Conditions

	Joint Label	X [k/in]	Y [k/in]	Rotation[k-ft/rad]	Footing
1	N1		Reaction		
2	N17	Reaction	Reaction		

Member Primary Data

	Label	I Joint	J Joint	Rotate(deg)	Section/Shape	Type	Design List	Material	Design Rules
1	M1	N1	N2		HR2	Beam	Tube	A500 Gr.46	Typical
2	M2	N2	N3		HR2	Beam	Tube	A500 Gr.46	Typical
3	M3	N3	N4		HR2	Beam	Tube	A500 Gr.46	Typical
4	M4	N4	N5		HR2	Beam	Tube	A500 Gr.46	Typical
5	M5	N5	N6		HR2	Beam	Tube	A500 Gr.46	Typical
6	M6	N6	N7		HR2	Beam	Tube	A500 Gr.46	Typical
7	M7	N7	N8		HR2	Beam	Tube	A500 Gr.46	Typical
8	M8	N8	N9		HR2	Beam	Tube	A500 Gr.46	Typical
9	M9	N9	N10		HR2	Beam	Tube	A500 Gr.46	Typical
10	M10	N10	N11		HR2	Beam	Tube	A500 Gr.46	Typical
11	M11	N11	N12		HR2	Beam	Tube	A500 Gr.46	Typical
12	M12	N12	N13		HR2	Beam	Tube	A500 Gr.46	Typical
13	M13	N13	N14		HR2	Beam	Tube	A500 Gr.46	Typical
14	M14	N14	N15		HR2	Beam	Tube	A500 Gr.46	Typical
15	M15	N15	N16		HR2	Beam	Tube	A500 Gr.46	Typical
16	M16	N16	N17		HR2	Beam	Tube	A500 Gr.46	Typical
17	M17	N18	N19		HR2	Beam	Tube	A500 Gr.46	Typical
18	m18	N19	N20		HR1	Beam	Tube	A500 Gr.46	Typical
19	M19	N20	N21		HR1	Beam	Tube	A500 Gr.46	Typical
20	M20	N21	N22		HR1	Beam	Tube	A500 Gr.46	Typical
21	M21	N22	N23		HR1	Beam	Tube	A500 Gr.46	Typical
22	M22	N23	N24		HR1	Beam	Tube	A500 Gr.46	Typical
23	M23	N24	N25		HR1	Beam	Tube	A500 Gr.46	Typical
24	M24	N25	N26		HR1	Beam	Tube	A500 Gr.46	Typical
25	M25	N26	N27		HR1	Beam	Tube	A500 Gr.46	Typical
26	M26	N27	N28		HR1	Beam	Tube	A500 Gr.46	Typical
27	M27	N28	N29		HR1	Beam	Tube	A500 Gr.46	Typical
28	M28	N29	N30		HR1	Beam	Tube	A500 Gr.46	Typical
29	M29	N30	N31		HR1	Beam	Tube	A500 Gr.46	Typical
30	m30	N31	N32		HR1	Beam	Tube	A500 Gr.46	Typical
31	m31	N32	N33		HR1	Beam	Tube	A500 Gr.46	Typical
32	m32	N33	N34		HR1	Beam	Tube	A500 Gr.46	Typical
33	m33	N1	N18		HR2	Beam	Tube	A500 Gr.46	Typical
34	m34	N2	N19		HR3	Beam	Tube	A500 Gr.46	Typical
35	m35	N3	N20		HR3	Beam	Tube	A500 Gr.46	Typical
36	m36	N4	N21		HR3	Beam	Tube	A500 Gr.46	Typical
37	m37	N5	N22		HR3	Beam	Tube	A500 Gr.46	Typical
38	m38	N6	N23		HR3	Beam	Tube	A500 Gr.46	Typical
39	m39	N7	N24		HR3	Beam	Tube	A500 Gr.46	Typical
40	m40	N8	N25		HR3	Beam	Tube	A500 Gr.46	Typical
41	m41	N9	N26		HR3	Beam	Tube	A500 Gr.46	Typical
42	m42	N10	N27		HR3	Beam	Tube	A500 Gr.46	Typical
43	m43	N11	N28		HR3	Beam	Tube	A500 Gr.46	Typical
44	m44	N12	N29		HR3	Beam	Tube	A500 Gr.46	Typical
45	m45	N13	N30		HR3	Beam	Tube	A500 Gr.46	Typical
46	m46	N14	N31		HR3	Beam	Tube	A500 Gr.46	Typical
47	m47	N15	N32		HR3	Beam	Tube	A500 Gr.46	Typical
48	m48	N16	N33		HR3	Beam	Tube	A500 Gr.46	Typical
49	m49	N17	N34		HR3	Beam	Tube	A500 Gr.46	Typical
50	m50	N2	N18		HR3	Beam	Tube	A500 Gr.46	Typical
51	m51	N3	N19		HR3	Beam	Tube	A500 Gr.46	Typical

Member Primary Data (Continued)

	Label	I Joint	J Joint	Rotate(deg)	Section/Shape	Type	Design List	Material	Design Rules
52	M52	N4	N20		HR3	Beam	Tube	A500 Gr.46	Typical
53	M53	N5	N21		HR3	Beam	Tube	A500 Gr.46	Typical
54	M54	N6	N22		HR3	Beam	Tube	A500 Gr.46	Typical
55	M55	N7	N23		HR3	Beam	Tube	A500 Gr.46	Typical
56	M56	N8	N24		HR3	Beam	Tube	A500 Gr.46	Typical
57	M57	N9	N25		HR3	Beam	Tube	A500 Gr.46	Typical
58	M58	N9	N27		HR3	Beam	Tube	A500 Gr.46	Typical
59	M59	N10	N28		HR3	Beam	Tube	A500 Gr.46	Typical
60	M60	N11	N29		HR3	Beam	Tube	A500 Gr.46	Typical
61	M61	N12	N30		HR3	Beam	Tube	A500 Gr.46	Typical
62	M62	N13	N31		HR3	Beam	Tube	A500 Gr.46	Typical
63	M63	N14	N32		HR3	Beam	Tube	A500 Gr.46	Typical
64	M64	N15	N33		HR3	Beam	Tube	A500 Gr.46	Typical
65	M65	N16	N34		HR3	Beam	Tube	A500 Gr.46	Typical

Joint Loads and Enforced Displacements (BLC 1 : dl)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N18	L	Y	-.25
2	N19	L	Y	-.5
3	N20	L	Y	-.5
4	N21	L	Y	-.5
5	N22	L	Y	-.5
6	N23	L	Y	-.5
7	N24	L	Y	-.5
8	N25	L	Y	-.5
9	N26	L	Y	-.5
10	N27	L	Y	-.5
11	N28	L	Y	-.5
12	N29	L	Y	-.5
13	N30	L	Y	-.5
14	N31	L	Y	-.5
15	N32	L	Y	-.5
16	N33	L	Y	-.5
17	N34	L	Y	-.5

Joint Loads and Enforced Displacements (BLC 2 : ll)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N18	L	Y	-.3
2	N19	L	Y	-.6
3	N20	L	Y	-.6
4	N21	L	Y	-.6
5	N22	L	Y	-.6
6	N23	L	Y	-.6
7	N24	L	Y	-.6
8	N25	L	Y	-.6
9	N26	L	Y	-.6
10	N27	L	Y	-.6
11	N28	L	Y	-.6
12	N29	L	Y	-.6
13	N30	L	Y	-.6
14	N31	L	Y	-.6
15	N32	L	Y	-.6
16	N33	L	Y	-.6
17	N34	L	Y	-.3

Joint Loads and Enforced Displacements (BLC 3 : l alternate joint)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N19	L	Y	-.6
2	N21	L	Y	-.6
3	N23	L	Y	-.6
4	N25	L	Y	-.6

Joint Loads and Enforced Displacements (BLC 4 : l half truss only)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N2	L	Y	-.6
2	N3	L	Y	-.6
3	N4	L	Y	-.6
4	N5	L	Y	-.6
5	N6	L	Y	-.6
6	N7	L	Y	-.6
7	N8	L	Y	-.6
8	N9	L	Y	0
9	N1	L	Y	-.3

Joint Loads and Enforced Displacements (BLC 5 : seismic)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N1	L	X	1
2	N18	L	X	2
3	N17	L	X	1
4	N34	L	X	2

Joint Loads and Enforced Displacements (BLC 6 : l half truss on righ)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N32	L	Y	-.6
2	N34	L	Y	-.3
3	N27	L	Y	-.6
4	N28	L	Y	-.6
5	N29	L	Y	-.6
6	N30	L	Y	-.6
7	N31	L	Y	-.6
8	N33	L	Y	-.6

Basic Load Cases

	BLC Description	Category	X Gravity	Y Gravity	Joint	Point	Distributed
1	dl	None		-1	17		
2	ll	None			17		
3	l alternate joint	None			4		
4	l half truss only	None			9		
5	seismic	None			4		
6	l half truss on righ	None			8		

Load Combinations

	Description	Solve	PD...	SR...	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor
1	d+l	Yes	Y		1	1	2	1												
2	d	Yes	Y		1	1														
3	l alt. jt. +d	Yes	Y		1	1			3	1										
4	l half truss o...	Yes	Y		1	1			4	1										
5	dl+.25 jj+sei...	Yes	Y		1	1	2	.25	5	1										
6	l half truss o...	Yes	Y		1	1			6	1										

Joint Reactions

	LC	Joint Label	X [k]	Y [k]	MZ [k-ft]
1	1	N1	0	12.768	0
2	1	N17	0	13.284	0
3	1	Totals:	0	26.051	
4	1	COG (ft):	X: 81.402	Y: 33.233	
5	2	N1	0	7.986	0
6	2	N17	0	8.466	0
7	2	Totals:	0	16.451	
8	2	COG (ft):	X: 82.22	Y: 32.981	
9	3	N1	0	9.781	0
10	3	N17	0	9.07	0
11	3	Totals:	0	18.851	
12	3	COG (ft):	X: 76.845	Y: 31.371	
13	4	N1	0	11.429	0
14	4	N17	0	9.523	0
15	4	Totals:	0	20.951	
16	4	COG (ft):	X: 72.579	Y: 28.57	
17	5	N1	0	10.007	0
18	5	N17	-6	8.845	0
19	5	Totals:	-6	18.851	
20	5	COG (ft):	X: 81.938	Y: 33.068	
21	6	N1	0	9.03	0
22	6	N17	0	11.921	0
23	6	Totals:	0	20.951	
24	6	COG (ft):	X: 90.908	Y: 36.182	

Joint Deflections

	LC	Joint Label	X [in]	Y [in]	Rotation [rad]
1	1	N1	-1.025	0	0
2	1	N2	-.589	-1.304	0
3	1	N3	-.155	-2.534	0
4	1	N4	.265	-3.652	0
5	1	N5	.652	-4.62	0
6	1	N6	.993	-5.404	0
7	1	N7	1.276	-5.978	0
8	1	N8	1.491	-6.325	0
9	1	N9	1.631	-6.432	0
10	1	N10	1.711	-6.357	0
11	1	N11	1.703	-6.034	0
12	1	N12	1.607	-5.473	0
13	1	N13	1.427	-4.692	0
14	1	N14	1.167	-3.718	0
15	1	N15	.835	-2.583	0
16	1	N16	.442	-1.328	0
17	1	N17	0	0	0
18	1	N18	-.149	-.011	0
19	1	N19	.262	-1.318	0
20	1	N20	.646	-2.545	0
21	1	N21	.983	-3.662	0
22	1	N22	1.262	-4.628	0
23	1	N23	1.473	-5.41	0
24	1	N24	1.609	-5.983	0
25	1	N25	1.667	-6.327	0
26	1	N26	1.645	-6.434	0
27	1	N27	1.562	-6.36	0
28	1	N28	1.398	-6.038	0

Joint Deflections (Continued)

	LC	Joint Label	X [in]	Y [in]	Rotation [rad]
29	1	N29	1.157	-5.479	0
30	1	N30	.848	-4.7	0
31	1	N31	.48	-3.728	0
32	1	N32	.067	-2.595	0
33	1	N33	-.376	-1.341	0
34	1	N34	-.832	-.015	0
35	2	N1	-.642	0	0
36	2	N2	-.37	-.817	0
37	2	N3	-.098	-1.587	0
38	2	N4	.165	-2.289	0
39	2	N5	.408	-2.896	0
40	2	N6	.622	-3.387	0
41	2	N7	.799	-3.748	0
42	2	N8	.934	-3.966	0
43	2	N9	1.022	-4.035	0
44	2	N10	1.073	-3.989	0
45	2	N11	1.068	-3.787	0
46	2	N12	1.009	-3.436	0
47	2	N13	.896	-2.947	0
48	2	N14	.733	-2.335	0
49	2	N15	.525	-1.623	0
50	2	N16	.278	-.834	0
51	2	N17	0	0	0
52	2	N18	-.094	-.007	0
53	2	N19	.164	-.825	0
54	2	N20	.404	-1.594	0
55	2	N21	.616	-2.295	0
56	2	N22	.79	-2.9	0
57	2	N23	.923	-3.391	0
58	2	N24	1.009	-3.751	0
59	2	N25	1.045	-3.968	0
60	2	N26	1.032	-4.036	0
61	2	N27	.98	-3.991	0
62	2	N28	.878	-3.79	0
63	2	N29	.727	-3.44	0
64	2	N30	.533	-2.952	0
65	2	N31	.302	-2.342	0
66	2	N32	.042	-1.63	0
67	2	N33	-.236	-.843	0
68	2	N34	-.522	-.009	0
69	3	N1	-.739	0	0
70	3	N2	-.419	-.959	0
71	3	N3	-.1	-1.859	0
72	3	N4	.207	-2.675	0
73	3	N5	.49	-3.376	0
74	3	N6	.737	-3.939	0
75	3	N7	.94	-4.344	0
76	3	N8	1.093	-4.58	0
77	3	N9	1.19	-4.64	0
78	3	N10	1.239	-4.567	0
79	3	N11	1.227	-4.318	0
80	3	N12	1.152	-3.903	0
81	3	N13	1.018	-3.337	0
82	3	N14	.83	-2.638	0
83	3	N15	.592	-1.829	0
84	3	N16	.313	-.939	0
85	3	N17	0	0	0

Joint Deflections (Continued)

	LC	Joint Label	X [in]	Y [in]	Rotation [rad]
86	3	N18	-.097	-.008	0
87	3	N19	.205	-.969	0
88	3	N20	.485	-1.868	0
89	3	N21	.73	-2.683	0
90	3	N22	.93	-3.382	0
91	3	N23	1.08	-3.943	0
92	3	N24	1.174	-4.346	0
93	3	N25	1.211	-4.582	0
94	3	N26	1.189	-4.641	0
95	3	N27	1.123	-4.569	0
96	3	N28	1	-4.321	0
97	3	N29	.824	-3.908	0
98	3	N30	.601	-3.342	0
99	3	N31	.338	-2.644	0
100	3	N32	.045	-1.837	0
101	3	N33	-.269	-.948	0
102	3	N34	-.591	-.01	0
103	4	N1	-.816	0	0
104	4	N2	-.458	-1.073	0
105	4	N3	-.101	-2.078	0
106	4	N4	.242	-2.986	0
107	4	N5	.557	-3.761	0
108	4	N6	.831	-4.376	0
109	4	N7	1.054	-4.814	0
110	4	N8	1.218	-5.06	0
111	4	N9	1.32	-5.11	0
112	4	N10	1.369	-5.014	0
113	4	N11	1.349	-4.727	0
114	4	N12	1.263	-4.263	0
115	4	N13	1.113	-3.637	0
116	4	N14	.905	-2.87	0
117	4	N15	.644	-1.987	0
118	4	N16	.339	-1.019	0
119	4	N17	0	0	0
120	4	N18	-.098	-.01	0
121	4	N19	.238	-1.084	0
122	4	N20	.551	-2.088	0
123	4	N21	.822	-2.993	0
124	4	N22	1.042	-3.766	0
125	4	N23	1.205	-4.38	0
126	4	N24	1.305	-4.816	0
127	4	N25	1.34	-5.06	0
128	4	N26	1.311	-5.111	0
129	4	N27	1.234	-5.017	0
130	4	N28	1.095	-4.731	0
131	4	N29	.899	-4.268	0
132	4	N30	.654	-3.643	0
133	4	N31	.366	-2.877	0
134	4	N32	.046	-1.995	0
135	4	N33	-.294	-1.028	0
136	4	N34	-.643	-.011	0
137	5	N1	-.672	0	0
138	5	N2	-.368	-.917	0
139	5	N3	-.065	-1.778	0
140	5	N4	.227	-2.561	0
141	5	N5	.497	-3.237	0
142	5	N6	.734	-3.783	0

Joint Deflections (Continued)

	LC	Joint Label	X [in]	Y [in]	Rotation [rad]
143	5	N7	.929	-4.181	0
144	5	N8	1.077	-4.42	0
145	5	N9	1.172	-4.49	0
146	5	N10	1.223	-4.428	0
147	5	N11	1.212	-4.193	0
148	5	N12	1.139	-3.793	0
149	5	N13	1.008	-3.242	0
150	5	N14	.822	-2.56	0
151	5	N15	.586	-1.772	0
152	5	N16	.309	-.907	0
153	5	N17	0	0	0
154	5	N18	-.059	-.008	0
155	5	N19	.227	-.926	0
156	5	N20	.494	-1.786	0
157	5	N21	.728	-2.568	0
158	5	N22	.921	-3.242	0
159	5	N23	1.066	-3.787	0
160	5	N24	1.159	-4.184	0
161	5	N25	1.196	-4.421	0
162	5	N26	1.178	-4.491	0
163	5	N27	1.115	-4.43	0
164	5	N28	.996	-4.196	0
165	5	N29	.824	-3.798	0
166	5	N30	.606	-3.248	0
167	5	N31	.348	-2.568	0
168	5	N32	.061	-1.78	0
169	5	N33	-.244	-.917	0
170	5	N34	-.554	-.012	0
171	6	N1	-.816	0	0
172	6	N2	-.481	-1.003	0
173	6	N3	-.147	-1.953	0
174	6	N4	.177	-2.824	0
175	6	N5	.478	-3.587	0
176	6	N6	.746	-4.216	0
177	6	N7	.972	-4.689	0
178	6	N8	1.148	-4.991	0
179	6	N9	1.268	-5.11	0
180	6	N10	1.348	-5.093	0
181	6	N11	1.357	-4.87	0
182	6	N12	1.293	-4.447	0
183	6	N13	1.158	-3.835	0
184	6	N14	.954	-3.054	0
185	6	N15	.687	-2.13	0
186	6	N16	.366	-1.098	0
187	6	N17	0	0	0
188	6	N18	-.14	-.008	0
189	6	N19	.177	-1.012	0
190	6	N20	.475	-1.961	0
191	6	N21	.74	-2.832	0
192	6	N22	.962	-3.593	0
193	6	N23	1.134	-4.221	0
194	6	N24	1.25	-4.693	0
195	6	N25	1.307	-4.994	0
196	6	N26	1.3	-5.111	0
197	6	N27	1.248	-5.094	0
198	6	N28	1.128	-4.873	0
199	6	N29	.943	-4.452	0

Joint Deflections (Continued)

	LC	Joint Label	X [in]	Y [in]	Rotation [rad]
200	6	N30	.697	-3.842	0
201	6	N31	.4	-3.062	0
202	6	N32	.062	-2.14	0
203	6	N33	-.304	-1.11	0
204	6	N34	-.682	-.013	0

Member AISC 13th(360-05): ASD Steel Code Checks

	LC	Member	Shape	UC Max	Loc[ft]	Shear UC	Loc[ft]	Pnc/om [k]	Pnt/om [k]	Mn/om [k-ft]	Cb	Eqn
1	1	M1	HSS4x4x4	.015	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1b
2	1	M2	HSS4x4x4	.113	5.27	.002	10.541	58.307	92.826	10.765	1.136	H1-1b
3	1	M3	HSS4x4x4	.380	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1a
4	1	M4	HSS4x4x4	.524	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1a
5	1	M5	HSS4x4x4	.642	5.27	.002	10.541	58.307	92.826	10.765	1.136	H1-1a
6	1	M6	HSS4x4x4	.733	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1a
7	1	M7	HSS4x4x4	.799	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1a
8	1	M8	HSS4x4x4	.838	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1a
9	1	M9	HSS4x4x4	.838	5.27	.002	10.541	58.307	92.826	10.765	1.136	H1-1a
10	1	M10	HSS4x4x4	.800	5.27	.002	10.541	58.307	92.826	10.765	1.136	H1-1a
11	1	M11	HSS4x4x4	.734	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1a
12	1	M12	HSS4x4x4	.643	5.27	.002	10.541	58.307	92.826	10.765	1.136	H1-1a
13	1	M13	HSS4x4x4	.525	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1a
14	1	M14	HSS4x4x4	.382	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1a
15	1	M15	HSS4x4x4	.113	5.27	.002	10.541	58.307	92.826	10.765	1.136	H1-1b
16	1	M16	HSS4x4x4	.015	5.27	.002	10.541	58.307	92.826	10.765	1.136	H1-1b
17	1	M17	HSS4x4x4	.323	5.161	.002	10.541	58.307	92.826	10.765	1.136	H1-1a
18	1	m18	HSS6x4x6	.321	5.161	.002	10.541	108.934	170.228	27.315	1.136	H1-1a
19	1	M19	HSS6x4x6	.443	5.161	.002	0	108.934	170.228	27.315	1.136	H1-1a
20	1	M20	HSS6x4x6	.544	5.161	.002	10.541	108.934	170.228	27.315	1.136	H1-1a
21	1	M21	HSS6x4x6	.622	5.161	.002	0	108.934	170.228	27.315	1.136	H1-1a
22	1	M22	HSS6x4x6	.678	5.161	.002	10.541	108.934	170.228	27.315	1.136	H1-1a
23	1	M23	HSS6x4x6	.712	5.161	.002	10.541	108.934	170.228	27.315	1.136	H1-1a
24	1	M24	HSS6x4x6	.724	5.161	.002	10.541	108.934	170.228	27.315	1.136	H1-1a
25	1	M25	HSS6x4x6	.724	5.161	.002	0	108.934	170.228	27.315	1.136	H1-1a
26	1	M26	HSS6x4x6	.714	5.161	.002	10.541	108.934	170.228	27.315	1.136	H1-1a
27	1	M27	HSS6x4x6	.680	5.161	.002	0	108.934	170.228	27.315	1.136	H1-1a
28	1	M28	HSS6x4x6	.624	5.161	.002	10.541	108.934	170.228	27.315	1.136	H1-1a
29	1	M29	HSS6x4x6	.546	5.161	.002	10.541	108.934	170.228	27.315	1.136	H1-1a
30	1	m30	HSS6x4x6	.445	5.161	.002	10.541	108.934	170.228	27.315	1.136	H1-1a
31	1	m31	HSS6x4x6	.322	5.161	.002	10.541	108.934	170.228	27.315	1.136	H1-1a
32	1	m32	HSS6x4x6	.094	5.27	.002	0	108.934	170.228	27.315	1.136	H1-1b
33	1	m33	HSS4x4x4	.084	0	.000	0	75.615	92.826	10.765	1	H1-1b
34	1	m34	HSS4x4x3	.204	0	.000	0	58.347	71.066	8.424	1	H1-1a
35	1	m35	HSS4x4x3	.089	0	.000	0	58.347	71.066	8.424	1	H1-1a
36	1	m36	HSS4x4x3	.075	0	.000	0	58.347	71.066	8.424	1	H1-1b
37	1	m37	HSS4x4x3	.062	0	.000	0	58.347	71.066	8.424	1	H1-1b
38	1	m38	HSS4x4x3	.048	0	.000	0	58.347	71.066	8.424	1	H1-1b
39	1	m39	HSS4x4x3	.035	0	.000	0	58.347	71.066	8.424	1	H1-1b
40	1	m40	HSS4x4x3	.021	0	.000	0	58.347	71.066	8.424	1	H1-1b
41	1	m41	HSS4x4x3	.014	0	.000	0	58.347	71.066	8.424	1	H1-1b
42	1	m42	HSS4x4x3	.022	0	.000	0	58.347	71.066	8.424	1	H1-1b
43	1	m43	HSS4x4x3	.035	0	.000	0	58.347	71.066	8.424	1	H1-1b
44	1	m44	HSS4x4x3	.049	0	.000	0	58.347	71.066	8.424	1	H1-1b
45	1	m45	HSS4x4x3	.062	0	.000	0	58.347	71.066	8.424	1	H1-1b
46	1	m46	HSS4x4x3	.076	0	.000	0	58.347	71.066	8.424	1	H1-1b
47	1	m47	HSS4x4x3	.089	0	.000	0	58.347	71.066	8.424	1	H1-1b
48	1	m48	HSS4x4x3	.205	0	.000	0	58.347	71.066	8.424	1	H1-1a

Member AISC 13th(360-05): ASD Steel Code Checks (Continued)

	LC	Member	Shape	UC Max	Loc[ft]	Shear UC	Loc[ft]	Pnc/om [k]	Pnt/om [k]	Mn/om [k-ft]	Cb	Eqn
49	1	m49	HSS4x4x3	.225	0	.000	0	58.347	71.066	8.424	1	H1-1a
50	1	m50	HSS4x4x3	.270	5.326	.002	0	45.018	71.066	8.424	1.136	H1-1a
51	1	m51	HSS4x4x3	.237	5.326	.002	0	45.018	71.066	8.424	1.136	H1-1a
52	1	M52	HSS4x4x3	.109	5.326	.002	0	45.018	71.066	8.424	1.136	H1-1b
53	1	M53	HSS4x4x3	.091	5.326	.002	0	45.018	71.066	8.424	1.136	H1-1b
54	1	M54	HSS4x4x3	.074	5.326	.002	0	45.018	71.066	8.424	1.136	H1-1b
55	1	M55	HSS4x4x3	.057	5.326	.002	10.651	45.018	71.066	8.424	1.136	H1-1b
56	1	M56	HSS4x4x3	.039	5.326	.002	0	45.018	71.066	8.424	1.136	H1-1b
57	1	M57	HSS4x4x3	.022	5.326	.002	10.651	45.018	71.066	8.424	1.136	H1-1b
58	1	M58	HSS4x4x3	.031	7.19	.002	14.38	30.922	71.066	8.424	1.136	H1-1b
59	1	M59	HSS4x4x3	.054	7.19	.002	0	30.922	71.066	8.424	1.136	H1-1b
60	1	M60	HSS4x4x3	.078	7.19	.002	0	30.922	71.066	8.424	1.136	H1-1b
61	1	M61	HSS4x4x3	.101	7.19	.002	0	30.922	71.066	8.424	1.136	H1-1b
62	1	M62	HSS4x4x3	.227	7.34	.002	14.38	30.922	71.066	8.424	1.136	H1-1a
63	1	M63	HSS4x4x3	.274	7.34	.002	14.38	30.922	71.066	8.424	1.136	H1-1a
64	1	M64	HSS4x4x3	.321	7.34	.002	0	30.922	71.066	8.424	1.136	H1-1a
65	1	M65	HSS4x4x3	.367	7.34	.002	0	30.922	71.066	8.424	1.136	H1-1a
66	2	M1	HSS4x4x4	.015	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1b
67	2	M2	HSS4x4x4	.075	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1b
68	2	M3	HSS4x4x4	.242	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1a
69	2	M4	HSS4x4x4	.332	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1a
70	2	M5	HSS4x4x4	.406	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1a
71	2	M6	HSS4x4x4	.464	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1a
72	2	M7	HSS4x4x4	.505	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1a
73	2	M8	HSS4x4x4	.530	5.27	.002	10.541	58.307	92.826	10.765	1.136	H1-1a
74	2	M9	HSS4x4x4	.531	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1a
75	2	M10	HSS4x4x4	.507	5.27	.002	10.541	58.307	92.826	10.765	1.136	H1-1a
76	2	M11	HSS4x4x4	.467	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1a
77	2	M12	HSS4x4x4	.409	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1a
78	2	M13	HSS4x4x4	.335	5.27	.002	10.541	58.307	92.826	10.765	1.136	H1-1a
79	2	M14	HSS4x4x4	.245	5.27	.002	10.541	58.307	92.826	10.765	1.136	H1-1a
80	2	M15	HSS4x4x4	.076	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1b
81	2	M16	HSS4x4x4	.015	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1b
82	2	M17	HSS4x4x4	.111	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1b
83	2	m18	HSS6x4x6	.107	5.27	.002	0	108.934	170.228	27.315	1.136	H1-1b
84	2	M19	HSS6x4x6	.281	5.161	.002	0	108.934	170.228	27.315	1.136	H1-1a
85	2	M20	HSS6x4x6	.344	5.161	.002	10.541	108.934	170.228	27.315	1.136	H1-1a
86	2	M21	HSS6x4x6	.393	5.161	.002	10.541	108.934	170.228	27.315	1.136	H1-1a
87	2	M22	HSS6x4x6	.428	5.161	.002	0	108.934	170.228	27.315	1.136	H1-1a
88	2	M23	HSS6x4x6	.450	5.161	.002	10.541	108.934	170.228	27.315	1.136	H1-1a
89	2	M24	HSS6x4x6	.458	5.161	.002	0	108.934	170.228	27.315	1.136	H1-1a
90	2	M25	HSS6x4x6	.458	5.161	.002	0	108.934	170.228	27.315	1.136	H1-1a
91	2	M26	HSS6x4x6	.452	5.161	.002	10.541	108.934	170.228	27.315	1.136	H1-1a
92	2	M27	HSS6x4x6	.431	5.161	.002	10.541	108.934	170.228	27.315	1.136	H1-1a
93	2	M28	HSS6x4x6	.396	5.161	.002	0	108.934	170.228	27.315	1.136	H1-1a
94	2	M29	HSS6x4x6	.347	5.161	.002	0	108.934	170.228	27.315	1.136	H1-1a
95	2	m30	HSS6x4x6	.284	5.161	.002	10.541	108.934	170.228	27.315	1.136	H1-1a
96	2	m31	HSS6x4x6	.109	5.27	.002	10.541	108.934	170.228	27.315	1.136	H1-1b
97	2	m32	HSS6x4x6	.063	5.27	.002	0	108.934	170.228	27.315	1.136	H1-1b
98	2	m33	HSS4x4x4	.053	0	.000	0	75.615	92.826	10.765	1	H1-1b
99	2	m34	HSS4x4x3	.063	0	.000	0	58.347	71.066	8.424	1	H1-1b
100	2	m35	HSS4x4x3	.055	0	.000	0	58.347	71.066	8.424	1	H1-1b
101	2	m36	HSS4x4x3	.046	0	.000	0	58.347	71.066	8.424	1	H1-1b
102	2	m37	HSS4x4x3	.038	0	.000	0	58.347	71.066	8.424	1	H1-1b
103	2	m38	HSS4x4x3	.030	0	.000	0	58.347	71.066	8.424	1	H1-1b
104	2	m39	HSS4x4x3	.021	0	.000	0	58.347	71.066	8.424	1	H1-1b
105	2	m40	HSS4x4x3	.013	0	.000	0	58.347	71.066	8.424	1	H1-1b

Member AISC 13th(360-05): ASD Steel Code Checks (Continued)

	LC	Member	Shape	UC Max	Loc[ft]	Shear UC	Loc[ft]	Pnc/om [k]	Pnt/om [k]	Mn/om [k-ft]	Cb	Eqn
106	2	m41	HSS4x4x3	.007	0	.000	0	58.347	71.066	8.424	1	H1-1b
107	2	m42	HSS4x4x3	.012	0	.000	0	58.347	71.066	8.424	1	H1-1b
108	2	m43	HSS4x4x3	.021	0	.000	0	58.347	71.066	8.424	1	H1-1b
109	2	m44	HSS4x4x3	.030	0	.000	0	58.347	71.066	8.424	1	H1-1b
110	2	m45	HSS4x4x3	.038	0	.000	0	58.347	71.066	8.424	1	H1-1b
111	2	m46	HSS4x4x3	.047	0	.000	0	58.347	71.066	8.424	1	H1-1b
112	2	m47	HSS4x4x3	.055	0	.000	0	58.347	71.066	8.424	1	H1-1b
113	2	m48	HSS4x4x3	.064	0	.000	0	58.347	71.066	8.424	1	H1-1b
114	2	m49	HSS4x4x3	.072	0	.000	0	58.347	71.066	8.424	1	H1-1b
115	2	m50	HSS4x4x3	.094	5.326	.002	0	45.018	71.066	8.424	1.136	H1-1b
116	2	m51	HSS4x4x3	.084	5.326	.002	0	45.018	71.066	8.424	1.136	H1-1b
117	2	M52	HSS4x4x3	.073	5.326	.002	0	45.018	71.066	8.424	1.136	H1-1b
118	2	M53	HSS4x4x3	.063	5.326	.002	10.651	45.018	71.066	8.424	1.136	H1-1b
119	2	M54	HSS4x4x3	.052	5.326	.002	10.651	45.018	71.066	8.424	1.136	H1-1b
120	2	M55	HSS4x4x3	.041	5.326	.002	10.651	45.018	71.066	8.424	1.136	H1-1b
121	2	M56	HSS4x4x3	.030	5.326	.002	0	45.018	71.066	8.424	1.136	H1-1b
122	2	M57	HSS4x4x3	.020	5.326	.002	0	45.018	71.066	8.424	1.136	H1-1b
123	2	M58	HSS4x4x3	.026	7.19	.002	0	30.922	71.066	8.424	1.136	H1-1b
124	2	M59	HSS4x4x3	.040	7.19	.002	14.38	30.922	71.066	8.424	1.136	H1-1b
125	2	M60	HSS4x4x3	.055	7.19	.002	14.38	30.922	71.066	8.424	1.136	H1-1b
126	2	M61	HSS4x4x3	.070	7.19	.002	0	30.922	71.066	8.424	1.136	H1-1b
127	2	M62	HSS4x4x3	.085	7.19	.002	14.38	30.922	71.066	8.424	1.136	H1-1b
128	2	M63	HSS4x4x3	.100	7.19	.002	0	30.922	71.066	8.424	1.136	H1-1b
129	2	M64	HSS4x4x3	.114	7.19	.002	0	30.922	71.066	8.424	1.136	H1-1b
130	2	M65	HSS4x4x3	.238	7.34	.002	0	30.922	71.066	8.424	1.136	H1-1a
131	3	M1	HSS4x4x4	.015	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1b
132	3	M2	HSS4x4x4	.090	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1b
133	3	M3	HSS4x4x4	.291	5.27	.002	10.541	58.307	92.826	10.765	1.136	H1-1a
134	3	M4	HSS4x4x4	.401	5.27	.002	10.541	58.307	92.826	10.765	1.136	H1-1a
135	3	M5	HSS4x4x4	.484	5.27	.002	10.541	58.307	92.826	10.765	1.136	H1-1a
136	3	M6	HSS4x4x4	.552	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1a
137	3	M7	HSS4x4x4	.593	5.27	.002	10.541	58.307	92.826	10.765	1.136	H1-1a
138	3	M8	HSS4x4x4	.618	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1a
139	3	M9	HSS4x4x4	.600	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1a
140	3	M10	HSS4x4x4	.566	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1a
141	3	M11	HSS4x4x4	.515	5.27	.002	10.541	58.307	92.826	10.765	1.136	H1-1a
142	3	M12	HSS4x4x4	.448	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1a
143	3	M13	HSS4x4x4	.365	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1a
144	3	M14	HSS4x4x4	.264	5.27	.002	10.541	58.307	92.826	10.765	1.136	H1-1a
145	3	M15	HSS4x4x4	.081	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1b
146	3	M16	HSS4x4x4	.015	5.27	.002	10.541	58.307	92.826	10.765	1.136	H1-1b
147	3	M17	HSS4x4x4	.253	5.161	.002	0	58.307	92.826	10.765	1.136	H1-1a
148	3	m18	HSS6x4x6	.245	5.161	.002	10.541	108.934	170.228	27.315	1.136	H1-1a
149	3	M19	HSS6x4x6	.339	5.161	.002	0	108.934	170.228	27.315	1.136	H1-1a
150	3	M20	HSS6x4x6	.410	5.161	.002	0	108.934	170.228	27.315	1.136	H1-1a
151	3	M21	HSS6x4x6	.468	5.161	.002	0	108.934	170.228	27.315	1.136	H1-1a
152	3	M22	HSS6x4x6	.503	5.161	.002	0	108.934	170.228	27.315	1.136	H1-1a
153	3	M23	HSS6x4x6	.525	5.161	.002	0	108.934	170.228	27.315	1.136	H1-1a
154	3	M24	HSS6x4x6	.524	5.161	.002	0	108.934	170.228	27.315	1.136	H1-1a
155	3	M25	HSS6x4x6	.525	5.161	.002	0	108.934	170.228	27.315	1.136	H1-1a
156	3	M26	HSS6x4x6	.510	5.161	.002	10.541	108.934	170.228	27.315	1.136	H1-1a
157	3	M27	HSS6x4x6	.481	5.161	.002	10.541	108.934	170.228	27.315	1.136	H1-1a
158	3	M28	HSS6x4x6	.438	5.161	.002	10.541	108.934	170.228	27.315	1.136	H1-1a
159	3	M29	HSS6x4x6	.380	5.161	.002	0	108.934	170.228	27.315	1.136	H1-1a
160	3	m30	HSS6x4x6	.309	5.161	.002	10.541	108.934	170.228	27.315	1.136	H1-1a
161	3	m31	HSS6x4x6	.223	5.161	.002	10.541	108.934	170.228	27.315	1.136	H1-1a
162	3	m32	HSS6x4x6	.067	5.27	.002	0	108.934	170.228	27.315	1.136	H1-1b

Member AISC 13th(360-05): ASD Steel Code Checks (Continued)

	LC	Member	Shape	UC Max	Loc[ft]	Shear UC	Loc[ft]	Pnc/om [k]	Pnt/om [k]	Mn/om [k-ft]	Cb	Eqn
163	3	m33	HSS4x4x4	.065	0	.000	0	75.615	92.826	10.765	1	H1-1b
164	3	m34	HSS4x4x3	.078	0	.000	0	58.347	71.066	8.424	1	H1-1b
165	3	m35	HSS4x4x3	.065	0	.000	0	58.347	71.066	8.424	1	H1-1b
166	3	m36	HSS4x4x3	.057	0	.000	0	58.347	71.066	8.424	1	H1-1b
167	3	m37	HSS4x4x3	.043	0	.000	0	58.347	71.066	8.424	1	H1-1b
168	3	m38	HSS4x4x3	.035	0	.000	0	58.347	71.066	8.424	1	H1-1b
169	3	m39	HSS4x4x3	.021	0	.000	0	58.347	71.066	8.424	1	H1-1b
170	3	m40	HSS4x4x3	.013	0	.000	0	58.347	71.066	8.424	1	H1-1b
171	3	m41	HSS4x4x3	.008	0	.000	0	58.347	71.066	8.424	1	H1-1b
172	3	m42	HSS4x4x3	.018	0	.000	0	58.347	71.066	8.424	1	H1-1b
173	3	m43	HSS4x4x3	.026	0	.000	0	58.347	71.066	8.424	1	H1-1b
174	3	m44	HSS4x4x3	.035	0	.000	0	58.347	71.066	8.424	1	H1-1b
175	3	m45	HSS4x4x3	.043	0	.000	0	58.347	71.066	8.424	1	H1-1b
176	3	m46	HSS4x4x3	.052	0	.000	0	58.347	71.066	8.424	1	H1-1b
177	3	m47	HSS4x4x3	.061	0	.000	0	58.347	71.066	8.424	1	H1-1b
178	3	m48	HSS4x4x3	.069	0	.000	0	58.347	71.066	8.424	1	H1-1b
179	3	m49	HSS4x4x3	.077	0	.000	0	58.347	71.066	8.424	1	H1-1b
180	3	m50	HSS4x4x3	.114	5.326	.002	0	45.018	71.066	8.424	1.136	H1-1b
181	3	m51	HSS4x4x3	.097	5.326	.002	0	45.018	71.066	8.424	1.136	H1-1b
182	3	M52	HSS4x4x3	.086	5.326	.002	0	45.018	71.066	8.424	1.136	H1-1b
183	3	M53	HSS4x4x3	.069	5.326	.002	10.651	45.018	71.066	8.424	1.136	H1-1b
184	3	M54	HSS4x4x3	.058	5.326	.002	0	45.018	71.066	8.424	1.136	H1-1b
185	3	M55	HSS4x4x3	.041	5.326	.002	10.651	45.018	71.066	8.424	1.136	H1-1b
186	3	M56	HSS4x4x3	.030	5.326	.002	0	45.018	71.066	8.424	1.136	H1-1b
187	3	M57	HSS4x4x3	.015	5.326	.002	0	45.018	71.066	8.424	1.136	H1-1b
188	3	M58	HSS4x4x3	.034	7.19	.002	0	30.922	71.066	8.424	1.136	H1-1b
189	3	M59	HSS4x4x3	.049	7.19	.002	0	30.922	71.066	8.424	1.136	H1-1b
190	3	M60	HSS4x4x3	.064	7.19	.002	0	30.922	71.066	8.424	1.136	H1-1b
191	3	M61	HSS4x4x3	.079	7.19	.002	0	30.922	71.066	8.424	1.136	H1-1b
192	3	M62	HSS4x4x3	.094	7.19	.002	0	30.922	71.066	8.424	1.136	H1-1b
193	3	M63	HSS4x4x3	.108	7.19	.002	0	30.922	71.066	8.424	1.136	H1-1b
194	3	M64	HSS4x4x3	.225	7.34	.002	0	30.922	71.066	8.424	1.136	H1-1a
195	3	M65	HSS4x4x3	.255	7.34	.002	0	30.922	71.066	8.424	1.136	H1-1a
196	4	M1	HSS4x4x4	.015	5.27	.002	10.541	58.307	92.826	10.765	1.136	H1-1b
197	4	M2	HSS4x4x4	.101	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1b
198	4	M3	HSS4x4x4	.335	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1a
199	4	M4	HSS4x4x4	.457	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1a
200	4	M5	HSS4x4x4	.553	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1a
201	4	M6	HSS4x4x4	.623	5.27	.002	10.541	58.307	92.826	10.765	1.136	H1-1a
202	4	M7	HSS4x4x4	.666	5.27	.002	10.541	58.307	92.826	10.765	1.136	H1-1a
203	4	M8	HSS4x4x4	.684	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1a
204	4	M9	HSS4x4x4	.651	5.27	.002	10.541	58.307	92.826	10.765	1.136	H1-1a
205	4	M10	HSS4x4x4	.610	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1a
206	4	M11	HSS4x4x4	.552	5.27	.002	10.541	58.307	92.826	10.765	1.136	H1-1a
207	4	M12	HSS4x4x4	.478	5.27	.002	10.541	58.307	92.826	10.765	1.136	H1-1a
208	4	M13	HSS4x4x4	.387	5.27	.002	10.541	58.307	92.826	10.765	1.136	H1-1a
209	4	M14	HSS4x4x4	.279	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1a
210	4	M15	HSS4x4x4	.085	5.27	.002	10.541	58.307	92.826	10.765	1.136	H1-1b
211	4	M16	HSS4x4x4	.015	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1b
212	4	M17	HSS4x4x4	.288	5.161	.002	0	58.307	92.826	10.765	1.136	H1-1a
213	4	m18	HSS6x4x6	.283	5.161	.002	10.541	108.934	170.228	27.315	1.136	H1-1a
214	4	M19	HSS6x4x6	.387	5.161	.002	10.541	108.934	170.228	27.315	1.136	H1-1a
215	4	M20	HSS6x4x6	.469	5.161	.002	0	108.934	170.228	27.315	1.136	H1-1a
216	4	M21	HSS6x4x6	.528	5.161	.002	10.541	108.934	170.228	27.315	1.136	H1-1a
217	4	M22	HSS6x4x6	.566	5.161	.002	10.541	108.934	170.228	27.315	1.136	H1-1a
218	4	M23	HSS6x4x6	.581	5.161	.002	10.541	108.934	170.228	27.315	1.136	H1-1a
219	4	M24	HSS6x4x6	.574	5.161	.002	0	108.934	170.228	27.315	1.136	H1-1a

Member AISC 13th(360-05): ASD Steel Code Checks (Continued)

	LC	Member	Shape	UC Max	Loc[ft]	Shear UC	Loc[ft]	Pnc/om [k]	Pnt/om [k]	Mn/om [k-ft]	Cb	Eqn
220	4	M25	HSS6x4x6	.574	5.161	.002	0	108.934	170.228	27.315	1.136	H1-1a
221	4	M26	HSS6x4x6	.553	5.161	.002	10.541	108.934	170.228	27.315	1.136	H1-1a
222	4	M27	HSS6x4x6	.518	5.161	.002	0	108.934	170.228	27.315	1.136	H1-1a
223	4	M28	HSS6x4x6	.469	5.161	.002	10.541	108.934	170.228	27.315	1.136	H1-1a
224	4	M29	HSS6x4x6	.405	5.161	.002	10.541	108.934	170.228	27.315	1.136	H1-1a
225	4	m30	HSS6x4x6	.327	5.161	.002	10.541	108.934	170.228	27.315	1.136	H1-1a
226	4	m31	HSS6x4x6	.235	5.161	.002	0	108.934	170.228	27.315	1.136	H1-1a
227	4	m32	HSS6x4x6	.070	5.27	.002	0	108.934	170.228	27.315	1.136	H1-1b
228	4	m33	HSS4x4x4	.074	0	.000	0	75.615	92.826	10.765	1	H1-1b
229	4	m34	HSS4x4x3	.085	0	.000	0	58.347	71.066	8.424	1	H1-1b
230	4	m35	HSS4x4x3	.072	0	.000	0	58.347	71.066	8.424	1	H1-1b
231	4	m36	HSS4x4x3	.058	0	.000	0	58.347	71.066	8.424	1	H1-1b
232	4	m37	HSS4x4x3	.045	0	.000	0	58.347	71.066	8.424	1	H1-1b
233	4	m38	HSS4x4x3	.031	0	.000	0	58.347	71.066	8.424	1	H1-1b
234	4	m39	HSS4x4x3	.018	0	.000	0	58.347	71.066	8.424	1	H1-1b
235	4	m40	HSS4x4x3	.004	0	.000	0	58.347	71.066	8.424	1	H1-1b
236	4	m41	HSS4x4x3	.008	0	.000	0	58.347	71.066	8.424	1	H1-1b
237	4	m42	HSS4x4x3	.022	0	.000	0	58.347	71.066	8.424	1	H1-1b
238	4	m43	HSS4x4x3	.030	0	.000	0	58.347	71.066	8.424	1	H1-1b
239	4	m44	HSS4x4x3	.039	0	.000	0	58.347	71.066	8.424	1	H1-1b
240	4	m45	HSS4x4x3	.047	0	.000	0	58.347	71.066	8.424	1	H1-1b
241	4	m46	HSS4x4x3	.056	0	.000	0	58.347	71.066	8.424	1	H1-1b
242	4	m47	HSS4x4x3	.064	0	.000	0	58.347	71.066	8.424	1	H1-1b
243	4	m48	HSS4x4x3	.073	0	.000	0	58.347	71.066	8.424	1	H1-1b
244	4	m49	HSS4x4x3	.081	0	.000	0	58.347	71.066	8.424	1	H1-1b
245	4	m50	HSS4x4x3	.241	5.326	.002	0	45.018	71.066	8.424	1.136	H1-1a
246	4	m51	HSS4x4x3	.112	5.326	.002	0	45.018	71.066	8.424	1.136	H1-1b
247	4	M52	HSS4x4x3	.094	5.326	.002	10.651	45.018	71.066	8.424	1.136	H1-1b
248	4	M53	HSS4x4x3	.077	5.326	.002	0	45.018	71.066	8.424	1.136	H1-1b
249	4	M54	HSS4x4x3	.060	5.326	.002	0	45.018	71.066	8.424	1.136	H1-1b
250	4	M55	HSS4x4x3	.042	5.326	.002	0	45.018	71.066	8.424	1.136	H1-1b
251	4	M56	HSS4x4x3	.025	5.326	.002	10.651	45.018	71.066	8.424	1.136	H1-1b
252	4	M57	HSS4x4x3	.023	5.326	.002	10.651	45.018	71.066	8.424	1.136	H1-1b
253	4	M58	HSS4x4x3	.041	7.19	.002	14.38	30.922	71.066	8.424	1.136	H1-1b
254	4	M59	HSS4x4x3	.056	7.19	.002	0	30.922	71.066	8.424	1.136	H1-1b
255	4	M60	HSS4x4x3	.071	7.19	.002	0	30.922	71.066	8.424	1.136	H1-1b
256	4	M61	HSS4x4x3	.085	7.19	.002	14.38	30.922	71.066	8.424	1.136	H1-1b
257	4	M62	HSS4x4x3	.100	7.19	.002	14.38	30.922	71.066	8.424	1.136	H1-1b
258	4	M63	HSS4x4x3	.115	7.19	.002	0	30.922	71.066	8.424	1.136	H1-1b
259	4	M64	HSS4x4x3	.238	7.34	.002	0	30.922	71.066	8.424	1.136	H1-1a
260	4	M65	HSS4x4x3	.268	7.34	.002	0	30.922	71.066	8.424	1.136	H1-1a
261	5	M1	HSS4x4x4	.022	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1b
262	5	M2	HSS4x4x4	.078	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1b
263	5	M3	HSS4x4x4	.260	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1a
264	5	M4	HSS4x4x4	.362	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1a
265	5	M5	HSS4x4x4	.444	5.27	.002	10.541	58.307	92.826	10.765	1.136	H1-1a
266	5	M6	HSS4x4x4	.508	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1a
267	5	M7	HSS4x4x4	.553	5.27	.002	10.541	58.307	92.826	10.765	1.136	H1-1a
268	5	M8	HSS4x4x4	.579	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1a
269	5	M9	HSS4x4x4	.574	5.27	.002	10.541	58.307	92.826	10.765	1.136	H1-1a
270	5	M10	HSS4x4x4	.544	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1a
271	5	M11	HSS4x4x4	.494	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1a
272	5	M12	HSS4x4x4	.425	5.27	.002	10.541	58.307	92.826	10.765	1.136	H1-1a
273	5	M13	HSS4x4x4	.336	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1a
274	5	M14	HSS4x4x4	.229	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1a
275	5	M15	HSS4x4x4	.059	5.27	.002	10.541	58.307	92.826	10.765	1.136	H1-1b
276	5	M16	HSS4x4x4	.058	5.27	.002	10.541	58.307	92.826	10.765	1.136	H1-1b

Member AISC 13th(360-05): ASD Steel Code Checks (Continued)

	LC	Member	Shape	UC Max	Loc[ft]	Shear UC	Loc[ft]	Pnc/om [k]	Pnt/om [k]	Mn/om [k-ft]	Cb	Eqn
277	5	M17	HSS4x4x4	.268	5.161	.002	0	58.307	92.826	10.765	1.136	H1-1a
278	5	m18	HSS6x4x6	.248	5.161	.002	0	108.934	170.228	27.315	1.136	H1-1a
279	5	M19	HSS6x4x6	.335	5.161	.002	0	108.934	170.228	27.315	1.136	H1-1a
280	5	M20	HSS6x4x6	.405	5.161	.002	10.541	108.934	170.228	27.315	1.136	H1-1a
281	5	M21	HSS6x4x6	.460	5.161	.002	0	108.934	170.228	27.315	1.136	H1-1a
282	5	M22	HSS6x4x6	.498	5.161	.002	10.541	108.934	170.228	27.315	1.136	H1-1a
283	5	M23	HSS6x4x6	.520	5.161	.002	0	108.934	170.228	27.315	1.136	H1-1a
284	5	M24	HSS6x4x6	.527	5.161	.002	10.541	108.934	170.228	27.315	1.136	H1-1a
285	5	M25	HSS6x4x6	.527	5.161	.002	10.541	108.934	170.228	27.315	1.136	H1-1a
286	5	M26	HSS6x4x6	.517	5.161	.002	0	108.934	170.228	27.315	1.136	H1-1a
287	5	M27	HSS6x4x6	.491	5.161	.002	10.541	108.934	170.228	27.315	1.136	H1-1a
288	5	M28	HSS6x4x6	.448	5.161	.002	0	108.934	170.228	27.315	1.136	H1-1a
289	5	M29	HSS6x4x6	.389	5.161	.002	0	108.934	170.228	27.315	1.136	H1-1a
290	5	m30	HSS6x4x6	.314	5.161	.002	0	108.934	170.228	27.315	1.136	H1-1a
291	5	m31	HSS6x4x6	.222	5.161	.002	10.541	108.934	170.228	27.315	1.136	H1-1a
292	5	m32	HSS6x4x6	.063	5.27	.002	0	108.934	170.228	27.315	1.136	H1-1b
293	5	m33	HSS4x4x4	.064	0	.000	0	75.615	92.826	10.765	1	H1-1b
294	5	m34	HSS4x4x3	.072	0	.000	0	58.347	71.066	8.424	1	H1-1b
295	5	m35	HSS4x4x3	.062	0	.000	0	58.347	71.066	8.424	1	H1-1b
296	5	m36	HSS4x4x3	.052	0	.000	0	58.347	71.066	8.424	1	H1-1b
297	5	m37	HSS4x4x3	.043	0	.000	0	58.347	71.066	8.424	1	H1-1b
298	5	m38	HSS4x4x3	.033	0	.000	0	58.347	71.066	8.424	1	H1-1b
299	5	m39	HSS4x4x3	.023	0	.000	0	58.347	71.066	8.424	1	H1-1b
300	5	m40	HSS4x4x3	.013	0	.000	0	58.347	71.066	8.424	1	H1-1b
301	5	m41	HSS4x4x3	.009	0	.000	0	58.347	71.066	8.424	1	H1-1b
302	5	m42	HSS4x4x3	.016	0	.000	0	58.347	71.066	8.424	1	H1-1b
303	5	m43	HSS4x4x3	.026	0	.000	0	58.347	71.066	8.424	1	H1-1b
304	5	m44	HSS4x4x3	.036	0	.000	0	58.347	71.066	8.424	1	H1-1b
305	5	m45	HSS4x4x3	.046	0	.000	0	58.347	71.066	8.424	1	H1-1b
306	5	m46	HSS4x4x3	.056	0	.000	0	58.347	71.066	8.424	1	H1-1b
307	5	m47	HSS4x4x3	.066	0	.000	0	58.347	71.066	8.424	1	H1-1b
308	5	m48	HSS4x4x3	.075	0	.000	0	58.347	71.066	8.424	1	H1-1b
309	5	m49	HSS4x4x3	.090	0	.000	0	58.347	71.066	8.424	1	H1-1b
310	5	m50	HSS4x4x3	.105	5.326	.002	10.651	45.018	71.066	8.424	1.136	H1-1b
311	5	m51	HSS4x4x3	.093	5.326	.002	0	45.018	71.066	8.424	1.136	H1-1b
312	5	M52	HSS4x4x3	.081	5.326	.002	0	45.018	71.066	8.424	1.136	H1-1b
313	5	M53	HSS4x4x3	.068	5.326	.002	0	45.018	71.066	8.424	1.136	H1-1b
314	5	M54	HSS4x4x3	.056	5.326	.002	0	45.018	71.066	8.424	1.136	H1-1b
315	5	M55	HSS4x4x3	.043	5.326	.002	0	45.018	71.066	8.424	1.136	H1-1b
316	5	M56	HSS4x4x3	.031	5.326	.002	0	45.018	71.066	8.424	1.136	H1-1b
317	5	M57	HSS4x4x3	.018	5.326	.002	0	45.018	71.066	8.424	1.136	H1-1b
318	5	M58	HSS4x4x3	.029	7.19	.002	14.38	30.922	71.066	8.424	1.136	H1-1b
319	5	M59	HSS4x4x3	.047	7.19	.002	14.38	30.922	71.066	8.424	1.136	H1-1b
320	5	M60	HSS4x4x3	.064	7.19	.002	0	30.922	71.066	8.424	1.136	H1-1b
321	5	M61	HSS4x4x3	.081	7.19	.002	0	30.922	71.066	8.424	1.136	H1-1b
322	5	M62	HSS4x4x3	.098	7.19	.002	14.38	30.922	71.066	8.424	1.136	H1-1b
323	5	M63	HSS4x4x3	.115	7.19	.002	0	30.922	71.066	8.424	1.136	H1-1b
324	5	M64	HSS4x4x3	.242	7.34	.002	14.38	30.922	71.066	8.424	1.136	H1-1a
325	5	M65	HSS4x4x3	.276	7.34	.002	0	30.922	71.066	8.424	1.136	H1-1a
326	6	M1	HSS4x4x4	.015	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1b
327	6	M2	HSS4x4x4	.084	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1b
328	6	M3	HSS4x4x4	.276	5.27	.002	10.541	58.307	92.826	10.765	1.136	H1-1a
329	6	M4	HSS4x4x4	.384	5.27	.002	10.541	58.307	92.826	10.765	1.136	H1-1a
330	6	M5	HSS4x4x4	.474	5.27	.002	10.541	58.307	92.826	10.765	1.136	H1-1a
331	6	M6	HSS4x4x4	.549	5.27	.002	10.541	58.307	92.826	10.765	1.136	H1-1a
332	6	M7	HSS4x4x4	.608	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1a
333	6	M8	HSS4x4x4	.650	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1a

Member AISC 13th(360-05): ASD Steel Code Checks (Continued)

	LC	Member	Shape	UC Max	Loc[ft]	Shear UC	Loc[ft]	Pnc/om [k]	Pnt/om [k]	Mn/om [k-ft]	Cb	Eqn
334	6	M9	HSS4x4x4	.685	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1a
335	6	M10	HSS4x4x4	.668	5.27	.002	10.541	58.307	92.826	10.765	1.136	H1-1a
336	6	M11	HSS4x4x4	.625	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1a
337	6	M12	HSS4x4x4	.555	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1a
338	6	M13	HSS4x4x4	.459	5.27	.002	10.541	58.307	92.826	10.765	1.136	H1-1a
339	6	M14	HSS4x4x4	.337	5.27	.002	10.541	58.307	92.826	10.765	1.136	H1-1a
340	6	M15	HSS4x4x4	.102	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1b
341	6	M16	HSS4x4x4	.015	5.27	.002	0	58.307	92.826	10.765	1.136	H1-1b
342	6	M17	HSS4x4x4	.234	5.161	.002	0	58.307	92.826	10.765	1.136	H1-1a
343	6	m18	HSS6x4x6	.233	5.161	.002	0	108.934	170.228	27.315	1.136	H1-1a
344	6	M19	HSS6x4x6	.324	5.161	.002	10.541	108.934	170.228	27.315	1.136	H1-1a
345	6	M20	HSS6x4x6	.402	5.161	.002	0	108.934	170.228	27.315	1.136	H1-1a
346	6	M21	HSS6x4x6	.466	5.161	.002	0	108.934	170.228	27.315	1.136	H1-1a
347	6	M22	HSS6x4x6	.516	5.161	.002	0	108.934	170.228	27.315	1.136	H1-1a
348	6	M23	HSS6x4x6	.552	5.161	.002	0	108.934	170.228	27.315	1.136	H1-1a
349	6	M24	HSS6x4x6	.574	5.161	.002	0	108.934	170.228	27.315	1.136	H1-1a
350	6	M25	HSS6x4x6	.574	5.161	.002	0	108.934	170.228	27.315	1.136	H1-1a
351	6	M26	HSS6x4x6	.582	5.161	.002	10.541	108.934	170.228	27.315	1.136	H1-1a
352	6	M27	HSS6x4x6	.568	5.161	.002	10.541	108.934	170.228	27.315	1.136	H1-1a
353	6	M28	HSS6x4x6	.531	5.161	.002	10.541	108.934	170.228	27.315	1.136	H1-1a
354	6	M29	HSS6x4x6	.471	5.161	.002	10.541	108.934	170.228	27.315	1.136	H1-1a
355	6	m30	HSS6x4x6	.389	5.161	.002	0	108.934	170.228	27.315	1.136	H1-1a
356	6	m31	HSS6x4x6	.285	5.161	.002	0	108.934	170.228	27.315	1.136	H1-1a
357	6	m32	HSS6x4x6	.085	5.27	.002	0	108.934	170.228	27.315	1.136	H1-1b
358	6	m33	HSS4x4x4	.060	0	.000	0	75.615	92.826	10.765	1	H1-1b
359	6	m34	HSS4x4x3	.072	0	.000	0	58.347	71.066	8.424	1	H1-1b
360	6	m35	HSS4x4x3	.064	0	.000	0	58.347	71.066	8.424	1	H1-1b
361	6	m36	HSS4x4x3	.056	0	.000	0	58.347	71.066	8.424	1	H1-1b
362	6	m37	HSS4x4x3	.047	0	.000	0	58.347	71.066	8.424	1	H1-1b
363	6	m38	HSS4x4x3	.039	0	.000	0	58.347	71.066	8.424	1	H1-1b
364	6	m39	HSS4x4x3	.030	0	.000	0	58.347	71.066	8.424	1	H1-1b
365	6	m40	HSS4x4x3	.022	0	.000	0	58.347	71.066	8.424	1	H1-1b
366	6	m41	HSS4x4x3	.008	0	.000	0	58.347	71.066	8.424	1	H1-1b
367	6	m42	HSS4x4x3	.009	0	.000	0	58.347	71.066	8.424	1	H1-1b
368	6	m43	HSS4x4x3	.023	0	.000	0	58.347	71.066	8.424	1	H1-1b
369	6	m44	HSS4x4x3	.037	0	.000	0	58.347	71.066	8.424	1	H1-1b
370	6	m45	HSS4x4x3	.050	0	.000	0	58.347	71.066	8.424	1	H1-1b
371	6	m46	HSS4x4x3	.064	0	.000	0	58.347	71.066	8.424	1	H1-1b
372	6	m47	HSS4x4x3	.077	0	.000	0	58.347	71.066	8.424	1	H1-1b
373	6	m48	HSS4x4x3	.091	0	.000	0	58.347	71.066	8.424	1	H1-1b
374	6	m49	HSS4x4x3	.202	0	.000	0	58.347	71.066	8.424	1	H1-1a
375	6	m50	HSS4x4x3	.106	5.326	.002	0	45.018	71.066	8.424	1.136	H1-1b
376	6	m51	HSS4x4x3	.095	5.326	.002	10.651	45.018	71.066	8.424	1.136	H1-1b
377	6	M52	HSS4x4x3	.085	5.326	.002	10.651	45.018	71.066	8.424	1.136	H1-1b
378	6	M53	HSS4x4x3	.074	5.326	.002	0	45.018	71.066	8.424	1.136	H1-1b
379	6	M54	HSS4x4x3	.063	5.326	.002	10.651	45.018	71.066	8.424	1.136	H1-1b
380	6	M55	HSS4x4x3	.052	5.326	.002	10.651	45.018	71.066	8.424	1.136	H1-1b
381	6	M56	HSS4x4x3	.041	5.326	.002	0	45.018	71.066	8.424	1.136	H1-1b
382	6	M57	HSS4x4x3	.031	5.326	.002	10.651	45.018	71.066	8.424	1.136	H1-1b
383	6	M58	HSS4x4x3	.037	7.04	.002	0	30.922	71.066	8.424	1.136	H1-1b
384	6	M59	HSS4x4x3	.034	7.19	.002	14.38	30.922	71.066	8.424	1.136	H1-1b
385	6	M60	HSS4x4x3	.058	7.19	.002	14.38	30.922	71.066	8.424	1.136	H1-1b
386	6	M61	HSS4x4x3	.081	7.19	.002	0	30.922	71.066	8.424	1.136	H1-1b
387	6	M62	HSS4x4x3	.105	7.19	.002	14.38	30.922	71.066	8.424	1.136	H1-1b
388	6	M63	HSS4x4x3	.235	7.34	.002	14.38	30.922	71.066	8.424	1.136	H1-1a
389	6	M64	HSS4x4x3	.282	7.34	.002	0	30.922	71.066	8.424	1.136	H1-1a
390	6	M65	HSS4x4x3	.328	7.34	.002	0	30.922	71.066	8.424	1.136	H1-1a

E2 Consulting Engineers, Inc. 1900 Powell Street, Suite 250 Emeryville, CA 94608	Designed By: KD	Date: 7/25/14
	Checked By: KJ	Date: 8/12/14
	Revised By:	Date:
Project No. WW-PAE-2174		Sheet No. 50

(50)

Project Description: Topock 160' Pipe Bridge Line I

Bridge Vertical Truss Line 'I'
Main Truss - 160' Long, Line I (200Pb6.topark)

(A) Unity checks

~~A.1 Top Compression Chord (HSS 6x4x6) Memb M24, M25~~

DL+LL UC Max = .724 < 1.0 ok

A.2 Bot. Tension Chord (HSS 4x4x6) Memb. M8, M9

DL+LL UC Max = .828 < 1.0

~~A-3 Diagonals Memb 50 & Memb 65 (HSS 4x4x3)~~
~~DL+LL UC Max .270 .367~~

~~A-4 Verticals Memb 34, Memb. 49 (HSS 4x4x3)~~
~~DL+LL .204 .225~~

(B) Deflection Check

~~Load~~ Comb. 1 DL+LL $\Delta_{max} = 6.432 = \frac{l}{298}$ ok

Comb. 2 DL $\Delta_{max} = 4.035$ provide camber $\frac{l}{500} = \frac{160 \times 12}{500} = 3.84''$

~~Net DL Defl = 4.035 - 3.84 = .195''~~

Comb. 3 DL + ALT LL $\Delta_{max} = 4.567''$

Comb. 4 DL + LL HALF SPAN $\Delta_{max} = 5.11$

Comb. 5 DL + Seismic $\Delta_{max} = 4.49''$

Comb. 6 DL + LL HALF SPAN ON RIGHT = 5.11

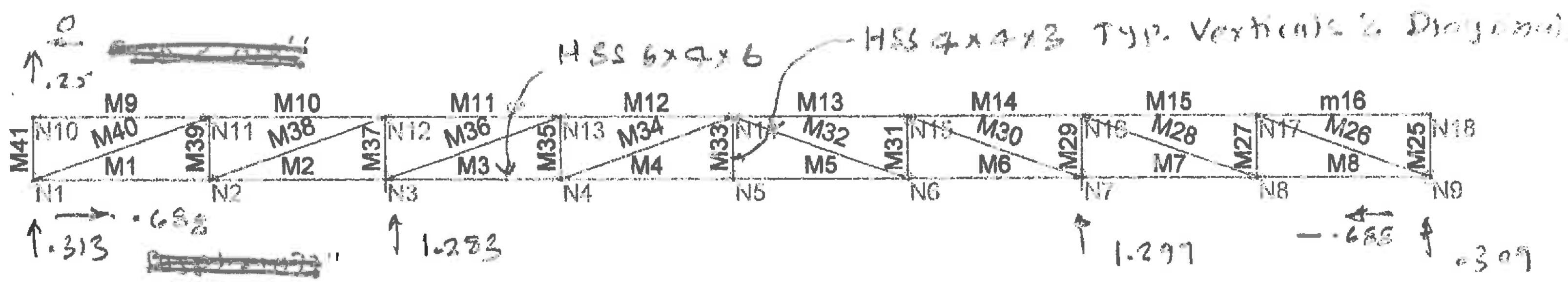
Net DL + LL Deflection = 6.432 - 4.035 + .195 = 2.592'' = $\frac{l}{740}$

(C) Design Support Forces
(Comb. 1)

Max. $R_{N_1} = 12.77^k$ $R_{N_{17}} = 13.28^k$

$H_{N17} = 6.0^k$ However 5^k Seismic may be used (Load input should be 5^k)

~~Max movement @ N_1 = 1.035'' (Roller)~~
(Comb. 1)



Results for LC 1, seismic

e2	topock 160' pipe bridge, 3 to 1 slope TOP DIAPH.	SK - 1
kd		Aug 6, 2014 at 7:25 AM
ww-peg-2174-043062		topockhbt3AA.pipebridge.r2d

Hot Rolled Steel Properties

	Label	E [ksi]	G [ksi]	Nu	Therm (\1E5 F)	Density[k/ft^3]	Yield[ksi]
1	A36 Gr.36	29000	11154	.3	.65	.49	36
2	A572 Gr.50	29000	11154	.3	.65	.49	50
3	A992	29000	11154	.3	.65	.49	50
4	A500 Gr.42	29000	11154	.3	.65	.49	42
5	A500 Gr.46	29000	11154	.3	.65	.49	46

Hot Rolled Steel Section Sets

	Label	Shape	Type	Design List	Material	Design Rules	A [in2]	I (90,270) [i...	I (0,180) [in4]
1	HR1A	HSS4x4x3	Beam	Tube	A500 Gr.46	Typical	2.58	6.21	6.21
2	HR2	HSS6x4x6	Beam	Tube	A500 Gr.46	Typical	6.18	14.9	28.3

Joint Coordinates and Temperatures

	Label	X [ft]	Y [ft]	Temp [F]
1	N1	0	0	0
2	N2	20	0	0
3	N3	40	0	0
4	N4	60	0	0
5	N5	80	0	0
6	N6	100	0	0
7	N7	120	0	0
8	N8	140	0	0
9	N9	160	0	0
10	N10	0	7	0
11	N11	20	7	0
12	N12	40	7	0
13	N13	60	7	0
14	N14	80	7	0
15	N15	100	7	0
16	N16	120	7	0
17	N17	140	7	0
18	N18	160	7	0

Joint Boundary Conditions

	Joint Label	X [k/in]	Y [k/in]	Rotation[k-ft/rad]	Footing
1	N1	Reaction	Reaction		
2	N3		Reaction		
3	N7		Reaction		
4	N9	Reaction	Reaction		

Member Primary Data

	Label	I Joint	J Joint	Rotate(deg)	Section/Shape	Type	Design List	Material	Design Rules
1	M1	N1	N2	90	HR2	Beam	Tube	A500 Gr.46	Typical
2	M2	N2	N3	90	HR2	Beam	Tube	A500 Gr.46	Typical
3	M3	N3	N4	90	HR2	Beam	Tube	A500 Gr.46	Typical
4	M4	N4	N5	90	HR2	Beam	Tube	A500 Gr.46	Typical
5	M5	N5	N6	90	HR2	Beam	Tube	A500 Gr.46	Typical
6	M6	N6	N7	90	HR2	Beam	Tube	A500 Gr.46	Typical
7	M7	N7	N8	90	HR2	Beam	Tube	A500 Gr.46	Typical
8	M8	N8	N9	90	HR2	Beam	Tube	A500 Gr.46	Typical
9	M9	N10	N11	90	HR2	Beam	Tube	A500 Gr.46	Typical
10	M10	N11	N12	90	HR2	Beam	Tube	A500 Gr.46	Typical

Member Primary Data (Continued)

	Label	I Joint	J Joint	Rotate(deg)	Section/Shape	Type	Design List	Material	Design Rules
11	M11	N12	N13	90	HR2	Beam	Tube	A500 Gr.46	Typical
12	M12	N13	N14	90	HR2	Beam	Tube	A500 Gr.46	Typical
13	M13	N14	N15	90	HR2	Beam	Tube	A500 Gr.46	Typical
14	M14	N15	N16	90	HR2	Beam	Tube	A500 Gr.46	Typical
15	M15	N16	N17	90	HR2	Beam	Tube	A500 Gr.46	Typical
16	M25	N18	N9		HR1A	Beam	Tube	A500 Gr.46	Typical
17	M26	N9	N17		HR1A	Beam	Tube	A500 Gr.46	Typical
18	M27	N17	N8		HR1A	Beam	Tube	A500 Gr.46	Typical
19	M28	N8	N16		HR1A	Beam	Tube	A500 Gr.46	Typical
20	M29	N16	N7		HR1A	Beam	Tube	A500 Gr.46	Typical
21	M30	N7	N15		HR1A	Beam	Tube	A500 Gr.46	Typical
22	M31	N15	N6		HR1A	Beam	Tube	A500 Gr.46	Typical
23	M32	N14	N6		HR1A	Beam	Tube	A500 Gr.46	Typical
24	M33	N14	N5		HR1A	Beam	Tube	A500 Gr.46	Typical
25	M34	N4	N14		HR1A	Beam	Tube	A500 Gr.46	Typical
26	M35	N13	N4		HR1A	Beam	Tube	A500 Gr.46	Typical
27	M36	N3	N13		HR1A	Beam	Tube	A500 Gr.46	Typical
28	M37	N12	N3		HR1A	Beam	Tube	A500 Gr.46	Typical
29	M38	N2	N12		HR1A	Beam	Tube	A500 Gr.46	Typical
30	M39	N11	N2		HR1A	Beam	Tube	A500 Gr.46	Typical
31	M40	N1	N11		HR2	Beam	Tube	A500 Gr.46	Typical
32	m16	N17	N18	90	HR1A	Beam	Tube	A500 Gr.46	Typical
33	M41	N1	N10		HR1A	Beam	Tube	A500 Gr.46	Typical

Joint Loads and Enforced Displacements (BLC 1 : seismic)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N10	L	Y	-.2
2	N11	L	Y	-.4
3	N12	L	Y	-.4
4	N13	L	Y	-.4
5	N14	L	Y	-.4
6	N15	L	Y	-.4
7	N16	L	Y	-.4
8	N17	L	Y	-.4
9	N18	L	Y	-.2
10	N1	L	Y	0
11	N2	L	Y	0
12	N3	L	Y	0
13	N4	L	Y	0
14	N5	L	Y	0
15	N6	L	Y	0
16	N7	L	Y	0
17	N8	L	Y	0
18	N9	L	Y	0

Basic Load Cases

	BLC Description	Category	X Gravity	Y Gravity	Joint	Point	Distributed
1	seismic	None			18		

Load Combinations

	Description	Solve	PD...	SR...	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor
1	seismic	Yes	Y		1	1														

Joint Reactions (By Combination)

	LC	Joint Label	X [k]	Y [k]	MZ [k-ft]
1	1	N1	.688	.313	0
2	1	N3	0	1.283	0
3	1	N7	0	1.299	0
4	1	N9	-.688	.305	0
5	1	Totals:	0	3.2	
6	1	COG (ft):	X: 80	Y: 7	

Joint Deflections

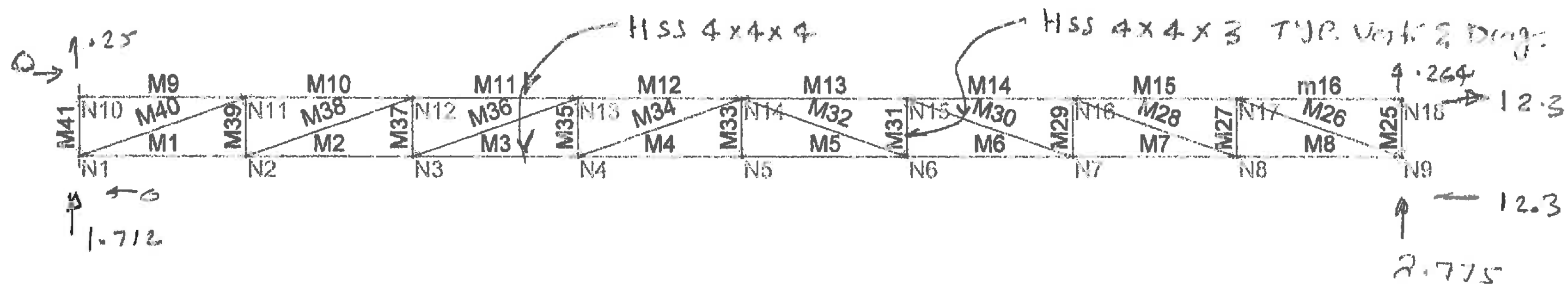
	LC	Joint Label	X [in]	Y [in]	Rotation [rad]
1	1	N1	0	0	0
2	1	N2	0	-.005	0
3	1	N3	-.002	0	0
4	1	N4	-.001	-.03	0
5	1	N5	0	-.04	0
6	1	N6	.002	-.03	0
7	1	N7	.002	0	0
8	1	N8	0	-.006	0
9	1	N9	0	0	0
10	1	N10	.001	0	0
11	1	N11	.001	-.006	0
12	1	N12	.001	0	0
13	1	N13	.002	-.029	0
14	1	N14	0	-.04	0
15	1	N15	-.001	-.029	0
16	1	N16	0	0	0
17	1	N17	-.001	-.007	0
18	1	N18	-.001	0	0

Member AISC 13th(360-05): ASD Steel Code Checks (By Combination)

	LC	Member	Shape	UC Max	Loc[ft]	Shear UC	Loc[ft]	Pnc/om [k]	Pnt/om [k]	Mn/om [k-ft]	Cb	Eqn
1	1	M1	HSS6x4x6	.005	0	.000	0	38.882	170.228	20.521	1	H1-1b
2	1	M2	HSS6x4x6	.015	0	.000	0	38.882	170.228	20.521	1	H1-1b
3	1	M3	HSS6x4x6	.002	0	.000	0	38.882	170.228	20.521	1	H1-1b
4	1	M4	HSS6x4x6	.003	0	.000	0	38.882	170.228	20.521	1	H1-1b
5	1	M5	HSS6x4x6	.003	0	.000	0	38.882	170.228	20.521	1	H1-1b
6	1	M6	HSS6x4x6	.001	0	.000	0	38.882	170.228	20.521	1	H1-1b
7	1	M7	HSS6x4x6	.016	0	.000	0	38.882	170.228	20.521	1	H1-1b
8	1	M8	HSS6x4x6	.005	0	.000	0	38.882	170.228	20.521	1	H1-1b
9	1	M9	HSS6x4x6	.000	0	.000	0	38.882	170.228	20.521	1	H1-1b
10	1	M10	HSS6x4x6	.004	0	.000	0	38.882	170.228	20.521	1	H1-1b
11	1	M11	HSS6x4x6	.001	0	.000	0	38.882	170.228	20.521	1	H1-1b
12	1	M12	HSS6x4x6	.016	0	.000	0	38.882	170.228	20.521	1	H1-1b
13	1	M13	HSS6x4x6	.015	0	.000	0	38.882	170.228	20.521	1	H1-1b
14	1	M14	HSS6x4x6	.002	0	.000	0	38.882	170.228	20.521	1	H1-1b
15	1	M15	HSS6x4x6	.004	0	.000	0	38.882	170.228	20.521	1	H1-1b
16	1	M25	HSS4x4x3	.002	0	.000	0	58.347	71.066	8.424	1	H1-1b
17	1	M26	HSS4x4x3	.011	0	.000	0	14.437	71.066	8.424	1	H1-1b
18	1	M27	HSS4x4x3	.003	0	.000	0	58.347	71.066	8.424	1	H1-1b
19	1	M28	HSS4x4x3	.006	0	.000	0	14.437	71.066	8.424	1	H1-1b
20	1	M29	HSS4x4x3	.006	0	.000	0	58.347	71.066	8.424	1	H1-1b
21	1	M30	HSS4x4x3	.063	0	.000	0	14.437	71.066	8.424	1	H1-1b
22	1	M31	HSS4x4x3	.001	0	.000	0	58.347	71.066	8.424	1	H1-1b
23	1	M32	HSS4x4x3	.021	0	.000	0	14.437	71.066	8.424	1	H1-1b
24	1	M33	HSS4x4x3	.000	0	.000	0	58.347	71.066	8.424	1	H1-1b

Member AISC 13th(360-05): ASD Steel Code Checks (By Combination) (Continued)

	LC	Member	Shape	UC Max	Loc[ft]	Shear UC	Loc[ft]	Pnc/om [k]	Pnt/om [k]	Mn/om [k-ft]	Cb	Eqn
25	1	M34	HSS4x4x3	.021	0	.000	0	14.437	71.066	8.424	1	H1-1b
26	1	M35	HSS4x4x3	.001	0	.000	0	58.347	71.066	8.424	1	H1-1b
27	1	M36	HSS4x4x3	.063	0	.000	0	14.437	71.066	8.424	1	H1-1b
28	1	M37	HSS4x4x3	.006	0	.000	0	58.347	71.066	8.424	1	H1-1b
29	1	M38	HSS4x4x3	.006	0	.000	0	14.437	71.066	8.424	1	H1-1b
30	1	M39	HSS4x4x3	.002	0	.000	0	58.347	71.066	8.424	1	H1-1b
31	1	M40	HSS6x4x6	.005	0	.000	0	34.638	170.228	27.315	1	H1-1b
32	1	m16	HSS4x4x3	.000	0	.000	0	16.205	71.066	8.424	1	H1-1b
33	1	M41	HSS4x4x3	.002	0	.000	0	58.347	71.066	8.424	1	H1-1b



Results for LC 1, seismic

e2	topock 160' pipe bridge, bot. chord truss	SK - 1
kd		Aug 6, 2014 at 7:35 AM
ww-peg-2174-043062		topockhbt3BB.pipebridge160.r2d

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Hot Rolled Steel Properties

	Label	E [ksi]	G [ksi]	Nu	Therm (\1E5 F)	Density[k/ft^3]	Yield[ksi]
1	A36 Gr.36	29000	11154	.3	.65	.49	36
2	A572 Gr.50	29000	11154	.3	.65	.49	50
3	A992	29000	11154	.3	.65	.49	50
4	A500 Gr.42	29000	11154	.3	.65	.49	42
5	A500 Gr.46	29000	11154	.3	.65	.49	46

Hot Rolled Steel Section Sets

	Label	Shape	Type	Design List	Material	Design Rules	A [in2]	I (90,270) [i...	I (0,180) [in4]
1	HR1A	HSS4x4x3	Beam	Tube	A500 Gr.46	Typical	2.58	6.21	6.21
2	HR2	HSS4x4x4	Beam	Tube	A500 Gr.46	Typical	3.37	7.8	7.8

Joint Coordinates and Temperatures

	Label	X [ft]	Y [ft]	Temp [F]
1	N1	0	0	0
2	N2	20	0	0
3	N3	40	0	0
4	N4	60	0	0
5	N5	80	0	0
6	N6	100	0	0
7	N7	120	0	0
8	N8	140	0	0
9	N9	160	0	0
10	N10	0	7	0
11	N11	20	7	0
12	N12	40	7	0
13	N13	60	7	0
14	N14	80	7	0
15	N15	100	7	0
16	N16	120	7	0
17	N17	140	7	0
18	N18	160	7	0

Joint Boundary Conditions

	Joint Label	X [k/in]	Y [k/in]	Rotation[k-ft/rad]	Footing
1	N1		Reaction		
2	N10		Reaction		
3	N9	Reaction	Reaction		
4	N18	Reaction	Reaction		

Member Primary Data

	Label	I Joint	J Joint	Rotate(deg)	Section/Shape	Type	Design List	Material	Design Rules
1	M1	N1	N2	90	HR2	Beam	Tube	A500 Gr.46	Typical
2	M2	N2	N3	90	HR2	Beam	Tube	A500 Gr.46	Typical
3	M3	N3	N4	90	HR2	Beam	Tube	A500 Gr.46	Typical
4	M4	N4	N5	90	HR2	Beam	Tube	A500 Gr.46	Typical
5	M5	N5	N6	90	HR2	Beam	Tube	A500 Gr.46	Typical
6	M6	N6	N7	90	HR2	Beam	Tube	A500 Gr.46	Typical
7	M7	N7	N8	90	HR2	Beam	Tube	A500 Gr.46	Typical
8	M8	N8	N9	90	HR2	Beam	Tube	A500 Gr.46	Typical
9	M9	N10	N11	90	HR2	Beam	Tube	A500 Gr.46	Typical
10	M10	N11	N12	90	HR2	Beam	Tube	A500 Gr.46	Typical

Member Primary Data (Continued)

	Label	I Joint	J Joint	Rotate(deg)	Section/Shape	Type	Design List	Material	Design Rules
11	M11	N12	N13	90	HR2	Beam	Tube	A500 Gr.46	Typical
12	M12	N13	N14	90	HR2	Beam	Tube	A500 Gr.46	Typical
13	M13	N14	N15	90	HR2	Beam	Tube	A500 Gr.46	Typical
14	M14	N15	N16	90	HR2	Beam	Tube	A500 Gr.46	Typical
15	M15	N16	N17	90	HR2	Beam	Tube	A500 Gr.46	Typical
16	M25	N18	N9		HR1A	Beam	Tube	A500 Gr.46	Typical
17	M26	N9	N17		HR1A	Beam	Tube	A500 Gr.46	Typical
18	M27	N17	N8		HR1A	Beam	Tube	A500 Gr.46	Typical
19	M28	N8	N16		HR1A	Beam	Tube	A500 Gr.46	Typical
20	M29	N16	N7		HR1A	Beam	Tube	A500 Gr.46	Typical
21	M30	N7	N15		HR1A	Beam	Tube	A500 Gr.46	Typical
22	M31	N15	N6		HR1A	Beam	Tube	A500 Gr.46	Typical
23	M32	N6	N14		HR1A	Beam	Tube	A500 Gr.46	Typical
24	M33	N14	N5		HR1A	Beam	Tube	A500 Gr.46	Typical
25	M34	N4	N14		HR1A	Beam	Tube	A500 Gr.46	Typical
26	M35	N13	N4		HR1A	Beam	Tube	A500 Gr.46	Typical
27	M36	N3	N13		HR1A	Beam	Tube	A500 Gr.46	Typical
28	M37	N12	N3		HR1A	Beam	Tube	A500 Gr.46	Typical
29	M38	N2	N12		HR1A	Beam	Tube	A500 Gr.46	Typical
30	M39	N11	N2		HR1A	Beam	Tube	A500 Gr.46	Typical
31	M40	N1	N11		HR1A	Beam	Tube	A500 Gr.46	Typical
32	M41	N1	N10		HR1A	Beam	Tube	A500 Gr.46	Typical
33	m16	N17	N18	90	HR2	Beam	Tube	A500 Gr.46	Typical

Joint Loads and Enforced Displacements (BLC 1 : seismic)

	Joint Label	L,D,M	Direction	Magnitude[(k,k-ft), (in,rad), (k*s^2/ft...
1	N10	L	Y	-.25
2	N11	L	Y	-.1
3	N12	L	Y	-.75
4	N13	L	Y	-.1
5	N14	L	Y	-.1
6	N15	L	Y	-.1
7	N16	L	Y	-.75
8	N17	L	Y	-.1
9	N18	L	Y	-.25
10	N1	L	Y	-.25
11	N2	L	Y	-.1
12	N3	L	Y	-.75
13	N4	L	Y	-.1
14	N5	L	Y	-.1
15	N6	L	Y	-.1
16	N7	L	Y	-.75
17	N8	L	Y	-.1
18	N9	L	Y	-.25

Basic Load Cases

	BLC Description	Category	X Gravity	Y Gravity	Joint	Point	Distributed
1	seismic	None			18		

Load Combinations

	Description	Solve	PD...	SR...	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor
1	seismic	Yes	Y		1	1														

Joint Reactions

	LC	Joint Label	X [k]	Y [k]	MZ [k-ft]
1	1	N1	0	1.712	0
2	1	N10	0	.25	0
3	1	N9	-12.303	2.775	0
4	1	N18	12.303	.264	0
5	1	Totals:	0	5	
6	1	COG (ft):	X: 80	Y: 3.5	

Joint Deflections

	LC	Joint Label	X [in]	Y [in]	Rotation [rad]
1	1	N1	-.077	0	0
2	1	N2	-.067	-.319	0
3	1	N3	-.048	-.572	0
4	1	N4	-.03	-.668	0
5	1	N5	-.016	-.659	0
6	1	N6	-.001	-.561	0
7	1	N7	.008	-.4	0
8	1	N8	.012	-.168	0
9	1	N9	0	0	0
10	1	N10	.018	0	0
11	1	N11	.018	-.317	0
12	1	N12	.008	-.571	0
13	1	N13	-.011	-.668	0
14	1	N14	-.029	-.659	0
15	1	N15	-.039	-.56	0
16	1	N16	-.043	-.398	0
17	1	N17	-.03	-.165	0
18	1	N18	0	0	0

Member AISC 13th(360-05): ASD Steel Code Checks (By Combination)

	LC	Member	Shape	UC Max	Loc[ft]	Shear UC	Loc[ft]	Pnc/om [k]	Pnt/om [k]	Mn/om [k-ft]	Cb	Eqn
1	1	M1	HSS4x4x4	.023	0	.000	0	20.354	92.826	10.765	1	H1-1b
2	1	M2	HSS4x4x4	.042	0	.000	0	20.354	92.826	10.765	1	H1-1b
3	1	M3	HSS4x4x4	.038	0	.000	0	20.354	92.826	10.765	1	H1-1b
4	1	M4	HSS4x4x4	.032	0	.000	0	20.354	92.826	10.765	1	H1-1b
5	1	M5	HSS4x4x4	.032	0	.000	0	20.354	92.826	10.765	1	H1-1b
6	1	M6	HSS4x4x4	.022	0	.000	0	20.354	92.826	10.765	1	H1-1b
7	1	M7	HSS4x4x4	.009	0	.000	0	20.354	92.826	10.765	1	H1-1b
8	1	M8	HSS4x4x4	.248	0	.000	0	20.354	92.826	10.765	1	H1-1a
9	1	M9	HSS4x4x4	.000	0	.000	0	20.354	92.826	10.765	1	H1-1b
10	1	M10	HSS4x4x4	.205	0	.000	0	20.354	92.826	10.765	1	H1-1a
11	1	M11	HSS4x4x4	.382	0	.000	0	20.354	92.826	10.765	1	H1-1a
12	1	M12	HSS4x4x4	.349	0	.000	0	20.354	92.826	10.765	1	H1-1a
13	1	M13	HSS4x4x4	.099	0	.000	0	20.354	92.826	10.765	1	H1-1b
14	1	M14	HSS4x4x4	.040	0	.000	0	20.354	92.826	10.765	1	H1-1b
15	1	M15	HSS4x4x4	.027	0	.000	0	20.354	92.826	10.765	1	H1-1b
16	1	M25	HSS4x4x3	.000	0	.000	0	58.347	71.066	8.424	1	H1-1b
17	1	M26	HSS4x4x3	.532	0	.000	0	14.437	71.066	8.424	1	H1-1a
18	1	M27	HSS4x4x3	.017	0	.000	0	58.347	71.066	8.424	1	H1-1b
19	1	M28	HSS4x4x3	.490	0	.000	0	14.437	71.066	8.424	1	H1-1a
20	1	M29	HSS4x4x3	.011	0	.000	0	58.347	71.066	8.424	1	H1-1b
21	1	M30	HSS4x4x3	.088	0	.000	0	14.437	71.066	8.424	1	H1-1b
22	1	M31	HSS4x4x3	.005	0	.000	0	58.347	71.066	8.424	1	H1-1b
23	1	M32	HSS4x4x3	.067	0	.000	0	14.437	71.066	8.424	1	H1-1b
24	1	M33	HSS4x4x3	.001	0	.000	0	58.347	71.066	8.424	1	H1-1b

Member AISC 13th(360-05): ASD Steel Code Checks (By Combination) (Continued)

	LC	Member	Shape	UC Max	Loc[ft]	Shear UC	Loc[ft]	Pnc/om [k]	Pnt/om [k]	Mn/om [k-ft]	Cb	Eqn
25	1	M34	HSS4x4x3	.009	0	.000	0	14.437	71.066	8.424	1	H1-1b
26	1	M35	HSS4x4x3	.003	0	.000	0	58.347	71.066	8.424	1	H1-1b
27	1	M36	HSS4x4x3	.005	0	.000	0	14.437	71.066	8.424	1	H1-1b
28	1	M37	HSS4x4x3	.004	0	.000	0	58.347	71.066	8.424	1	H1-1b
29	1	M38	HSS4x4x3	.265	0	.000	0	14.437	71.066	8.424	1	H1-1a
30	1	M39	HSS4x4x3	.010	0	.000	0	58.347	71.066	8.424	1	H1-1b
31	1	M40	HSS4x4x3	.306	0	.000	0	14.437	71.066	8.424	1	H1-1a
32	1	M41	HSS4x4x3	.000	0	.000	0	58.347	71.066	8.424	1	H1-1b
33	1	m16	HSS4x4x4	.066	0	.000	0	20.354	92.826	10.765	1	H1-1b

E2 Consulting Engineers, Inc.
1900 Powell Street, Suite 250
Emeryville, CA 94608

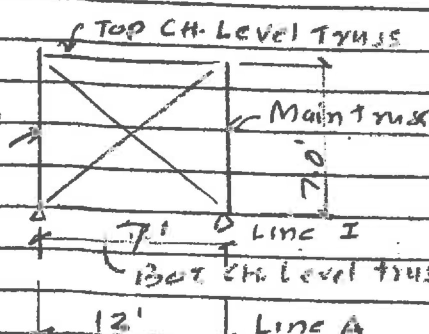
Designed By:	KD	Date:	3/19/14
Checked By:	KJ	Date:	8/12/14
Revised By:		Date:	
Project No.	WW-PAE-2174	Sheet No.	61

Project Description: Topock 160' Pipe Bridge Line 'I'

Top Chord Level horizontal truss (For Line I)
See computer output (topock hbt 3A pipe bridge)
This truss shall carry seismic loads.
Forces are transferred at supports (vertical trusses at 4 supports)
Max $P_{seismic} = 3.2^k$
Reaction at Supports
Y dir. $R_{N1} = .313 = R_{N4}$ $R_{N3} = 1.30 = R_{N7}$
All Deflections & unity checks ok - (See computer output)
~~Size of chord members = HSS 6x6x3~~
Size of diagonal & vertical = HSS 4x4x3 $r = 1.52''$
Length of diagonals = 21.19' $\frac{kl}{r} = \frac{21.19 \times 12}{1.55} = 164 < 200$
For unity check see pg.
Bot. Chord Level horizontal truss (For line I)
See computer output (topock hbt 3BB pipe bridge)
This truss shall transfer (forces from top chord level truss to vertical trusses) loads to Hinge support

Reactions
X dir. $R_{xN1} = 0.0$ $R_{xN4} = 12.30^k$ $R_{yN18} = .264$ $R_{xN18} = 12.30^k$
Y dir. $R_{yN1} = 1.712^k$ $R_{yN4} = 2.775^k$ $R_{yN10} = .25^k$ $R_{xN10} = 0$
All Deflections & unity check (see Computer output)
Size of Chord members - HSS 4x4x4
Size of diagonal & vertical - HSS 4x4x3
See pg. for unity check
Vertical truss to transfer from Top diaph. truss to Bot. diaph. truss
Load from Top chord support $= 1.3^k$

X bracing $l = \sqrt{7^2+7^2} = 9.9'$
~~Try HSS 3x3x1/4, r = 1.10~~



Line I $\frac{Kl}{r} = \frac{9.90 \times 12}{1.10} = 108$
Cap In Ten. $= 2.59 \times .6 \times 46 = 71^k$
USE HSS 3x3x4
Line A ~~$\frac{Kl}{r} = \frac{13.89 \times 12}{1.10} = 151.5$~~
USE HSS 3x3x4

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	Checked By: KJ	Date: 8/12/14
	Revised By:	Date:
Project No. IVW - PAE - 2174		Sheet No. 62

Project Description: Topock 160' & 180' pipe bridge at line 1 & +1.

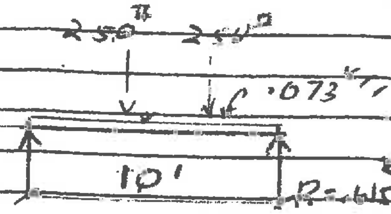
Line I

Walkway Beam

Max. span = 10'

$W_{TL} = [(.01 \times 1.5 + .02) + .025 \times 1.5]$ (DL, LL)

$= .035 + .0375 = .073^{k/l}$



Add 2 - 250# Man Load @ 2.5' o.c. (center)

$R = .073 \times 5 + .250 = .615^k$

$M = .615 \times 5 - \frac{.073 \times 5^2}{2} = 2.163^{1k}$ $w_{eq} = \frac{2.163 \times 8}{10^2} = .173^{k/l}$

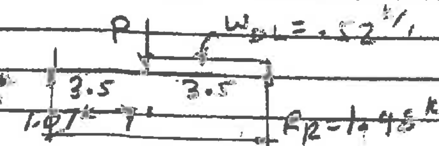
$f_b = \frac{2.163 \times 12}{3.90} = 6.655^{ksi} < .6 \times 46^{ksi}$ ok

$\Delta_{TL} = \frac{5}{384} \times \frac{.173 \times 10^4}{29000 \times 7.8} \times 1728 = .172'' = \frac{l}{697} < \frac{l}{240}$ ok

USE HSS 4x4x4 $A = 3.37^{in^2}$, $I = 7.8^{in^4}$, $S = 3.9^{in^3}$, $r = 1.52''$

Walkway Girder

$P = .615 \times 2 = 1.23^k$



$W_{DL} = .05 \times 10 + .02 = .52^{k/l}$ (pipe)

$R_L \times 7 = 1.23 \times 3.5 + .52 \times 3.5^2$ $R_1 = 1.07^k$

$M_{max} = 1.07 \times 3.5 = 3.75^{1k}$

Try HSS 4x4x3/8 $S = 5.97^{in^3}$ $I = 11.9^{in^4}$

$f_b = \frac{3.75 \times 12}{3.9} = 11.54^{ksi} < .6 \times 46 = 27.6^{ksi}$ $w_{eq} = \frac{3.75 \times 8}{7^2} = .61^{k/l}$

$\Delta_{TL} = \frac{5}{384} \times \frac{.61 \times 7^4}{29000 \times 7.8} \times 1728 = .15'' = \frac{l}{560} < \frac{l}{240}$ ok

USE HSS 4x4x4 $S = 6.41$, $I = 16.0$

Line A

Walkway Bm (6.9') - USE HSS 5x5x4 $R = .073 \times 4.5 + .25 = .579^k$

Walkway Girder ($l = 12.0'$) $P = .58 \times 2 = 1.16^k$

$W_{DL} = .08 \times 9 + .02 = .74^{k/l}$ $P = 1.16 + .74 \times 6 \times .5 = 3.38^k$

$M_{max} = 3.38 \times 6.0 - 1.16 \times 3.0 - \frac{.74 \times 3^2}{2} = 13.47^{1k}$ $w_{eq} = .748^{k/l}$

Try HSS 5x5x6 $S = 8.68^{in^3}$ $I = 21.7^{in^4}$

$f_b = \frac{13.47 \times 12}{8.68} = 18.62^{ksi}$ $\Delta_{TL} = \frac{5}{384} \times \frac{.748 \times 12^4}{29000 \times 21.7} \times 1728 = .554'' = \frac{l}{260}$ ok

USE HSS 5x5x6

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Checked By:	[illegible]	Date:	8/12/14
Revised By:		Date:	
Project No.		Sheet No.	63

Project Description: TOPOCK 160' TRUSS LINE I & TOPOCK 150' LINE A

TOP DIAPHGRAM TRUSS (See pg. 21)
→ LINE I

CHORD MEMBERS (Memb. M1 TO M16) HSS 6x4x6
UC MAX = .016

DIAG & VERT. Members (All HSS 4x4x3)
UC MAX = .063 (Memb. 26)

BOT. DIAPH TRUSS (See pg. 26)
HSS4x4x4
CHORDS - UC MAX = .382 (M11)
DIAG.-VERT'S - UC MAX = .532 (M26)

APPENDIX A - CALCULATION COVER SHEET

CALCULATION ID NUMBER	
REVISION NUMBER	
JOB NUMBER	

TITLE	Topock Ground Water Remediation Project Aerial Crossing Pipe Line A Bridge & I Bridge

Page No	CONTENT
1	Design References, Related Dwgs References Pipeline A
2	Pipe Bridge Abutment loading Pipe Line A
3, 4 & 5	Pipe Bridge Abutment stability & Reinforcing Pipeline A
6 & 7	Bearing Plate Design Pipe line A
7	Pipe Line "I" Bridge

	initial	date
PREPARED	RJ	7/25/14
TITLE		
REVIEWED		
TITLE		

REVISION NOTES	

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	Checked By:		Date:
	Reviewed By:		Date:
Project No.			Sheet No. 1 of 9
Project Description:			

Reference:

Related Project Drawings

S-07-03 – Aerial Crossing Pipe Line A
S-07-04 – Section & Details Pipe Line A
S-07-05 – Abutment Plan, Sections & Details Pipe line A
S-07-06 – Aerial Crossing Pipe Line I
S-07-07 – Sections & Details Pipe Line I
S-07-08 – Abutment Plan Sections & Detail Pipe line I

Applied Codes

ASCE – 7-10 Non Building Structures
IBC 2009/CBC 2010 as amended by San Bernardino County
ACI 318-11 – Concrete $f'_c = 5.0$ ksi, Fy=60 ksi

Seismic Data

USGS for ASCE 7-10 Site coordinates
Site Class D

Soil Data

Soil Bearing 4.0 ksf

Bridge Design Aids

RISA – 2D Version 12.0.0

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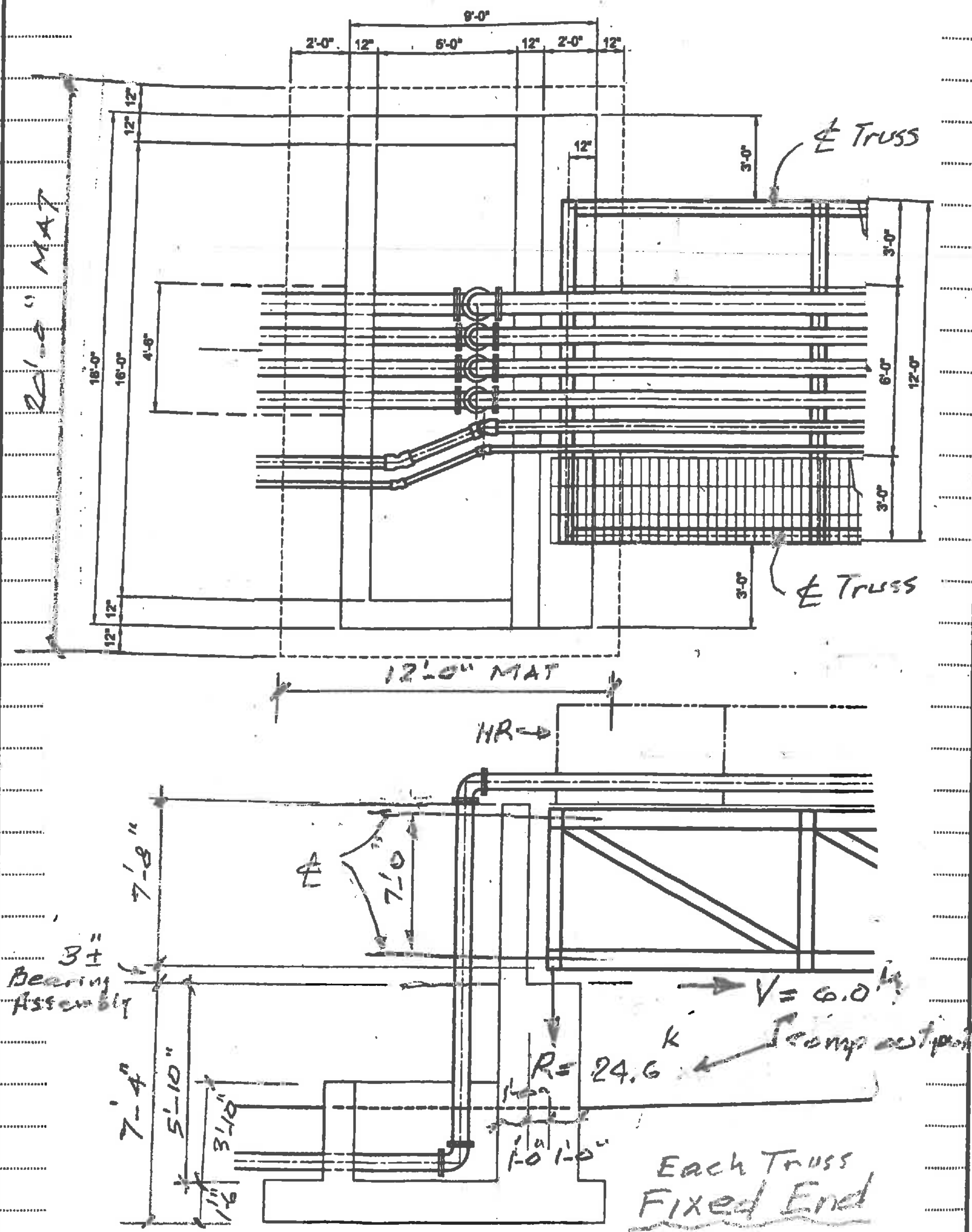
Project Description:			

Reference:



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Project No.			Sheet No. 3 of 7
Project Description:			

Reference:

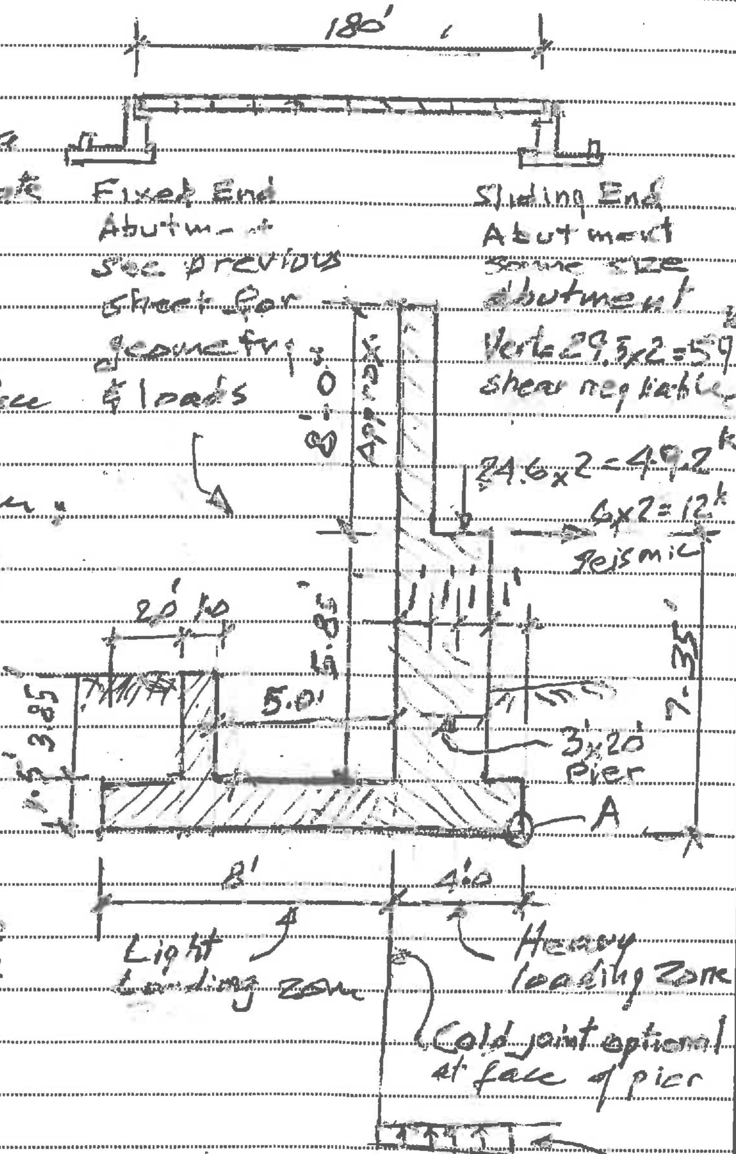
Pipe line A - 180' Pipe support Bridge Abutments

critical w/seismic

Geometry of concrete abutments developed for operation maintenance equipments that also tolerate bridge design forces as shown here and and following sheet

① Try cold joint at pier face

② Try no cold join



Conc weight Heavy Zone:

$1.5' \times 4' \times 20' \times 0.15 = 18.0^k$

$5.85 \times 3 \times 18 \times 0.15 = 47.4$

$8.0 \times 1' \times 18 \times 0.15 = 21.6$

$\overline{87.0}$

Bridge Reaction $= 49.2$

Heavy Zone Weight $\overline{136.2}$

Conc weight Light Zone:

$1.5 \times 8' \times 20' \times 0.15 = 36.0^k$

$3.85 \times 1 \times 18' \times 0.15 = 10.4$

$3.85 \times 1 \times 2 \times 5 \times 0.15 = 5.8$

Soil $3.85 \times 2 \times 20 \times 0.1 = 15.4$

Light Zone weight $\overline{67.6}$

① Try with cold joint at pier face

$SF_{OT} = \dfrac{(49.2 \times 2) + (18 \times 2) + (47.4 \times 2.5) + (17.1 \times 3.5)}{12 \times 7.35} = \dfrac{312.8}{88} = 3.5 > 2$ ok

$SF_{sliding} = 136.2 \times 0.3 / 12 = 3.4 > 2$ ok

Soil Bearing $\pm = 136.2/20 \times 4 \pm 12 \times 7.35 \times 6 / 20 \times (4)^2 = 1.8$ Max ksf, 1.6 Min

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Project Description:			

Reference:

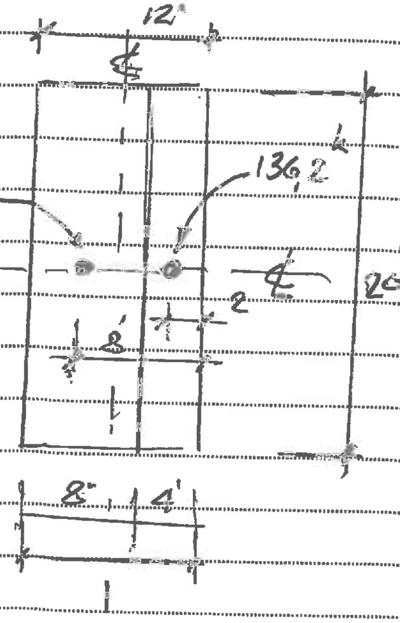
② Try no cold joint

Applied load from sht 2

$R = 136.2 + 67.6 = 203.8^{k}$

$e = \frac{88}{203.8} = 0.43'$ negligible

Soil bearing $= \frac{203.8}{20 \times 12'} = 0.85$ ksf



Conclusion:

If provide cold joint lighty heavy loaded zones can have separate foundation which not considered.

Reinforcing

For 12" Screenwall use ACI Diagram min flexural reinf

$d = 12 - 1\frac{1}{2} = 10\frac{1}{2}"$ #5@12 EF/EW

For 18" Mat use ACI Diagram min flexural reinf,

$d = 18" - 3" = 15"$ #6@12 T/B & EW

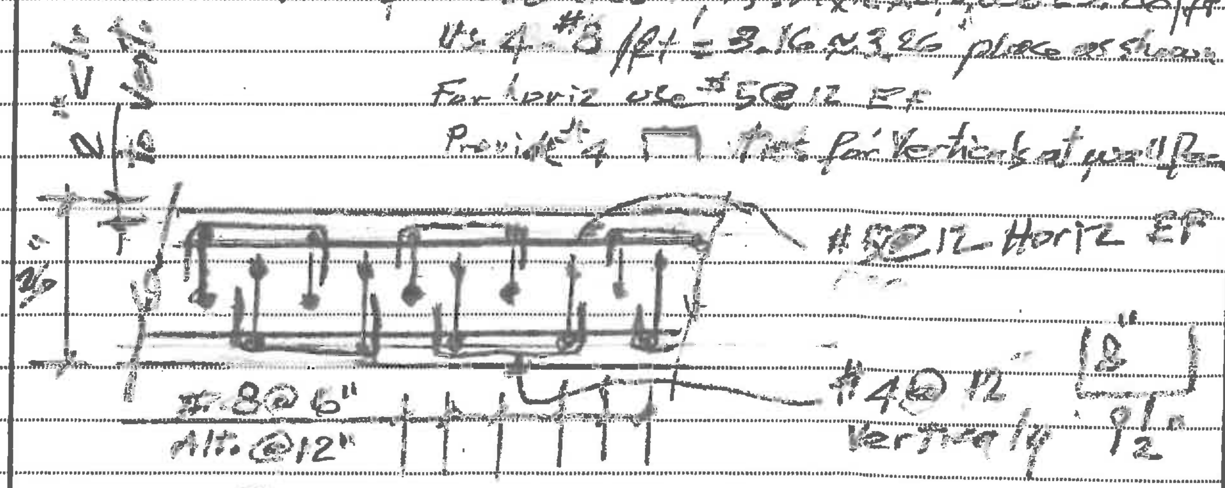
For 36" Wall use ACI min comp reinf 0.008 □"

Mass conc reinf. $d = 36 - 2 = 34"$ $A_s = 34 \times 12 \times 0.008 = 3.26$ □"/ft

Use 4-#8 /ft = 3.16 ≈ 3.26 □" place as shown

For horiz use #5@12 EF

Provide #4 ⊓ ties for verticals at wall face



⊓ 12" = 4-#8/ft as required

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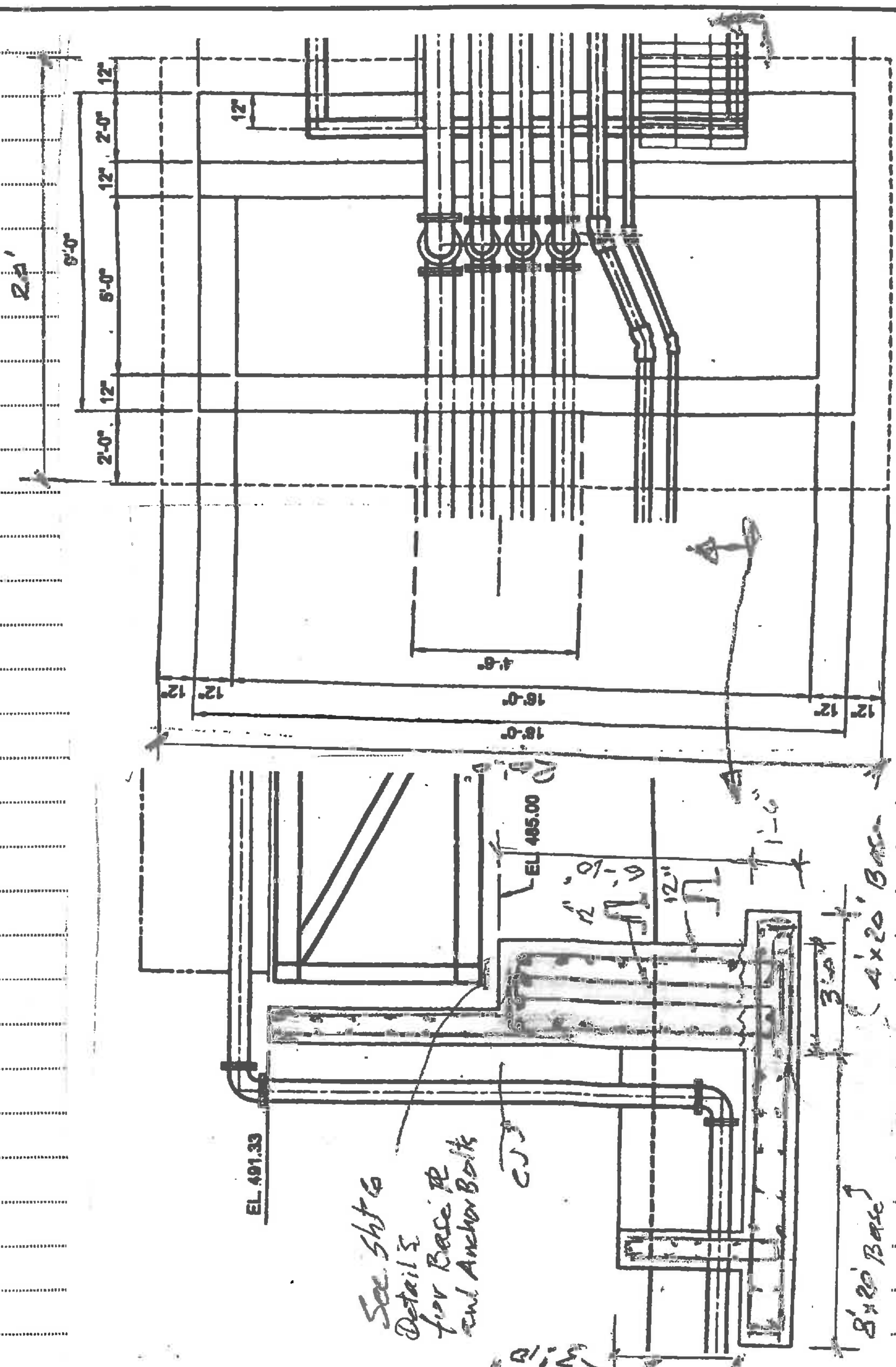
Project Description:			

Reference:



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Project No.			Sheet No. 6 of 7
Project Description:			

Reference:

Fixed End Bearing (Type 1)

Bearing PL Thickness

AISC guide lines

$$t = \sqrt{\frac{3 f_p n^2}{F_b}}$$

$$f_p = \frac{24.6}{144} = 0.17^{ksi} < 0.78 \text{ Allow}$$

$F_b = 27^{ksi}$

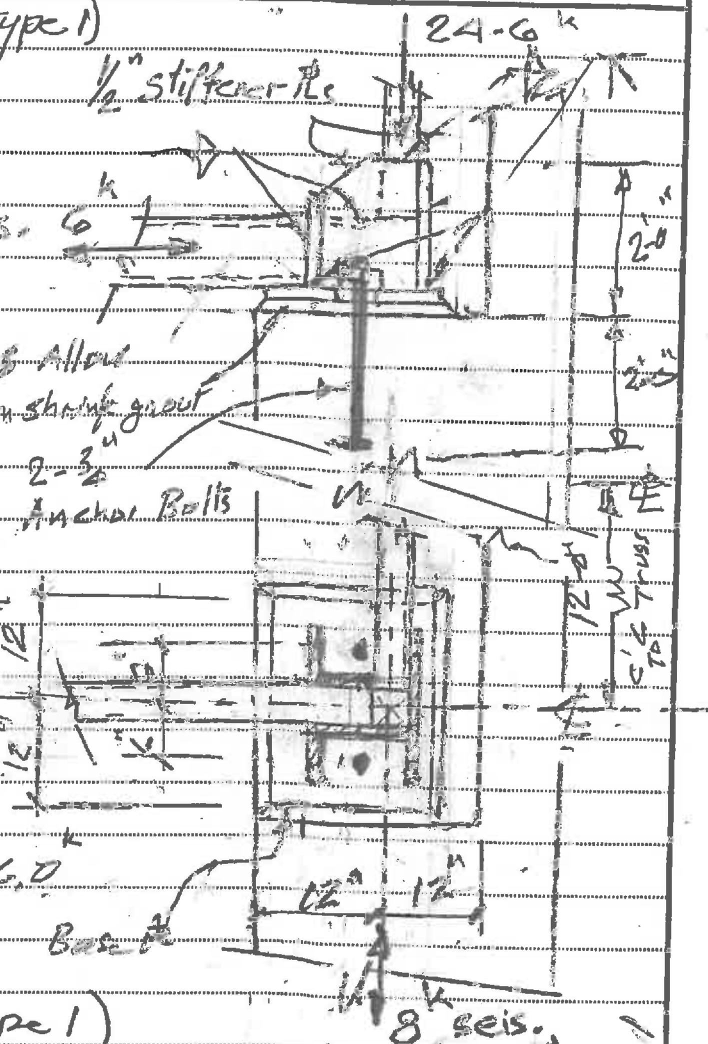
$n = 12'' - 8'' = 4''$

$$t = \sqrt{\frac{3 \times 0.17 \times 4^2}{27}} = 0.55''$$

Use $\frac{3}{4}$" Base PL

& 2-$\frac{3}{4}$"φ AB

AB shear = $2 \times 3.1 \times 1.33^k > 6.0^k$



Sliding End Bearing (Type 1)

Vert. Load = $21.61^k < 24.6^k$

Shear negligible Longitudinally

2 Flurgold plate provided 20"x16"x½"

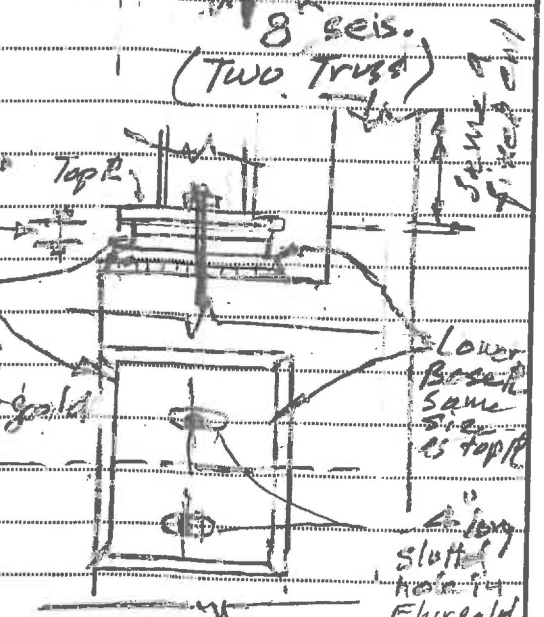
1-¾" lower Base PL

same size as upper PL

2-¾"φ AB with finger tight nuts

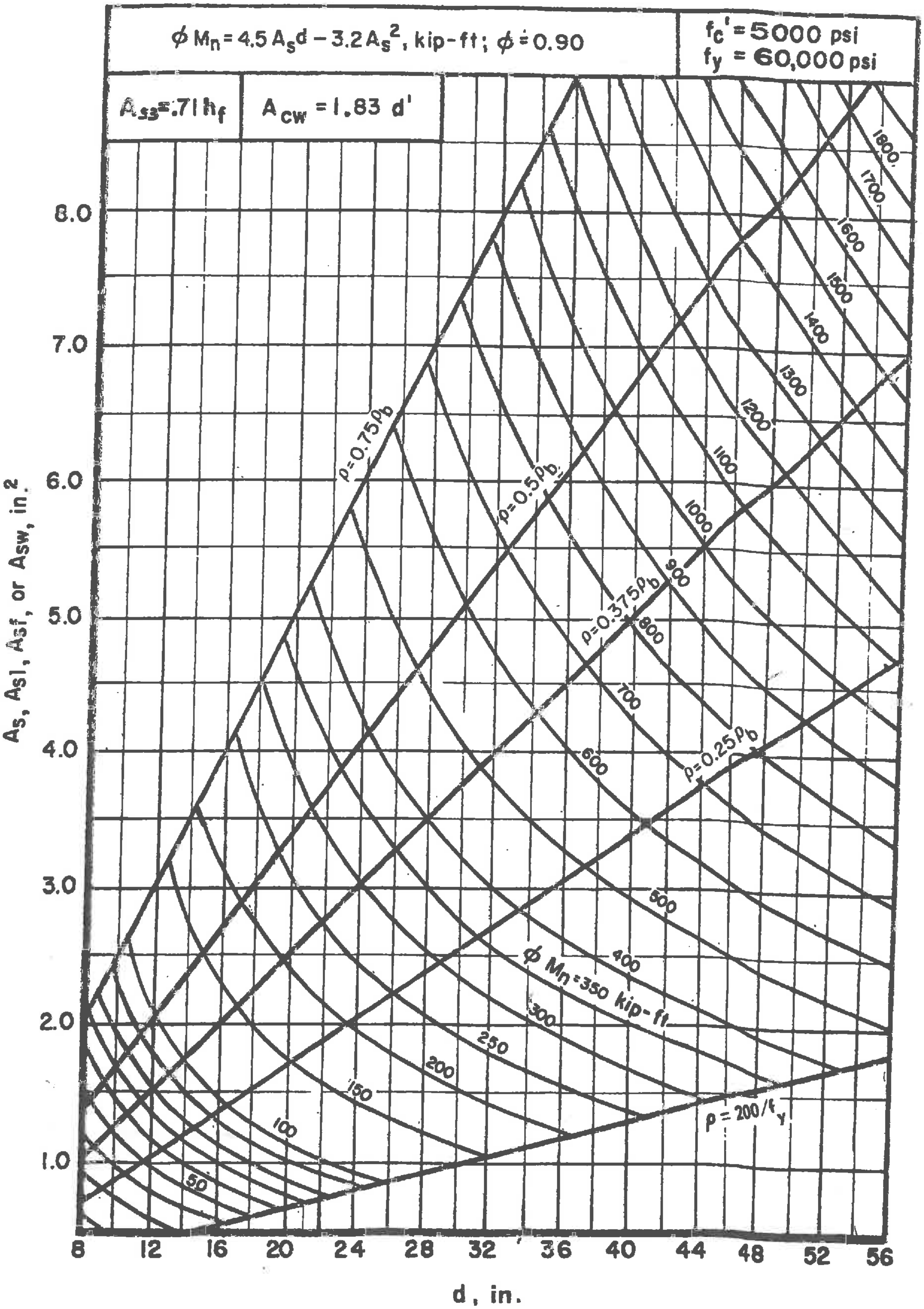
and 4" long slotted hole in Flurgold

Weld upper Flurgold to upper Base PL and lower Flurgold to lower Base PL



FLEXURE 8.8.2–Design moment strength ϕM_n for beam sections 10 in. wide

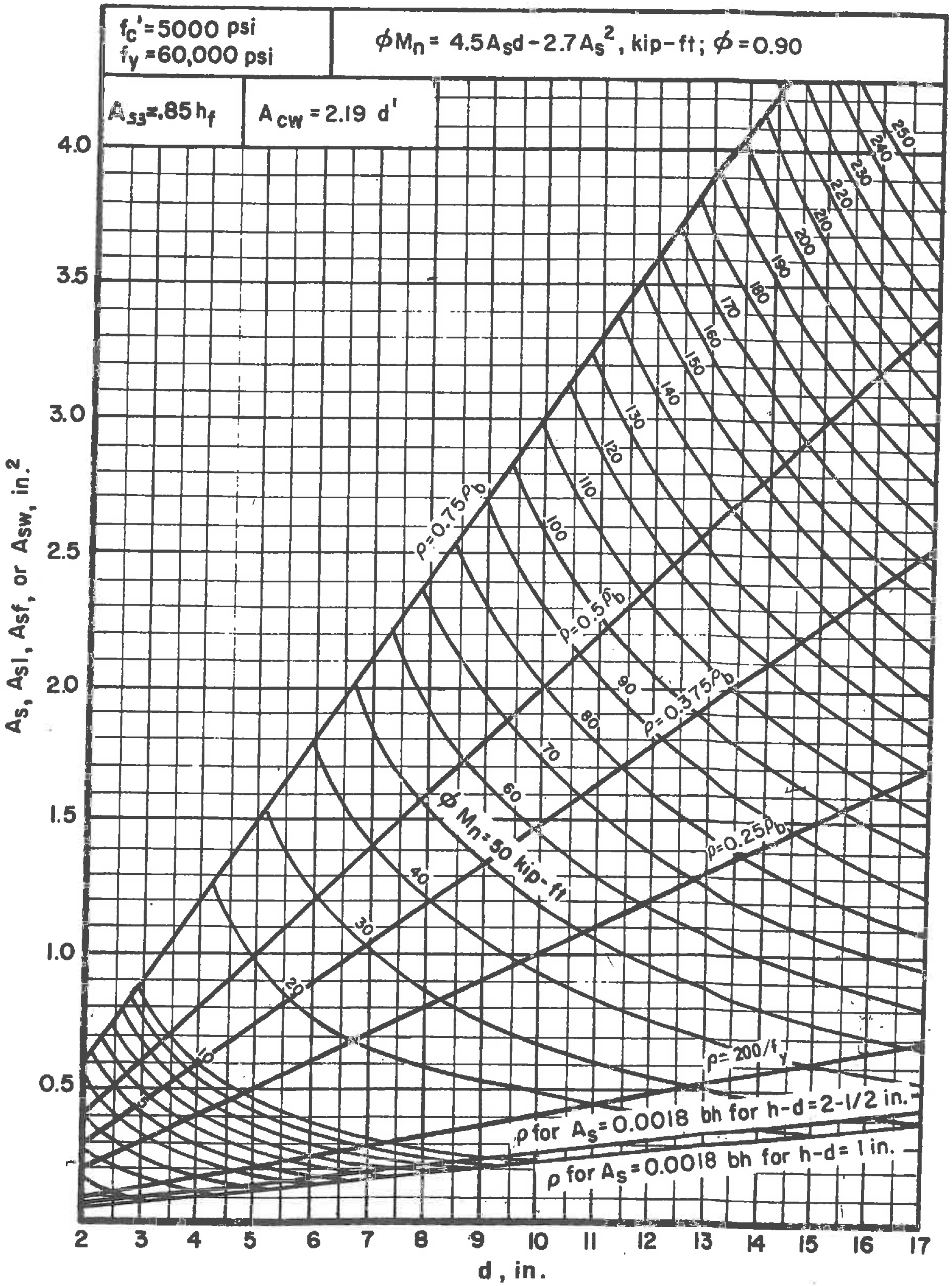
Reference: ACI 318-89 Sections 7.12, 8.4.1, 8.4.3, 9.3.2, 10.2, 10.3.1–10.3.3, 10.5.1, and 10.5.3 and ACI 318R-89 Sections 10.3.1 and 10.3.2



For use of this Design Aid, see Flexure Examples 1, 2, 7, 10, and 14.

FLEXURE 8.8.1–Design moment strength ϕM_n for slab sections 12 in. wide

Reference: ACI 318-89 Sections 7.12, 8.4.1, 8.4.3, 9.3.2, 10.2, 10.3.1–10.3.3, 10.5.1, and 10.5.3 and ACI 318R-89 Sections 10.3.1 and 10.3.2



For use of this Design Aid, see Flexure Examples 4-6 and 15.

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Project No.		**Sheet No.**	7 of 7
Project Description:			

Reference:

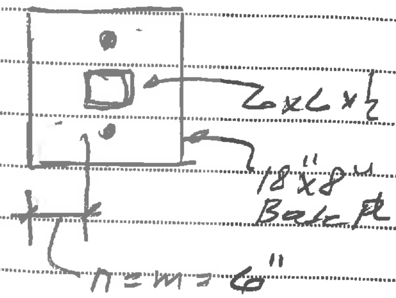
Fixed End or Sliding End (Type II)

DL+LL max = 29.5^k

$f_p = \frac{29.5}{18^2} = 0.09$

$t = \sqrt{\frac{3 \times .09 \times 6^2}{27}} = 0.6"$

Use $\frac{3}{4}$" thick Base PL



Sliding End plate arrangement same as (Type I). Use same Anchor bolts as Type I

Pipe Line I Aerial Crossing Bridge

All design application for Abutment for 180' long pipe line A also applicable for 160' long pipe line I Bridge on conservative side

DRESSER®

Style 63 Expansion Joints

Dresser offers the broadest line of Style 63 Expansion Joints including single-end (Type 1 and Type 3 shown below), and double-end (Type 2 & 4), limited-movement types, flanged, lock coupled, or weld ends. Aggressive wear and pipe wall failure caused by fatigue of the convoluted surfaces present in rubber accordion or metal bellows types is eliminated with Dresser expansion joints. There is no need for expensive pipe loop systems.

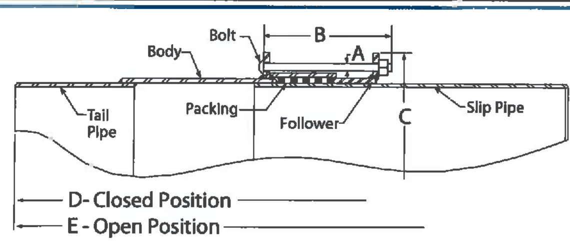
Dresser expansion joints are built to order and are available up to 120" in diameter. Provided with rugged welded steel construction, Dresser expansion joints are also available in stainless or carbon steel, monel or other alloys for special applications. Single-end expansion joints permit up to 10" of concentrated pipe movement. Larger amounts of movement are available per application.

Special packing and lubrication requirements are custom-matched to specific fluid processes or application requirements. Temperature ratings to 800 F and pressure ratings to 1200 psi.

Available with Dresser AL-CLAD™ coating for optimum protection against aggressive water conditions and for handling brine, brackish water, coke oven gas, petroleum and other line content.

Style 63 Type 1 Sizes and Specifications

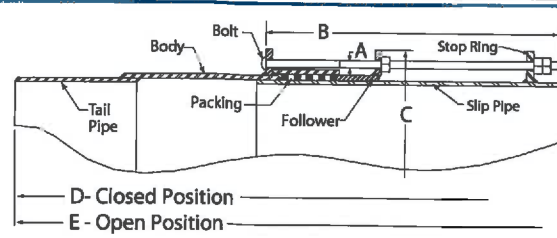
Pipe Nominal Size (In)	Outside Diameter (OD)	Bolts No./Diam. x Length (A&B)	Overall Dimensions Diam. (C)	Overall Dimensions Length (D) (E)	Weight Per Joint (Lbs)
3	3.500	4–5/8 x 11	8-1/2	36 46	65
4	4.500	4–5/8 x 11	9-1/2	36 46	75
5	5.563	4–5/8 x 11	10-5/8	36 46	110
6	6.625	6–5/8 x 11	11-3/4	36 46	130
8	8.625	6–5/8 x 11	13-3/4	36 46	180
10	10.750	8–5/8 x 11	15-7/8	36 46	250
12	12.750	8–5/8 x 11	17-7/8	36 46	315
	14.000	8–5/8 x 11	19-1/2	36 46	340
	16.000	10–5/8 x 11	21-1/2	36 46	380
	18.000	10–5/8 x 11	23-1/2	36 46	415
	20.000	12–5/8 x 11	25-1/2	36 46	470
	22.000	14–5/8 x 11	27-1/2	36 46	525
	24.000	14–5/8 x 11	29-1/2	36 46	565



Type 1 is a single-end expansion joint permitting up to 10" of concentrated pipe movement. Standard packing consists of alternate layers of split resilient sealing rings and jute lubricating rings. Other packing for special conditions can be supplied.

Style 63 Type 3 Sizes and Specifications

Pipe Nominal Size (In)	Outside Diameter (OD)	Bolts No./Diam. x Length (A&B)	Overall Dimensions Diam. (C)	Overall Dimensions Length (D) (E)	Weight Per Joint (Lbs)
3	3.500	4–5/8 x 24	8-1/2	36 46	80
4	4.500	4–5/8 x 24	9-1/2	36 46	95
5	5.563	4–5/8 x 24	10-5/8	36 46	125
6	6.625	6–5/8 x 24	11-3/4	36 46	155
8	8.625	6–5/8 x 24	13-3/4	36 46	205
10	10.750	8–5/8 x 24	15-7/8	36 46	285
12	12.750	8–5/8 x 24	17-7/8	36 46	350
	14.000	8–5/8 x 24	19-1/2	36 46	385
	16.000	10–5/8 x 24	21-1/2	36 46	430
	18.000	10–5/8 x 24	23-1/2	36 46	470
	20.000	12–5/8 x 24	25-1/2	36 46	530
	22.000	14–5/8 x 24	27-1/2	36 46	590
	24.000	14–5/8 x 24	29-1/2	36 46	635



Type 3 is a single-end expansion joint equipped with a limited movement feature to limit the maximum amount of pipe withdrawal. Slip pipes are regularly furnished for Type 3 expansion joints.

Distributed in Australia, New Zealand and South East Asia by Anode Engineering:

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Loganholme 4129 QLD
Australia

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sales@anodeengineeering.com

ANODE ENGINEERING
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FLUOROGOLD® Slide Bearings

WHY FLUOROGOLD® SLIDE BEARINGS?

Function

1. To accommodate movement under load with minimal friction.
2. To provide release or sliding surfaces at bearing ends of structural members, thereby accommodating shrinkage or thermal motion of members.
3. To isolate components or parts of a structure or assembly of parts when their relative movements must be independent of each other.
4. To provide a release bearing system in order to prevent stresses from entering certain parts of a structure.
5. To provide positive seismic separations.

Composition

FLUOROGOLD® is a special formulation of PTFE, reinforced with a strong glass aggregate and other reinforcing agents to provide a structural material that offers significant compressive strength without cold creep, yet retains the low friction and chemical inertness of virgin PTFE.

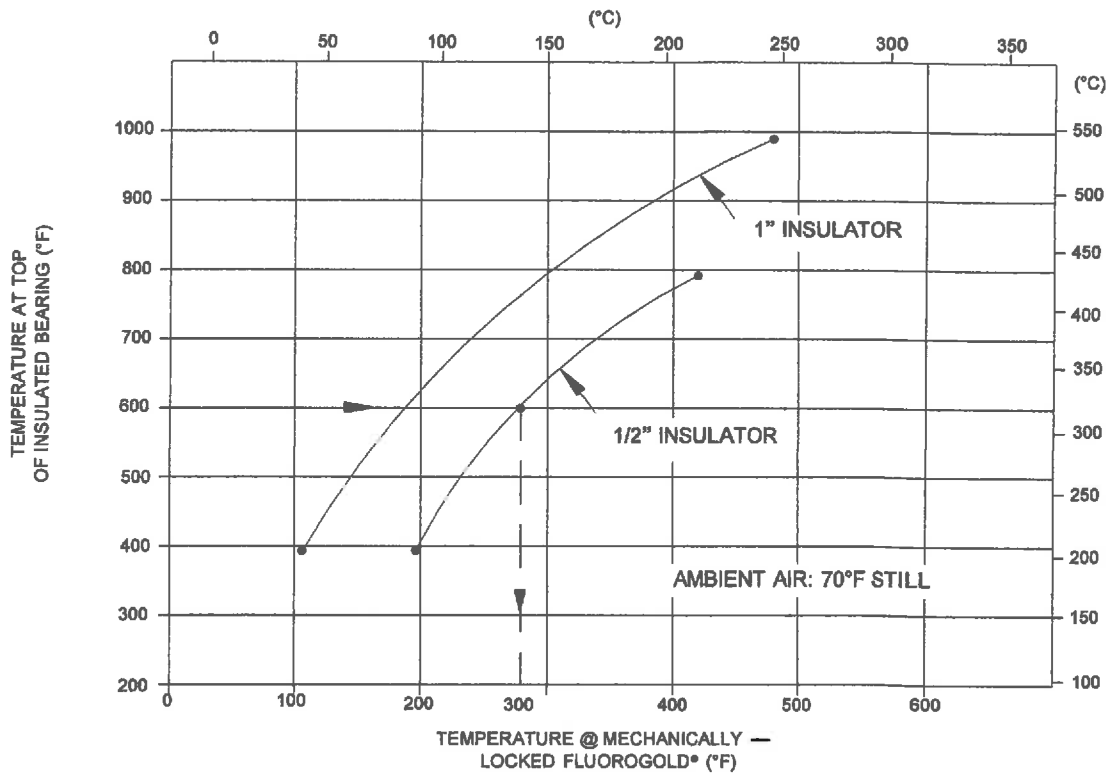
The FLUOROGOLD® composition, molded, sintered, and skived to the required thicknesses, is factory bonded to specially prepared backing plates, such as carbon steel, stainless steel or elastomeric-backed plates.

FLUOROGOLD® bearing composition is identified by its own characteristic gold color. Pure unfilled PTFE is a cloudy white color and may be processed into nearly any color by use of coloring agents. By always looking for exclusive golden color, you are assured that only the properly engineered structural PTFE composition known as FLUOROGOLD® is being utilized.

Advantages

- ☒ FLUOROGOLD® is structural PTFE.
- ☒ Lowest friction factor of any solid material.
- ☒ Chemically inert.
- ☒ Able to absorb dirt and grit without increasing the coefficient of friction.
- ☒ Weatherproof – less than 0.01% moisture absorption.
- ☒ Able to allow for misalignment.
- ☒ Provides electrical insulation – no galvanic corrosion.

TEMPERATURE DROP ACROSS FLUOROTEMP® BEARING



FLUOROTEMP® BEARING SPECIFICATION

A. GENERAL

Furnish and install FLUOROTEMP® bearings as complete factory produced assemblies manufactured by Slide Bearings, LP, 11133 I-45 S. #P, Conroe, TX 77302. Phone (936) 441-5910. These bearing assemblies shall be Type FT-A-1. Upper element: 4" x 4", lower element: 6" x 6", Max. reaction 40 kips. Operating temperature:800°F. Coefficient of friction to be 0.02 at maximum load.

B. INSTALLATION

Fluorotemp® bearings shall be placed in accordance with the recommendations of the manufacturer, contract drawings, or as directed by the engineer. Contact surfaces shall be parallel to within $^1/_{32}$" / 12" (2.6mm/m). Load must be distributed over full surface of upper element, not concentrated on a small section. Concentrated loads may require the addition of a heavy steel plate over the bearings to effectively distribute the load.

C. SHOP DRAWINGS

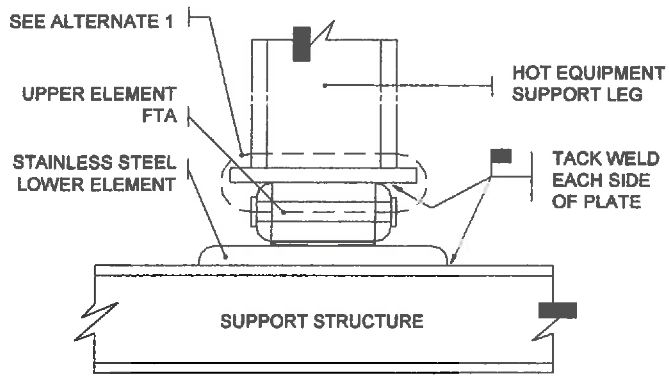
The contractor shall furnish shop drawings detailing the structural features of each bearing to be approved by the engineer prior to fabrication.

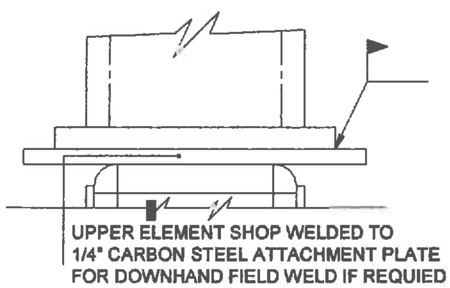
Our experienced staff of technical representatives is available to offer prompt assistance at any location in the continental United States.

TYPICAL INSTALLATION DETAILS

HIGH LOAD TYPE

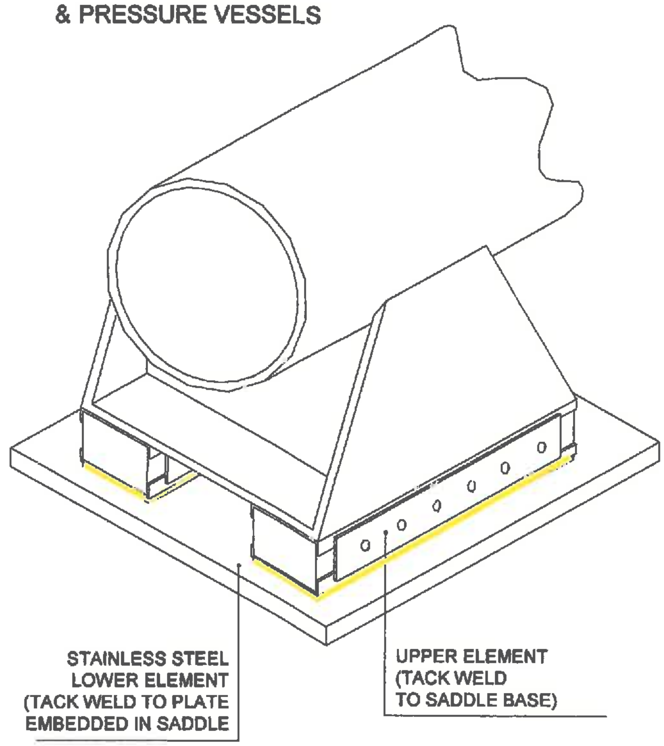
PRECIPITATORS



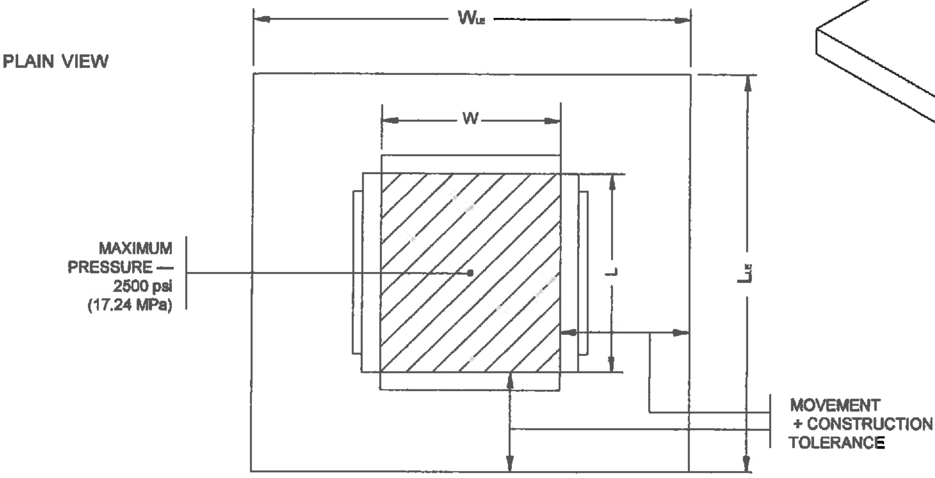


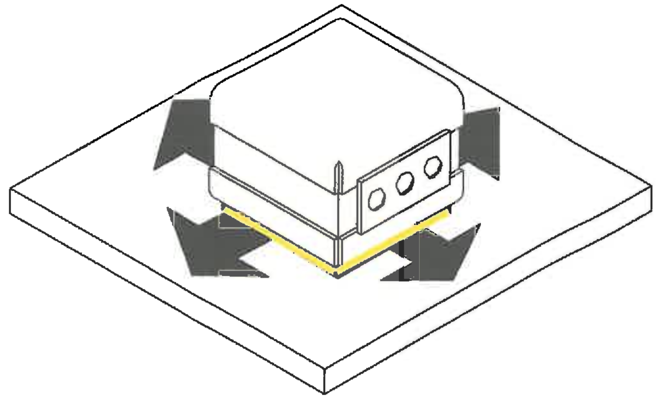
ALTERNATE 1

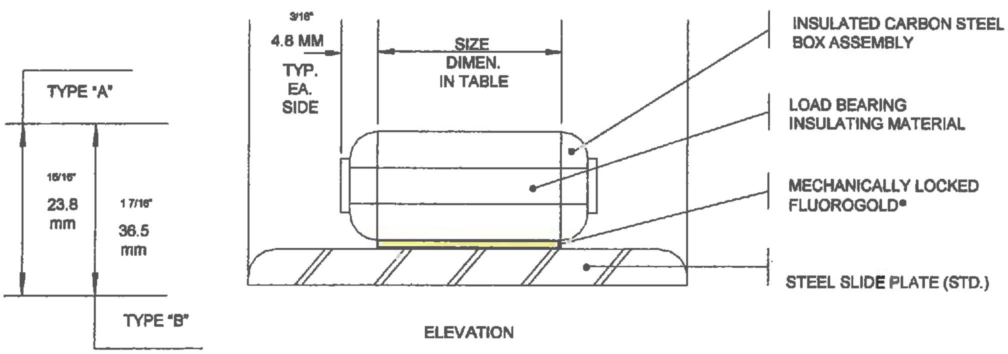
HEAT EXCHANGERS & PRESSURE VESSELS



HIGH LOAD BEARINGS







ELEVATION

W_{LE} = W + total movement + construction tolerance

L_{LE} = L + total movement + construction tolerance

TYPE "A"

For Use to 800°F (427°C)
1/2" (12.7 mm) Insulator

Part No.	Size W X L	Max. Load
FT-A-1	4" X 4" 101.6mm X 101.6mm	40,000 lbs. 178 kN
FT-A-2	4" X 6" 101.6 mm X 152.4 mm	60,000 lbs. 267 kN
FT-A-3	4" X 8" 101.6 mm X 203.2 mm	80,000 lbs. 356 kN
FT-A-4	6" X 6" 152.4 mm X 152.4 mm	90,000 lbs. 400 kN
FT-A-5	6" X 8" 152.4 mm X 203.2 mm	120,000 lbs. 534 kN
FT-A-6	8" X 8" 203.2 mm X 203.2 mm	160,000 lbs. 712 kN
FT-A-7	8" X 10" 203.2 mm X 254 mm	200,000 lbs. 890 kN

TYPE "B"

For Use to 1000°F (538°C)
1" (25.4 mm) Insulator

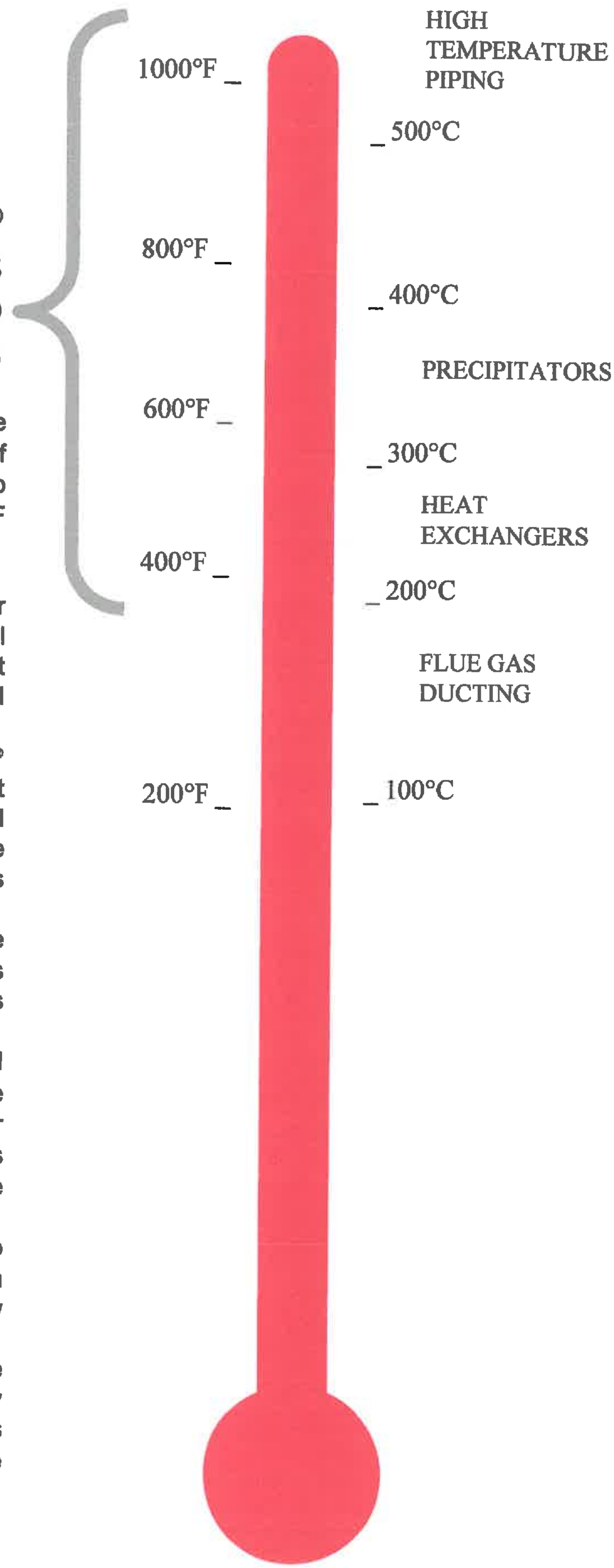
Part No.	Size W X L	Max. Load
FT-B-1	4" X 4" 101.6mm X 101.6mm	40,000 lbs. 178 kN
FT-B-2	4" X 6" 101.6 mm X 152.4 mm	60,000 lbs. 267 kN
FT-B-3	4" X 8" 101.6 mm X 203.2 mm	80,000 lbs. 356 kN
FT-B-4	6" X 6" 152.4 mm X 152.4 mm	90,000 lbs. 400 kN
FT-B-5	6" X 8" 152.4 mm X 203.2 mm	120,000 lbs. 534 kN
FT-B-6	8" X 8" 203.2 mm X 203.2 mm	160,000 lbs. 712 kN
FT-B-7	8" X 10" 203.2 mm X 254 mm	200,000 lbs. 890 kN

The lower stainless element shall be sized by the engineer for the movement as shown in the plan view plus a construction tolerance of 1" total (±1/2")

Typical call-out:
FLUOROTEMP® Bearing System consisting of:
FT-A-1 Upper Element: 4" X 4" (101.6 mm X 101.6 mm)
FC0010SS Lower Element: 6" X 6" (152.4 mm X 152.4 mm)

Bearings listed are standard items. Custom bearings can be designed to meet your special requirements by our capable staff.

FLUOROTEMP® SLIDE BEARINGS FOR ELEVATED TEMPERATURES



FLUOROTEMP® slide bearings incorporate the proven performance characteristics of FLUOROGOLD® bearings with the ability to operate satisfactorily at temperatures up to 1000°F (538°C).

FLUOROGOLD® is a special formulation of PTFE reinforced with a strong glass aggregate and other reinforcing agents. This provides a structural material that offers significant compressive strength without cold creep, yet retains the low friction properties and chemical inertness of virgin PTFE.

For more than forty years FLUOROGOLD® bearings have been used in bridges, buildings, transit systems and pipe lines. Their economy and maintenance-free dependability continue to please architects and engineers. They are as permanent as the structures they support.

FLUOROTEMP® bearings offer these same benefits for high temperature service in applications such as precipitators, heat exchangers, flue-gas ducts and high temperature piping.

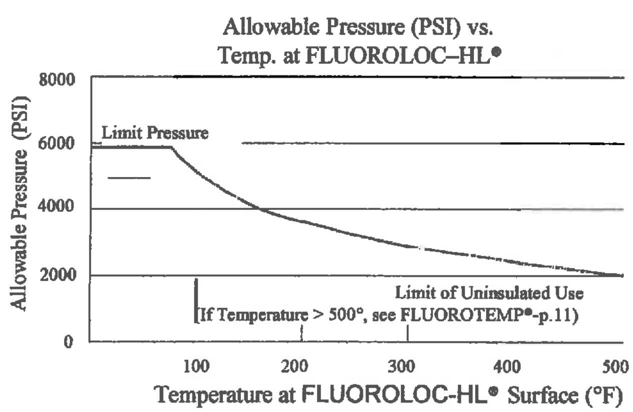
FLUOROTEMP® bearings consist of an insulated upper element with a FLUOROGOLD® slide surface which rides on a 2B finish, stainless steel lower element. The FLUOROGOLD® material is mechanically locked to the upper element without the use of adhesives.

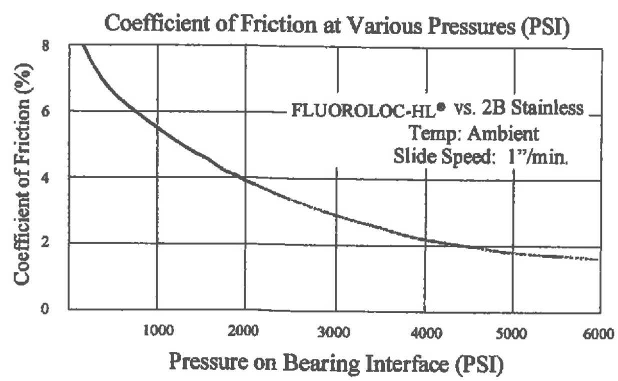
FLUOROTEMP® bearings are supplied in two styles. The High Load type is for use with precipitators and heat exchangers, and the Low Load type is for use with ducts and piping.

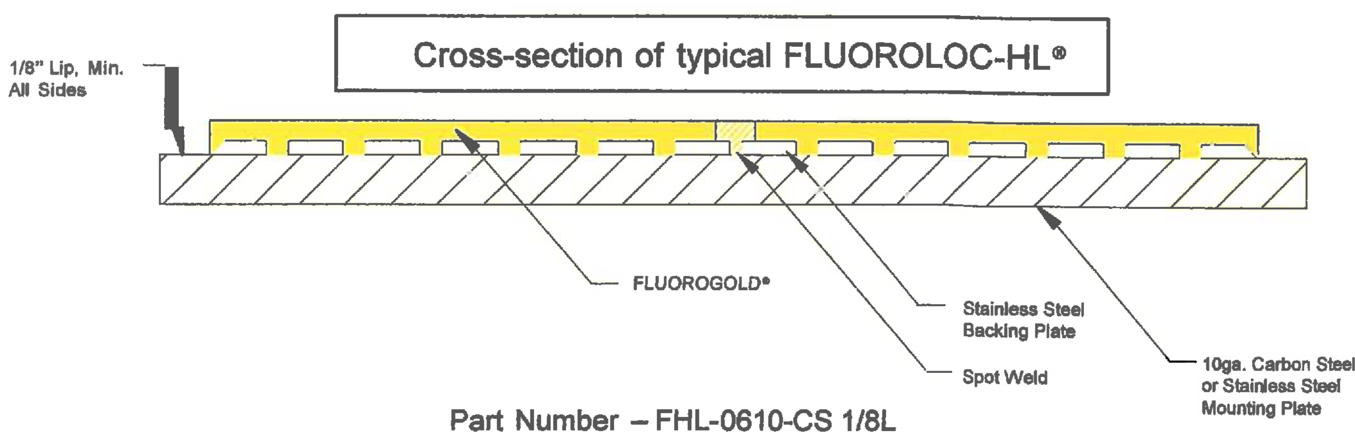
Whenever you need reliable, maintenance-free performance year after year, consider bearings by Slide Bearings, LP. FLUOROGOLD® slide bearings for applications up to 400°F (204°C), Fluorotemp slide bearings up to 1000°F (538°C).

Slide Bearings, LP Tames Movement Problems with FLUOROLOC-HL®

Structures and pipes are subjected to movement from thermal, seismic, and mechanical expansion and contraction. The important factor is not to stop the movement, but to accommodate it and, thereby, prevent any structural damage or poor operation. The answer is supplied with Slide Bearings, LP's FLUOROLOC-HL®, a mechanically locked FLUOROGOLD® slide bearing. Designed to withstand 6000psi, the FLUOROLOC-HL® is spot welded to a 10 gauge mounting plate as part of the standard system. The mounting plate can be welded to any thickness base plate to accommodate for elevation variations. The PTFE-based bearing system incorporates stainless steel backing which is perforated, locking the FLUOROGOLD® securely in place. The FLUOROGOLD® is chemically inert, absorbs dirt and grit without increasing friction, is weather proof, and possesses a high dielectric constant. These bearings are used in petrochemical plants, pipeline supports, power plants, freeway structures, bridges, buildings, offshore docking facilities and submerged piping. Contact us to see if we can accommodate your application.







Part Number – FHL-0610-CS 1/8L

FLUOROLOC-HL® bearing system interfaces with specially prepared stainless steel upper element. This bearing system eliminates high temperature epoxy bond failures and offers solutions for corrosive atmospheres.

For specifications about FLUOROLOC-HL® and specific job applications, contact your Slide Bearings, LP representative.

GUIDE SPECIFICATIONS

The following specification for FLUOROGOLD® slide bearings insures the designer that a proven, failure-free product will be installed.

"Self-lubricating bearing elements shall be FLUOROGOLD®(FC-1010-CS) as manufactured by Slide Bearings, LP in Conroe, Texas which is a composition of 100% virgin polytetrafluoroethylene polymer and reinforcing aggregates and prebonded to appropriate backing materials. The principal constituent of the aggregate shall be ground glass fibers. The coefficient of static friction of the material to itself shall be .06 from initial installation and shall not deform more than .002" (0.05mm) under allowable static load. The bond between the material and the steel shall be heat cured, high temperature epoxy capable of temperatures of -320°F to 400°F(-195° to 205°C)."

"FLUOROGOLD® slide bearing elements shall be suitable for the operating conditions as follows: (list or describe speed, load, temperature, deflection, atmosphere, mounting surface, attachment and any other factor which may govern the service involved)."

The FLUOROGOLD® material shall be 3/32" (2.4mm) thick, suitably bonded to appropriate substrate (insert bearing element number and size). Attachment in the field will be (state: bolting or tack welding).

APPLICABLE STANDARDS

Please see the ASTM Test Properties on the previous page.

COST

Because of custom requirements necessitating a need for custom fabrications, contact the Slide Bearings, LP estimating department, for budget figures applicable to specific projects, or submit drawings of bearing details.

ASSEMBLY, INSTALLATION

No special knowledge, technique or equipment is required to install most FLUOROGOLD® bearing applications. The plates are fabricated and installed in a manner similar to conventional steel bearing plates, shims, washers or anchor assemblies.

Care should be taken to assure that the plates in the assembly are installed in their proper positions, with the larger plate usually being the upper half of the assembly. The FLUOROGOLD® surfaces should be protected from mechanical damage and contamination as well as from ultraviolet rays prior to installation.

FLUOROGOLD® plates may be drilled with slotted or oversized holes and installed with bolting through the entire assembly; they may be made with anchor bolts or bars attached for embedment into concrete members; they may be tack-welded to the steel assemblies to which they are to be connected. Heat from small tack welds will not harm the standard FLUOROGOLD® assembly. If full welding of bearings to supporting structure is required bearings are available with FLUOROGOLD® recessed from the edges of the backing plates (lipped). Bearing plates may be installed into framework to form low-friction bearing pockets for cast-in-place concrete members. Frequently, special anchorage or connections are not necessary at all because the friction between the bearings and their supporting materials is much greater than that at the FLUOROGOLD® interface.

FLUOROGOLD® bearing surfaces should operate against opposing FLUOROGOLD® surfaces wherever possible for best performance. Rough, corrodible, uneven or improperly mated surfaces should not operate against a FLUOROGOLD® bearing surface. Greater friction and excessive bearing wear are the results. Normally, the upper FLUOROGOLD® element should be larger than the lower one by the amount of the anticipated movement so that the unit load is constant and the lower surface is not exposed to accumulate dirt, grit and contaminants.

OPERATION, MAINTENANCE

FLUOROGOLD® requires no maintenance when utilized as recommended.

Backing plates and accessory hardware exposed to certain environments may require protection from corrosion. In this situation the assembly should be fabricated from corrosion resisting materials such as stainless steel, or protected by suitable coating systems. High performance prime coatings are provided by the manufacturer when specified or required. Under nominal protected conditions, carbon steel backing plates will require little or no maintenance.

AVAILABILITY

Slide Bearings, LP maintains a stock of pre-bonded 24" x 48" FLUOROGOLD® sheets with 10 gauge stainless, carbon or galvanized steel backing. 24" x 30" x ¼" carbon steel backing is also kept in stock and is available for immediate delivery. Size of stocked sheets does not limit fabrication ability. Contact us for price and delivery of custom manufactured bearing assemblies or custom sized applications.

GUARANTEE

FLUOROGOLD® bearing systems will, when properly designed and installed, perform according to the data furnished by Slide Bearings, LP. The bond of FLUOROGOLD® composition to the supporting materials is guaranteed only when bonding is done by Slide Bearings, LP. There are no guarantees or warranties which extend beyond the actual materials and assemblies furnished by Slide Bearings, LP, and no responsibility is assumed for installation or other operations beyond the control of Slide Bearings, LP.

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TECHNICAL SUPPORT

Slide Bearings, LP has an experienced staff of trained technical representatives available for assistance. To arrange a consultation, call us at (936) 441-5910 or contact us through our web site

www.slidebearings.net

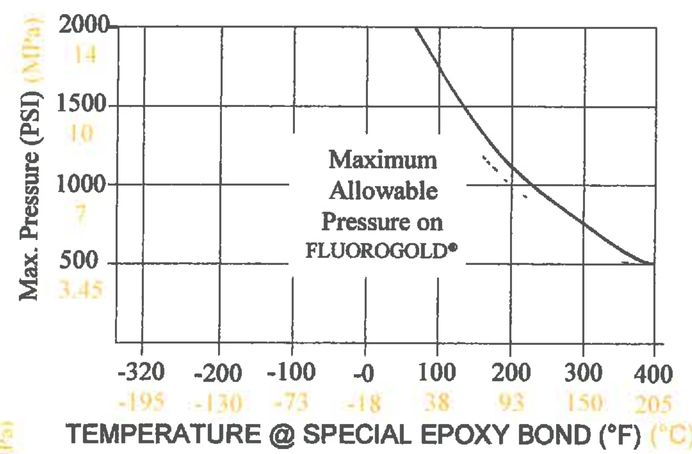
DESIGN CHARTS

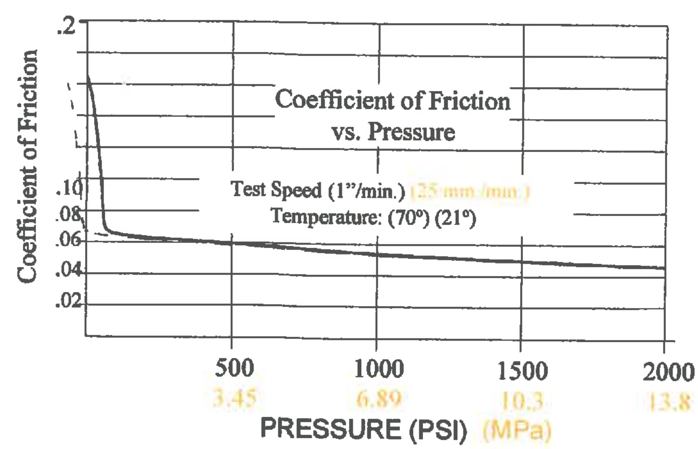
The following information applies to FLUOROGOLD® as an unbonded reinforced PTFE:

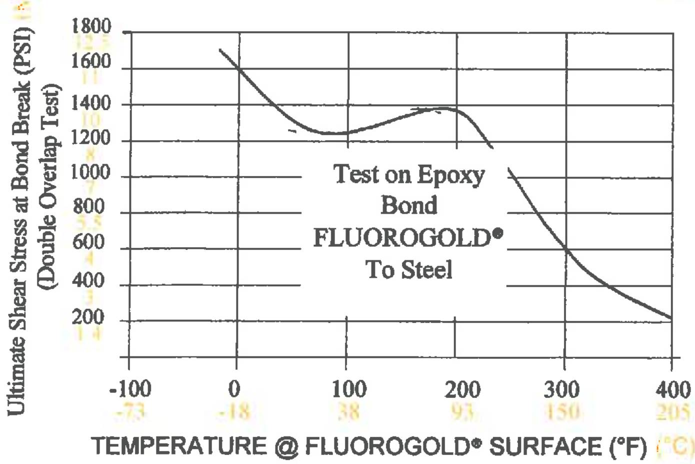
Properties of FLUOROGOLD®:

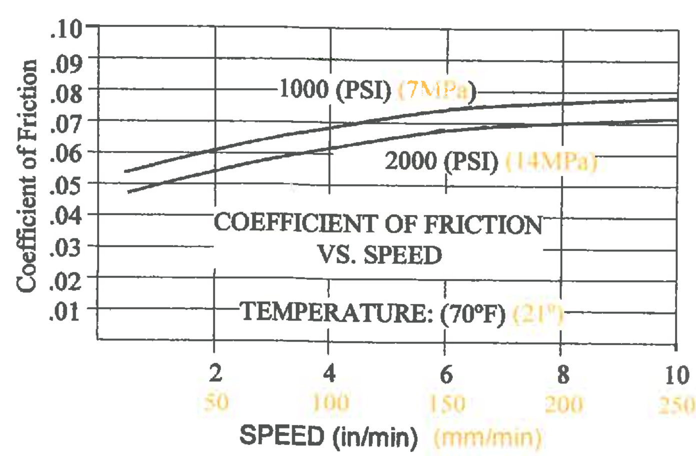
Property	ASTM Method	Result
MECHANICAL		
Tensile strength (min)	D-1457	2000psi (13.8MPa)
Tensile elongation (min)	D-1457	200%
Hardness, Durometer (Shore D)	D-2240	60 – 70
PHYSICAL		
Specific gravity	D-792	2.22
Melting point	D-1457	327°C ± 10 °

The following information applies to FLUOROGOLD® epoxy bonded to a metal back-up plate:

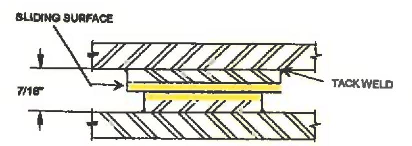
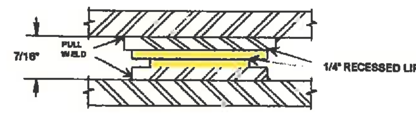
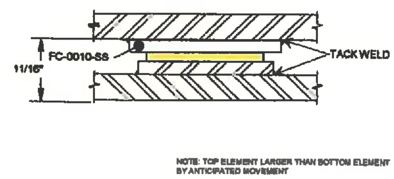
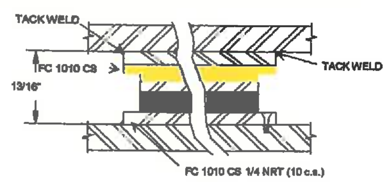
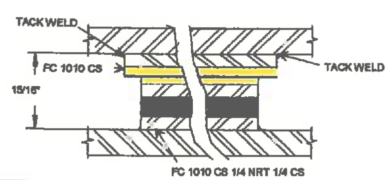
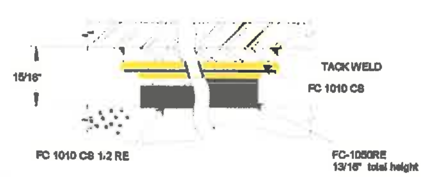
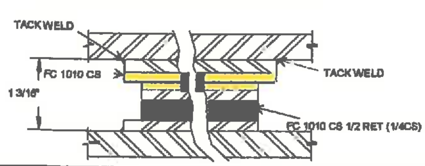
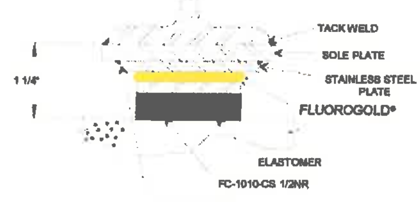








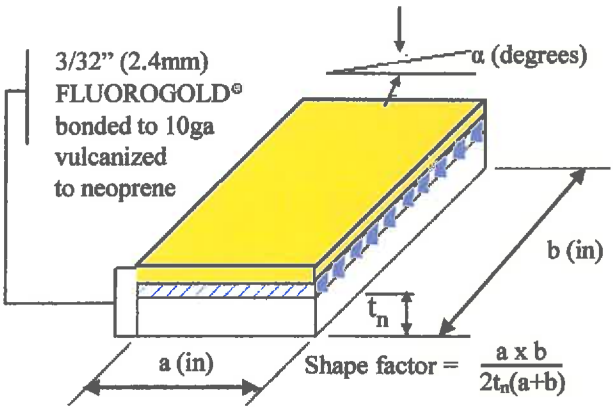
SELECTOR CHART FOR FLUOROGOLD® SLIDE BEARING ELEMENTS

STANDARD ELEMENTS	ALTERNATE ELEMENTS	DESCRIPTION	DETAILS
FC-1010-CS tack weld element	FC-1025-CS FC-1037-CS FC-1050-CS FC-1075-CS FC-10100-CS Note: 25-¼"PL 37-⅜"PL 50-½"PL 75-¾"PL 100-1"PL	3/32" FLUOROGOLD® bonded to 10 gauge carbon steel (CS) for tack welding. Loads: 75psi to 2000psi Temperature: -320°F to +400°F Note: Alternate backing materials SS – stainless steel CT – Corten Al – aluminum GL galvanized (hot dipped or electroplated)	
FC-1010-CS ¼ L full weld element LSO – recess short side only LLO – recess long side only	FC-1010-CS¼"L FC-1025-CS¼"L FC-1037-CS¼"L FC-1050-CS¼"L FC-1075-CS¼"L FC-10100-CS¼"L Note: ½ " lip also available	3/32" FLUOROGOLD® bonded to 10 gauge carbon steel (CS) with a ¼" lip of steel for full welding. Loads: 75psi to 2000psi Temperature: -320°F to +400°F Note: Alternate backing materials are available.	
FC-1010-CS ¼ L Full weld element Alternate application With SS upper element.	Note: Top element call out is FC-0010-SS (2B finish Type 304 SS is standard)	Upper Element: 10ga Type 304 SS-2b finish. Lower Element: 3/32" FLUOROGOLD® bonded to 10 gauge carbon steel (CS) with ¼" lip all around. Loads: 75psi to 3500psi Temperature: -320°F to +400°F Note: Alternate backer thicknesses and materials are available.	
FC-1010-CS ¼ NRT 10CS 1/4L tack weld element for rotation deflection expansion Note: ¼" Lip on tack plate (10ga)	Note: top element call out is FC-1010-CS (2B finish SS is available)	3/32" FLUOROGOLD® bonded to 10 gauge carbon steel (CS) then vulcanized to ¼" neoprene which is vulcanized to 10 gauge steel for tack weld Loads: 75psi to 800psi Temperature: -50°F to +200°F Note: Alternate neoprene thicknesses are available.	
FC-1010-CS ¼ NRT ¼CS tack weld element for rotation defelection expansion	Note: with flush design for tack plate use ¼" PL min. (2B finish SS is available)	3/32" FLUOROGOLD® bonded to 10 gauge carbon steel (CS) then vulcanized to ¼" neoprene which is vulcanized to ¼" carbon steel for tack weld Loads: 75psi to 800psi Temperature: -50°F to +200°F Note: Alternate neoprene thicknesses are available.	
FC-1010-CS ½ RE element for deflection expansion at higher loads	FC-1050-RE Note: top element call out is FC-1010-CS	3/32" FLUOROGOLD® bonded to 10 gauge carbon steel (CS) then vulcanized to ½" reinforced elastomer (AASHTO 18.4. 10.1) Loads: 75psi to 1500psi Temperature: -50°F to +200°F Note: Alternate neoprene thicknesses of reinforced elastomer available.	
FC-1010-CS ½ RET tack weld element	Note: with flush design for tack plate use ¼" PL min.	3/32" FLUOROGOLD® bonded to 10 gauge carbon steel (CS) then vulcanized to ½" reinforced elastomer (AASHTO 18.4. 10.1) Loads: 75 psi to 1500 psi Temperature: -50°F to +200°F Note: Alternate neoprene thicknesses of reinforced elastomer available.	
FC-0016-SST½CS ¼ L top element	Note: 25 – ¼"PL 50 – ½"PL etc.	16 gauge 304-SS with a 2b finish, fusion welded to ½" sole PL Note: Alternate thicknesses of stainless steel and sole PL available.	
FC-1010-CS ½ NR Bottom element for deflection expansion	VFC-1010-CS ½NR (Virgin, unfilled PTFE)	3/32" thick FLUOROGOLD® bonded to 10 gauge carbon steel (CS) then bonded to ½" reinforced elastomer. Loads: 75psi to 1500psi Temperature: -50°F to +200°F Note: Alternate thicknesses of reinforced elastomer available.	

ELASTOMERIC BACKED FLUOROGOLD® SLIDE BEARINGS
DESIGN RECOMMENDATIONS

(Maximum temperature at bearings = 200°F (93°C) for elastomeric backed slide bearings)

FOR NEOPRENE BACKED BEARINGS: (Preferably smaller lower element)



Shape factor = $\dfrac{a \times b}{2t_n(a+b)}$

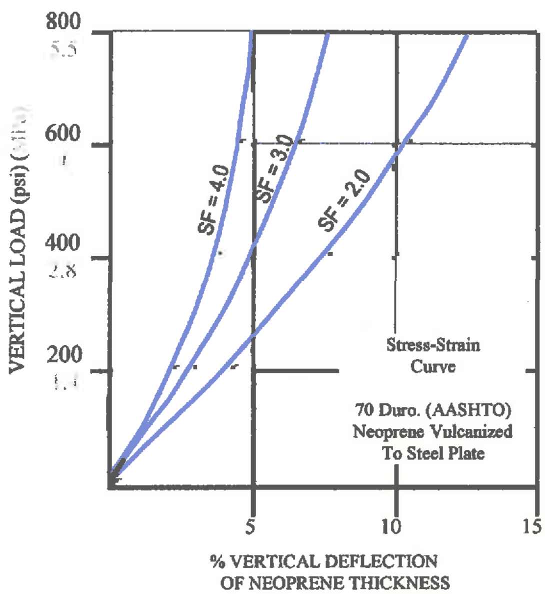
t_n = thickness of neoprene

DESIGN CRITERIA:

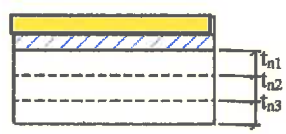
1. Maximum compressive load = 800 psi (5.5 Mpa)
2. Maximum dead load = 500 psi (3.5 Mpa)
3. Minimum Dimension (a) ≈ $5t_n$
4. Shape factor ≈ 3 but ≥ 2
5. Vertical compressive strain $\Delta c^* \geq$ rotation movement $\Delta R = a \tan \alpha$
6. $t_n \leq 1"$ (25.4 mm) (If greater use shims)

*Δc from chart below

Note: Rotation is enhanced by making the dimension "a" smaller



Use trial & error procedure to satisfy criteria 1 to 6 above.
If rotation capability cannot be satisfied in a plain pad, design a laminated pad using 12ga. steel shims.



$\Delta c = \Delta ct_{n1} + \Delta ct_{n2} \times \Delta ct_{n3}$
total

FOR REINFORCED ELASTOMER BACKED BEARING:
(Preferably smaller lower element)   (See pad layout above)

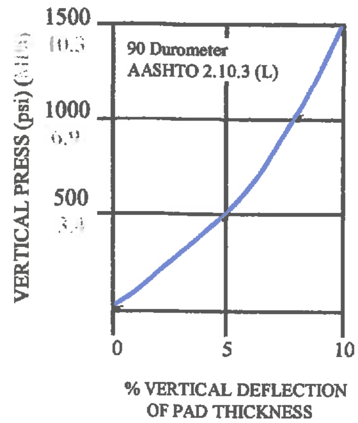
DESIGN CRITERIA:

1. Max. compressive load = 1500psi (10.3MPa) (unless concrete design limits to 1000psi) (6.9Mpa)
2. t_f = thickness of reinforced elastomer =

$$\frac{\tan \alpha \times (a)}{.10}$$

at 1500 psi (see chart)

a = pad rotation width (in.)
α = rotation required (degrees)



Shape factor is not a determinate in this type bearing.

SPECIFYING AND SELECTING FLUOROGOLD® SLIDE BEARINGS
(Elastomeric Backed Systems)

Elastomeric backed bearings are used as the lower element of the system only. The mating top element is the standard FC-1010-CS as shown in the Selector Chart on page 7.

In the case of neoprene backed bearings the elastomer is vulcanized to a carbon steel intermediate plate. If reinforced elastomer is specified, the intermediate plate is not required.

When specifying elastomer backed bearings, the appropriate symbols designating the elastomer and thickness desired are added to the standard callouts.

Examples: FLUOROGOLD® bearing with ½" (12.7mm) neoprene backing and 10 gauge carbon steel intermediate plate.

FC-1010-CS ½ NR 4" x 8"

- Indicates dimensions of system
- Indicates ½" (12.7mm) neoprene elastomer
- Indicates 10 gauge carbon steel intermediate plate
- Indicates 3/32" (2.38mm) FLUOROGOLD® (std. Thickness)

Example: FLUOROGOLD® bearing with ½" (12.7mm) reinforced elastomer

FC-1050-RE 4" x 8"

- Indicates dimensions of system
- Indicates ½" (12.7mm) reinforced elastomer
- Indicates 3/32" (2.38mm) FLUOROGOLD® (std. Thickness)

For elastomer backed bearings on concrete no tack plate is required. However, if the minimum pressure is less than 200 psi (1.38Mpa) it is recommended that the elastomer be epoxy bonded to the concrete.

For attachment to steel, a tack plate must be provided below the elastomer. This tack plate must be at least ¼" (6.35mm) thick to prevent damage to the elastomer or its bond.

The appropriate symbols for tack plate, material and thickness must be added to the callout as shown below.

Example: Neoprene backed bearing with ¼" carbon steel tack plate.

FC-1010-CS ½ NRT ¼ CS 4" x 8"

- Indicates dimensions of system
- Indicates tack plate, ¼" (6.35mm) carbon steel
- Indicates ½" (12.7mm) neoprene
- Indicates 10 gauge carbon steel intermediate plate
- Indicates 3/32" (2.38mm) FLUOROGOLD® (std. Thickness)

Example: Reinforced elastomer backed bearing with ¼" (6.35mm) carbon steel tack plate.

FC-1050-RET ¼ CS 4" x 8"

- Indicates dimensions of system
- Indicates tack plate, ¼" (6.35mm) carbon steel
- Indicates ½ " (12.7mm) neoprene elastomer
- Indicates 3/32" (2.38mm) FLUOROGOLD® (std. Thickness)

SPECIFYING AND SELECTING FLUOROGOLD® SLIDE BEARINGS
(Metal-Backed Systems Only)

FLUOROGOLD® slide bearings are available in a variety of constructions to meet your specific requirements. Varying elements are the back-up plate material and thickness, and the construction for installation.

Back-up Material

Thickness	Material Available	"H" Element Height Complete
10 = 10 Ga (3.4mm)	CS, SS, AL, CT, GL CS—Carbon Steel SS—Stainless Steel AL—Aluminum CT—Corten GL—Galvanized These materials available In thicknesses listed and others.	7/16" (11.1mm)
25 = ¼" (6.35mm)		11/16" (17.5mm)
37 = ⅜" (9.53mm)		15/16" (23.8mm)
50 = ½" (12.7mm)		1 3/16" (30.2mm)
75 = ¾" (19.1mm)		1 11/16" (42.9mm)
100 = 1" (25.4mm)		2 3/16" (55.6mm)

If the element is to be continuously welded, the FLUOROGOLD® must be recessed (or lipped) ¼" (6.35mm) minimum) on each of those sides. This recess is not necessary for stitch welds.

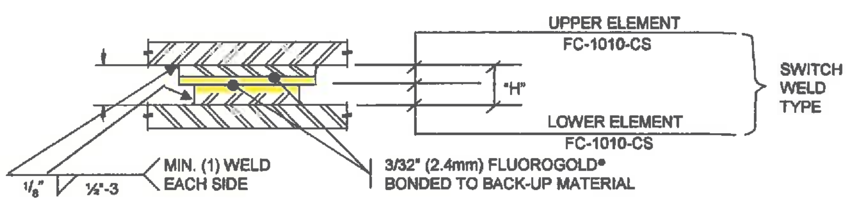
This recess is specified by a letter "L" in the callout and may be restricted to the short sides only or the long sides only by use of the appropriate letters (L-recess all sides, LSO-recess short side only, LLO-recess long side only).

These variable elements must be specified in the callout for each element.

Example: 10" x 10" (254mm x 254mm) FLUOROGOLD® bearing with 10 gauge carbon steel back-up plate for stitch weld installation.

FC-1010-CS 10" x 10"

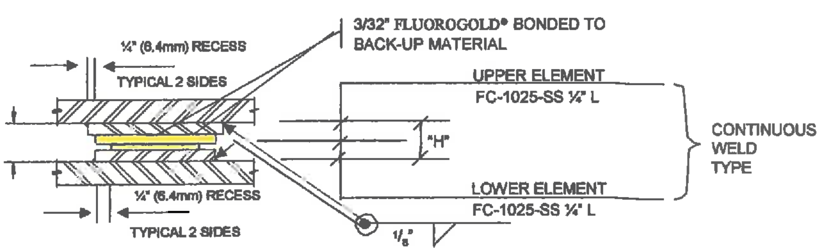
- 10" x 10" — Indicates width and length of bearing element
- 1010-CS — Indicates thickness and material for backer plate (10 gauge carbon steel)
- FC — Indicates Slide Bearings, LP's 3/32" (2.38mm) FLUOROGOLD® (std. Thickness)



Example: 5" x 10" (127mm X 254mm) FLUOROGOLD® bearing with ¼" (6.35mm) stainless steel back-up plate to be continuous welded on long sides.

FC - 1025-SS ¼ LLO 5" x 10"

- 5" x 10" — Indicates dimensions of backer material (not FLUOROGOLD®)
- ¼ LLO — Indicates ¼" (6.35mm) recess on the long sides only
- 1025-SS — Indicates ¼" (6.35mm) stainless steel back-up plate
- FC — Indicates Slide Bearings, LP's 3/32" (2.38mm) FLUOROGOLD®



GENERAL NOTES:

If the elements have slotted or round holes indicate as follows: Upper Element: FC-1010-CS W/(2) 13/16" X 1½" (21mm x 38mm) slots; 10" x 10" (254mm x 254mm) Lower Element: FC-1010-CS W/(2) 13/16" (21mm) holes; 9¼" x 9¼" (235mm x 235mm).

Alternate FLUOROGOLD® thickness available is 1/8". Unfilled PTFE is also available in 3/32" or 1/8" thickness.

- ☒ No stick – slip action.
- ☒ Easy to install – simply bolt or weld.
- ☒ Reduced support costs – the low friction factor remains constant.
- ☒ Only half as much bearing area is needed compared to virgin PTFE.
- ☒ Takes compressive loads of 75psi to 2000psi.
- ☒ Temperature range of – 320°F. to 400°F.
- ☒ Shear of the epoxy bond exceeds shear of the material.

Applications

Architectural

- Building separations
- Mutual bearing walls
- Seismic Separations
- Precast or post-tensioned structural
- Concrete – between beam and haunch
- Ramps
- Mullion facades
- Roof slabs
- Loading docks
- Beams and joists
- Airport hangar door
- Girder slip joints

Petrochemical

- Pipe Slides
- Heat exchangers
- Pressure vessels
- Cryogenic supports
- Air preheaters
- Boilers
- Distillation towers
- Pipe hangers
- Storage tanks
- Vacuum fractionating towers

Power Plants

- Under steam lines
- Condensers
- Towers

Industrial Equipment

- Conveyors
- Cranes
- Slides
- Material handling
- Dust collectors
- Heavy machinery
- Vibration pads
- Antenna towers

Bridges

- Post-tensioned, prestressed or box girder
- Highway and railway bridges
- Roadway expansion joints
- Pedestrian bridges
- Cast in place

Marine

- Wharfs
- Cargo slides
- Service gates
- Wedge blocks
- Trash racks
- Sonar bearings

FLUOROGOLD® SLIDE BEARINGS

FLUOROGOLD® slide bearings systems are engineered products of Slide Bearings, LP in Conroe, TX. They fill the need for simple and economical structural supports by allowing simultaneously for thermal, seismic and mechanical expansions and contractions. These systems operate with the lowest coefficient of friction over a broad range of temperatures.

FLUOROGOLD® is comprised of virgin PTFE and special reinforcing agents. This blend yields a structural material that offers significantly higher mechanical properties than PTFE itself. Compressive creep is virtually eliminated, wear is substantially reduced and initial deformation is decreased. However, the low friction and chemical inertness of PTFE are retained.

This structural bearing surface is bonded to a back-up steel plate with a high temperature homogenous epoxy system that is cured under precise heat and pressure in hydraulic presses. All FLUOROGOLD® bearings are factory bonded using strictly controlled, semi-automated procedures, developed to eliminate poor quality field-made bonds. FLUOROGOLD® bearings can be obtained with elastomeric back-up which will enable the system to accept live-load rotations.

In all cases, a slide bearing system is composed of two elements. The upper element, with its FLUOROGOLD® face down, mates with the lower element with its FLUOROGOLD® face up. The system is normally designed so that the upper element is larger than the lower element by the dimension of the anticipated motion so that the lower element is under uniform load throughout movement and so that foreign matter will not collect on the lower element.

The maximum design pressure of FLUOROGOLD® Slide Bearings, without elastomeric backing is 2000psi (see pressure vs. temperature chart for specific design criteria). For neoprene backed bearings the maximum recommended pressure is 800psi (5.5MPa) and for the cotton duck reinforced elastomer it is 1500 psi (10.3MPa).

PuSheng
PuSheng Steel Fencing Industrial Co.

E-mail
sales@steelfencing.org

Steel Picket Fencing

Steel picket fencing is constructed of steel for maximum longevity and strength, and crafted to look like traditional wrought iron fence. While aluminum fence has become popular for property enclosures due to its corrosion resistance and weight, steel fencing is a stronger alternative. With a chemically bonded powder coated finish and zinc phosphate undercoat, a steel fence panel can outlast an aluminum panel even in harsh conditions. Steel construction allows for longer panels without sag under weight or stress, which also allows for fewer post holes and less labor!

Post enlarged by 25% from 2 to 2-1/2 square
Post reinforced by internal rib to resist bending
Rail enlarged by 25% from 1 to 1-1/4 high
Rail reinforced internally to resist side impact
Picket enlarged by 25% from 5/8 to 3/4 square
Holes to mount rail eliminated from post design
Replaced by stronger exterior bracket

Standard color is black. Other powder coat colors are available as special order.

Technical Info:
PICKET:
5/8" x 5/8" x. 050" wall thickness
1" x 5/8" x. 050" wall thickness
1" x 1" x. 065" wall thickness

RAIL:
1" x 1" x. 055" top wall, 080" side wall

Products Catalog

FEEDBACK
ONLINE ORDER

1 1/2" x 1 1/8" x. 060" top wall, 070" side wall

1 5/8" x 1 5/8" x. 070" top wall, 100" side wall

POST:

2" x 2" x. 060" wall

2 1/2" x 2 1/2" x. 060" wall, 100" power corner

2 1/2" x 2 1/2" x. 075" wall

GATE POST:

2" x 2" x. 125" wall

2 1/2" x 2 1/2" x. 060" wall, 100" power corner

4" x 4" x. 125" wall

6" x 6" x. 188" wall

SPACING:

3 13/16" between pickets

1 39/64" (styles Higaleah and Innsbruck)

3 31/32" between pickets

3 31/32" between pickets

INSTALLED CENTERS:

72 3/4" on center 2" posts

100 13/16" on center 2 1/2" posts (2 rail Elba 71" on center 2 1/2" posts)

71" on center 2 1/2" posts

HEIGHTS:

36", 42", 48", 54", 60", 72"

48", 54", 60", 72"

48", 60", 72", 84", 96"

COLORS:

Black, White, Bronze, Hunter Green

HORIZONTAL RAILS:

3 on 36", 42", 48", 54", 60"; 4 on 72"

3 on 48", 54", 60"; 4 on 72"

(2 on 48" Guardian Elba)

3 on 48", 60", 72"; 4 on 84", 96"

ALLOY:

6063-T5 on pickets; 6061-T6 on posts and rails

STRENGTH:

Over 350 lbs

Over 350 lbs

Over 1, 100 lbs

FIG. 230 ROLLER STAND

www.pipingtech.com/fig230

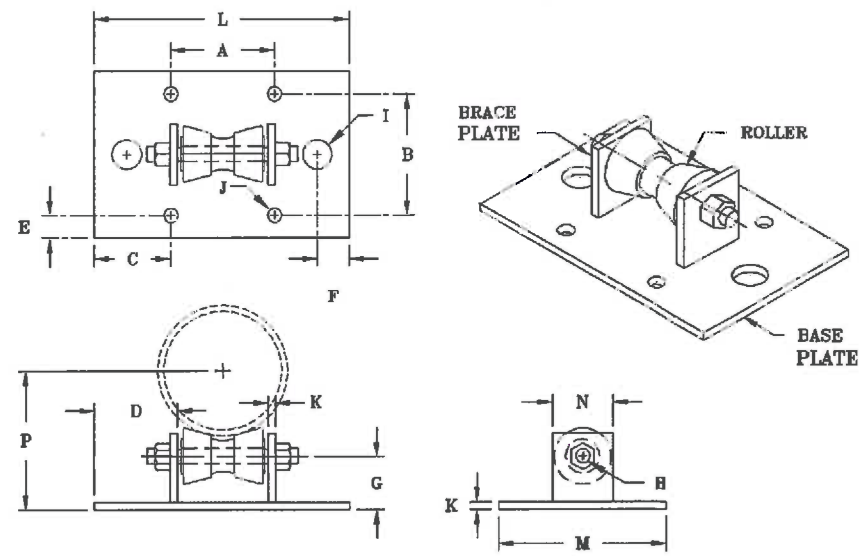
MATERIAL: Cast iron roll and stand.

SERVICE: For support of piping that expands and contracts longitudinally and where vertical adjustment is not necessary.

HOW TO SIZE:
1. If roll is to support bare pipe, select size from nominal pipe size.
2. If used with pipe covering protection saddle, see FIG. 183 for size of pipe roll.

INSTALLATION: Two cored holes "I" for anchorage bolting purpose.

ORDERING: Specify pipe size, figure number, description and finish.



PIPE SIZE		2 - 3 1/2	4 - 6	8 - 10	12 - 14	16 - 20	24	30	36 - 42
MAX. RECOM. SIZE LOAD (lb.)		390	950	2,100	3,075	4,980	6,100	7,500	12,000
COMPLETE	(APPROX. WEIGHT - lb. per 100)	640	885	1,530	2,810	3,965	4,950	9,925	15,200
ROLL AND ROD	(APPROX. WEIGHT - lb. per 100)	90	135	530	1,010	1,565	1,950	3,390	5,700
ROLL ONLY	(APPROX. WEIGHT - lb. per 100)	70	110	440	850	1,270	1,450	2,400	4,100

PIPE SIZE	A	B	C	D	E	F	G	H	I	J	K	L	M	N	P
2	3 7/16	4	2 1/2	2 11/16	3/4	1 1/16	1 3/4	9/16	1	1/2	1/4	8 7/16	5 1/2	2	3 1/2
2 1/2	3 7/16	4	2 1/2	2 11/16	3/4	1 1/16	1 3/4	9/16	1	1/2	1/4	8 7/16	5 1/2	2	3 6/7
3	3 7/16	4	2 1/2	2 11/16	3/4	1 1/16	1 3/4	9/16	1	1/2	1/4	8 7/16	5 1/2	2	4 1/8
3 1/2	3 7/16	4	2 1/2	2 11/16	3/4	1 1/16	1 3/4	9/16	1	1/2	1/4	8 7/16	5 1/2	2	4 3/8
4	4 11/16	4 1/4	2 5/8	3	7/8	1 1/16	2	9/16	1	1/2	1/4	9 15/16	6	3	4 3/4
5	4 11/16	4 1/4	2 5/8	3	7/8	1 1/16	2	9/16	1	1/2	1/4	9 15/16	6	3	5 3/8
6	4 11/16	4 1/4	2 5/8	3	7/8	1 1/16	2	9/16	1	1/2	1/4	9 15/16	6	3	6
8	7	5	3/4	1 1/8	1 1/2	2 1/4	3 3/8	3/4	1	5/8	3/8	8 1/2	8	3	8 5/8
10	7	5	3/4	1 1/8	1 1/2	2 1/4	3 3/8	3/4	1	5/8	3/8	8 1/2	8	3	9 3/4
12	9 1/16	6	1	1 7/16	1	2 1/2	3 3/4	7/8	1	3/4	3/8	11 1/16	8	3	11 1/4
14	9 1/16	6	1	1 7/16	1	2 1/2	3 3/4	7/8	1	3/4	3/8	11 1/16	8	3	11 6/7
16	10 1/4	6 1/2	1 3/8	1 7/8	1 1/4	2 3/16	4 1/4	1 1/4	1	13/16	1/2	13	9	4	13 5/8
18	10 1/4	6 1/2	1 3/8	1 7/8	1 1/4	2 3/16	4 1/4	1 1/4	1	13/16	1/2	13	9	4	14 5/8
20	10 1/4	6 1/2	1 3/8	1 7/8	1 1/4	2 3/16	4 1/4	1 1/4	1	13/16	1/2	13	9	4	15 5/8
24	11 3/8	6 1/2	1	1 9/16	1 1/4	3	4 3/8	1 1/2	1	13/16	1/2	13 3/8	9	4	17 3/4
30	14 1/4	8	1 3/8	2 3/8	1 1/2	3 1/2	5 1/8	1 7/8	1	1 1/16	1/2	17	11	5	21 6/7
36	17	9	1 1/2	2 7/16	1 1/2	4	5 3/4	2 1/8	1	1 5/16	3/4	20	12	6	25 3/4
42	17	9	1 1/2	2 7/16	1 1/2	4	5 3/4	2 1/8	1	1 5/16	3/4	20	12	6	28 6/7

SCOMPONENTS06.XLS-12/29/09

Attachment 6

Appendix C
Design Criteria

APPENDIX C

Design Criteria

In conformance with requirements from the 1996 Corrective Action Consent Agreement (CACA) (California Department of Toxic Substances Control 1996) and the 2013 Remedial Action/Remedial Design (RD/RA) Consent Decree (U.S. Department of the Interior [DOI] 2013), this appendix describes the design criteria for the groundwater remedy at the Topock Compressor Station (TCS). The design criteria are the technical parameters upon which the design is based, and are based on the translation of the identified applicable or relevant and appropriate requirements (ARARs) and the Environmental Impact Report (EIR; California Department of Toxic Substances Control [DTSC] 2011) mitigation measures (where applicable) into site-specific engineering parameters.

The design criteria are grouped into engineering disciplines (Civil [Section C.2], Structural [Section C.3], Geotechnical [Section C.4], Mechanical [including electrical] [Section C.5], Electrical [Section C.6], Instrumentation and Control [Section C.7], and Architectural [Section C.8]). In addition, this appendix describes PG&E Personnel Requirements (Section C.9) and design criteria for Health and Safety (Section C.10) and Noise (Section C.11).

This appendix includes five Attachments that contain a large amount of data; these Attachments are presented in PDF format on the CD-ROM version of the 90% Basis of Design (BOD) Report (enclosed within the report binders).

- Attachment A contains a detailed description of the in situ remediation design basis including carbon substrate selection and discussion of chemical reactions.
- Attachment B provides calculations in the following order:
  - Remedy-produced water pump calculations – recirculation; filter feed; conditioned water transfer
  - Remedy-produced water influent tank eductor sizing
  - Remedy-produced water caustic usage
  - Remedy project structural calculations related to the pipe bridges, Remedy-produced Water Conditioning Building, conditioned water storage, freshwater storage, the Contingent Freshwater Pre-injection Treatment Building, and L-300 load calculation
  - Freshwater supply and injection hydraulic network modeling calculations from EPANET software[1]
  - Hydraulic calculations for National Trails Highway In-situ Remediation Zone (NTH IRZ), Inner Recirculation Loop, and TCS Recirculation Loop wells
  - Structural design calculations for the MW-20 Bench Carbon Amendment Building
  - Fire suppression calculations for the MW-20 Bench and TW Bench Carbon Amendment Buildings
  - Sand separator collection system
- Attachment C summarizes information on existing site geology and geotechnical data in support of the groundwater remedy design and to propose areas where supplemental geotechnical investigation is needed to verify design parameters.
- Attachment D includes a bulletin on remediation well design and field approach.
- Attachment E includes a summary of the hydraulic analysis of the firewater system.

C.1 Codes and Standards

The Groundwater Remedy Project is generally being designed in accordance with the applicable standards, codes, ordinances and regulations, including but not limited to:

[1] Developed by the U.S. Environmental Protection Agency for hydraulic network modeling and drinking water quality analysis. For details, see http://www.epa.gov/nrmrl/wswrd/dw/epanet.html.

- American Association of State Highway Traffic Officials
- American Concrete Institute (ACI)
- American National Standards Institute (ANSI)
- American Petroleum Institute (API)
- American Railway Engineering and Maintenance of Way Association
- American Society for Testing and Materials (ASTM) International
- American Water Works Association Standard (AWWA)
- American Welding Society (AWS)
- Asphalt Institute
- Arizona Department of Transportation Policy for Accommodating Utilities on Highway Rights of Way
- Burlington Northern Santa Fe Railway (BNSF) Utility Accommodation Policy
- California Building Code (2013) as amended by San Bernardino County
- California Fire Code (2010)
- California Mechanical Code (2010)
- California Plumbing Code (2010)
- California Division of Occupational Safety and Health (Cal/OSHA)
- Crane Manufacturer's Association of America
- County of San Bernardino 2007 Development Code
- Illuminating Engineering Society of North America (IES) procedures
- International Energy Conservation Code (IECC)
- International Green Building Code
- Institute of Electrical and Electronic Engineers (IEEE)
- Instrument Society of America (ISA)
- Insulated Cable Engineers Association (ICEA)
- Minimum Design Loads for Building and Other Structures (American Society of Civil Engineers [ASCE] 7-10)
- Mohave County Regulations (including Drainage Design Manual for Mohave County)
- Mohave County Floodplain Administrator requirements
- National Association of Corrosion Engineers
- National Electrical Manufacturers Association (NEMA)
- National Electrical Code (NEC)
- National Electrical Safety Code (NESC)
- National Fire Protection Association (NFPA)
- National Sanitation Foundation
- Occupational Safety and Health Administration (OSHA)
- PG&E standards
- San Bernardino County Department of Public Health, Division of Environmental Services
- San Bernardino Fire Department/Certified Unified Program Agencies (CUPA) requirements
- San Bernardino County Floodplain regulations
- Uniform Fire Code (UFC) (Local Fire Code)
- Underwriters Laboratory (UL)

C.2 Civil

C.2.1 Site Datum

The topographic map (with 1-foot topographic contours) used in the design was based on an aerial survey conducted in 2011 by Toponex. Ground surveys were also conducted in localized areas to support the design. The following data were used to establish control for the project and conduct site survey work:

- Coordinates listed are 1983 State Plane Ground Coordinates, Zone 5 (NAD1983, State Plane, California, V, FIPS, 0405).
- The elevations are based on North American Vertical Datum of 1988 (NAVD88) in U.S. Survey feet.
- Units = International feet: 1 foot = 0.3048 meter.
- All bearing are grid bearings, distances are ground distances, and coordinates are ground coordinates.

C.2.2 Earthwork

This section describes the design criteria for the movement of soil and rock into forms and structures needed for the project.

- Grading, Paving and Access Roads

  Cut and grading will take place at the site to install new remedy facilities. Access roads are required to access certain project locations for construction and O&M. Access roads will be designed to the following standards (barring terrain or cultural, biological or natural resource constraints):

  - Maximum grade ≤ 10%, with the exception of the access road to IRL-4 and the access road east of Transwestern (TW) Bench
  - One way traffic width = 14 feet minimum
  - Two way traffic width = 20 feet minimum (Note that San Bernardino County Code Chapter 5 allows a variance for narrower fire access roads if turnouts [6 feet wide by 50 feet long] are provided about every 600 feet [County Standard 503.1]).
  - Cut slopes 1.5:1 (H:V) or flatter
  - Fill slopes 2:1 (H:V) or flatter
  - Out slope road (1/4 inch per foot) so that drainage flows perpendicular to road centerline
  - Roadside ditches (V shaped or trapezoidal) with a minimum top width of 2 feet
  - Per San Bernardino County requirements (Section 7 of San Bernardino County Department of Public Works – General Permit Conditions and Trench Specifications): 95% compaction of asphalt pavement, paving base material and the portion of backfill within 6 inches of paving base material. Below 6 inches, 90% compaction.
  - Pavement replacement will be in accordance with the California Department of Transportation's (Caltrans') *Flexible Pavement Structural Section Design Guide for California Cities and Counties* (latest edition).

- Utility trenches will be excavated to a minimum 3 feet deep and 2 feet wide. Utility trenches may include pipes (freshwater, extracted groundwater, carbon-amended water, remedy-produced water, clean in place (CIP), acid, coagulant, caustic, slurry, waste sump, utility, or spare pipes), as well as electrical and instrumentation conduits. Trench cutoff walls with drain systems may be installed at locations where pipe slopes exceed 8%-10% for long runs (300 to 500 feet) to help divert any potential water flow that may undermine the trench section. In areas where utility crossings exist there will be a minimum of 2 feet separation between utilities unless directed otherwise by the utility owner. The location and depth of utilities encountered during construction will be surveyed. The survey data, utility size, and material type will be recorded on as-built documents.
- Pipe and conduit bedding material will be free of rock(s), rubbish, debris, and other objectionable material, and minimum compaction will be 90% to 95% relative density, per American Society for Testing and Materials (ASTM) International D-1557 in areas sensitive to settlement. The minimum pipe bedding thickness will be 6 inches and the minimum pipe/conduit backfill zone thickness will be 3 inches. Bedding will be without voids,

placed and compacted to the proper depth in 8-inch maximum lifts. The backfill will be placed to final grade to conform to the elevation of the adjoining surface elevation.

- A survey of aboveground and underground utilities will be conducted within all work areas prior to beginning intrusive site work and construction activities. This survey will include, but will not be limited to, the following activities:
  - Notify Underground Service Alert (USA) or “DigAlert” in California, or Arizona Blue Stake in Arizona
  - Geophysical survey to identify underground features
  - Excavation to expose and identify known or suspected utilities before excavation. It is Topock Compressor Station policy to minimize operational and safety risks by limiting subsurface intrusion as much as possible, and thus abandoned utilities are typically left in place. Because positive identification of all active and abandoned underground utilities prior to any intrusive activity within the station fence line is impossible, Compressor Station protocol requires all intrusive work be performed by hydro vacuum or hand excavation methods.

    As described during the October 24, 2011 site visit with the DTSC and the DOI, PG&E policy requires all excavations in the vicinity of existing infrastructure to be hand dug when within 3 feet of existing infrastructure; in more open areas. Hydro vacuum excavation may be used in lieu of hand digging. Depending on the location, density of utilities encountered, and available information regarding a specific location, hand excavation or clearing using the hydrovacuum may be required as deep as 10 feet below ground surface. No power equipment will be used until the excavation has been physically cleared for utilities. A station employee observes each excavation effort and determines when it is safe to proceed with more intrusive methods. PG&E does not have a written procedure for this requirement; however, it is policy and is understood and strictly followed by all station personnel.
- It is preferred that piping installed in utility corridors will be below ground. There are many reasons for this preference, including but not limited to the following:
  a) The National Electrical Safety Code (NESC) considers an above-ground, non-overhead, high voltage electrical supply line to be an example of non-Code compliant, therefore, medium and high voltage electrical lines will be place underground. In addition, aboveground low voltage electrical 480 volt power lines carry the risk of causing electrical injuries from contact, and long runs of exposed electrical conduit also present numerous design and O&M challenges.
     i. It is worth noting that along the Route 66 segment in the Upland Area, considerations were also given to the piping alignment (underground) to maintain usable road width in narrow stretches of the road. The California/San Bernardino County Fire Code (Chapter 5) requires 26 feet minimum width for vehicle access. Although variances are allowed if turnarounds are available every 600 feet (County Standard 503.1), additional grading and cut backs would be required to create these turnarounds in several narrow road sections or sections with steep ravine. Note that aboveground structures would also require drainage features which adds to the footprint.

  b) Placement of water lines underground (versus aboveground) will not only avoid increased visual impacts, but will also protect the health, safety, and free movement of humans and animals. Underground piping will also enhance the integrity of the remedy infrastructure (e.g., avoid being hit by vehicular traffic), and minimize remedy footprint and future O&M challenges.

  c) Aboveground piping is inherently vulnerable as members of the public have been known to shoot pipes and large rocks or other debris may strike the pipe during a storm event. In addition, aboveground pipe will need periodic re-coating therefore, would require more maintenance compared to underground piping and as such, create more disturbance to nearby habitats as a result of maintenance activities.

  d) However, in certain cases, aboveground installations will be necessary to protect sensitive resources (e.g., aerial crossings of Bat Cave Wash, crossing of the Colorado River on the Arched Bridge).

Belowground utility corridors may be constructed with direct burial, pre-cast concrete, or cast-in-place utility trenches with lids or buried directly in the soil. The installation option was selected based on the following criteria subject to constraints for the particular route (e.g., width of usable terrain):

- Directly buried electrical conduits may be installed beneath other electrical conduits.
- There must be at least 3 inches of clearance between directly buried water piping. The clearance between directly buried water piping may be increased up to 12 inches.
- The minimum spacing between directly buried electrical conduit shall be 3 inches or half the diameter of the conduit, whichever is greater.
- Tracer wire for locating non-metallic pipes or conduit will be installed in the trenches.

- Trenchless construction will be used underneath the I-40 highway. In this location, horizontal auger boring will be used. The method will be designed such that it complies with relevant guidelines prepared by the Arizona Department of Transportation (ADOT) (see also Section 5.3.2 of the Basis of Design Report for encroachment permits).
  - ADOT Policy for Accommodating Utilities on Highway Rights-of-Way, December 2009

  Pipes and conduit will be installed in steel casings when required by BNSF or ADOT. The need for cathodic protection will be evaluated on a case-by-case basis using site conditions and utility requirements. The casing will have centralizers and end caps 10 feet from the end of the casing. Identified spare pipes and conduits will be installed during construction. Exhibit C.1-1 lists minimum depth of cover for trenchless crossings. In some cases, concerns for pavement or railroad settlement or potential for drill fluid “frac-out” may require a thicker cover. Geotechnical borings may be required by ADOT or BNSF (see Section C.4). If drilling fluids are used, continuous monitoring for frac-out conditions will be performed to prevent harm to human health and the environment caused by the release of such fluids.

- Any earthwork in areas of sensitive habitat (including floodplain and riparian areas, wetlands, and waters of the US, as well as desert washes and desert riparian) will be subject to the substantive equivalents of Section 404 requirements and the California Department of Fish and Wildlife’s Avoidance and Minimization Measures under mitigation measure BIO-1 (see the Mitigation Monitoring and Reporting Program in the EIR [DTSC 2011]).

EXHIBIT C.1-1
Depth of Cover Design Criteria for Trenchless Crossings
Groundwater Remedy Basis of Design Report/Pre-Final (90%) Design
PG&E Topock Compressor Station, Needles, California

Transportation Agency	Minimum Depth Of Cover
ADOT	• 3 feet minimum[1] • 6 feet minimum for un-sleeved (uncased) crossings up to 48” diameter • 10 feet minimum for pipelines larger than 48”

[1]Source: Article 3.2.4 of ADOT Policy for Accommodating Utilities on Highway Rights-of-Way

C.2.3 Storm Drainage

Stormwater will be managed to protect new structures and facilities built as part of the remedy. This section describes the design criteria associated with stormwater drainage.

Surfaces will be graded to drain. Culverts or other drainage structures will be used to drain roadside ditches and protect stream crossings. Roof drainage from buildings will be collected in gutters and drain towards drainage systems. Stormwater captured within secondary containment will be managed at the remedy-produced water conditioning system. All drainage features and structures will be sized to meet San Bernardino County requirements for storm frequency and intensity.

- Rainfall intensity based on period equal to time of concentration for the basin being considered and 25-year recurrence interval.
- Minimum velocity for culverts is 2.0 feet per second. Maximum velocity for culverts is 10.0 feet per second.

During construction, erosion control measures will be implemented in accordance with San Bernardino County requirements and the construction Stormwater Pollution Prevention Plan (SWPPP). The erosion control measures will be tailored to the site to prevent sediment-laden water from leaving the site. The following erosion control measures may be used onsite as appropriate (for details, see the Construction/Remedial Action Work Plan [CH2M HILL 2014]):

- Site development considerations with construction scheduling
- Maintenance of buffer zones
- Disturbed-soil areas with decomposed granite
- Dust control on disturbed areas and access roads
- Diversion of runoff with earthen dikes, brow ditches, and berms to protect excavations
- Energy dissipaters, riprap channel protection, or outlet protection for discharge pipes, channels, and ditches
- Silt fence at limits of clearing
- Temporary sediment basins to protect existing drainage basins and culverts
- Check dams to control velocity along ditches and long longitudinal grades
- Stabilized construction entrance to all paved surfaces
- Materials management with material delivery, storage, and waste management
- Vehicle and equipment management with construction practices, cleaning, fueling, and maintenance

C.2.4 Site Security

In general, the security for remedial facilities located inside the Compressor Station will be provided for by the Compressor Station security system. Remedial facilities located outside of the Compressor Station will be equipped with security features/systems that are consistent with PG&E's current security standards. Such features, as determined necessary and in compliance with project and landowners' requirements, could include, but are not limited to, fencing to protect the equipment and provide safety for personnel and the public; locks to prevent unauthorized access; security devices and instrumentation; security communication systems; alarms to notify PG&E's security operations; and security cameras. Where appropriate, security features like cameras and card readers are noted on the 90% engineering plans/drawings (see Appendix D of this 90% BOD Report). Examples of security features to be installed at remedy facilities located at the TW Bench, MW-20 Bench, HNWR-1A well site, the North and South Aerial Crossings (crosses Bat Cave Wash) are described below. In compliance with the EIR mitigation measure CUL-1a-6, any additional phone calls and alarms associated with remedial activities will not be routed through PG&E's existing alarm system at the Compressor Station.

Transwestern Bench

- A perimeter fence will be installed with a motorized main gate and a personnel gate. The main gate will have a security card reader and camera to monitor and prevent unauthorized access.
- Perimeter cameras will be installed at the Operations Building.
- The Operations Building will have card readers at entrances.

MW-20 Bench

- Each new gate(s) will have a security card reader and camera.
- Additional perimeter cameras will be installed.
- A motorized gate with security card reader and camera will be installed.

HNWR-1A Well Site

- A perimeter fence will be installed along with a security camera to monitor and prevent unauthorized access.

North and South Aerial Crossings (Bat Cave Wash)

- Personnel gates with locks will be installed at each end of the 2 new aerial crossings.

C.2.5 Concrete Vaults

Concrete vaults will be installed to house mechanical and electrical equipment. Vaults will be precast concrete sections where possible. The vaults will vary in depth depending upon use and location, but to the extent possible they will be designed to be shallow enough that entry would not require a confined space entry procedure. Each vault will be equipped with a steel ladder with extension, conforming to California Division of Occupational Safety and Health (Cal/OSHA) standards. Well vaults will be designed for an H-20 loading in traffic areas and the lids will be supplied with spring assists for safe opening. Fall protection removable grating (live load 300 pounds per square foot [psf]) will be provided. For non-traffic areas, standard lids (300 psf) will be supplied. All vault lids will be equipped with security locks or other security devices (e.g., embedded locks or 5-point bolts).

C.2.6 Construction in 100-year Floodplain

The 100-year floodplain is defined in the Flood Insurance Rate Map (FIRM), Panel 5705 of 9400 for San Bernardino County, California and Unincorporated Areas, Revised August 28, 2008, and Panel 5675 of 6700 for Mohave County, Arizona and Unincorporated Areas, Revised November 18, 2009 (Map Number 04015C5675G). The base flood elevation shown on the current FIRM is 464 feet NAVD at River Mile (RM) 234 of the Colorado River. A review of the Mohave County Flood Insurance Study (FIS) shows that this elevation is specific to the California side of the river only, and is different from information found in the newer FIS for Mohave County, AZ.

The effective FIS for San Bernardino County lists a regulatory base flood elevation of 463.90 feet NAVD. This design uses the more conservative elevation of 464 feet NAVD as the base flood elevation for the project on the California side of the Colorado River. The vertical datum for all flood elevations shown on the San Bernardino County FIRM is NAVD88.

The effective FIS for Mohave County lists a regulatory base flood elevation of 465.3 feet NAVD. This is used as the base flood elevation for the project on the Arizona side of the Colorado River. The vertical datum for all flood elevations shown on the Mohave County FIRM is NAVD88.

In this 90% design, certain infrastructure (piping) cannot be located outside of the 100-year floodplain as defined by the above baseline flood elevation. PG&E are working with Mohave County Flood Administrator to ensure compliance with the county requirements for construction in the floodplain.

C.3 Structural

This section describes design criteria for physical structures made of wood, concrete, reinforced masonry, and steel. Detailed structural design criteria are shown in Exhibit C.3-1.

C.3.1 Concrete

Minimum requirements are listed below for structural concrete:

- Strength of poured-in-place concrete will be a minimum of 5,000 pounds per square inch (psi) at 28 days for all structures. Lower strengths of 3,000 psi will be used for non-critical structural elements and improvements at TCS evaporation ponds as indicated in the specifications. 2,000 psi will be used for concrete fill, pipe and conduit encasement.
- Cement will be clean, fresh, Type V, low alkali, Portland cement conforming to ASTM C150.
- Aggregate will be non-reactive.
- Cement content for all structures will be a minimum of 7.5 sacks per cubic yard of concrete.

- Slump of concrete will be as low as practicable to produce a dense, well consolidated concrete and not exceed 4" unless otherwise authorized by PG&E Project Engineer.
- Finish of formed surfaces will be smooth and free of fins, honeycomb, and segregation.
- When the surfaces have become sufficiently hardened, they will be kept continually moist for a period of not less than seven days. Curing compound conforming to ASTM C309 may be used in-lieu of wetting surfaces only where approved by the Engineer.
- In conformance with the EIR mitigation measures AES-1d and AES-2e, integral color concrete will be used in place of standard gray concrete.

EXHIBIT C.3-1
Structural Design Criteria
Groundwater Remedy Basis of Design Report/Pre-Final (90%) Design
PG&E Topock Compressor Station, Needles, California

Category	Criteria
General	
Governing Code	CBC (2013) as amended by San Bernardino County, IBC 2012, ASCE 7-10
Concrete: CODE and SPECIFICATION	ACI 318-11, Building Code Requirements for Reinforced Concrete ACI 350-06, Environmental Engineering Concrete Structures
Concrete Masonry Units: SPECIFICATIONS	CBC (2013)
Structural Steel: SPECIFICATIONS	AISC Steel Construction Manual , 14th Edition
Aluminum: SPECIFICATIONS	CBC (2013)
Concrete	
Strength	F'c = 5,000 psi for all structures (pipe bridge foundation and precast concrete containment trench), 3,000 psi for general structural concrete (pump pads, thrust blocks, valve vaults) and improvements at TCS evaporation ponds, and 2,000 psi for concrete fill, pipe/conduit encasement.
Reinforcing	ASTM A615, Grade 60, Type S
Prestressing Strand	ASTM A416
Welded Steel Wire Fabric	ASTM A185 or ASTM A497
Design	Strength Design or Alternate Method
Detailing	ACI-SP66 (04) Manual of Standard Practice for Detailing Concrete Structures
Color	Integral color concrete in place of standard gray color concrete (EIR mitigation measures AES-1d and AES-2e)
Reinforced Masonry	
Concrete Masonry Units	ASTM C90, Grade N, Type I (Unit Compressive Strength f'm = 1,900 psi at 28 days
Mortar for Unit Masonry	ASTM C270, Type M, Minimum Compressive Strength at 28 days = 2,500 psi**.**
Reinforcing	ASTM A615, Grade 60, Type S
Cold-Drawn Steel Wire	ASTM A 482
Grout	ASTM C476, Minimum Compressive Strength at 28 days = 3,000 psi.
Structural Steel	
Structural "W" Shapes	ASTM A992 (Fy = 50 ksi)
Structural channels. plates, angles, etc.	ASTM A36 (Fy = 36 ksi)

EXHIBIT C.3-1
Structural Design Criteria
Groundwater Remedy Basis of Design Report/Pre-Final (90%) Design
PG&E Topock Compressor Station, Needles, California

Category	Criteria
Structural Tubing	ASTM A500, Grade B (Fy = 46 ksi)
Steel Pipes	ASTM A53, Grade B
Stainless Steel	Alloy Types conforming to ASTM A-167 and ASTM A-276.
Plates and Shapes	Type 316 unless otherwise noted
Bolts, Nuts and Washers	Type 316
Welding	AWS E70 Electrodes
High Strength Bolts	ASTM A325N, Type 1, Min 3/4" Diameter
Other Bolts	ASTM A307, Grade A
Anchor Bolts	ASTM A36
Chemical Anchor Bolts	SS Type 316, Threaded Rod with Hilti HIT-HY200 Adhesive, or Equivalent
Expansion Anchors	SS Type 316 Hilti Kwik Bolt TZ, or Equivalent
Timber	
TBD	CBC (2013)
TBD	National Design Specification for Wood Construction

C.3.2 Reinforcing Steel (Minimum Requirements)

Minimum requirements for reinforcing steel are as follows:

- Reinforcing steel will be deformed, grade 60, conforming to ASTM A615, and be free from coating which will reduce the bond.
- Reinforcing steel will be sized in accordance with the Strength Design Method or Alternate method.
- Reinforcing steel splices will be in accordance with the requirements of ACI 318-11.

C.3.3 Dead Loads

Dead loads will consist of gravity loads induced by all structural elements, equipment, piping, and contained liquids.

C.3.4 Live Loads

Live loads for different structural elements are listed below:

- Roof live loads will be designed for a minimum live load of 20 psf.
- Stairs, walkways, and platforms will be designed for a minimum live load of 100 psf.
- Concrete floor on Grade and Grating will conform to the latest edition (2013) of the California Building Code (CBC), but will be a minimum live load of 500 psf, or Wheel Load of 16 kips.
- Elevated Concrete floor – 200 psf or Fork Lift load – 4 kips.
- Live load on aerial crossings (pipe bridges) will be:
    - A minimum concentrated load of 500 pounds at alternate panel point of trusses.
    - A minimum uniform live load of 25 pounds per square foot on walking surfaces.

C.3.5 Seismic Loads

The design will meet CBC (2013) and as amended by San Bernardino County and/or ASCE 7-10 "Minimum Design Loads for Buildings and Other Structures". In addition, the criteria have been updated to the site-specific location, from Needles, CA to the Compressor Station site. Specifically:

- CBC 2013, Site Class D
- Ss = 0.23 (Compressor Station site)
- S1 = 0.12 (Compressor Station site)
- I = 1.25 (importance Factor)

C.3.6 Wind Loads

The design will meet CBC (2013) and as amended by San Bernardino County and/or ASCE 7-10 "Minimum Design Loads for Buildings and Other Structures". Minimum Wind Load = 20 psf.

C.4 Geotechnical

A geotechnical data summary is included in Attachment C of this Appendix. The purpose of this geotechnical summary is to provide information on existing site geology and geotechnical data (CH2M HILL 2004, CH2M HILL 2009) in support of the groundwater remedy design and to propose areas where supplemental geotechnical investigation is needed to verify design parameters. Coordination with the Soil RFI/RI investigation program was conducted in planning of the supplemental geotechnical investigation to minimize the number of boreholes, thereby minimizing ground disturbance. Due to the limited amount of geotechnical data available at the time of this design, assumptions made during the design will be reviewed after receipt of supplemental geotechnical data, currently planned to be collected as part of the forthcoming Soil RFI/RI sampling effort (anticipated in early 2015). Any material changes to the design required by this supplemental information will be discussed with the agencies. It is important to note that as PG&E continues to engage in discussions with transportation agencies, counties, and other property owners/land managers to obtain institutional controls, access agreements, and permits, additional geotechnical data may be required to meet specific requirements of agencies and/or property owners/land managers.

The geotechnical design criteria presented in Exhibit C.4-1 are based on existing site-specific geologic information and geotechnical data to support foundation and trenching designs, as well as the trenchless crossing of I-40 in Arizona.

EXHIBIT C.4-1
Geotechnical Design Criteria
Groundwater Remedy Basis of Design Report/Pre-Final (90%) Design
PG&E Topock Compressor Station, Needles, California

Parameter	Criteria
Moist soil unit weight	120 pounds per cubic foot (pcf)
Shear strength parameters	Cohesionless Soils Friction angle: from 32 to 35 degrees for compacted fill Friction angle: from 28 to 30 degrees for native soils Cohesive Soils Undrained shear strength: from 800 to 1,000 pounds per square foot (psf)
Controlling earthquake magnitudes	Mean earthquake magnitude is 6.6 Modal earthquake magnitude is 7.9
Peak ground acceleration	For structure design is 0.10 g (design value for Site Class D) For liquefaction assessment is 0.15 g (for Site Class D)
Allowable bearing capacity	4,000 psf for CH2M HILL-designed structures on the TCS 2,000 psf for CH2M HILL designed structure outside the TCS
Allowable long-term settlement	1 inch
Sliding coefficient of friction	0.45
Lateral soil pressure equivalent fluid unit weight	Active pressure: 45 pcf Pressure at rest : 60 pcf. Passive resistance = 175 pcf
Temporary cut and fill slopes	2 Horizontal:1Vertical
Frost depth	8-10 inches

Additional Geotechnical Criteria

- Soil is corrosive to concrete structures and steel (resistivity > 1,000 ohm-centimeters, sulfate > 2,000 parts per million (ppm) and chloride > 500 ppm).
- Soil profile is classified as Site Class D (stiff soil site), as defined in the CBC (2010).
- Shallow foundations for buildings with support extending a minimum of 2 feet below lowest adjacent grade. Slabs and footings set on a minimum of 6” layer of granular base leveling course.
- Pipe design based on depth of fill, weight of fill, compaction of fill and modulus of soil reaction (E’ = 1,000 psi).
- Native onsite materials may be considered for backfill if they have an expansion index (EI) less than 50 and contain less than 8 percent fines, as determined by ASTM D4829 and D422.

C.5 Mechanical

This section describes the design criteria associated with key mechanical elements of the project. Mechanical design will follow the California Mechanical Code (2010) unless noted, and fire requirements per the California Fire Code (2010).

C.5.1 Piping

Based on experience with operation and maintenance of the IM facilities, the groundwater in the floodplain has high levels of total dissolved solids, chlorides, sulfate, and other minerals that have caused significant corrosion to iron-based piping material from mild carbon steel to Type 316 stainless steel. Therefore, piping will be designed and installed in accordance with best practices and past site experience for operation and maintenance, including use of flanged or union joints for serviceability and isolation valves for systems requiring routine maintenance.

In general, piping materials will be compatible with the characteristic of the conveying fluids and will be single-walled unless the pipe is used to convey: (1) groundwater or remedy-produced water that exhibits the hazardous waste characteristic; or (2) concentrated carbon substrate. In these cases, double-walled piping will be used. Double-walled pipe segments conveying either of the fluids described above will include appropriately designed leak detection systems. Low point sumps/traps with level switches and alarms will be the primary method of detecting leaks. Continuous leak detection systems may be used as an alternative to low point switches if switches are deemed impractical or incompatible with the installation. Pipeline segments installed in belowground concrete trenches (e.g., Pipeline A) will be designed with leak detection at low points (level switch with alarm). Drawing C-07-02 of Appendix D is a pipeline key map that shows the locations of the pipeline segments.

In the case of Pipeline H which connects to well IRL-4 located at the bottom of a wash, double walled pipe segments will be used to convey remedy produced water from the wellhead to a valve vault located on the plateau. As access to this well is difficult and via a steep slope, this containment design is to provide for safe operations during well rehabilitation where acids and chemicals are used. In the event of a leak, the secondary containment will drain to a concrete sump located at the wellhead. The concrete sump will be equipment with a level switch and alarm, as well as a sump pump.

Corrosion Control

For corrosion control, above ground and belowground steel pipe will be coated. Any steel pipe near the point where it emerges from the ground will be coated. Air-to-soil transition piping is any steel piping located 18" below ground or 6" above ground. Cathodic protection equipment will be applied as follows: 1) steel piping and structures will be cathodically protected underground; 2) plastic pipe (e.g., HDPE or CPVC or PVC) will be preferentially used when appropriate for corrosion resistance; and 3) steel pipe will be cement mortar-lined to prevent internal corrosion. Piping cathodic protection will conform to National Association of Corrosion Engineers SP0177-2007 Standard Recommended Practice - Mitigation of Alternating Current and Lightning Effects on Metallic Structures and Corrosion Control Systems.

In compliance with the EIR mitigation measures AES-1d and AES-2e, the external coatings used for wells, pipelines, storage tanks, structures, and utilities will consist of muted, earth tone colors that are consistent with the surrounding natural color palette, and matte finishes. Coating materials will be corrosion-resistant to protect the underlying surfaces.

Pressure Loss

For the freshwater and the remedy-produced water piping network, a hydraulic model built using the EPANET water supply program was used to simulate and optimize the piping design. Attachment B of this Appendix contains more details about the hydraulic modeling.

For the design of the in-situ remediation piping system, to ensure adequate distribution, the pressure loss in the branch distribution piping to each of the injection wells (including frictional losses and wellhead pressures from drop pipe frictional losses and pressure drop across the foot valve) will be designed to be 10 times higher than the pressure drop in the distribution header. The CIP loop conveyance piping will be designed to operate at a velocity of 3 to 5 feet per second (fps) and will have cleanouts at least every 400 feet.

C.5.2 Process Equipment

Primary process equipment (substrate dosing pumps, compliance related sensors, safety switches, etc.) will be designed for parallel operation or provide stand-by equipment to provide sufficient redundant capacity.

To the extent practical, all valving, instrumentation, manways, and access ladders for tanks will be located on the northern face (including northeastern face) of the remedial facilities to allow O&M personnel to work on the shady side during O&M activities.

C.5.3 Valves

Valves installed for throttling and flow control will include globe, needle, and diaphragm valves. Isolation valves will include; gate, ball, and butterfly valves. Other valves expected to be included in the remedy system include spring and swing check valves, pressure relief, air relief, variable orifice, foot, and combined air and vacuum relief valves. Carbon substrate storage tanks may include additional safety valves, including emergency ventilation and combination pressure/vacuum relief valves in accordance with applicable standards. Valves will meet PG&E and industry standards appropriate to the application and process conditions.

Exhibit C.5-1 lists potential valve types associated with the major equipment. Valves will meet industry standards appropriate to the application and process conditions.

EXHIBIT C.5-1
Potential Valve Type with Associated Device
Groundwater Remedy Basis of Design Report/Pre-Final (90%) Design
PG&E Topock Compressor Station, Needles, California

Equipment	Potential Valve Type
Fresh Water Injection Pumps	Pressure reducing, ball, swing check
Freshwater Extraction Well Pumps	Butterfly valve, swing check, and surge anticipation valve
Riverbank Extraction Pumps	Swing check, globe, butterfly, ball, gate
Transwestern Bench Extraction Pumps	Swing check, globe, ball
IRZ Pumps	Swing check, globe, ball, pressure reducing, pressure relief
East Ravine Pumps	Swing check, globe, ball
IRZ Backflush Pumps	Swing check, gate, ball, butterfly
Freshwater Backflush Pumps	Swing check, butterfly, flow control
Carbon Substrate Pumps	Pressure and vacuum relief, solenoid, swing check, motor operate valve, ball
Pipelines	Butterfly, motor-operated valve, combination air release, ball, and gate
Well Maintenance Reagent Pumps	Ball, swing check, solenoid, multi-port, motor-operated valve
Ethanol Storage and Transfer	Pressure and vacuum relief, swing check, solenoid, ball, emergency vent
Process Pumps (Submersible Sump Pumps, Air-operated Diaphragm Pumps, Metering Pumps, Centrifugal Pumps)	Butterfly, swing or other check, motor-operated valve, ball, solenoid, pneumatically actuated valve

C.5.4 Water Storage Tanks

Fixed steel tanks used for storing conditioned remedy-produced water will be designed in accordance with American Water Works Association Standard D-100 (2011). Foundations will be designed in accordance with the structural criteria described in Section C.3 above. Frac tanks used for storing remedy-produced water will be fabricated of welded steel and equipped with axles and wheels to enable them to be moved. Corrosion prevention measures will be applied to all tanks, including internal coatings. Permanent metal tank(s) will also have internal and external cathodic protection except for ethanol tanks mounted on saddle-type supports.

C.5.5 Secondary Containment

Secondary containment systems will be sized and designed in conformance with NFPA standards and California Fire Code (2010). In general, key design criteria are:

- Containment Volume
  - Secondary containment for a single container (tank) will be 110 percent of the primary container. Secondary containment for multiple containers will be 100 percent of the largest container's volume or 10 percent of the aggregate volumes of all containers, whichever is greater. In addition to the aforementioned, secondary containment systems open to rainfall will also be sized to accommodate spillage from the largest single tank at a minimum plus a 24-hr rainfall, as determined by a 25-yr storm. All secondary containment systems open to fire sprinkler discharge will also be sized to accommodate the discharge from all sprinkler heads over the secondary containment system for 20 minutes.
- Containment Construction and Drainage
  - Secondary containment will be constructed using materials capable of containing a spill or leak for at least as long as the period between monitoring inspections. Drainage can be accomplished through the use of one of the following methods:
    - Liquid-tight sloped or recessed floors in indoor locations or similar areas in outdoor locations
    - Liquid-tight floors in indoor locations or similar areas in outdoor locations provided with liquid- tight raised or recessed sills or dikes
    - Sumps and collection systems (e.g., collection sump)
    - Drainage systems leading to an approved location
    - Other approved engineered systems
  - Collection systems will be equipped with a monitoring system to monitor level in containment sumps. Upon detection of fluids in the sump an alarm will be initiated to alert the operators of a potential release.
- Overfill Protection
  - A means of providing overfill protection for primary container will be required. This may be an overfill prevention device and/or an attention getting high level alarm.
- Separation of Materials
  - Materials that in combination may cause a fire or explosion, or the production of a flammable, toxic, or poisonous gas, or the deterioration of a primary or secondary container will be separated in both the primary and secondary containment so as to avoid intermixing.

C.5.5.1 Remedy-produced Water Conditioning Plant and Associated Tank Farm Areas

The Remedy-produced Water Conditioning Plant will contain hazardous materials (caustic, acids, etc.) and the A-side Remedy portion of the plant will process water streams with known or suspected contamination. The conditioned water tank farm area will be equipped with the capability for local neutralization using caustic or acids. Therefore, these areas (see Figure 3.5-1) will be designed with the following secondary containment and monitoring systems:

- Area 1 – The influent storage tank farm area will have secondary containment constructed with concrete, coated with epoxy, and equipped with a collection sump and a sump pump that pumps to either the Influent

Storage Tanks or the Compressor Station Wastewater Tank.[2] The destination will be selected manually. A level switch mounted in the sump will issue an alarm when liquids are detected.

- Area 2 – The remedy-produced water conditioning system will have secondary containment constructed with concrete, coated with epoxy, and equipped with a sump and a sump pump that pumps to the Influent Storage Tanks or the TCS Cooling Tower Blowdown line (which connects to the Compressor Station Wastewater Tank). Sump monitoring will be accomplished via a level switch and alarm.
- Area 3 – The conditioned water tank farm area will have secondary containment constructed with concrete, coated with epoxy, and equipped with a sump and a sump pump that pumps to the TCS Cooling Tower Blowdown line or the Influent Storage Tanks. Sump monitoring will be accomplished via a level switch and alarm.

C.5.5.2 Truck Loading/Unloading Areas

There will be three truck loading/unloading stations with one at the MW-20 Bench, one at the Transwestern Bench, and one at the Compressor Station. Each truck loading/unloading area will be equipped with a secondary containment system constructed of epoxy-coated concrete, transfer pumps, pipes or hoses for connecting to the trucks, and sumps and sump pumps. The sumps will have level switches that will alarm in the event of a spill.

C.5.5.3 Equipment Decontamination Pads

Consistent with the EIR mitigation measure CUL-1a-9, the existing decontamination pad at the Transwestern Bench will be reused during remedy implementation. This pad will be repaired and equipped with a collection sump and a sump pump that pumps to the Remedy-produced Water Conditioning Plant at the Compressor Station.

Two new equipment decontamination pads will be installed for use by the project; one is located inside TCS adjacent to the Remedy-produced Water Conditioning Plant, and one is located at Moabi Regional Park within the main construction yard.

The new decontamination pad inside TCS will be constructed in the footprint of the Contingent Freshwater Pre-Injection Treatment System. It will be equipped with a collection sump and a sump pump that pumps to the influent tank farm of the water conditioning plant.

C.5.6 Septic and Plumbing System

The bathrooms in the Operations Building at the Transwestern Bench will be connected to a new leach field. The work will follow San Bernardino County Department of Public Health Environmental Services Division requirements (note that PG&E is currently seeking a variance from the setback requirement for the leach field; the outcome of this request for variance will be reported to the agencies).

Fresh water will be supplied for use in the onsite laboratory and sample preparation area in the Remedy-produced Water Conditioning Plant building. Washbasins or sinks in the laboratory will be drained to a double-contained tank specifically for storing the fluids. The contained fluids can be pumped to the Remedy-produced Water influent storage tanks or to the TCS wastewater tank, or be disposed of off-site.

The Remedy-produced Water Conditioning building will include rain water downspouts with spill out fittings to outside splash blocks for surface runoff, and plant water piping with wash-down hose bibs and connections for flushing of the chemical feed systems.

Information regarding emergency eyewashes and showers are provided below:

- The station located inside the Remedy-produced Water Conditioning Plant will be in the chemical storage area and near the sample room.

[2] The Wastewater Tank receives wastewater from the Oil/Water Separator and other sources of non-oily wastewater streams such as the cooling tower blowdown. Water from the Wastewater Tank is pumped directly to the TCS evaporation ponds.

- The stations at the MW-20 Bench and Transwestern Bench will be located inside the Carbon Amendment Buildings.

C.5.7 Fire Protection Equipment

The Remedy-produced Water Conditioning Plant at the Compressor Station and the Operations at the Transwestern Bench are unclassified, as described by NFPA 820; hence, only fire hydrants for fire protection are required. No fire and explosion hazard, materials of construction and ventilation requirements are listed in NFPA 820 for these facilities. The California Building Code 2013 does not require the buildings to be equipped with sprinklers; however, PG&E risk assessment requires a sprinkler system in both the Operations and Carbon Amendment buildings on the Transwestern Bench, as well as the Carbon Amendment building on the MW-20 Bench.

Portable fire extinguishers will be mounted in buildings in accordance with PG&E requirements and County Fire codes. Portable fire extinguishers will be ABC multipurpose dry chemical type UL-rated 20A:120B:C.

All electrical equipment will have Underwriters Laboratory approval where applicable. Areas of the electrical installation will be classified in accordance by Class, Division, and Group. Specifically, for the IRZ facilities at the MW-20 Bench and the Transwestern Bench, the following will apply:

- Class I, Division I within a 5-ft radius of the carbon storage tank vents.
- Class I, Division II within a 15-ft radius of the carbon storage tank vents (from vent elevation to ground).
- Class I, Division II from ground surface to 18-inches above grade within a 10-ft radius of the tank footprint.
- Class I, Division II within a 15-ft radius of the existing concrete decontamination pad at the Transwestern Bench.
- Class I, Division II within the carbon amendment building where there are pipes with >10% ethanol.

C.5.8 Heating, Ventilation, and Air Conditioning

The new heating, ventilation, and air conditioning (HVAC) systems in planned remedy facilities are independent of the existing Compressor Station HVAC system. The design criteria for makeup air and temperature control for the laboratory/office and motor control center (MCC) rooms are as follows:

- Office/ sampling room: Summer temperature <86 degrees F with no control for humidity. Makeup ventilation rate at 0.15 cubic feet per minute (cfm) per square foot or 15 cfm/person by code requirements.
- MCC Room: Summer temperature <90 degrees F with no control for humidity.

Wall-mounted ductless mini-split heat pumps will serve the rooms. A second, 100 percent capacity redundant unit will be installed for the Office/laboratory space. Wall mounted ductless mini-split heat pumps have two main components: an outdoor compressor/condenser and an indoor air-handling unit. Each unit will be capable of both cooling and heating the space. A conduit that houses the power cable, refrigerant tubing, suction tubing, and a condensate drain links the outdoor and indoor units. The indoor units will be mounted on the upper part of the room wall. Each unit will be sized per the heating and cooling requirements of each room.

For ventilation air in the Office/ sampling room space, a 60 cfm exhaust fan will be installed with either inlet door louvers or by undercutting the door to transfer outside air from the filter room.

Outside of the office/ sampling room and MCC room, the first and second floors of the remedy-produced water conditioning system will be naturally ventilated by constructing the building with no walls on three sides of the first floor (north, east and west), a wall on the north side with louvers, and a steel grating on the second floor adjacent to the filters and outside the MCC room and laboratory/office.

C.5.9 Air Pollution Control

Temporary and permanent mobile and fixed equipment emissions will comply with Clean Air Act - USC §§ 7401, et seq. (National Emission Standards for Hazardous Air Pollutants [NESHAP]); 40 Code of Federal Register (CFR) 61; 40 CFR 63 and local air district requirements (e.g., Mojave Desert Air Quality Control District).

C.5.10 Hazardous Materials Storage

The Hazardous Materials Division of the San Bernardino County Fire Department is the Administering Agency and the CUPA for San Bernardino County with responsibility for regulating hazardous materials handlers, hazardous waste generators, underground storage tank facilities, aboveground storage tanks, and stationary sources handling regulated substances. The handling and management of hazardous materials within the remedy facilities (e.g., the remedy-produced water conditioning facility) located within the Compressor Station will be incorporated into the existing Compressor Station Hazardous Materials Business Plan (HMBP). A separate HMBP will cover the handling and management of hazardous materials at remedy facilities located outside of the Compressor Station (e.g., MW-20 Bench, Transwestern Bench).

Chemicals that are anticipated to be used in remedy processes and stored on site are listed below with location:

- Potential chemicals to be used and stored in the Remedy-produced Water Conditioning System at the Compressor Station include the following:
  - 25% sodium hydroxide (caustic), to be stored in a 550-gallon tank
  - 19% hydrochloric acid, to be stored in a 550-gallon tank
  - A coagulant (e.g., Nalco Ultrion 8187) for aiding in settling solids in the Conditioning System
  - A flocculent addition (e.g., Nalco® 7878 Flocculant [anionic type]) to aid in the dewatering of the influent tank bottoms prior to pumping to the liquid phase separators (the need for this dewatering aid and flocculent type would have to be tested during operations)
  - Laboratory reagents (to be used in the sampling room located inside the conditioning building) and related waste
- Potential chemicals to be used and stored at the carbon amendment facilities include the following:
  - Carbon substrate (95% ethanol and 5% isopropyl alcohol) – one 15,000-gallon tank located at the MW-20 Bench and one 3,000-gallon tank located at the Transwestern Bench
  - Acids, caustics, and/or dispersants for use in the Clean-In-Place (CIP) systems at the MW-20 Bench and Transwestern Bench (330-gallon totes or smaller-volume drums). The potential chemicals are hydrochloric, glycolic (hydroxyacetic), and phosphoric acids, sodium hydroxide, and hydrogen peroxide

Potential chemicals to be used in well maintenance include hydrochloric acid, sulfamic acid, sulfuric acid, phosphoric acid, hydroxyacetic acid, acetic acid, citric acid, oxalic acid, ascorbic acid, hydrogen peroxide, sodium hypochlorite, sodium hydroxide, chlorine dioxide, potassium hydroxide, polyphosphate, Aqua Clear™ PFD, Rodine-103/Rodine 213, QC-21, CB4, NuWell 120, NuWell 130, nitrogen, and/or carbon dioxide. These materials will be brought on site during the well maintenance/rehabilitation activities, but will not be permanently stored on site.[3]

C.6 Electrical

In this section, the electrical design criteria and goals are described. Electrical systems and equipment will be designed to meet PG&E standards and the California Electrical Code (2010) unless specifically noted. The new Remedy electrical power distribution system will receive power from a single source; potential sources of power are under evaluation by PG&E. Regardless of its source, electrical power will be distributed to the project loads at

[3] For additional details, see the Operations and Maintenance Manual, Volume 1, Section 4, Exhibit 4.2-5.

the Transwestern Bench, the Remedy-produced Water Conditioning Plant at the Compressor Station, the MW-20 Bench, and three distribution locations for wells.

C.6.1 Safety, Availability, Reliability, and Efficiency

Of paramount importance is the need to minimize electrical hazards to operating personnel, including shock, arc flash, electrical fire, and combustion of explosive atmospheres. This is accomplished by applying electrical equipment within its ratings and in accordance with the electrical, fire, and life safety codes listed herein. Every 480 volt and above disconnect will have provisions for lock-out tag-out. This will provide safe working for equipment that may not be in view of the breaker handle. Where possible, the breaker handles will be in view of the connected load for additional safety.

A portable, rental backup generator of similar make and model of the existing generator (Isuzu Model 6WG1X) will be mobilized onsite as needed during project implementation to provide power. A connection panel is included in the 90% design (see BOD Report Appendix D, Drawing E-00-51, Detail 4) and space has been reserved for the portable rental generator (see Figure 3.5-1).

The power distribution system will include energy management features, such as real-time power and energy monitoring, which can be used in conjunction with process data to optimize process efficiency.

C.6.2 Distribution Voltage Selection

The project's standard distribution systems include the following:

- 12.47 kV, ungrounded delta, 3-phase, 3-wire
- 480Y/277 volts solidly grounded wye, 3-phase, 4-wire
- 240/120 volts solidly grounded wye, 1-phase, 3-wire
- 208/120 volts solidly grounded wye, 3-phase, 4-wire

The distribution voltages used throughout the project will be selected to reduce maximum load flows to levels below standard electrical equipment capacity ratings, to increase the distance that it may be transmitted, to reduce fault duty to levels standard electrical equipment withstand and interrupting ratings, and to minimize the cost of the electrical installation. Exhibit C.6-1 lists the equipment utilization voltages.

EXHIBIT C.6-1
Equipment Utilization Voltages
Groundwater Remedy Basis of Design Report/Pre-Final (90%) Design
PG&E Topock Compressor Station, Needles, California

Equipment	Volts	Phase
Fluorescent Lighting	120	Single, in office areas
Incandescent Lighting	120	Single
High-Intensity Discharge Lighting	120 or 240	Single
Other lighting	120	Single
Convenience Outlets	120	Single
Motor Control	120	Single
Motors, less than 1/2 horsepower (hp)	120	Single
Motors, 1/2 hp and above	480	Three

C.6.2.1 Voltage Drop

Total voltage drop from the transformer secondary to the point of utilization, including feeder, branch circuit, and transformation, will not exceed:

- Lighting - 3 percent
- Motors - 5 percent
- Receptacles - 5 percent
- Electric Heaters - 5 percent

Voltage dip calculations will be performed for motor starting whenever an individual motor exceeds 20 horsepower or if the motor is the longest or shortest distance from the transformer.

C.6.2.2 Demand Factors

The demand factors listed in Exhibit C.6-2 will be used for sizing power switchboards, MCCs, panelboards, and transformers. Connected load will be used for circuit and equipment sizing in accordance with NEC requirements. A 10 to 20 percent spare capacity will be provided at MCCs and panelboards. In accordance with the NEC, where it is unlikely that two or more coincident loads will be in use simultaneously, only the largest load(s) that will be in operation at one time will be used for calculating the total load of a feeder.

EXHIBIT C.6-2
Demand Factors
Groundwater Remedy Basis of Design Report/Pre-Final (90%) Design
PG&E Topock Compressor Station, Needles, California

Service	Demand Factor
Lighting	1.0 x Connected Load
Emergency Lighting	1.0 x Connected Load
Air Conditioning Equipment	1.0 x Connected Load
Ventilation Equipment	1.0 x Connected Load
Drainage Pumps and Ejectors	1.0 x Connected Load
Convenience Receptacles	180 VA each [a]
Process Loads	1 x Full Load Amps of loads plus 25% of largest motor

Notes:
a. Apply NEC demand factor of 50% for totals over 10 kW
VA = volt-amperes

C.6.2.3 Metering

Multifunction digital meters will be provided for the MCC in the Remedy-produced Water Conditioning Plant.

C.6.2.4 Branch Circuits

- Connected load and NEC requirements will be used for sizing branch circuit breakers and conductors.
- A minimum wire size of No. 12 American wire gauge (AWG) copper will be used for lighting and receptacle branch circuits. There will be NO common neutral for multiple lighting circuits.
- In general, lighting branch circuit loads will be limited to 1,500 watts. Lighting and receptacle branch circuits will not be combined, and the number of convenience receptacles on any one branch circuit will be limited to five duplex in process areas, and six duplex in office areas.
- The electrical design will include a circuit and raceway schedule providing unique names and termination location information for each power, control, and signal circuit.

C.6.2.5 Panelboards

- Branch circuits or feeders on the drawings will identify the panelboard and device protecting the individual circuit or feeder.
- Each panelboard will be equipped with a minimum of 20 percent spare breakers with spaces, bus work, and terminations to complete the standard size panelboard.
- Panelboard schedules will be prepared indicating circuit identification, protective device trip rating, number of poles, load in volt-amps by phase, rating of main lugs or main circuit breaker, neutral bus size, ground bus size, and the integrated short circuit rating of the panelboard.

C.6.2.6 Uninterruptible Power Supply

Uninterruptible power supply (UPS) will be provided for each control panel. The UPS output will be automatically selected through an automatic bypass relay.

C.6.2.7 Motor Control and Protection

Safety interlocks, such as emergency stop pushbuttons, will be hardwired directly to motor control circuits. Process controls and interlocks will be hardwired from Supervisory Control and Data Acquisition (SCADA) system programmable logic controllers (PLCs) to motor starters. Electrical metering data will be transmitted from intelligent motor overloads and relays to the SCADA system over an Ethernet network. Elementary (ladder-type) control diagrams will be prepared for each motor showing control wiring, pilot devices, auxiliary contacts, and external connections. A single diagram will be used for more than one motor having the same control.

In addition, the following guidelines will be used:

- Adjustable overload relays will be provided for all MCC-mounted and remote mounted constant-speed motor controllers. MCC-type construction will be used.
- MCCs located in the same room with the switchboard that powers them will not have a main circuit breaker. MCCs located in areas remote from the common MCC or switchboard that powers them will have a main circuit breaker.
- MCC enclosures will be NEMA 1 gasketed. Circuit breakers 225 amps and smaller and motor starters NEMA 4 and smaller will be the cubicle type with auto disconnect of control and motor power conductors.
- MCCs will include feeder circuit breakers and motor starters. Motor starters for motors up to 25 hp will be the full-voltage, non-reversing, combination type with a magnetic-only circuit breaker. Motor starters for motors larger than 25 hp will be the solid-state, soft-start, reduced-voltage, combination type with a magnetic-only circuit breaker.
- Motor starters will include an ON/OFF/AUTO or HAND/OFF/REMOTE selector switch, GREEN motor ON light, RED motor OFF light, and AMBER abnormal condition, fault, or alarm lights, as required. Lights will be the LED push-to-test type. These devices will be mounted on the front of the motor starter control center cubical.

C.6.2.8 Equipment Identification

Process and instrumentation diagram (P&ID) tag numbers will be used for motors, instrumentation and control devices, and other process equipment shown on electrical drawings. This same numbering method will be used to create unique tags for major electrical distribution equipment.

C.6.3 Electrical Equipment

This section discusses general guidelines for the selection and configuration of electrical equipment.

C.6.3.1 Distribution System Equipment

Equipment will be selected with adequate momentary and interrupting capacity for the point in the system where it is used. Series-rated criteria will not be used, except for self-contained equipment. Where practical, phase and ground fault protective devices and device settings will be selected that will function selectively to disconnect that portion of the system that is malfunctioning, and with as little disturbance to the rest of the system as possible.

Distribution equipment criteria include the following:

- 15 kV-class metal-clad switchgear will be specified to provide power distribution selection at the front end of the Remedy system.
- The switches will be interlocked, so only one power feed will be allowed to connect to the system at any given time. There will not be any provisions or need for paralleling systems.
- 15 kV-class cable will connect the transformers together through underground conduit.
- Sectionalizing equipment will allow for individual transformers to be isolated and replaced or repaired.
- The transformers will be distribution style, similar to those used for commercial buildings. The secondary voltage will be 480/277 volt.
- 480-volt MCCs with combination motor starters of the motor circuit protector (MCP) type rated for the available fault current.
  - Starters that are NEMA size 2 (25 hp) and larger will be the solid-state, soft-start type or adjustable-speed drives.
  - MCCs will be hardwired to the PLC for motor control.
  - Field-mounted, maintained, emergency stop push buttons will be hardwired directly to the motor starter.
  - MCCs will be sized to accept future loads and either allow for space in the structures, or floor space for future sections.
- 480-volt and 240/120-volt power distribution and lighting panelboards with molded case, bolt-in, circuit breakers with integrated short-circuit rating suitable for the available fault current.

C.6.3.2 Raceway Systems

Separate ductbanks will be used for the following systems:

- 12.47-kV power distribution
- 480-volt power wiring and 120-volt control wiring
- Communications systems, including Ethernet, low-voltage signal for fire alarm, telephone and data systems, and fiber optic cabling

Special consideration will be given to separation of raceways involving low-level process control signal wiring and power system wiring to minimize the possibility of interference. General guidelines for raceway sizing, selection, and installation are as follows:

- Conduit sizing will be based on Type THW insulation.
- The following minimum sizes will be used:
  - 3/4-inch minimum diameter for conduit not in ductbanks used within buildings or connected directly to the equipment or device.
  - 1-inch minimum diameter for conduit in ductbanks for field interconnection of equipment or buildings.
- Raceways will be a combination of concealed and exposed in process areas.

- Raceways will be concealed in walls and ceilings in control rooms, offices, and areas that have finished interiors.
- PVC-coated rigid galvanized steel conduit will be used for the transition from underground direct burial and under-slab PVC conduit and concrete-encased (in-floor slab) PVC and rigid galvanized steel conduit to exposed rigid galvanized steel conduit. The transition section will extend from 1 foot below grade or top of floor slab or the last foot of conduit in the floor slab, to 6 inches out of the floor slab, concrete encasement, or above grade.
- The number of conduit bends will be limited to an equivalent of 270 degrees on long runs without pull boxes.
- PVC-coated rigid galvanized steel conduit and fittings that are resistant to direct sunlight and include an interior urethane coating will be used in exposed corrosive interior and exterior areas. This conduit will also be used for underground direct-burial. Direct buried conduit will have a 3-inch red colored concrete cap.
- PVC Schedule 40 conduit and fittings will be used for under-slab and concrete-encased ductbanks.
- Rigid galvanized steel conduit and fittings will be used when exposed in interior non-corrosive process and non-process areas, pre-cast concrete utility trenches, and in non-corrosive areas outdoors.
- Flexible, nonmetallic, liquid-tight conduit 4 inches or smaller in size will be used for connections to motors, transformers, etc., as required. Fittings will be PVC-coated in wet or corrosive areas. Length of flexible conduit will be limited to 36 inches.
- Underground conduit routes will be identified with nonmetallic warning tape and tracer wire above underground direct-burial conduits.
- Raceways will be tagged with an engraved plastic or nonferrous metal embossed tag attached to the raceway with a stainless steel wiring. Raceway tags as defined in the plans and conduit schedule will be located at each terminus, pullbox, and at minimum intervals of every 50 feet on exposed raceways (in ceiling spaces and surface-mounted).
- Cable trays will be evaluated for use where appropriate.

C.6.3.3 Wire and Cable

- Stranded copper conductors will be used for all except lighting and receptacle wiring. Solid conductors No. 10 AWG and smaller will be used for lighting and receptacle wiring.
- A minimum conductor size of No. 12 AWG will be used for power and lighting branch circuits. Type THHN/THWN-2 insulation will be used for No. 10 AWG and smaller conductors (conduit will be sized for Type THW conductors). Type XHHW-2 insulation will be used for No. 8 AWG and larger conductors (conduit will be sized for THW conductors). Conductor ampacity ratings of 75°C will be used for sizing conductors.
- A minimum conductor size of No. 14 AWG will be used for individual 120-volt control circuits.
- A minimum conductor size of No. 14 AWG will be used for 120-volt control circuits routed in a common conduit with the power conductors to the motor circuit controls. Combining individual motor power and control conductors in a common conduit will be done up to a maximum power conductor size of No. 2 AWG.
- Power and control conductors will be color-coded. Conductors No. 8 AWG and smaller will have colored insulation. Conductors No. 6 AWG and larger will be color-coded with tape at each end and at accessible intermediate points.
- Conductors and control cables will be tagged with a permanent sleeve or nylon marker plate attached with a nylon strap. Conductor tags with an approved tag number will be provided by the Contractor and will be located in accessible locations at each termination.

- Under normal conditions, the maximum wire size will be limited to 500 kcmil. Parallel conductors will be used for circuits requiring greater capacity.
- The 120-volt control circuits will be combined in control cables containing multiple No. 14 AWG stranded copper conductors with type THHN insulation and a common PVC outer jacket.
- A 600-volt multi-circuit control cable will be used where grouping control circuits is practical, and the number of individual wires exceeds six conductors. When selecting control cable size, 25 percent spare (plus or minus 10 percent) conductors will be used.
- Multi-conductor control cable color-coding will be ICEA S-61-402 Appendix K, Method 1, Table K-2.
- Low-voltage analog signal circuits will be routed in 600-volt single twisted shielded pair instrumentation control cables. The cables will consist of No. 16 AWG stranded copper conductors with combination PVC/nylon insulation, drain wire, shield, and PVC outer jacket. Signal circuits may be combined in multi-twisted shielded pair instrumentation control cables with common overall shield. The cables will consist of No. 18 AWG minimum stranded copper conductors, with a combination PVC/nylon insulation, pair and common drain wires, pair and common shields, and PVC outer jacket. Instrumentation control cables will be in accordance with ICEA S-82-552. Low-voltage analog signal circuits will not be routed in the same control cable or conduit with 120-volt control or power circuits.
- Adequate separation of power and instrumentation and control (I&C) wiring will be provided to avoid signal interference.
- Shielded power cables will be used between adjustable-frequency drives and the driven motor.

C.6.3.4 Color Coding

Conductor insulation colors will be as shown in Exhibit C.6-3.

EXHIBIT C.6-3
System Color Coding
Groundwater Remedy Basis of Design Report/Pre-Final (90%) Design
PG&E Topock Compressor Station, Needles, California

System	Conductor	Color
All Systems	Ground	Green
208Y/120 Volts	Neutral	White
	Phase A	Black
	Phase B	Red
	Phase C	Blue
240/120 Volts	Neutral	White
	Phase L1	Black
	Phase L2	Red
480Y/277 Volts	Neutral	White
	Phase A	Brown
	Phase B	Orange
	Phase C	Yellow
12.47 kV	Phase A	Phase A
	Phase B	Phase B
	Phase C	Phase C

C.6.3.5 Circuit Identification

Circuit names will be assigned based on the device or equipment at the load end of the circuit. Circuits will be identified at each termination and in accessible manholes and pull boxes. Plastic sleeves for conductor No. 3 AWG or smaller and plastic marker plates for larger conductors will be used. For lighting circuits, the panel and circuit number will be identified for each fixture.

C.6.3.6 Enclosures

NEMA 1 enclosures will be used for equipment in electrical rooms and finished areas, while NEMA 12 enclosures will be used for electrical equipment in dry industrial locations. NEMA 3R enclosures will be used for outside and in wet locations, and NEMA 4X enclosures will be used for corrosive locations. NEMA 4 enclosures will be used for underground and in wet locations.

C.6.3.7 Fiber Optic Cabling

Where used, fiber optic cabling will be installed either in conduit (4-inch-diameter minimum with three 1 ¼-inch inner ducts), or in a cable tray. Routing of the raceway system will provide for large-radius turns to prevent breaking of the fiber optic cable.

C.6.3.8 Convenience Receptacles

General-service duplex receptacles will not be spaced more than 25 feet apart in process areas. Receptacles will be surface-mounted on walls or columns. Weatherproof receptacles will be installed in damp areas or areas subject to washdown.

Outlet-mounted ground-fault circuit-interrupters (GFCIs) will be provided where required by the NEC. Panelboard or feed-through-type devices will not be used.

C.6.3.9 Low Voltage AC Induction Motors

Enclosures for both horizontal and vertical motors 25 hp and smaller will be totally enclosed, fan-cooled (TEFC) severe-duty for indoor and outdoor locations. In wet and/or corrosive locations, chemical industry severe-duty (CISD-TEFC) motors will be used. Motors larger than 25 hp will be open drip-proof, unless TEFC or CISD-TEFC is required for specific conditions (evaluated on a case-by-case basis considering cost and required physical protection). Submerged motors will be totally submersible, air- or oil-sealed. Bearings will be rated for 100,000-hour Anti-Friction Bearings Manufacturers' Association (AFBMA) B-10 life.

Alternating current (AC) induction motors will be the premium efficiency type with the following:

- Motors will have a 1.15 service factor at 50 degrees Celsius ambient, except where inverter-duty rated.
- NEMA design letter to fit the application (usually NEMA design B), and locked rotor kV-amps kVA Code G or lower.
- Motor windings will be copper wire.
- Motors 15 hp and larger located in damp or wet areas will be provided with 115-volt space heaters to prevent moisture condensation.
- TEFC motors will be equipped with weep holes and drain plugs to withdraw condensed moisture.
- Motors operated by variable frequency drives (VFDs) will be specified with special provisions for inverter duty operation.

C.6.4 Electrical Systems Analysis

An analysis of the fault current was done during the 90% design. Maximum fault current was analyzed with sufficient accuracy to establish the required interrupting ratings of circuit protective devices specified.

During construction, a final load flow, short circuit, coordination, and arc flash hazard analysis will be performed by the Project Engineer, based on actual equipment purchased, to establish protective device settings that will result in reasonable selectivity of device operation for both three-phase and ground faults, while minimizing the arc flash hazard to workers. The following protective device characteristics will be specified:

- Protective relay model, pickup, and time delay settings
- Circuit breaker model, frame size, trip unit, trip settings, and time delay settings
- Current transformer ratios

Arc flash labels will be placed on the installed electrical equipment.

C.6.5 Grounding System

An integrated grounding system will be installed throughout the new remedial facilities and interconnected with the existing grounding system at the Compressor Station. A lightning protection system will be connected to the facility ground ring as well as to any exposed metallic surfaces.

Grounding electrode ground mats or embedded rods and cables will be designed for a maximum resistance to ground of 25 ohms. Where more than one rod is required, rods will be installed at least 20 feet apart. A minimum of No. 4/0 AWG stranded bare copper cable will be used for interconnecting to ground rods and footing rebar.

A lightning protection system will be designed with air terminals and separate grounding system on buildings or structures used for operations and maintenance and chemical storage, including shade structures. Shade structures, if isolated from electrical equipment, may not be required to have lightning protection.

Equipment Grounding

A separate ground conductor sized in accordance with NEC requirements will be installed in raceways for power feeders and branch circuit raceways for motor control, lighting, and receptacle loads.

Shields of shielded instrumentation cables will be grounded to the ground bus at the power supply for the analog or low-voltage discrete signal circuit. Shielded instrumentation cables will not be grounded at more than one point.

C.6.6 Hazardous and Corrosive Area Definition

Area classification are shown on the drawings at the 90% design stage.

C.6.7 Energy Efficiency and Lighting

Energy efficiency will be a factor in equipment selection. Motors will be specified to be Premium Efficient per latest NEMA MG 1 standard where possible. Lighting equipment and facilities for safe operations will be designed to be energy efficient and comply with California Title 24 and county lighting ordinances. In compliance with EIR mitigation measure CUL-1a-7, to minimize construction and operations-related lighting impacts, the lighting for the remedy will include the following features: (1) shrouding/shielding for portable lights during construction and operational activities; (2) installation of portable lights at the lowest allowable height and in the smallest number feasible to maintain adequate night lighting for safety; and (3) shielding and orientation of lights such that off-site visibility of light sources, glare, and light from construction activities are minimized to the extent feasible. In addition, no additional permanent poles will be installed for lighting.

C.6.7.1 General Lighting Requirements

Since CUL-1a-7 is not meant to replace or subsume any actions required by the County or state or federal entities with regard to lighting required for minimum security and safety purposes, the following specifications will also be met:

- Construction Industry 29 CFR 1926.56 (lighting safety requirements)
- General Industry 29 CFR 1910.120 (HAZWOPER) (lighting safety requirements)
- San Bernardino County Code Title 8 Section § 83.07.040 Glare and Outdoor Lighting - Mountain and Desert Regions

- Mohave County Outdoor Light Control Ordinance 87-1
- Specific requirements from land owners, if feasible and is not in conflicting with the mitigation measures and county codes

The San Bernardino County lighting requirements are divided into two categories: residential and commercial/industrial. Remedy facilities are located both on and outside of PG&E-owned land, as follows:

- PG&E parcel (zoned industrial) – Compressor Station and Transwestern Bench
- Outside of PG&E parcel (zoned recreational) – Federally-owned land (including MW-20 Bench), the Havasu National Wildlife Refuge, and Fort Mojave Indian Tribe-owned land

PG&E will apply industrial requirements on the PG&E parcel and residential requirements outside of the PG&E parcel. The rationale for installing lights outside of the PG&E parcel is as follows:

Well Sites

- Nighttime access is not necessary; therefore no permanent lights will be installed. No new permanent light poles will be installed.
- Portable or truck-mounted lights can be brought in the event that an emergency or unforeseen condition occurs and plugged in locally.
- At the freshwater supply well site (HNWR-1A), security camera poles will have lights to allow for remote viewing of the well site during night time.

MW-20 Bench

- Similar to the IM-3 Brine Storage Facilities located at the MW-20 bench, nighttime access is not normally required. Exterior lights will be installed but activated manually.
- No new permanent light poles will be installed.

In both Mohave and San Bernardino Counties, the lighting requirements are intended to reduce glare or other light emissions on adjacent properties. Exhibit C.6-4 lists San Bernardino County shielding requirements for different types of fixtures in residential and commercial areas.

Fixtures prohibited by the County Code will not be used on the project. Fixtures planned for use in the remedy project are listed in Exhibit C.6-5. Fixtures used at the Compressor Station will comply with County requirements and follow PG&E standards for energy efficiency and lighting at operating facilities.

EXHIBIT C.6-4

Shielding Requirements For Outdoor Lighting In the Mountain Region and Desert Region

Groundwater Remedy Basis of Design Report/Pre-Final (90%) Design

PG&E Topock Compressor Station, Needles, California

Fixture Lamp Type	Residential Area Shielded	Commercial/Industrial Area Shielded
Low pressure sodium	Fully	Fully
High pressure sodium	Prohibited except fully shielded on streets	Fully
Metal halide	Prohibited	Fully
Fluorescent	Fully	Fully
Quartz	Prohibited	Fully
Incandescent > 60 watts	Fully	Fully
Incandescent 60 watts or less	No requirement	No requirement
Glass tubes filled with neon, argon, or krypton	No requirement	No requirement
Mercury vapor	Prohibited	Fully
Halogen	Prohibited	Fully
Searchlights for advertising purposes	Prohibited	Prohibited
Laser source light or similar light intensity light for advertising purposes	Prohibited when projected above the horizontal	Prohibited when projected above the horizontal

Source: San Bernardino County Development Code, Ch. 83.07.040 Table 83-7. Note that LED lights (a low energy form) may be suitable for the Remedy. This technology is not covered in the County Code.

EXHIBIT C.6-5

Planned Fixtures for Remedy and Associated County Requirements For Outdoor Lighting

Groundwater Remedy Basis of Design Report/Pre-Final (90%) Design

PG&E Topock Compressor Station, Needles, California

Fixture Lamp Type	Shielding Requirement	Type Used in Remedy Project?
Low pressure sodium	Fully	Indoors/Outdoors
Fluorescent	Fully	Indoors
Incandescent > 60 watts	Fully	Indoors
Incandescent 60 watts or less	No requirement	Indoors
LED	No requirement (not covered in the County Code)	Indoors

Source: San Bernardino County Development Code, Ch. 83.07.040 Table 83-7.

The amount of light or the illumination level is based on having sufficient light to do the expected tasks safely. OSHA sets standards for construction activities as shown on Exhibit C.6-6.

EXHIBIT C.6-6
Minimum Illumination Intensities
Groundwater Remedy Basis of Design Report/Pre-Final (90%) Design
PG&E Topock Compressor Station, Needles, California

Level (foot-candles)	Area of Operation
5	General construction area lighting.
3	General construction areas, concrete placement, excavation and waste areas, access ways, active storage areas, loading platforms, refueling, and field maintenance areas.
5	Indoors: warehouses, corridors, hallways, and exit ways.
5	Tunnels, shafts, and general underground work areas. (Exception: minimum of 10 foot-candles is required at tunnel and shaft heading during drilling, mucking, and scaling. Bureau of Mines approved cap lights shall be acceptable for use in the tunnel heading.)
10	General construction plant and shops (e.g., batch plants, screening plants, mechanical and electrical equipment rooms, carpenter shops, rigging lofts and active store rooms, mess halls, and indoor toilets and workrooms.)
30	First aid stations, infirmaries, and offices.

Source: Safety Lighting Levels During Construction – OSHA 29 CFR 1926.56(a) Table D-3.

For activities and areas not included under the OSHA standard, the ANSI/IES has established recommended illumination levels under Recommended Practice RP-07-01 (see Exhibit C.6-7).

EXHIBIT C.6-7
Recommended Illumination Levels per ANSI/IES RP-07-01
Groundwater Remedy Basis of Design Report/Pre-Final (90%) Design
PG&E Topock Compressor Station, Needles, California

Category	Description	Level
A	Public spaces	3 fc (30 lux)
B	Simple orientation for short visits	5 fc (50 lux)
C	Working space where simple visual tasks are performed	10 fc (100 lux)
D	Performance of visual tasks of high contrast and large size	30 fc (300 lux)
E	Performance of visual tasks of high contrast and small size, or tasks of low contrast and large size	50 fc (500 lux)
F	Performance of visual tasks of low contrast and small size	100 fc (1,000 lux)
G	Performance of visual tasks of critical importance	300 – 1,000 fc (3,000 – 10,000 lux)

Notes:
fc=foot-candles
1 fc ≈ 10 lux

C.6.7.2 Lighting Calculations

The recommended illumination level (foot-candles) for each space will be calculated in accordance with IES procedures. The following assumptions will be made, unless specific information is available:

Reflectances for finished rooms:

- Ceilings: 80 percent reflectance
- Walls: 50 percent reflectance
- Floors: 20 percent reflectance

Reflectances for unfinished rooms:

- Ceilings: 50 percent reflectance
- Walls: 30 percent reflectance
- Floors: 10 percent reflectance

Maintenance factor (light loss factor):

- Fluorescent lighting: 0.80

C.6.7.3 Emergency Lighting System

- Emergency illumination will be provided in appropriate spaces, as required by code to provide life safety, property, and equipment protection.
- Adequate lighting levels will be provided to maintain safe building egress and critical process plant functions. Emergency lighting will be located near MCCs and any equipment locations that need to be monitored on a continuing basis.
- In large process areas, emergency standby lighting units with a battery pack and two lamps and lighted exit signs with a battery pack will be provided. The battery pack will power the lights for at least 90 minutes.

C.6.7.4 Explosion-Proof Luminaires

Any room or space listed as a hazardous atmosphere area will have explosion-proof-type luminaires UL listed for installation in the hazardous area classifications, as required by Article 500 of the NEC.

C.6.7.5 Nighttime Construction Lighting

The first step will be to determine whether nighttime construction work is required. Nighttime construction-related activities will be limited to work that cannot be disrupted or suspended until the following day, such as, but not limited to, well drilling and development or decommissioning activities. If nighttime construction is required, the following principles will be applied:

- Identify the active area for construction and the applicable lighting standards. Only areas of active construction may be illuminated.
- Obtain portable lighting (including solar-powered). Lights must include shielding/shrouding (e.g., downward facing fixtures with cutoff shields to reduce light diffusion). No permanent poles will be installed for nighttime lighting.
- Install the minimum lighting feasible to maintain adequate night lighting for safety at the lowest allowable height. Orient the lights such that off-site visibility of light sources, glare, and construction activities is limited.
- Assign a responsible member of the construction crew, such as foreman or crew boss, to extinguish the lighting as soon as the nighttime construction work is completed.

C.6.8 Communications

Fiber optic cable or conventional copper wire will be used for sending signals via cable. Wireless communications devices like radio, satellite, or cellular, may be used as appropriate.

C.6.9 Existing Utilities

A utility survey was conducted in early 2012, and utility potholing were conducted in 2013 and 2014 to support the remedy design. A survey of aboveground and underground utilities will be conducted within all work areas prior to beginning intrusive site work and construction activities, including maintaining a minimum 25-foot right-of-way for the L300 gas pipelines located near occupied buildings. Existing engineering drawings have been reviewed to identify areas of potential conflict, but are for planning purposes only, not solely relied upon. See also Section C.2.2, Earthwork.

C.7 Instrumentation and Control

The I&C system for the project will utilize a stand-alone Remedy SCADA system and local PLCs. The Remedy SCADA system will be located at the Operations Building (Transwestern Bench) and will provide monitoring, supervisory control, alarming, and control functions. The Remedy SCADA includes hardware (e.g., servers, PCs, touch screen panels) and software. Historian software will collect, archive and distribute project-wide raw data and provide access to historical data.

In general, emergency shutdown of equipment due to alarm conditions (low discharge flow, high discharge pressure, motor overload, pump seal water failure, high level vault alarms, etc.) will be hardwired and will occur remotely or be executed locally. These alarm conditions will require manual reset at the SCADA or the local digital controller. In conformance with the EIR mitigation measure CUL-1a-6, all additional phone calls and alarms associated with remediation activities or facilities will not be routed through PG&E's existing alarm system utilized at the Compressor Station. The notification system for remediation-related alerts and/or phone calls will not introduce additional noise to the project area, to the maximum extent feasible, provided there is ongoing compliance with applicable safety regulations or standards of the Federal Energy Regulatory Commission, Occupational Safety and Health Administration, and other agencies.

There are 6 control nodes equipped with a PLC to control equipment in the field. Node PLCs will have operator interface terminals. The operator interface will include sufficient access to modify system set-points, parameters, alarms limits, and indication of associated process variables and instruments. This data will also be available to the Remedy SCADA system for full remote control, alarming, trending, archiving, etc.

Each PLC switch will be connected to the Operations Building's gigabit capable Ethernet backbone switch. The fiber cable will be run from the Operations Building communication panel to remote communication panels and onto each remote PLC. The fiber cable will be multimode or single mode as applicable, consisting of 12 fibers per cable. All fiber cables will be color coded, labeled and terminated at a fiber interconnect panel.

The system has been designed to allow for isolation/removal of components that could fail from operational sequencing, thereby minimizing downtime. Full redundancy of the Remedy SCADA system was determined to be unnecessary. System outage in individual area is expected to be repaired and put back into service within two to three days given an appropriate inventory of parts and skilled staff availability.

Power Distribution to Instrument Power Panel

All control power for each node PLC will be supplied by a control panel. The control panel shall be fed from the area primary distribution transformer. All I&C power for field devices or panels will be sourced from the control.

Uninterruptible Power Supply

The UPS will be double conversion "true online" and configured with an automatic bypass switch for battery maintenance. The UPS will provide power to the PLC, 24-volt DC power supply, Digital Input/Digital Output (DI&DO) cards, and analyzer power.

Power System Monitoring/Control from SCADA

Power distribution panels, motor control centers, and communications panels will be supplied with digitally networked power metering devices for remote energy monitoring and control. Primary distribution equipment and selected secondary equipment will be supplied with electrically actuated circuit breakers or contactors which will be available for remote position monitoring and alarming as well as remote manual and automatic control via the SCADA system. Automatic sequencing for restarting of equipment after restoration of power will be provided through SCADA.

C.8 Architectural

Building and all infrastructure components will conform to the following. Specifics for the Remedy-produced Water Conditioning Plant, Transwestern Bench Operations Building, and Transwestern Carbon Amendment Building are noted:

All Buildings (Water Conditioning, TW Bench Operations, TW Bench Carbon Amendment):

- Exterior finishes: In conformance with the EIR mitigation measure AES-1d and AES-2e, the color of the wells, pipelines, reagent storage tanks, control structures, and utilities shall consist of muted, earth-tone colors that are consistent with the surrounding natural color palette. Matte finishes shall be used to prevent reflectivity along the view corridor. Integral color concrete should be used in place of standard gray concrete.
- The design, location, and physical appearance and character of new construction at the Topock Compressor Station will be consistent with existing buildings in scale, form, materials, and architectural detail.
- In keeping with the Secretary of the Interior's Standards for the Rehabilitation of Historic Buildings, the new construction will be differentiated from existing historic architecture on the property, but will be compatible with the historic materials, features, size, scale and proportion, and massing to protect the integrity of the Topock Compressor Station and its environment.
- Floors: In process areas these will be reinforced cast-in-place concrete and aluminum grates where required for liquid containment. In containment areas, a chemical resistant polymer coating will be applied to concrete floor and containment basin surfaces. Six-inch housekeeping pads at equipment locations.
- Doors and frames: Heavy-gauge hollow metal doors and frames will be used. Hardware to be of heavy gauge and made of stainless steel where practical. Windows: Aluminum framed windows with a clear anodized finish. Energy efficient insulated tempered glass with a low-E coating. Extensive use of day lighting through windows.
- Louvers: Aluminum drainable louver with a clear anodized finish.
- Fire protection: Fire extinguishers as required per building and fire codes including NFPA 10. Pedestrian doors: Field finished with polyurethane and epoxy finish coating.

Specific design features for the Remedy-produced Water Conditioning Plant:

- Doors from the exterior into the facility and the interior door into the groundwater sampling equipment room will receive a tempered glass window.
- Interior finishes: Epoxy paint over gypsum board and concrete masonry unit (CMU). Clear sealer at concrete not covered with polymer containment coating. All paint to be off-white to promote a bright space where light can reach areas behind equipment.
- Overhead sectional doors: An 18-foot wide by 12-foot high heavy-gauge steel overhead sectional door with perforations to allow for air movement. Overhead door to be manually operated.
- Exterior wall assemblies: Exposed concrete on the lower floor. Insulated metal siding on the upper floor with Kynar finishes to match existing adjacent buildings.
- Structural steel framing: Steel framing to be finished with an epoxy primer and polyurethane finish coating at the upper floor of the remedy building. Exposed steel structure of the lower floor of the remedy building to hot-dip galvanized.

- Interior walls and ceilings: Metal studs with Batt insulation where separating conditioned and non-conditioned spaces. Wall to be built on a concrete curb and receive moisture resistant gypsum board on both sides. Epoxy paint over gypsum board in laboratory room and MCC room, insulation above structural metal deck at metal roof, painted concrete at lower floor ceiling to improve light reflectivity.
- Cabinetry: Wood cabinets with chemical-resistant countertops and stainless steel pulls.
- Floors: Smooth texture and finished with a clear surface sealer to increase the durability of the concrete surface and to maintain a clean, dust-free environment.
- Roof: Insulated metal roof with continuous ridge vent and Kynar light colored finishes to match existing adjacent buildings.
- Fire Protection: portable fire extinguishers.

Specific design features for the TW Bench Operations Building:

- Floors: Operations building to have a utilitarian – level polished concrete floor to minimize life cycle costs.
- Roof: Standing seam metal similar to Remedy Produced Water Conditioning Plant.
- Fire Protection: In addition to portable fire extinguishers, an automatic fire sprinkler system is provided.
- Interior wall finish to be semi-gloss sheen over gypsum board. Clear sealer at ground and polished concrete. All paint to be off-white to promote a bright space where light can reach areas behind equipment. Cabinetry to be of plastic laminate covered wood overlay construction with plastic laminate countertops.
- Structural steel framing to be of hot-dip galvanized steel when exposed.

Specific design features for the TW Bench Carbon Amendment Building:

- Floors: Process areas to receive chemical resistant polymer coatings.
- Roof: Standing seam metal similar to Remedy Produced Water Conditioning Plant.
- Structural steel framing to be of hot-dip galvanized steel.
- Fire Protection: In addition to portable fire extinguishers, an automatic fire sprinkler system is provided.
- Interior surfaces to be epoxy paint over CMU. Clear sealer at concrete not covered with polymer chemical containment coating. All paint to be off-white to promote a bright space where light can reach areas behind equipment.

C.9 PG&E Personnel Requirements

PG&E personnel will perform the following activities during construction:

- PG&E personnel, or their designee, will lead TCS-specific safety and biological and cultural sensitivity training for contractors and employees.
- Serve as liaison and primary contact for any agency, tribal, or other third party personnel inspecting and/or monitoring construction and O&M activities.
- Serve as liaison and primary contact for community, stakeholders, agencies, Tribes, members of the press, and others requesting site tours or project-related information.
- Initiate communications with/notifications to agencies, land owners, and others, as required, in the event of emergencies or contingency triggers.
- Attend stand-up tailboard (safety) meetings before the start of work each day to review safety policies and specific hazards likely to be encountered in the day’s activities.
- Sign waste manifest forms and compliance documents that require PG&E certification.

- Monitor for compliance with PG&E safety standards and requirements and contract specifications, terms, and conditions.

C.10 Health and Safety

The project falls under federal Occupational Safety and Health Administration (OSHA) Hazardous Waste Operations and Emergency Response (HAZWOPER) requirements (29 CFR 1910.120) so these procedures must be followed in addition to California and Arizona state requirements.

These requirements are embodied in the project-specific health and safety plan(s) for construction and O&M. In addition, health and safety work plans will be prepared or amended by construction, drilling and other service contractors working on the project. Existing health and safety plans will be reviewed and amended, as needed, to suit new project requirements and/or conditions. PG&E personnel similarly work under PG&E's own health and safety requirements. These health and safety plans will be available onsite and will describe such things as training, site control, medical surveillance, safety personnel roles and responsibilities, personnel protective equipment, exposure monitoring and air sampling programs, heat and cold stress, and site work rules and procedures.

Project-specific health and safety plans for construction and O&M activities are provided in the Construction/Remedial Action Work Plan and Volume 5 of the O&M Manual.

C.11 Noise

- A design margin of 3 to 5 A-weighted decibels (dB[A]) will be considered in all noise design criteria.
- In conformance with the EIR mitigation measures NOISE-3 and CUL-1a-10, the operational noise design criteria for the project will be per San Bernardino County Development Code 83.01.080 for acceptable exterior noise standards for place of worship, which is 55 dB(A) Leq daytime (7 a.m.-10 p.m.) and 45 dB(A) Leq nighttime (10 p.m.-7 a.m.) (Leq is the equivalent average hourly noise level) (see page 4.9-24 of the EIR [DTSC 2011]). The noise measurement locations will be at the edge of the Maze closest to the subject facilities and at the short-term ambient noise measurement locations (ST-1, ST-2, and ST-3) in Exhibit 4.9-2 of the certified EIR (DTSC 2011).
- For remedy facilities in Arizona, the operational noise design criteria will be 60 dB daytime and 50 dB nighttime average at closest residences (per current Mohave General Plan, Exhibit V-5, Maximum Noise Levels for Various Land Use (Freilich, Leitner & Carlisle 2010).
- For remedy facilities on the Refuge, the operational noise design criteria will be 60 dB.
- For remedy facilities located on the Compressor Station and within PG&E property, the operational noise design criteria will be consistent with the noise environment at the Station, per San Bernardino County Development Code 83.01.080 for industrial land use, 70 dB(A).
- The construction noise criteria will conform to San Bernardino Development Code and Mojave County standards, as well as the EIR mitigation measures NOISE-1, -2, and -3. Per San Bernardino County Code Division 3 Chapter 83.01.080, temporary construction, maintenance, repair, or demolition activities between 7:00 a.m. and 7:00 p.m., except Sundays and federal holidays, are exempt from noise limits.

C.12 References

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California Department of Transportation (Caltrans). 2002. *Caltrans Manual for Encroachment Permits on California State Highways*. Seventh Edition. January.

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Freilich, Leitner & Carlisle. 2010. *Mohave County, Arizona General Plan*. Original adoption March 10, 1995; revised November 15, 2010. Online: http://resources.mohavecounty.us/File/PlanningAndZoning/General%20Plan/General%20Plan%20Approved%20093011%20Master.pdf

U.S. Department of the Interior (DOI). 2013. Remedial Action/Remedial Design Consent Decree (CD) between the United States of America and Pacific Gas & Electric Company. Case 5:13-cv-00074-VAP-OP, Document 5-1. Filed January 15.

Topock Remediation Design

Load Calculations for L-300 pipe

Background

The boneyard area south of the Topock Compressor Station will be backfilled with soil to create an embankment and access area to the proposed Remedy Produced Water Conditioning Building as shown on TCS Civil Site Plan (Drawing C-10-01 from the 60% design). Up to eight feet of fill will be added on top of the existing L-300 pipe that crosses through this area. The depth of cover over this pipe varies. According to PG & E personnel, there is only one foot of cover on the L-300 pipe (30 inch diameter) in certain areas. An analysis is needed to determine whether the L-300 pipe will be detrimentally affected short term by construction operations or long term by dead loads due to increased cover on top of the pipe.

Analysis

Information on the L-300 pipeline is incomplete. While we know the pipe diameter and material, we don't know the pipe thickness, yield strength or whether the pipe is lined and/or coated. For this reason, pipeline analysis was conducted for a number of different pipe thicknesses and yield strengths. The pipe thicknesses and yield strengths were selected based upon a review of PG & E Document A-34 and matching them to the Maximum Allowable Operating Pressure of 660 psi (from PG & E staff). The selected pipes are:

- API 5L X42 (yield stress 42,000 psi) with thicknesses of 0.406, 0.438 and 0.469
- API 5L X52 (yield stress 52,000 psi) with thicknesses of 0.375, 0.406 and 0.438
- API 5L X60 (yield stress 60,000 psi) with thicknesses of 0.375, 0.406 and 0.438

Each of these pipes has different pressure ratings based on % of maximum yield stress. This is presented in Table 1. PG & E Utility Standard TD-4127S establishes a procedure determining this percentage based on compliance requirements in accordance with 49 CFR § 192.5, "Class Locations". The class location for this area is unknown and the determination of class is outside the scope of this analysis.

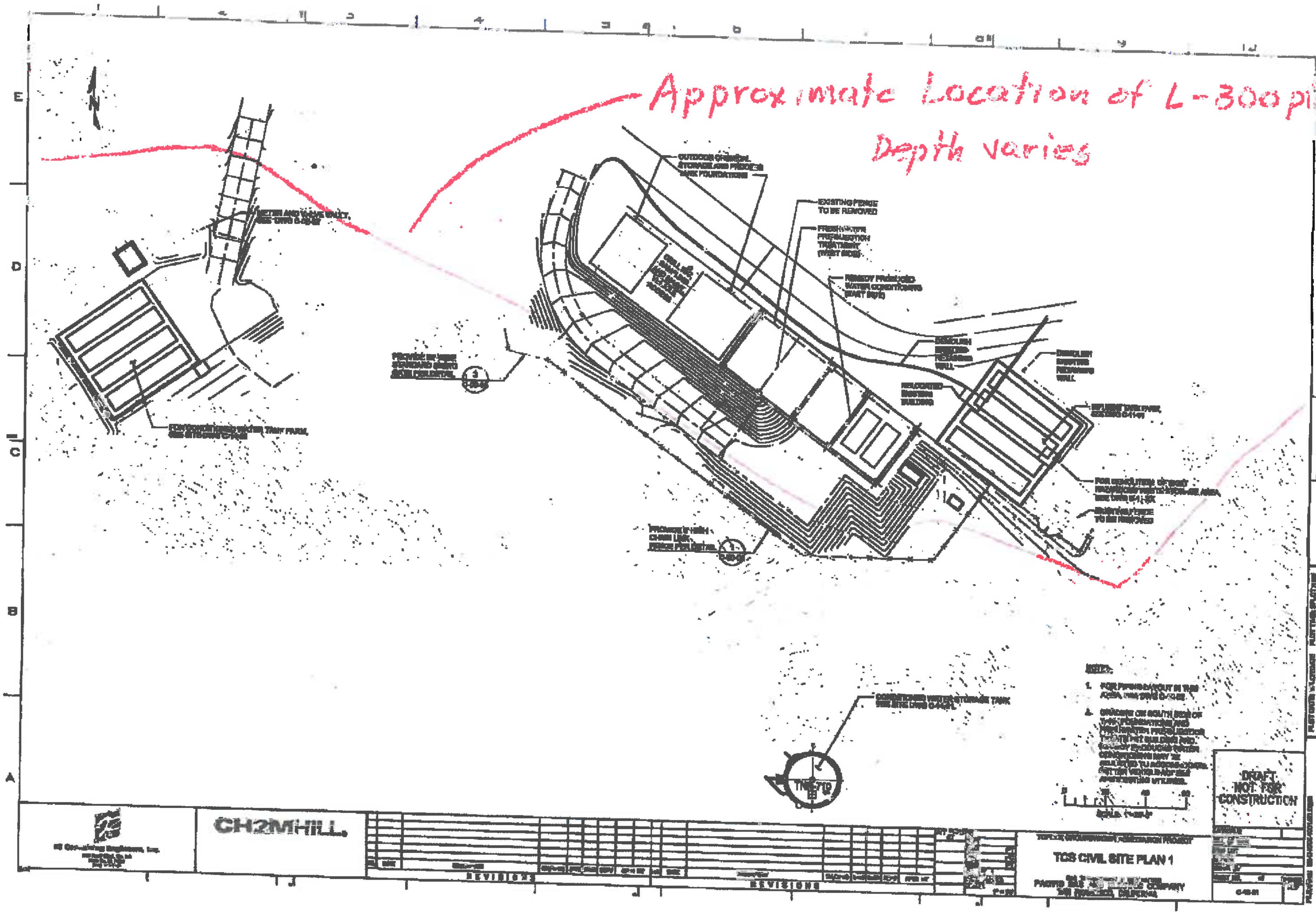
The L-300 pipe was analyzed in accordance with AWWA M-11, Steel Pipe Design Manual. The following data and assumptions were utilized during analysis:

- Minimum cover = 1' (during construction operations)
- Maximum cover = 13' (5' of existing cover plus 8' of backfill placed on top)
- Soil Weight = 120 pcf (from Geotechnical Investigation for Topock AOC 4)
- Soil Classification = SM (from Geotechnical Investigation for Topock AOC 4 boring logs)
- Compaction of existing soil = 85%
- Water table is substantially below the pipe, so buoyancy effects can be neglected
- Deflection Lag Factor = 1.0 (Long term deflections are offset by internal hydrostatic pressure)

BY PT, E2 Consulting Engineers, July 2013

- Steel pipe with linings and coatings that are **not** comprised of mortar
- Steel pipe modulus of elasticity = 30,000,000 psi
- Transverse moment of inertia (per unit length of pipe wall) = $t^3/12$
- Soil reaction modulus (for 13' calculations) = 1,000 psi (from Table 6-1 in AWWA M-11, based on 85% relative compaction, coarse grained soils and 10-15' depth of cover)
- Soil reaction modulus (for 1' calculations) = 600 psi (from Table 6-1 in AWWA M-11, based on 85% relative compaction, coarse grained soils and 2-5' depth of cover)
- Live loads are negligible at 8 feet of cover and greater, so they were not considered in the analysis with 13' of cover
- Live loads are based on large loaders with dual wheels, weighing approximately 127,000 lbs with 42,300 lbs per wheel.

Results from the analysis are presented in Tables 2 through 7. It is recommended that cover on the L-300 pipe be increased to a minimum of 3' prior to construction to protect the pipe during construction activities. The analysis for this condition is contained in Tables 6 and 7.


Approximate Location of L-300 pipe
Depth varies
EXISTING FENCE TO BE REMOVED
CH2MHILL
TCS CIVIL SITE PLAN 1
DRAFT NOT FOR CONSTRUCTION
REVISIONS

Extreme External Loading Conditions

Worst case is 1' minimum cover of pipe subjected to heavy equipment loading during construction

Assume the following:

- Live load from a large loader
- Total weight = 127,000 lbs
- Weight on one set of dual wheels, P = 42,300 lbs
- Tire pattern is 44" x 24"

Calculation:

Tire pattern: 44/12 x 24/12 = 3.66 x 2 = 7.33 sq ft (for dual wheels)

Surface pressure: 42,300 lbs/7.33 sq ft = 5,768 psf

If height of cover = 1', then determine coefficients for modified Boussinesq equation (Table 6-4 in AWWA M-11 – Steel Pipe Design Manual)

A = 3.66/1, B = 2/1

m = A/H = 3.66/1 = 3.66

n = B/H = 2/1 = 2.00

from Table 6-4, Influence coefficient = 0.23833

Then P = 0.23833 x 4 x 5,768 = 5,498 psf

Dead load for 1' of cover = 120 pcf / 1' = 120 psf

Combined dead load and live load

= 5,498 + 120 = 5,618 psf = 468.2 lbs per inch of pipeline length = 39.0 psi

If height of cover = 3', then determine coefficients for modified Boussinesq equation (Table 6-4 in AWWA M-11 – Steel Pipe Design Manual)

A = 3.66/3, B = 2/3

m = A/H = 3.66/3 = 1.22

n = B/H = 2/3 = 0.67

from Table 6-4, Influence coefficient = 0.152

Then P = 0.152 x 4 x 5,768 = 3507 psf

Dead load for 3' of cover = 3*120 pcf / 1' = 360 psf

Combined dead load and live load

= 3,507 + 360 = 3,867 psf = 322.3 lbs per inch of pipeline length = 26.9 psi

Table 1
Steel Pipe Pressure Ratings

API 5L Pipe Grade	Wall Thickness (in)	Pressure % of SMYS Piping							
		Class Location		1	2	3	4		
		100%	90%	72%	60%	50%	40%	30%	20%
X42	0.406	1137	1024	819	683	569	455	342	228
X42	0.438	1227	1104	884	736	614	491	368	246
X42	0.469	1314	1182	946	788	657	526	394	263
X52	0.375	1300	1170	934	780	650	520	390	260
X52	0.406	1408	1267	1014	845	704	563	423	282
X52	0.438	1519	1367	1091	912	760	608	456	304
X60	0.375	1500	1350	1080	900	750	600	450	300
X60	0.406	1624	1462	1170	975	812	650	488	325
X60	0.438	1752	1577	1262	1052	876	701	526	351

Values in Table are from Pacific Gas and Electric Document A-34, Attachment B, Piping Design and Test Requirements
SMYS = Specified Maximum Yield Stress which corresponds to API Pipe Grade (X42 = 42,000 psi yield stress)

Shaded areas indicate the pipe grades, wall thickness and pressure conditions which are rated higher than the maximum allowable operating pressure for the L-300 pipeline

Table 2
Summary of Pipe Deflections for L-300 Pipeline based on 13 feet of cover
(Dead Loads only, Live Loads neglected)

API 5L Pipe Grade	Wall Thickness (in)	Horizontal Deflection, Δx (in)	% Horizontal Deflection	% Horizontal Deflection < 5%
X42	0.406	0.294	0.98%	yes
X42	0.438	0.264	0.88%	yes
X42	0.469	0.237	0.79%	yes
X52	0.375	0.325	1.08%	yes
X52	0.406	0.294	0.98%	yes
X52	0.438	0.264	0.88%	yes
X60	0.375	0.325	1.08%	yes
X60	0.406	0.294	0.98%	yes
X60	0.438	0.264	0.88%	yes

Deflection Lag Factor (D_l) = 1
Bedding Constant (K) = 0.1
Load per unit length (W)= 325 lbs/in
Pipe radius (r) = 15 in
Modulus of Elasticity (E) = 30000000 psi
Moment of Inertia (I) = $t^3/12$ in^3
Modulus of Soil (E') = 1000 psi

Horizontal Deflection from Iowa deflection formula by Marston
% Horizontal Deflection = Δx/pipe dia = Δx/30
Allowable Deflection = 5% of 30 inches = 1.5 inches

Table 3

Summary of Buckling Pressures for L-300 Pipeline with 13 feet of cover

API 5L Pipe Grade	Wall Thickness (in)	Buckling Pressure (psi)	Load (psi)	Load < Buckling Pressure
X42	0.406	199.1	10.8	yes
X42	0.438	223.1	10.8	yes
X42	0.469	247.2	10.8	yes
X52	0.375	176.7	10.8	yes
X52	0.406	199.1	10.8	yes
X52	0.438	223.1	10.8	yes
X60	0.375	176.7	10.8	yes
X60	0.406	199.1	10.8	yes
X60	0.438	223.1	10.8	yes

Factor of Safety (FS) = 2

Pipe Diameter (D) = 30 in

Water Buoyancy Fact. (R_W) = 1.0

Coeff of Elastic Support (B') = 0.79943

Modulus of Elasticity (E) = 30000000 psi

Moment of Inertia (I) = $t^3/12$ in^3

Modulus of Soil (E') = 1000 psi

Table 4
Summary of Pipe Deflections for L-300 Pipeline based on 1 feet of cover
(Dead Loads plus Live Loads)

API 5L Pipe Grade	Wall Thickness (in)	Horizontal Deflection, Δx (in)	% Horizontal Deflection	% Horizontal Deflection < 5%
X42	0.406	1.358	4.53%	yes
X42	0.438	1.184	3.95%	yes
X42	0.469	1.036	3.45%	yes
X52	0.375	1.547	5.16%	no
X52	0.406	1.358	4.53%	yes
X52	0.438	1.184	3.95%	yes
X60	0.375	1.547	5.16%	no
X60	0.406	1.358	4.53%	yes
X60	0.438	1.184	3.95%	yes

Deflection Lag Factor (D_l) =	1	
Bedding Constant (K) =	0.1	
Load per unit length (W)=	1170.5	lbs/in
Pipe radius (r) =	15	in
Modulus of Elasticity (E) =	30000000	psi
Moment of Inertia (I) =	$t^3/12$	in^3
Modulus of Soil (E') =	600	psi

Horizontal Deflection from Iowa deflection formula by Marston
% Horizontal Deflection = Δx/pipe dia = Δx/30
Allowable Deflection = 5% of 30 inches = 1.5 inches

Table 5
Summary of Pipe Deflections for L-300 Pipeline based on 1 feet of cover
(Dead Loads plus Live Loads)

API 5L Pipe Grade	Wall Thickness (in)	Buckling Pressure (psi)	Load (psi)	Load < Buckling Pressure
X42	0.406	83.8	39.0	yes
X42	0.438	93.9	39.0	yes
X42	0.469	104.1	39.0	yes
X52	0.375	74.4	39.0	yes
X52	0.406	83.8	39.0	yes
X52	0.438	93.9	39.0	yes
X60	0.375	74.4	39.0	yes
X60	0.406	83.8	39.0	yes
X60	0.438	93.9	39.0	yes

Factor of Safety (FS) = 2
Pipe Diameter (D) = 30 in
Water Buoyancy Fact. (R_W) = 1.0
Coeff of Elastic Support (B') = 0.23626
Modulus of Elasticity (E) = 30000000 psi
Moment of Inertia (I) = $t^3/12$ in^3
Modulus of Soil (E') = 600 psi

Table 6

Summary of Pipe Deflections for L-300 Pipeline based on 3 feet of cover

(Dead Loads plus Live Loads)

API 5L Pipe Grade	Wall Thickness (in)	Horizontal Deflection, Δx (in)	% Horizontal Deflection	% Horizontal Deflection < 5%
X42	0.406	0.935	3.12%	yes
X42	0.438	0.815	2.72%	yes
X42	0.469	0.713	2.38%	yes
X52	0.375	1.065	3.55%	yes
X52	0.406	0.935	3.12%	yes
X52	0.438	0.815	2.72%	yes
X60	0.375	1.065	3.55%	yes
X60	0.406	0.935	3.12%	yes
X60	0.438	0.815	2.72%	yes
Deflection Lag Factor (D_l) =		1		
Bedding Constant (K) =		0.1		
Load per unit length (W)=		805.6	lbs/in	
Pipe radius (r) =		15	in	
Modulus of Elasticity (E) =		30000000	psi	
Moment of Inertia (I) =		$t^3/12$	in^3	
Modulus of Soil (E') =		600	psi	
Horizontal Deflection from Iowa deflection formula by Marston				
% Horizontal Deflection = Δx/pipe dia = Δx/30				
Allowable Deflection = 5% of 30 inches = 1.5 inches				

Table 7

Summary of Pipe Deflections for L-300 Pipeline based on 3 feet of cover

(Dead Loads plus Live Loads)

API 5L Pipe Grade	Wall Thickness (in)	Buckling Pressure (psi)	Load (psi)	Load < Buckling Pressure
X42	0.406	97.8	26.9	yes
X42	0.438	109.6	26.9	yes
X42	0.469	121.4	26.9	yes
X52	0.375	86.8	26.9	yes
X52	0.406	97.8	26.9	yes
X52	0.438	109.6	26.9	yes
X60	0.375	86.8	26.9	yes
X60	0.406	97.8	26.9	yes
X60	0.438	109.6	26.9	yes
Factor of Safety (FS) =		2		
Pipe Diameter (D) =		30	in	
Water Buoyancy Fact. (R_W) =		1.0		
Coeff of Elastic Support (B') =		0.32140		
Modulus of Elasticity (E) =		30000000	psi	
Moment of Inertia (I) =		$t^3/12$	in^3	
Modulus of Soil (E') =		600	psi	

Freshwater Injection/ Remedy-Produced Water Collection/ Conditioned Remedy Water Distribution and Disposal Hydraulic Network Modeling Calculations from EPANET Software

Topock Remediation Design

Hydraulic Analysis of Freshwater Injection System

The piping for the freshwater injection system on the Topock Remediation project was sized from simulations of a hydraulic network model of the system. The hydraulic network model of the freshwater injection system proposed for Topock remediation was constructed using EPANET. EPANET is software that models water distribution piping systems. EPANET tracks the flow of water at each pipe, the pressure at each node, pumping heads and levels of water in tanks and reservoirs. Chemical species can be tracked, although that was not needed for the freshwater system at Topock.

Pipe junctions, reservoirs and tanks are represented as nodes. A listing of nodes is contained on the following pages. Pipes, pumps and valves are represented as links. A listing of links is contained on the pages following the node listing. A map showing the location of all nodes and links is attached separately.

The piping routes and corridors have been approved by the client, Pacific Gas & Electric; however, they are subject to change pending stakeholder and regulatory review. The following summary describes the development of the hydraulic model:

Junction nodes, tanks and wells (modeled as pumps attached to an underground reservoir) have been located on the plan and profile sheets for the 90% submittal. Some liberties were taken with underground reservoir (well) locations to make the node and link map more legible, however, this did not affect the accuracy of the analysis as exact coordinates were used in model simulations. A summary of the model development is as follows:

Ground elevations for pipe junctions, reservoirs, wells and tanks are taken from the 90% plan and profile sheets, which were based on the Toponex aerial survey.

Pipe lengths have been taken off from plan and profile drawings.

Probable maximum flows are used for demands. The following demands are used:

- Freshwater Injection Well no. 1 (FW-1, node 122) = 200 gpm
- Freshwater Injection Well no. 2 (FW-2, node 406) = 100 gpm
- Inner Recirculation Loop Well no. 1 (IRL-1, node 124) = 0 gpm during the maximum condition
- Inner Recirculation Loop Well no. 2 (IRL-2, node 126) =200 gpm during the maximum condition
- Inner Recirculation Loop Well no. 3 (IRL-3, node 128) = 200 gpm during the maximum condition
- Inner Recirculation Loop Well no. 4 (IRL-4, node 132) = 200 gpm during the maximum condition
- Transwestern bench service (node 133) = 5 gpm during maximum condition
- MW-20 bench service (node 111) = 5 gpm during maximum condition
- TCS Loop Injection Well no. 1 (TCS-1, node 411) = 13.5 gpm
- TCS Loop Injection Well no. 2 (TCS-2, node 409) = 13.5 gpm

Inner Loop injection wells no 3 and 4 and TCS loop injection wells no. 1 and 2 are normally fed with carbon amended water from the floodplain extracted wells, but will be designed to accept freshwater as a backup measure.

Injection wells will be fed from a pressure reducing valve (PRV). Minimum pressure upstream of the PRV is to be 5 psi.

There are three potential sources of supply for the freshwater injection system. All are wells located, or to be located, in Arizona (where water quality is more suitable for freshwater injection). A new 12 inch diameter transmission main is proposed to connect these wells to a new freshwater storage tank at Topock Compressor Station (TCS). Most likely only one of the three wells will ultimately be used to supply the remediation project. Since it has not been determined which well will be used, all three wells were modeled individually to determine their suitability for supplying the freshwater injection system.

- Existing Havasu National Wildlife Refuge well (HNWR-1 well, node 300 and pump 300) currently supplies a revegetation project in Topock marsh. A manufacturer's pump curve was used to model this pump. The pumping well level has been observed to be about 410 feet (above sea level) and this was used for the analysis.
- Havasu National Wildlife Refuge well (HNWR-1A well, node 100 and pump 100) would be a new well located approximately 100 feet north of the existing HNWR-1 well. A pumping level of 410 feet (above sea level) has been assumed, similar to the existing well. An input horsepower capable of supplying maximum demands at high water levels in the freshwater storage tank was selected in lieu of manufacturer's pump curve.
- New well at Site B (node 200 and pump 200) located approximately 3500 feet north of HNWR wells. Pumping level of 410 feet was assumed. In lieu of manufacturer's pump curves, an input horsepower was selected that was capable of supplying maximum demands at high water levels in the freshwater storage tank at TCS.

The new freshwater storage tank at TCS is located at a base elevation of 631.50 feet. The tank is 12 foot diameter with a maximum water elevation of 644.50 (13 feet above floor). The tank capacity is approximately 11,000 gallons. Low water level is assumed to be 2 feet and high water level is assumed to be 12 feet for simulations.

New steel pipes were assumed to have a Hazen-Williams C value of 130 and new HDPE and PVC pipes were assumed to have a C value of 150.

Pipe sizing is an iterative process. After the initial simulation, pipe diameters for various segments of pipes are increased or decreased for subsequent simulations until an optimum size is selected for each segment. The criterion used for determining optimum size was based on unit head loss. In general, unit head losses of between 1 to 10 feet per 1,000 foot of pipe length yield the optimal combination of pipe capital cost and pumping energy costs. This was the criteria used to size most of the pipes. The only exceptions to this were for 1) short segments of pipes, such as pumping manifolds and 2) dead end pipes connected to injection wells. In the latter case, there was excess pressure which would have been dissipated in the pressure reducing valve. A larger pipe size does not serve any purpose in this case.

By PT, E2 Consulting Engineers, August 2014

The freshwater system was modeled with a parallel pipe along National Trails Highway and for the IM-3 access road up to IRL-3. Low water levels (in the new freshwater water storage tank) and high water levels were simulated for this configuration. The results from these simulations are contained in the following sections.

The selected piping configuration is capable of transmitting maximum flows and adequate system pressures for any of the three potential wells.

Freshwater Injection System - Junction, Reservoir and Tank Data

Network Table - Nodes

Node ID	Elevation ft	Base Demand GPM	Initial Quality
Junc 101	382	0	0
Junc 102	466	0	0
Junc 103	466	0	0
Junc 104	466	0	0
Junc 105	466	0	0
Junc 106	459	0	0
Junc 107	459	0	0
Junc 108	495	0	0
Junc 109	551	0	0
Junc 110	536	0	0
Junc 111	480	5	0
Junc 112	481	0	0
Junc 113	542	0	0
Junc 114	489	0	0
Junc 115	489	0	0
Junc 116	497	0	0
Junc 117	554	0	0
Junc 118	556	0	0
Junc 119	556	0	0
Junc 120	556	0	0
Junc 121	558	0	0
Junc 121A	558	0	0
Junc 121B	558	0	0
Junc 122	558	200	0
Junc 123	498	0	0

Freshwater Injection System - Junction, Reservoir and Tank Data

Node ID	Elevation ft	Base Demand GPM	Initial Quality
Junc 123A	498	0	0
Junc 123B	498	0	0
Junc 124	498	0	0
Junc 125	551	0	0
Junc 125A	551	0	0
Junc 125B	551	0	0
Junc 126	551	200	0
Junc 127	552	0	0
Junc 127A	552	0	0
Junc 127B	552	0	0
Junc 128	552	200	0
Junc 129	567	0	0
Junc 129A	567	0	0
Junc 129B	567	0	0
Junc 130	567	0	0
Junc 131	557	0	0
Junc 132	557	200	0
Junc 133	537	5	0
Junc 201	382	0	0
Junc 202	479	0	0
Junc 203	479	0	0
Junc 204	479	0	0
Junc 301	382	0	0
Junc 302	466	0	0
Junc 303	466	0	0
Junc 304	459	0	0

Freshwater Injection System - Junction, Reservoir and Tank Data

Node ID	Elevation ft	Base Demand GPM	Initial Quality
Junc 401	632.5	0	0
Junc 402	632	0	0
Junc 403	607	0	0
Junc 403A	607	0	0
Junc 403B	607	0	0
Junc 404	604	0	0
Junc 405	552	0	0
Junc 406	546	100	0
Junc 407	623	0	0
Junc 408	622	0	0
Junc 408A	622	0	0
Junc 408B	622	0	0
Junc 409	584	13.5	0
Junc 410A	619	0	0
Junc 410B	619	0	0
Junc 411	619	13.5	0
Resvr 100	410	#N/A	0
Resvr 200	410	#N/A	0
Resvr 300	410	#N/A	0
Tank 400	631.5	#N/A	0

Freshwater Injection System - Pipe, Pump and Valve Data

Network Table - Links

Link ID	Length ft	Diameter in	Roughness
Pipe 101	84	6	130
Pipe 102	66	6	130
Pipe 103A	89	6	130
Pipe 103B	32	6	130
Pipe 104	22	6	130
Pipe 105	145	12	150
Pipe 106	50	12	150
Pipe 107	4205	12	150
Pipe 108	2111	12	150
Pipe 109	1847	12	150
Pipe 110A	813	8	150
Pipe 110B	813	8	150
Pipe 111A	2608	8	150
Pipe 111B	2608	8	150
Pipe 112A	170	8	150
Pipe 112B	170	8	150
Pipe 113A	1057	6	150
Pipe 113B	1057	6	150
Pipe 114A	1283	6	150
Pipe 114B	1283	6	150
Pipe 115A	225	6	130
Pipe 115B	225	6	130
Pipe 116A	375	6	150
Pipe 116B	375	6	150
Pipe 117A	578	6	150

Freshwater Injection System - Pipe, Pump and Valve Data

Link ID	Length ft	Diameter in	Roughness
Pipe 117B	578	6	150
Pipe 118A	159	6	150
Pipe 118B	159	6	150
Pipe 119	47	6	150
Pipe 120	127	6	150
Pipe 121	881	6	150
Pipe 122A	13	4	150
Pipe 122B	51	4	150
Pipe 123	73	6	150
Pipe 124A	13	4	150
Pipe 124B	51	4	150
Pipe 125	242	6	150
Pipe 126A	13	4	150
Pipe 126B	51	4	150
Pipe 127	70	6	150
Pipe 128A	13	4	150
Pipe 128B	51	4	150
Pipe 129	178	6	150
Pipe 130A	9	6	150
Pipe 130B	15	6	150
Pipe 131	512	6	150
Pipe 132	33	4	150
Pipe 133	44	3	150
Pipe 201	155	6	130
Pipe 202A	89	6	130
Pipe 202B	32	6	130

Freshwater Injection System - Pipe, Pump and Valve Data

Link ID	Length ft	Diameter in	Roughness
Pipe 203	22	6	130
Pipe 204	3652	12	150
Pipe 301	111	6	130
Pipe 302	140	12	130
Pipe 303	41	12	150
Pipe 304	123	12	150
Pipe 400	53	3	150
Pipe 401	24	3	150
Pipe 402	217	3	150
Pipe 403A	21	2	150
Pipe 403B	159	2	150
Pipe 404	196	4	130
Pipe 405	204	2	150
Pipe 406	162	4	150
Pipe 407	716	4	150
Pipe 408A	22	4	150
Pipe 408B	188	4	150
Pipe 409A	208	4	150
Pipe 409B	31	4	150
Pump P100	#N/A	#N/A	#N/A
Pump P200	#N/A	#N/A	#N/A
Pump P300	#N/A	#N/A	#N/A
Valve V501	#N/A	2	#N/A
Valve V502	#N/A	4	#N/A
Valve V503	#N/A	4	#N/A
Valve V504	#N/A	4	#N/A

Freshwater Injection System - Pipe, Pump and Valve Data

Link ID	Length ft	Diameter in	Roughness
Valve V505	#N/A	4	#N/A
Valve V506	#N/A	4	#N/A
Valve V507	#N/A	4	#N/A
Valve V508	#N/A	4	#N/A

Freshwater Injection System
Node and Link Tabulation

Node	Type	Elevation	Demand		Link	Start Node	End Node	Type	Mtl	Length	Dia	"C"	K	Setting
100	Res	410	0		P100	100	101	Pump	Stl	-	6	-		
101	Junc	382	0		101	101	102	Pipe	Stl	84	6	130		
102	Junc	466	0		102	102	103	Pipe	Stl	66	6	130		
103	Junc	466	0		103A	103	104	Pipe	Stl	89	6	130	12.75	
104	Junc	466	0		103B	103	104	Pipe	Stl	32	6	130		
105	Junc	466	0		104	104	105	Pipe	Stl	22	6	130		
106	Junc	459	0		105	105	106	Pipe	HDPE	145	12	150		
107	Junc	459	0		106	106	107	Pipe	HDPE	50	12	150		
108	Junc	495	0		107	107	108	Pipe	HDPE	4205	12	150		
109	Junc	551	0		108	108	109	Pipe	HDPE	2111	12	150		
110	Junc	536	0		109	109	400	Pipe	HDPE	1847	12	150	0.5	
111	Junc	480	5		110A	109	110	Pipe	HDPE	813	8	150		
112	Junc	481	0		110B	109	110	Pipe	HDPE	813	8	150		
113	Junc	542	0		111A	110	111	Pipe	HDPE	2608	8	150		
114	Junc	489	0		111B	110	111	Pipe	HDPE	2608	8	150		
115	Junc	489	0		112A	111	112	Pipe	HDPE	170	8	150		
116	Junc	497	0		112B	111	112	Pipe	HDPE	170	8	150		
117	Junc	554	0		113A	112	113	Pipe	HDPE	1057	6	150		
118	Junc	556	0		113B	112	113	Pipe	HDPE	1057	6	150		
119	Junc	556	0		114A	113	114	Pipe	HDPE	1283	6	150		
120	Junc	556	0		114B	113	114	Pipe	HDPE	1283	6	150		
121	Junc	558	0		115A	114	115	Pipe	Stl	225	6	130		
121A	Junc	558	0		115B	114	115	Pipe	Stl	225	6	130		
121B	Junc	558	0		116A	115	116	Pipe	HDPE	375	6	150		
122	Junc	558	200		116B	115	116	Pipe	HDPE	375	6	150		
123	Junc	498	0		117A	116	117	Pipe	HDPE	578	6	150		
123A	Junc	498	0		117B	116	117	Pipe	HDPE	578	6	150		
123B	Junc	498	0		118A	117	118	Pipe	HDPE	159	6	150		
124	Junc	498	0		118B	117	118	Pipe	HDPE	159	6	150		
125	Junc	551	0		119	118	119	Pipe	HDPE	47	6	150		
125A	Junc	551	0		120	119	120	Pipe	HDPE	127	6	150		
125B	Junc	551	0		121	120	121	Pipe	HDPE	881	6	150		
126	Junc	551	200		122A	121	121A	Pipe	HDPE	13	4	150		

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Freshwater Injection System
Node and Link Tabulation

Node	Type	Elevation	Demand		Link	Start Node	End Node	Type	Mtl	Length	Dia	"C"	K	Setting
127	Junc	552	0		V508	121A	121B	Valve	PVC	-	4	-		10.46
127A	Junc	552	0		122B	121B	122	Pipe	HDPE	51	4	150		
127B	Junc	552	0		123	116	123	Pipe	HDPE	73	6	150		
128	Junc	552	200		124A	123	123A	Pipe	PVC	13	4	150		
129	Junc	567	0		V504	123A	123B	Valve	PVC	-	4	-		10.46
129A	Junc	567	0		124B	123B	124	Pipe	HDPE	51	4	150		
129B	Junc	567	0		125	117	125	Pipe	HDPE	242	6	150		
130	Junc	567	0		126A	125	125A	Pipe	PVC	13	4	150		
131	Junc	557	0		V505	125A	125B	Valve	PVC	-	4	-		10.46
132	Junc	557	200		126B	125B	126	Pipe	HDPE	51	4	150		
133	Junc	537	5		127	118	127	Pipe	HDPE	70	6	150		
200	Res	410	0		128A	127	127A	Pipe	HDPE	13	4	150		
201	Junc	382	0		V506	V127A	V127B	Valve	PVC	-	4	-		10.46
202	Junc	479	0		128B	127B	128	Pipe	HDPE	51	4	150		
203	Junc	479	0		129	119	129	Pipe	HDPE	178	6	150		
204	Junc	479	0		130A	129	129A	Pipe	HDPE	9	6	150		
300	Res	410	0		V507	129A	129B	Valve	PVC	-	6	-		6.62
301	Junc	382	0		130B	129B	130	Pipe	HDPE	15	6	150		
302	Junc	466	0		131	130	131	Pipe	HDPE	512	6	150		
303	Junc	466	0		132	131	132	Pipe	PVC	33	4	150		
304	Junc	459	0		133	110	133	Pipe	HDPE	44	3	150		
400	Tank	631.5	0		P200	200	201	Pump	Stl	-	6	-		
401	Junc	632.5	0		201	201	202	Pipe	Stl	155	6	130		
402	Junc	632	0		202A	202	203	Pipe	Stl	89	6	130	12.75	
403	Junc	607	0		202B	202	203	Pipe	Stl	32	6	130		
403A	Junc	607	0		203	203	204	Pipe	Stl	22	6	130		
403B	Junc	607	0		204	204	106	Pipe	HDPE	3652	12	150		
404	Junc	604	0		P300	300	301	Pipe	Stl	-	6	-		
405	Junc	552	0		301	301	302	Pipe	Stl	111	6	130		
406	Junc	546	100		302	302	303	Pipe	Stl	140	12	130		
407	Junc	623	0		303	303	304	Pipe	Stl	41	12	150		
408	Junc	622	0		304	304	107	Pipe	HDPE	123	12	150		
408A	Junc	622	0		400	400	401	Pipe	HDPE	53	3	150	1	

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Freshwater Injection System
Node and Link Tabulation

Node	Type	Elevation	Demand		Link	Start Node	End Node	Type	Mtl	Length	Dia	"C"	K	Setting
408B	Junc	622	0		401	401	402	Pipe	HDPE	24	3	150		
409	Junc	584	13.5		402	402	403	Pipe	HDPE	217	3	150		
410A	Junc	619	0		403A	403	403A	Pipe	HDPE	21	2	150		
410B	Junc	619	0		V501	403A	403B	Valve	PVC		2	150		10
411	Junc	619	13.5		403B	403B	404	Pipe	HDPE	159	2	150		
					404	404	405	Pipe	Stl	196	4	130		
					405	405	406	Pipe	HDPE	204	2	150		
					406	402	407	Pipe	HDPE	162	4	150		
					407	407	408	Pipe	HDPE	716	4	150		
					408A	408	408A	Pipe	HDPE	22	4	150		
					V502	408A	408B	Valve	PVC	-	4	-		10
					408B	408B	409	Pipe	HDPE	188	4	150		
					409A	408	410A	Pipe	HDPE	208	4	150		
					V503	410A	410B	Valve	PVC	-	4	-		10
					409B	410B	411	Pipe	HDPE	31	4	150		

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New well at HNWR-1A pumping to high water level in new freshwater tank

Network Table - Nodes

Node ID	Demand GPM	Head ft	Pressure psi
Junc 101	0.00	694.34	135.34
Junc 102	0.00	688.82	96.55
Junc 103	0.00	684.48	94.67
Junc 104	0.00	656.25	82.43
Junc 105	0.00	654.80	81.81
Junc 106	0.00	654.55	84.73
Junc 107	0.00	654.47	84.70
Junc 108	0.00	647.22	65.96
Junc 109	0.00	643.58	40.11
Junc 110	0.00	641.44	45.69
Junc 111	5.00	634.67	67.02
Junc 112	0.00	634.23	66.40
Junc 113	0.00	623.21	35.19
Junc 114	0.00	609.83	52.36
Junc 115	0.00	606.78	51.03
Junc 116	0.00	602.87	45.87
Junc 117	0.00	596.84	18.56
Junc 118	0.00	595.87	17.27
Junc 119	0.00	595.38	17.06
Junc 120	0.00	595.01	16.90
Junc 121	0.00	592.47	14.93
Junc 121A	0.00	592.19	14.82
Junc 121B	0.00	582.14	10.46
Junc 122	200.00	581.08	10.00
Junc 123	0.00	602.87	45.44

New well at HNWR-1A pumping to high water level in new freshwater tank

Node ID	Demand GPM	Head ft	Pressure psi
Junc 123A	0.00	602.87	45.44
Junc 123B	0.00	522.14	10.46
Junc 124	0.00	522.14	10.46
Junc 125	0.00	596.14	19.56
Junc 125A	0.00	595.87	19.44
Junc 125B	0.00	575.14	10.46
Junc 126	200.00	574.08	10.00
Junc 127	0.00	595.66	18.92
Junc 127A	0.00	595.39	18.80
Junc 127B	0.00	576.14	10.46
Junc 128	200.00	575.08	10.00
Junc 129	0.00	594.86	12.07
Junc 129A	0.00	594.84	12.06
Junc 129B	0.00	582.28	6.62
Junc 130	0.00	582.23	6.60
Junc 131	0.00	580.76	10.29
Junc 132	200.00	580.07	10.00
Junc 133	5.00	641.44	45.25
Junc 201	0.00	654.55	118.10
Junc 202	0.00	654.55	76.07
Junc 203	0.00	654.55	76.07
Junc 204	0.00	654.55	76.07
Junc 301	0.00	654.47	118.06
Junc 302	0.00	654.47	81.66
Junc 303	0.00	654.47	81.66
Junc 304	0.00	654.47	84.70

New well at HNWR-1A pumping to high water level in new freshwater tank

Node ID	Demand GPM	Head ft	Pressure psi
Junc 401	0.00	641.05	3.71
Junc 402	0.00	640.18	3.54
Junc 403	0.00	635.10	12.17
Junc 403A	0.00	631.55	10.64
Junc 403B	0.00	630.08	10.00
Junc 404	0.00	603.25	-0.32
Junc 405	0.00	601.78	21.57
Junc 406	100.00	567.36	9.25
Junc 407	0.00	640.09	7.41
Junc 408	0.00	639.73	7.68
Junc 408A	0.00	639.73	7.68
Junc 408B	0.00	633.54	5.00
Junc 409	13.50	633.51	21.45
Junc 410A	0.00	639.70	8.97
Junc 410B	0.00	639.70	8.97
Junc 411	13.50	639.70	8.97
Resvr 100	-937.00	410.00	0.00
Resvr 200	0.00	410.00	0.00
Resvr 300	0.00	410.00	0.00
Tank 400	0.00	643.50	5.20

New well at HNWR-1A pumping to high water level in new freshwater tank

Network Table - Links

Link ID	Flow GPM	Velocity fps	Unit Headloss ft/Kft	Status
Pipe 101	937.00	10.63	65.75	Open
Pipe 102	937.00	10.63	65.75	Open
Pipe 103A	937.00	10.63	317.19	Open
Pipe 103B	0.00	0.00	0.00	Closed
Pipe 104	937.00	10.63	65.75	Open
Pipe 105	937.00	2.66	1.72	Open
Pipe 106	937.00	2.66	1.72	Open
Pipe 107	937.00	2.66	1.72	Open
Pipe 108	937.00	2.66	1.72	Open
Pipe 109	127.00	0.36	0.04	Open
Pipe 110A	405.00	2.59	2.63	Open
Pipe 110B	405.00	2.59	2.63	Open
Pipe 111A	402.50	2.57	2.60	Open
Pipe 111B	402.50	2.57	2.60	Open
Pipe 112A	400.00	2.55	2.57	Open
Pipe 112B	400.00	2.55	2.57	Open
Pipe 113A	400.00	4.54	10.43	Open
Pipe 113B	400.00	4.54	10.43	Open
Pipe 114A	400.00	4.54	10.43	Open
Pipe 114B	400.00	4.54	10.43	Open
Pipe 115A	400.00	4.54	13.59	Open
Pipe 115B	400.00	4.54	13.59	Open
Pipe 116A	400.00	4.54	10.43	Open
Pipe 116B	400.00	4.54	10.43	Open
Pipe 117A	400.00	4.54	10.43	Open

New well at HNWR-1A pumping to high water level in new freshwater tank

Link ID	Flow GPM	Velocity fps	Unit Headloss ft/Kft	Status
Pipe 117B	400.00	4.54	10.43	Open
Pipe 118A	300.00	3.40	6.12	Open
Pipe 118B	300.00	3.40	6.12	Open
Pipe 119	400.00	4.54	10.43	Open
Pipe 120	200.00	2.27	2.89	Open
Pipe 121	200.00	2.27	2.89	Open
Pipe 122A	200.00	5.11	20.82	Open
Pipe 122B	200.00	5.11	20.82	Open
Pipe 123	0.00	0.00	0.00	Open
Pipe 124A	0.00	0.00	0.00	Open
Pipe 124B	0.00	0.00	0.00	Open
Pipe 125	200.00	2.27	2.89	Open
Pipe 126A	200.00	5.11	20.81	Open
Pipe 126B	200.00	5.11	20.82	Open
Pipe 127	200.00	2.27	2.89	Open
Pipe 128A	200.00	5.11	20.81	Open
Pipe 128B	200.00	5.11	20.82	Open
Pipe 129	200.00	2.27	2.89	Open
Pipe 130A	200.00	2.27	2.89	Open
Pipe 130B	200.00	2.27	2.88	Open
Pipe 131	200.00	2.27	2.89	Open
Pipe 132	200.00	5.11	20.81	Open
Pipe 133	5.00	0.23	0.09	Open
Pipe 201	0.00	0.00	0.00	Open
Pipe 202A	0.00	0.00	0.00	Open
Pipe 202B	0.00	0.00	0.00	Closed

New well at HNWR-1A pumping to high water level in new freshwater tank

Link ID	Flow GPM	Velocity fps	Unit Headloss ft/Kft	Status
Pipe 203	0.00	0.00	0.00	Open
Pipe 204	0.00	0.00	0.00	Open
Pipe 301	0.00	0.00	0.00	Open
Pipe 302	0.00	0.00	0.00	Open
Pipe 303	0.00	0.00	0.00	Open
Pipe 304	0.00	0.00	0.00	Open
Pipe 400	127.00	5.76	46.18	Open
Pipe 401	127.00	5.76	36.45	Open
Pipe 402	100.00	4.54	23.41	Open
Pipe 403A	100.00	10.21	168.72	Open
Pipe 403B	100.00	10.21	168.73	Open
Pipe 404	100.00	2.55	7.52	Open
Pipe 405	100.00	10.21	168.73	Open
Pipe 406	27.00	0.69	0.51	Open
Pipe 407	27.00	0.69	0.51	Open
Pipe 408A	13.50	0.34	0.14	Open
Pipe 408B	13.50	0.34	0.14	Open
Pipe 409A	13.50	0.34	0.14	Open
Pipe 409B	13.50	0.34	0.14	Open
Pump P100	937.00	0.00	-284.34	Open
Pump P200	0.00	0.00	0.00	Closed
Pump P300	0.00	0.00	0.00	Closed
Valve V501	100.00	10.21	1.48	Active
Valve V502	13.50	0.34	6.19	Active
Valve V503	13.50	0.34	0.00	Open
Valve V504	0.00	0.00	80.73	Active

New well at HNWR-1A pumping to high water level in new freshwater tank

Link ID	Flow GPM	Velocity fps	Unit Headloss ft/Kft	Status
Valve V505	200.00	5.11	20.73	Active
Valve V506	200.00	5.11	19.25	Active
Valve V507	200.00	5.11	12.56	Active
Valve V508	200.00	5.11	10.05	Active

New well at HNWR-1A pumping to low water level in new freshwater tank

Network Table - Nodes

Node ID	Demand GPM	Head ft	Pressure psi
Junc 101	0.00	684.34	131.00
Junc 102	0.00	678.82	92.21
Junc 103	0.00	674.48	90.33
Junc 104	0.00	646.25	78.10
Junc 105	0.00	644.80	77.48
Junc 106	0.00	644.55	80.40
Junc 107	0.00	644.47	80.36
Junc 108	0.00	637.22	61.62
Junc 109	0.00	633.58	35.78
Junc 110	0.00	631.44	41.36
Junc 111	5.00	624.67	62.69
Junc 112	0.00	624.23	62.06
Junc 113	0.00	613.21	30.86
Junc 114	0.00	599.83	48.02
Junc 115	0.00	596.78	46.70
Junc 116	0.00	592.87	41.54
Junc 117	0.00	586.84	14.23
Junc 118	0.00	585.87	12.94
Junc 119	0.00	585.38	12.73
Junc 120	0.00	585.01	12.57
Junc 121	0.00	582.47	10.60
Junc 121A	0.00	582.19	10.48
Junc 121B	0.00	582.14	10.46
Junc 122	200.00	581.08	10.00
Junc 123	0.00	592.87	41.11

New well at HNWR-1A pumping to low water level in new freshwater tank

Node ID	Demand GPM	Head ft	Pressure psi
Junc 123A	0.00	592.87	41.11
Junc 123B	0.00	522.14	10.46
Junc 124	0.00	522.14	10.46
Junc 125	0.00	586.14	15.23
Junc 125A	0.00	585.87	15.11
Junc 125B	0.00	575.14	10.46
Junc 126	200.00	574.08	10.00
Junc 127	0.00	585.66	14.59
Junc 127A	0.00	585.39	14.47
Junc 127B	0.00	576.14	10.46
Junc 128	200.00	575.08	10.00
Junc 129	0.00	584.86	7.74
Junc 129A	0.00	584.84	7.73
Junc 129B	0.00	582.28	6.62
Junc 130	0.00	582.23	6.60
Junc 131	0.00	580.76	10.29
Junc 132	200.00	580.07	10.00
Junc 133	5.00	631.44	40.92
Junc 201	0.00	644.55	113.76
Junc 202	0.00	644.55	71.73
Junc 203	0.00	644.55	71.73
Junc 204	0.00	644.55	71.73
Junc 301	0.00	644.47	113.73
Junc 302	0.00	644.47	77.33
Junc 303	0.00	644.47	77.33
Junc 304	0.00	644.47	80.36

New well at HNWR-1A pumping to low water level in new freshwater tank

Node ID	Demand GPM	Head ft	Pressure psi
Junc 401	0.00	631.05	-0.63
Junc 402	0.00	630.18	-0.79
Junc 403	0.00	625.10	7.84
Junc 403A	0.00	621.55	6.31
Junc 403B	0.00	621.55	6.31
Junc 404	0.00	594.73	-4.02
Junc 405	0.00	593.25	17.88
Junc 406	100.00	558.83	5.56
Junc 407	0.00	630.09	3.07
Junc 408	0.00	629.73	3.35
Junc 408A	0.00	629.73	3.35
Junc 408B	0.00	629.73	3.35
Junc 409	13.50	629.70	19.80
Junc 410A	0.00	629.70	4.64
Junc 410B	0.00	629.70	4.64
Junc 411	13.50	629.70	4.63
Resvr 100	-937.01	410.00	0.00
Resvr 200	0.00	410.00	0.00
Resvr 300	0.00	410.00	0.00
Tank 400	0.00	633.50	0.87

New well at HNWR-1A pumping to low water level in new freshwater tank

Network Table - Links

Link ID	Flow GPM	Velocity fps	Unit Headloss ft/Kft	Status
Pipe 101	937.01	10.63	65.75	Open
Pipe 102	937.01	10.63	65.75	Open
Pipe 103A	937.01	10.63	317.19	Open
Pipe 103B	0.00	0.00	0.00	Closed
Pipe 104	937.01	10.63	65.75	Open
Pipe 105	937.01	2.66	1.72	Open
Pipe 106	937.01	2.66	1.72	Open
Pipe 107	937.00	2.66	1.72	Open
Pipe 108	937.00	2.66	1.72	Open
Pipe 109	127.00	0.36	0.04	Open
Pipe 110A	405.00	2.59	2.63	Open
Pipe 110B	405.00	2.59	2.63	Open
Pipe 111A	402.50	2.57	2.60	Open
Pipe 111B	402.50	2.57	2.60	Open
Pipe 112A	400.00	2.55	2.57	Open
Pipe 112B	400.00	2.55	2.57	Open
Pipe 113A	400.00	4.54	10.43	Open
Pipe 113B	400.00	4.54	10.43	Open
Pipe 114A	400.00	4.54	10.43	Open
Pipe 114B	400.00	4.54	10.43	Open
Pipe 115A	400.00	4.54	13.59	Open
Pipe 115B	400.00	4.54	13.59	Open
Pipe 116A	400.00	4.54	10.43	Open
Pipe 116B	400.00	4.54	10.43	Open
Pipe 117A	400.00	4.54	10.43	Open

New well at HNWR-1A pumping to low water level in new freshwater tank

Link ID	Flow GPM	Velocity fps	Unit Headloss ft/Kft	Status
Pipe 117B	400.00	4.54	10.43	Open
Pipe 118A	300.00	3.40	6.12	Open
Pipe 118B	300.00	3.40	6.12	Open
Pipe 119	400.00	4.54	10.43	Open
Pipe 120	200.00	2.27	2.89	Open
Pipe 121	200.00	2.27	2.89	Open
Pipe 122A	200.00	5.11	20.82	Open
Pipe 122B	200.00	5.11	20.82	Open
Pipe 123	0.00	0.00	0.00	Open
Pipe 124A	0.00	0.00	0.00	Open
Pipe 124B	0.00	0.00	0.00	Open
Pipe 125	200.00	2.27	2.89	Open
Pipe 126A	200.00	5.11	20.81	Open
Pipe 126B	200.00	5.11	20.82	Open
Pipe 127	200.00	2.27	2.89	Open
Pipe 128A	200.00	5.11	20.82	Open
Pipe 128B	200.00	5.11	20.82	Open
Pipe 129	200.00	2.27	2.89	Open
Pipe 130A	200.00	2.27	2.89	Open
Pipe 130B	200.00	2.27	2.88	Open
Pipe 131	200.00	2.27	2.89	Open
Pipe 132	200.00	5.11	20.81	Open
Pipe 133	5.00	0.23	0.09	Open
Pipe 201	0.00	0.00	0.00	Open
Pipe 202A	0.00	0.00	0.00	Open
Pipe 202B	0.00	0.00	0.00	Closed

New well at HNWR-1A pumping to low water level in new freshwater tank

Link ID	Flow GPM	Velocity fps	Unit Headloss ft/Kft	Status
Pipe 203	0.00	0.00	0.00	Open
Pipe 204	0.00	0.00	0.00	Open
Pipe 301	0.00	0.00	0.00	Open
Pipe 302	0.00	0.00	0.00	Open
Pipe 303	0.00	0.00	0.00	Open
Pipe 304	0.00	0.00	0.00	Open
Pipe 400	127.00	5.76	46.18	Open
Pipe 401	127.00	5.76	36.45	Open
Pipe 402	100.00	4.54	23.41	Open
Pipe 403A	100.00	10.21	168.73	Open
Pipe 403B	100.00	10.21	168.73	Open
Pipe 404	100.00	2.55	7.52	Open
Pipe 405	100.00	10.21	168.73	Open
Pipe 406	27.00	0.69	0.51	Open
Pipe 407	27.00	0.69	0.51	Open
Pipe 408A	13.50	0.34	0.14	Open
Pipe 408B	13.50	0.34	0.14	Open
Pipe 409A	13.50	0.34	0.14	Open
Pipe 409B	13.50	0.34	0.14	Open
Pump P100	937.01	0.00	-274.34	Open
Pump P200	0.00	0.00	0.00	Closed
Pump P300	0.00	0.00	0.00	Closed
Valve V501	100.00	10.21	0.00	Open
Valve V502	13.50	0.34	0.00	Open
Valve V503	13.50	0.34	0.00	Open
Valve V504	0.00	0.00	70.73	Active

New well at HNWR-1A pumping to low water level in new freshwater tank

Link ID	Flow GPM	Velocity fps	Unit Headloss ft/Kft	Status
Valve V505	200.00	5.11	10.73	Active
Valve V506	200.00	5.11	9.25	Active
Valve V507	200.00	5.11	2.56	Active
Valve V508	200.00	5.11	0.05	Active

New well at Site B pumping to high water level in new freshwater tank

Network Table - Nodes

Node ID	Demand GPM	Head ft	Pressure psi
Junc 101	0.00	654.55	118.10
Junc 102	0.00	654.55	81.70
Junc 103	0.00	654.55	81.70
Junc 104	0.00	654.55	81.70
Junc 105	0.00	654.55	81.70
Junc 106	0.00	654.55	84.73
Junc 107	0.00	654.47	84.70
Junc 108	0.00	647.22	65.96
Junc 109	0.00	643.58	40.11
Junc 110	0.00	641.44	45.69
Junc 111	5.00	634.67	67.02
Junc 112	0.00	634.23	66.40
Junc 113	0.00	623.21	35.19
Junc 114	0.00	609.83	52.36
Junc 115	0.00	606.78	51.03
Junc 116	0.00	602.87	45.87
Junc 117	0.00	596.84	18.56
Junc 118	0.00	595.87	17.27
Junc 119	0.00	595.38	17.06
Junc 120	0.00	595.01	16.90
Junc 121	0.00	592.47	14.93
Junc 121A	0.00	592.19	14.82
Junc 121B	0.00	582.14	10.46
Junc 122	200.00	581.08	10.00
Junc 123	0.00	602.87	45.44

New well at Site B pumping to high water level in new freshwater tank

Node ID	Demand GPM	Head ft	Pressure psi
Junc 123A	0.00	602.87	45.44
Junc 123B	0.00	522.14	10.46
Junc 124	0.00	522.14	10.46
Junc 125	0.00	596.14	19.56
Junc 125A	0.00	595.87	19.44
Junc 125B	0.00	575.14	10.46
Junc 126	200.00	574.08	10.00
Junc 127	0.00	595.66	18.92
Junc 127A	0.00	595.39	18.80
Junc 127B	0.00	576.14	10.46
Junc 128	200.00	575.08	10.00
Junc 129	0.00	594.86	12.07
Junc 129A	0.00	594.84	12.06
Junc 129B	0.00	582.28	6.62
Junc 130	0.00	582.23	6.60
Junc 131	0.00	580.76	10.29
Junc 132	200.00	580.07	10.00
Junc 133	5.00	641.44	45.25
Junc 201	0.00	700.72	138.10
Junc 202	0.00	690.52	91.65
Junc 203	0.00	662.29	79.42
Junc 204	0.00	660.85	78.79
Junc 301	0.00	654.47	118.06
Junc 302	0.00	654.47	81.66
Junc 303	0.00	654.47	81.66
Junc 304	0.00	654.47	84.70

New well at Site B pumping to high water level in new freshwater tank

Node ID	Demand GPM	Head ft	Pressure psi
Junc 401	0.00	641.05	3.71
Junc 402	0.00	640.18	3.54
Junc 403	0.00	635.10	12.17
Junc 403A	0.00	631.55	10.64
Junc 403B	0.00	630.08	10.00
Junc 404	0.00	603.25	-0.32
Junc 405	0.00	601.78	21.57
Junc 406	100.00	567.36	9.25
Junc 407	0.00	640.09	7.41
Junc 408	0.00	639.73	7.68
Junc 408A	0.00	639.73	7.68
Junc 408B	0.00	633.54	5.00
Junc 409	13.50	633.51	21.45
Junc 410A	0.00	639.70	8.97
Junc 410B	0.00	639.70	8.97
Junc 411	13.50	639.70	8.97
Resvr 100	0.00	410.00	0.00
Resvr 200	-937.00	410.00	0.00
Resvr 300	0.00	410.00	0.00
Tank 400	0.00	643.50	5.20

New well at Site B pumping to high water level in new freshwater tank

Network Table - Links

Link ID	Flow GPM	Velocity fps	Unit Headloss ft/Kft	Status
Pipe 101	0.00	0.00	0.00	Open
Pipe 102	0.00	0.00	0.00	Open
Pipe 103A	0.00	0.00	0.00	Open
Pipe 103B	0.00	0.00	0.00	Closed
Pipe 104	0.00	0.00	0.00	Open
Pipe 105	0.00	0.00	0.00	Open
Pipe 106	937.00	2.66	1.72	Open
Pipe 107	937.00	2.66	1.72	Open
Pipe 108	937.00	2.66	1.72	Open
Pipe 109	127.00	0.36	0.04	Open
Pipe 110A	405.00	2.59	2.63	Open
Pipe 110B	405.00	2.59	2.63	Open
Pipe 111A	402.50	2.57	2.60	Open
Pipe 111B	402.50	2.57	2.60	Open
Pipe 112A	400.00	2.55	2.57	Open
Pipe 112B	400.00	2.55	2.57	Open
Pipe 113A	400.00	4.54	10.43	Open
Pipe 113B	400.00	4.54	10.43	Open
Pipe 114A	400.00	4.54	10.43	Open
Pipe 114B	400.00	4.54	10.43	Open
Pipe 115A	400.00	4.54	13.59	Open
Pipe 115B	400.00	4.54	13.59	Open
Pipe 116A	400.00	4.54	10.43	Open
Pipe 116B	400.00	4.54	10.43	Open
Pipe 117A	400.00	4.54	10.43	Open

New well at Site B pumping to high water level in new freshwater tank

Link ID	Flow GPM	Velocity fps	Unit Headloss ft/Kft	Status
Pipe 117B	400.00	4.54	10.43	Open
Pipe 118A	300.00	3.40	6.12	Open
Pipe 118B	300.00	3.40	6.12	Open
Pipe 119	400.00	4.54	10.43	Open
Pipe 120	200.00	2.27	2.89	Open
Pipe 121	200.00	2.27	2.89	Open
Pipe 122A	200.00	5.11	20.82	Open
Pipe 122B	200.00	5.11	20.82	Open
Pipe 123	0.00	0.00	0.00	Open
Pipe 124A	0.00	0.00	0.00	Open
Pipe 124B	0.00	0.00	0.00	Open
Pipe 125	200.00	2.27	2.89	Open
Pipe 126A	200.00	5.11	20.81	Open
Pipe 126B	200.00	5.11	20.82	Open
Pipe 127	200.00	2.27	2.89	Open
Pipe 128A	200.00	5.11	20.82	Open
Pipe 128B	200.00	5.11	20.82	Open
Pipe 129	200.00	2.27	2.89	Open
Pipe 130A	200.00	2.27	2.89	Open
Pipe 130B	200.00	2.27	2.88	Open
Pipe 131	200.00	2.27	2.89	Open
Pipe 132	200.00	5.11	20.81	Open
Pipe 133	5.00	0.23	0.09	Open
Pipe 201	937.00	10.63	65.75	Open
Pipe 202A	937.00	10.63	317.19	Open
Pipe 202B	0.00	0.00	0.00	Closed

New well at Site B pumping to high water level in new freshwater tank

Link ID	Flow GPM	Velocity fps	Unit Headloss ft/Kft	Status
Pipe 203	937.00	10.63	65.75	Open
Pipe 204	937.00	2.66	1.72	Open
Pipe 301	0.00	0.00	0.00	Open
Pipe 302	0.00	0.00	0.00	Open
Pipe 303	0.00	0.00	0.00	Open
Pipe 304	0.00	0.00	0.00	Open
Pipe 400	127.00	5.76	46.18	Open
Pipe 401	127.00	5.76	36.45	Open
Pipe 402	100.00	4.54	23.41	Open
Pipe 403A	100.00	10.21	168.72	Open
Pipe 403B	100.00	10.21	168.73	Open
Pipe 404	100.00	2.55	7.52	Open
Pipe 405	100.00	10.21	168.73	Open
Pipe 406	27.00	0.69	0.51	Open
Pipe 407	27.00	0.69	0.51	Open
Pipe 408A	13.50	0.34	0.14	Open
Pipe 408B	13.50	0.34	0.14	Open
Pipe 409A	13.50	0.34	0.14	Open
Pipe 409B	13.50	0.34	0.14	Open
Pump P100	0.00	0.00	0.00	Closed
Pump P200	937.00	0.00	-290.72	Open
Pump P300	0.00	0.00	0.00	Closed
Valve V501	100.00	10.21	1.48	Active
Valve V502	13.50	0.34	6.19	Active
Valve V503	13.50	0.34	0.00	Open
Valve V504	0.00	0.00	80.73	Active

New well at Site B pumping to high water level in new freshwater tank

Link ID	Flow GPM	Velocity fps	Unit Headloss ft/Kft	Status
Valve V505	200.00	5.11	20.73	Active
Valve V506	200.00	5.11	19.25	Active
Valve V507	200.00	5.11	12.56	Active
Valve V508	200.00	5.11	10.05	Active

New well at Site B pumping to low water level in new freshwater tank

Network Table - Nodes

Node ID	Demand GPM	Head ft	Pressure psi
Junc 101	0.00	645.10	114.00
Junc 102	0.00	645.10	77.61
Junc 103	0.00	645.10	77.61
Junc 104	0.00	645.10	77.61
Junc 105	0.00	645.10	77.61
Junc 106	0.00	645.10	80.64
Junc 107	0.00	645.01	80.60
Junc 108	0.00	637.42	61.71
Junc 109	0.00	633.61	35.79
Junc 110	0.00	631.47	41.37
Junc 111	5.00	624.70	62.70
Junc 112	0.00	624.26	62.08
Junc 113	0.00	613.24	30.87
Junc 114	0.00	599.86	48.04
Junc 115	0.00	596.81	46.71
Junc 116	0.00	592.90	41.55
Junc 117	0.00	586.87	14.24
Junc 118	0.00	585.90	12.95
Junc 119	0.00	585.41	12.74
Junc 120	0.00	585.04	12.58
Junc 121	0.00	582.50	10.61
Junc 121A	0.00	582.22	10.50
Junc 121B	0.00	582.14	10.46
Junc 122	200.00	581.08	10.00
Junc 123	0.00	592.90	41.12

New well at Site B pumping to low water level in new freshwater tank

Node ID	Demand GPM	Head ft	Pressure psi
Junc 123A	0.00	592.90	41.12
Junc 123B	0.00	522.14	10.46
Junc 124	0.00	522.14	10.46
Junc 125	0.00	586.17	15.24
Junc 125A	0.00	585.90	15.12
Junc 125B	0.00	575.14	10.46
Junc 126	200.00	574.08	10.00
Junc 127	0.00	585.69	14.60
Junc 127A	0.00	585.42	14.48
Junc 127B	0.00	576.14	10.46
Junc 128	200.00	575.08	10.00
Junc 129	0.00	584.89	7.75
Junc 129A	0.00	584.87	7.74
Junc 129B	0.00	582.28	6.62
Junc 130	0.00	582.23	6.60
Junc 131	0.00	580.76	10.29
Junc 132	200.00	580.07	10.00
Junc 133	5.00	631.47	40.93
Junc 201	0.00	693.54	134.99
Junc 202	0.00	682.87	88.33
Junc 203	0.00	653.21	75.49
Junc 204	0.00	651.70	74.83
Junc 301	0.00	645.01	113.96
Junc 302	0.00	645.01	77.57
Junc 303	0.00	645.01	77.57
Junc 304	0.00	645.01	80.60

New well at Site B pumping to low water level in new freshwater tank

Node ID	Demand GPM	Head ft	Pressure psi
Junc 401	0.00	631.05	-0.63
Junc 402	0.00	630.18	-0.79
Junc 403	0.00	625.10	7.84
Junc 403A	0.00	621.55	6.31
Junc 403B	0.00	621.55	6.31
Junc 404	0.00	594.73	-4.02
Junc 405	0.00	593.25	17.88
Junc 406	100.00	558.83	5.56
Junc 407	0.00	630.09	3.07
Junc 408	0.00	629.73	3.35
Junc 408A	0.00	629.73	3.35
Junc 408B	0.00	629.73	3.35
Junc 409	13.50	629.70	19.80
Junc 410A	0.00	629.70	4.64
Junc 410B	0.00	629.70	4.64
Junc 411	13.50	629.70	4.63
Resvr 100	0.00	410.00	0.00
Resvr 200	-960.72	410.00	0.00
Resvr 300	0.00	410.00	0.00
Tank 400	23.72	633.50	0.87

New well at Site B pumping to low water level in new freshwater tank

Network Table - Links

Link ID	Flow GPM	Velocity fps	Unit Headloss ft/Kft	Status
Pipe 101	0.00	0.00	0.00	Open
Pipe 102	0.00	0.00	0.00	Open
Pipe 103A	0.00	0.00	0.00	Open
Pipe 103B	0.00	0.00	0.00	Closed
Pipe 104	0.00	0.00	0.00	Open
Pipe 105	0.00	0.00	0.00	Open
Pipe 106	960.72	2.73	1.81	Open
Pipe 107	960.72	2.73	1.81	Open
Pipe 108	960.72	2.73	1.81	Open
Pipe 109	150.72	0.43	0.06	Open
Pipe 110A	405.00	2.59	2.63	Open
Pipe 110B	405.00	2.59	2.63	Open
Pipe 111A	402.50	2.57	2.60	Open
Pipe 111B	402.50	2.57	2.60	Open
Pipe 112A	400.00	2.55	2.57	Open
Pipe 112B	400.00	2.55	2.57	Open
Pipe 113A	400.00	4.54	10.43	Open
Pipe 113B	400.00	4.54	10.43	Open
Pipe 114A	400.00	4.54	10.43	Open
Pipe 114B	400.00	4.54	10.43	Open
Pipe 115A	400.00	4.54	13.59	Open
Pipe 115B	400.00	4.54	13.59	Open
Pipe 116A	400.00	4.54	10.43	Open
Pipe 116B	400.00	4.54	10.43	Open
Pipe 117A	400.00	4.54	10.43	Open

New well at Site B pumping to low water level in new freshwater tank

Link ID	Flow GPM	Velocity fps	Unit Headloss ft/Kft	Status
Pipe 117B	400.00	4.54	10.43	Open
Pipe 118A	300.00	3.40	6.12	Open
Pipe 118B	300.00	3.40	6.12	Open
Pipe 119	400.00	4.54	10.43	Open
Pipe 120	200.00	2.27	2.89	Open
Pipe 121	200.00	2.27	2.89	Open
Pipe 122A	200.00	5.11	20.81	Open
Pipe 122B	200.00	5.11	20.82	Open
Pipe 123	0.00	0.00	0.00	Open
Pipe 124A	0.00	0.00	0.00	Open
Pipe 124B	0.00	0.00	0.00	Open
Pipe 125	200.00	2.27	2.89	Open
Pipe 126A	200.00	5.11	20.82	Open
Pipe 126B	200.00	5.11	20.82	Open
Pipe 127	200.00	2.27	2.89	Open
Pipe 128A	200.00	5.11	20.82	Open
Pipe 128B	200.00	5.11	20.82	Open
Pipe 129	200.00	2.27	2.89	Open
Pipe 130A	200.00	2.27	2.89	Open
Pipe 130B	200.00	2.27	2.88	Open
Pipe 131	200.00	2.27	2.89	Open
Pipe 132	200.00	5.11	20.81	Open
Pipe 133	5.00	0.23	0.09	Open
Pipe 201	960.72	10.90	68.86	Open
Pipe 202A	960.72	10.90	333.20	Open
Pipe 202B	0.00	0.00	0.00	Closed

New well at Site B pumping to low water level in new freshwater tank

Link ID	Flow GPM	Velocity fps	Unit Headloss ft/Kft	Status
Pipe 203	960.72	10.90	68.86	Open
Pipe 204	960.72	2.73	1.81	Open
Pipe 301	0.00	0.00	0.00	Open
Pipe 302	0.00	0.00	0.00	Open
Pipe 303	0.00	0.00	0.00	Open
Pipe 304	0.00	0.00	0.00	Open
Pipe 400	127.00	5.76	46.18	Open
Pipe 401	127.00	5.76	36.45	Open
Pipe 402	100.00	4.54	23.41	Open
Pipe 403A	100.00	10.21	168.73	Open
Pipe 403B	100.00	10.21	168.73	Open
Pipe 404	100.00	2.55	7.52	Open
Pipe 405	100.00	10.21	168.73	Open
Pipe 406	27.00	0.69	0.51	Open
Pipe 407	27.00	0.69	0.51	Open
Pipe 408A	13.50	0.34	0.14	Open
Pipe 408B	13.50	0.34	0.14	Open
Pipe 409A	13.50	0.34	0.14	Open
Pipe 409B	13.50	0.34	0.14	Open
Pump P100	0.00	0.00	0.00	Closed
Pump P200	960.72	0.00	-283.54	Open
Pump P300	0.00	0.00	0.00	Closed
Valve V501	100.00	10.21	0.00	Open
Valve V502	13.50	0.34	0.00	Open
Valve V503	13.50	0.34	0.00	Open
Valve V504	0.00	0.00	70.76	Active

New well at Site B pumping to low water level in new freshwater tank

Link ID	Flow GPM	Velocity fps	Unit Headloss ft/Kft	Status
Valve V505	200.00	5.11	10.76	Active
Valve V506	200.00	5.11	9.28	Active
Valve V507	200.00	5.11	2.59	Active
Valve V508	200.00	5.11	0.08	Active

Existing well at HNWR-1 pumping to high water level in new freshwater tank

Network Table - Nodes

Node ID	Demand GPM	Head ft	Pressure psi
Junc 101	0.00	655.10	118.34
Junc 102	0.00	655.10	81.94
Junc 103	0.00	655.10	81.94
Junc 104	0.00	655.10	81.94
Junc 105	0.00	655.10	81.94
Junc 106	0.00	655.10	84.97
Junc 107	0.00	655.10	84.97
Junc 108	0.00	647.45	66.06
Junc 109	0.00	643.61	40.13
Junc 110	0.00	641.48	45.70
Junc 111	5.00	634.70	67.03
Junc 112	0.00	634.27	66.41
Junc 113	0.00	623.25	35.20
Junc 114	0.00	609.87	52.37
Junc 115	0.00	606.81	51.05
Junc 116	0.00	602.90	45.89
Junc 117	0.00	596.87	18.58
Junc 118	0.00	595.90	17.29
Junc 119	0.00	595.41	17.08
Junc 120	0.00	595.04	16.92
Junc 121	0.00	592.50	14.95
Junc 121A	0.00	592.23	14.83
Junc 121B	0.00	582.14	10.46
Junc 122	200.00	581.08	10.00
Junc 123	0.00	602.90	45.45

Existing well at HNWR-1 pumping to high water level in new freshwater tank

Node ID	Demand GPM	Head ft	Pressure psi
Junc 123A	0.00	602.90	45.45
Junc 123B	0.00	522.14	10.46
Junc 124	0.00	522.14	10.46
Junc 125	0.00	596.18	19.57
Junc 125A	0.00	595.91	19.46
Junc 125B	0.00	575.14	10.46
Junc 126	200.00	574.08	10.00
Junc 127	0.00	595.70	18.94
Junc 127A	0.00	595.43	18.82
Junc 127B	0.00	576.14	10.46
Junc 128	200.00	575.08	10.00
Junc 129	0.00	594.90	12.09
Junc 129A	0.00	594.87	12.08
Junc 129B	0.00	582.28	6.62
Junc 130	0.00	582.23	6.60
Junc 131	0.00	580.76	10.29
Junc 132	200.00	580.07	10.00
Junc 133	5.00	641.47	45.27
Junc 201	0.00	655.10	118.34
Junc 202	0.00	655.10	76.31
Junc 203	0.00	655.10	76.31
Junc 204	0.00	655.10	76.31
Junc 301	0.00	663.44	121.95
Junc 302	0.00	655.73	82.21
Junc 303	0.00	655.40	82.07
Junc 304	0.00	655.33	85.07

Existing well at HNWR-1 pumping to high water level in new freshwater tank

Node ID	Demand GPM	Head ft	Pressure psi
Junc 401	0.00	641.05	3.71
Junc 402	0.00	640.18	3.54
Junc 403	0.00	635.10	12.17
Junc 403A	0.00	631.55	10.64
Junc 403B	0.00	630.08	10.00
Junc 404	0.00	603.25	-0.32
Junc 405	0.00	601.78	21.57
Junc 406	100.00	567.36	9.25
Junc 407	0.00	640.09	7.41
Junc 408	0.00	639.73	7.68
Junc 408A	0.00	639.73	7.68
Junc 408B	0.00	633.54	5.00
Junc 409	13.50	633.51	21.45
Junc 410A	0.00	639.70	8.97
Junc 410B	0.00	639.70	8.97
Junc 411	13.50	639.70	8.97
Resvr 100	0.00	410.00	0.00
Resvr 200	0.00	410.00	0.00
Resvr 300	-964.64	410.00	0.00
Tank 400	27.64	643.50	5.20

Existing well at HNWR-1 pumping to high water level in new freshwater tank

Network Table - Links

Link ID	Flow GPM	Velocity fps	Unit Headloss ft/Kft	Status
Pipe 101	0.00	0.00	0.00	Open
Pipe 102	0.00	0.00	0.00	Open
Pipe 103A	0.00	0.00	0.00	Open
Pipe 103B	0.00	0.00	0.00	Closed
Pipe 104	0.00	0.00	0.00	Open
Pipe 105	0.00	0.00	0.00	Open
Pipe 106	0.00	0.00	0.00	Open
Pipe 107	964.64	2.74	1.82	Open
Pipe 108	964.64	2.74	1.82	Open
Pipe 109	154.64	0.44	0.06	Open
Pipe 110A	405.00	2.59	2.63	Open
Pipe 110B	405.00	2.59	2.63	Open
Pipe 111A	402.50	2.57	2.60	Open
Pipe 111B	402.50	2.57	2.60	Open
Pipe 112A	400.00	2.55	2.57	Open
Pipe 112B	400.00	2.55	2.57	Open
Pipe 113A	400.00	4.54	10.43	Open
Pipe 113B	400.00	4.54	10.43	Open
Pipe 114A	400.00	4.54	10.43	Open
Pipe 114B	400.00	4.54	10.43	Open
Pipe 115A	400.00	4.54	13.59	Open
Pipe 115B	400.00	4.54	13.59	Open
Pipe 116A	400.00	4.54	10.43	Open
Pipe 116B	400.00	4.54	10.43	Open
Pipe 117A	400.00	4.54	10.43	Open

Existing well at HNWR-1 pumping to high water level in new freshwater tank

Link ID	Flow GPM	Velocity fps	Unit Headloss ft/Kft	Status
Pipe 117B	400.00	4.54	10.43	Open
Pipe 118A	300.00	3.40	6.12	Open
Pipe 118B	300.00	3.40	6.12	Open
Pipe 119	400.00	4.54	10.43	Open
Pipe 120	200.00	2.27	2.89	Open
Pipe 121	200.00	2.27	2.89	Open
Pipe 122A	200.00	5.11	20.81	Open
Pipe 122B	200.00	5.11	20.82	Open
Pipe 123	0.00	0.00	0.00	Open
Pipe 124A	0.00	0.00	0.00	Open
Pipe 124B	0.00	0.00	0.00	Open
Pipe 125	200.00	2.27	2.89	Open
Pipe 126A	200.00	5.11	20.81	Open
Pipe 126B	200.00	5.11	20.82	Open
Pipe 127	200.00	2.27	2.89	Open
Pipe 128A	200.00	5.11	20.81	Open
Pipe 128B	200.00	5.11	20.82	Open
Pipe 129	200.00	2.27	2.89	Open
Pipe 130A	200.00	2.27	2.89	Open
Pipe 130B	200.00	2.27	2.88	Open
Pipe 131	200.00	2.27	2.89	Open
Pipe 132	200.00	5.11	20.81	Open
Pipe 133	5.00	0.23	0.09	Open
Pipe 201	0.00	0.00	0.00	Open
Pipe 202A	0.00	0.00	0.00	Open
Pipe 202B	0.00	0.00	0.00	Closed

Existing well at HNWR-1 pumping to high water level in new freshwater tank

Link ID	Flow GPM	Velocity fps	Unit Headloss ft/Kft	Status
Pipe 203	0.00	0.00	0.00	Open
Pipe 204	0.00	0.00	0.00	Open
Pipe 301	964.64	10.95	69.38	Open
Pipe 302	964.64	2.74	2.37	Open
Pipe 303	964.64	2.74	1.82	Open
Pipe 304	964.64	2.74	1.82	Open
Pipe 400	127.00	5.76	46.18	Open
Pipe 401	127.00	5.76	36.45	Open
Pipe 402	100.00	4.54	23.41	Open
Pipe 403A	100.00	10.21	168.72	Open
Pipe 403B	100.00	10.21	168.73	Open
Pipe 404	100.00	2.55	7.52	Open
Pipe 405	100.00	10.21	168.73	Open
Pipe 406	27.00	0.69	0.51	Open
Pipe 407	27.00	0.69	0.51	Open
Pipe 408A	13.50	0.34	0.14	Open
Pipe 408B	13.50	0.34	0.14	Open
Pipe 409A	13.50	0.34	0.14	Open
Pipe 409B	13.50	0.34	0.14	Open
Pump P100	0.00	0.00	0.00	Closed
Pump P200	0.00	0.00	0.00	Closed
Pump P300	964.64	0.00	-253.44	Open
Valve V501	100.00	10.21	1.48	Active
Valve V502	13.50	0.34	6.19	Active
Valve V503	13.50	0.34	0.00	Open
Valve V504	0.00	0.00	80.76	Active

Existing well at HNWR-1 pumping to high water level in new freshwater tank

Link ID	Flow GPM	Velocity fps	Unit Headloss ft/Kft	Status
Valve V505	200.00	5.11	20.77	Active
Valve V506	200.00	5.11	19.29	Active
Valve V507	200.00	5.11	12.59	Active
Valve V508	200.00	5.11	10.09	Active

Existing well at HNWR-1 pumping to low water level in new freshwater tank

Network Table - Nodes

Node ID	Demand GPM	Head ft	Pressure psi
Junc 101	0.00	645.67	114.25
Junc 102	0.00	645.67	77.85
Junc 103	0.00	645.67	77.85
Junc 104	0.00	645.67	77.85
Junc 105	0.00	645.67	77.85
Junc 106	0.00	645.67	80.88
Junc 107	0.00	645.67	80.88
Junc 108	0.00	637.67	61.82
Junc 109	0.00	633.65	35.81
Junc 110	0.00	631.51	41.39
Junc 111	5.00	624.74	62.72
Junc 112	0.00	624.30	62.09
Junc 113	0.00	613.28	30.89
Junc 114	0.00	599.90	48.05
Junc 115	0.00	596.85	46.73
Junc 116	0.00	592.94	41.57
Junc 117	0.00	586.91	14.26
Junc 118	0.00	585.94	12.97
Junc 119	0.00	585.45	12.76
Junc 120	0.00	585.08	12.60
Junc 121	0.00	582.54	10.63
Junc 121A	0.00	582.26	10.51
Junc 121B	0.00	582.14	10.46
Junc 122	200.00	581.08	10.00
Junc 123	0.00	592.94	41.14

Existing well at HNWR-1 pumping to low water level in new freshwater tank

Node ID	Demand GPM	Head ft	Pressure psi
Junc 123A	0.00	592.94	41.14
Junc 123B	0.00	522.14	10.46
Junc 124	0.00	522.14	10.46
Junc 125	0.00	586.21	15.26
Junc 125A	0.00	585.94	15.14
Junc 125B	0.00	575.14	10.46
Junc 126	200.00	574.08	10.00
Junc 127	0.00	585.73	14.62
Junc 127A	0.00	585.46	14.50
Junc 127B	0.00	576.14	10.46
Junc 128	200.00	575.08	10.00
Junc 129	0.00	584.93	7.77
Junc 129A	0.00	584.91	7.76
Junc 129B	0.00	582.28	6.62
Junc 130	0.00	582.23	6.60
Junc 131	0.00	580.76	10.29
Junc 132	200.00	580.07	10.00
Junc 133	5.00	631.51	40.95
Junc 201	0.00	645.67	114.25
Junc 202	0.00	645.67	72.22
Junc 203	0.00	645.67	72.22
Junc 204	0.00	645.67	72.22
Junc 301	0.00	654.39	118.03
Junc 302	0.00	646.33	78.14
Junc 303	0.00	645.98	77.99
Junc 304	0.00	645.90	80.99

Existing well at HNWR-1 pumping to low water level in new freshwater tank

Node ID	Demand GPM	Head ft	Pressure psi
Junc 401	0.00	631.05	-0.63
Junc 402	0.00	630.18	-0.79
Junc 403	0.00	625.10	7.84
Junc 403A	0.00	621.55	6.31
Junc 403B	0.00	621.55	6.31
Junc 404	0.00	594.73	-4.02
Junc 405	0.00	593.25	17.88
Junc 406	100.00	558.83	5.56
Junc 407	0.00	630.09	3.07
Junc 408	0.00	629.73	3.35
Junc 408A	0.00	629.73	3.35
Junc 408B	0.00	629.73	3.35
Junc 409	13.50	629.70	19.80
Junc 410A	0.00	629.70	4.64
Junc 410B	0.00	629.70	4.64
Junc 411	13.50	629.70	4.63
Resvr 100	0.00	410.00	0.00
Resvr 200	0.00	410.00	0.00
Resvr 300	-988.46	410.00	0.00
Tank 400	51.45	633.50	0.87

Existing well at HNWR-1 pumping to low water level in new freshwater tank

Network Table - Links

Link ID	Flow GPM	Velocity fps	Unit Headloss ft/Kft	Status
Pipe 101	0.00	0.00	0.00	Open
Pipe 102	0.00	0.00	0.00	Open
Pipe 103A	0.00	0.00	0.00	Open
Pipe 103B	0.00	0.00	0.00	Closed
Pipe 104	0.00	0.00	0.00	Open
Pipe 105	0.00	0.00	0.00	Open
Pipe 106	0.00	0.00	0.00	Open
Pipe 107	988.45	2.80	1.90	Open
Pipe 108	988.45	2.80	1.90	Open
Pipe 109	178.45	0.51	0.08	Open
Pipe 110A	405.00	2.59	2.63	Open
Pipe 110B	405.00	2.59	2.63	Open
Pipe 111A	402.50	2.57	2.60	Open
Pipe 111B	402.50	2.57	2.60	Open
Pipe 112A	400.00	2.55	2.57	Open
Pipe 112B	400.00	2.55	2.57	Open
Pipe 113A	400.00	4.54	10.43	Open
Pipe 113B	400.00	4.54	10.43	Open
Pipe 114A	400.00	4.54	10.43	Open
Pipe 114B	400.00	4.54	10.43	Open
Pipe 115A	400.00	4.54	13.59	Open
Pipe 115B	400.00	4.54	13.59	Open
Pipe 116A	400.00	4.54	10.43	Open
Pipe 116B	400.00	4.54	10.43	Open
Pipe 117A	400.00	4.54	10.43	Open

Existing well at HNWR-1 pumping to low water level in new freshwater tank

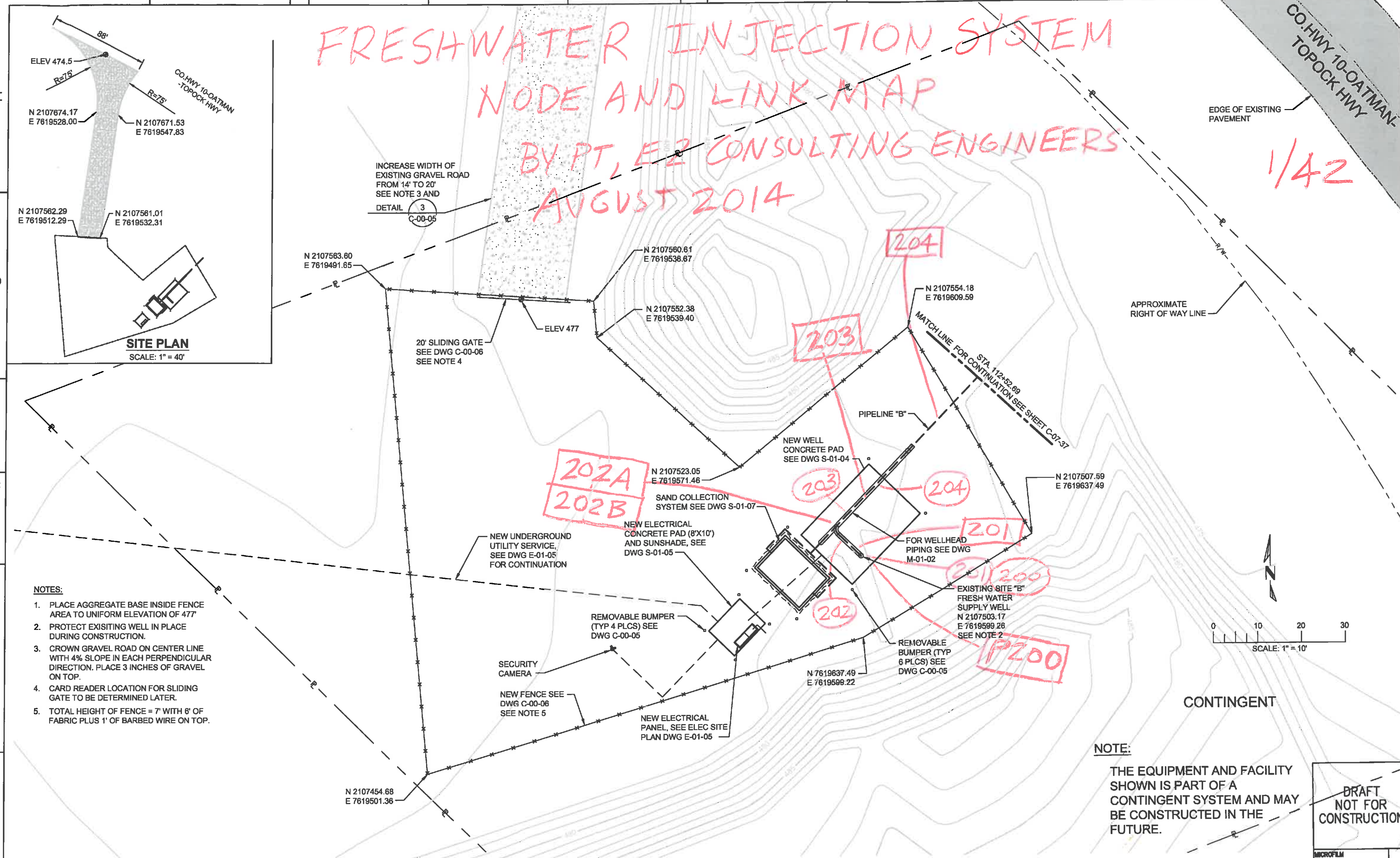
Link ID	Flow GPM	Velocity fps	Unit Headloss ft/Kft	Status
Pipe 117B	400.00	4.54	10.43	Open
Pipe 118A	300.00	3.40	6.12	Open
Pipe 118B	300.00	3.40	6.12	Open
Pipe 119	400.00	4.54	10.43	Open
Pipe 120	200.00	2.27	2.89	Open
Pipe 121	200.00	2.27	2.89	Open
Pipe 122A	200.00	5.11	20.81	Open
Pipe 122B	200.00	5.11	20.82	Open
Pipe 123	0.00	0.00	0.00	Open
Pipe 124A	0.00	0.00	0.00	Open
Pipe 124B	0.00	0.00	0.00	Open
Pipe 125	200.00	2.27	2.89	Open
Pipe 126A	200.00	5.11	20.82	Open
Pipe 126B	200.00	5.11	20.82	Open
Pipe 127	200.00	2.27	2.89	Open
Pipe 128A	200.00	5.11	20.82	Open
Pipe 128B	200.00	5.11	20.82	Open
Pipe 129	200.00	2.27	2.89	Open
Pipe 130A	200.00	2.27	2.89	Open
Pipe 130B	200.00	2.27	2.88	Open
Pipe 131	200.00	2.27	2.89	Open
Pipe 132	200.00	5.11	20.81	Open
Pipe 133	5.00	0.23	0.09	Open
Pipe 201	0.00	0.00	0.00	Open
Pipe 202A	0.00	0.00	0.00	Open
Pipe 202B	0.00	0.00	0.00	Closed

Existing well at HNWR-1 pumping to low water level in new freshwater tank

Link ID	Flow GPM	Velocity fps	Unit Headloss ft/Kft	Status
Pipe 203	0.00	0.00	0.00	Open
Pipe 204	0.00	0.00	0.00	Open
Pipe 301	988.46	11.22	72.59	Open
Pipe 302	988.46	2.80	2.48	Open
Pipe 303	988.46	2.80	1.90	Open
Pipe 304	988.46	2.80	1.90	Open
Pipe 400	127.00	5.76	46.18	Open
Pipe 401	127.00	5.76	36.45	Open
Pipe 402	100.00	4.54	23.41	Open
Pipe 403A	100.00	10.21	168.73	Open
Pipe 403B	100.00	10.21	168.73	Open
Pipe 404	100.00	2.55	7.52	Open
Pipe 405	100.00	10.21	168.73	Open
Pipe 406	27.00	0.69	0.51	Open
Pipe 407	27.00	0.69	0.51	Open
Pipe 408A	13.50	0.34	0.14	Open
Pipe 408B	13.50	0.34	0.14	Open
Pipe 409A	13.50	0.34	0.14	Open
Pipe 409B	13.50	0.34	0.14	Open
Pump P100	0.00	0.00	0.00	Closed
Pump P200	0.00	0.00	0.00	Closed
Pump P300	988.46	0.00	-244.39	Open
Valve V501	100.00	10.21	0.00	Open
Valve V502	13.50	0.34	0.00	Open
Valve V503	13.50	0.34	0.00	Open
Valve V504	0.00	0.00	70.80	Active

Existing well at HNWR-1 pumping to low water level in new freshwater tank

Link ID	Flow GPM	Velocity fps	Unit Headloss ft/Kft	Status
Valve V505	200.00	5.11	10.80	Active
Valve V506	200.00	5.11	9.32	Active
Valve V507	200.00	5.11	2.63	Active
Valve V508	200.00	5.11	0.12	Active



E2 Consulting Engineers, Inc.

CH2MHILL.

NO.	DATE	DESCRIPTION	GM/SPEC	DWN	CHKD	SUPV	APVD BY
0	9/8/14	PRE-FINAL (90%) DESIGN		PH	PT	PT	VMB

REVISIONS

SUPV	VMB
DSGN	PT
DWN	PH
CHKD	VMB
OK	VMB
DATE	09/08/14

TOPOCK GROUNDWATER REMEDIATION PROJECT

FRESHWATER SUPPLY WELL SITE B - SITE PLAN

GAS TRANSMISSION & DISTRIBUTION
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

C-01-02 REV 0

FILENAME: E2-C-XXX-0726.dwg

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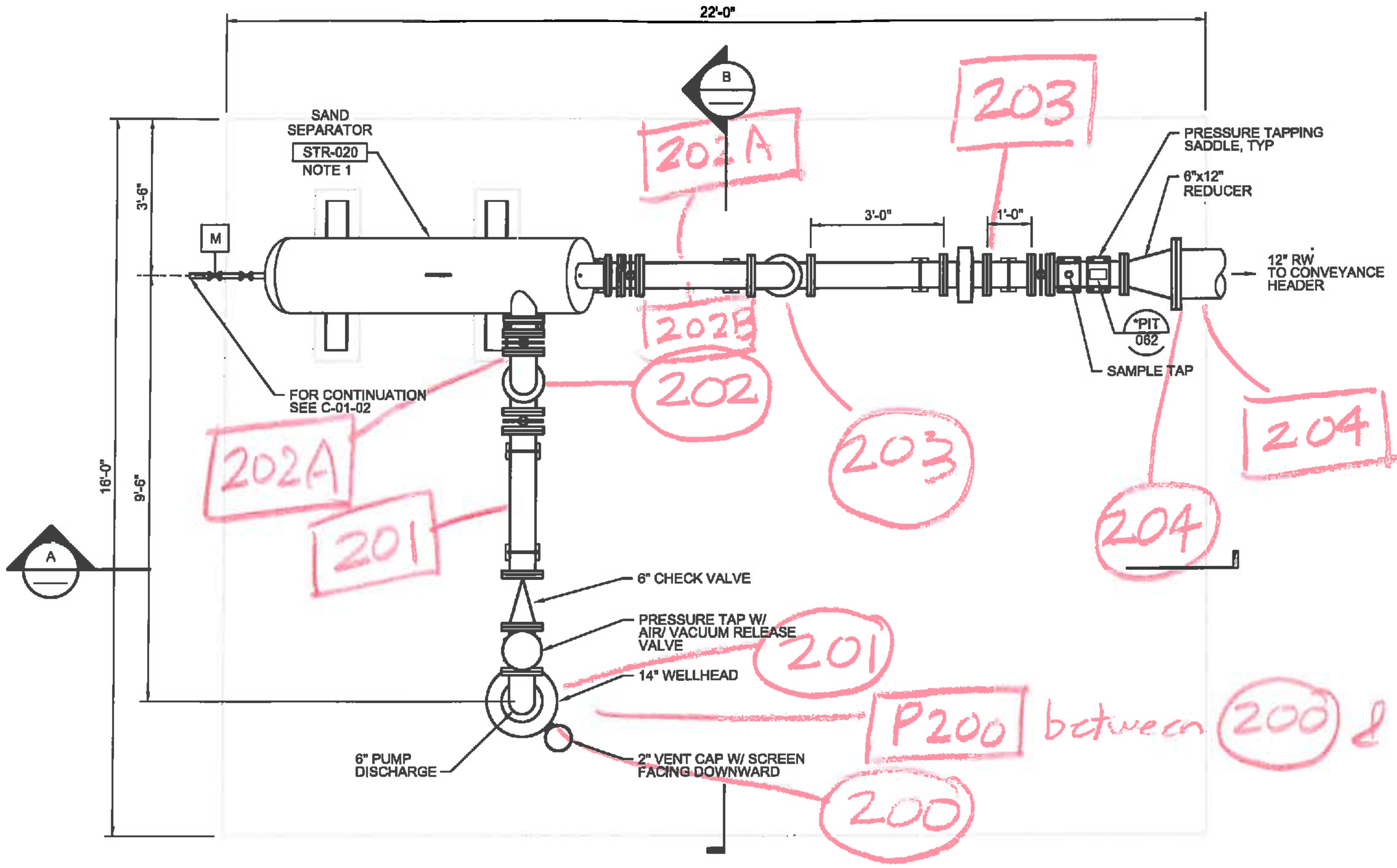
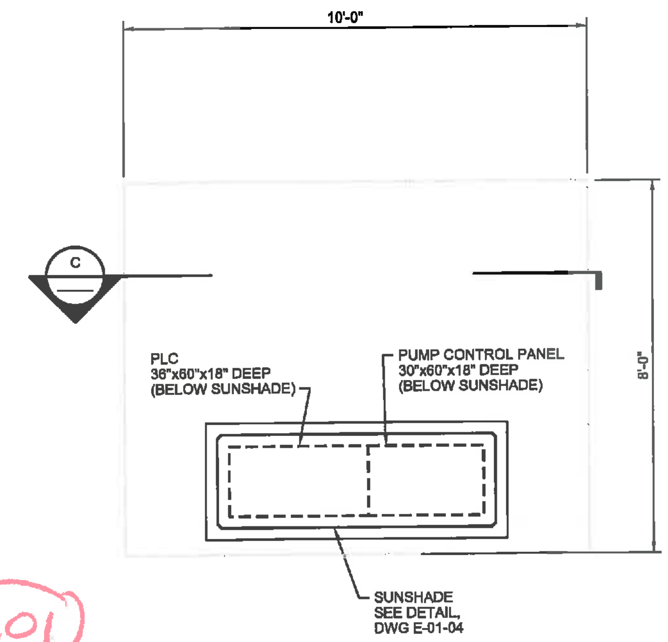
GENERAL NOTES

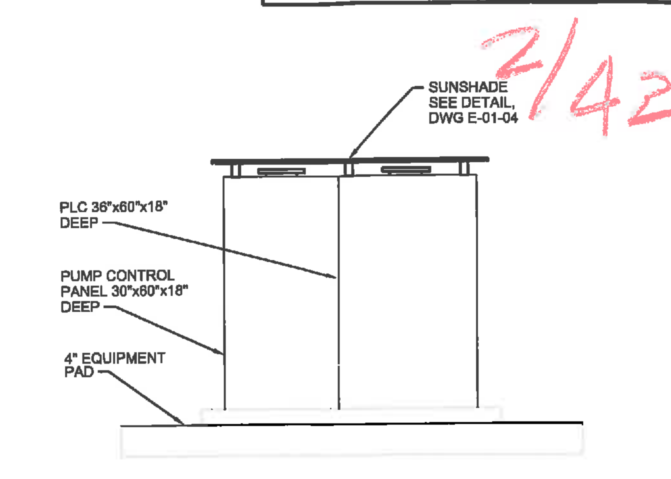
1. LAKOS SEPARATOR MODEL IHB-0500 (GROOVED JOINTS). PROVIDE 1 1/2" LAKOS BRONZE COMPACT MOTORIZED BALL VALVE FOR PURGE LINE. VALVE SHALL HAVE OPERATOR ADJUSTABLE SETTINGS FOR PURGE FREQUENCY AND DURATION. ELECTRIC ACTUATOR (120V) SHALL HAVE NEMA 4 HOUSING SUITABLE FOR OUTDOOR INSTALLATION. INSTALL PIPE SUPPORT FOR VALVE.
2. FOR PIPE SUPPORT SEE (4005-501).



WELL HEAD PIPING PAD PLAN
1/2"=1'-0"



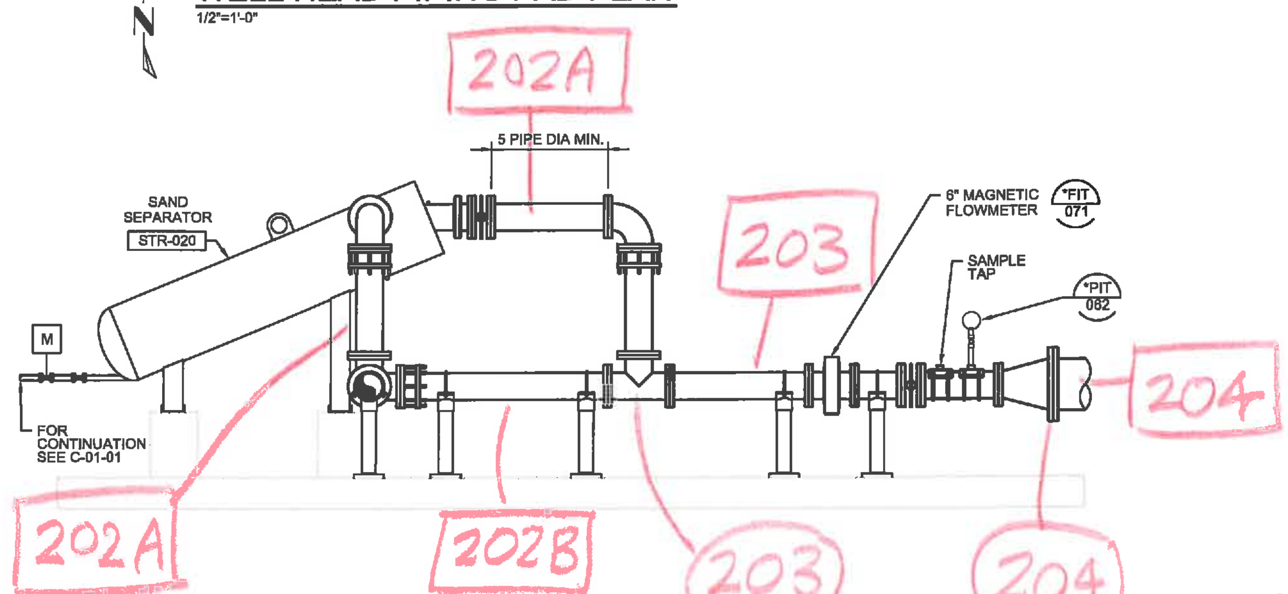
ELECTRICAL PAD PLAN
1/2"=1'-0"



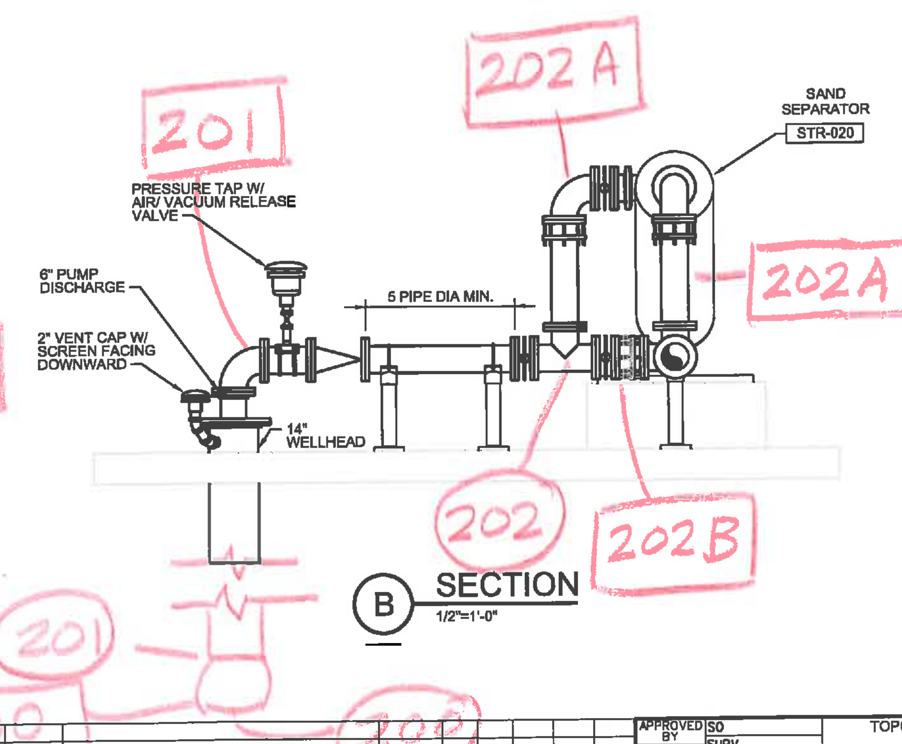
NOTES:

1. SEE DWG E-01-04 FOR ELECTRICAL PAD DETAIL AND DWG C-01-02 FOR CIVIL LAYOUT.

SECTION C
1/2"=1'-0"



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



SECTION B
1/2"=1'-0"

CONTINGENT MAY BE BUILT

DRAFT NOT FOR CONSTRUCTION

CH2MHILL.

NO.	DATE	DESCRIPTION	GM/SPEC	DWN	CHKD	SUPV	APVD BY

REVISIONS

NO.	DATE	DESCRIPTION	GM/SPEC	DWN	CHKD	SUPV	APVD BY

REVISIONS

APPROVED BY	
SO	
SUPV	
DSGN	RH
DWN	GJ
CHKD	ML
OK	
DATE	2012/2012
SCALES	

TOPOCK GROUNDWATER REMEDIATION PROJECT
SITE B WELL HEAD PIPING AND ELECTRICAL PAD PLAN AND SECTION
GAS TRANSMISSION & DISTRIBUTION
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

MICROFILM
BILL OF MATL
DWG LIST
SUPSDS
SUPSD BY
SHEET NO. of SHEETS
M-01-02 REV 1

PLOT DATE: 6/25/2014 PLOT TIME: 4:38:42 PM
FILENAME: CH-M-XXX-0102AD.dgn
FILENAME: .DGN - -04

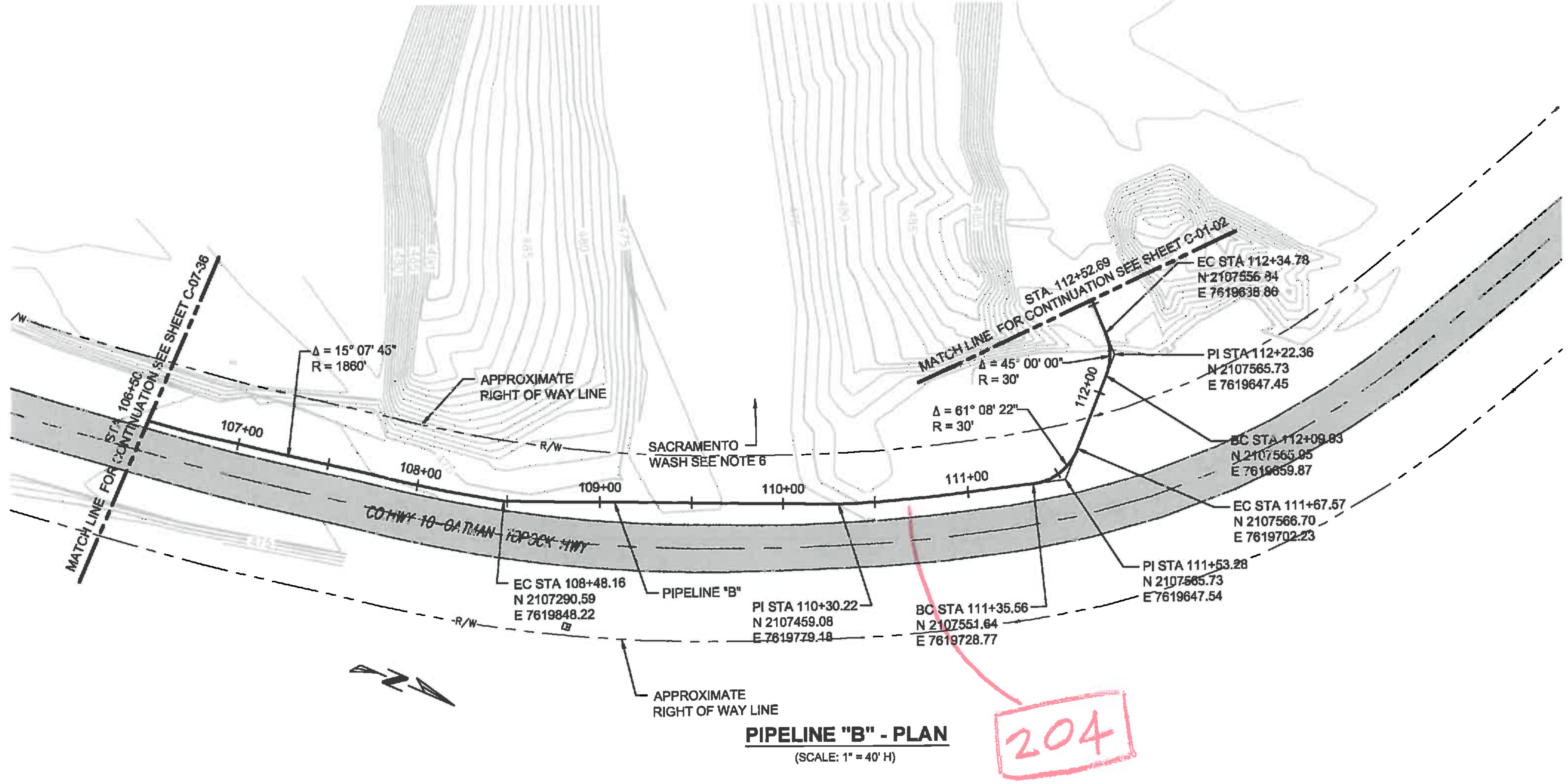
NOTES:

1. THE NEW PIPELINE ALIGNMENT SHOWS CENTER OF TRENCH.
2. ASSUMED DEPTH AND APPROXIMATE LOCATION ARE SHOWN. LOCATE BY POTHOLING BEFORE STARTING CONSTRUCTION. COORDINATE WITH PG&E TO RELOCATE INTERFERING UTILITIES AS NECESSARY TO ACCOMMODATE PIPELINE B.
3. PRESERVE AND PROTECT EXISTING STRUCTURE, TYP.
4. PROVIDE TRAFFIC CONTROL WHEN WORKING IN/NEAR ROADWAYS. COMPLY WITH OWNER'S ENCROACHMENT PERMIT WHEN WORKING IN COUNTY HIGHWAY 10.
5. SURVEY TOPOGRAPHY OF SACRAMENTO WASH AND SURROUNDING AREA. SUBMIT SURVEY MAP AND CAD FILE FOR OWNER REVIEW. DO NOT START CONSTRUCTION WITHOUT OWNER APPROVAL.

3/42

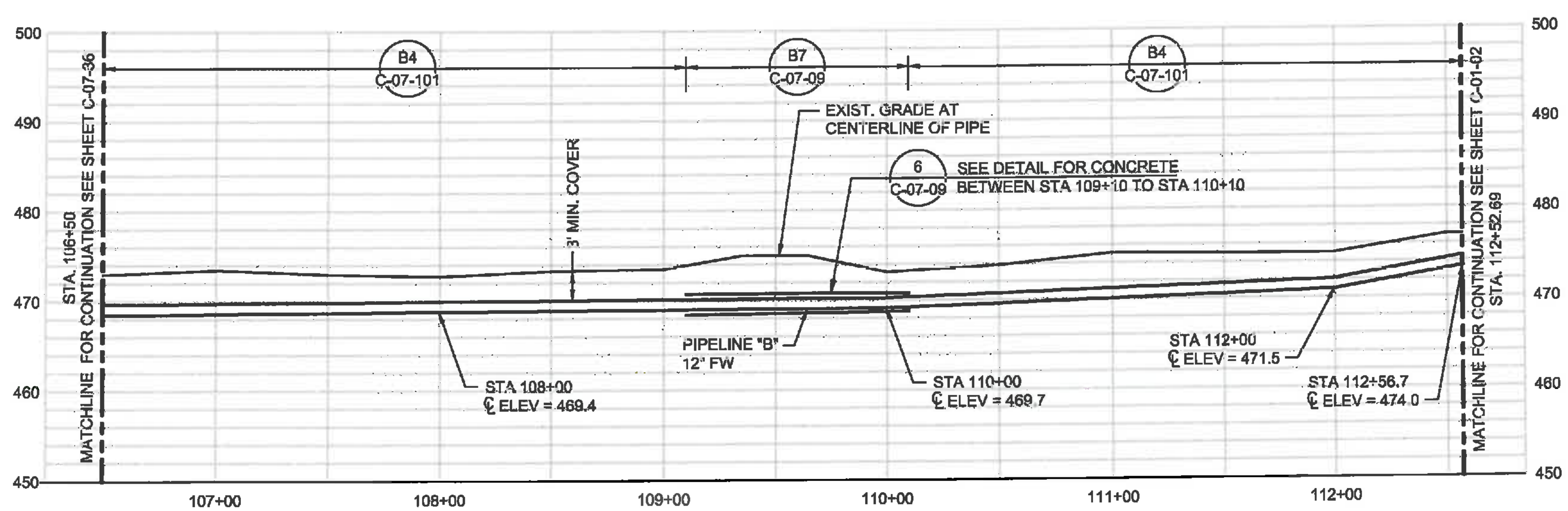
HORZ: SCALE: 1"=40'

VERT: SCALE: 1"=10'



PIPELINE "B" - PLAN

(SCALE: 1" = 40' H)



PIPELINE "B" - PROFILE

(SCALE: 1" = 40' H; 1" = 10' V)

CONTINGENT

NOTE:

THE EQUIPMENT AND FACILITY SHOWN IS PART OF A CONTINGENT SYSTEM AND MAY BE CONSTRUCTED IN THE FUTURE.

DRAFT NOT FOR CONSTRUCTION

E2 Consulting Engineers, Inc.

CH2MHILL.

NO.	DATE	DESCRIPTION	GM/SPEC	DWN	CHKD	SUPV	APVD BY
0	9/8/14	PRE-FINAL (90%) DESIGN		PH	VMB	VMB	VMB

REVISIONS

SUPV	VMB
DSGN	PT
DWN	PH
CHKD	VMB
OK	VMB
DATE	09/08/14

TOPOCK GROUNDWATER REMEDIATION PROJECT

PLAN AND PROFILE

PIPELINE "B"

STA 106+50 TO STA 112+52.69

GAS TRANSMISSION & DISTRIBUTION

PACIFIC GAS AND ELECTRIC COMPANY

SAN FRANCISCO, CALIFORNIA

SHEET NO. C-07-37 REV 0

FILENAME: E2-C-XXX-0737.dwg

PLOT DATE: $PLOTDATE PLOT TIME: $PLOTTIME

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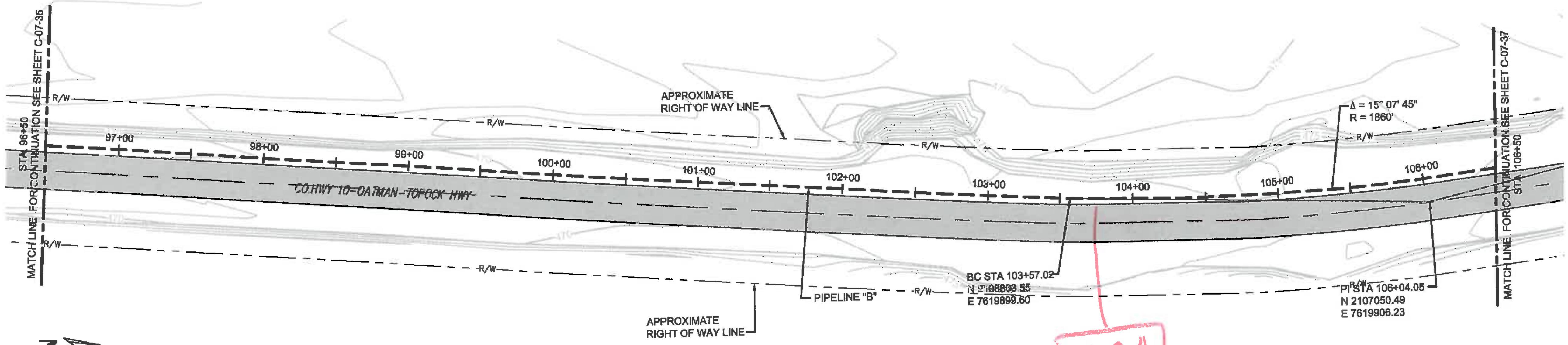
NOTES:

1. THE NEW PIPELINE ALIGNMENT SHOWS CENTER OF TRENCH.
2. ASSUMED DEPTH AND APPROXIMATE LOCATION ARE SHOWN. LOCATE BY POTHOLING BEFORE STARTING CONSTRUCTION. COORDINATE WITH PG&E TO RELOCATE INTERFERING UTILITIES AS NECESSARY TO ACCOMMODATE PIPELINE B.
3. PRESERVE AND PROTECT EXISTING STRUCTURE, TYP.
4. PROVIDE TRAFFIC CONTROL WHEN WORKING IN/NEAR ROADWAYS. COMPLY WITH OWNER'S ENCROACHMENT PERMIT WHEN WORKING IN COUNTY HIGHWAY 10.

4/42

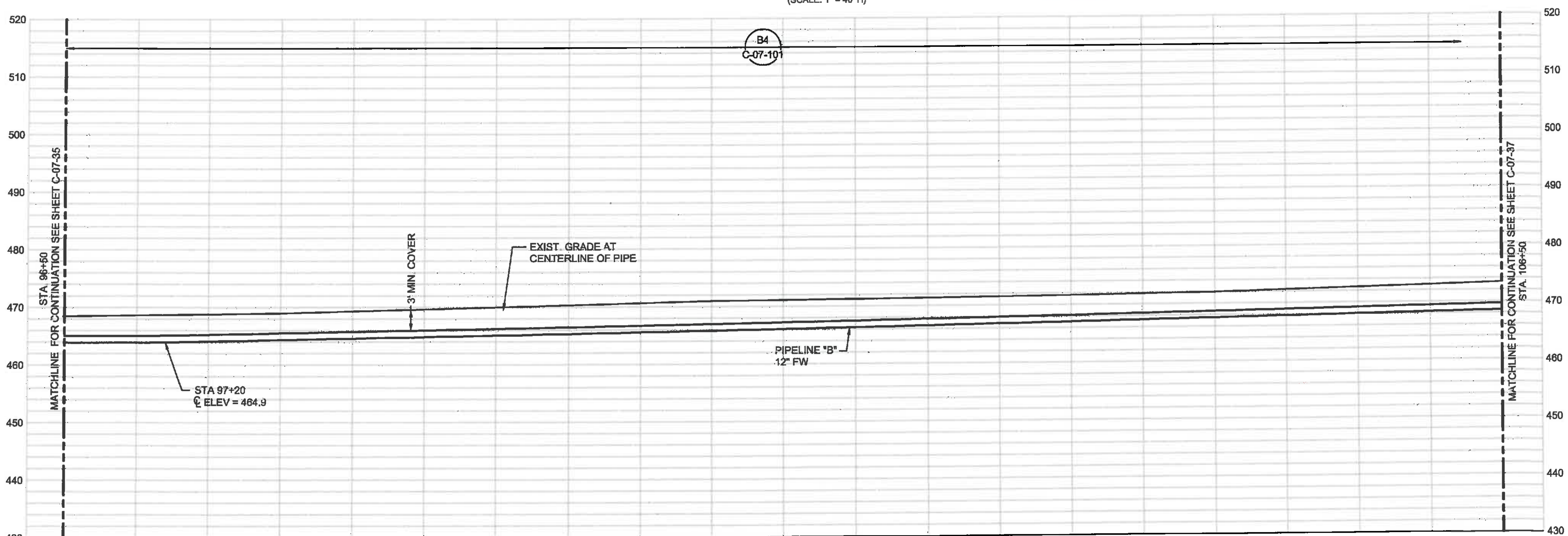


HORZ: SCALE: 1"=40'

VERT: SCALE: 1"=10'

PIPELINE "B" - PLAN

(SCALE: 1" = 40' H)



PIPELINE "B" - PROFILE

(SCALE: 1" = 40' H; 1" = 10' V)

CONTINGENT

NOTE:

THE EQUIPMENT AND FACILITY SHOWN IS PART OF A CONTINGENT SYSTEM AND MAY BE CONSTRUCTED IN THE FUTURE.

DRAFT NOT FOR CONSTRUCTION

E2 Consulting Engineers, Inc.

CH2MHILL.

NO.	DATE	DESCRIPTION	GM/SPEC	DWN	CHKD	SUPV	APVD BY
0	9/8/14	PRE-FINAL (90%) DESIGN		PH	VMB	VMB	VMB

REVISIONS

SUPV	VMB
DSGN	PT
DWN	PH
CHKD	VMB
OK	VMB
DATE	09/08/14

TOPOCK GROUNDWATER REMEDIATION PROJECT
PLAN AND PROFILE
PIPELINE "B"
STA 96+50 TO STA 106+50
GAS TRANSMISSION & DISTRIBUTION
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

SHEET NO. C-07-36 REV 0

FILENAME: E2-C-XXX-0736.dwg

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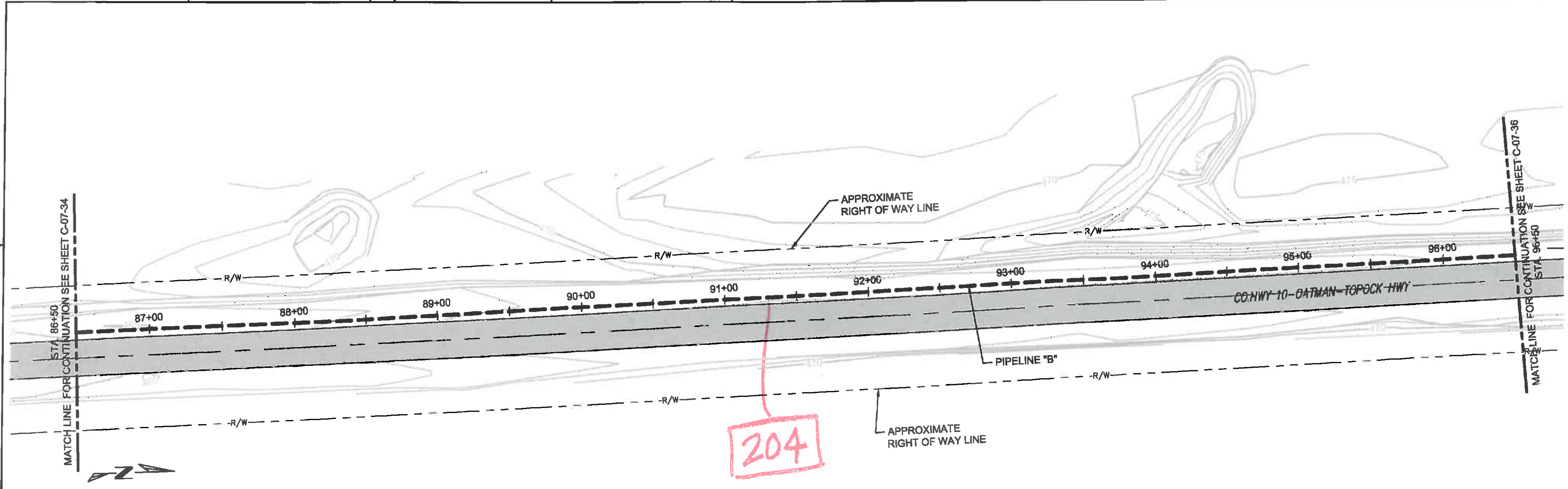
NOTES:

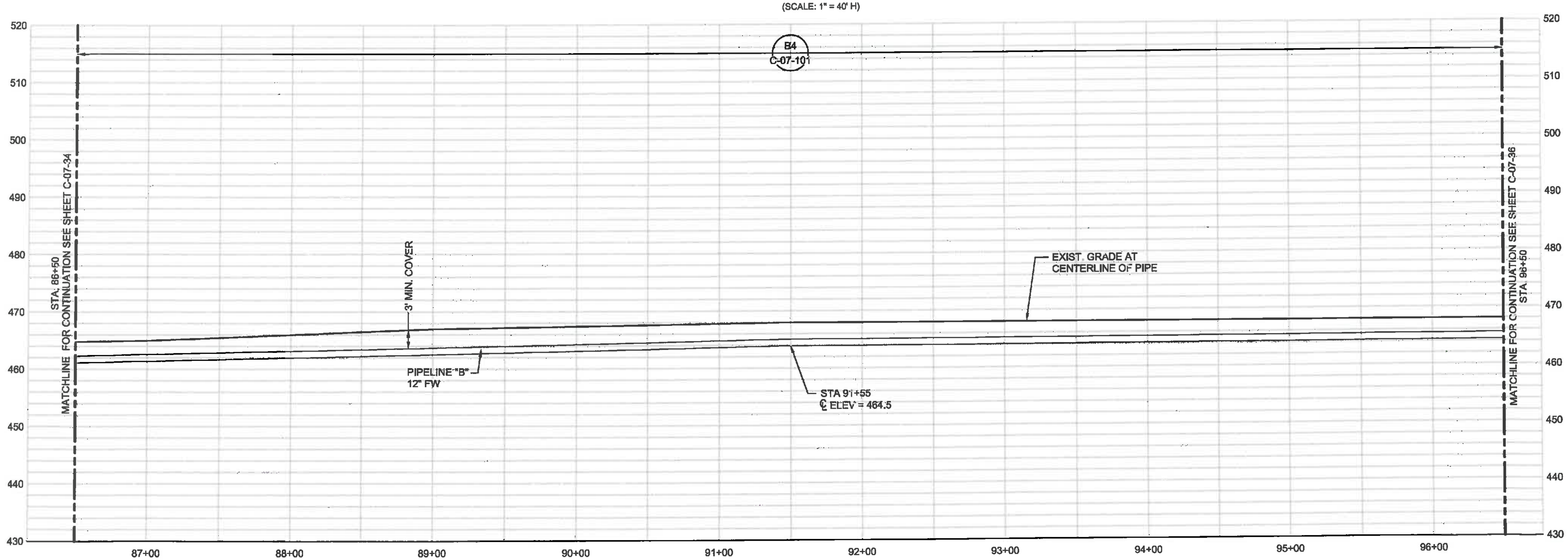
1. THE NEW PIPELINE ALIGNMENT SHOWS CENTER OF TRENCH.
2. ASSUMED DEPTH AND APPROXIMATE LOCATION ARE SHOWN. LOCATE BY POTHOLING BEFORE STARTING CONSTRUCTION. COORDINATE WITH PG&E TO RELOCATE INTERFERING UTILITIES AS NECESSARY TO ACCOMMODATE PIPELINE B.
3. PRESERVE AND PROTECT EXISTING STRUCTURE, TYP.
4. PROVIDE TRAFFIC CONTROL WHEN WORKING IN/NEAR ROADWAYS. COMPLY WITH OWNER'S ENCROACHMENT PERMIT WHEN WORKING IN COUNTY HIGHWAY 10.

5/42



PIPELINE "B" - PLAN

(SCALE: 1" = 40' H)



PIPELINE "B" - PROFILE

(SCALE: 1" = 40' H; 1" = 10' V)

CONTINGENT

NOTE:

THE EQUIPMENT AND FACILITY SHOWN IS PART OF A CONTINGENT SYSTEM AND MAY BE CONSTRUCTED IN THE FUTURE.

DRAFT NOT FOR CONSTRUCTION

E2 Consulting Engineers, Inc.
1900 Powell Street, Ste. 250
Emeryville, CA 94608
(510) 652-1164

CH2MHILL.

NO.	DATE	DESCRIPTION	GM/SPEC	DWN	CHKD	SUPV	APVD BY
0	9/8/14	PRE-FINAL (90%) DESIGN		PH	VMB	VMB	VMB

REVISIONS

APPROVED BY	
SO	
SUPV	VMB
DSGN	PT
DWN	PH
CHKD	VMB
OK	VMB
DATE	09/08/14
SCALES	

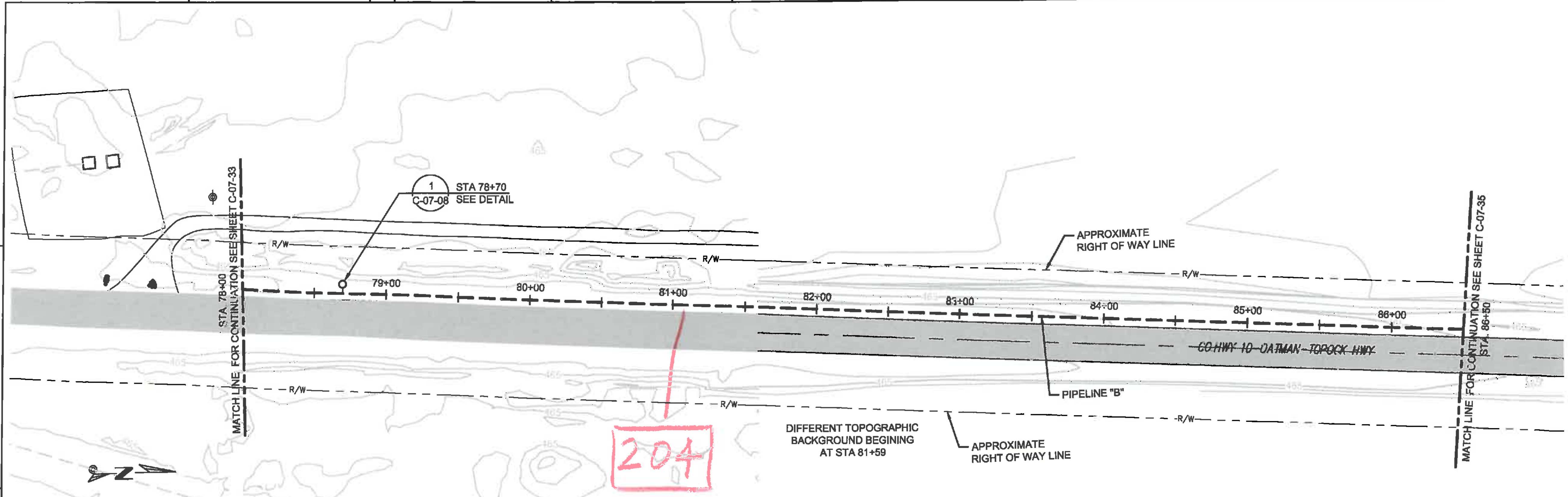
TOPOCK GROUNDWATER REMEDIATION PROJECT
PLAN AND PROFILE
PIPELINE "B"
STA 86+50 TO STA 96+50
GAS TRANSMISSION & DISTRIBUTION
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

MICROFILM
BILL OF MAT'L
DWG LIST
SUPSDS
SUPSD BY
SHEET NO. of SHEETS
C-07-35
REV 0

NOTES:

1. THE NEW PIPELINE ALIGNMENT SHOWS CENTER OF TRENCH.
2. ASSUMED DEPTH AND APPROXIMATE LOCATION ARE SHOWN. LOCATE BY POTHOLING BEFORE STARTING CONSTRUCTION. COORDINATE WITH PG&E TO RELOCATE INTERFERING UTILITIES AS NECESSARY TO ACCOMMODATE PIPELINE B.
3. PRESERVE AND PROTECT EXISTING STRUCTURE, TYP.
4. PROVIDE TRAFFIC CONTROL WHEN WORKING IN/NEAR ROADWAYS. COMPLY WITH OWNER'S ENCROACHMENT PERMIT WHEN WORKING IN COUNTY HIGHWAY 10.

6/42

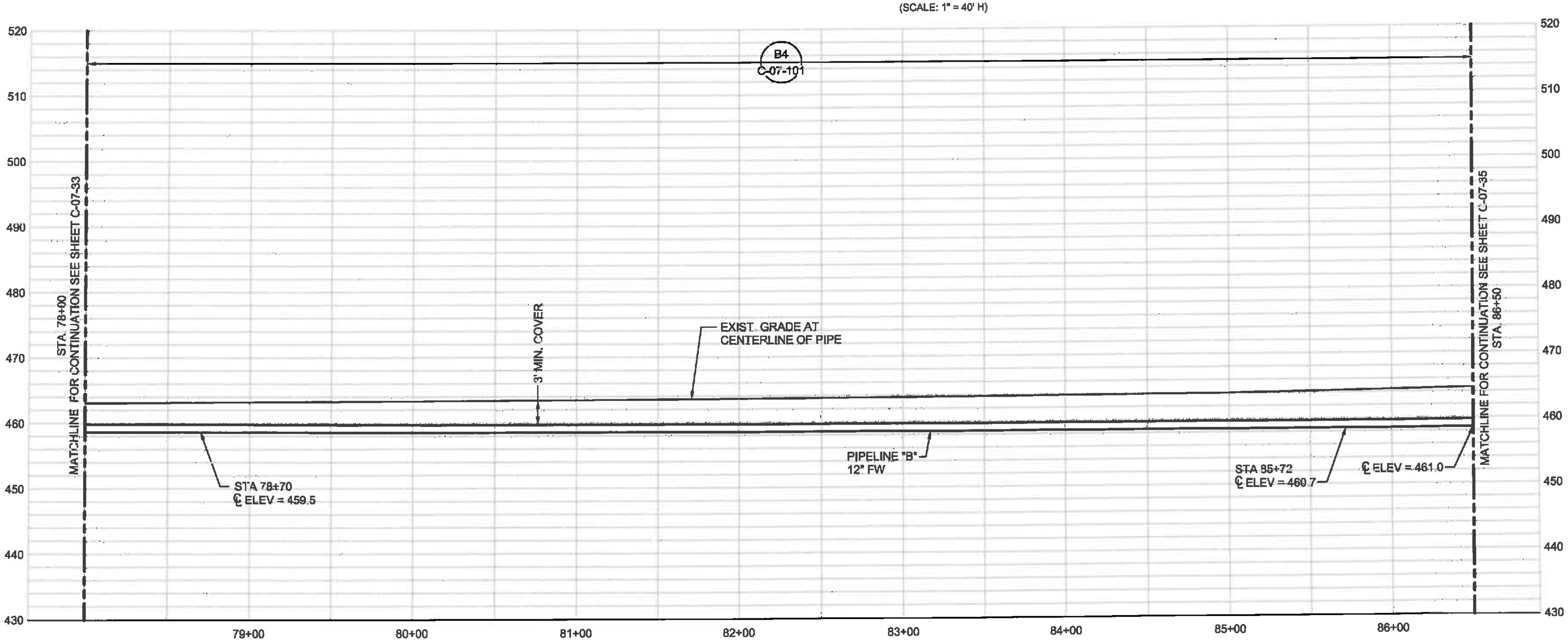


HORZ: SCALE: 1"=40'

VERT: SCALE: 1"=10'

PIPELINE "B" - PLAN

(SCALE: 1" = 40' H)



PIPELINE "B" - PROFILE

(SCALE: 1" = 40' H; 1" = 10' V)

CONTINGENT

NOTE:

THE EQUIPMENT AND FACILITY SHOWN IS PART OF A CONTINGENT SYSTEM AND MAY BE CONSTRUCTED IN THE FUTURE.

DRAFT NOT FOR CONSTRUCTION

E2 Consulting Engineers, Inc.

CH2MHILL.

NO.	DATE	DESCRIPTION	GM/SPEC	DWN	CHKD	SUPV	APVD BY
0	8/8/14	PRE-FINAL (90%) DESIGN		PH	VMB	VMB	VMB

REVISIONS

SUPV	VMB
DSGN	PT
DWN	PH
CHKD	VMB
OK	VMB
DATE	09/08/14

TOPOCK GROUNDWATER REMEDIATION PROJECT

PLAN AND PROFILE PIPELINE "B" STA 78+00 TO STA 86+50

GAS TRANSMISSION & DISTRIBUTION

PACIFIC GAS AND ELECTRIC COMPANY SAN FRANCISCO, CALIFORNIA

SHEET NO. C-07-34 REV 0

FILENAME: E2-C-XXX-0734.dwg

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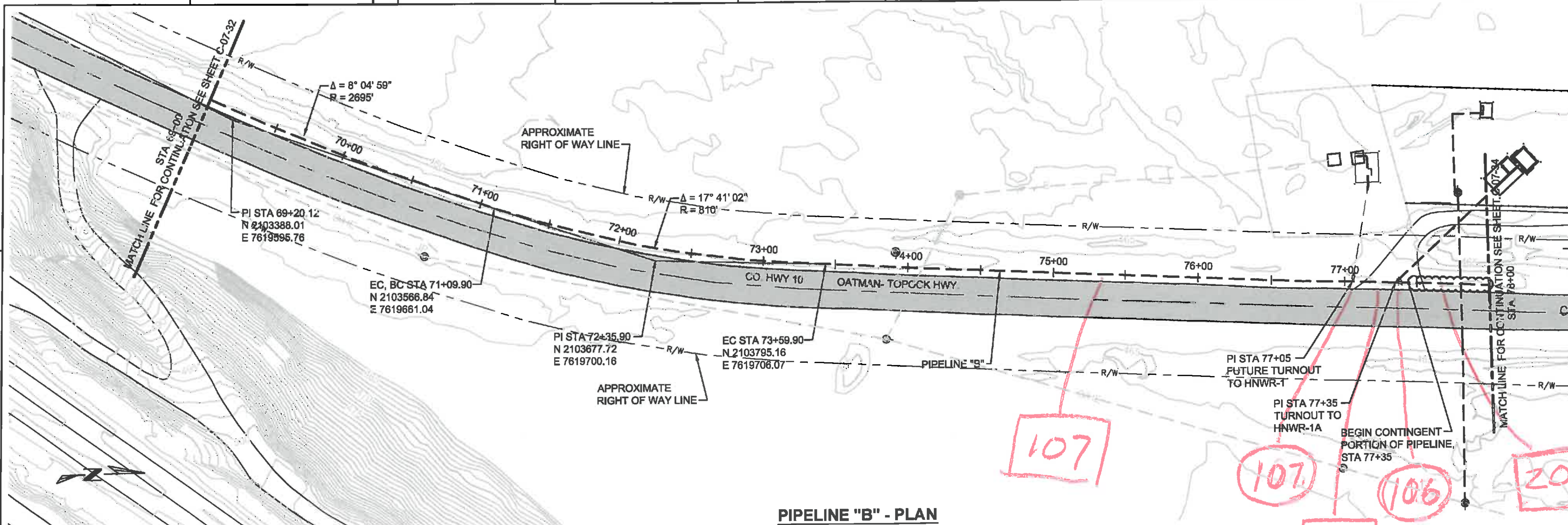


NOTES:

1. THE NEW PIPELINE ALIGNMENT SHOWS CENTER OF TRENCH.
2. ASSUMED DEPTH AND APPROXIMATE LOCATION ARE SHOWN. LOCATE BY POTHOLING BEFORE STARTING CONSTRUCTION. COORDINATE WITH PG&E TO RELOCATE INTERFERING UTILITIES AS NECESSARY TO ACCOMMODATE PIPELINE B.
3. PRESERVE AND PROTECT EXISTING STRUCTURE, TYP.
4. PROVIDE TRAFFIC CONTROL WHEN WORKING IN/NEAR ROADWAYS. COMPLY WITH OWNER'S ENCROACHMENT PERMIT WHEN WORKING IN COUNTY HIGHWAY 10.

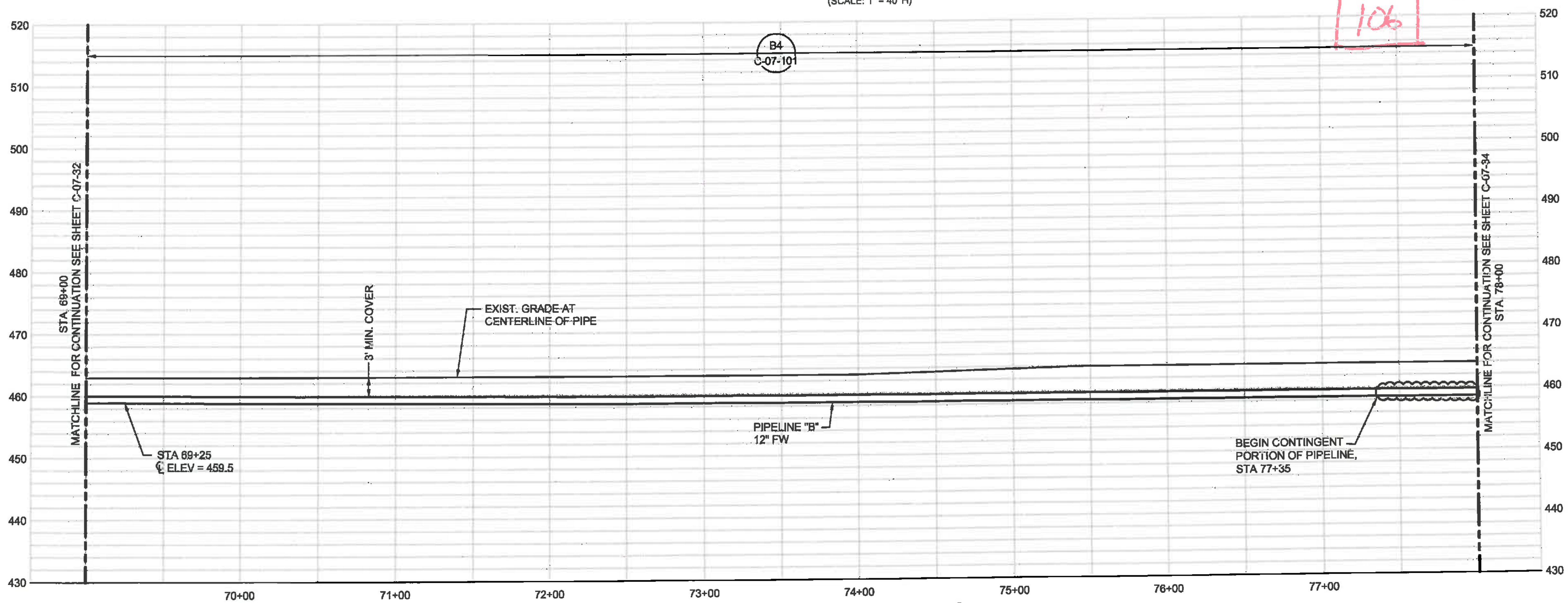
7/42

HORZ: SCALE: 1"=40' (0, 40, 80, 120)

VERT: SCALE: 1"=10' (0, 10, 20, 30)

PIPELINE "B" - PLAN

(SCALE: 1" = 40' H)



PIPELINE "B" - PROFILE

(SCALE: 1" = 40' H; 1" = 10' V)

CONTINGENT

NOTE:

THE EQUIPMENT AND FACILITY SHOWN CLOUDED IS PART OF A CONTINGENT SYSTEM AND MAY BE CONSTRUCTED IN THE FUTURE.

DRAFT NOT FOR CONSTRUCTION

E2 Consulting Engineers, Inc.
1900 Powell Street, Ste. 250
Emeryville, CA 94608
(510) 652-1164

CH2MHILL

NO.	DATE	DESCRIPTION	GM/SPEC	DWN	CHKD	SUPV	APVD BY
2	9/8/14	PRE-FINAL (90%) DESIGN	PH	VMB	VMB	VMB	
1	4/5/13	INTERMEDIATE (60%) DESIGN	PC	VMB	VMB	VMB	
0	11/18/11	PRELIMINARY (30%) DESIGN	PC	VMB	VMB	VMB	

REVISIONS

APPROVED BY	
SUPV	VMB
DSGN	PT
DWN	PH
CHKD	VMB
OK	VMB
DATE	09/08/14
SCALES	1" = 40'

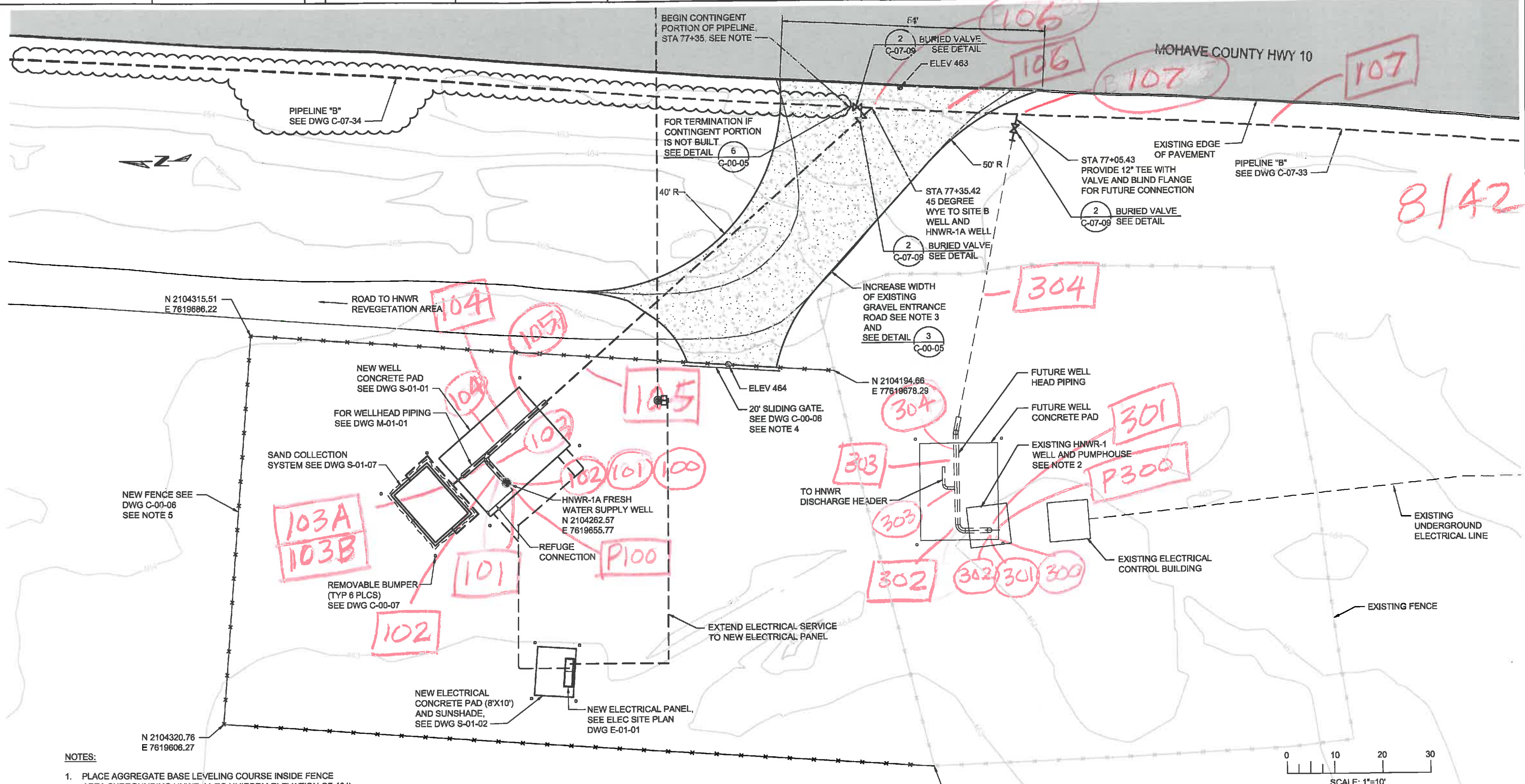
TOPOCK GROUNDWATER REMEDIATION PROJECT
PLAN AND PROFILE
PIPELINE "B"
STA 69+00 TO STA 78+00
GAS TRANSMISSION & DISTRIBUTION
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

MICROFILM / BILL OF MAT'L / DWG LIST / SUPSDS / SUPSD BY

SHEET NO. C-07-33 of SHEETS — REV 2

PLOT DATE: $PLOTDATE PLOT TIME: $PLOTTIME

FILENAME: E2-C-XXX-0733.dwg



NOTES:

1. PLACE AGGREGATE BASE LEVELING COURSE INSIDE FENCE AREA SURROUNDING HNWR-1A TO UNIFORM ELEVATION OF 464'
2. PROTECT EXISITING WELL SITE DURING CONSTRUCTION.
3. CROWN GRAVEL ENTRANCE ROAD ON CENTER LINE WITH 4% SLOPE IN EACH PERPENDICULAR DIRECTION. PLACE 3 INCHES OF GRAVEL ON TOP.
4. SURVEILLANCE CAMERA LOCATION AND CARD READER LOCATION FOR SLIDING GATE TO BE DETERMINED LATER.
5. TOTAL HEIGHT OF FENCE = 7' WITH 6' OF FABRIC PLUS 1' OF BARBED WIRE ON TOP.

NOTE:

THE EQUIPMENT AND FACILITY SHOWN CLOUDED IS PART OF A CONTINGENT SYSTEM AND MAY BE CONSTRUCTED IN THE FUTURE.

DRAFT NOT FOR CONSTRUCTION

E2 Consulting Engineers, Inc.

CH2MHILL.

NO.	DATE	DESCRIPTION	GM/SPEC	DWN	CHKD	SUPV	APVD BY
1	9/8/14	PRE-FINAL (90%) DESIGN	PH	PT	PT	VMB	
0	4/5/13	INTERMEDIATE (60%) DESIGN	PC/EE	PT	PT	VMB	

REVISIONS

SUPV	VMB
DSGN	PT
DWN	PH
CHKD	VMB
OK	VMB
DATE	09/08/14

TOPOCK GROUNDWATER REMEDIATION PROJECT

HNWR FRESHWATER SUPPLY WELL SITE PLAN

GAS TRANSMISSION & DISTRIBUTION

PACIFIC GAS AND ELECTRIC COMPANY SAN FRANCISCO, CALIFORNIA

SHEET NO. C-01-01 REV 1

FILENAME: E2-C-XXX-0101AD.DWG

PLOT DATE: $PLOTDATE PLOT TIME: $PLOTTIME

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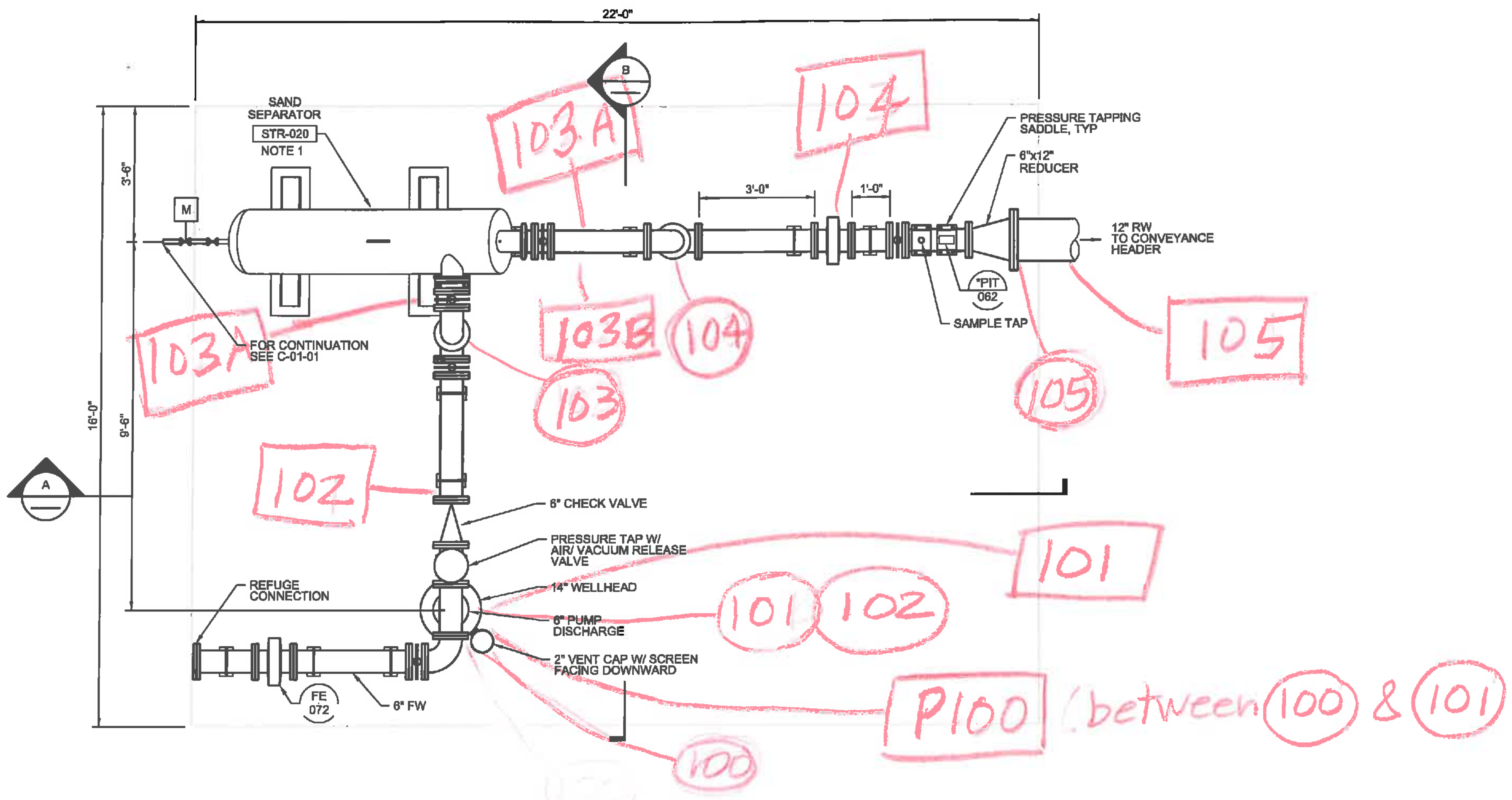
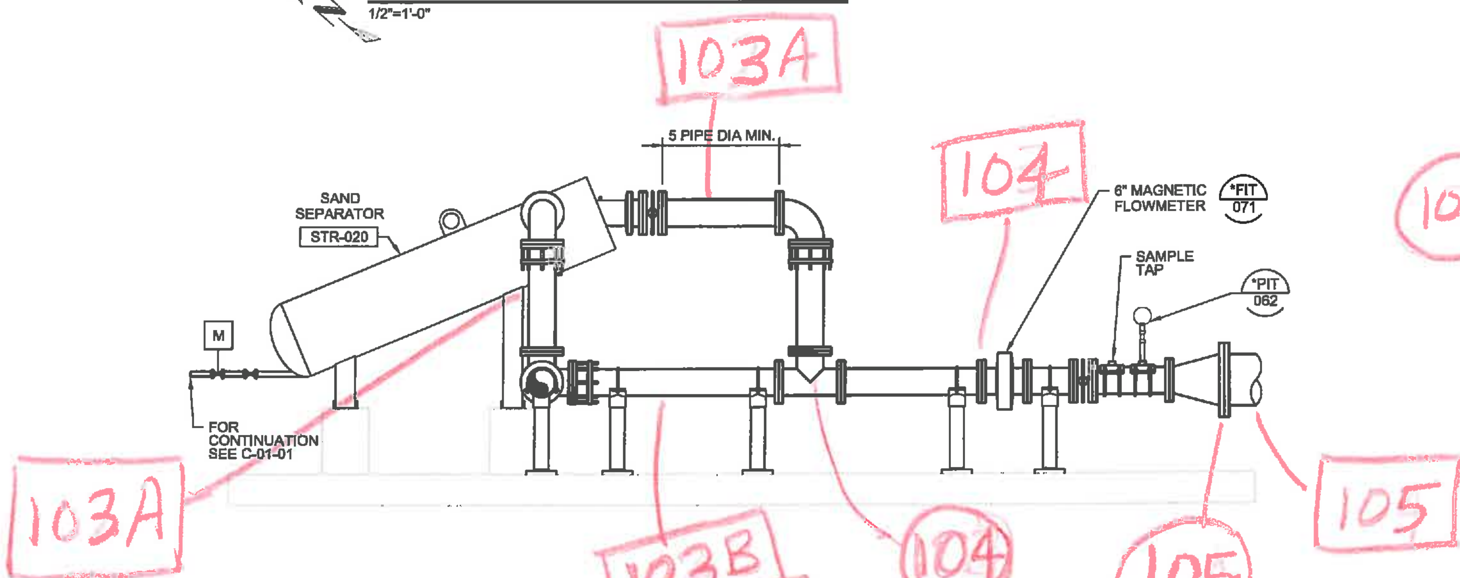


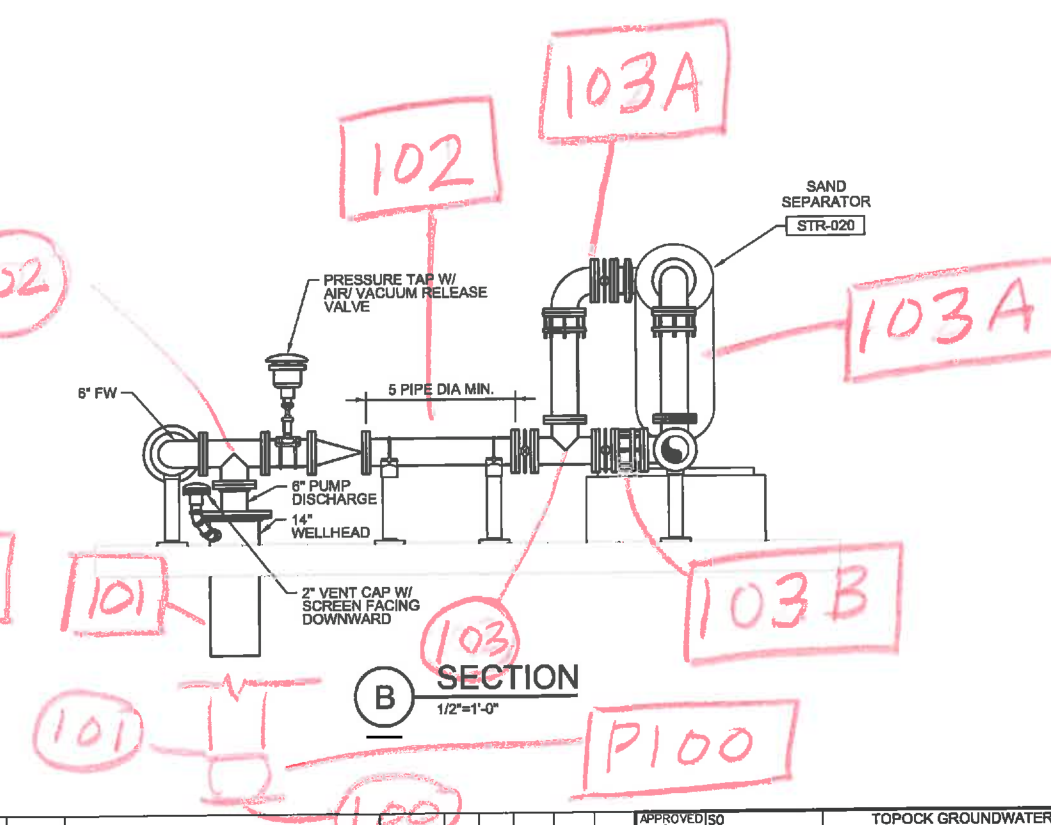
WELL HEAD PIPING PAD PLAN

1/2"=1'-0"



(A) SECTION

1/2"=1'-0"



(B) SECTION

1/2"=1'-0"

9/42

GENERAL NOTES

1. LAKOS SEPARATOR MODEL IHB-0500 (GROOVED JOINTS). PROVIDE 1 1/2" LAKOS BRONZE COMPACT MOTORIZED BALL VALVE FOR PURGE LINE. VALVE SHALL HAVE OPERATOR ADJUSTABLE SETTINGS FOR PURGE FREQUENCY AND DURATION. ELECTRIC ACTUATOR (120V) SHALL HAVE NEMA 4 HOUSING SUITABLE FOR OUTDOOR INSTALLATION. INSTALL PIPE SUPPORT FOR VALVE.
2. FOR PIPE SUPPORT SEE (4005-501).

DRAFT NOT FOR CONSTRUCTION

PLOT DATE: 2014/07/23 PLOT TIME: 10:14:44 AM

CH2MHILL.

NO.	DATE	DESCRIPTION	GM/SPEC	DWN	CHKD	SUPV	APVD BY

REVISIONS

NO.	DATE	DESCRIPTION	GM/SPEC	DWN	CHKD	SUPV	APVD BY

REVISIONS

APPROVED BY		
	SO	
	SUPV	
	DSGN	RH
	DWN	GJ
	CHKD	ML
	OK	
	DATE 201[illegible]	
	SCALES	

TOPOCK GROUNDWATER REMEDIATION PROJECT

HNWR-1A WELL HEAD PIPING AND ELECTRICAL PAD PLAN AND SECTION

GAS TRANSMISSION & DISTRIBUTION

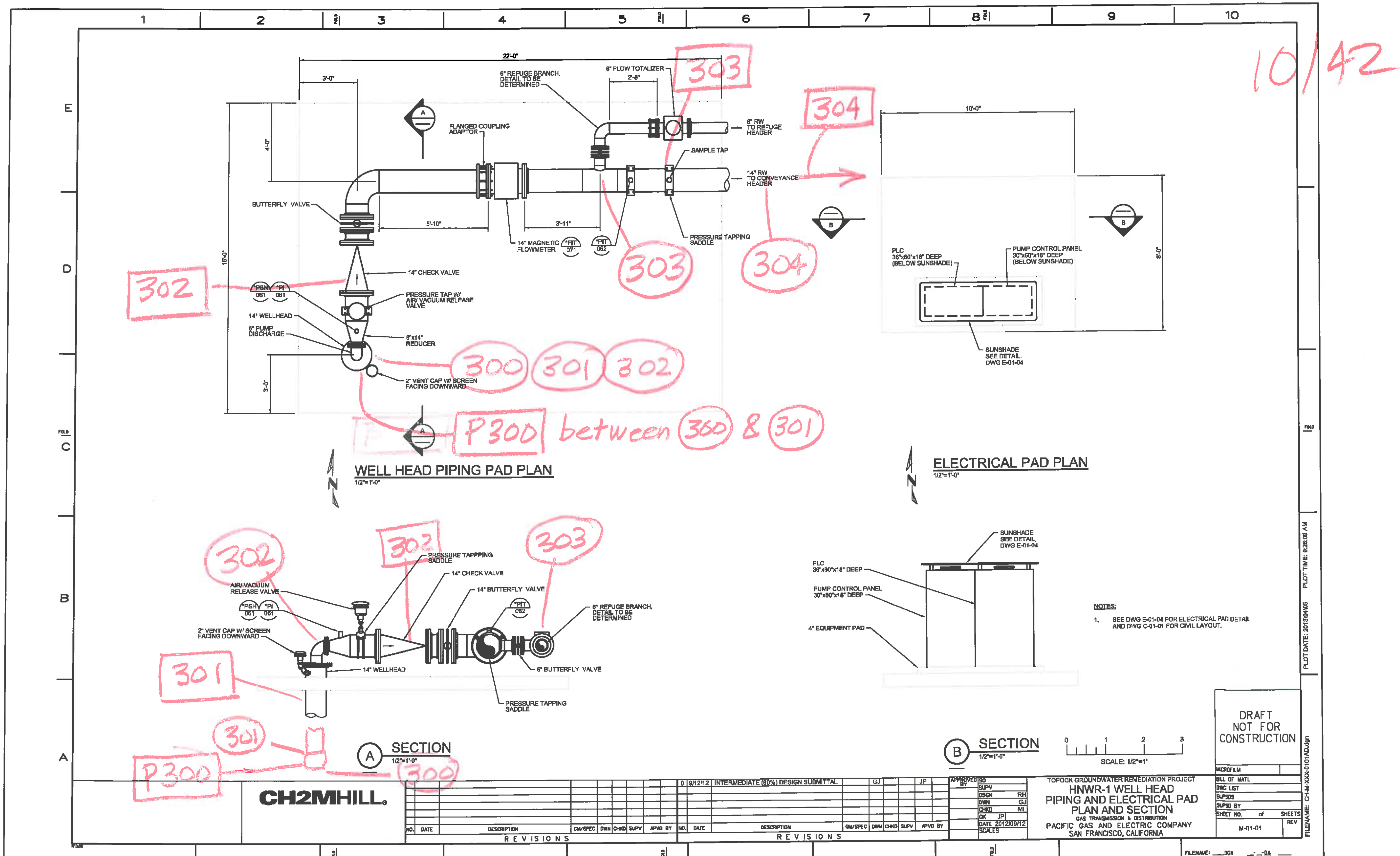
PACIFIC GAS AND ELECTRIC COMPANY

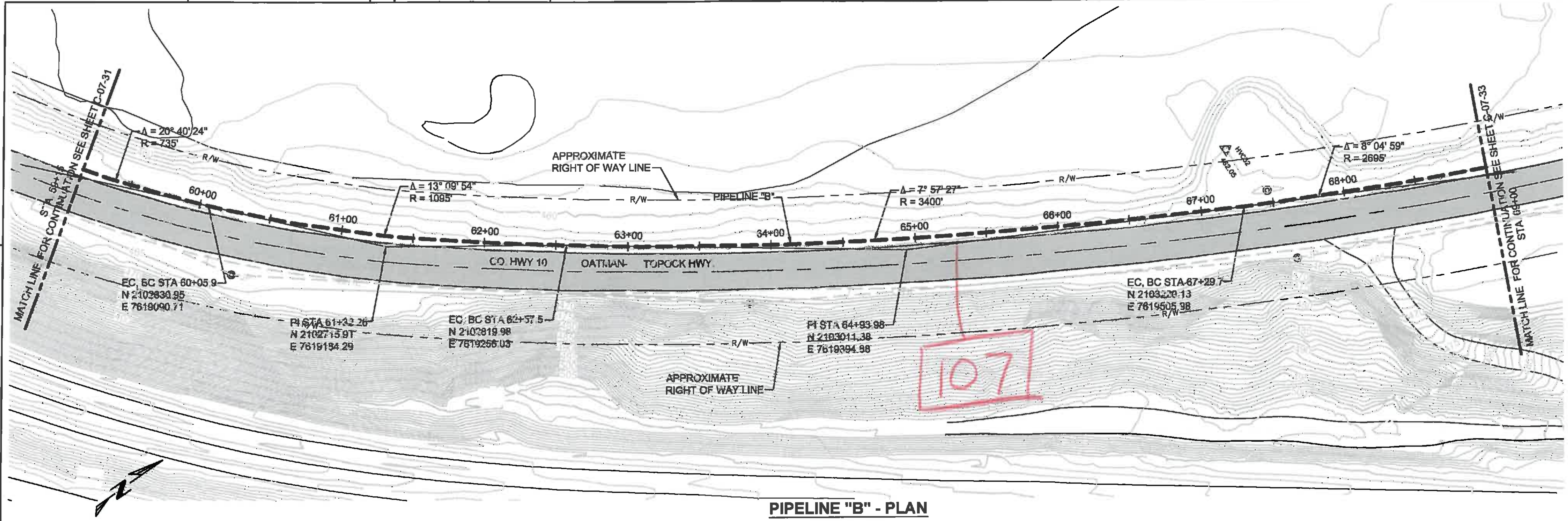
SAN FRANCISCO, CALIFORNIA

MICROFILM	
BILL OF MATL	
DWG LIST	
SUPSDS	
SUPSD BY	
SHEET NO. of SHEETS	REV
M-01-01	1

FILENAME: CH-M-XXX-0101AD.dgn

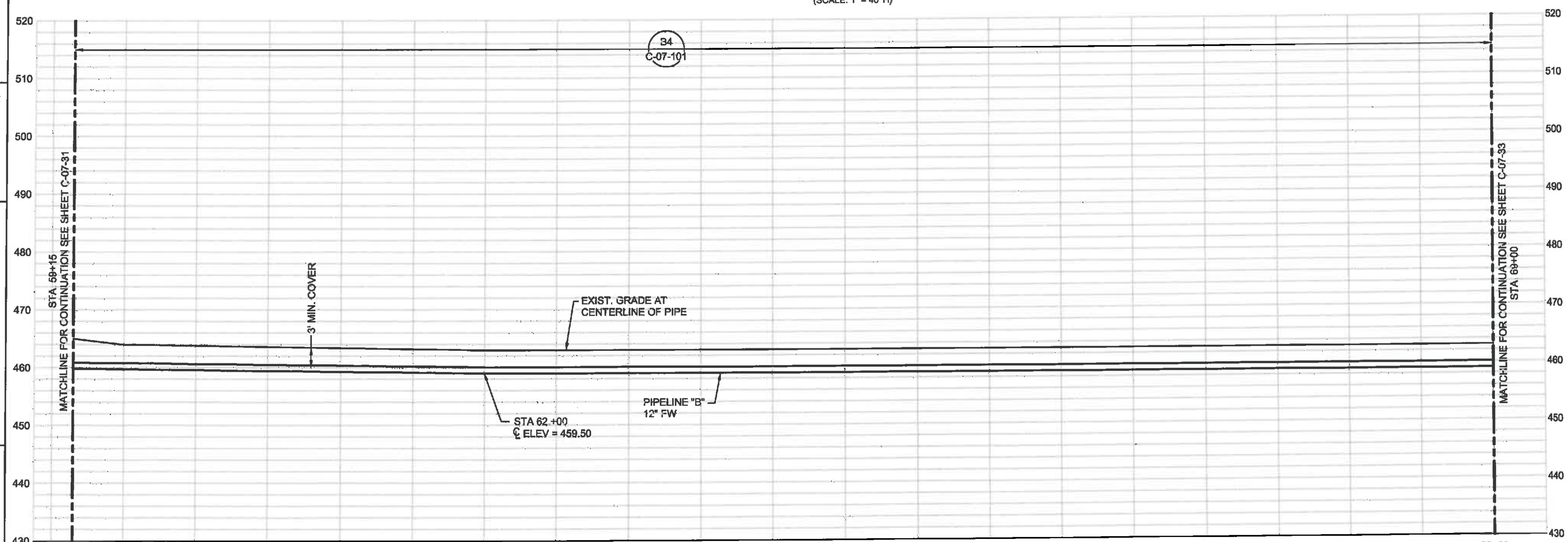
FILENAME: .DGN - -04


10/42
22'-0"
3'-0"
6" REFUGE BRANCH, DETAIL TO BE DETERMINED
6" FLOW TOTALIZER
2'-6"
FLANGED COUPLING ADAPTOR
6" RW TO REFUGE HEADER
SAMPLE TAP
14" RW TO CONVEYANCE HEADER
4'-0"
BUTTERFLY VALVE
5'-10"
3'-11"
14" MAGNETIC FLOWMETER
PRESSURE TAPPING SADDLE
16'-0"
14" CHECK VALVE
PRESSURE TAP W/ AIR/ VACUUM RELEASE VALVE
14" WELLHEAD
6" PUMP DISCHARGE
8"x14" REDUCER
2" VENT CAP W/ SCREEN FACING DOWNWARD
3'-0"
303
304
302
303
304
300
301
302
P300 between 300 & 301
WELL HEAD PIPING PAD PLAN
1/2"=1'-0"
10'-0"
8'-0"
PLC 36"x80"x18" DEEP (BELOW SUNSHADE)
PUMP CONTROL PANEL 30"x60"x18" DEEP (BELOW SUNSHADE)
SUNSHADE SEE DETAIL DWG E-01-04
ELECTRICAL PAD PLAN
1/2"=1'-0"
302
302
303
PRESSURE TAPPPING SADDLE
14" CHECK VALVE
14" BUTTERFLY VALVE
AIR/ VACUUM RELEASE VALVE
6" REFUGE BRANCH, DETAIL TO BE DETERMINED
2" VENT CAP W/ SCREEN FACING DOWNWARD
14" WELLHEAD
6" BUTTERFLY VALVE
PRESSURE TAPPING SADDLE
301
301
P300
300
SECTION A
1/2"=1'-0"
SUNSHADE SEE DETAIL DWG E-01-04
PLC 36"x60"x18" DEEP
PUMP CONTROL PANEL 30"x60"x18" DEEP
4" EQUIPMENT PAD
NOTES:
1. SEE DWG E-01-04 FOR ELECTRICAL PAD DETAIL AND DWG C-01-01 FOR CIVIL LAYOUT.
SECTION B
1/2"=1'-0"
SCALE: 1/2"=1'
DRAFT NOT FOR CONSTRUCTION
CH2MHILL.
0 9/12/12 INTERMEDIATE (60%) DESIGN SUBMITTAL GJ JP
REVISIONS
DSGN RH
DWN GJ
CHKD ML
OK JP
DATE 2012/09/12
TOPOCK GROUNDWATER REMEDIATION PROJECT
HNWR-1 WELL HEAD PIPING AND ELECTRICAL PAD PLAN AND SECTION
GAS TRANSMISSION & DISTRIBUTION
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA
M-01-01
FILENAME: CH-M-XXX-0101AD.dgn



PIPELINE "B" - PLAN

(SCALE: 1" = 40' H)



PIPELINE "B" - PROFILE

(SCALE: 1" = 40' H; 1" = 10' V)

NOTES:

1. THE NEW PIPELINE ALIGNMENT SHOWS CENTER OF TRENCH.
2. ASSUMED DEPTH AND APPROXIMATE LOCATION ARE SHOWN. LOCATE BY POTHOLING BEFORE STARTING CONSTRUCTION. COORDINATE WITH PG&E TO RELOCATE INTERFERING UTILITIES AS NECESSARY TO ACCOMMODATE PIPELINE B.
3. MAINTAIN CONTINUOUS ACCESS TO PRIVATE BUSINESS DURING CONSTRUCTION. COORDINATE EXACT REQUIREMENTS IN FIELD WITH OWNER.
4. PRESERVE AND PROTECT STRUCTURES, TYP. MAINTAIN SAFE DISTANCE FROM OVERHEAD ELECTRICAL LINES.
5. PROVIDE TRAFFIC CONTROL WHEN WORKING IN/NEAR ROADWAYS. COMPLY WITH OWNER'S ENCROACHMENT PERMIT WHEN WORKING IN COUNTY HIGHWAY 10.

11/42

0 40 80 120
HORZ: SCALE: 1"=40'

0 10 20 30
VERT: SCALE: 1"=10'

DRAFT NOT FOR CONSTRUCTION

E2 Consulting Engineers, Inc.

CH2MHILL

NO.	DATE	DESCRIPTION	GM/SPEC	DWN	CHKD	SUPV	APVD BY
2	9/8/14	PRE-FINAL (90%) DESIGN		PH	VMB	VMB	VMB
1	4/5/13	INTERMEDIATE (60%) DESIGN		PC	VMB	VMB	VMB
0	11/18/11	PRELIMINARY (30%) DESIGN		PC	VMB	VMB	VMB

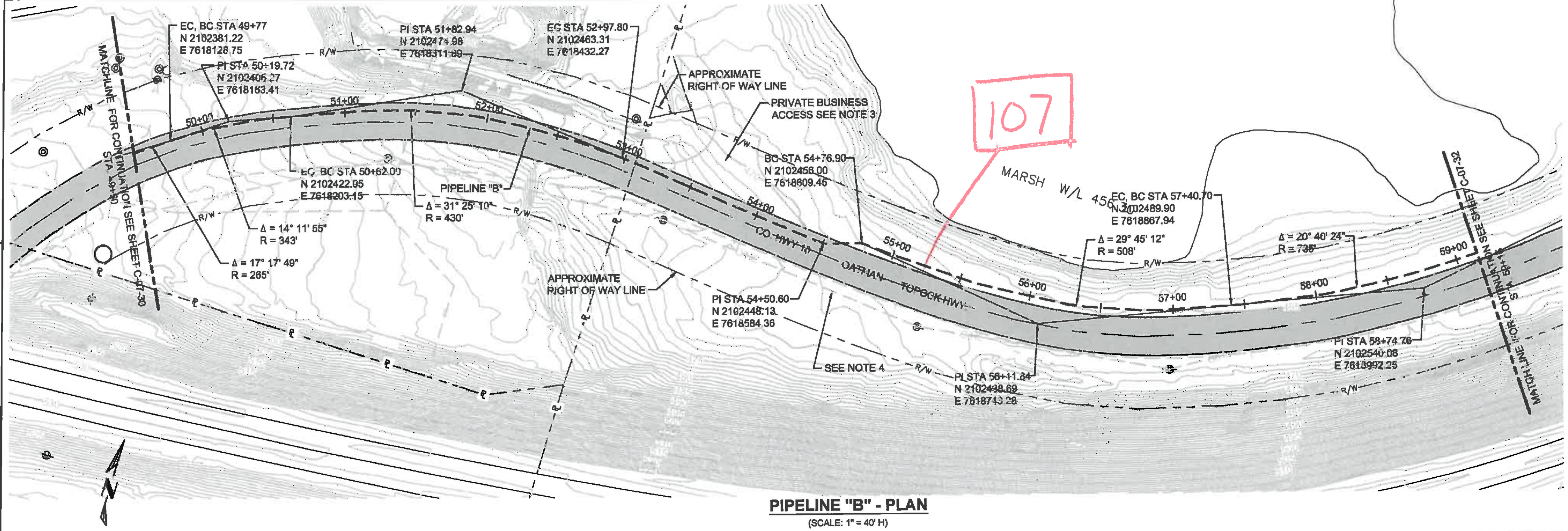
REVISIONS

APPROVED BY	
SUPV	VMB
DSGN	PT
DWN	PH
CHKD	VMB
OK	VMB
DATE	09/08/14
SCALES	

TOPOCK GROUNDWATER REMEDIATION PROJECT
PLAN AND PROFILE
PIPELINE "B"
STA 59+15 TO STA 69+00
GAS TRANSMISSION & DISTRIBUTION
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

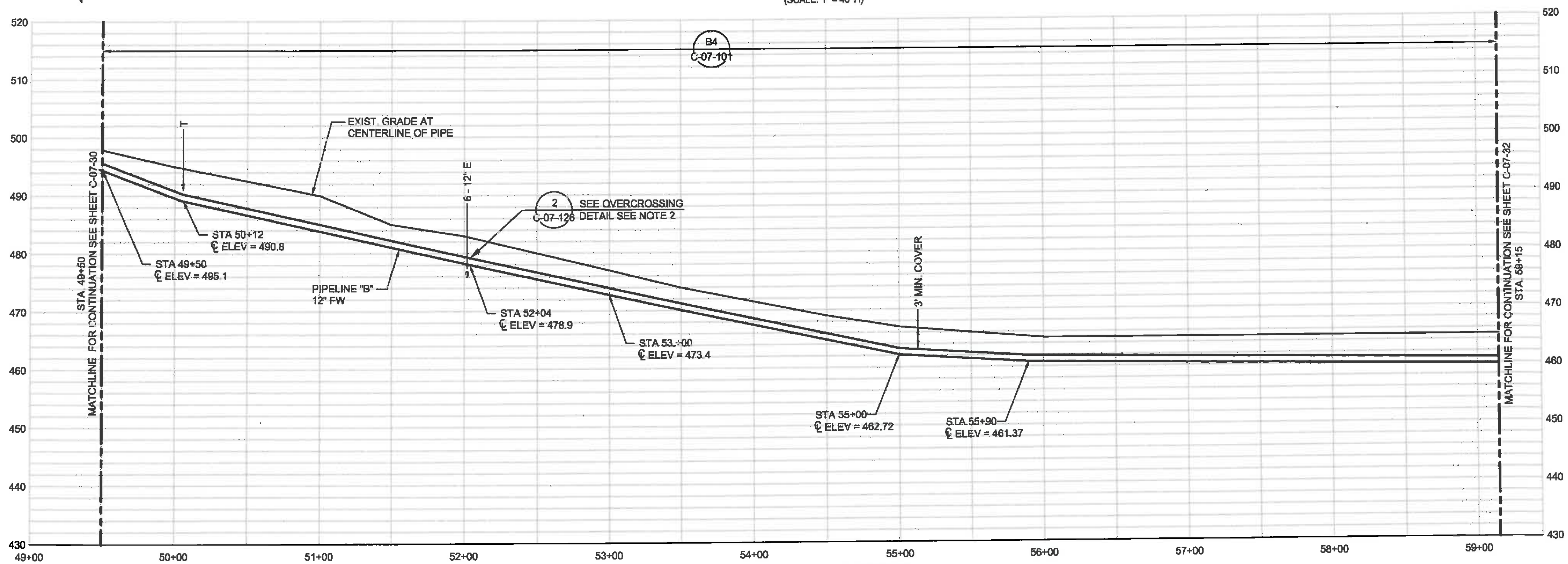
MICROFILM
BILL OF MAT'L
DWG LIST
SUPSDS
SUPSD BY
SHEET NO. of SHEETS
C-07-32 REV 2

FILENAME: E2-C-XXX-0732.dwg
PLOT DATE: $PLOTDATE PLOT TIME: $PLOTTIME



PIPELINE "B" - PLAN

(SCALE: 1" = 40' H)



PIPELINE "B" - PROFILE

(SCALE: 1" = 40' H; 1" = 10' V)

NOTES:

1. THE NEW PIPELINE ALIGNMENT SHOWS CENTER OF TRENCH.
2. ASSUMED DEPTH AND APPROXIMATE LOCATION ARE SHOWN. LOCATE BY POTHOLING BEFORE STARTING CONSTRUCTION. COORDINATE WITH PG&E TO RELOCATE INTERFERING UTILITIES AS NECESSARY TO ACCOMMODATE PIPELINE B.
3. MAINTAIN CONTINUOUS ACCESS TO PRIVATE BUSINESS DURING CONSTRUCTION. COORDINATE EXACT REQUIREMENTS IN FIELD WITH OWNER.
4. PRESERVE AND PROTECT STRUCTURES, TYP. MAINTAIN SAFE DISTANCE FROM OVERHEAD ELECTRICAL LINES.
5. PROVIDE TRAFFIC CONTROL WHEN WORKING IN/NEAR ROADWAYS. COMPLY WITH OWNER'S ENCROACHMENT PERMIT WHEN WORKING IN COUNTY HIGHWAY 10.

12/42

HORZ: SCALE: 1"=40' (0, 40, 80, 120)

VERT: SCALE: 1"=10' (0, 10, 20, 30)

DRAFT NOT FOR CONSTRUCTION

E2 Consulting Engineers, Inc.
1900 Powell Street, Ste. 250
Emeryville, CA 94608
(510) 652-1164

CH2MHILL.

NO.	DATE	DESCRIPTION	GM/SPEC	DWN	CHKD	SUPV	APVD BY
2	9/8/14	PRE-FINAL (90%) DESIGN		PH	VMB	VMB	VMB
1	4/5/13	INTERMEDIATE (60%) DESIGN		PC	VMB	VMB	VMB
0	11/18/11	PRELIMINARY (30%) DESIGN		PC	VMB	VMB	VMB

REVISIONS

APPROVED BY	
SO	
SUPV	VMB
DSGN	PT
DWN	PH
CHKD	VMB
OK	VMB
DATE	09/08/14
SCALES	

TOPOCK GROUNDWATER REMEDIATION PROJECT
PLAN AND PROFILE
PIPELINE "B"
STA 49+50 TO STA 59+15
GAS TRANSMISSION & DISTRIBUTION
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

MICROFILM
BILL OF MAT'L
DWG LIST
SUPSDS
SUPSD BY
SHEET NO. of SHEETS
C-07-31 REV 2

FILENAME: E2-C-XXX-0731.dwg

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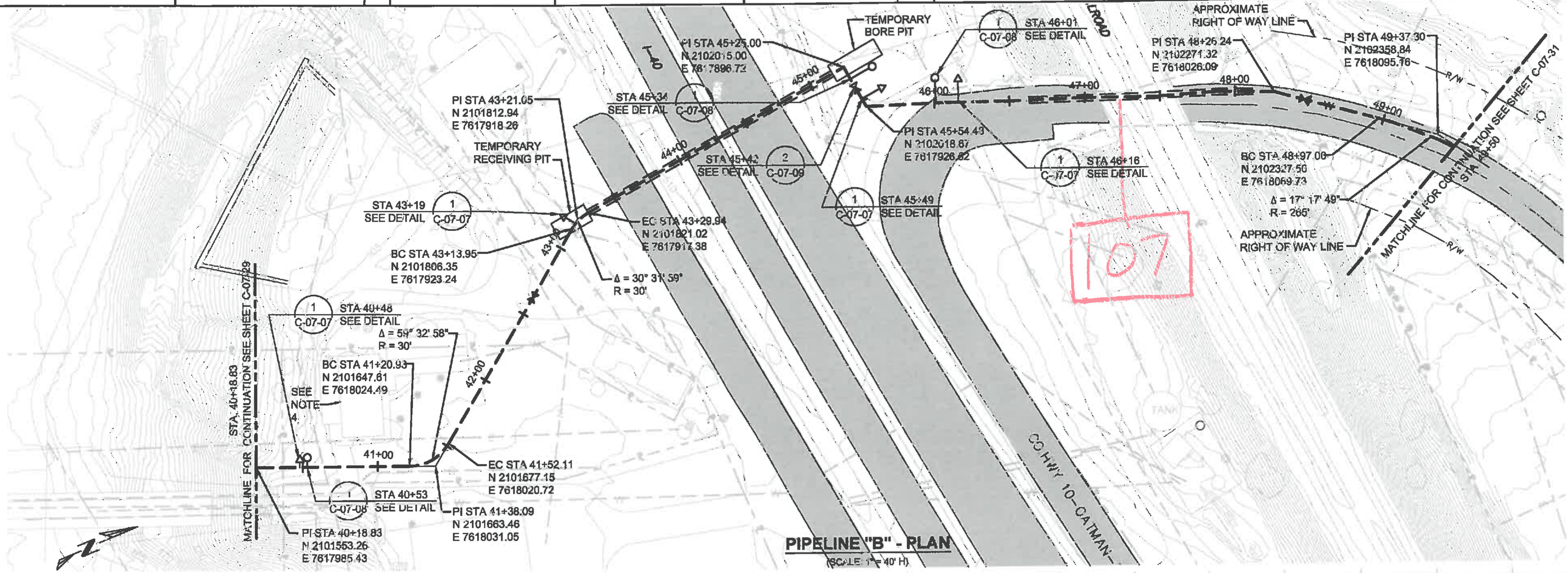


PIPELINE "B" - PLAN

(SCALE: 1" = 40' H)

107

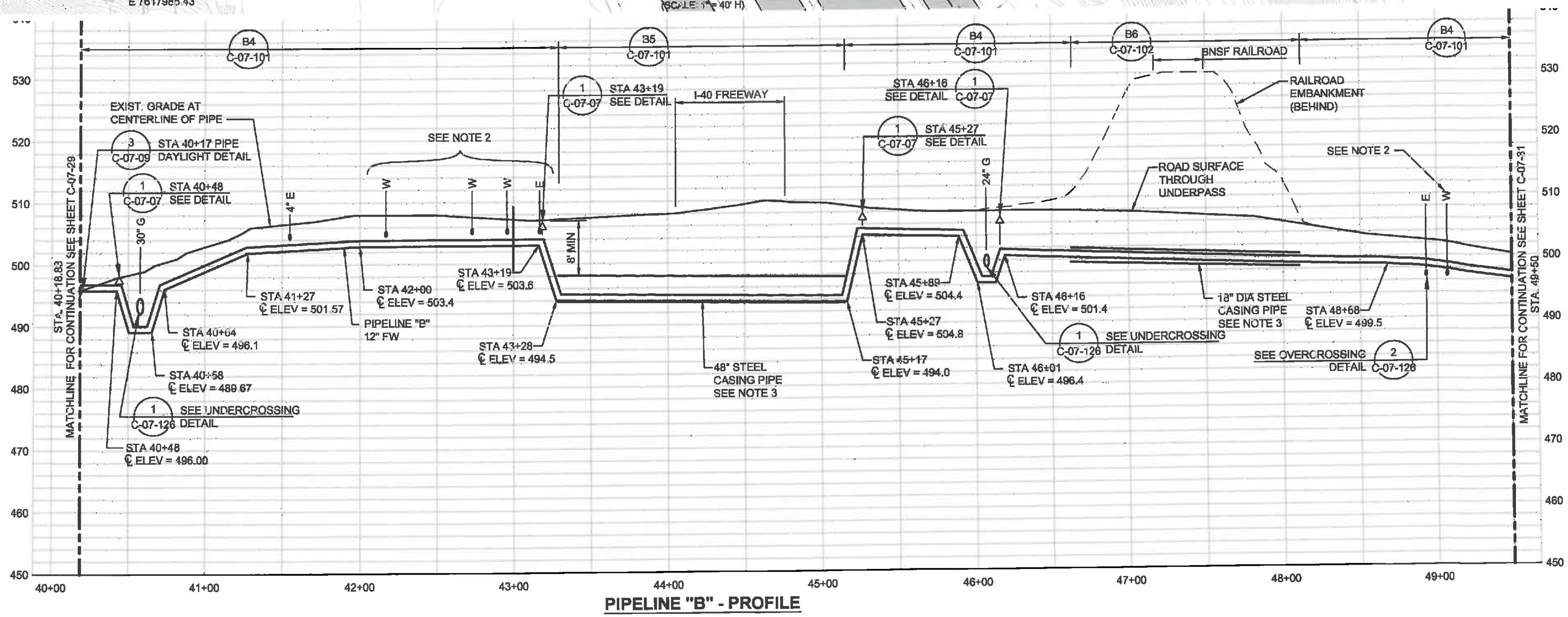
13/42

NOTES:

1. THE NEW PIPELINE ALIGNMENT SHOWS CENTER OF TRENCH.
2. ASSUMED DEPTH AND APPROXIMATE LOCATION ARE SHOWN. LOCATE BY POTHOLING BEFORE STARTING CONSTRUCTION. COORDINATE WITH PG&E TO RELOCATE INTERFERING UTILITIES AS NECESSARY TO ACCOMMODATE PIPELINE B.
3. DESIGN AND PROVIDE CATHODIC PROTECTION AS SPECIFIED.
4. PRESERVE AND PROTECT EXISTING STRUCTURE, TYP.
5. PROVIDE TRAFFIC CONTROL WHEN WORKING IN/NEAR ROADWAYS. COMPLY WITH OWNER'S ENCROACHMENT PERMIT WHEN WORKING IN COUNTY HIGHWAY 10.

0 40 80 120
HORZ: SCALE: 1"=40'

0 10 20 30
VERT: SCALE: 1"=10'



PIPELINE "B" - PROFILE

(SCALE: 1" = 40' H; 1" = 10' V)

DRAFT NOT FOR CONSTRUCTION

E2 Consulting Engineers, Inc.
1900 Powell Street, Ste. 250
Emeryville, CA 94608
(510) 652-1164

CH2MHILL.

NO.	DATE	DESCRIPTION	GM/SPEC	DWN	CHKD	SUPV	APVD BY
2	9/8/14	PRE-FINAL (90%) DESIGN		PH	VMB	VMB	VMB
1	4/5/13	INTERMEDIATE (60%) DESIGN		WTH	VMB	VMB	VMB
0	11/18/11	PRELIMINARY (30%) DESIGN		EE	VMB	VMB	VMB

REVISIONS

APPROVED BY	
SO	
SUPV	VMB
DSGN	PT
DWN	PH
CHKD	VMB
OK	VMB
DATE	09/08/14
SCALES	1" = 40'

TOPOCK GROUNDWATER REMEDIATION PROJECT

PLAN AND PROFILE
PIPELINE "B"
STA 40+18.83 TO STA 49+50

GAS TRANSMISSION & DISTRIBUTION
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

MICROFILM
BILL OF MATL
DWG LIST
SUPSDS
SUPSD BY
SHEET NO. of SHEETS
C-07-30 REV 2

FILENAME: E2-C-XXX-0730.dwg

PLOT DATE: $PLOTDATE PLOT TIME: $PLOTTIME

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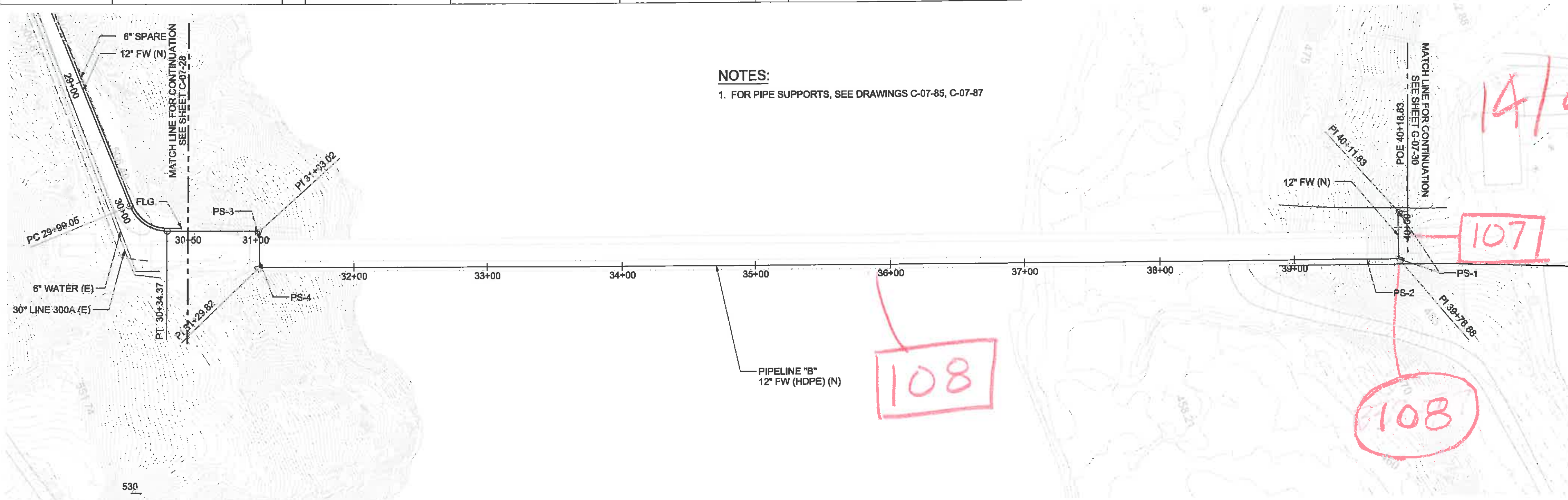
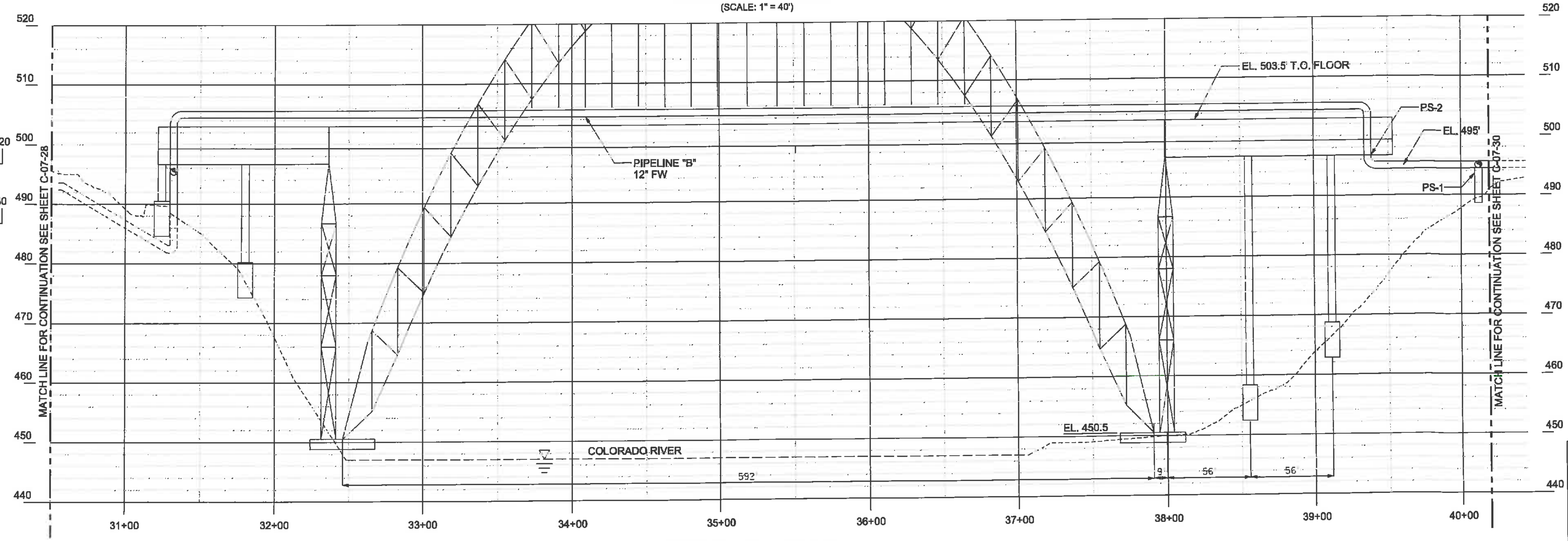


PIPELINE "B" - PLAN

(SCALE: 1" = 40')

HORIZ: SCALE: 1"=40'

VERT: SCALE: 1"=10'



PIPELINE "B" - PROFILE

(SCALE: 1" = 40' H; 1" = 10' V)

- DRAFT -
NOT FOR CONSTRUCTION

AECOM
2101 WEBSTER STREET SUITE 1900
OAKLAND, CA 94612-3060
PROJECT NO. 60272335

NO.	DATE	DESCRIPTION	GM/SPEC	DWN	CHKD	SUPV	APVD BY
0	9/8/14	PRE-FINAL (90%) DESIGN					

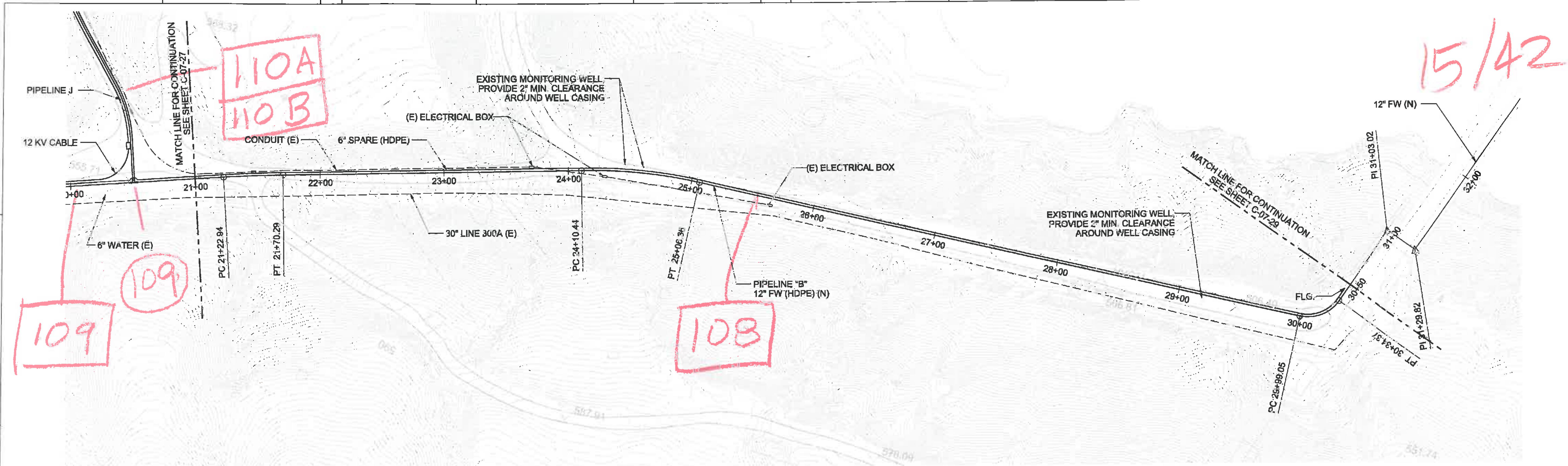
REVISIONS

SO	XXXXX
SUPV	PD
DSGN	GO
DWN	LD
CHKD	JM
OK	PD
DATE	9/8/14
SCALES	1" = 40'-0"

TOPOCK GROUNDWATER REMEDIATION PROJECT
PIPELINE - PLAN AND PROFILE
STA 30+50 TO STA 40+18.83
PIPELINE "B"
GAS TRANSMISSION & DISTRIBUTION
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

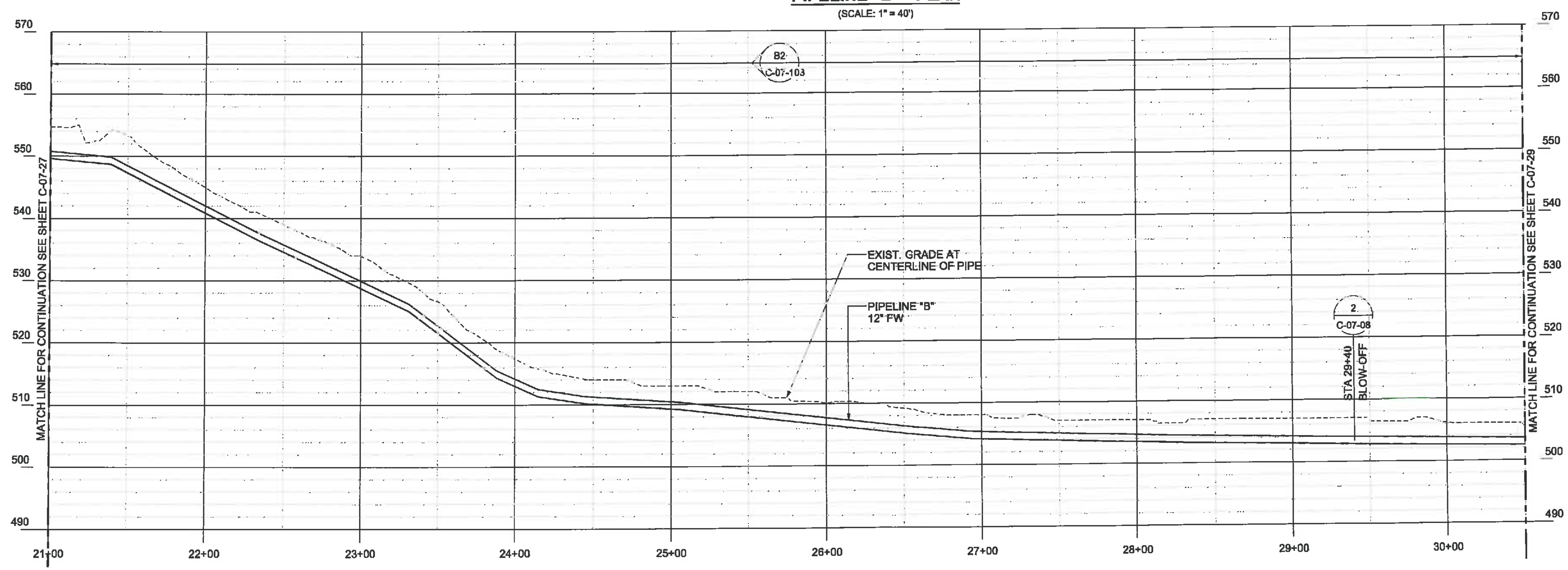
MICROFILM
BILL OF MATL
DWG LIST
SUPSDS
SUPSD BY
SHEET NO. OF SHEETS

C-07-29 REV 0



PIPELINE "B" - PLAN

(SCALE: 1" = 40')



PIPELINE "B" - PROFILE

(SCALE: 1" = 40' H; 1" = 10' V)

HORIZ: SCALE: 1"=40' (0, 40, 80, 120)

VERT: SCALE: 1"=10' (0, 10, 20, 30)

B2
C-07-103

- DRAFT - NOT FOR CONSTRUCTION

AECOM
2101 WEBSTER STREET SUITE 1000
OAKLAND, CA 94612-3060
PROJECT NO. 60272335

NO.	DATE	DESCRIPTION	GM/SPEC	DWN	CHKD	SUPV	APVD BY
0	9/8/14	PRE-FINAL (90%) DESIGN					

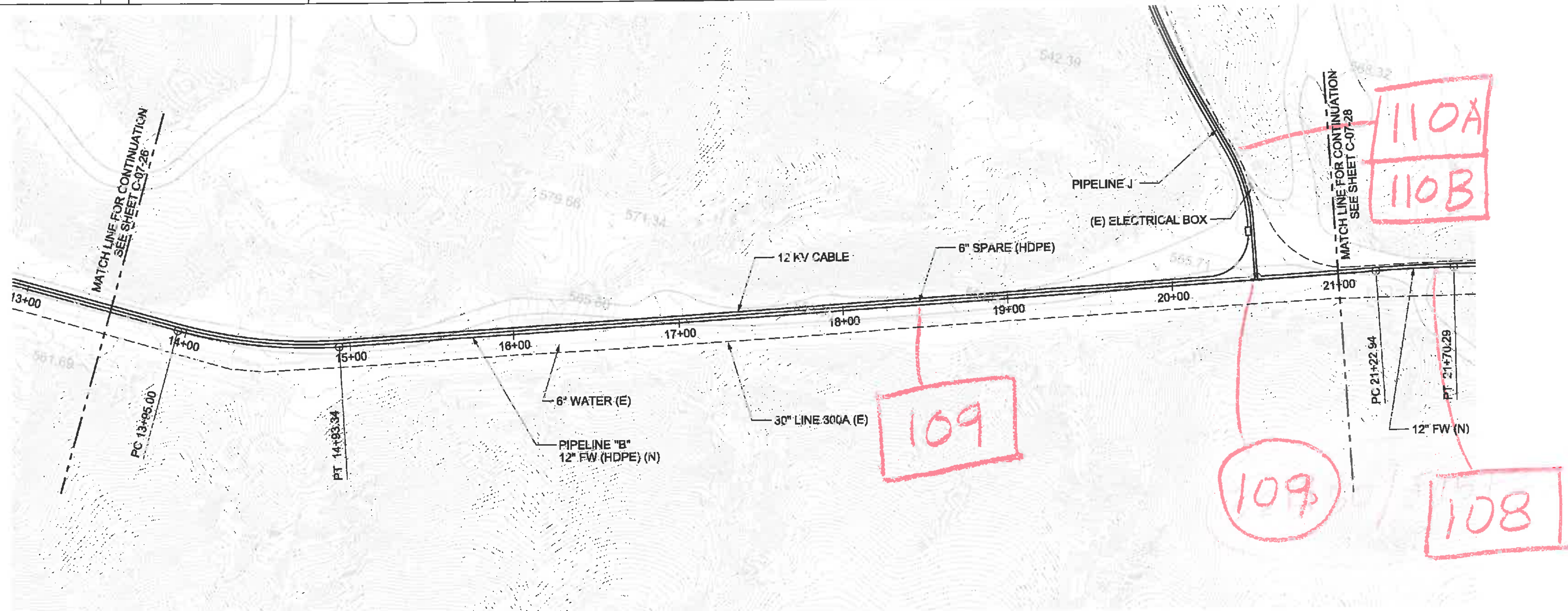
REVISIONS

SO	XX/XX
SUPV	PD
DSGN	GO
DWN	LD
CHKD	JM
OK	PD
DATE	9/8/14
SCALES	1" = 40'-0"

TOPOCK GROUNDWATER REMEDIATION PROJECT
PIPELINE - PLAN AND PROFILE
STA 21+00 TO STA 30+50
PIPELINE "B"
GAS TRANSMISSION & DISTRIBUTION
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

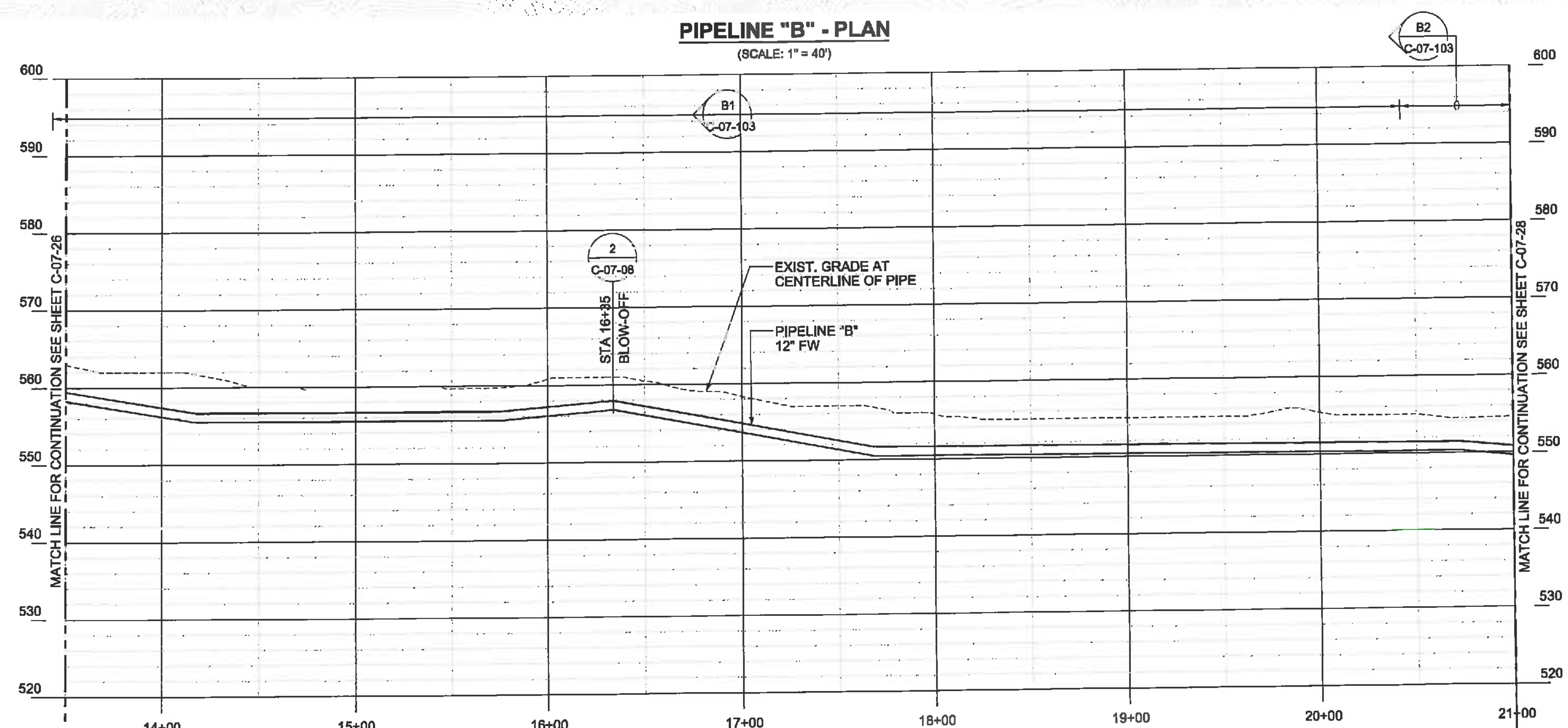
MICROFILM
BILL OF MATL
DWG LIST
SUPSDS
SUPSD BY
SHEET NO. OF SHEETS
C-07-28
REV 0

16/42



PIPELINE "B" - PLAN

(SCALE: 1" = 40')



PIPELINE "B" - PROFILE

(SCALE: 1" = 40' H; 1" = 10' V)

HORIZ: SCALE: 1"=40'

VERT: SCALE: 1"=10'

- DRAFT - NOT FOR CONSTRUCTION

AECOM
2101 WEBSTER STREET SUITE 1900
OAKLAND, CA 94612-3060
PROJECT NO. 60272335

NO.	DATE	DESCRIPTION	GM/SPEC	DWN	CHKD	SUPV	APVD BY
1	9/8/14	PRE-FINAL (90%) DESIGN					
0	9/12/12	INTERMEDIATE (60%) DESIGN					

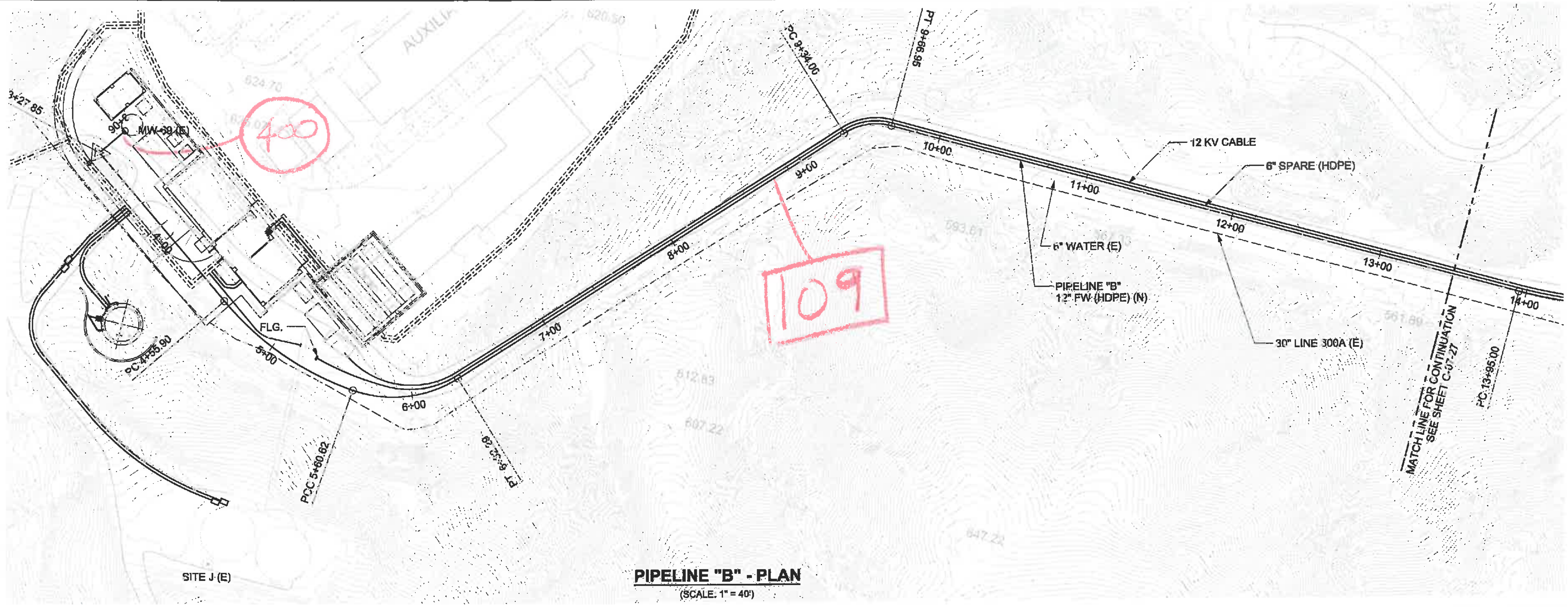
REVISIONS

APPROVED BY	
SO	XX/XX
SUPV	PD
DSGN	GO
DWN	LD
CHKD	JM
OK	PD
DATE	9/8/14
SCALES	1" = 40'-0"

TOPOCK GROUNDWATER REMEDIATION PROJECT
PIPELINE - PLAN AND PROFILE
STA 13+50 TO STA 21+00
PIPELINE "B"
GAS TRANSMISSION & DISTRIBUTION
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

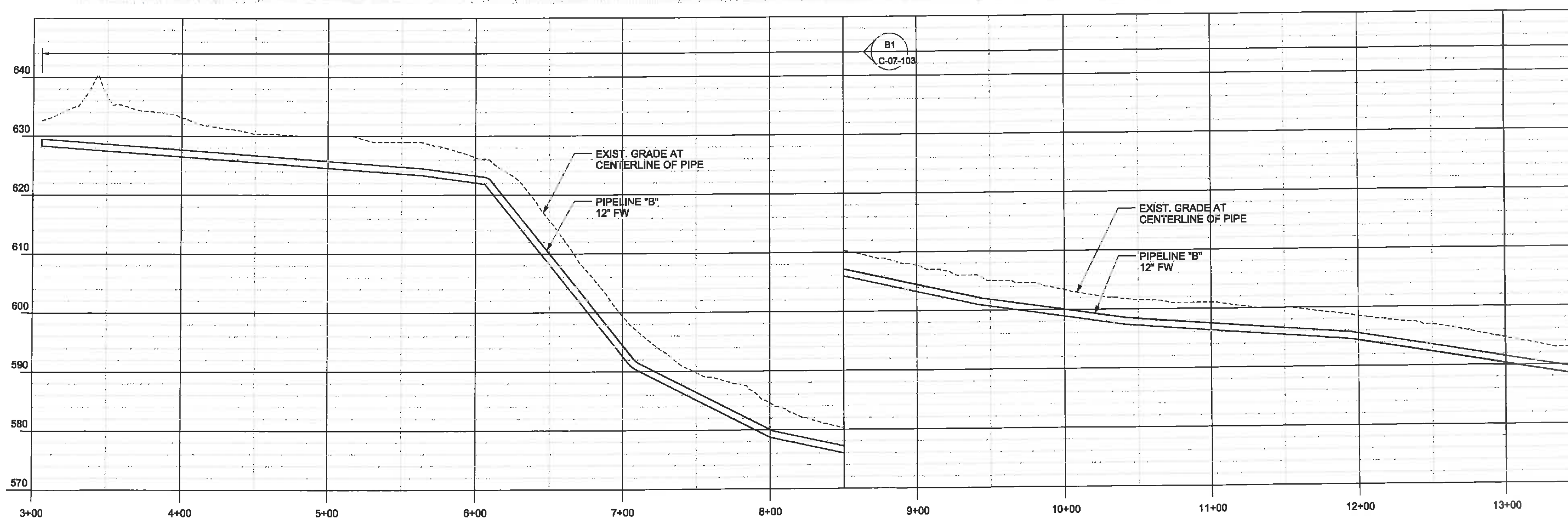
MICROFILM
BILL OF MATL
DWG LIST
SUPSDS
SUPSD BY
SHEET NO. OF SHEETS
C-07-27 REV 1

17/42



PIPELINE "B" - PLAN

(SCALE: 1" = 40')



PIPELINE "B" - PROFILE

(SCALE: 1" = 40' H; 1" = 10' V)

HORIZ: SCALE: 1"=40' (0, 40, 80, 120)

VERT: SCALE: 1"=10' (0, 10, 20, 30)

- DRAFT - NOT FOR CONSTRUCTION

AECOM
2101 WEBSTER STREET SUITE 1900
OAKLAND, CA 94612-3060
PROJECT NO. 60272335

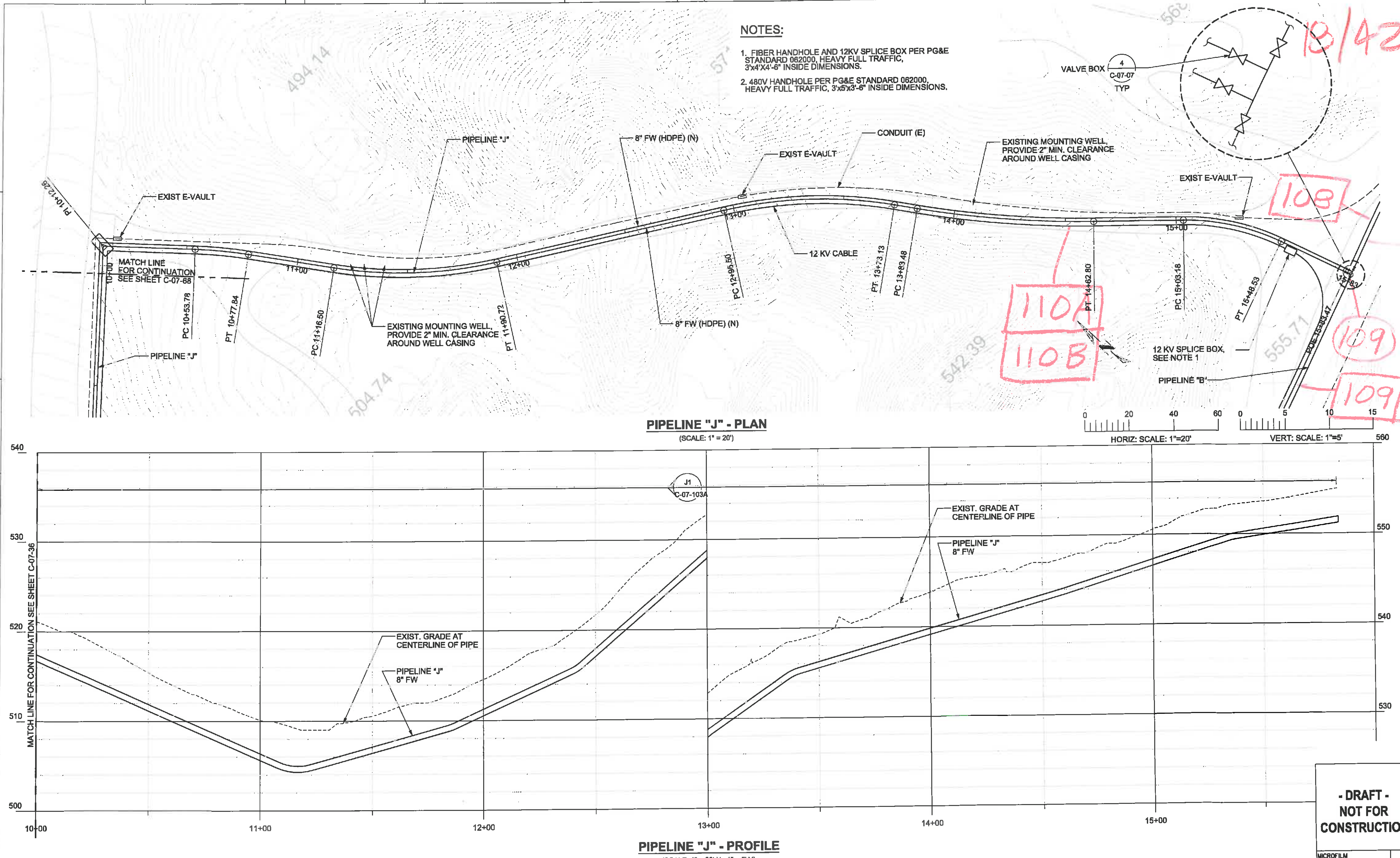
NO.	DATE	DESCRIPTION	GM/SPEC	DWN	CHKD	SUPV	APVD BY
1	9/8/14	PRE-FINAL(90%) DESIGN					
0	8/12/12	INTERMEDIATE (60%) DESIGN					

REVISIONS

APPROVED BY	
SO	XXXX
SUPV	PD
DSGN	GO
DWN	LD
CHKD	JM
OK	PD
DATE	9/8/14
SCALES	1" = 40'-0"

TOPOCK GROUNDWATER REMEDIATION PROJECT
PIPELINE - PLAN AND PROFILE
STA 3+05 TO STA 13+50
PIPELINE "B"
GAS TRANSMISSION & DISTRIBUTION
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

MICROFILM
BILL OF MATL
DWG LIST
SUPSDS
SUPSD BY
SHEET NO. C-07-26 OF SHEETS
REV 1



NOTES:

1. FIBER HANDHOLE AND 12KV SPLICE BOX PER PG&E STANDARD 062000, HEAVY FULL TRAFFIC, 3'x4'X4'-6" INSIDE DIMENSIONS.
2. 480V HANDHOLE PER PG&E STANDARD 062000, HEAVY FULL TRAFFIC, 3'x5'x3'-6" INSIDE DIMENSIONS.

18/42

108

110A

110B

109

109

- DRAFT -
NOT FOR CONSTRUCTION

AECOM
2101 WEBSTER STREET SUITE 1000
OAKLAND, CA 94612-3060
PROJECT NO. 60272335

NO.	DATE	DESCRIPTION	GM/SPEC	DWN	CHKD	SUPV	APVD BY
1	9/8/14	PRE-FINAL (90%) DESIGN					
0	9/12/12	INTERMEDIATE (60%) DESIGN					

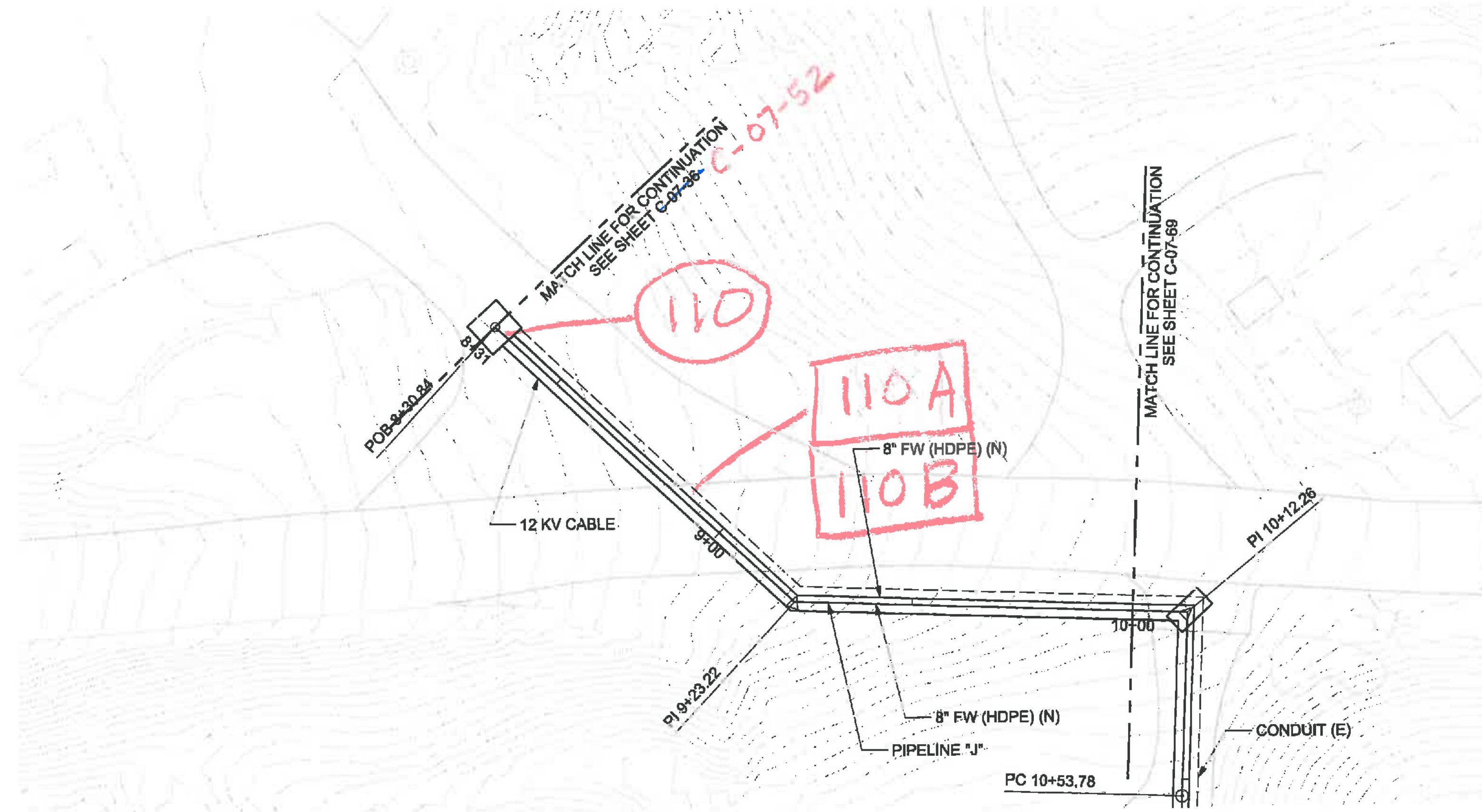
REVISIONS

APPROVED BY	
SO	XXXXX
SUPV	PD
DSGN	GO
DWN	LD
CHKD	JM
OK	PD
DATE	9/8/14
SCALES	1" = 20'-0"

TOPOCK GROUNDWATER REMEDIATION PROJECT
PIPELINE - PLAN AND PROFILE
STA 10+04 TO STA 15+83
PIPELINE "J"
GAS TRANSMISSION & DISTRIBUTION
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

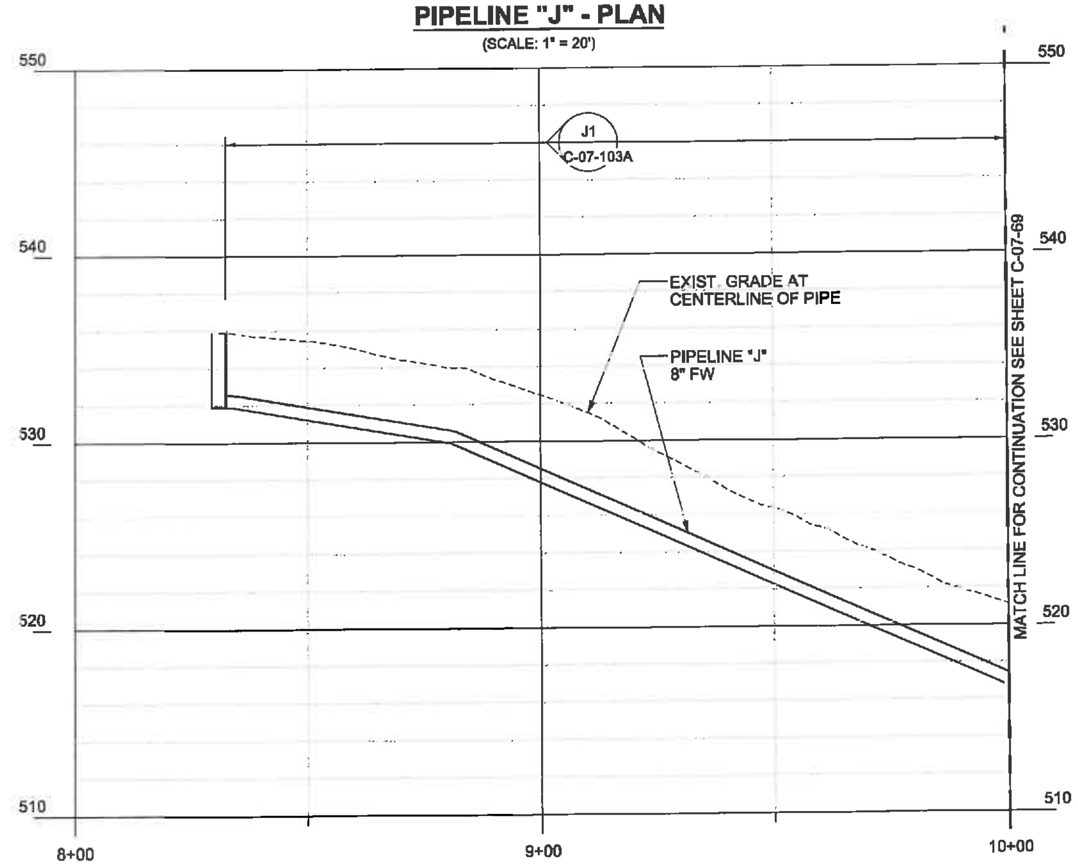
MICROFILM
BILL OF MATL
DWG LIST
SUPSDS
SUPSD BY
SHEET NO. OF SHEETS
C-07-89 REV 1

19/42



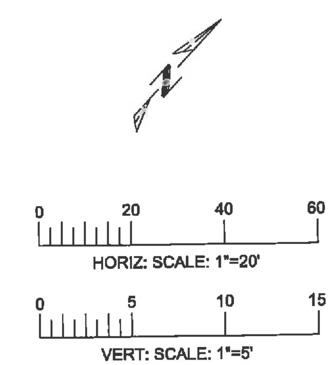
PIPELINE "J" - PLAN

(SCALE: 1" = 20')



PIPELINE "J" - PROFILE

(SCALE: 1" = 20' H; 1" = 5' V)



- DRAFT - NOT FOR CONSTRUCTION

AECOM
2101 WEBSTER STREET SUITE 1000
OAKLAND, CA 94612-3060
PROJECT NO. 60272335

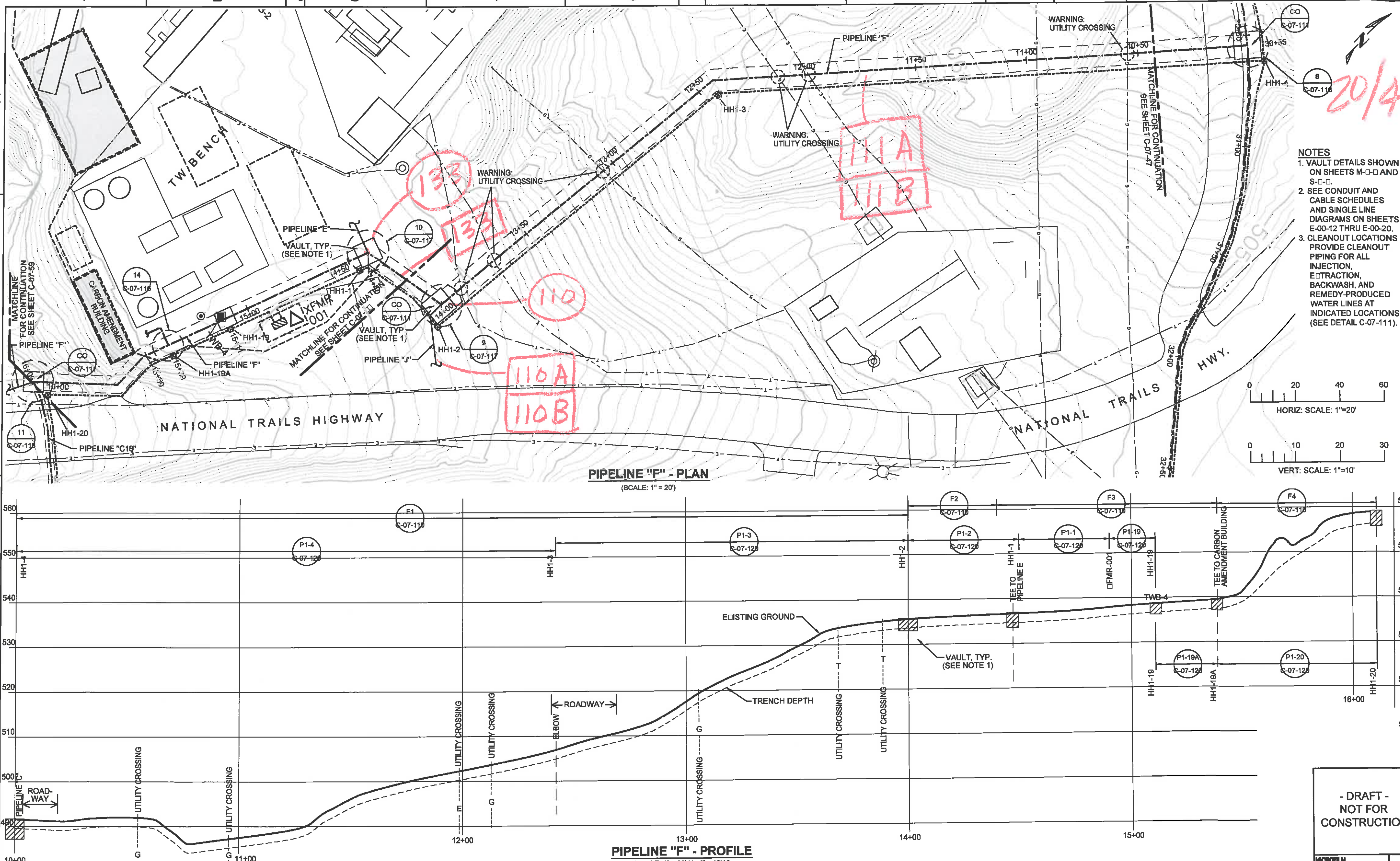
NO.	DATE	DESCRIPTION	CM/SPEC	DWN	CHKD	SUPV	APVD BY
0	9/8/14	PRE-FINAL (90%) DESIGN					

REVISIONS

SO	XX/XX
SUPV	PD
DSGN	TL
DWN	TL
CHKD	JM
OK	PD
DATE	9/8/14
SCALES	1" = 20'-0"

TOPOCK GROUNDWATER REMEDIATION PROJECT
PIPELINE - PLAN AND PROFILE
STA 8+31 TO STA 10+00
PIPELINE "J"
GAS TRANSMISSION & DISTRIBUTION
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

MICROFILM
BILL OF MATL
DWG LIST
SUPSDS
SUPSD BY
SHEET NO. OF SHEETS
C-07-68 REV 0



NOTES

1. VAULT DETAILS SHOWN ON SHEETS M-□-□ AND S-□-□.
2. SEE CONDUIT AND CABLE SCHEDULES AND SINGLE LINE DIAGRAMS ON SHEETS E-00-12 THRU E-00-20.
3. CLEANOUT LOCATIONS PROVIDE CLEANOUT PIPING FOR ALL INJECTION, E□TRACTION, BACKWASH, AND REMEDY-PRODUCED WATER LINES AT INDICATED LOCATIONS (SEE DETAIL C-07-111).

- DRAFT -
NOT FOR CONSTRUCTION

ETIC ENGINEERING

ARCADIS

NO.	DATE	DESCRIPTION	GM/SPEC	DWN	CHKD	SUPV	APVD BY
1	09/08/14	PRE-FINAL (90%) DESIGN		AJW	BAS	JPB	JEF
0	04/05/13	INTERMEDIATE (60%) DESIGN		AJW	KLD	JPB	JEF

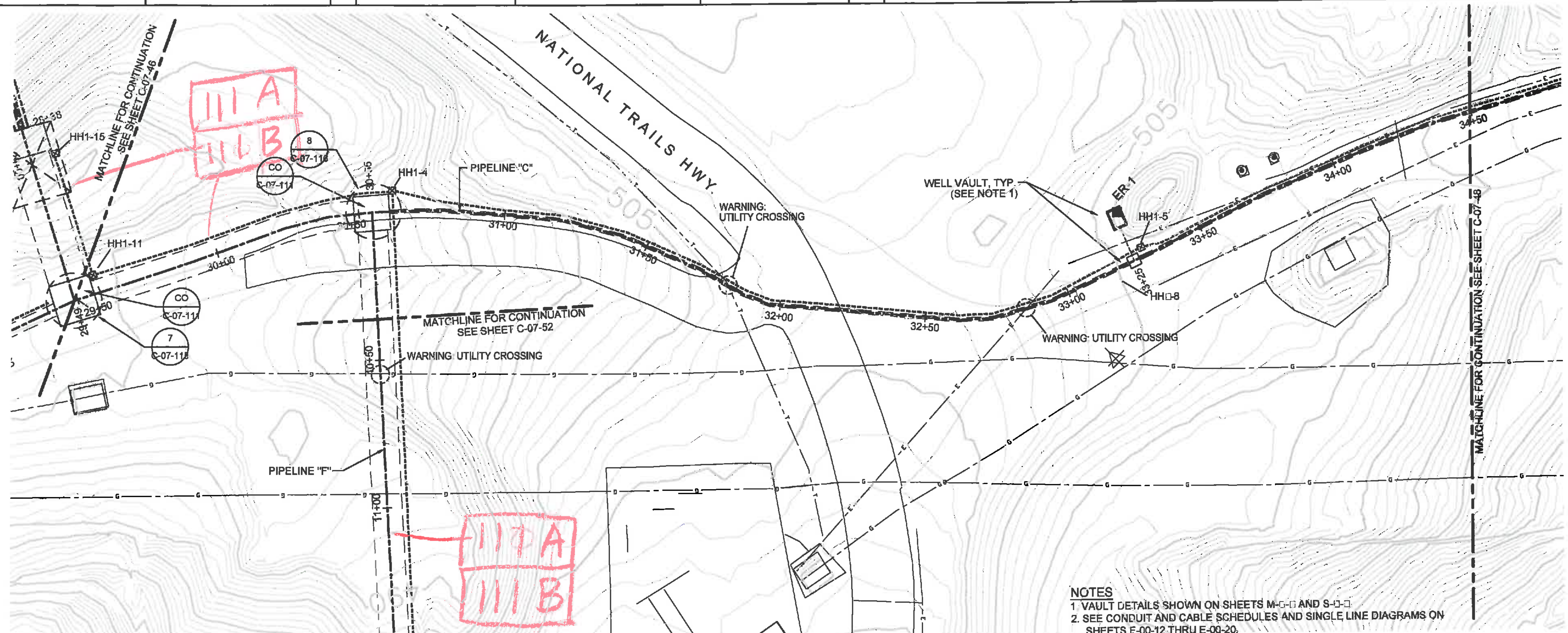
REVISIONS

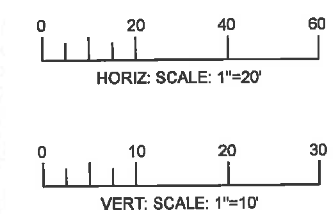
APPROVED BY: JEF
SUPV: JPB
DSGN: BAS
DWN: AJW
CHKD: JPB
OK: JEF
DATE: 09/08/14
SCALES: 1" = 20'

TOPOCK GROUNDWATER REMEDIATION PROJECT
PIPELINE - PLAN AND PROFILE
PIPELINE "F"
STA 10+00 TO STA 16+11
GAS TRANSMISSION & DISTRIBUTION
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

SHEET NO. C-07-52 REV 1

21/42



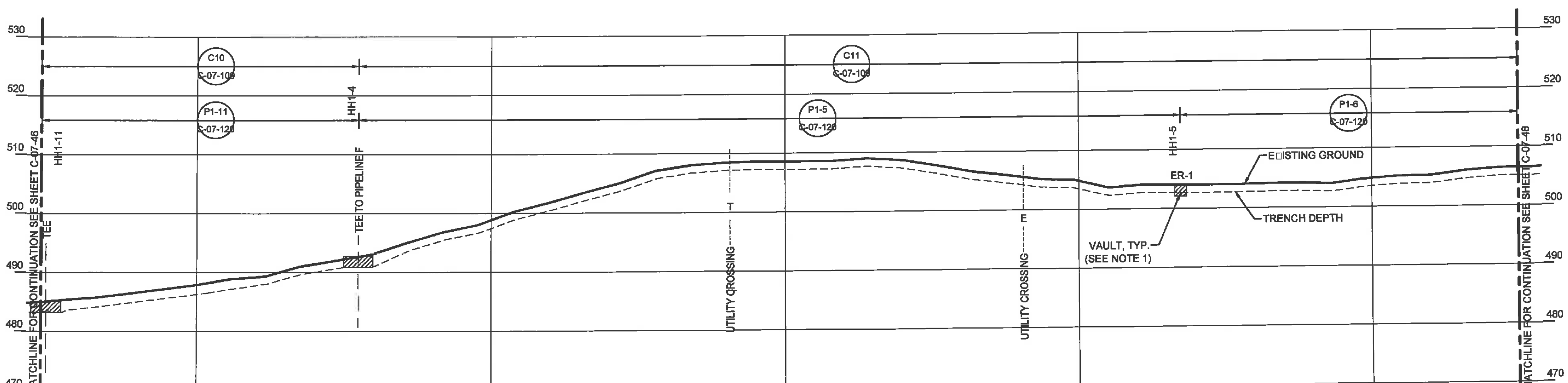


PIPELINE "C" - PLAN

(SCALE: 1" = 20')

NOTES

1. VAULT DETAILS SHOWN ON SHEETS M-□-□ AND S-□-□.
2. SEE CONDUIT AND CABLE SCHEDULES AND SINGLE LINE DIAGRAMS ON SHEETS E-00-12 THRU E-00-20.
3. CLEANOUT LOCATIONS PROVIDE CLEANOUT PIPING FOR ALL INJECTION, E□TRACTION, BACKWASH, AND REMEDY-PRODUCED WATER LINES AT INDICATED LOCATIONS (SEE DETAIL C-07-111).



PIPELINE "C" - PROFILE

(SCALE: 1" = 20' H; 1" = 10' V)

- DRAFT -
NOT FOR CONSTRUCTION

ETIC ENGINEERING

ARCADIS

NO.	DATE	DESCRIPTION	GM/SPEC	DWN	CHKD	SUPV	APVD BY
1	09/08/14	PRE-FINAL (90%) DESIGN		AJW	BAS	JPB	JEF
0	04/05/13	INTERMEDIATE (60%) DESIGN		AJW	KLD	JPB	JEF

REVISIONS

APPROVED BY	JEF
SO	
SUPV	JPB
DSGN	BAS
DWN	AJW
CHKD	JPB
OK	JEF
DATE	09/08/14
SCALES	1" = 20'

TOPOCK GROUNDWATER REMEDIATION PROJECT

PIPELINE - PLAN AND PROFILE
PIPELINE "C10" □ "C11"
STA 44+00 TO STA 49+20

GAS TRANSMISSION & DISTRIBUTION
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

MICROFILM	
BILL OF MATL	
DWG LIST	
SUPSDS	
SUPSD BY	
SHEET NO. of SHEETS	
C-07-47	REV 1

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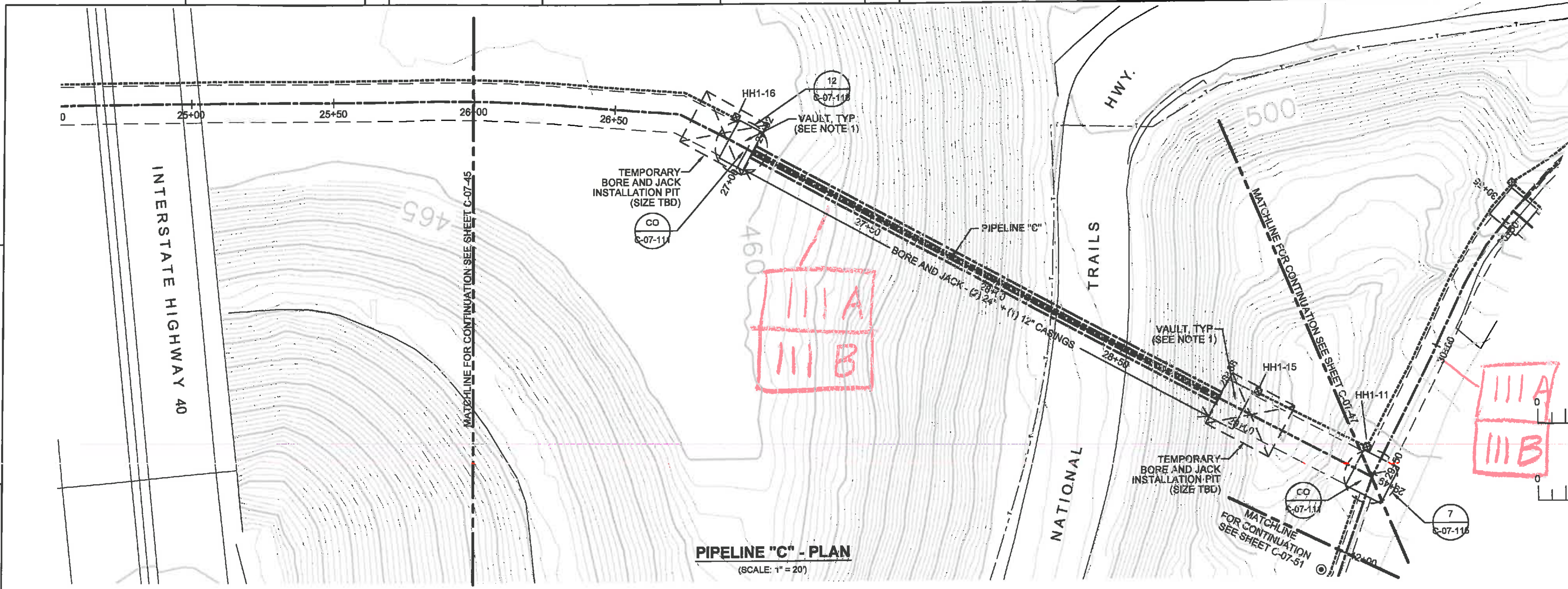
22/42

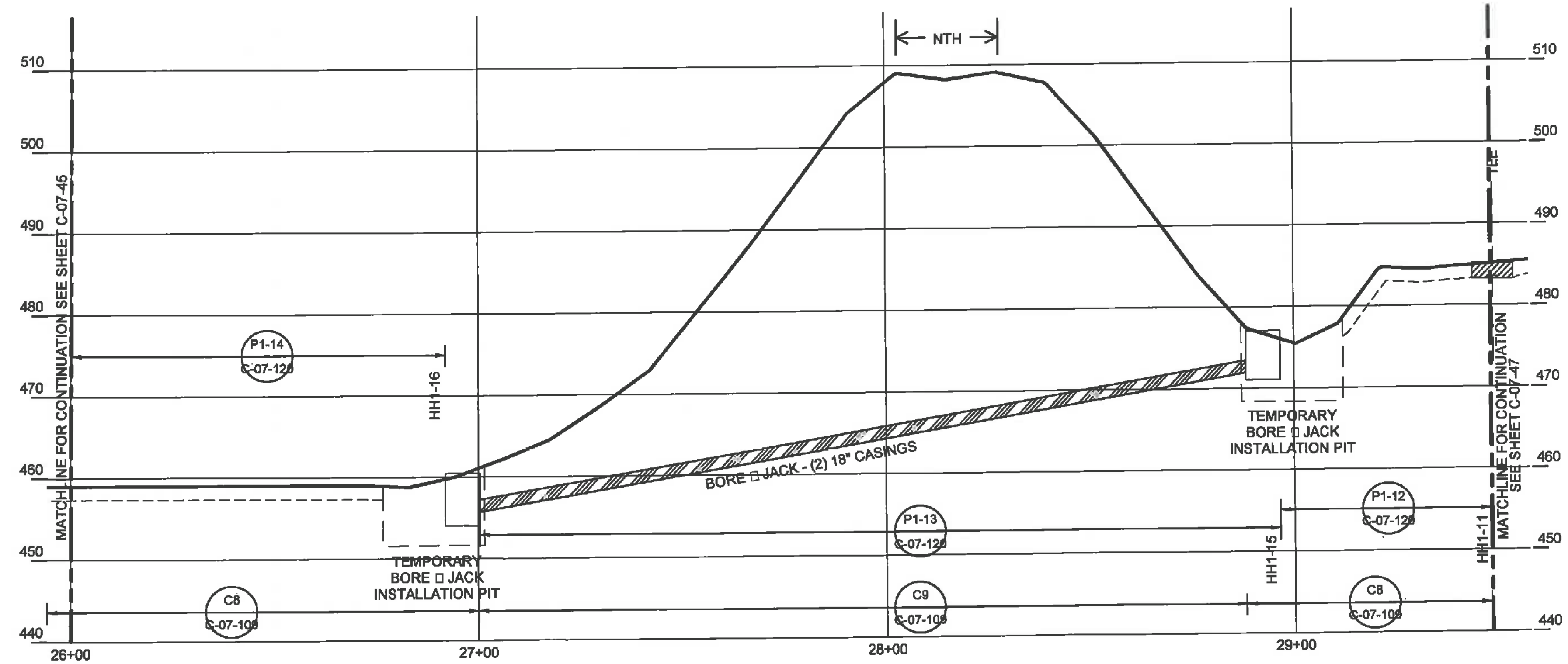


PIPELINE "C" - PLAN

(SCALE: 1" = 20')

NOTES

1. VAULT DETAILS SHOWN ON SHEETS M-□-□ AND S-□-□.
2. SEE CONDUIT AND CABLE SCHEDULES AND SINGLE LINE DIAGRAMS ON SHEETS E-00-12 THRU E-00-20.
3. CLEANOUT LOCATIONS PROVIDE CLEANOUT PIPING FOR ALL INJECTION, EXTRACTION, BACKWASH, AND REMEDY-PRODUCED WATER LINES AT INDICATED LOCATIONS (SEE DETAIL C-07-111).



PIPELINE "C" - PROFILE

(SCALE: 1" = 20' H; 1" = 10' V)

- DRAFT -
NOT FOR CONSTRUCTION

ETIC ENGINEERING | ARCADIS

NO.	DATE	DESCRIPTION	GM/SPEC	DWN	CHKD	SUPV	APVD BY
1	09/08/14	PRE-FINAL (90%) DESIGN		AJW	BAS	JPB	JEF
0	04/05/13	INTERMEDIATE (60%) DESIGN		AJW	KLD	JPB	JEF

APPROVED BY: JEF; SUPV: JPB; DSGN: BAS; DWN: AJW; CHKD: JPB; OK: JEF; DATE: 09/08/14; SCALES: 1" = 20'

TOPOCK GROUNDWATER REMEDIATION PROJECT
PIPELINE - PLAN AND PROFILE
PIPELINE "C9A"
STA 40+60 TO STA 44+00
GAS TRANSMISSION & DISTRIBUTION
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

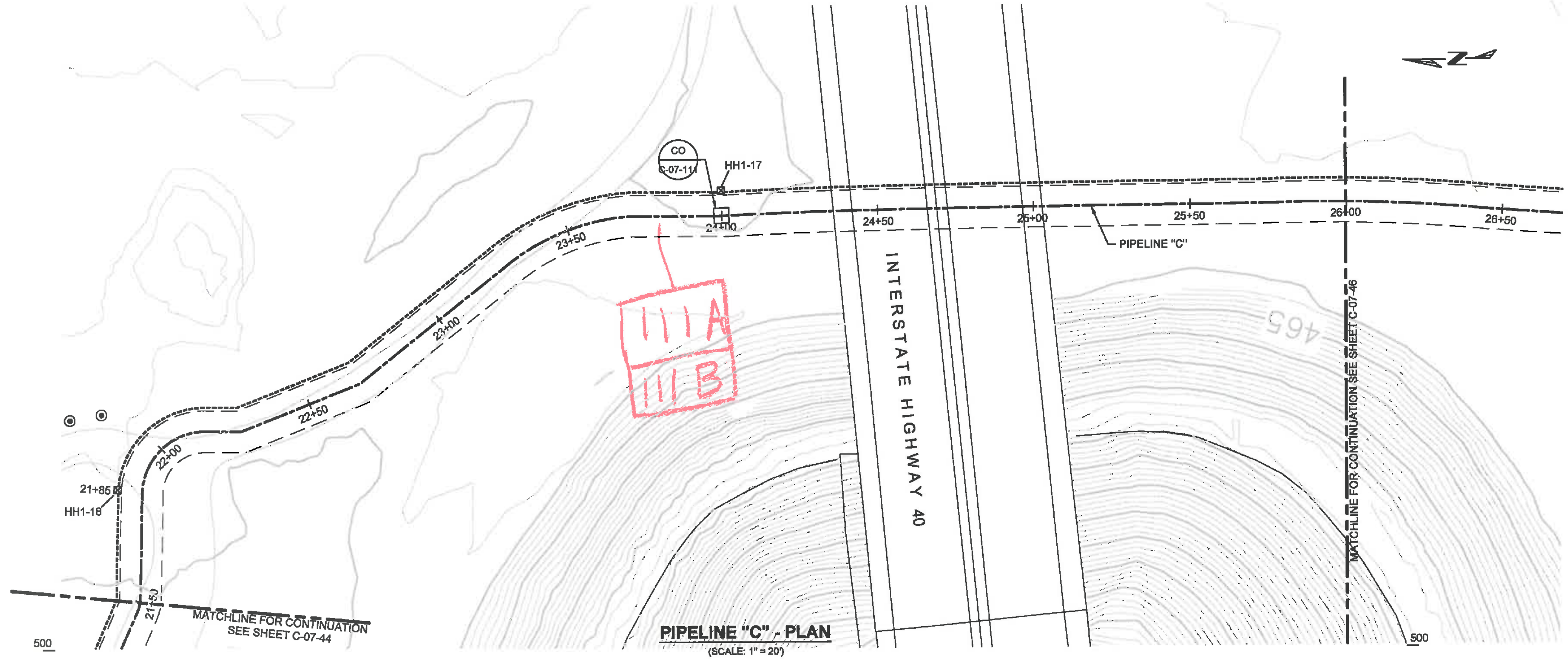
SHEET NO. C-07-46 REV 1

08/14/2014, 10:48

23/42

NOTES

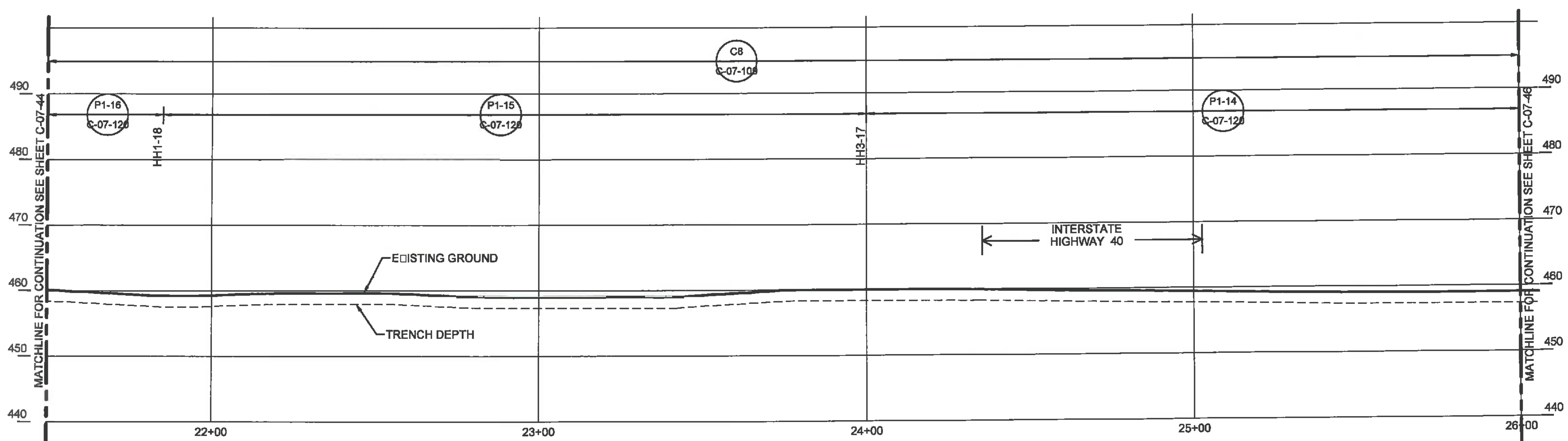
1. VAULT DETAILS SHOWN ON SHEETS M-□-□ AND S-□-□.
2. SEE CONDUIT AND CABLE SCHEDULES AND SINGLE LINE DIAGRAMS ON SHEETS E-00-12 THRU E-00-20.
3. CLEANOUT LOCATIONS PROVIDE CLEANOUT PIPING FOR ALL INJECTION, E□TRACTION, BACKWASH, AND REMEDY-PRODUCED WATER LINES AT INDICATED LOCATIONS (SEE DETAIL C-07-111).



PIPELINE "C" - PLAN
(SCALE: 1" = 20')

HORIZ: SCALE: 1"=20' (0, 20, 40, 60)

VERT: SCALE: 1"=10' (0, 10, 20, 30)



PIPELINE "C" - PROFILE
(SCALE: 1" = 20' H; 1" = 10' V)

- DRAFT -
NOT FOR CONSTRUCTION

ETIC ENGINEERING

ARCADIS

NO.	DATE	DESCRIPTION	GM/SPEC	DWN	CHKD	SUPV	APVD BY
1	09/08/14	PRE-FINAL (90%) DESIGN		AJW	BAS	JPB	JEF
0	04/05/13	INTERMEDIATE (60%) DESIGN		AJW	KLD	JPB	JEF

REVISIONS

APPROVED BY: JEF

SO	
SUPV	JPB
DSGN	BAS
DWN	AJW
CHKD	JPB
OK	JEF
DATE	09/08/14
SCALES	1" = 20'

TOPOCK GROUNDWATER REMEDIATION PROJECT

PIPELINE - PLAN AND PROFILE
PIPELINE "C9"
STA 36+40 TO STA 40+60

GAS TRANSMISSION & DISTRIBUTION
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

MICROFILM
BILL OF MATL
DWG LIST
SUPSDS
SUPSD BY
SHEET NO. of SHEETS
C-07-45
REV 1

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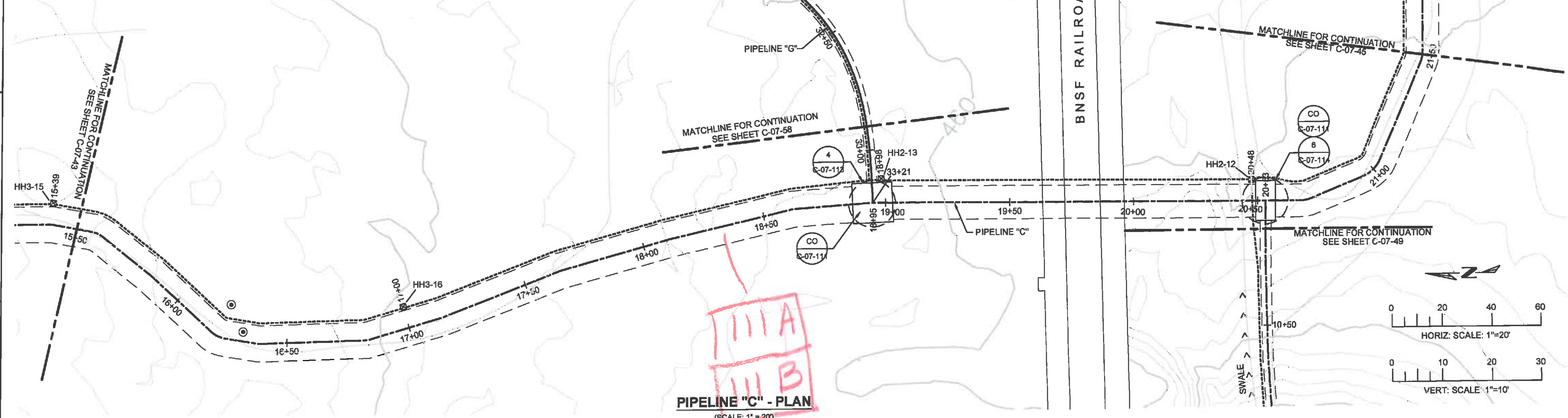
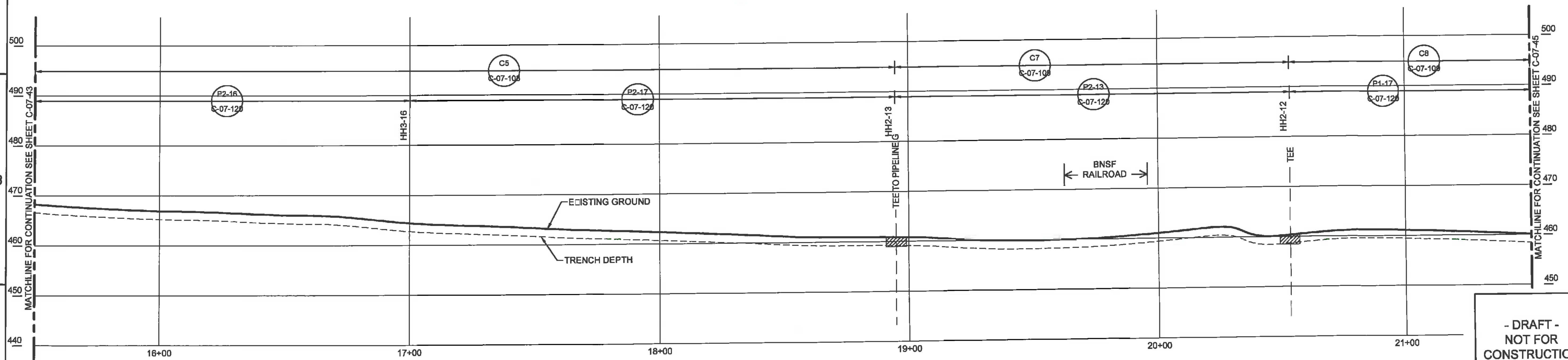
24/42

NOTES

1. VAULT DETAILS SHOWN ON SHEETS M-□-□ AND S-□-□.
2. SEE CONDUIT AND CABLE SCHEDULES AND SINGLE LINE DIAGRAMS ON SHEETS E-00-12 THRU E-00-20.
3. CLEANOUT LOCATIONS PROVIDE CLEANOUT PIPING FOR ALL INJECTION, E□TRACTION, BACKWASH, AND REMEDY-PRODUCED WATER LINES AT INDICATED LOCATIONS (SEE DETAIL C-07-111).



PIPELINE "C" - PLAN
(SCALE: 1" = 20')



PIPELINE "C" - PROFILE
(SCALE: 1" = 20' H; 1" = 10' V)

- DRAFT -
NOT FOR CONSTRUCTION

ETIC ENGINEERING

ARCADIS

NO.	DATE	DESCRIPTION	GM/SPEC	DWN	CHKD	SUPV	APVD BY
1	09/08/14	PRE-FINAL (90%) DESIGN		AJW	BAS	JPB	JEF
0	04/05/13	INTERMEDIATE (60%) DESIGN		AJW	KLD	JPB	JEF

REVISIONS

APPROVED BY: JEF
SUPV: JPB
DSGN: BAS
DWN: AJW
CHKD: JPB
OK: JEF
DATE: 09/08/14
SCALES: 1" = 20'

TOPOCK GROUNDWATER REMEDIATION PROJECT

PIPELINE - PLAN AND PROFILE
PIPELINE "C7", "C8" □ "C9"
STA 29+50 TO 35+60

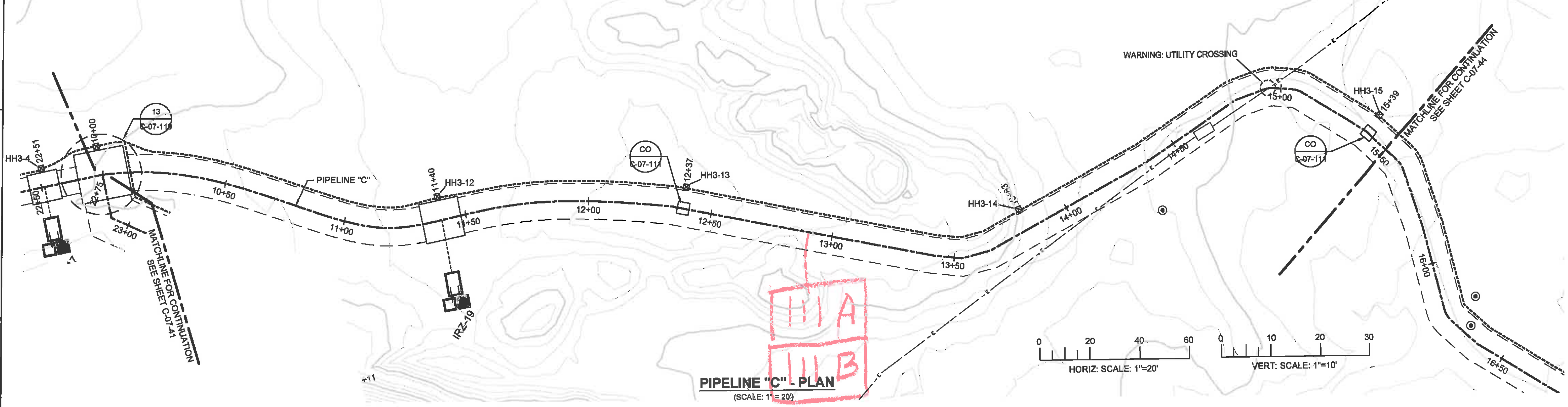
GAS TRANSMISSION & DISTRIBUTION
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

SHEET NO. C-07-44
REV 1

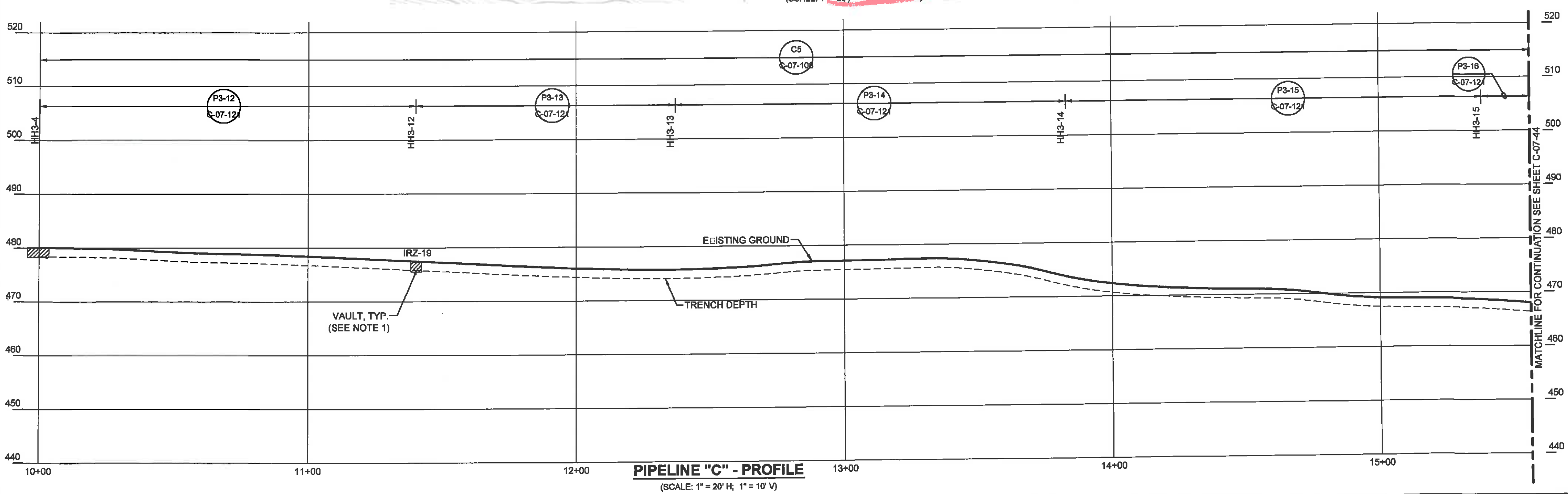
08/14/2014, 10:48

NOTES
1. VAULT DETAILS SHOWN ON SHEETS M-□-□ AND S-□-□.
2. SEE CONDUIT AND CABLE SCHEDULES AND SINGLE LINE DIAGRAMS ON SHEETS E-00-12 THRU E-00-20.
3. CLEANOUT LOCATIONS PROVIDE CLEANOUT PIPING FOR ALL INJECTION, E□TRACTION, BACKWASH, AND REMEDY-PRODUCED WATER LINES AT INDICATED LOCATIONS (SEE DETAIL C-07-111).

25/42



PIPELINE "C" - PLAN
(SCALE: 1" = 20')



PIPELINE "C" - PROFILE
(SCALE: 1" = 20' H; 1" = 10' V)

- DRAFT -
NOT FOR CONSTRUCTION

ETIC ENGINEERING

ARCADIS

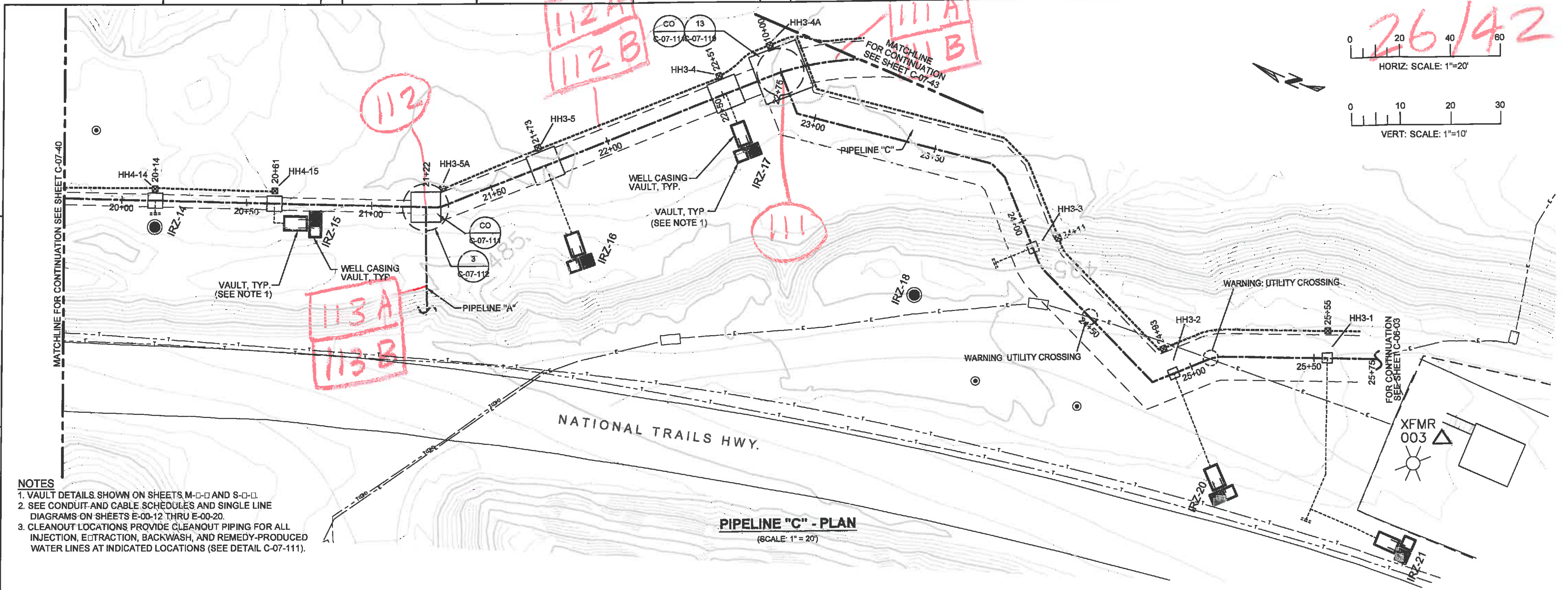
NO.	DATE	DESCRIPTION	GM/SPEC	DWN	CHKD	SUPV	APVD BY
1	09/08/14	PRE-FINAL (90%) DESIGN		AJW	BAS	JPB	JEF
0	04/05/13	INTERMEDIATE (60%) DESIGN		AJW	KLD	JPB	JEF

REVISIONS

APPROVED BY JEF; SUPV JPB; DSGN BAS; DWN AJW; CHKD JPB; OK JEF; DATE 09/08/14; SCALES 1" = 20'

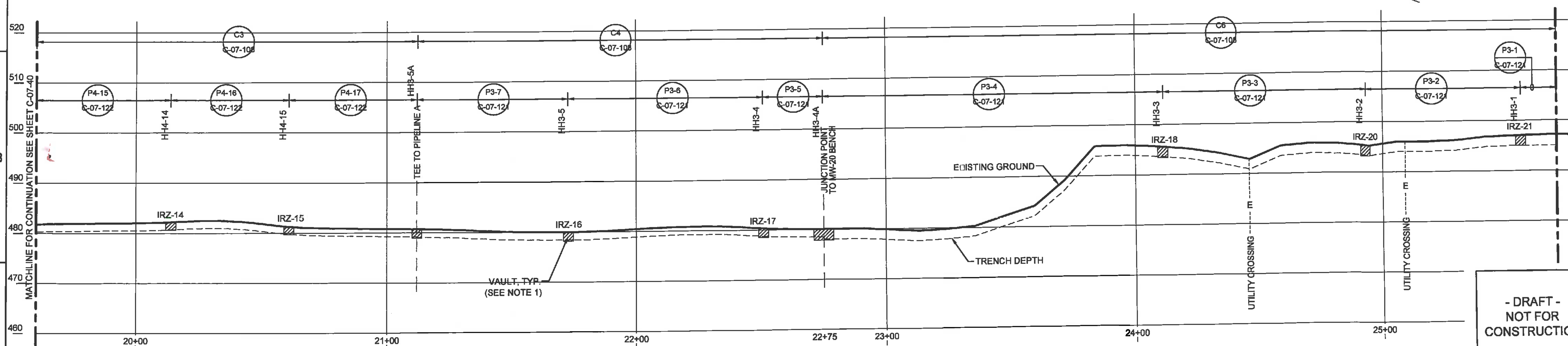
TOPOCK GROUNDWATER REMEDIATION PROJECT
PIPELINE - PLAN AND PROFILE
PIPELINE "C6 □ C7"
STA 26+00 TO STA 29+50
GAS TRANSMISSION & DISTRIBUTION
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

SHEET NO. C-07-43 REV 1



PIPELINE "C" - PLAN

(SCALE: 1" = 20')



PIPELINE "C" - PROFILE

(SCALE: 1" = 20' H; 1" = 10' V)

NOTES

1. VAULT DETAILS SHOWN ON SHEETS M-□-□ AND S-□-□.
2. SEE CONDUIT AND CABLE SCHEDULES AND SINGLE LINE DIAGRAMS ON SHEETS E-00-12 THRU E-00-20.
3. CLEANOUT LOCATIONS PROVIDE CLEANOUT PIPING FOR ALL INJECTION, EXTRACTION, BACKWASH, AND REMEDY-PRODUCED WATER LINES AT INDICATED LOCATIONS (SEE DETAIL C-07-111).

- DRAFT -
NOT FOR CONSTRUCTION

ETIC ENGINEERING

ARCADIS

NO.	DATE	DESCRIPTION	GM/SPEC	DWN	CHKD	SUPV	APVD BY
1	09/08/14	PRE-FINAL (90%) DESIGN		AJW	BAS	JPB	JEF
0	04/05/13	INTERMEDIATE (60%) DESIGN		AJW	KLD	JPB	JEF

REVISIONS

APPROVED BY: JEF
SUPV: JPB
DSGN: BAS
DWN: AJW
CHKD: JPB
OK: JEF
DATE: 09/08/14
SCALES: 1" = 20'

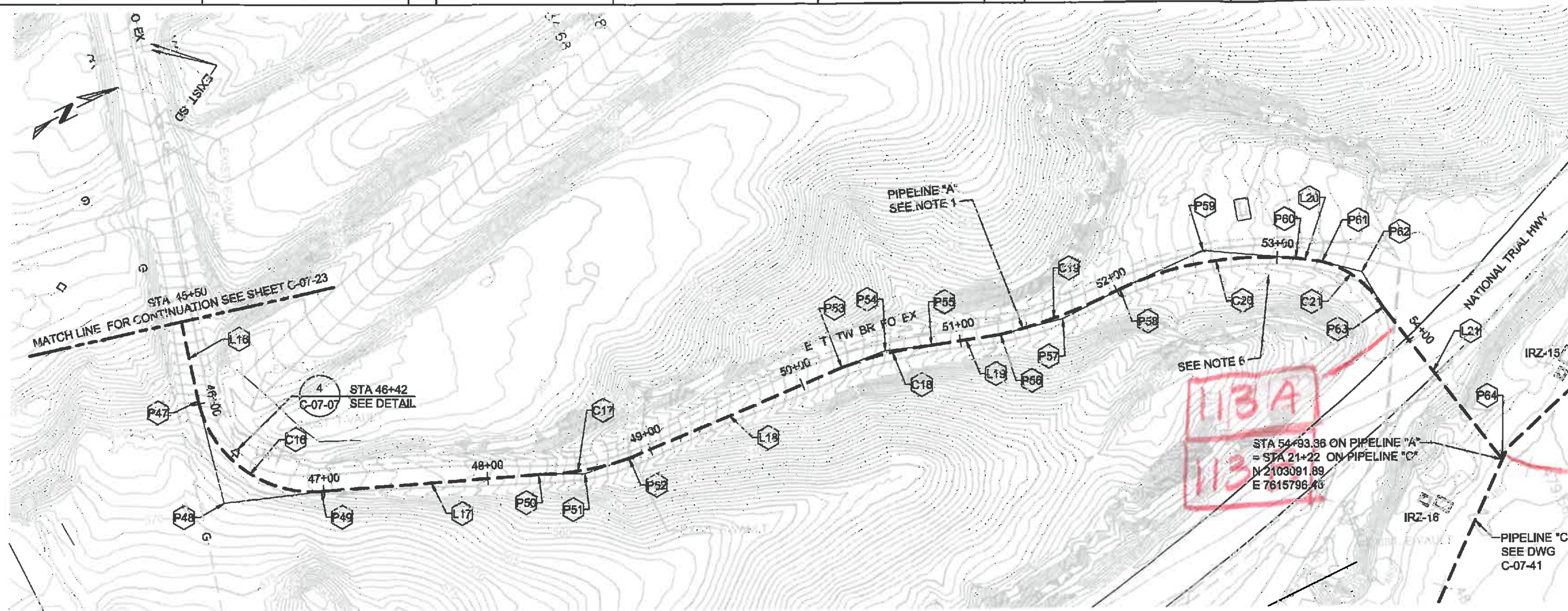
TOPOCK GROUNDWATER REMEDIATION PROJECT
PIPELINE - PLAN AND PROFILE
PIPELINE "C3" □ "C4"
STA 19+60 TO STA 25+89
GAS TRANSMISSION & DISTRIBUTION
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

SHEET NO. C-07-41
REV 1

27/42

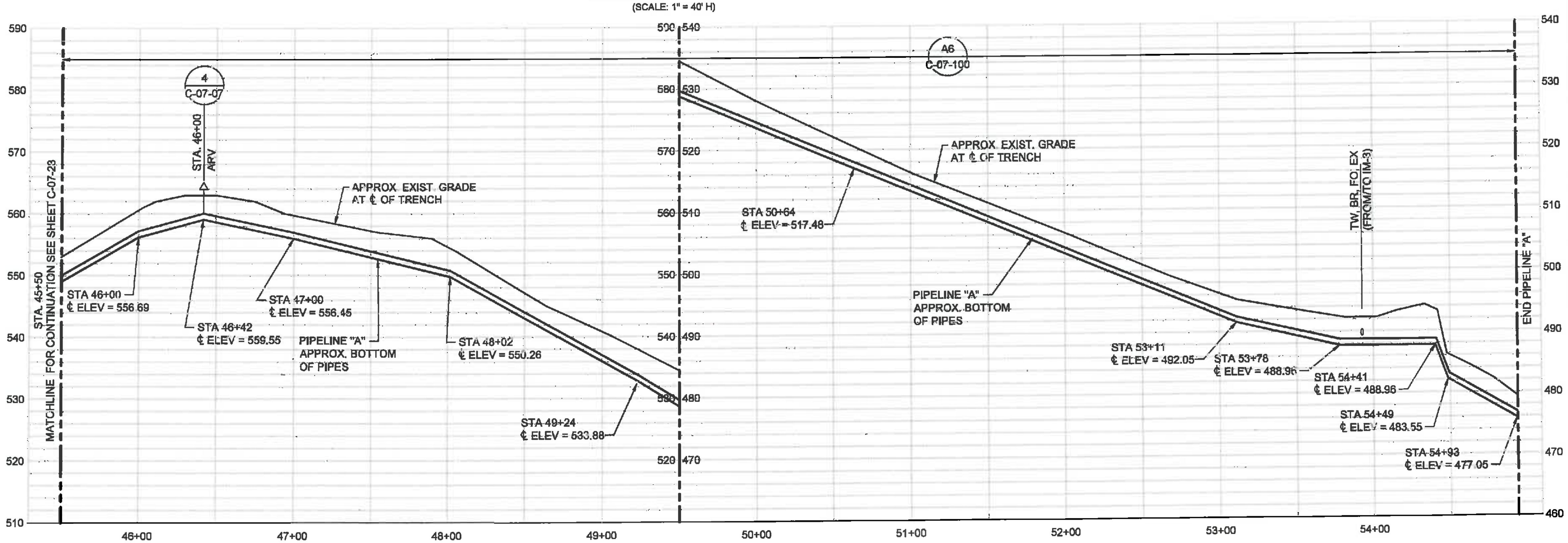
NOTES:

1. THE NEW PIPELINE ALIGNMENT SHOWS CENTER OF TRENCH.
2. PROVIDE TRAFFIC CONTROL WHEN WORKING IN / NEAR ROADWAYS. COMPLY WITH OWNER'S ENCROACHMENT PERMIT WHEN WORKING IN ROAD RIGHT OF WAY.
3. PROVIDE VEHICLE ACCESS AT OWNER'S DIRECTION.
4. MAINTAIN 3' MINIMUM HORIZONTAL CLEARANCE FROM EXISTING IM-3 PIPING (E, T, TW, BR & FO)
5. MAINTAIN 3' MINIMUM HORIZONTAL CLEARANCE FROM EXISTING GAS PIPING.
6. PRESERVE AND MAINTAIN EXISTING DRAINAGE DITCH



PIPELINE "A" - PLAN

(SCALE: 1" = 40' H)



PIPELINE "A" - PROFILE

(SCALE: 1" = 40' H; 1" = 10' V)

Point Table				
Point	Description	Sta	Northing	Easting
P47	BC	45+91.43	2102395.16	7615404.76
P48	PI	46+54.02	2102382.21	7615465.99
P49	EC	46+94.39	2102441.12	7615487.18
P50	BC	48+25.18	2102562.16	7615536.73
P51	PI	48+53.43	2102587.61	7615549.00
P52	EC	48+81.21	2102615.63	7615552.64
P53	BC	50+23.07	2102757.14	7615562.56
P54	PI	50+51.56	2102785.48	7615565.51
P55	EC	50+79.76	2102812.23	7615575.30
P56	BC	51+22.20	2102852.56	7615588.53
P57	PI	51+61.49	2102890.87	7615597.22
P58	EC, BC	52+00.44	2102930.16	7615597.10
P59	PI	52+56.89	2102986.55	7615599.66
P60	EC	53+10.88	2103034.52	7615629.42
P61	BC	53+27.24	2103048.01	7615638.68
P62	PI	53+52.37	2103066.90	7615655.25
P63	EC	53+74.89	2103068.58	7615680.32
P64	PI	54+93.36	2103091.89	7615796.48

Line Table				
Line	Beg Point	End Point	Distance	Bearing
L16	P46	P47	340.67	S 75° 13' 48" E
L17	P49	P50	130.79	N 22° 15' 46" E
L18	P52	P53	141.86	N 04° 00' 36" E
L19	P55	P56	42.44	N 18° 09' 42" E
L20	P60	P61	16.36	N 34° 28' 01" E
L21	P63	P64	118.47	N 78° 39' 11" E

Curve Table						
Curve	Beg Point	End Point	Distance	Δ	Radius	Tangent
C16	P47	P49	102.96	82° 09' 48"	71.80	62.59
C17	P50	P52	56.03	18° 18' 55"	175.27	28.25
C18	P53	P55	56.69	14° 10' 35"	229.11	28.49
C19	P56	P58	78.24	12° 57' 00"	346.16	39.29
C20	P58	P60	110.44	29° 12' 09"	216.70	56.45
C21	P61	P63	47.65	44° 54' 45"	60.79	25.13

HORZ. SCALE: 1"=40'

VERT. SCALE: 1"=10'

DRAFT NOT FOR CONSTRUCTION

E2 Consulting Engineers, Inc.

CH2MHILL

NO.	DATE	DESCRIPTION	GM/SPEC	DWN	CHKD	SUPV	APVD BY
2	9/8/14	PRE-FINAL (90%) DESIGN		PH	PT	PT	VMB
1	4/5/13	INTERMEDIATE (60%) DESIGN		PC/EE	PT	PT	VMB
0	11/18/11	PRELIMINARY (30%) DESIGN		EE	PT	PT	VMB

REVISIONS

APPROVED BY	
SO	
SUPV	VMB
DSGN	PT
DWN	PC/EE
CHKD	VMB
OK	VMB
DATE	09/08/14
SCALES	

TOPOCK GROUNDWATER REMEDIATION PROJECT

PLAN AND PROFILE PIPELINE "A" STA 45+50 TO STA 54+93.36

GAS TRANSMISSION & DISTRIBUTION

PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

MICROFILM
BILL OF MATL
DWG LIST
SUPSDS
SUPSD BY
SHEET NO. of SHEETS

C-07-24 REV 2

FILENAME: E2-C-XXX-0724.dwg

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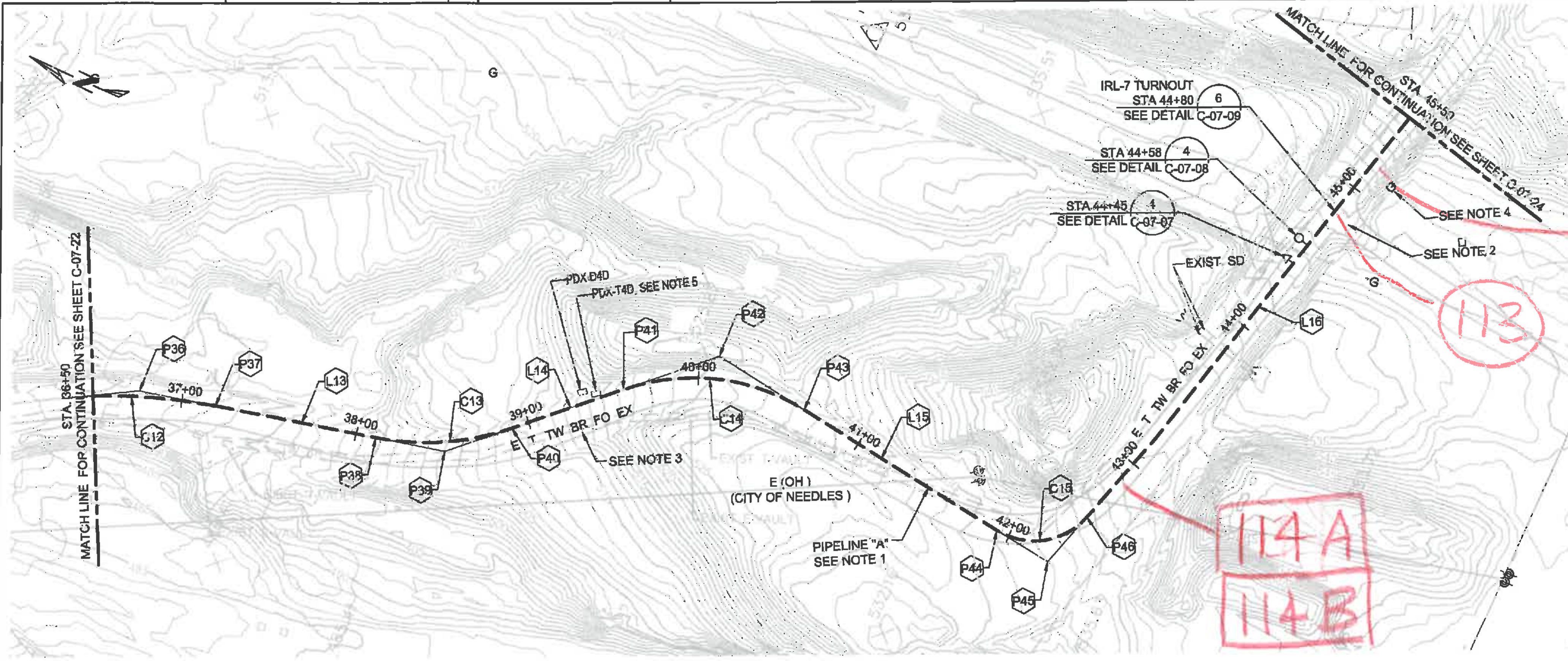
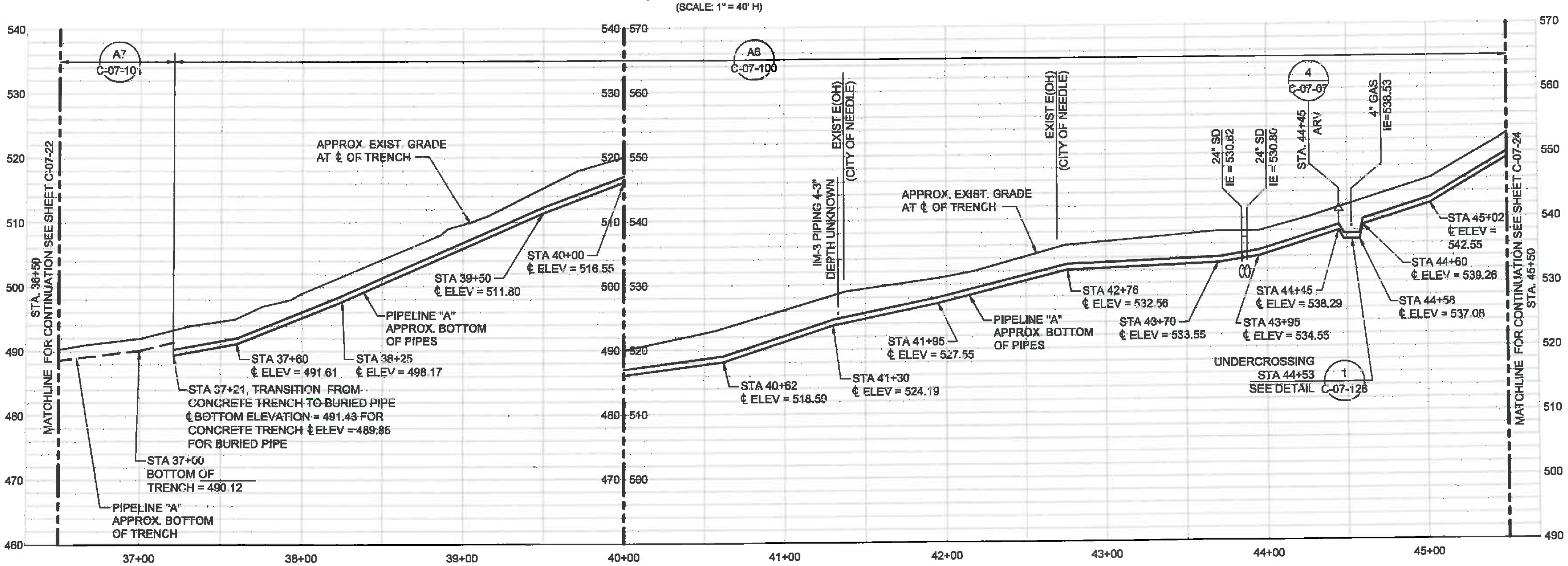


PIPELINE "A" - PLAN

(SCALE: 1" = 40' H)



PIPELINE "A" - PROFILE

(SCALE: 1" = 40' H; 1" = 10' V)

NOTES:

1. THE NEW PIPELINE ALIGNMENT SHOWS CENTER OF TRENCH.
2. PROVIDE VEHICLE ACCESS AT OWNER'S DIRECTION.
3. MAINTAIN 3' MINIMUM HORIZONTAL CLEARANCE FROM EXISTING IM-3 PIPING (E, T, TW, BR & FO)
4. MAINTAIN 3' MINIMUM HORIZONTAL CLEARANCE FROM EXISTING GAS PIPING.
5. FOR ELECTRICAL (PDX-DXX) AND COMMUNICATIONS (PDX-TXX) SEE DWGS E-00-07 AND E-00-08

Point Table

Point	Description	Sta	Northing	Easting
P36	PI	36+78.23	2103000.45	7614917.88
P37	EC	37+21.36	2102957.92	7614928.08
P38	BC	38+13.50	2102868.32	7614949.55
P39	PI	38+53.72	2102829.20	7614958.93
P40	EC	38+92.10	2102800.03	7614986.62
P41	BC	39+59.06	2102751.46	7615032.71
P42	PI	40+16.42	2102709.85	7615072.20
P43	EC	40+66.08	2102652.99	7615064.62
P44	BC	41+94.72	2102525.48	7615047.61
P45	PI	42+28.45	2102492.05	7615043.15
P46	EC	42+50.76	2102482.01	7615075.35

Line Table

Line	Beg Point	End Point	Distance	Bearing
L13	P37	P38	92.14	S 13° 28' 31" E
L14	P40	P41	66.96	S 43° 29' 57" E
L15	P43	P44	128.64	S 07° 05' 24" E
L16	P46	P47	328.70	S 75° 12' 36" E

Curve Table

Curve	Beg Point	End Point	Distance	Δ	Radius	Tangent
C12	P35	P37	86.87	30° 35' 29"	300.00	43.74
C13	P38	P40	78.60	30° 01' 22"	150.00	40.22
C14	P41	P43	107.02	51° 05' 57"	120.00	57.36
C15	P44	P46	56.04	80° 16' 28"	40.00	33.73

HORZ: SCALE: 1"=40'

VERT: SCALE: 1"=10'

DRAFT NOT FOR CONSTRUCTION

E2 Consulting Engineers, Inc.
1900 Powell Street, Ste. 250
Emeryville, CA 94608
(510) 652-1164

CH2MHILL.

REVISIONS

NO.	DATE	DESCRIPTION	GM/SPEC	DWN	CHKD	SUPV	APVD BY
2	9/8/14	PRE-FINAL (90%) DESIGN	PH	PT	PT	VMB	
1	4/5/13	INTERMEDIATE (60%) DESIGN	PC/EE	PT	PT	VMB	
0	11/18/11	PRELIMINARY (30%) DESIGN	EE	PT	PT	VMB	

APPROVED BY	
SD	
SUPV	VMB
DSGN	PT
DWN	PC/EE
CHKD	VMB
OK	VMB
DATE	09/08/14
SCALES	

TOPOCK GROUNDWATER REMEDIATION PROJECT
PLAN AND PROFILE
PIPELINE "A"
STA 36+50 TO STA 45+00
GAS TRANSMISSION & DISTRIBUTION
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

MICROFILM
BILL OF MATL
DWG LIST
SUPSDS
SUPSD BY
SHEET NO. of SHEETS
C-07-23
REV 2

FILENAME: E2-C-XXX-0723.dwg
PLOT DATE: $PLOTDATE PLOT TIME: $PLOTTIME

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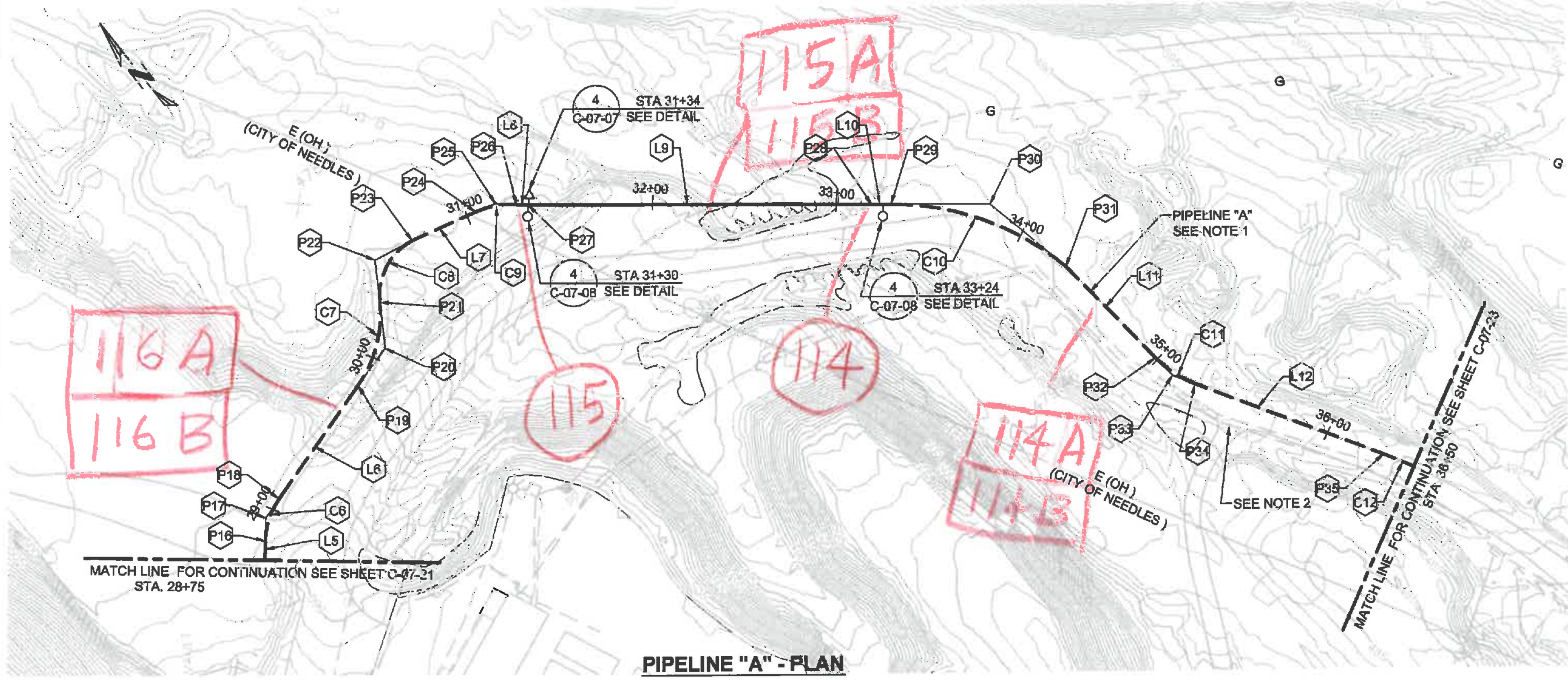
NOTES:

1. THE NEW PIPELINE ALIGNMENT SHOWS CENTER OF TRENCH.
2. PROVIDE VEHICLE ACCESS AT OWNER'S DIRECTION.
3. MAINTAIN 3' MINIMUM HORIZONTAL CLEARANCE FROM EXISTING IM-3 PIPING (E, T, TW, BR & FO)

29/42



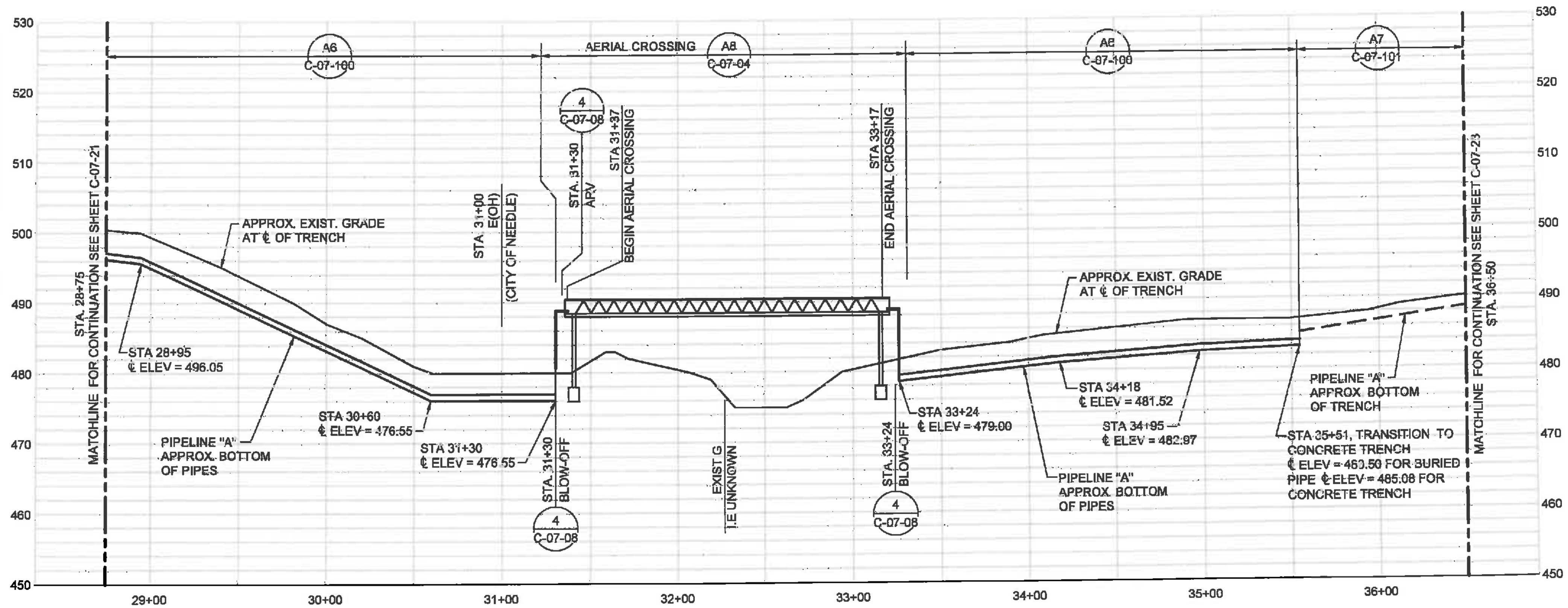
PIPELINE "A" - PLAN

(SCALE: 1" = 40' H)

Point Table				
Point	Descrip-tion	Sta	Northing	Easting
P16	BC	28+84.13	2103382.90	7614402.32
P17	PI	28+96.44	2103392.37	7614410.18
P18	EC	29+08.01	2103395.79	7614422.00
P19	BC	29+81.73	2103416.25	7614492.82
P20	PI	30+06.33	2103422.60	7614516.59
P21	EC, BC	30+28.57	2103443.45	7614529.65
P22	PI	30+51.26	2103462.68	7614541.70
P23	EC	30+68.32	2103458.11	7614563.92
P24	BC	31+05.78	2103448.43	7614600.11
P25	PI	31+17.11	2103445.25	7614610.99
P26	EC	31+28.06	2103437.69	7614619.42
P27	VPI	31+34.06	2103433.90	7614624.07
P28	VPI	33+20.05	2103316.52	7614768.34
P29	BC	33+30.16	2103310.14	7614776.18
P30	PI	33+83.22	2103276.39	7614817.13
P31	EC	34+32.16	2103224.42	7614827.82
P32	BC	35+00.68	2103156.19	7614834.11
P33	PI	35+13.88	2103143.05	7614835.32
P34	EC	35+26.66	2103131.63	7614841.93
P35	BC	36+34.49	2103038.31	7614895.96

Line Table				
Line	Beg Point	End Point	Distance	Bearing
L5	P15	P16	85.16	S 40° 35' 59" W
L6	P18	P19	73.72	N 73° 42' 58" E
L7	P23	P24	37.46	S 75° 01' 31" E
L8	P26	P27	6.00	S 50° 52' 04" E
L9	P27	P28	185.99	S 50° 52' 04" E
L10	P28	P29	10.11	S 50° 52' 04" E
L11	P31	P32	68.52	S 05° 16' 02" E
L12	P34	P35	107.83	S 40° 35' 59" W

Curve Table						
Curve	Beg Point	End Point	Distance	Δ	Radius	Tangent
C6	P16	P18	23.88	34° 12' 03"	40.00	12.31
C7	P19	P21	46.84	43° 17' 19"	62.00	24.60
C8	P21	P23	39.75	69° 01' 17"	33.00	22.69
C9	P24	P26	22.28	25° 31' 50"	50.00	11.33
C10	P29	P31	102.00	38° 57' 43"	150.00	53.06
C11	P32	P34	25.98	24° 48' 23"	60.00	13.20
C12	P35	P37	86.87	16° 35' 29"	300.00	43.74



PIPELINE "A" - PROFILE

(SCALE: 1" = 40' H; 1" = 10' V)

HORZ: SCALE: 1"=40'

VERT: SCALE: 1"=10'

DRAFT NOT FOR CONSTRUCTION

E2 Consulting Engineers, Inc.

CH2MHILL.

NO.	DATE	DESCRIPTION	GM/SPEC	DWN	CHKD	SUPV	APVD BY
2	9/8/14	PRE-FINAL (90%) DESIGN		PH	PT	PT	VMB
1	4/5/13	INTERMEDIATE (60%) DESIGN		PC/EE	PT	PT	VMB
0	11/18/11	PRELIMINARY (30%) DESIGN		EE	PT	PT	VMB

REVISIONS

APPROVED BY: SUPV VMB; DSGN PT; DWN PC/EE; CHKD VMB; OK VMB; DATE 09/08/14; SCALES

TOPOCK GROUNDWATER REMEDIATION PROJECT

PLAN AND PROFILE PIPELINE "A" STA 28+75 TO STA 36+50

GAS TRANSMISSION & DISTRIBUTION

PACIFIC GAS AND ELECTRIC COMPANY

SAN FRANCISCO, CALIFORNIA

MICROFILM / BILL OF MATL / DWG LIST / SUPSDS / SUPSD BY / SHEET NO. of SHEETS

C-07-22 REV 2

FILENAME: E2-C-XXX-0722.dwg

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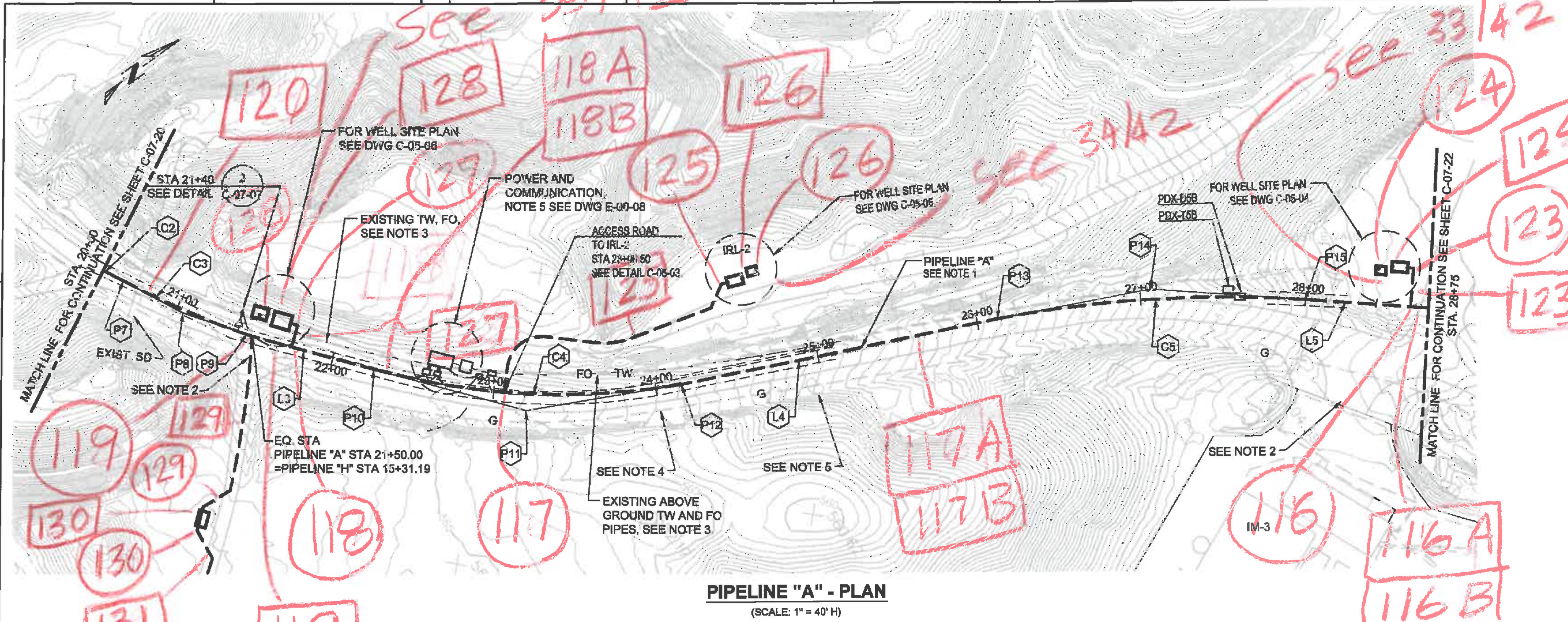


PIPELINE "A" - PLAN

(SCALE: 1" = 40' H)

NOTES:

1. THE NEW PIPELINE ALIGNMENT SHOWS CENTER OF TRENCH.
2. PROVIDE VEHICLE ACCESS AT OWNER'S DIRECTION - AT ALL TIMES FOR IM-3 ENTRANCE ROAD
3. PROTECT ABOVE GROUND PIPES IN PLACE.
4. MAINTAIN 3' MINIMUM HORIZONTAL CLEARANCE FROM EXISTING GAS LINE.
5. PROTECT EXISTING FLAGSTONE CUTTER IN PLACE.
6. FOR ELECTRICAL (PDX-DXX) COMMUNICATIONS (PDX-TXX) SEE DWGS E-00-07 AND E-00-08.

Point Table

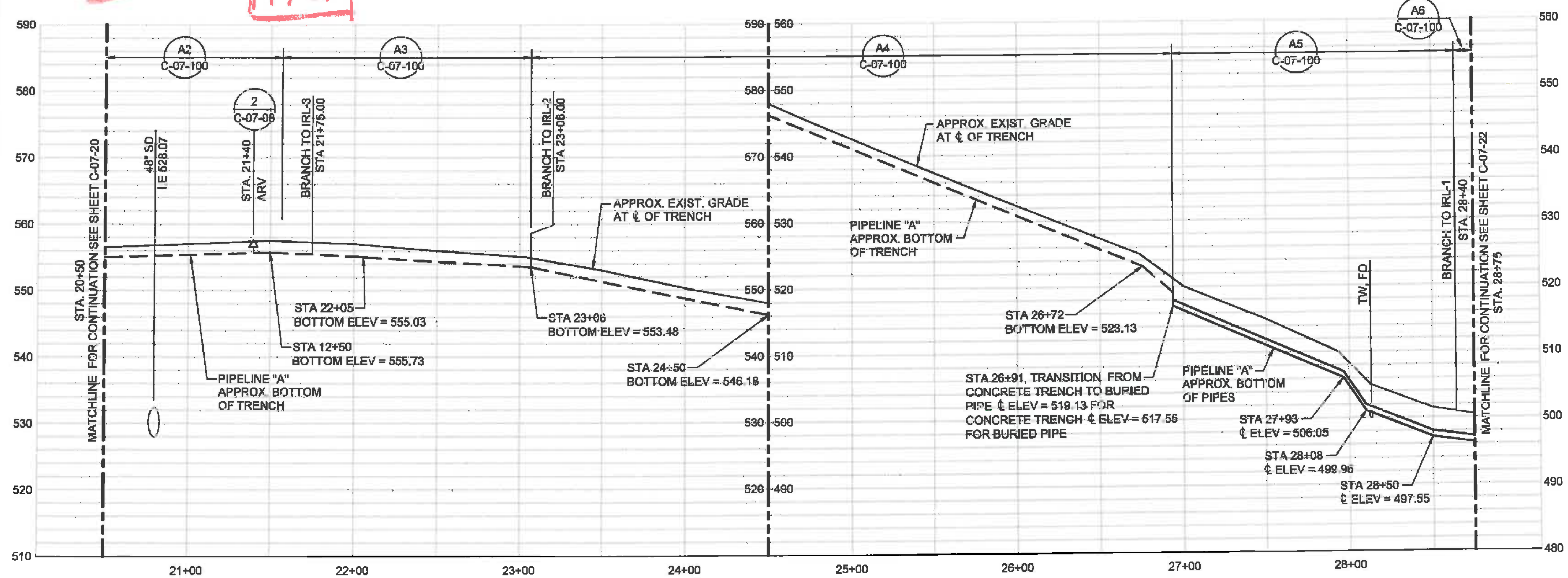
Point	Description	Sta	Northing	Easting
P7	EC,BC	20+62.08	2102744.04	7613910.28
P8	PI	20+90.53	2102762.08	7613947.32
P9	EC	21+44.29	2102786.06	7613980.83
P10	BC	22+24.40	2102836.23	7614043.28
P11	PI	23+20.66	2102896.59	7614118.27
P12	EC	24+13.99	2102982.56	7614161.58
P13	BC	26+10.49	2103160.89	7614244.11
P14	PI	27+05.27	2103246.29	7614285.21
P15	EC	27+98.97	2103318.24	7614346.90

Line Table

Line	Beg Point	End Point	Distance	Bearing
L3	P9	P10	80.11	N 38° 46' 38" E
L4	P12	P13	196.50	S 24° 50' 04" E
L5	P15	P16	85.16	S 40° 35' 59" E

Curve Table

Curve	Beg Point	End Point	Distance	Δ	Radius	Tangent
C2	P5	P7	56.48	17° 07' 16"	189.00	28.45
C3	P7	P9	82.21	09° 36' 47"	490.00	41.20
C4	P10	P12	189.59	24° 27' 57"	444.00	96.26
C5	P13	P15	188.48	14° 53' 44"	725.00	94 78



PIPELINE "A" - PROFILE

(SCALE: 1" = 40' H; 1" = 10' V)

HORZ: SCALE: 1"=40'

VERT: SCALE: 1"=10'

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E2 Consulting Engineers, Inc.

CH2MHILL.

NO.	DATE	DESCRIPTION	GM/SPEC	DWN	CHKD	SUPV	APVD BY
2	9/8/14	PRE-FINAL (90%) DESIGN	PH	PT	PT	VMB	
1	4/5/13	INTERMEDIATE (60%) DESIGN	PC/EE	PT	PT	VMB	
0	11/18/11	PRELIMINARY (30%) DESIGN	EE	PT	PT	VMB	

REVISIONS

APPROVED BY	SO
SUPV	VMB
DSGN	PT
DWN	PH
CHKD	VMB
OK	VMB
DATE	09/08/14
SCALES	

TOPOCK GROUNDWATER REMEDIATION PROJECT

PLAN AND PROFILE

PIPELINE "A"

STA 20+50 TO STA 28+75

GAS TRANSMISSION & DISTRIBUTION

PACIFIC GAS AND ELECTRIC COMPANY

SAN FRANCISCO, CALIFORNIA

MICROFILM

BILL OF MATL

DWG LIST

SUPSDS

SUPSD BY

SHEET NO. of SHEETS

C-07-21 REV 2

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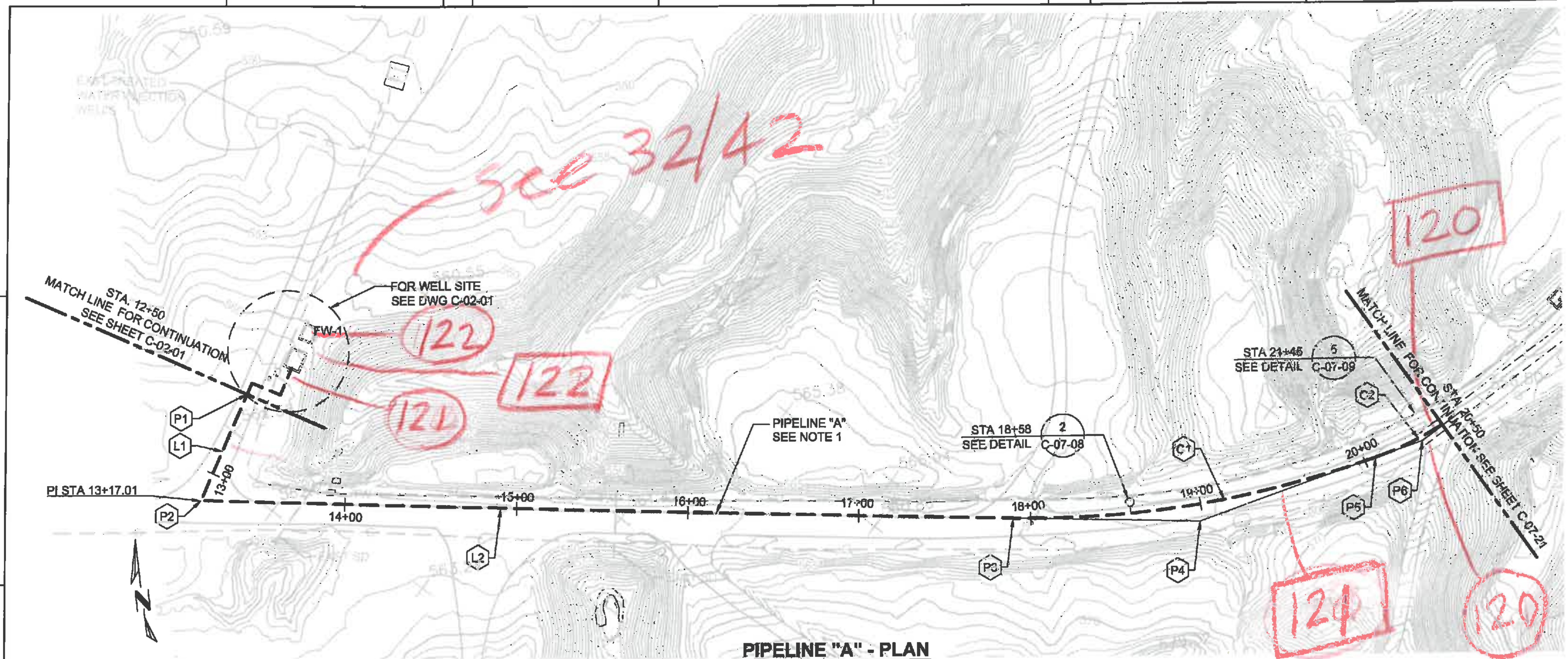


PIPELINE "A" - PLAN

(SCALE: 1" = 40' H)

NOTES:

1. THE NEW PIPELINE ALIGNMENT SHOWS CENTER OF TRENCH.
2. ASSUMED DEPTH AND APPROXIMATE LOCATION ARE SHOWN. LOCATE BY POTHOLING BEFORE STARTING CONSTRUCTION. COORDINATE WITH PG&E TO RELOCATE INTERFERING UTILITIES AS NECESSARY TO ACCOMMODATE PIPELINE A.

31/42

Point Table

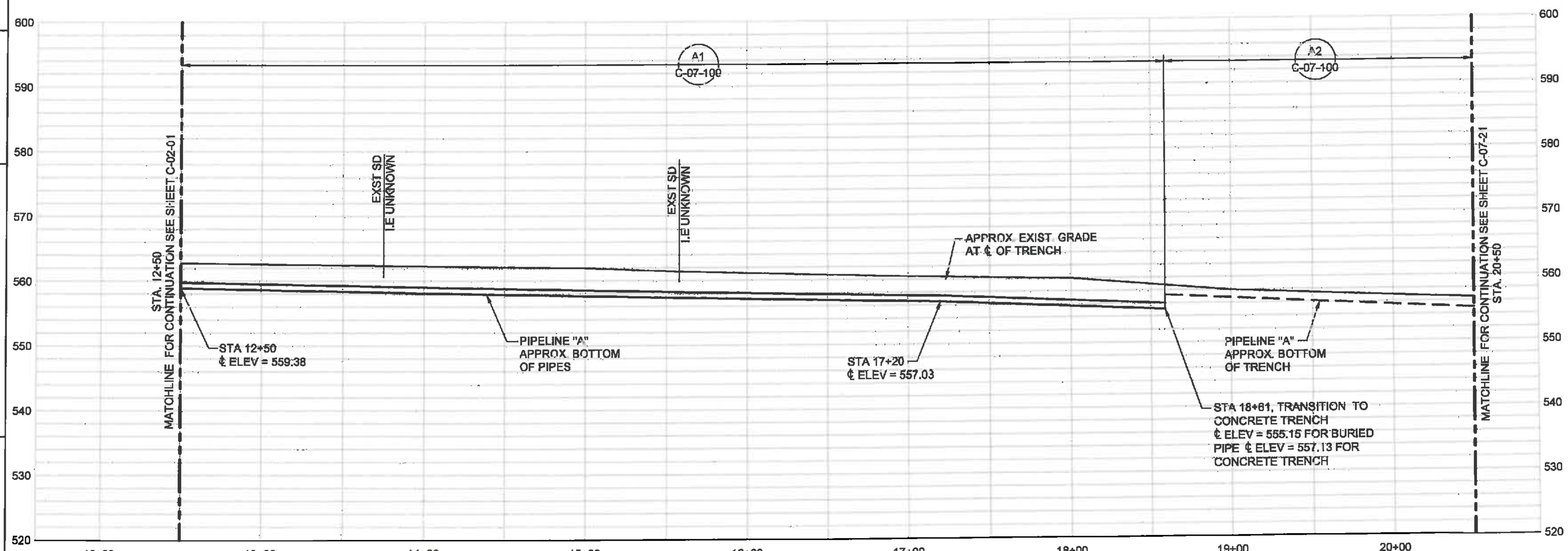
Point	Description	Sta	Northing	Easting
P1	FW-1	12+50.00	2102853.17	7613210.70
P2	PI	13+17.01	2102795.79	7163176.10
P3	BC	17+90.36	2102720.38	7613643.40
P4	PI	18+99.16	2102703.05	7613750.81
P5	EC, BC	20+05.60	2102724.74	7613857.43
P6	PI	20+34.05	2102730.40	7613885.31

Line Table

Line	Beg Point	End Point	Distance	Bearing
L1	P1	P2	67.01	S 31° 05' 24" W
L2	P2	P3	473.35	S 80° 49' 59" W

Curve Table

Curve	Beg Point	End Point	Distance	Δ	Radius	Tangent
C1	P3	P5	215.24	20° 39' 26"	597.00	108.80
C2	P5	P7	56.48	17° 07' 16"	189.00	28.45



PIPELINE "A" - PROFILE

(SCALE: 1" = 40' H; 1" = 10' V)

HORZ: SCALE: 1"=40' (0, 40, 80, 120)

VERT: SCALE: 1"=10' (0, 10, 20, 30)

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CH2MHILL

REVISIONS

NO.	DATE	DESCRIPTION	GM/SPEC	DWN	CHKD	SUPV	APVD BY
2	9/8/14	PRE-FINAL (90%) DESIGN	PH	PT	PT	VMB	
1	4/5/13	INTERMEDIATE (60%) DESIGN	PC/EE	PT	PT	VMB	
0	11/18/11	PRELIMINARY (30%) DESIGN	EE	PT	PT	VMB	

APPROVED BY	
SO	
SUPV	VMB
DSGN	PT
DWN	PH
CHKD	VMB
OK	VMB
DATE	09/08/14
SCALES	

TOPOCK GROUNDWATER REMEDIATION PROJECT
PIPELINE - PLAN AND PROFILE
STA 12+50 TO STA 20+50
PIPELINE "A"
GAS TRANSMISSION & DISTRIBUTION
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

MICROFILM / BILL OF MATL / DWG LIST / SUPSDS / SUPSD BY / SHEET NO. of SHEETS

C-07-20 REV 2

FILENAME: E2-C-XXX-07209.dwg

PLOT DATE: $PLOTDATE PLOT TIME: $PLOTTIME

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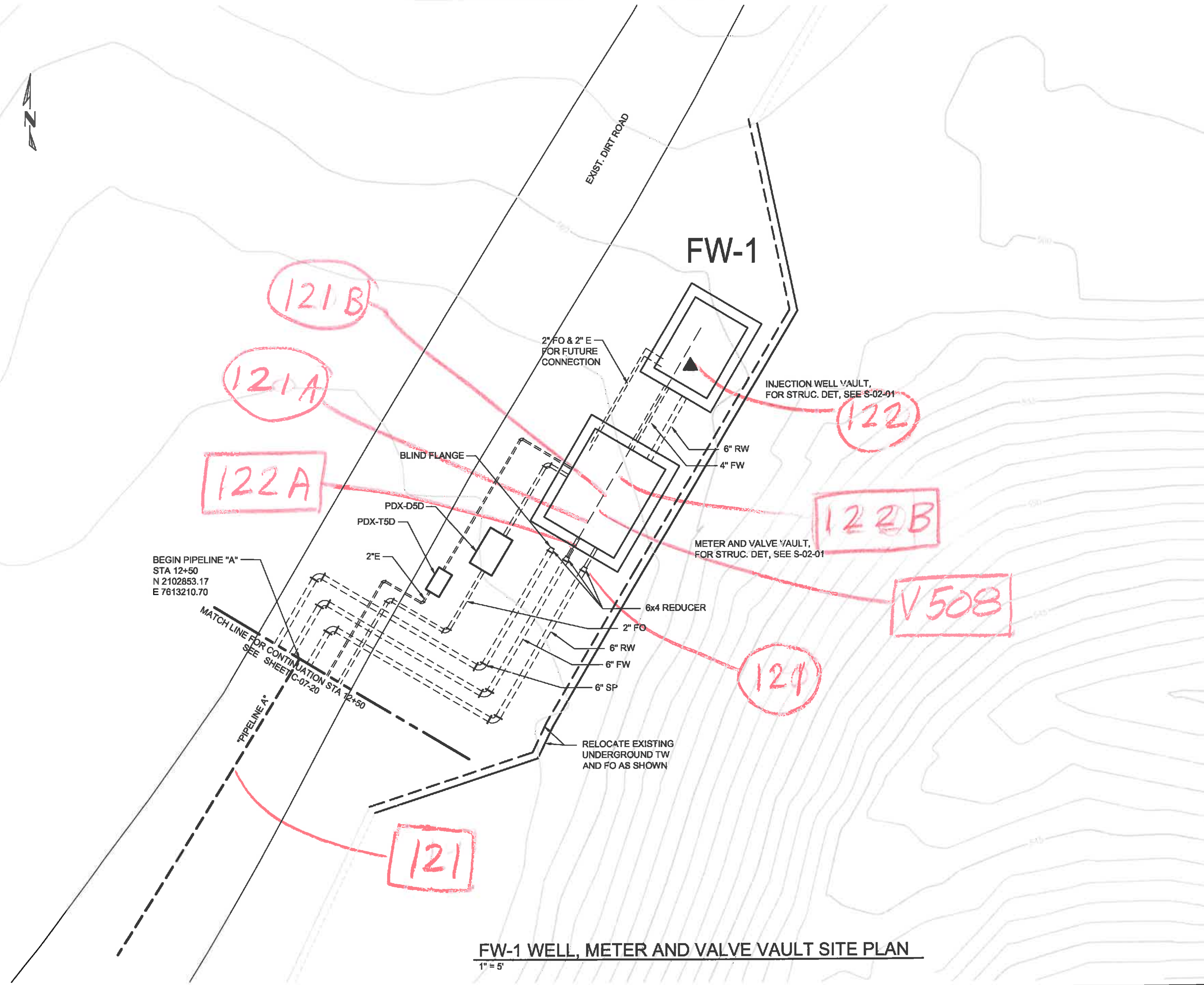
NOTES:

1. FOR STANDARD PLANS OF WELL VAULT AND METER VAULT, SEE DWG S-02-01.
2. FOR MECHANICAL PLANS OF WELL VAULT AND METER VAULT, SEE DWG M-02-01.
3. FOR PLC PANEL, SEE DWG E-02-01.



FW-1 WELL, METER AND VALVE VAULT SITE PLAN

1" = 5'

0 5 10 15

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NO.	DATE	DESCRIPTION	GM/SPEC	DWN	CHKD	SUPV	APVD BY
1	9/8/14	PRE-FINAL (90%) DESIGN		PH	PT	PT	VMB
0	4/5/13	INTERMEDIATE (60%) DESIGN		PC/EE	PT	PT	VMB

REVISIONS

SO	
SUPV	VMB
DSGN	PT
DWN	PH
CHKD	VMB
OK	VMB
DATE	09/08/14
SCALES	1" =5'-0"

TOPOCK GROUNDWATER REMEDIATION PROJECT

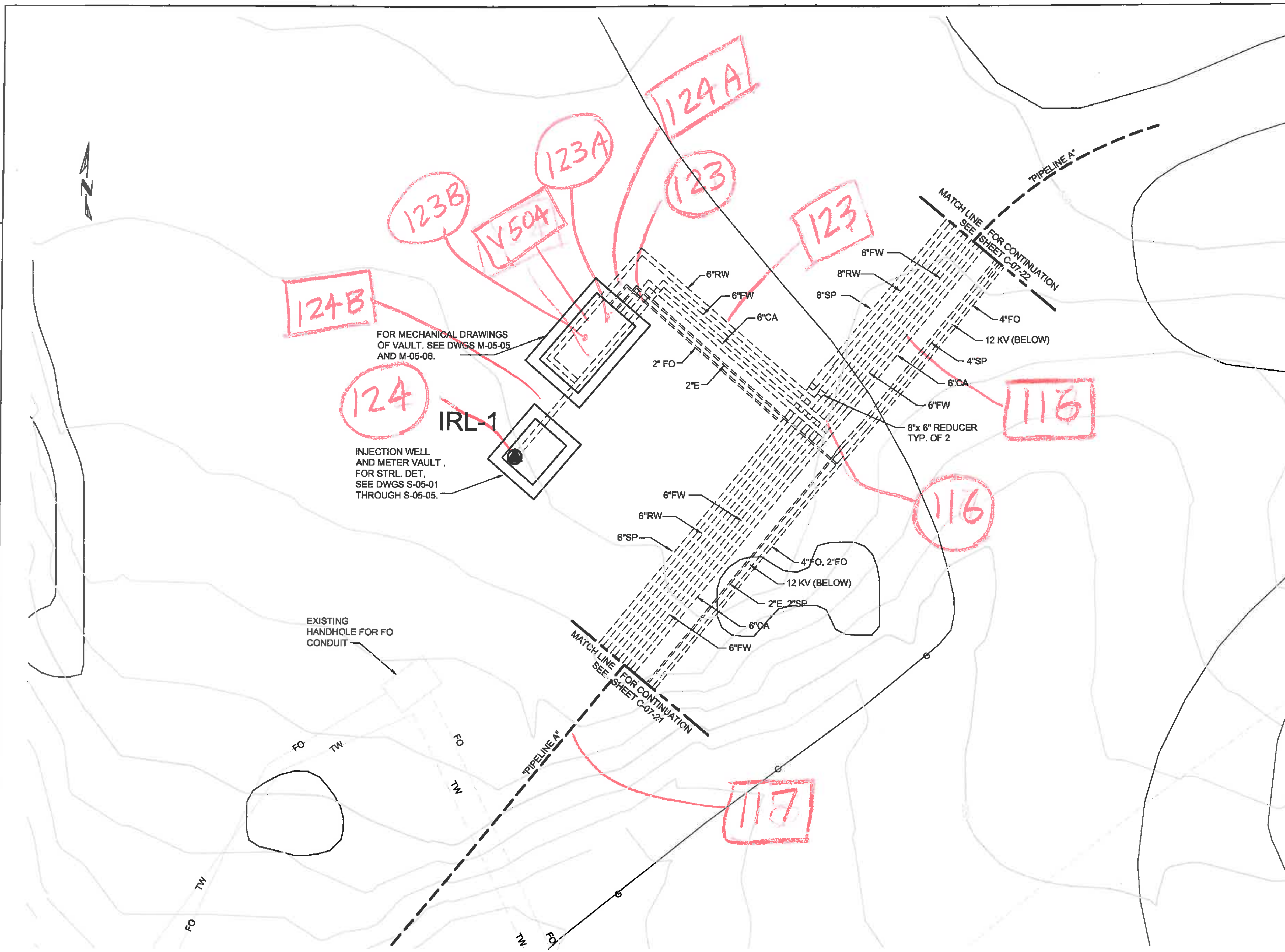
FRESHWATER INJECTION WELL FW-1 - SITE PLAN

GAS TRANSMISSION & DISTRIBUTION
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

MICROFILM
BILL OF MATL
DWG LIST
SUPSDS
SUPSD BY
SHEET NO. of SHEETS
C-02-01 REV 1

FILENAME: E2-C-XXX-0201AD.DWG

PLOT DATE: $PLOTDATE PLOT TIME: $PLOTTIME



IRL-1 WELL, METER AND VALVE VAULT SITE PLAN

1" = 5'

NOTES:

1. FOR INJECTION WELL AND METER VAULT STRUCTURAL DETAILS, SEE DWGS. S-05-01 THROUGH S-05-05.
2. FOR WELL, METER AND VALVE VAULT MECHANICAL DETAILS, SEE DWGS. M-05-05 AND M-05-06.
3. SURVEILLANCE CAMERA LOCATION AND DETAILS TO BE DETERMINED LATER.

33142

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0 5 10 15

SCALE: 1"=5'

E2 Consulting Engineers, Inc.
1900 Powell Street, Ste. 250
Emeryville, CA 94608
(510) 652-1164

CH2MHILL.

NO.	DATE	DESCRIPTION	GM/SPEC	DWN	CHKD	SUPV	APVD BY
1	9/8/14	PRE-FINAL (90%) DESIGN		PH	PT	VMB	VMB
0	4/5/13	INTERMEDIATE (60%) DESIGN		PC	PT	VMB	VMB

REVISIONS

APPROVED BY	
SUPV	VMB
DSGN	PT
DWN	PH
CHKD	VMB
OK	VMB
DATE	09/08/14
SCALES	1" =5'-0"

TOPOCK GROUNDWATER REMEDIATION PROJECT
INNER RECIRCULATION LOOP
INJECTION WELL IRL-1
SITE PLAN

GAS TRANSMISSION & DISTRIBUTION
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

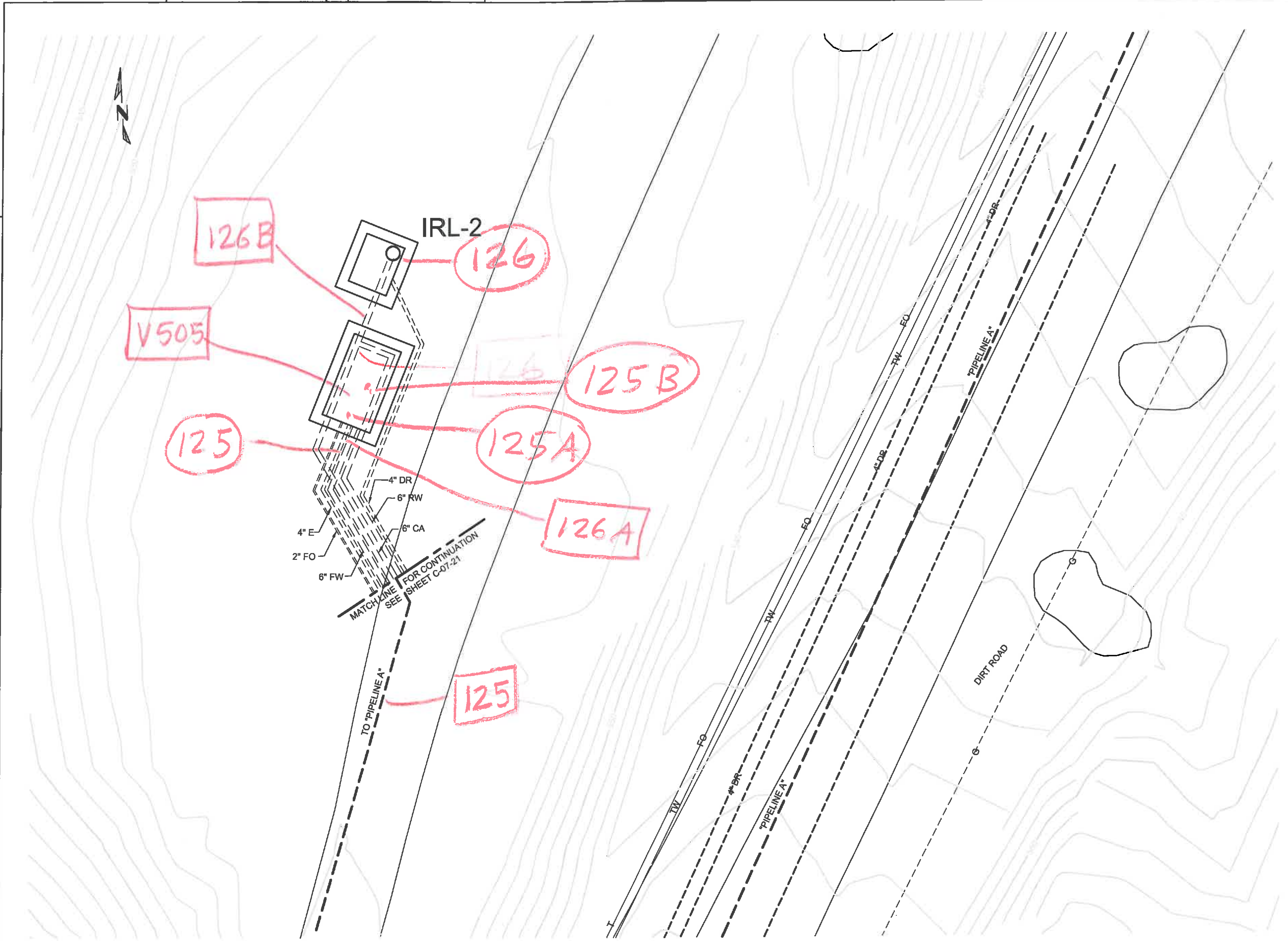
MICROFILM
BILL OF MATL
DWG LIST
SUPSDS
SUPSD BY
SHEET NO. of SHEETS
C-05-04
REV 1

PLOT DATE: $PLOTDATE PLOT TIME: $PLOTTIME
FILENAME: E2-C-XXX-0504AD.DWG

NOTES:

1. FOR INJECTION WELL AND METER VAULT STRUCTURAL DETAILS, SEE DWGS. S-05-01 THROUGH S-05-05.
2. FOR WELL, METER AND VALVE VAULT MECHANICAL DETAILS, SEE DWGS. M-05-05 AND M-05-06.
3. SURVEILLANCE CAMERA LOCATION AND DETAILS TO BE DETERMINED LATER.

34/42



IRL-2 WELL, METER AND VALVE VAULT SITE PLAN

1" = 5'

SCALE: 1"=5'

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CH2MHILL.

NO.	DATE	DESCRIPTION	GM/SPEC	DWN	CHKD	SUPV	APVD BY
1	9/8/14	PRE-FINAL (90%) DESIGN		PH	PT	VMB	VMB
0	4/5/13	INTERMEDIATE (60%) DESIGN		PC	PT	VMB	VMB

REVISIONS

SO	
SUPV	VMB
DSGN	PT
DWN	PH
CHKD	VMB
OK	VMB
DATE	09/08/14
SCALES	1" =5'-0"

TOPOCK GROUNDWATER REMEDIATION PROJECT

INNER RECIRCULATION LOOP INJECTION WELL IRL-2 SITE PLAN

GAS TRANSMISSION & DISTRIBUTION

PACIFIC GAS AND ELECTRIC COMPANY

SAN FRANCISCO, CALIFORNIA

MICROFILM
BILL OF MATL
DWG LIST
SUPSDS
SUPSD BY
SHEET NO. of SHEETS
C-05-05 REV 1

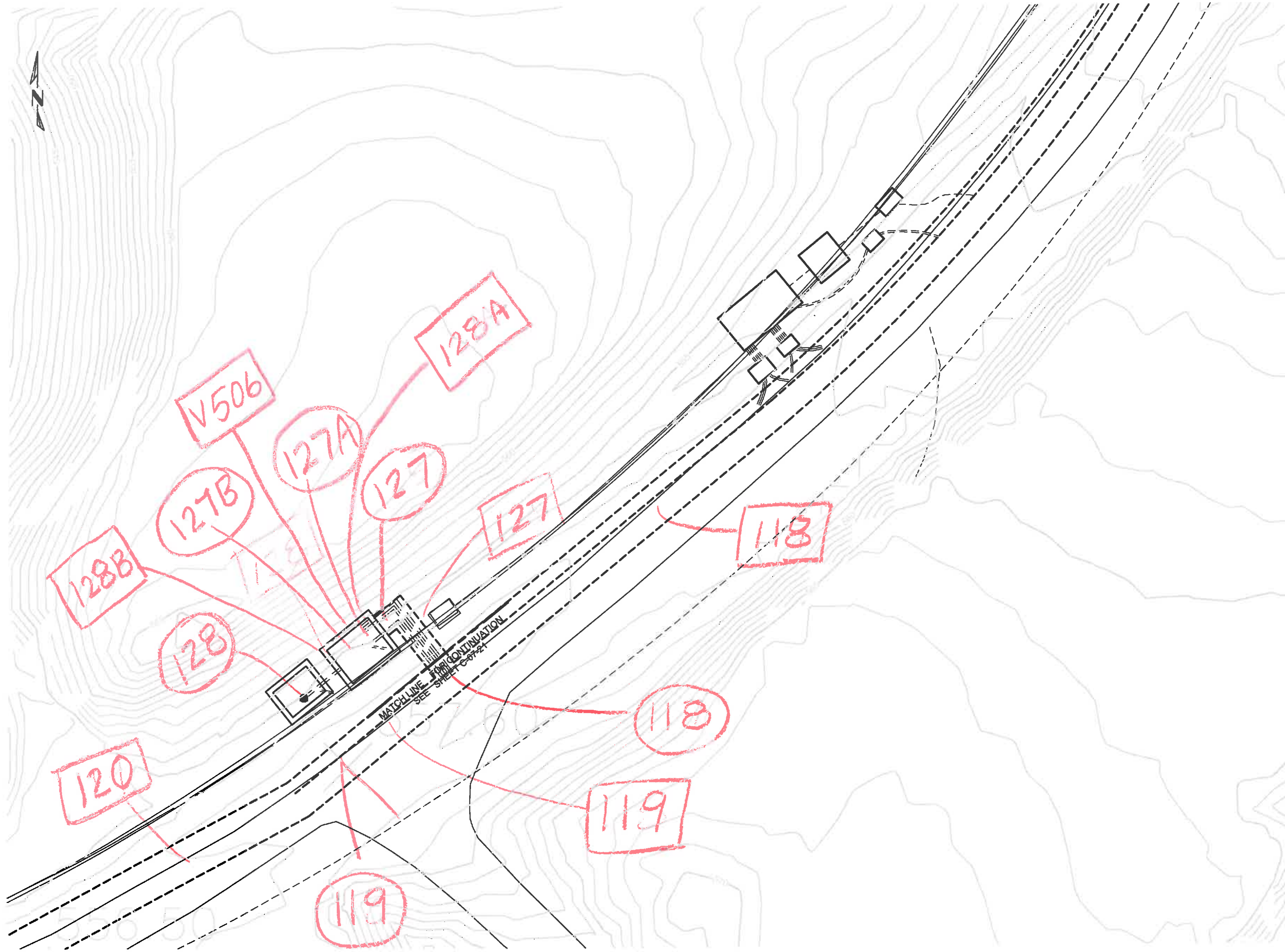
FILENAME: E2-C-XXX-0505AD.DWG

PLOT DATE: $PLOTDATE PLOT TIME: $PLOTTIME

NOTES:

1. FOR INJECTION WELL AND METER VAULT STRUCTURAL DETAILS, SEE DWGS. S-05-01 THROUGH S-05-05.
2. FOR WELL, METER AND VALVE VAULT MECHANICAL DETAILS, SEE DWGS. M-05-05 AND M-05-06.
3. SURVEILLANCE CAMERA LOCATION AND DETAILS TO BE DETERMINED LATER.

35/42



IRL-3 WELL, METER AND VALVE VAULT SITE PLAN

1" = 5'

SCALE: 1" = 10'

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E2 Consulting Engineers, Inc.

CH2MHILL

NO.	DATE	DESCRIPTION	GM/SPEC	DWN	CHKD	SUPV	APVD BY
1	9/8/14	PRE-FINAL (90%) DESIGN		PH	PT	VMB	VMB
0	4/5/13	INTERMEDIATE (60%) DESIGN		PC	PT	VMB	VMB

REVISIONS

SO	
SUPV	VMB
DSGN	PT
DWN	PH
CHKD	VMB
OK	VMB
DATE	09/08/14
SCALES	1" =5'-0"

TOPOCK GROUNDWATER REMEDIATION PROJECT
INNER RECIRCULATION LOOP
INJECTION WELL IRL-3
SITE PLAN
GAS TRANSMISSION & DISTRIBUTION
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

MICROFILM
BILL OF MATL
DWG LIST
SUPSDS
SUPSD BY
SHEET NO. of SHEETS
C-05-06 REV 1

FILENAME: E2-C-XXX-0506AD.DWG

PLOT DATE: $PLOTDATE PLOT TIME: $PLOTTIME

NOTES:

1. THE NEW PIPELINE ALIGNMENT SHOWS CENTER OF TRENCH.
2. ASSUMED DEPTH AND APPROXIMATE LOCATION ARE SHOWN. LOCATE BY POTHOLING BEFORE STARTING CONSTRUCTION. COORDINATE WITH PG&E TO RELOCATE INTERFERING UTILITIES AS NECESSARY TO ACCOMMODATE PIPELINE H.
3. TWO POTENTIAL ELEVATIONS ARE SHOWN FOR THE EXISTING 30 INCH GAS PIPELINE. ONE ELEVATION DENOTES A STRAIGHT LINE INTERPOLATION BETWEEN POTHOLE ELEVATION 35' EAST OF NEW PIPELINE CROSSING AND DAYLIGHT ELEVATION OF PIPE 85' WEST OF NEW PIPELINE CROSSING TOP OF PIPE = 567.88' AND BOTTOM OF PIPE = 565.38. THE OTHER ELEVATION ASSUMES THAT GAS PIPELINE IS LEVEL FROM POTHOLE TO PIPELINE CROSSING AND THAT PIPE DESCENDS AFTER PIPELINE CROSSING. TOP OF PIPE = 572.90 BOTTOM OF PIPE = 570.40. CONTRACTOR SHALL POTHOLE AT NEW PIPELINE CROSSING TO DETERMINE EXACT LOCATION.
4. FOR NEW ACCESS ROAD PLAN, PROFILE AND SECTIONS SEE DRAWINGS C-05-01 & C-05-02

36/42

Point Table

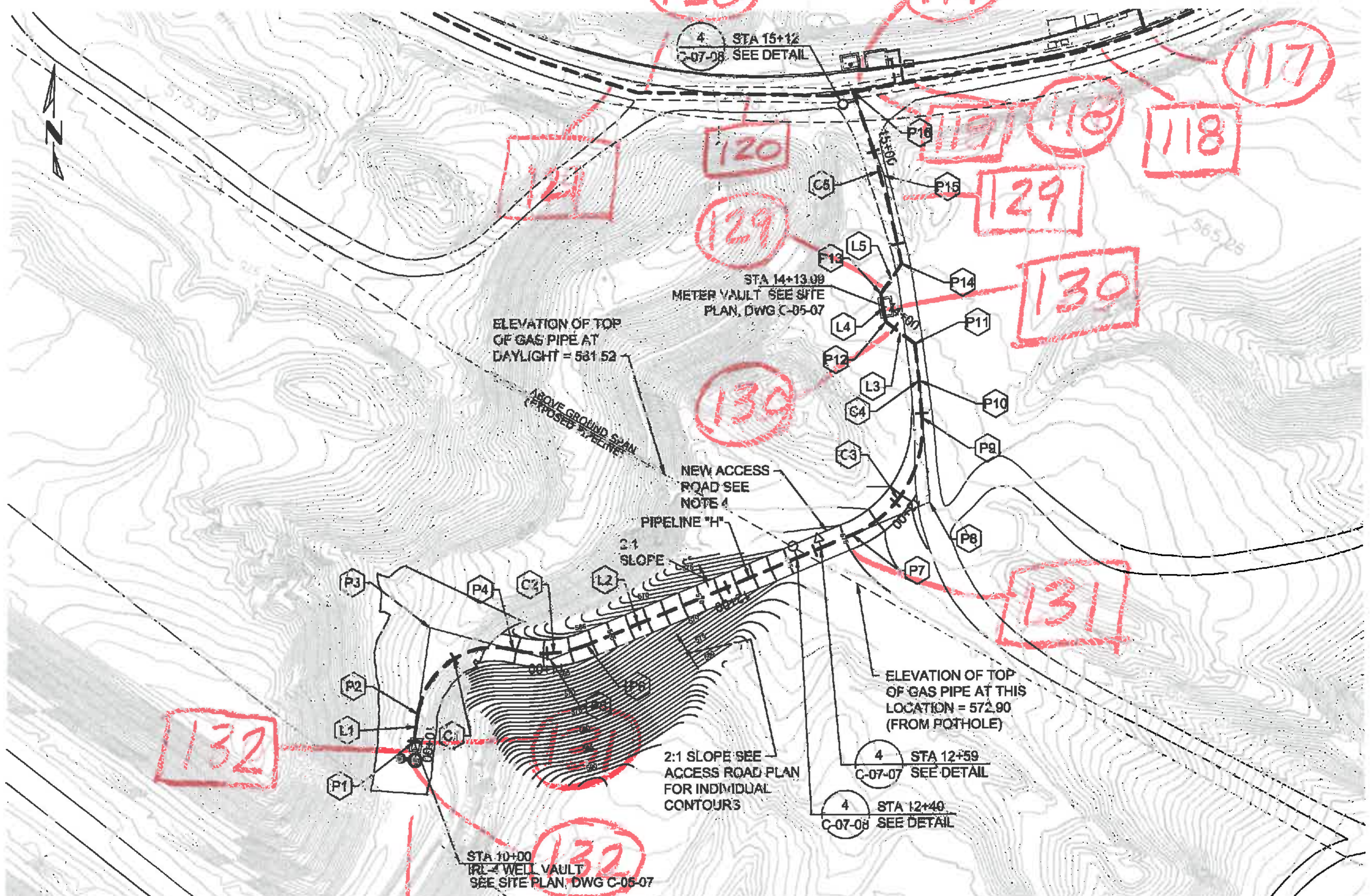
Point	Description	Sta	Northing	Easting
P1	Well	10+00.00	2102380.66	7613953.83
P2	BC	10+14.59	2102394.17	7613948.33
P3	PI	10+59.83	2102436.07	7613931.28
P4	EC, BC	10+82.33	2102447.87	7613974.95
P5	PI	11+02.43	2102453.14	7613994.35
P6	EC	11+19.58	2102468.99	7614006.71
P7	BC	12+69.91	2102587.76	7614098.87
P8	PI	13+14.24	2102622.78	7614126.04
P9	EC, BC	13+46.26	2102659.05	7614100.55
P10	PI	13+65.54	2102675.12	7614089.90
P11	EC	13+84.80	2102690.45	7614078.21
P12	PI	14+04.04	2102692.69	7614059.10
P13	PI	14+18.94	2102704.24	7614049.68
P14	BC	14+37.90	2102723.12	7614051.41
P15	PI	14+84.64	2102758.16	7614020.48
P16	EC	15+31.19	2102787.86	7613984.38

Line Table

Line	Beg Point	End Point	Distance	Bearing
L1	P1	P2	14.59	N 22° 09' 05"W
L2	P6	P7	150.33	N 37° 48' 35"E
L3	P11	P12	19.24	N 83° 18' 52"W
L4	P12	P13	14.90	N 39° 12' 01"W
L6	P13	P14	18.96	N 22° 09' 05"W

Curve Table

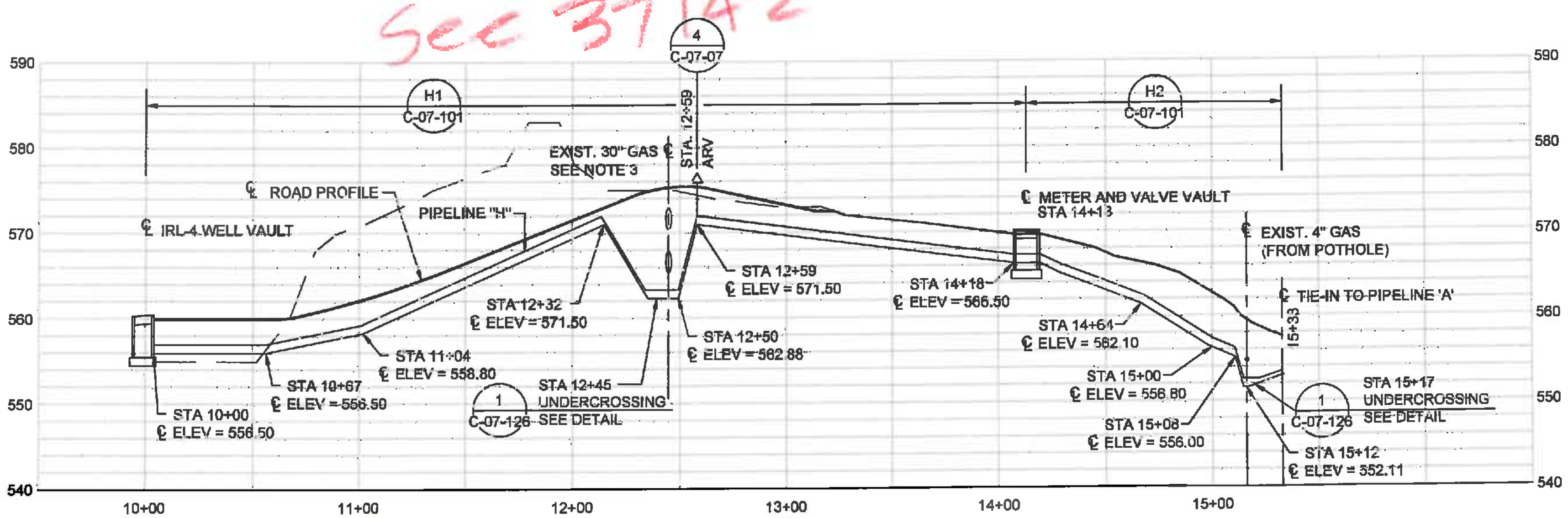
Curve	Beg Point	End Point	Distance	Δ	Radius	Tangent
C1	P2	P4	67.74	97° 01' 50"	40.00	45.24
C2	P4	P6	37.25	53° 21' 43"	40.00	20.10
C3	P7	P9	76.35	72° 54' 48"	60.00	44.33
C4	P9	P11	38.54	03° 45' 58"	586.36	19.28
C5	P14	P16	93.29	09° 06' 56"	586.36	46.74



PIPELINE "H" - PLAN

(SCALE: 1" = 40' H)

See 37/42



PIPELINE "H" - PROFILE

(SCALE: 1" = 40' H; 1" = 10' V)

0 40 80 120
HORZ: SCALE: 1"=40'

0 10 20 30
VERT: SCALE: 1"=10'

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E2 Consulting Engineers, Inc.
1900 Powell Street, Ste. 250
Emeryville, CA 94608
(510) 652-1164

CH2MHILL.

APVD BY	NO.	DATE	DESCRIPTION	GM/SPEC	DWN	CHKD	SUPV	APVD BY
	2	9/8/14	PRE-FINAL (90%) DESIGN		PH	PT	VMB	VMB
	1	4/5/13	INTERMEDIATE (60%) DESIGN		PC	PT	PT	VMB
	0	11/18/11	PRELIMINARY (30%) DESIGN		EE	PT	PT	VMB

REVISIONS

APPROVED BY

SO	
SUPV	VMB
DSGN	PT
DWN	PC
CHKD	VMB
OK	VMB
DATE	09/08/14
SCALES	

TOPOCK GROUNDWATER REMEDIATION PROJECT

PLAN AND PROFILE
PIPELINE "H"
STA 10+00 TO STA 15+31.19

GAS TRANSMISSION & DISTRIBUTION
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

MICROFILM
BILL OF MATL
DWG LIST
SUPSDS
SUPSD BY
SHEET NO. of SHEETS
C-07-25 REV 2

FILENAME: E2-C-XXX-0725.dwg

PLOT DATE: $PLOTDATE PLOT TIME: $PLOTTIME

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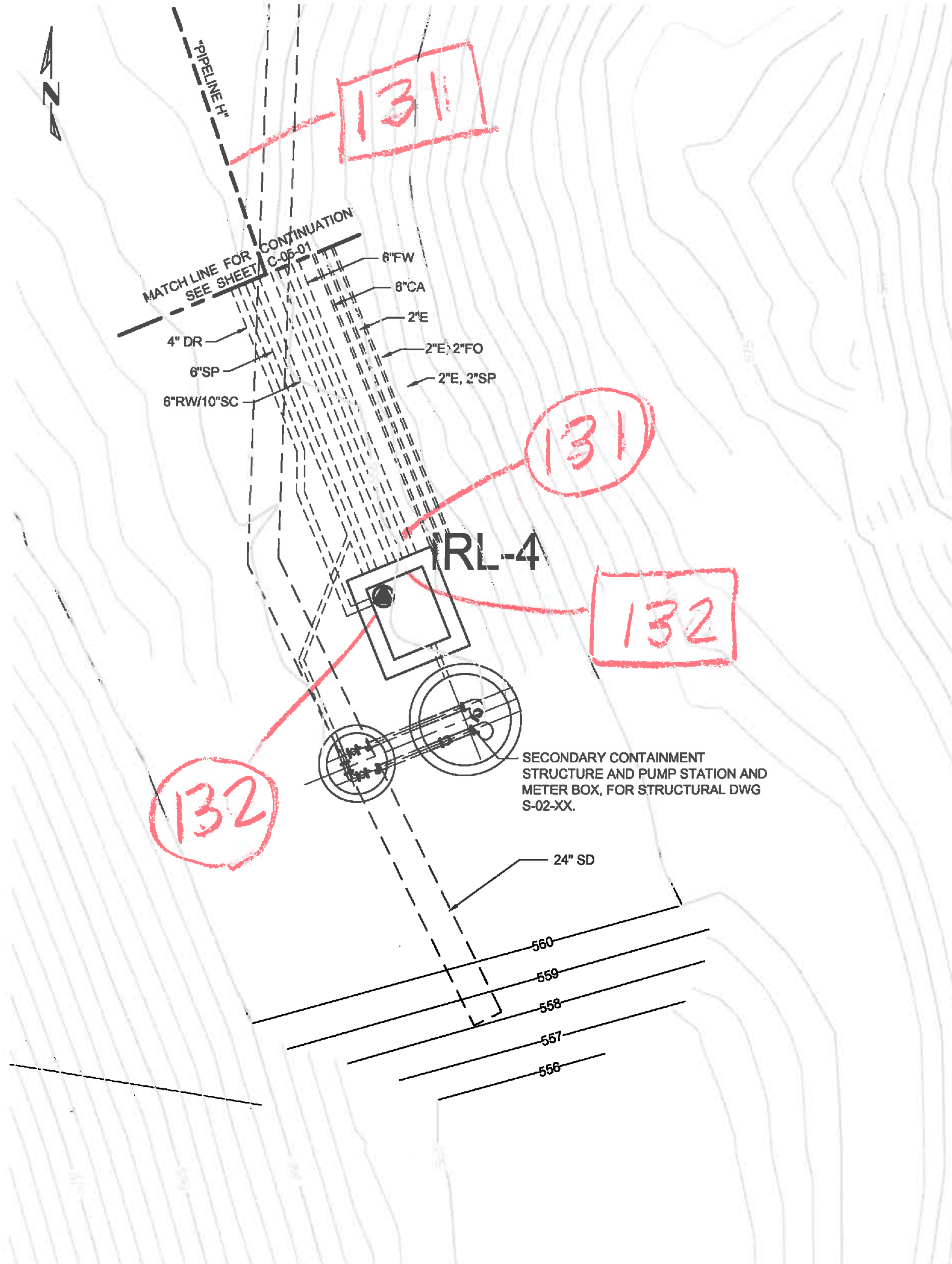
37/42

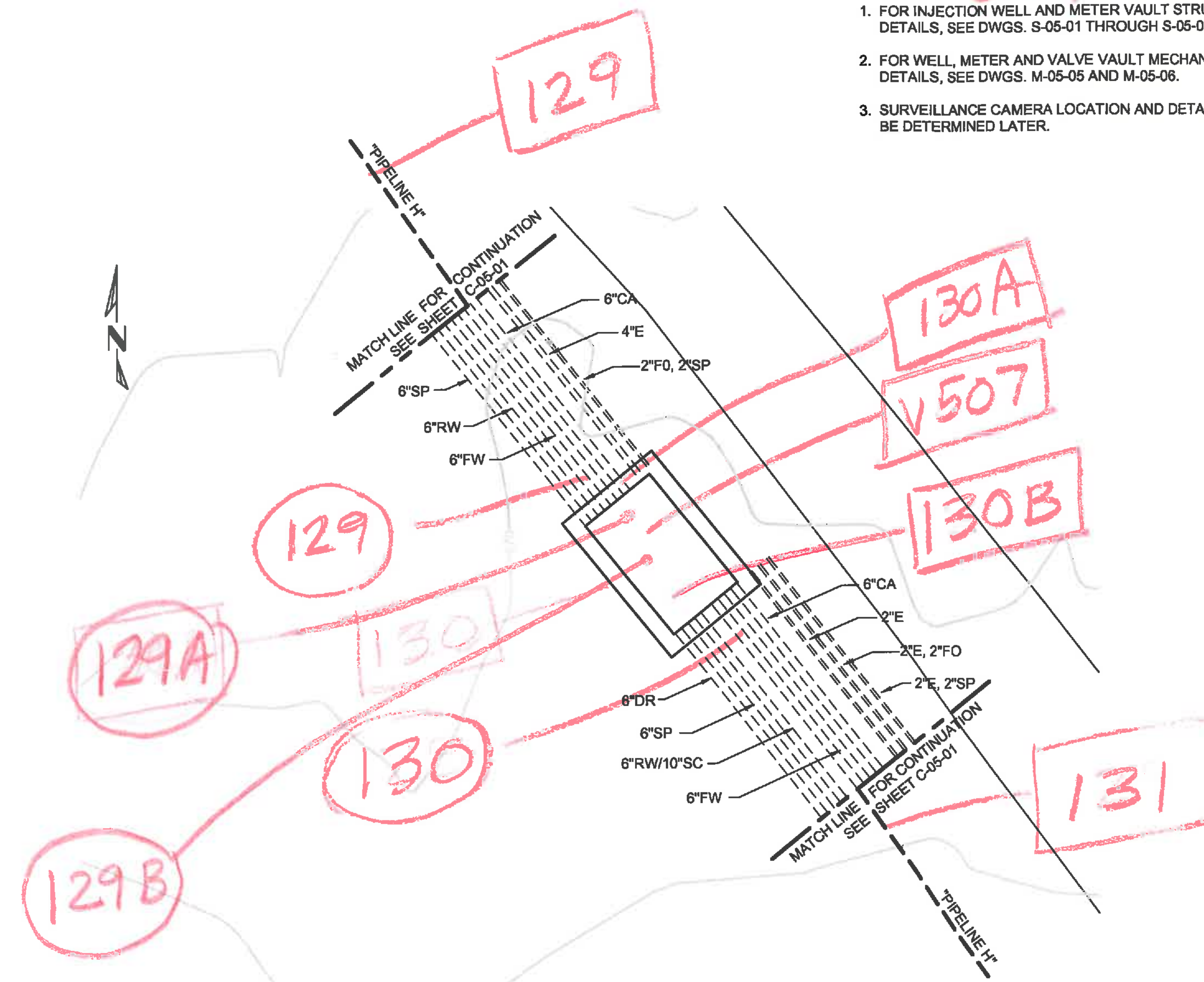
NOTES:

1. FOR INJECTION WELL AND METER VAULT STRUCTURAL DETAILS, SEE DWGS. S-05-01 THROUGH S-05-05.
2. FOR WELL, METER AND VALVE VAULT MECHANICAL DETAILS, SEE DWGS. M-05-05 AND M-05-06.
3. SURVEILLANCE CAMERA LOCATION AND DETAILS TO BE DETERMINED LATER.



IRL-4 WELL VAULT SITE PLAN

1" = 5'



IRL-4 METER AND VALVE VAULT SITE PLAN

1" = 5'

0 5 10 15

SCALE: 1"=5'

DRAFT NOT FOR CONSTRUCTION

E2 Consulting Engineers, Inc.

CH2MHILL.

NO.	DATE	DESCRIPTION	GM/SPEC	DWN	CHKD	SUPV	APVD BY
1	9/8/14	PRE-FINAL (90%) DESIGN	PH	PT	VMB	VMB	
0	4/5/13	INTERMEDIATE (60%) DESIGN	PC	PT	VMB	VMB	

REVISIONS

APPROVED BY	
SO	
SUPV	VMB
DSGN	PT
DWN	PC
CHKD	VMB
OK	VMB
DATE	09/08/14
SCALES	1" =5'-0"

TOPOCK GROUNDWATER REMEDIATION PROJECT

INNER RECIRCULATION LOOP INJECTION WELL IRL-4 SITE PLAN

GAS TRANSMISSION & DISTRIBUTION

PACIFIC GAS AND ELECTRIC COMPANY SAN FRANCISCO, CALIFORNIA

MICROFILM / BILL OF MATL / DWG LIST / SUPSDS / SUPSD BY / SHEET NO. of SHEETS / C-05-07 / REV 1

FILENAME: E2-C-XXX-0507AD.DWG

PLOT DATE: $PLOTDATE PLOT TIME: $PLOTTIME

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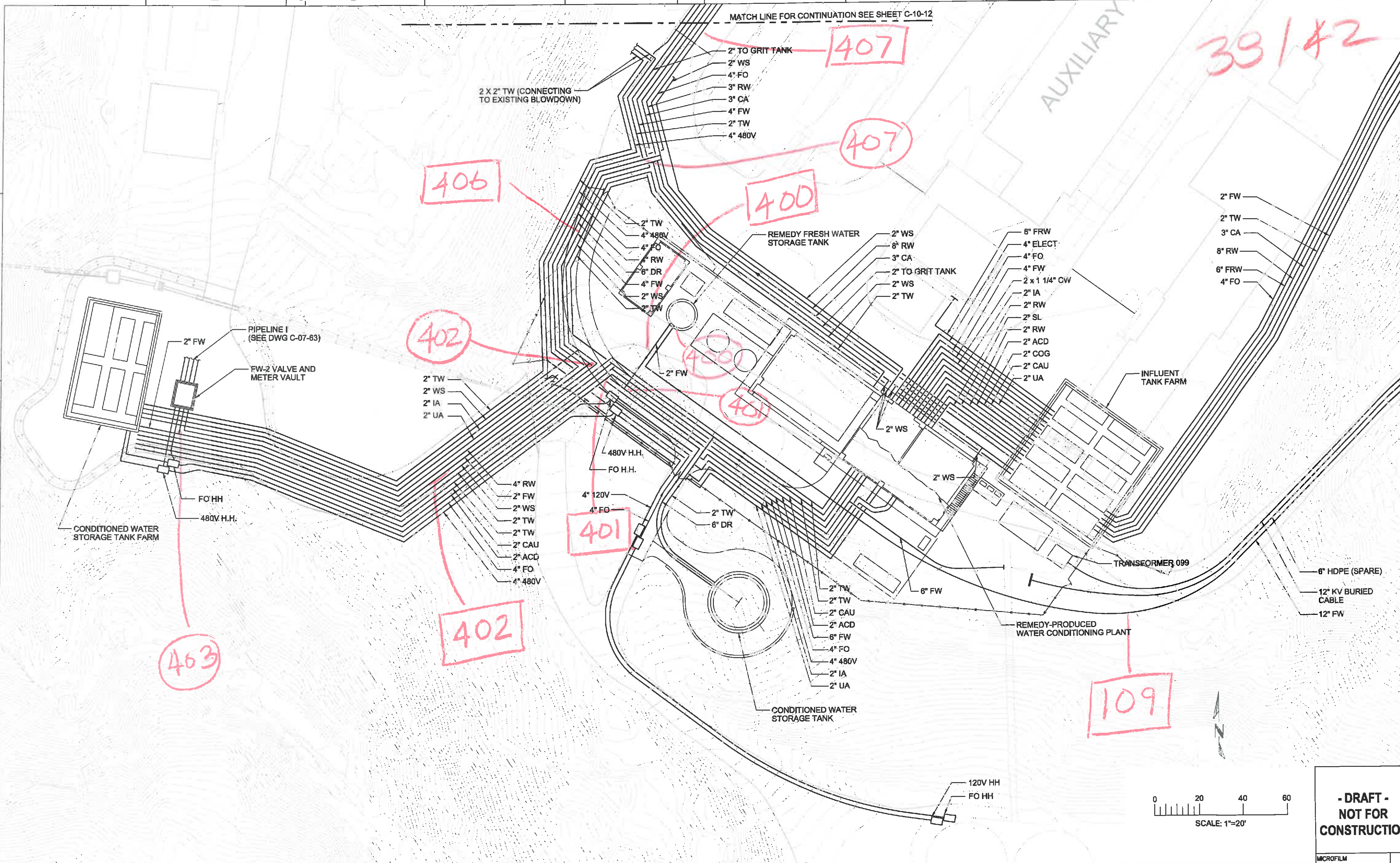


- DRAFT - NOT FOR CONSTRUCTION

AECOM
2101 WEBSTER STREET SUITE 1000
OAKLAND, CA 94612-3060
PROJECT NO. 60272335

NO.	DATE	DESCRIPTION	GM/SPEC	DWN	CHKD	SUPV	APVD BY
1	9/8/14	PRE-FINAL (90%) DESIGN					
0	9/12/12	INTERMEDIATE (60%) DESIGN					

REVISIONS

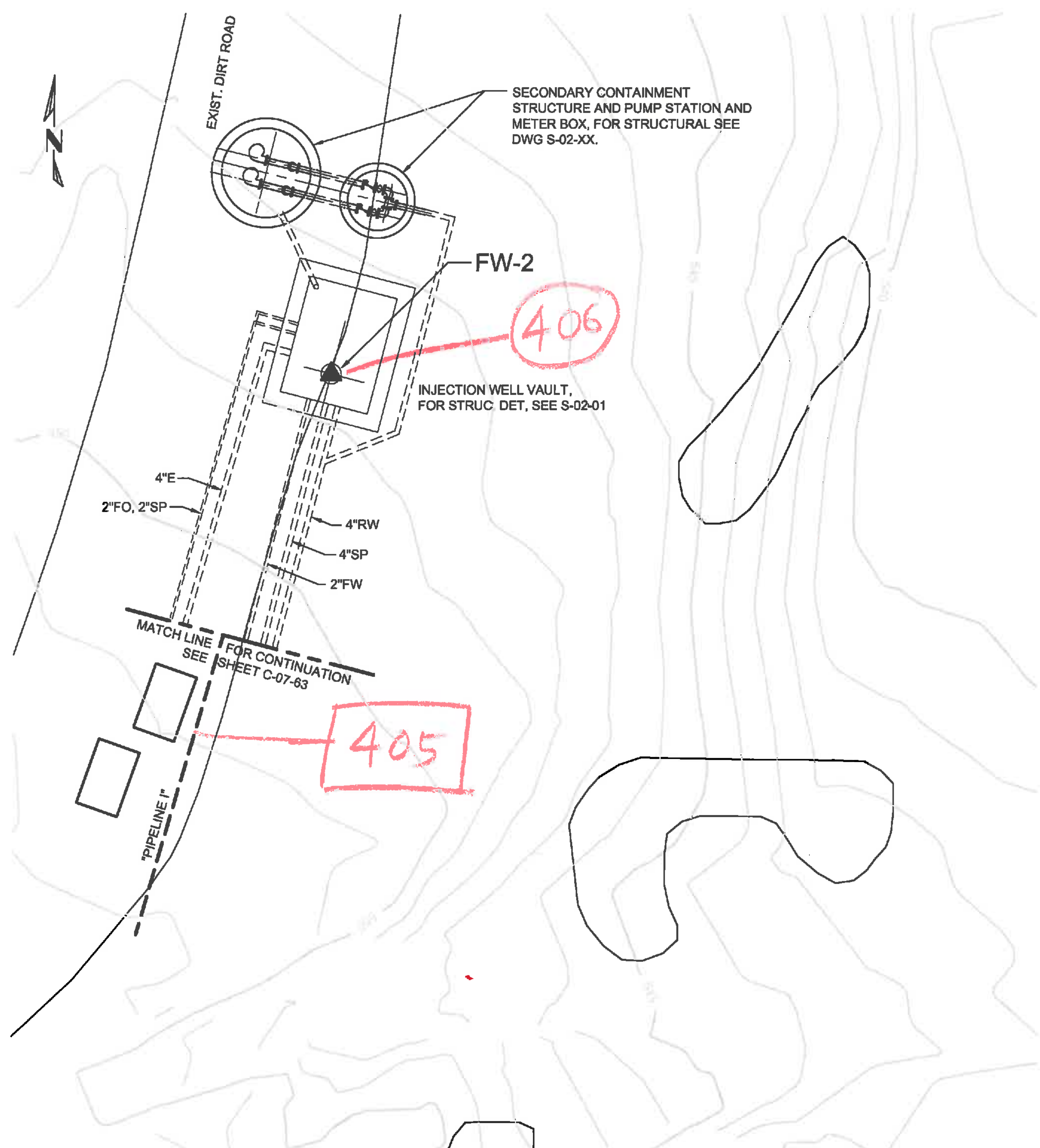
SO	XX/XX
SUPV	PD
DSGN	TL
DWN	TL
CHKD	JM
OK	PD
DATE	9/8/14
SCALES	1" = 20'-0"

TOPOCK GROUNDWATER REMEDIATION PROJECT

PIPE LAYOUT
SHEET 1 OF 4

GAS TRANSMISSION & DISTRIBUTION
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

MICROFILM	
BILL OF MATL	
DWG LIST	
SUPSDS	
SUPSD BY	
SHEET NO.	OF SHEETS
C-10-11	REV 1



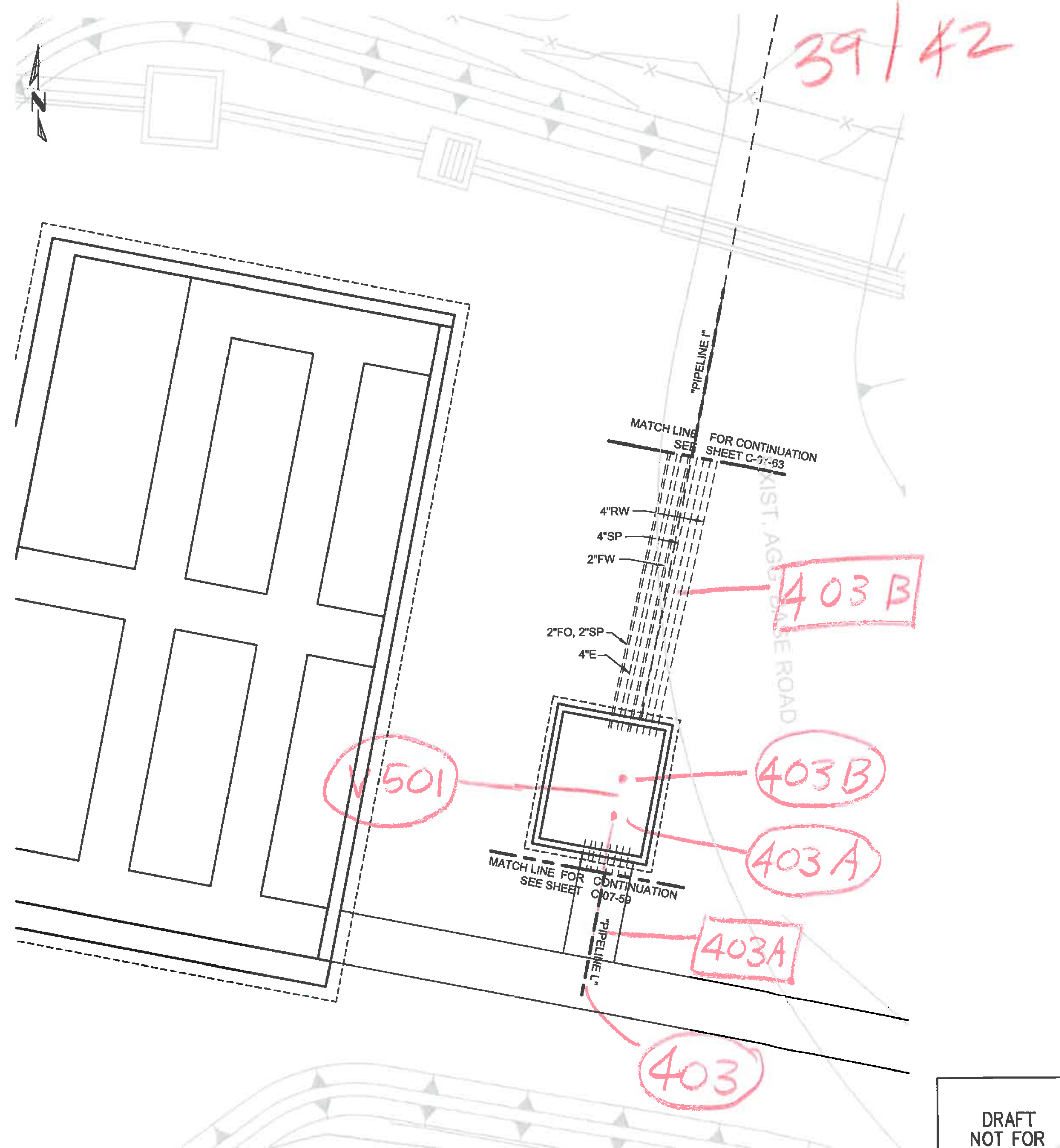
FW-2 WELL VAULT SITE PLAN

1" = 5'

SCALE: 1"=5' (0, 5, 10, 15)

NOTES:

1. FOR STANDARD PLANS OF WELL VAULT AND METER VAULT, SEE DWG S-02-01.
2. FOR MECHANICAL PLANS OF WELL VAULT AND METER VAULT, SEE DWG M-02-01.
3. FOR PLC PANEL, SEE DWG E-02-01.
4. FOR STRUCTURAL PLANS OF SECONDARY CONTAINMENT STRUCTURE AND VALVE BOX, SEE DWG S-02-XX
5. FOR MECHANICAL PLANS OF SECONDARY CONTAINMENT STRUCTURE, SEE DWG M-02-XX.



FW-2 METER AND VALVE VAULT SITE PLAN

1" = 5'

DRAFT NOT FOR CONSTRUCTION

E2 Consulting Engineers, Inc.
1900 Powell Street, Ste. 250
Emeryville, CA 94608
(510) 652-1164

CH2MHILL.

NO.	DATE	DESCRIPTION	GM/SPEC	DWN	CHKD	SUPV	APVD BY
1	9/8/14	PRE-FINAL (90%) DESIGN	PH	PT	PT	VMB	
0	4/5/13	INTERMEDIATE (60%) DESIGN	PC/EE	PT	PT	VMB	

REVISIONS

APPROVED BY	
SUPV	VMB
DSGN	PT
DWN	PH
CHKD	VMB
OK	VMB
DATE	09/08/14
SCALES	1" = 5'-0"

TOPOCK GROUNDWATER REMEDIATION PROJECT

FRESHWATER INJECTION WELL FW-2 - SITE PLAN

GAS TRANSMISSION & DISTRIBUTION
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

MICROFILM | BILL OF MATL | DWG LIST | SUPSDS | SUPSD BY | SHEET NO. of SHEETS | C-02-02 | REV 1

FILENAME: E2-C-XXX-0202AD.DWG
PLOT DATE: $PLOTDATE PLOT TIME: $PLOTTIME

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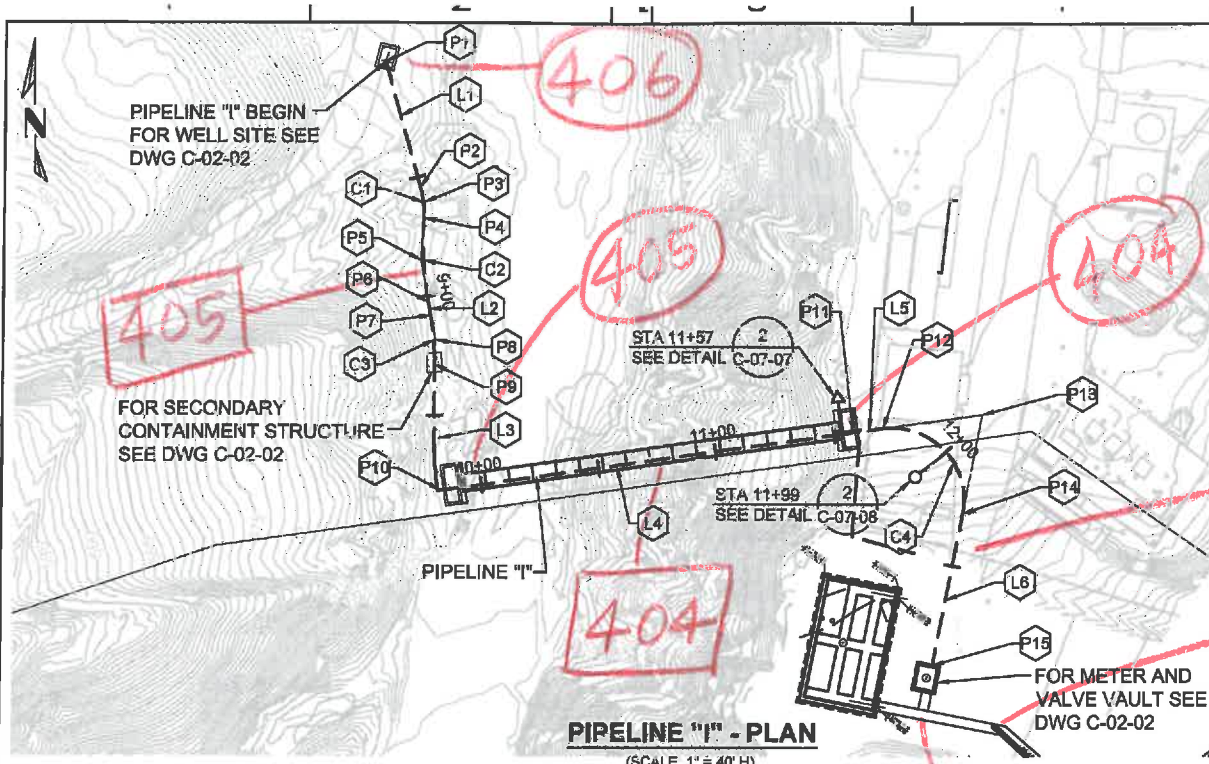
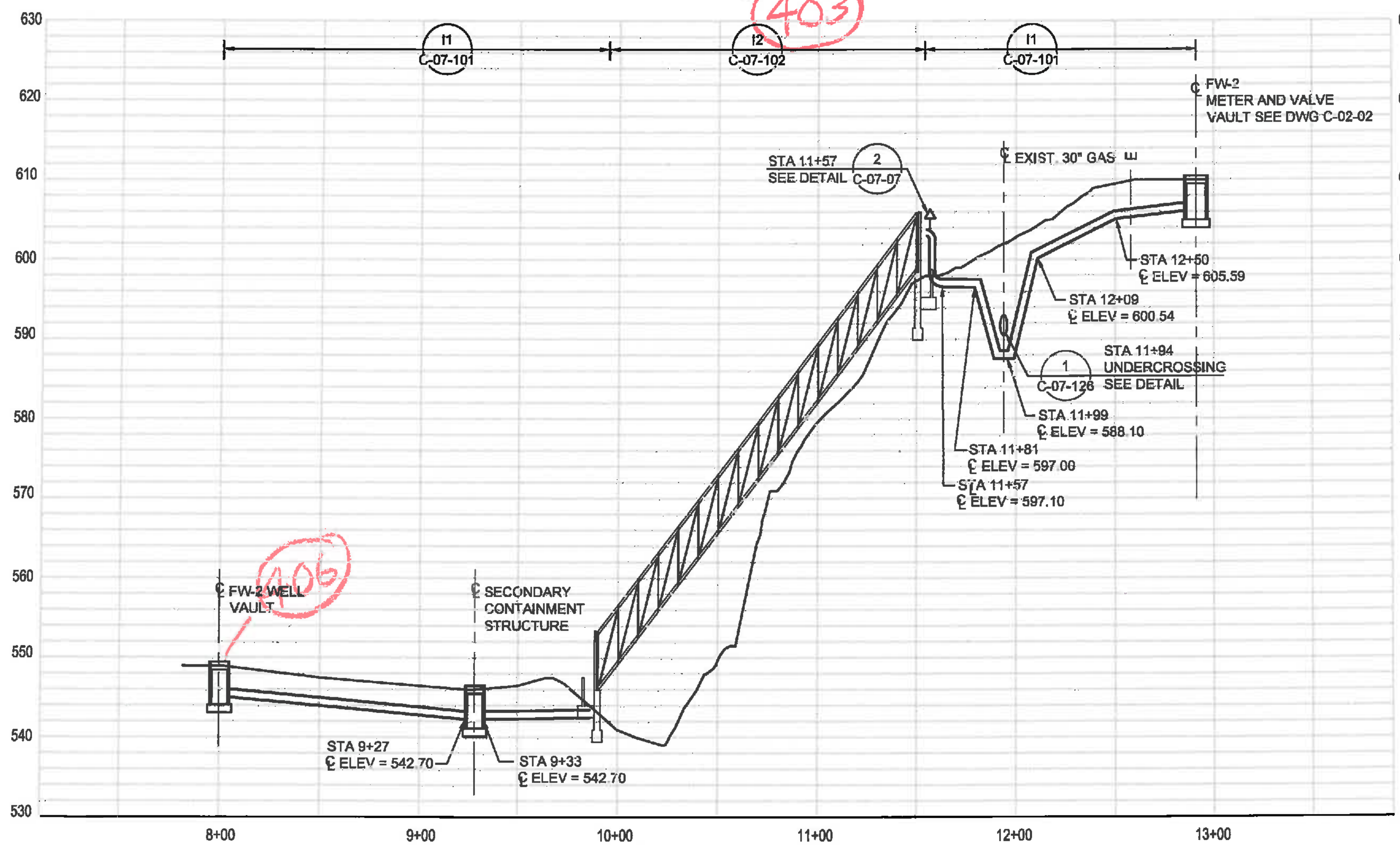


PIPELINE "I" - PLAN
(SCALE. 1" = 40' H)



PIPELINE "I" - PROFILE
(SCALE: 1" = 40' H; 1" = 4' V)

NOTES:

1. DEPTHS OF EXISTING UTILITIES ARE UNKNOWN. ALL POTENTIAL CONFLICTS BETWEEN NEW PIPE CONSTRUCTION AND EXISTING UTILITIES WILL BE POTHOLED PRIOR TO THE 100% DESIGN. A DETERMINATION WILL BE MADE WHETHER TO RELOCATE EXISTING UTILITIES OR RE-ROUTE NEW PIPE TRENCHES AROUND EXISTING UTILITIES. THIS WILL BE INCORPORATED INTO THE 100% DESIGN.

2. THE NEW PIPELINE ALIGNMENT SHOWS CENTER OF TRENCH. THE NUMBER AND SIZES OF PIPE IN EACH TRENCH VARIES, REFER TO PIPE SECTION NUMBER ON EACH PLAN AND PROFILE SHEET AND PIPE SCHEDULE ON DRAWING C-07-03 FOR NUMBER AND SIZE OF EACH PIPE. REFER TO TRENCH DETAILS ON DRAWINGS C-100, C-101 AND C-102 FOR ARRANGEMENT OF PIPING IN EACH TRENCH SECTION.

Point Table

Point	Description	Sta	Northing	Easting
P1	Well	8+00.00	2100511.51	7614682.70
P2	BC	8+54.39	2100459.25	7614697.61
P3	PI	8+60.89	2100453.01	7614699.39
P4	EC, BC	8+67.38	2100446.52	7614699.05
P5	PI	8+85.22	2100428.76	7614698.10
P6	EC	9+02.90	2100411.31	7614701.33
P7	BC	9+08.48	2100405.83	7614702.35
P8	PI	9+18.82	2100395.66	7614704.24
P9	EC	9+29.14	2100385.33	7614704.72
P10	PI	9+81.71	2100332.82	7614707.15
P11	VPI	11+56.73	2100357.17	7614880.46
P12	BC	11+69.48	2100358.95	7614893.08
P13	PI	12+11.41	2100364.54	7614934.65
P14	EC	12+26.48	2100323.40	7614926.52
P15	Meter Vault	12+91.01	2100260.10	7614914.00

Line Table

Line	Beg Point	End Point	Distance	Bearing
L1	P1	P2	54.39	S 15° 55' 25" E
L2	P6	P7	5.58	S 10° 32' 38" E
L3	P9	P10	52.57	S 02° 38' 58" E
L4	P10	P11	175.02	N 82° 00' 08" E
L5	P11	P12	12.75	N 82° 00' 08" E
L6	P14	P15	64.53	S 11° 11' 17" W

Curve Table

Curve	Beg Point	End Point	Distance	Δ	Radius	Tangent
C1	P2	P4	12.99	04° 57' 43"	150.00	6.50
C2	P4	P6	35.52	13° 33' 58"	150.00	17.84
C3	P7	P9	20.66	07° 53' 24"	150.00	10.34
C4	P12	P14	56.99	108° 50' 36"	30.00	41.94

HORZ. SCALE: 1"=40' (0, 40, 80, 120)

VERT. SCALE: 1"=10' (0, 10, 20, 30)

DRAFT NOT FOR CONSTRUCTION

E2 Consulting Engineers, Inc.

CH2MHILL.

NO.	DATE	DESCRIPTION	DWN	CHKD	SUPV	APVD BY
2	9/8/14	PRE-FINAL (90%) DESIGN	PH	VMB	VMB	VMB
1	4/5/13	INTERMEDIATE (60%) DESIGN	PH	VMB	VMB	VMB
0	11/11/11	PRELIMINARY (30%) DESIGN	PC	VMB	VMB	VMB

REVISIONS

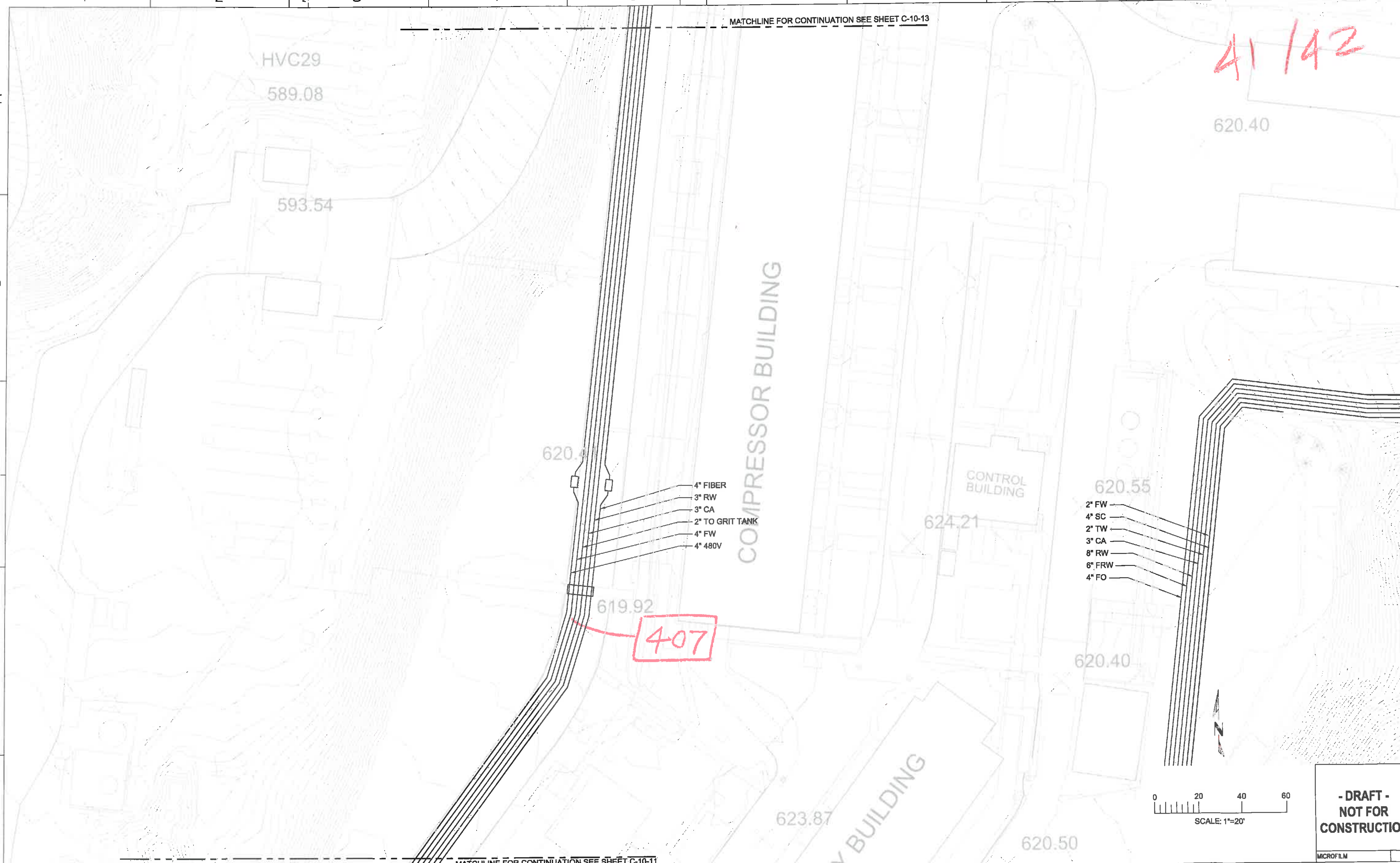
SUPV VMB; DSGN PT; DWN PH; CHKD VMB; OK VMB; DATE 09/08/14; SCALES 1" = 40'

TOPOCK GROUNDWATER REMEDIATION PROJECT
PLAN AND PROFILE
PIPELINE "I"
STA 8+00 TO STA 14+60
GAS TRANSMISSION & DISTRIBUTION
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

C-07-78 REV 2

FILENAME: E2-C-XXX-0778AD.DWG

PLOT DATE: $PLOTDATE PLOT TIME: $PLOTTIME



- DRAFT -
NOT FOR CONSTRUCTION

AECOM
2101 WEBSTER STREET SUITE 1000
OAKLAND, CA 94612-3060
PROJECT NO. 60272335

NO.	DATE	DESCRIPTION	GM/SPEC	DWN	CHKD	SUPV	APVD BY
1	9/3/14	PRE-FINAL (90%) DESIGN					
0	9/12/12	INTERMEDIATE (60%) DESIGN					

REVISIONS

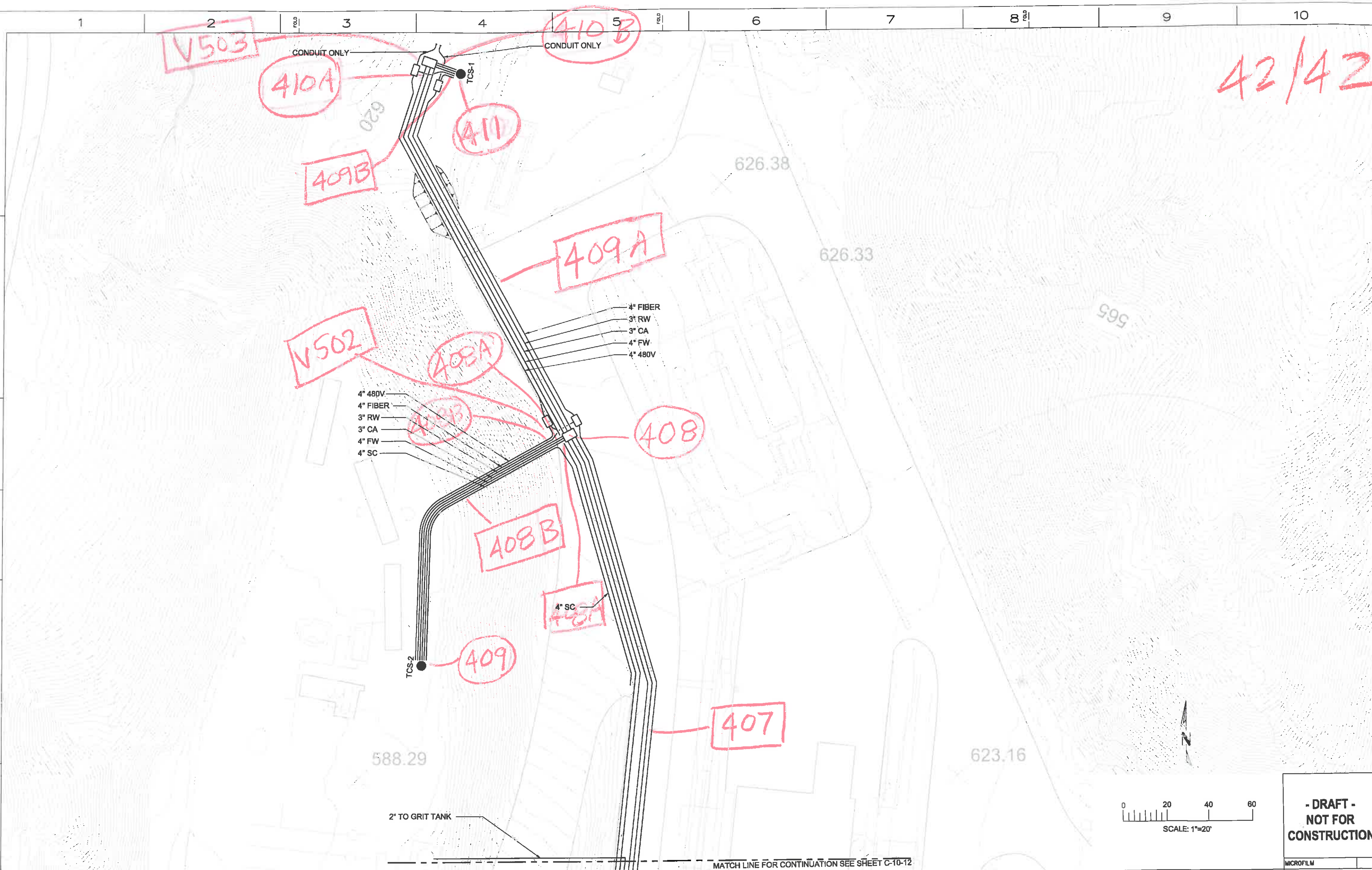
APPROVED BY	
SO	XXXXX
SUPV	PD
DSGN	TL
DWN	TL
CHKD	JM
OK	PD
DATE	9/8/14
SCALES	1" = 20'-0"

TOPOCK GROUNDWATER REMEDIATION PROJECT

PIPE LAYOUT
SHEET 2 OF 4

GAS TRANSMISSION & DISTRIBUTION
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

MICROFILM	
BILL OF MATL	
DWG LIST	
SUPSDS	
SUPSD BY	
SHEET NO. OF SHEETS	REV
C-10-12	1



- DRAFT - NOT FOR CONSTRUCTION

AECOM
2101 WEBSTER STREET SUITE 1000
OAKLAND, CA 94612-3060
PROJECT NO. 60272335

NO.	DATE	DESCRIPTION	GM/SPEC	DWN	CHKD	SUPV	APVD BY
1	9/8/14	PRE-FINAL (90%) DESIGN					
0	9/12/12	INTERMEDIATE (60%) DESIGN					

REVISIONS

APPROVED BY		
	SO	XXXXX
	SUPV	PD
	DSGN	TL
	DWN	TL
	CHKD	JM
	OK	PD
	DATE	9/8/14
	SCALES	1" = 20'-0"

TOPOCK GROUNDWATER REMEDIATION PROJECT

PIPE LAYOUT
SHEET 3 OF 4

GAS TRANSMISSION & DISTRIBUTION
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

MICROFILM	
BILL OF MATL	
DWG LIST	
SUPSDS	
SUPSD BY	
SHEET NO. OF SHEETS	REV
C-10-13	1

Hydraulic Calculations for NTH IRZ, Inner Recirculation Loop, and TCS Recirculation Loop Wells

Pre-Final Design Submittal for Final Groundwater Remedy
PG&E Topock Compressor Station
Needles, California

Hydraulic Calculations

09/08/2014

Prepared for:

Pacific Gas and Electric Company

Reviewed by:

Brent Searcy, P.E.
Senior Engineer
ETIC Engineering, Inc.

Prepared by

Katie Douglas
Project Civil Engineer
ARCADIS U.S., Inc

Header and Branch Distribution Piping Hydraulic Worksheet - IRZ Extraction Header

Site: Pacific Gas & Electric Topock Compressor Station
Location: Topock, California

Created By: CL
Revision No. 0
Revision Date: 7/18/2012

Fluid:	**Water**
Fluid Temperature (deg F):	**50**
Maximum Flowrate	200
Header Length (ft):	1,600
Number of Branches	3
Average Branch Flowrate (gpm):	66.7

◉ DISCHARGE HEADER

○ RETURN HEADER

Header Pipe Material:
Smooth Pipes (PE and other thermoplastics/Brass/Glass and

Header Pipe Type:
SDR 11 - HDPE

Header Pipe Nominal Diameter (in): 6

Header Pipe, e (ft):	**0.00001**
Header Pipe Inner Diameter (in):	**5.348**
e / D:	**0.00001**

Branch Pipe Material:
Smooth Pipes (PE and other thermoplastics/Brass/Glass and

Branch Pipe Type:
SDR 11 - HDPE

Branch Pipe Nominal Diameter (in): 2
2

Branch Pipe, e (ft):	**0.00001**
Branch Pipe Inner Diameter (in):	**1.917**
e / D:	**0.00003**

Fluid Density (lb/ft^3):	**62.36**
Viscosity (cP):	**1.12**
Kinematic viscosity, v (ft^2/s):	**1.21E-05**
g (ft/s^2):	**32.17**
Oriface Coefficient, C_o:	**0.62**
Oriface Value, K[1]:	**0.5**

Header Pressure Drop, Δp_p (lb$_f$/ft^2):	7.7
Header Pressure Drop, Δp_p (psig):	**0.05**
Branch Outlet Pressure Drop, Δp_o (lb$_f$/ft^2):	199.4
Branch Outlet Pressure Drop, Δp_o (psig):	**1.38**
Percent Maldistribution (%)[5]:	**1.94%**
Average Branch Pipe Pressure Drop (ft w.c.):	**7.48**
Average Well Head Pressure (ft w.c.):	**0.00**
Average Branch Pipe Pressure Drop (ft w.c.)[5]:	**7.48**
Average Branch Pipe Pressure Drop (psig):	**3.24**
Average Branch Pipe Pressure Drop > 10x Δp_p:	**Yes**

	Header Pipe Estimated Conditions											
Location:	**Entrance**	1	2	3	4	5	6	7	8	9	10	
Description:		IRZ-1 to IRZ-5	IRZ-5 to IRZ-9	IRZ-9 to MW-20		Static Head IRZ-1 to IRZ-9						
Length of Segment (ft):	0	300	300	1000								
Header flow rate (gpm):		40	120	200								
Branch flow rate (gpm):	---	40	80	80								
Header Pipe Velocity (ft/s):	0.00	0.57	1.71	2.86								
Reynolds Number, Re:		2.11E+04	6.33E+04	1.05E+05								
Fanning Friction Factor, f (Eq(6)):		0.00639	0.00497	0.00446								
Pressure Drop (ft w.c.), (Eq.(7)):		0.09	0.61	5.08								
Velocity Head, $v^2/2g_c$ (ft w.c.):	0.000	0.005	0.046	0.127								
Pressure Drop (ft w.c.):	0.00	0.09	0.61	5.08		2.50						
	Branch Pipe Estimated Conditions											
Location:	**Entrance**	1	2	3	4	5	6	7	8	9	10	
Orifice Velocity (ft/s):	---	4.45	8.89	8.89								
Length of Branch Pipe (ft)[2]:	---	67	78	68								
Reynolds Number, Re:	---	5.89E+04	1.18E+05	1.18E+05								
Fanning Friction Factor, f:	---	0.00507	0.00439	0.00439								
Pressure Drop (ft w.c.), (Eq.(7)):	---	2.60	10.61	9.25								
Velocity Head, $v^2/2g_c$ (ft w.c.):	---	0.307	1.229	1.229								
Pressure Drop (ft w.c.)[3]:	---	2.60	10.61	9.25								
Well Head Pressure (ft w.c.)[4]:	---	0	0	0	0	0	0	0	0	0	0	

	Header Pipe Estimated Conditions (Continued)											
Location:	11	12	13	14	15	16	17	18	19	20	**Summary**	
Length of Segment (ft):											**1,600**	**(Total)**
Header flow rate (gpm):											---	---
Branch flow rate (gpm):											---	---
Header Pipe Velocity (ft/s):											**1.3**	**(Avg.)**
Reynolds Number, Re:											**6.33E+04**	**(Avg.)**
Fanning Friction Factor, f:											**0.00528**	**(Avg.)**
Velocity Head, $v^2/2g_c$ (ft w.c.):											**0.044**	**(Avg.)**
Pressure Drop (ft w.c.):											**8.28**	**(Total)**
	Branch Pipe Estimated Conditions (Continued)											
Location:	11	12	13	14	15	16	17	18	19	20	**Summary**	
Orifice Velocity (ft/s):											**7.41**	**(Avg.)**
Length of Branch Pipe (ft)[2]:											**71.12**	**(Avg.)**
Reynolds Number, Re:											**9.81E+04**	**(Avg.)**
Fanning Friction Factor, f:											**0.00462**	**(Avg.)**
Velocity Head, $v^2/2g_c$ (ft w.c.):											**0.922**	**(Avg.)**
Pressure Drop (ft w.c.)[3]:											**7.48**	**(Avg.)**
Well Head Pressure (ft w.c.)[4]:											**0.00**	**(Avg.)**

Eq. (1)
Discharge Header Pressure Drop:

$$\Delta p_p = \left(\frac{4 f_{avg} L_p}{3 D_p} - 2K\right)\frac{\rho V_p^2}{2 g_c}$$

Eq. (2)
Return Header Pressure Drop:

$$\Delta p_p = \left(\frac{4 f_{avg} L_p}{3 D_p} + 2K\right)\frac{\rho V_p^2}{2 g_c}$$

Eq. (3)
Branch Outlet Pressure Drop:

$$\Delta p_o = \frac{1}{C_o^2}\frac{\rho V_o^2}{2 g_c}$$

Eq. (4)
Reynolds Number:

$$Re = \frac{D \cdot v \cdot \rho}{\mu} = \frac{D \cdot v}{\eta}$$

Eq. (5)
Distribution Equation:

$$\%\,Maldistribution = 100\left(1 - \sqrt{\frac{\Delta p_o - |\Delta p_p|}{\Delta p_o}}\right)$$

Eq. (6)
Fanning Friction Factor:

$$f = \frac{1}{4}\left(\frac{D}{L}\right)\left(\frac{[(p_0 - p_L) - \rho g(h_0 - h_L)]}{\frac{1}{2}\rho v^2}\right)$$

Eq. (7)
Darcy Equation:

$$h_L = \left[\left(4f\,\frac{L}{D}\right)\right]\frac{v^2}{2g}$$

Notes:

(1) K = 0.5 when viscous losses are negligible, K = 1.0 for return headers.
(2) Include the equivalent length of valves and fittings.
(3) Pressure drop due to velocity head and friction losses across the length of the branch pipe.
(4) Pressure at the well head taking into consideration frictional losses across the length of the drop pipe, static head associated with water elevation and mounding, and pressure drop required for foot valve or variable area valve.
(5) Maldistribution of 10 percent or less is recommended.
(6) If the branch piping exhibits average pressure losses (due to length, fittings, and/or well head pressures) of at least 10 times higher than the header, pressure losses maldistribution will be less than 10 percent.

Header and Branch Distribution Piping Hydraulic Worksheet - IRZ North Injection Header

Site: Pacific Gas & Electric Topock Compressor Station
Location: Topock, California

Created By: CL
Revision No. 1
Revision Date: 7/18/2012

Fluid:	Water
Fluid Temperature (deg F):	50
Initial Flowrate	220
Header Length (ft):	820
Number of Branches	8
Average Branch Flowrate (gpm):	24.4

◉ DISCHARGE HEADER

○ RETURN HEADER

Header Pipe Material: Smooth Pipes (PE and other thermoplastics/Brass/Glass and

Header Pipe Type: SDR 11 - HDPE

Header Pipe Nominal Diameter (in): 6

Header Pipe, e (ft): **0.00001**
Header Pipe Inner Diameter (in): **5.348**
e / D: 0.00001

Branch Pipe Material: Smooth Pipes (PE and other thermoplastics/Brass/Glass and

Branch Pipe Type: SDR 11 - HDPE

Branch Pipe Nominal Diameter (in): 2

Branch Pipe, e (ft): **0.00001**
Branch Pipe Inner Diameter (in): **1.917**
e / D: 0.00003

Fluid Density (lb/ft^3): **62.36**
Viscosity (cP): **1.12**

Kinematic viscosity, v (ft^2/s): **1.21E-05**
g (ft/s^2): **32.17**
Oriface Coefficient, C_o: **0.62**
Oriface Value, K[1]: **0.5**

Header Pipe Estimated Conditions (Continued)

Location:	Entrance	1	2	3	4	5	6	7	8	9	10
Description:	MW-20 to IRZ-21	IRZ-21 to IRZ-20	IRZ-20 to IRZ-19	IRZ-19 to IRZ-17	IRZ-17 to IRZ-16	IRZ-16 to IRZ-15	IRZ-21 to IRZ-20	IRZ-15 to IRZ-13	IRZ-13 to IRZ-11		Static Head IRZ -15 to IRZ- 20
Length of Segment (ft):	0	35	30	70	260	70	65	140	150		
Header flow rate (gpm):	**220**	220	200	184	156	128	104	76	40		
Branch flow rate (gpm):	**---**	20	16	28	28	24	28	36	40		
Header Pipe Velocity (ft/s):	3.14	3.14	2.86	2.63	2.23	1.83	1.49	1.09	0.57		
Reynolds Number, Re:	1.16E+05	1.16E+05	1.05E+05	9.71E+04	8.23E+04	6.75E+04	5.49E+04	4.01E+04	2.11E+04		
Fanning Friction Factor, f (Eq(6)):	0.00438	0.00438	0.00446	0.00454	0.00470	0.00490	0.00513	0.00550	0.00639		
Pressure Drop (ft w.c.), (Eq.(7)):	0.00	0.21	0.15	0.31	0.85	0.16	0.10	0.13	0.04		
Velocity Head, $v^2/2g_c$ (ft w.c.):	0.153	0.153	0.127	0.107	0.077	0.052	0.034	0.018	0.005		
Pressure Drop (ft w.c.):	0.00	0.21	0.15	0.31	0.85	0.16	0.10	0.13	0.04		18.00

Branch Pipe Estimated Conditions (Continued)

Location:	Entrance	1	2	3	4	5	6	7	8	9	10
Orifice Velocity (ft/s):	---	2.22	1.78	3.11	3.11	2.67	3.11	4.00	4.45		
Length of Branch Pipe (ft)[2]:	---	148	141	60	140	149	55	62	73		
Reynolds Number, Re:	---	2.94E+04	2.35E+04	4.12E+04	4.12E+04	3.53E+04	4.12E+04	5.30E+04	5.89E+04		
Fanning Friction Factor, f:	---	0.00592	0.00624	0.00548	0.00548	0.00568	0.00548	0.00519	0.00507		
Pressure Drop (ft w.c.), (Eq.(7)):	---	1.68	1.08	1.25	2.90	2.34	1.14	2.02	2.86		
Velocity Head, $v^2/2g_c$ (ft w.c.):	---	0.077	0.049	0.151	0.151	0.111	0.151	0.249	0.307		
Pressure Drop (ft w.c.)[3]:	---	1.68	1.08	1.25	2.90	2.34	1.14	2.02	2.86		
Well Head Pressure (ft w.c.)[4]:	---	23.1	23.1	23.1	23.1	23.1	23.1	23.1	23.1		

Header Pipe Estimated Conditions

Location:	11	12	13	14	15	16	17	18	19	20	Summary	
Length of Segment (ft):											**820**	**(Total)**
Header flow rate (gpm):											**---**	**---**
Branch flow rate (gpm):											**---**	**---**
Header Pipe Velocity (ft/s):											**2.1**	**(Avg.)**
Reynolds Number, Re:											**7.78E+04**	**(Avg.)**
Fanning Friction Factor, f:											**0.00493**	**(Avg.)**
Velocity Head, $v^2/2g_c$ (ft w.c.):											**0.081**	**(Avg.)**
Pressure Drop (ft w.c.):											**19.95**	**(Total)**

Branch Pipe Estimated Conditions

Location:	11	12	13	14	15	16	17	18	19	20	Summary	
Orifice Velocity (ft/s):											**3.06**	**(Avg.)**
Length of Branch Pipe (ft)[2]:											**103.73**	**(Avg.)**
Reynolds Number, Re:											**2.02E+04**	**(Avg.)**
Fanning Friction Factor, f:											**0.00557**	**(Avg.)**
Velocity Head, $v^2/2g_c$ (ft w.c.):											**0.156**	**(Avg.)**
Pressure Drop (ft w.c.)[3]:											**1.91**	**(Avg.)**
Well Head Pressure (ft w.c.)[4]:											**23.10**	**(Avg.)**

Eq. (1)
Discharge Header Pressure Drop:

$$\Delta p_p = \left(\frac{4f_{avg}L_p}{3D_p} - 2K\right)\frac{\rho V_p^2}{2g_c}$$

Eq. (2)
Return Header Pressure Drop:

$$\Delta p_p = \left(\frac{4f_{avg}L_p}{3D_p} + 2K\right)\frac{\rho V_p^2}{2g_c}$$

Eq. (3)
Branch Outlet Pressure Drop:

$$\Delta p_o = \frac{1}{C_o^2}\frac{\rho V_o^2}{2g_c}$$

Eq. (4)
Reynolds Number:

$$Re = \frac{D \cdot v \cdot \rho}{\mu} = \frac{D \cdot v}{\eta}$$

Eq. (5)
Distribution Equation:

$$\%\,Maldistribution = 100\left(1 - \sqrt{\frac{\Delta p_o - |\Delta p_p|}{\Delta p_o}}\right)$$

Eq. (6)
Fanning Friction Factor:

$$f = \frac{1}{4}\left(\frac{D}{L}\right)\left(\frac{[(p_0 - p_L) - \rho g(h_0 - h_L)]}{\frac{1}{2}\rho v^2}\right)$$

Eq. (7)
Darcy Equation:

$$h_L = \left[\left(4f\,\frac{L}{D}\right)\right]\frac{v^2}{2g}$$

Header Pressure Drop, Δp_p (lb_f/ft^2): 106.2
Header Pressure Drop, Δp_p (psig): 0.74
Branch Outlet Pressure Drop, Δp_o (lb_f/ft^2): 49.9
Branch Outlet Pressure Drop, Δp_o (psig): 0.35
Percent Maldistribution (%)[5]: Unbalanced
Average Branch Pipe Pressure Drop (ft w.c.): 1.91
Average Well Head Pressure (ft w.c.): 23.10
Average Branch Pipe Pressure Drop (ft w.c.)[5]: 25.01
Average Branch Pipe Pressure Drop (psig): 10.83
Average Branch Pipe Pressure Drop > 10x Δp_p: Yes

Notes:

(1) K = 0.5 when viscous losses are negligible, K = 1.0 for return headers.
(2) Include the equivalent length of valves and fittings.
(3) Pressure drop due to velocity head and friction losses across the length of the branch pipe.
(4) Pressure at the well head taking into consideration frictional losses across the length of the drop pipe, static head associated with water elevation and mounding, and pressure drop required for foot valve or variable area valve.
(5) Maldistribution of 10 percent or less is recommended.
(6) If the branch piping exhibits average pressure losses (due to length, fittings, and/or well head pressures) of at least 10 times higher than the header, pressure losses maldistribution will be less than 10 percent.

Header and Branch Distribution Piping Hydraulic Worksheet - IRZ South Injection Header (IRZ-24 to IRZ-28)

Site: Pacific Gas & Electric Topock Compressor Station
Location: Topock, California

Created By: CL
Revision No. 1
Revision Date: 7/18/2012

Fluid:	Water
Fluid Temperature (deg F):	50
Initial Flowrate	32
Header Length (ft):	285
Number of Branches	2
Average Branch Flowrate (gpm):	16.0

(●) DISCHARGE HEADER

(○) RETURN HEADER

Header Pipe Material: Smooth Pipes (PE and other thermoplastics/Brass/Glass ar

Header Pipe Type: SDR 11 - HDPE

Header Pipe Nominal Diameter (in): 6

Header Pipe, e (ft): **0.00001**
Header Pipe Inner Diameter (in): **5.348**
e / D: 0.00001

Branch Pipe Material: Smooth Pipes (PE and other thermoplastics/Brass/Glass ar

Branch Pipe Type: SDR 11 - HDPE

Branch Pipe Nominal Diameter (in): 2

Branch Pipe, e (ft): **0.00001**
Branch Pipe Inner Diameter (in): **1.917**
e / D: 0.00003

Fluid Density (lb/ft^3):	**62.36**
Viscosity (cP):	**1.12**
Kinematic viscosity, v (ft^2/s):	**1.21E-05**
g (ft/s^2):	**32.17**
Oriface Coefficient, C_o:	**0.62**
Oriface Value, K[1]:	**0.5**

Header Pressure Drop, Δp_p (lb$_f$/ft^2):	1.0
Header Pressure Drop, Δp_p (psig):	**0.01**
Branch Outlet Pressure Drop, Δp_o (lb$_f$/ft^2):	8.0
Branch Outlet Pressure Drop, Δp_o (psig):	**0.06**
Percent Maldistribution (%)[5]:	**6.75%**
Average Branch Pipe Pressure Drop (ft w.c.):	**0.68**
Average Well Head Pressure (ft w.c.):	**23.10**
Average Branch Pipe Pressure Drop (ft w.c.)[5]:	**23.78**
Average Branch Pipe Pressure Drop (psig):	**10.29**
Average Branch Pipe Pressure Drop > 10x Δp_p:	**Yes**

Header Pipe Estimated Conditions (Continued)											
Location:	**Entrance**	1	2	3	4	5	6	7	8	9	10
Description:		MW-20 to IRZ-25	MW-20 to IRZ-27								Static Head IRZ-25 to IRZ-27
Length of Segment (ft):	0	115	170								
Header flow rate (gpm):	**32**	32	16								
Branch flow rate (gpm):	---	16	16								
Header Pipe Velocity (ft/s):	0.46	0.46	0.23								
Reynolds Number, Re:	1.69E+04	1.69E+04	8.44E+03								
Fanning Friction Factor, f (Eq(6)):	0.00675	0.00675	0.00808								
Pressure Drop (ft w.c.), (Eq.(7)):	0.00	0.02	0.01								
Velocity Head, $v^2/2g_c$ (ft w.c.):	0.003	0.003	0.001								
Pressure Drop (ft w.c.):	0.00	0.02	0.01								2.50
Branch Pipe Estimated Conditions (Continued)											
Location:	**Entrance**	1	2	3	4	5	6	7	8	9	10
Orifice Velocity (ft/s):	---	1.78	1.78								
Length of Branch Pipe (ft)[2]:	---	136	41								
Reynolds Number, Re:	---	2.35E+04	2.35E+04								
Fanning Friction Factor, f:	---	0.00624	0.00624								
Pressure Drop (ft w.c.), (Eq.(7)):	---	1.04	0.32								
Velocity Head, $v^2/2g_c$ (ft w.c.):	---	0.049	0.049								
Pressure Drop (ft w.c.)[3]:	---	1.04	0.32								
Well Head Pressure (ft w.c.)[4]:	---	23.1	23.1								

Header Pipe Estimated Conditions											
Location:	11	12	13	14	15	16	17	18	19	20	**Summary**	
Length of Segment (ft):											**285**	**(Total)**
Header flow rate (gpm):											**---**	**---**
Branch flow rate (gpm):											**---**	**---**
Header Pipe Velocity (ft/s):											**0.4**	**(Avg.)**
Reynolds Number, Re:											**1.41E+04**	**(Avg.)**
Fanning Friction Factor, f:											**0.00720**	**(Avg.)**
Velocity Head, $v^2/2g_c$ (ft w.c.):											**0.002**	**(Avg.)**
Pressure Drop (ft w.c.):											**2.53**	**(Total)**
Branch Pipe Estimated Conditions												
Location:	11	12	13	14	15	16	17	18	19	20	**Summary**	
Orifice Velocity (ft/s):											**1.78**	**(Avg.)**
Length of Branch Pipe (ft)[2]:											**88.52**	**(Avg.)**
Reynolds Number, Re:											**2.35E+04**	**(Avg.)**
Fanning Friction Factor, f:											**0.00624**	**(Avg.)**
Velocity Head, $v^2/2g_c$ (ft w.c.):											**0.002**	**(Avg.)**
Pressure Drop (ft w.c.)[3]:											**0.68**	**(Avg.)**
Well Head Pressure (ft w.c.)[4]:											**23.10**	**(Avg.)**

Eq. (1)
Discharge Header Pressure Drop:

$$\Delta p_p = \left(\frac{4f_{avg}L_p}{3D_p} - 2K\right)\frac{\rho V_p^2}{2g_c}$$

Eq. (2)
Return Header Pressure Drop:

$$\Delta p_p = \left(\frac{4f_{avg}L_p}{3D_p} + 2K\right)\frac{\rho V_p^2}{2g_c}$$

Eq. (3)
Branch Outlet Pressure Drop:

$$\Delta p_o = \frac{1}{C_o^2}\frac{\rho V_o^2}{2g_c}$$

Eq. (4)
Reynolds Number:

$$Re = \frac{D \cdot v \cdot \rho}{\mu} = \frac{D \cdot v}{\eta}$$

Eq. (5)
Distribution Equation:

$$\%\,Maldistribution = 100\left(1 - \sqrt{\frac{\Delta p_o - |\Delta p_p|}{\Delta p_o}}\right)$$

Eq. (6)
Fanning Friction Factor:

$$f = \frac{1}{4}\left(\frac{D}{L}\right)\left(\frac{[(p_0 - p_L) - \rho g(h_0 - h_L)]}{\frac{1}{2}\rho v^2}\right)$$

Eq. (7)
Darcy Equation:

$$h_L = \left[\left(4f\,\frac{L}{D}\right)\right]\frac{v^2}{2g}$$

Notes:

(1) K = 0.5 when viscous losses are negligible, K = 1.0 for return headers.
(2) Include the equivalent length of valves and fittings.
(3) Pressure drop due to velocity head and friction losses across the length of the branch pipe.
(4) Pressure at the well head taking into consideration frictional losses across the length of the drop pipe, static head associated with water elevation and mounding, and pressure drop required for foot valve or variable area valve.
(5) Maldistribution of 10 percent or less is recommended.
(6) If the branch piping exhibits average pressure losses (due to length, fittings, and/or well head pressures) of at least 10 times higher than the header, pressure losses maldistribution will be less than 10 percent.

Header and Branch Distribution Piping Hydraulic Worksheet- IRZ South Injection Header (IRZ-29 to IRZ-37)

Site: Pacific Gas & Electric Topock Compressor Station
Location: Topock, California

Created By: CL
Revision No. 1
Revision Date: 6/18/2012

Fluid:	Water
Fluid Temperature (deg F):	50
Initial Flowrate	44
Header Length (ft):	1,950
Number of Branches	5
Average Branch Flowrate (gpm):	8.8

(●) DISCHARGE HEADER

( ) RETURN HEADER

Header Pipe Material:
Smooth Pipes (PE and other thermoplastics/Brass/Glass and

Header Pipe Type:
SDR 11 - HDPE

Header Pipe Nominal Diameter (in): 4

Header Pipe, e (ft):	0.00001
Header Pipe Inner Diameter (in):	3.633
e / D:	0.00002

Branch Pipe Material:
Smooth Pipes (PE and other thermoplastics/Brass/Glass and

Branch Pipe Type:
SDR 11 - HDPE

Branch Pipe Nominal Diameter (in): 2

Branch Pipe, e (ft):	0.00001
Branch Pipe Inner Diameter (in):	1.917
e / D:	0.00003

Fluid Density (lb/ft^3):	62.36
Viscosity (cP):	1.12
Kinematic viscosity, v (ft^2/s):	1.21E-05
g (ft/s^2):	32.17
Oriface Coefficient, C_o:	0.62
Oriface Value, K[1]:	0.5

Header Pressure Drop, Δp_p (lb$_f$/ft^2):	111.5
Header Pressure Drop, Δp_p (psig):	**0.77**
Branch Outlet Pressure Drop, Δp_o (lb$_f$/ft^2):	2.0
Branch Outlet Pressure Drop, Δp_o (psig):	**0.01**
Percent Maldistribution (%)[5]:	**Unbalanced**
Average Branch Pipe Pressure Drop (ft w.c.):	**0.21**
Average Well Head Pressure (ft w.c.):	**23.10**
Average Branch Pipe Pressure Drop (ft w.c.)[5]:	**23.31**
Average Branch Pipe Pressure Drop (psig):	**10.09**
Average Branch Pipe Pressure Drop > 10x Δp_p:	**Yes**

		Header Pipe Estimated Conditions (Continued)									
Location:	**Entrance**	1	2	3	4	5	6	7	8	9	10
		MW-20 to Tee	**Tee to IRZ-31**	**Tee to IRZ-33**	**IRZ-33 to IRZ-35**	**IRZ-35 to IRZ-37**		**Static Head IRZ-30 to IRZ-37**			
Length of Segment (ft):	1360	55	135	100	150	150					
Header flow rate (gpm):	**44**	40	28	18	10	4					
Branch flow rate (gpm):	---	12	14	8	6	4					
Header Pipe Velocity (ft/s):	1.36	1.24	0.87	0.56	0.31	0.12					
Reynolds Number, Re:	3.42E+04	3.11E+04	2.17E+04	1.40E+04	7.76E+03	3.11E+03					
Fanning Friction Factor, f (Eq(6)):	0.00571	0.00583	0.00635	0.00709	0.00827	0.01077					
Pressure Drop (ft w.c.), (Eq.(7)):	2.96	0.10	0.13	0.05	0.02	0.01					
Velocity Head, $v^2/2g_c$ (ft w.c.):	0.029	0.024	0.012	0.005	0.001	0.000					
Pressure Drop (ft w.c.):	2.96	0.10	0.13	0.05	0.02	0.01		2.50			
		Branch Pipe Estimated Conditions (Continued)									
Location:	**Entrance**	1	2	3	4	5	6	7	8	9	10
Orifice Velocity (ft/s):	---	1.33	1.56	0.89	0.67	0.44					
Length of Branch Pipe (ft)[2]:	---	49	50	46	44	37					
Reynolds Number, Re:	---	1.77E+04	2.06E+04	1.18E+04	8.83E+03	5.89E+03					
Fanning Friction Factor, f:	---	0.00669	0.00644	0.00741	0.00799	0.00893					
Pressure Drop (ft w.c.), (Eq.(7)):	---	0.23	0.30	0.10	0.06	0.03					
Velocity Head, $v^2/2g_c$ (ft w.c.):	---	0.028	0.038	0.012	0.007	0.003					
Pressure Drop (ft w.c.)[3]:	---	0.23	0.30	0.10	0.06	0.03					
Well Head Pressure (ft w.c.)[4]:	---	23.1	23.1	23.1	23.1	23.1					

	Header Pipe Estimated Conditions											
Location:	11	12	13	14	15	16	17	18	19	20	**Summary**	
Length of Segment (ft):											**1,950**	**(Total)**
Header flow rate (gpm):											---	---
Branch flow rate (gpm):											---	---
Header Pipe Velocity (ft/s):											**0.7**	**(Avg.)**
Reynolds Number, Re:											**1.86E+04**	**(Avg.)**
Fanning Friction Factor, f:											**0.00734**	**(Avg.)**
Velocity Head, $v^2/2g_c$ (ft w.c.):											**0.012**	**(Avg.)**
Pressure Drop (ft w.c.):											**5.76**	**(Total)**
	Branch Pipe Estimated Conditions											
Location:	11	12	13	14	15	16	17	18	19	20	**Summary**	
Orifice Velocity (ft/s):											**0.98**	**(Avg.)**
Length of Branch Pipe (ft)[2]:											**45.11**	**(Avg.)**
Reynolds Number, Re:											**1.29E+04**	**(Avg.)**
Fanning Friction Factor, f:											**0.00749**	**(Avg.)**
Velocity Head, $v^2/2g_c$ (ft w.c.):											**0.018**	**(Avg.)**
Pressure Drop (ft w.c.)[3]:											**0.21**	**(Avg.)**
Well Head Pressure (ft w.c.)[4]:											**23.10**	**(Avg.)**

Eq. (1)
Discharge Header Pressure Drop:

$$\Delta p_p = \left(\frac{4f_{avg}L_p}{3D_p} - 2K\right)\frac{\rho V_p^2}{2g_c}$$

Eq. (2)
Return Header Pressure Drop:

$$\Delta p_p = \left(\frac{4f_{avg}L_p}{3D_p} + 2K\right)\frac{\rho V_p^2}{2g_c}$$

Eq. (3)
Branch Outlet Pressure Drop:

$$\Delta p_o = \frac{1}{C_o^2}\frac{\rho V_o^2}{2g_c}$$

Eq. (4)
Reynolds Number:

$$Re = \frac{D \cdot v \cdot \rho}{\mu} = \frac{D \cdot v}{\eta}$$

Eq. (5)
Distribution Equation:

$$\%\,Maldistribution = 100\left(1 - \sqrt{\frac{\Delta p_o - |\Delta p_p|}{\Delta p_o}}\right)$$

Eq. (6)
Fanning Friction Factor:

$$f = \frac{1}{4}\left(\frac{D}{L}\right)\left(\frac{[(p_0 - p_L) - \rho g(h_0 - h_L)]}{\frac{1}{2}\rho v^2}\right)$$

Eq. (7)
Darcy Equation:

$$h_L = \left[\left(4f\,\frac{L}{D}\right)\right]\frac{v^2}{2g}$$

Notes:

(1) K = 0.5 when viscous losses are negligible, K = 1.0 for return headers.
(2) Include the equivalent length of valves and fittings.
(3) Pressure drop due to velocity head and friction losses across the length of the branch pipe.
(4) Pressure at the well head taking into consideration frictional losses across the length of the drop pipe, static head associated with water elevation and mounding, and pressure drop required for foot valve or variable area valve.
(5) Maldistribution of 10 percent or less is recommended.
(6) If the branch piping exhibits average pressure losses (due to length, fittings, and/or well head pressures) of at least 10 times higher than the header, pressure losses maldistribution will be less than 10 percent.

Header and Branch Distribution Piping Hydraulic Worksheet- IRZ South Injection Header (IRZ-38 to IRZ-40)

Site: Pacific Gas & Electric Topock Compressor Station
Location: Topock, California

Created By: CL
Revision No. 1
Revision Date: 7/18/2012

Fluid:	Water
Fluid Temperature (deg F):	50
Initial Flowrate	4
Header Length (ft):	996
Number of Branches	1
Average Branch Flowrate (gpm):	4.0

(●) DISCHARGE HEADER

( ) RETURN HEADER

Header Pipe Material: Smooth Pipes (PE and other thermoplastics/Brass/Glass ar

Header Pipe Type: SDR 11 - HDPE

Header Pipe Nominal Diameter (in): 4

Header Pipe, e (ft): **0.00001**
Header Pipe Inner Diameter (in): **3.633**
e / D: 0.00002

Branch Pipe Material: Smooth Pipes (PE and other thermoplastics/Brass/Glass ar

Branch Pipe Type: SDR 11 - HDPE

Branch Pipe Nominal Diameter (in): 2

Branch Pipe, e (ft): **0.00001**
Branch Pipe Inner Diameter (in): **1.917**
e / D: 0.00003

Fluid Density (lb/ft^3):	**62.36**
Viscosity (cP):	**1.12**
Kinematic viscosity, v (ft^2/s):	**1.21E-05**
g (ft/s^2):	**32.17**
Oriface Coefficient, C_o:	**0.62**
Oriface Value, K[(1)]:	**0.5**

Header Pressure Drop, Δp_p (lb$_f$/ft^2):	0.7
Header Pressure Drop, Δp_p (psig):	**0.005**
Branch Outlet Pressure Drop, Δp_o (lb$_f$/ft^2):	0.5
Branch Outlet Pressure Drop, Δp_o (psig):	**0.003**
Percent Maldistribution (%)[(5)]:	**Unbalanced**
Average Branch Pipe Pressure Drop (ft w.c.):	**0.01**
Average Well Head Pressure (ft w.c.):	**23.10**
Average Branch Pipe Pressure Drop (ft w.c.)[(5)]:	**23.11**
Average Branch Pipe Pressure Drop (psig):	**10.01**
Average Branch Pipe Pressure Drop > 10x Δp_p:	**Yes**

	Header Pipe Estimated Conditions (Continued)										
Location:	**Entrance**	1	2	3	4	5	6	7	8	9	10
Description:	MW-20 to Tee	Tee to IRZ-39		Static Head IRZ-39 to lowest point							
Length of Segment (ft):	856	140									
Header flow rate (gpm):	**4**	4									
Branch flow rate (gpm):	---	4									
Header Pipe Velocity (ft/s):	0.12	0.12									
Reynolds Number, Re:	3.11E+03	3.11E+03									
Fanning Friction Factor, f (Eq(6)):	0.01077	0.01077									
Pressure Drop (ft w.c.), (Eq.(7)):	0.03	0.00									
Velocity Head, $v^2/2g_c$ (ft w.c.):	0.0002	0.0002									
Pressure Drop (ft w.c.):	0.03	0.00		27.50							

	Branch Pipe Estimated Conditions (Continued)										
Location:	**Entrance**	1	2	3	4	5	6	7	8	9	10
Orifice Velocity (ft/s):	---	0.44									
Length of Branch Pipe (ft)[(2)]:	---	20									
Reynolds Number, Re:	---	5.89E+03									
Fanning Friction Factor, f:	---	0.00893									
Pressure Drop (ft w.c.), (Eq.(7)):	---	0.01									
Velocity Head, $v^2/2g_c$ (ft w.c.):	---	0.003									
Pressure Drop (ft w.c.)[(3)]:	---	0.01									
Well Head Pressure (ft w.c.)[(4)]:	---	23.1									

	Header Pipe Estimated Conditions										Summary	
Location:	11	12	13	14	15	16	17	18	19	20	**Summary**	
Length of Segment (ft):											**996**	**(Total)**
Header flow rate (gpm):											**---**	**---**
Branch flow rate (gpm):											**---**	**---**
Header Pipe Velocity (ft/s):											**0.1**	**(Avg.)**
Reynolds Number, Re:											**3.11E+03**	**(Avg.)**
Fanning Friction Factor, f:											**0.01077**	**(Avg.)**
Velocity Head, $v^2/2g_c$ (ft w.c.):											**0.000**	**(Avg.)**
Pressure Drop (ft w.c.):											**27.53**	**(Total)**

	Branch Pipe Estimated Conditions										Summary	
Location:	11	12	13	14	15	16	17	18	19	20	**Summary**	
Orifice Velocity (ft/s):											**0.44**	**(Avg.)**
Length of Branch Pipe (ft)[(2)]:											**20.00**	**(Avg.)**
Reynolds Number, Re:											**5.89E+03**	**(Avg.)**
Fanning Friction Factor, f:											**0.00893**	**(Avg.)**
Velocity Head, $v^2/2g_c$ (ft w.c.):											**0.003**	**(Avg.)**
Pressure Drop (ft w.c.)[(3)]:											**0.01**	**(Avg.)**
Well Head Pressure (ft w.c.)[(4)]:											**23.10**	**(Avg.)**

Eq. (1)
Discharge Header Pressure Drop:

$$\Delta p_p = \left(\frac{4 f_{avg} L_p}{3 D_p} - 2K\right)\frac{\rho V_p^2}{2 g_c}$$

Eq. (2)
Return Header Pressure Drop:

$$\Delta p_p = \left(\frac{4 f_{avg} L_p}{3 D_p} + 2K\right)\frac{\rho V_p^2}{2 g_c}$$

Eq. (3)
Branch Outlet Pressure Drop:

$$\Delta p_o = \frac{1}{C_o^2}\frac{\rho V_o^2}{2 g_c}$$

Eq. (4)
Reynolds Number:

$$Re = \frac{D \cdot v \cdot \rho}{\mu} = \frac{D \cdot v}{\eta}$$

Eq. (5)
Distribution Equation:

$$\%\ Maldistribution = 100\left(1 - \sqrt{\frac{\Delta p_o - |\Delta p_p|}{\Delta p_o}}\right)$$

Eq. (6)
Fanning Friction Factor:

$$f = \frac{1}{4}\left(\frac{D}{L}\right)\left(\frac{[(p_o - p_L) - \rho g (h_o - h_L)]}{\frac{1}{2}\rho v^2}\right)$$

Eq. (7)
Darcy Equation:

$$h_L = \left[\left(4f\,\frac{L}{D}\right)\right]\frac{v^2}{2g}$$

Notes:

(1) K = 0.5 when viscous losses are negligible, K = 1.0 for return headers.
(2) Include the equivalent length of valves and fittings.
(3) Pressure drop due to velocity head and friction losses across the length of the branch pipe.
(4) Pressure at the well head taking into consideration frictional losses across the length of the drop pipe, static head associated with water elevation and mounding, and pressure drop required for foot valve or variable area valve.
(5) Maldistribution of 10 percent or less is recommended.
(6) If the branch piping exhibits average pressure losses (due to length, fittings, and/or well head pressures) of at least 10 times higher than the header, pressure losses maldistribution will be less than 10 percent.

Header and Branch Distribution Piping Hydraulic Worksheet - IRL

Site: Pacific Gas & Electric Topock Compressor Station
Location: Topock, California

Created By: YS
Revision No. 1
Revision Date: 7/20/2012

Fluid:	Water
Fluid Temperature (deg F):	50
Initial Flowrate	450
Header Length (ft):	4,000
Number of Branches	4
Average Branch Flowrate (gpm):	112.5

(●) DISCHARGE HEADER

( ) RETURN HEADER

Header Pipe Material:
Smooth Pipes (PE and other thermoplastics/Brass/Glass a

Header Pipe Type:
SDR 11 - HDPE

Header Pipe Nominal Diameter (in): 8

Header Pipe, e (ft):	**0.00001**
Header Pipe Inner Diameter (in):	**6.963**
e / D:	**0.00001**

Branch Pipe Material:
Smooth Pipes (PE and other thermoplastics/Brass/Glass a

Branch Pipe Type:
SDR 11 - HDPE

Branch Pipe Nominal Diameter (in): 3

Branch Pipe, e (ft):	**0.00001**
Branch Pipe Inner Diameter (in):	**2.825**
e / D:	**0.00002**

	Header Pipe Estimated Conditions										
Location:	Entrance	1	2	3	4	5	6	7	8	9	10
Description:		MW-20 to IRL-1	IRL-1 to IRL-2	IRL-2 to IRL-3	IRL-3 to IRL-4		Static Head IRL-4 to IRL-1				
Length of Segment (ft):	0	3000	350	350	300						
Header flow rate (gpm):	**450**	450	375	300	200						
Branch flow rate (gpm):	---	75	75	100	200						
Header Pipe Velocity (ft/s):	3.79	3.79	3.16	2.53	1.69						
Reynolds Number, Re:	1.82E+05	1.82E+05	1.52E+05	1.22E+05	8.10E+04						
Fanning Friction Factor, f:	0.00400	0.00400	0.00414	0.00433	0.00471						
Fanning Friction Factor, f (Eq(6)):	0.00400	0.00400	0.00414	0.00433	0.00471						
Pressure Drop (ft w.c.), (Eq.(7)):	0.00	18.48	1.55	1.04	0.43						
Velocity Head, $v^2/2g_c$ (ft w.c.):	0.223	0.223	0.155	0.099	0.044						
Pressure Drop (ft w.c.):	0.00	18.48	1.55	1.04	0.43		TBD				
	Branch Pipe Estimated Conditions										
Location:	**Entrance**	1	2	3	4	5	6	7	8	9	10
Orifice Velocity (ft/s):	---	3.84	3.84	5.12	10.24						
Length of Branch Pipe (ft)[2]:	---	93	77	98	389						
Reynolds Number, Re:	---	7.49E+04	7.49E+04	9.99E+04	2.00E+05						
Fanning Friction Factor, f:	---	0.00481	0.00481	0.00453	0.00395						
Pressure Drop (ft w.c.), (Eq.(7)):	---	1.75	1.44	3.07	42.62						
Velocity Head, $v^2/2g_c$ (ft w.c.):	---	0.229	0.229	0.407	1.629						
Pressure Drop (ft w.c.)[3]:	---	1.75	1.44	3.07	42.62						
Well Head Pressure (ft w.c.)[4]:	---	80.32	56.72	155.17	500.15						

	Header Pipe Estimated Conditions (Continued)											
Location:	11	12	13	14	15	16	17	18	19	20	**Summary**	
Length of Segment (ft):											**4,000**	**(Total)**
Header flow rate (gpm):											**---**	**---**
Branch flow rate (gpm):											**---**	**---**
Header Pipe Velocity (ft/s):											**3.0**	**(Avg.)**
Reynolds Number, Re:											**1.44E+05**	**(Avg.)**
Fanning Friction Factor, f:											**0.00424**	**(Avg.)**
Velocity Head, $v^2/2g_c$ (ft w.c.):											**0.149**	**(Avg.)**
Pressure Drop (ft w.c.):											**21.50**	**(Total)**
	Branch Pipe Estimated Conditions (Continued)											
Location:	11	12	13	14	15	16	17	18	19	20	**Summary**	
Orifice Velocity (ft/s):											**5.76**	**(Avg.)**
Length of Branch Pipe (ft)[2]:											**164**	**(Avg.)**
Reynolds Number, Re:											**1.12E+05**	**(Avg.)**
Fanning Friction Factor, f:											**0.00452**	**(Avg.)**
Velocity Head, $v^2/2g_c$ (ft w.c.):											**0.624**	**(Avg.)**
Pressure Drop (ft w.c.)[3]:											**12.22**	**(Avg.)**
Well Head Pressure (ft w.c.)[4]:											**198.1**	**(Avg.)**

Fluid Density (lb/ft³):	**62.36**
Viscosity (cP):	**1.12**
Kinematic viscosity, v (ft²/s):	**1.21E-05**
g (ft/s²):	**32.17**
Oriface Coefficient, C_o:	**0.62**
Oriface Value, K[1]:	**0.5**

Header Pressure Drop, Δp_p (lb_f/ft^2):	329.0
Header Pressure Drop, Δp_p (psig):	**2.29**
Branch Outlet Pressure Drop, Δp_o (lb_f/ft^2):	264.3
Branch Outlet Pressure Drop, Δp_o (psig):	**1.84**
Percent Maldistribution (%)[5]:	**Unbalanced**
Average Branch Pipe Pressure Drop (ft w.c.):	**12.22**
Average Well Head Pressure (ft w.c.):	**198.09**
Average Branch Pipe Pressure Drop (ft w.c.)[5]:	**210.31**
Average Branch Pipe Pressure Drop (psig):	**91.04**

Eq. (1)
Discharge Header Pressure Drop:

$$\Delta p_p = \left(\frac{4f_{avg}L_p}{3D_p} - 2K\right)\frac{\rho V_p^2}{2g_c}$$

Eq. (2)
Return Header Pressure Drop:

$$\Delta p_p = \left(\frac{4f_{avg}L_p}{3D_p} + 2K\right)\frac{\rho V_p^2}{2g_c}$$

Eq. (3)
Branch Outlet Pressure Drop:

$$\Delta p_o = \frac{1}{C_o^2}\frac{\rho V_o^2}{2g_c}$$

Eq. (4)
Reynolds Number:

$$Re = \frac{D \cdot v \cdot \rho}{\mu} = \frac{D \cdot v}{\eta}$$

Eq. (5)
Distribution Equation:

$$\%\,Maldistribution = 100\left(1 - \sqrt{\frac{\Delta p_o - |\Delta p_p|}{\Delta p_o}}\right)$$

Eq. (6)
Fanning Friction Factor:

$$f = \frac{1}{4}\left(\frac{D}{L}\right)\left(\frac{[(p_0 - p_L) - \rho g(h_0 - h_L)]}{\frac{1}{2}\rho v^2}\right)$$

Eq. (7)
Darcy Equation:

$$h_L = \left[\left(4f\,\frac{L}{D}\right)\right]\frac{v^2}{2g}$$

Notes:

(1) K = 0.5 when viscous losses are negligible, K = 1.0 for return headers.
(2) Include the equivalent length of valves and fittings.
(3) Pressure drop due to velocity head and friction losses across the length of the branch pipe.
(4) Pressure at the well head taking into consideration frictional losses across the length of the drop pipe, static head associated with water elevation and mounding, and pressure drop required for foot valve or variable area valve.
(5) Maldistribution of 10 percent or less is recommended.
(6) If the branch piping exhibits average pressure losses (due to length, fittings, and/or well head pressures) of at least 10 times higher than the header, pressure losses maldistribution will be less than 10 percent.

Header and Branch Distribution Piping Hydraulic Worksheet - ER
Site: Pacific Gas & Electric Topock Compressor Station
Location: Topock, California

Created By: YS
Revision No. 0
Revision Date: 7/23/2012

Fluid:	Water
Fluid Temperature (deg F):	50
Maximum Flowrate	2
Header Length (ft):	1,130
Number of Branches	4
Average Branch Flowrate (gpm):	0.4

○ DISCHARGE HEADER

◉ RETURN HEADER

Header Pipe Material: Smooth Pipes (PE and other thermoplastics/Brass/Glass a

Header Pipe Type: SDR 11 - HDPE

Header Pipe Nominal Diameter (in): 2

Header Pipe, e (ft): **0.00001**
Header Pipe Inner Diameter (in): **1.917**
e / D: 0.00003

Branch Pipe Material: Smooth Pipes (PE and other thermoplastics/Brass/Glass a

Branch Pipe Type: SDR 11 - HDPE

Branch Pipe Nominal Diameter (in): 2

Branch Pipe, e (ft): **0.00001**
Branch Pipe Inner Diameter (in): **1.917**
e / D: 0.00003

Fluid Density (lb/ft³): **62.36**
Viscosity (cP): **1.12**
Kinematic viscosity, v (ft²/s): **1.21E-05**
g (ft/s²): **32.17**
Oriface Coefficient, C_o: **0.62**
Oriface Value, K[1]: **1.0**

Header Pressure Drop, Δp_p (lb_f/ft^2): 2.5
Header Pressure Drop, Δp_p (psig): 0.02
Branch Outlet Pressure Drop, Δp_o (lb_f/ft^2): 0.008
Branch Outlet Pressure Drop, Δp_o (psig): 0.0001
Percent Maldistribution (%)[5]: Unbalanced
Average Branch Pipe Pressure Drop (ft w.c.): 0.00
Average Well Head Pressure (ft w.c.): 23.10
Average Branch Pipe Pressure Drop (ft w.c.)[5]: 23.10
Average Branch Pipe Pressure Drop (psig): 10.00
Average Branch Pipe Pressure Drop > 10x Δp_p: Yes

Header Pipe Estimated Conditions

Location:	Entrance	1	2	3	4	5	6	7	8	9	10
		ER-4 to ER-3	ER-3 to ER-2	ER-2 to ER-1	ER-1 to TWB		Static Head ER-4 to ER-1				
Length of Segment (ft):	0	575	175	230	150						
Header flow rate (gpm):		0.5	1	1.5	2						
Branch flow rate (gpm):		0.5	0.5	0.5	0.5						
Header Pipe Velocity (ft/s):		0.06	0.11	0.17	0.22						
Reynolds Number, Re:		7.36E+02	1.47E+03	2.21E+03	2.94E+03						
Fanning Friction Factor, f (Eq(6)):		0.02175	0.01087	0.01198	0.01095						
Pressure Drop (ft w.c.), (Eq.(7)):		0.02	0.01	0.03	0.03						
Velocity Head, $v^2/2g_c$ (ft w.c.):		0.0000	0.0002	0.0004	0.0008						
Pressure Drop (ft w.c.):		0.02	0.01	0.03	0.03		17.50				

Branch Pipe Estimated Conditions

Location:	Entrance	1	2	3	4	5	6	7	8	9	10
Orifice Velocity (ft/s):	---	0.06	0.06	0.06	0.06						
Length of Branch Pipe (ft)[2]:	---	27	27	37	47						
Reynolds Number, Re:	---	7.36E+02	7.36E+02	7.36E+02	7.36E+02						
Fanning Friction Factor, f:	---	0.02175	0.02175	0.02175	0.02175						
Pressure Drop (ft w.c.), (Eq.(7)):	---	0.001	0.001	0.001	0.001						
Velocity Head, $v^2/2g_c$ (ft w.c.):	---	0.00005	0.00005	0.00005	0.00005						
Pressure Drop (ft w.c.)[3]:	---	0.001	0.001	0.001	0.001						
Well Head Pressure (ft w.c.)[4]:	---	23.1	23.1	23.1	23.1						

Header Pipe Estimated Conditions (Continued)

Location:	11	12	13	14	15	16	17	18	19	20	Summary	
Length of Segment (ft):											1,130	(Total)
Header flow rate (gpm):											---	---
Branch flow rate (gpm):											---	---
Header Pipe Velocity (ft/s):											0.1	(Avg.)
Reynolds Number, Re:											1.84E+03	(Avg.)
Fanning Friction Factor, f:											0.01389	(Avg.)
Velocity Head, $v^2/2g_c$ (ft w.c.):											0.000	(Avg.)
Pressure Drop (ft w.c.):											17.59	(Total)

Branch Pipe Estimated Conditions (Continued)

Location:	11	12	13	14	15	16	17	18	19	20	Summary	
Orifice Velocity (ft/s):											0.06	(Avg.)
Length of Branch Pipe (ft)[2]:											34.14	(Avg.)
Reynolds Number, Re:											7.36E+02	(Avg.)
Fanning Friction Factor, f:											0.02175	(Avg.)
Velocity Head, $v^2/2g_c$ (ft w.c.):											0.000	(Avg.)
Pressure Drop (ft w.c.)[3]:											0.00	(Avg.)
Well Head Pressure (ft w.c.)[4]:											23.10	(Avg.)

Eq. (1)
Discharge Header Pressure Drop:

$$\Delta p_p = \left(\frac{4f_{avg}L_p}{3D_p} - 2K\right)\frac{\rho V_p^2}{2g_c}$$

Eq. (2)
Return Header Pressure Drop:

$$\Delta p_p = \left(\frac{4f_{avg}L_p}{3D_p} + 2K\right)\frac{\rho V_p^2}{2g_c}$$

Eq. (3)
Branch Outlet Pressure Drop:

$$\Delta p_o = \frac{1}{C_o^2}\frac{\rho V_o^2}{2g_c}$$

Eq. (4)
Reynolds Number:

$$Re = \frac{D \cdot v \cdot \rho}{\mu} = \frac{D \cdot v}{\eta}$$

Eq. (5)
Distribution Equation:

$$\%\,Maldistribution = 100\left(1 - \sqrt{\frac{\Delta p_o - |\Delta p_p|}{\Delta p_o}}\right)$$

Eq. (6)
Fanning Friction Factor:

$$f = \frac{1}{4}\left(\frac{D}{L}\right)\left(\frac{[(p_0 - p_L) - \rho g(h_0 - h_L)]}{\frac{1}{2}\rho v^2}\right)$$

Eq. (7)
Darcy Equation:

$$h_L = \left[\left(4f\,\frac{L}{D}\right)\right]\frac{v^2}{2g}$$

Notes:

(1) K = 0.5 when viscous losses are negligible, K = 1.0 for return headers.
(2) Include the equivalent length of valves and fittings.
(3) Pressure drop due to velocity head and friction losses across the length of the branch pipe.
(4) Pressure at the well head taking into consideration frictional losses across the length of the drop pipe, static head associated with water elevation and mounding, and pressure drop required for foot valve or variable area valve.
(5) Maldistribution of 10 percent or less is recommended.
(6) If the branch piping exhibits average pressure losses (due to length, fittings, and/or well head pressures) of at least 10 times higher than the header, pressure losses maldistribution will be less than 10 percent.

Header and Branch Distribution Piping Hydraulic Worksheet - TWB

Site: Pacific Gas & Electric Topock Compressor Station
Location: Topock, California

Created By: YS
Revision No. 1
Revision Date: 7/20/2012

Fluid:	Water
Fluid Temperature (deg F):	50
Maximum Flowrate	13
Header Length (ft):	320
Number of Branches	2
Average Branch Flowrate (gpm):	4.3

○ DISCHARGE HEADER

◉ RETURN HEADER

Header Pipe Material: Smooth Pipes (PE and other thermoplastics/Brass/Glass and

Header Pipe Type: SDR 11 - HDPE

Header Pipe Nominal Diameter (in): 4

Header Pipe, e (ft): **0.00001**
Header Pipe Inner Diameter (in): **3.633**
e / D: 0.00002

Branch Pipe Material: Smooth Pipes (PE and other thermoplastics/Brass/Glass and

Branch Pipe Type: SDR 11 - HDPE

Branch Pipe Nominal Diameter (in): 2

Branch Pipe, e (ft): **0.00001**
Branch Pipe Inner Diameter (in): **1.917**
e / D: 0.00003

Fluid Density (lb/ft^3):	**62.36**
Viscosity (cP):	**1.12**
Kinematic viscosity, v (ft^2/s):	**1.21E-05**
g (ft/s^2):	**32.17**
Oriface Coefficient, C_o:	**0.62**
Oriface Value, K[1]:	**1.0**

Header Pressure Drop, Δp_p (lb_f/ft^2):	3.5
Header Pressure Drop, Δp_p (psig):	**0.02**
Branch Outlet Pressure Drop, Δp_o (lb_f/ft^2):	3.8
Branch Outlet Pressure Drop, Δp_o (psig):	**0.03**
Percent Maldistribution (%)[5]:	**71.46%**
Average Branch Pipe Pressure Drop (ft w.c.):	**0.25**
Average Well Head Pressure (ft w.c.):	**38.92**
Average Branch Pipe Pressure Drop (ft w.c.)[6]:	**39.17**
Average Branch Pipe Pressure Drop (psig):	**16.96**
Average Branch Pipe Pressure Drop > 10x Δp_p:	**Yes**

	Header Pipe Estimated Conditions										
Location:	**Entrance**	1	2	3	4	5	6	7	8	9	10
Description		TWB-1 to TWB-2	TWB-2 to TWB		Static Head						
Length of Segment (ft):	0	140	180								
Header flow rate (gpm):		13	22								
Branch flow rate (gpm):		13	9								
Header Pipe Velocity (ft/s):		0.40	0.68								
Reynolds Number, Re:		1.01E+04	1.71E+04								
Fanning Friction Factor, f (Eq(6)):		0.0077	0.0067								
Pressure Drop (ft w.c.), (Eq.(7)):		0.04	0.12								
Velocity Head, $v^2/2g_c$ (ft w.c.):		0.003	0.007								
Pressure Drop (ft w.c.):		0.04	0.12		TBD						
	Branch Pipe Estimated Conditions										
Location:	**Entrance**	1	2	3	4	5	6	7	8	9	10
Orifice Velocity (ft/s):	---	1.45	1.00								
Length of Branch Pipe (ft)[2]:	---	62	59								
Reynolds Number, Re:	---	1.91E+04	1.32E+04								
Fanning Friction Factor, f:	---	0.00656	0.00719								
Pressure Drop (ft w.c.), (Eq.(7)):	---	0.33	0.16								
Velocity Head, $v^2/2g_c$ (ft w.c.):	---	0.032	0.016								
Pressure Drop (ft w.c.)[3]:	---	0.33	0.16								
Well Head Pressure (ft w.c.)[4]:	---	198.42	190.80	0	0	0	0	0	0	0	0

	Header Pipe Estimated Conditions (Continued)											
Location:	11	12	13	14	15	16	17	18	19	20	**Summary**	
Length of Segment (ft):											**320**	**(Total)**
Header flow rate (gpm):											---	---
Branch flow rate (gpm):											---	---
Header Pipe Velocity (ft/s):											**0.5**	**(Avg.)**
Reynolds Number, Re:											**1.36E+04**	**(Avg.)**
Fanning Friction Factor, f:											**0.00722**	**(Avg.)**
Velocity Head, $v^2/2g_c$ (ft w.c.):											**0.005**	**(Avg.)**
Pressure Drop (ft w.c.):											**0.15**	**(Total)**
	Branch Pipe Estimated Conditions (Continued)											
Location:	11	12	13	14	15	16	17	18	19	20	**Summary**	
Orifice Velocity (ft/s):											**1.22**	**(Avg.)**
Length of Branch Pipe (ft)[2]:											**60.29**	**(Avg.)**
Reynolds Number, Re:											**1.62E+04**	**(Avg.)**
Fanning Friction Factor, f:											**0.00687**	**(Avg.)**
Velocity Head, $v^2/2g_c$ (ft w.c.):											**0.024**	**(Avg.)**
Pressure Drop (ft w.c.)[3]:											**0.25**	**(Avg.)**
Well Head Pressure (ft w.c.)[4]:											**38.92**	**(Avg.)**

Eq. (1)
Discharge Header Pressure Drop:

$$\Delta p_p = \left(\frac{4f_{avg}L_p}{3D_p} - 2K\right)\frac{\rho V_p^2}{2g_c}$$

Eq. (2)
Return Header Pressure Drop:

$$\Delta p_p = \left(\frac{4f_{avg}L_p}{3D_p} + 2K\right)\frac{\rho V_p^2}{2g_c}$$

Eq. (3)
Branch Outlet Pressure Drop:

$$\Delta p_o = \frac{1}{C_o^2}\frac{\rho V_o^2}{2g_c}$$

Eq. (4)
Reynolds Number:

$$Re = \frac{D \cdot v \cdot \rho}{\mu} = \frac{D \cdot v}{\eta}$$

Eq. (5)
Distribution Equation:

$$\%\,Maldistribution = 100\left(1 - \sqrt{\frac{\Delta p_o - |\Delta p_p|}{\Delta p_o}}\right)$$

Eq. (6)
Fanning Friction Factor:

$$f = \frac{1}{4}\left(\frac{D}{L}\right)\left(\frac{[(p_0 - p_L) - \rho g(h_0 - h_L)]}{\frac{1}{2}\rho v^2}\right)$$

Eq. (7)
Darcy Equation:

$$h_L = \left[\left(4f\,\frac{L}{D}\right)\right]\frac{v^2}{2g}$$

Notes:

(1) K = 0.5 when viscous losses are negligible, K = 1.0 for return headers.
(2) Include the equivalent length of valves and fittings.
(3) Pressure drop due to velocity head and friction losses across the length of the branch pipe.
(4) Pressure at the well head taking into consideration frictional losses across the length of the drop pipe, static head associated with water elevation and mounding, and pressure drop required for foot valve or variable area valve.
(5) Maldistribution of 10 percent or less is recommended.
(6) If the branch piping exhibits average pressure losses (due to length, fittings, and/or well head pressures) of at least 10 times higher than the header, pressure losses maldistribution will be less than 10 percent.

Header and Branch Distribution Piping Hydraulic Worksheet - TCS

Site: Pacific Gas & Electric Topock Compressor Station
Location: Topock, California

Created By: YS
Revision No. 1
Revision Date: 7/20/2012

Fluid: **Water**
Fluid Temperature (deg F): **50**

Initial Flowrate: 24
Header Length (ft): 3,550
Number of Branches: 2
Average Branch Flowrate (gpm): 12.0

◉ DISCHARGE HEADER

○ RETURN HEADER

Header Pipe Material:
Smooth Pipes (PE and other thermoplastics/Brass/Glass a

Header Pipe Type:
SDR 11 - HDPE

Header Pipe Nominal Diameter (in): 2

Header Pipe, e (ft): **0.00001**
Header Pipe Inner Diameter (in): **1.917**
e / D: 0.00003

Branch Pipe Material:
Smooth Pipes (PE and other thermoplastics/Brass/Glass a

Branch Pipe Type:
SDR 11 - HDPE

Branch Pipe Nominal Diameter (in): 2

Branch Pipe, e (ft): **0.00001**
Branch Pipe Inner Diameter (in): **1.917**
e / D: 0.00003

Fluid Density (lb/ft^3): **62.36**
Viscosity (cP): **1.12**

Kinematic viscosity, v (ft^2/s): **1.21E-05**
g (ft/s^2): **32.17**
Oriface Coefficient, C_o: **0.62**
Oriface Value, K[(1)]: **0.5**

Header Pressure Drop, Δp_p (lb_f/ft^2): 848.8
Header Pressure Drop, Δp_p (psig): 5.89
Branch Outlet Pressure Drop, Δp_o (lb_f/ft^2): 4.5
Branch Outlet Pressure Drop, Δp_o (psig): 0.03
Percent Maldistribution (%)[(5)]: Unbalanced
Average Branch Pipe Pressure Drop (ft w.c.): 1.26
Average Well Head Pressure (ft w.c.): 48.59
Average Branch Pipe Pressure Drop (ft w.c.)[(5)]: 49.86
Average Branch Pipe Pressure Drop (psig): 21.58
Average Branch Pipe Pressure Drop > 10x Δp_p: No

	Header Pipe Estimated Conditions										
Location:	**Entrance**	1	2	3	4	5	6	7	8	9	10
Description		TWB to TCS-2	TCS-2 to TCS-1		Static Head						
Length of Segment (ft):	0	3500	50								
Header flow rate (gpm):	**24**	24	12								
Branch flow rate (gpm):	**---**	12	12								
Header Pipe Velocity (ft/s):	2.67	2.67	1.33								
Reynolds Number, Re:	3.53E+04	3.53E+04	1.77E+04								
Fanning Friction Factor, f (Eq(6)):	0.00568	0.00568	0.00669								
Pressure Drop (ft w.c.), (Eq.(7)):	0.00	55.03	0.23								
Velocity Head, $v^2/2g_c$ (ft w.c.):	0.111	0.111	0.028								
Pressure Drop (ft w.c.):	0.00	55.03	0.23		TBD						
	Branch Pipe Estimated Conditions										
Location:	**Entrance**	1	2	3	4	5	6	7	8	9	10
Orifice Velocity (ft/s):	---	1.33	1.33								
Length of Branch Pipe (ft)[(2)]:	---	68	68								
Reynolds Number, Re:	---	1.77E+04	1.77E+04								
Fanning Friction Factor, f:	---	0.02700	0.02700								
Pressure Drop (ft w.c.), (Eq.(7)):	---	1.26	1.26								
Velocity Head, $v^2/2g_c$ (ft w.c.):	---	0.028	0.028								
Pressure Drop (ft w.c.)[(3)]:	---	1.26	1.26								
Well Head Pressure (ft w.c.)[(4)]:	---	48.74	48.44								

	Header Pipe Estimated Conditions (Continued)										
Location:	11	12	13	14	15	16	17	18	19	20	**Summary**
Length of Segment (ft):											**3,550 (Total)**
Header flow rate (gpm):											**--- ---**
Branch flow rate (gpm):											**--- ---**
Header Pipe Velocity (ft/s):											**2.2 (Avg.)**
Reynolds Number, Re:											**2.94E+04 (Avg.)**
Fanning Friction Factor, f:											**0.00601 (Avg.)**
Velocity Head, $v^2/2g_c$ (ft w.c.):											**0.083 (Avg.)**
Pressure Drop (ft w.c.):											**55.26 (Total)**
	Branch Pipe Estimated Conditions (Continued)										
Location:	11	12	13	14	15	16	17	18	19	20	**Summary**
Orifice Velocity (ft/s):											**1.33 (Avg.)**
Length of Branch Pipe (ft)[(2)]:											**68 (Avg.)**
Reynolds Number, Re:											**1.77E+04 (Avg.)**
Fanning Friction Factor, f:											**0.02700 (Avg.)**
Velocity Head, $v^2/2g_c$ (ft w.c.):											**0.028 (Avg.)**
Pressure Drop (ft w.c.)[(3)]:											**1.26 (Avg.)**
Well Head Pressure (ft w.c.)[(4)]:											**48.6 (Avg.)**

Eq. (1)
Discharge Header Pressure Drop:

$$\Delta p_p = \left(\frac{4f_{avg}L_p}{3D_p} - 2K\right)\frac{\rho V_p^2}{2g_c}$$

Eq. (2)
Return Header Pressure Drop:

$$\Delta p_p = \left(\frac{4f_{avg}L_p}{3D_p} + 2K\right)\frac{\rho V_p^2}{2g_c}$$

Eq. (3)
Branch Outlet Pressure Drop:

$$\Delta p_o = \frac{1}{C_o^2}\frac{\rho V_o^2}{2g_c}$$

Eq. (4)
Reynolds Number:

$$Re = \frac{D \cdot v \cdot \rho}{\mu} = \frac{D \cdot v}{\eta}$$

Eq. (5)
Distribution Equation:

$$\%\,Maldistribution = 100\left(1 - \sqrt{\frac{\Delta p_o - |\Delta p_p|}{\Delta p_o}}\right)$$

Eq. (6)
Fanning Friction Factor:

$$f = \frac{1}{4}\left(\frac{D}{L}\right)\left(\frac{[(p_0 - p_L) - \rho g(h_0 - h_L)]}{\frac{1}{2}\rho v^2}\right)$$

Eq. (7)
Darcy Equation:

$$h_L = \left[\left(4f\,\frac{L}{D}\right)\right]\frac{v^2}{2g}$$

Notes:

(1) K = 0.5 when viscous losses are negligible, K = 1.0 for return headers.
(2) Include the equivalent length of valves and fittings.
(3) Pressure drop due to velocity head and friction losses across the length of the branch pipe.
(4) Pressure at the well head taking into consideration frictional losses across the length of the drop pipe, static head associated with water elevation and mounding, and pressure drop required for foot valve or variable area valve.
(5) Maldistribution of 10 percent or less is recommended.
(6) If the branch piping exhibits average pressure losses (due to length, fittings, and/or well head pressures) of at least 10 times higher than the header, pressure losses maldistribution will be less than 10 percent.

Header and Branch Distribution Piping Hydraulic Worksheet - North IRZ BW Extraction Header

Site: Pacific Gas & Electric Topock Compressor Station
Location: Topock, California

Created By: BAS
Revision No. 2
Revision Date: 2/20/2013

Fluid:	Water
Fluid Temperature (deg F):	50
Maximum Flowrate	40
Header Length (ft):	755
Number of Branches	1
Average Branch Flowrate (gpm):	40.0

◉ DISCHARGE HEADER

○ RETURN HEADER

Header Pipe Material: [ ] 13

Header Pipe Type: SDR 11 - HDPE

Header Pipe Nominal Diameter (in): 2 9

Header Pipe, e (ft): **0.00001**
Header Pipe Inner Diameter (in): **1.917**
e / D: 0.00003

Branch Pipe Material: [ ] 13

Branch Pipe Type: SDR 11 - HDPE

Branch Pipe Nominal Diameter (in): 2 2

Branch Pipe, e (ft): **0.00001**
Branch Pipe Inner Diameter (in): **1.917**
e / D: 0.00003

Fluid Density (lb/ft^3):	**62.36**
Viscosity (cP):	**1.12**
Kinematic viscosity, v (ft^2/s):	**1.21E-05**
g (ft/s^2):	**32.17**
Oriface Coefficient, C_o:	**0.62**
Oriface Value, K[1]:	**0.5**

Header Pressure Drop, Δp_p (lb$_f$/ft^2): 593.0
Header Pressure Drop, Δp_p (psig): 4.12
Branch Outlet Pressure Drop, Δp_o (lb$_f$/ft^2): 49.9
Branch Outlet Pressure Drop, Δp_o (psig): 0.35
Percent Maldistribution (%)[5]: Unbalanced
Average Branch Pipe Pressure Drop (ft w.c.): 2.85
Average Well Head Pressure (ft w.c.): 0.00
Average Branch Pipe Pressure Drop (ft w.c.)[5]: 2.85
Average Branch Pipe Pressure Drop (psig): 1.23
Average Branch Pipe Pressure Drop > 10x Δp_p: No

	Header Pipe Estimated Conditions											
Location:	**Entrance**	1	2	3	4	5	6	7	8	9	10	
Description:		EXIRZ-11 to MW-20									Static Head EXIRZ-11 to MW-20	
Length of Segment (ft):	0	755	0	0	0	0	0	0	0			
Header flow rate (gpm):		40										
Branch flow rate (gpm):	---	40										
Header Pipe Velocity (ft/s):	0.00	4.45										
Reynolds Number, Re:		5.89E+04										
Fanning Friction Factor, f (Eq(6)):		0.00507										
Pressure Drop (ft w.c.), (Eq.(7)):		29.45										
Velocity Head, $v^2/2g_c$ (ft w.c.):	0.000	0.307										
Pressure Drop (ft w.c.):	0.00	29.45									15.0	
	Branch Pipe Estimated Conditions											
Location:	**Entrance**	1	2	3	4	5	6	7	8	9	10	
Orifice Velocity (ft/s):	---	4.45										
Length of Branch Pipe (ft)[2]:	---	73										
Reynolds Number, Re:	---	5.89E+04										
Fanning Friction Factor, f:	---	0.00507										
Pressure Drop (ft w.c.), (Eq.(7)):	---	2.85										
Velocity Head, $v^2/2g_c$ (ft w.c.):	---	0.307										
Pressure Drop (ft w.c.)[3]:	---	2.85										
Well Head Pressure (ft w.c.)[4]:	---	0	0	0	0	0	0	0	0	0	0	

	Header Pipe Estimated Conditions (Continued)											
Location:	11	12	13	14	15	16	17	18	19	20	**Summary**	
Length of Segment (ft):											**755**	**(Total)**
Header flow rate (gpm):											---	---
Branch flow rate (gpm):											---	---
Header Pipe Velocity (ft/s):											**2.2**	**(Avg.)**
Reynolds Number, Re:											**5.89E+04**	**(Avg.)**
Fanning Friction Factor, f:											**0.00507**	**(Avg.)**
Velocity Head, $v^2/2g_c$ (ft w.c.):											**0.154**	**(Avg.)**
Pressure Drop (ft w.c.):											**44.45**	**(Total)**
	Branch Pipe Estimated Conditions (Continued)											
Location:	11	12	13	14	15	16	17	18	19	20	**Summary**	
Orifice Velocity (ft/s):											**4.45**	**(Avg.)**
Length of Branch Pipe (ft)[2]:											**73.00**	**(Avg.)**
Reynolds Number, Re:											**5.89E+04**	**(Avg.)**
Fanning Friction Factor, f:											**0.00507**	**(Avg.)**
Velocity Head, $v^2/2g_c$ (ft w.c.):											**0.307**	**(Avg.)**
Pressure Drop (ft w.c.)[3]:											**2.85**	**(Avg.)**
Well Head Pressure (ft w.c.)[4]:											**0.00**	**(Avg.)**

Eq. (1)
Discharge Header Pressure Drop:

$$\Delta p_p = \left(\frac{4f_{avg}L_p}{3D_p} - 2K\right)\frac{\rho V_p^2}{2g_c}$$

Eq. (2)
Return Header Pressure Drop:

$$\Delta p_p = \left(\frac{4f_{avg}L_p}{3D_p} + 2K\right)\frac{\rho V_p^2}{2g_c}$$

Eq. (3)
Branch Outlet Pressure Drop:

$$\Delta p_o = \frac{1}{C_o^2}\frac{\rho V_o^2}{2g_c}$$

Eq. (4)
Reynolds Number:

$$Re = \frac{D \cdot v \cdot \rho}{\mu} = \frac{D \cdot v}{\eta}$$

Eq. (5)
Distribution Equation:

$$\%\,Maldistribution = 100\left(1 - \sqrt{\frac{\Delta p_o - |\Delta p_p|}{\Delta p_o}}\right)$$

Eq. (6)
Fanning Friction Factor:

$$f = \frac{1}{4}\left(\frac{D}{L}\right)\left(\frac{[(p_0 - p_L) - \rho g(h_0 - h_L)]}{\frac{1}{2}\rho v^2}\right)$$

Eq. (7)
Darcy Equation:

$$h_L = \left[\left(4f\ \frac{L}{D}\right)\right]\frac{v^2}{2g}$$

Notes:

(1) K = 0.5 when viscous losses are negligible, K = 1.0 for return headers.
(2) Include the equivalent length of valves and fittings.
(3) Pressure drop due to velocity head and friction losses across the length of the branch pipe.
(4) Pressure at the well head taking into consideration frictional losses across the length of the drop pipe, static head associated with water elevation and mounding, and pressure drop required for foot valve or variable area valve.
(5) Maldistribution of 10 percent or less is recommended.
(6) If the branch piping exhibits average pressure losses (due to length, fittings, and/or well head pressures) of at least 10 times higher than the header, pressure losses maldistribution will be less than 10 percent.

4.45

Header and Branch Distribution Piping Hydraulic Worksheet - IRZ Backwash Header

Site: Pacific Gas & Electric Topock Compressor Station

Location: Topock, California

Created By: BAS
Revision No. 2
Revision Date: 2/20/2013

Fluid:	Water
Fluid Temperature (deg F):	50
Maximum Flowrate	14
Header Length (ft):	290
Number of Branches	1
Average Branch Flowrate (gpm):	14.0

◉ DISCHARGE HEADER

○ RETURN HEADER

Header Pipe Material:

Header Pipe Type: SDR 11 - HDPE

Header Pipe Nominal Diameter (in): 2

Header Pipe, e (ft):	**0.00001**
Header Pipe Inner Diameter (in):	**1.917**
e / D:	**0.00003**

Branch Pipe Material:

Branch Pipe Type: SDR 11 - HDPE

Branch Pipe Nominal Diameter (in): 2 / 2

Branch Pipe, e (ft):	**0.00001**
Branch Pipe Inner Diameter (in):	**1.917**
e / D:	**0.00003**

Fluid Density (lb/ft^3):	**62.36**
Viscosity (cP):	**1.12**
Kinematic viscosity, v (ft^2/s):	**1.21E-05**
g (ft/s^2):	**32.17**
Oriface Coefficient, C_o:	**0.62**
Oriface Value, K[(1)]:	**0.5**

Header Pressure Drop, Δp_p (lb_f/ft^2):	34.3
Header Pressure Drop, Δp_p (psig):	**0.24**
Branch Outlet Pressure Drop, Δp_o (lb_f/ft^2):	6.1
Branch Outlet Pressure Drop, Δp_o (psig):	**0.04**
Percent Maldistribution (%)[(5)]:	**Unbalanced**
Average Branch Pipe Pressure Drop (ft w.c.):	**1.03**
Average Well Head Pressure (ft w.c.):	**0.00**
Average Branch Pipe Pressure Drop (ft w.c.)[(5)]:	**1.03**
Average Branch Pipe Pressure Drop (psig):	**0.45**
Average Branch Pipe Pressure Drop > 10x Δp_p:	**No**

Header Pipe Estimated Conditions											
Location:	**Entrance**	1	2	3	4	5	6	7	8	9	10
Description:		EXIRZ-27 to MW-20									Static Head IRZ-27 to MW-20
Length of Segment (ft):	0	290									
Header flow rate (gpm):		14									
Branch flow rate (gpm):	---	14									
Header Pipe Velocity (ft/s):	0.00	1.56									
Reynolds Number, Re:		2.06E+04									
Fanning Friction Factor, f (Eq(6)):		0.00644									
Pressure Drop (ft w.c.), (Eq.(7)):		1.76									
Velocity Head, $v^2/2g_c$ (ft w.c.):	0.000	0.038									
Pressure Drop (ft w.c.):	0.00	1.76									-3.00
Branch Pipe Estimated Conditions											
Location:	**Entrance**	1	2	3	4	5	6	7	8	9	10
Orifice Velocity (ft/s):	---	1.56									
Length of Branch Pipe (ft)[(2)]:	---	170									
Reynolds Number, Re:	---	2.06E+04									
Fanning Friction Factor, f:	---	0.00644									
Pressure Drop (ft w.c.), (Eq.(7)):	---	1.03									
Velocity Head, $v^2/2g_c$ (ft w.c.):	---	0.038									
Pressure Drop (ft w.c.)[(3)]:	---	1.03									
Well Head Pressure (ft w.c.)[(4)]:	---	0	0	0	0	0	0	0	0	0	0

Header Pipe Estimated Conditions (Continued)											Summary	
Location:	11	12	13	14	15	16	17	18	19	20	**Summary**	
Length of Segment (ft):											**290**	**(Total)**
Header flow rate (gpm):											---	---
Branch flow rate (gpm):											---	---
Header Pipe Velocity (ft/s):											**0.8**	**(Avg.)**
Reynolds Number, Re:											**2.06E+04**	**(Avg.)**
Fanning Friction Factor, f:											**0.00644**	**(Avg.)**
Velocity Head, $v^2/2g_c$ (ft w.c.):											**0.019**	**(Avg.)**
Pressure Drop (ft w.c.):											**-1.24**	**(Total)**
Branch Pipe Estimated Conditions (Continued)												
Location:	11	12	13	14	15	16	17	18	19	20	**Summary**	
Orifice Velocity (ft/s):											**1.56**	**(Avg.)**
Length of Branch Pipe (ft)[(2)]:											**170.00**	**(Avg.)**
Reynolds Number, Re:											**2.06E+04**	**(Avg.)**
Fanning Friction Factor, f:											**0.00644**	**(Avg.)**
Velocity Head, $v^2/2g_c$ (ft w.c.):											**0.038**	**(Avg.)**
Pressure Drop (ft w.c.)[(3)]:											**1.03**	**(Avg.)**
Well Head Pressure (ft w.c.)[(4)]:											**0.00**	**(Avg.)**

Eq. (1)
Discharge Header Pressure Drop:

$$\Delta p_p = \left(\frac{4f_{avg}L_p}{3D_p} - 2K\right)\frac{\rho V_p^2}{2g_c}$$

Eq. (2)
Return Header Pressure Drop:

$$\Delta p_p = \left(\frac{4f_{avg}L_p}{3D_p} + 2K\right)\frac{\rho V_p^2}{2g_c}$$

Eq. (3)
Branch Outlet Pressure Drop:

$$\Delta p_o = \frac{1}{C_o^2}\frac{\rho V_o^2}{2g_c}$$

Eq. (4)
Reynolds Number:

$$Re = \frac{D \cdot v \cdot \rho}{\mu} = \frac{D \cdot v}{\eta}$$

Eq. (5)
Distribution Equation:

$$\%\,Maldistribution = 100\left(1 - \sqrt{\frac{\Delta p_o - |\Delta p_p|}{\Delta p_o}}\right)$$

Eq. (6)
Fanning Friction Factor:

$$f = \frac{1}{4}\left(\frac{D}{L}\right)\left(\frac{[(p_0 - p_L) - \rho g(h_0 - h_L)]}{\frac{1}{2}\rho v^2}\right)$$

Eq. (7)
Darcy Equation:

$$h_L = \left[\left(4f\ \frac{L}{D}\right)\right]\frac{v^2}{2g}$$

Notes:

(1) K = 0.5 when viscous losses are negligible, K = 1.0 for return headers.

(2) Include the equivalent length of valves and fittings.

(3) Pressure drop due to velocity head and friction losses across the length of the branch pipe.

(4) Pressure at the well head taking into consideration frictional losses across the length of the drop pipe, static head associated with water elevation and mounding, and pressure drop required for foot valve or variable area valve.

(5) Maldistribution of 10 percent or less is recommended.

(6) If the branch piping exhibits average pressure losses (due to length, fittings, and/or well head pressures) of at least 10 times higher than the header, pressure losses maldistribution will be less than 10 percent.

1.56

Header and Branch Distribution Piping Hydraulic Worksheet - IRZ Backwash Header

Site: Pacific Gas & Electric Topock Compressor Station
Location: Topock, California

Created By: BAS
Revision No. 2
Revision Date: 2/15/2013

Fluid:	**Water**
Fluid Temperature (deg F):	**50**
Maximum Flowrate	28
Header Length (ft):	1,540
Number of Branches	1
Average Branch Flowrate (gpm):	28.0

○ DISCHARGE HEADER

◉ RETURN HEADER

Header Pipe Material:

Header Pipe Type: SDR 11 - HDPE

Header Pipe Nominal Diameter (in): 2

Header Pipe, e (ft):	**0.00001**
Header Pipe Inner Diameter (in):	**1.917**
e / D:	**0.00003**

Branch Pipe Material:

Branch Pipe Type: SDR 11 - HDPE

Branch Pipe Nominal Diameter (in): 2 / 2

Branch Pipe, e (ft):	**0.00001**
Branch Pipe Inner Diameter (in):	**1.917**
e / D:	**0.00003**

Fluid Density (lb/ft^3):	**62.36**
Viscosity (cP):	**1.12**
Kinematic viscosity, v (ft^2/s):	**1.21E-05**
g (ft/s^2):	**32.17**
Oriface Coefficient, C_o:	**0.62**
Oriface Value, K[(1)]:	**1.0**

Header Pressure Drop, Δp_p (lb_f/ft^2):	#VALUE!
Header Pressure Drop, Δp_p (psig):	**#VALUE!**
Branch Outlet Pressure Drop, Δp_o (lb_f/ft^2):	#VALUE!
Branch Outlet Pressure Drop, Δp_o (psig):	**#VALUE!**
Percent Maldistribution (%)[(5)]:	**Unbalanced**
Average Branch Pipe Pressure Drop (ft w.c.):	**1.03**
Average Well Head Pressure (ft w.c.):	**0.00**
Average Branch Pipe Pressure Drop (ft w.c.)[(5)]:	**1.03**
Average Branch Pipe Pressure Drop (psig):	**0.45**
Average Branch Pipe Pressure Drop > 10x Δp_p:	**#VALUE!**

	Header Pipe Estimated Conditions										
Location:	**Entrance**	1	2	3	4	5	6	7	8	9	10
Description:		EXIRZ-29 to Tee	EXIRZ-35 to EXIRZ-33	EXIRZ-33 to Tee	EXIRZ-31 to Tee						Static Head IRZ-29 to Tee
Length of Segment (ft):	1360	180	0	0	0			0			
Header flow rate (gpm):	**0**	28									
Branch flow rate (gpm):	**--**	28	0	0	0			0			
Header Pipe Velocity (ft/s):	0.00	3.11									
Reynolds Number, Re:		4.12E+04									
Fanning Friction Factor, f (Eq(6)):		0.00548									
Pressure Drop (ft w.c.), (Eq.(7)):		3.72									
Velocity Head, $v^2/2g_c$ (ft w.c.):	0.000	0.151									
Pressure Drop (ft w.c.):	0.00	3.72									-2.50
	Branch Pipe Estimated Conditions										
Location:	**Entrance**	1	2	3	4	5	6	7	8	9	10
Orifice Velocity (ft/s):	---	3.11									
Length of Branch Pipe (ft)[(2)]:	---	50									
Reynolds Number, Re:	---	4.12E+04									
Fanning Friction Factor, f:	---	0.00548									
Pressure Drop (ft w.c.), (Eq.(7)):	---	1.03									
Velocity Head, $v^2/2g_c$ (ft w.c.):	---	0.151									
Pressure Drop (ft w.c.)[(3)]:	---	1.03									
Well Head Pressure (ft w.c.)[(4)]:	---	0	0	0	0	0	0	0	0	0	0

	Header Pipe Estimated Conditions (Continued)											
Location:	11	12	13	14	15	16	17	18	19	20	**Summary**	
Length of Segment (ft):											**1,540**	**(Total)**
Header flow rate (gpm):											**---**	**---**
Branch flow rate (gpm):											**---**	**---**
Header Pipe Velocity (ft/s):											**1.6**	**(Avg.)**
Reynolds Number, Re:											**4.12E+04**	**(Avg.)**
Fanning Friction Factor, f:											**0.00548**	**(Avg.)**
Velocity Head, $v^2/2g_c$ (ft w.c.):											**0.075**	**(Avg.)**
Pressure Drop (ft w.c.):											**1.22**	**(Total)**
	Branch Pipe Estimated Conditions (Continued)											
Location:	11	12	13	14	15	16	17	18	19	20	**Summary**	
Orifice Velocity (ft/s):											**3.11**	**(Avg.)**
Length of Branch Pipe (ft)[(2)]:											**50.00**	**(Avg.)**
Reynolds Number, Re:											**4.12E+04**	**(Avg.)**
Fanning Friction Factor, f:											**0.00548**	**(Avg.)**
Velocity Head, $v^2/2g_c$ (ft w.c.):											**0.151**	**(Avg.)**
Pressure Drop (ft w.c.)[(3)]:											**1.03**	**(Avg.)**
Well Head Pressure (ft w.c.)[(4)]:											**0.00**	**(Avg.)**

Eq. (1)
Discharge Header Pressure Drop:

$$\Delta p_p = \left(\frac{4 f_{avg} L_p}{3 D_p} - 2K\right)\frac{\rho V_p^2}{2 g_c}$$

Eq. (2)
Return Header Pressure Drop:

$$\Delta p_p = \left(\frac{4 f_{avg} L_p}{3 D_p} + 2K\right)\frac{\rho V_p^2}{2 g_c}$$

Eq. (3)
Branch Outlet Pressure Drop:

$$\Delta p_o = \frac{1}{C_o^2}\frac{\rho V_o^2}{2 g_c}$$

Eq. (4)
Reynolds Number:

$$Re = \frac{D \cdot v \cdot \rho}{\mu} = \frac{D \cdot v}{\eta}$$

Eq. (5)
Distribution Equation:

$$\% \, Maldistribution = 100\left(1 - \sqrt{\frac{\Delta p_o - |\Delta p_p|}{\Delta p_o}}\right)$$

Eq. (6)
Fanning Friction Factor:

$$f = \frac{1}{4}\left(\frac{D}{L}\right)\left(\frac{[(p_0 - p_L) - \rho g (h_0 - h_L)]}{\frac{1}{2}\rho v^2}\right)$$

Eq. (7)
Darcy Equation:

$$h_L = \left[\left(4f \, \frac{L}{D}\right)\right]\frac{v^2}{2g}$$

Notes:

(1) K = 0.5 when viscous losses are negligible, K = 1.0 for return headers.
(2) Include the equivalent length of valves and fittings.
(3) Pressure drop due to velocity head and friction losses across the length of the branch pipe.
(4) Pressure at the well head taking into consideration frictional losses across the length of the drop pipe, static head associated with water elevation and mounding, and pressure drop required for foot valve or variable area valve.
(5) Maldistribution of 10 percent or less is recommended.
(6) If the branch piping exhibits average pressure losses (due to length, fittings, and/or well head pressures) of at least 10 times higher than the header, pressure losses maldistribution will be less than 10 percent.

3.11

Header and Branch Distribution Piping Hydraulic Worksheet - IRZ Backwash Header

Site: Pacific Gas & Electric Topock Compressor Station
Location: Topock, California

Created By: BAS
Revision No. 2
Revision Date: 2/15/2013

Fluid: Water
Fluid Temperature (deg F): 50
Maximum Flowrate: 16
Header Length (ft): 996
Number of Branches: 1
Average Branch Flowrate (gpm): 16.0

○ DISCHARGE HEADER

◉ RETURN HEADER

Header Pipe Material:

Header Pipe Type: SDR 11 - HDPE

Header Pipe Nominal Diameter (in): 2

Header Pipe, e (ft): **0.00001**
Header Pipe Inner Diameter (in): **1.917**
e / D: 0.00003

Branch Pipe Material:

Branch Pipe Type: SDR 11 - HDPE

Branch Pipe Nominal Diameter (in): 2
2

Branch Pipe, e (ft): **0.00001**
Branch Pipe Inner Diameter (in): **1.917**
e / D: 0.00003

Fluid Density (lb/ft^3): **62.36**
Viscosity (cP): **1.12**
Kinematic viscosity, v (ft^2/s): **1.21E-05**
g (ft/s^2): **32.17**
Oriface Coefficient, C_o: **0.62**
Oriface Value, K[1]: **1.0**

Header Pressure Drop, Δp_p (lb_f/ft^2): **0.0**
Header Pressure Drop, Δp_p (psig): 0.00
Branch Outlet Pressure Drop, Δp_o (lb_f/ft^2): 0.0
Branch Outlet Pressure Drop, Δp_o (psig): 0.00
Percent Maldistribution (%)[5]: Unbalanced
Average Branch Pipe Pressure Drop (ft w.c.): 0.05
Average Well Head Pressure (ft w.c.): 0.00
Average Branch Pipe Pressure Drop (ft w.c.)[5]: 0.05
Average Branch Pipe Pressure Drop (psig): 0.02
Average Branch Pipe Pressure Drop > 10x Δp_p: #DIV/0!

Header Pipe Estimated Conditions

Location:	Entrance	1	2	3	4	5	6	7	8	9	10
Description:		EXIRZ-39 to Tee									Static Head EXIRZ-39 to Tee
Length of Segment (ft):	856	140		0	0	0	0	0	0		
Header flow rate (gpm):	**0**	16									
Branch flow rate (gpm):	---	8									
Header Pipe Velocity (ft/s):	0.00	1.78									
Reynolds Number, Re:		2.35E+04									
Fanning Friction Factor, f (Eq(6)):		0.00624									
Pressure Drop (ft w.c.), (Eq.(7)):		1.08									
Velocity Head, $v^2/2g_c$ (ft w.c.):	0.000	0.049									
Pressure Drop (ft w.c.):	0.00	1.08									2.00

Branch Pipe Estimated Conditions

Location:	Entrance	1	2	3	4	5	6	7	8	9	10
Orifice Velocity (ft/s):	---	0.89									
Length of Branch Pipe (ft)[2]:	---	20									
Reynolds Number, Re:	---	1.18E+04									
Fanning Friction Factor, f:	---	0.00741									
Pressure Drop (ft w.c.), (Eq.(7)):	---	0.05									
Velocity Head, $v^2/2g_c$ (ft w.c.):	---	0.012									
Pressure Drop (ft w.c.)[3]:	---	0.05									
Well Head Pressure (ft w.c.)[4]:	---	0	0	0	0	0	0	0	0	0	0

Header Pipe Estimated Conditions (Continued)

Location:	11	12	13	14	15	16	17	18	19	20	Summary	
Length of Segment (ft):											**996**	**(Total)**
Header flow rate (gpm):											---	---
Branch flow rate (gpm):											---	---
Header Pipe Velocity (ft/s):											**0.9**	**(Avg.)**
Reynolds Number, Re:											**2.35E+04**	**(Avg.)**
Fanning Friction Factor, f:											**0.00624**	**(Avg.)**
Velocity Head, $v^2/2g_c$ (ft w.c.):											**0.025**	**(Avg.)**
Pressure Drop (ft w.c.):											**3.08**	**(Total)**

Branch Pipe Estimated Conditions (Continued)

Location:	11	12	13	14	15	16	17	18	19	20	Summary	
Orifice Velocity (ft/s):											**0.89**	**(Avg.)**
Length of Branch Pipe (ft)[2]:											**20.00**	**(Avg.)**
Reynolds Number, Re:											**1.18E+04**	**(Avg.)**
Fanning Friction Factor, f:											**0.00741**	**(Avg.)**
Velocity Head, $v^2/2g_c$ (ft w.c.):											**0.012**	**(Avg.)**
Pressure Drop (ft w.c.)[3]:											**0.05**	**(Avg.)**
Well Head Pressure (ft w.c.)[4]:											**0.00**	**(Avg.)**

Eq. (1)
Discharge Header Pressure Drop:

$$\Delta p_p = \left(\frac{4 f_{avg} L_p}{3 D_p} - 2K\right)\frac{\rho V_p^2}{2 g_c}$$

Eq. (2)
Return Header Pressure Drop:

$$\Delta p_p = \left(\frac{4 f_{avg} L_p}{3 D_p} + 2K\right)\frac{\rho V_p^2}{2 g_c}$$

Eq. (3)
Branch Outlet Pressure Drop:

$$\Delta p_o = \frac{1}{C_o^2}\frac{\rho V_o^2}{2 g_c}$$

Eq. (4)
Reynolds Number:

$$Re = \frac{D \cdot v \cdot \rho}{\mu} = \frac{D \cdot v}{\eta}$$

Eq. (5)
Distribution Equation:

$$\%\, Maldistribution = 100\left(1 - \sqrt{\frac{\Delta p_o - |\Delta p_p|}{\Delta p_o}}\right)$$

Eq. (6)
Fanning Friction Factor:

$$f = \frac{1}{4}\left(\frac{D}{L}\right)\left(\frac{[(p_0 - p_L) - \rho g(h_0 - h_L)]}{\frac{1}{2}\rho v^2}\right)$$

Eq. (7)
Darcy Equation:

$$h_L = \left[\left(4f\ \frac{L}{D}\right)\right]\frac{v^2}{2g}$$

Notes:

(1) K = 0.5 when viscous losses are negligible, K = 1.0 for return headers.
(2) Include the equivalent length of valves and fittings.
(3) Pressure drop due to velocity head and friction losses across the length of the branch pipe.
(4) Pressure at the well head taking into consideration frictional losses across the length of the drop pipe, static head associated with water elevation and mounding, and pressure drop required for foot valve or variable area valve.
(5) Maldistribution of 10 percent or less is recommended.
(6) If the branch piping exhibits average pressure losses (due to length, fittings, and/or well head pressures) of at least 10 times higher than the header, pressure losses maldistribution will be less than 10 percent.

1.78

Header and Branch Distribution Piping Hydraulic Worksheet - TCS Backwash Header

Site: Pacific Gas & Electric Topock Compressor Station
Location: Topock, California

Created By: BAS
Revision No. 2
Revision Date: 2/15/2013

Fluid:	Water
Fluid Temperature (deg F):	50
Maximum Flowrate	48
Header Length (ft):	3,550
Number of Branches	1
Average Branch Flowrate (gpm):	48.0

○ DISCHARGE HEADER

◉ RETURN HEADER

Header Pipe Material:

Header Pipe Type:

SDR 11 - HDPE

Header Pipe Nominal Diameter (in): 2

Header Pipe, e (ft): **0.00001**
Header Pipe Inner Diameter (in): **1.917**
e / D: 0.00003

Branch Pipe Material:

Branch Pipe Type:

SDR 11 - HDPE

Branch Pipe Nominal Diameter (in):

2
2

Branch Pipe, e (ft): **0.00001**
Branch Pipe Inner Diameter (in): **1.917**
e / D: 0.00003

Fluid Density (lb/ft^3):	**62.36**
Viscosity (cP):	**1.12**
Kinematic viscosity, ν (ft^2/s):	**1.21E-05**
g (ft/s^2):	**32.17**
Oriface Coefficient, C_o:	**0.62**
Oriface Value, K[1]:	**1.0**

Header Pressure Drop, Δp_p (lb_f/ft^2):	**0.0**
Header Pressure Drop, Δp_p (psig):	**0.00**
Branch Outlet Pressure Drop, Δp_o (lb_f/ft^2):	71.8
Branch Outlet Pressure Drop, Δp_o (psig):	**0.50**
Percent Maldistribution (%)[5]:	**0.00%**
Average Branch Pipe Pressure Drop (ft w.c.):	**3.67**
Average Well Head Pressure (ft w.c.):	**0.00**
Average Branch Pipe Pressure Drop (ft w.c.)[5]:	**3.67**
Average Branch Pipe Pressure Drop (psig):	**1.59**
Average Branch Pipe Pressure Drop > 10x Δp_p:	**#DIV/0!**

	Header Pipe Estimated Conditions										
Location:	**Entrance**	1	2	3	4	5	6	7	8	9	10
Description:		TCS-2 to TWB									Static Head
Length of Segment (ft):	0	3550		0	0	0	0	0	0		
Header flow rate (gpm):		48	0								
Branch flow rate (gpm):	---	48									
Header Pipe Velocity (ft/s):	0.00	5.34	0.00								
Reynolds Number, Re:		7.06E+04	0.00E+00								
Fanning Friction Factor, f (Eq(6)):		0.00488									
Pressure Drop (ft w.c.), (Eq.(7)):		191.82	#VALUE!								
Velocity Head, $v^2/2g_c$ (ft w.c.):	0.000	0.443	0.000								
Pressure Drop (ft w.c.):	0.00	191.82			-27.50						TBD
	Branch Pipe Estimated Conditions										
Location:	**Entrance**	1	2	3	4	5	6	7	8	9	10
Orifice Velocity (ft/s):	---	5.34	0.00								
Length of Branch Pipe (ft)[2]:	---	68									
Reynolds Number, Re:	---	7.06E+04	0.00E+00								
Fanning Friction Factor, f:	---	0.00488									
Pressure Drop (ft w.c.), (Eq.(7)):	---	3.67	#VALUE!								
Velocity Head, $v^2/2g_c$ (ft w.c.):	---	0.443	0.000								
Pressure Drop (ft w.c.)[3]:	---	3.67									
Well Head Pressure (ft w.c.)[4]:	---	0	0	0	0	0	0	0	0	0	0

	Header Pipe Estimated Conditions (Continued)											
Location:	11	12	13	14	15	16	17	18	19	20	**Summary**	
Length of Segment (ft):											**3,550**	**(Total)**
Header flow rate (gpm):											---	---
Branch flow rate (gpm):											---	---
Header Pipe Velocity (ft/s):											**1.8**	**(Avg.)**
Reynolds Number, Re:											**3.53E+04**	**(Avg.)**
Fanning Friction Factor, f:											**0.00488**	**(Avg.)**
Velocity Head, $v^2/2g_c$ (ft w.c.):											**0.148**	**(Avg.)**
Pressure Drop (ft w.c.):											**164.32**	**(Total)**
	Branch Pipe Estimated Conditions (Continued)											
Location:	11	12	13	14	15	16	17	18	19	20	**Summary**	
Orifice Velocity (ft/s):											**2.67**	**(Avg.)**
Length of Branch Pipe (ft)[2]:											**68.00**	**(Avg.)**
Reynolds Number, Re:											**3.53E+04**	**(Avg.)**
Fanning Friction Factor, f:											**0.00488**	**(Avg.)**
Velocity Head, $v^2/2g_c$ (ft w.c.):											**0.221**	**(Avg.)**
Pressure Drop (ft w.c.)[3]:											**3.67**	**(Avg.)**
Well Head Pressure (ft w.c.)[4]:											**0.00**	**(Avg.)**

Eq. (1)
Discharge Header Pressure Drop:

$$\Delta p_p = \left(\frac{4f_{avg}L_p}{3D_p} - 2K\right)\frac{\rho V_p^2}{2g_c}$$

Eq. (2)
Return Header Pressure Drop:

$$\Delta p_p = \left(\frac{4f_{avg}L_p}{3D_p} + 2K\right)\frac{\rho V_p^2}{2g_c}$$

Eq. (3)
Branch Outlet Pressure Drop:

$$\Delta p_o = \frac{1}{C_o^2}\frac{\rho V_o^2}{2g_c}$$

Eq. (4)
Reynolds Number:

$$Re = \frac{D \cdot v \cdot \rho}{\mu} = \frac{D \cdot v}{\eta}$$

Eq. (5)
Distribution Equation:

$$\%\,Maldistribution = 100\left(1 - \sqrt{\frac{\Delta p_o - |\Delta p_p|}{\Delta p_o}}\right)$$

Eq. (6)
Fanning Friction Factor:

$$f = \frac{1}{4}\left(\frac{D}{L}\right)\left(\frac{[(p_0 - p_L) - \rho g(h_0 - h_L)]}{\frac{1}{2}\rho v^2}\right)$$

Eq. (7)
Darcy Equation:

$$h_L = \left[\left(4f\ \frac{L}{D}\right)\right]\frac{v^2}{2g}$$

Notes:

(1) K = 0.5 when viscous losses are negligible, K = 1.0 for return headers.
(2) Include the equivalent length of valves and fittings.
(3) Pressure drop due to velocity head and friction losses across the length of the branch pipe.
(4) Pressure at the well head taking into consideration frictional losses across the length of the drop pipe, static head associated with water elevation and mounding, and pressure drop required for foot valve or variable area valve.
(5) Maldistribution of 10 percent or less is recommended.
(6) If the branch piping exhibits average pressure losses (due to length, fittings, and/or well head pressures) of at least 10 times higher than the header, pressure losses maldistribution will be less than 10 percent.

2.67

North IRZ CIP (using Injection line)

Site: Pacific Gas & Electric Topock Compressor Station
Location: Topock, California

Created By: BAS
Revision No. 1
Revision Date: 2/26/2013

Fluid:	Water
Fluid Temperature (deg F):	50
Maximum Flowrate	420.0628601
Header Length (ft):	755
Number of Branches	1
Average Branch Flowrate (gpm):	420.1

◉ DISCHARGE HEADER

○ RETURN HEADER

Header Pipe Material: 13

Header Pipe Type: SDR 11 - HDPE

Header Pipe Nominal Diameter (in): 6 15

Header Pipe, e (ft): **0.00001**
Header Pipe Inner Diameter (in): **5.348**
e / D: 0.00001

Branch Pipe Material: 13

Branch Pipe Type: SDR 11 - HDPE

Branch Pipe Nominal Diameter (in): 2 2

Branch Pipe, e (ft): **0.00001**
Branch Pipe Inner Diameter (in): **1.917**
e / D: 0.00003

Fluid Density (lb/ft^3): **62.36**
Viscosity (cP): **1.12**

Kinematic viscosity, v (ft^2/s): **1.21E-05**
g (ft/s^2): **32.17**
Oriface Coefficient, C_o: **0.62**
Oriface Value, K[1]: **0.5**

Header Pressure Drop, Δp_p (lb_f/ft^2): 269.1
Header Pressure Drop, Δp_p (psig): 1.87
Branch Outlet Pressure Drop, Δp_o (lb_f/ft^2): 0.0
Branch Outlet Pressure Drop, Δp_o (psig): 0.00
Percent Maldistribution (%)[5]:
Average Branch Pipe Pressure Drop (ft w.c.):
Average Well Head Pressure (ft w.c.):
Average Branch Pipe Pressure Drop (ft w.c.)[5]:
Average Branch Pipe Pressure Drop (psig):
Average Branch Pipe Pressure Drop > 10x Δp_p:

	Header Pipe Estimated Conditions										
Location:	**Entrance**	1	2	3	4	5	6	7	8	9	10
Description:		MW-20 to IRZ-11							Static Head EXIRZ-11 to MW-20		
Length of Segment (ft):	0	755	0	0	0	0	0	0			
Header flow rate (gpm):		420.0628601									
Branch flow rate (gpm):	---	420.0628601									
Header Pipe Velocity (ft/s):	0.00	6.00									
Reynolds Number, Re:		2.22E+05									
Fanning Friction Factor, f (Eq(6)):		0.00386									
Pressure Drop (ft w.c.), (Eq.(7)):		14.62									
Velocity Head, $v^2/2g_c$ (ft w.c.):	0.000	0.560									
Pressure Drop (ft w.c.):	0.00	14.62							15.0		
	Branch Pipe Estimated Conditions										
Location:	**Entrance**	1	2	3	4	5	6	7	8	9	10
Orifice Velocity (ft/s):	---	0.00									0.00
Length of Branch Pipe (ft)[2]:	---	73									
Reynolds Number, Re:	---	0.00E+00									0.00E+00
Fanning Friction Factor, f:	---										
Pressure Drop (ft w.c.), (Eq.(7)):	---										
Velocity Head, $v^2/2g_c$ (ft w.c.):	---	0.000									0.000
Pressure Drop (ft w.c.)[3]:	---	0.00									0.00
Well Head Pressure (ft w.c.)[4]:	---	0	0	0	0	0	0	0	0	0	0

	Header Pipe Estimated Conditions (Continued)										
Location:	11	12	13	14	15	16	17	18	19	20	**Summary**	
Length of Segment (ft):											**755**	**(Total)**
Header flow rate (gpm):											---	---
Branch flow rate (gpm):											---	---
Header Pipe Velocity (ft/s):											**3.0**	**(Avg.)**
Reynolds Number, Re:											**2.22E+05**	**(Avg.)**
Fanning Friction Factor, f:											**0.00386**	**(Avg.)**
Velocity Head, $v^2/2g_c$ (ft w.c.):											**0.280**	**(Avg.)**
Pressure Drop (ft w.c.):											**29.62**	**(Total)**
	Branch Pipe Estimated Conditions (Continued)											
Location:	11	12	13	14	15	16	17	18	19	20	**Summary**	
Orifice Velocity (ft/s):											**0.00**	**(Avg.)**
Length of Branch Pipe (ft)[2]:											**73.00**	**(Avg.)**
Reynolds Number, Re:											**0.00E+00**	**(Avg.)**
Fanning Friction Factor, f:											**#DIV/0!**	**(Avg.)**
Velocity Head, $v^2/2g_c$ (ft w.c.):											**0.000**	**(Avg.)**
Pressure Drop (ft w.c.)[3]:											**0.00**	**(Avg.)**
Well Head Pressure (ft w.c.)[4]:											**0.00**	**(Avg.)**

Eq. (1)
Discharge Header Pressure Drop:

$$\Delta p_p = \left(\frac{4f_{avg}L_p}{3D_p} - 2K\right)\frac{\rho V_p^2}{2g_c}$$

Eq. (2)
Return Header Pressure Drop:

$$\Delta p_p = \left(\frac{4f_{avg}L_p}{3D_p} + 2K\right)\frac{\rho V_p^2}{2g_c}$$

Eq. (3)
Branch Outlet Pressure Drop:

$$\Delta p_o = \frac{1}{C_o^2}\frac{\rho V_o^2}{2g_c}$$

Eq. (4)
Reynolds Number:

$$Re = \frac{D \cdot v \cdot \rho}{\mu} = \frac{D \cdot v}{\eta}$$

Eq. (5)
Distribution Equation:

$$\%\,Maldistribution = 100\left(1 - \sqrt{\frac{\Delta p_o - |\Delta p_p|}{\Delta p_o}}\right)$$

Eq. (6)
Fanning Friction Factor:

$$f = \frac{1}{4}\left(\frac{D}{L}\right)\left(\frac{[(p_0 - p_L) - \rho g(h_0 - h_L)]}{\frac{1}{2}\rho v^2}\right)$$

Eq. (7)
Darcy Equation:

$$h_L = \left[\left(4f\ \frac{L}{D}\right)\right]\frac{v^2}{2g}$$

Notes:

(1) K = 0.5 when viscous losses are negligible, K = 1.0 for return headers.
(2) Include the equivalent length of valves and fittings.
(3) Pressure drop due to velocity head and friction losses across the length of the branch pipe.
(4) Pressure at the well head taking into consideration frictional losses across the length of the drop pipe, static head associated with water elevation and mounding, and pressure drop required for foot valve or variable area valve.
(5) Maldistribution of 10 percent or less is recommended.
(6) If the branch piping exhibits average pressure losses (due to length, fittings, and/or well head pressures) of at least 10 times higher than the header, pressure losses maldistribution will be less than 10 percent.

6.00

North IRZ CIP line back (using Extraction line)
Site: Pacific Gas & Electric Topock Compressor Station
Location: Topock, California

Created By: BAS
Revision No. 1
Revision Date: 2/26/2013

Fluid:	Water
Fluid Temperature (deg F):	50
Maximum Flowrate	420.0628601
Header Length (ft):	755
Number of Branches	1
Average Branch Flowrate (gpm):	420.1

◉ DISCHARGE HEADER

○ RETURN HEADER

Header Pipe Material: 13

Header Pipe Type: SDR 11 - HDPE

Header Pipe Nominal Diameter (in): 6 15

Header Pipe, e (ft):	**0.00001**
Header Pipe Inner Diameter (in):	**5.348**
e / D:	**0.00001**

Branch Pipe Material: 13

Branch Pipe Type: SDR 11 - HDPE

Branch Pipe Nominal Diameter (in): 2 2

Branch Pipe, e (ft):	**0.00001**
Branch Pipe Inner Diameter (in):	**1.917**
e / D:	**0.00003**

Fluid Density (lb/ft^3):	**62.36**
Viscosity (cP):	**1.12**
Kinematic viscosity, v (ft^2/s):	**1.21E-05**
g (ft/s^2):	**32.17**
Oriface Coefficient, C_o:	**0.62**
Oriface Value, K[(1)]:	**0.5**

Header Pressure Drop, Δp_p (lb$_f$/ft^2):	269.1
Header Pressure Drop, Δp_p (psig):	**1.87**
Branch Outlet Pressure Drop, Δp_o (lb$_f$/ft^2):	5498.2
Branch Outlet Pressure Drop, Δp_o (psig):	**38.18**
Percent Maldistribution (%)[(5)]:	**2.48%**
Average Branch Pipe Pressure Drop (ft w.c.):	**203.88**
Average Well Head Pressure (ft w.c.):	**0.00**
Average Branch Pipe Pressure Drop (ft w.c.)[(5)]:	**203.88**
Average Branch Pipe Pressure Drop (psig):	**88.26**
Average Branch Pipe Pressure Drop > 10x Δp_p:	**Yes**

Header Pipe Estimated Conditions											
Location:	**Entrance**	1	2	3	4	5	6	7	8	9	10
Description:		EXIRZ-11 to MW-20							Static Head EXIRZ-11 to MW-20		
Length of Segment (ft):	0	755	0	0	0	0	0	0			
Header flow rate (gpm):		420.0628601									
Branch flow rate (gpm):	---	420.0628601									
Header Pipe Velocity (ft/s):	0.00	6.00									
Reynolds Number, Re:		2.22E+05									
Fanning Friction Factor, f (Eq(6)):		0.00386									
Pressure Drop (ft w.c.), (Eq.(7)):		14.62									
Velocity Head, $v^2/2g_c$ (ft w.c.):	0.000	0.560									
Pressure Drop (ft w.c.):	0.00	14.62							-15.0		
Branch Pipe Estimated Conditions											
Location:	**Entrance**	1	2	3	4	5	6	7	8	9	10
Orifice Velocity (ft/s):	---	46.70									0.00
Length of Branch Pipe (ft)[(2)]:	---	73									
Reynolds Number, Re:	---	6.18E+05									0.00E+00
Fanning Friction Factor, f:	---	0.00329									
Pressure Drop (ft w.c.), (Eq.(7)):	---	203.88									#VALUE!
Velocity Head, $v^2/2g_c$ (ft w.c.):	---	33.892									0.000
Pressure Drop (ft w.c.)[(3)]:	---	203.88									
Well Head Pressure (ft w.c.)[(4)]:	---	0	0	0	0	0	0	0	0	0	0

Header Pipe Estimated Conditions (Continued)												
Location:	11	12	13	14	15	16	17	18	19	20	**Summary**	
Length of Segment (ft):											**755**	**(Total)**
Header flow rate (gpm):											---	---
Branch flow rate (gpm):											---	---
Header Pipe Velocity (ft/s):											**3.0**	**(Avg.)**
Reynolds Number, Re:											**2.22E+05**	**(Avg.)**
Fanning Friction Factor, f:											**0.00386**	**(Avg.)**
Velocity Head, $v^2/2g_c$ (ft w.c.):											**0.280**	**(Avg.)**
Pressure Drop (ft w.c.):											**-0.38**	**(Total)**
Branch Pipe Estimated Conditions (Continued)												
Location:	11	12	13	14	15	16	17	18	19	20	**Summary**	
Orifice Velocity (ft/s):											**23.35**	**(Avg.)**
Length of Branch Pipe (ft)[(2)]:											**73.00**	**(Avg.)**
Reynolds Number, Re:											**3.09E+05**	**(Avg.)**
Fanning Friction Factor, f:											**0.00329**	**(Avg.)**
Velocity Head, $v^2/2g_c$ (ft w.c.):											**16.946**	**(Avg.)**
Pressure Drop (ft w.c.)[(3)]:											**203.88**	**(Avg.)**
Well Head Pressure (ft w.c.)[(4)]:											**0.00**	**(Avg.)**

Eq. (1)
Discharge Header Pressure Drop:

$$\Delta p_p = \left(\frac{4f_{avg}L_p}{3D_p} - 2K\right)\frac{\rho V_p^2}{2g_c}$$

Eq. (2)
Return Header Pressure Drop:

$$\Delta p_p = \left(\frac{4f_{avg}L_p}{3D_p} + 2K\right)\frac{\rho V_p^2}{2g_c}$$

Eq. (3)
Branch Outlet Pressure Drop:

$$\Delta p_o = \frac{1}{C_o^2}\frac{\rho V_o^2}{2g_c}$$

Eq. (4)
Reynolds Number:

$$Re = \frac{D \cdot v \cdot \rho}{\mu} = \frac{D \cdot v}{\eta}$$

Eq. (5)
Distribution Equation:

$$\%\,Maldistribution = 100\left(1 - \sqrt{\frac{\Delta p_o - |\Delta p_p|}{\Delta p_o}}\right)$$

Eq. (6)
Fanning Friction Factor:

$$f = \frac{1}{4}\left(\frac{D}{L}\right)\left(\frac{[(p_0 - p_L) - \rho g(h_0 - h_L)]}{\frac{1}{2}\rho v^2}\right)$$

Eq. (7)
Darcy Equation:

$$h_L = \left[\left(4f\ \frac{L}{D}\right)\right]\frac{v^2}{2g}$$

Notes:

(1) K = 0.5 when viscous losses are negligible, K = 1.0 for return headers.
(2) Include the equivalent length of valves and fittings.
(3) Pressure drop due to velocity head and friction losses across the length of the branch pipe.
(4) Pressure at the well head taking into consideration frictional losses across the length of the drop pipe, static head associated with water elevation and mounding, and pressure drop required for foot valve or variable area valve.
(5) Maldistribution of 10 percent or less is recommended.
(6) If the branch piping exhibits average pressure losses (due to length, fittings, and/or well head pressures) of at least 10 times higher than the header, pressure losses maldistribution will be less than 10 percent.

6.00

South CIP line MW20 to 27 (using injection line)

Site: Pacific Gas & Electric Topock Compressor Station
Location: Topock, California

Created By: BAS
Revision No. 1
Revision Date: 2/26/2013

Fluid:	Water
Fluid Temperature (deg F):	50
Maximum Flowrate	150
Header Length (ft):	290
Number of Branches	1
Average Branch Flowrate (gpm):	150.0

◉ DISCHARGE HEADER

○ RETURN HEADER

Header Pipe Material:

Header Pipe Type: SDR 11 - HDPE

Header Pipe Nominal Diameter (in): 6

Header Pipe, e (ft): **0.00001**
Header Pipe Inner Diameter (in): **5.348**
e / D: 0.00001

Branch Pipe Material:

Branch Pipe Type: SDR 11 - HDPE

Branch Pipe Nominal Diameter (in): 2
2

Branch Pipe, e (ft): **0.00001**
Branch Pipe Inner Diameter (in): **1.917**
e / D: 0.00003

Fluid Density (lb/ft³): **62.36**
Viscosity (cP): **1.12**

Kinematic viscosity, v (ft²/s): **1.21E-05**
g (ft/s²): **32.17**
Oriface Coefficient, C_o: **0.62**
Oriface Value, K[1]: **0.5**

Header Pressure Drop, Δp_p (lb_f/ft^2): 13.8
Header Pressure Drop, Δp_p (psig): 0.10
Branch Outlet Pressure Drop, Δp_o (lb_f/ft^2): 0.0
Branch Outlet Pressure Drop, Δp_o (psig): 0.00
Percent Maldistribution (%)[5]: Unbalanced
Average Branch Pipe Pressure Drop (ft w.c.):
Average Well Head Pressure (ft w.c.):
Average Branch Pipe Pressure Drop (ft w.c.)[5]:
Average Branch Pipe Pressure Drop (psig):
Average Branch Pipe Pressure Drop > 10x Δp_p:

Header Pipe Estimated Conditions

Location:	Entrance	1	2	3	4	5	6	7	8	9	10
Description:		MW-20 to EXIRZ-27								Equip Losses	Static Head MW-20 to EXIRZ-27
Length of Segment (ft):	0	290									
Header flow rate (gpm):		150									
Branch flow rate (gpm):	---	150									
Header Pipe Velocity (ft/s):	0.00	2.14									
Reynolds Number, Re:		7.91E+04									
Fanning Friction Factor, f (Eq(6)):		0.00474									
Pressure Drop (ft w.c.), (Eq.(7)):		0.88									
Velocity Head, $v^2/2g_c$ (ft w.c.):	0.000	0.071									
Pressure Drop (ft w.c.):	0.00	0.88								1.76	3.00

Branch Pipe Estimated Conditions

Location:	Entrance	1	2	3	4	5	6	7	8	9	10
Orifice Velocity (ft/s):	---	0.00									
Length of Branch Pipe (ft)[2]:	---	170									
Reynolds Number, Re:	---	0.00E+00									
Fanning Friction Factor, f:	---										
Pressure Drop (ft w.c.), (Eq.(7)):	---	#VALUE!									
Velocity Head, $v^2/2g_c$ (ft w.c.):	---	0.000									
Pressure Drop (ft w.c.)[3]:	---										
Well Head Pressure (ft w.c.)[4]:	---	0	0	0	0	0	0	0	0	0	0

Header Pipe Estimated Conditions (Continued)

Location:	11	12	13	14	15	16	17	18	19	20	Summary	
Length of Segment (ft):											290	(Total)
Header flow rate (gpm):											---	---
Branch flow rate (gpm):											---	---
Header Pipe Velocity (ft/s):											1.1	(Avg.)
Reynolds Number, Re:											7.91E+04	(Avg.)
Fanning Friction Factor, f:											0.00474	(Avg.)
Velocity Head, $v^2/2g_c$ (ft w.c.):											0.036	(Avg.)
Pressure Drop (ft w.c.):											5.64	(Total)

Branch Pipe Estimated Conditions (Continued)

Location:	11	12	13	14	15	16	17	18	19	20	Summary	
Orifice Velocity (ft/s):											0.00	(Avg.)
Length of Branch Pipe (ft)[2]:											170.00	(Avg.)
Reynolds Number, Re:											0.00E+00	(Avg.)
Fanning Friction Factor, f:											#DIV/0!	(Avg.)
Velocity Head, $v^2/2g_c$ (ft w.c.):											0.000	(Avg.)
Pressure Drop (ft w.c.)[3]:											#DIV/0!	(Avg.)
Well Head Pressure (ft w.c.)[4]:											0.00	(Avg.)

Eq. (1)
Discharge Header Pressure Drop:

$$\Delta p_p = \left(\frac{4f_{avg}L_p}{3D_p} - 2K\right)\frac{\rho V_p^2}{2g_c}$$

Eq. (2)
Return Header Pressure Drop:

$$\Delta p_p = \left(\frac{4f_{avg}L_p}{3D_p} + 2K\right)\frac{\rho V_p^2}{2g_c}$$

Eq. (3)
Branch Outlet Pressure Drop:

$$\Delta p_o = \frac{1}{C_o^2}\frac{\rho V_o^2}{2g_c}$$

Eq. (4)
Reynolds Number:

$$Re = \frac{D \cdot v \cdot \rho}{\mu} = \frac{D \cdot v}{\eta}$$

Eq. (5)
Distribution Equation:

$$\%\,Maldistribution = 100\left(1 - \sqrt{\frac{\Delta p_o - |\Delta p_p|}{\Delta p_o}}\right)$$

Eq. (6)
Fanning Friction Factor:

$$f = \frac{1}{4}\left(\frac{D}{L}\right)\left(\frac{[(p_0 - p_L) - \rho g(h_0 - h_L)]}{\frac{1}{2}\rho v^2}\right)$$

Eq. (7)
Darcy Equation:

$$h_L = \left[\left(4f\ \frac{L}{D}\right)\right]\frac{v^2}{2g}$$

Notes:

(1) K = 0.5 when viscous losses are negligible, K = 1.0 for return headers.
(2) Include the equivalent length of valves and fittings.
(3) Pressure drop due to velocity head and friction losses across the length of the branch pipe.
(4) Pressure at the well head taking into consideration frictional losses across the length of the drop pipe, static head associated with water elevation and mounding, and pressure drop required for foot valve or variable area valve.
(5) Maldistribution of 10 percent or less is recommended.
(6) If the branch piping exhibits average pressure losses (due to length, fittings, and/or well head pressures) of at least 10 times higher than the header, pressure losses maldistribution will be less than 10 percent.

2.14

South CIP line MW20 to 27 (using BW line)
Site: Pacific Gas & Electric Topock Compressor Station
Location: Topock, California

Created By: BAS
Revision No. 2
Revision Date: 2/20/2013

Fluid:	Water
Fluid Temperature (deg F):	50
Maximum Flowrate	150
Header Length (ft):	290
Number of Branches	1
Average Branch Flowrate (gpm):	150.0

◉ DISCHARGE HEADER

○ RETURN HEADER

Header Pipe Material:

Header Pipe Type: SDR 11 - HDPE

Header Pipe Nominal Diameter (in): 2

Header Pipe, e (ft): **0.00001**
Header Pipe Inner Diameter (in): **1.917**
e / D: 0.00003

Branch Pipe Material:

Branch Pipe Type: SDR 11 - HDPE

Branch Pipe Nominal Diameter (in): 2 / 2

Branch Pipe, e (ft): **0.00001**
Branch Pipe Inner Diameter (in): **1.917**
e / D: 0.00003

Fluid Density (lb/ft^3):	**62.36**
Viscosity (cP):	**1.12**
Kinematic viscosity, v (ft^2/s):	**1.21E-05**
g (ft/s^2):	**32.17**
Oriface Coefficient, C_o:	**0.62**
Oriface Value, K[1]:	**0.5**

Location:	Entrance	1	2	3	4	5	6	7	8	9	10
Header Pipe Estimated Conditions											
Description:		EXIRZ-27 to MW-20								Equip Losses	Static Head MW-20 to IRZ-27
Length of Segment (ft):	0	290									
Header flow rate (gpm):		150									
Branch flow rate (gpm):	---	150									
Header Pipe Velocity (ft/s):	0.00	16.68									
Reynolds Number, Re:		2.21E+05									
Fanning Friction Factor, f (Eq(6)):		0.00390									
Pressure Drop (ft w.c.), (Eq.(7)):		122.45									
Velocity Head, $v^2/2g_c$ (ft w.c.):	0.000	4.322									
Pressure Drop (ft w.c.):	0.00	122.45								158.09	-3.00
Branch Pipe Estimated Conditions											
Location:	Entrance	1	2	3	4	5	6	7	8	9	10
Orifice Velocity (ft/s):	---	0.00									
Length of Branch Pipe (ft)[2]:	---	115									
Reynolds Number, Re:	---	0.00E+00									
Fanning Friction Factor, f:	---										
Pressure Drop (ft w.c.), (Eq.(7)):	---										
Velocity Head, $v^2/2g_c$ (ft w.c.):	---	0.000									
Pressure Drop (ft w.c.)[3]:	---	0.00									
Well Head Pressure (ft w.c.)[4]:	---	0	0	0	0	0	0	0	0	0	0

Location:	11	12	13	14	15	16	17	18	19	20	Summary	
Header Pipe Estimated Conditions (Continued)												
Length of Segment (ft):											290	(Total)
Header flow rate (gpm):											---	---
Branch flow rate (gpm):											---	---
Header Pipe Velocity (ft/s):											8.3	(Avg.)
Reynolds Number, Re:											2.21E+05	(Avg.)
Fanning Friction Factor, f:											0.00390	(Avg.)
Velocity Head, $v^2/2g_c$ (ft w.c.):											2.161	(Avg.)
Pressure Drop (ft w.c.):											277.54	(Total)
Branch Pipe Estimated Conditions (Continued)												
Location:	11	12	13	14	15	16	17	18	19	20	Summary	
Orifice Velocity (ft/s):											0.00	(Avg.)
Length of Branch Pipe (ft)[2]:											115.00	(Avg.)
Reynolds Number, Re:											0.00E+00	(Avg.)
Fanning Friction Factor, f:											#DIV/0!	(Avg.)
Velocity Head, $v^2/2g_c$ (ft w.c.):											0.000	(Avg.)
Pressure Drop (ft w.c.)[3]:											0.00	(Avg.)
Well Head Pressure (ft w.c.)[4]:											0.00	(Avg.)

Eq. (1)
Discharge Header Pressure Drop:

$$\Delta p_p = \left(\frac{4f_{avg}L_p}{3D_p} - 2K\right)\frac{\rho V_p^2}{2g_c}$$

Eq. (2)
Return Header Pressure Drop:

$$\Delta p_p = \left(\frac{4f_{avg}L_p}{3D_p} + 2K\right)\frac{\rho V_p^2}{2g_c}$$

Eq. (3)
Branch Outlet Pressure Drop:

$$\Delta p_o = \frac{1}{C_o^2}\frac{\rho V_o^2}{2g_c}$$

Eq. (4)
Reynolds Number:

$$Re = \frac{D \cdot v \cdot \rho}{\mu} = \frac{D \cdot v}{\eta}$$

Eq. (5)
Distribution Equation:

$$\%\,Maldistribution = 100\left(1 - \sqrt{\frac{\Delta p_o - |\Delta p_p|}{\Delta p_o}}\right)$$

Eq. (6)
Fanning Friction Factor:

$$f = \frac{1}{4}\left(\frac{D}{L}\right)\left(\frac{[(p_0 - p_L) - \rho g(h_0 - h_L)]}{\frac{1}{2}\rho v^2}\right)$$

Eq. (7)
Darcy Equation:

$$h_L = \left[\left(4f\,\frac{L}{D}\right)\right]\frac{v^2}{2g}$$

Header Pressure Drop, Δp_p (lb_f/ft^2): 2275.8
Header Pressure Drop, Δp_p (psig): 15.80
Branch Outlet Pressure Drop, Δp_o (lb_f/ft^2): 0.0
Branch Outlet Pressure Drop, Δp_o (psig): 0.00
Percent Maldistribution (%)[5]:
Average Branch Pipe Pressure Drop (ft w.c.):
Average Well Head Pressure (ft w.c.):
Average Branch Pipe Pressure Drop (ft w.c.)[5]:
Average Branch Pipe Pressure Drop (psig):
Average Branch Pipe Pressure Drop > 10x Δp_p:

Notes:
(1) K = 0.5 when viscous losses are negligible, K = 1.0 for return headers.
(2) Include the equivalent length of valves and fittings.
(3) Pressure drop due to velocity head and friction losses across the length of the branch pipe.
(4) Pressure at the well head taking into consideration frictional losses across the length of the drop pipe, static head associated with water elevation and mounding, and pressure drop required for foot valve or variable area valve.
(5) Maldistribution of 10 percent or less is recommended.
(6) If the branch piping exhibits average pressure losses (due to length, fittings, and/or well head pressures) of at least 10 times higher than the header, pressure losses maldistribution will be less than 10 percent.

16.68

South CIP line MW20 to 37 (using injection line)

Site: Pacific Gas & Electric Topock Compressor Station
Location: Topock, California

Created By: BAS
Revision No. 2
Revision Date: 2/20/2013

Fluid: **Water**
Fluid Temperature (deg F): **50**

Maximum Flowrate 150
Header Length (ft): 1,760
Number of Branches 1
Average Branch Flowrate (gpm): 150.0

○ DISCHARGE HEADER

◉ RETURN HEADER

Header Pipe Material:

Header Pipe Type:
SDR 11 - HDPE

Header Pipe Nominal Diameter (in): 4

Header Pipe, e (ft): **0.00001**
Header Pipe Inner Diameter (in): **3.633**
e / D: **0.00002**

Branch Pipe Material:

Branch Pipe Type:
SDR 11 - HDPE

Branch Pipe Nominal Diameter (in): 2
2

Branch Pipe, e (ft): **0.00001**
Branch Pipe Inner Diameter (in): **1.917**
e / D: **0.00003**

Fluid Density (lb/ft^3): **62.36**
Viscosity (cP): **1.12**

Kinematic viscosity, v (ft^2/s): **1.21E-05**
g (ft/s^2): **32.17**
Oriface Coefficient, C_o: **0.62**
Oriface Value, K[1]: **1.0**

Header Pressure Drop, Δp_p (lb_f/ft^2): 0.0
Header Pressure Drop, Δp_p (psig): 0.00
Branch Outlet Pressure Drop, Δp_o (lb_f/ft^2): 0.0
Branch Outlet Pressure Drop, Δp_o (psig): 0.00
Percent Maldistribution (%)[5]:
Average Branch Pipe Pressure Drop (ft w.c.):
Average Well Head Pressure (ft w.c.):
Average Branch Pipe Pressure Drop (ft w.c.)[5]:
Average Branch Pipe Pressure Drop (psig):
Average Branch Pipe Pressure Drop > 10x Δp_p:

	Header Pipe Estimated Conditions										
Location:	**Entrance**	1	2	3	4	5	6	7	8	9	10
Description:		MW-20 to EXIRZ-37						Equip	Static Head MW-20 to EXIRZ-37		
Length of Segment (ft):	0	1760									
Header flow rate (gpm):	**0**	150	0								
Branch flow rate (gpm):	**--**	150									
Header Pipe Velocity (ft/s):	0.00	4.64	0.00								
Reynolds Number, Re:		1.16E+05	0.00E+00								
Fanning Friction Factor, f (Eq(6)):		0.00438									
Pressure Drop (ft w.c.), (Eq.(7)):		34.14	#VALUE!								
Velocity Head, $v^2/2g_c$ (ft w.c.):	0.000	0.335	0.000								
Pressure Drop (ft w.c.):	0.00	34.14						40.53	2.00		
	Branch Pipe Estimated Conditions										
Location:	**Entrance**	1	2	3	4	5	6	7	8	9	10
Orifice Velocity (ft/s):	---	0.00	0.00								
Length of Branch Pipe (ft)[2]:	---	37									
Reynolds Number, Re:	---	0.00E+00	0.00E+00								
Fanning Friction Factor, f:	---										
Pressure Drop (ft w.c.), (Eq.(7)):	---	#VALUE!	#VALUE!								
Velocity Head, $v^2/2g_c$ (ft w.c.):	---	0.000	0.000								
Pressure Drop (ft w.c.)[3]:	---										
Well Head Pressure (ft w.c.)[4]:	---	0	0	0	0	0	0	0	0	0	0

	Header Pipe Estimated Conditions (Continued)											
Location:	11	12	13	14	15	16	17	18	19	20	**Summary**	
Length of Segment (ft):											**1,760**	**(Total)**
Header flow rate (gpm):											**---**	**---**
Branch flow rate (gpm):											**---**	**---**
Header Pipe Velocity (ft/s):											**1.5**	**(Avg.)**
Reynolds Number, Re:											**5.82E+04**	**(Avg.)**
Fanning Friction Factor, f:											**0.00438**	**(Avg.)**
Velocity Head, $v^2/2g_c$ (ft w.c.):											**0.112**	**(Avg.)**
Pressure Drop (ft w.c.):											**76.67**	**(Total)**
	Branch Pipe Estimated Conditions (Continued)											
Location:	11	12	13	14	15	16	17	18	19	20	**Summary**	
Orifice Velocity (ft/s):											**0.00**	**(Avg.)**
Length of Branch Pipe (ft)[2]:											**37.00**	**(Avg.)**
Reynolds Number, Re:											**0.00E+00**	**(Avg.)**
Fanning Friction Factor, f:											**#DIV/0!**	**(Avg.)**
Velocity Head, $v^2/2g_c$ (ft w.c.):											**0.000**	**(Avg.)**
Pressure Drop (ft w.c.)[3]:											**#DIV/0!**	**(Avg.)**
Well Head Pressure (ft w.c.)[4]:											**0.00**	**(Avg.)**

Eq. (1)
Discharge Header Pressure Drop:

$$\Delta p_p = \left(\frac{4f_{avg}L_p}{3D_p} - 2K\right)\frac{\rho V_p^2}{2g_c}$$

Eq. (2)
Return Header Pressure Drop:

$$\Delta p_p = \left(\frac{4f_{avg}L_p}{3D_p} + 2K\right)\frac{\rho V_p^2}{2g_c}$$

Eq. (3)
Branch Outlet Pressure Drop:

$$\Delta p_o = \frac{1}{C_o^2}\frac{\rho V_o^2}{2g_c}$$

Eq. (4)
Reynolds Number:

$$Re = \frac{D \cdot v \cdot \rho}{\mu} = \frac{D \cdot v}{\eta}$$

Eq. (5)
Distribution Equation:

$$\%\,Maldistribution = 100\left(1 - \sqrt{\frac{\Delta p_o - |\Delta p_p|}{\Delta p_o}}\right)$$

Eq. (6)
Fanning Friction Factor:

$$f = \frac{1}{4}\left(\frac{D}{L}\right)\left(\frac{[(p_o - p_L) - \rho g(h_o - h_L)]}{\frac{1}{2}\rho v^2}\right)$$

Eq. (7)
Darcy Equation:

$$h_L = \left[\left(4f\ \frac{L}{D}\right)\right]\frac{v^2}{2g}$$

Notes:

(1) K = 0.5 when viscous losses are negligible, K = 1.0 for return headers.
(2) Include the equivalent length of valves and fittings.
(3) Pressure drop due to velocity head and friction losses across the length of the branch pipe.
(4) Pressure at the well head taking into consideration frictional losses across the length of the drop pipe, static head associated with water elevation and mounding, and pressure drop required for foot valve or variable area valve.
(5) Maldistribution of 10 percent or less is recommended.
(6) If the branch piping exhibits average pressure losses (due to length, fittings, and/or well head pressures) of at least 10 times higher than the header, pressure losses maldistribution will be less than 10 percent.

2.32

South CIP line 37 to MW20 (using extraction line)

Site: Pacific Gas & Electric Topock Compressor Station
Location: Topock, California

Created By: BAS
Revision No. 1
Revision Date: 2/26/2013

Fluid:	Water
Fluid Temperature (deg F):	50
Maximum Flowrate	150
Header Length (ft):	1,760
Number of Branches	1
Average Branch Flowrate (gpm):	150.0

○ DISCHARGE HEADER

◉ RETURN HEADER

Header Pipe Material:

Header Pipe Type: SDR 11 - HDPE

Header Pipe Nominal Diameter (in): 2

Header Pipe, e (ft):	**0.00001**
Header Pipe Inner Diameter (in):	**1.917**
e / D:	**0.00003**

Branch Pipe Material:

Branch Pipe Type: SDR 11 - HDPE

Branch Pipe Nominal Diameter (in): 2 / 2

Branch Pipe, e (ft):	**0.00001**
Branch Pipe Inner Diameter (in):	**1.917**
e / D:	**0.00003**

Fluid Density (lb/ft^3):	**62.36**
Viscosity (cP):	**1.12**
Kinematic viscosity, v (ft^2/s):	**1.21E-05**
g (ft/s^2):	**32.17**
Oriface Coefficient, C_o:	**0.62**
Oriface Value, K[(1)]:	**1.0**

Header Pressure Drop, Δp_p (lb_f/ft^2):	0.0
Header Pressure Drop, Δp_p (psig):	**0.00**
Branch Outlet Pressure Drop, Δp_o (lb_f/ft^2):	0.0
Branch Outlet Pressure Drop, Δp_o (psig):	**0.00**
Percent Maldistribution (%)[(5)]:	
Average Branch Pipe Pressure Drop (ft w.c.):	
Average Well Head Pressure (ft w.c.):	
Average Branch Pipe Pressure Drop (ft w.c.)[(5)]:	
Average Branch Pipe Pressure Drop (psig):	
Average Branch Pipe Pressure Drop > 10x Δp_p:	

	Header Pipe Estimated Conditions											
Location:	**Entrance**	1	2	3	4	5	6	7	8	9	10	
Description:		EXIRZ-37 to MW20								Equip	Static Head IRZ-37 to Tee	
Length of Segment (ft):	0	1760										
Header flow rate (gpm):	**0**	150	0									
Branch flow rate (gpm):	--	150										
Header Pipe Velocity (ft/s):	0.00	16.68	0.00									
Reynolds Number, Re:		2.21E+05	0.00E+00									
Fanning Friction Factor, f (Eq(6)):		0.00390										
Pressure Drop (ft w.c.), (Eq.(7)):		743.14	#VALUE!									
Velocity Head, $v^2/2g_c$ (ft w.c.):	0.000	4.322	0.000									
Pressure Drop (ft w.c.):	0.00	743.14								807.92	-2.00	
	Branch Pipe Estimated Conditions											
Location:	**Entrance**	1	2	3	4	5	6	7	8	9	10	
Orifice Velocity (ft/s):	---	0.00	0.00									
Length of Branch Pipe (ft)[(2)]:	---	37										
Reynolds Number, Re:	---	0.00E+00	0.00E+00									
Fanning Friction Factor, f:	---											
Pressure Drop (ft w.c.), (Eq.(7)):	---	#VALUE!	#VALUE!									
Velocity Head, $v^2/2g_c$ (ft w.c.):	---	0.000	0.000									
Pressure Drop (ft w.c.)[(3)]:	---											
Well Head Pressure (ft w.c.)[(4)]:	---	0	0	0	0	0	0	0	0	0	0	

	Header Pipe Estimated Conditions (Continued)											
Location:	11	12	13	14	15	16	17	18	19	20	**Summary**	
Length of Segment (ft):											**1,760**	**(Total)**
Header flow rate (gpm):											---	---
Branch flow rate (gpm):											---	---
Header Pipe Velocity (ft/s):											**5.6**	**(Avg.)**
Reynolds Number, Re:											**1.10E+05**	**(Avg.)**
Fanning Friction Factor, f:											**0.00390**	**(Avg.)**
Velocity Head, $v^2/2g_c$ (ft w.c.):											**1.441**	**(Avg.)**
Pressure Drop (ft w.c.):											**1549.06**	**(Total)**
	Branch Pipe Estimated Conditions (Continued)											
Location:	11	12	13	14	15	16	17	18	19	20	**Summary**	
Orifice Velocity (ft/s):											**0.00**	**(Avg.)**
Length of Branch Pipe (ft)[(2)]:											**37.00**	**(Avg.)**
Reynolds Number, Re:											**0.00E+00**	**(Avg.)**
Fanning Friction Factor, f:											**#DIV/0!**	**(Avg.)**
Velocity Head, $v^2/2g_c$ (ft w.c.):											**0.000**	**(Avg.)**
Pressure Drop (ft w.c.)[(3)]:											**#DIV/0!**	**(Avg.)**
Well Head Pressure (ft w.c.)[(4)]:											**0.00**	**(Avg.)**

Eq. (1)
Discharge Header Pressure Drop:

$$\Delta p_p = \left(\frac{4f_{avg}L_p}{3D_p} - 2K\right)\frac{\rho V_p^2}{2g_c}$$

Eq. (2)
Return Header Pressure Drop:

$$\Delta p_p = \left(\frac{4f_{avg}L_p}{3D_p} + 2K\right)\frac{\rho V_p^2}{2g_c}$$

Eq. (3)
Branch Outlet Pressure Drop:

$$\Delta p_o = \frac{1}{C_o^2}\frac{\rho V_o^2}{2g_c}$$

Eq. (4)
Reynolds Number:

$$Re = \frac{D \cdot v \cdot \rho}{\mu} = \frac{D \cdot v}{\eta}$$

Eq. (5)
Distribution Equation:

$$\%\,Maldistribution = 100\left(1 - \sqrt{\frac{\Delta p_o - |\Delta p_p|}{\Delta p_o}}\right)$$

Eq. (6)
Fanning Friction Factor:

$$f = \frac{1}{4}\left(\frac{D}{L}\right)\left(\frac{[(p_o - p_L) - \rho g(h_o - h_L)]}{\frac{1}{2}\rho v^2}\right)$$

Eq. (7)
Darcy Equation:

$$h_L = \left[\left(4f\ \frac{L}{D}\right)\right]\frac{v^2}{2g}$$

Notes:

(1) K = 0.5 when viscous losses are negligible, K = 1.0 for return headers.
(2) Include the equivalent length of valves and fittings.
(3) Pressure drop due to velocity head and friction losses across the length of the branch pipe.
(4) Pressure at the well head taking into consideration frictional losses across the length of the drop pipe, static head associated with water elevation and mounding, and pressure drop required for foot valve or variable area valve.
(5) Maldistribution of 10 percent or less is recommended.
(6) If the branch piping exhibits average pressure losses (due to length, fittings, and/or well head pressures) of at least 10 times higher than the header, pressure losses maldistribution will be less than 10 percent.

8.34

South CIP line MW20 to 39 (using injection line)

Site: Pacific Gas & Electric Topock Compressor Station
Location: Topock, California

Created By: BAS
Revision No. 1
Revision Date: 2/26/2013

Fluid:	Water
Fluid Temperature (deg F):	50
Maximum Flowrate	150
Header Length (ft):	996
Number of Branches	1
Average Branch Flowrate (gpm):	150.0

○ DISCHARGE HEADER

◉ RETURN HEADER

Header Pipe Material:

Header Pipe Type: SDR 11 - HDPE

Header Pipe Nominal Diameter (in): 4

Header Pipe, e (ft):	**0.00001**
Header Pipe Inner Diameter (in):	**3.633**
e / D:	**0.00002**

Branch Pipe Material:

Branch Pipe Type: SDR 11 - HDPE

Branch Pipe Nominal Diameter (in): 2 / 2

Branch Pipe, e (ft):	**0.00001**
Branch Pipe Inner Diameter (in):	**1.917**
e / D:	**0.00003**

Fluid Density (lb/ft^3):	**62.36**
Viscosity (cP):	**1.12**
Kinematic viscosity, v (ft^2/s):	**1.21E-05**
g (ft/s^2):	**32.17**
Oriface Coefficient, C_o:	**0.62**
Oriface Value, K[1]:	**1.0**

Header Pressure Drop, Δp_p (lb_f/ft^2):	**0.0**
Header Pressure Drop, Δp_p (psig):	**0.00**
Branch Outlet Pressure Drop, Δp_o (lb_f/ft^2):	0.0
Branch Outlet Pressure Drop, Δp_o (psig):	**0.00**
Percent Maldistribution (%)[5]:	
Average Branch Pipe Pressure Drop (ft w.c.):	
Average Well Head Pressure (ft w.c.):	
Average Branch Pipe Pressure Drop (ft w.c.)[5]:	
Average Branch Pipe Pressure Drop (psig):	
Average Branch Pipe Pressure Drop > 10x Δp_p:	

	Header Pipe Estimated Conditions											
Location:	**Entrance**	1	2	3	4	5	6	7	8	9	10	
Description:		MW20 to IRZ-39								Equip	Static Head MW20 to IRZ-39	
Length of Segment (ft):	0	996		0	0	0	0	0	0			
Header flow rate (gpm):	**0**	150										
Branch flow rate (gpm):	---	150										
Header Pipe Velocity (ft/s):	0.00	4.64										
Reynolds Number, Re:		1.16E+05										
Fanning Friction Factor, f (Eq(6)):		0.00438										
Pressure Drop (ft w.c.), (Eq.(7)):		19.32										
Velocity Head, $v^2/2g_c$ (ft w.c.):	0.000	0.335										
Pressure Drop (ft w.c.):	0.00	19.32								25.19	-17.00	
	Branch Pipe Estimated Conditions											
Location:	**Entrance**	1	2	3	4	5	6	7	8	9	10	
Orifice Velocity (ft/s):	---	0.00										
Length of Branch Pipe (ft)[2]:	---	20										
Reynolds Number, Re:	---	0.00E+00										
Fanning Friction Factor, f:	---											
Pressure Drop (ft w.c.), (Eq.(7)):	---	#VALUE!										
Velocity Head, $v^2/2g_c$ (ft w.c.):	---	0.000										
Pressure Drop (ft w.c.)[3]:	---											
Well Head Pressure (ft w.c.)[4]:	---	0	0	0	0	0	0	0	0	0	0	

	Header Pipe Estimated Conditions (Continued)											
Location:	11	12	13	14	15	16	17	18	19	20	**Summary**	
Length of Segment (ft):											**996**	**(Total)**
Header flow rate (gpm):											---	---
Branch flow rate (gpm):											---	---
Header Pipe Velocity (ft/s):											**2.3**	**(Avg.)**
Reynolds Number, Re:											**1.16E+05**	**(Avg.)**
Fanning Friction Factor, f:											**0.00438**	**(Avg.)**
Velocity Head, $v^2/2g_c$ (ft w.c.):											**0.168**	**(Avg.)**
Pressure Drop (ft w.c.):											**27.51**	**(Total)**
	Branch Pipe Estimated Conditions (Continued)											
Location:	11	12	13	14	15	16	17	18	19	20	**Summary**	
Orifice Velocity (ft/s):											**0.00**	**(Avg.)**
Length of Branch Pipe (ft)[2]:											**20.00**	**(Avg.)**
Reynolds Number, Re:											**0.00E+00**	**(Avg.)**
Fanning Friction Factor, f:											**#DIV/0!**	**(Avg.)**
Velocity Head, $v^2/2g_c$ (ft w.c.):											**0.000**	**(Avg.)**
Pressure Drop (ft w.c.)[3]:											**#DIV/0!**	**(Avg.)**
Well Head Pressure (ft w.c.)[4]:											**0.00**	**(Avg.)**

Eq. (1)
Discharge Header Pressure Drop:

$$\Delta p_p = \left(\frac{4f_{avg}L_p}{3D_p} - 2K\right)\frac{\rho V_p^2}{2g_c}$$

Eq. (2)
Return Header Pressure Drop:

$$\Delta p_p = \left(\frac{4f_{avg}L_p}{3D_p} + 2K\right)\frac{\rho V_p^2}{2g_c}$$

Eq. (3)
Branch Outlet Pressure Drop:

$$\Delta p_o = \frac{1}{C_o^2}\frac{\rho V_o^2}{2g_c}$$

Eq. (4)
Reynolds Number:

$$Re = \frac{D \cdot v \cdot \rho}{\mu} = \frac{D \cdot v}{\eta}$$

Eq. (5)
Distribution Equation:

$$\%\,Maldistribution = 100\left(1 - \sqrt{\frac{\Delta p_o - |\Delta p_p|}{\Delta p_o}}\right)$$

Eq. (6)
Fanning Friction Factor:

$$f = \frac{1}{4}\left(\frac{D}{L}\right)\left(\frac{[(p_0 - p_L) - \rho g(h_0 - h_L)]}{\frac{1}{2}\rho v^2}\right)$$

Eq. (7)
Darcy Equation:

$$h_L = \left[\left(4f\ \frac{L}{D}\right)\right]\frac{v^2}{2g}$$

Notes:

(1) K = 0.5 when viscous losses are negligible, K = 1.0 for return headers.
(2) Include the equivalent length of valves and fittings.
(3) Pressure drop due to velocity head and friction losses across the length of the branch pipe.
(4) Pressure at the well head taking into consideration frictional losses across the length of the drop pipe, static head associated with water elevation and mounding, and pressure drop required for foot valve or variable area valve.
(5) Maldistribution of 10 percent or less is recommended.
(6) If the branch piping exhibits average pressure losses (due to length, fittings, and/or well head pressures) of at least 10 times higher than the header, pressure losses maldistribution will be less than 10 percent.

4.64

South CIP line MW20 to 39 (using extraction line)

Site: Pacific Gas & Electric Topock Compressor Station
Location: Topock, California

Created By: BAS
Revision No. 1
Revision Date: 2/26/2013

Fluid:	Water
Fluid Temperature (deg F):	50
Maximum Flowrate	150
Header Length (ft):	996
Number of Branches	1
Average Branch Flowrate (gpm):	150.0

○ DISCHARGE HEADER

◉ RETURN HEADER

Header Pipe Material:

Header Pipe Type: SDR 11 - HDPE

Header Pipe Nominal Diameter (in): 2

Header Pipe, e (ft): **0.00001**
Header Pipe Inner Diameter (in): **1.917**
e / D: 0.00003

Branch Pipe Material:

Branch Pipe Type: SDR 11 - HDPE

Branch Pipe Nominal Diameter (in): 2 / 2

Branch Pipe, e (ft): **0.00001**
Branch Pipe Inner Diameter (in): **1.917**
e / D: 0.00003

Fluid Density (lb/ft^3): **62.36**
Viscosity (cP): **1.12**

Kinematic viscosity, v (ft^2/s): **1.21E-05**
g (ft/s^2): **32.17**
Oriface Coefficient, C_o: **0.62**
Oriface Value, K[1]: **1.0**

Header Pressure Drop, Δp_p (lb_f/ft^2): **0.0**
Header Pressure Drop, Δp_p (psig): 0.00
Branch Outlet Pressure Drop, Δp_o (lb_f/ft^2): 0.0
Branch Outlet Pressure Drop, Δp_o (psig): 0.00
Percent Maldistribution (%)[5]:
Average Branch Pipe Pressure Drop (ft w.c.):
Average Well Head Pressure (ft w.c.):
Average Branch Pipe Pressure Drop (ft w.c.)[5]:
Average Branch Pipe Pressure Drop (psig):
Average Branch Pipe Pressure Drop > 10x Δp_p: 16.68

	Header Pipe Estimated Conditions											
Location:	**Entrance**	1	2	3	4	5	6	7	8	9	10	
Description:		IRZ-39 to MW-20								Equip	Static Head IRZ-39 to MW20	
Length of Segment (ft):	0	996		0	0	0	0	0	0			
Header flow rate (gpm):	**0**	150										
Branch flow rate (gpm):	---	150										
Header Pipe Velocity (ft/s):	0.00	16.68										
Reynolds Number, Re:		2.21E+05										
Fanning Friction Factor, f (Eq(6)):		0.00390										
Pressure Drop (ft w.c.), (Eq.(7)):		420.55										
Velocity Head, $v^2/2g_c$ (ft w.c.):	0.000	4.322										
Pressure Drop (ft w.c.):	0.00	420.55								475.34	17.00	
	Branch Pipe Estimated Conditions											
Location:	**Entrance**	1	2	3	4	5	6	7	8	9	10	
Orifice Velocity (ft/s):	---	0.00										
Length of Branch Pipe (ft)[2]:	---	20										
Reynolds Number, Re:	---	0.00E+00										
Fanning Friction Factor, f:	---											
Pressure Drop (ft w.c.), (Eq.(7)):	---	#VALUE!										
Velocity Head, $v^2/2g_c$ (ft w.c.):	---	0.000										
Pressure Drop (ft w.c.)[3]:	---											
Well Head Pressure (ft w.c.)[4]:	---	0	0	0	0	0	0	0	0	0	0	

	Header Pipe Estimated Conditions (Continued)											
Location:	11	12	13	14	15	16	17	18	19	20	**Summary**	
Length of Segment (ft):											**996**	**(Total)**
Header flow rate (gpm):											---	---
Branch flow rate (gpm):											---	---
Header Pipe Velocity (ft/s):											**8.3**	**(Avg.)**
Reynolds Number, Re:											**2.21E+05**	**(Avg.)**
Fanning Friction Factor, f:											**0.00390**	**(Avg.)**
Velocity Head, $v^2/2g_c$ (ft w.c.):											**2.161**	**(Avg.)**
Pressure Drop (ft w.c.):											**912.89**	**(Total)**
	Branch Pipe Estimated Conditions (Continued)											
Location:	11	12	13	14	15	16	17	18	19	20	**Summary**	
Orifice Velocity (ft/s):											**0.00**	**(Avg.)**
Length of Branch Pipe (ft)[2]:											**20.00**	**(Avg.)**
Reynolds Number, Re:											**0.00E+00**	**(Avg.)**
Fanning Friction Factor, f:											**#DIV/0!**	**(Avg.)**
Velocity Head, $v^2/2g_c$ (ft w.c.):											**0.000**	**(Avg.)**
Pressure Drop (ft w.c.)[3]:											**#DIV/0!**	**(Avg.)**
Well Head Pressure (ft w.c.)[4]:											**0.00**	**(Avg.)**

Eq. (1)
Discharge Header Pressure Drop:

$$\Delta p_p = \left(\frac{4f_{avg}L_p}{3D_p} - 2K\right)\frac{\rho V_p^2}{2g_c}$$

Eq. (2)
Return Header Pressure Drop:

$$\Delta p_p = \left(\frac{4f_{avg}L_p}{3D_p} + 2K\right)\frac{\rho V_p^2}{2g_c}$$

Eq. (3)
Branch Outlet Pressure Drop:

$$\Delta p_o = \frac{1}{C_o^2}\frac{\rho V_o^2}{2g_c}$$

Eq. (4)
Reynolds Number:

$$Re = \frac{D \cdot v \cdot \rho}{\mu} = \frac{D \cdot v}{\eta}$$

Eq. (5)
Distribution Equation:

$$\%\,Maldistribution = 100\left(1 - \sqrt{\frac{\Delta p_o - |\Delta p_p|}{\Delta p_o}}\right)$$

Eq. (6)
Fanning Friction Factor:

$$f = \frac{1}{4}\left(\frac{D}{L}\right)\left(\frac{[(p_0 - p_L) - \rho g(h_0 - h_L)]}{\frac{1}{2}\rho v^2}\right)$$

Eq. (7)
Darcy Equation:

$$h_L = \left[\left(4f\ \frac{L}{D}\right)\right]\frac{v^2}{2g}$$

Notes:

(1) K = 0.5 when viscous losses are negligible, K = 1.0 for return headers.
(2) Include the equivalent length of valves and fittings.
(3) Pressure drop due to velocity head and friction losses across the length of the branch pipe.
(4) Pressure at the well head taking into consideration frictional losses across the length of the drop pipe, static head associated with water elevation and mounding, and pressure drop required for foot valve or variable area valve.
(5) Maldistribution of 10 percent or less is recommended.
(6) If the branch piping exhibits average pressure losses (due to length, fittings, and/or well head pressures) of at least 10 times higher than the header, pressure losses maldistribution will be less than 10 percent.

Conditioned Water Line
Site: Pacific Gas & Electric Topock Compressor Station
Location: Topock, California

Created By: BAS
Revision No. 1
Revision Date: 3/14/2013

Fluid: Water
Fluid Temperature (deg F): 50
Maximum Flowrate: 100
Header Length (ft): 2,025
Number of Branches: 1
Average Branch Flowrate (gpm): 100.0

◉ DISCHARGE HEADER

○ RETURN HEADER

Header Pipe Material: 13

Header Pipe Type: SDR 11 - HDPE

Header Pipe Nominal Diameter (in): 4 13

Header Pipe, e (ft): **0.00001**
Header Pipe Inner Diameter (in): **3.633**
e / D: 0.00002

Branch Pipe Material: 13

Branch Pipe Type: SDR 11 - HDPE

Branch Pipe Nominal Diameter (in): 2 2

Branch Pipe, e (ft): **0.00001**
Branch Pipe Inner Diameter (in): **1.917**
e / D: 0.00003

Fluid Density (lb/ft^3): **62.36**
Viscosity (cP): **1.12**
Kinematic viscosity, ν (ft^2/s): **1.21E-05**
g (ft/s^2): **32.17**
Oriface Coefficient, C_o: **0.62**
Oriface Value, K[1]: **0.5**

	Header Pipe Estimated Conditions										
Location:	**Entrance**	1	2	3	4	5	6	7	8	9	10
Description:		HH1-13 junction to TCS							HH1-13 to TCS		
Length of Segment (ft):	0	2,025	0	0	0	0	0	0			
Header flow rate (gpm):		100									
Branch flow rate (gpm):	---	100									
Header Pipe Velocity (ft/s):	0.00	3.10									
Reynolds Number, Re:		7.76E+04									
Fanning Friction Factor, f (Eq(6)):		0.00476									
Pressure Drop (ft w.c.), (Eq.(7)):		18.98									
Velocity Head, $v^2/2g_c$ (ft w.c.):	0.000	0.149									
Pressure Drop (ft w.c.):	0.00	18.98							138.5		
	Branch Pipe Estimated Conditions										
Location:	**Entrance**	1	2	3	4	5	6	7	8	9	10
Orifice Velocity (ft/s):	---	0.00									0.00
Length of Branch Pipe (ft)[2]:	---	73									
Reynolds Number, Re:	---	0.00E+00									0.00E+00
Fanning Friction Factor, f:	---										
Pressure Drop (ft w.c.), (Eq.(7)):	---										#VALUE!
Velocity Head, $v^2/2g_c$ (ft w.c.):	---	0.000									0.000
Pressure Drop (ft w.c.)[3]:	---	0.00									
Well Head Pressure (ft w.c.)[4]:	---	0	0	0	0	0	0	0	0	0	0

	Header Pipe Estimated Conditions (Continued)											
Location:	11	12	13	14	15	16	17	18	19	20	**Summary**	
Length of Segment (ft):											**2,025**	**(Total)**
Header flow rate (gpm):											---	---
Branch flow rate (gpm):											---	---
Header Pipe Velocity (ft/s):											**1.5**	**(Avg.)**
Reynolds Number, Re:											**7.76E+04**	**(Avg.)**
Fanning Friction Factor, f:											**0.00476**	**(Avg.)**
Velocity Head, $v^2/2g_c$ (ft w.c.):											**0.074**	**(Avg.)**
Pressure Drop (ft w.c.):											**157.48**	**(Total)**
	Branch Pipe Estimated Conditions (Continued)											
Location:	11	12	13	14	15	16	17	18	19	20	**Summary**	
Orifice Velocity (ft/s):											**0.00**	**(Avg.)**
Length of Branch Pipe (ft)[2]:											**73.00**	**(Avg.)**
Reynolds Number, Re:											**0.00E+00**	**(Avg.)**
Fanning Friction Factor, f:											**#DIV/0!**	**(Avg.)**
Velocity Head, $v^2/2g_c$ (ft w.c.):											**0.000**	**(Avg.)**
Pressure Drop (ft w.c.)[3]:											**0.00**	**(Avg.)**
Well Head Pressure (ft w.c.)[4]:											**0.00**	**(Avg.)**

Eq. (1)
Discharge Header Pressure Drop:

$$\Delta p_p = \left(\frac{4f_{avg}L_p}{3D_p} - 2K\right)\frac{\rho V_p^2}{2g_c}$$

Eq. (2)
Return Header Pressure Drop:

$$\Delta p_p = \left(\frac{4f_{avg}L_p}{3D_p} + 2K\right)\frac{\rho V_p^2}{2g_c}$$

Eq. (3)
Branch Outlet Pressure Drop:

$$\Delta p_o = \frac{1}{C_o^2}\frac{\rho V_o^2}{2g_c}$$

Eq. (4)
Reynolds Number:

$$Re = \frac{D \cdot v \cdot \rho}{\mu} = \frac{D \cdot v}{\eta}$$

Eq. (5)
Distribution Equation:

$$\%\,Maldistribution = 100\left(1 - \sqrt{\frac{\Delta p_o - |\Delta p_p|}{\Delta p_o}}\right)$$

Eq. (6)
Fanning Friction Factor:

$$f = \frac{1}{4}\left(\frac{D}{L}\right)\left(\frac{[(p_0 - p_L) - \rho g(h_0 - h_L)]}{\frac{1}{2}\rho v^2}\right)$$

Eq. (7)
Darcy Equation:

$$h_L = \left[\left(4f\ \frac{L}{D}\right)\right]\frac{v^2}{2g}$$

Header Pressure Drop, Δp_p (lb$_f$/ft^2): 385.2
Header Pressure Drop, Δp_p (psig): 2.68
Branch Outlet Pressure Drop, Δp_o (lb$_f$/ft^2): 0.0
Branch Outlet Pressure Drop, Δp_o (psig): 0.00
Percent Maldistribution (%)[5]:
Average Branch Pipe Pressure Drop (ft w.c.):
Average Well Head Pressure (ft w.c.):
Average Branch Pipe Pressure Drop (ft w.c.)[5]:
Average Branch Pipe Pressure Drop (psig):
Average Branch Pipe Pressure Drop > 10x Δp_p: 3.10

Notes:

(1) K = 0.5 when viscous losses are negligible, K = 1.0 for return headers.
(2) Include the equivalent length of valves and fittings.
(3) Pressure drop due to velocity head and friction losses across the length of the branch pipe.
(4) Pressure at the well head taking into consideration frictional losses across the length of the drop pipe, static head associated with water elevation and mounding, and pressure drop required for foot valve or variable area valve.
(5) Maldistribution of 10 percent or less is recommended.
(6) If the branch piping exhibits average pressure losses (due to length, fittings, and/or well head pressures) of at least 10 times higher than the header, pressure losses maldistribution will be less than 10 percent.

MW-20 Bench Structural Calculations

Pre-Final Design Submittal for Final Groundwater Remedy
PG&E Topock Compressor Station
Needles, California

MW-20 Bench Carbon Amendment Building

09/08/2014

Prepared for:

Pacific Gas and Electric Company

Reviewed by:
Lawrence Tabat, P.E.
Principal Structural Engineer
ARCADIS U.S., Inc.

Prepared by

Matt Lotycz, P.E.
Project Structural Engineer
ARCADIS U.S., Inc

ARCADIS

ARCADIS

SUBJECT: TOPOCK - MW 20 BENCH

BY: [initials] DATE: 3-14-13

CHKD: DATE:

JOB NO: RC000753.0008

PAGE

SHEET 1

DEAD LOADS

ROOF PANEL	1.5 PSF
LINER	1.5
INSUL BOTT	1
PURLINS 4#/ft/2ft	2
	6 PSF

WALL LOADS	
WALL PANEL	1.5
LINER	1.5
INSUL	1
GIRTS	2
	6 PSF

COLLATERAL DL	5 PSF

LOADS ON INTERIOR FRAME SPACING = 16'-8

w_D = 6 PSF (16.67) + 50 PLF
w_D = 0.15 K/ft

w_C = 5 PSF (16.67)
w_C = 0.083

COLUMN LOAD (WALL LOADS)
P_D = 6 PSF (16.67) 12 ft
P_D = 1.2 K

LOADS ON END FRAME
w_D = 6 PSF (16.67/2) ft + 50
w_D = 0.1 K/ft

w_C = 5(16.67/2)
w_C = 0.04 K/ft

COLUMN LOAD
P_D = [6(16.67/2) + 6(25/4)] 12
P_D = 1.1 K
END WALL

(CENTER COL SUPPORTS 1/2 END WALL DL)

AGM Form 30 12-01

ARCADIS

SUBJECT:

JOB NO:

BY: PD DATE: 3-14-13

CHKD: DATE:

PAGE

SHEET 1

LIVE LOADS

ROOF LIVE 20 psf

LOADS ON INTERIOR FRAME

$w_L = 20\text{ psf}(16.67)$
$w_L = 0.33\text{ k/ft}$

LOADS ON END FRAME

$w_L = 20(16.67/2)$
$w_L = 0.17\text{ k/ft}$

FLOOR LIVE - SLAB ON GRADE 500 psf
WHEEL LOAD 16 k

IBC 2009 1609.6

h = 15 ft MEAN ROOF HEIGHT V = 90 MPH

PARTIALLY ENCLOSED ASCE 7-05 EXPOSURE C

K_z = 0.85 ASCE TBL 6-3 I = 1 CATAGORY II TBL 6-1

g_s = 20.7 psf IBC TBL 1609.6.2(1) K_{zt} = 1.0

$P_{NET} = g_s K_z C_{NET} I K_{zt}$

$= 20.7(0.85)(1)(1)$

P_{NET} = 17.6 C_{NET}

MIN WIND LOAD = 20 psf
(PG+E DESIGN CRITERIA)

USE P_{NET} = 20 psf C_{NET}

IBC TBL 1609.6.2(2)

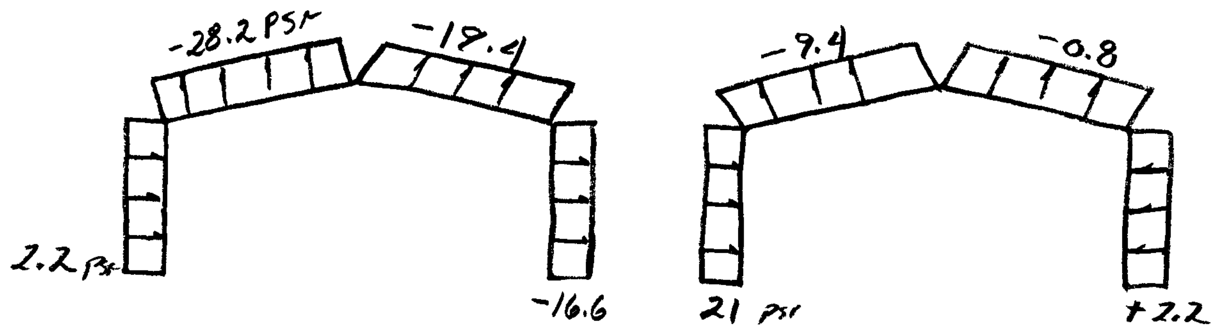
MWFRS
PARTIALLY ENCLOSED

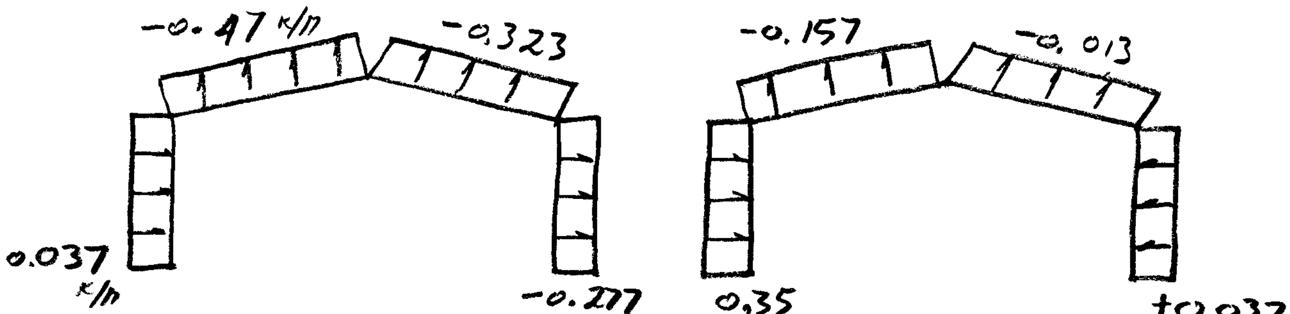
	C_{NET} CASE 1	C_{NET} CASE 2	P_{NET} (PSF) CASE 1	P_{NET} (PSF) CASE 2
WINDWARD WALL	+0.11	+1.05	+2.2	+21
LEEWARD WALL	−0.83	+0.11	−16.6	+2.2
SIDE WALL	−0.97	−0.04	−19.4	−0.8
WINDWARD ROOF	−1.41	−0.47	−28.2	−9.4
LEEWARD ROOF	−0.97	−0.04	−19.4	−0.8

ARCADIS	SUBJECT: WIND LOADS	BY: B DATE: 3-14-13	PAGE
	JOB NO:	CHKD: DATE:	SHEET 1

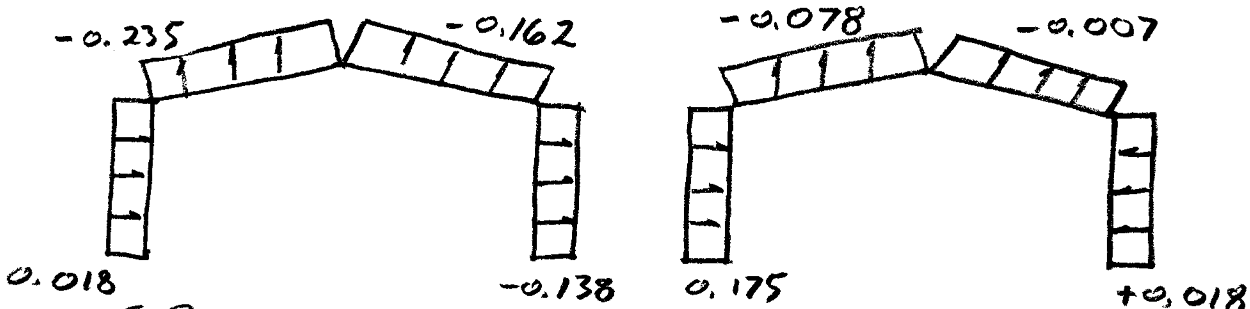
TRANSVERSE WIND

CASE 1 CASE 2





INTERIOR FRAME - TRIB AREA = 16.67 ft



END FRAME - TRIB AREA = 8.3 ft

AGM Form 30 12-01

ARCADIS

SUBJECT: WIND LOADS

JOB NO:

BY: [initials] DATE: 3-11-13

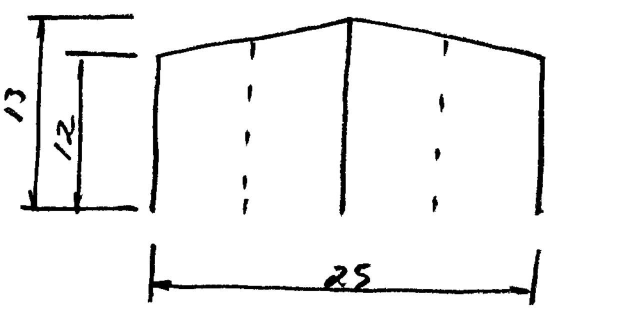
CHKD: DATE:

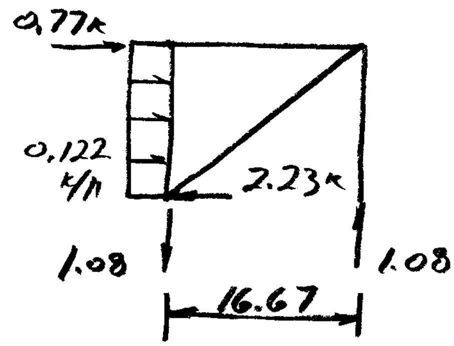
PAGE

SHEET 1

LONGITUDINAL WIND

BRACED FRAME





16.6 + 2.2 = 18.8 psf

LOAD ON END WALL COLUMN

$18.8 \text{ psf} \,(25 \text{ ft}/2) = 0.235 \text{ k/ft}$

$R_1 = 0.235 \text{ k/ft} \,(13 \text{ ft}/2) = 1.53 \text{k}$

$R_2 = 1.53 \text{k}$

LOAD ON FRAME COLUMN

$$18.8 \text{ psf} \left(\frac{25 \text{ ft}}{4}\right)\left(\frac{13 \text{ ft} + 12 \text{ ft}}{2}\right) / 12 \text{ ft} = 0.122 \text{ k/ft}$$

$P = \frac{R_2}{2} = \frac{1.53}{2}$ CONCENTRATED DIAPHRAGM LOAD AT TOP

$P = 0.77 \text{k}$

ARCADIS

SUBJECT: WIND LOADS

JOB NO:

BY: [initials] DATE: 3-14-13

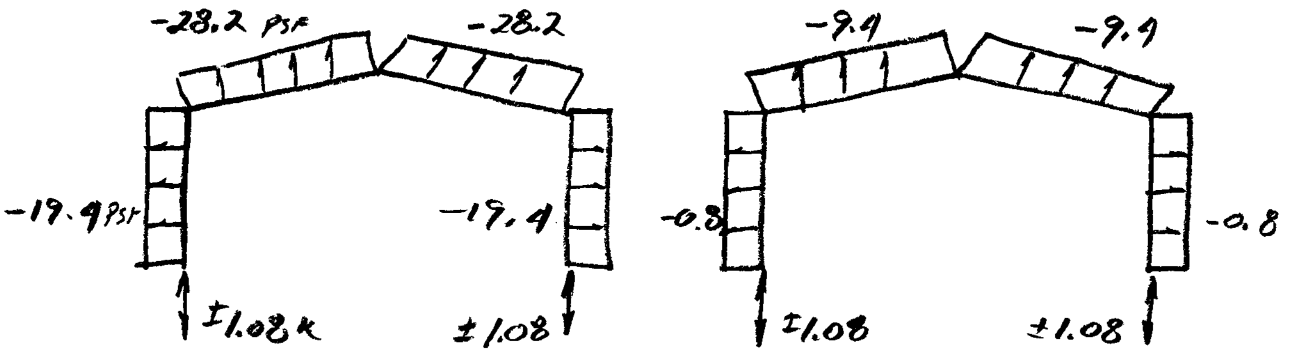
CHKD: DATE:

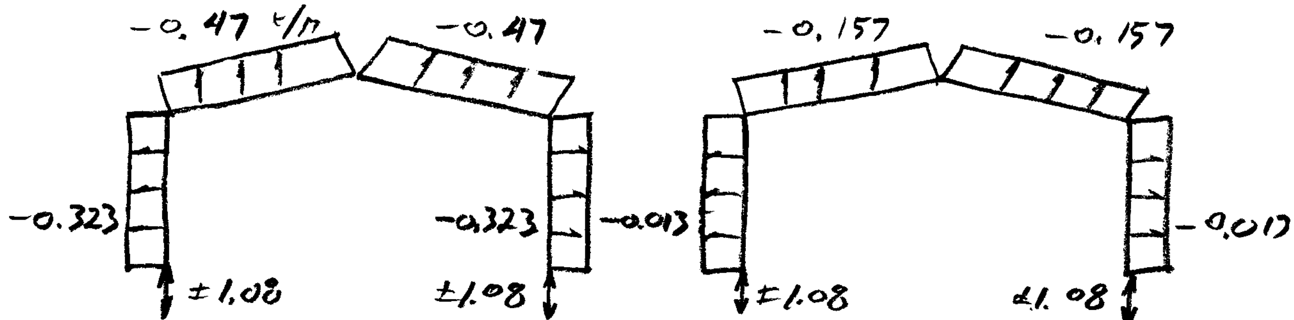
PAGE

SHEET 1

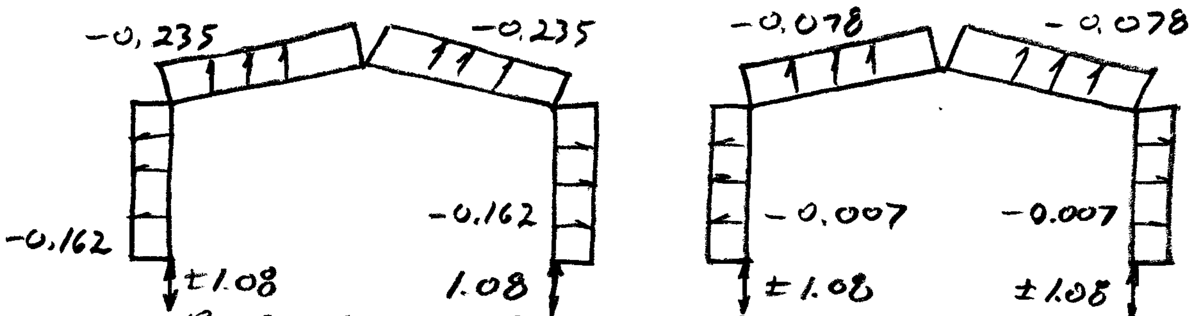
LONGITUDINAL WIND

CASE 1 CASE 2





INTERIOR FRAME - TRIB AREA = 16.67 m



END FRAME - TRIB AREA = 8.3 m

Seismic Design Equivalent Lateral Force Procedure per IBC 2009 and ASCE 7-2005

ASCE 7-20.2

Reference:H:\MATHCAD WORKSHEETS\Units.xmcd

Site Class $Class := D$ - per geotechnical engineer

Spectral Response Accelerations

$S_s := 43.4\%$ - mapped spectral acceleration for the short period, see CD rom output

$S_1 := 13.5 \cdot \%$ - mapped spectral acceleration for a 1-second period, see CD rom output

Adjusted Spectral Response Accelerations (ASCE 7-11.4.3)

$F_a = 1.45$ $S_{MS} := F_a \cdot S_s$ $S_{MS} = 63.1 \cdot \%$

$F_v = 2.26$ $S_{M1} := F_v \cdot S_1$ $S_{M1} = 30.5 \cdot \%$

Design Spectral Response Accelerations

$S_{DS} := \frac{2}{3} \cdot S_{MS}$ $S_{DS} = 42.0 \cdot \%$

$S_{D1} := \frac{2}{3} \cdot S_{M1}$ $S_{D1} = 20.3 \cdot \%$

Building Category

OccupancyCategory := "II" - IBC Table 1604.5 , Enter a Category I, II, III or IV.

$Seimic\_Design\_Category_{sds.}$ = "C" - ASCE 7 Table 11.6-1

$Seimic\_Design\_Category_{sd1.}$ = "D" - ASCE 7 Table 11.6-2

$Seismic\_Design\_Category := \max(Seimic\_Design\_Category_{sds}, Seimic\_Design\_Category_{sd1})$

Seismic_Design_Category = "D"

ASCE Table 12.2-1 Design Coefficients and Factors for Seismic Force-Resisting Systems

Select Seismic Force-Resisting System:

4. Ordinary steel moment frames

DETAILING REFERENCE SECTION	Refer to IBC
RESPONSE MODIFICATION COEFFICIENT, R[a]	3.5
SYSTEM OVER-STRENGTH FACTOR, – [g]	3
DEFLECTION AMPLIFICATION FACTOR, C_D[b]	3
BASIC SEISMIC-FORCE-RESISTING SYSTEM	C - 4

Str. System Limitions and Building Height				
Seismic Design Category				
B	C	D	E	F
NL	NL	NPh	NPh	NPi

Equivalent Lateral Force Procedure (ASCE 7-12.8)

$V := C_S \cdot W$ W = effective seismic weight per ASCE 7 section 12.7.2

C_s= seismic response coefficient

$R = 3.5$ - Response Modification Coef. (ASCE 7 - Table 12.2-1)

$I_E = 1$ - Seismic Importance Factor (ASCE 7 - Table 11.5-1)

ASCE 7-12.8.1

$$C_{s\_2} := \frac{S_{DS}}{\frac{R}{I_E}}$$ $C_{s\_2} = 12.01\cdot\%$ - ASCE 7 equation 12.8-2

ASCE 7-12.8.2.1 $T_L := 6$ - ASCE 7 figure 22-15

Structure Type (ASCE 7 Table 12.8-2)	Ct	x
Steel moment-resisting frames	0.028	0.8

$h_n := 12$ - height in ft above the base to the highest level of th structure

$T_a := C_T \cdot h_n^{\,x}$ $T_a = 0.204$ - ASCE 7 equation 12.8-7

$$C_{s\_3} := \frac{S_{D1}}{T_a \cdot \frac{R}{I_E}}$$ $C_{s\_3} = 28.43\cdot\%$ - ASCE 7 equation 12.8-3

$$C_{s\_4} := \frac{S_{D1} \cdot T_L}{T_a^{\,2} \cdot \frac{R}{I_E}}$$ $C_{s\_4} = 834.50\cdot\%$ - ASCE 7 equation 12.8-4

$$C_{s\_3\_4} := \begin{cases} C_{s\_3} & \text{if } T_a \le T_L \\ C_{s\_4} & \text{if } T_a > T_L \end{cases}$$ $C_{s\_3\_4} = 28.43\cdot\%$

$C_{s\_5} := 0.01$ $C_{s\_5} = 1.00\cdot\%$ - ASCE 7 equation 12.8-5

$$C_{s\_6} := \frac{0.5 \cdot S_1}{\frac{R}{I_E}}$$ $C_{s\_6} = 1.93\cdot\%$ - ASCE 7 equation 12.8-6

Seismic Response Coefficient in accordance with ASCE 7 section 12.8.1.1

$$C_s := \begin{cases} \max(\min(C_{s\_2}, C_{s\_3\_4}), C_{s\_5}) & \text{if } S_1 < 0.06 \\ \max(\max(\min(C_{s\_2}, C_{s\_3\_4}), C_{s\_5}), C_{s\_6}) & \text{if } S_1 \ge 0.06 \end{cases}$$

$C_s = 12.01\cdot\%$

$0.7C_s = 8.41\cdot\%$

Seismic Load Effects and Combinations (ASCE 7-12.4)

$E := E_h + E_v$ - ASCE 7 equation 12.4-1

$E := E_h - E_v$ - ASCE 7 equation 12.4-2

$E_h := \rho \cdot Q_E$ - ASCE 7 equation 12.4-2

$\rho := 1.3$

$Q_E := C_s$

	Factored	Service
$E_h := \rho \cdot Q_E$	$E_h = 0.156 \cdot W$	$0.7 \cdot E_h = 0.109 \cdot W$
$E_v := \begin{cases} 0 & \text{if } S_{DS} \le 0.125 \\ (0.2 \cdot S_{DS} \cdot D) & \text{otherwise} \end{cases}$	$E_v = 0.084 \cdot D$	$0.7E_v = 0.059 \cdot D$

Determining Dynamic Soil Pressure Coefficient

$K_h := \frac{S_{DS}}{2.5}$ $K_h = 16.814 \cdot \%$ - 2003 NEHRP Commentary, Chapter 7, pg 156

Seismic Design Equivalent Lateral Force Procedure per IBC 2009 and ASCE 7-2005

ASCE 7-20.2

Reference:H:\MATHCAD WORKSHEETS\Units.xmcd

Site Class Class := D - per geotechnical engineer

Spectral Response Accelerations

$S_s := 43.4\%$ - mapped spectral acceleration for the short period, see CD rom output

$S_1 := 13.5\%$ - mapped spectral acceleration for a 1-second period, see CD rom output

Adjusted Spectral Response Accelerations (ASCE 7-11.4.3)

Design Spectral Response Accelerations

$F_a = 1.45$ $S_{MS} := F_a \cdot S_s$ $S_{MS} = 63.1 \cdot \%$ $S_{DS} := \frac{2}{3} \cdot S_{MS}$ $S_{DS} = 42.0 \cdot \%$

$F_v = 2.26$ $S_{M1} := F_v \cdot S_1$ $S_{M1} = 30.5 \cdot \%$ $S_{D1} := \frac{2}{3} \cdot S_{M1}$ $S_{D1} = 20.3 \cdot \%$

Building Category

OccupancyCategory := "II" - IBC Table 1604.5 , Enter a Category I, II, III or IV.

$Seimic\_Design\_Category_{sds.}$ = "C" - ASCE 7 Table 11.6-1

$Seimic\_Design\_Category_{sd1.}$ = "D" - ASCE 7 Table 11.6-2

Seismic_Design_Category := max(Seimic_Design_Category$_{sds}$, Seimic_Design_Category$_{sd1}$)

Seismic_Design_Category = "D"

ASCE Table 12.2-1 Design Coefficients and Factors for Seismic Force-Resisting Systems

Select Seismic Force-Resisting System:

4. Ordinary steel concentrically braced frames

DETAILING REFERENCE SECTION	Refer to IBC
RESPONSE MODIFICATION COEFFICIENT, R[a]	3.25
SYSTEM OVER-STRENGTH FACTOR, □[g]	2
DEFLECTION AMPLIFICATION FACTOR, C_D[b]	3.25
BASIC SEISMIC-FORCE-RESISTING SYSTEM	B - 4

Str. System Limitions and Building Height				
Seismic Design Category				
B	C	D	E	F
NL	NL	35j	35j	NPj

Equivalent Lateral Force Procedure (ASCE 7-12.8)

$V := C_S \cdot W$ — W = effective seismic weight per ASCE 7 section 12.7.2; C_s= seismic response coefficient

$R = 3.25$ - Response Modification Coef. (ASCE 7 - Table 12.2-1)

$I_E = 1$ - Seismic Importance Factor (ASCE 7 - Table 11.5-1)

ASCE 7-12.8.1

$$C_{S\_2} := \frac{S_{DS}}{\frac{R}{I_E}} \qquad C_{S\_2} = 12.93 \cdot \%$$ - ASCE 7 equation 12.8-2

ASCE 7-12.8.2.1 $T_L := 6$ - ASCE 7 figure 22-15

Structure Type (ASCE 7 Table 12.8-2)	Ct	x
All other structural systems	0.02	0.7

$h_n := 12$ - height in ft above the base to the highest level of the structure

$T_a := C_T \cdot h_n^{\,x}$ $T_a = 0.129$ - ASCE 7 equation 12.8-7

$$C_{S\_3} := \frac{S_{D1}}{T_a \cdot \frac{R}{I_E}} \qquad C_{S\_3} = 48.53 \cdot \%$$ - ASCE 7 equation 12.8-3

$$C_{S\_4} := \frac{S_{D1} \cdot T_L}{T_a^{\,2} \cdot \frac{R}{I_E}} \qquad C_{S\_4} = 2258.33 \cdot \%$$ - ASCE 7 equation 12.8-4

$$C_{S\_3\_4} := \begin{cases} C_{S\_3} & \text{if } T_a \le T_L \\ C_{S\_4} & \text{if } T_a > T_L \end{cases} \qquad C_{S\_3\_4} = 48.53 \cdot \%$$

$C_{S\_5} := 0.01$ $C_{S\_5} = 1.00 \cdot \%$ - ASCE 7 equation 12.8-5

$$C_{S\_6} := \frac{0.5 \cdot S_1}{\frac{R}{I_E}} \qquad C_{S\_6} = 2.08 \cdot \%$$ - ASCE 7 equation 12.8-6

Seismic Response Coefficient in accordance with ASCE 7 section 12.8.1.1

$$C_S := \begin{cases} \max(\min(C_{S\_2}, C_{S\_3\_4}), C_{S\_5}) & \text{if } S_1 < 0.06 \\ \max(\max(\min(C_{S\_2}, C_{S\_3\_4}), C_{S\_5}), C_{S\_6}) & \text{if } S_1 \ge 0.06 \end{cases}$$

$C_S = 12.93 \cdot \%$

$0.7C_S = 9.05 \cdot \%$

ARCADIS
Infrastructure · Water · Environment · Buildings

By:	PJD	Date:	3/13/2013	Page:	of
Checked by:		Date:		Job No.	RC000753.0008
Project:	TOPOCK GROUNDWATER REMEDIATION PROJECT				
Subject:	MW-20 BENCH BUILDING		BRACED FRAMES		

Seismic Load Effects and Combinations (ASCE 7-12.4)

$E := E_h + E_v$ - ASCE 7 equation 12.4-1

$E := E_h - E_v$ - ASCE 7 equation 12.4-2

$E_h := \rho \cdot Q_E$ - ASCE 7 equation 12.4-2

$\rho := 1.3$

$Q_E := C_s$

	Factored	Service
$E_h := \rho \cdot Q_E$	$E_h = 0.168 \cdot W$	$0.7 \cdot E_h = 0.118 \cdot W$
$E_v := \begin{cases} 0 & \text{if } S_{DS} \le 0.125 \\ (0.2 \cdot S_{DS} \cdot D) & \text{otherwise} \end{cases}$	$E_v = 0.084 \cdot D$	$0.7E_v = 0.059 \cdot D$

ARCADIS

SUBJECT: SEISMIC LOAD COMBINATIONS

JOB NO:

BY: [signature] DATE: 3-14-13

CHKD: DATE:

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SHEET 1

STRENGTH COMBINATIONS

$1.2D + 1.0E$

$E = \rho Q_E + 0.2 S_{DS} D$

$\rho = 1.3 \quad S_{DS} = 0.42$

$1.2D + \rho Q_E + 0.2 S_{DS} D$

$1.2D + 1.3 Q_E + 0.2(0.42)D$

$(1.2 + 0.084)D + 1.3 Q_E$

$1.284D + 1.3 Q_E$

$0.9D + 1.0E$

$0.9D - 0.2 S_{DS} D + \rho Q_E$

$0.9D - 0.2(0.42)D + 1.3 Q_E$

$(0.9 - 0.084)D + 1.3 Q_E$

$0.816D + 1.3 Q_E$

ARCADIS

SUBJECT: SEISMIC LOAD COMBINATIONS

JOB NO:

BY: PD DATE: 3-14-13

CHKD: DATE:

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SHEET 1

SERVICE LOAD COMBINATIONS

$$(1.0 + 0.14 S_{DS}) D + 0.7 \rho q_L$$

$$(1 + 0.14(0.42)) D + 0.7(1.3) q_L$$

$$1.06 D + 0.91 q_L$$

$$(0.6 - 0.14 S_{DS}) D + 0.7 \rho q_L$$

$$(0.6 - 0.14(0.42)) D + 0.7(1.3) q_L$$

$$0.541 D + 0.91 q_L$$

ARCADIS

SUBJECT: SEISMIC COMBINATIONS

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SHEET 1

ORTHOGONAL COMBINATIONS AS PER 12.5.4
FOR SDC D

STRENGTH COMBINATIONS

COMBINE 100% Q BRACED FRAME Q_2
30% Q MOMENT FRAME Q_1

$1.2D + 1.0E$

$1.2D + 0.3\rho Q_1 + \rho Q_2 + 0.2 S_{DS} D$

$1.284D + 0.39 Q_1 + 1.3 Q_2$

$0.9D + 1.0E$

$0.9D - 0.2 S_{DS} + 0.3 \rho Q_1 + \rho Q_2$

$0.816D + 0.39 Q_1 + 1.3 Q_2$

ARCADIS

SUBJECT: SEISMIC COMBINATIONS

JOB NO:

BY: [illegible] DATE: 3-14-13

CHKD: DATE:

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SHEET 1

ORTHOGONAL COMBINATIONS

SERVICE LOAD COMBINATIONS

$$(1.0 + 0.14 S_{DS})D + 0.3(0.7)\rho q_1 + 0.7 \rho q_2$$

$$1.06D + 0.273 q_1 + 0.91 q_2$$

$$(0.6 - 0.14 S_{DS})D + 0.3(0.7)\rho q_1 + 0.7 \rho q_2$$

$$0.541D + 0.273 q_1 + 0.91 q_2$$

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SUBJECT: SEISMIC

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SHEET 1

MOMENT FRAMES

INTERIOR MOMENT FRAME

$C_s = 0.12$

$q_E = C_s W$

W = EFFECTIVE SEISMIC WEIGHT
= DL + COLLATERAL

W =	0.15 k/ft (25 ft)	=	3.8
	2 (1.2)	=	2.4
	0.083 k/ft (25 ft)	=	2.1
W =			8.3 k

$q_E = 0.12(8.3)$
$q_E = 1$ k

END MOMENT FRAME

W =	0.1 k/ft (25) ft	=	2.5
	2 (1.5)	=	3
	0.04 k/ft (25)	=	1
W =			6.5 k

$q_E = 0.12(6.5)$
$q_E = 0.8$ k

ARCADIS

SUBJECT: SEISMIC

JOB NO:

BY: [signature] DATE: 3-14-13

CHKD: DATE:

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SHEET 1

BRACED FRAMES

$C_s = 0.13$

$q_E = C_s W$

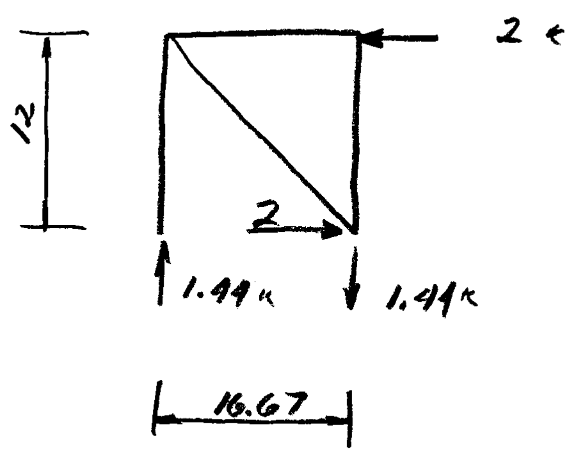
$W = \frac{8.3}{2\ \text{SIDES}}(2) + \frac{6.5k}{2\ \text{SIDES}}\,2$

2 INT FRAMES, 2 END FRAMES

$W = 14.8\ k$

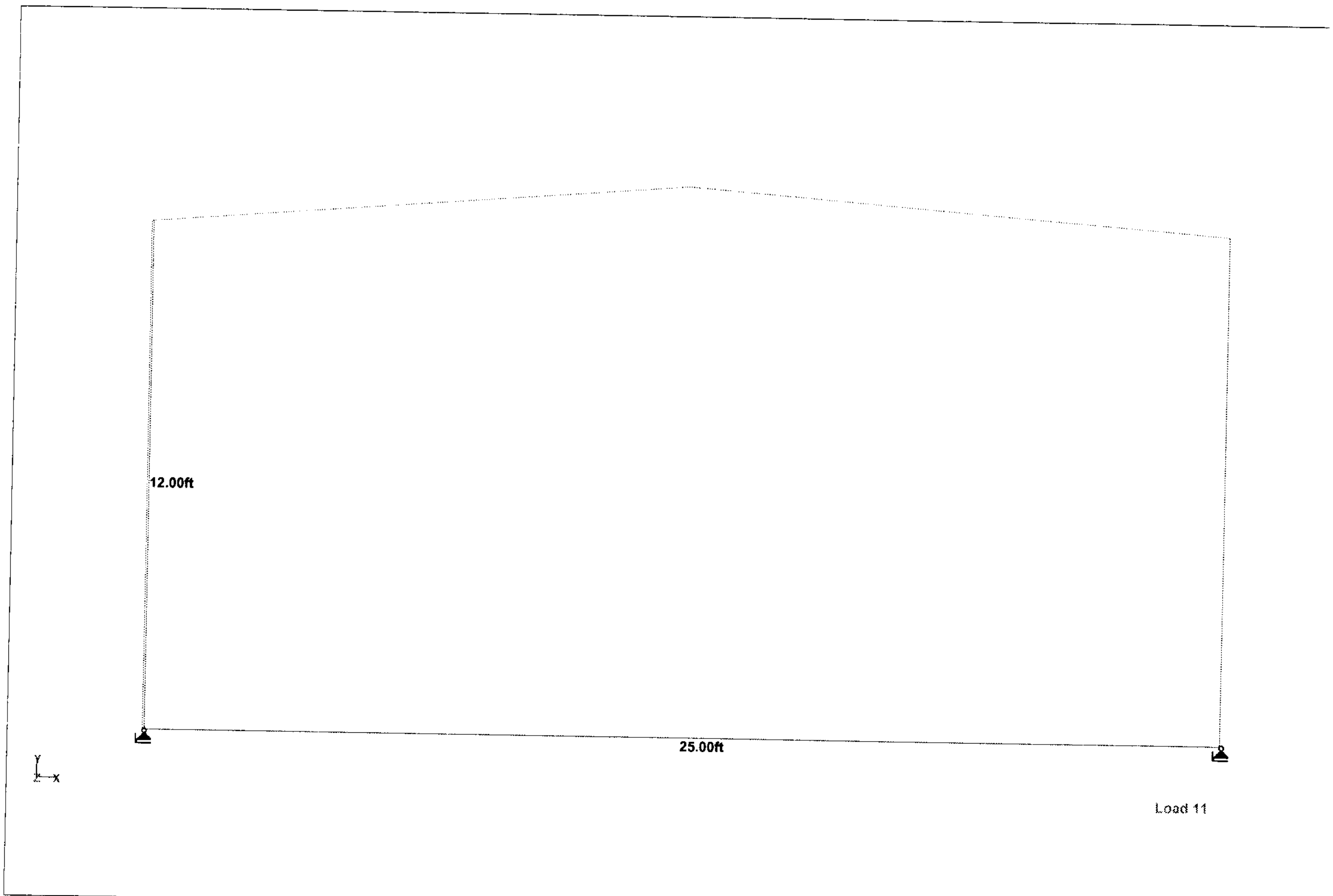
$q_E = 0.13(14.8)$

$q_E = 2\ k$



AGM Form 30 12-01

Software licensed to ARCADIS	Job No RC000753.000	Sheet No 1		Re
Job Title Topock Groundwater Remediation Project	Part End Frame			
	Ref			
	By PJD	Date 14-Mar-13	Chd	
Client PG&E	File END FRAME.std	Date/Time 15-Mar-201		



Whole Structure

Basic Load Cases

Number	Name
1	DEAD
2	COLLATERAL
3	WIND1
4	WIND2
5	WIND3
6	WIND4
7	WIND5
8	LIVE1
9	LIVE2
10	Q1
11	Q2

Combination Load Cases

Comb.	Combination L/C Name	Primary	Primary L/C Name	Factor
13	1.2D + 1.6L1	1	DEAD	1.20
		2	COLLATERAL	1.20
		8	LIVE1	1.60
14	1.2D + 1.6L2	1	DEAD	1.20
		2	COLLATERAL	1.20
		9	LIVE2	1.60
15	1.2D + 1.6L1 + 0.8W2	1	DEAD	1.20
		2	COLLATERAL	1.20
		8	LIVE1	1.60
		4	WIND2	0.80
16	1.2D + 1.6L1 + 0.8(W4-W5)	1	DEAD	1.20
		2	COLLATERAL	1.20
		8	LIVE1	1.60
		6	WIND4	0.80
		7	WIND5	-0.80
17	1.2D + 1.6L2 + 0.8W2	1	DEAD	1.20
		2	COLLATERAL	1.20
		9	LIVE2	1.60
		4	WIND2	0.80
18	1.2D + 1.6L2 + 0.8(W4-W5)	1	DEAD	1.20
		2	COLLATERAL	1.20
		9	LIVE2	1.60
		6	WIND4	0.80
		7	WIND5	-0.80
19	1.2D + 0.5L1 + 1.6W2	1	DEAD	1.20
		2	COLLATERAL	1.20
		8	LIVE1	0.50
		4	WIND2	1.60
20	1.2D + 0.5L1 + 1.6(W4-W5)	1	DEAD	1.20
		2	COLLATERAL	1.20
		8	LIVE1	0.50
		6	WIND4	1.60
		7	WIND5	-1.60
21	1.2D + 0.5L2 + 1.6W2	1	DEAD	1.20
		2	COLLATERAL	1.20
		9	LIVE2	0.50
		4	WIND2	1.60
22	1.2D + 0.5L2 + 1.6(W4-W5)	1	DEAD	1.20
		2	COLLATERAL	1.20
		9	LIVE2	0.50
		6	WIND4	1.60
		7	WIND5	-1.60
23	0.9D + 1.6W1	1	DEAD	0.90
		3	WIND1	1.60
24	0.9D + 1.6(W3+W5)	1	DEAD	0.90
		5	WIND3	1.60

Combination Load Cases Cont...

Comb.	Combination L/C Name	Primary	Primary L/C Name	Factor
		7	WIND5	1.60
25	1.284D + 1.3Q1	1	DEAD	1.28
		2	COLLATERAL	1.28
		10	Q1	1.30
26	1.284D + 1.3Q2	1	DEAD	1.28
		2	COLLATERAL	1.28
		11	Q2	-1.30
27	0.816D + 1.3Q2	1	DEAD	0.82
		11	Q2	1.30
28	1.284D + 0.39Q1 + 1.3Q2	1	DEAD	1.28
		2	COLLATERAL	1.28
		10	Q1	0.39
		11	Q2	-1.30
29	0.816D + 0.39Q1 + 1.3Q2	1	DEAD	0.82
		10	Q1	0.39
		11	Q2	1.30
30	D + L1	1	DEAD	1.00
		2	COLLATERAL	1.00
		8	LIVE1	1.00
31	D + L2	1	DEAD	1.00
		2	COLLATERAL	1.00
		9	LIVE2	1.00
32	D + 0.75L1 + 0.75W2	1	DEAD	1.00
		2	COLLATERAL	1.00
		8	LIVE1	0.75
		4	WIND2	0.75
33	D + 0.75L1 + 0.75(W4-W5)	1	DEAD	1.00
		2	COLLATERAL	1.00
		8	LIVE1	0.75
		6	WIND4	0.75
		7	WIND5	-0.75
34	D + 0.75L2 + 0.75W2	1	DEAD	1.00
		2	COLLATERAL	1.00
		9	LIVE2	0.75
		4	WIND2	0.75
35	D + 0.75L2 + 0.75(W4-W5)	1	DEAD	1.00
		2	COLLATERAL	1.00
		9	LIVE2	0.75
		6	WIND4	0.75
		7	WIND5	-0.75
36	0.6D + 1.0W1	1	DEAD	0.60
		3	WIND1	1.00
37	0.6D + 1.0(W3+W5)	1	DEAD	0.60
		5	WIND3	1.00
		7	WIND5	1.00
38	1.06D + 0.91Q1	1	DEAD	1.06

Combination Load Cases Cont...

Comb.	Combination L/C Name	Primary	Primary L/C Name	Factor
		2	COLLATERAL	1.06
		10	Q1	0.91
39	1.06D + 0.91Q2	1	DEAD	1.06
		2	COLLATERAL	1.06
		11	Q2	0.91
40	0.54D + 0.91Q2	1	DEAD	0.54
		11	Q2	0.91
41	1.06D + 0.273Q1 + 0.91Q2	1	DEAD	1.06
		2	COLLATERAL	1.06
		10	Q1	0.27
		11	Q2	0.91
42	0.54D + 0.273Q1 + 0.91Q2	1	DEAD	0.54
		10	Q1	0.27
		11	Q2	0.91

```
STAAD PLANE
START JOB INFORMATION
ENGINEER DATE 14-Mar-13
JOB NAME Topock Groundwater Remediation Project
JOB CLIENT PG&E
JOB NO RC000753.0008
JOB PART End Frame
ENGINEER NAME PJD
END JOB INFORMATION
INPUT WIDTH 79
UNIT FEET KIP
JOINT COORDINATES
1 0 0 0; 2 25 0 0; 3 12.5 13 0; 4 0 12 0; 5 25 12 0;
MEMBER INCIDENCES
1 1 4; 2 2 5; 3 4 3; 4 3 5;
DEFINE MATERIAL START
ISOTROPIC STEEL
E 4.176e+006
POISSON 0.3
DENSITY 0.489024
ALPHA 6e-006
DAMP 0.03
TYPE STEEL
STRENGTH FY 5184 FU 8352 RY 1.5 RT 1.2
END DEFINE MATERIAL
MEMBER PROPERTY AMERICAN
1 TO 4 TABLE ST W24X55
CONSTANTS
MATERIAL STEEL ALL
SUPPORTS
1 2 PINNED
LOAD 1 LOADTYPE None  TITLE DEAD
MEMBER LOAD
3 4 UNI GY -0.1
JOINT LOAD
4 5 FY -1.1
LOAD 2 LOADTYPE None  TITLE COLLATERAL
MEMBER LOAD
3 4 UNI GY -0.04
LOAD 3 LOADTYPE None  TITLE WIND1
* TRANSVERSE WIND
MEMBER LOAD
1 UNI GX 0.018
3 UNI Y 0.235
2 UNI GX 0.138
4 UNI Y 0.162
LOAD 4 LOADTYPE None  TITLE WIND2
* TRANSVERSE WIND
MEMBER LOAD
1 UNI GX 0.175
2 UNI GX -0.018
3 UNI Y 0.078
4 UNI Y 0.007
LOAD 5 LOADTYPE None  TITLE WIND3
* LONGITUDINAL WIND SIDEWALL FRAME LOADS
MEMBER LOAD
3 4 UNI Y 0.235
1 UNI GX -0.162
2 UNI GX 0.162
LOAD 6 LOADTYPE None  TITLE WIND4
* LONGITUDINAL WIND SIDEWALL FRAME LOADS
MEMBER LOAD
3 4 UNI Y 0.078
1 UNI GX -0.007
2 UNI GX 0.007
LOAD 7 LOADTYPE None  TITLE WIND5
```

```
* LONGITUDINAL WIND X BRACE COLUMN LOADS
JOINT LOAD
1 2 FY 1.08
LOAD 8 LOADTYPE None  TITLE LIVE1
MEMBER LOAD
3 4 UNI GY -0.17
LOAD 9 LOADTYPE None  TITLE LIVE2
MEMBER LOAD
3 UNI GY -0.17
LOAD 10 LOADTYPE None  TITLE Q1
* E-W SEISMIC
JOINT LOAD
4 FX 0.8
LOAD 11 LOADTYPE None  TITLE Q2
* N-S SEISMIC
JOINT LOAD
1 2 FY 1.44
LOAD COMB 13 1.2D + 1.6L1
1 1.2 2 1.2 8 1.6
LOAD COMB 14 1.2D + 1.6L2
1 1.2 2 1.2 9 1.6
LOAD COMB 15 1.2D + 1.6L1 + 0.8W2
1 1.2 2 1.2 8 1.6 4 0.8
LOAD COMB 16 1.2D + 1.6L1 + 0.8(W4-W5)
1 1.2 2 1.2 8 1.6 6 0.8 7 -0.8
LOAD COMB 17 1.2D + 1.6L2 + 0.8W2
1 1.2 2 1.2 9 1.6 4 0.8
LOAD COMB 18 1.2D + 1.6L2 + 0.8(W4-W5)
1 1.2 2 1.2 9 1.6 6 0.8 7 -0.8
LOAD COMB 19 1.2D + 0.5L1 + 1.6W2
1 1.2 2 1.2 8 0.5 4 1.6
LOAD COMB 20 1.2D + 0.5L1 + 1.6(W4-W5)
1 1.2 2 1.2 8 0.5 6 1.6 7 -1.6
LOAD COMB 21 1.2D + 0.5L2 + 1.6W2
1 1.2 2 1.2 9 0.5 4 1.6
LOAD COMB 22 1.2D + 0.5L2 + 1.6(W4-W5)
1 1.2 2 1.2 9 0.5 6 1.6 7 -1.6
LOAD COMB 23 0.9D + 1.6W1
1 0.9 3 1.6
LOAD COMB 24 0.9D + 1.6(W3+W5)
1 0.9 5 1.6 7 1.6
LOAD COMB 25 1.284D + 1.3Q1
1 1.284 2 1.284 10 1.3
LOAD COMB 26 1.284D + 1.3Q2
1 1.284 2 1.284 11 -1.3
LOAD COMB 27 0.816D + 1.3Q2
1 0.816 11 1.3
* 30%Q1 + 100%Q2
LOAD COMB 28 1.284D + 0.39Q1 + 1.3Q2
1 1.284 2 1.284 10 0.39 11 -1.3
* 30%Q1 + 100%Q2
LOAD COMB 29 0.816D + 0.39Q1 + 1.3Q2
1 0.816 10 0.39 11 1.3
* SERVICE COMBINATIONS
LOAD COMB 30 D + L1
1 1.0 2 1.0 8 1.0
LOAD COMB 31 D + L2
1 1.0 2 1.0 9 1.0
LOAD COMB 32 D + 0.75L1 + 0.75W2
1 1.0 2 1.0 8 0.75 4 0.75
LOAD COMB 33 D + 0.75L1 + 0.75(W4-W5)
1 1.0 2 1.0 8 0.75 6 0.75 7 -0.75
LOAD COMB 34 D + 0.75L2 + 0.75W2
1 1.0 2 1.0 9 0.75 4 0.75
LOAD COMB 35 D + 0.75L2 + 0.75(W4-W5)
1 1.0 2 1.0 9 0.75 6 0.75 7 -0.75
```

```
LOAD COMB 36 0.6D + 1.0W1
1 0.6 3 1.0
LOAD COMB 37 0.6D + 1.0(W3+W5)
1 0.6 5 1.0 7 1.0
LOAD COMB 38 1.06D + 0.91Q1
1 1.06 2 1.06 10 0.91
LOAD COMB 39 1.06D + 0.91Q2
1 1.06 2 1.06 11 0.91
LOAD COMB 40 0.54D + 0.91Q2
1 0.54 11 0.91
* 30%Q1 + 100%Q2
LOAD COMB 41 1.06D + 0.273Q1 + 0.91Q2
1 1.06 2 1.06 10 0.273 11 0.91
* 30%Q1 + 100%Q2
LOAD COMB 42 0.54D + 0.273Q1 + 0.91Q2
1 0.54 10 0.273 11 0.91
PERFORM ANALYSIS
FINISH
```

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Job No	Sheet No	Re
RC000753.000	1	

Job Title: Topock Groundwater Remediation Project

Part: End Frame

Ref

By: PJD Date: 14-Mar-13 Chd

Client: PG&E

File: END FRAME.std Date/Time: 21-Mar-201

Reactions

Node	L/C	Horizontal FX (kip)	Vertical FY (kip)	Horizontal FZ (kip)	Moment MX (kip-ft)	Moment MY (kip-ft)	Moment MZ (kip-ft)
1	1:DEAD	0.32	2.35	0.00	0.00	0.00	0.00
	2:COLLATERA	0.13	0.50	0.00	0.00	0.00	0.00
	3:WIND1	-1.18	-3.12	0.00	0.00	0.00	0.00
	4:WIND2	-1.61	-1.17	0.00	0.00	0.00	0.00
	5:WIND3	0.20	-2.94	0.00	0.00	0.00	0.00
	6:WIND4	-0.21	-0.98	0.00	0.00	0.00	0.00
	7:WIND5	0.00	-1.08	0.00	0.00	0.00	0.00
	8:LIVE1	0.55	2.13	0.00	0.00	0.00	0.00
	9:LIVE2	0.27	1.60	0.00	0.00	0.00	0.00
	10:Q1	-0.41	-0.38	0.00	0.00	0.00	0.00
	11:Q2	0.00	-1.44	0.00	0.00	0.00	0.00
2	1:DEAD	-0.32	2.35	0.00	0.00	0.00	0.00
	2:COLLATERA	-0.13	0.50	0.00	0.00	0.00	0.00
	3:WIND1	-0.62	-1.84	0.00	0.00	0.00	0.00
	4:WIND2	-0.20	0.11	0.00	0.00	0.00	0.00
	5:WIND3	-0.20	-2.94	0.00	0.00	0.00	0.00
	6:WIND4	0.21	-0.98	0.00	0.00	0.00	0.00
	7:WIND5	0.00	-1.08	0.00	0.00	0.00	0.00
	8:LIVE1	-0.55	2.13	0.00	0.00	0.00	0.00
	9:LIVE2	-0.27	0.53	0.00	0.00	0.00	0.00
	10:Q1	-0.39	0.38	0.00	0.00	0.00	0.00
	11:Q2	0.00	-1.44	0.00	0.00	0.00	0.00

Software licensed to ARCADIS	Job No RC000753.000	Sheet No 1	Re
Job Title Topock Groundwater Remediation Project	Part End Frame		
	Ref		
	By PJD	Date 14-Mar-13	Chd
Client PG&E	File END FRAME.std	Date/Time 21-Mar-201	

Reactions

		Horizontal	Vertical	Horizontal	Moment		
Node	L/C	FX (kip)	FY (kip)	FZ (kip)	MX (kip`ft)	MY (kip`ft)	MZ (kip`ft)
1	13:1.2D + 1.6L	1.42	6.84	0.00	0.00	0.00	0.00
	14:1.2D + 1.6L	0.98	5.98	0.00	0.00	0.00	0.00
	15:1.2D + 1.6L	0.13	5.90	0.00	0.00	0.00	0.00
	16:1.2D + 1.6L	1.25	6.92	0.00	0.00	0.00	0.00
	17:1.2D + 1.6L	-0.31	5.05	0.00	0.00	0.00	0.00
	18:1.2D + 1.6L	0.81	6.07	0.00	0.00	0.00	0.00
	19:1.2D + 0.5L	-1.76	2.62	0.00	0.00	0.00	0.00
	20:1.2D + 0.5L	0.48	4.66	0.00	0.00	0.00	0.00
	21:1.2D + 0.5L	-1.90	2.35	0.00	0.00	0.00	0.00
	22:1.2D + 0.5L	0.34	4.39	0.00	0.00	0.00	0.00
	23:0.9D + 1.6W	-1.60	-2.88	0.00	0.00	0.00	0.00
	24:0.9D + 1.6(\	0.61	-4.31	0.00	0.00	0.00	0.00
	25:1.284D + 1.	0.04	3.17	0.00	0.00	0.00	0.00
	26:1.284D + 1.	0.58	5.54	0.00	0.00	0.00	0.00
	27:0.816D + 1.	0.26	0.05	0.00	0.00	0.00	0.00
	28:1.284D + 0.	0.42	5.39	0.00	0.00	0.00	0.00
	29:0.816D + 0.	0.10	-0.10	0.00	0.00	0.00	0.00
2	13:1.2D + 1.6L	-1.42	6.84	0.00	0.00	0.00	0.00
	14:1.2D + 1.6L	-0.98	4.28	0.00	0.00	0.00	0.00
	15:1.2D + 1.6L	-1.58	6.92	0.00	0.00	0.00	0.00
	16:1.2D + 1.6L	-1.25	6.92	0.00	0.00	0.00	0.00
	17:1.2D + 1.6L	-1.14	4.37	0.00	0.00	0.00	0.00
	18:1.2D + 1.6L	-0.81	4.36	0.00	0.00	0.00	0.00
	19:1.2D + 0.5L	-1.14	4.66	0.00	0.00	0.00	0.00
	20:1.2D + 0.5L	-0.48	4.66	0.00	0.00	0.00	0.00
	21:1.2D + 0.5L	-1.00	3.86	0.00	0.00	0.00	0.00
	22:1.2D + 0.5L	-0.34	3.86	0.00	0.00	0.00	0.00
	23:0.9D + 1.6W	-1.28	-0.83	0.00	0.00	0.00	0.00
	24:0.9D + 1.6(\	-0.61	-4.31	0.00	0.00	0.00	0.00
	25:1.284D + 1.	-1.08	4.17	0.00	0.00	0.00	0.00
	26:1.284D + 1.	-0.58	5.54	0.00	0.00	0.00	0.00
	27:0.816D + 1.	-0.26	0.05	0.00	0.00	0.00	0.00
	28:1.284D + 0.	-0.73	5.69	0.00	0.00	0.00	0.00
	29:0.816D + 0.	-0.41	0.20	0.00	0.00	0.00	0.00

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Job No	Sheet No	Re
RC000753.000	1	

Part End Frame

Ref

By PJD Date 14-Mar-13 Chd

File END FRAME.std Date/Time 21-Mar-201

Job Title Topock Groundwater Remediation Project

Client PG&E

Reactions

Node	L/C	Horizontal FX (kip)	Vertical FY (kip)	Horizontal FZ (kip)	Moment MX (kip·ft)	MY (kip·ft)	MZ (kip·ft)
1	30:D + L1	1.00	4.99	0.00	0.00	0.00	0.00
	31:D + L2	0.72	4.45	0.00	0.00	0.00	0.00
	32:D + 0.75L1	-0.35	3.58	0.00	0.00	0.00	0.00
	33:D + 0.75L1	0.70	4.53	0.00	0.00	0.00	0.00
	34:D + 0.75L2	-0.55	3.18	0.00	0.00	0.00	0.00
	35:D + 0.75L2	0.50	4.13	0.00	0.00	0.00	0.00
	36:0.6D + 1.0W	-0.99	-1.71	0.00	0.00	0.00	0.00
	37:0.6D + 1.0(\	0.39	-2.61	0.00	0.00	0.00	0.00
	38:1.06D + 0.9	0.10	2.68	0.00	0.00	0.00	0.00
	39:1.06D + 0.9	0.48	1.72	0.00	0.00	0.00	0.00
	40:0.54D + 0.9	0.17	-0.04	0.00	0.00	0.00	0.00
	41:1.06D + 0.2	0.36	1.61	0.00	0.00	0.00	0.00
	42:0.54D + 0.2	0.06	-0.14	0.00	0.00	0.00	0.00
2	30:D + L1	-1.00	4.99	0.00	0.00	0.00	0.00
	31:D + L2	-0.72	3.39	0.00	0.00	0.00	0.00
	32:D + 0.75L1	-1.01	4.53	0.00	0.00	0.00	0.00
	33:D + 0.75L1	-0.70	4.53	0.00	0.00	0.00	0.00
	34:D + 0.75L2	-0.81	3.34	0.00	0.00	0.00	0.00
	35:D + 0.75L2	-0.50	3.33	0.00	0.00	0.00	0.00
	36:0.6D + 1.0W	-0.81	-0.43	0.00	0.00	0.00	0.00
	37:0.6D + 1.0(\	-0.39	-2.61	0.00	0.00	0.00	0.00
	38:1.06D + 0.9	-0.83	3.38	0.00	0.00	0.00	0.00
	39:1.06D + 0.9	-0.48	1.72	0.00	0.00	0.00	0.00
	40:0.54D + 0.9	-0.17	-0.04	0.00	0.00	0.00	0.00
	41:1.06D + 0.2	-0.58	1.82	0.00	0.00	0.00	0.00
	42:0.54D + 0.2	-0.28	0.07	0.00	0.00	0.00	0.00

```
STAAD PLANE
START JOB INFORMATION
ENGINEER DATE 14-Mar-13
JOB NAME Topock Groundwater Remediation Project
JOB CLIENT PG&E
JOB NO RC000753.0008
JOB PART Interior Frame
ENGINEER NAME PJD
END JOB INFORMATION
INPUT WIDTH 79
UNIT FEET KIP
JOINT COORDINATES
1 0 0 0; 2 25 0 0; 3 12.5 13 0; 4 0 12 0; 5 25 12 0;
MEMBER INCIDENCES
1 1 4; 2 2 5; 3 4 3; 4 3 5;
DEFINE MATERIAL START
ISOTROPIC STEEL
E 4.176e+006
POISSON 0.3
DENSITY 0.489024
ALPHA 6e-006
DAMP 0.03
TYPE STEEL
STRENGTH FY 5184 FU 8352 RY 1.5 RT 1.2
END DEFINE MATERIAL
MEMBER PROPERTY AMERICAN
1 TO 4 TABLE ST W24X55
CONSTANTS
MATERIAL STEEL ALL
SUPPORTS
1 2 PINNED
LOAD 1 LOADTYPE None  TITLE DEAD
MEMBER LOAD
3 4 UNI GY -0.15
JOINT LOAD
4 5 FY -1.2
LOAD 2 LOADTYPE None  TITLE COLLATERAL
MEMBER LOAD
3 4 UNI GY -0.083
LOAD 3 LOADTYPE None  TITLE WIND1
* TRANSVERSE WIND
MEMBER LOAD
1 UNI GX 0.037
3 UNI Y 0.47
2 UNI GX 0.277
4 UNI Y 0.323
LOAD 4 LOADTYPE None  TITLE WIND2
* TRANSVERSE WIND
MEMBER LOAD
1 UNI GX 0.35
2 UNI GX -0.037
3 UNI Y 0.157
4 UNI Y 0.013
LOAD 5 LOADTYPE None  TITLE WIND3
* LONGITUDINAL WIND SIDEWALL FRAME LOADS
MEMBER LOAD
3 4 UNI Y 0.47
1 UNI GX -0.323
2 UNI GX 0.323
LOAD 6 LOADTYPE None  TITLE WIND4
* LONGITUDINAL WIND SIDEWALL FRAME LOADS
MEMBER LOAD
3 4 UNI Y 0.157
1 UNI GX -0.013
2 UNI GX 0.013
LOAD 7 LOADTYPE None  TITLE WIND5
```

```
* LONGITUDINAL WIND X BRACE COLUMN LOADS
JOINT LOAD
1 2 FY 1.08
LOAD 8 LOADTYPE None  TITLE LIVE1
MEMBER LOAD
3 4 UNI GY -0.33
LOAD 9 LOADTYPE None  TITLE LIVE2
MEMBER LOAD
3 UNI GY -0.33
LOAD 10 LOADTYPE None  TITLE Q1
* E-W SEISMIC
JOINT LOAD
4 FX 1
LOAD 11 LOADTYPE None  TITLE Q2
* N-S SEISMIC
JOINT LOAD
1 2 FY 1.44
LOAD COMB 13 1.2D + 1.6L1
1 1.2 2 1.2 8 1.6
LOAD COMB 14 1.2D + 1.6L2
1 1.2 2 1.2 9 1.6
LOAD COMB 15 1.2D + 1.6L1 + 0.8W2
1 1.2 2 1.2 8 1.6 4 0.8
LOAD COMB 16 1.2D + 1.6L1 + 0.8(W4-W5)
1 1.2 2 1.2 8 1.6 6 0.8 7 -0.8
LOAD COMB 17 1.2D + 1.6L2 + 0.8W2
1 1.2 2 1.2 9 1.6 4 0.8
LOAD COMB 18 1.2D + 1.6L2 + 0.8(W4-W5)
1 1.2 2 1.2 9 1.6 6 0.8 7 -0.8
LOAD COMB 19 1.2D + 0.5L1 + 1.6W2
1 1.2 2 1.2 8 0.5 4 1.6
LOAD COMB 20 1.2D + 0.5L1 + 1.6(W4-W5)
1 1.2 2 1.2 8 0.5 6 1.6 7 -1.6
LOAD COMB 21 1.2D + 0.5L2 + 1.6W2
1 1.2 2 1.2 9 0.5 4 1.6
LOAD COMB 22 1.2D + 0.5L2 + 1.6(W4-W5)
1 1.2 2 1.2 9 0.5 6 1.6 7 -1.6
LOAD COMB 23 0.9D + 1.6W1
1 0.9 3 1.6
LOAD COMB 24 0.9D + 1.6(W3+W5)
1 0.9 5 1.6 7 1.6
LOAD COMB 25 1.284D + 1.3Q1
1 1.284 2 1.284 10 1.3
LOAD COMB 26 1.284D + 1.3Q2
1 1.284 2 1.284 11 -1.3
LOAD COMB 27 0.816D + 1.3Q2
1 0.816 11 1.3
* 30%Q1 + 100%Q2
LOAD COMB 28 1.284D + 0.39Q1 + 1.3Q2
1 1.284 2 1.284 10 0.39 11 -1.3
* 30%Q1 + 100%Q2
LOAD COMB 29 0.816D + 0.39Q1 + 1.3Q2
1 0.816 10 0.39 11 1.3
* SERVICE COMBINATIONS
LOAD COMB 30 D + L1
1 1.0 2 1.0 8 1.0
LOAD COMB 31 D + L2
1 1.0 2 1.0 9 1.0
LOAD COMB 32 D + 0.75L1 + 0.75W2
1 1.0 2 1.0 8 0.75 4 0.75
LOAD COMB 33 D + 0.75L1 + 0.75(W4-W5)
1 1.0 2 1.0 8 0.75 6 0.75 7 -0.75
LOAD COMB 34 D + 0.75L2 + 0.75W2
1 1.0 2 1.0 9 0.75 4 0.75
LOAD COMB 35 D + 0.75L2 + 0.75(W4-W5)
1 1.0 2 1.0 9 0.75 6 0.75 7 -0.75
```

```
LOAD COMB 36 0.6D + 1.0W1
1 0.6 3 1.0
LOAD COMB 37 0.6D + 1.0(W3+W5)
1 0.6 5 1.0 7 1.0
LOAD COMB 38 1.06D + 0.91Q1
1 1.06 2 1.06 10 0.91
LOAD COMB 39 1.06D + 0.91Q2
1 1.06 2 1.06 11 0.91
LOAD COMB 40 0.54D + 0.91Q2
1 0.54 11 0.91
* 30%Q1 + 100%Q2
LOAD COMB 41 1.06D + 0.273Q1 + 0.91Q2
1 1.06 2 1.06 10 0.273 11 0.91
* 30%Q1 + 100%Q2
LOAD COMB 42 0.54D + 0.273Q1 + 0.91Q2
1 0.54 10 0.273 11 0.91
PERFORM ANALYSIS
FINISH
```

		Job No	Sheet No	Re
Software licensed to ARCADIS		RC000753.000	1	
		Part Interior Frame		
Job Title	Topock Groundwater Remediation Project	Ref		
		By PJD	Date 14-Mar-13	Chd
Client	PG&E	File INTERIOR FRAME.std	Date/Time 21-Mar-201	

Reactions

		Horizontal	Vertical	Horizontal	Moment		
Node	L/C	FX (kip)	FY (kip)	FZ (kip)	MX (kip`ft)	MY (kip`ft)	MZ (kip`ft)
1	1:DEAD	0.48	3.08	0.00	0.00	0.00	0.00
	2:COLLATERA	0.27	1.04	0.00	0.00	0.00	0.00
	3:WIND1	-2.37	-6.25	0.00	0.00	0.00	0.00
	4:WIND2	-3.21	-2.34	0.00	0.00	0.00	0.00
	5:WIND3	0.39	-5.88	0.00	0.00	0.00	0.00
	6:WIND4	-0.43	-1.96	0.00	0.00	0.00	0.00
	7:WIND5	0.00	-1.08	0.00	0.00	0.00	0.00
	8:LIVE1	1.06	4.14	0.00	0.00	0.00	0.00
	9:LIVE2	0.53	3.10	0.00	0.00	0.00	0.00
	10:Q1	-0.52	-0.48	0.00	0.00	0.00	0.00
	11:Q2	0.00	-1.44	0.00	0.00	0.00	0.00
2	1:DEAD	-0.48	3.08	0.00	0.00	0.00	0.00
	2:COLLATERA	-0.27	1.04	0.00	0.00	0.00	0.00
	3:WIND1	-1.25	-3.67	0.00	0.00	0.00	0.00
	4:WIND2	-0.40	0.22	0.00	0.00	0.00	0.00
	5:WIND3	-0.39	-5.88	0.00	0.00	0.00	0.00
	6:WIND4	0.43	-1.96	0.00	0.00	0.00	0.00
	7:WIND5	0.00	-1.08	0.00	0.00	0.00	0.00
	8:LIVE1	-1.06	4.14	0.00	0.00	0.00	0.00
	9:LIVE2	-0.53	1.03	0.00	0.00	0.00	0.00
	10:Q1	-0.48	0.48	0.00	0.00	0.00	0.00
	11:Q2	0.00	-1.44	0.00	0.00	0.00	0.00

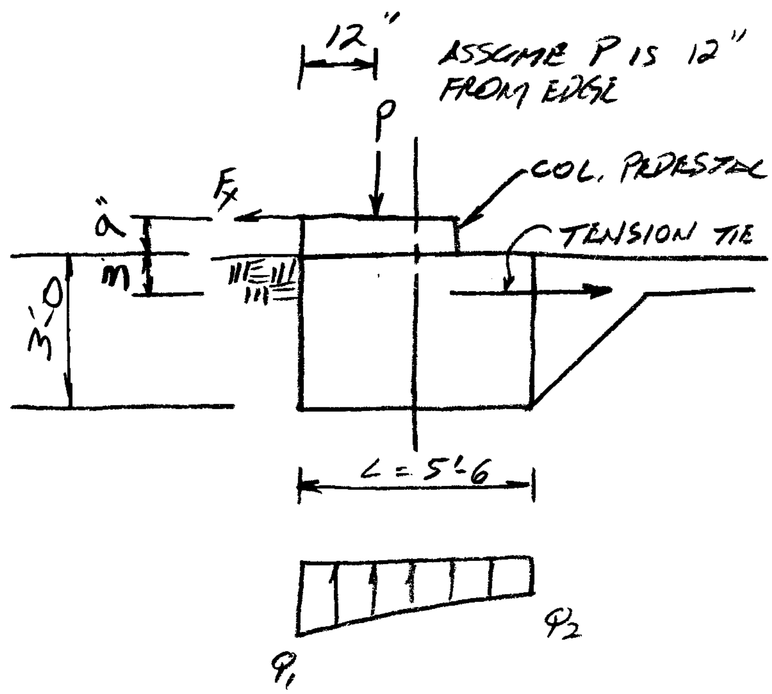
Reactions

		Horizontal	Vertical	Horizontal	Moment		
Node	L/C	FX (kip)	FY (kip)	FZ (kip)	MX (kip-ft)	MY (kip-ft)	MZ (kip-ft)
1	13:1.2D + 1.6L	2.60	11.57	0.00	0.00	0.00	0.00
	14:1.2D + 1.6L	1.75	9.91	0.00	0.00	0.00	0.00
	15:1.2D + 1.6L	0.03	9.69	0.00	0.00	0.00	0.00
	16:1.2D + 1.6L	2.26	10.86	0.00	0.00	0.00	0.00
	17:1.2D + 1.6L	-0.82	8.04	0.00	0.00	0.00	0.00
	18:1.2D + 1.6L	1.41	9.21	0.00	0.00	0.00	0.00
	19:1.2D + 0.5L	-3.71	3.27	0.00	0.00	0.00	0.00
	20:1.2D + 0.5L	0.75	5.60	0.00	0.00	0.00	0.00
	21:1.2D + 0.5L	-3.98	2.75	0.00	0.00	0.00	0.00
	22:1.2D + 0.5L	0.48	5.09	0.00	0.00	0.00	0.00
	23:0.9D + 1.6W	-3.36	-7.22	0.00	0.00	0.00	0.00
	24:0.9D + 1.6(\	1.06	-8.36	0.00	0.00	0.00	0.00
	25:1.284D + 1.	0.29	4.67	0.00	0.00	0.00	0.00
	26:1.284D + 1.	0.96	7.16	0.00	0.00	0.00	0.00
	27:0.816D + 1.	0.39	0.64	0.00	0.00	0.00	0.00
	28:1.284D + 0.	0.76	6.98	0.00	0.00	0.00	0.00
	29:0.816D + 0.	0.19	0.45	0.00	0.00	0.00	0.00
2	13:1.2D + 1.6L	-2.60	11.57	0.00	0.00	0.00	0.00
	14:1.2D + 1.6L	-1.75	6.60	0.00	0.00	0.00	0.00
	15:1.2D + 1.6L	-2.92	11.74	0.00	0.00	0.00	0.00
	16:1.2D + 1.6L	-2.26	10.86	0.00	0.00	0.00	0.00
	17:1.2D + 1.6L	-2.07	6.77	0.00	0.00	0.00	0.00
	18:1.2D + 1.6L	-1.41	5.90	0.00	0.00	0.00	0.00
	19:1.2D + 0.5L	-2.07	7.36	0.00	0.00	0.00	0.00
	20:1.2D + 0.5L	-0.75	5.60	0.00	0.00	0.00	0.00
	21:1.2D + 0.5L	-1.80	5.81	0.00	0.00	0.00	0.00
	22:1.2D + 0.5L	-0.48	4.05	0.00	0.00	0.00	0.00
	23:0.9D + 1.6W	-2.43	-3.09	0.00	0.00	0.00	0.00
	24:0.9D + 1.6(\	-1.06	-8.36	0.00	0.00	0.00	0.00
	25:1.284D + 1.	-1.59	5.92	0.00	0.00	0.00	0.00
	26:1.284D + 1.	-0.96	7.16	0.00	0.00	0.00	0.00
	27:0.816D + 1.	-0.39	0.64	0.00	0.00	0.00	0.00
	28:1.284D + 0.	-1.15	7.35	0.00	0.00	0.00	0.00
	29:0.816D + 0.	-0.58	0.83	0.00	0.00	0.00	0.00

Reactions

Node	L/C	Horizontal FX (kip)	Vertical FY (kip)	Horizontal FZ (kip)	Moment MX (kip`ft)	MY (kip`ft)	MZ (kip`ft)
1	30:D + L1	1.81	8.26	0.00	0.00	0.00	0.00
	31:D + L2	1.28	7.23	0.00	0.00	0.00	0.00
	32:D + 0.75L1	-0.86	5.47	0.00	0.00	0.00	0.00
	33:D + 0.75L1	1.23	6.56	0.00	0.00	0.00	0.00
	34:D + 0.75L2	-1.26	4.69	0.00	0.00	0.00	0.00
	35:D + 0.75L2	0.83	5.79	0.00	0.00	0.00	0.00
	36:0.6D + 1.0V	-2.08	-4.40	0.00	0.00	0.00	0.00
	37:0.6D + 1.0(\	0.68	-5.11	0.00	0.00	0.00	0.00
	38:1.06D + 0.9	0.32	3.93	0.00	0.00	0.00	0.00
	39:1.06D + 0.9	0.79	3.06	0.00	0.00	0.00	0.00
	40:0.54D + 0.9	0.26	0.35	0.00	0.00	0.00	0.00
	41:1.06D + 0.2	0.65	2.93	0.00	0.00	0.00	0.00
	42:0.54D + 0.2	0.12	0.22	0.00	0.00	0.00	0.00
2	30:D + L1	-1.81	8.26	0.00	0.00	0.00	0.00
	31:D + L2	-1.28	5.16	0.00	0.00	0.00	0.00
	32:D + 0.75L1	-1.85	7.39	0.00	0.00	0.00	0.00
	33:D + 0.75L1	-1.23	6.56	0.00	0.00	0.00	0.00
	34:D + 0.75L2	-1.45	5.06	0.00	0.00	0.00	0.00
	35:D + 0.75L2	-0.83	4.24	0.00	0.00	0.00	0.00
	36:0.6D + 1.0V	-1.54	-1.82	0.00	0.00	0.00	0.00
	37:0.6D + 1.0(\	-0.68	-5.11	0.00	0.00	0.00	0.00
	38:1.06D + 0.9	-1.23	4.81	0.00	0.00	0.00	0.00
	39:1.06D + 0.9	-0.79	3.06	0.00	0.00	0.00	0.00
	40:0.54D + 0.9	-0.26	0.35	0.00	0.00	0.00	0.00
	41:1.06D + 0.2	-0.93	3.19	0.00	0.00	0.00	0.00
	42:0.54D + 0.2	-0.39	0.48	0.00	0.00	0.00	0.00

SOIL BEARING



ARCADIS

By:	PJD	Date:	25-Mar-13	Page:	of
Checked by:		Date:		Job No.	
Project:	Topock Groundwater Remediation Projet MW 20 Bench Building				
Subject:	Column Foundations Interior Frame		FACTORED LOADS		
	LC	30			

CONC 0.15 KCF SOIL 0.125 KCF

LOAD COMBINATION 1.00 D + L

	FACTOR	L	B	H	A	WEIGHT (K)	X (FT)	WX (KFT)
DEAD LOADS								
FOOTING	1.00	5.50	5.50	3.00	16.50	13.61	2.75	-37.43
CONC PIER	1.00	2.50	1.50	0.50	1.25	0.28	1.25	-0.35
COLUMN LOAD 8.26 K						8.26	1.00	-8.26
HORIZ LOAD -1.81 K							1.00	1.81
						22.15		-44.24

L/6 = 0.92 FT
Xc= 2.00
e= 0.75 FT < L/6

Q1= 1.33 KSF Q2= 0.13 KSF

ARCADIS

By:	PJD	Date:	25-Mar-13	Page:	of
Checked by:		Date:		Job No.	
Project:	Topock Groundwater Remediation Projet MW 20 Bench Building				
Subject:	Column Foundations Interior Frame		FACTORED LOADS		
	LC	36			

CONC 0.15 KCF SOIL 0.125 KCF

LOAD COMBINATION 0.60 D + W

	FACTOR	L	B	H	A	WEIGHT (K)	X (FT)	WX (KFT)
DEAD LOADS								
FOOTING	0.60	5.50	5.50	3.00	16.50	8.17	2.75	-22.46
CONC PIER	0.60	2.50	1.50	0.50	1.25	0.17	1.25	-0.21
COLUMN LOAD -4.40 K						-4.40	1.00	4.40
HORIZ LOAD 2.08 K							1.00	-2.08
						3.94		-20.35

L/6 = 0.92 FT
Xc= 5.17
e= -2.42 FT > L/6
X= 0.99
Q1= 0.00 KSF
Q2= 1.45 KSF

ARCADIS

By:	PJD	Date:	25-Mar-13	Page:	of
Checked by:		Date:		Job No.	
Project:	Topock Groundwater Remediation Projet MW 20 Bench Building				
Subject:	Column Foundations Interior Frame			FACTORED LOADS	
	LC 37				

CONC 0.15 KCF SOIL 0.125 KCF

LOAD COMBINATION 0.60 D + W

	FACTOR	L	B	H	A	WEIGHT (K)	X (FT)	WX (KFT)
DEAD LOADS								
FOOTING	0.60	5.50	5.50	3.00	16.50	8.17	2.75	-22.46
CONC PIER	0.60	2.50	1.50	0.50	1.25	0.17	1.25	-0.21
COLUMN LOAD -5.11 K						-5.11	1.00	5.11
HORIZ LOAD -0.68 K							1.00	0.68
						3.23		-16.88

L/6 = 0.92 FT

Xc= 5.23

e= -2.48 FT > L/6

X= 0.80

Q1= 0.00 KSF Q2= 1.46 KSF

ARCADIS

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Checked by:		Date:		Job No.		
Project:	Topock Groundwater Remediation Projet MW 20 Bench Building					
Subject:	Column Foundations Interior Frame			FACTORED LOADS		
	LC		15			

CONC 0.15 KCF SOIL 0.125 KCF

LOAD COMBINATION 1.20 D + 1.6L

		FACTOR	L	B	H	A	WEIGHT (K)	X (FT)	WX (KFT)
DEAD LOADS									
FOOTING		1.20	5.50	5.50	3.00	16.50	16.34	2.75	-44.92
CONC PIER		1.20	2.50	1.50	0.50	1.25	0.34	1.25	-0.42
COLUMN LOAD	11.74 K						11.74	1.00	-11.74
HORIZ LOAD	-2.92 K							1.00	2.92
							28.41		-54.16

L/6 = 0.92 FT
Xc= 1.91
e= 0.84 FT < L/6

Q1= 1.80 KSF Q2= 0.07 KSF

ARCADIS
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By:	PJD	Date:	25-Mar-13	Page:		of
Checked by:		Date:		Job No.		
Project:	Topock Groundwater Remediation Projet MW 20 Bench Building					
Subject:	Column Foundations					
	LC	30				

L=	5.50 FT		SY=	27.73 FT^3		
B=	5.50 FT		SX=	27.73 FT^3		
			A=	30.25		
T=	3.00	THICKNESS OF FOOTING	Xc=	2.75	Yc=	2.75
			GC=	0.15 KCF	CONCRETE	
			GS=	0.12 KCF	SOIL	

DEAD LOADS

	P	X	X-Xc	P*(X-Xc)	Y	Yc-Y	P*(Y-Yc)
FOOTING	13.61	2.75	0.00	0.00	2.75	0.00	0.00
CONC PIER	0.94	1.25	-1.50	-1.41	1.25	1.50	1.41

14.55 K My= -1.41 KFT Mx= 1.41 KFT

Q1= 0.38 KSF Q2= 0.38 KSF Q3= 0.38 KSF Q4= 0.38 KSF

COLUMN LOAD

	P	X	X-Xc	P*(X-Xc)	Y	Yc-Y	P*(Y-Yc)
	4.99	1.00	-1.75	-8.73	1.00	1.75	8.73
-1						1.00	-1.00

4.99 K My= -8.73 KFT Mx= 7.73 KFT

Q1= -0.43 KSF Q2= -0.43 KSF Q3= -0.43 KSF Q4= -0.43 KSF

COMBINATIONS LC 30

1.00 D +L1

P=	19.54 K	My=	-10.14 KFT	Mx=	10.14 KFT		
		ex=	-0.52	ey=	-0.52		
Q1=	-0.09 KSF	Q2=	-0.09 KSF	Q3= -0.09 KSF	Q4= -0.09 KSF		Q<0
L'=	4.46	B'=	4.46	REDUCED AREA		Q=	0.98 KSF

ARCADIS
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Project: Topock Groundwater Remediation Projet MW 20 Bench Building
Subject: Column Foundations
LC 37

L= 5.50 FT
B= 5.50 FT

SY= 27.73 FT^3
SX= 27.73 FT^3

T= 3.00 THICKNESS OF FOOTING

A= 30.25
Xc= 2.75 Yc= 2.75

GC= 0.15 KCF CONCRETE
GS= 0.12 KCF SOIL

DEAD LOADS

	P	X	X-Xc	P*(X-Xc)	Y	Yc-Y	P*(Y-Yc)
FOOTING	13.61	2.75	0.00	0.00	2.75	0.00	0.00
CONC PIER	0.94	1.25	-1.50	-1.41	1.25	1.50	1.41

14.55 K My= -1.41 KFT Mx= 1.41 KFT

Q1= 0.38 KSF Q2= 0.38 KSF Q3= 0.38 KSF Q4= 0.38 KSF

COLUMN LOAD

	P	X	X-Xc	P*(X-Xc)	Y	Yc-Y	P*(Y-Yc)
	-2.61	1.00	-1.75	4.57	1.00	1.75	-4.57
-0.39						1.00	-0.39

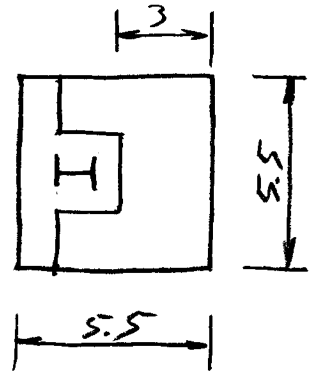
-2.61 K My= 4.57 KFT Mx= -4.96 KFT

Q1= 0.26 KSF Q2= 0.26 KSF Q3= 0.26 KSF Q4= 0.26 KSF

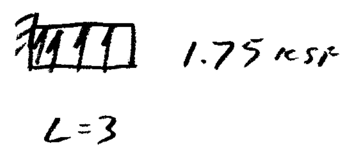
COMBINATIONS LC 37

1.00 D +L1
P= 11.94 K My= 3.16 KFT Mx= -3.16 KFT
ex= 0.26 ey= 0.26
Q1= 0.62 KSF Q2= 0.62 KSF Q3= 0.62 KSF Q4= 0.62 KSF

CONCRETE STRENGTH UNDER FACTORED LOADS



$w_u = 1.75 \text{ ksf} (5.5 \text{ ft})$
$w_u = 9.63 \text{ k/ft}$



$M_u = \frac{wL^2}{2}$

$M_u = \frac{9.63(3)^2}{2}$

$M_u = 43.3 \text{ kft}$

$V_u = wL$

$= 9.63 \text{ k/ft} (3 \text{ ft})$

$V_u = 29 \text{k}$

FOR UPLIFT CASE, FOOTING UNDER ITS OWN WEIGHT

$w_u = 0.15 \text{ k/ft}^3 (3 \text{ ft})(1.4)$
$w_u = 0.63 \text{ k/ft}^2$

$M_u = 0.63(5.5)(3)^2/2$

$M_u = 16 \text{ kft}$

ARCADIS
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By: PJD | Date: 25-Mar-13 | Page:
Checked by: | Date: | Job No.
Project: Topock MW 20 Bench Bldg
Subject: Interior Foundation

CONCRETE BEAM DESIGN BY ACI 318 OR 350

CODE = ACI 318

f'c = 4,000 PSI   FY= 60,000 PSI   ϕb= 0.90
Ec = 3605 KSI   ϕv= 0.75

BEAM

Normal

B= 66.00 IN   Tu < 109.39 KFT FOR TORSION TO BE NEGLECTED
H= 36.00 IN
BOTTOM COVER: 3.00 IN
SIDE COVER: 3.00 IN

FLEXURE
BOTTOM BARS   Mu+ = 43.30 KFT
Sd Mu+ = 43.30 KFT

VERT CLR	QTY	BAR NO.	CLR SPA	As	
2.00				0	0
2.00				0	0
	6	5	11.2500	1.86	
					3.3125 Yc

d= 32.6875 IN

1.3258

As MAX = 0.75ρbal = 46.1249 IN^2   Sd = 1.0000
As MIN 7.1913 IN^2
REQ'D As= 0.2947 IN^2
As= 1.8600 IN^2   As < MIN   ACI 12.11.3
ϕ Mn= 271.51 KFT   Ld < = Mn/Vu + La
Mn > 4/3Mu OK   Mn/Vu= 10.40 FT
4/3 Mu= 57.73 KFT

SERVICE LOAD   Msl = 32.66057 KFT

Smax= 71.71 > 11.8750
OK

Cc = 3.0000 IN Clear Cover   Mcr= 563.52 KFT
n = 8.0 Es / Ec   Ig= 256,608.00 IN^4
c = 3.6298 IN NA   Icr= 13,685.78 IN^4
fs = 6.7 KSI   Ie= 256,608.00 IN^4

ARCADIS
Infrastructure · Water · Environment · Buildings

By: PJD | Date: 25-Mar-13 | Page:
Checked by: | Date: | Job No. 0
Project: Topock MW 20 Bench Bldg
Subject: Interior Foundation

CONCRETE BEAM DESIGN BY ACI 318 OR 350

BEAM 0.00
TOP COVER 2.00 IN

TOP BARS Mu- = 16.00 KFT
Sd Mu- = 16.00 KFT

VERT CLR	QTY	BAR NO.	CLR SPA	As	
2.00				0	0
2.00				0	0
	6	5	11.2500	1.86	
					2.3125 Yc

d= 33.6875 IN

1.4000
As MAX = 0.75ρbal = 47.5360 IN^2 Sd = 1.0000
As MIN 7.4113 IN^2
REQ'D As= 0.1056 IN^2
As= 1.8600 IN^2 As < MIN
ϕ Mn= 279.88 KFT
Mn > 4/3Mu OK
4/3 Mu= 21.33 KFT

SERVICE LOAD Msl = 11.42857 KFT

Smax= 211.30 > 11.8750
OK

Cc = 2.0000 IN Clear Cover
n = 8.0 Es / Ec
c = 3.6881 IN NA
fs = 2.3 KSI

Mcr= 563.52 KFT
Ig= 256,608.00 IN^4
Icr= 14,569.42 IN^4
Ie= 256,608.00 IN^4

MAX AGG 2 in # 467

SHEAR Vu= 29 K
SERVICE SHEAR Vs= K
TENSION Tu= K
d= 32.6875 IN
STIRRUPS - BAR NO.
4SQRT(fc)bd= 545.78 K

SPACING MAX= 16.34375 IN
10 IN

ϕ Vc= 204.67 K
STIRRUPS NOT REQUIRED

#DIV/0!
Sd= 1.0000

Av= 0.00 IN^2
AvFyd/s= 0.00 K
Vs= 0.00 K

ϕ Vn= 204.67 K OK

MAX ANCHOR BOLT FORCES

$T_u = 8.4$ k
LC 24

$V_{u1} = 3.36$ k
LC 23

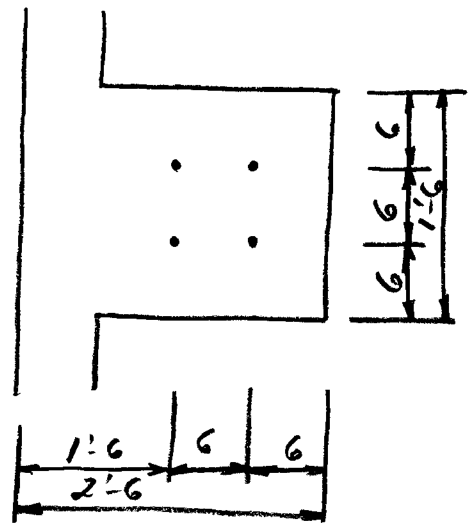
$V_{u2} = 2.23$ k
END WALL WIND

$V_u = \sqrt{(3.36)^2 + (2.23)^2}$

$V_u = 4.1$ k

USE (4) 3/4 ϕ ASTM F1554 GR 36
THD RODS

SPA = 6 in EW
MIN EDGE = 4 in
MIN EMBEDMENT = 9 in



ARCADIS
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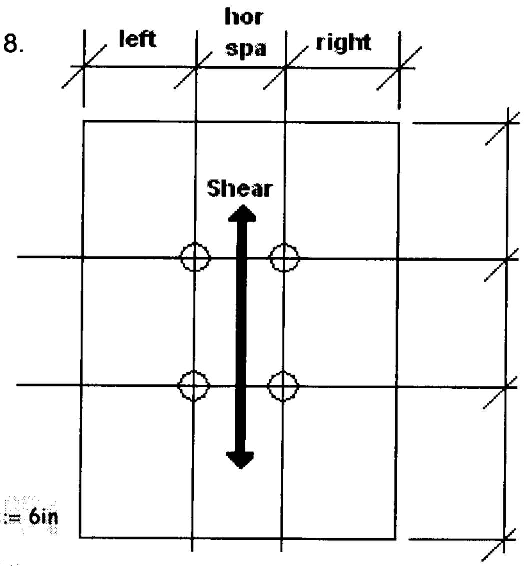
By: PJD Date: 3/25/2013 Page: ____ of ____
Checked by: ____ Date: ____ Job No. R000753.0008
Project: Topock Groundwater Remediation Project MW 20 Bench Building
Subject: Anchor Bolts

Group-Anchor Bolt Design

Reference:H:\MATHCAD WORKSHEETS\Units.xmcd

REFERENCE: Appendix D, ACI 318-05 & chapter 34 of PCA's Notes on ACI 318.

D.4 - GENERAL STRENGTH REQUIREMENTS FOR ANCHORS



$f'_c := 4000psi$

$n := 4$ - number of tensioned anchors in the group

$N_{ua} := 8.4kip$ - factored design load, **Tension**

$V_{ua} := 4.1kip$ - factored design load, Shear

$d_o := 0.75in$ - outside diameter of anchor or shaft diameter of headed stud, headed bolt ot hooked bolt.

Material := 1554 $fy := 36ksi$ $futa := 58ksi$

typical_embedment = 9·in vert_anchor_spacing := 6in hor_anchor_spacing := 6in

top_edge := 6in bot_edge := 6in left_edge := 6in right_edge := 6in

c_{amax} := max(top_edge, bot_edge, right_edge, left_edge) $c_{amax} = 0.5\,ft$

c_{amin} := min(top_edge, bot_edge, right_edge, left_edge) $c_{amin} = 6\cdot in$

h_{ef1} := typical_embedment $h_{ef1} = 9\cdot in$ - effective embedment length

Is this an anchor group?

answer$_1$:= | "Yes" if min(vert_anchor_spacing, hor_anchor_spacing) ≤ 3·h_{ef1}
| "No, use single anchor factors." otherwise

answer$_1$ = "Yes"

a) Steel Strength of anchors in tension (D.5.1)

$\phi_{nsa} := 0.75$ - D.4.4, D.4.5 - Strength reduction factor based on anchor

AB_diam := d_o $n_t := 10$ - number of threads per inch of anchor - AISC 13th Ed.Manual pg 7-83 or AISC/ASD Manual pg 4-147. Se table on the right.

$$A_{se} := \frac{\pi}{4}\cdot\left(d_o - \frac{0.9743\cdot 1in}{n_t}\right)^2 \qquad A_{se} = 0.33\cdot in^2$$

- effective cross sectional area of threaded anchor, ACI 318 pg. 399

$$f_{ut} := \min\left(f_{uta}, 1.9fy, 125ksi\right) \qquad f_{uta} = 58\cdot ksi$$

- specified tensile strength of anchor steel

$$\phi N_{sa} := \phi_{nsa}\cdot n\cdot A_{se}\cdot f_{uta} \qquad \phi N_{sa} = 58.2\cdot kips$$

- Nsa, nominal strength of a single anchor or group of anchors in tension as governed by the steel strength

$$A_{se\_required} := \frac{N_{ua}}{\phi_{nsa}\cdot n\cdot f_{uta}} \qquad A_{se\_required} = 0.05\cdot in^2$$

check$_1$:= | "OK" if $A_{se} \ge A_{se\_required}$
| "NG" otherwise

check$_1$ = "OK"

b) Concrete Breakout strength of Anchor in Tension (D.5.2)

$1.5h_{ef1} = 13.5 \cdot in$ $\quad vert\_anchor\_spacing = 6 \cdot in$ $\quad hor\_anchor\_spacing = 6 \cdot in$

$top\_edge_1 := \min(top\_edge, 1.5h_{ef1}$ $right\_edge_1 := \min(right\_edge, 1.5h_{ef1})$ $bot\_edge_1 := \min(bot\_edge, 1.5h_{ef}$ $left\_edge_1 := \min(left\_edge,$

$A_{Nc} := (right\_edge_1 + hor\_anchor\_spacing + left\_edge_1) \cdot (top\_edge_1 + vert\_anchor\_spacing + bot\_edge_1)$ $\quad A_{Nc} = 324 \cdot in^2$

- A_{Nc} projected area of the failure surface approximated by a rectangle with edges bounded by 1.5hef and free edges of the concrete to the centerline of the anchors.

$\phi_{cbg} := 0.7$ — D.4.4 or D.4.5 - Strength reduction factor bas concrete breakout, Condition **A** or **B**.

$$h_{ef} := \begin{cases} \frac{c_{amax}}{1.5} & \text{if } c_{amax} \le 1.5h_{ef1} \\ h_{ef1} & \text{otherwise} \end{cases} \qquad h_{ef} = 4 \cdot in$$

- For the special case where there are 3 or 4 e with the largest edge distance ca max ≤1.5hef, embedment depth hef used in D-6 through D-11 limited to camax/1.5, D.5.2.3

$$A_{Nco} := 9 \cdot h_{ef}^2 \qquad A_{Nco} = 144 \cdot in^2$$

-Equation D-6, Ano, projected area of failure su of single anchor, away from the edges

$$A_{Nc} := \min(A_{Nc}, n \cdot A_{Nco}) \qquad A_{Nc} = 324 \cdot in^2$$

-An, projected area of failure surface of anchor group of anchors, 1.5hef away from the edges

$$k_c := 24 \qquad N_b := k_c \cdot \sqrt{f'_c \cdot \frac{1}{psi}} \cdot \left(h_{ef} \cdot \frac{1}{in}\right)^{1.5} \cdot lb \qquad N_b = 12143.15\, lb$$

- kc=24 Cast-In or kc=17 Post-Installed Anchors. D.5.2.2. See also RD.5.2.2. Equation D-7, Basic concrete breakout strength in tension of a sinc anchor in cracked concrete

$$e_N' := 0in \qquad \psi_{ecN} := \begin{cases} \frac{1}{\left(1 + \frac{2 \cdot e_N'}{3 \cdot h_{ef}}\right)} & \text{if } \frac{1}{\left(1 + \frac{2 \cdot e_N'}{3 \cdot h_{ef}}\right)} \le 1 \\ 1.0 & \text{otherwise} \end{cases} \qquad \psi_{ecN} = 1$$

- Eccentricity in the connection, see D.5.2.4 for eccentricity requirements

$$\psi_{edN} := \begin{cases} 1.0 & \text{if } c_{amin} \ge 1.5 \cdot h_{ef} \\ \left(0.7 + \frac{0.3 \cdot c_{amin}}{1.5h_{ef}}\right) & \text{otherwise} \end{cases} \qquad \psi_{edN} = 1$$

-Equations D-10 & D-11, Modification Factor for e effects

$$\psi_{cN} := 1.25 \qquad \psi_{cN} = 1.25$$

- D.5.2.6 1.25 for Cast-in anchors, 1.4 for Post-Installed anchors with a value of kc = 17. Otherwise refer to ACI 355.2

$$c_{ac} := 4.5in \qquad c_{ac} = 4.5 \cdot in \qquad \psi_{cpN} := \begin{cases} 1.0 & \text{if } c_{amin} \ge c_{ac} \\ \frac{c_{amin}}{c_{ac}} & \text{if } \frac{c_{amin}}{c_{ac}} \ge \frac{1.5h_{ef}}{c_{ac}} \\ \frac{1.5h_{ef}}{c_{ac}} & \text{otherwise} \end{cases} \qquad \psi_{cpN} = 1.33$$

- D.8.6, critical edge distance as determined fr ACI 355.2. See D.8.6 for values of c_{ac}.

$$\phi N_{cbg} := \phi_{cbg} \cdot \frac{A_{Nc}}{A_{Nco}} \cdot \psi_{ecN} \cdot \psi_{edN} \cdot \psi_{cN} \cdot \psi_{cpN} \cdot N_b \qquad \phi N_{cbg} = 31.88 \cdot kip$$

- Equation D-6, Nominal concrete breakout str in tension of a group of anchors in tension

$$check_2 := \begin{cases} \text{"OK"} & \text{if } \phi N_{cbg} \ge N_{ua} \\ \text{"NG"} & \text{otherwise} \end{cases} \qquad check_2 = \text{"OK"}$$

c) Pullout Strength of anchors in tension (D.5.3)

$\phi_{pn} := 0.7$ — - D.4.4 or D.4.5 - Strength reduction factor based on concrete breakout, Condition A or B.

$AB\_diam = \frac{3}{4} \cdot in$ — - Anchor diameter, see table 34-2 in Notes on ACI 318-05 for Bearing area or washers & nuts.

$\psi_{cP} := 1.0$ — - D.5.3.6 For an anchor located in a region where analysis indicates no cracking at service load level. Where cracking will occur ψ_{cP} shall be taken as 1.0.

$$A_{brg\_reqd} := \frac{\frac{N_{ua}}{n}}{\phi_{pn} \cdot \psi_{cP} \cdot 8 \cdot f'_c}$$

$A_{brg\_reqd} = 0.09 \cdot in^2$ — - Bearing area from equation D-15, in ACI 318-05

$A_{brg} := 0.911 in^2$ — - Bearing area of a heavy hex nut per table 34-2 of the Notes on ACI 318-05 or of a flat round washer. See table on adjacent page

$$check3 := \begin{cases} \text{"OK"} & \text{if } A_{brg} \geq A_{brg\_reqd} \\ \text{"NG"} & \text{otherwise} \end{cases}$$

$check3 = \text{"OK"}$

$N_p := 8 \cdot A_{brg} \cdot f'_c$

$\phi N_{pn} := \phi_{pn} \cdot \psi_{cP} \cdot N_p$ $\qquad \phi N_{pn} = 20.41 \cdot kip$

d) Concrete side face blowout strength of a headed anchor in tension (D.5.4)

$\phi_{nsb} := 0.7$ $\qquad c_{a1} := \min(c_{amin}, c_{amax})$ $\qquad c_{a2} := \max(c_{amin}, c_{amax})$

$$N_{sb} := \begin{cases} 160 \cdot c_{a1} \cdot \sqrt{A_{brg}} \cdot \sqrt{\frac{f'_c}{psi}} \cdot psi & \text{if } c_{a1} \leq 0.4 h_{ef} \\ \left(160 \cdot c_{a1} \cdot \sqrt{A_{brg}} \cdot \sqrt{\frac{f'_c}{psi}} \cdot psi\right) \cdot \frac{\left(1 + \frac{c_{a2}}{c_{a1}}\right)}{4} & \text{if } c_{a1} \leq 0.4 h_{ef} \wedge c_{a2} \leq 3 \cdot c_{a1} \\ \text{"Not Applicable"} & \text{otherwise} \end{cases}$$

- Equation D-17, nominal side-face blowout strength of a anchor (usually applies to cast anchors), without modifica a perpendicular edge distance. Use for anchor groups. Th requirements are applicable to Cast-in anchors.

$N_{sb} = \text{"Not Applicable"}$

$s := \min(vert\_anchor\_spacing, hor\_anchor\_spacing, 6 c_{a1})$

$$\phi N_{sbg} := \phi_{nsb} \cdot \left(1 + \frac{s}{6 \cdot c_{a1}}\right) \cdot N_{sb}$$

$\phi N_{sbg} = 816.67 \cdot kip$

- Equation D-18, nominal strength of the group of anchors side-face blowout (usually applies to cast anchors), witho modification for a perpendicular edge distance. Use for groups.

$$check2 := \begin{cases} \text{"OK"} & \text{if } \phi N_{sbg} \geq N_{ua} \\ \text{"NG"} & \text{otherwise} \end{cases}$$

$check2 = \text{"OK"}$

Summary of design requirements for tensile loading:

Steel strength of anchor in tension D.5.1 :	$\phi N_{sa} = 58.2 \cdot kip$
Concrete breakout strength of anchor in tension D.5.2 :	$\phi N_{cbg} = 31.88 \cdot kip$
Pullout strength of anchor in tension D.5.3 :	$\phi N_{pn} = 20.41 \cdot kip$
Concrete side-face blowout strength of a headed anchor in tension :	$\phi N_{sbg} = 816.67 \cdot kip$

e) Steel strength of anchor in shear (D.6.1)

$\phi_s := 0.7$ $\quad$ $grout\_pad := 0.8$

$V_{sa} := n \cdot 0.6 \cdot A_{se} \cdot futa \cdot grout\_pad$ $\quad V_{sa} = 37.25 \cdot kip$ $\quad \phi V_s := \phi_s \cdot V_{sa}$ $\quad \phi V_s = 26.07 \cdot kip$

$check_4 := \begin{cases} \text{"OK"} & \text{if } \phi V_s \geq V_{ua} \\ \text{"NG"} & \text{otherwise} \end{cases}$ $\quad check_4 = \text{"OK"}$

- Equation D-20, D.6.1.2 b for cast-in headed bolts and for post-instc anchors where sleeves do not extend through shear plane. Also see D.6.1.3 for anchors used with built up grout pads.

f) Concrete Breakout Strength of anchor in shear (D.6.2)

$\phi_{vcbg} := 0.7$

The two anchors located closest to the edge toward which the shear is directed will control the concrete bre strength. These anchors are assumed to carry one half of the shear. The total breakout strength will be twi value calculated for these two anchors (the anchors away from the edge are assumed to develop the same valu

$c_{a1} := \min(top\_edge, bot\_edge)$ $\quad c_{a1} = 6 \cdot in$ $\quad 1.5 \cdot c_{a1} = 9 \cdot in$

$right\_edge_1 := \min(right\_edge, 1.5 c_{a1})$ $\quad right\_edge_1 = 6 \cdot in$

$left\_edge_1 := \min(left\_edge, 1.5 c_{a1})$ $\quad left\_edge_1 = 6 \cdot in$

- Applicable only to shear as shown on the diagram at the beginning of this worksheet. If shear is applied in the other direction, change the input parameters of cc to right_edge & left_edge. Similar for right & left edges.

$Avc := (right\_edge_1 + hor\_anchor\_spacing + left\_edge_1) \cdot (1.5 \cdot c_{a1})$ $\quad Avc = 162 \cdot in^2$

- Avc, projected concrete failure area of an anchor or anchors

$A_{vco} := 4.5 \cdot c_{a1}^2$ $\quad A_{vco} = 162 \cdot in^2$

- Avco, pojected concrete failure area of one anchor, u limited by corner influences, spacing or member thickn

$A_{vc} := \min(Avc, n \cdot A_{vco})$ $\quad A_{vc} = 162 \cdot in^2$

$eV' := 0in$ $\quad \psi_{ecV} := \begin{cases} \dfrac{1}{\left(1 + \dfrac{2 \cdot eV'}{3 \cdot c_{a1}}\right)} & \text{if } \dfrac{1}{\left(1 + \dfrac{2 \cdot eV'}{3 \cdot c_{a1}}\right)} \leq 1 \\ 1.0 & \text{otherwise} \end{cases}$ $\quad \psi_{ecV} = 1$

- NO eccentricity in the connection, see D.6.2.5 for eccentricity requirements

$c_{a2} := \min(right\_edge, left\_edge)$ $\quad c_{a2} = 6 \cdot in$

- Applicable only to shear as shown on the diagram at the beginning of this worksheet. If shear is applied in the other direction, change the input parameters to top_edge & bot_edge **in the calculation of ca1 above and right & left edge also above.**

$\psi_{edV} := \begin{cases} 1.0 & \text{if } c_{a2} \geq 1.5 \cdot c_{a1} \\ \left(0.7 + 0.3 \cdot \dfrac{c_{a2}}{1.5 \cdot c_{a1}}\right) & \text{otherwise} \end{cases}$ $\quad \psi_{edV} = 0.9$ $\quad$ - D.6.2.6

$\psi_{cV} := 1$ $\quad \psi_{cV} = 1$

- D.6.2.7, For anchors located in a region of the membe where analysis indicates no cracking at service loads. Conservative, for locations where cracking is likely to occur.

$l_e := \min(typical\_embedment, 8 \cdot d_o)$ $\quad l_e = 6 \cdot in$

- D.6.2.2 load bearing length of the anchor for shear. basic breakout strength in shear of a single anchor in c concrete Vb.

$V_b := 7 \cdot \left(\dfrac{l_e}{d_o}\right)^{0.2} \cdot \sqrt{d_o \cdot \dfrac{1}{in}} \cdot \sqrt{f'_c \cdot \dfrac{1}{psi}} \cdot \left(c_{a1} \cdot \dfrac{1}{in}\right)^{1.5} \cdot lb$ $\quad V_b = 8.54 \cdot kip$

Total breakout strength of the four anchor group (2 anchors) :

$\phi V_{cbg} := 2 \cdot \phi_{cbg} \cdot \dfrac{A_{vc}}{A_{vco}} \cdot \psi_{ecV} \cdot \psi_{edV} \cdot \psi_{cV} \cdot V_b$ $\quad \phi V_{cbg} = 10.76 \cdot kip$ $\quad check_5 := \text{"OK" if } \phi V_{cbg} \geq V_{ua}$ $\quad check_5 = \text{"OK"}$

g) Concrete Pryout Strength of anchor in shear (D.6.3)

$\phi_{cpg} := 0.7$

$k_{cp} := \begin{cases} 1.0 & \text{if } h_{ef} < 2.5in \\ 2.0 & \text{if } h_{ef} \geq 2.5in \end{cases}$ $k_{cp} = 2$ - D.6.3.1, kcp coefficient for pryout strength

$\phi V_{cpg} := \phi_{cpg} \cdot k_{cp} \cdot \frac{\phi N_{cbg}}{\phi_{cbg}}$ $\phi V_{cpg} = 63.75 \cdot kip$ - Equation D-30, D.6.3.1 Nominal pryout strength

$check_6 := \begin{cases} \text{"OK"} & \text{if } \phi V_{cpg} \geq V_{ua} \\ \text{"NG"} & \text{otherwise} \end{cases}$ $check_6 = \text{"OK"}$

Summary of design requirements for SHEAR:

SSteel strength of anchor in shear D.6.1 : $\phi V_s = 26.07 \cdot kip$

Concrete breakout strength of anchor in tension D.6.2 : $\phi V_{cbg} = 10.76 \cdot kip$

Concrete pryout strength of anchor in shear D.6.3 : $\phi V_{cpg} = 63.75 \cdot kip$

Therefore, $\phi V_n := \min(\phi V_s, \phi V_{cbg}, \phi V_{cpg})$ $\phi V_n = 10.76 \cdot kip$

h) Interaction of tensile and shear forces (D.7)

Is the full TENSION strength permitted?

answer3 := | "yes" if $V_{ua} \le 0.2 \cdot \phi V_n$
| "no" otherwise

answer3 = "no"

Is the full SHEAR strength permitted?

answer4 := | "yes" if $N_{ua} \le 0.2 \cdot \phi N_n$
| "no" otherwise

answer4 = "no"

If both answers above are "NO", the interaction equation must be used.

$$\text{interaction\_equation} := \frac{N_{ua}}{\phi N_n} + \frac{V_{ua}}{\phi V_n}$$

interaction_equation = 0.79

check7 := | "OK" if interaction_equation ≤ 1.2
| "NG" otherwise

check7 = "OK"

i) Required edge distances, spacings, and center to center spacing (D.8)

Minimum center to center spacing of the anchors:

min_spacing := $4 \cdot d_o$

min_spacing = 3·in

- Section D.8.1 & D.8.4, minimum spacing of ancho shall be 4 do for untorqued cast-in anchors, 6 do f torqued cast-in anchors and post installed anchors Otherwise refer to ACI 355.2 for product-specif tests.

Minimum edge distance for the anchors:

min_edge_distance_ACI := 3in

min_edge_distance_ACI = 3·in

- Section D.8.2 ~ D.8.4,

(per ACI 318, 7.7)

ARCADIS

SUBJECT:

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SHEET 1

DOWELS TO TIE THE PEDESTAL TO FOOTING

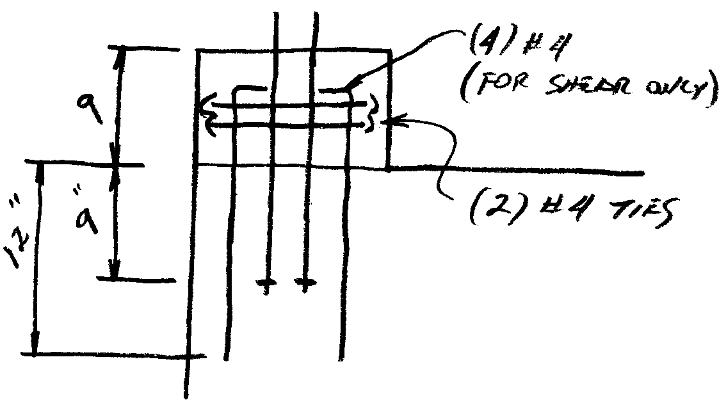
#4 BAR HOOK L_{dh} = 7 in H_{min} = 9 in PEDESTAL HEIGHT

FOR TENSION $A_{s\,REQ} = \frac{8.4k}{0.9(60\,k/in^2)} = 0.156\ in^2$

FOR SHEAR $A_{s\,REQ} = \frac{4.1k}{0.75(60)\,0.6} = 0.152$

$A_s = 0.31\ in^2$

USE (4) #4 $A_s = 0.4\ in^2$



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ARCADIS

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SHEET 1

TENSION TIE BETWEEN OPPOSITE COLUMNS

$T_u = 2.08k$

$A_s = \frac{2.08}{0.9(60)} = 0.04\ in^2$

USE (2) # 4's HOOKED AROUND ANCHOR BOLTS

ARCADIS

SUBJECT: LATERAL SOIL RESISTANCE

JOB NO:

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SHEET 1

INTERIOR FRAME

TRANSVERSE DIRECTION

LC

32 −0.86 −1.85 = 2.71

34 −1.26 −1.45 = 2.71

36 −2.08 −1.54 = 3.62

LC 36 V = 2.08 UPLIFT = 4.4k 0.6D + W

WT OF FOOTING

W = 0.15 (5.5)(5.5) 3

W = 13.6k

NET DL = 0.6(13.6) − 4.4

= 3.76k

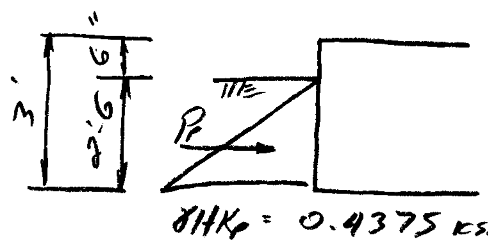
μ = 0.45

FRICTIONAL RESISTANCE F_F = 3.76 (0.45) = 1.7k

PASSIVE PRESSURE RESISTANCE γK_P = 175 KCF

$P_P = 0.4375 \frac{k}{ft^2} \left(\frac{2.5 ft}{2}\right) 5.5 ft$

P_P = 3k



B = 5.5 ft

$P_P + F_F$ = 3k + 1.7k = 4.7k

$\frac{4.7}{2.08}$ = 2.26

CONNECTION TO FLEXIBLE DIAPHRAGM

12.11.2.1 $F_p = 0.8 S_{DS} I W_p$

$= 0.8(0.42)1(61 psf)$

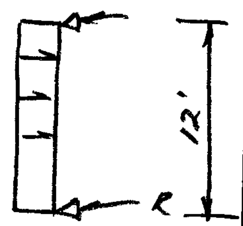
$F_p = 20.5 psf$

$0.7 \rho q_E = 0.7(1.3)(20.5) = 18.7 psf$

AT TOP & BOTTOM $R = \frac{18.7 \, lb/ft^2}{2}(12 ft)$

$R = 112$ PLF

MIN FORCE = 280 PLF (12.11.2 c)



WIND PRESSURE ON INTERNAL WALL

$P = q_H\, GC_{pi}$ (6-22) $GC_{pi} = 0.55$ PART. ENCLOSED

$q_H = 0.00256\, K_z K_{zt} K_D V^2 I$

$K_z = 0.85$
$K_{zt} = 1$
$K_D = 0.85$
$V = 90$
$I = 1$

$q_H = 15$ PSF

$P = 15$ PSF (0.55)
$P = 8.24$ PSF

0.7E CONTROLS
ALLOWABLE STRESS

ARCADIS

SUBJECT: MASONRY PARTITION WALL

JOB NO:

BY: [signature] DATE: 3-25-13

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SHEET 1

ASCE 7 13.3 NON STRUCTURAL COMPONENTS

$$F_p = \frac{0.4 a_p S_{DS} W_p}{R_p/I_p}\left(1 + 2\frac{z}{h}\right)$$

$S_{DS} = 0.42$

$I_p = 1$ (13.1.3)

8" REINFORCED CMU $W_p = 61$ psf $h = 15$ ft $z = 15$

TBL 13.5-1 $a_p = 1$ $R_p = 2.5$ REINFORCED MASONRY

$$F_p = \frac{0.4(1)(0.42)}{2.5/1}(1 + 2(1))\,W_p$$

$F_p = 0.202\,W_p$

$F_p \le 1.6 S_{DS} I_p W_p$

$F_p \le 1.6(0.42)\,W_p$

$F_p \le 0.672\,W_p$

$F_p \ge 0.3 S_{DS} I_p W_p$

$F_p \ge 0.3(0.42)\,1\,W_p$

$F_p \ge 0.126\,W_p$

USE $F_p = 0.202\,W_p$

$F_p = 0.202(61\text{ psf})$

$F_p = 12.3\ \#/\text{ft}^2$

$0.7\rho Q_E = 0.7(1.3)12.3 = 11.2$ psf ALLOWABLE STRESS

VERTICAL LOAD 1.0 6D

$(1.0 + 0.14 S_{DS})D + 0.7\rho Q_E$

REINFORCING - 8" CMU
#4 @ 48

Reference:H:\MATHCAD WORKSHEETS\Units.xmcd
Reference:H:\MATHCAD WORKSHEETS\Masonry weights.xmcd(R)

$b := 48in$ Vertical Bar Spacing

$t := 7.625in$ Block SIze

$q_d := q_{w848}$ Weight of Masonry Wall

$q_d = 61 \cdot psf$

$H := 12ft$ Wall Height

WALL SEISMIC LOAD

$q_w := 0.91 \cdot 12.3psf$ 0.91Qe

$w := q_w \cdot b$ $w = 44.772 \cdot \frac{lb}{ft}$

$M_w := \frac{w \cdot H^2}{8}$ $M_w = 805.896 \cdot lb \cdot ft$

LOAD CASE 1.06D+0.91Qe

$e_1 := 0$ Actual eccentricity of axial load only

$P := 1.06\left(q_d \cdot \frac{H}{2} \cdot b\right)$ 1.06D Axial @ H/2

$P = 1.552 \times 10^3 lb$

WALL MOMENT

$M_1 := 1.0M_w$ $M_1 = 805.896 \cdot lb \cdot ft$

$f_m := 1500 \frac{lb}{in^2}$ $\quad E_m := 900 \cdot f_m$ $\quad n := \frac{29000000 \frac{lb}{in^2}}{E_m}$ $\quad n = 21.48$

$E_m = 1.35 \times 10^3 \cdot ksi$

$d := \frac{t}{2}$ $\quad d = 3.8125 \cdot in$

$As := 0.44 in^2$ $\quad$ 1 # 4

$\rho := \frac{As}{b \cdot d}$ $\quad \rho = 0.0024$

$k_1 := \sqrt{(n \cdot \rho)^2 + 2 \cdot n \cdot \rho} - n \cdot \rho$ $\quad k_1 = 0.2739$ $\quad k_1 \cdot d = 1.0442 \cdot in$ $\quad t_f = 1.25 \cdot in$

$$k := \begin{cases} k_1 & \text{if } k_1 \cdot d \le t_f \\ \dfrac{n \cdot \rho + \dfrac{t_f^2}{2 \cdot d^2}}{n \cdot \rho + \dfrac{t_f}{d}} & \text{otherwise} \end{cases}$$

Neutral Axis Location:

NA = "Flange"

$k = 0.2739$

$k \cdot d = 1.0442 \cdot in$

$j := 1 - \frac{k}{3}$ $\quad j = 0.9087$

STRESS IN MASONRY

$$f_b := \begin{cases} 2 \cdot \dfrac{M_1}{j \cdot k \cdot b \cdot d^2} & \text{if } k \cdot d \le t_f \\ \dfrac{2 \cdot M_1 \cdot k \cdot d}{(2 \cdot k \cdot d - t_f) \cdot b \cdot t_f \cdot \left(d - \dfrac{t_f}{2}\right)} & \text{otherwise} \end{cases}$$

$f_b = 111.391 \cdot psi$

STRESS IN STEEL

$f_s := \frac{M_1}{As \cdot j \cdot d}$ $\quad f_s = 6344.1 \cdot psi$

ALLOWABLE STRESSES

$F_b := 0.33 \cdot f_m$ $\quad F_b = 495 \cdot psi$

$F_s := 24000 psi$

AXIAL

Properties For 8 in CMU Grouted at 48 in O.C.

$A_1 := A_{848}$ $\quad I_1 := I_{848}$

$A_1 = 57 \cdot \frac{in^2}{ft}$ $\quad I_1 = 377.08 \cdot \frac{in^4}{ft}$

$A := A_1 \cdot b$ $\quad A = 228 \cdot in^2$ $\quad I := I_1 b$ $\quad I = 1508.3 \cdot in^4$

$r := \sqrt{\frac{I}{A}}$ $\quad r = 2.572 \cdot in$ $\quad \frac{H}{r} = 55.986$

$e_1 = 0 \cdot in$ Actual eccentricity of axial load only

$$F_a := \begin{cases} 0.25 \cdot f_m \cdot \left[1 - \left(\frac{H}{140 \cdot r}\right)^2\right] & \text{if } \frac{H}{r} \le 99 \\ 0.25 \cdot f_m \cdot \left(70 \cdot \frac{r}{H}\right)^2 & \text{if } \frac{H}{r} > 99 \end{cases}$$

$f_a := \frac{P}{A}$ $\quad f_a = 6.8 \cdot psi$

$F_a = 315 \cdot psi$

$$P_e := \pi^2 \cdot E_m \cdot \frac{I}{H^2} \cdot \left(1 - 0.577 \frac{e_1}{r}\right)^3$$

$P_e = 9.692 \times 10^5 \cdot lb$

$\frac{f_a}{F_a} + \frac{f_b}{F_b} \le 1$ $\quad \frac{P}{P_e} \le 0.25$

$\frac{f_a}{F_a} + \frac{f_b}{F_b} = 0.2466$ $\quad \frac{P}{P_e} = 0.0016$

IN PLANE FORCES $\quad (1.0+0.14S_{DS})D + 0.7\rho Q_E$

$F_p = 11.2\ \#/ft^2\ (12\ ft)(25\ ft)$ $\quad 0.7\rho Q_E$

$F_p = 3.4k$

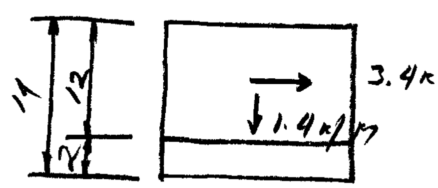
$W = 61\ psf\ (12\ ft)$

$W = 0.73\ k/ft$ CMU WALL

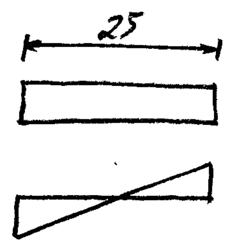
WEIGHT OF FOOTING
$0.15\ (2ft)2ft = 0.6\ k/ft$

$W = 1.06\ (0.73 + 0.6)\ k/ft$ $\quad 1.06D$

$W = 1.4\ k/ft$



$M = 3.4k\ (8ft)$
$M = 27.2\ k\,ft$



$S = \frac{(25)^2\,2}{6}$

$S = 208.3\ ft^3$

SOIL BEARING

$f_p = \frac{1.4\ k/ft}{2ft} \pm \frac{27.2\ k\,ft}{208.3\ ft^3}$

$f_p = 0.7\ ksf + 0.131\ ksf = 0.83\ ksf$

$f_p = 0.7 - 0.131 = 0.57\ ksf$

MW-20 Bench and TW Bench Carbon Amendment Buildings Fire Suppression Calculations

Pre-Final Design Submittal for Final Groundwater Remedy
PG&E Topock Compressor Station
Needles, California

Fire Protection Calculations

09/08/2014

Prepared for:

Pacific Gas and Electric Company

Prepared and Reviewed by:

Tom Hintz
Licensed Fire Protection Contractor
Marquee Fire Protection

ARCADIS

MARQUEE
FIRE PROTECTION

MARQUEE

FIRE PROTECTION

LICENSED FIRE PROTECTION CONTRACTOR
MARQUEE FIRE PROTECTION ENGINEERING
CLASSIFICATION
C-16
LICENSE No.
570970
STATE OF CALIFORNIA

Marquee Fire Protection
710 West Stadium Lane
Sacramento, CA 95843
916-641-7997

Job Name	:	TOPOCK CARBON AMENDMENT BUILDING
Building	:	MW-20 BENCH
Location	:	NEEDLES, CA
System	:	ONE
Contract	:	1814-695
Data File	:	PGE AREA 1.WXF

Hydraulic Design Information Sheet

```
Name - TOPOCK CARBON AMENDMENT BUILDING                        Date - 8-13-14
Location - NEEDLES, CA
Building - MW-20 BENCH                                 System No. - ONE
Contractor - ETIC ENGINEERING                          Contract No. - 1814-695
Calculated By - T. HINTZ                               Drawing No. - FP-2
Construction: ( ) Combustible  (X) Non-Combustible    Ceiling Height - VARIES
Occupancy -

S   (X) NFPA 13  ( ) Lt. Haz.   Ord.Haz.Gp. ( ) 1 (X) 2         ( ) Ex.Haz.
Y   ( ) NFPA 231 ( ) NFPA 231C   ( ) Figure              Curve
S   Other
T   Specific Ruling                      Made By             Date
E
M    Area of Sprinkler Operation - RM DSGN   System Type     Sprinkler/Nozzle
     Density                     - 0.2       (X) Wet         Make VIKING
D    Area Per Sprinkler          - 124       ( ) Dry         Model MFAST
E    Elevation at Highest Outlet - 11.25     ( ) Deluge      Size 1/2"
S    Hose Allowance - Inside     -           ( ) Preaction   K-Factor 5.6
I    Rack Sprinkler Allowance    -           ( ) Other      Temp.Rat.200
G    Hose Allowance - Outside    - 250
N
     Note

Calculation  Flow Required - 642.142 Press Required - 47.385   At BOR
Summary      C-Factor Used:  120   Overhead          N/A   Underground

W   Water Flow Test:               Pump Data:            Tank or Reservoir:
A   Date of Test   -                                   Cap. -
T   Time of Test   -            Rated Cap.-           Elev.-
E   Static Press   -            @ Press   -
R   Residual Press -            Elev.     -                  Well
    Flow           -                                       Proof Flow
S   Elevation      -
U
P   Location -
P
L   Source of Information -
Y

C   Commodity                         Class         Location
O   Storage Ht.                       Area          Aisle W.
M   Storage Method:    Solid Piled     %     Palletized     %     Rack
M
       ( ) Single Row   ( ) Conven. Pallet   ( ) Auto. Storage   ( ) Encap.
S  R   ( ) Double Row   ( ) Slave Pallet     ( ) Solid Shelf     ( ) Non
T  A   ( ) Mult. Row                          ( ) Open Shelf
O  C
R  K    Flue Spacing                     Clearance:Storage to Ceiling
A       Longitudinal                     Transverse
G
E       Horizontal Barriers Provided:
```

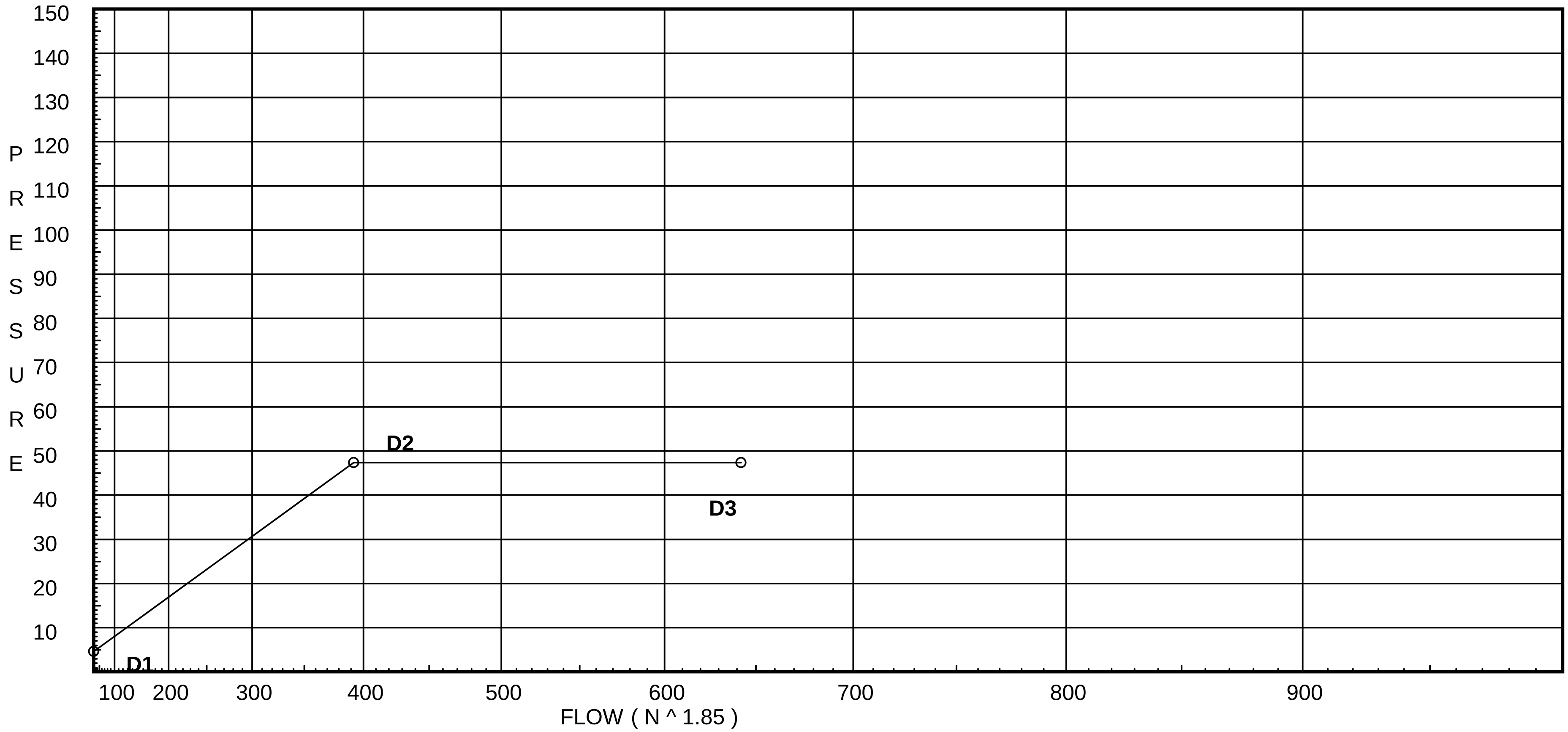
Water Supply Curve C

Marquee Fire Protection
TOPOCK CARBON AMENDMENT BUILDING

Page 2
Date 8-13-14

Demand:

D1 - Elevation	: 4.656
D2 - System Flow	: 392.142
D2 - System Pressure	: 47.384
Hose (Demand)	: 250
D3 - System Demand	: 642.142
Safety Margin	: ________



Fittings Used Summary

Fitting Legend

Abbrev.	Name	½	¾	1	1¼	1½	2	2½	3	3½	4	5	6	8	10	12	14	16	18	20	24
B	NFPA 13 Butterfly Valve	0	0	0	0	0	6	7	10	0	12	9	10	12	19	21	0	0	0	0	0
E	NFPA 13 90' Standard Elbow	1	2	2	3	4	5	6	7	8	10	12	14	18	22	27	35	40	45	50	61
T	NFPA 13 90' Flow thru Tee	3	4	5	6	8	10	12	15	17	20	25	30	35	50	60	71	81	91	101	121

Units Summary

Diameter Units	Inches
Length Units	Feet
Flow Units	US Gallons per Minute
Pressure Units	Pounds per Square Inch

Note: Fitting Legend provides equivalent pipe lengths for fittings types of various diameters. Equivalent lengths shown are standard for actual diameters of Sched 40 pipe and CFactors of 120 except as noted with *. The fittings marked with a * show equivalent lengths values supplied by manufacturers based on specific pipe diameters and CFactors and they require no adjustment. All values for fittings not marked with a * will be adjusted in the calculation for CFactors of other than 120 and diameters other than Sched 40 per NFPA.

SUPPLY ANALYSIS

Node at Source Pressure	Static Pressure	Residual Pressure	Flow	Available Pressure	Total Demand	Required

NODE ANALYSIS

Node Tag	Elevation	Node Type	Pressure at Node	Discharge at Node	Notes
S9	11.25	5.6	19.61	24.8	
S8	11.25	5.6	21.36	25.88	
S7	11.25	5.6	23.08	26.9	
R3	11.25		25.18		
M3	9.5		29.23		
M2	9.5		30.55		
M1	9.5		32.67		
TOR1	9.5		36.77		
BOR1	0.5		47.38	250.0	
S3	11.25	5.6	22.1	26.33	
S2	11.25	5.6	24.05	27.46	
S1	11.25	5.6	25.97	28.54	
R1	11.25		28.28		
M5	9.5		28.2		
M4	9.5		28.35		
S6	11.25	5.6	20.63	25.43	
S5	11.25	5.6	22.45	26.54	
S4	11.25	5.6	24.26	27.58	
R2	11.25		26.38		
S12	11.25	5.6	19.04	24.44	
S11	11.25	5.6	20.74	25.5	
S10	11.25	5.6	22.41	26.51	
R4	11.25		24.42		
S15	11.25	5.6	18.94	24.37	
S14	11.25	5.6	20.62	25.43	
S13	11.25	5.6	22.29	26.44	
R5	11.25		24.29		

Node1 to Node2	Elev1 Elev2	K Fact	Qa Qt	Nom Act	Fitting or Eqv.	Ln.	Pipe Ftng's Total	CFact Pf/Ft	Pt Pe Pf	******* Notes ******
*EQUIVALENT K'S										
*REMOTE HEAD TO SUPPLY										
S9	11.25	5.60	24.80	1		0.0	9.000	120	19.612	
to						0.0	0.0		0.0	
S8	11.25		24.8	1.049		0.0	9.000	0.1938	1.744	Vel = 9.21
S8	11.25	5.60	25.88	1.25		0.0	9.000	120	21.356	
to						0.0	0.0		0.0	
S7	11.25		50.68	1.38		0.0	9.000	0.1911	1.720	Vel = 10.87
S7	11.25	5.60	26.90	1.25	1E	3.0	2.000	120	23.076	
to						0.0	3.000		0.0	
R3	11.25		77.58	1.38		0.0	5.000	0.4202	2.101	Vel = 16.64
R3	11.25		0.0	1.25	1T	6.0	1.833	120	25.177	
to						0.0	6.000		0.758	
M3	9.5		77.58	1.38		0.0	7.833	0.4203	3.292	Vel = 16.64
M3	9.5		152.68	2.5		0.0	9.833	120	29.227	
to						0.0	0.0		0.0	
M2	9.5		230.26	2.635		0.0	9.833	0.1348	1.325	Vel = 13.55
M2	9.5		79.55	2.5		0.0	9.083	120	30.552	
to						0.0	0.0		0.0	
M1	9.5		309.81	2.635		0.0	9.083	0.2333	2.119	Vel = 18.23
M1	9.5		82.33	2.5	1E	8.237	3.125	120	32.671	
to						0.0	8.237		0.0	
TOR1	9.5		392.14	2.635		0.0	11.362	0.3609	4.100	Vel = 23.07
TOR1	9.5		0.0	2.5	1B	9.61	9.000	120	36.771	
to						0.0	9.610		3.898	
BOR1	0.5		392.14	2.635		0.0	18.610	0.3608	6.715	Vel = 23.07
			250.00							Qa = 250.00
BOR1			642.14						47.384	K Factor = 93.29
*NEW PATH										
S3	11.25	5.60	26.33	1		0.0	9.000	120	22.102	
to						0.0	0.0		0.0	
S2	11.25		26.33	1.049		0.0	9.000	0.2164	1.948	Vel = 9.77
S2	11.25	5.60	27.46	1.25		0.0	9.000	120	24.050	
to						0.0	0.0		0.0	
S1	11.25		53.79	1.38		0.0	9.000	0.2134	1.921	Vel = 11.54
S1	11.25	5.60	28.54	1.25	1E	3.0	1.920	120	25.971	
to						0.0	3.000		0.0	
R1	11.25		82.33	1.38		0.0	4.920	0.4689	2.307	Vel = 17.66
R1	11.25		0.0	1.25	1T	6.0	1.750	120	28.278	
to						0.0	6.000		0.758	
M1	9.5		82.33	1.38		0.0	7.750	0.4690	3.635	Vel = 17.66
			0.0							
M1			82.33						32.671	K Factor = 14.40
*NEW PATH										
M5	9.5		76.24	2.5		0.0	8.500	120	28.202	
to						0.0	0.0		0.0	
M4	9.5		76.24	2.635		0.0	8.500	0.0174	0.148	Vel = 4.49

Node1 to Node2	Elev1 Elev2	K Fact	Qa Qt	Nom Act	Fitting or Eqv.	Ln.	Pipe Ftng's Total	CFact Pf/Ft	Pt Pe Pf	******* Notes ******
M4	9.5		76.44	2.5		0.0	13.917	120	28.350	
to						0.0	0.0		0.0	
M3	9.5		152.68	2.635		0.0	13.917	0.0630	0.877	Vel = 8.98
			0.0							
M3			152.68						29.227	K Factor = 28.24
*NEW PATH										
S6	11.25	5.60	25.43	1		0.0	9.000	120	20.626	
to						0.0	0.0		0.0	
S5	11.25		25.43	1.049		0.0	9.000	0.2030	1.827	Vel = 9.44
S5	11.25	5.60	26.54	1.25		0.0	9.000	120	22.453	
to						0.0	0.0		0.0	
S4	11.25		51.97	1.38		0.0	9.000	0.2003	1.803	Vel = 11.15
S4	11.25	5.60	27.58	1.25	1E	3.0	1.833	120	24.256	
to						0.0	3.000		0.0	
R2	11.25		79.55	1.38		0.0	4.833	0.4401	2.127	Vel = 17.06
R2	11.25		0.0	1.25	1T	6.0	1.750	120	26.383	
to						0.0	6.000		0.758	
M2	9.5		79.55	1.38		0.0	7.750	0.4401	3.411	Vel = 17.06
			0.0							
M2			79.55						30.552	K Factor = 14.39
*NEW PATH										
S12	11.25	5.60	24.44	1		0.0	9.000	120	19.040	
to						0.0	0.0		0.0	
S11	11.25		24.44	1.049		0.0	9.000	0.1886	1.697	Vel = 9.07
S11	11.25	5.60	25.50	1.25		0.0	9.000	120	20.737	
to						0.0	0.0		0.0	
S10	11.25		49.94	1.38		0.0	9.000	0.1860	1.674	Vel = 10.71
S10	11.25	5.60	26.51	1.25	1E	3.0	1.920	120	22.411	
to						0.0	3.000		0.0	
R4	11.25		76.45	1.38		0.0	4.920	0.4089	2.012	Vel = 16.40
R4	11.25		0.0	1.25	1T	6.0	1.750	120	24.423	
to						0.0	6.000		0.758	
M4	9.5		76.45	1.38		0.0	7.750	0.4089	3.169	Vel = 16.40
			0.0							
M4			76.45						28.350	K Factor = 14.36
*NEW PATH										
S15	11.25	5.60	24.37	1		0.0	9.000	120	18.935	
to						0.0	0.0		0.0	
S14	11.25		24.37	1.049		0.0	9.000	0.1876	1.688	Vel = 9.05
S14	11.25	5.60	25.43	1.25		0.0	9.000	120	20.623	
to						0.0	0.0		0.0	
S13	11.25		49.8	1.38		0.0	9.000	0.1851	1.666	Vel = 10.68
S13	11.25	5.60	26.44	1.25	1E	3.0	1.920	120	22.289	
to						0.0	3.000		0.0	
R5	11.25		76.24	1.38		0.0	4.920	0.4067	2.001	Vel = 16.35
R5	11.25		0.0	1.25	1T	6.0	1.750	120	24.290	
to						0.0	6.000		0.758	
M5	9.5		76.24	1.38		0.0	7.750	0.4070	3.154	Vel = 16.35

Node1 to Node2	Elev1 Elev2	K Fact	Qa Qt	Nom Act	Fitting or Eqv. Ln.	Pipe Ftng's Total	CFact Pf/Ft	Pt Pe Pf	******* Notes ******
M5			0.0 76.24					28.202	K Factor = 14.36

MARQUEE

FIRE PROTECTION

LICENSED FIRE PROTECTION CONTRACTOR
MARQUEE FIRE PROTECTION ENGINEERING
CLASSIFICATION C-16
LICENSE No. 570970
STATE OF CALIFORNIA

Marquee Fire Protection
710 West Stadium Lane
Sacramento, CA 95843
916-641-7997

Job Name : TOPOCK CARBON AMENDMENT BUILDING
Building : TW BENCH
Location : NEEDLES, CA
System : TWO
Contract : 1814-695
Data File : PGE AREA 2.WXF

Hydraulic Design Information Sheet

Name - TOPOCK CARBON AMENDMENT BUILDING — Date - 8-13-14
Location - NEEDLES, CA
Building - TW BENCH — System No. - TWO
Contractor - ETIC ENGINEERING — Contract No. - 1814-695
Calculated By - T. HINTZ — Drawing No. - FP-3
Construction: (X) Combustible ( ) Non-Combustible — Ceiling Height - VARIES
Occupancy -

SYSTEM DESIGN

(X) NFPA 13 ( ) Lt. Haz. Ord.Haz.Gp. ( ) 1 (X) 2 ( ) Ex.Haz.
( ) NFPA 231 ( ) NFPA 231C ( ) Figure Curve
Other
Specific Ruling — Made By — Date

		System Type	Sprinkler/Nozzle
Area of Sprinkler Operation	- RM DSGN		
Density	- 0.2	(X) Wet	Make VIKING
Area Per Sprinkler	- 128	( ) Dry	Model MFAST
Elevation at Highest Outlet	- 8.5	( ) Deluge	Size 1/2"
Hose Allowance - Inside	-	( ) Preaction	K-Factor 5.6
Rack Sprinkler Allowance	-	( ) Other	Temp.Rat.200
Hose Allowance - Outside	- 250		

Note

Calculation Summary

Flow Required - 361.154 Press Required - 45.467 At BOR
C-Factor Used: 120 Overhead N/A Underground

WATER SUPPLY

Water Flow Test:		Pump Data:		Tank or Reservoir:
Date of Test	-			Cap. -
Time of Test	-	Rated Cap.-		Elev.-
Static Press	-	@ Press	-	
Residual Press	-	Elev.	-	Well
Flow	-			Proof Flow
Elevation	-			

Location -

Source of Information -

COMM

Commodity — Class — Location
Storage Ht. — Area — Aisle W.
Storage Method: Solid Piled % Palletized % Rack

STORAGE — RACK

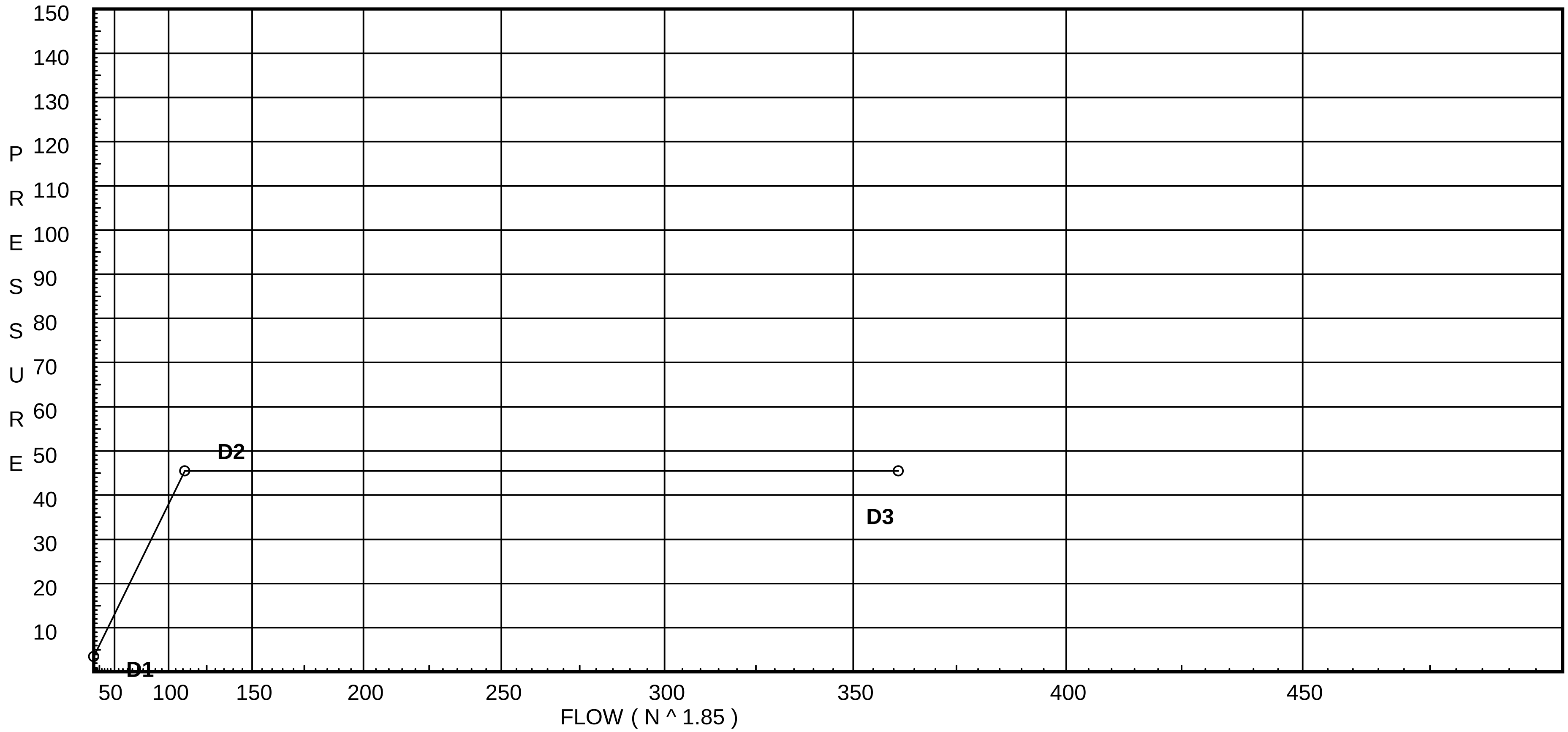
( ) Single Row	( ) Conven. Pallet	( ) Auto. Storage	( ) Encap.
( ) Double Row	( ) Slave Pallet	( ) Solid Shelf	( ) Non
( ) Mult. Row		( ) Open Shelf	

Flue Spacing — Clearance:Storage to Ceiling
Longitudinal — Transverse

Horizontal Barriers Provided:

Demand:

D1 - Elevation	: 3.465
D2 - System Flow	: 111.154
D2 - System Pressure	: 45.467
Hose (Demand)	: 250
D3 - System Demand	: 361.154
Safety Margin	: ________



Fittings Used Summary

Fitting Legend

Abbrev.	Name	½	¾	1	1¼	1½	2	2½	3	3½	4	5	6	8	10	12	14	16	18	20	24
B	NFPA 13 Butterfly Valve	0	0	0	0	0	6	7	10	0	12	9	10	12	19	21	0	0	0	0	0
E	NFPA 13 90' Standard Elbow	1	2	2	3	4	5	6	7	8	10	12	14	18	22	27	35	40	45	50	61
T	NFPA 13 90' Flow thru Tee	3	4	5	6	8	10	12	15	17	20	25	30	35	50	60	71	81	91	101	121

Units Summary

Diameter Units	Inches
Length Units	Feet
Flow Units	US Gallons per Minute
Pressure Units	Pounds per Square Inch

Note: Fitting Legend provides equivalent pipe lengths for fittings types of various diameters. Equivalent lengths shown are standard for actual diameters of Sched 40 pipe and CFactors of 120 except as noted with *. The fittings marked with a * show equivalent lengths values supplied by manufacturers based on specific pipe diameters and CFactors and they require no adjustment. All values for fittings not marked with a * will be adjusted in the calculation for CFactors of other than 120 and diameters other than Sched 40 per NFPA.

SUPPLY ANALYSIS

Node at Source Pressure	Static Pressure	Residual Pressure	Flow	Available Pressure	Total Demand	Required

NODE ANALYSIS

Node Tag	Elevation	Node Type	Pressure at Node	Discharge at Node	Notes
S21	8.5	5.6	20.9	25.6	
S22	8.5	5.6	23.53	27.16	
S23	8.5	5.6	25.67	28.37	
S24	8.5	5.6	28.74	30.02	
TOR2	8.5		41.28		
BOR2	0.5		45.47	250.0	

Node1 to Node2	Elev1 Elev2	K Fact	Qa Qt	Nom Act	Fitting or Eqv.	Ln.	Pipe Ftng's Total	CFact Pf/Ft	Pt Pe Pf	******* Notes ******
*EQUIVALENT K'S										
*REMOTE HEAD TO SUPPLY										
S21	8.5	5.60	25.60	1		0.0	12.790	120	20.898	
to						0.0	0.0		0.0	
S22	8.5		25.6	1.049		0.0	12.790	0.2055	2.628	Vel = 9.50
S22	8.5	5.60	27.16	1.25		0.0	10.420	120	23.526	
to						0.0	0.0		0.0	
S23	8.5		52.76	1.38		0.0	10.420	0.2060	2.146	Vel = 11.32
S23	8.5	5.60	28.38	1.25		0.0	6.710	120	25.672	
to						0.0	0.0		0.0	
S24	8.5		81.14	1.38		0.0	6.710	0.4565	3.063	Vel = 17.40
S24	8.5	5.60	30.01	1.25	1E	3.0	6.350	120	28.735	
to					1T	6.0	9.000		0.0	
TOR2	8.5		111.15	1.38		0.0	15.350	0.8173	12.546	Vel = 23.84
TOR2	8.5		0.0	2.5	1B	7.0	8.000	120	41.281	
to						0.0	7.000		3.465	
BOR2	0.5		111.15	2.469		0.0	15.000	0.0481	0.721	Vel = 7.45
			250.00							Qa = 250.00
BOR2			361.15						45.467	K Factor = 53.56

Sand Separator System

Sand Concentrator Calculation for High Purge Rate and High Purge Frequency

Purge Rate (gpm) =				300			
Purge Duration (sec) =				15			
Purge Volume (gal) =				60			
Purge Frequency (min) =				15			
Sand Concentrator flowrate (gpm) =				4			
Number of holes per row =				40			
100% Open Screen Area							
Q (cfs)	Nominal Dia (in)	Dia (in)	Area (ft^2)	Vel (fps)	$V^2/2g$	Kirschmer's h_L (ft)	Orifice coefficient
0.00022	0.50	0.622	0.00211	0.11	0.00	0.00	0.93
0.00022	1.00	1.049	0.00600	0.04	0.00	0.00	0.93
0.00022	1.50	1.610	0.01414	0.02	0.00	0.00	0.93
0.00022	2.00	2.067	0.02330	0.01	0.00	0.00	0.93
75% Open Screen Area							
Q (cfs)	Nominal Dia (in)	Dia (in)	Area (ft^2)	Vel (fps)	$V^2/2g$	Kirschmer's h_L (ft)	Orifice coefficient
0.00022	0.50	0.622	0.00158	0.14	0.00	0.00	0.75
0.00022	1.00	1.049	0.00450	0.05	0.00	0.00	0.75
0.00022	1.50	1.610	0.01060	0.02	0.00	0.00	0.75
0.00022	2.00	2.067	0.01748	0.01	0.00	0.00	0.75
50% Open Screen Area							
Q (cfs)	Nominal Dia (in)	Dia (in)	Area (ft^2)	Vel (fps)	$V^2/2g$	Kirschmer's h_L (ft)	Orifice coefficient
0.00022	0.50	0.622	0.00106	0.21	0.00	0.00	0.59
0.00022	1.00	1.049	0.00300	0.07	0.00	0.00	0.59
0.00022	1.50	1.610	0.00707	0.03	0.00	0.00	0.59
0.00022	2.00	2.067	0.01165	0.02	0.00	0.00	0.59
25% Open Screen Area							
Q (cfs)	Nominal Dia (in)	Dia (in)	Area (ft^2)	Vel (fps)	$V^2/2g$	Kirschmer's h_L (ft)	Orifice coefficient
0.00022	0.50	0.622	0.00053	0.42	0.00	0.02	0.41
0.00022	1.00	1.049	0.00150	0.15	0.00	0.00	0.41
0.00022	1.50	1.610	0.00353	0.06	0.00	0.00	0.41
0.00022	2.00	2.067	0.00583	0.04	0.00	0.00	0.41
10% Open Screen Area							
Q (cfs)	Nominal Dia (in)	Dia (in)	Area (ft^2)	Vel (fps)	$V^2/2g$	Kirschmer's h_L (ft)	Orifice coefficient
0.00022	0.50	0.622	0.00021	1.06	0.02	0.23	0.28
0.00022	1.00	1.049	0.00060	0.37	0.00	0.03	0.28
0.00022	1.50	1.610	0.00141	0.16	0.00	0.01	0.28
0.00022	2.00	2.067	0.00233	0.10	0.00	0.00	0.28

By PT, E2 Consulting Engineers

Sand Concentrator Calculation for High Purge Rate and High Purge Frequency

5% Open Screen Area							
Q (cfs)	Nominal Dia (in)	Dia (in)	Area (ft^2)	Vel (fps)	$V^2/2g$	Kirschmer's h_L (ft)	Orifice coefficient
0.00022	0.50	0.622	0.00011	2.11	0.07	1.56	0.21
0.00022	1.00	1.049	0.00030	0.74	0.01	0.19	0.21
0.00022	1.50	1.610	0.00071	0.32	0.00	0.03	0.21
0.00022	2.00	2.067	0.00117	0.19	0.00	0.01	0.21
1% Open Screen Area							
Q (cfs)	Nominal Dia (in)	Dia (in)	Area (ft^2)	Vel (fps)	$V^2/2g$	Kirschmer's h_L (ft)	Orifice coefficient
0.00022	0.50	0.622	0.00002	10.56	1.73	127.47	0.12
0.00022	1.00	1.049	0.00006	3.71	0.21	15.76	0.12
0.00022	1.50	1.610	0.00014	1.58	0.04	2.84	0.12
0.00022	2.00	2.067	0.00023	0.96	0.01	1.05	0.12

By PT, E2 Consulting Engineers

Sand Concentrator Calculation for High Purge Rate and Low Purge Frequency

Purge Rate (gpm) =				300			
Purge Duration (sec) =				12			
Purge Volume (gal) =				60			
Purge Frequency (min) =				240			
Sand Concentrator flowrate (gpm) =				0.25			
Number of holes per row =				40			
100% Open Screen Area							
Q (cfs)	Nominal Dia (in)	Dia (in)	Area (ft^2)	Vel (fps)	V^2/2g	Kirschmer's h_L (ft)	Orifice coefficient
0.00001	0.50	0.622	0.00211	0.01	0.00	0.00	0.93
0.00001	1.00	1.049	0.00600	0.00	0.00	0.00	0.93
0.00001	1.50	1.610	0.01414	0.00	0.00	0.00	0.93
0.00001	2.00	2.067	0.02330	0.00	0.00	0.00	0.93
75% Open Screen Area							
Q (cfs)	Nominal Dia (in)	Dia (in)	Area (ft^2)	Vel (fps)	V^2/2g	Kirschmer's h_L (ft)	Orifice coefficient
0.00001	0.50	0.622	0.00158	0.01	0.00	0.00	0.75
0.00001	1.00	1.049	0.00450	0.00	0.00	0.00	0.75
0.00001	1.50	1.610	0.01060	0.00	0.00	0.00	0.75
0.00001	2.00	2.067	0.01748	0.00	0.00	0.00	0.75
50% Open Screen Area							
Q (cfs)	Nominal Dia (in)	Dia (in)	Area (ft^2)	Vel (fps)	V^2/2g	Kirschmer's h_L (ft)	Orifice coefficient
0.00001	0.50	0.622	0.00106	0.01	0.00	0.00	0.59
0.00001	1.00	1.049	0.00300	0.00	0.00	0.00	0.59
0.00001	1.50	1.610	0.00707	0.00	0.00	0.00	0.59
0.00001	2.00	2.067	0.01165	0.00	0.00	0.00	0.59
25% Open Screen Area							
Q (cfs)	Nominal Dia (in)	Dia (in)	Area (ft^2)	Vel (fps)	V^2/2g	Kirschmer's h_L (ft)	Orifice coefficient
0.00001	0.50	0.622	0.00053	0.03	0.00	0.00	0.41
0.00001	1.00	1.049	0.00150	0.01	0.00	0.00	0.41
0.00001	1.50	1.610	0.00353	0.00	0.00	0.00	0.41
0.00001	2.00	2.067	0.00583	0.00	0.00	0.00	0.41
10% Open Screen Area							
Q (cfs)	Nominal Dia (in)	Dia (in)	Area (ft^2)	Vel (fps)	V^2/2g	Kirschmer's h_L (ft)	Orifice coefficient
0.00001	0.50	0.622	0.00021	0.07	0.00	0.00	0.28
0.00001	1.00	1.049	0.00060	0.02	0.00	0.00	0.28
0.00001	1.50	1.610	0.00141	0.01	0.00	0.00	0.28
0.00001	2.00	2.067	0.00233	0.01	0.00	0.00	0.28

By PT, E2 Consulting Engineers

Sand Concentrator Calculation for High Purge Rate and Low Purge Frequency

5% Open Screen Area							
Q (cfs)	Nominal Dia (in)	Dia (in)	Area (ft^2)	Vel (fps)	$V^2/2g$	Kirschmer's h_L (ft)	Orifice coefficient
0.00001	0.50	0.622	0.00011	0.13	0.00	0.01	0.21
0.00001	1.00	1.049	0.00030	0.05	0.00	0.00	0.21
0.00001	1.50	1.610	0.00071	0.02	0.00	0.00	0.21
0.00001	2.00	2.067	0.00117	0.01	0.00	0.00	0.21
1% Open Screen Area							
Q (cfs)	Nominal Dia (in)	Dia (in)	Area (ft^2)	Vel (fps)	$V^2/2g$	Kirschmer's h_L (ft)	Orifice coefficient
0.00001	0.50	0.622	0.00002	0.66	0.01	0.50	0.12
0.00001	1.00	1.049	0.00006	0.23	0.00	0.06	0.12
0.00001	1.50	1.610	0.00014	0.10	0.00	0.01	0.12
0.00001	2.00	2.067	0.00023	0.06	0.00	0.00	0.12

By PT, E2 Consulting Engineers

Sand Concentrator Calculation for Low Purge Rate and High Purge Frequency

Purge Rate (gpm) =				50			
Purge Duration (sec) =				12			
Purge Volume (gal) =				10			
Purge Frequency (min) =				15			
Sand Concentrator flowrate (gpm) =				0.67			
Number of holes per row =				40			
100% Open Screen Area							
Q (cfs)	Nominal Dia (in)	Dia (in)	Area (ft^2)	Vel (fps)	$V^2/2g$	Kirschmer's h_L (ft)	Orifice coefficient
0.00004	0.50	0.622	0.00211	0.02	0.00	0.00	0.93
0.00004	1.00	1.049	0.00600	0.01	0.00	0.00	0.93
0.00004	1.50	1.610	0.01414	0.00	0.00	0.00	0.93
0.00004	2.00	2.067	0.02330	0.00	0.00	0.00	0.93
75% Open Screen Area							
Q (cfs)	Nominal Dia (in)	Dia (in)	Area (ft^2)	Vel (fps)	$V^2/2g$	Kirschmer's h_L (ft)	Orifice coefficient
0.00004	0.50	0.622	0.00158	0.02	0.00	0.00	0.75
0.00004	1.00	1.049	0.00450	0.01	0.00	0.00	0.75
0.00004	1.50	1.610	0.01060	0.00	0.00	0.00	0.75
0.00004	2.00	2.067	0.01748	0.00	0.00	0.00	0.75
50% Open Screen Area							
Q (cfs)	Nominal Dia (in)	Dia (in)	Area (ft^2)	Vel (fps)	$V^2/2g$	Kirschmer's h_L (ft)	Orifice coefficient
0.00004	0.50	0.622	0.00106	0.04	0.00	0.00	0.59
0.00004	1.00	1.049	0.00300	0.01	0.00	0.00	0.59
0.00004	1.50	1.610	0.00707	0.01	0.00	0.00	0.59
0.00004	2.00	2.067	0.01165	0.00	0.00	0.00	0.59
25% Open Screen Area							
Q (cfs)	Nominal Dia (in)	Dia (in)	Area (ft^2)	Vel (fps)	$V^2/2g$	Kirschmer's h_L (ft)	Orifice coefficient
0.00004	0.50	0.622	0.00053	0.07	0.00	0.00	0.41
0.00004	1.00	1.049	0.00150	0.02	0.00	0.00	0.41
0.00004	1.50	1.610	0.00353	0.01	0.00	0.00	0.41
0.00004	2.00	2.067	0.00583	0.01	0.00	0.00	0.41
10% Open Screen Area							
Q (cfs)	Nominal Dia (in)	Dia (in)	Area (ft^2)	Vel (fps)	$V^2/2g$	Kirschmer's h_L (ft)	Orifice coefficient
0.00004	0.50	0.622	0.00021	0.18	0.00	0.01	0.28
0.00004	1.00	1.049	0.00060	0.06	0.00	0.00	0.28
0.00004	1.50	1.610	0.00141	0.03	0.00	0.00	0.28
0.00004	2.00	2.067	0.00233	0.02	0.00	0.00	0.28

By PT, E2 Consulting Engineers

Sand Concentrator Calculation for Low Purge Rate and High Purge Frequency

5% Open Screen Area							
Q (cfs)	Nominal Dia (in)	Dia (in)	Area (ft^2)	Vel (fps)	$V^2/2g$	Kirschmer's h_L (ft)	Orifice coefficient
0.00004	0.50	0.622	0.00011	0.35	0.00	0.04	0.21
0.00004	1.00	1.049	0.00030	0.12	0.00	0.01	0.21
0.00004	1.50	1.610	0.00071	0.05	0.00	0.00	0.21
0.00004	2.00	2.067	0.00117	0.03	0.00	0.00	0.21
1% Open Screen Area							
Q (cfs)	Nominal Dia (in)	Dia (in)	Area (ft^2)	Vel (fps)	$V^2/2g$	Kirschmer's h_L (ft)	Orifice coefficient
0.00004	0.50	0.622	0.00002	1.76	0.05	3.54	0.12
0.00004	1.00	1.049	0.00006	0.62	0.01	0.44	0.12
0.00004	1.50	1.610	0.00014	0.26	0.00	0.08	0.12
0.00004	2.00	2.067	0.00023	0.16	0.00	0.03	0.12

Sand Concentrator
Low Purge Rate and Low Purge Frequency

			Purge Rate (gpm) =	50			
			Purge Duration (sec) =	12			
			Purge Volume (gal) =	10			
			Purge Frequency (min) =	240			
			Sand Concentrator flowrate (gpm) =	0.04			
			Number of holes per row =	40			
100% Open Screen Area							
Q (cfs)	Nominal Dia (in)	Dia (in)	Area (ft^2)	Vel (fps)	$V^2/2g$	Kirschmer's h_L (ft)	Orifice coefficient
0.00000	0.50	0.622	0.00211	0.00	0.00	0.00	0.93
0.00000	1.00	1.049	0.00600	0.00	0.00	0.00	0.93
0.00000	1.50	1.610	0.01414	0.00	0.00	0.00	0.93
0.00000	2.00	2.067	0.02330	0.00	0.00	0.00	0.93
75% Open Screen Area							
Q (cfs)	Nominal Dia (in)	Dia (in)	Area (ft^2)	Vel (fps)	$V^2/2g$	Kirschmer's h_L (ft)	Orifice coefficient
0.00000	0.50	0.622	0.00158	0.00	0.00	0.00	0.75
0.00000	1.00	1.049	0.00450	0.00	0.00	0.00	0.75
0.00000	1.50	1.610	0.01060	0.00	0.00	0.00	0.75
0.00000	2.00	2.067	0.01748	0.00	0.00	0.00	0.75
50% Open Screen Area							
Q (cfs)	Nominal Dia (in)	Dia (in)	Area (ft^2)	Vel (fps)	$V^2/2g$	Kirschmer's h_L (ft)	Orifice coefficient
0.00000	0.50	0.622	0.00106	0.00	0.00	0.00	0.59
0.00000	1.00	1.049	0.00300	0.00	0.00	0.00	0.59
0.00000	1.50	1.610	0.00707	0.00	0.00	0.00	0.59
0.00000	2.00	2.067	0.01165	0.00	0.00	0.00	0.59
25% Open Screen Area							
Q (cfs)	Nominal Dia (in)	Dia (in)	Area (ft^2)	Vel (fps)	$V^2/2g$	Kirschmer's h_L (ft)	Orifice coefficient
0.00000	0.50	0.622	0.00053	0.00	0.00	0.00	0.41
0.00000	1.00	1.049	0.00150	0.00	0.00	0.00	0.41
0.00000	1.50	1.610	0.00353	0.00	0.00	0.00	0.41
0.00000	2.00	2.067	0.00583	0.00	0.00	0.00	0.41
10% Open Screen Area							
Q (cfs)	Nominal Dia (in)	Dia (in)	Area (ft^2)	Vel (fps)	$V^2/2g$	Kirschmer's h_L (ft)	Orifice coefficient
0.00000	0.50	0.622	0.00021	0.01	0.00	0.00	0.28
0.00000	1.00	1.049	0.00060	0.00	0.00	0.00	0.28
0.00000	1.50	1.610	0.00141	0.00	0.00	0.00	0.28
0.00000	2.00	2.067	0.00233	0.00	0.00	0.00	0.28

By PT, E2 Consulting Engineers

Sand Concentrator

Low Purge Rate and Low Purge Frequency

5% Open Screen Area							
Q (cfs)	Nominal Dia (in)	Dia (in)	Area (ft^2)	Vel (fps)	$V^2/2g$	Kirschmer's h_L (ft)	Orifice coefficient
0.00000	0.50	0.622	0.00011	0.02	0.00	0.00	0.21
0.00000	1.00	1.049	0.00030	0.01	0.00	0.00	0.21
0.00000	1.50	1.610	0.00071	0.00	0.00	0.00	0.21
0.00000	2.00	2.067	0.00117	0.00	0.00	0.00	0.21
1% Open Screen Area							
Q (cfs)	Nominal Dia (in)	Dia (in)	Area (ft^2)	Vel (fps)	$V^2/2g$	Kirschmer's h_L (ft)	Orifice coefficient
0.00000	0.50	0.622	0.00002	0.11	0.00	0.01	0.12
0.00000	1.00	1.049	0.00006	0.04	0.00	0.00	0.12
0.00000	1.50	1.610	0.00014	0.02	0.00	0.00	0.12
0.00000	2.00	2.067	0.00023	0.01	0.00	0.00	0.12

Attachment C
Geotechnical Summary (*on CD-ROM only*)

- Geotechnical Data Summary and Proposed Supplemental Geotechnical Investigation
- Selected Boring Logs from RFI/RI Report Volume 2 (CH2M HILL 2009)
- *Geotechnical Investigation Report, Topock Compressor Station, Water Treatment Plant* (CH2M HILL 2004)
- *Geotechnical Investigation, Topock AOC 4 Remediation – Pre-Work Plan Data Collection Activities, PG&E Compressor Station, Needles, California* (CH2M HILL 2009)

Geotechnical Data Summary and Proposed Supplemental Geotechnical Investigation

Geotechnical Data Summary and Proposed Supplemental Geotechnical Investigation

The purpose of this geotechnical summary is to provide information on existing site geology and geotechnical data in support of the groundwater remedy design and to propose areas where supplemental geotechnical investigation is needed to verify design parameters. Coordination with the Soil RCRA Facility Investigation/Remedial Investigation (RFI/RI) investigation program was conducted in planning the supplemental geotechnical investigation to minimize the number of required boreholes, thereby minimizing ground disturbance.

C.1 Summary of Existing Site Geologic and Geotechnical Data

In 2004 and 2009, CH2M HILL conducted geotechnical investigations in and around the compressor station and Area of Concern (AOC) 4, respectively. Results were presented in the following reports and are summarized below:

- *Geotechnical Investigation Report, Topock Compressor Station, Water Treatment Plant*. Prepared by CH2M HILL in September 2004. (Full report presented in PDF format as part of this Attachment to Appendix C of the 60% Basis of Design Report on the Appendix C CD-ROM).
- *Geotechnical Investigation, Topock AOC 4 Remediation – Pre-Work Plan Data Collection Activities, PG&E Compressor Station, Needles, California*. Prepared by CH2M HILL in October 2009. (Full report presented in PDF format as part of this Attachment to Appendix C on the Appendix C CD-ROM).

In addition, geologic information for the MW-20 Bench and hydrogeologic cross sections throughout the site are also summarized in the sections below. Original results were reported in the following reports:

- *Work Plan for Installation of Extraction Well TW-3D, Interim Measure No. 3 Groundwater Extraction System, PG&E Topock Compressor Station, Needles, California.* Prepared by CH2M HILL in October 2005.
- *RCRA Facility Investigation/Remedial Investigation Report, PG&E Topock Compressor Station, Needles, California, Volume 2 – Hydrogeologic Characterization and Results of Groundwater and Surface Water Investigation.* Prepared by CH2M HILL in February 2009. A selection of relevant borings logs from this report is included following this geotechnical data summary on the Appendix C CD-ROM.

C.1.1 Compressor Station

The 2004 geotechnical investigation found that in the vicinity of monitoring wells MW-13 and MW-14 the area consists of alternating layers of gravelly sand and sandy gravel down to an approximate elevation of 435 feet above mean sea level (msl). In the vicinity of MW-37D gravelly sand with clay and sandy clay layers starts at an elevation of approximately 465 feet msl underlying the sandy gravel. The difference in material in this boring can be attributed to the fact that it was located in a wash that transports the finer material from higher elevations.

Soil borings B-01, B02, B-02A, and B-03 were also advanced during this investigation. Exhibit C.1-1 presents a summary of the generalized subsurface profile and design strength parameters. Complete details of the soil borings can be found in the 2004 *Geotechnical Investigation Report*, which is included in PDF format as part of this Attachment to Appendix C on the Appendix C CD-ROM. Generally, medium dense to very dense, silty sands and poorly graded silty sands underlie the proposed treatment plant site. Blow counts in the dry, silty sands were generally in the range of 20 to greater than 50. Therefore, liquefaction potential of the site soils is estimated to be low, especially where the groundwater is greater than 50 feet below ground surface (bgs).

In addition, the following conclusions were made as a result of the 2004 geotechnical investigation:

- Expansion/Collapse – Based on the medium dense to very dense granular material encountered at the project site, expansion and collapse potential is regarded as low.

- Settlement – Based on the medium dense to very dense granular material encountered at the project site (above and below the proposed/ existing footing elevation), and the relatively deep groundwater table (>45 feet), consolidation settlement is not considered an issue. Secondary compression settlement has been determined to be negligible.

EXHIBIT C.1-1
Generalized Subsurface Soil Profile and Design Strength Parameters
Groundwater Remedy Basis of Design Report/Intermediate (60%) Design
PG&E Topock Compressor Station, Needles, California

Geologic Unit	Approximate Elevation of Layer (± feet)	Soil Type [1]	Average Corrected SPT N-Values [2] (blows per foot)	Total Unit Weight (lbs/ft^3)	Friction Angle (degree)
Boring B-01					
Alluvium	508-498	SMg	20	120	32
Alluvium	498-493	SMg	>50	120	35
Alluvium	493-474	SW-SM	>50	120	35
Alluvium	<474	SMg	>50	120	35
Boring B-02					
Alluvium	505-495	SMg	46	120	32
Alluvium	<495	SMg	>50	120	35
Boring B-02A					
Alluvium	505-495	SMg	63	120	32
Alluvium	<495	SMg	>50	120	35
Boring B-03					
Alluvium	508-498	SMg	44	120	32
Alluvium	498-488	SMg	>50	120	35
Alluvium	<488	SP-SM	>50	120	35

Notes:
[1] Unified Soil Classification System per ASTM standard D2487 and D2488.
[2] SPT = standard penetration test described in ASTM Standard D1586.
Source: *Geotechnical Investigation Report, Topock Compressor Station, Water Treatment Plant* (CH2M HILL 2004)

- Corrosion Conditions – Comparison between the laboratory test results and the Caltrans corrosion criteria indicates that the onsite soils are considered to be corrosive to concrete structures. The Caltrans corrosion criteria should not be applied to piping and other metal structures. Concrete in contact with onsite soil shall be batched using Type V cement in accordance with the 2001 California Building Code (CBC). Adequate concrete cover over reinforcing steel should be provided in accordance with good construction practices and design standards. Exhibit C.1-2 summarizes the results of the laboratory corrosion tests.
- Solubility – The solubility results are low at this site, so it is not expected to be an issue. Exhibit C.1-3 summarizes the results of the solubility tests.
- Seismicity – The Chemehuevi Graben Fault, approximately 18.8 kilometers from the project site, is the controlling fault at the project site. The Chemehuevi Graben Fault is a normal style fault with a maximum credible earthquake (MCE) moment magnitude (Mw) of 6.0. The fault is classified as Seismic Source Type C, the project site lies in Seismic Zone 3, and the soil profile is classified as type SD as defined in the 2001 CBC.

EXHIBIT C.1-2
Summary of Laboratory Corrosion Test
Groundwater Remedy Basis of Design Report/Intermediate (60%) Design
PG&E Topock Compressor Station, Needles, California

Boring	Sample Depth (feet)	Soil Type[1]	Minimum Resistivity (ohm-cm)	pH	Sulfate Content (ppm)	Chloride Content (ppm)
B-01	6.5-8.0	SM	370	8.63	2,888	1,025
B-02	6.5-8.0	SM	725	8.67	3,988	350

Notes:
[1] Unified Soil Classification System per ASTM standard D2487 and D2488.
Source: *Geotechnical Investigation Report, Topock Compressor Station, Water Treatment Plant* (CH2M HILL 2004)

EXHIBIT C.1-3
Summary of Solubility Tests
Groundwater Remedy Basis of Design Report/Intermediate (60%) Design
PG&E Topock Compressor Station, Needles, California

Boring	Sample Depth (feet)	Soil Type	Solubility (%)
B-01	6.5-8.0	SM	0.79
B-03	5.0-6.5	SM	0.33

Note:
[1] Unified Soil Classification System per ASTM standard D2487 and D2488.
Source: *Geotechnical Investigation Report, Topock Compressor Station, Water Treatment Plant* (CH2M HILL 2004)

Using the attenuation curves of Sadigh et al. (see Blake 1998), probabilistic analyses indicate that a horizontal peak ground acceleration (HPGA) of 0.07g may be used for a 10 percent probability of exceedance in 50 years. Deterministic analyses indicate a peak ground acceleration (PGA) of 0.20g at the project site.

Recommendations that were discussed in 2004 geotechnical investigation include:

- Shallow foundations are recommended for support of the water treatment plant. The depth of foundation support should be down to a minimum of 2 feet bgs.
- The slab and footings should be set on a minimum 6-inch-thick layer of granular base leveling course. The granular material should consist of well-graded sand and gravel with a maximum particle size of 3 inches and no more than 6 percent passing the No. 200 sieve. The granular material should be placed in 6-inch lifts and compacted to 95 percent of maximum dry density per American Society for Testing and Materials (ASTM) D1557.
- The native soil under the granular base course should be well compacted down to a depth of 12 inches to a minimum of 95 percent of maximum dry density per ASTM D1557 to provide a firm, unyielding surface. If the native soil under the granular course cannot be compacted to a minimum of 95 percent of maximum dry density per ASTM D1557, it should be removed to a maximum depth of 1 foot and replaced with competent granular backfill compacted in 6-inch lifts.
- The foundation design should be based on an evaluation of the allowable bearing capacity, settlement, and sliding coefficient of friction.
- Bearing capacity – Based on the calculations, it was determined that the subgrade at or near the bottom of the proposed footings will have an allowable bearing capacity of 2,000 pounds per square foot.

- Siding coefficient of friction – An ultimate sliding coefficient of friction equal to 0.45 may be used for foundation design.
- Cut and fill slopes – Cut slopes in the native soil are recommended to be 2H:1V or flatter. In fill areas, the native soil should be placed in 6-inch lifts and compacted to 95 percent of maximum dry density per ASTM D1557.

C.1.2 AOC 4

During the 2009 geotechnical investigation, four geotechnical borings were drilled in the areas on top of the ravine slopes in the AOC 4 area. The scope of the geotechnical investigation did not include evaluation of fill along the slope face and at the bottom of the slope. The four borings were drilled until the augers refused on possible rock or other obstructions. Exhibit C.1-4 presents a summary of field exploration details. Complete results of the 2009 investigation can be found in the 2009 *Geotechnical Investigation, Topock AOC 4 Remediation – Pre-Work Plan Data Collection Activities* report, which is included as part of this Attachment to Appendix C on the Appendix C CD-ROM.

EXHIBIT C.1-4
Summary of Field Exploration Details
Groundwater Remedy Basis of Design Report/Intermediate (60%) Design
PG&E Topock Compressor Station, Needles, California

Exploration Number	Approximate Location (NAD 83 Lat./Long,)	Approximate Ground Surface Elevation (feet)	Type of Boring	Depth to Auger Refusal (feet)	Groundwater Depth (feet)
AOC4-GEO1	34°42'47" N; 114° 29'37" W	611.0	Hollow-stem auger	38.5	NE
AOC4-GEO2	34°42'47" N; 114°29'38" W	611.0	Hollow-stem auger	56	NE
AOC4-GEO3	34°42'46" N; 114°29'37" W	612.0	Hollow-stem auger	26	NE
AOC4-GEO4	34°42'46" N; 114°29'36" W	612.0	Hollow-stem auger	8.5	NE

Notes:
NE = Not Encountered
Source: *Geotechnical Investigation, Topock AOC 4 Remediation – Pre-Work Plan Data Collection Activities, PG&E Compressor Station, Needles, California* (CH2M HILL 2009b)

Based on the soil borings, the subsurface materials in the vicinity of AOC 4 generally consist of gray to grayish brown, dry, medium dense to very dense, silty sand and silty gravel. The gravel sizes ranged from 0.5 to 3 inches. The uncorrected standard penetration test (SPT) N-value in this zone ranges from 17 for 12 inches of penetration to 50 for 6 inches of penetration.

Below the fill layer and alluvial sediments, weathered rock materials were encountered in some of the borings to the explored maximum depths overlying relatively unweathered metadiorite bedrock. The weathered rock generally consists of dense to very dense gravel and sand with silt. Gravel sizes varied from less than an inch up to 5 inches. In some areas broken cobbles or fragments of bedrock were present in the recovered samples. The uncorrected SPT N-values within the native soil zone were above 50. Detailed boring logs are presented in the 2009 *Geotechnical Investigation, Topock AOC 4 Remediation – Pre-Work Plan Data Collection Activities* report that is included as part of this Attachment.

Results and conclusions of the 2009 geotechnical investigation include:

- The depth of debris fill materials encountered in the borings extends approximately 5 feet bgs on the nearly level area of AOC 4 and contains silty sand and gravel mixed with debris including some trash, roots and peaty materials. This depth corresponds to elevations of 606 feet and 607 feet above mean sea level on the west and east sides of the AOC 4 area, respectively, above the ravines.
- The debris fill is underlain by possible weakly cemented alluvium and weathered metadiorite bedrock. These materials consist of dense to very dense silty sand (SM) to silty gravels (GM). The gravel sizes ranges from 0.5 to 3 inches.
- Boring refusal, indicating bedrock or obstructions, was encountered at depths varying from 56 to 5 feet bgs. Boring AOC4-GEO2, located on the west edge of the existing slope, encountered refusal at EL 556 feet or about 56 feet bgs. Boring AOC4-GEO4, located on the east side of the existing slope, encountered refusal at EL 607 feet or at about 5 feet bgs. With respect to the exposed bedrock observed near the investigation site, boring refusal is interpreted as the surface of relatively unweathered bedrock.
- Based on the results of the slope stability analyses, a 35-foot-tall slope with a 1H: 1V slope ratio is expected to be globally stable during construction and remediation activities. A factor of safety (FOS) for slope failure of 1.2 was computed for this condition. An FOS of 1.1 or greater is normally considered adequate for temporary slopes during construction activities.
- It is recommended that temporary slopes be maintained no steeper than 1H: 1V and not higher than 35 feet. Shorter, steeper slopes may be achievable and should be evaluated if proposed.
- The surficial stability of a localized side slope should be considered during the grading and other construction activities. Localized instabilities, if left unchecked, could lead to larger stability issues.

C.1.3 MW-20 Bench Geology

In the vicinity of the MW-20 Bench, the current active interim measure (IM) extraction well TW-2D is screened from 115 feet to 150 feet bgs, in the lower portion of the Alluvial Aquifer above Miocene conglomerate bedrock. During initial pumping tests, TW-2D was pumped at sustained rates of 90 to 100 gallons per minute (gpm). The specific capacity of TW-2D has increased by a factor of two since installation and is currently 8 gpm per foot of drawdown.

Well TW-2D is screened in sandy gravel alluvial deposits that appear to be more conductive than the formations encountered at similar elevations in monitoring wells MW-20 to the south or MW-31 to the north. Although the saturated alluvium above bedrock is thicker to the north of TW-2D, the alluvial deposits at the two monitoring well locations generally had higher clay content and may be less productive than the formation at the TW-2D/TW-2S well pair.

Well TW-2S is screened as a water table extraction well, with the bottom of the screen at 95 feet bgs and the top of the screen at 45 feet bgs. The static water level in both TW-2S and TW-2D is roughly 45 feet bgs under non-pumping conditions. The screened intervals of TW-2S and TW-2D are separated, with TW-2S screened above 95 feet and TW-2D screened below 115 feet. The reason for drilling separate shallow TW-2S and deep TW-2D wells was that an aquitard appeared to be present at the intervening depth in the MW-20 wells, and Consultative Technical Workgroup members expressed concern that a single extraction well should not be screened across the aquitard. However, this aquitard does not appear to be present in the northern portion of the MW-20 bench at the MW-31 location.

A fine-grained unit that forms a local aquitard was encountered at a depth between 100 and 110 feet bgs in TW-2D. Flowing sands were encountered within the fine-grained horizon during drilling at well MW-20. The TW-2 wells were drilled using mud rotary methods, which did not allow for identification of flowing sands.

C.1.4 Hydrogeologic Cross Sections

In the 2009 RFI/RI hydrogeologic characterization report a series of cross sections were prepared to illustrate the site hydrogeology, hydrostratigraphy, bedrock structure, and aquifer distribution and geometry. The hydrogeologic features shown on several of the cross sections which are pertinent to the 60% design are summarized below. A complete discussion of the cross section and site hydrogeology can be found in Volume 2 of the 2009 RFI/RI report.

Hydrogeologic Cross Section A-A' (Figure 5-2 of the 2009 RFI/RI) extends northward from the bedrock outcrop of the Chemehuevi Mountains, along the upper part of Bat Cave Wash, and farther north to the Colorado River floodplain. Wells shown include the former injection well PGE-8 (SWMU 2) as well as the well clusters in the upland area (MW-24), IM extraction area (TW-2, TW-3, MW-20), and the floodplain (MW-34, MW-36, MW-39). Also shown on this cross section are the southward pinch-out of the saturated Alluvial Aquifer, the Alluvial Aquifer hydrostratigraphic units, and the inferred depiction of bedrock contacts and the projected trace of the regional Chemehuevi detachment fault.

Hydrogeologic Cross Section B-B' (Figure 5-3 of the 2009 RFI/RI) extends along the axis of Bat Cave Wash and illustrates the progressive south-to-north thickening of the saturated Alluvial Aquifer. The Alluvial Aquifer consists of the older alluvial fan deposits of the Tertiary Alluvium and Basal Alluvium.

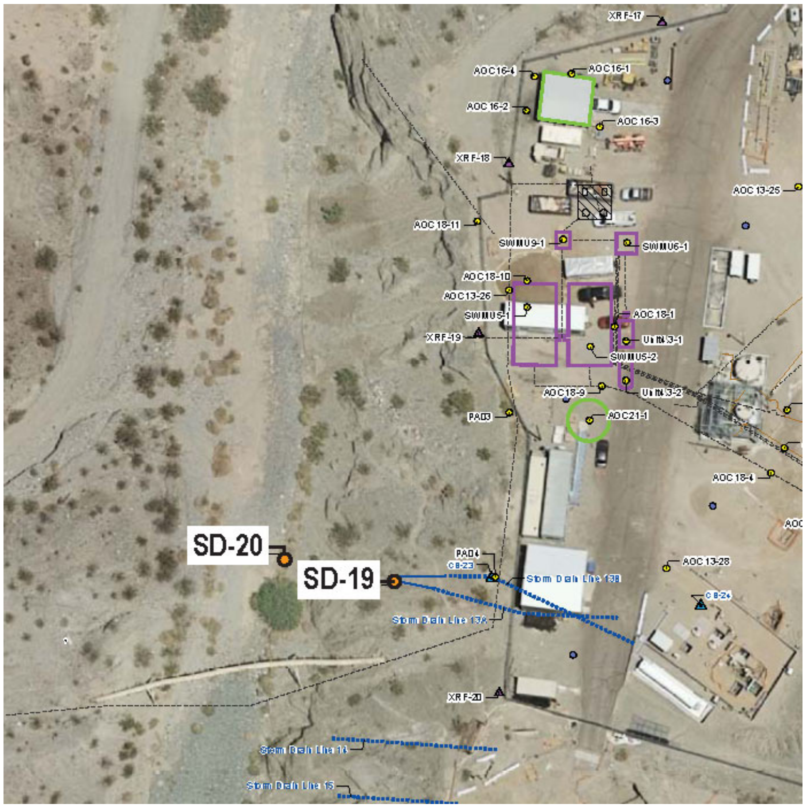
Hydrogeologic Cross Section E-E' (Figure 5-6 of the 2009 RFI/RI) extends from the IM-3 injection area eastward to the Colorado River. Key features shown include the generalized Miocene bedrock structure and the inferred distribution and depositional contacts of the alluvial fan deposits (Toa0, Toa) and the younger fluvial sediments of the Colorado River (Qr1, Qr2, Qr3). As shown on this cross section, the injection interval at the injection well field (wells IW-2 and IW-3) span the mid-depth and deep portions of the Alluvial Aquifer.

Hydrogeologic Cross Section F-F' (Figure 5-7 of the 2009 RFI/RI) extends eastward from the MW-20 bench across the floodplain to the MW-34 monitoring well cluster adjacent to the Colorado River. Features shown include the screen depths of the two active IM extraction wells (TW-3D and PE-1) and the distribution and depositional contacts of the alluvial fan deposits (Toa0, Toa) and the younger fluvial sediments of the Colorado River (Qr1, Qr2, Qr3).

C.2 Proposed Areas for Supplemental Geotechnical Investigation to support Remedy Design

Collection of additional geotechnical samples to support remedy design was coordinated with the Soil RFI/RI investigation program; as a result, no new boreholes will be required just for geotechnical data collection, thereby minimizing disturbance. Geotechnical samples will be collected from proposed soil sample locations SD-19 and SD-20 near the Compressor Station and Bat Cave Wash; and AOC11-3 on the Transwestern Bench (see Exhibit C.2-1). The supplemental geotechnical data will be evaluated to verify design assumptions associated with the new pipe bridge that crosses Bat Cave Wash and the new Central Maintenance Facility at the Transwestern Bench.

As PG&E continues to engage in discussions with transportation agencies, counties, and other property owners/land managers to obtain institutional controls, access agreements, and permits, additional geotechnical data may be required to meet specific requirements of agencies and/or property owners/land managers. This attachment will be updated as needed to reflect changes in requirements.



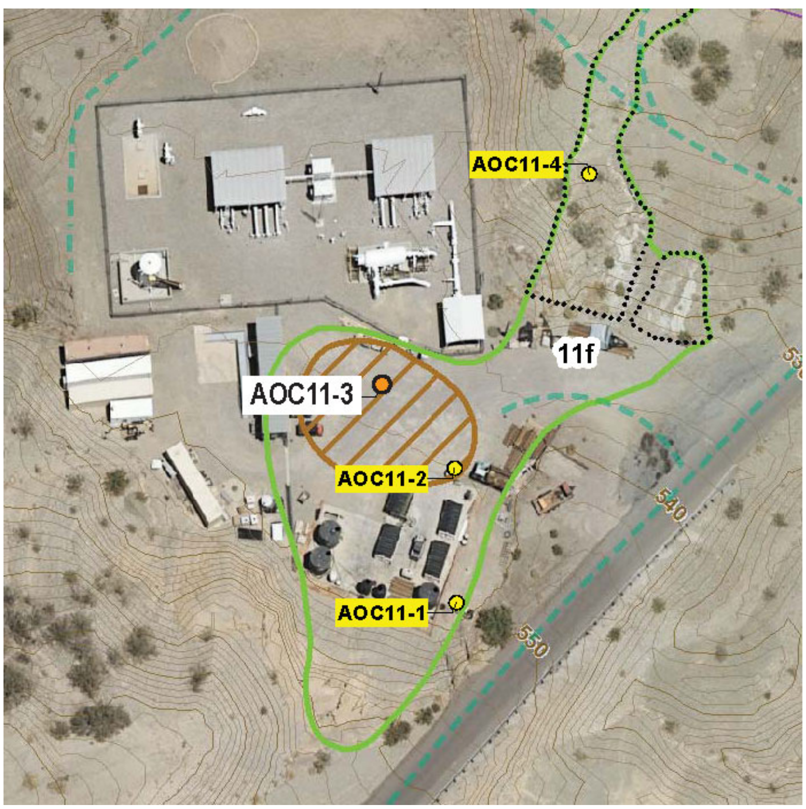


EXHIBIT C.2-1

Geotechnical Sampling Locations in Bat Wash Cave and the Transwestern Bench

Groundwater Remedy Basis of Design Report/Intermediate (60%) Design
PG&E Topock Compressor Station, Needles, California

Source: Soil RFI/RI Work Plan (CH2M HILL 2012)

C.3 References

Blake, T.F. 1998. *FRISKSP, A Computer Program for the Probabilistic Estimation of Seismic Hazard Using Faults as Earthquake Sources*. User's Manual.

CH2M HILL. 2004. *Geotechnical Investigation Report, Topock Compressor Station, Water Treatment Plant.* September.

_______. 2005. *Work Plan for Installation of Extraction Well TW-3D, Interim Measures No. 3 Groundwater Extraction System, PG&E Topock Compressor Station, Needles, California.* October.

_______.2009a. *RCRA Facility Investigation/Remedial Investigation Report, PG&E Topock Compressor Station, Needles, California, Volume 2 – Hydrogeologic Characterization and Results of Groundwater and Surface Water Investigation.* February.

_______. 2009b. *Geotechnical Investigation, Topock AOC 4 Remediation – Pre-Work Plan Data Collection Activities, PG&E Compressor Station, Needles, California.* October.

_______.2012. *Soil RCRA Facility Investigation/Remedial Investigation Work Plan, PG&E Compressor Station, Needles, California.* September 5.

International Code Council and the California Building Standards Commission. 2001. *2001 California Building Code*. California Code of Regulations Title 24, Part 2.

Selected Boring Logs from RFI/RI Report Volume 2 (CH2M HILL 2009)

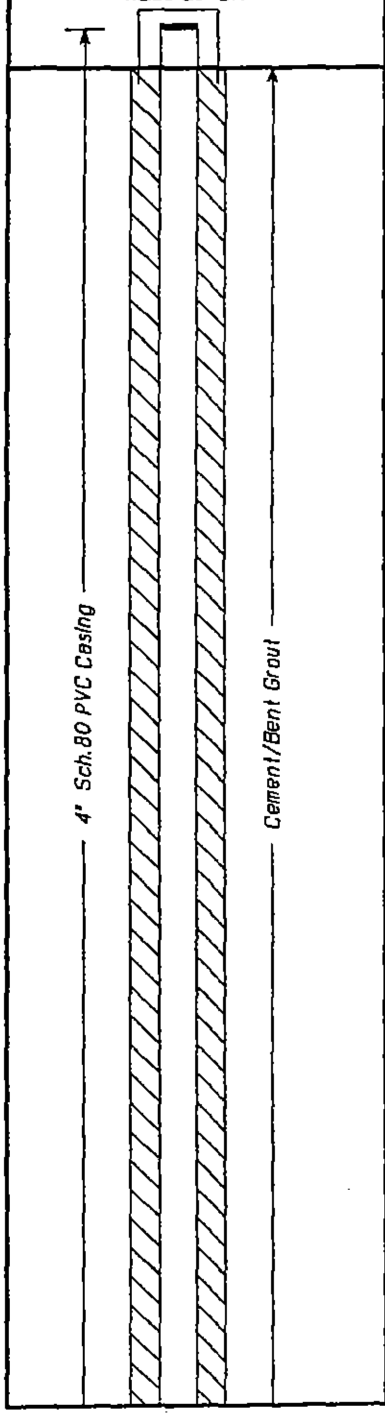
ALISTO ENGINEERING GROUP
WALNUT CREEK, CALIFORNIA

LOG OF WELL MW-9

SEE SITE PLAN

ALISTO PROJECT NO: *10-320-06*	DATE DRILLED: *07/01/97*
CLIENT: *Pacific Gas and Electric Co.*	
LOCATION: *Topock Compressor Station*	
DRILLING METHOD: *Resonant Sonic, Continuous Coring*	
DRILLING COMPANY: *Boart Longyear*	CASING ELEVATION: *536.18*
LOGGED BY: *Dan Salaices*	*APPROVED BY: Dan Salaices*

WELL DIAGRAM



DEPTH feet: 5, 10, 15, 20, 25, 30

SOIL CLASS	GEOLOGIC DESCRIPTION
GP	sandy GRAVEL: Pale yellowish brown, to light gray; 85% gravel, 4–40 mm, subangular; 15% sand, mostly fine; dry.
SP	SAND: Moderate yellowish brown; fine grained, dry, fill ?
GM	silty GRAVEL: moderate brown to dark yellowish brown; 70% gravel, 4–30 mm, subangular.
GP	sandy GRAVEL: Pale yellowish brown, to light gray; 85% gravel, 4–40 mm, subangular; 15% sand, mostly fine; dry. 6.5' sandy GRAVEL: Light olive gray; 80% gravel, 4–30 mm, subangular; 40% sand, fine to coarse. 7.5' color change to yellowish gray; 80% gravel, 4–40 mm, subangular; 20% sand, mostly fine and coarse, dry.
GM	sandy silty GRAVEL: Pale yellowish brown; 70% gravel, 4–30 mm, subangular, occasional cobble fragment; 15% sand, fine and coarse grained; 15% fines; dry. Same: color change to moderate brown, moist.

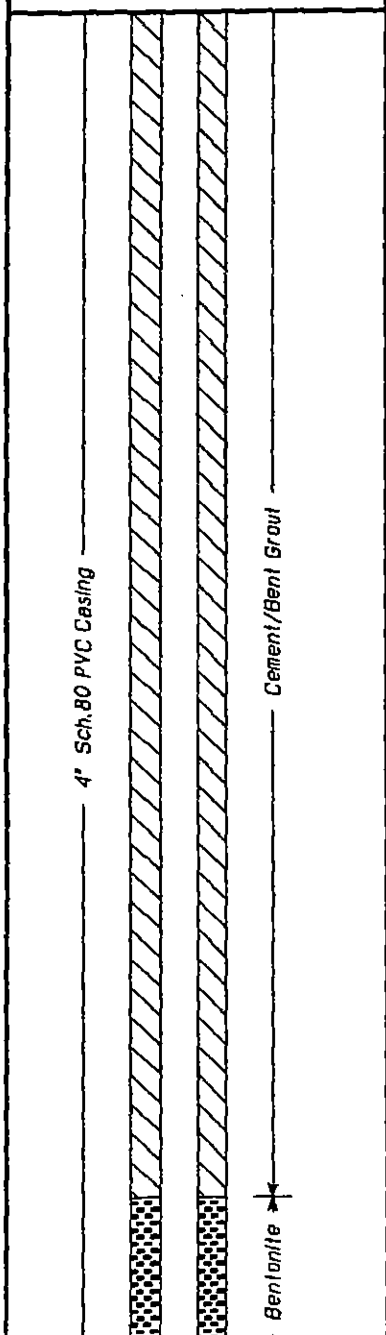
ALISTO ENGINEERING GROUP
WALNUT CREEK, CALIFORNIA

LOG OF WELL MW-9

SEE SITE PLAN

ALISTO PROJECT NO: *10-320-08*	DATE DRILLED: *07/01/97*
CLIENT: *Pacific Gas and Electric Co.*	
LOCATION: *Topock Compressor Station*	
DRILLING METHOD: *Resonant Sonic, Continuous Coring*	
DRILLING COMPANY: *Boart Longyear*	CASING ELEVATION: *536.18*
LOGGED BY: *Dan Salaices*	APPROVED BY: *Dan Salaices*

WELL DIAGRAM



DEPTH feet	SOIL CLASS	GEOLOGIC DESCRIPTION
40, 45, 50	GM	Same: 80% gravel; 20% sand, fine to coarse grained; 20% fines; dry.
55	GP/SP	gravelly SAND/sandy GRAVEL: moderate yellowish brown; appears to be 50% gravel, 4-30mm; 50% sand, fine to coarse grained; moist.
60	GP/GC	sandy clayey GRAVEL: moderate yellowish brown; 70% gravel, 4-30 mm, subangular; 20% sand, fine to coarse grained; 10% fines; damp.
65	GP	sandy GRAVEL: moderate yellowish brown; 70 % gravel, 4-30 mm, subangular and somewhat fractured; 30% sand, fine to coarse grained; damp.
	GM	sandy silty GRAVEL: Moderate yellowish brown; 70% gravel, 4-50 mm, subangular and somewhat fractured; 15% sand, fine to coarse; 15% fines; moist.

ALISTO ENGINEERING GROUP
WALNUT CREEK, CALIFORNIA

LOG OF WELL MW-9

SEE SITE PLAN

ALISTO PROJECT NO: *10-320-06* DATE DRILLED: *07/01/97*

CLIENT: *Pacific Gas and Electric Co.*

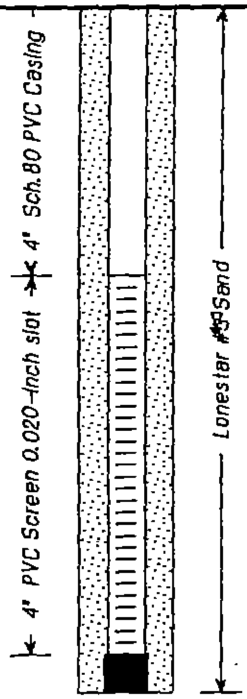
LOCATION: *Topock Compressor Station*

DRILLING METHOD: *Resonant Sonic, Continuous Coring*

DRILLING COMPANY: *Boart Longyear* CASING ELEVATION: *536.18*

LOGGED BY: *Dan Salaices* APPROVED BY: *Dan Salaices*

WELL DIAGRAM



DEPTH feet	SOIL CLASS	GEOLOGIC DESCRIPTION
to ~76	GM	
~76–80	GP GM	sandy silty GRAVEL: moderate brown; 70% gravel, 4-30 mm, subangular; 20% sand, fine to coarse grained; 10% fines; very moist.
80–~86	GC	clayey GRAVEL: dark yellowish brown; 60% gravel, 4-30 mm, occasional cobble fragments; 20% sand, fine grained; 20% fines; wet.
~86–89	GM	RED FANGLOMERATE sandy silty GRAVEL: (GM although rock at 88.5) moderate reddish brown, wet to 88.5, dry at 88.5.
89		refusal at 89 feet. Total depth of borehole is 89 feet.

Depth scale: 75, 80, 85, 90, 95, 100

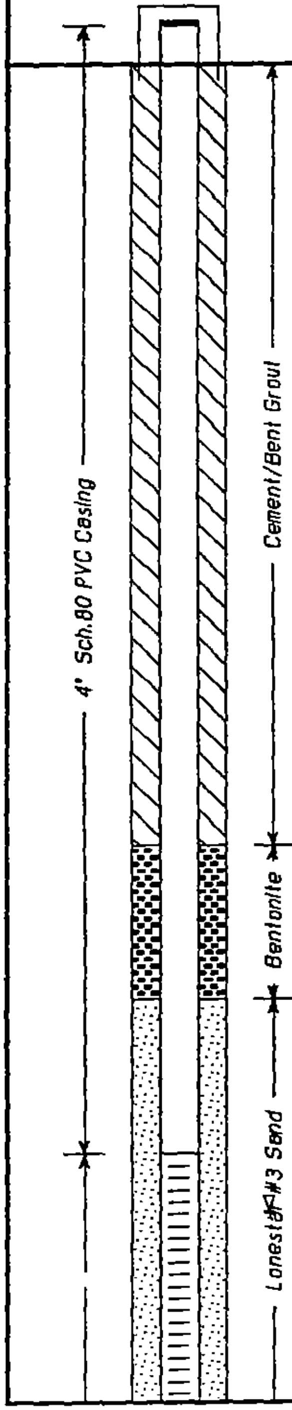
ALISTO ENGINEERING GROUP
WALNUT CREEK, CALIFORNIA

LOG OF WELL MW-13

ALISTO PROJECT NO: *10-320-06*	DATE DRILLED: *07/09/97*
CLIENT: *Pacific Gas and Electric Co.*	
LOCATION: *Topock Compressor Station*	
DRILLING METHOD: *Resonant Sonic, Continuous Coring*	
DRILLING COMPANY: *Boart Longyear*	CASING ELEVATION: *488.19*
LOGGED BY: *Ted Moise/Dan Birch*	APPROVED BY: *Dan Salaices*

SEE SITE PLAN

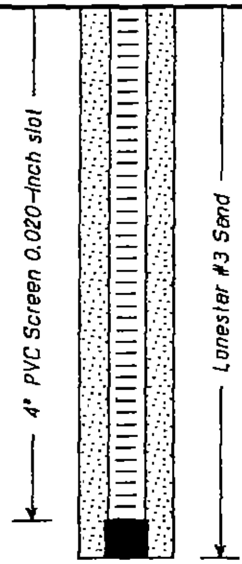
WELL DIAGRAM



DEPTH feet	SOIL CLASS	GEOLOGIC DESCRIPTION
0	SP	gravelly SAND: yellowish gray; 50% sand, fine to coarse grained; 45% gravel, 4-50 mm, subangular, occasional cobbles; minor fines; dry.
5		color change to light olive gray
12	GP	sandy GRAVEL: light gray; 60% gravel, 4-75 mm, subangular; 40% sand, fine to medium grained; dry.
18		at 18 feet, 150 mm cobble.
19.5		at 19.5 feet, color change to pale yellowish brown; 70% gravel; 30% sand, fine to medium grained. Possibly older alluvium.
26.5		at 26.5 feet, 60% gravel, 40% sand.
30		Wet at 30 feet.
35	SP	gravelly SAND: pale brown; 60% sand, fine to coarse grained;

ALISTO ENGINEERING GROUP WALNUT CREEK, CALIFORNIA	LOG OF WELL MW-13	*Page 2 of 2*

SEE SITE PLAN	
	ALISTO PROJECT NO: *10-320-06* DATE DRILLED: *07/09/97*
	CLIENT: *Pacific Gas and Electric Co.*
	LOCATION: *Topock Compressor Station*
	DRILLING METHOD: *Resonant Sonic, Continuous Coring*
	DRILLING COMPANY: *Boart Longyear* CASING ELEVATION: *488.19*
	LOGGED BY: *Ted Moise/Dan Birch* APPROVED BY: *Dan Salaices*



DEPTH feet	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION
		SP	35% gravel, 4-40 mm, subangular; wet.
40			At 40 feet, color change to pale red; 70% sand, fine to coarse grained; 30% gravel, 4-25 mm, subangular.
			At 43 feet, color change to light brownish gray, cobble to 100 mm.
45			
50			Total depth of borehole is 49.5 feet.
55			
60			
65			

ALISTO ENGINEERING GROUP
WALNUT CREEK, CALIFORNIA

LOG OF WELL MW-14

SEE SITE PLAN

ALISTO PROJECT NO: *10-320-06* DATE DRILLED: *07/14-15/97*

CLIENT: *Pacific Gas and Electric Co.*

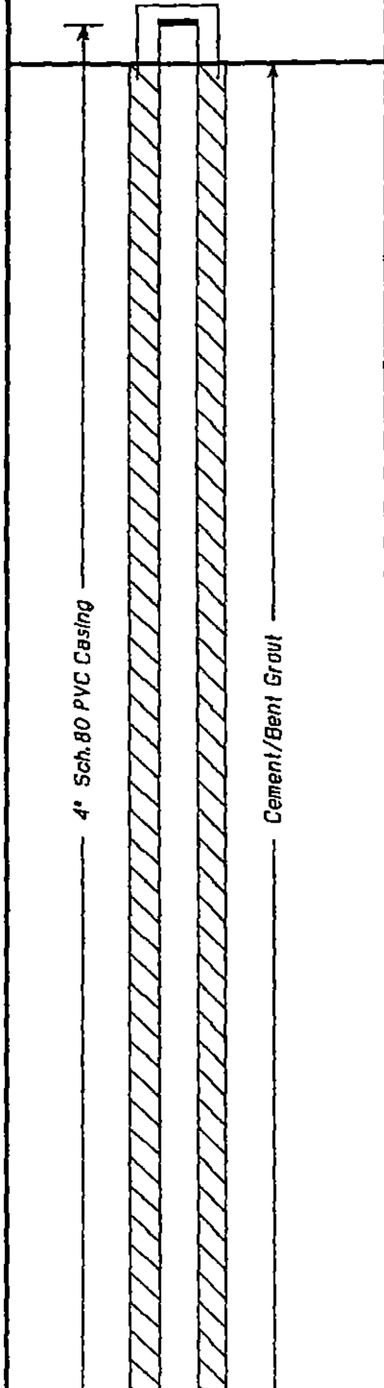
LOCATION: *Topock Compressor Station*

DRILLING METHOD: *Resonant Sonic, Continuous Coring*

DRILLING COMPANY: *Boart Longyear* CASING ELEVATION: *570.54*

LOGGED BY: *Ted Moise/Ken Simas* APPROVED BY: *Dan Salaices*

WELL DIAGRAM



DEPTH feet	SOIL CLASS	GEOLOGIC DESCRIPTION
0	GP	sandy GRAVEL: grayish orange pink; 70% gravel, 4-75 mm, rounded to subangular; 30% sand, fine to coarse grained; dry.
3	SP	gravelly SAND: pale yellowish brown; 80% sand, fine to coarse grained; 20% gravel, 4-50 mm, subangular; dry.
8		At 8 feet, 60% sand, fine to coarse grained; 40% gravel, 4-70 mm, subangular.
14	GP	sandy GRAVEL: pale yellowish brown; 60% gravel, 4-35 mm; subangular; 40% sand, fine to coarse grained, dry.
16.5	SP	gravelly SAND: pale yellowish brown; 90% sand, fine to coarse grained; 10% gravel, 4-20 mm, subangular, dry.
20		At 20 feet, 55% sand, fine to coarse grained; 45% gravel, 4-50 mm.
22		At 22 feet, color change to light gray; 60% sand, fine to coarse grained; 40% gravel, 4-50 mm, angular to subrounded.
25		At 25 feet, color change to light olive gray; 40% gravel, 4-25 mm, subangular.
30		At 30 feet, color change to pale yellowish brown; 75% sand, fine to coarse grained; 25% gravel, 4-80 mm, subangular; dry.

ALISTO ENGINEERING GROUP WALNUT CREEK, CALIFORNIA	LOG OF WELL MW-14	Page 2 of 4

SEE SITE PLAN

ALISTO PROJECT NO: *10-320-06* DATE DRILLED: *07/14-15/97*

CLIENT: *Pacific Gas and Electric Co.*

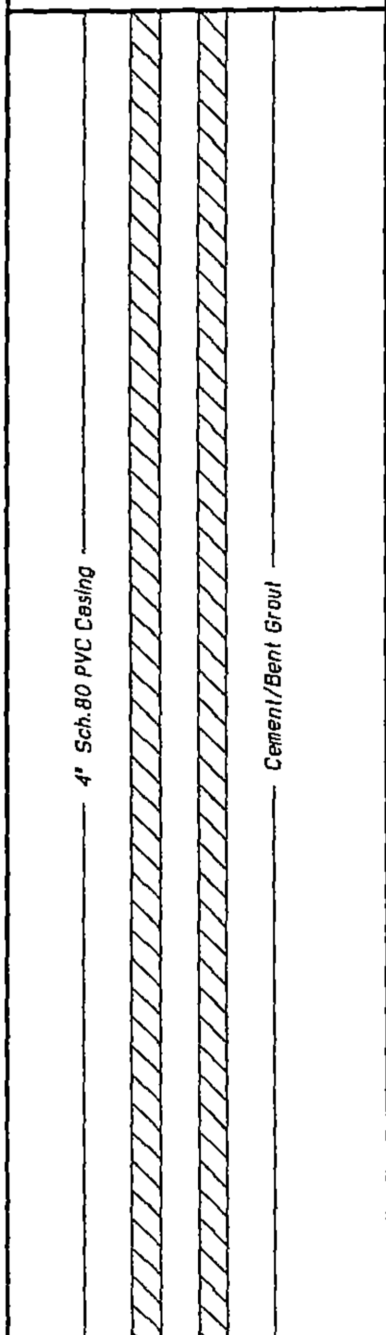
LOCATION: *Topock Compressor Station*

DRILLING METHOD: *Resonant Sonic, Continuous Coring*

DRILLING COMPANY: *Boart Longyear* CASING ELEVATION: *570.54*

LOGGED BY: *Ted Moise/Ken Simas* APPROVED BY: *Dan Salaices*

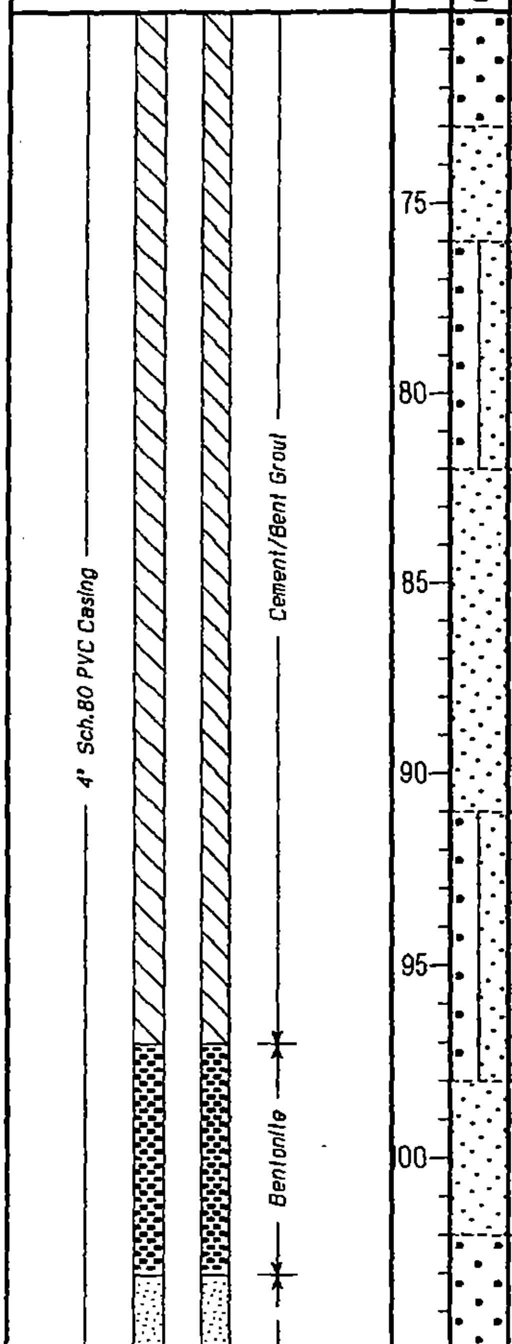
WELL DIAGRAM



DEPTH feet	SOIL CLASS	GEOLOGIC DESCRIPTION
	SP	At 36 feet, gravel, 4-40 mm, subangular.
		At 38 feet, color change to light olive gray; 60% sand, fine to coarse grained; 40% gravel, 4-75 mm, subrounded to subangular; dry.
40		
	GP SP	sandy GRAVEL/gravelly SAND: Pale yellowish brown; 50% sand, fine to coarse grained; 50% gravel, 4-75 mm, subangular to subrounded; dry.
45		
	SP	gravelly SAND: Pale yellowish brown; 70% sand, fine to coarse grained; 30% gravel, 4-75 mm, subangular.
50		At 50 feet, 60% sand, fine to coarse grained; 40% gravel, 4-65 mm, subrounded to subangular; dry.
		At 54 feet; color change to light gray, 55% sand, fine to coarse grained; 40% gravel, 4-35 mm, subangular to subrounded; 5% fines; dry.
55		
		At 57 feet, 65% sand, fine to coarse grained; 30% gravel, subangular to subrounded, 4-75 mm; 5% fines.
60		
	GP	sandy GRAVEL: light gray; 60% gravel, subangular to subrounded, 4-75 mm; 40% sand, fine to coarse grained.
65		

ALISTO ENGINEERING GROUP WALNUT CREEK, CALIFORNIA	LOG OF WELL MW-14	

SEE SITE PLAN	ALISTO PROJECT NO: *10-320-06* DATE DRILLED: *07/14-15/97*
	CLIENT: *Pacific Gas and Electric Co.*
	LOCATION: *Topock Compressor Station*
	DRILLING METHOD: *Resonant Sonic, Continuous Coring*
	DRILLING COMPANY: *Boart Longyear* CASING ELEVATION: *570.54*
	LOGGED BY: *Ted Moise/Ken Simas* APPROVED BY: *Dan Salaices*



SOIL CLASS	GEOLOGIC DESCRIPTION
GP	Same
SP	gravelly SAND: pale yellowish brown; 80% sand, fine to coarse grained; 40% gravel, 4-50 mm, subangular.
GP/SP	sandy GRAVEL/gravelly SAND: light olive brown; 50% sand, fine to coarse grained; 50% gravel, 4-50 mm, subangular. At 79.5 feet, 1.5 foot long boulder core, 8-inches wide. Rock flour is light gray.
SP	gravelly SAND: light olive gray; 80% sand, fine to coarse grained; 40% gravel, 4-50 mm, subangular.
GP/SP	sandy GRAVEL/gravelly SAND: light olive gray, 50% sand, fine to coarse grained; 50% gravel, 4-50 mm, subangular.
SP	gravelly SAND: light gray; 80% sand, fine to coarse grained; 20% gravel, 4-50 mm, subangular.
GP	sandy GRAVEL: light gray; 75% gravel, 4-50 mm, subangular to subrounded; 25% sand, fine to coarse grained, dry.

GP/SP

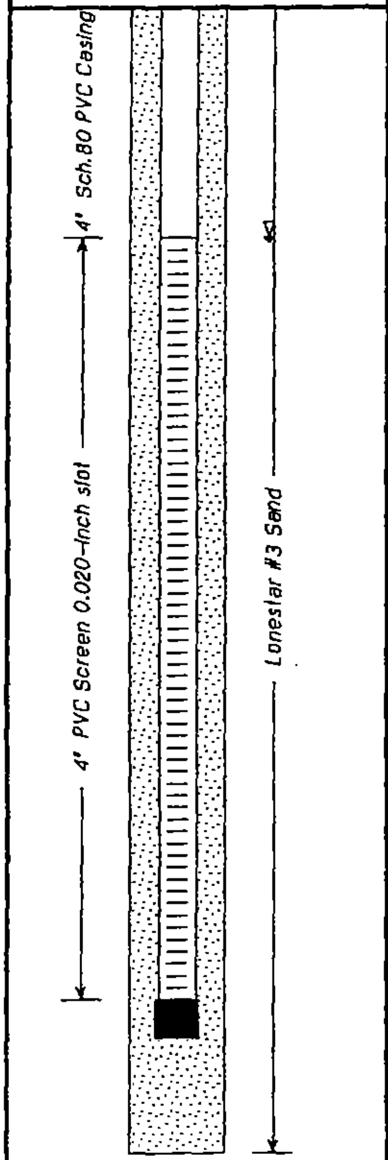
ALISTO ENGINEERING GROUP
WALNUT CREEK, CALIFORNIA

LOG OF WELL MW-14

SEE SITE PLAN

ALISTO PROJECT NO: *10-320-08*	DATE DRILLED: *07/14-15/97*
CLIENT: *Pacific Gas and Electric Co.*	
LOCATION: *Topock Compressor Station*	
DRILLING METHOD: *Resonant Sonic, Continuous Coring*	
DRILLING COMPANY: *Boart Longyear*	CASING ELEVATION: *570.54*
LOGGED BY: *Ted Moise/Ken Simas*	*APPROVED BY: Dan Salaices*

WELL DIAGRAM



DEPTH feet	SOIL CLASS	GEOLOGIC DESCRIPTION
	GP SP	sandy GRAVEL/gravelly SAND: moderate brown; 50% gravel, 4-75 mm, subrounded to subangular; 50% sand, fine to coarse grained; damp.
	SP	gravelly SAND: light olive brown; 60% sand, fine to coarse grained; 40% gravel, subangular, 4-40 mm; moist to wet.
110	GP	sandy GRAVEL: light olive gray; 60% gravel, subangular to subrounded, 4-75 mm; 40% sand, fine to coarse grained; wet at 111 feet.
115		At 116 feet, color change to light brown; gravel 4-75 mm. At 117.5 feet, 140 mm cobble, light gray rock flour.
120	SP	gravelly SAND: pale yellowish brown; 65% sand, fine to coarse grained, 30% gravel, subangular, 4-75 mm; 5% fines; wet.
125	GP GM	sandy silty GRAVEL: pale yellowish brown; 55% gravel, subangular, 4-50 mm, occasional cobble to 80 mm; 35% sand, fine to coarse grained; 10% fines; wet.
130	SP	gravelly SAND: pale yellowish brown; 60% sand, fine to coarse grained; 35% gravel, subangular, 4-20 mm; 5% fines; wet.
	SM	gravelly silty SAND: pale yellowish brown; 60% sand, fine to coarse grained; 20% gravel, subangular, 4-30 mm; 20% fines; wet.
135	SP	gravelly SAND: light olive gray; 65% sand, fine to coarse grained; 30% gravel, subangular, 4-25 mm; 5% fines; wet.
		Total depth of the boring is 135 feet.

ALISTO ENGINEERING GROUP
WALNUT CREEK, CALIFORNIA

LOG OF BORING MW-20/70

SEE SITE PLAN

ALISTO PROJECT NO: *10-320-08* DATE DRILLED: *03/24-25/98*

CLIENT: *Pacific Gas and Electric Co.*

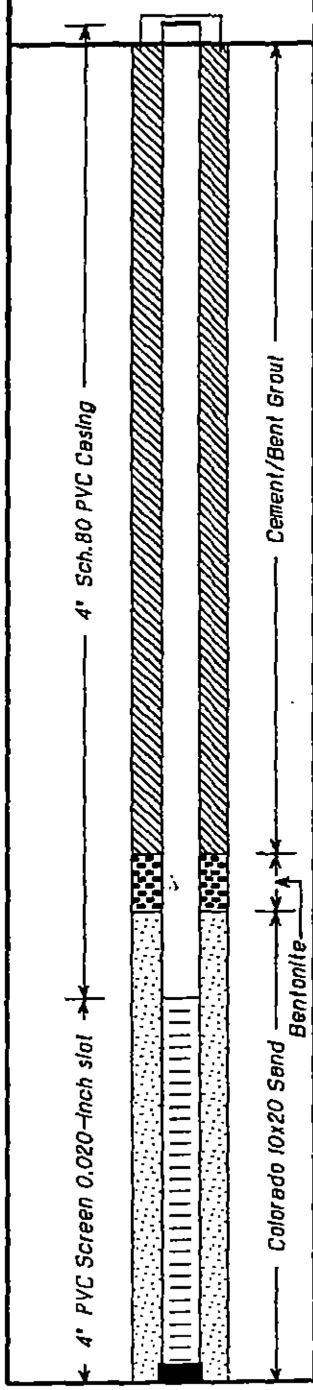
LOCATION: *Topock Compressor Station*

DRILLING METHOD: *AP-1000 Dual Tube Percussion*

DRILLING COMPANY: *THF Drilling* CASING ELEVATION:

LOGGED BY: *Dan Salaices* APPROVED BY: *Dan Salaices*

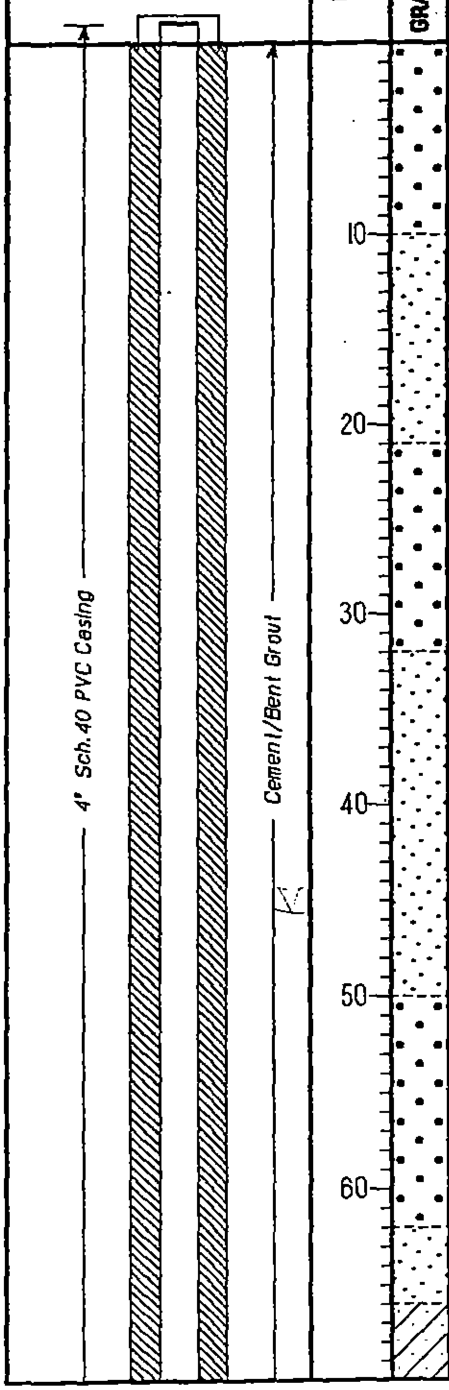
BORING DIAGRAM



DEPTH feet	SOIL CLASS	GEOLOGIC DESCRIPTION
0	GP	sandy GRAVEL: moderate yellowish-brown; ~60-70% gravel, subrounded, to 80 mm; ~30-40% sand.
10	SP	SAND: pale yellowish-brown; very fine- to fine-grained; ~5% gravel.
20	GP	sandy GRAVEL: light brownish-gray; cobble at 21-24 feet. Changes at 24 feet of color to moderate yellowish-brown; ~60-70% gravel, subrounded, to 80 mm.
30	SP	gravelly SAND: light gray; ~90% sand, very fine- to fine-grained; ~10% gravel, subrounded, to 50 mm. gravelly SAND continued.
		SAND: reddish brown; fine- to very fine-grained; ~5% fines; damp.
50	GP	sandy GRAVEL: reddish-brown; ~55% gravel, subrounded, to 80 mm; ~45% sand.
60		Appears wet at 60 feet.

ALISTO ENGINEERING GROUP WALNUT CREEK, CALIFORNIA	LOG OF BORING MW-20/100	Page 1 of 2

SEE SITE PLAN	ALISTO PROJECT NO: *10-320-09* DATE DRILLED: *04/28-29/99*
	CLIENT: *Pacific Gas and Electric Co.*
	LOCATION: *Topock Compressor Station*
	DRILLING METHOD: *Roto Sonic, Continuous Coring*
	DRILLING COMPANY: *Boart Longyear* CASING ELEVATION:
	LOGGED BY: *Chris Reinheimer* APPROVED BY: *Dan Hidalgo*

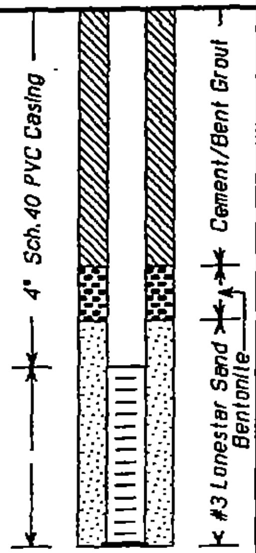


BORING DIAGRAM / DEPTH feet / GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION
	GP	sandy GRAVEL: moderate yellowish-brown; ~60-70% gravel, subrounded, ~80 mm; ~30-40% sand.
10	SP	SAND: pale yellowish-brown; very fine- to fine-grained; ~5% gravel.
20	GP	sandy GRAVEL: light brownish-gray; cobble at 21 to 24 feet. At 24 feet color change to moderate yellowish-brown; ~60-70% gravel, subrounded, ~80 mm.
30	SP	gravelly SAND: light gray; ~80% sand, very fine- to fine-grained; ~10% gravel, subrounded, ~50 mm. gravelly SAND continued.
		SAND: reddish-brown; very fine- to fine-grained; ~5% fines; damp.
50	GP	sandy GRAVEL: reddish-brown; ~55% gravel, subrounded, ~80 mm; ~45% sand.
	SP	gravelly SAND: brown to reddish-brown; 70% sand, fine- to coarse-grained; gravel, subrounded to subangular, 4 to 10 mm; wet.
	SC	gravelly clayey SAND: reddish-brown; 70% sand, fine- to coarse-grained; gravel, 4 to 8 mm; ~15% fines, plastic; wet.

ALISTO ENGINEERING GROUP
WALNUT CREEK, CALIFORNIA

LOG OF BORING MW-20/100

BORING DIAGRAM



SOIL CLASS	GEOLOGIC DESCRIPTION
SC	gravelly clayey SAND continued.
SP	SAND: reddish-brown; fine- to coarse-grained; minor gravel, fine-grained; wet.
SC	gravelly clayey SAND: reddish-brown; 70% sand, fine- to coarse-grained; gravel, 4 to 8 mm; ~15% fines, plastic; wet.
SP	SAND: reddish-brown; fine- to coarse-grained; minor gravel, fine-grained; wet.
SC	gravelly clayey SAND: reddish-brown; 70% sand, fine- to coarse-grained; gravel, 4 to 8 mm; ~15% fines, plastic; wet.
SP	gravelly SAND: reddish-brown; 85% sand, very fine- to coarse-grained; gravel; wet.
SC	gravelly clayey SAND: reddish-brown; 70% sand, fine- to coarse-grained; gravel, 4 to 8 mm; ~15% fines, plastic; wet.
SP	gravelly SAND: reddish-brown; ~85% sand, very fine- to coarse-grained; gravel, ~4 to 20 mm; wet.
	At 98 feet color change to moderate yellowish-brown; 80% sand, medium- to coarse-grained.
	At 98 feet color change to brown; 85% sand, very fine- to coarse-grained.
	Total depth of borehole at 99.5 feet.

DEPTH feet: 80, 90, 100, 110, 120, 130, 140, 150

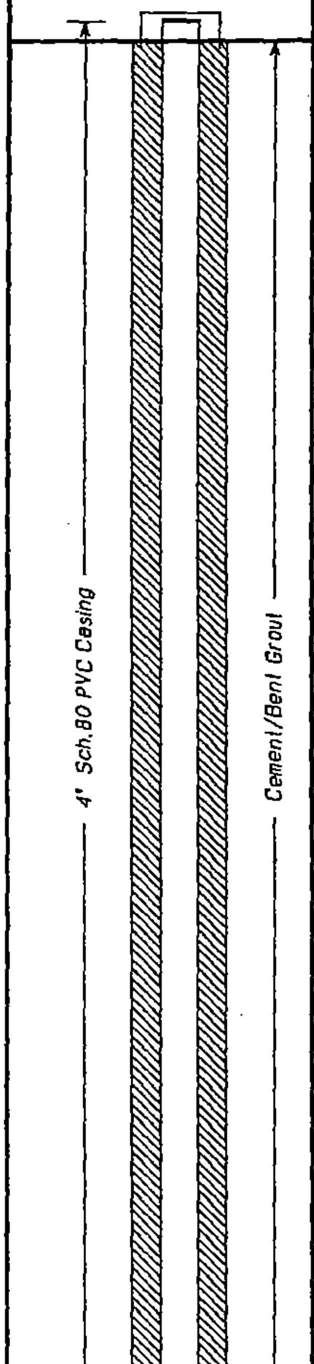
ALISTO ENGINEERING GROUP
WALNUT CREEK, CALIFORNIA

LOG OF BORING MW-20/130

SEE SITE PLAN

ALISTO PROJECT NO: *10-320-09*	DATE DRILLED: *04/25-27/99*
CLIENT: *Pacific Gas and Electric Co.*	
LOCATION: *Topock Compressor Station*	
DRILLING METHOD: *Roto Sonic, Continuous Coring*	
DRILLING COMPANY: *Boart Longyear*	CASING ELEVATION:
LOGGED BY: *Dan Hidalgo & Chris Reinheimer*	APPROVED BY: *Dan Hidalgo*

BORING DIAGRAM

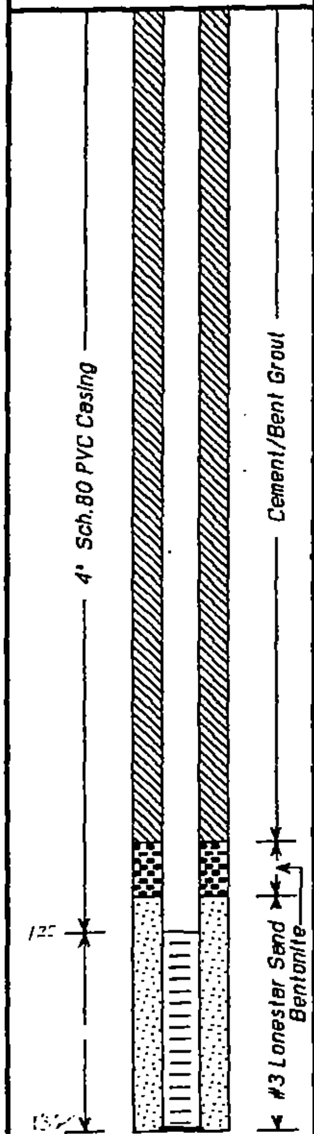


DEPTH feet	SOIL CLASS	GEOLOGIC DESCRIPTION
0	GP	sandy GRAVEL: moderate yellowish-brown; ~60-70% gravel, subrounded, ~90 mm; ~30-40% sand.
10	SP	SAND: pale yellowish-brown; very fine- to fine-grained; ~5% gravel.
20	GP	sandy GRAVEL: light brownish-gray; cobbles at 21 to 24 feet. At 24 feet color change to moderate yellowish-brown; ~60-70% gravel, subrounded, ~90 mm.
31	SP	gravelly SAND: light gray; ~90% sand, very fine- to fine-grained; ~10% gravel, subrounded, ~50 mm. gravelly SAND continued.
45		SAND: reddish-brown; very fine- to fine-grained; ~5% fines; damp.
50	GP	sandy GRAVEL: reddish-brown; ~55% gravel, subrounded, ~90 mm; ~45% sand.
62	SP	gravelly SAND: brown to reddish-brown; 70% sand, fine- to coarse-grained; gravel, subrounded to subangular, 4 to 10 mm; wet.
66	SC	gravelly clayey SAND: reddish-brown; 70% sand, fine- to coarse-grained; gravel, 4 to 8 mm; ~15% fines, plastic; wet.

ALISTO ENGINEERING GROUP
WALNUT CREEK, CALIFORNIA

LOG OF BORING MW-20/130

BORING DIAGRAM | DEPTH feet | GRAPHIC LOG | SOIL CLASS | GEOLOGIC DESCRIPTION



Depth scale (feet): 80, 90, 100, 110, 120, 130, 140, 150

Soil class (in order, top to bottom): SC, SP, SC, SP, SC, SP, SC, SP, ML, SP, ML, SC, GM

gravelly clayey SAND continued.

SAND: reddish-brown; fine- to coarse-grained; minor gravel, fine-grained; wet.

gravelly clayey SAND: reddish-brown; 70% sand, fine- to coarse-grained; gravel, 4 to 6 mm; ~15% fines, plastic; wet.

SAND: reddish-brown; fine- to coarse-grained; minor gravel, fine-grained; wet.

No recovery.

gravelly clayey SAND: reddish-brown; 70% sand, fine- to coarse-grained; gravel, 4 to 6 mm; ~15% fines, plastic; wet.

gravelly SAND: reddish-brown; 85% sand, very fine- to coarse-grained; gravel, ~4 to 20 mm; wet.

gravelly clayey SAND: reddish-brown; 70% sand, fine- to coarse-grained; gravel, 4 to 6 mm; ~15% fines, plastic; wet.

gravelly SAND: reddish-brown; ~85% sand, very fine- to coarse-grained; gravel, ~4 to 20 mm; wet.

At 98 feet color change to moderate yellowish-brown; 80% sand, medium- to coarse-grained.

At 98 feet color change to brown; 85% sand, very fine- to coarse-grained.

gravelly sandy SILT: medium reddish-brown with less than 2% greenish-gray stain; ~80% fines, non-plastic; ~20% gravel to 2", coarse-grained; moist to wet.

gravelly sandy SILT continued.

silty SAND: medium reddish-brown; ~80% sand, medium- to coarse-grained; ~10% gravel; ~10% fines, non-plastic; wet.

At 114 feet change to ~30% gravel.

gravelly sandy SILT: medium reddish-brown with less than 2% greenish-gray stain; ~80% fines, non-plastic; ~20% gravel to 2", coarse-grained; moist to wet.

clayey SAND: medium-orange; 80% sand, medium- to coarse-grained; ~30% fines, medium plasticity; ~10% gravel to 2"; wet to saturated.

silty GRAVEL: medium reddish-brown; ~70% gravel to 3"; ~30% fines, non-slight plasticity; moist.

At 129.5 feet changes to ~80% gravel to 3"; ~15% fines, non plastic; angular clast to 2"; damp.

RED FANGLOMERATE cemented dry, drill refusal at 132 feet.

Total depth of borehole at 132 feet.

PROJECT NUMBER: 326128.01.07.AR

BORING NUMBER: MW-41

SOIL BORING LOG

PROJECT NAME: IM-3 Hydrogeologic Investigation, PG&E Topock		HOLE DEPTH (ft): 320.0	DRILLING CONTRACTOR: WDC Exploration & Wells, Montclair, CA	
SURFACE ELEVATION: 476.9 ft. MSL	NORTHING (CCS NAD 27 Z 5): 2,103,536.66	EASTING (CCS NAD 27 Z 5): 7,614,578.85	DATE STARTED: 10/22/2004	DATE COMPLETED: 11/05/2004
DRILLING METHOD: Rotosonic		WATER LEVEL (ft): ---	DRILLING EQUIPMENT: Gefco SS-15K-HL	
LOCATION: Bat Cave Wash, Parcel No. 650-151-06			LOGGED BY: T. McDonald	

DEPTH BGS (feet)	SAMPLE INTERVAL	SAMPLE TYPE/NUMBER	SAMPLE RECOVERY (ft)	USCS CODE	SOIL DESCRIPTION: SOIL NAME, USCS SYMBOL, COLOR, PERCENT COMPOSITION, GRADING, GRAIN SHAPE, MINERALOGY, DENSITY/CONSISTENCY, STRUCTURE, MOISTURE.	COMMENTS: DRILLING OBSERVATIONS AND OPERATIONS, DAILY START AND END TIMES , DRILL RATE, REFUSALS, SAMPLING AND TESTING NOTES.
0–20				SW	**WELL GRADED SAND WITH GRAVEL (SW)** - 45% rnd to ang gravel/cobbles up to 0.75", 40% f-m sand, 10% coarse sand, 5% silty clay.	0 to 20 ft not collected in core barrel during conductor casing set. Description is from homogenized cuttings
20	20–31	CC1	11	SW		Box 1 - 20 to 23 ft
23						Box 2: 23 to 27 ft
27						Box 3: 27 to 31 ft
29.5–31.5				GW-GM	**WELL GRADED GRAVEL WITH SILT AND SAND (GW-GM)** - 65% f-c gravel avg 2.5" up to 3", 20% c sand, 10% silt/clay, 5% f-m sand, sand and gravel ang to subang, metamorphic, 50% of gravels are highly weathered, moist, abrupt lower boundary.	
31.5–35	31–35			SC	**SILTY SAND WITH GRAVEL (SC)** - olive brn (2.5Y 4/3), 30% c sand, 25-30% silt, 20% m sand, 10% f gravel (0.2" to 0.75"), 10% f sand, sand and gravel ang to subang, metamorphic, moist.	Box 4: 31 to 34 ft Appears to be fining upward from to 31 to __ ft bgs Box 5: 34 to 38 ft

CH2MHILL

SHEET 2 of 10	**PROJECT NUMBER:** 326128.01.07.AR	**BORING NUMBER:** MW-41

SOIL BORING LOG

PROJECT NAME: IM-3 Hydrogeologic Investigation, PG&E Topock		**HOLE DEPTH (ft):** 320.0	**DRILLING CONTRACTOR:** WDC Exploration & Wells, Montclair, CA	
SURFACE ELEVATION: 476.9 ft. MSL	**NORTHING (CCS NAD 27 Z 5):** 2,103,536.66	**EASTING (CCS NAD 27 Z 5):** 7,614,578.85	**DATE STARTED:** 10/22/2004	**DATE COMPLETED:** 11/05/2004
DRILLING METHOD: Rotosonic		**WATER LEVEL (ft):** ---	**DRILLING EQUIPMENT:** Gefco SS-15K-HL	
LOCATION: Bat Cave Wash, Parcel No. 650-151-06			**LOGGED BY:** T. McDonald	

DEPTH BGS (feet)	SAMPLE INTERVAL	SAMPLE TYPE/NUMBER	SAMPLE RECOVERY (ft)	USCS CODE	SOIL DESCRIPTION: SOIL NAME, USCS SYMBOL, COLOR, PERCENT COMPOSITION, GRADING, GRAIN SHAPE, MINERALOGY, DENSITY/CONSISTENCY, STRUCTURE, MOISTURE.	COMMENTS: DRILLING OBSERVATIONS AND OPERATIONS, DAILY START AND END TIMES , DRILL RATE, REFUSALS, SAMPLING AND TESTING NOTES.
		CC2	8.5	SW-SC	**WELL GRADED SAND WITH SILT AND GRAVEL (SW-SC)** - olive brn (2.5Y 4/3), 40% f sand, 30% m sand, 10-15% silt, 10% c sand, 5-10% f gravel, sand and gravel ang to subang, metamorphic, moist, abrupt lower boundary.	
				SW	**WELL GRADED SAND WITH GRAVEL (SW)** - brn (7.5YR 4/4), 50% m sand, 20% f sand, 15% c sand, 10% f gravel coarsening with depth, 5% silt, moderate caliche development, sand and gravel ang to subang, metamorphic, moist.	Box 6: 38 to 42 ft
40						
				SW-SM	**SAND WITH SILT AND GRAVEL (SW-SM)** - brn (10YR 4/4), 40% m sand, 25% c sand, 10-15% f gravel, 10-15% silt, 10% f sand well graded, sand and gravel ang to subang, metamorphic.	Box 7: 42 to 46 ft
					- lt to moderate caliche	Appears to encounter water table at 45 to 46 ft bgs
45		CC3	9.5			
				SW	**WELL GRADED SAND WITH GRAVEL (SW)** - dark grayish brn to brn (10YR 4/2-4/3), 60% m sand, 15% f sand, 15% f-m gravel, 10% f sand, ang to subang, metamorphic, wet.	Box 8: 46 to 50 ft
					- 20% f gravel	
50					- 5% gravel, 15% silt	Box 9: 50 to 54 ft
					- 30% f gravel, 25% vf sand, 15% silt, 15% f sand, 5% m sand, 10% c sand	Box 10: 54 to 58 ft
55		CC4	10			
					- brn (10YR 4/3), 40% c sand , 15% f sand, 15% m sand, 15% f gravel, 10% c gravel, 5% silt, ang to subang, metamorphic, wet	Box 11: 58 to 62 ft
60						
						Box 12: 62 to 66 ft Collect grain size sample at 62 to 64 ft, ID: MW-41D-63
65		CC5	10	SW	- 5% silt, 10% f sand, 10% m sand, 60% c sand, 5-10% f gravel	Collect grain size sample at 65 to 66 ft, ID: MW-41D-66
						Box 13: 66 to 70 ft
					- increasing silt content, 10% silt at 70 ft bgs, 15% silt at 71 ft bgs	Collect groundwater grab sample, ID: MW-41D-70
70						

SHEET 3 of 10	**PROJECT NUMBER:** 326128.01.07.AR	**BORING NUMBER:** MW-41

SOIL BORING LOG

PROJECT NAME: IM-3 Hydrogeologic Investigation, PG&E Topock		**HOLE DEPTH (ft):** 320.0	**DRILLING CONTRACTOR:** WDC Exploration & Wells, Montclair, CA	
SURFACE ELEVATION: 476.9 ft. MSL	**NORTHING (CCS NAD 27 Z 5):** 2,103,536.66	**EASTING (CCS NAD 27 Z 5):** 7,614,578.85	**DATE STARTED:** 10/22/2004	**DATE COMPLETED:** 11/05/2004
DRILLING METHOD: Rotosonic		**WATER LEVEL (ft):** ---	**DRILLING EQUIPMENT:** Gefco SS-15K-HL	
LOCATION: Bat Cave Wash, Parcel No. 650-151-06			**LOGGED BY:** T. McDonald	

DEPTH BGS (feet)	SAMPLE INTERVAL	SAMPLE TYPE/NUMBER	SAMPLE RECOVERY (ft)	USCS CODE	SOIL DESCRIPTION SOIL NAME, USCS SYMBOL, COLOR, PERCENT COMPOSITION, GRADING, GRAIN SHAPE, MINERALOGY, DENSITY/CONSISTENCY, STRUCTURE, MOISTURE.	COMMENTS DRILLING OBSERVATIONS AND OPERATIONS, DAILY START AND END TIMES , DRILL RATE, REFUSALS, SAMPLING AND TESTING NOTES.
					WELL GRADED SAND WITH GRAVEL (SW) - dark grayish brn to brn (10YR 4/2-4/3), 60% m sand, 15% f sand, 15% f-m gravel, 10% f sand, ang to subang, metamorphic, wet.	Box 14: 70 to 74 ft Box 15: 74 to 78 ft Box 16: 78 to 82 ft
75		CC6	9.5			
					- 10-15% silt	Stop drilling at 80 ft bgs on 10/22/04, continue drilling on 10/23/04
80					- 5-10% silt	
						Box 17: 82 to 86 ft
85		CC7	10	ML	**SANDY SILT WITH GRAVEL (ML)** - greenish gray (GLEY1 5/5GY), 50% silt, 20% vf sand, 10% f sand, 10% m sand, 10% f gravel, sand and gravel ang to subang, metamorphic, silty plastic, silty sticky to not sticky, moist to wet. Abrupt lower boundary (< 2 cm).	Box 18: 86 to 90 ft
				SW	**WELL GRADED SAND WITH GRAVEL (SW)** - brn (7.5YR 4/4), 40% f sand, 20% m sand, 20% c sand, 10% silt, 10% f gravel, sand and gravel ang to subang, metamorphic, moist, distinct layers of 15-20% silt < 2 cm thick.	
90				SM	**SILTY SAND WITH GRAVEL (SM)** - brn (10YR 5/3-4/3), 35% f sand, 20% silt, 15% f gravel 0.2" to 1", 10% vf sand, 10% m sand, 10% c sand, sand and gravel dominantly ang to subang, v few subrnd, metamorphic and v few conglomerate, moist.	Box 19: 90 to 94 ft Collect grain size sample at 93 ft, ID: MW-41D-93 Box 20: 94 to 98 ft
95		CC8	10		- silt caliche	
				SW-SM	**SAND WITH SILT AND GRAVEL (SW-SM)** - brn (7.5YR 4/3), 30% m sand, 20% f sand, 20% c sand, 20% f-m gravel, 10% silt, sand and gravel ang to subang, metamorphic, moist to wet, silt caliche.	Box 21: 98 to 102 ft Drilled 100 to 110 ft but dropped core during retrieval and recovered on next run
100		CC9	5		- 15% silt, 5% f-m gravel	Box 22: 102 to 106 ft
105						

CH2MHILL

SHEET 4 of 10	PROJECT NUMBER: 326128.01.07.AR	BORING NUMBER: MW-41

SOIL BORING LOG

PROJECT NAME: IM-3 Hydrogeologic Investigation, PG&E Topock		HOLE DEPTH (ft): 320.0	DRILLING CONTRACTOR: WDC Exploration & Wells, Montclair, CA	
SURFACE ELEVATION: 476.9 ft. MSL	NORTHING (CCS NAD 27 Z 5): 2,103,536.66	EASTING (CCS NAD 27 Z 5): 7,614,578.85	DATE STARTED: 10/22/2004	DATE COMPLETED: 11/05/2004
DRILLING METHOD: Rotosonic		WATER LEVEL (ft): ---	DRILLING EQUIPMENT: Gefco SS-15K-HL	
LOCATION: Bat Cave Wash, Parcel No. 650-151-06			LOGGED BY: T. McDonald	

DEPTH BGS (feet)	SAMPLE INTERVAL	SAMPLE TYPE/ NUMBER	SAMPLE RECOVERY (ft)	USCS CODE	SOIL DESCRIPTION: SOIL NAME, USCS SYMBOL, COLOR, PERCENT COMPOSITION, GRADING, GRAIN SHAPE, MINERALOGY, DENSITY/CONSISTENCY, STRUCTURE, MOISTURE.	COMMENTS: DRILLING OBSERVATIONS AND OPERATIONS, DAILY START AND END TIMES , DRILL RATE, REFUSALS, SAMPLING AND TESTING NOTES.
				SW	**WELL GRADED SAND WITH GRAVEL (SW)** - brn (7.5YR 4/4), 30% m sand, 30% c sand, 20% f sand, 15% f-m gravel, 5% silt, sand and gravel ang to subang, metamorphic, moist. Moderate caliche development, silty cemented throughout. Distinct 1/8" silt layers are dark gray (5Y4/1), 90% silt, 10% vf sand.	Box 23: 106 to 110 ft
				SW	**WELL GRADED SAND (SW)** - brn (10YR 4/3), 30% f sand, 30% m sand, 15% silt, 15% c sand, 10% f gravel, ang to subang, metamorphic, wet.	
110		CC10	14	SW	**WELL GRADED SAND WITH GRAVEL (SW)** - brn (10YR 4/3 at top, 7.5YR 4/3 at bottom), 30% m sand, 30% c sand, 25% f-c gravel, 10% f sand, 5% silt, sand ang to subang and fining downwards, gravel ang to subrnd, metamorphic, wet.	Box 24: 110 to 114 ft Box 25: 114 to 118 ft
115					- 20% silt	Box 26: 118 to 122 ft
120		CC11	10	MH	**SILT WITH GRAVEL (MH)** - dark brn (2.5Y 4/3 or 4/4), 65% silt, 30% f-m ang to subang gravel up to 2.75", 5% clay, 5% c sand, metamorphic, med-high elasticity, sticky, plastic, dry, caliche on gravels, abrupt lower boundary. - interbedded sand with gravels, brn (7.5YR 4/3), 30% c sand, 20% f gravel, 20% m sand, 20% f gravel, 10% silt, well graded	Box 27: 122 to 126 ft Collect grain size sample at 122 to 124 ft, ID: MW-14D-123 Box 28: 126 to 130 ft
125						
130		CC12	10	SW	**SILTY SAND (SW)** - dark greenish gray (Y2 4/10G), 30% vf sand, 30% f sand, 20% silt, 10% m-c sand, 10% ang to subang gravel, metamorphic, moist. Moderate caliche development. Mottled brn (7.5YR 4/4) over 10% of surface, mottling increases to 50% of surface at bottom 3". - 80% silt, 10% f sand, 10% c sand	Box 29: 130 to 134 ft Box 30: 134 to 138 ft
135					**WELL GRADED SAND WITH GRAVEL (SW)** - 40% m sand, 25% f-c gravel (1/5" to 1"), 20% c sand, 10% f sand, 5% silt, ang to subang, metamorphic, wet. - 10% silt, slit horizontal fabric in gravels	Collect grain size sample at 136.5 to 137.5 ft, ID: MW-14D-137 Box 31: 138 to 142 ft Collect groundwater sample at 139 ft
140						

PROJECT NUMBER:	BORING NUMBER:
326128.01.07.AR	MW-41

SOIL BORING LOG

PROJECT NAME: IM-3 Hydrogeologic Investigation, PG&E Topock		HOLE DEPTH (ft): 320.0	DRILLING CONTRACTOR: WDC Exploration & Wells, Montclair, CA	
SURFACE ELEVATION: 476.9 ft. MSL	NORTHING (CCS NAD 27 Z 5): 2,103,536.66	EASTING (CCS NAD 27 Z 5): 7,614,578.85	DATE STARTED: 10/22/2004	DATE COMPLETED: 11/05/2004
DRILLING METHOD: Rotosonic		WATER LEVEL (ft): ---	DRILLING EQUIPMENT: Gefco SS-15K-HL	
LOCATION: Bat Cave Wash, Parcel No. 650-151-06			LOGGED BY: T. McDonald	

DEPTH BGS (feet)	SAMPLE INTERVAL	SAMPLE TYPE/NUMBER	SAMPLE RECOVERY (ft)	USCS CODE	SOIL DESCRIPTION: SOIL NAME, USCS SYMBOL, COLOR, PERCENT COMPOSITION, GRADING, GRAIN SHAPE, MINERALOGY, DENSITY/CONSISTENCY, STRUCTURE, MOISTURE.	COMMENTS: DRILLING OBSERVATIONS AND OPERATIONS, DAILY START AND END TIMES, DRILL RATE, REFUSALS, SAMPLING AND TESTING NOTES.
					WELL GRADED SAND WITH GRAVEL (SW) - 40% m sand, 25% f-c gravel (1/5" to 1"), 20% c sand, 10% f sand, 5% silt, ang to subang, metamorphic, wet.	bgs, ID: MW-41D-139 Appears to be reworked due to drilling
					- dark grayish brn (10YR 4/2), 40% f sand, 20% f-c gravel 1/5" up to 3", 10% m sand, 5-10% silt, moist. Mottling in blocks of brn (7.5YR 4/3)	Box 32: 142 to 146 ft
145					- 35% m sand, 25% c sand, 25% f sand, 15% gravel, 5-10% silt, well graded, caliche development throughout and increased cementation with depth	Box 33: 146 to 150 ft
150		CC13	15	SW		Box 34: 150 to 154 ft
155						Box 35: 154 to 158 ft Reworking at 140 to 176 indicated by lack of fabric, no silt layers around gravels, color, and blocks of mottled brown
160					- brn (10YR 4/3 to 7.5YR 4/3), 5% silt, 10% f sand, 40% m sand, 35% c sand, 10% f gravel, well graded, sand and gravel ang to subang - metamorphic. Gravels less than 2 cm	
165		CC14	10			
					WELL GRADED SAND WITH SILT (SW-SM) - brn (7.5YR 4/2 to 4/3), 35% m sand, 30% f sand, 15% c sand, 10-15% silt, 5-10% f-c gravel (0.2" avg, up to 2"), ang to subang with v few subang gravel, moist to wet.	
170						
				SW-SM		Collect grain size sample at 172.5 to 173.5 ft, ID: MW-41D-173
175						

SHEET 6 of 10	**PROJECT NUMBER:** 326128.01.07.AR	**BORING NUMBER:** MW-41

SOIL BORING LOG

PROJECT NAME: IM-3 Hydrogeologic Investigation, PG&E Topock		**HOLE DEPTH (ft):** 320.0	**DRILLING CONTRACTOR:** WDC Exploration & Wells, Montclair, CA	
SURFACE ELEVATION: 476.9 ft. MSL	**NORTHING (CCS NAD 27 Z 5):** 2,103,536.66	**EASTING (CCS NAD 27 Z 5):** 7,614,578.85	**DATE STARTED:** 10/22/2004	**DATE COMPLETED:** 11/05/2004
DRILLING METHOD: Rotosonic		**WATER LEVEL (ft):** ---	**DRILLING EQUIPMENT:** Gefco SS-15K-HL	
LOCATION: Bat Cave Wash, Parcel No. 650-151-06			**LOGGED BY:** T. McDonald	

DEPTH BGS (feet)	SAMPLE INTERVAL	SAMPLE TYPE/NUMBER	SAMPLE RECOVERY (ft)	USCS CODE	SOIL DESCRIPTION: SOIL NAME, USCS SYMBOL, COLOR, PERCENT COMPOSITION, GRADING, GRAIN SHAPE, MINERALOGY, DENSITY/CONSISTENCY, STRUCTURE, MOISTURE.	COMMENTS: DRILLING OBSERVATIONS AND OPERATIONS, DAILY START AND END TIMES, DRILL RATE, REFUSALS, SAMPLING AND TESTING NOTES.
		CC15	10		**WELL GRADED SAND WITH SILT (SW-SM)** - brn (7.5YR 4/2 to 4/3), 35% m sand, 30% f sand, 15% c sand, 10-15% silt, 5-10% f-c gravel (0.2" avg, up to 2"), ang to subang with v few subang gravel, moist to wet. - < 5% red mottling (2.5YR 4/6), < 5% silt, 20% f sand, 50% m sand, 20% c sand, 5% gravel	
180				SW	**WELL GRADED SAND WITH GRAVEL (SW)** - brn (10YR 5/3), 50% m sand, 20% c sand, 20% f sand, 5% silt, 5% gravel avg 0.5", ang to subang, metamorphic, wet.	
				SP	**POORLY GRADED SAND (SP)** - grayish brn (10YR 5/2), 85% m sand, 10% f sand, < 5% silt, ang to subang, metamorphic, wet.	
185				SW	**WELL GRADED SAND WITH GRAVEL (SW)** - brn (10YR 5/3), 50% m sand, 20% f sand, 20% c sand, 5% silt, 5% gravel avg 0.5", ang to subang, metamorphic, wet.	
190		CC16	18	SM	**SILTY SAND WITH GRAVEL (SM)** - brn (7.5YR 4/3) with 15% dark greenish gray (GLEY1 4/10Y) and 10% red (10R 4/6) mottling, 25% m sand, 25% c sand, 20% silt, 15% f sand, 15% gravel 0.5" - 2.5", ang to subang with v few subrnd, metamorphic. Silty caliche development, faint fabric with aligned gravels.	
195						
200				SW-SM	**WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM)** - brn (7.5YR 4/3) with 10% dark greenish gray (GLEY1 4/10Y) mottling, 30% m sand, 25% c sand, 20% f sand, 15% gravel from 0.5" - 2.5", 10% silt, sand and gravel ang to subang, metamorphic, silt caliche development, abrupt lower boundary.	
205						
210						

CH2MHILL

PROJECT NUMBER: 326128.01.07.AR

BORING NUMBER: MW-41

SOIL BORING LOG

PROJECT NAME: IM-3 Hydrogeologic Investigation, PG&E Topock		HOLE DEPTH (ft): 320.0	DRILLING CONTRACTOR: WDC Exploration & Wells, Montclair, CA	
SURFACE ELEVATION: 476.9 ft. MSL	NORTHING (CCS NAD 27 Z 5): 2,103,536.66	EASTING (CCS NAD 27 Z 5): 7,614,578.85	DATE STARTED: 10/22/2004	DATE COMPLETED: 11/05/2004
DRILLING METHOD: Rotosonic		WATER LEVEL (ft): ---	DRILLING EQUIPMENT: Gefco SS-15K-HL	
LOCATION: Bat Cave Wash, Parcel No. 650-151-06			LOGGED BY: T. McDonald	

DEPTH BGS (feet)	SAMPLE INTERVAL	SAMPLE TYPE/ NUMBER	SAMPLE RECOVERY (ft)	USCS CODE	SOIL DESCRIPTION (SOIL NAME, USCS SYMBOL, COLOR, PERCENT COMPOSITION, GRADING, GRAIN SHAPE, MINERALOGY, DENSITY/CONSISTENCY, STRUCTURE, MOISTURE.)	COMMENTS (DRILLING OBSERVATIONS AND OPERATIONS, DAILY START AND END TIMES, DRILL RATE, REFUSALS, SAMPLING AND TESTING NOTES.)
		CC17	18	GW-GM	**WELL GRADED GRAVEL WITH SILT AND SAND (GW-GM)** - brn (7.5YR 4/2), 50% gravel up to 2" , 20% m sand, 20% c sand, 5% silt, 5% f sand, sand and gravel ang to subang, metamorphic.	Appears to be coarsening upward sequence 210 to 213 ft bgs
215				SW-SM	**WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM)** - brn (7.5YR 4/3) with 10% dark greenish gray (GLEY1 4/10Y) mottling, 30% m sand, 25% c sand, 20% f sand, 15% gravel from 0.5" to 2", 10% silt, ang to subang, metamorphic with lt caliche development.	
220				SW	**WELL GRADED SAND WITH SILT AND GRAVEL (SW)** - brn (7.5YR 4/3), 40% m sand, 30% f sand, 20% c sand, 5% silt, 5% gravel, sand and gravel ang to subang, metamorphic, wet, moderate to strong caliche development, silt fabric with horizontally aligned gravels and c sand.	
				SP	**POORLY GRADED SAND (SP)** - dark grayish brn (2.5Y 4/2), 50% m sand, 50% c sand, subang, metamorphic, wet.	Core from 220 to 233 appears to be washed out from drilling process
225					**WELL GRADED SAND (SW)** - brn (7.5YR 5/3), 40% m sand, 30% c sand, 15% f sand, 10% gravel, 5% silt, sand and gravel ang to subang, metamorphic, wet, silt cementation. - 10% silt - reddish brn (5YR 4/3), 45% m sand, 5-10% silt, 10% f sand, 5-10% gravel .5 to 8 cm, moderate caliche development	
230		CC18	17			
235					- 60-70% m sand, 20% c sand, 5% silt, 5% gravel 0.5 - 2 cm - 45% m sand, 30% c sand, 5-10% silt, 10% f sand, 5-10% gravel 0.5 to 8 cm	
240					- 30% m sand, 30% c sand, 10-15% silt, 15% f sand, 10-15% gravel, some caliche, wet	
245						

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PROJECT NUMBER: 326128.01.07.AR	BORING NUMBER: MW-41

SOIL BORING LOG

PROJECT NAME: IM-3 Hydrogeologic Investigation, PG&E Topock		HOLE DEPTH (ft): 320.0	DRILLING CONTRACTOR: WDC Exploration & Wells, Montclair, CA	
SURFACE ELEVATION: 476.9 ft. MSL	NORTHING (CCS NAD 27 Z 5): 2,103,536.66	EASTING (CCS NAD 27 Z 5): 7,614,578.85	DATE STARTED: 10/22/2004	DATE COMPLETED: 11/05/2004
DRILLING METHOD: Rotosonic		WATER LEVEL (ft): ---	DRILLING EQUIPMENT: Gefco SS-15K-HL	
LOCATION: Bat Cave Wash, Parcel No. 650-151-06			LOGGED BY: T. McDonald	

DEPTH BGS (feet)	SAMPLE INTERVAL	SAMPLE TYPE/ NUMBER	SAMPLE RECOVERY (ft)	USCS CODE	SOIL DESCRIPTION: SOIL NAME, USCS SYMBOL, COLOR, PERCENT COMPOSITION, GRADING, GRAIN SHAPE, MINERALOGY, DENSITY/CONSISTENCY, STRUCTURE, MOISTURE.	COMMENTS: DRILLING OBSERVATIONS AND OPERATIONS, DAILY START AND END TIMES , DRILL RATE, REFUSALS, SAMPLING AND TESTING NOTES.
		CC19	10		**WELL GRADED SAND (SW)** - brn (7.5YR 5/3), 40% m sand, 30% c sand, 15% f sand, 10% gravel, 5% silt, sand and gravel ang to subang, metamorphic, wet, silt cementation.	
					- reddish brn (5YR 4/4), 5% red (10R 4/8), 5% grayish green (GLEY1 4/5G) mottled, 60-70% m sand, 10-15% silt, 15% f sand, 5% gravel, some caliche, silty consolidated	
250				SW	- 40% f sand, 40% m sand, 10% c sand, 5% silt, 5% f gravel, very few c gravel of 4 to 5 cm, silty indurated, slit fabric with horizontal gravel, strongest at base	
255		CC20	9		- brn (10YR 5/3) matrix, 60% yellowish red (5YR 4/6), 20% v dark greenish gray GLEY2 3/5BG mottling, 30% f sand, 20% vf sand, 20% m sand, 15-20% silt, 5% c sand, 5% c gravel, few thin layers of 25-30% silt, abrupt lower boundary	
					- reddish brn (5YR 4/4), 40% f sand, 35% c sand, 10% m sand, 10% f gravel up to 2 cm, 5% silt, gravel ang to subang, c sand ang to subround, metamorphic, wet, slit clay films on gravels	
260						
265		CC21	9		- red (2.5YR 4/4 to 4/6), 5-10% silt/clay, 30% f sand, 30% c sand, 20% m sand, 15% gravel, increased induration, v few weak clay films around gravels - strong caliche - 2 to 6 cm gravels from 267 to 268 ft bgs	
270					- brn (5YR 4/4), 50% c sand, 25% f gravel up to 0.5", 10% f sand, 10% m sand, 5% clay/silt	
275		CC22	5		- v few spots of dk greenish gray (GLEY2 4/5BG) mottling, 40% f sand, 20% m sand, 20% c sand, 10% silt, 10% f gravel, well graded, silty indurated, moderate caliche, strongest in top 6 inches	
280					**SILTY SAND WITH GRAVEL (SM)** - dark reddish brn (2.5YR 3/3), 30% f sand, 25% silt, 20% c sand, 15% gravel, 10% m sand, subang, little metamorphic, wet, silty indurated, weathered.	

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PROJECT NUMBER: 326128.01.07.AR

BORING NUMBER: MW-41

SOIL BORING LOG

PROJECT NAME: IM-3 Hydrogeologic Investigation, PG&E Topock		**HOLE DEPTH (ft):** 320.0	**DRILLING CONTRACTOR:** WDC Exploration & Wells, Montclair, CA
SURFACE ELEVATION: 476.9 ft. MSL	**NORTHING (CCS NAD 27 Z 5):** 2,103,536.66	**EASTING (CCS NAD 27 Z 5):** 7,614,578.85	**DATE STARTED:** 10/22/2004 / **DATE COMPLETED:** 11/05/2004
DRILLING METHOD: Rotosonic		**WATER LEVEL (ft):** ---	**DRILLING EQUIPMENT:** Gefco SS-15K-HL
LOCATION: Bat Cave Wash, Parcel No. 650-151-06			**LOGGED BY:** T. McDonald

DEPTH BGS (feet)	SAMPLE INTERVAL	SAMPLE TYPE/NUMBER	SAMPLE RECOVERY (ft)	USCS CODE	SOIL DESCRIPTION (SOIL NAME, USCS SYMBOL, COLOR, PERCENT COMPOSITION, GRADING, GRAIN SHAPE, MINERALOGY, DENSITY/CONSISTENCY, STRUCTURE, MOISTURE.)	COMMENTS (DRILLING OBSERVATIONS AND OPERATIONS, DAILY START AND END TIMES, DRILL RATE, REFUSALS, SAMPLING AND TESTING NOTES.)
280–285	X	CC23	5	SM	**SILTY SAND WITH GRAVEL (SM)** - dark reddish brn (2.5YR 3/3), 30% f sand, 25% silt, 20% c sand, 15% gravel, 10% m sand, subang, little metamorphic, wet, silty indurated, weathered.	
285	X	CC24	15	SW	**WELL GRADED SAND (SW)** - grayish brn (10YR 5/2), 40% m sand, 25% c sand, 15% f sand, 10% fines, 10% gravel to 0.5", sand and gravel ang to subang, some metamorphic, wet, silty indurated, trace caliche.	
290						
				SM	**SILTY SAND (SM)** - grayish brn (10YR 5/2), 30% m sand, 25% fines, 25% gravel, 20% c sand, 10% f sand, ang to subang, some metamorphic, wet, moderately indurated.	
295						Angled bedding plane seen at 301' (photo)
				SW	**SAND (SW)** - dark red (2.5YR 3/6) with brn (7.5YR4/3 clay layer, 30% m sand, 25% gravel up to 1.5", 20% c sand, 15% fines, 10% f sand, weathered bedrock, moderately indurated, wet.	
300	X	CC25	15	BR	**CONGLOMERATE (BR)** - dark reddish brn (2.5YR 3/3), 30% m sand, 30% c sand, 20% f sand, 10% fines, 10% gravel up to 1.5", ang to subang, dry, strongly indurated.	
				BR	**CONGLOMERATE (BR)** - reddish brn (2.5YR 4/4), 30% m sand, 30% c sand, 20% f sand, 10% fines, 10% gravel, gravel subrnd, dry.	
305				BR	**CONGLOMERATE (BR)** - reddish brn (2.5YR 4/3), 30% f sand, 20% fines, 20% c sand, 20% subang gravel up to 1", 10% m sand, wet.	
310						
					CONGLOMERATE (BR) - dark reddish brn (2.5YR 3/3), 30% m sand, 30% subang gravel to 1.5", 20% f sand, 10% fines, 10% c sand, dry, silty indurated, weathered.	
315						

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SHEET 10 of 10	PROJECT NUMBER: 326128.01.07.AR	BORING NUMBER: MW-41

SOIL BORING LOG

PROJECT NAME: IM-3 Hydrogeologic Investigation, PG&E Topock		**HOLE DEPTH (ft):** 320.0	**DRILLING CONTRACTOR:** WDC Exploration & Wells, Montclair, CA	
SURFACE ELEVATION: 476.9 ft. MSL	**NORTHING (CCS NAD 27 Z 5):** 2,103,536.66	**EASTING (CCS NAD 27 Z 5):** 7,614,578.85	**DATE STARTED:** 10/22/2004	**DATE COMPLETED:** 11/05/2004
DRILLING METHOD: Rotosonic		**WATER LEVEL (ft):** ---	**DRILLING EQUIPMENT:** Gefco SS-15K-HL	
LOCATION: Bat Cave Wash, Parcel No. 650-151-06			**LOGGED BY:** T. McDonald	

DEPTH BGS (feet)	SAMPLE INTERVAL	SAMPLE TYPE/NUMBER	SAMPLE RECOVERY (ft)	USCS CODE	SOIL DESCRIPTION: SOIL NAME, USCS SYMBOL, COLOR, PERCENT COMPOSITION, GRADING, GRAIN SHAPE, MINERALOGY, DENSITY/CONSISTENCY, STRUCTURE, MOISTURE.	COMMENTS: DRILLING OBSERVATIONS AND OPERATIONS, DAILY START AND END TIMES , DRILL RATE, REFUSALS, SAMPLING AND TESTING NOTES.
320	X	CC26	5	BR	**CONGLOMERATE (BR)** - dark reddish brn (2.5YR 3/3), 30% m sand, 30% subang gravel to 1.5", 20% f sand, 10% fines, 10% c sand, dry, silty indurated, weathered. - silty more indurated, moist	Well Completion: TD = 311.5' bgs; Screen Interval = 271 to 291 ft bgs; Filter Pack = 299 - 261 ft bgs; Stick-up Approx = 2.6 ft; Sump = 291 to 311 bgs

Boring Terminated at 320 ft

ABBREVIATIONS

cc = continuous core run
brn = brown
lt = light
dk = dark
vf = very fine-grained
f = fine-grained
m = medium-grained
c = coarse-grained
vc = very coarse-grained
ang = angular
subang = subangular
subrnd = subrounded
rnd = rounded
br = bedrock formation
ss = sandstone
conglom = conglomerate
comptd = compacted
qtz = quartz

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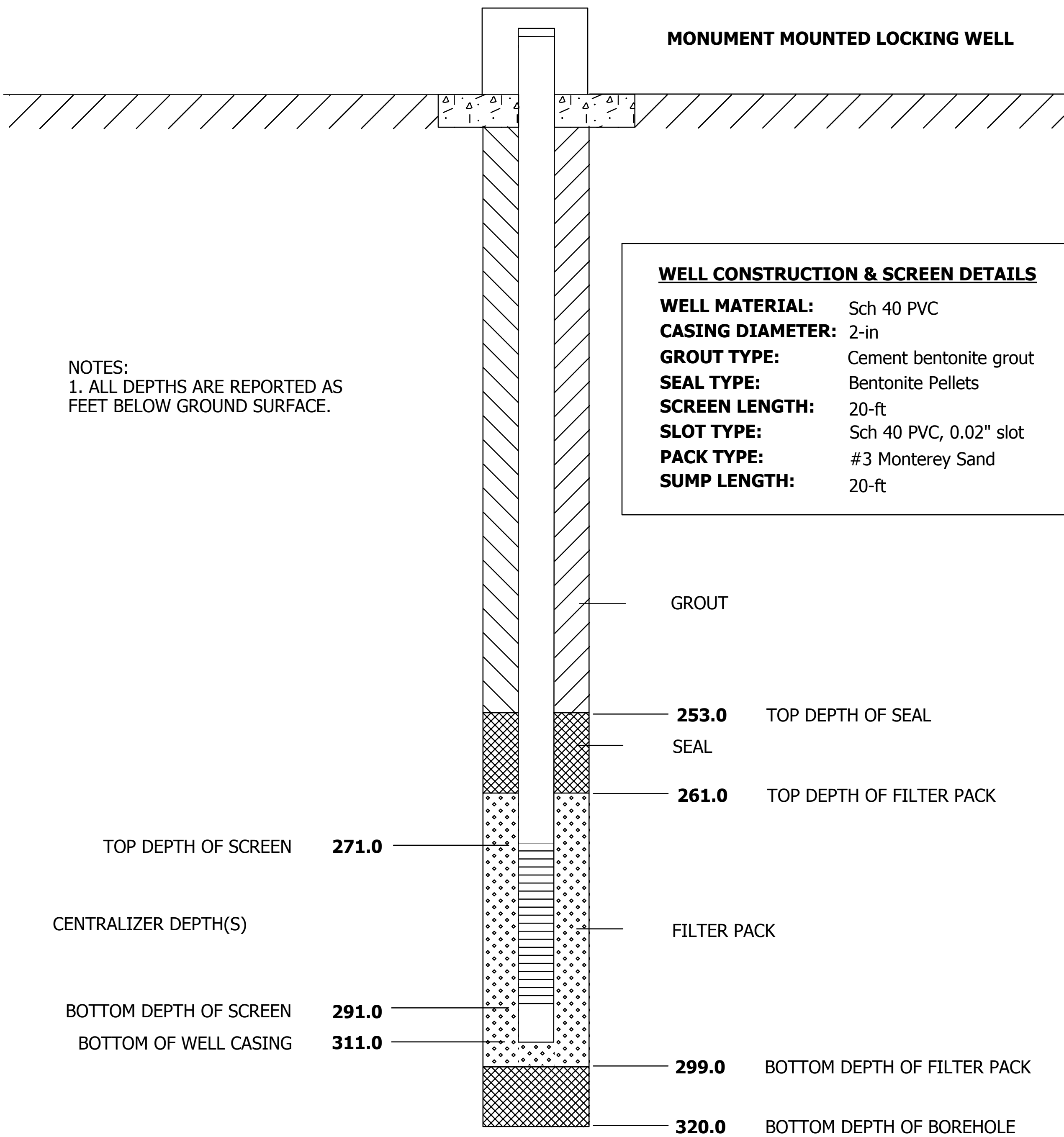
WELL COMPLETION DIAGRAM

PROJECT NO: 326128.01.07.AR	**PROJECT:** IM-3 Hydrogeologic Investigation, PG&E Topock
WELL NO: MW-41D	
LOCATION: Bat Cave Wash, Parcel No. 650-151-06	
DRILLING CONTRACTOR: WDC Exploration & Wells, Montclair, CA	**DRILLING START DATE:** 10/22/2004
DRILLING METHOD: Rotosonic	**DRILLING END DATE:** 11/05/2004
LOGGER: T. McDonald	**WELL COMPLETION DATE:** 11/05/2004
TOP OF WELL CASING (NGVD 29): 479.42	**NORTHING COORDINATE (CCS DAND 27, ZONE 5):** 2103536.66
GROUND SURFACE ELEVATION (NGVD 29): 476.88	**EASTING COORDINATE (CCS NAD 27 ZONE 5):** 7614578.85



WELL CONSTRUCTION & SCREEN DETAILS

WELL MATERIAL:	Sch 40 PVC
CASING DIAMETER:	2-in
GROUT TYPE:	Cement bentonite grout
SEAL TYPE:	Bentonite Pellets
SCREEN LENGTH:	20-ft
SLOT TYPE:	Sch 40 PVC, 0.02" slot
PACK TYPE:	#3 Monterey Sand
SUMP LENGTH:	20-ft

NOTES:
1. ALL DEPTHS ARE REPORTED AS FEET BELOW GROUND SURFACE.

WELL DIAGRAM IS NOT TO SCALE

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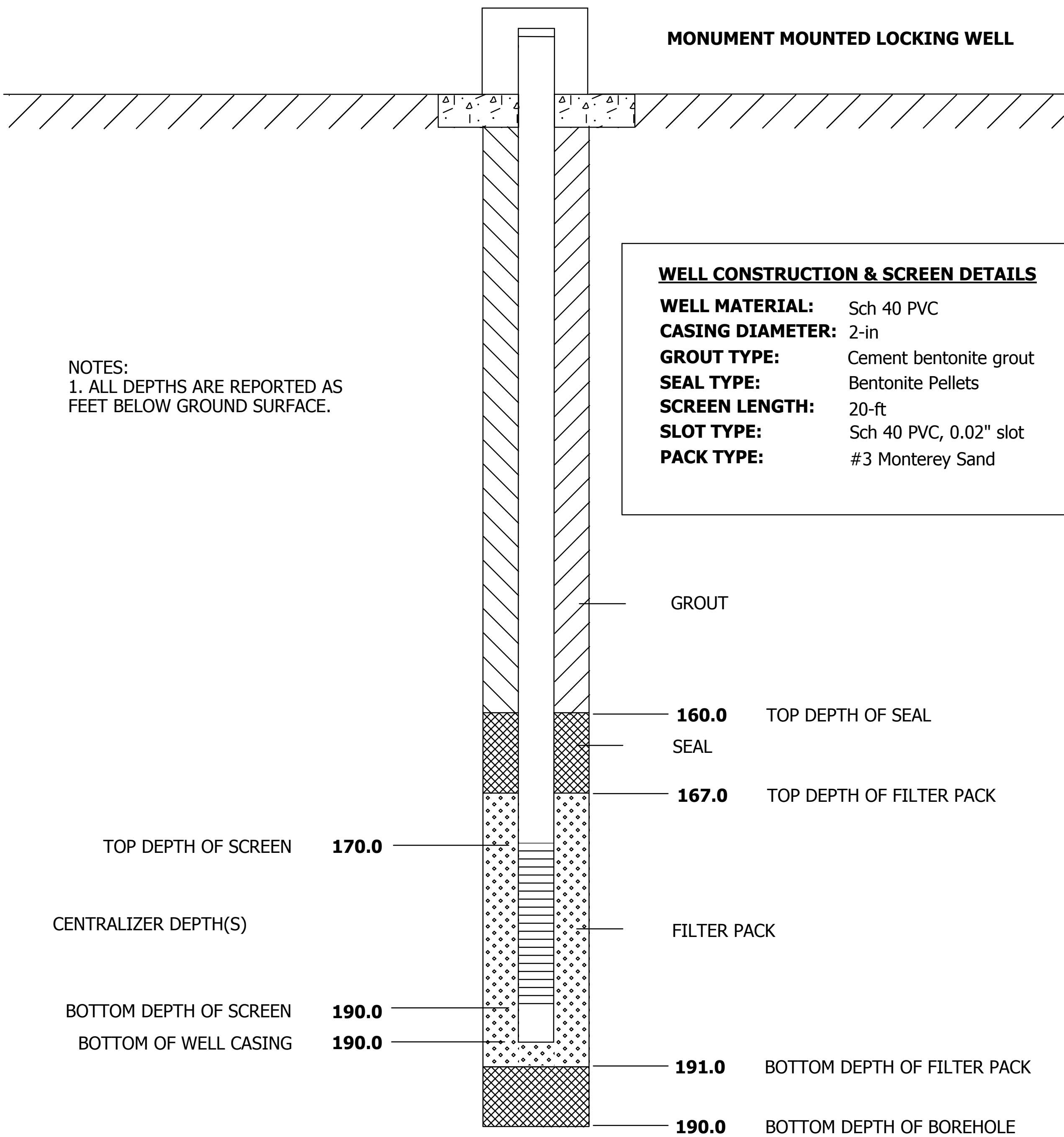
WELL COMPLETION DIAGRAM

PROJECT NO: 326128.01.07.AR	**PROJECT:** IM-3 Hydrogeologic Investigation, PG&E Topock
WELL NO: MW-41M	
LOCATION: Bat Cave Wash, Parcel No. 650-151-06	
DRILLING CONTRACTOR: WDC Exploration & Wells, Montclair, CA	**DRILLING START DATE:** 11/01/2004
DRILLING METHOD: Rotosonic	**DRILLING END DATE:** 11/01/2004
LOGGER: T. McDonald	**WELL COMPLETION DATE:** 11/07/2004
TOP OF WELL CASING (NGVD 29): 479.84	**NORTHING COORDINATE (CCS DAND 27, ZONE 5):** 2103527.41
GROUND SURFACE ELEVATION (NGVD 29): 477.06	**EASTING COORDINATE (CCS NAD 27 ZONE 5):** 7614583.19



NOTES:
1. ALL DEPTHS ARE REPORTED AS FEET BELOW GROUND SURFACE.

WELL CONSTRUCTION & SCREEN DETAILS

WELL MATERIAL:	Sch 40 PVC
CASING DIAMETER:	2-in
GROUT TYPE:	Cement bentonite grout
SEAL TYPE:	Bentonite Pellets
SCREEN LENGTH:	20-ft
SLOT TYPE:	Sch 40 PVC, 0.02" slot
PACK TYPE:	#3 Monterey Sand

WELL DIAGRAM IS NOT TO SCALE

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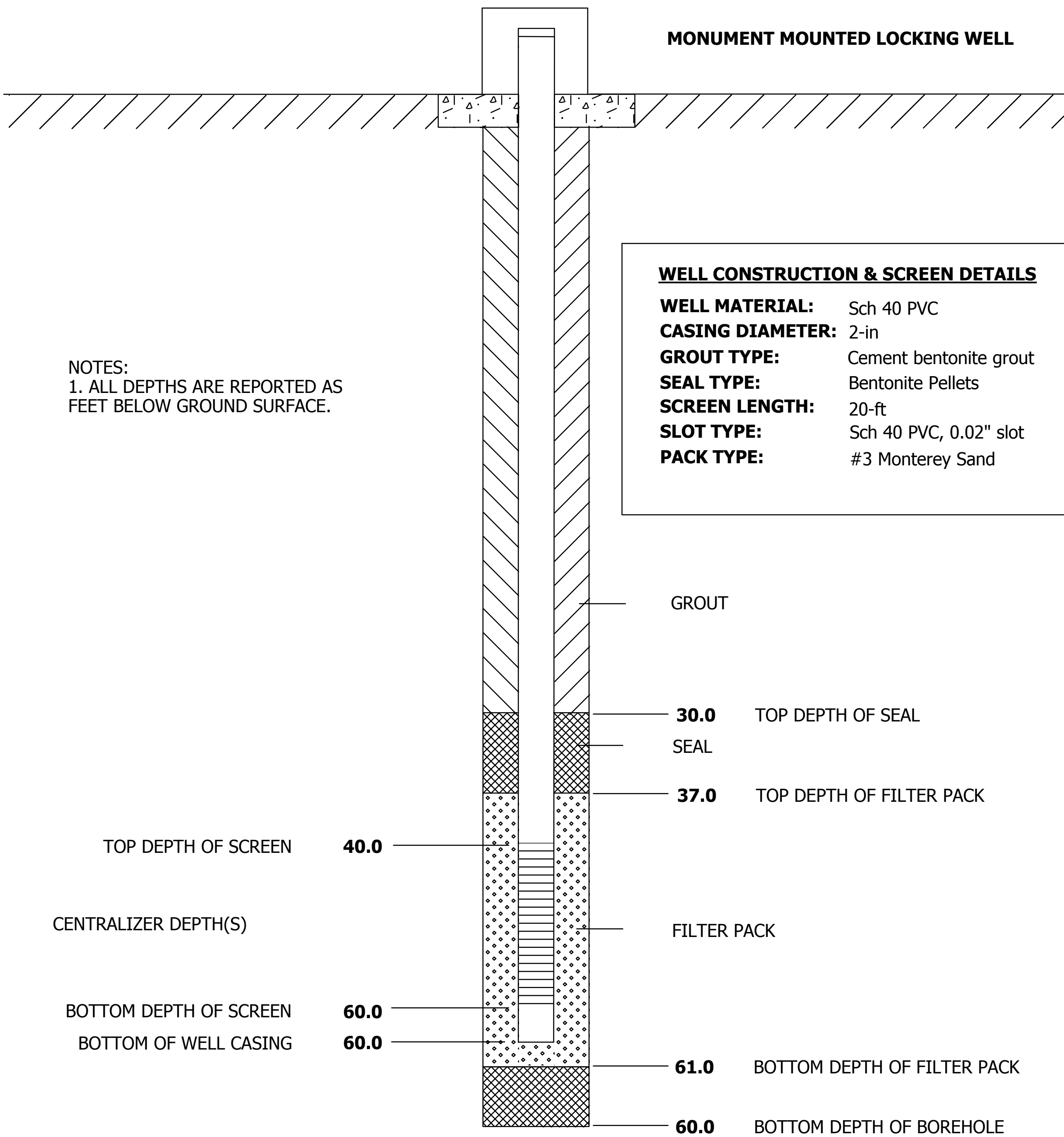
WELL COMPLETION DIAGRAM

PROJECT NO: 326128.01.07.AR	**PROJECT:** IM-3 Hydrogeologic Investigation, PG&E Topock	**WELL NO:** **MW-41S**

LOCATION: Bat Cave Wash, Parcel No. 650-151-06

DRILLING CONTRACTOR: WDC Exploration & Wells, Montclair, CA	**DRILLING START DATE:** 11/01/2004
DRILLING METHOD: Rotosonic	**DRILLING END DATE:** 11/01/2004
LOGGER: T. McDonald	**WELL COMPLETION DATE:** 11/08/2004
TOP OF WELL CASING (NGVD 29): 480.07	**NORTHING COORDINATE (CCS DAND 27, ZONE 5):** 2103518.07
GROUND SURFACE ELEVATION (NGVD 29): 477.41	**EASTING COORDINATE (CCS NAD 27 ZONE 5):** 7614588.78



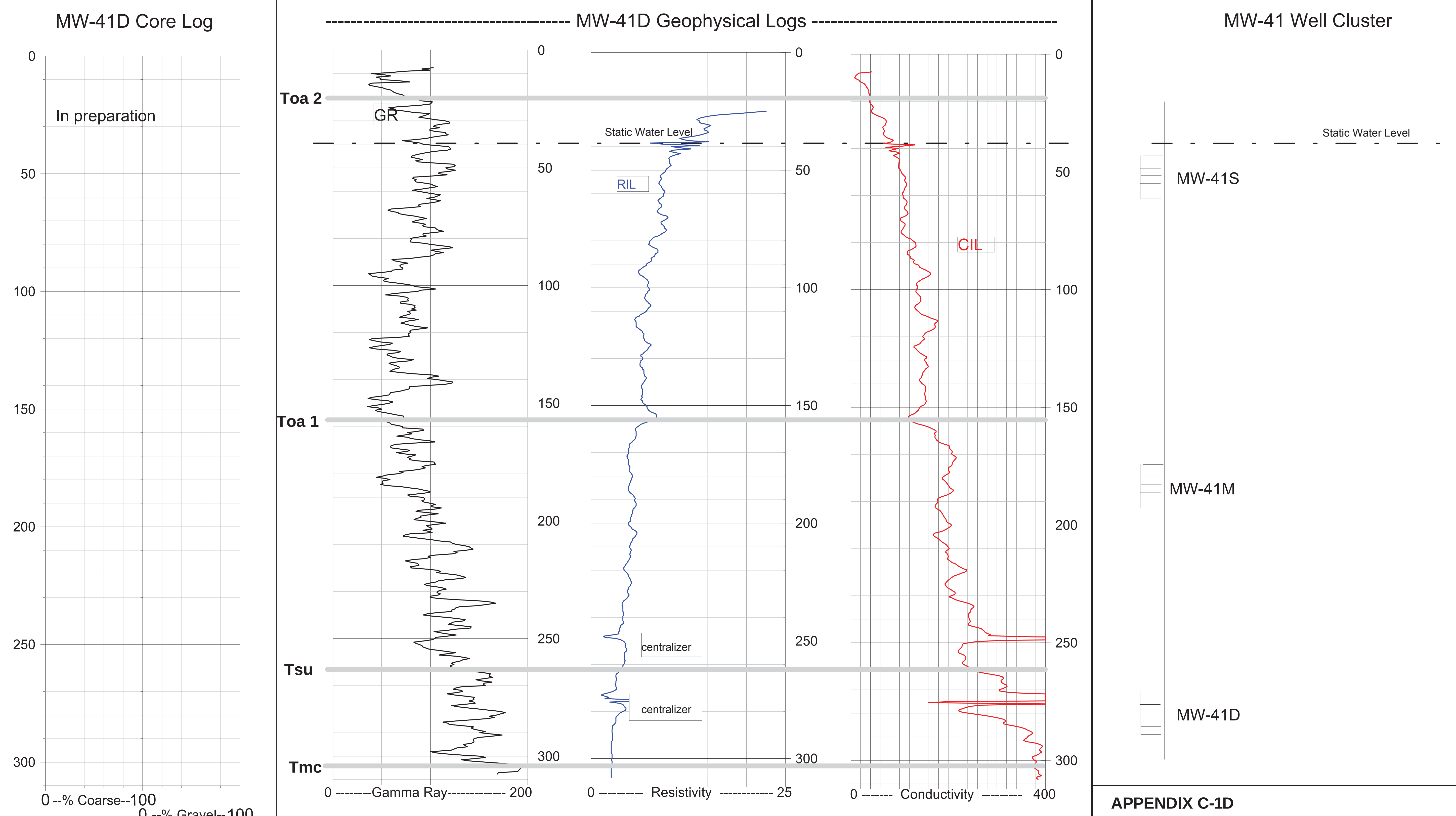
WELL CONSTRUCTION & SCREEN DETAILS

WELL MATERIAL:	Sch 40 PVC
CASING DIAMETER:	2-in
GROUT TYPE:	Cement bentonite grout
SEAL TYPE:	Bentonite Pellets
SCREEN LENGTH:	20-ft
SLOT TYPE:	Sch 40 PVC, 0.02" slot
PACK TYPE:	#3 Monterey Sand

NOTES:
1. ALL DEPTHS ARE REPORTED AS FEET BELOW GROUND SURFACE.

WELL DIAGRAM IS NOT TO SCALE

CH2MHILL



Plots show percentages of coarse sediment (> No. 200 sieve) and gravel-size fragments logged in MW-41D core.

Cased Well Geophysical Log November 5, 2004

Log Units: Gamma Ray (API units), Induction Resistivity (ohm/m), Induction Conductivity (µS/cm)

APPENDIX C-1D
SUMMARY OF HYDROGEOLOGIC LOGGING FOR MW-41 WELL CLUSTER

RCRA FACILITY INVESTIGATION/
REMEDIAL INVESTIGATION REPORT (VOLUME 2)
PG&E TOPOCK COMPRESSOR STATION
NEEDLES, CALIFORNIA

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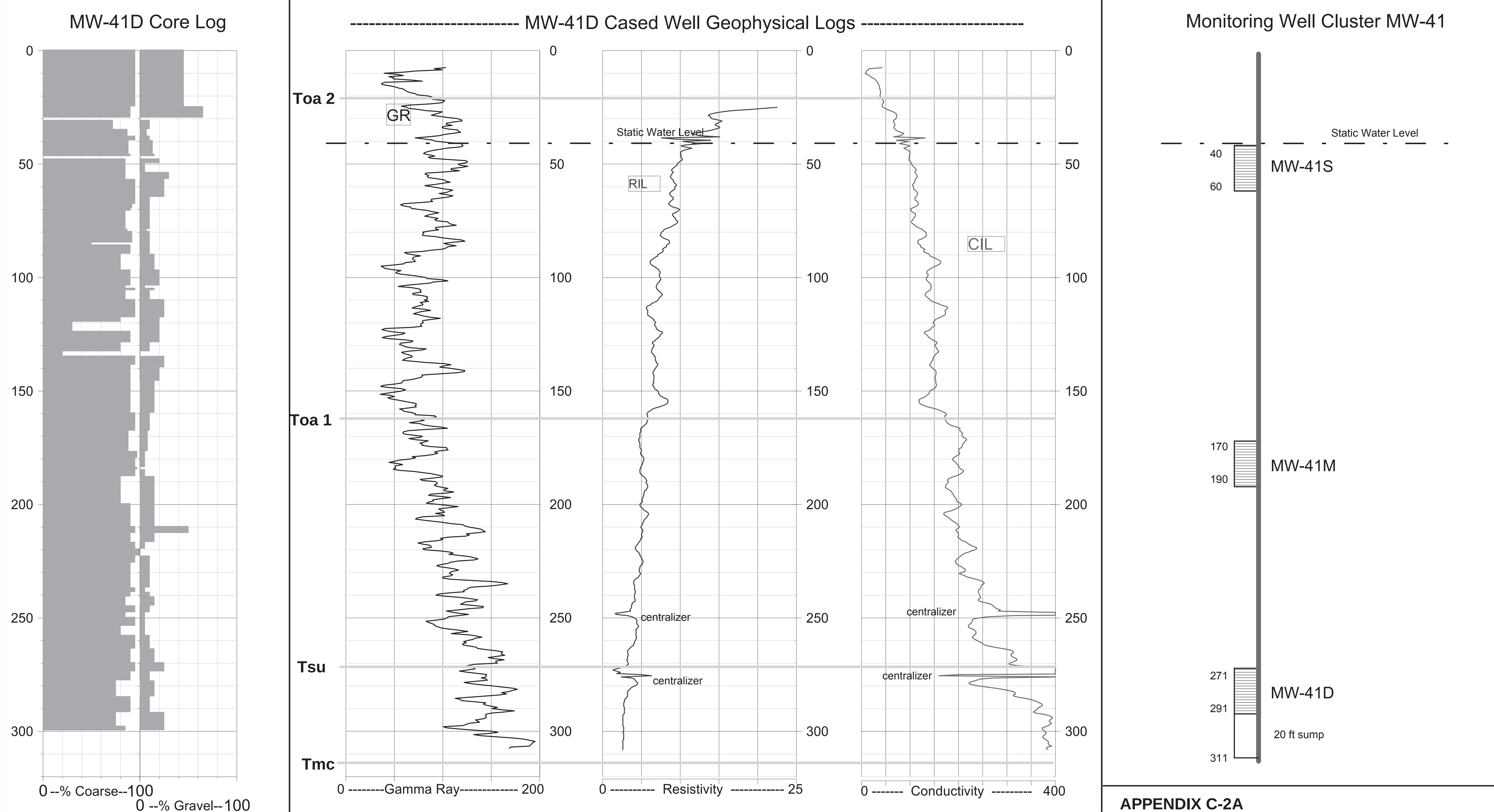

Plots show percentages of coarse sediment (> No. 200 sieve) and gravel-size fragments logged in MW-41D core.

Cased Well Geophysical Log November 5, 2004

Log Units: Gamma Ray (API units), Induction Resistivity (ohm/m), Induction Conductivity (µS/cm)

APPENDIX C-2A
SUMMARY OF HYDROGEOLOGIC LOGGING FOR MW-41 WELL CLUSTER

RCRA FACILITY INVESTIGATION/
REMEDIAL INVESTIGATION REPORT (VOLUME 2)
PG&E TOPOCK COMPRESSOR STATION
NEEDLES, CALIFORNIA

CH2MHILL

ES102007005BAO_Appendix_C_figures.indd_022708_lho

SHEET 1 of 6	**PROJECT NUMBER:** 315024.IM.02	**BORING NUMBER:** TW-2

SOIL BORING LOG

PROJECT NAME: PG&E Topock IM Investigation (Phase 1 2004)		**HOLE DEPTH (ft):** 180.0	**DRILLING CONTRACTOR:** WDC Exploration and Wells, Montclair, CA	
SURFACE ELEVATION: 497.0 ft. MSL	**NORTHING (CCS NAD 27 Z 5):** 2,102,633.34	**EASTING (CCS NAD 27 Z 5):** 7,615,861.57	**DATE AND TIME STARTED:** 03/30/2004	**DATE AND TIME COMPLETED:** 04/01/2004
DRILLING METHOD: Mud Rotary		**WATER LEVEL (ft):** ---	**DRILLING EQUIPMENT:** Speedstar 30K Rig with 94-mm Punch Core	
LOCATION: MW-20 Bench			**LOGGED BY:** J. Sarabia	

DEPTH BGS (feet)	SAMPLE INTERVAL	SAMPLE TYPE/ NUMBER	SAMPLE RECOVERY (ft)	USCS CODE	SOIL DESCRIPTION: SOIL NAME, USCS SYMBOL, COLOR, PERCENT COMPOSITION, GRADING, GRAIN SHAPE, MINERALOGY, DENSITY/CONSISTENCY, STRUCTURE, MOISTURE.	COMMENTS: DRILLING OBSERVATIONS AND OPERATIONS, DAILY START AND END TIMES , DRILL RATE, REFUSALS, SAMPLING AND TESTING NOTES.
					No core	AM activities: rig-up, set conductor casing to 17' bgs with air rotary. P.M. activities: set up mud circulation system, drill direct 17'-40' bgs. 15:30 begin first core run
5						
10						
15						
20						
25						
30						
35						

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SHEET 2 of 6	**PROJECT NUMBER:** 315024.IM.02	**BORING NUMBER:** TW-2

SOIL BORING LOG

PROJECT NAME: PG&E Topock IM Investigation (Phase 1 2004)	**HOLE DEPTH (ft):** 180.0	**DRILLING CONTRACTOR:** WDC Exploration and Wells, Montclair, CA
SURFACE ELEVATION: 497.0 ft. MSL / **NORTHING (CCS NAD 27 Z 5):** 2,102,633.34	**EASTING (CCS NAD 27 Z 5):** 7,615,861.57	**DATE AND TIME STARTED:** 03/30/2004 / **DATE AND TIME COMPLETED:** 04/01/2004
DRILLING METHOD: Mud Rotary	**WATER LEVEL (ft):** ---	**DRILLING EQUIPMENT:** Speedstar 30K Rig with 94-mm Punch Core
LOCATION: MW-20 Bench		**LOGGED BY:** J. Sarabia

DEPTH BGS (feet)	SAMPLE INTERVAL	SAMPLE TYPE/ NUMBER	SAMPLE RECOVERY (ft)	USCS CODE	SOIL DESCRIPTION (SOIL NAME, USCS SYMBOL, COLOR, PERCENT COMPOSITION, GRADING, GRAIN SHAPE, MINERALOGY, DENSITY/CONSISTENCY, STRUCTURE, MOISTURE.)	COMMENTS (DRILLING OBSERVATIONS AND OPERATIONS, DAILY START AND END TIMES , DRILL RATE, REFUSALS, SAMPLING AND TESTING NOTES.)
					No core	
40		CC124	0.75	SW	**WELL GRADED SAND WITH GRAVEL (SW)** - brn 10YR4/3, well graded sand, c silt, f gravel up to 3/4, subang to ang.	
		CC125	0.5	ML	**SILT WITH GRAVEL (ML)** - brn 10YR4/3, sand fraction nearly absent.	very slow coring very slow - rig maxed out
		CC126	3.5	SW	**WELL GRADED SAND WITH GRAVEL (SW)** - brn 10YR4/3, 80% well graded c silt to f gravel, m gravel up to 2, ang.	hard coring
45		CC127	0.5			very hard coring
		CC128	2			
		CC129	0.5	SM	**SILTY SAND WITH GRAVEL (SM)** - brn 10YR4/3, well graded c silt to 0.75 gravel, subang to ang, slight plasticity.	
50		CC130	2.25			
		CC131	0.75		**WELL GRADED SAND WITH GRAVEL (SW)** - brn 10YR4/3, c silt, gravel up to 1, subang to subrnd.	moderate to hard coring, core is less dense/consolidated-remains intact after extraction from core barrel
		CC132	3.5			
55		CC133	0.5			very hard coring
		CC134	1.5			
		CC135	0			very hard coring, obstruction at 57' - will try to drill through with bit drill ahead to try to get through obstruction
		CC136	1.5			attempt to core- no recovery
60					- 1/8 to 1 ang gravel, subrnd cobbles to 2.5	hard coring cannot core, will drill ahead and attempt to core at 62' bgs attempted to core at 62'bgs - too many rocks, will drill to 65' bgs
65						attempted to core at 65'bgs - too many rocks, will drill ahead to 67' bgs and attempt to core attempted to core at 67'bgs - too many rocks, will drill ahead to 70' bgs and attempt to core
70						

PROJECT NUMBER: 315024.IM.02

BORING NUMBER: TW-2

SOIL BORING LOG

PROJECT NAME: PG&E Topock IM Investigation (Phase 1 2004)		**HOLE DEPTH (ft):** 180.0	**DRILLING CONTRACTOR:** WDC Exploration and Wells, Montclair, CA
SURFACE ELEVATION: 497.0 ft. MSL	**NORTHING (CCS NAD 27 Z 5):** 2,102,633.34	**EASTING (CCS NAD 27 Z 5):** 7,615,861.57	**DATE AND TIME STARTED:** 03/30/2004 / **DATE AND TIME COMPLETED:** 04/01/2004
DRILLING METHOD: Mud Rotary		**WATER LEVEL (ft):** ---	**DRILLING EQUIPMENT:** Speedstar 30K Rig with 94-mm Punch Core
LOCATION: MW-20 Bench			**LOGGED BY:** J. Sarabia

DEPTH BGS (feet)	SAMPLE INTERVAL	SAMPLE TYPE/ NUMBER	SAMPLE RECOVERY (ft)	USCS CODE	SOIL DESCRIPTION SOIL NAME, USCS SYMBOL, COLOR, PERCENT COMPOSITION, GRADING, GRAIN SHAPE, MINERALOGY, DENSITY/CONSISTENCY, STRUCTURE, MOISTURE.	COMMENTS DRILLING OBSERVATIONS AND OPERATIONS, DAILY START AND END TIMES , DRILL RATE, REFUSALS, SAMPLING AND TESTING NOTES.
				SW	**WELL GRADED SAND WITH GRAVEL (SW)** - brn 10YR4/3, c silt, gravel up to 1, subang to subrnd.	attempted to core at 70'bgs - refusal, will drill ahead rig chatter significant in this zone, becomes progressively harder to drill with depth, and impossible to core (possible basal conglomerate)
75						
80						at ~79.5 bgs, rig chatter subsides (possible lith, contact), will attempt to core at 80'bgs attempted to core at 80' bgs, could not advance the core barrel - will continue to attempt to get core.
85						attempted to core - could not advance core, will drill forward and attempt to core when lithology changes or 90' bgs (which ever comes first)
90					**SILTY SAND WITH GRAVEL (SM)** - brn 10YR4/3, silt.	core barrel cannot be advanced (too many rocks/ cobbles. Will continue to drill direct with tricone bit and attempt to core every 3-5 feet.
95						continued strong rig chatter. Still unable to advance core barrel
100				GM		
105						

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SHEET 4 of 6	PROJECT NUMBER: 315024.IM.02	BORING NUMBER: TW-2

SOIL BORING LOG

PROJECT NAME: PG&E Topock IM Investigation (Phase 1 2004)		HOLE DEPTH (ft): 180.0	DRILLING CONTRACTOR: WDC Exploration and Wells, Montclair, CA	
SURFACE ELEVATION: 497.0 ft. MSL	NORTHING (CCS NAD 27 Z 5): 2,102,633.34	EASTING (CCS NAD 27 Z 5): 7,615,861.57	DATE AND TIME STARTED: 03/30/2004	DATE AND TIME COMPLETED: 04/01/2004
DRILLING METHOD: Mud Rotary		WATER LEVEL (ft): ---	DRILLING EQUIPMENT: Speedstar 30K Rig with 94-mm Punch Core	
LOCATION: MW-20 Bench			LOGGED BY: J. Sarabia	

DEPTH BGS (feet)	SAMPLE INTERVAL	SAMPLE TYPE/ NUMBER	SAMPLE RECOVERY (ft)	USCS CODE	SOIL DESCRIPTION SOIL NAME, USCS SYMBOL, COLOR, PERCENT COMPOSITION, GRADING, GRAIN SHAPE, MINERALOGY, DENSITY/CONSISTENCY, STRUCTURE, MOISTURE.	COMMENTS DRILLING OBSERVATIONS AND OPERATIONS, DAILY START AND END TIMES , DRILL RATE, REFUSALS, SAMPLING AND TESTING NOTES.
					SILTY SAND WITH GRAVEL (SM) - brn 10YR4/3, silt.	
110		CC137	2.75	SW	**WELL GRADED SAND WITH GRAVEL (SW)** - reddish brn 2.5YR4/4, well graded c silt, gravel up to 2, subang to ang, massive.	lithology still causing rig chatter, but will attempt core run. partial core recovery; core color implies geologic contact
115		CC138	1.75			poor core recovery, punch coring bit has been chewed up due to cobbles/rocks. Well put on another bit. Very hard coring
120		CC139	1			
		CC140	1.75			hard to very hard coring
		CC141	2			very hard coring
125		CC142	0.5	SM	**SILTY SAND (SM)** - reddish brn 2.5YR4/4, increasing silts and clays, ang gravel clasts, variable mineralogy, massive.	very hard coring
		CC143	4			hard coring - good core recovery and competence (less very large stones/cobbles, more cohesion in lithology) alternating moderate to hard coring
130		CC144	2.5			stones/cobbles stuck on both ends of returned core preventing better recovery
135		CC145	2			moderate to easy coring
		CC146	2			
140						moderate coring difficulty

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SHEET 5 of 6	PROJECT NUMBER: 315024.IM.02	BORING NUMBER: TW-2

SOIL BORING LOG

PROJECT NAME: PG&E Topock IM Investigation (Phase 1 2004)		**HOLE DEPTH (ft):** 180.0	**DRILLING CONTRACTOR:** WDC Exploration and Wells, Montclair, CA
SURFACE ELEVATION: 497.0 ft. MSL	**NORTHING (CCS NAD 27 Z 5):** 2,102,633.34	**EASTING (CCS NAD 27 Z 5):** 7,615,861.57	**DATE AND TIME STARTED:** 03/30/2004 — **DATE AND TIME COMPLETED:** 04/01/2004
DRILLING METHOD: Mud Rotary		**WATER LEVEL (ft):** ---	**DRILLING EQUIPMENT:** Speedstar 30K Rig with 94-mm Punch Core
LOCATION: MW-20 Bench			**LOGGED BY:** J. Sarabia

DEPTH BGS (feet)	SAMPLE INTERVAL	SAMPLE TYPE/NUMBER	SAMPLE RECOVERY (ft)	USCS CODE	SOIL DESCRIPTION: SOIL NAME, USCS SYMBOL, COLOR, PERCENT COMPOSITION, GRADING, GRAIN SHAPE, MINERALOGY, DENSITY/CONSISTENCY, STRUCTURE, MOISTURE.	COMMENTS: DRILLING OBSERVATIONS AND OPERATIONS, DAILY START AND END TIMES , DRILL RATE, REFUSALS, SAMPLING AND TESTING NOTES.
	X	CC147	3	SC	**CLAYEY GRAVEL WITH SAND (SC)** - dk reddish brn 2.5YR3/4, well graded vf sand to 0.125, 20% gravel up to 2.	
	X	CC148	3			very easy coring
145	X	CC149	3			very hard coring
	X	CC150	2			very hard coring, probable geologic contact at 150' very dense/tough material
150	X	CC151	0.5	SM	**SILTY SAND WITH GRAVEL (SC)** - dk reddish brn 2.5YR3/4, well graded vf sand, 20% gravel 0.125 up to 2.	extremely hard coring
	X	CC152	1.5		- dark red, geologic contact, dense, lithified, stiff, rock-like	extremely hard coring, will drill 2.5'
						drill ahead due to difficult or impossible coring
155	X	CC153	2			extremely hard coring
						extremely hard core refusal
	X	CC154	0.4			drill ahead due to core refusal, will attempt to core again at 162' bgs
160						very slow drill with abundant rig chatter
	X	CC155	0.3			extremely hard core refusal at 6
						drill ahead due to core refusal, will attempt to core again at 167' bgs
165						lots of rig chatter, very slow drilling
	X	CC156	0.5			extremely hard core, refusal at 6
						drill ahead due to core refusal
170						extremely slow drilling, abundant rig chatter, will attempt core run at 172'
	X	CC157	0.25			attempted core run, refusal at 3, will drill ahead
175						

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SHEET 6 of 6	**PROJECT NUMBER:** 315024.IM.02	**BORING NUMBER:** TW-2

SOIL BORING LOG

PROJECT NAME: PG&E Topock IM Investigation (Phase 1 2004)	**HOLE DEPTH (ft):** 180.0	**DRILLING CONTRACTOR:** WDC Exploration and Wells, Montclair, CA
SURFACE ELEVATION: 497.0 ft. MSL / **NORTHING (CCS NAD 27 Z 5):** 2,102,633.34	**EASTING (CCS NAD 27 Z 5):** 7,615,861.57	**DATE AND TIME STARTED:** 03/30/2004 / **DATE AND TIME COMPLETED:** 04/01/2004
DRILLING METHOD: Mud Rotary	**WATER LEVEL (ft):** ---	**DRILLING EQUIPMENT:** Speedstar 30K Rig with 94-mm Punch Core
LOCATION: MW-20 Bench		**LOGGED BY:** J. Sarabia

DEPTH BGS (feet)	SAMPLE INTERVAL	SAMPLE TYPE/ NUMBER	SAMPLE RECOVERY (ft)	USCS CODE	SOIL DESCRIPTION: SOIL NAME, USCS SYMBOL, COLOR, PERCENT COMPOSITION, GRADING, GRAIN SHAPE, MINERALOGY, DENSITY/CONSISTENCY, STRUCTURE, MOISTURE.	COMMENTS: DRILLING OBSERVATIONS AND OPERATIONS, DAILY START AND END TIMES , DRILL RATE, REFUSALS, SAMPLING AND TESTING NOTES.
180					**SILTY SAND WITH GRAVEL (SC)** - reddish brn, 2.5YR3/4, well graded vf sand, 20% gravel 0.125 up to 2. (overprinted: Trend … to 2.5YR4/4, increasing silts and clays, ang gravel clasts, variable mineralogy, massive.)	extremely hard drilling to 180' bgs

Boring Terminated at 180 ft

ABBREVIATIONS

cc = continuous core run
brn = brown
lt = light
dk = dark
vf = very fine-grained
f = fine-grained
m = medium-grained
c = coarse-grained
vc = very coarse-grained
ang = angular
subang = subangular
subrnd = subrounded
rnd = rounded
br = bedrock formation
ss = sandstone
conglom = conglomerate
comptd = compacted
qtz = quartz

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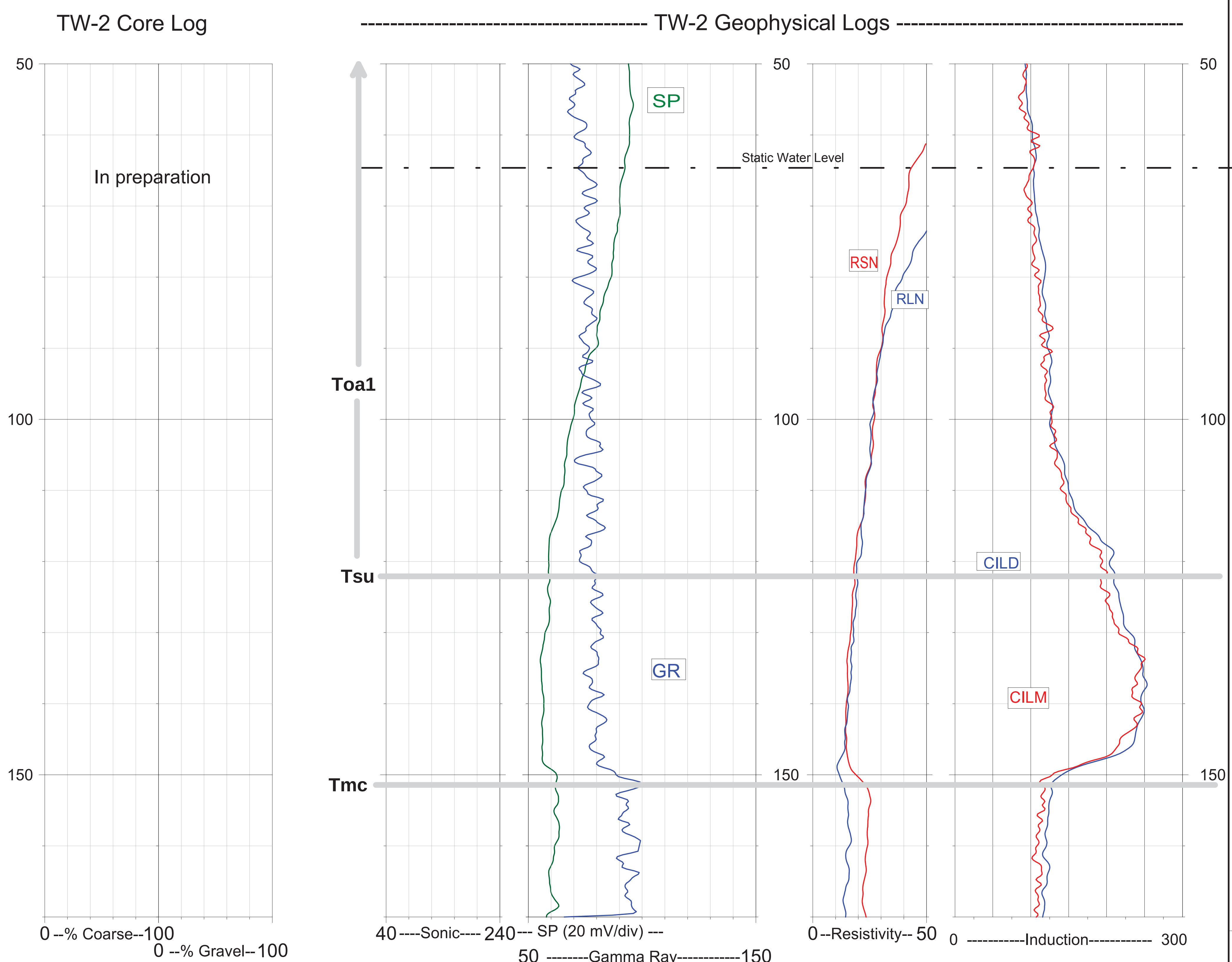
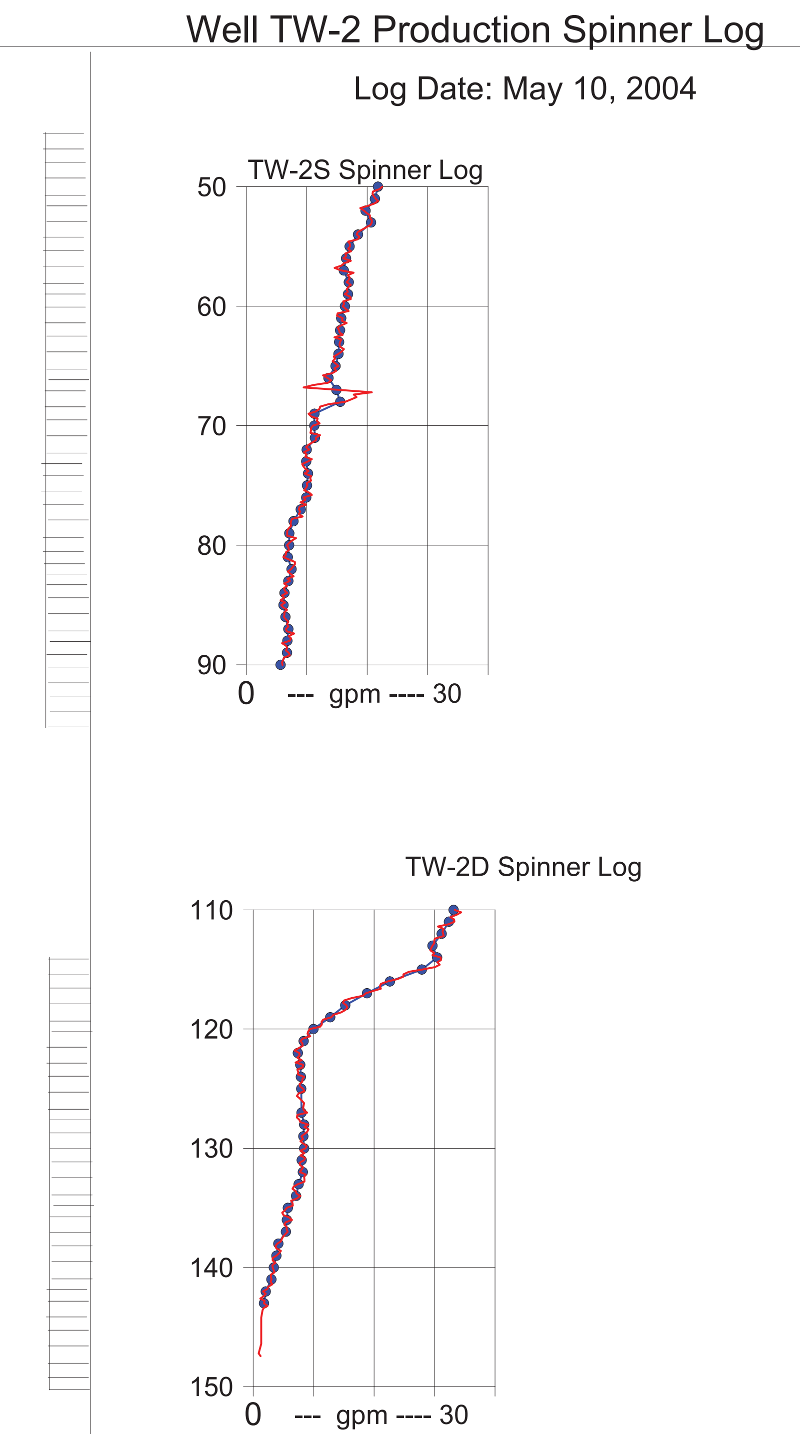


Plot shows percentages of coarse sediment (> No. 200 sieve) and gravel-size fragments logged in OW corehole adjacent to IW location. Core log depths adjusted to match ground surface datum for IW logs.

Cased Well Geophysical Log April 1, 2004

Log Units:
Sonic (µsecs/ft), SP (mV/div.), Gamma Ray (API units), Resistivity (RLN = 64" Normal (ohm/m), RSN = 16" Normal (ohm/m)), Induction (µS/m)



Spinner Logs Represent a combination of data from two Spinner tests. One in TW-2S and one in TW-2D

TW-2S (screen 42-93 ft bgs) pumped at 18 pgm, pump at about 50 feet bgs
TW-2D (screen 113-148 ft bgs) pumped at 33 gpm, pump at about 80 ft bgs

APPENDIX C-1I
SUMMARY OF HYDROGEOLOGIC LOGGING AND TESTING FOR WELL TW-2
RCRA FACILITY INVESTIGATION/
REMEDIAL INVESTIGATION REPORT (VOLUME 2)
PG&E TOPOCK COMPRESSOR STATION
NEEDLES, CALIFORNIA

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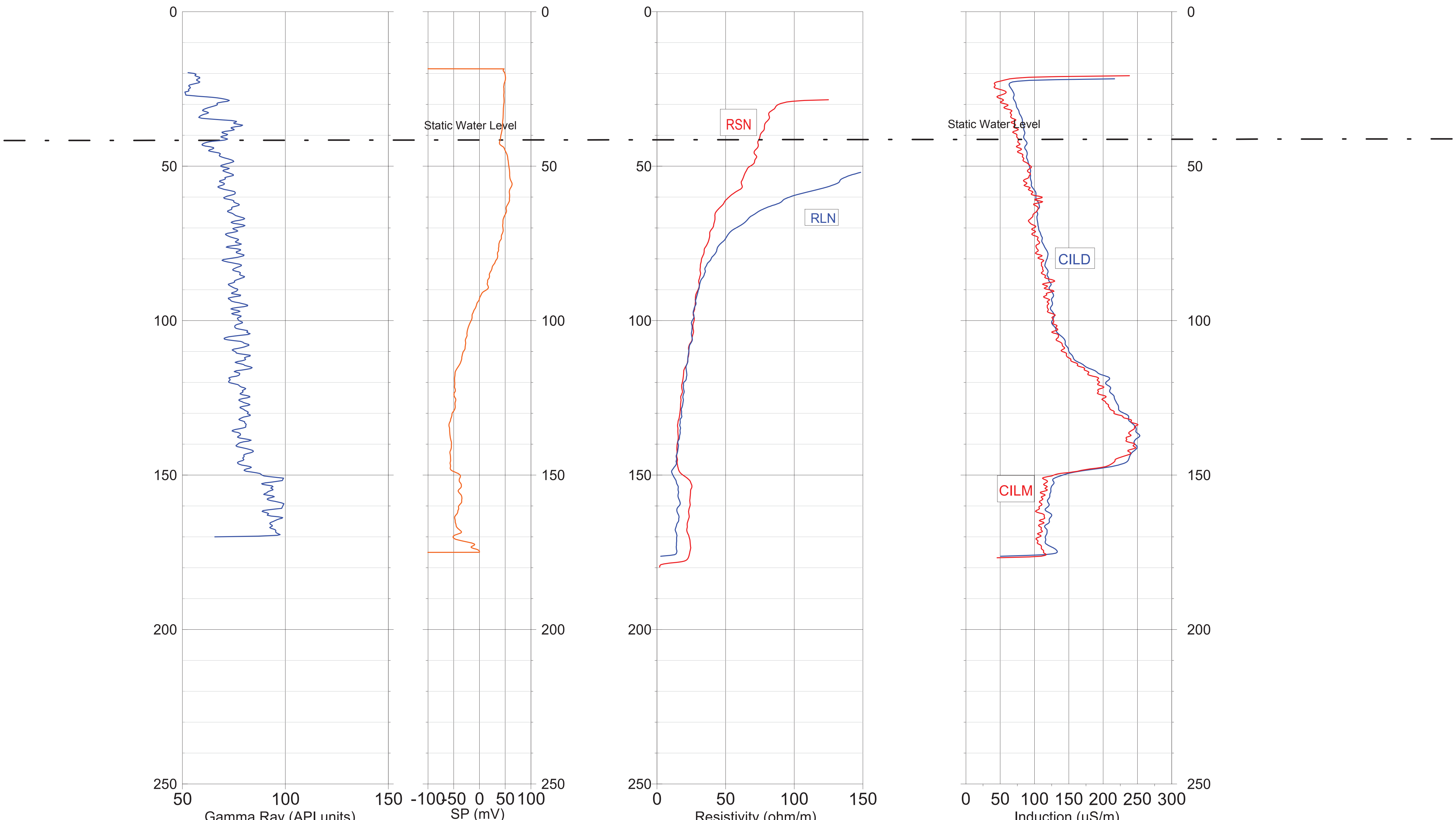

APPENDIX C-1J
TW-2 GEOPHYSICAL LOGS
RCRA FACILITY INVESTIGATION/
REMEDIAL INVESTIGATION REPORT (VOLUME 2)
PG&E TOPOCK COMPRESSOR STATION
NEEDLES, CALIFORNIA

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SHEET 1 of 5	PROJECT NUMBER: 326128.01.19.EW	BORING NUMBER: *TW-3D*

SOIL BORING LOG

PROJECT NAME: PG&E Topock Interim Measures Extraction Well		**HOLE DEPTH (ft):** 157.0	**DRILLING CONTRACTOR:** Prosonic Corp., Phoenix, AZ	
SURFACE ELEVATION: 497.0 ft. MSL	**NORTHING (CCS NAD 83):** Approx. 2,102,627.34	**EASTING (CCS NAD 83):** Approx. 7,615,874.57	**DATE STARTED:** 10/20/2005 09:00	**DATE COMPLETED:** 10/24/2005 14:15
DRILLING METHOD: Rotosonic		**DRILLING EQUIPMENT:** Standard Rotosonic Rig		
LOCATION: MW-20 bench, approx. 13 ft. west and 6 ft. south of TW-2D		**LOGGED BY:** J. Piper		

DEPTH BGS (feet)	SAMPLE: INTERVAL	SAMPLE: RECOVERY (ft)	SAMPLE: PID (PPM)	SAMPLE: SOIL SAMPLE	USCS CODE	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY
						- start coring at 9:00 AM 10/20/05
						Note: TW-3D pilot boring (7") diameter) continuously cored using sonic core barrel system. No analytical sampling conducted during drilling.
5					SW	**GRAVELLY SAND WITH SILT (SW)** - dk yellowish brn (10YR4/2 to 5/4), 65% poorly sorted f-m sand, 30% rnd quartz, limestone, and vesicular basaltic gravel up to 15 cm (minor portion reworked? subang mm clasts), 5% silt, moist.
						- dry
10					SP	**POORLY GRADED SAND (SP)** - dk yellowish orange (10YR7/4 to 6/6), 95% well sorted f sand, 5% gravel up to 1 cm, loose, moist
15					SW	**GRAVELLY SAND (SW)** - dk yellowish brn (10YR4/2), 55% sand, 40% rnd qtz, limestone, and jasper gravel up to 4-5 cm, 5% fines
20						- 60% sand, no fines (coarsening downwards), rounded chert and limestone clasts up to 12 cm
25					GW	**WELL GRADED SANDY GRAVEL (GW)** - 10YR4/2, 60% rnd (fluvial) gravel up to 15 cm (diverse rock types), 40% sand
30					SW/GW	**GRAVELLY SILTY SAND (SW/GW)** - med brn (5YR4/4), 50% sand, 40% subang mm gravel with weathered rinds, 10% fines, weakly cemented
35						

PROJECT NUMBER:	BORING NUMBER:
326128.01.19.EW	*TW-3D*

SOIL BORING LOG

PROJECT NAME: PG&E Topock Interim Measures Extraction Well	**HOLE DEPTH (ft):** 157.0	**DRILLING CONTRACTOR:** Prosonic Corp., Phoenix, AZ	
SURFACE ELEVATION: 497.0 ft. MSL / **NORTHING (CCS NAD 83):** Approx. 2,102,627.34	**EASTING (CCS NAD 83):** Approx. 7,615,874.57	**DATE STARTED:** 10/20/2005 09:00	**DATE COMPLETED:** 10/24/2005 14:15
DRILLING METHOD: Rotosonic	**DRILLING EQUIPMENT:** Standard Rotosonic Rig		
LOCATION: MW-20 bench, approx. 13 ft. west and 6 ft. south of TW-2D	**LOGGED BY:** J. Piper		

DEPTH BGS (feet)	SAMPLE: INTERVAL	SAMPLE: RECOVERY (ft)	SAMPLE: PID (PPM)	SAMPLE: SOIL SAMPLE	USCS CODE	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY
					SW/GW	**GRAVELLY SILTY SAND (SW/GW)** - med brn (5YR4/4), 50% sand, 40% subang mm gravel with weathered rinds, 10% fines, weakly cemented
40					SW/SM	**GRAVELLY SILTY SAND (SW/SM)** - med brn (5YR4/4), 45% sand, 40% gravel up to 5 cm, 15% fines, slightly cohesive - weakly cemented, dry to moist
45					SM/GM	**SILTY GRAVEL WITH SAND (SM/GM)** - 45% gravel up to 9 cm, 40% sand, 20% fines
50					SM	- saturated conditions encountered at 47 ft. **GRAVELLY SILTY SAND (SM)** - med brn (5YR4/4), 55% sand, 30% fines, 15% gravel up to 3 cm, slightly plastic
55						- 55% sand, 25% gravel up to 5 cm, 20% fines, coarsening downwards
60					SW	**GRAVELLY SAND (SW)** - 5YR4/4-3/4, 55% poorly sorted sand, 40% subang weathered mm gravel up to 15 cm, 5% fines - increasing sand and less fines, gravel up to 4 cm
65					SM	**GRAVELLY SILTY SAND (SM)** - 45% sand, 30% gravel up to 7 cm, 25% clayey fines
					SW	**SAND WITH GRAVEL AND SILT (SW)** - 60% poorly sorted f-c sand, 25% mm gravel, 15% fines
70					GW	**SANDY GRAVEL (GW)** - 5YR5/2 - 10YR6/2, 70% fluvial (and some reworked? mm) gravel up to 8 cm, 27% sand, 3% fines

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PROJECT NUMBER:	BORING NUMBER:
326128.01.19.EW	*TW-3D*

SOIL BORING LOG

PROJECT NAME:	HOLE DEPTH (ft):	DRILLING CONTRACTOR:	
PG&E Topock Interim Measures Extraction Well	157.0	Prosonic Corp., Phoenix, AZ	

SURFACE ELEVATION:	NORTHING (CCS NAD 83):	EASTING (CCS NAD 83):	DATE STARTED:	DATE COMPLETED:
497.0 ft. MSL	Approx. 2,102,627.34	Approx. 7,615,874.57	10/20/2005 09:00	10/24/2005 14:15

DRILLING METHOD:	DRILLING EQUIPMENT:
Rotosonic	Standard Rotosonic Rig

LOCATION:	LOGGED BY:
MW-20 bench, approx. 13 ft. west and 6 ft. south of TW-2D	J. Piper

DEPTH BGS (feet)	SAMPLE: INTERVAL	SAMPLE: RECOVERY (ft)	SAMPLE: PID (PPM)	SAMPLE: SOIL SAMPLE	USCS CODE	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY
					GW	**SANDY GRAVEL (GW)** - 5YR5/2 - 10YR6/2, 70% fluvial (and some reworked? mm) gravel up to 8 cm, 27% sand, 3% fines - 65% ang to subang mm gravel up to 3 cm, 35% sand
75						- 5YR4/4, 65% gravel up to 3 cm, 25% sand, 10% fines
					SW	- end of drilling on 10/20/05 **SAND (SW)** - 60% sand, 30% gravel up to 9 cm, 10% fines, gradational contact (grades finer) - start of drilling at 8:45 10/21/05
80					SM	**GRAVELLY SAND WITH SILT AND CLAY (SM)** - 55% sand, 25% gravel up to 5 cm, 20% fines
85					SW	**SAND (SW)** - 55% m-c sand, 25% gravel up to 13 cm, 20% fines (clay increasing with depth), becoming slightly plastic - 50% sand, 35% gravel, 15% fines
					GW	**SANDY GRAVEL (GW)** - 65% gravel up to 3 cm, 35% sand, 5% fines
90						
					GM/SM	**SILTY SAND AND GRAVEL (GM/SM)** - 5YR4/4, 40% sand, 40% mm gravel up to 13 cm, 20% fines
95					SW	**GRAVELLY SAND (SW)** - 52% well sorted m-c sand, 45% f gravel up to 2 cm, 3% fines - 62% gravel up to 15 cm, 35% sand, 3% fines
					GW	**GRAVEL WITH SAND (GW)** - 50% sand, 45% gravel up to 4 cm (90% of gravel is subang mm clasts, 10% is reworked? subrnd mm clasts), 5% fines
100						
105						

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PROJECT NUMBER:	BORING NUMBER:
326128.01.19.EW	*TW-3D*

SOIL BORING LOG

PROJECT NAME:	HOLE DEPTH (ft):	DRILLING CONTRACTOR:	
PG&E Topock Interim Measures Extraction Well	157.0	Prosonic Corp., Phoenix, AZ	

SURFACE ELEVATION:	NORTHING (CCS NAD 83):	EASTING (CCS NAD 83):	DATE STARTED:	DATE COMPLETED:
497.0 ft. MSL	Approx. 2,102,627.34	Approx. 7,615,874.57	10/20/2005 09:00	10/24/2005 14:15

DRILLING METHOD:	DRILLING EQUIPMENT:
Rotosonic	Standard Rotosonic Rig

LOCATION:	LOGGED BY:
MW-20 bench, approx. 13 ft. west and 6 ft. south of TW-2D	J. Piper

DEPTH BGS (feet)	SAMPLE: INTERVAL	SAMPLE: RECOVERY (ft)	SAMPLE: PID (PPM)	SAMPLE: SOIL SAMPLE	USCS CODE	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY
					GW	**GRAVEL WITH SAND (GW)** - 50% sand, 45% gravel up to 4 cm (90% of gravel is subang mm clasts, 10% is reworked? subrnd mm clasts), 5% fines - 57% gravel up to 4 cm, 40% sand, 3% fines - 50% sand, 40% gravel, 10% fines
110					SW/SM	**GRAVELLY SILTY SAND (SW/SM)** - 5YR3/4, 55% sand, 25% gravel up to 3 cm, 20% fines
115					SM	**SILTY SAND (SM)** - 65% sand, 25% fines (clayey), 10% gravel, slightly plastic - clayey - clayey
120					SW	**GRAVELLY SAND (SW)** - 60% gravel up to 4 cm, 25% well sorted m-c sand, 15% fines
125						
130					GW	**GRAVEL WITH SAND AND SILT (GW)** - 50% sand, 40% gravel up to 15 cm, 10% fines
					SM	**SILTY SAND (SM)** - 55% sand, 25% gravel (mm cobble), 20% fines
					SW	**SAND WITH GRAVEL AND SILT (SW)** - 5YR4/4, 60% sand, 25% gravel up to 4 cm, 15% silty fines - maximum clast size decreasing
135					SM	**GRAVELLY SILTY SAND (SM)** - 50% sand, 40% gravel up to 3 cm, 10% fines
					SW	**GRAVELLY SAND (SW)** - 45% sand, 40% gravel up to 3 cm, 15% fines
140						

SHEET 5 of 5	**PROJECT NUMBER:** 326128.01.19.EW	**BORING NUMBER:** ***TW-3D***

SOIL BORING LOG

PROJECT NAME: PG&E Topock Interim Measures Extraction Well		**HOLE DEPTH (ft):** 157.0	**DRILLING CONTRACTOR:** Prosonic Corp., Phoenix, AZ	
SURFACE ELEVATION: 497.0 ft. MSL	**NORTHING (CCS NAD 83):** Approx. 2,102,627.34	**EASTING (CCS NAD 83):** Approx. 7,615,874.57	**DATE STARTED:** 10/20/2005 09:00	**DATE COMPLETED:** 10/24/2005 14:15
DRILLING METHOD: Rotosonic		**DRILLING EQUIPMENT:** Standard Rotosonic Rig		
LOCATION: MW-20 bench, approx. 13 ft. west and 6 ft. south of TW-2D		**LOGGED BY:** J. Piper		

DEPTH BGS (feet)	SAMPLE: INTERVAL	SAMPLE: RECOVERY (ft)	SAMPLE: PID (PPM)	SAMPLE: SOIL SAMPLE	USCS CODE	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY
					GW	**SANDY GRAVEL (GW)** - 50% gravel up to 12 cm, 45% sand, 5% fines, grading finer downwards
145					SM	**GRAVEL WITH SAND AND SILT (SM)** - 60% gravel up to 15 cm, 35% sand, 5% fines - becoming stiff - transition to weathered bedrock - stronger white CO3 cemented zones, mm clasts very weathered
150					SM	- 45% sand, 45% gravel up to 12 cm, 10% fines, weathered bedrock with (mm clasts), stiff, competent, moist - drilling becomes harder below 150 ft.
155					BR	**BEDROCK (BR)** - consolidated Miocene conglomerate, 45% gravel up to 15 cm, 40% sand, 15% fines, competent, dry, dark reddish brown - shattered, moist - shattered, dry bedrock - End of boring 16:30 10/21/05 - Enlarged borehole to 10.7" for installing extraction well TW-3D. See TW-3D installation report.

Total Depth = 157 ft bgs

ABBREVIATIONS

brn = brown
lt = light
dk = dark
vf = very fine-grained
f = fine-grained
m = medium-grained
c = coarse-grained
ang = angular
subang = subangular
subrnd = subrounded
rnd = rounded
mm = metamorphic

CH2MHILL

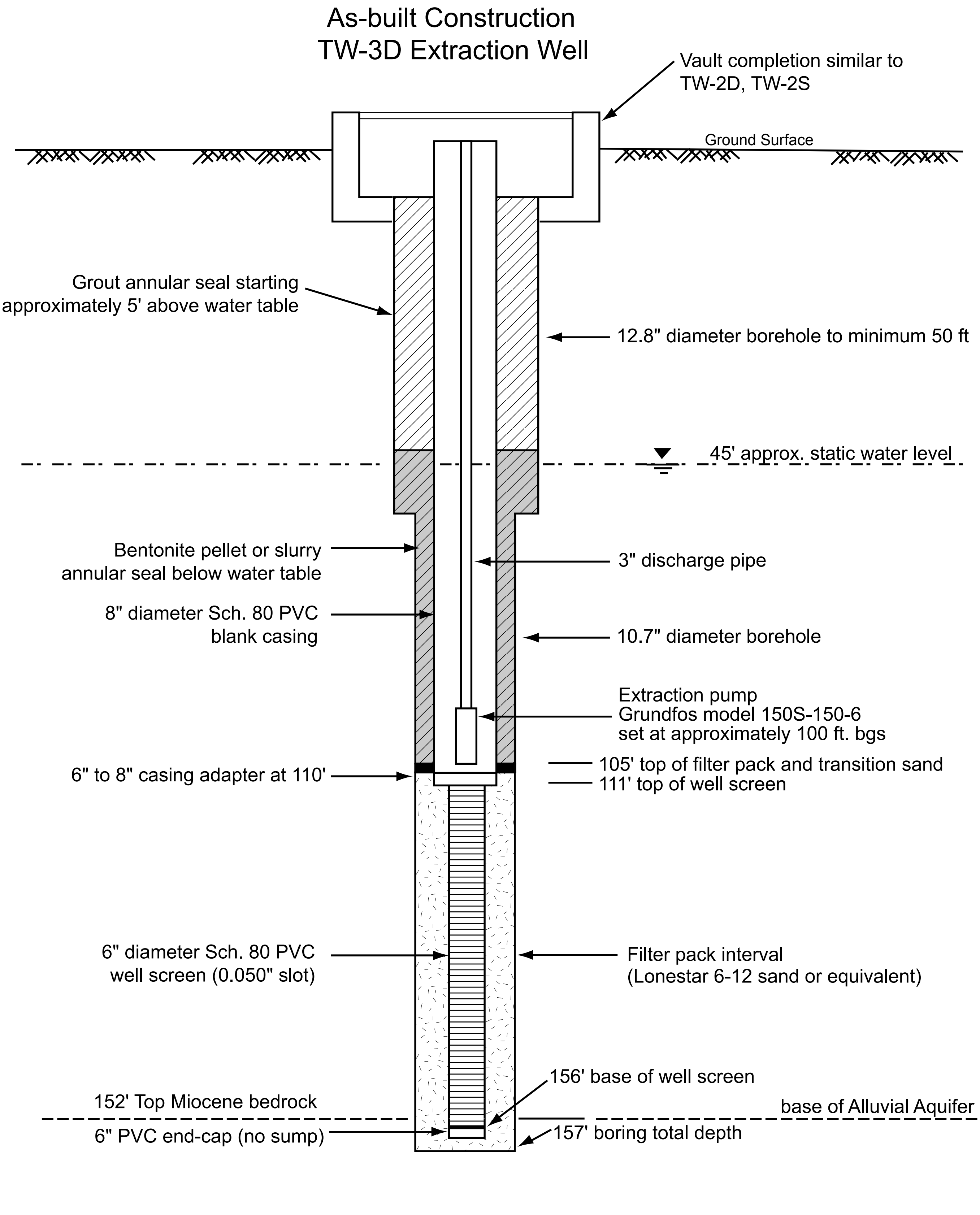

DIAGRAM NOT TO SCALE

Well screen selection reviewed with DTSC 10/21/05

Well TW-3D installed 10/26-27/05

FIGURE 3
WELL CONSTRUCTION DIAGRAM
TW-3D EXTRACTION WELL
IM NO. 3 GROUNDWATER EXTRACTION SYSTEM
PG&E TOPOCK COMPRESSOR STATION

CH2MHILL

326128.01.19.EW_Diagram Extraction Well_12/29/05_ccc_sfo

ALISTO ENGINEERING GROUP
WALNUT CREEK, CALIFORNIA

LOG OF BORING XMW-9

SEE SITE PLAN

ALISTO PROJECT NO: *10-320-06* DATE DRILLED: *06/25/97*

CLIENT: *Pacific Gas and Electric Company*

LOCATION: *Topock Compressor Station, Needles, CA*

DRILLING METHOD: *Resonant Sonic, Continuous Core*

DRILLING COMPANY: *Boart Longyear* CASING ELEVATION:

LOGGED BY: *Dan Salaices/ Dan Birch* APPROVED BY: *Dan Salaices*

BORING DIAGRAM	DEPTH feet	SOIL CLASS	GEOLOGIC DESCRIPTION
GROUT		GP	GRAVEL: pinkish gray, yellowish gray, light medium gray; 4–70 mm, subangular.
			At 2 feet, sandy GRAVEL: light medium gray; 80% gravel, 4–8 mm; 40% sand, fine to coarse grained.
		SP	At 3 feet, GRAVEL: pinkish yellow, light medium gray; 80% gravel, 4–70 mm; 40% cobbles, fractured.
			ALLUVIUM/OLDER ALLUVIUM CONTACT AT 4 FEET. gravelly SAND: dark yellowish brown; 70% sand, fine to medium grained; 30% gravel, subangular to angular, various grays and browns.
	10	GP GC	sandy clayey GRAVEL: mottled olive gray to dark yellowish brown; 80–70% gravel, 4–40 mm, subangular to angular; 15–20% sand, fine to coarse grained; 10–25% fines; slightly moist.
	20	SP	gravelly SAND: dark yellowish brown; 70% sand, fine grained, minor coarse grained; 30% gravel, light medium gray, subangular, 4–20 mm; occasional fractured cobbles.
	30, 40	GP GC	sandy clayey GRAVEL: mottled light olive gray to dark yellowish brown; 80% gravel, 4–20 mm, subangular, 0–15% cobble fragments; 20–30% sand, fine to coarse grained; 5–15% fines; slightly moist; slight to low plasticity. At 42 feet, 70–85% gravel.
	50	GP	sandy GRAVEL: light olive brown; 80% gravel, 4–30 mm, subangular, fractured cobbles; 20% sand, fine grained with minor coarse grained; slightly moist.
		GP GM	sandy silty GRAVEL: mottled dark yellowish brown to olive gray; 80% gravel, 4–30 mm, subangular and fractured; 10% sand, fine grained; 10% fines, moist.
	60	CL	sandy CLAY: moderate brown; 40% sand, very fine; occasional fine gravel; low plasticity; moist.
			Fractured cobbles.
		GP GM	sandy silty GRAVEL: light olive gray to moderate brown; 80% gravel, 4–50 mm, subangular to fractured; 10% sand, fine grained; 10% fines; moist.
		GP	RED FANGLOMERATE
			GRAVEL: moderate reddish brown; 80% gravel, 4–50 mm, appears crushed by drill bits, very angular; less than 10% sand/fines; dry.
			At 89 feet, color change to pale red.

LOG OF BORING XMW-9

BORING DIAGRAM	DEPTH feet	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION
GROUT			GP	At 73 feet, color change to dark yellowish brown; material is very crushed and powdered; rock fragments are up to 100 mm and olive gray with dark reddish brown mineral coating on fractures.
				CHEMEHUEVI FORMATION: olive gray; very hard; old fracture surfaces with dark reddish brown mineral coating.
	80			Total depth of boring is 77.5 feet.
	90			
	100			
	110			
	120			
	130			
	140			
	150			

Geotechnical Investigation Report, Topock Compressor Station, Water Treatment Plant
(CH2M HILL 2004)

Geotechnical Investigation Report
Topock Compressor Station
Water Treatment Plant

Prepared for

Pacific Gas & Electric Company

September 2004

CH2MHILL

9193 South Jamaica Street
Englewood, Colorado
80112

The following individuals have participated in the preparation and/or have completed quality review of this geotechnical report for the *Geotechnical Investigation Report, Topock Compressor Station Water Treatment Plant.*

Jack Woo
Primary Preparer

Curt Basnett, G.E.
Senior Reviewer

REGISTERED PROFESSIONAL ENGINEER
CURTIS R. BASNETT
No. GE002593
Exp. 12/31/05
GEOTECHNICAL
STATE OF CALIFORNIA

Contents

Appendixes

Tables

Figures

1.0 Introduction

1.1 Project Description

This report describes the results of a geotechnical investigation regarding construction of a new water treatment plant (WTP) for remediating contaminated groundwater at Pacific Gas and Electric Company's (PG&E's) Topock compressor station. The Topock site is located in eastern San Bernardino County, approximately 15 miles to the southeast of Needles, California. Figure 1 shows the Topock site and the location of WTP, while Figure 2 shows a detailed layout of the WTP and soil borings drilled during this investigation. The main purpose of this investigation was to provide site-specific data regarding geotechnical properties for foundation design and excavation in the existing ground, and to develop appropriate geotechnical design recommendations.

The water treatment plant is situated on Metropolitan Water District of Southern California (MWD) property and permission was required from MWD, as well as the Bureau of Land Management (BLM), to conduct the geotechnical investigation.

1.2 Objectives and Scope

The primary objective of CH2M HILL's geotechnical services was to provide appropriate geotechnical information for the foundation design of the water treatment plant. The geotechnical design criteria and recommendations described here were developed based on evaluation of available subsurface information, field exploration, laboratory testing, and engineering analyses.

The scope of work for this study includes the following tasks:

Task 1. Compile and Review Existing Information

This task involved compilation and review of available geologic and geotechnical information in the vicinity of the WTP. The following information was reviewed:

- Area geologic data
- Area monitoring well installation logs

Task 2. Field Exploration

This task included drilling four (4) soil borings within the treatment plant footprint. This task also included planning the field investigation, arranging for a drilling subcontractor, obtaining the necessary utility clearances for the work, and coordinating with the various parties involved.

Task 3. Laboratory Testing

A laboratory testing program was conducted on selected soil samples as required to determine pertinent engineering properties and to aid in soil classification.

Task 4. Engineering Evaluation

Engineering evaluations were carried out to aid in the development of geotechnical design and construction recommendations for the WTP.

Task 5. Geotechnical Report Preparation

This geotechnical report was prepared to document the methods and results of the field and laboratory investigations, and to provide geotechnical design criteria for various project facilities.

1.3 Limitations

This report has been prepared according to generally accepted principles and practices of geotechnical engineering applicable at the time of the work. No other warranty, express or implied, is made. This report is for the exclusive use of PG&E and CH2M HILL for specific application to the Topock water treatment plant project.

The analyses and recommendations contained in this report are based on the results of field exploration, laboratory testing, and engineering evaluation. The soil explorations indicate subsurface conditions only at specific locations and times, and only to the depths penetrated. They do not necessarily reflect strata variations that may exist between or outside such locations. If variations in subsurface conditions from those described are noted during construction, the recommendations in this report must be reevaluated.

If any significant changes in the nature, design, or location of the facilities are planned, the conclusions and recommendations contained in this report should not be considered valid unless the changes are reviewed and the conclusions of this report are modified or verified in writing by CH2M HILL. CH2M HILL is not responsible for any claims, damages, or liability associated with interpretation of subsurface data or reuse of the subsurface data or engineering analyses without the express written authorization of CH2M HILL.

We recommend that CH2M HILL be provided the opportunity to review the project plans and specifications to confirm that the intent of the geotechnical recommendations provided in this report has been appropriately incorporated.

2.0 Technical Data

2.1 Field Exploration

The geotechnical field exploration program conducted at the Topock water treatment plant site included site reconnaissance and drilling soil borings. The reconnaissance was performed to locate onsite utilities and to identify locations of soil borings.

2.1.1 Current Investigation

CH2M HILL conducted a field exploration at the project site on August 13, 2004. Four borings were advanced to depths ranging from 11.5 to 36.5 feet below existing ground surface. Approximate boring locations are shown on Figure 2. Locations were determined by measuring from existing site reference features.

Boring locations were selected to provide site-specific information below the proposed structure. Before drilling began, utility locates were requested so boring locations would avoid underground utility lines.

Kleinfelder, Inc. of Las Vegas, Nevada mobilized a truck-mounted B-61 drill rig to the site. Soil borings were advanced using 6-inch outside diameter hollow stem auger techniques.

Soil samples were obtained in borings by driving 1.4-inch ID split spoon samplers. The 1.4-inch ID sampler was driven by a 140-pound autohammer with a 30-inch drop in accordance with standard penetration test (SPT) procedures described in ASTM Standard D1586. Recovered soil samples obtained with the split spoon samplers were sealed in double plastic bags with locking tops to preserve the natural moisture content. Soil samples were typically obtained at 5-foot intervals throughout each boring. One sample was also obtained using a modified California sampler, but this method was abandoned due to the difficulty in obtaining a full sample in the sample liner.

Bulk samples were also obtained from each boring by taking a grab sample directly from the auger stem.

A CH2M HILL geotechnical engineer supervised drilling and sampling operations, and also logged soil borings and obtained representative soil samples. The soils encountered during drilling were visually classified in the field according to the Unified Soil Classification System (USCS). Table 2-1 provides a summary of the depth of the soil borings. Logs of the soil borings drilled during this study are included in Appendix A. A key sheet explaining terms used on the logs is also included in Appendix A.

All borings were terminated above the groundwater table; therefore, no groundwater levels were recorded. At the completion of drilling, all borings were backfilled with drill cuttings back to ground surface.

Table 2-1
Soil Boring Summary
Topock Water Treatment Plant

Soil Boring	Approximate Ground Surface Elevation (ft msl)	Depth Explored (ft bgs)
B-01	508	36.5
B-02	505	11.5
B-02A	505	15.0
B-03	508	31.5

2.1.2 Previous Investigations

Several monitoring wells have been installed throughout the Topock site to characterize and monitor the groundwater. The new water treatment plant is located north of the compressor station and Interstate 40, and west of Bat Cave Wash (see Figure 1). The closest monitoring well to the WTP site is approximately 400 feet away to the southeast (MW-13). The discussion of existing subsurface information will focus on three wells that have been installed near the WTP site (MW-13, MW-14, and MW-37D). These boring logs are included in Appendix B.

The logs for MW-13 and MW-14 indicate that the area consists of alternating layers of gravelly sand and sandy gravel down to an approximate elevation of 435 feet above mean sea level (msl). The log for MW-37D revealed gravelly sand with clay and sandy clay layers starting at an elevation of approximately 465 feet msl underlying the sandy gravel. The difference in material in this boring can be attributed to the fact that it was located in a wash that transports the finer material from higher elevations.

Groundwater elevations encountered during drilling range from 455 to 459.5 feet msl.

2.2 Laboratory Testing Program

Laboratory tests to determine pertinent geotechnical index and engineering properties on selected soil samples were performed by Kleinfelder, Inc. of Las Vegas, Nevada. Tests were conducted to confirm field classifications and provide additional data needed for geotechnical engineering analyses. Laboratory tests were conducted in accordance with American Society for Testing and Materials (ASTM) standards as follows:

- Moisture Content (ASTM D2216)
- Grain-size Analyses (ASTM D422 and D1140)
- Corrosion Potential (pH, resistivity, sulfates, chlorides)
- R-value (ASTM D2844)
- Solubility (AWWA test methods)

Laboratory test results are presented in Appendix C.

3.0 Interpretation

3.1 Regional and Local Geology

The Topock site is located in the Mojave Desert area southeast of Needles, CA and west of the Colorado River. The surficial soils consist of nonmarine sedimentary rocks and alluvial deposits of the Cenozoic period (California Geologic Survey, 2002). Volcanic rocks may also be present.

Logs from current borings and installation of monitoring wells indicate that the surficial soils consist of silty sands, sandy gravels and gravelly sands at depths of over 50 feet below ground surface. There is also evidence of sandy clay layers.

3.2 Site Conditions

The interpretation of site and subsurface conditions presented here has been developed from the soil borings, laboratory testing, and review of previous investigations.

3.2.1 Surface

The topography of the site is relatively flat with an elevation ranging between 505 and 510 feet above mean sea level (msl). Historic Route 66 runs north of the site. Bat Cave Wash runs east of the site into the Colorado River.

3.2.2 Subsurface

3.2.2.1 Soil Classification

In the preparation of this report, soil has been classified using the USCS per ASTM Standards D2487 and D2488. The relative consistency of the soil, used in the soil description, relies on the standard penetration test (SPT) blow count (N) that was obtained during the subsurface investigation.

3.2.2.2 General

A total of four borings (B-01 to B-03) were drilled across the site ranging in depth from 11.5 to 36.5 feet. Boring B-01 was drilled down to a depth of 36.5 feet near the southeast corner of the WTP footprint. Boring B-02 was located near the northwest corner of the WTP site and hit refusal at 11.5 feet. The drill rig was moved approximately 12 feet west where boring B-02A was drilled and the auger hit refusal at 15 feet. The driller stated that boulders were probably the cause of refusal in both borings. Boring B-03 was drilled at the center of the WTP site down to 31.5 feet. The soils encountered can be grouped into two general categories. These categories are silty sand with gravel, and poorly graded sand with silt and gravel. Not all soil categories are present at each location drilled. Discussions of individual soil categories, including locations encountered, are presented below.

3.2.2.3 Silty Sand with Gravel

The entire site appears to be underlain by a layer of silty sand with gravel ranging from 11.5 to 31.5 feet thick as identified in the borings. The consistency of the material ranged from medium dense to very dense, according to SPT blow counts. The sand was fine to coarse grained and the amount of gravel was estimated to range from 10 to 30 percent of the sample. The percentage of gravel increased with depth and the gravel sizes ranged from 1/8 to 2 inches.

The driller noted the presence of cobbles and boulders. In the deeper holes, there was no sample recovery after 15 feet, most likely due to the presence of cobbles obstructing the sampling tip. Boring B-02 and B-02A probably encountered large boulders at depths of 11.5 and 15 feet, respectively, causing auger refusal.

3.2.2.4 Poorly Graded Sand with Silt and Gravel

A 1.5 feet thick layer of poorly graded sand with silt and gravel was identified below the silty sand with gravel layer in Boring B-03 at a depth of 20 feet. The consistency of the material was very dense containing approximately 40 to 50 percent gravels ranging in size from 1/8 to 1/2 inch.

3.2.3 Engineering Parameters

Current and previous investigations and laboratory test results were used to develop the engineering properties of the subsurface materials. In addition to laboratory tests, SPT blow counts from various test borings were used to estimate equivalent friction angles for granular soils based on established correlations in the literature (Federal Highway Administration [FHWA], 1996).

The generalized soil profiles and material properties used for engineering analyses are presented in Table 3-1.

TABLE 3-1
Generalized Subsurface Soil Profile and Design Strength Parameters
Topock Water Treatment Plant

Geologic Unit	Approx. Elevation of Layer[1] (± feet)	Soil Type	Average Corrected[2] SPT N-Values (blows per foot)	Total Unit Weight [lbs/ft^3]	Friction Angle (degree)
		Boring B-01			
Alluvium	508 – 498	SMg	20	120	32
Alluvium	498 – 493	SMg	>50	120	35
Alluvium	493 – 474	SW-SM	>50	120	35
Alluvium	<474	SMg	>50	120	35
		Boring B-02			
Alluvium	505 – 495	SMg	46	120	32
Alluvium	<495	SMg	>50	120	35

TABLE 3-1
Generalized Subsurface Soil Profile and Design Strength Parameters
Topock Water Treatment Plant

Geologic Unit	Approx. Elevation of Layer[1] (± feet)	Soil Type	Average Corrected[2] SPT N-Values (blows per foot)	Total Unit Weight [lbs/ft^3]	Friction Angle (degree)
		Boring B-02A			
Alluvium	505 – 495	SMg	63	120	32
Alluvium	<495	SMg	>50	120	35
		Boring B-03			
Alluvium	508 – 498	SMg	44	120	32
Alluvium	498 – 488	SMg	>50	120	35
Alluvium	<488	SP-SM	>50	120	35

Notes:
1. Bottom of footing elevation for the proposed slab on grade at the treatment plant is approximately 2 feet below grade.
2. SPT blow counts corrected for overburden and efficiency.
3. Groundwater table was not encountered during current investigation.

3.3 Groundwater

The groundwater table was not encountered during the current investigation. The deepest boring (Boring B-01) was terminated at a depth of 36.5 feet below ground surface, or approximately elevation 471.5 feet msl. There was no surface flow in washes at the time the borings were performed. The groundwater table may fluctuate due to seasonal variation, nearby construction, irrigation, vegetation, and other man-made influences. Groundwater elevations in the monitoring wells nearby ranged from 455 to 459.5 feet msl.

3.4 Liquefaction

The term liquefaction, as used herein, describes a phenomenon in which a cohesionless saturated soil loses strength during an earthquake and acquires a degree of mobility sufficient to permit movements ranging from settlement to lateral spreading. The factors known to influence liquefaction potential include grain size, relative density, groundwater conditions, effective confining pressures, and intensity and duration of ground shaking. Saturated, loose and medium dense, near-surface cohesionless soils exhibit the highest liquefaction potential, while dry, dense cohesionless soils, and cohesive soils exhibit low to negligible liquefaction potential.

Generally, medium dense to very dense, silty sands and poorly graded silty sands underlie the proposed treatment plant site. Blow counts in the dry, silty sands were generally in the range of 20 to greater than 50. Therefore, liquefaction potential of the site soils is estimated to be low, especially where the groundwater is greater than 50 feet bgs.

3.5 Expansion/Collapse

Based on the medium dense to very dense granular material encountered at the project site, expansion and collapse potential is regarded as low.

3.6 Settlement

Primary consolidation settlement occurs when a load is applied to saturated compressible materials, causing an increase in pore water pressure (in excess of the static groundwater conditions) that results in a reduction in volume due to the expulsion of water from the pores of the soil (Fang, 1991). Based on the medium dense to very dense granular material encountered at the project site (above and below the proposed/existing footing elevation), and the relatively deep groundwater table (>45 feet), consolidation settlement is not considered an issue.

Secondary compression settlement is not a result of a reduction in volume due to the expulsion of water from the pores of the soil. It is the result of compression of bonds between individual particles after excess hydrostatic pressure is zero (Fang, 1991). Secondary compression settlement has been determined to be negligible.

3.7 Corrosion Conditions

Two samples collected at the site were tested for minimum soil resistivity, soil pH, water soluble sulfate content, and chloride content. The results of those laboratory tests are presented in Appendix C. Caltrans Bridge Memo to Designers 3-1 (Caltrans, 1998), regarding deep foundations, defines a corrosive environment as being a site where the soil has electrochemical resistivity of less than 1,000 ohm-centimeters (ohm-cm), a sulfate content greater than 2,000 parts per million (ppm), or chloride content of greater than 500 ppm. Comparison between the laboratory test results and the Caltrans corrosion criteria indicates that the onsite soils are considered to be corrosive to concrete structures. The results of the laboratory corrosion testing are summarized in Table 3-1. The Caltrans corrosion criteria should not be applied to piping and other metal structures. A corrosion engineer should review the test results and make recommendations for any metal structures.

Concrete in contact with onsite soil shall be batched using Type V cement in accordance with the 2001 California Building Code (CBC, 2001). Adequate concrete cover over reinforcing steel should be provided in accordance with good construction practices and design standards.

TABLE 3-2
Summary of Laboratory Corrosion Tests
Topock Water Treatment Plant

Boring	Sample Depth (ft)	Soil Type	Minimum Resistivity (ohm-cm)	pH	Sulfate Content (ppm)	Chloride Content (ppm)
B-01	6.5 – 8.0	SM	370	8.63	2,888	1,025
B-02	6.5 – 8.0	SM	725	8.67	3,988	350

3.8 Solubility

Due to the highly corrosive nature of the granular soil at the site, two soil samples were tested for solubility. Solubility refers to the potential for soluble particles to be present (i.e. salts, gypsum) that appear to be sand/gravel, but will dissolve when wet and cause excessive settlement. The results are shown in Table 3-3 and included in Appendix C.

TABLE 3-3
Summary of Solubility Tests
Topock Water Treatment Plant

Boring	Sample Depth (ft)	Soil Type	Solubility (%)
B-01	6.5 – 8.0	SM	0.79
B-03	5.0 – 6.5	SM	0.33

Local practice dictates that solubility results greater than 1.0 % require remedial efforts. Remedial efforts include mixing non-soluble soil with the soluble soil or pre-wetting the soluble soil. The solubility results are low at this site, so it is not expected to be an issue.

3.9 Seismicity

The proposed site is located in a seismically active region. The nearest faults that are considered capable of producing strong ground shaking are the Chemehuevi Graben Fault, Pahrump-Stateline Fault, and the Pisgah-Bullion Fault. The Chemehuevi Graben Fault, approximately 18.8 kilometers from the project site, is the controlling fault at the project site. The Chemehuevi Graben Fault is a normal style fault with a maximum credible earthquake (MCE) moment magnitude (M_w) of 6.0. The fault is classified as Seismic Source Type C, the project site lies in Seismic Zone 3, and the soil profile is classified as type S_D as defined in the California Building Code (CBC, 2001).

There are no Alquist-Priolo Fault-Rupture Hazard Zones in proximity to the project site, and no active faults are known to transect the proposed site. Therefore, the possibility of primary surface rupture or deformation at the site is considered low.

Site-specific probabilistic and deterministic analyses of ground motion were performed for active faults within the region using the computer programs EQFAULT and FRISKSP published by Thomas Blake (1998). The deterministic ground-motion analysis requires information regarding the fault geometry, maximum credible earthquake (MCE) magnitude of the fault, and a regional attenuation equation, which relates the relevant seismic parameters to the magnitude source and the source-site distance. Fault geometry was based on the CGS fault database for the State of California. Using the attenuation curves of Sadigh et al. (see Blake, 1998), probabilistic analyses indicate that a horizontal peak ground acceleration (HPGA) of 0.07g may be used for a 10 percent probability of exceedance in 50 years. Deterministic analyses indicate a peak ground acceleration (PGA) of 0.20g at the project site.

In order to verify the deterministic analysis, the results were compared to the California Seismic Hazard Map (Caltrans, 1996). Using this map, the peak bedrock acceleration at the site was estimated to be 0.20g. Additionally, the attenuation equation by Sadigh (Sadigh et al., 1997), which accounts for fault style and proximity, also estimated a peak bedrock acceleration of 0.20g based on distance to fault and fault MCE data from the Caltrans Seismic Hazard Map.

3.10 Frost Depth

According to a figure in NAVFAC DM 7.01-42 (1986), the depth of extreme frost penetration in the Needles, CA area is approximately 8 to 10 inches. Structures should be founded below this depth to mitigate frost heave potential.

4.0 Discussions and Recommendations

4.1 General

The soils at the Topock water treatment plant site consist primarily of alluvial deposits of silty sand with gravel and some poorly graded sand with silt and gravel. Groundwater was not encountered in any of the borings.

4.2 Water Treatment Plant

4.2.1 Facility Description

The water treatment plant consists of a prefabricated metal building with dimensions of approximately 50 feet by 140 feet built on a 6-inch concrete slab. The slab has a thickened edge that acts as a footing embedded approximately 2 feet below ground surface with a width of 2 feet. Tanks, compressors, and reactors will be installed inside the building and will sit on individual concrete footings also embedded 2 feet below ground surface with widths between 2 and 8.5 feet. There is also one area that will be excavated down to 12 feet bgs to accommodate a drain sump.

The existing ground will be leveled to build the WTP. One side will be cut and the other filled to make a level pad with a net fill of approximately 72 cubic yards. An access road with a ditch will surround the treatment plant facility. Site access will come from historic Route 66 at the north end of the site.

4.2.2 Recommendations

Shallow foundations are recommended for support of the water treatment plant. The depth of foundation support should be down to a minimum of 2 feet bgs.

The slab and footings should be set on a minimum 6-inch thick layer of granular base leveling course. The granular material should consist of well-graded sand and gravel with a maximum particle size of 3 inches and no more than 6 percent passing the No. 200 sieve. The granular material should be placed in 6-inch lifts and compacted to 95 percent of maximum dry density per ASTM D1557.

The native soil under the granular base course should be well compacted down to a depth of 12-inches to a minimum of 95 percent of maximum dry density per ASTM D1557 to provide a firm, unyielding surface. If the native soil under the granular course cannot be compacted to a minimum of 95 percent of maximum dry density per ASTM D1557, it should be removed to a maximum depth of 1 foot and replaced with competent granular backfill compacted in 6-inch lifts.

The foundation design should be based on an evaluation of the allowable bearing capacity, settlement, and sliding coefficient of friction.

4.2.2.1 Bearing Capacity

The allowable bearing capacity was determined, using soil parameters determined based on SPT blow counts and laboratory test results, for the soil at the proposed bottom of footing elevation. Calculations were based on methods proposed by Meyerhoff (1965), Bowles (1977), and Peck et al. (1974). All three methods are based on SPT blow counts in sandy soils, and all take into account an allowable settlement. For the purpose of design, an allowable settlement of 1 inch was used in the calculations. Based on the calculations, it was determined that the subgrade at or near the bottom of the proposed footings will have an allowable bearing capacity of 2,000 psf.

4.2.2.2 Sliding Coefficient of Friction

An ultimate sliding coefficient of friction equal to 0.45 may be used for foundation design. The recommended sliding coefficient of friction was estimated for mass concrete on silty medium to coarse sand through the use of a correlation table given in NAVFAC DM 7.2-63 (1986).

4.2.2.3 Cut and Fill Slopes

Cut slopes in the native soil are recommended to be 2H:1V or flatter. The native soil was classified as medium dense to very dense in the borings. In fill areas, the native soil should be placed in 6-inch lifts and compacted to 95 percent of maximum dry density per ASTM D1557.

Excavation of the overburden can be accomplished using conventional heavy earth-moving equipment. According to the boring logs, boulders and cobbles may be encountered in the excavation for the drain sump. The contractor should be aware of this possibility and be suitably prepared. All excavations should conform to OSHA, state, and local standards. Using OSHA criteria (CCH, 2000), the overburden soil would be classified as Type B.

5.0 Construction Considerations

5.1 Trenching and Temporary Excavations

The design of all temporary excavations (either braced or sloped) and work safety should be the responsibility of the contractor. Temporary excavations should be designed in accordance with the Occupational Safety and Health Administration's (OSHA) most recent revised standard for excavations. Adequate provisions should be made to protect the slopes from raveling and sloughing during construction. The design of the excavation wall support system is the responsibility of the contractor. The contractor should develop their own means and methods, based on experience and availability of materials, for constructing the required elements. Performance of the temporary construction must conform to the requirements stated in the contract documents. The analysis of the stability of the excavation and design of appropriate sheeting or shoring may require the contractor to hire a qualified professional engineer. Existing structures near the excavations shall be monitored during the excavation to detect any movement due to the excavations.

Soil types may mandate different types/styles of bracing or excavation support. However, regardless of soil type, excavation depth and configuration drive the requirement to brace or not to brace.

If groundwater is encountered in an excavation, instability may be created as a result of upward seepage of water into the cut if the water level inside the cut is lowered below the groundwater table. The design of the dewatering systems should consider these factors. It shall be the contractor's responsibility to install an appropriate dewatering system to achieve a proper working base for the subgrade of the excavation.

Temporary excavation bracing should be designed to protect adjacent traffic, utilities, and construction personnel. Suitable factors of safety should be used in the contractor's sheeting and bracing design.

During excavation, all equipment should be stored at a distance from the edge of the excavation equal to at least the depth of the excavation, so as not to produce a surcharge load, which could affect the stability of the slope. Temporary stockpiles of excavated materials should be stored well away from any settlement-sensitive utilities and pipelines.

5.2 Pipeline Design

It is our understanding that PVC or HDPE pipe will be used in the buried pipelines. The performance of the pipe is highly dependent on the support provided by the soils around it. Flexible pipe, such as PVC, normally is designed to transmit the load of the backfill over the pipe to the soil at the sides of the pipe. As the vertical load increases on the pipe, the vertical diameter of the pipe decreases and the horizontal diameter increases due to deformation of the pipe (i.e., the pipe becomes more elliptical). The increase in horizontal diameter is resisted by the soil at the sides of the pipe. The side soil must support the load without the pipe deflecting beyond acceptable limits. Thus, adequate soil support at the sides of the pipe is essential for the structural integrity of the pipe.

Along with depth of fill, unit weight of fill, and compaction of fill, the modulus of soil reaction, E', of the soil surrounding the trench is a parameter in flexible pipe design, because it controls the lateral support provided by the soil and, therefore, the deformation of the pipe. For the soils found along the project, an E' value of 1,000 pounds per square inch (psi) is recommended for pipe design. For the purposes of design, a total unit weight of 120 pounds per cubic foot (pcf) may be used for the fill above the pipeline.

5.2.1 Pipe Zone Backfill

The pipe zone backfill material placed surrounding the pipe from 6 inches below the invert to 1 foot above the top of pipe should be composed of sand, gravel, or crushed rock, that is reasonably well graded from coarse to fine with a maximum particle size of ½-inch, and free from excessive clay, organic material, and other deleterious substances.

Pipe zone backfill should be placed and spread in layers, not to exceed 6 inches loose thickness and compacted to at least 90 percent of the maximum dry density as determined by ASTM D1557, within 2 percent of the optimum moisture content. Compaction of the pipe zone backfill should be increased to 95 percent relative compaction (RC) in areas that are sensitive to surficial settlement. The contractor should be responsible for verifying that the pipe strength is adequate to withstand the weight and energy delivered by a compactor during the pipe backfill operation.

Although unanticipated, areas where weaker soil (e.g., soft clay or loose sand) is encountered during construction of the pipeline should be overexcavated a minimum depth of 1 foot below the proposed trench bottom and replaced with granular fill in 6-inch lifts compacted to 95 percent of the maximum dry density as determined by ASTM D1557.

5.2.2 Trench Backfill

Backfill material around structures and more than 1 foot above the top of the pipe (above the pipe zone backfill) may consist of excavated onsite soil. However, all topsoil, organic material, rubbish, debris, rock, and broken concrete larger than 2 inches in diameter and other unsuitable material should be removed prior to use as backfill. Rocks greater than 6 inches in any dimension should not be permitted in backfill placed within 1 foot of pavement subgrade.

Backfill should be placed and spread in layers, not to exceed 8 inches loose thickness and compacted to at least 90 percent of the maximum dry density as determined by ASTM D1557. Moisture conditions of backfill soils shall be at or above the optimum moisture content. Increased compaction is advised where greater sensitivity to surficial settlements may exist, so long as it does not damage or cause excessive deflections of the pipe.

5.3 Roadways

It is our understanding that the roadway around the WTP will consist of graded aggregate base course. No asphalt or Portland cement concrete pavement will be laid.

5.4 Fill Placement and Compaction

Native on-site materials may be considered for use as backfill if they have an expansion index (EI) less than 50, and contain less than 8 percent fines as determined in accordance with ASTM D4829 and D422, respectively. If native materials are considered, they should be tested for verification. The granular base course material shall be imported. The geotechnical engineer should approve the imported material prior to placement.

All fill soil should be placed in thin, loose lifts; moisture-conditioned, as necessary, to near optimum moisture content; and compacted to a minimum 95 percent relative compaction beneath structures as determined by ASTM D1557.

5.5 Site Drainage

Drainage is an important key to successful performance of any foundation or pavement scheme. Good surface drainage should be established prior to construction and maintained afterward to prevent water from ponding within or adjacent to the structures, or pavement areas. During and after construction, positive drainage should be provided to direct surface water away from structures and all excavations towards suitable, non-erosive drainage devices. Final grading should slope away from structures.

5.6 Geotechnical Observation

A geotechnical engineer or a technician under the supervision of a geotechnical engineer should observe the preparations for footing subgrades and backfill. Variations in soil and geologic conditions are possible and may be encountered during construction. To permit correlation between the exploration data and the actual conditions encountered during construction, a qualified geotechnical engineer should perform onsite reviews during construction.

5.7 Review of Construction Plans and Specifications

The geotechnical recommendations in this report are based on preliminary construction plans. The geotechnical designer should review construction plans and specifications to verify that the geotechnical recommendations have been incorporated into the design. If the nature, design, or location of the proposed facilities vary from those used to develop the recommendations provided in this report, then the recommendations should be re-evaluated.

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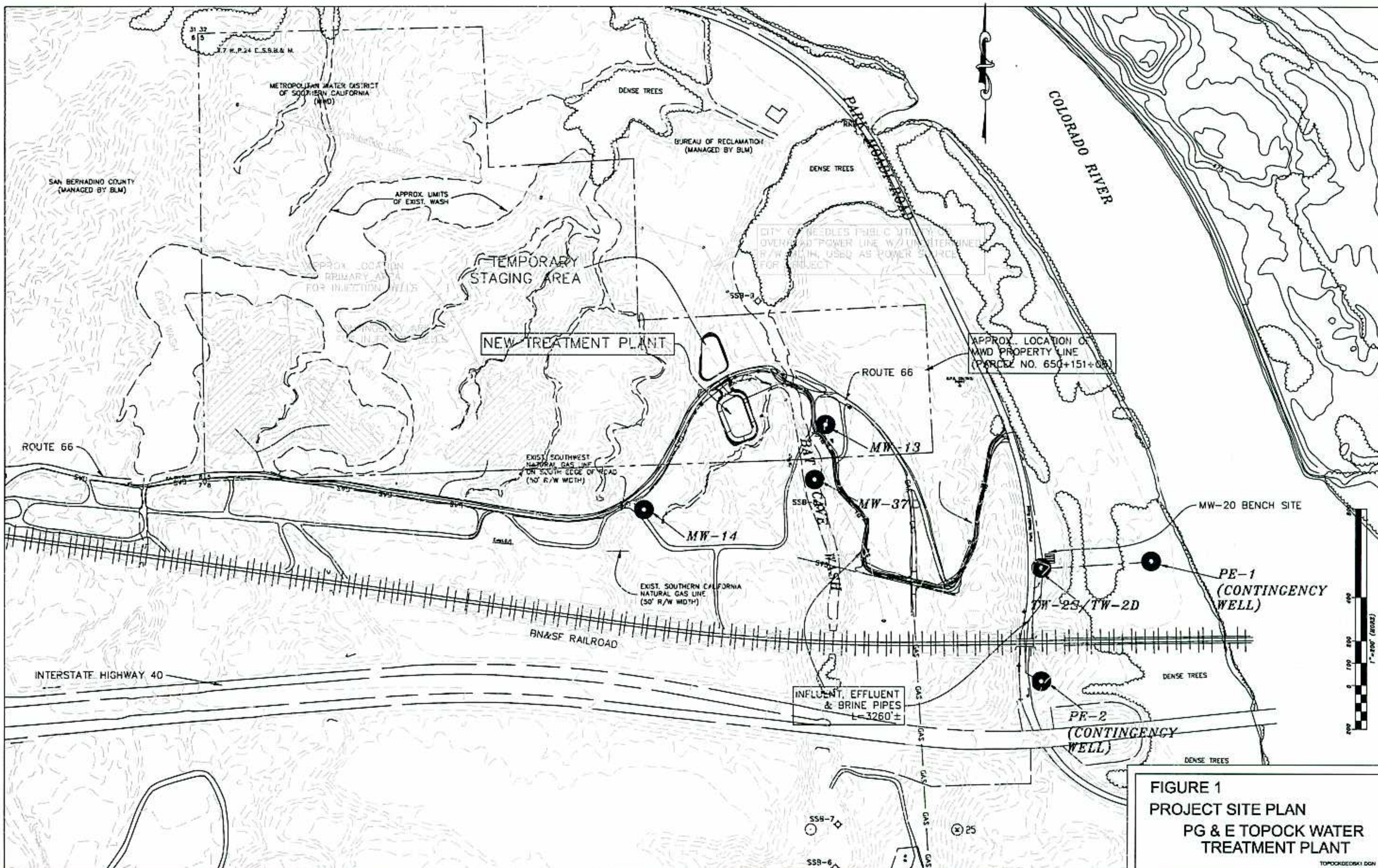


FIGURE 1
PROJECT SITE PLAN
PG & E TOPOCK WATER TREATMENT PLANT

TOPOCKDEOSKI DGN
SEPT 10, 2004

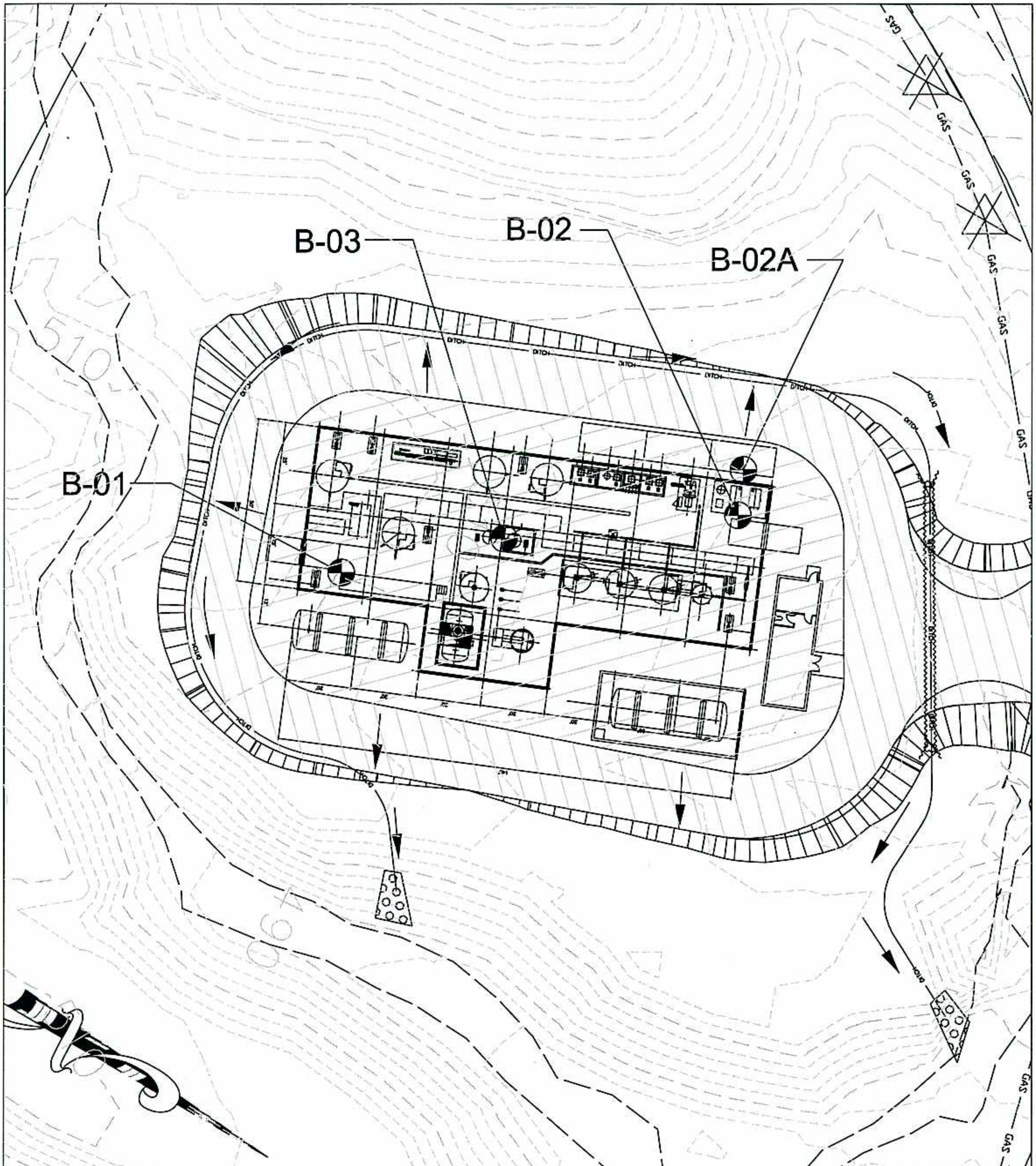
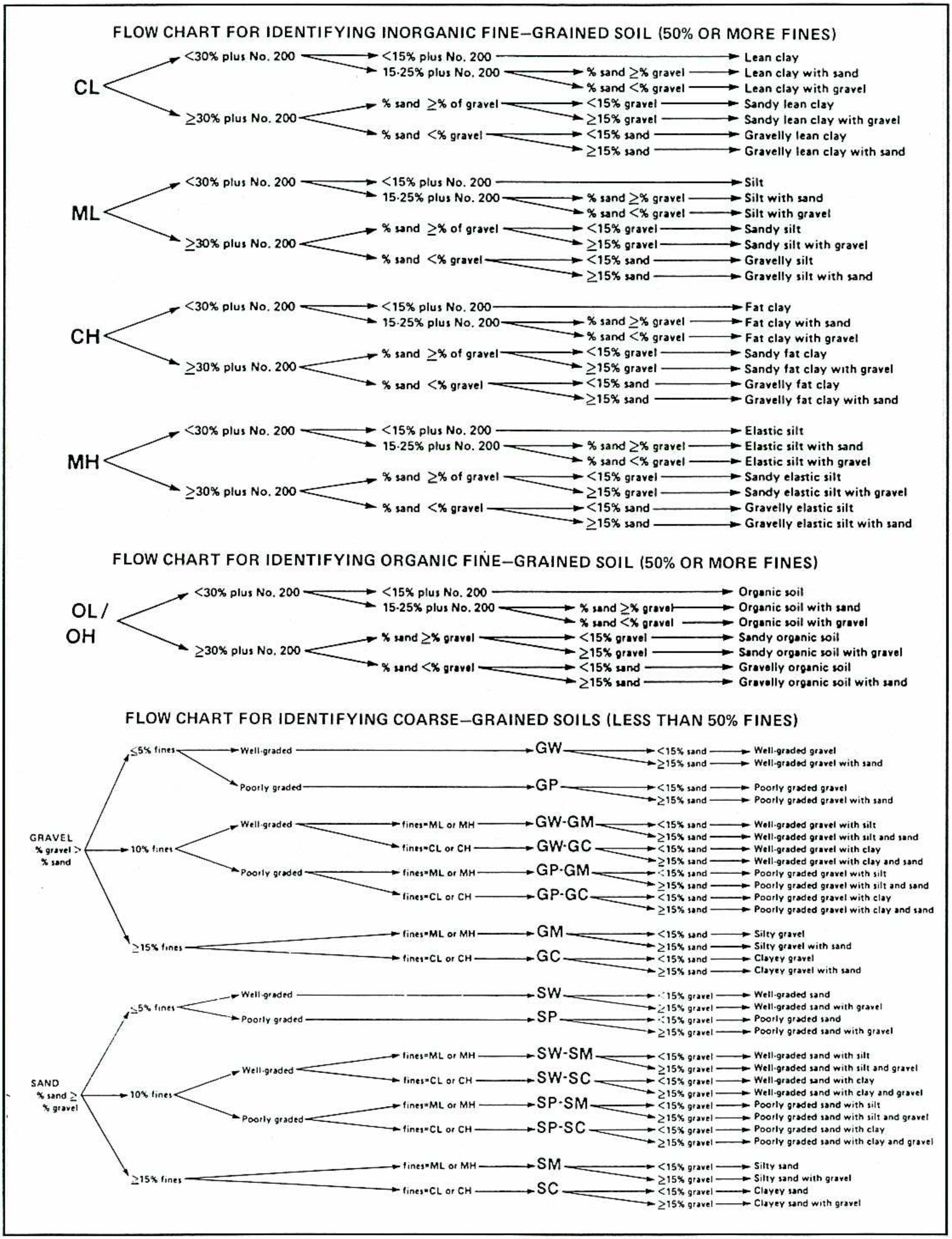


FIGURE 2
BORING LOCATIONS
PG & E TOPOCK WATER TREATMENT PLANT

TOPOCKGEOSK2.DGN
08/23/04

APPENDIX A

Soil Boring Logs



ANC10.51 SoilCla.NO
Rev 0 11/5/93

CH2M HILL

Soil Classification System Used on Logs (From ASTM D2488, Based on Unified Soil Classification System)

TERMS USED ON LOGS

Criteria for Describing Moisture Condition

Description	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp, but no visible water
Wet	Visible free water, usually soil is below water table

Relative Density of Coarse-Grained Soil

Blows/ Foot*	Description	Approximate Relative Density (%)	Field Test
0-4	Very loose	0-20	Easily penetrated with 1/2-inch steel rod pushed by hand
5-10	Loose	20-40	Easily penetrated with 1/2-inch steel rod pushed by hand
11-30	Medium	40-70	Easily penetrated with 1/2-inch steel rod driven with 5-pound hammer
31-50	Dense	70-90	Penetrated a foot with 1/2-inch steel rod driven with 5-pound hammer
50	Very Dense	90-100	Penetrated only a few inches with 1/2-inch steel rod driven with 5-pound hammer

Consistency of Fine-Grained Soil

Blows/ Foot*	Consistency	Pocket Penetrometer (TSF)	Torvane (TSF)	Field Test
<2	Very soft	<0.25	<0.12	Easily penetrated several inches by fist
2-4	Soft	0.25-0.50	<0.12-0.25	Easily penetrated several inches by thumb
5-8	Firm	0.50-1.0	0.25-0.5	Can be penetrated several inches by thumb with moderate effort
9-15	Stiff	1.0-2.0	0.5-1.0	Readily indented by thumbnail, but penetrated only with great effort
16-30	Very stiff	2.0-4.0	1.0-2.0	Readily indented by thumbnail
30	Hard	>4.0	>2.0	Indented with difficulty by thumbnail

*The number of blows on a 2-inch OD, split-spoon sampler by a 140-pound hammer falling 30 inches required to drive the sampler a distance of 1 foot from 6 to 18 inches (Standard Penetration Test, ASTM D1586). Actual sampler/hammer characteristics and actual field blow counts are noted on the boring logs.

Source: Sowers, 1979.

CH2MHILL

PROJECT NUMBER:

BORING NUMBER:

SHEET 1 OF 1

BORING LOG EXPLANATION

PROJECT : LOCATION :

ELEVATION : DRILLING CONTRACTOR :

DRILLING METHOD AND EQUIPMENT :

WATER LEVELS : START : END : LOGGER :

DEPTH BELOW GROUND SURFACE (ft)	DEPTH BELOW GROUND SURFACE (m)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION	COMMENTS
						SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
		1.0					
			1.5			Sample Interval: Top/Bottom (ft. bgs) Amount of Sample Recovered (ft)	Comments Comments and observations regarding drilling or sampling made by the driller or field personnel.
		2.5					
	1	3.5					
				S-1		Sample Type - Sample Number	Test
5		5.0				(S) Standard split-spoon drive sampler, 2.0-inch (51-mm) outside diameter, 1.4-inch (35-mm) inside diameter (without liners)	Field and Laboratory tests include the following: WC Moisture Content (ASTM D-2216)
	2					(M) Modified split-spoon drive sampler, 2.5-inch (64-mm) outside diameter, 2.0-inch (51-mm) inside diameter (with liners)	UW Dry Unit Weight (ASTM D-2937) in pounds per cubic foot (pcf) or kilonewtons per cubic meter (kN/m3)
10	3					(MC) Modified California split-spoon drive sampler, 3.0-inch (76-mm) outside diameter, 2.4-inch (64-mm) inside diameter (with liners)	SA Seive analysis (ASTM D-1140) See appropriate laboratory data sheets for gradation curve p200 Percentage of soil particles passing the No.200 sieve (ASTM D-422)
						(ST) Thin-walled Shelby tube sampler, 3.0-inch (76-mm) outside diameter, 2.9-inch (74-mm) inside diameter	HD Standard hydrometer analysis
	4					(G) Grab sample collected from drill cuttings	LL PL PI Atterberg Limits (ASTM D-4318) LL = Liquid Limit, PL = Plastic Limit, PI = Plasticity Index
15		15.0					PP Unconfined Compressive Strength in tons per square foot (tsf) or kilopascals (kPa) measured using a pocket penetrometer device
	5	16.5			3-5-6 (11)	Standard Penetration Test Results Number of blows required to advance driven sampler over three 6-inch (152-mm) increments. Number in parenthesis is the total number of blows required to advance the sampler 12-inch (305 mm) beyond the first 6-inch (152-mm) interval. Drive samplers advanced using a 140 lb (63.5 kg) Hammer with the 30-inch (762-mm) drop. The blow counts given have not been modified to account for field and/or depth conditions.	TV Unconfined Compressive Strength in tsf or kPa measured using a torvane device
20	6					General Notes 1) Soil classifications are based on the Unified Soil Classification System. Classifications and descriptions made in the field have been modified based on the results of laboratory testing.	TX-UU Unconsolidated Undrained Triaxial Shear Strength in pounds per square foot (psf) or kPa as measured in the laboratory (ASTM D-2850). Confining pressure given in parenthesis
25	7					2) Boring logs depict subsurface conditions only at the specific locations and times the boring was made. Logs do not necessarily reflect strata variations that may exist between boring locations.	TX-CU Consolidated Undrained Triaxial Shear Strength in psf or kPa as measured in the laboratory (ASTM D-4767). Confining pressure given in parenthesis
	8						CONSOL One-Dimensional Consolidation (ASTM D-2435) PERM Triaxial, Falling Head Permeability (ASTM D-5084)
30	9						OC Organic content (ASTM D-2974) CA Corrosion Analysis

CH2MHILL

PROJECT NUMBER:	BORING NUMBER:	
315994.PS.07.GE	B-01	SHEET 1 OF 2

SOIL BORING LOG

PROJECT : PG&E Topock Compressor Station, Needles, CA — LOCATION : Proposed Water Treatment Plant - Southeast Corner

ELEVATION : Approximately 508 to 510 feet mean sea level — DRILLING CONTRACTOR : Kent Groover/Klienfelder/Las Vegas, NV

DRILLING METHOD AND EQUIPMENT : Hollow Stem Auger, B-61 Mobile Truck-Mounted, 140-lbs 30-in Drop Hammer with Cathead/Rope, 6-in OD and 3 1/4-in ID Auger

WATER LEVELS : Not Encountered — START : 08/13/2004 08:20 — END : 08/13/2004 14:30 — LOGGER : P.Srinavakul

DEPTH BELOW GROUND SURFACE (ft)	DEPTH BELOW GROUND SURFACE (m)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
							Driller notes easy to drill between 0 and 3.5 ft below ground surface (bgs)
	1						Driller notes dense soils and small gravels from 3.5 ft bgs.
5		5.0					
	2	6.5	0.9	S-1	3-8-12 (20)	SILTY SAND WITH GRAVEL (SM), light brown, dry, medium dense, fine grained, with subrounded gravels (1/8 to 1 inch diameter)	WC = 1%; 29.6% gravel; 42.4% sand; 28.0% fines
		8.0	Bulk	B-2	Bulk	SILTY SAND (SM), similar to above, with approximately less than 10% gravels	CA; PI = Non Plastic
10	3	10.0					
		11.5	0.7	MC-3	45-50/1" (>50)	SILTY SAND WITH GRAVEL (SM), similar to above, very dense, fine to medium grained, with approximately 30% subangular gravels (1/8 to 2 inches diameter)	Driller notes gravelly soils and some cobbles between 11.5 and 15 ft bgs
	4						
15		15.0					
	5	16.5	1.0	S-4	21-38-50/5" (>50)	WELL-GRADED SAND WITH SILT AND GRAVEL (SW-SM), brown and gray, dry, very dense, fine to coarse grained, with subangular gravels (1/8 to 1/2 inch diameter)	WC = 1%; 34.2% gravel; 57.0% sand; 8.8% fines
20	6	20.0					
		21.5	NR	MC-5	50/1" (>50)		No Recovery. Driller notes small cobbles and rocks while driving sample MC-5
	7						
25		25.0					
	8	26.5	NR	S-6	50/1" (>50)		No Recovery. Driller notes gravels and cobbles with occasional big cobbles
	9						
30							

CH2MHILL

PROJECT NUMBER: 315994.PS.07.GE	BORING NUMBER: B-01 SHEET 2 OF 2

SOIL BORING LOG

PROJECT : PG&E Topock Compressor Station, Needles, CA

LOCATION : Proposed Water Treatment Plant - Southeast Corner

ELEVATION : Approximately 508 to 510 feet mean sea level

DRILLING CONTRACTOR : Kent Groover/Klienfelder/Las Vegas, NV

DRILLING METHOD AND EQUIPMENT : Hollow Stem Auger, B-61 Mobile Truck-Mounted, 140-lbs 30-in Drop Hammer with Cathead/Rope, 6-in OD and 3 1/4-in ID Auger

WATER LEVELS : Not Encountered

START : 08/13/2004 08:20

END : 08/13/2004 14:30

LOGGER : P.Srinavakul

DEPTH BELOW GROUND SURFACE (ft)	DEPTH BELOW GROUND SURFACE (m)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
		30.0 – 31.5	NR	S-7	50/5" (>50)		No Recovery Driller notes gravelly and rocky soils
	10						
35		34.0 – 35.0	Bulk	B-8	Bulk	SILTY SAND WITH GRAVEL (SM), brown and dark brown, moist, fine to coarse grained, with approximately 20% subangular to subrounded gravels (1/8 to 1 inch diameter), more silty than above	
	11	35.0 – 36.5	NR	S-9	50/3" (>50)		No Recovery
							Hole backfilled with drill cuttings 8/13/04 14:30
	12						
40						Bottom of Hole at 36.5 ft below ground surface 08/13/2004 10:00 Groundwater Not Encountered	
	13						
45	14						
	15						
50	16						
55	17						
	18						
60							

CH2MHILL

PROJECT NUMBER:	BORING NUMBER:	
315994.PS.07.GE	B-02	SHEET 1 OF 1

SOIL BORING LOG

PROJECT : PG&E Topock Compressor Station, Needles, CA LOCATION : Proposed Water Treatment Plant - Northwest Corner

ELEVATION : Approximately 505 to 507 feet mean sea level DRILLING CONTRACTOR : Kent Groover/Kleinfelder/Las Vegas, NV

DRILLING METHOD AND EQUIPMENT : Hollow Stem Auger, B-61 Mobile Truck-Mounted, 140-lbs 30-in Drop Hammer with Cathead/Rope, 6-in OD and 3 1/4-in ID Auger

WATER LEVELS : Not Encountered START : 08/13/2004 10:10 END : 08/13/2004 11:10 LOGGER : P.Srinavakul

DEPTH BELOW GROUND SURFACE (ft)	DEPTH BELOW GROUND SURFACE (m)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	1						
5		5.0					
	2	6.5	1.2	S-1	16-25-21 (46)	SILTY SAND WITH GRAVEL (SM), brown and gray, dry, dense, fine to medium grained, with lots of gravels at bottom 6 inches of sample, subangular and flat gravels (1/8 to 2 inches diameter)	WC = 1%; 35.6% gravel; 50.7% sand; 13.7% fines
		8.0	Bulk	B-2	Bulk	SILTY SAND WITH GRAVEL (SM), similar to above, with subangular gravels (up to 3 inches diameter)	CA; PI = Non Plastic; R-Value = 83 Driller notes big cobbles, drill chatter, between 8 and 10 ft bgs
10	3	10.0					
		11.5	NR	S-3	50/0" (>50)		No Recovery
	4						Auger refusal at 11.5 ft bgs Moved 12 ft to the west to drill B-02A Hole backfilled with drill cuttings 8/13/04 11:10
15						Bottom of Hole at 11.5 ft below ground surface (Auger Refusal) 08/13/2004 11:00 Groundwater Not Encountered	
	5						
20	6						
	7						
25	8						
30	9						

CH2MHILL

PROJECT NUMBER: 315994.PS.07.GE

BORING NUMBER: B-02A SHEET 1 OF 1

SOIL BORING LOG

PROJECT : PG&E Topock Compressor Station, Needles, CA

LOCATION : Proposed Water Treatment Plant - Northwest Corner (12 ft west of B-02)

ELEVATION : Approximately 505 to 507 feet mean sea level

DRILLING CONTRACTOR : Kent Groover/Klienfelder/Las Vegas, NV

DRILLING METHOD AND EQUIPMENT : Hollow Stem Auger, B-61 Mobile Truck-Mounted, 140-lbs 30-in Drop Hammer with Cathead/Rope, 6-in OD and 3 1/4-in ID Auger

WATER LEVELS : Not Encountered

START : 08/13/2004 11:15

END : 08/13/2004 14:40

LOGGER : P.Srinavakul

DEPTH BELOW GROUND SURFACE (ft)	DEPTH BELOW GROUND SURFACE (m)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
							Light brown, dry, fine silty sand in cuttings between 1 and 5 ft bgs
	1						
5							Becoming gravelly sand at 5 ft bgs
	2						
							Driller notes big cobbles, drill chatter, at 8 ft bgs, then, easy to drill between 9 and 10 ft bgs
10	3	10.0 11.5	1.0	S-1	22-29-34 (63)	SILTY SAND WITH GRAVEL (SM), orange-brown with gray and dark gray, dry, very dense, fine to medium grained, with subangular to angular gravels (1/8 to 2 inches diameter)	WC = 1%; 37.3% gravel; 48.5% sand; 14.2% fines
	4						
15	5						Auger refusal at 15 ft bgs Hole backfilled with drill cuttings 8/13/04 14:40
						Bottom of Hole at 15 ft below ground surface (Auger Refusal) 08/13/2004 11:30 Groundwater Not Encountered	
20	6						
	7						
25	8						
	9						
30							

CH2MHILL

PROJECT NUMBER: 315994.PS.07.GE

BORING NUMBER: B-03

SOIL BORING LOG

PROJECT : PG&E Topock Compressor Station, Needles, CA

LOCATION : Proposed Water Treatment Plant - Middle

ELEVATION : Approximately 508 to 510 feet mean sea level

DRILLING CONTRACTOR : Kent Groover/Klienfelder/Las Vegas, NV

DRILLING METHOD AND EQUIPMENT : Hollow Stem Auger, B-61 Mobile Truck-Mounted, 140-lbs 30-in Drop Hammer with Cathead/Rope, 6-in OD and 3 1/4-in ID Auger

WATER LEVELS : Not Encountered

START : 08/13/2004 11:50

END : 08/13/2004 14:00

LOGGER : P.Srinavakul

DEPTH BELOW GROUND SURFACE (ft)	DEPTH BELOW GROUND SURFACE (m)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	1						Fine silty sand, easy to drill, between 0 and 5 ft bgs
5	2	5.0–6.5	0.8	S-1	12-16-13 (29)	SILTY SAND WITH GRAVEL (SM), brown and gray, dry, medium dense, fine to coarse grained, with approximately 20% subangular to subrounded gravels (1/8 to 1 1/2 inches diameter)	Gravelly sand in cuttings between 5 and 10 ft bgs
10	3	10.0–11.5	0.9	S-2	19-27-31 (58)	SITLY SAND WITH GRAVEL (SM), similar to above, very dense	WC = 1%; 22.8% gravel; 64.0% sand; 13.2% fines
	4	11.5–13.0	Bulk	B-3	Bulk	SILTY SAND WITH GRAVEL (SM), similar to above, brown, with approximately 15% to 20% flat and subangular gravels (1/8 to 3 inches diameter)	
15	5	15.0–16.5	NR	S-4	50/0" (>50)		No Recovery Gravelly soils and large cobbles in cuttings between 16.5 and 20 ft bgs
20	6	20.0–21.5	0.3	S-5	30-50/5" (>50)	POORLY GRADED SAND WITH SILT (SP-SM), brown and light gray, dry, very dense, fine to coarse grained, with subangular and flat gravels (1/8 to 1/2 inch diameter)	WC = 4%; 13.9% gravel Driller notes gravelly soils with large cobbles between 21.5 and 25 ft bgs
25	7, 8	25.0–26.5	NR	S-6	50/0" (>50)		No Recovery
30	9						

CH2MHILL

PROJECT NUMBER: 315994.PS.07.GE	BORING NUMBER: B-03	SHEET 2 OF 2

SOIL BORING LOG

PROJECT : PG&E Topock Compressor Station, Needles, CA — LOCATION : Proposed Water Treatment Plant - Middle

ELEVATION : Approximately 508 to 510 feet mean sea level — DRILLING CONTRACTOR : Kent Groover/Klienfelder/Las Vegas, NV

DRILLING METHOD AND EQUIPMENT : Hollow Stem Auger, B-61 Mobile Truck-Mounted, 140-lbs 30-in Drop Hammer with Cathead/Rope, 6-in OD and 3 1/4-in ID Auger

WATER LEVELS : Not Encountered — START : 08/13/2004 11:50 — END : 08/13/2004 14:00 — LOGGER : P.Srinavakul

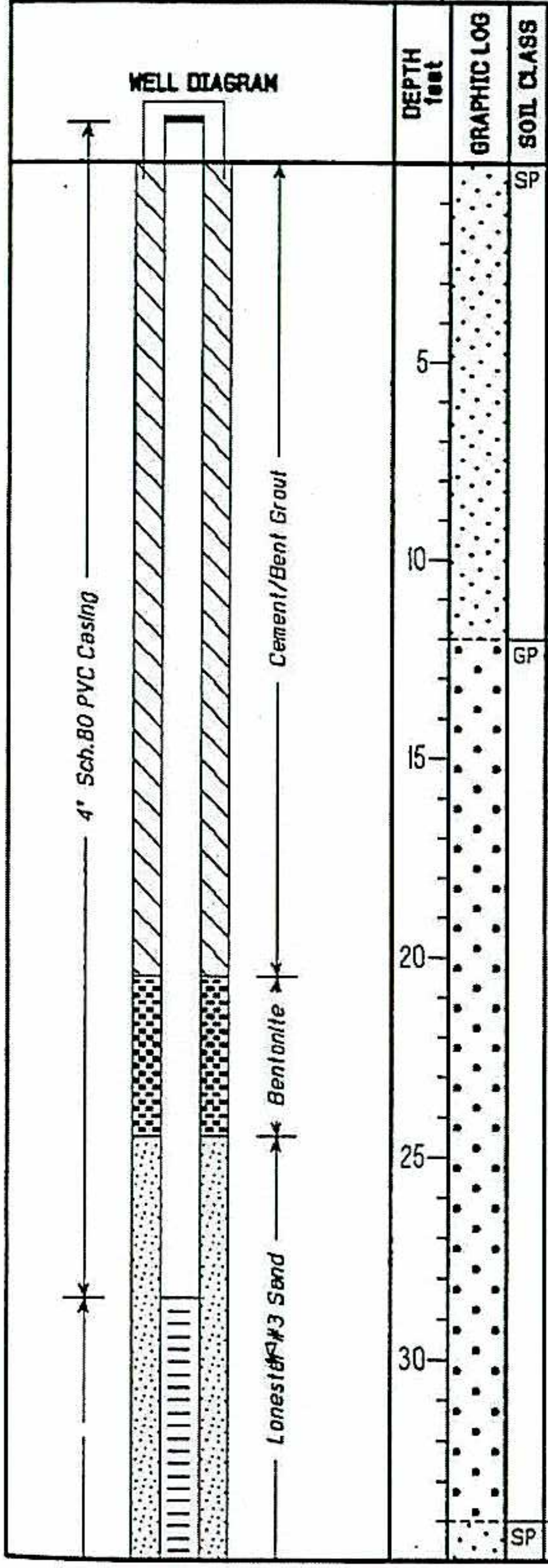
DEPTH BELOW GROUND SURFACE (ft)	DEPTH BELOW GROUND SURFACE (m)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
		30.0–31.5	NR	S-7	50/0" (>50)		No Recovery
	10						Hole backfilled with drill cuttings 8/13/04 14:00
35	11					Bottom of Hole at 31.5 ft below ground surface 08/13/2004 13:10 Groundwater Not Encountered	
40	12						
	13						
45	14						
50	15						
	16						
55	17						
60	18						

APPENDIX B

Existing Monitoring Well Logs

SEE SITE PLAN

ALISTO PROJECT NO: 10-320-08	DATE DRILLED: 07/09/97
CLIENT: Pacific Gas and Electric Co.	
LOCATION: Topock Compressor Station	
DRILLING METHOD: Resonant Sonic, Continuous Coring	
DRILLING COMPANY: Boart Longyear	CASING ELEVATION: 488.19
LOGGED BY: Ted Moise/Dan Birch	APPROVED BY: Dan Salaices



SOIL CLASS	GEOLOGIC DESCRIPTION
SP	gravelly SAND: yellowish gray; 50% sand, fine to coarse grained; 45% gravel, 4-50 mm, subangular, occasional cobbles; minor fines; dry.
	color change to light olive gray
GP	sandy GRAVEL: light gray; 60% gravel, 4-75 mm, subangular; 40% sand, fine to medium grained; dry.
	at 19 feet, 150 mm cobble.
	at 19.5 feet, color change to pale yellowish brown; 70% gravel; 30% sand, fine to medium grained. Possibly older alluvium.
	at 26.5 feet, 60% gravel, 40% sand.
	Wet at 30 feet.
SP	gravelly SAND: pale brown; 60% sand, fine to coarse grained;

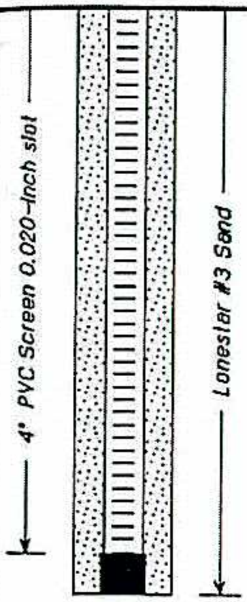
ALISTO ENGINEERING GROUP
WALNUT CREEK, CALIFORNIA

LOG OF WELL MW-13

SEE SITE PLAN

ALISTO PROJECT NO: *10-320-06*	DATE DRILLED: *07/09/97*
CLIENT: *Pacific Gas and Electric Co.*	
LOCATION: *Topock Compressor Station*	
DRILLING METHOD: *Resonant Sonic, Continuous Coring*	
DRILLING COMPANY: *Boart Longyear*	CASING ELEVATION: *488.19*
LOGGED BY: *Ted Moise/Dan Birch*	APPROVED BY: *Dan Salaices*

WELL DIAGRAM



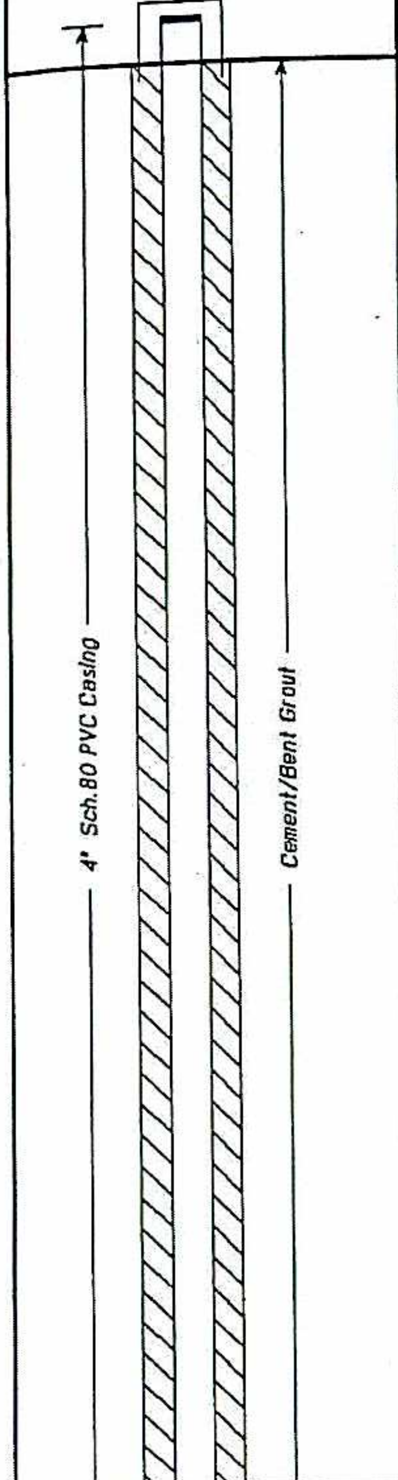
DEPTH feet	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION
		SP	35% gravel, 4-40 mm, subangular; wet.
40			At 40 feet, color change to pale red; 70% sand, fine to coarse grained; 30% gravel, 4-25 mm, subangular.
			At 43 feet, color change to light brownish gray, cobble to 100 mm.
45			
50			Total depth of borehole is 49.5 feet.
55			
60			
65			

LOG OF WELL MW-14

SEE SITE PLAN

ALISTO PROJECT NO: *10-320-06*	DATE DRILLED: *07/14-15/97*
CLIENT: *Pacific Gas and Electric Co.*	
LOCATION: *Topock Compressor Station*	
DRILLING METHOD: *Resonant Sonic, Continuous Coring*	
DRILLING COMPANY: *Boart Longyear*	CASING ELEVATION: *570.54*
LOGGED BY: *Ted Moise/Ken Simas*	APPROVED BY: *Dan Salaices*

WELL DIAGRAM



DEPTH feet	SOIL CLASS	GEOLOGIC DESCRIPTION
	GP	sandy GRAVEL: grayish orange pink; 70% gravel, 4-75 mm, rounded to subangular; 30% sand, fine to coarse grained; dry.
	SP	gravelly SAND: pale yellowish brown; 80% sand, fine to coarse grained; 20% gravel, 4-50 mm, subangular; dry.
5		
		At 8 feet, 80% sand, fine to coarse grained; 40% gravel, 4-70 mm, subangular.
10		
	GP	sandy GRAVEL: pale yellowish brown; 80% gravel, 4-35 mm; subangular; 40% sand, fine to coarse grained, dry.
15		
	SP	gravelly SAND: pale yellowish brown; 90% sand, fine to coarse grained; 10% gravel, 4-20 mm, subangular, dry.
20		At 20 feet, 55% sand, fine to coarse grained; 45% gravel, 4-50 mm.
		At 22 feet, color change to light gray; 80% sand, fine to coarse grained; 40% gravel, 4-50 mm, angular to subrounded.
25		At 25 feet, color change to light olive gray; 40% gravel, 4-25 mm, subangular.
30		At 30 feet, color change to pale yellowish brown; 75% sand, fine to coarse grained; 25% gravel, 4-80 mm, subangular; dry.

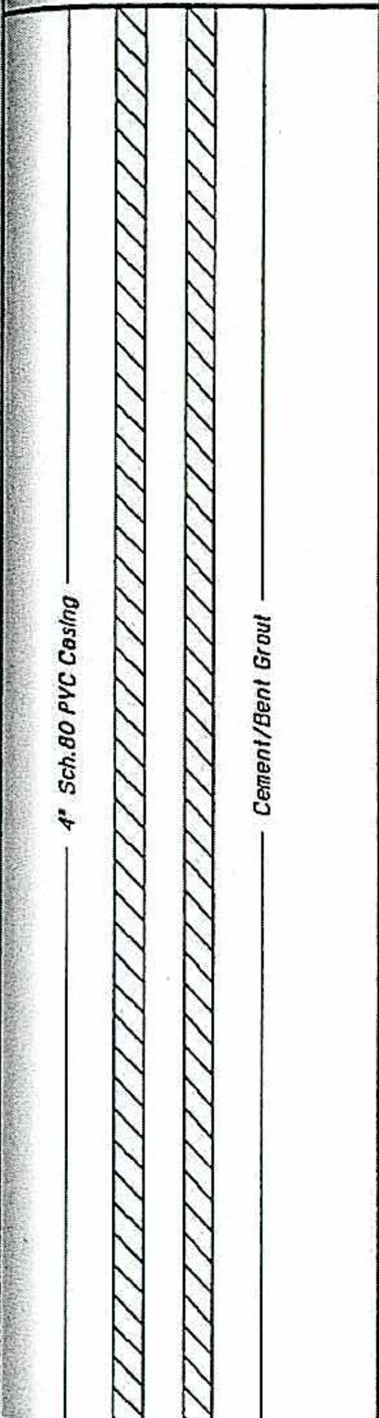
ALISTO ENGINEERING GROUP
WALNUT CREEK, CALIFORNIA

LOG OF WELL MW-14

SEE SITE PLAN

ALISTO PROJECT NO: *10-320-08*	DATE DRILLED: *07/14-15/97*
CLIENT: *Pacific Gas and Electric Co.*	
LOCATION: *Topock Compressor Station*	
DRILLING METHOD: *Resonant Sonic, Continuous Coring*	
DRILLING COMPANY: *Boart Longyear*	CASING ELEVATION: *570.54*
LOGGED BY: *Ted Moise/Ken Simas*	*APPROVED BY: Dan Salaices*

WELL DIAGRAM



DEPTH feet	SOIL CLASS	GEOLOGIC DESCRIPTION
	SP	At 36 feet, gravel, 4-40 mm, subangular.
		At 38 feet, color change to light olive gray; 60% sand, fine to coarse grained; 40% gravel, 4-75 mm, subrounded to subangular; dry.
40		
	GP SP	sandy GRAVEL/gravelly SAND: Pale yellowish brown; 50% sand, fine to coarse grained; 50% gravel, 4-75 mm, subangular to subrounded; dry.
45		
	SP	gravelly SAND: Pale yellowish brown; 70% sand, fine to coarse grained; 30% gravel, 4-75 mm, subangular.
50		At 50 feet, 60% sand, fine to coarse grained; 40% gravel, 4-85 mm, subrounded to subangular; dry.
		At 54 feet; color change to light gray, 55% sand, fine to coarse grained; 40% gravel, 4-35 mm, subangular to subrounded; 5% fines; dry.
55		
		At 57 feet, 65% sand, fine to coarse grained; 30% gravel, subangular to subrounded, 4-75 mm; 5% fines.
60		
	GP	sandy GRAVEL: light gray; 60% gravel, subangular to subrounded, 4-75 mm; 40% sand, fine to coarse grained.
65		

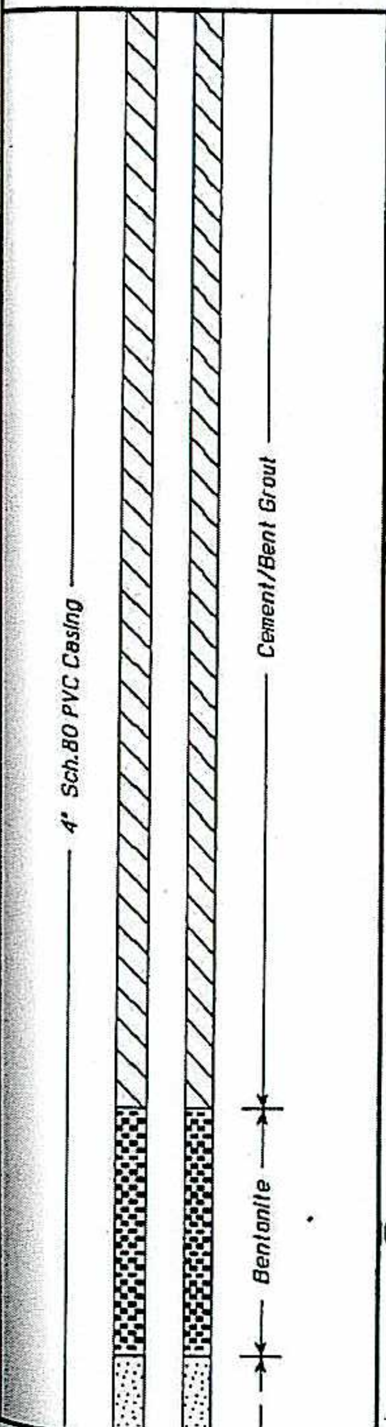
ALISTO ENGINEERING GROUP
WALNUT CREEK, CALIFORNIA

LOG OF WELL MW-14

SEE SITE PLAN

ALISTO PROJECT NO: *10-320-08*	DATE DRILLED: *07/14-15/97*
CLIENT: *Pacific Gas and Electric Co.*	
LOCATION: *Topock Compressor Station*	
DRILLING METHOD: *Resonant Sonic, Continuous Coring*	
DRILLING COMPANY: *Boart Longyear*	CASING ELEVATION: *570.54*
LOGGED BY: *Ted Moise/Ken Simas*	APPROVED BY: *Dan Salaices*

WELL DIAGRAM



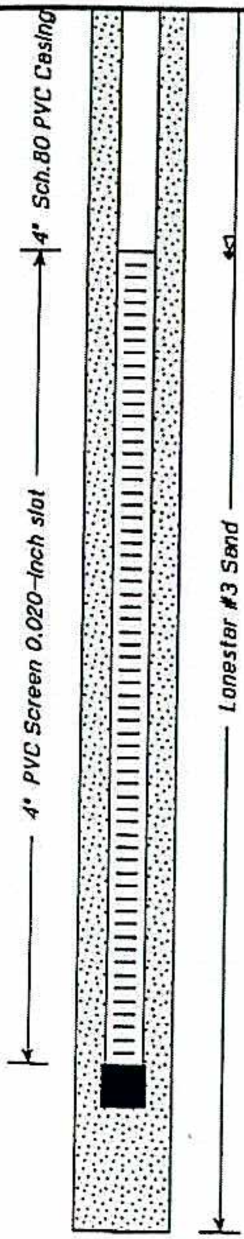
DEPTH feet	SOIL CLASS	GEOLOGIC DESCRIPTION
	GP	Same
75	SP	gravelly SAND: pale yellowish brown; 80% sand, fine to coarse grained; 40% gravel, 4-50 mm, subangular.
	GP/SP	sandy GRAVEL/gravelly SAND: light olive brown; 50% sand, fine to coarse grained; 50% gravel, 4-50 mm, subangular.
80		At 79.5 feet, 1.5 foot long boulder core, 8-inches wide. Rock flour is light gray.
85	SP	gravelly SAND: light olive gray; 80% sand, fine to coarse grained; 40% gravel, 4-50 mm, subangular.
90	GP/SP	sandy GRAVEL/gravelly SAND: light olive gray, 50% sand, fine to coarse grained; 50% gravel, 4-50 mm, subangular.
95		
100	SP	gravelly SAND: light gray; 80% sand, fine to coarse grained; 20% gravel, 4-50 mm, subangular.
	GP	sandy GRAVEL: light gray; 75% gravel, 4-50 mm, subangular to subrounded; 25% sand, fine to coarse grained, dry.
	GP/SP	

ALISTO ENGINEERING GROUP WALNUT CREEK, CALIFORNIA	LOG OF WELL MW-14	Page 4 of 4

ALISTO PROJECT NO: 10-320-08	DATE DRILLED: 07/14-15/97
CLIENT: Pacific Gas and Electric Co.	
LOCATION: Topock Compressor Station	
DRILLING METHOD: Resonant Sonic, Continuous Coring	
DRILLING COMPANY: Boart Longyear	CASING ELEVATION: 570.54
LOGGED BY: Ted Moise/Ken Simas	APPROVED BY: Dan Salaices

SEE SITE PLAN

WELL DIAGRAM



DEPTH feet	SOIL CLASS	GEOLOGIC DESCRIPTION
	GP SP	sandy GRAVEL/gravelly SAND: moderate brown; 50% gravel, 4-75 mm, subrounded to subangular; 50% sand, fine to coarse grained; damp.
	SP	gravelly SAND: light olive brown; 80% sand, fine to coarse grained; 40% gravel, subangular, 4-40 mm; moist to wet.
110	GP	sandy GRAVEL: light olive gray; 80% gravel, subangular to subrounded, 4-75 mm; 40% sand, fine to coarse grained; wet at 111 feet.
115		At 118 feet, color change to light brown; gravel 4-75 mm. At 117.5 feet, 140 mm cobble, light gray rock flour.
120	SP	gravelly SAND: pale yellowish brown; 85% sand, fine to coarse grained, 30% gravel, subangular, 4-75 mm; 5% fines; wet.
125	GP GM	sandy silty GRAVEL: pale yellowish brown; 55% gravel, subangular, 4-50 mm, occasional cobble to 80 mm; 35% sand, fine to coarse grained; 10% fines; wet.
130	SP	gravelly SAND: pale yellowish brown; 80% sand, fine to coarse grained; 35% gravel, subangular, 4-20 mm; 5% fines; wet.
	SM	gravelly silty SAND: pale yellowish brown; 80% sand, fine to coarse grained; 20% gravel, subangular, 4-30 mm; 20% fines; wet.
135	SP	gravelly SAND: light olive gray; 85% sand, fine to coarse grained; 30% gravel, subangular, 4-25 mm; 5% fines; wet.
		Total depth of the boring is 135 feet.

CH2MHILL

PROJECT NUMBER	BORING NUMBER	SHEET	OF
315024.JM.01	MW37D	1	8

SOIL BORING LOG

PROJECT PG&E Topock LOCATION Back cave wash North of I-40

ELEVATION 482 DRILLING CONTRACTOR WDC Drilling & Exploration

DRILLING METHOD AND EQUIPMENT Sonic

WATER LEVELS 30.81' BTOC 4/23/04 START 4/13/04 1400 FINISH 4/21/04 LOGGER Stacy Cooper

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION	Corebox
					0-8' Lost in setting conductor pipe.		
5							
						1500 - Drillers lost 8'-13' Dropped. Drilling is soft	
10	8-18		5'/10'				
		1		13-14 GW-GC	Well Graded Sandy Gravel (GW-GC) Dark Gray (2.5Y 4/1), wet, high dry strength, no plasticity. 50% well-graded, angular to subangular gravel, 40% well-graded sand, subangular, 10% Fines. Becomes finer @16'.		
15						MW37D-15' (Cr6)	1
				SC	Gravelly Sand w/ Clay (SC) (2.5Y 5/2) Grayish brown, Dry, Low Dry Strength 30% Gravel, well graded, subangular, 50% well-graded sand, subangular, 20% Fines no plasticity	1600	2
20	18-28		20'/20'		slightly moist layer @ 18 to 19' then the same as above.		3
		2		GW	22-23' well-graded Gravel with Sand (GW) Dry, Gray (2.5Y 5/1), 70% Gravel, Cobbles 3", course to fine, subrounded to subangular. 25% Sand, angular to subangular, course to medium, quartz, gneiss, feldspar, 5% Fines-clay.		4
25				SC	23-25 Gravelly Sand with Clay (SC) (2.5Y 4/1) Dark Gray, moist, high dry strength, 30% Gravel, subangular, well-graded, course to fine. 50% sand well graded, subangular, 20% fines clay	26-28 - Becomes more sandy, Besides that, same as above	5

REV 9/96 FORM D1586

CH2MHILL

PROJECT NUMBER 315024.JM.01 | BORING NUMBER MW-37D | SHEET 2 OF 8

SOIL BORING LOG

PROJECT PG&E Topock LOCATION Bat Cave Wash North of I-40
ELEVATION 482 DRILLING CONTRACTOR WDC Drilling & Exploration
DRILLING METHOD AND EQUIPMENT Sonic
WATER LEVELS START 4/13/04 1400 FINISH 4/21/04 LOGGER S. Cooper

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
30						
		2	20'/20'	SC	Sandy Clay w/Gravel (SC) Dark Grayish Brown (10YR 4/2) 20% well-graded gravel, subrounded, moist Medium plasticity, high dry strength, 40% well graded, subangular sand, 40% clay fines.	6
35						7
40		3	10'/10'	SC		8
45					Clayey Sand w/Gravel (SC) Dark Gray (10YR 4/1), moist, high dry strength, Low plasticity. 30% round + subround, well-graded gravel, medium plasticity, 40% sand, 30% well-graded to round subround clay fines.	9
						10
50		4	10'/10'	SC	Sandy Clay with Gravel (SC) Dark Grayish Brown (10YR (4/2)), moist, high dry strength, medium plasticity. 30% well-graded gravel, subangular, 30% sand, well graded, subround to subangular, 40% clay fines. Gravelly Sand with clay (SC) Color Change @ 55' 7.5YR (4/3) Brown more sand, 40% angular gravel-well-graded 45% subangular to subround well-graded course to medium sand, 15% fines.	MW-37D-50 Grout 0814 11
55					Becomes a little less consolidated @ 60'	MW-37D-55 Grout 0816 12
		5		0737 4/14/04		

CH2MHILL

PROJECT NUMBER	BORING NUMBER	
315024.JM.01	MW-37D	SHEET 3 OF 8

SOIL BORING LOG

PROJECT: PG&E Topock LOCATION: Bat Cave Wash North of I-40

ELEVATION: 482 DRILLING CONTRACTOR: WDC Drilling

DRILLING METHOD AND EQUIPMENT: Sonic

WATER LEVELS: ______ START: 4/13/04 FINISH: 4/21/04 LOGGER: S. Cooper

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION	Core Box
60					a little less sandy, more clay to 62'	0845 Drilling is Hard MW-37D-60 Cr6+ 0930	13
		5	10'/10'				
					Becomes more Gravelly, unconsolidated		14
65				GW-GC	well-graded Sandy Gravel (GW-GC) Dark Brown (10YR 3/3) - moist, 60% well-graded, angular, subangular, Gneiss, quartz, feldspar, 30% angular, subangular Sand, 10% Fines, no plasticity	MW-37D-65 Cr6+ 0935	
				SC	Same as 48'-60' Clayey Sand w/Gravel, moist. High dry strength.		15
70			10'/10'		70-72 Slightly more clay, less Gravel. Still very sandy	MW-37D-70 Cr6+ 1030	
		6		GC	Sandy Gravel w/Clay (GC) (2.5Y 6/3) Light Yellowish Brown, Dry, Unconsolidated, medium plasticity 50% Gravel, cobbles to 3", Gneiss mostly, subangular, well-graded, 20% subangular well graded, coarse to medium Sand. Fdsp, quartz, gneiss, 20% clay fines.		16
75		1300				MW-37D-75 Cr6+ 1035	17
			1300				
				CL	Sandy Lean Clay with Gravel (CL) (2.5Y 4/3) Olive Brown, Moist, high plasticity High dry strength, 15% Subround, fine, to medium, well graded Gravel. 30% Sand, subround, well graded. 55% clay fines.		18
80			15'/15'			MW-37D-80 1405 Cr6+	
		7		GC	Sandy Gravel w/Clay (GC) (2.5Y 4/3) Olive Brown, Dry to moist, 50% subangular to subround gravel, well-graded - metamorphics, 30% well graded Sand, subangular to subround. 20% clay fines. Low plasticity. Unconsolidated low dry strength.		19
		1345					
85						MW-37D-85 1410 Cr6+	
							20
				SC	See next page		21

CH2MHILL

PROJECT NUMBER 315024.IM.01 | BORING NUMBER MW37D | SHEET 4 OF 8

SOIL BORING LOG

PROJECT PG & E Topock LOCATION Bat Cave wash

ELEVATION 482 DRILLING CONTRACTOR WDC Drilling & Exploration

DRILLING METHOD AND EQUIPMENT Sonic

WATER LEVELS ______ START 4/13/04 FINISH 4/21/04 LOGGER S. Cooper

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
90				SC	Clayey Sand w/Gravel (SC) (10YR 4/3) Brown, moist, medium dry strength 25% subangular to subround well graded Gravel. 40% well-graded medium to fine sand, subangular to sub round. 35% clay fines. Becomes a little sandier @ 93'. Also becomes wet.	MW-37D-90 1415
95			15'/15'	CL	Lean clay w/ Sand (CL) (2.5Y 4(5/2)) Grayish Brown, wet, medium plasticity low dry strength... mush. 10% gravel, well graded, to 1", subangular, MM, 20% course to medium sand. 70% clay fines. Becomes more sandy & gravelly with depth.	MW-37D-95 (crat) 1630 MM=metamorphic
100		(8) 1500				MW-37D-100 1635 crat
105				SC	Gravelly Sand w/Clay (SC) (7.5YR 4/2) Brown, has some reddish mottles & clasts. 40% fine gravel, subangular to angular, 40% course to medium sand, well-graded, subangular Quartz, Gneiss, green minerals. 20% fines + clayey. Gravel & sands has thin interlayers of clay.	Hard Drilling MW-37D-105 1640 crat
110		(9) 0800 4/15/04	10'/15'	SC	Gravelly Sand w/Clay (SC) Dark Grayish Brown (10YR 4/2), moist, 40% well-graded angular gravel, metamorphic, gneiss, 40% well-graded angular to subangular sand. Same mineralogy as above. 20% clay fines. Gravel to 2". Unconsolidated at top of run.	MW-37D-110 0845 crat
115					116-118' - more gravelly than @ top - a little more reddish in color, multicolored mineralogy with some red staining. Still moist, but a little drier.	MW-37D-115 0850 crat

Right margin (core run numbers): 21, 22, 23, 24, 25, 26, 27, 28, 29

CH2MHILL

PROJECT NUMBER	BORING NUMBER	SHEET	OF
315024.IM.01	MW37D	5	8

SOIL BORING LOG

PROJECT: P G&E Topock LOCATION: Bat Cave wash
ELEVATION: 482 DRILLING CONTRACTOR: WDC Drilling & Exploration
DRILLING METHOD AND EQUIPMENT: Sonic
WATER LEVELS: START: 4/13/04 FINISH: 4/21/04 LOGGER: S. Cooper

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION	core box
120					Clayey Sand w/Gravel (SC) Brown (10YR 4/3), wet, medium plasticity 20% angular to subangular gravel, to 3" well-graded, 60% well-graded, subangular sand, quartz, mm gneiss, green MM mineral, 20% clay fines,	MW-37D-120 1145 crvt	29
			20'/20'	SC			30
125					126'-128' - Same, but wetter.	MW-37D-125 1145 crvt	
		(10) 1200 4/20/04			Same as above to 136'		31
130						MW-37D-130 1150 crvt	32
135						MW-37D-135 1155 crvt	33
				SC	Gravelly Sand w/clay (SC) (10YR 4/3) Brown, moist, low plasticity 25% well-graded, subangular gravel to 2", 60% sand, subangular, same mineralogy as above, 15% clay fines.		
140		(11) 1500	20'/20'	SW-SC	Gravelly Sand w/clay (SW-SC) Brown (10YR 4/3), wet, low plasticity, 40% well-graded, subangular gravel, 50% well-graded, angular to subangular sand, 10% clay fines.	Some heaving gravels @ 138' gneiss, green MM mineral, feldspar quartz MW-37D-140 crvt 1445	34
					Becomes more clayey w/depth		35
145				CL	Sandy Lean Clay (CL) Brown (10YR 5/3), wet, medium plasticity, 10% well-graded, subangular gravel, 40% well-graded, subangular sand, 50% clay fines.	MW-37-145 crvt 1450	36

CH2MHILL

PROJECT NUMBER: 315024.IM.01
BORING NUMBER: MW 37D
SHEET 6 OF 8

SOIL BORING LOG

PROJECT: PG&E Topock
LOCATION: Bat Cave Wash
ELEVATION: 482
DRILLING CONTRACTOR: WDC Drilling & Exploration
DRILLING METHOD AND EQUIPMENT: Sonic
WATER LEVELS:
START: 4/13/04
FINISH: 4/21/04
LOGGER: S. Cooper

150

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION	Core Box
150		(11) 1500	20'/20'	SC	Clayey Sand w/Gravel (SC) (10YR 4/2) Dark Grayish Brown, wet, medium plasticity, 10% well-graded subangular gravel, 60% well-graded subangular sand, 30% clay fines. 150-156' - slightly drier - moist not wet	MW-37D-150 1455 crct	37
155						wet ↑ MW-37D-155 1500	
				GC	Sandy Gravel w/Clay (GC) Dark Grayish Brown (10YR 4/2), moist, Low plasticity, some reddish areas, 40% well-graded gravel, subangular, 40% well-graded angular to subangular sand, 20% clay fines. Reddish staining, multi-colored gravels, more consolidated than above.	Drilling got harder here Gravel, → Reworked red Fanglomerate	38
				CL			
160					Gravelly Lean Clay w/Sand (CL) (10YR 4/2) Dark Grayish Brown, moist, medium plasticity 30% well-graded, subangular gravel, green mineralogy, 20% well-graded, subangular sand, 50% clay fines.	MW-37D-160 1630 Fairly Hard drilling	39
165		(12) 1630	20'/20'			MW-37D-165 1635 crct	40
				SC	Gravelly Sand w/clay (SC) (10YR 4/2) Dark Grayish Brown, wet, medium plasticity 25% well-graded, angular to subangular, gravel, 50% well-graded, subangular sand - qtz, amphiboles, gneiss, 25% clay fines.		41
170					more clay w/depth to 174'	MW-37D-170 crct 1640	42
175						MW-37D-175 - crct 1645	
				GC	Sandy Gravel w/Clay (GC) (10YR 4/3) Dark Grayish Brown, moist to dry, medium plasticity, 50% well-graded, subangular gravel, 30% well-graded, subangular sand, same mineralogy as above, 20% clay fines.		43
							44

CH2MHILL

D,P

SOIL BORING LOG

PROJECT PG&E Topock LOCATION Bat Cave Wash
ELEVATION 482 DRILLING CONTRACTOR WDC Drilling & Exploration
DRILLING METHOD AND EQUIPMENT Sonic
WATER LEVELS ______ START 4/13/04 FINISH 4/21/04 LOGGER S.Cooper

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION	
180				SC	Clayey Sand w/ Gravel (SC) (7.5YR 4/3) Brown, moist, medium plasticity, 30% well-graded, subangular gravel, gneiss, 40% subangular, well-graded sand, quartz, gneiss, amphiboles, 30% clay fines. Reddish stains, matrix supported.	gravels to 3"	44
							45
185		(13) 1830	20'/20'				46
190					190-194 - more wet than above, slightly more sand & gravel than above, but the same otherwise.		47
195					194-198' back to moist but same as 190 to 194' otherwise. (not quite as wet) Brown, but reddish tone throughout this run.		48
200		(14) 1245	20'/20' 4/21/04	SC	Gravelly Sand w/ Clay (SC) (7.5YR 4/4) Brown, moist, low plasticity 25% well-graded, subangular to angular gravel, 60% well graded course to fine, subangular to angular sand, 15% clay fines. matrix supported. High dry strength	MW-37D-200' 1300 cr&t Fractures obliquely re-worked red fanglomerate	
205					204-208' Becomes more gravelly w/ depth. Cobbles to 3", still mostly sand.	MW-37D-205 cr&t 1305	
					208-214 - Less gravel again - as above.		

REV 9/96 FORM D1586

CH2MHILL

PROJECT NUMBER	BORING NUMBER	SHEET	OF
315024.IM.01	MW37D	8	8

SOIL BORING LOG

PROJECT: PG&E Topock LOCATION: Bat Cave Wash

ELEVATION: 482 DRILLING CONTRACTOR: WDC Drilling & Exploration

DRILLING METHOD AND EQUIPMENT: Sonic

WATER LEVELS: START: 4/13/04 FINISH: 4/21/04 LOGGER:

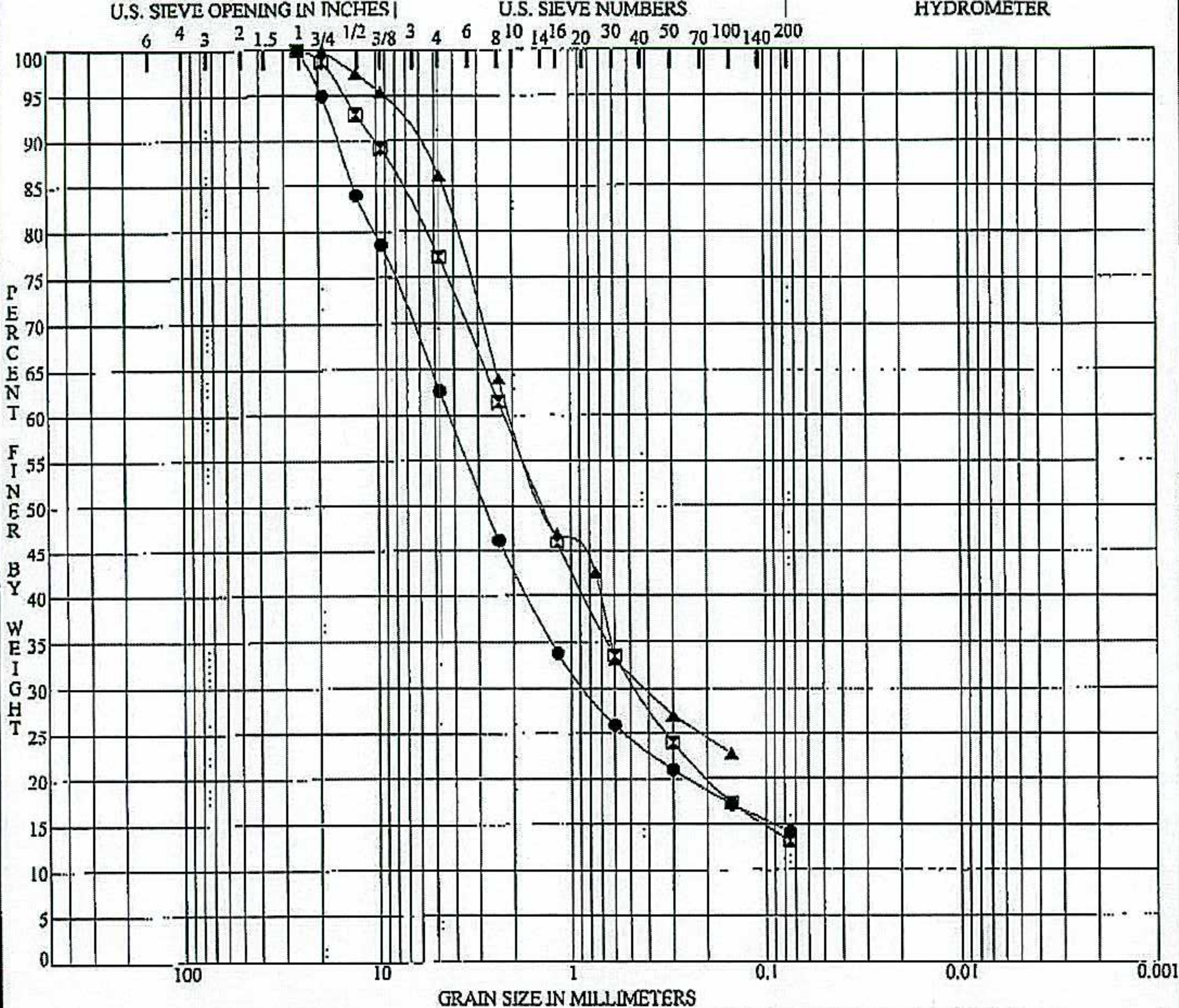
DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE NUMBER AND TYPE	SAMPLE RECOVERY (FT)	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
210						MW-37D-210 1310 crgt
		(14) 1245	20'/20'	SC		Still Fractures obliquely
215					214-218' more consolidated here - harder, still moist, high dry strength. More gravelly (30%). Whole run is Brown, but reddish tone.	MW-37D-215 1315 crgt
220				SC	Gravelly sand w/clay (SC) Brown (7.5 YR 4/3), moist, low plasticity Same as @ 198'. Looser than 214-218'. Gravels to 2".	
		(15) 1600	10'/10'		At 222', some bright red, brick red material color is (5YR 4/4) reddish Brown. Material is same as above just redder in color.	
225					226-228' A little more consolidated. otherwise, as above.	226.' Digital photo of oblique Fracture in Red fanglomerate, photo #4. & #5.
					EOB	
					TD=228'	
230						
235						

APPENDIX C

Laboratory Test Results

Moisture Test Results

Exploration Number	Sample Depth (ft.)	Moisture Content (%)
B-1	5	1%
B-1	15	1%
B-3	20	4%
B-2	5	1%
B-3	10	1%
B-2A	10	1%



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Exploration No.	Depth(ft)	Classification	LL	PL	PI	Cc	Cu
●	B-2a	10.0	0					
⊠	B-3	10.0	0					
▲	B-3	20.0	0					

	Exploration No.	Depth(ft)	D100 (mm)	D60 (mm)	D30 (mm)	D10 (mm)	%Gravel	%Sand	%Silt	%Clay
●	B-2a	10.0	25.40	4.24	0.852		37.3	48.5	14.2	
⊠	B-3	10.0	25.40	2.21	0.466		22.8	64.0	13.2	
▲	B-3	20.0	19.00	2.01	0.422		13.9			

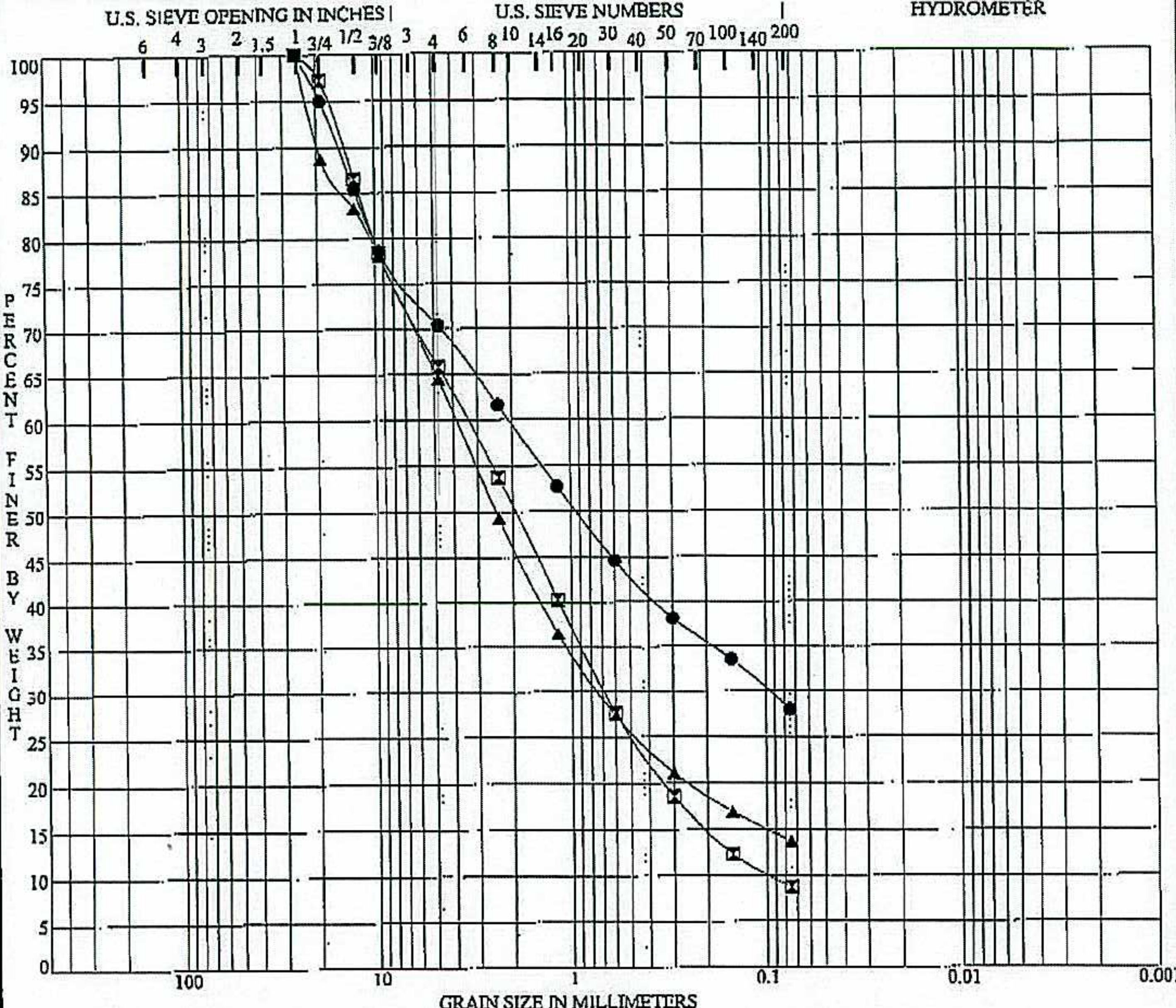
KLEINFELDER
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS
SOILS AND MATERIALS TESTING

PROJECT NO. 48294

PROJECT: Needles Improvements

GRAIN SIZE ANALYSES

PLATE
B-2



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Exploration No.	Depth(ft)	Classification	LL	PL	PI	Cc	Cu
●	B-1	5.0	0					
⊠	B-1	15.0	0				1.44	35.5
▲	B-2	5.0	0					

	Exploration No.	Depth(ft)	D100 (mm)	D60 (mm)	D30 (mm)	D10 (mm)	%Gravel	%Sand	%Silt	%Clay
●	B-1	5.0	25.40	2.08	0.096		29.6	42.4	28.0	
⊠	B-1	15.0	25.40	3.39	0.682	0.0953	34.2	57.0	8.8	
▲	B-2	5.0	25.40	3.87	0.732		35.6	50.7	13.7	

KLEINFELDER
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS
SOILS AND MATERIALS TESTING

PROJECT NO. 48294

PROJECT: Needles Improvements

GRAIN SIZE ANALYSES

PLATE

B-1

Atlas Consultants, Inc.

6000 S. Eastern Avenue, Suite 10J • Las Vegas, Nevada 89119
(702) 383-1199 • Fax (702) 383-4983

member of
AMERICAN SOCIETY FOR TESTING MATERIALS

LABORATORY NO: 12541(c)
SAMPLE: Soil
MARKED: 48294
SUBMITTED BY: Kleinfelder, Inc.

DATE: August 19, 2004
P.O.:
LAB ID: 27468
SOIL SIEVE = -10

REPORT OF DETERMINATION

BORING NUMBER	B-01	B-02				
SAMPLE NO.	27468-B2A	27468-B2B				
DEPTH (feet)	6.5-8.0	6.5-8.0				
pH VALUE	8.63	8.67				
RED-OX (mv)	+646	+668				
SULFATE (mg/Kg)	2,888	3,988				
SULFIDE (mg/Kg)	Nil	Nil				
TOTAL SALTS (mg/Kg)	7,890	6,574				
CHLORIDE (mg/Kg)	1,025	350				
RESISTIVITY (Ohm-cm)	370	725				

Respectfully submitted,

Robert L. Summers
Analytical Chemist

NOTES:

1. The soil:water extract ratio was 1:5, the results are in mg/Kg in the soil.
2. The standard methods used for the determinations are AWWA 4500 H pH Value, ASTM D 1498 Red-Ox, AWWA 4500-SO_4 E Turbidimetric, AWWA 4500-S D Methylene Blue, AWWA 2510 Electrical Conductivity. AWWA 4500-Cl B Argentometric and ASTM G 57.
3. Nil is less than 1.0 mg/Kg.

Job # => 48294
Project => PG & E TOPOCK
Client => CH2M HILL
Phase =>
Sample Location => Boring B-02, Sample B-2 @ 6.5 - 8.0

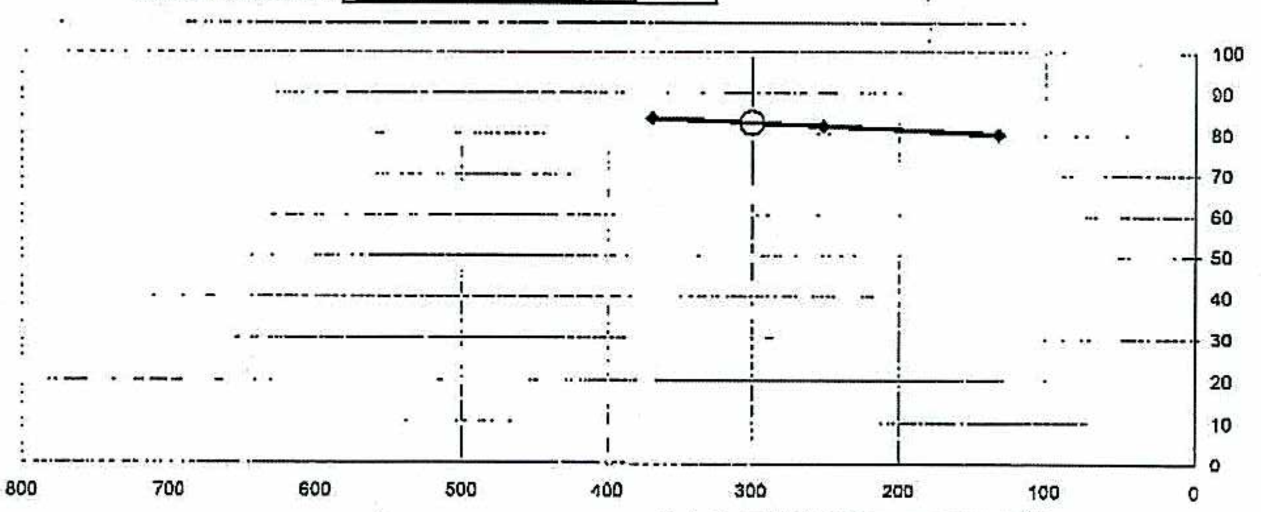
Lab Number => 27468
Date Sampled =>
Date Received => 23-Aug-04
Sampled By => Client
Tested By => J Wallis
Reviewed By => W Henshaw

Mold Label:	A	B	C
Moisture Content:	4.2%	5.0%	4.6%
Weight of Material used,gms:	1200.0	1200.0	1200.0
Water Added,gms:	50.0	60.0	55.0
Height of Specimen:	2.40	2.40	2.50
Weight of Specimen & mold:	3241.4	3293.8	3265.7
Weight of Mold,gms:	2098.4	2126.7	2110.3
Specimen Weight,gms:	1143	1167.1	1155.4
Exudation Pressure,lbs:	4636	1670	3150
Exudation Load Psi.:	369	133	251
Expansion Dial Reading:	0.0001	-0.0005	-0.0003
Stabilometer Reading @ 1000			
Stabilometer Reading @ 2000	16	27	21
Turns of Displacement:	4.05	2.94	3.63
Un-Corrected R-Value:	85	81	82
Correction from Chart:	-1	-1	
Corrected R-Value:	84	80	82
R-Value @ 300 psi. Exudation:			83
Dry Density PCF.:	138.6	140.5	134.0

Initial Moisture

Pan Number:	
Wet Wt of Sample + Pan:	2.0
Dry Wt of Sample + Pan:	2.0
Weight of Water:	
Weight of Pan:	1.0
Dry Weight of Sample:	1.0
Moisture content:	

Remarks and observations



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member of
AMERICAN SOCIETY FOR TESTING MATERIALS

ACT LAB NO: 12594(e) **DATE:** September 13, 2004

PROJECT NO: 48294 **P.O.:**

ANALYZED BY: Robert L. Summers **LAB ID:** 26468

WATER SOLUBLE SALT ANALYSIS IN SOIL

1:5 (soil:water) Aqueous Extraction
AWWA 3500-Na D, AWWA 4500 E
AWWA 2540 C

SOIL SIEVE SIZE = -10 MESH

Sample No.	Location	Depth (feet)	Sodium (Percent)	Water Soluble Sulfate (SO_4) (Percent)	Total Available Water Soluble Sodium Sulfate (Na_2SO_4) (Percent)
	B-01-B-2	6.5-8.0	0.07	0.20	0.21
Solubility = 0.79%					
	B-03-S-1	5.0-6.5	0.04	0.03	0.04
Solubility = 0.33%					

Robert L. Summers

LABORATORY MANAGER

Notes: The results for each constituent denote the percentage of that analyte, at a 1:5 (soil:water) extraction ratio, which is present in the soil. Sodium was determined by flame photometry, sulfate turbidimetrically, and sodium sulfate by calculation.

Geotechnical Investigation, Topock AOC 4 Remediation – Pre-Work Plan Data Collection Activities, PG&E Compressor Station, Needles, California (CH2M HILL 2009)

Geotechnical Investigation, Topock AOC 4 Remediation – Pre-Work Plan Data Collection Activities, PG&E Compressor Station, Needles, California

PREPARED FOR:	Pacific Gas & Electric Company
PROJECT NO:	382653.FP.03.01
SUBMITTED BY:	CH2M HILL
PREPARED BY	Karthik Radhakrishnan, PE
REVIEWED BY:	Mike Cavaliere, PG Curt Basnett, GE
DATE:	October 9, 2009

REGISTERED PROFESSIONAL ENGINEER KARTHIKEYAN RADHAKRISHNAN C 73454 EXP. 12/21/09 CIVIL STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER CURTIS R. BASNETT No. GE002593 Exp. 12-31-09 GEOTECHNICAL STATE OF CALIFORNIA

Summary

This memorandum presents a summary of the geotechnical investigation conducted for the PG&E's Topock Compressor Station AOC 4 Pre-Work Plan data collection activities, including the field logs and laboratory test results. The purpose of this memorandum is to summarize the field investigation program, laboratory tests performed to evaluate the strength parameters of the subsurface materials, and present the findings from the stability analyses performed to assist with the planning of construction activities. This memorandum includes descriptions of the field investigation program and laboratory tests performed on collected samples including strength characteristics of the subsurface soils.

Four geotechnical borings were drilled in the areas on top of the ravine slopes in the AOC4 area. The scope of the geotechnical investigation did not include evaluation of fill along the slope face and at the bottom of the slope. The four borings were drilled until the augers refused on possible rock or other obstructions. Soil samples were obtained from the borings and tested for index properties, strength, and compaction characteristics. Profiles were developed based on the subsurface data and laboratory results. Slope stability analyses were also performed to evaluate the maximum slope ratio that can be maintained during construction activities, based on the estimated material strengths of the subsurface materials encountered.

Based on the subsurface exploration conducted, all the borings indicated fill material to depths of 5 feet below the existing ground surface. Based on results of the slope stability analyses, a 35 foot tall cut-slope with a 1 Horizontal (H): 1 Vertical (V) slope ratio is expected to be globally stable during construction and remediation activities. A factor of safety (FOS) for slope failure of over 1.2 was computed for this condition considering a surcharge of about 500 pounds per square foot (psf) on top of the slope. A factor of safety of 1.1 or greater is normally considered adequate for temporary slopes during construction activities.

Field Explorations

To characterize the subsurface conditions at the project site, a geotechnical field exploration was conducted at the truck-accessible locations in a nearly level area within the primary debris area of AOC4. The geotechnical field investigation included drilling four hollow stem auger (HSA) soil borings. Figure 1 shows the boring locations relative to the existing ravine, slopes, and the AOC4 area at the plant site. The figure also shows the existing grading at 1-foot contour intervals. Table 1 summarizes the field exploration.

Table 1 Summary of Field Exploration

Exploration Number	Approximate Location (NAD 83 Lat. /Lon.)	Approximate Ground Surface Elevation (feet)	Type of Boring	Depth to Auger Refusal (feet)	Groundwater Depth (feet)
AOC4-GEO1	34°42’47” N; 114°29’37” W	611.0	HSA	38.5	NE
AOC4-GEO2	34°42’47” N; 114°29’38” W	611.0	HSA	56	NE
AOC4-GEO3	34°42’46” N; 114°29’37” W	612.0	HSA	26	NE
AOC4-GEO4	34°42’46” N; 114°29’36” W	612.0	HSA	8.5	NE

NE – Not Encountered
NAD – North American Datum
Lat. – Latitude
Lon. – Longitude

Cascade Drilling, Inc., of La Habra, California, was contracted by CH2M HILL to drill the soil borings using a truck-mounted CME 85 drill rig equipped with an 8-inch-diameter HSA. The soil borings, B-1 and B-2, were drilled and sampled to the depth of 38.5 and 56 feet below ground surface (bgs), and borings B-3 and B-4 were drilled and sampled to the depth of 26 and 8.5 feet bgs. The borings were drilled until augers refused to advance either due to potential top of hard bedrock or due to hard cobbles. Groundwater was not encountered in the borings during drilling. A CH2M HILL geotechnical specialist specified the locations, depths, and sampling intervals of the borings, logged materials encountered, and observed the drilling and sampling operations.

Hand augering was performed for the first 5 feet in each of the boring to avoid possible underground utilities. Soil samples were collected at 5-foot intervals using the standard penetration test (SPT) and modified California ring (ring) samplers. The SPT and ring samplers were driven using a down-hole hydraulic hammer, 140-pound, free falling from a height of approximately 24 inches, for a total penetration of 18 inches into the ground. The blow counts were recorded for every 6 inches of penetration. The blow counts presented in parentheses on the boring logs are the blow counts for the last 12 inches of penetration and represent the field N-value.

Relatively intact soil samples were collected from the borings using the ring sampler. Sampling procedures generally followed SPT and split-barrel sampling of soils (American Society for Testing and Materials [ASTM] D1586). In addition, representative bulk samples were collected from the borings at shallow depths from the hand auger cuttings. Each soil sample collected was examined and classified in accordance with the Unified Soils Classification System (USCS) per ASTM D2488. Following drilling, sampling, and logging, the borings were grouted with a Sodium Bentonite slurry mix. The soil boring logs are included in Attachment A of this memorandum.

Laboratory Testing

A laboratory testing program was conducted using the soils collected during the surface sampling program, as discussed in the previous section. These samples were used to perform index testing, strength testing, and compaction testing.

Index, Strength, and Compaction Testing

Index testing was performed to properly classify the soil obtained from the field exploration program in accordance with the Unified Soil Classification System (USCS). Compaction characteristics were also determined including the maximum dry density and optimum moisture content of a surface sample. Direct-shear tests were performed to evaluate the strength characteristics of the fill and native soil materials. Confining pressures were used corresponding to the depth from which the sample is obtained.

The laboratory testing was conducted by Environmental Geotechnology Laboratories of Arcadia, California, under subcontract to CH2M HILL. Test assignment and coordination were provided by CH2M HILL. Laboratory testing included the following ASTM standard test methods:

- ASTM D422 – Test Method for Particle-Size Analysis of Soils (grain size and hydrometer analyses)
- ASTM D4318 – Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- ASTM D1557 – Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort
- ASTM D3080 – Test Method for Direct-Shear Test of Soils Under Consolidated Drained Conditions

Laboratory Test Results

The results of the laboratory testing programs are summarized in Tables 1 and 2 below. Laboratory testing is also summarized in Table B-1 provided in Attachment B. Detailed test results are presented in Attachment B.

The results of the index testing are presented in Table 2. Results of the index testing indicate that the grain size analyses for soil samples have predominantly granular components with fines content up to 32 percent. The results also indicate that all the tested samples had amounts of gravel ranging from 24 to 55 percent.

TABLE 2
Results of Index Testing

Boring Location	Sample Depth (ft)	% Gravel	% Sand	% Fines	LL (%)	PL (%)	PI (%)
AOC4-GEO1	1	-	-	-	17	16	1
	5	24	44	32			
	25	51	31	18			
	35	33	47	20			
AOC4-GEO2	15	37	41	22	19	18	1
	35	55	33	12			
	45	40	42	18			
AOC4-GEO3	1	44	35	21			
	15	33	38	29			
AOC4-GEO4	1	40	45	15			

ft = feet
LL = Liquid Limit
PL = Plastic Limit
PI = Plasticity Index

The results of strength testing are presented in Table 3. The in situ (field) moisture content of the native samples varied from 0.5 percent to 3.7 percent.

TABLE 3
Results of Direct Shear Strength Testing

			Peak Strength		Ultimate Strength	
Boring Location	Sample Depth (ft)	Sample Condition	Cohesion, C (psf)	Friction Angle, ϕ°	Cohesion, C (psf)	Friction Angle, ϕ°
AOC-GEO1	10	Relatively Intact	366	48	342	48
AOC-GEO2	20	Relatively Intact	6	40	0	40
	1	Remolded to 90% RC	185	36	86	34
	20	Relatively Intact	15	45	13	45
	30	Relatively Intact	301	44	307	44
AOC-GEO3	10	Remolded to 90% RC	534	31	112	33

psf = pound per square foot

RC = relative compaction

Subsurface Conditions

Based on the subsurface exploration conducted in AOC 4, the depth of debris fill materials is approximately 5 feet in the nearly level area and consists of silty sands and gravel mixed with debris, including some trash, roots, and peaty materials. These depths correspond to elevations of 606 feet and 607 feet, respectively, above mean sea level on the west and east side of the AOC4 area above the ravine. The debris and fill material is underlain by possible weakly cemented alluvium or weathered native materials. Boring AOC4-GEO2, located at the west edge of the existing slope above the ravine, encountered gravelly materials to approximately 35 feet bgs (El 577 feet). Based on the soil borings, the subsurface materials at the project site generally consist of gray to grayish brown, dry, medium dense to very dense, silty sand and silty gravel. The gravel sizes ranges from 0.5 to 3 inches. The uncorrected SPT N-values in this zone range from 17 for 12 inches of penetration to 50 for 6 inches of penetration.

Below the fill layer and alluvial sediments, weathered rock materials were encountered in some of the borings to the explored maximum depths overlying relatively unweathered metadiorite bedrock. The weathered rock generally consists of dense to very dense gravel and sand with silt. Gravel sizes varied from less than an inch up to 5 inches. In some areas broken cobbles or fragments of bedrock were present in the recovered samples. The uncorrected SPT N-values within the native soil zone were above 50. Detailed boring logs are presented in Attachment A.

Stability Analyses

Development of Stability Profiles

A critical cross section location was chosen passing through the existing slope at the point of maximum height. The section location is designated A-A′. CH2M HILL located the sections with respect to the existing grading plans, and the potential for overall impacts during slope excavations. As such, section A-A′ is located along the western side of the AOC 4 area running north-south across the slope as shown in Figure 1.

Cross sections to develop stability profile models used in the stability analyses were generated from the most recent topographic map provided. The cross sections were developed manually using the topographic map. Section modifications were completed to demarcate estimated fill, alluvium, and the bedrock. The existing ravine slopes in the AOC 4 area are approximately 1.5H: 1V. Steeper slopes of varying grades ranging from 1H: 1V to less than 0.75H: 1V were modeled to represent the potential temporary slopes that may be maintained during remediation and construction operations. The material types within the slopes and below the slope subsurface were stratified, and their boundaries were demarcated based on materials encountered in the borings.

Design Soil Parameters

The strength parameters used in the stability analyses are developed based on the geotechnical exploration and laboratory testing data. Shear strength parameters of 100 psf of cohesion (C) and a friction angle (ϕ) of 38 degrees were used for the fill and alluvial materials. For native materials consisting of very dense alluvium and weathered bedrock, a C of 100 psf and a ϕ of 40 degrees were used. The bedrock beneath the native soils is modeled using a C of 350 psf and a ϕ of 48 degrees.

Analyses Methodology

The slope stability analyses performed considers the overall (global) stability of slopes using circular and wedge-shaped failure planes. The slope stability analyses were performed using the Modified Bishop method for circular slip surfaces and Janbu Corrected method for wedge failures. The calculations were performed using the limit equilibrium computer program SLIDE v.5.0 (Rocscience, 2006). The method of slices estimates slope stability by assuming a failure surface and calculating the forces that would cause slope movement (driving forces) and the forces resisting slope movement (resisting forces) for the selected failure surface. The ratio of resisting forces to driving forces is known as the factor of safety. SLIDE 5.0 employs a searching routine to determine the failure surface with the minimum factor of safety. The critical slip surface for each major slope is shown on the analyses results.

Static slope stability analyses were conducted. A factor of safety of 1.1 or greater is normally considered adequate for temporary slopes during construction activities.

An equipment surcharge load of up to 500 psf is considered in the stability analyses to account for additional wheel loads on top of the slopes from vehicles and construction equipment. The following sections discuss the results and limitations of the analyses.

Stability Analyses Results

Cross section A-A′ was analyzed for slope stability assuming global circular and block failure surfaces considering a 1H: 1V slope. The maximum slope height used is 35 feet. The lowest FOS obtained is 1.2. The results show a 35 foot tall slope with a 1H: 1V slope ratio is expected to be globally stable during construction and remediation activities. A steeper slope with 0.75H: 1V was also analyzed for global stability. The lowest FOS obtained considering circular and block failure surfaces is slightly less than 1.1.

The surficial stability of a localized side slope should be considered during the grading and other construction activities. Localized instabilities, if left unchecked, could lead to larger stability issues.

Conclusions, Recommendations, and Discussion

Based on the results of the field explorations, laboratory testing results, and stability analyses, the following can be inferred:

- The depth of debris fill materials encountered in the borings extends approximately 5 feet bgs on the nearly level area of AOC 4 and contains silty sand and gravel mixed with debris including some trash, roots and peaty materials. These depths correspond to elevations of 606 feet and 607 feet above mean sea level, respectively, on the west and east side of the AOC 4 area above the ravines.

- The debris fill is underlain by possible weakly cemented alluvium and weathered metadiorite bedrock. These materials consist of dense to very dense silty sand (SM) to silty gravels (GM). The gravel sizes ranges from 0.5 to 3 inches.
- Boring refusal, indicating bedrock or obstructions, was encountered at depths varying from 56 to 5 feet bgs. Boring AOC4-GEO2, located on the west edge of the existing slope, encountered refusal at EL 556 feet or about 56 feet bgs. Boring AOC4-GEO4, located on the east side of the existing slope, encountered refusal at EL 607 feet or at about 5 feet bgs. With respect to the exposed bedrock observed near the investigation site, boring refusal is interpreted as the surface of relatively unweathered bedrock.
- Based on the results of the slope stability analyses, a 35 foot tall slope with a 1H: 1V slope ratio is expected to be globally stable during construction and remediation activities. A FOS for slope failure of 1.2 was computed for this condition. An FOS of 1.1 or greater is normally considered adequate for temporary slopes during construction activities.
- It is recommended that temporary slopes be maintained no steeper than 1H: 1V and not higher than 35 feet. Shorter, steeper slopes may be achievable and should be evaluated if proposed.
- The surficial stability of a localized side slope should be considered during the grading and other construction activities. Localized instabilities, if left unchecked, could lead to larger stability issues

The scope of the geotechnical investigation and subsequent analyses noted above did not include evaluation of fill along the slope face and at the bottom of the slope. The fill thickness and engineering properties are unknown in these areas. Because of this, stability of the fill along the slope was not conducted. In addition, a detailed geologic assessment of bedrock conditions, including mapping of fractures and bedding planes, was not part of this scope of work. The analyses conducted assumed a homogeneous subgrade consisting of dense to very dense alluvial type materials underlain by bedrock, which was encountered in the borings.

Additional assessments are recommended during the removal phase of the slope. This may include, but may not be limited to, conducting test pits along the slope face and bottom of slope to determine fill thicknesses and engineering properties. Once obtained, this data should be reviewed by the removal contractor to provide further direction on the contractor's means and methods for fill removal.

Limitations

This memorandum has been prepared for the use of the PG&E for specific application to the Topock AOC 4 – Pre-Work plan data collection activities. This memorandum was prepared in accordance with generally accepted geotechnical engineering practice; no warranty, expressed or implied, is made.

The conclusions and recommendations contained in this memorandum are based on information from the current field exploration, laboratory testing, and analyses performed. These results reflect subsurface conditions only at specific locations, times, and to the depths explored. They do not necessarily reflect strata variations that might exist between exploration locations. The nature and extent of any variations in subsurface conditions might not become evident until construction. If conditions encountered during construction differ from those described in this memorandum, recommendations made in this memorandum will need to be re-evaluated by CH2M HILL.

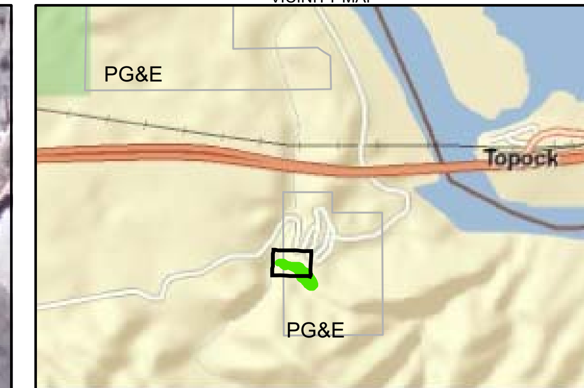
If any changes in the nature, design, or locations of the facilities are planned, the conclusions and recommendations contained in this memorandum should not be considered valid unless the changes are reviewed and the conclusions of this memorandum are modified or verified in writing by CH2M HILL.

References

Rocscience, Inc. 2006. SLIDE V5.04, *User's Guide 1989-2003*

Figures

VICINITY MAP



LEGEND

- AOC-4 Geotech Borings
- AOC 4 Boundary
- AOC4 Area 1 ft contour

N

0 25 50 100
Feet

FIGURE 1
AOC 4 GEOTECHNICAL BORINGS
GROUND SUFRACE ELEVATIONS
PG&E Topock Compressor Station
Needles, California

CH2MHILL

Attachments

Attachment A
Boring Logs

PROJECT NUMBER	BORING NUMBER:
382653.FP.03.01	AOC4-GE01 SHEET 1 OF 2

CH2MHILL

SOIL BORING LOG

PROJECT : PG & E TOPOCK SITE REMEDIATION | LOCATION : Topock, CA

ELEVATION : 611.0 | DRILLING CONTRACTOR : Cascade Drilling, Inc.

DRILLING METHOD AND EQUIPMENT : CME 85, HSA Downhole Hammer (140 lbs., 24 inch drop)

WATER LEVELS : --- | START: 7/29/2009 | END: 7/30/2009 | LOGGER : KR

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	0.0		B-1		SILTY SAND (SM), FILL, gray, dry, with fine to coarse gravel (1"-3"), trash, peat.	
5	5.0 6.5	1.1	S-2	18-24-38 (62)	-- dense, fine sand, low plastic silt, no trash, no peat.	
10	10.0 11.5	1.6	D-3	30-18-16 (34)	-- medium dense, medium to coarse gravel (1"-3"), low plastic silt.	
15	15.0 16.5	1.4	S-4	15-18-24 (42)	-- dense, grayish brown.	
20	20.0 21.5	1.0	D-5	38-27-37 (64)	-- gravel sizes from <0.5" to 2", coarse sand.	
25	25.0 26.5	0.2	S-6	39-50/6" (50/6")	SILTY GRAVEL (GM), gray, dry, very dense, with coarse sand, fine gravel, low plastic silt.	
30						

PROJECT NUMBER	BORING NUMBER:
382653.FP.03.01	AOC4-GE01 SHEET 2 OF 2

SOIL BORING LOG

PROJECT : PG & E TOPOCK SITE REMEDIATION LOCATION : Topock, CA

ELEVATION : 611.0 DRILLING CONTRACTOR : Cascade Drilling, Inc.

DRILLING METHOD AND EQUIPMENT : CME 85, HSA Downhole Hammer (140 lbs., 24 inch drop)

WATER LEVELS : --- START: 7/29/2009 END: 7/30/2009 LOGGER : KR

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	30.0 – 31.5	0.6	D-7	50/6" (50/6")		
	31.5 – 32.0					
	32.0 – 35.0		B-8			
35	35.0 – 36.5	0.5	S-9	48-50/2" (50/2")	SILTY SAND (SM), gray, dry, very dense, with fine gravel, medium grained sand, low plastic silt. @36' - possible Bedrock, light gray, dry, weathered.	
					Auger refusal @38.5'. Bottom of Hole @38.5'. No groundwater encountered. 7/30/09 8:00 AM	
40						
45						
50						
55						
60						

PROJECT NUMBER	BORING NUMBER:
382653.FP.03.01	AOC4-GE02 SHEET 1 OF 2

CH2MHILL

SOIL BORING LOG

PROJECT : PG & E TOPOCK SITE REMEDIATION LOCATION : Topock, CA

ELEVATION : 611.0 DRILLING CONTRACTOR : Cascade Drilling, Inc.

DRILLING METHOD AND EQUIPMENT : CME 85, HSA Downhole Hammer (140 lbs., 24 inch drop)

WATER LEVELS : --- START: 7/30/2009 END: 7/30/2009 LOGGER : KR

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	0.0		B-1		SILTY GRAVEL (GM), FILL, gray, moist, fine sand, low plastic silt, gravel sizes from <0.5" to 3", some waste debris.	Start @1:35 pm.
5	5.0					
	6.5	0.4	S-2	8-9-17 (26)	-- medium dense, no waste/debris.	
10	10.0					
	11.5	0.5	D-3	16-19-27 (46)		
15	15.0					
	16.5	0.6	S-4	18-19-24 (43)	SILTY SAND (SM), grayish-brown, with fine to medium gravel, fine sand, low plastic silt.	
20	20.0					
	21.5	1.0	D-5	19-27-31 (58)		
25	25.0					
	26.5	1.1	S-6	20-23-26 (49)	-- olive brown, dense.	
30						

CH2MHILL

PROJECT NUMBER	BORING NUMBER:
382653.FP.03.01	AOC4-GE02 SHEET 2 OF 2

SOIL BORING LOG

PROJECT : PG & E TOPOCK SITE REMEDIATION — LOCATION : Topock, CA

ELEVATION : 611.0 — DRILLING CONTRACTOR : Cascade Drilling, Inc.

DRILLING METHOD AND EQUIPMENT : CME 85, HSA Downhole Hammer (140 lbs., 24 inch drop)

WATER LEVELS : --- START: 7/30/2009 END: 7/30/2009 LOGGER : KR

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	30.0–31.5	1.0	D-7	19-20-26 (46)	-- medium dense, turn into gray rock fragments/gravel @31'.	
35	35.0–36.5	0.8	S-8	20-24-27 (51)	POORLY GRADED GRAVEL WITH SILT AND SAND (GP-GM), olive-gray, dry, dense, gravel sizes (2" to 4"), fine sand, low plastic silt.	
40	40.0–41.5	1.0	D-9	50/6" (50/6")	-- very dense, broken rock fragments/cobble.	
45	45.0–46.5	0.8	S-10	27-50/6" (50/6")	SILTY SAND (SM), gray, dry, very dense, with fine to medium gravel, up to 1-5", coarse sand, low plastic silt.	
50	50.0–51.5	1.0	D-11	50/6" (50/6")		
55	55.0–56.5	0.7	S-12	39-50/2" (50/2")	Auger refusal @56'. Bottom of Hole @56'. No groundwater encountered. Backfilled with Bentonite grout. 7/30/09 3:45 PM	
60						

CH2MHILL

PROJECT NUMBER	BORING NUMBER:	
382653.FP.03.01	AOC4-GE03	SHEET 1 OF 1

SOIL BORING LOG

PROJECT : PG & E TOPOCK SITE REMEDIATION — LOCATION : Topock, CA

ELEVATION : 612.0 — DRILLING CONTRACTOR : Cascade Drilling, Inc.

DRILLING METHOD AND EQUIPMENT : CME 85, HSA Downhole Hammer (140 lbs., 24 inch drop)

WATER LEVELS : --- START: 7/30/2009 END: 7/30/2009 LOGGER : KR

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	0.0		B-1		SILTY SAND (SM), FILL, gray, dry, fine sand, with gravel size <0.2" to 4", low plastic silt, some debris.	
5	5.0–6.5	0.3	S-2	20-25-32 (57)	-- dense, no debris.	
10	10.0–11.5	0.3	D-3	12-15-17 (32)	-- medium dense.	
15	15.0–16.5	0.4	S-4	26-50/6" (50/6")	-- very dense.	
			B-5		SILTY GRAVEL (GM), gray to brown, dry, fine sand, low plastic silt, fine to medium gravel.	
20	20.0–21.5	0.5	D-6	16-21-19 (40)	-- medium dense.	
25	25.0–26.5	0.0	S-7	50/0" (50/0")	-- possible Bedrock or cobble.	
					Auger and spoon refusal @26'. Bottom of Hole @26'. No groundwater encountered. 7/30/09 12:00 PM	
30						

PROJECT NUMBER 382653.FP.03.01

BORING NUMBER: AOC4-GE04 SHEET 1 OF 1

SOIL BORING LOG

PROJECT : PG & E TOPOCK SITE REMEDIATION | LOCATION : Topock, CA

ELEVATION : 612.0 | DRILLING CONTRACTOR : Cascade Drilling, Inc.

DRILLING METHOD AND EQUIPMENT : CME 85, HSA Downhole Hammer (140 lbs., 24 inch drop)

WATER LEVELS : --- | START: 7/30/2009 | END: 7/30/2009 | LOGGER : KR

DEPTH BELOW GROUND SURFACE (ft)	INTERVAL (ft)	RECOVERY (ft)	#TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION
	0.0		B-1		SILTY SAND (SM), FILL, gray, dry, fine to coarse sand, with gravel size <0.2" to 2", some waste and debris.	Start @9:50 am.
5	5.0					
	6.5	0.3	S-2	50/3" (50/3")	-- gray, Bedrock (possible), soft, weathered, no waste or debris.	
10					Bedrock @8.5'. Auger refusal @8.5'. Bottom of Hole @8.5'. No groundwater encountered. Backfilled with Bentonite grout. 7/30/09 11:00 AM	
15						
20						
25						
30						

Attachment B
Laboratory Testing Results

TABLE B-1
SUMMARY OF LABORATORY TEST RESULTS - PG E TOPOCK SITE REMEDIATION

Boring	Sample	Sample Depth (ft)	USCS Classification	Field Dry Density (pcf)	Field Moisture Content (%)	Compaction		Grain Size (GR:SD:FN)	Atterberg Limits			Direct Shear				Direct Shear			
												Undisturbed				Remolded to 90% RC			
						Max. Dry Density (pcf)	Opt. Moisture Content (%)		Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Peak C (psf)	Peak Phi (deg)	Ultimate C (psf)	Ultimate Phi (deg)	Peak C (psf)	Peak Phi (deg)	Ultimate C (psf)	Ultimate Phi (deg)
A0C4-GEO1	B1	1 - 5	SM		1.8				17	16	1								
	S2	5 - 6.5	SM		1.4			24:44:32											
	D3	10 - 11.5	SM									366	48	342	48				
	S4	15 - 16.5	SM		1.2														
	D5	20 - 21.5	SM									6	40	0	40				
	S6	25 - 26.5	GM		2.0			51:31:18											
	D7	30 - 31.5	GM		1.5														
	S9	35 - 36.5	SM		1.9			33:47:20											
A0C4-GEO2	B1	1 - 5	GM													185	36	86	34
	S2	5 - 6.5	GM		1.0														
	S4	15 - 16.5	SM		1.4			37:41:22	19	18	1								
	D5	20 - 21.5	SM									15	45	13	45				
	S6	25 - 26.5	SM		2.0														
	D7	30 - 31.5	SM									301	44	307	44				
	S8	35 - 36.5	GP-GM		0.5			55:33:12											
	D9	40 - 41.5	GP-GM	126.7	2.0														
	S10	45 - 46.5	SM		2.7			40:42:18											
	S12	55 - 56.5	SM		3.7														
A0C4-GEO3	B1	1 - 5	SM		1.2			44:35:21											
	S4	15 - 16.5	SM		1.6			33:38:29											
	B5	10 - 11.5	SM			141.0	5.5									534	31	112	33
	D6	20 - 21.5	GM	113.4	1.2														
A0C4-GEO4	B1	1 - 5	SM					40:45:15											

SUMMARY OF LABORATORY TEST RESULTS

PROJECT NAME: PG&E TOPOCK

EGL JOB NO: 09-119-001

PROJECT NO: 382653.FP.03.01

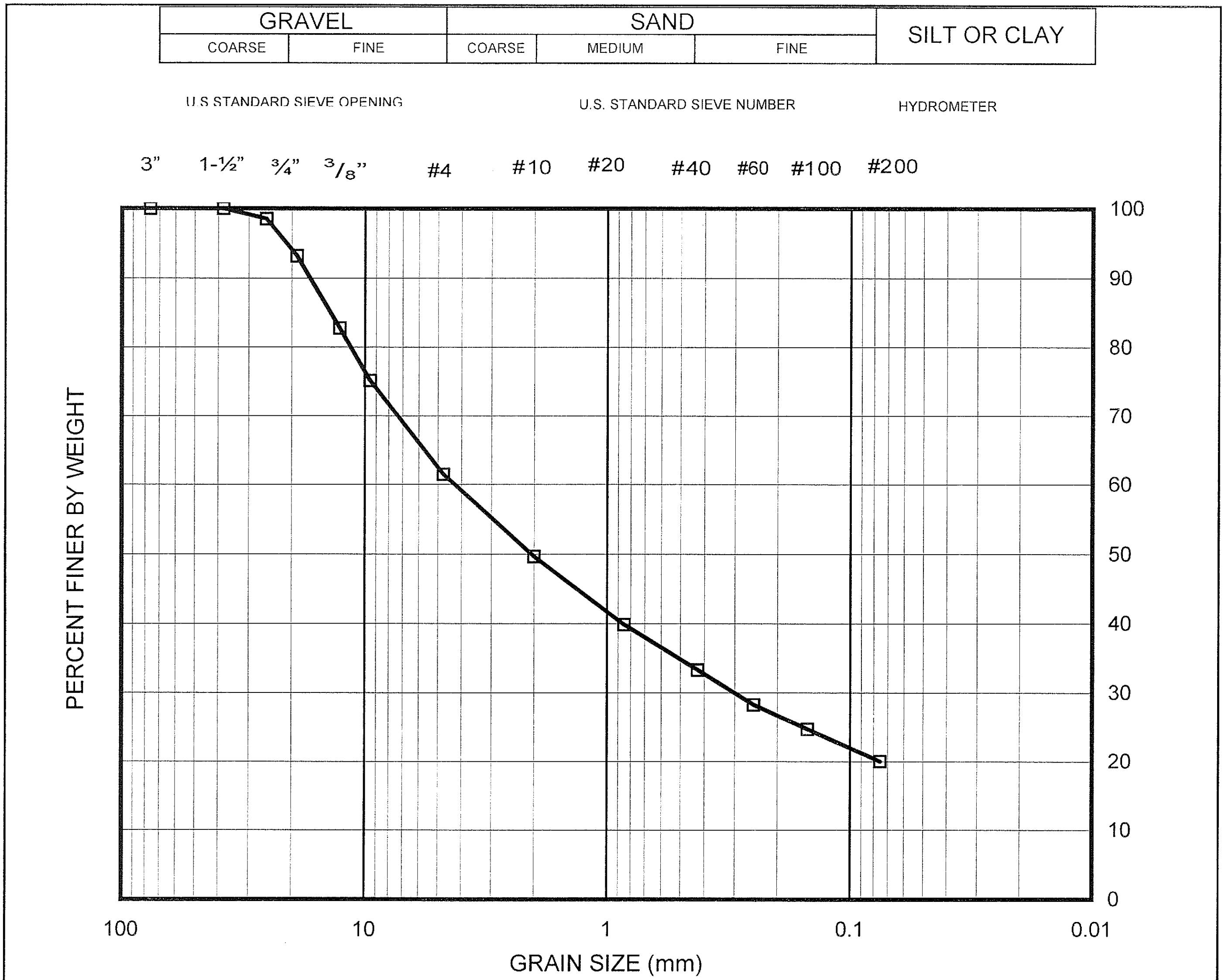
CLIENT: CH2M HILL

DATE: 8/19/2009

SUMMARIZED BY: RJ

BORING NO	SAMPLE NO	DEPTH (ft)	MOISTURE CONTENT ASTM D2216 (%)	DRY DENSITY ASTM D2937 (pcf)	ATTERBERG LIMITS ASTM D4318 *(LL,PL,PI)
N/A	AOC4-Geo1-B1	1-5	1.8		17,16,1
N/A	AOC4-Geo1-S2	5-6.5	1.4		
N/A	AOC4-Geo1-S4	15-16.5	1.2		
N/A	AOC4-Geo1-S6	25-26.5	0.7		
N/A	AOC4-Geo1-D7	30-31.5	1.5	disturbed	
N/A	AOC4-Geo1-S9	35-36.5	1.9		
N/A	AOC4-Geo2-S2	5-6.5	1.0		
N/A	AOC4-Geo2-S4	15-16.5	1.4		19,18,1
N/A	AOC4-Geo2-S6	25-26.5	2.0		
N/A	AOC4-Geo2-S8	35-36.5	0.5		
N/A	AOC4-Geo2-D9	40-41.5	2.0	126.7	
N/A	AOC4-Geo2-S10	45-46.5	2.7		
N/A	AOC4-Geo2-S12	55-56.5	3.7		
N/A	AOC4-Geo3-B1	1-5	1.2		
N/A	AOC4-Geo3-S4	15-16.5	1.6		
N/A	AOC4-Geo3-D6	20-21.5	1.2	113.4	

*LL,PL,PI = LIQUID LIMIT, PLASTIC LIMIT, PLASTICITY INDEX



SYMBOL	BORING NO	SAMPLE NO	DEPTH (FT)	SAMPLE TYPE	SOIL TYPE	LIQUID LIMIT	PLASTICITY INDEX
□	N/A	AOC4-Geo1-B1	1-5	Bulk	SM	17	1

ENVIRONMENTAL GEOTECHNOLOGY LABORATORY

Project Name: PG&E Topock

Client Job No.: 382653.FP.03.01

Client Name: CH2M Hill

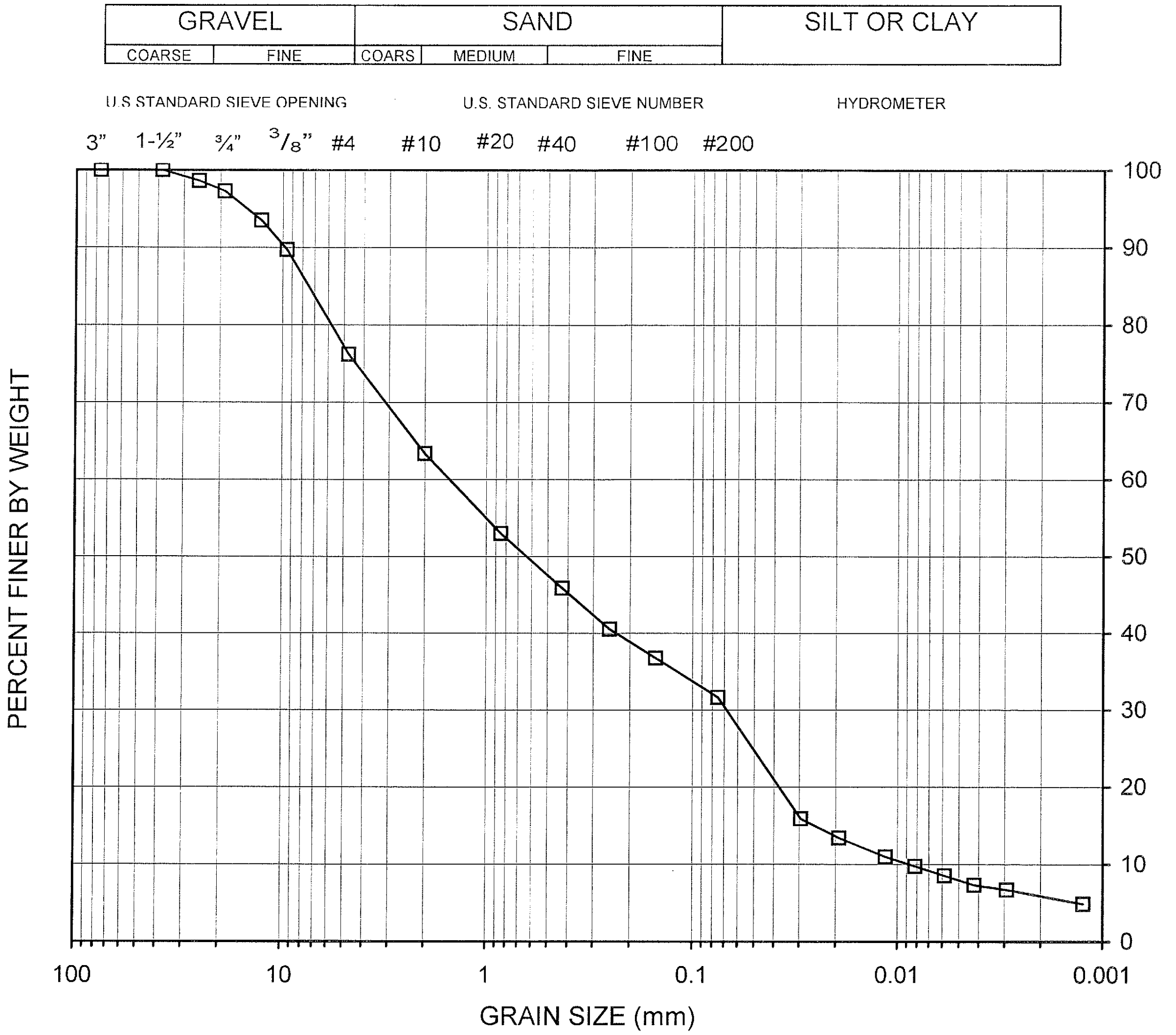
EGL Project No: 09-119-001

GRAIN SIZE DISTRIBUTION CURVE

(ASTM D422)

Aug-09

FIGURE



SYMBOL	BORING No.	SAMPLE No.	DEPTH (FT)	SAMPLE TYPE	SOIL TYPE	LIQUID LIMIT	PLASTICITY INDEX
□	N/A	AOC4-Geo1-S2	5-6.5	Bag	SM	N/A	N/A

ENVIRONMENTAL GEOTECHNOLOGY LABORATORY

Project Name: PG & E Topock

Client: CH2M Hill

Job No: 382653.FP.03.01

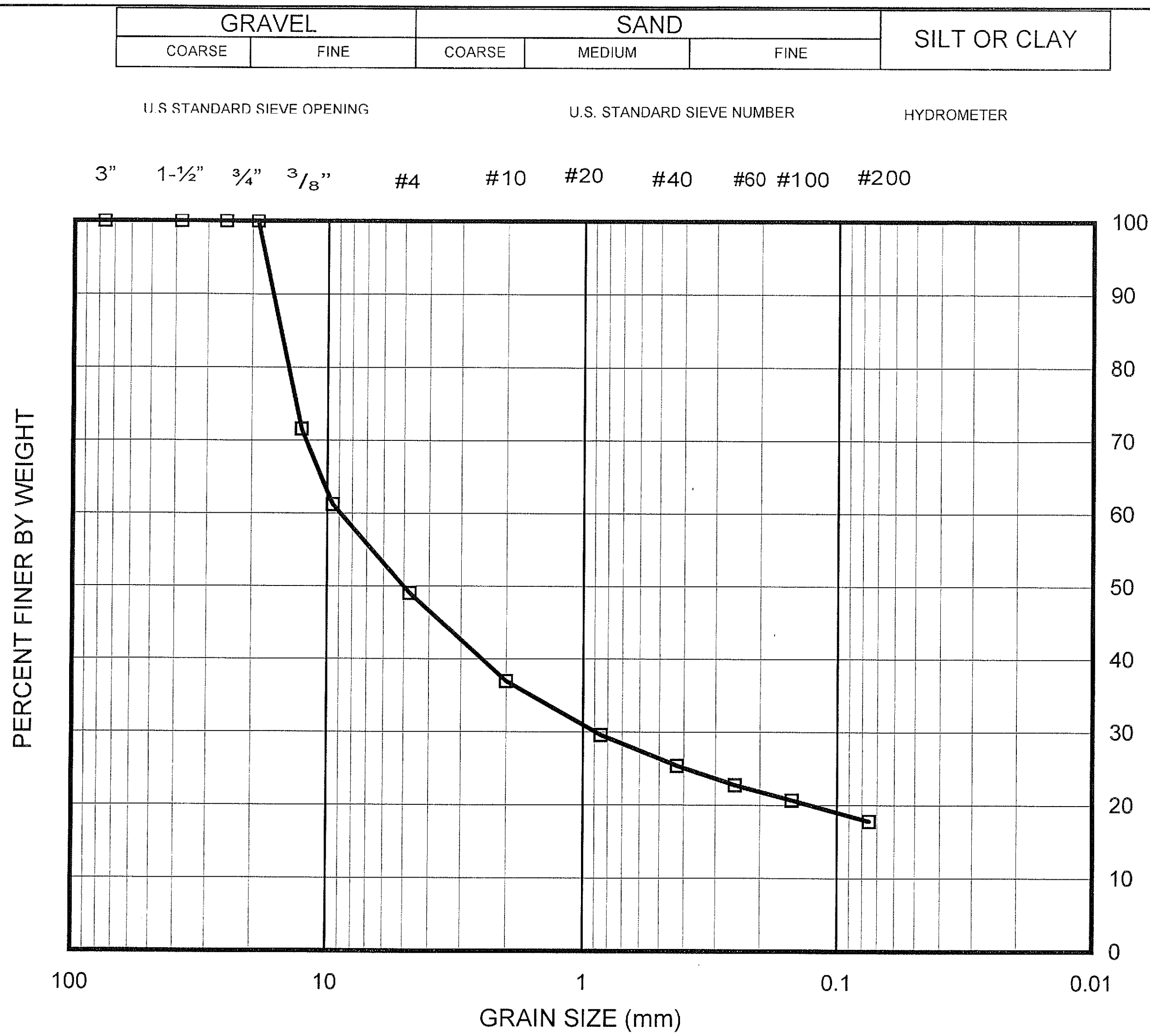
EGL Project No: 09-119-001

GRAINSIZE DISTRIBUTION CURVE

(ASTM D422)

08/21/09

FIGURE

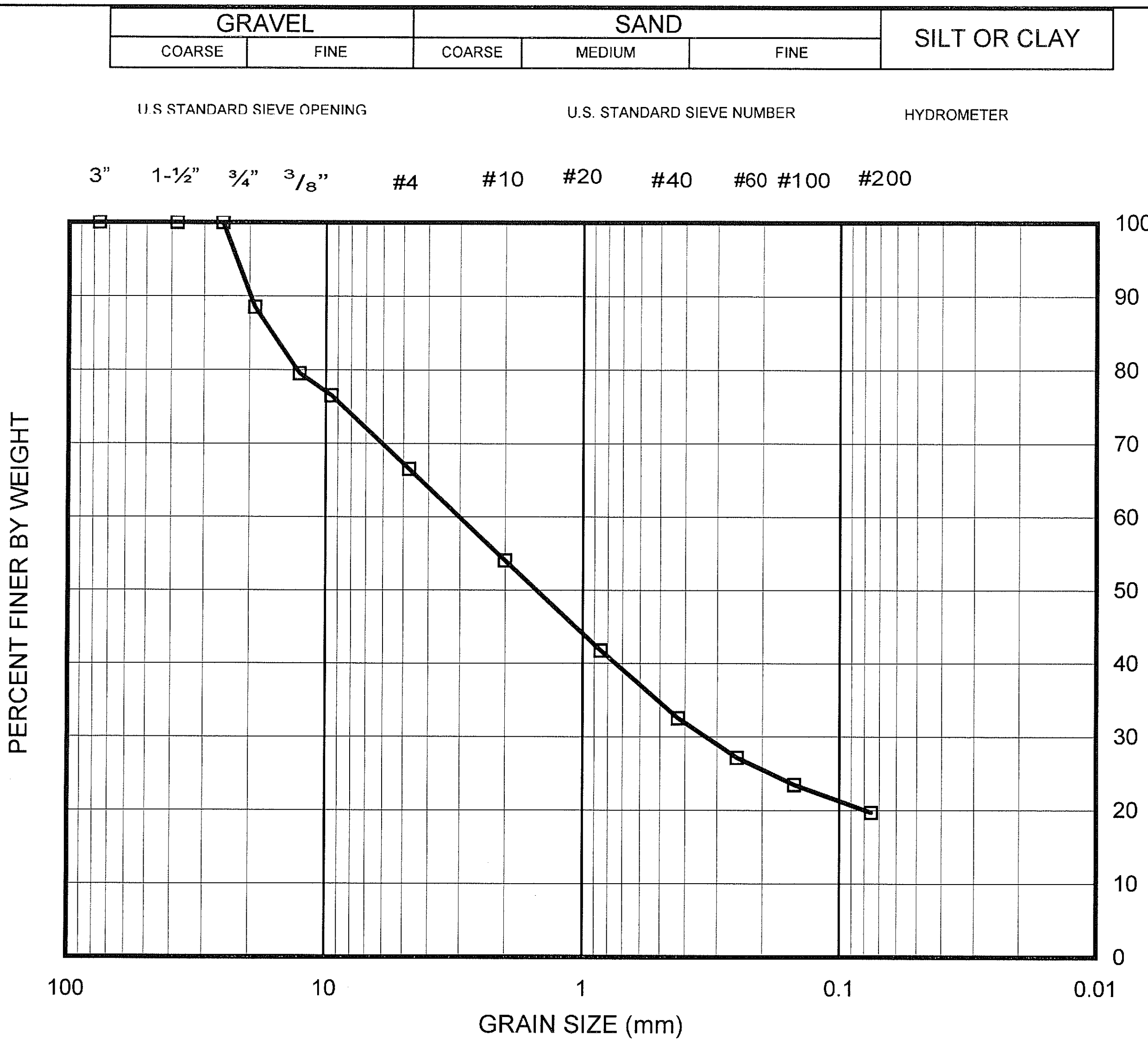


SYMBOL	BORING NO	SAMPLE NO	DEPTH (FT)	SAMPLE TYPE	SOIL TYPE	LIQUID LIMIT	PLASTIC INDEX
□	N/A	AOC4-Geo1-S6	25-26.5	Bag	GM	N/A	N/A

ENVIRONMENTAL GEOTECHNOLOGY LABORATORY	Project Name: PG&E Topock
	Client Job No.: 382653.FP.03.01
	Client Name: CH2M Hill
	EGL Project No: 09-119-001

GRAIN SIZE DISTRIBUTION CURVE

08/21/09 (ASTM D422) FIGURE

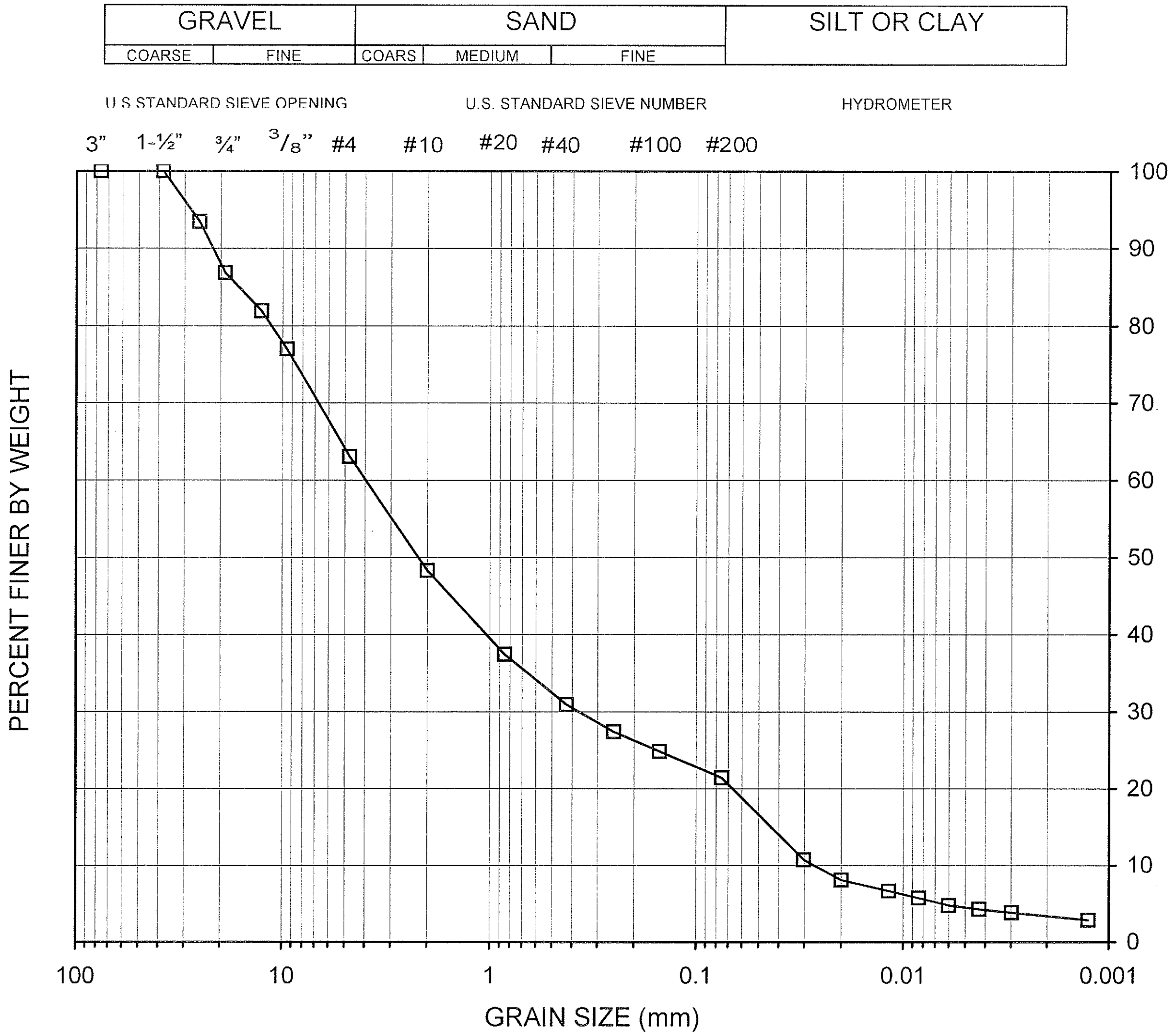


SYMBOL	BORING NO	SAMPLE NO	DEPTH (FT)	SAMPLE TYPE	SOIL TYPE	LIQUID LIMIT	PLASTIC INDEX
□	N/A	AOC4-Geo1-S9	35-36.5	Bag	SM	N/A	N/A

ENVIRONMENTAL GEOTECHNOLOGY LABORATORY	Project Name: PG&E Topock Client Job No.: 382653.FP.03.01 Client Name: CH2M Hill EGL Project No: 09-119-001

GRAIN SIZE DISTRIBUTION CURVE

08/19/09 (ASTM D422) FIGURE



SYMBOL	BORING No.	SAMPLE No.	DEPTH (FT)	SAMPLE TYPE	SOIL TYPE	LIQUID LIMIT	PLASTICITY INDEX
□	N/A	AOC4-Geo2-S4	15-16.5	Bag	SM	19	1

ENVIRONMENTAL GEOTECHNOLOGY LABORATORY

Project Name: PG & E Topock

Client: CH2M Hill

Job No: 382653.FP.03.01

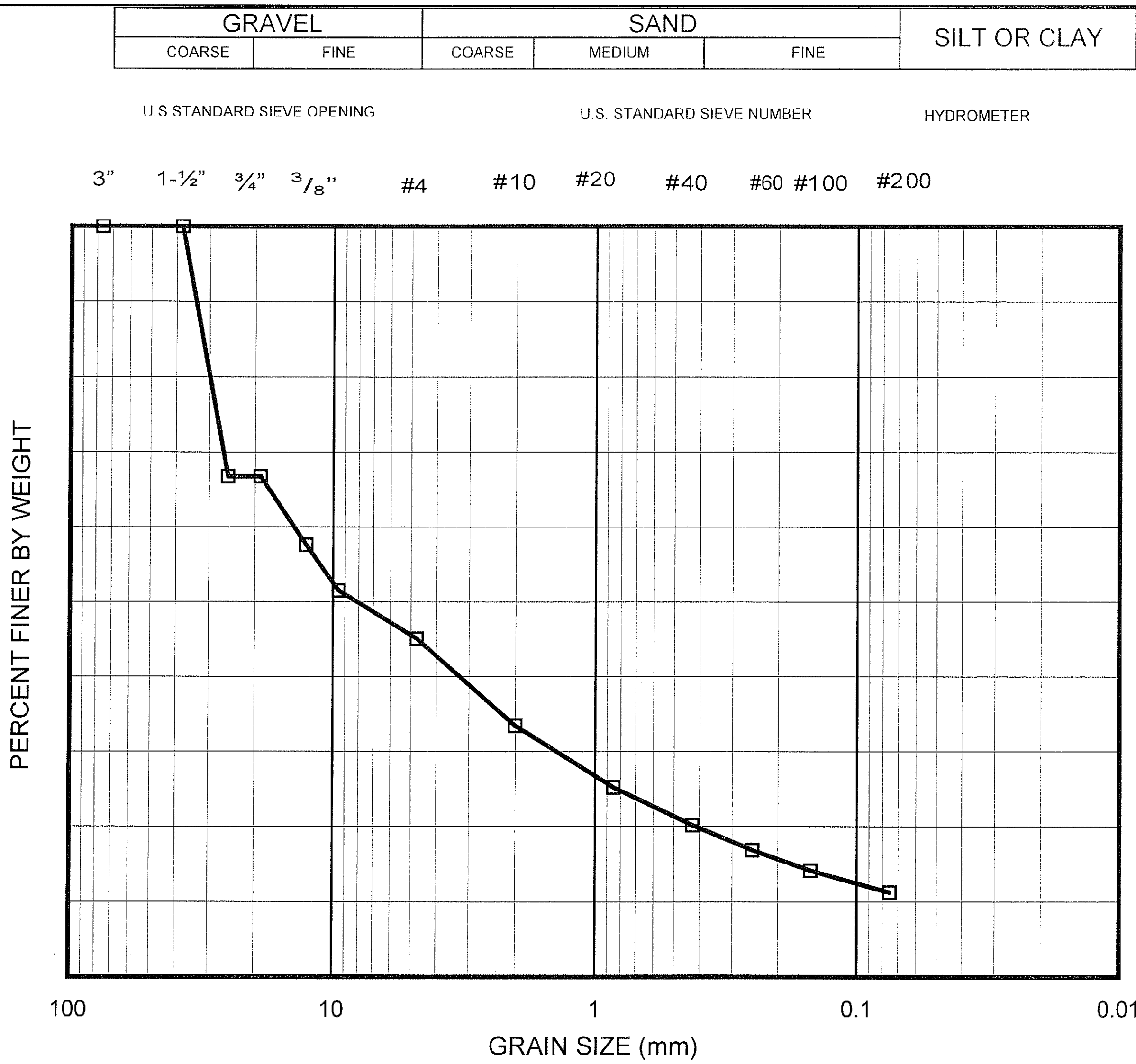
EGL Project No: 09-119-001

GRAINSIZE DISTRIBUTION CURVE

(ASTM D422)

08/24/09

FIGURE

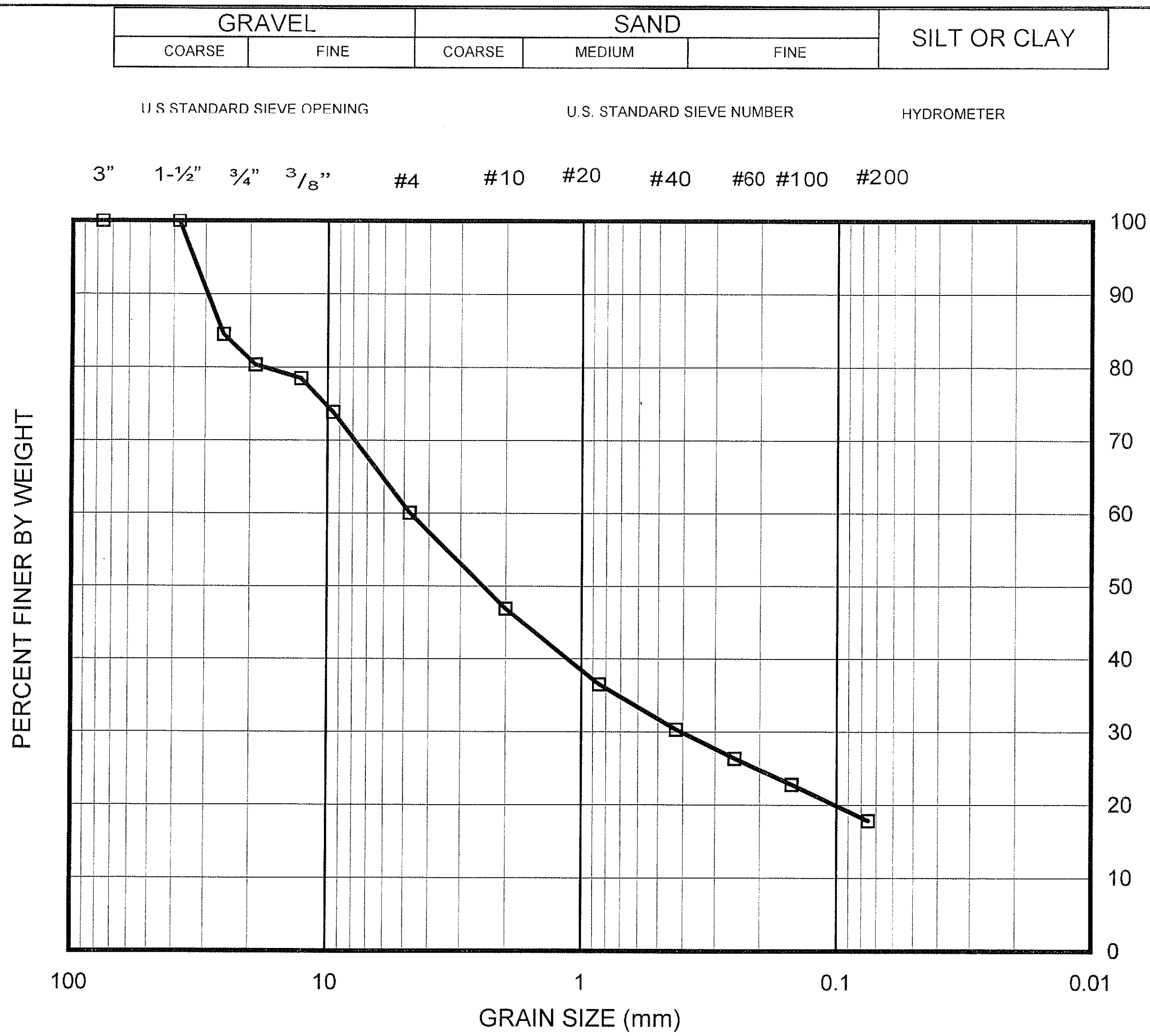


SYMBOL	BORING NO	SAMPLE NO	DEPTH (FT)	SAMPLE TYPE	SOIL TYPE	LIQUID LIMIT	PLASTIC INDEX
□	N/A	AOC4-Geo2-S8	35-36.5	Bag	GP-GM	N/A	N/A

ENVIRONMENTAL GEOTECHNOLOGY LABORATORY	Project Name: PG&E Topock Client Job No.: 382653.FP.03.01 Client Name: CH2M Hill EGL Project No: 09-119-001

GRAIN SIZE DISTRIBUTION CURVE

08/21/09 (ASTM D422) FIGURE



SYMBOL	BORING NO	SAMPLE NO	DEPTH (FT)	SAMPLE TYPE	SOIL TYPE	LIQUID LIMIT	PLASTIC INDEX
□	N/A	AOC4-Geo2-S10	45-46.5	Bag	SM	N/A	N/A

ENVIRONMENTAL GEOTECHNOLOGY LABORATORY

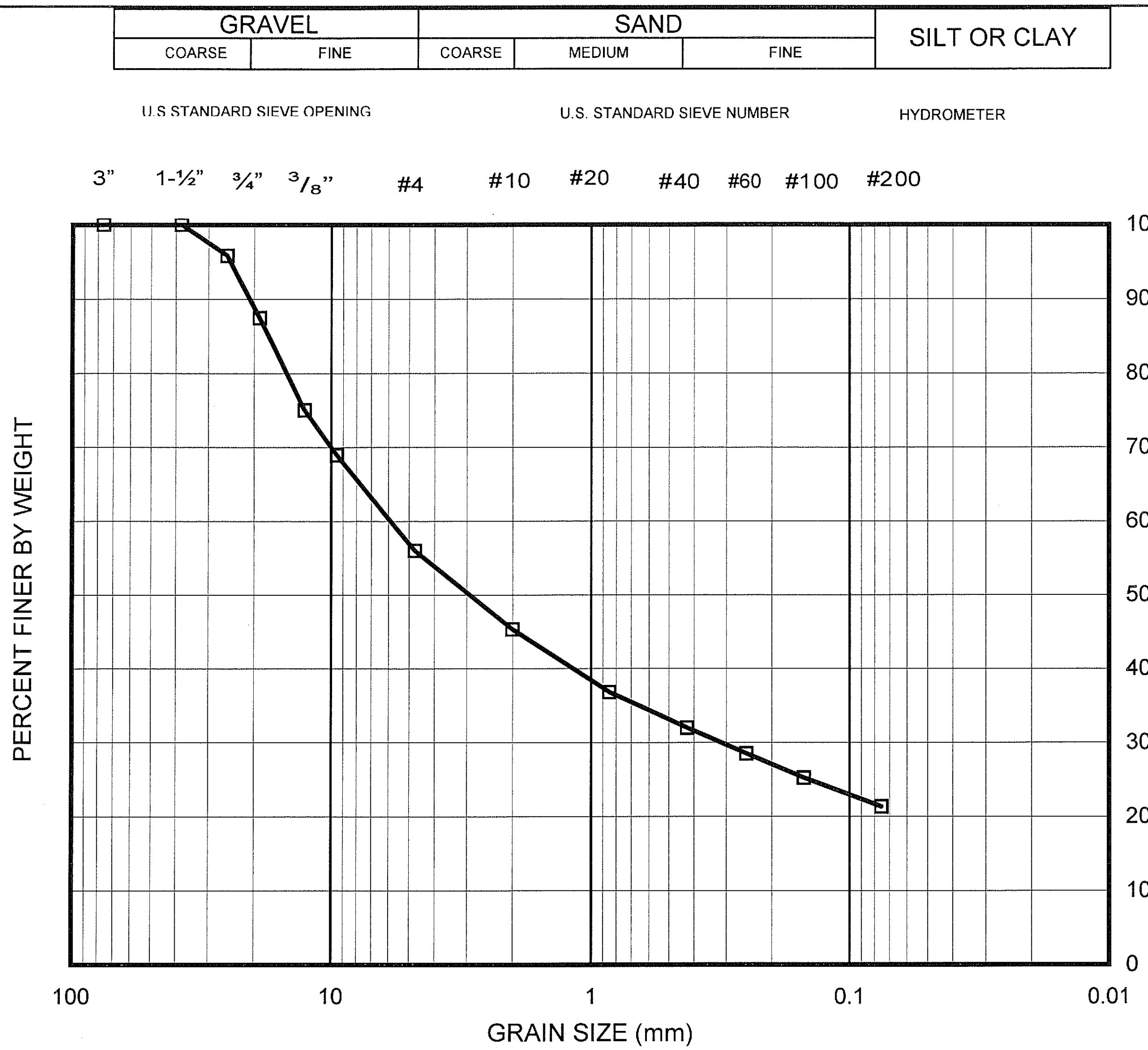
Project Name: PG&E Topock
Client Job No.: 382653.FP.03.01
Client Name: CH2M Hill
EGL Project No: 09-119-001

GRAIN SIZE DISTRIBUTION CURVE

(ASTM D422)

08/21/09

FIGURE

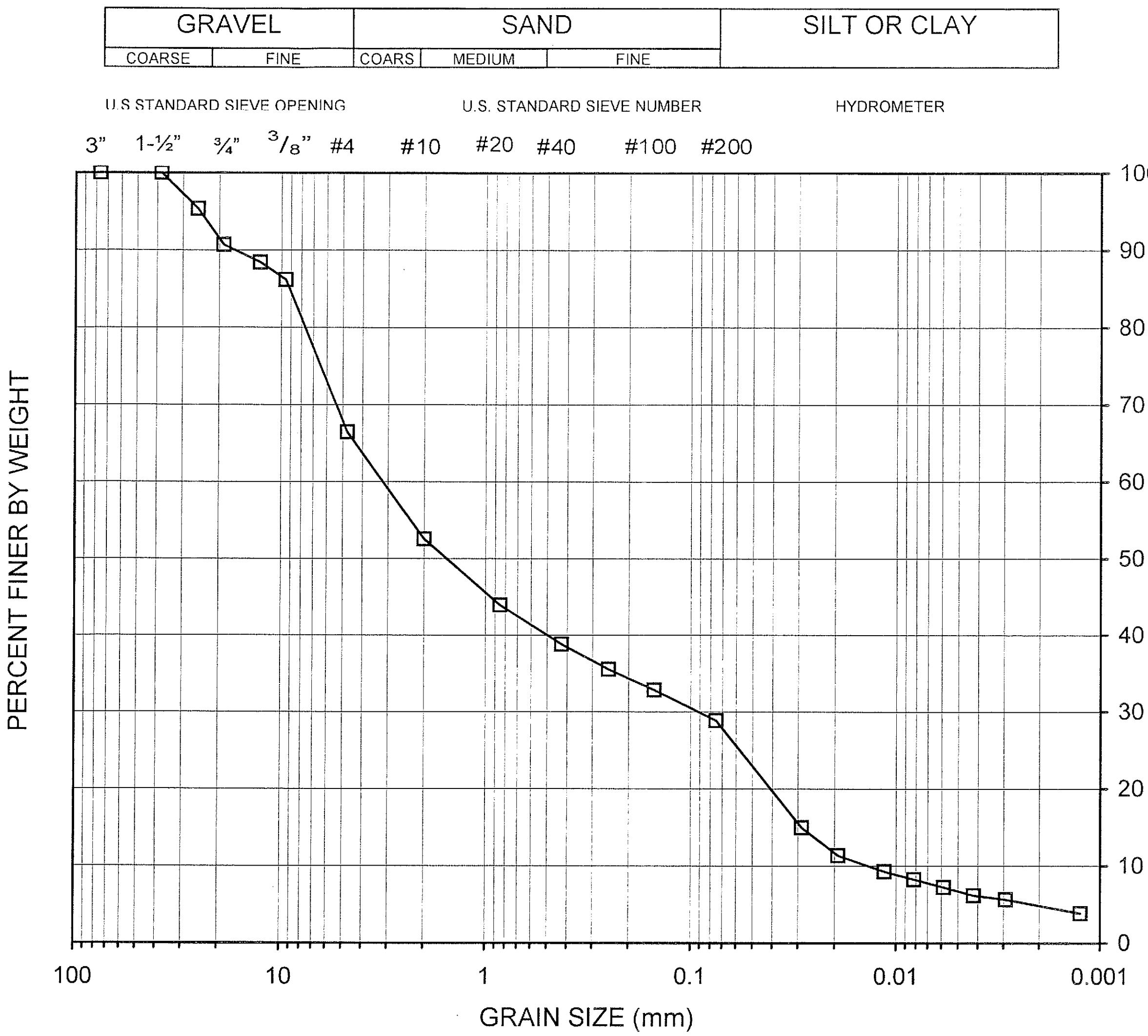


SYMBOL	BORING NO	SAMPLE NO	DEPTH (FT)	SAMPLE TYPE	SOIL TYPE	LIQUID LIMIT	PLASTIC INDEX
□	N/A	AOC4-Geo3-B1	1-5	Bulk	SM	N/A	N/A

ENVIRONMENTAL GEOTECHNOLOGY LABORATORY	Project Name: PG&E Topock
	Client Job No.: 382653.FP.03.01
	Client Name: CH2M Hill
	EGL Project No: 09-119-001

GRAIN SIZE DISTRIBUTION CURVE

Aug-09 (ASTM D422) FIGURE



SYMBOL	BORING No.	SAMPLE No.	DEPTH (FT)	SAMPLE TYPE	SOIL TYPE	LIQUID LIMIT	PLASTICITY INDEX
□	N/A	AOC4-Geo3-S4	15-16.5	Bag	SM	N/A	N/A

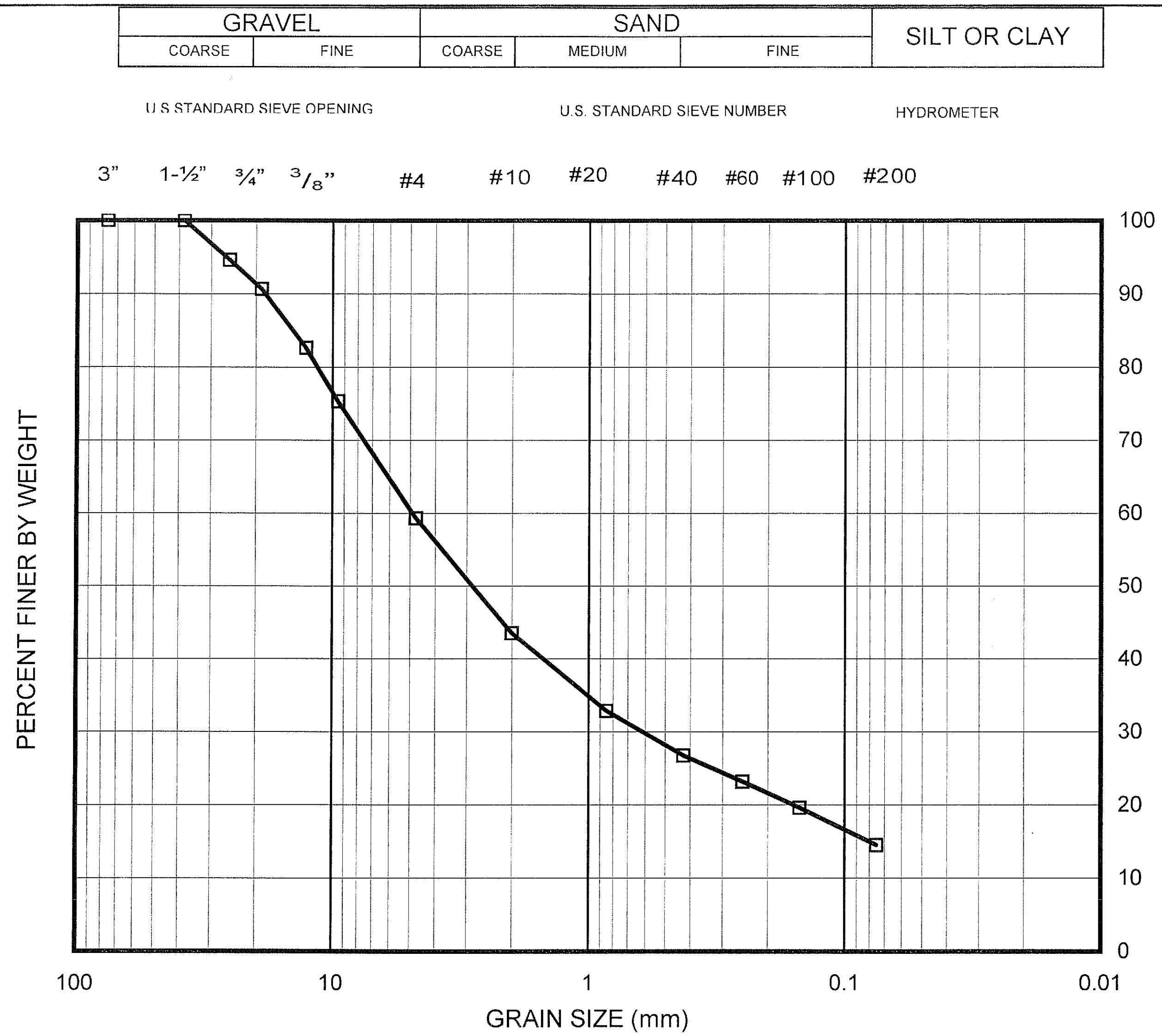
ENVIRONMENTAL GEOTECHNOLOGY LABORATORY	Project Name: PG & E Topock Client: CH2M Hill Job No: 382653.FP.03.01 EGL Project No: 09-119-001

GRAINSIZE DISTRIBUTION CURVE

(ASTM D422)

08/21/09

FIGURE



SYMBOL	BORING NO	SAMPLE NO	DEPTH (FT)	SAMPLE TYPE	SOIL TYPE	LIQUID LIMIT	PLASTIC INDEX
□	N/A	AOC4-Geo4-B1	1-5	Bulk	SM	N/A	N/A

ENVIRONMENTAL GEOTECHNOLOGY LABORATORY

Project Name: PG&E Topock

Client Job No.: 382653.FP.03.01

Client Name: CH2M Hill

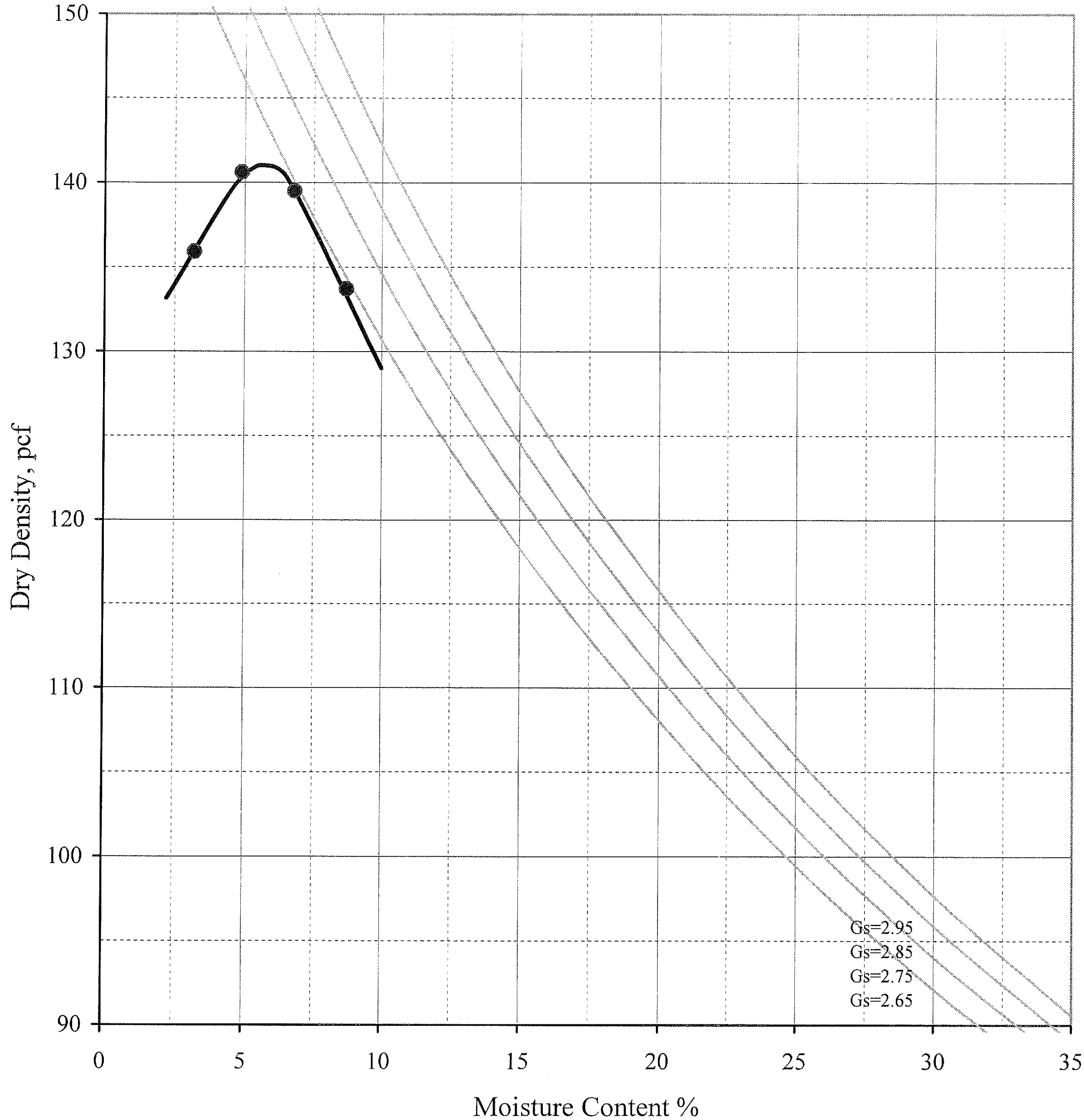
EGL Project No: 09-119-001

GRAIN SIZE DISTRIBUTION CURVE

(ASTM D422)

Aug-09

FIGURE



Maximum Dry Density =	141	pcf
Optimum Moisture Content =	5.5	%

Boring No: N/A

Sample: ACO4-Geo4-B1

Depth : 1-5 feet

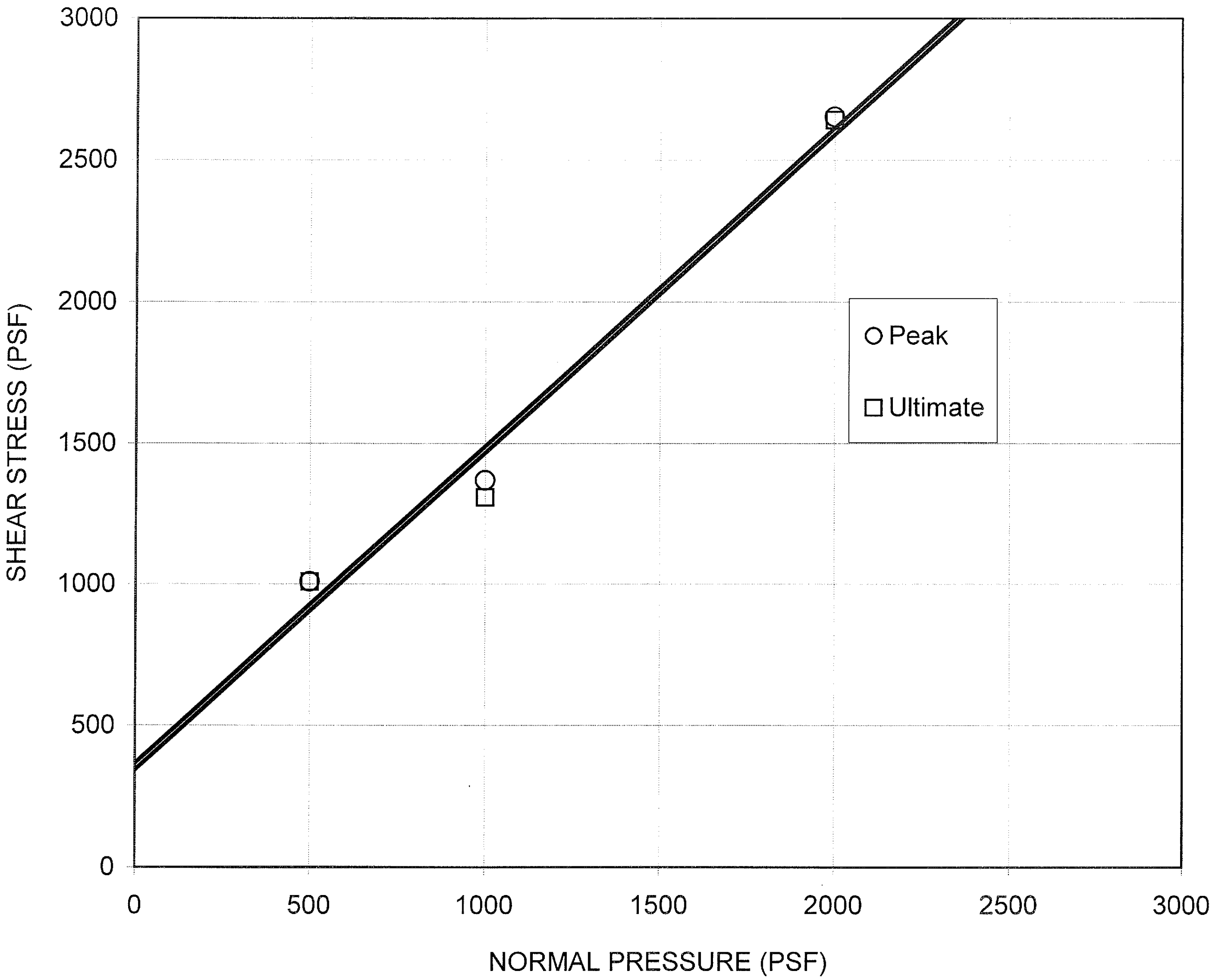
Description : SC

Environmental Geotechnology Laboratory

Project Name:	PG & E Topock
	0
Client Name:	CH2M Hill
Job No:	382653.FP.03.01
EGL Project No.:	09-119-001
Date : Aug-09	Figure

Modified Proctor

(ASTM D1557)



Boring No.:	Sample No.	Depth (ft)	Sample Type	Soil Type	Symbol	Cohesion (PSF)	Friction Angle
N/A	AOC4-Geo1-D3	10-11.5	Ring	SM	○	366	48
					□	342	48

Normal Stress (psf)	Initial Moisture (%)	Final Moisture (%)
500	1.5	14.3
1000	1.5	13.4
2000	1.5	12.1

ENVIRONMENTAL GEOTECHNOLOGY LABORATORY

Project Address: PG&E Topock

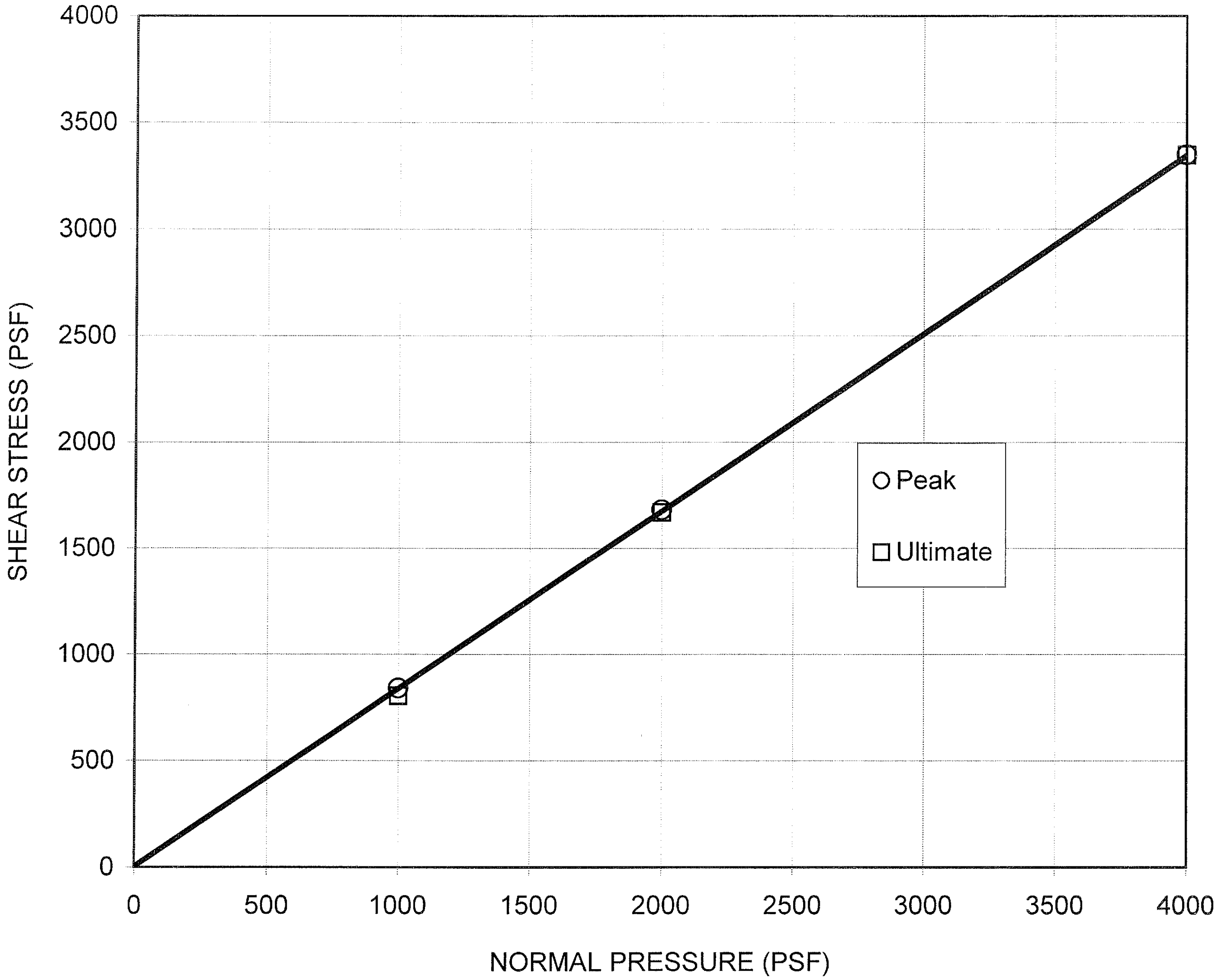
Client: CH2M Hill

Project No: 382653.FP.03.01

EGL Project No: 09-119-001

DIRECT SHEAR

08/09 (ASTM D3080) Figure



Boring No.:	Sample No.	Depth (ft)	Sample Type	Soil Type	Symbol	Cohesion (PSF)	Friction Angle
N/A	AOC4-Geo1-D5	20-21.5	Ring	SM	○	6	40
					□	0	40

Normal Stress (psf)	Initial Moisture (%)	Final Moisture (%)
1000	1.7	16.3
2000	1.7	15.7
4000	1.7	15.1

EGL
ENVIRONMENTAL
GEOTECHNOLOGY
LABORATORY

Project Address:
PG&E Topock

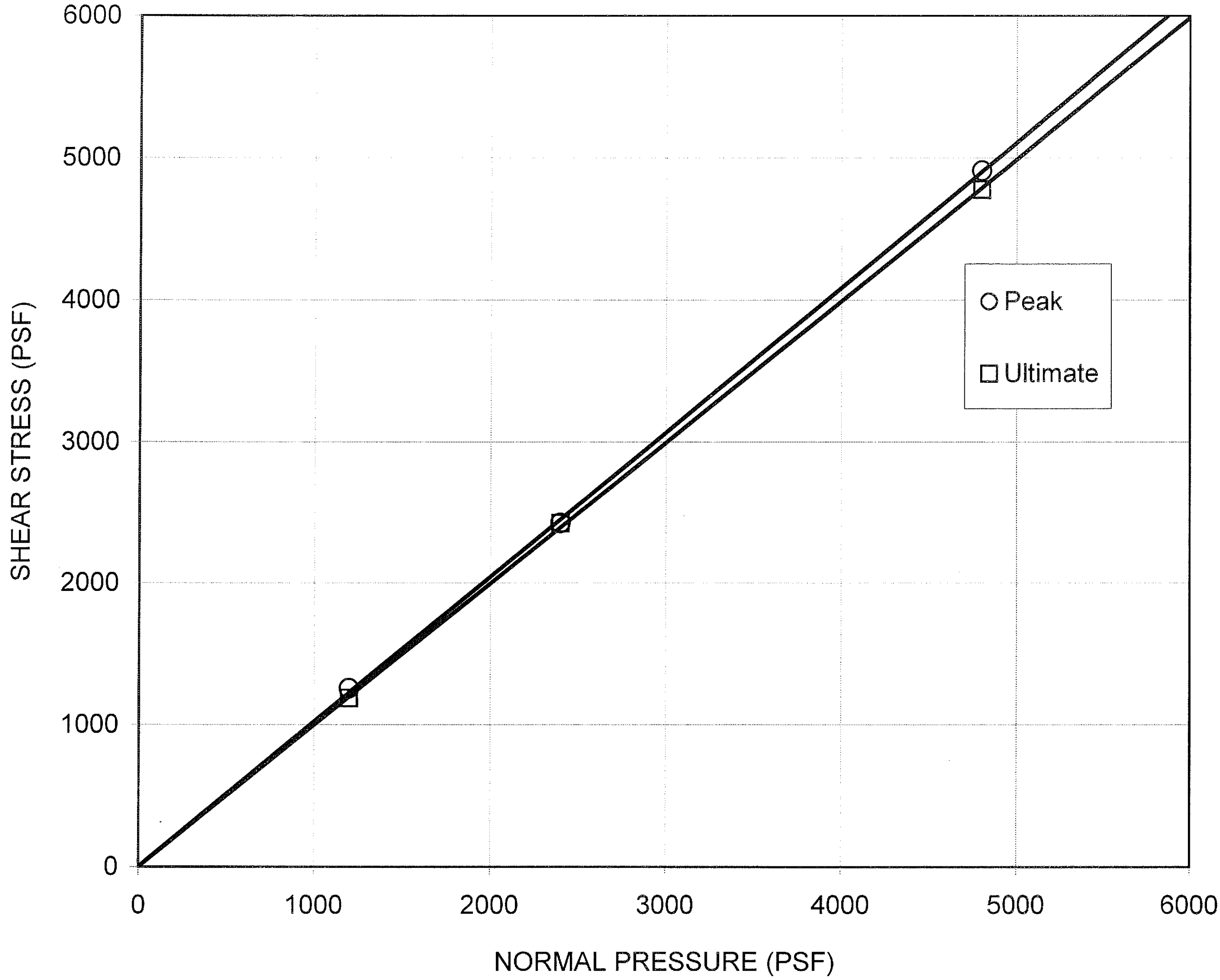
Client: CH2M Hill

Project No: 382653.FP.03.01

EGL Project No: 09-119-001

DIRECT SHEAR

08/09 (ASTM D3080) Figure



Boring No.:	Sample No.	Depth (ft)	Sample Type	Soil Type	Symbol	Cohesion (PSF)	Friction Angle
N/A	AOC4-Geo2-D5	20-21.5	Ring	SM	○	15	45
					□	13	45

Normal Stress (psf)	Initial Moisture (%)	Final Moisture (%)
1200	1.4	14.1
2400	1.4	13.7
4800	1.4	13.2

ENVIRONMENTAL GEOTECHNOLOGY LABORATORY

Project Address:
PG&E Topock

Client: CH2M Hill

Project No: 382653.FP.03.01

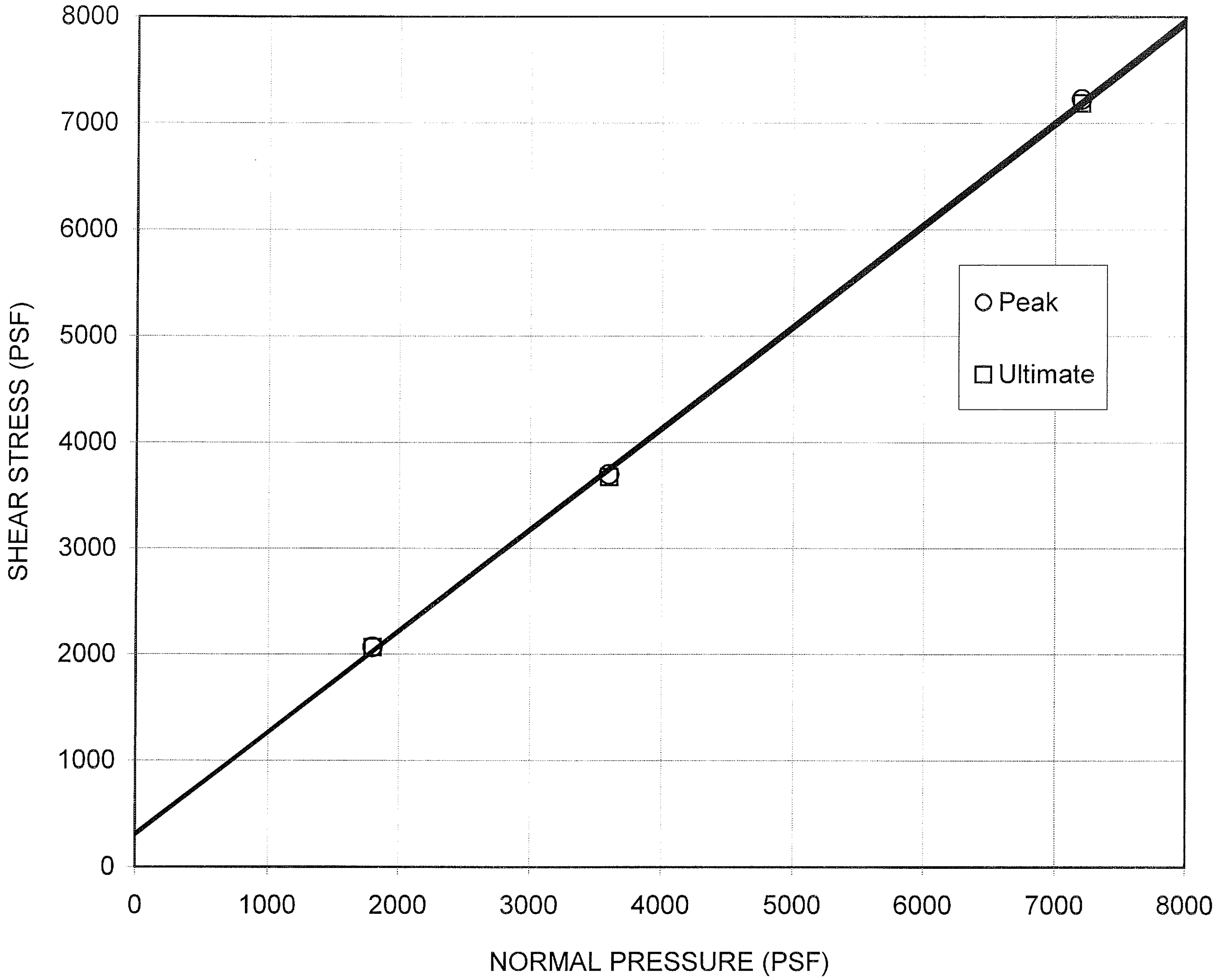
EGL Project No: 09-119-001

DIRECT SHEAR

08/09

(ASTM D3080)

Figure



Boring No.:	Sample No.	Depth (ft)	Sample Type	Soil Type	Symbol	Cohesion (PSF)	Friction Angle
N/A	AOC4-Geo2-D7	30-31.5	Ring	SM	○	301	44
					□	307	44

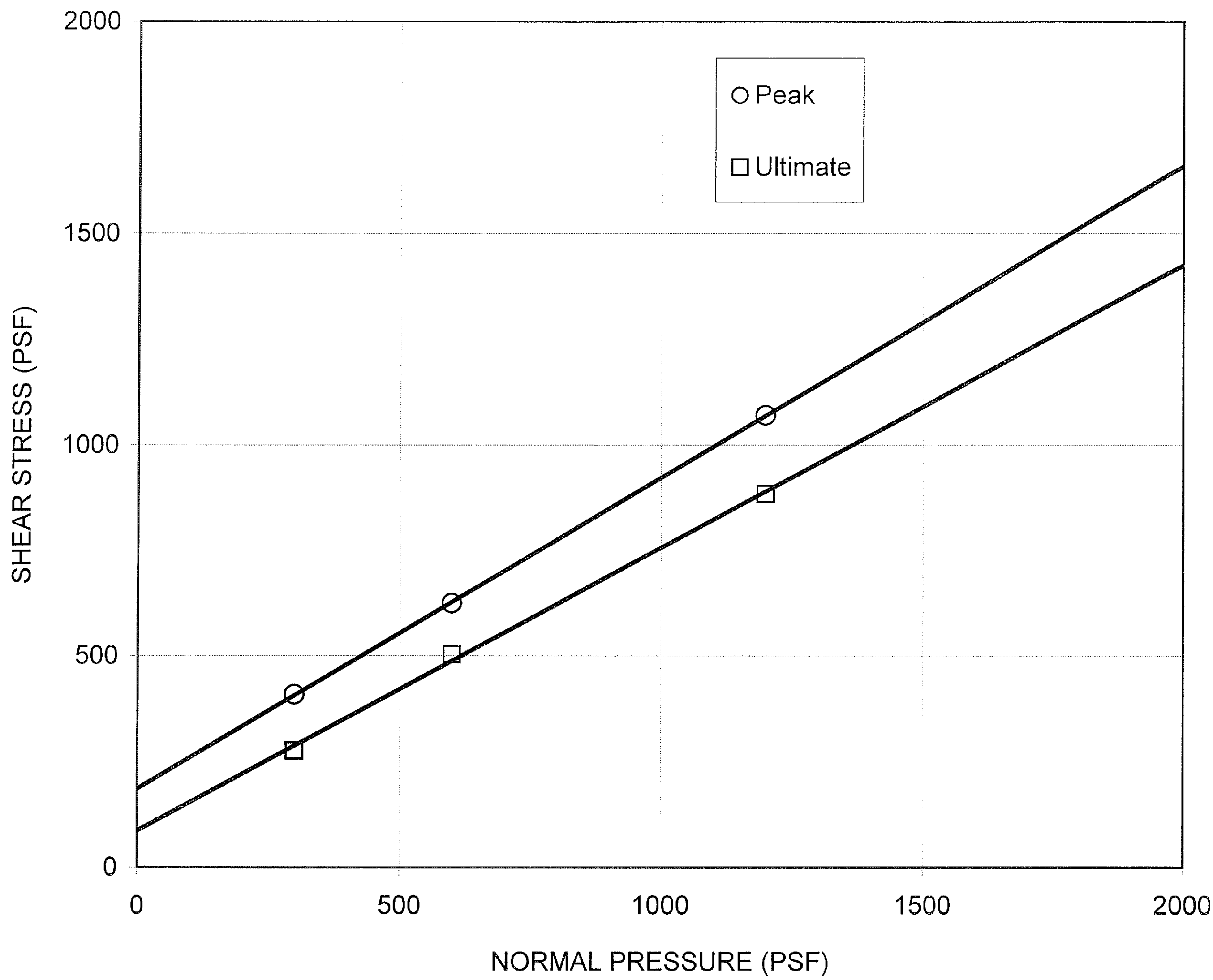
Normal Stress (psf)	Initial Moisture (%)	Final Moisture (%)
1800	0.9	12.8
3600	0.9	12.3
7200	0.9	11.0

ENVIRONMENTAL GEOTECHNOLOGY LABORATORY

Project Address:
PG&E Topock
Client: CH2M Hill
Project No: 382653.FP.03.01
EGL Project No: 09-119-001

DIRECT SHEAR

08/09 (ASTM D3080) Figure



Boring No.:	Sample No.	Depth (ft)	Sample Type	Soil Type	Symbol	Cohesion (PSF)	Friction Angle
N/A	AOC4-Geo2-B1	1-5	Bulk	SM	○	185	36
					□	86	34

Note: Sample was remolded to 90% maximum relative density and optimum moisture

Maximum Dry Density: 141 pcf Optimum Moisture: 5.5 %

Normal Stress (psf)	Initial Moisture (%)	Final Moisture (%)
300	5.5	13.1
600	5.5	12.5
1200	5.5	12.0

ENVIRONMENTAL GEOTECHNOLOGY LABORATORY

Project Address:
PG&E Topock

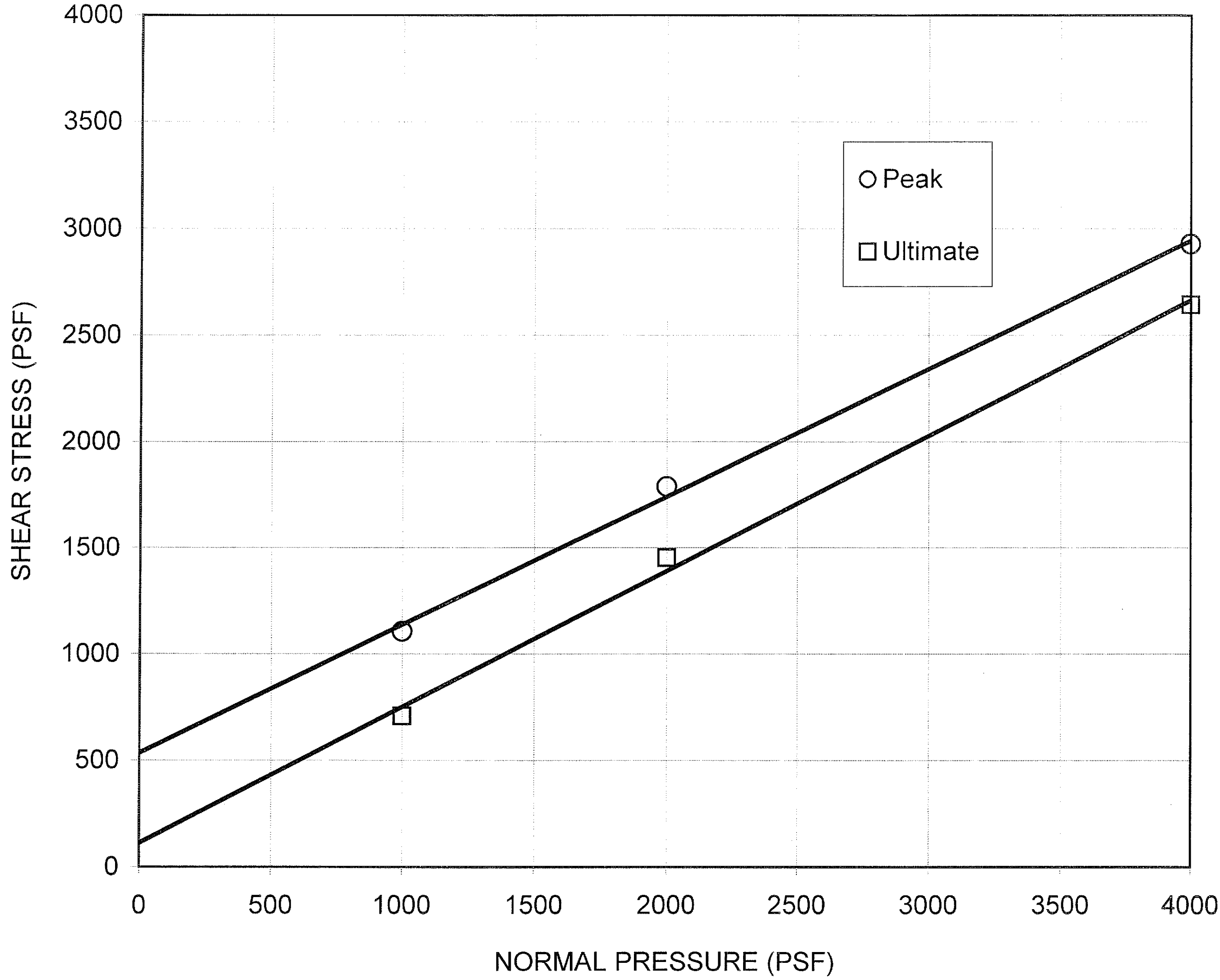
Client: CH2M Hill

Project No: 382653.FP.03.01

EGL Project No: 09-119-001

DIRECT SHEAR

08/09 (ASTM D3080) Figure



Boring No.:	Sample No.	Depth (ft)	Sample Type	Soil Type	Symbol	Cohesion (PSF)	Friction Angle
N/A	AOC4-Geo3-B5	16.5-20.0	Bulk	SM	○	534	31
					□	112	33

Note: Sample was remolded to 90% maximum relative density and optimum moisture

Maximum Dry Density: 141 pcf Optimum Moisture: 5.5 %

Normal Stress (psf)	Initial Moisture (%)	Final Moisture (%)
1000	5.5	12.9
2000	5.5	12.5
4000	5.5	12.3

ENVIRONMENTAL GEOTECHNOLOGY LABORATORY

Project Address: PG&E Topock

Client: CH2M Hill

Project No: 382653.FP.03.01

EGL Project No: 09-119-001

DIRECT SHEAR

08/09 (ASTM D3080) Figure

Attachment D
Remediation Well Design and Field Approach
(*on CD-ROM only*)

1. Introduction

The three primary types of remediation wells that are part of the remedy design are as follows.

1) Extraction Wells
2) Freshwater/Upland Injection Wells
3) In-situ Reactive Zone (IRZ) Injection Wells

Although each type of remediation well has its specific function within the remedy design, there are design and construction objectives in common with each of the remediation wells. For example, each type of remediation well will be constructed within boreholes of a 12-inch diameter or larger. Also common to each of the three types of remediation wells are the following overall design goals: (1) optimize the hydraulic connection between the remediation well and the natural subsurface materials (i.e., the formation); (2) select the optimal interval(s) at which to screen the well (i.e., the well screen interval[s]); and (3) build the well to ease/minimize well maintenance.

This Design Bulletin presents an approach for achieving these goals through well design planning and field construction methods. Section 2 presents the general design plan, including three designs for the remediation wells: (1) single-screen wells; (2) multi-screen wells; and (3) bedrock wells. Section 3 is a discussion of field methods to be considered for design and construction of the remediation wells.

2. Remediation Well Design General Plan

Geology at the site consists of unconsolidated alluvial and fluvial sediments that overlie a conglomerate bedrock unit. The unconsolidated sediments are typically a poorly-sorted mixture of silt, sand, and gravel with varying amounts of clay, and these sediments vary in thickness significantly from north to south, with thicknesses of greater than 400 ft reported to the north near proposed well IRZ-1and less than 75 ft reported to the south near proposed well IRZ-39. The identification of distinct, laterally-continuous lithostratigraphic or hydrostratigraphic zones cannot be correlated from borehole to borehole. Therefore, the screened intervals proposed for the remediation wells as shown on Table 3.2.1-1 of the 60% design document are preliminary, and are based in part on the total vertical thickness of the unconsolidated sediments that are saturated.

Final determination of the screened intervals will be made based on information collected in the field during construction of the wells. Borehole data, discrete vertical interval sampling, and data from newly constructed wells may be used to inform each well design as the construction program proceeds. Information collected during the drilling of the boreholes can be used to identify permeable portions of the vertical section (i.e., these may represent target intervals for either extraction, injection, or delivery of the carbon source material), and in the case of the IRZ wells, to identify the zones with the highest concentrations of Cr(VI). The screened intervals will be based on these considerations.

The remediation wells will be constructed using 8-inch or larger nominal diameter well casing with one or more screens targeting a specific interval or intervals of the unconsolidated sediments (and also bedrock in a few of the extraction wells). The following are three general designs for the remediation wells that will likely be implemented.

1) **Single Screen Wells –** This type of construction would consist of a single screen well installed within

the unconsolidated sediments. The length of the screen would be based on formation thickness, the intended function of the well, and potentially other data developed in the field. This is the likely construction of the Freshwater/Upland Injection Wells, most of the Extraction Wells, and potentially some of the IRZ Injection wells. Depending on the geologic conditions encountered in the field, it is possible that one or more blank sections of casing could be inserted within the screen zone to avoid screening intervals where significant fines are encountered.

2) **Multi-Screen Wells** – This type of construction would consist of two or more screens installed within the unconsolidated sediments. The well screen intervals would be selected using field data to target specific zones based on permeability and concentrations of Cr(VI) in groundwater. This is the expected construction for many of the IRZ Wells, although as noted above, there is the potential that some of the IRZ wells could be installed using a longer single screen design.
3) **Bedrock Wells** – This type of construction would consist of drilling through the unconsolidated sediments and installing an outer/conductor casing to the top of the bedrock. After the conductor casing is installed the drilling methodology may change to accommodate drilling in the bedrock formation. Sonic, air rotary, and wire line drilling methods – or combinations of these methods may be employed to reach the target depth within the bedrock. The final well construction may be either an open hole completion within the bedrock or a more traditional well with a single screened interval installed within the bedrock. This will depend on the competency of the bedrock. If the bedrock is weathered and/or unstable, it would be desirable to install a traditional well with a single screen. The most appropriate construction will be deployed based on site conditions encountered in the East Ravine.

3. Field Methods

There are a number of potential tools that may be used for the collection and analysis of field data for final well design. Such tools described herein include: pilot borings, grain-size distribution analysis, vertical aquifer sampling, and downhole geophysical logging. These tools can be important in the selection and design of well screens and the associated filter pack material. Also discussed in this section are well drilling, construction, and development methods.

It is likely that the field program will evolve as data are collected and assessed for the purposes of remediation well design. Thus, it is important that the well design program, including the field methods described below, retain a measure of flexibility.

Pilot Borings

Drilling boreholes of the size and depth necessary to install the remediation wells generally requires the use of rotary drilling methods (see below for further discussion of drilling methods). It is difficult when using rotary drilling methods to gain accurate and depth-specific information on subsurface materials. For this reason, it may be desirable to drill a smaller diameter (4 to 6-inch diameter) pilot boring at selected locations using the sonic drilling method. Pilot borings would facilitate the collection of a continuous core of subsurface materials, allowing more accurate visual assessment of the geology and selection of subsurface sediment and groundwater samples for further analysis in support of well design.

Visual Description and Grain-Size Distribution Analysis

The subsurface materials will be described in the field and written descriptions will be included on the field boring log. If a pilot boring is drilled at a location, then the continuous core would be described. If a pilot boring is not drilled then the cuttings would be described. The descriptions will be used to identify potential screen interval(s).

Subsurface sediment samples may be collected at several intervals and submitted to a geotechnical laboratory (potentially onsite if needed for quick sample analysis turnaround) for grain-size distribution analysis. The lab would run each subsurface sediment sample through a series of sieves to determine grain-size distribution. The grain-size distribution data would be used to custom design the remediation well screen slot size and filter pack (Driscoll, 1987).

Vertical Aquifer Sampling

Vertical aquifer sampling (VAS) may be conducted at selected pilot borings to further define the subsurface distribution of Cr(VI) in groundwater. VAS depth interval(s) will be selected based on data developed during drilling of the pilot holes, available data from previous investigations, and general aquifer characteristics (i.e., saturated thickness, grain size distribution, etc.). The decision to conduct VAS at any individual pilot boring and the decision of which depth intervals to sample will likely evolve as the field program progresses. .

VAS would likely be conducted as the borehole is advanced using a Hydro-Punch, a temporary well, or another alternate sampling method. The VAS sampling methodology selected would typically depend on drilling conditions and saturated aquifer thickness. In general, the Hydro-Punch method is quicker but typically produces a more turbid sample as compared to a temporary well method. The Hydro-Punch method is essentially a “grab” sample that allows for collection of a groundwater sample at a discrete depth without purging using a specialized tool that is run inside the drill stem using drilling rods. The temporary well sampling method uses a temporary 2-inch diameter well with an inflatable packer above the well screen; and once the target depth is reached, the temporary well is installed inside the drill stem which is then pulled back 5ft to expose the screen to the formation. The packer is inflated to isolate the well screen from the overlying water column and then the well is purged/pumped to collect the sample.

In instances when drilling conditions are difficult, the Hydro-Punch method would likely be the preferred method. In instances when drilling conditions are not difficult, the temporary well method may be preferred due to its ability to produce a less turbid sample and its greater sample integrity.

Downhole Geophysical Logging

Another type of data that may be collected from the pilot borings is downhole geophysical logs. There are many types of geophysical logging instruments that could potentially be used to develop additional subsurface data at the site to assist with determining appropriate remediation well screened intervals. Some types of downhole geophysical logging devices require direct access to the formation while others can be used inside a casing. Because the borehole may collapse when the drill stem is pulled back within the unconsolidated sediments, downhole geophysical logging methods may be limited to those that can be used inside a casing. One such geophysical logging method that could be used inside a drilling casing would be gamma-ray logging (Keys, 1988). If boreholes are stable, then open-hole borehole geophysical tools can be considered, including spontaneous potential, electrical resistivity, and sonic methods along with gamma-ray.

Screen and Filterpack Design

There are two key well components that can be designed using site-specific lithologic data: well screen slot size and filter pack. The screen slot size for a particular well design may be selected on a site-specific basis using lithologic data collected from a pilot boring as described above (samples selected from a continuous core for grain-size distribution analysis). Otherwise, if there is found to be little variability in the subsurface sediments, a more qualitative averaging approach can be used to select the screen slot size instead.

Typical accepted screen slot size design recommendations for non-homogeneous formations allows for a range of 40-50% of the formation materials to pass through the screen based on the grain size distribution (Driscoll, 1987 and Misstear et al., 2006). The percent passing recommendation for screen slot size selection may influence screen interval selection depending on the degree of heterogeneity in the subsurface materials.

Recommendations for well screen slot size design are typically a balance between maximizing open screen area which improves well performance and reduces the frequency of well maintenence, well development requirements which increase as percent passing increases, and the amount of fine-grained heterogeneities that could pose longer term turbidity issues in the well, a potential concern for the remediation wells. In some instances it may be desirable to recommend a different slot size for one portion of a screened interval compared to another or to even recommend that a blank section be installed.

In addition, the filter pack material that surrounds the screen may also be custom designed for each screen section in the well based on the formation grain-size and screen slot size recommendation. Typically, the recommended filter pack will consist of a well sorted, well rounded, sand of a grain size that allows <10% passing through the screen.

Well Drilling/Construction Methods

Unconsolidated Deposits

There are only a few drilling technologies available that will drill boreholes in the unconsolidated sediments of the size and depth needed to install the remediation wells. Drilling methods such as sonic and hollow stem augers are limited in regards to borehole diameter, and the cable tool method is generally considered too slow. Therefore, rotary methods are the likely recommendation for drilling the remediation wells in the unconsolidated sediments due to their speed and ability to drill large diameter (i.e., >12-inch diameter) boreholes to the likely target depths at the site. In general, it will be preferable to avoid the use of drilling mud to optimize the hydraulic connection between the well and the formation and to reduce the required well development time. For these reasons, dual tube rotary or reverse circulation rotary drilling methods which typically use water as drilling fluid would be preferred over the mud rotary drilling method. When pilot borings are needed the likely drilling method would be sonic.

Bedrock

The East Ravine area is the only location at the site where bedrock drilling is anticipated. Geology in this area consists of <200ft of unconsolidated sediments directly on top of bedrock. As discussed above, the bedrock wells would consist of installing a conductor casing to the top of the bedrock (or perhaps a few feet into the bedrock if the bedrock is weathered) using sonic drilling, followed by changing drilling methods to air rotary, wire line, or another appropriate method to drill the bedrock portion of the borehole.

Well Development Methods

Well development is a primary step in optimizing well performance after well construction and before well operation. A variety of development methods may be used to properly develop the remediation wells, including over pumping, jetting, air lifting, surging, and backwashing. The specific development methods will be determined based on the drilling method, well construction characteristics such as the number and length of well screens, and the grain-size distribution and sorting of the formation.

In general, the goals of well development are to repair damage to the formation incurred during drilling, and to optimize the hydraulic connection of the well to the formation. Typically it is recommended that turbidity and potentially other field parameters such as conductivity and pH are measured in the extracted fluids during well development to assess progress.

REFERENCES

Driscoll 1987. *Groundwater and Wells Second Edition*. Pub. Johnson Division, St. Paul, Minnesota 1089p.

Keys 1988. *Borehole Geophysics Applied To Ground-Water Investigations*. United States Geological Survey Open File Report 87-539, Denver, Colorado 305p.

Misstear, Banks, and Clark 2006. *Water Wells and Boreholes.* Pub. John Wiley & Sons, LTD, West Sussex, England 498p.

Attachment E
Firewater System Analyses
(*on CD-ROM only*)

By Paul Tjogas, E2 Consulting Engineers
August 2014

Topock Remediation Design

Hydraulic Analysis of Fire Water System

The existing fire water system at Topock Compressor Station needs to be expanded to accommodate new facilities associated with the groundwater remediation system. The existing fire water system is supplied from the freshwater tanks and consists of a pump station discharging to a six inch diameter distribution loop with branches to fourteen hydrants serving buildings and structures at the compressor station. This system needs to be expanded to provide water in case of fire at either the carbon amendment building at the TW bench or the MW-20 bench. A hydraulic network analysis was conducted to determine 1) the size of the expanded piping segments to serve TW and MW-20 bench, 2) whether existing storage capacity is sufficient and 3) if the existing fire pump station is adequate or needs to be modified.

A hydraulic network model of the expanded fire water system proposed for Topock remediation improvements was constructed using EPANET. EPANET is a software program that models water distribution piping systems. EPANET tracks the flow of water at each pipe, the pressure at each node, pumping heads and levels of water in tanks and reservoirs. Chemical species can be tracked, although that was not needed for the fire water system at Topock.

Pipe junctions, reservoirs and tanks are represented as nodes. A listing of nodes is contained on the following pages. Pipes, pumps and valves are represented as links. A listing of links is contained on the pages following the node listing. A schematic map showing the location of all nodes and links is shown on the sheet following the links listing.

The existing fire water system was compiled from as-built drawings when available. In the areas where as-built information was not available, piping routes were hypothesized based on logical assumptions. If more as-built information becomes available, then the analysis can be refined.

The piping routes and corridors for expanded piping segments have been approved by the client, Pacific Gas & Electric; however, they are subject to change pending stakeholder and regulatory review. The following summary describes the development of the hydraulic model:

Ground elevations for pipe junctions and tanks were taken from the 60% plan and profile sheets, which were based on the Toponex aerial survey. Pipe lengths have been taken off from plant as-built drawings and plan and profile drawings for the 60% submittal. Pump curve and test data was provided by PG & E

Projected fire flow demands are based on information provided from PG & E's fire protection consultant and data provided by the carbon amendment building designers. For the both the TW bench and MW-20 bench, the worst case fire flow scenario occurs at the carbon amendment buildings with its combustible roof and flammable liquid mixing. The projected fire flow demands are 0.30 gpm per sq ft plus a 500 gpm hose allowance. For the 480 sq ft building at the TW bench, this amounts to 644 gpm (at node 103). At the MW-20 bench this computes to 863 gpm (at node 102).

There are two existing fresh water tanks located above TCS at a base elevation of 672 feet (above sea level). Each tank is 30 feet high and contains 210,000 gallons. A minimum tank level of 2 feet and maximum tank level of 28 feet was assumed for this analysis.

There are two fire water pumps. One is an electric driven pump rated for approximately 900 gpm. The other is a diesel engine backup rated for approximately 1050 gpm.

Hazen-Williams C value of 120 was assumed for all existing pipes. New HDPE pipes were assumed to have a C value of 150.

The hydraulic network model of existing system was calibrated against the most recent pump test data results (September 2012) at hydrant 78. A comparison is shown in the table below.

Hydrant at Node 78	Measured	Modeled
Static pressure (closed)	160	156
Dynamic pressure (flowing)	98	96

Pipe sizing is an iterative process. After the initial simulation, pipe diameters for various segments of pipes are increased or decreased for subsequent simulations until an optimum size is selected for each segment. Typically, the criterion used for determining optimum size is unit head loss. In general, unit head losses of between 1 to 10 feet per 1,000 foot of pipe length yield the optimal combination of pipe capital cost and pumping energy costs. In this instance, the TW bench and MW-20 are sufficiently lower than the existing fire water system so that head losses in excess of 10 feet per 1,000 feet of pipe length are tolerable. The governing factor then becomes providing a minimum of 20 psi dynamic pressure at the hydrant. Hydraulic analysis simulations of 6 inch diameter (5.421 internal diameter for SDR 11 HDPE) for the expanded fire water piping yield sufficient dynamic pressures as shown in the table below:

Location	Pump	Tank Level	Residual Pressure
TW Bench	Electric	High	145
TW Bench	Electric	Low	133
TW Bench	Diesel	High	145
TW Bench	Diesel	Low	133
MW-20 Bench	Electric	High	44
MW-20 Bench	Electric	Low	33
MW-20 Bench	Diesel	High	44
MW-20 Bench	Diesel	Low	33

The criteria for fire flow volume is based on Insurance Services Office standard of one hour duration for each 1,000 gpm of fire flow plus one hour for each increment of 1,000 gpm fire flow. For the worst case scenario of 863 gpm, this indicates a one hour duration and a required fire flow volume of 51,780 gallons. The combined capacity of the 30 foot high freshwater tanks when full is 420,000 gallons, which is more than adequate. If the tanks are less than full, then storage is adequate assuming the following minimum tanks are maintained prior to the onset of a fire:

No. of Tanks in service	Supply wells	Required Minimum tank level
2	On	5.7
2	Off	7.2
1	On	9.4
1	Off	12.3

The required minimum tank level calculation assumes that the bottom two feet of the tank is dead storage and not available for consumption. It is assumed that the supply wells (from Arizona) will fully supply the groundwater remediation system and compressor system water demands during a fire flow emergency. If for some reason the supply wells are off (power outage, etc), then the tank must supply the fire flow (863 gpm) plus the combined remediation and compressor station demand (1200 gpm).

The supply well pumps will be set to maintain tanks levels significantly higher than the highest required minimum tank level (12.3).

The horsepower required to pump fire flows is less than the rated horsepower for the electric motor and diesel engine pumps. The electric driven pump results are summarized as follows:

Location	Q (gpm)	TDH (ft)	Pump Eff	Motor Eff	Hp	Rated Hp
TW bench	644	255.4	0.83	0.90	55.6	69.0
MW-20 bench	863	211.2	0.80	0.90	63.9	69.0

Q and TDH are taken from the hydraulic network simulations. Pump Eff is from the pump curves supplied by PG & E. Motor Eff is assumed at 90%. The rated hp includes a 1.15 service factor.

The diesel engine driven pump results are summarized as follows:

Location	Q (gpm)	TDH (ft)	Pump Eff	Engine Eff	Hp	Rated HP
TW bench	644	256.6	0.72	0.92	63.0	75.0
MW-20 bench	863	212.8	0.76	0.92	66.3	75.0

Q and TDH are taken from the hydraulic network simulations. Pump Eff and Engine Eff are from the pump curves supplied by PG & E. Engine Eff is back calculated from the engine hp curve.

The following conclusions may be drawn from the hydraulic analysis:

- Six inch diameter piping is sufficient for the expanded portion of the fire water system
- Existing storage is adequate for the fire flow scenarios anticipated
- Existing pumps are capable of supplying the worst case fire flows

If building sizes increase, then this analysis may need to be revisited.

By Paul Tjogas, E2 Consulting Engineers
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TCS Firewater Node Junction and Tank Data

Node	Type	Ground Elev	Demand
1	Tank	672	
2	Tank	672	
3	Junction	672	
4	Junction	627	
4A	Junction	627	
4B	Junction	627	
5	Junction	627	
5A	Junction	627	
5B	Junction	627	
6	Junction	627	
7	Junction	627	
8	Junction	621	
9	Junction	621	
10	Junction	617	
11	Junction	617	
12	Junction	623	
13	Junction	623	
14	Junction	621	
15	Junction	620	
16	Junction	617	
17	Junction	617	
18	Junction	617	
19	Junction	619	
20	Junction	621	
21	Junction	590	
22	Junction	590	
70	Hydrant	626	
71	Hydrant	626	
72	Hydrant	622	
73	Hydrant	626	
74	Hydrant	622	
75	Hydrant	622	
76	Hydrant	625	
77	Hydrant	622	
78	Hydrant	625	920
79	Hydrant	627	
80	Hydrant	622	
81	Hydrant	596	
82	Hydrant	590	
83	Hydrant	595	
101	Junction	532	
102	Junction	500	863
103	Junction	550	644

TCS Fire Water System Pipe and Pump Data

Link	Type	Upstr Node	Downstr Node	Dia (in)	Material	C value	Straight Length	Fitting Length	Equivalent Length	$V^2/2g$
1	Pipe	1	3	8	Stl	120	21	49	70	0.5
2	Pipe	2	3	8	Stl	120	21	49	70	0.5
3	Pipe	3	4	8	Stl	120	263	64	327	
4A	Pipe	4	4A	6	Stl	120	6	58	64	
4B	Pump	4A	4B							
4C	Pipe	4B	5	6	Stl	120	6	76	82	
5	Pipe	4	6	6	Stl	120	6	15	21	
6A	Pipe	6	6A	6	Stl	120	6	58	64	
6B	Pump	6A	6B							
6C	Pipe	6B	7	6	Stl	120	6	76	82	
7	Pipe	5	7	6	Stl	120	6	15	21	
8	Pipe	7	8	6	Stl	120	52	45	97	
9	Pipe	8	9	6	Stl	120	238	27	265	
10	Pipe	9	10	6	Stl	120	123	11	134	
11	Pipe	10	11	6	Stl	120	57	11	68	
12	Pipe	11	12	6	Stl	120	453	35	488	
13	Pipe	12	14	6	Stl	120	287	27	314	
14	Pipe	14	15	6	Stl	120	113	22	135	
15	Pipe	15	16	6	Stl	120	98	11	109	
16	Pipe	16	17	6	Stl	120	41	11	52	
17	Pipe	17	18	6	Stl	120	107	11	118	
18	Pipe	18	19	6	Stl	120	58	11	69	
19	Pipe	19	20	6	Stl	120	213	19	232	
20	Pipe	20	5	6	Stl	120	79	50	129	
21	Pipe	8	70	4	Stl	120	30	34	64	
22	Pipe	9	72	4	Stl	120	39	34	73	
23	Pipe	10	21	4	Stl	120	117	13	130	
24	Pipe	21	81	3	Stl	120	17	31	48	
25	Pipe	21	22	4	Stl	120	13	23	36	
26	Pipe	22	83	4	Stl	120	109	30	139	
27	Pipe	22	82	4	Stl	120	198	30	228	
28	Pipe	11	80	4	Stl	120	26	30	56	
29	Pipe	12	13	6	Stl	120	21	28	49	
30	Pipe	13	79	3	Stl	120	11	14	25	
31	Pipe	14	78	3	Stl	120	31	14	45	
32	Pipe	15	77	4	Stl	120	82	30	112	
33	Pipe	16	76	4	Stl	120	36	30	66	
34	Pipe	17	75	4	Stl	120	9	30	39	
35	Pipe	18	74	4	Stl	120	34	30	64	
36	Pipe	19	73	3	Stl	120	8	14	22	
37	Pipe	20	71	4	Stl	120	16	30	46	
101	Pipe	17	101	7.057	HDPE	150	911	55	966	
102	Pipe	101	102	5.421	HDPE	150	2661	283	2944	
103	Pipe	101	103	5.421	HDPE	150	290	45	335	

TCS Fire Pump Curve Data

Pump Curve Data				
Diesel Pump			Electric Pump	
Flow (gpm)	Head (ft)		Flow (gpm)	Head (ft)
0	144		0	290
200	140		200	286
400	130		400	280
600	117		600	265
800	100		800	229
1000	77		1000	170
1200	47		1200	100
Test Data				
Diesel Pump			Electric Pump	
Flow (gpm)	Head (ft)		Flow (gpm)	Head (ft)
0	334.56		0	281.50
272	318.41		450	276.88
800	230.73		784	239.96
1125	138.44		968	173.05

644 gpm fire flow at TW bench, electric pump on, high water tank levels

Network Table - Nodes

Node ID	Demand GPM	Head ft	Pressure psi
Junc 3	0.00	699.79	12.04
Junc 4	0.00	696.72	30.21
Junc 4A	0.00	694.28	29.15
Junc 4B	0.00	949.72	139.83
Junc 5	0.00	946.59	138.48
Junc 6A	0.00	696.72	30.21
Junc 6B	0.00	946.48	138.43
Junc 6	0.00	696.72	30.21
Junc 7	0.00	946.48	138.43
Junc 8	0.00	945.94	140.80
Junc 9	0.00	944.47	140.16
Junc 10	0.00	943.73	141.57
Junc 11	0.00	943.36	141.41
Junc 12	0.00	940.65	137.64
Junc 13	0.00	940.65	137.64
Junc 14	0.00	938.92	137.75
Junc 15	0.00	938.17	137.86
Junc 16	0.00	937.57	138.90
Junc 17	0.00	937.28	138.78
Junc 18	0.00	939.28	139.65
Junc 19	0.00	940.46	139.29
Junc 20	0.00	944.40	140.13
Junc 21	0.00	943.73	153.27
Junc 22	0.00	943.73	153.27
Junc 70	0.00	945.94	138.63

644 gpm fire flow at TW bench, electric pump on, high water tank levels

Node ID	Demand GPM	Head ft	Pressure psi
Junc 71	0.00	944.40	137.96
Junc 72	0.00	944.47	139.73
Junc 73	0.00	940.46	136.25
Junc 74	0.00	939.28	137.48
Junc 75	0.00	937.28	136.61
Junc 76	0.00	937.57	135.43
Junc 77	0.00	938.17	137.00
Junc 78	0.00	938.92	136.02
Junc 79	0.00	940.65	135.91
Junc 80	0.00	943.36	139.24
Junc 81	0.00	943.73	150.67
Junc 82	0.00	943.73	153.27
Junc 83	0.00	943.73	151.11
Junc 101	0.00	897.39	158.32
Junc 102	0.00	897.39	172.19
Junc 103	644.00	883.56	144.53
Tank 1	-322.01	700.00	12.13
Tank 2	-322.01	700.00	12.13

644 gpm fire flow at TW bench, electric pump on, high water tank levels

Network Table - Links

Link ID	Flow GPM	Velocity fps	Unit Headloss ft/Kft	Status
Pipe 1	322.01	2.06	3.07	Open
Pipe 2	322.01	2.06	3.07	Open
Pipe 3	644.01	4.11	9.38	Open
Pipe 4A	644.01	7.31	38.08	Open
Pipe 4C	644.01	7.31	38.08	Open
Pipe 5	0.00	0.00	0.00	Open
Pipe 6A	0.00	0.00	0.00	Open
Pipe 6C	0.00	0.00	0.00	Open
Pipe 7	227.34	2.58	5.53	Open
Pipe 8	227.34	2.58	5.54	Open
Pipe 9	227.34	2.58	5.54	Open
Pipe 10	227.34	2.58	5.54	Open
Pipe 11	227.34	2.58	5.54	Open
Pipe 12	227.34	2.58	5.54	Open
Pipe 13	227.33	2.58	5.54	Open
Pipe 14	227.33	2.58	5.54	Open
Pipe 15	227.33	2.58	5.54	Open
Pipe 16	227.33	2.58	5.54	Open
Pipe 17	-416.67	4.73	17.00	Open
Pipe 18	-416.67	4.73	17.00	Open
Pipe 19	-416.67	4.73	17.00	Open
Pipe 20	-416.67	4.73	17.00	Open
Pipe 21	0.00	0.00	0.00	Open
Pipe 22	0.00	0.00	0.00	Open
Pipe 23	0.00	0.00	0.00	Open

644 gpm fire flow at TW bench, electric pump on, high water tank levels

Link ID	Flow GPM	Velocity fps	Unit Headloss ft/Kft	Status
Pipe 24	0.00	0.00	0.00	Open
Pipe 25	0.00	0.00	0.00	Open
Pipe 26	0.00	0.00	0.00	Open
Pipe 27	0.00	0.00	0.00	Open
Pipe 28	0.00	0.00	0.00	Open
Pipe 29	0.00	0.00	0.00	Open
Pipe 30	0.00	0.00	0.00	Open
Pipe 31	0.00	0.00	0.00	Open
Pipe 32	0.00	0.00	0.00	Open
Pipe 33	0.00	0.00	0.00	Open
Pipe 34	0.00	0.00	0.00	Open
Pipe 35	0.00	0.00	0.00	Open
Pipe 36	0.00	0.00	0.00	Open
Pipe 37	0.00	0.00	0.00	Open
Pipe 101	644.00	8.95	41.29	Open
Pipe 102	0.00	0.00	0.00	Open
Pipe 103	644.00	8.95	41.29	Open
Pump 4B	644.01	0.00	-255.43	Open
Pump 6B	0.00	0.00	0.00	Closed

644 gpm fire flow at TW bench, electric pump on, low water tank levels

Network Table - Nodes

Node ID	Demand GPM	Head ft	Pressure psi
Junc 3	0.00	673.79	0.77
Junc 4	0.00	670.72	18.94
Junc 4A	0.00	668.28	17.89
Junc 4B	0.00	923.72	128.57
Junc 5	0.00	920.59	127.21
Junc 6A	0.00	670.72	18.94
Junc 6B	0.00	920.48	127.16
Junc 6	0.00	670.72	18.94
Junc 7	0.00	920.48	127.16
Junc 8	0.00	919.94	129.53
Junc 9	0.00	918.47	128.90
Junc 10	0.00	917.73	130.31
Junc 11	0.00	917.35	130.14
Junc 12	0.00	914.65	126.37
Junc 13	0.00	914.65	126.37
Junc 14	0.00	912.92	126.49
Junc 15	0.00	912.17	126.60
Junc 16	0.00	911.56	127.63
Junc 17	0.00	911.28	127.51
Junc 18	0.00	913.28	128.38
Junc 19	0.00	914.46	128.02
Junc 20	0.00	918.40	128.86
Junc 21	0.00	917.73	142.01
Junc 22	0.00	917.73	142.01
Junc 70	0.00	919.94	127.36

644 gpm fire flow at TW bench, electric pump on, low water tank levels

Node ID	Demand GPM	Head ft	Pressure psi
Junc 71	0.00	918.40	126.70
Junc 72	0.00	918.47	128.46
Junc 73	0.00	914.46	124.99
Junc 74	0.00	913.28	126.21
Junc 75	0.00	911.28	125.34
Junc 76	0.00	911.56	124.17
Junc 77	0.00	912.17	125.73
Junc 78	0.00	912.92	124.75
Junc 79	0.00	914.65	124.64
Junc 80	0.00	917.35	127.98
Junc 81	0.00	917.73	139.41
Junc 82	0.00	917.73	142.01
Junc 83	0.00	917.73	139.84
Junc 101	0.00	871.39	147.06
Junc 102	0.00	871.39	160.92
Junc 103	644.00	857.56	133.26
Tank 1	-322.01	674.00	0.87
Tank 2	-322.01	674.00	0.87

644 gpm fire flow at TW bench, electric pump on, low water tank levels

Network Table - Links

Link ID	Flow GPM	Velocity fps	Unit Headloss ft/Kft	Status
Pipe 1	322.01	2.06	3.07	Open
Pipe 2	322.01	2.06	3.07	Open
Pipe 3	644.01	4.11	9.38	Open
Pipe 4A	644.01	7.31	38.08	Open
Pipe 4C	644.01	7.31	38.08	Open
Pipe 5	0.00	0.00	0.00	Open
Pipe 6A	0.00	0.00	0.00	Open
Pipe 6C	0.00	0.00	0.00	Open
Pipe 7	227.34	2.58	5.54	Open
Pipe 8	227.34	2.58	5.54	Open
Pipe 9	227.34	2.58	5.54	Open
Pipe 10	227.34	2.58	5.54	Open
Pipe 11	227.34	2.58	5.54	Open
Pipe 12	227.34	2.58	5.54	Open
Pipe 13	227.33	2.58	5.54	Open
Pipe 14	227.33	2.58	5.54	Open
Pipe 15	227.33	2.58	5.54	Open
Pipe 16	227.33	2.58	5.54	Open
Pipe 17	-416.67	4.73	17.00	Open
Pipe 18	-416.67	4.73	17.00	Open
Pipe 19	-416.67	4.73	17.00	Open
Pipe 20	-416.67	4.73	17.00	Open
Pipe 21	0.00	0.00	0.00	Open
Pipe 22	0.00	0.00	0.00	Open
Pipe 23	0.00	0.00	0.00	Open

644 gpm fire flow at TW bench, electric pump on, low water tank levels

Link ID	Flow GPM	Velocity fps	Unit Headloss ft/Kft	Status
Pipe 24	0.00	0.00	0.00	Open
Pipe 25	0.00	0.00	0.00	Open
Pipe 26	0.00	0.00	0.00	Open
Pipe 27	0.00	0.00	0.00	Open
Pipe 28	0.00	0.00	0.00	Open
Pipe 29	0.00	0.00	0.00	Open
Pipe 30	0.00	0.00	0.00	Open
Pipe 31	0.00	0.00	0.00	Open
Pipe 32	0.00	0.00	0.00	Open
Pipe 33	0.00	0.00	0.00	Open
Pipe 34	0.00	0.00	0.00	Open
Pipe 35	0.00	0.00	0.00	Open
Pipe 36	0.00	0.00	0.00	Open
Pipe 37	0.00	0.00	0.00	Open
Pipe 101	644.00	8.95	41.29	Open
Pipe 102	0.00	0.00	0.00	Open
Pipe 103	644.00	8.95	41.29	Open
Pump 4B	644.01	0.00	-255.43	Open
Pump 6B	0.00	0.00	0.00	Closed

644 gpm fire flow at TW bench, diesel pump on, high water tank levels

Network Table - Nodes

Node ID	Demand GPM	Head ft	Pressure psi
Junc 3	0.00	699.79	12.04
Junc 4	0.00	696.72	30.21
Junc 4A	0.00	696.72	30.21
Junc 4B	0.00	946.64	138.50
Junc 5	0.00	946.64	138.50
Junc 6A	0.00	693.48	28.81
Junc 6B	0.00	950.12	140.01
Junc 6	0.00	695.92	29.86
Junc 7	0.00	947.00	138.65
Junc 8	0.00	946.44	141.01
Junc 9	0.00	944.93	140.36
Junc 10	0.00	944.16	141.76
Junc 11	0.00	943.77	141.59
Junc 12	0.00	940.98	137.78
Junc 13	0.00	940.98	137.78
Junc 14	0.00	939.19	137.87
Junc 15	0.00	938.41	137.97
Junc 16	0.00	937.79	139.00
Junc 17	0.00	937.49	138.87
Junc 18	0.00	939.46	139.72
Junc 19	0.00	940.62	139.36
Junc 20	0.00	944.49	140.17
Junc 21	0.00	944.16	153.46
Junc 22	0.00	944.16	153.46
Junc 70	0.00	946.44	138.85

644 gpm fire flow at TW bench, diesel pump on, high water tank levels

Node ID	Demand GPM	Head ft	Pressure psi
Junc 71	0.00	944.49	138.00
Junc 72	0.00	944.93	139.92
Junc 73	0.00	940.62	136.32
Junc 74	0.00	939.46	137.56
Junc 75	0.00	937.49	136.70
Junc 76	0.00	937.79	135.53
Junc 77	0.00	938.41	137.10
Junc 78	0.00	939.19	136.14
Junc 79	0.00	940.98	136.05
Junc 80	0.00	943.77	139.42
Junc 81	0.00	944.16	150.86
Junc 82	0.00	944.16	153.46
Junc 83	0.00	944.16	151.29
Junc 101	0.00	897.61	158.42
Junc 102	0.00	897.61	172.28
Junc 103	644.00	883.77	144.62
Tank 1	-322.00	700.00	12.13
Tank 2	-322.00	700.00	12.13

644 gpm fire flow at TW bench, diesel pump on, high water tank levels

Network Table - Links

Link ID	Flow GPM	Velocity fps	Unit Headloss ft/Kft	Status
Pipe 1	322.00	2.06	3.07	Open
Pipe 2	322.00	2.06	3.07	Open
Pipe 3	644.00	4.11	9.38	Open
Pipe 4A	0.00	0.00	0.00	Open
Pipe 4C	0.00	0.00	0.00	Open
Pipe 5	644.00	7.31	38.08	Open
Pipe 6A	644.00	7.31	38.08	Open
Pipe 6C	644.00	7.31	38.08	Open
Pipe 7	-412.67	4.68	16.70	Open
Pipe 8	231.33	2.62	5.72	Open
Pipe 9	231.33	2.62	5.72	Open
Pipe 10	231.33	2.62	5.72	Open
Pipe 11	231.33	2.62	5.72	Open
Pipe 12	231.33	2.62	5.72	Open
Pipe 13	231.33	2.62	5.72	Open
Pipe 14	231.33	2.62	5.72	Open
Pipe 15	231.33	2.62	5.72	Open
Pipe 16	231.33	2.62	5.72	Open
Pipe 17	-412.67	4.68	16.70	Open
Pipe 18	-412.67	4.68	16.70	Open
Pipe 19	-412.67	4.68	16.70	Open
Pipe 20	-412.67	4.68	16.70	Open
Pipe 21	0.00	0.00	0.00	Open
Pipe 22	0.00	0.00	0.00	Open
Pipe 23	0.00	0.00	0.00	Open

644 gpm fire flow at TW bench, diesel pump on, high water tank levels

Link ID	Flow GPM	Velocity fps	Unit Headloss ft/Kft	Status
Pipe 24	0.00	0.00	0.00	Open
Pipe 25	0.00	0.00	0.00	Open
Pipe 26	0.00	0.00	0.00	Open
Pipe 27	0.00	0.00	0.00	Open
Pipe 28	0.00	0.00	0.00	Open
Pipe 29	0.00	0.00	0.00	Open
Pipe 30	0.00	0.00	0.00	Open
Pipe 31	0.00	0.00	0.00	Open
Pipe 32	0.00	0.00	0.00	Open
Pipe 33	0.00	0.00	0.00	Open
Pipe 34	0.00	0.00	0.00	Open
Pipe 35	0.00	0.00	0.00	Open
Pipe 36	0.00	0.00	0.00	Open
Pipe 37	0.00	0.00	0.00	Open
Pipe 101	644.00	8.95	41.29	Open
Pipe 102	0.00	0.00	0.00	Open
Pipe 103	644.00	8.95	41.29	Open
Pump 4B	0.00	0.00	0.00	Closed
Pump 6B	644.00	0.00	-256.64	Open

644 gpm fire flow at TW bench, diesel pump on, low water tank levels

Network Table - Nodes

Node ID	Demand GPM	Head ft	Pressure psi
Junc 3	0.00	673.79	0.77
Junc 4	0.00	670.72	18.94
Junc 4A	0.00	670.72	18.94
Junc 4B	0.00	920.64	127.24
Junc 5	0.00	920.64	127.24
Junc 6A	0.00	667.48	17.54
Junc 6B	0.00	924.12	128.74
Junc 6	0.00	669.92	18.60
Junc 7	0.00	921.00	127.39
Junc 8	0.00	920.44	129.75
Junc 9	0.00	918.93	129.09
Junc 10	0.00	918.16	130.49
Junc 11	0.00	917.77	130.32
Junc 12	0.00	914.98	126.52
Junc 13	0.00	914.98	126.52
Junc 14	0.00	913.19	126.60
Junc 15	0.00	912.41	126.70
Junc 16	0.00	911.79	127.73
Junc 17	0.00	911.49	127.60
Junc 18	0.00	913.46	128.46
Junc 19	0.00	914.62	128.09
Junc 20	0.00	918.49	128.90
Junc 21	0.00	918.16	142.19
Junc 22	0.00	918.16	142.19
Junc 70	0.00	920.44	127.58

644 gpm fire flow at TW bench, diesel pump on, low water tank levels

Node ID	Demand GPM	Head ft	Pressure psi
Junc 71	0.00	918.49	126.74
Junc 72	0.00	918.93	128.66
Junc 73	0.00	914.62	125.06
Junc 74	0.00	913.46	126.29
Junc 75	0.00	911.49	125.44
Junc 76	0.00	911.79	124.27
Junc 77	0.00	912.41	125.84
Junc 78	0.00	913.19	124.87
Junc 79	0.00	914.98	124.78
Junc 80	0.00	917.77	128.16
Junc 81	0.00	918.16	139.59
Junc 82	0.00	918.16	142.19
Junc 83	0.00	918.16	140.03
Junc 101	0.00	871.61	147.15
Junc 102	0.00	871.61	161.02
Junc 103	644.00	857.77	133.36
Tank 1	-322.00	674.00	0.87
Tank 2	-322.00	674.00	0.87

644 gpm fire flow at TW bench, diesel pump on, low water tank levels

Network Table - Links

Link ID	Flow GPM	Velocity fps	Unit Headloss ft/Kft	Status
Pipe 1	322.00	2.06	3.07	Open
Pipe 2	322.00	2.06	3.07	Open
Pipe 3	644.00	4.11	9.38	Open
Pipe 4A	0.00	0.00	0.00	Open
Pipe 4C	0.00	0.00	0.00	Open
Pipe 5	644.00	7.31	38.08	Open
Pipe 6A	644.00	7.31	38.08	Open
Pipe 6C	644.00	7.31	38.08	Open
Pipe 7	-412.67	4.68	16.70	Open
Pipe 8	231.33	2.62	5.72	Open
Pipe 9	231.33	2.62	5.72	Open
Pipe 10	231.33	2.62	5.72	Open
Pipe 11	231.33	2.62	5.72	Open
Pipe 12	231.33	2.62	5.72	Open
Pipe 13	231.33	2.62	5.72	Open
Pipe 14	231.33	2.62	5.72	Open
Pipe 15	231.33	2.62	5.72	Open
Pipe 16	231.33	2.62	5.72	Open
Pipe 17	-412.67	4.68	16.70	Open
Pipe 18	-412.67	4.68	16.70	Open
Pipe 19	-412.67	4.68	16.70	Open
Pipe 20	-412.67	4.68	16.70	Open
Pipe 21	0.00	0.00	0.00	Open
Pipe 22	0.00	0.00	0.00	Open
Pipe 23	0.00	0.00	0.00	Open

644 gpm fire flow at TW bench, diesel pump on, low water tank levels

Link ID	Flow GPM	Velocity fps	Unit Headloss ft/Kft	Status
Pipe 24	0.00	0.00	0.00	Open
Pipe 25	0.00	0.00	0.00	Open
Pipe 26	0.00	0.00	0.00	Open
Pipe 27	0.00	0.00	0.00	Open
Pipe 28	0.00	0.00	0.00	Open
Pipe 29	0.00	0.00	0.00	Open
Pipe 30	0.00	0.00	0.00	Open
Pipe 31	0.00	0.00	0.00	Open
Pipe 32	0.00	0.00	0.00	Open
Pipe 33	0.00	0.00	0.00	Open
Pipe 34	0.00	0.00	0.00	Open
Pipe 35	0.00	0.00	0.00	Open
Pipe 36	0.00	0.00	0.00	Open
Pipe 37	0.00	0.00	0.00	Open
Pipe 101	644.00	8.95	41.29	Open
Pipe 102	0.00	0.00	0.00	Open
Pipe 103	644.00	8.95	41.29	Open
Pump 4B	0.00	0.00	0.00	Closed
Pump 6B	644.00	0.00	-256.64	Open

863 gpm fire flow at MW-20 bench, electric pump on, high water tank levels

Network Table - Nodes

Node ID	Demand GPM	Head ft	Pressure psi
Junc 3	0.00	699.63	11.97
Junc 4	0.00	694.36	29.19
Junc 4A	0.00	690.16	27.37
Junc 4B	0.00	901.39	118.89
Junc 5	0.00	896.02	116.57
Junc 6A	0.00	694.36	29.19
Junc 6B	0.00	895.82	116.48
Junc 6	0.00	694.36	29.19
Junc 7	0.00	895.82	116.48
Junc 8	0.00	894.90	118.68
Junc 9	0.00	892.38	117.59
Junc 10	0.00	891.10	118.77
Junc 11	0.00	890.45	118.49
Junc 12	0.00	885.81	113.88
Junc 13	0.00	885.81	113.88
Junc 14	0.00	882.82	113.45
Junc 15	0.00	881.54	113.32
Junc 16	0.00	880.50	114.17
Junc 17	0.00	880.00	113.96
Junc 18	0.00	883.45	115.45
Junc 19	0.00	885.47	115.46
Junc 20	0.00	892.25	117.53
Junc 21	0.00	891.10	130.47
Junc 22	0.00	891.10	130.47
Junc 70	0.00	894.90	116.51

863 gpm fire flow at MW-20 bench, electric pump on, high water tank levels

Node ID	Demand GPM	Head ft	Pressure psi
Junc 71	0.00	892.25	115.37
Junc 72	0.00	892.38	117.15
Junc 73	0.00	885.47	112.43
Junc 74	0.00	883.45	113.29
Junc 75	0.00	880.00	111.79
Junc 76	0.00	880.50	110.71
Junc 77	0.00	881.54	112.46
Junc 78	0.00	882.82	111.71
Junc 79	0.00	885.81	112.14
Junc 80	0.00	890.45	116.32
Junc 81	0.00	891.10	127.87
Junc 82	0.00	891.10	130.47
Junc 83	0.00	891.10	128.30
Junc 101	0.00	811.41	121.07
Junc 102	863.00	602.37	44.36
Junc 103	0.00	811.41	113.27
Tank 1	-431.51	700.00	12.13
Tank 2	-431.51	700.00	12.13

863 gpm fire flow at MW-20 bench, electric pump on, high water tank levels

Network Table - Links

Link ID	Flow GPM	Velocity fps	Unit Headloss ft/Kft	Status
Pipe 1	431.51	2.75	5.31	Open
Pipe 2	431.51	2.75	5.31	Open
Pipe 3	863.01	5.51	16.13	Open
Pipe 4A	863.01	9.79	65.48	Open
Pipe 4C	863.01	9.79	65.48	Open
Pipe 5	0.00	0.00	0.00	Open
Pipe 6A	0.00	0.00	0.00	Open
Pipe 6C	0.00	0.00	0.00	Open
Pipe 7	304.65	3.46	9.52	Open
Pipe 8	304.65	3.46	9.52	Open
Pipe 9	304.65	3.46	9.52	Open
Pipe 10	304.65	3.46	9.52	Open
Pipe 11	304.64	3.46	9.52	Open
Pipe 12	304.64	3.46	9.52	Open
Pipe 13	304.64	3.46	9.52	Open
Pipe 14	304.64	3.46	9.52	Open
Pipe 15	304.64	3.46	9.52	Open
Pipe 16	304.64	3.46	9.52	Open
Pipe 17	-558.36	6.34	29.23	Open
Pipe 18	-558.36	6.34	29.23	Open
Pipe 19	-558.36	6.34	29.23	Open
Pipe 20	-558.36	6.34	29.23	Open
Pipe 21	0.00	0.00	0.00	Open
Pipe 22	0.00	0.00	0.00	Open
Pipe 23	0.00	0.00	0.00	Open

863 gpm fire flow at MW-20 bench, electric pump on, high water tank levels

Link ID	Flow GPM	Velocity fps	Unit Headloss ft/Kft	Status
Pipe 24	0.00	0.00	0.00	Open
Pipe 25	0.00	0.00	0.00	Open
Pipe 26	0.00	0.00	0.00	Open
Pipe 27	0.00	0.00	0.00	Open
Pipe 28	0.00	0.00	0.00	Open
Pipe 29	0.00	0.00	0.00	Open
Pipe 30	0.00	0.00	0.00	Open
Pipe 31	0.00	0.00	0.00	Open
Pipe 32	0.00	0.00	0.00	Open
Pipe 33	0.00	0.00	0.00	Open
Pipe 34	0.00	0.00	0.00	Open
Pipe 35	0.00	0.00	0.00	Open
Pipe 36	0.00	0.00	0.00	Open
Pipe 37	0.00	0.00	0.00	Open
Pipe 101	863.00	12.00	71.01	Open
Pipe 102	863.00	12.00	71.01	Open
Pipe 103	0.00	0.00	0.00	Open
Pump 4B	863.01	0.00	-211.23	Open
Pump 6B	0.00	0.00	0.00	Closed

863 gpm fire flow at MW-20 bench, electric pump on, low water tank levels

Network Table - Nodes

Node ID	Demand GPM	Head ft	Pressure psi
Junc 3	0.00	673.63	0.71
Junc 4	0.00	668.36	17.92
Junc 4A	0.00	664.16	16.10
Junc 4B	0.00	875.39	107.63
Junc 5	0.00	870.02	105.30
Junc 6A	0.00	668.36	17.92
Junc 6B	0.00	869.82	105.22
Junc 6	0.00	668.36	17.92
Junc 7	0.00	869.82	105.22
Junc 8	0.00	868.90	107.42
Junc 9	0.00	866.38	106.32
Junc 10	0.00	865.10	107.50
Junc 11	0.00	864.45	107.22
Junc 12	0.00	859.81	102.61
Junc 13	0.00	859.81	102.61
Junc 14	0.00	856.82	102.18
Junc 15	0.00	855.54	102.06
Junc 16	0.00	854.50	102.91
Junc 17	0.00	854.00	102.69
Junc 18	0.00	857.45	104.19
Junc 19	0.00	859.47	104.20
Junc 20	0.00	866.25	106.27
Junc 21	0.00	865.10	119.20
Junc 22	0.00	865.10	119.20
Junc 70	0.00	868.90	105.25

863 gpm fire flow at MW-20 bench, electric pump on, low water tank levels

Node ID	Demand GPM	Head ft	Pressure psi
Junc 71	0.00	866.25	104.10
Junc 72	0.00	866.38	105.89
Junc 73	0.00	859.47	101.16
Junc 74	0.00	857.45	102.02
Junc 75	0.00	854.00	100.53
Junc 76	0.00	854.50	99.44
Junc 77	0.00	855.54	101.19
Junc 78	0.00	856.82	100.45
Junc 79	0.00	859.81	100.88
Junc 80	0.00	864.45	105.06
Junc 81	0.00	865.10	116.60
Junc 82	0.00	865.10	119.20
Junc 83	0.00	865.10	117.04
Junc 101	0.00	785.41	109.80
Junc 102	863.00	576.37	33.09
Junc 103	0.00	785.41	102.00
Tank 1	-431.51	674.00	0.87
Tank 2	-431.51	674.00	0.87

863 gpm fire flow at MW-20 bench, electric pump on, low water tank levels

Network Table - Links

Link ID	Flow GPM	Velocity fps	Unit Headloss ft/Kft	Status
Pipe 1	431.51	2.75	5.31	Open
Pipe 2	431.51	2.75	5.31	Open
Pipe 3	863.01	5.51	16.13	Open
Pipe 4A	863.01	9.79	65.48	Open
Pipe 4C	863.01	9.79	65.48	Open
Pipe 5	0.00	0.00	0.00	Open
Pipe 6A	0.00	0.00	0.00	Open
Pipe 6C	0.00	0.00	0.00	Open
Pipe 7	304.65	3.46	9.52	Open
Pipe 8	304.65	3.46	9.52	Open
Pipe 9	304.65	3.46	9.52	Open
Pipe 10	304.65	3.46	9.52	Open
Pipe 11	304.64	3.46	9.52	Open
Pipe 12	304.64	3.46	9.52	Open
Pipe 13	304.64	3.46	9.52	Open
Pipe 14	304.64	3.46	9.52	Open
Pipe 15	304.64	3.46	9.52	Open
Pipe 16	304.64	3.46	9.52	Open
Pipe 17	-558.36	6.34	29.23	Open
Pipe 18	-558.36	6.34	29.23	Open
Pipe 19	-558.36	6.34	29.23	Open
Pipe 20	-558.36	6.34	29.23	Open
Pipe 21	0.00	0.00	0.00	Open
Pipe 22	0.00	0.00	0.00	Open
Pipe 23	0.00	0.00	0.00	Open

863 gpm fire flow at MW-20 bench, electric pump on, low water tank levels

Link ID	Flow GPM	Velocity fps	Unit Headloss ft/Kft	Status
Pipe 24	0.00	0.00	0.00	Open
Pipe 25	0.00	0.00	0.00	Open
Pipe 26	0.00	0.00	0.00	Open
Pipe 27	0.00	0.00	0.00	Open
Pipe 28	0.00	0.00	0.00	Open
Pipe 29	0.00	0.00	0.00	Open
Pipe 30	0.00	0.00	0.00	Open
Pipe 31	0.00	0.00	0.00	Open
Pipe 32	0.00	0.00	0.00	Open
Pipe 33	0.00	0.00	0.00	Open
Pipe 34	0.00	0.00	0.00	Open
Pipe 35	0.00	0.00	0.00	Open
Pipe 36	0.00	0.00	0.00	Open
Pipe 37	0.00	0.00	0.00	Open
Pipe 101	863.00	12.00	71.01	Open
Pipe 102	863.00	12.00	71.01	Open
Pipe 103	0.00	0.00	0.00	Open
Pump 4B	863.01	0.00	-211.23	Open
Pump 6B	0.00	0.00	0.00	Closed

863 gpm fire flow at MW-20 bench, diesel pump on, high water tank levels

Network Table - Nodes

Node ID	Demand GPM	Head ft	Pressure psi
Junc 3	0.00	699.63	11.97
Junc 4	0.00	694.36	29.19
Junc 4A	0.00	694.36	29.19
Junc 4B	0.00	895.65	116.41
Junc 5	0.00	895.65	116.41
Junc 6A	0.00	688.79	26.77
Junc 6B	0.00	901.63	119.00
Junc 6	0.00	692.98	28.59
Junc 7	0.00	896.26	116.67
Junc 8	0.00	895.30	118.86
Junc 9	0.00	892.70	117.73
Junc 10	0.00	891.38	118.89
Junc 11	0.00	890.71	118.60
Junc 12	0.00	885.91	113.92
Junc 13	0.00	885.91	113.92
Junc 14	0.00	882.83	113.45
Junc 15	0.00	881.50	113.31
Junc 16	0.00	880.43	114.14
Junc 17	0.00	879.92	113.92
Junc 18	0.00	883.31	115.39
Junc 19	0.00	885.29	115.38
Junc 20	0.00	891.95	117.40
Junc 21	0.00	891.38	130.59
Junc 22	0.00	891.38	130.59
Junc 70	0.00	895.30	116.69

863 gpm fire flow at MW-20 bench, diesel pump on, high water tank levels

Node ID	Demand GPM	Head ft	Pressure psi
Junc 71	0.00	891.95	115.24
Junc 72	0.00	892.70	117.29
Junc 73	0.00	885.29	112.35
Junc 74	0.00	883.31	113.22
Junc 75	0.00	879.92	111.76
Junc 76	0.00	880.43	110.68
Junc 77	0.00	881.50	112.44
Junc 78	0.00	882.83	111.72
Junc 79	0.00	885.91	112.19
Junc 80	0.00	890.71	116.43
Junc 81	0.00	891.38	127.99
Junc 82	0.00	891.38	130.59
Junc 83	0.00	891.38	128.42
Junc 101	0.00	811.33	121.03
Junc 102	863.00	602.29	44.32
Junc 103	0.00	811.33	113.23
Tank 1	-431.51	700.00	12.13
Tank 2	-431.51	700.00	12.13

863 gpm fire flow at MW-20 bench, diesel pump on, high water tank levels

Network Table - Links

Link ID	Flow GPM	Velocity fps	Unit Headloss ft/Kft	Status
Pipe 1	431.51	2.75	5.31	Open
Pipe 2	431.51	2.75	5.31	Open
Pipe 3	863.01	5.51	16.13	Open
Pipe 4A	0.00	0.00	0.00	Open
Pipe 4C	0.00	0.00	0.00	Open
Pipe 5	863.01	9.79	65.48	Open
Pipe 6A	863.01	9.79	65.48	Open
Pipe 6C	863.01	9.79	65.48	Open
Pipe 7	-553.00	6.28	28.72	Open
Pipe 8	310.01	3.52	9.83	Open
Pipe 9	310.01	3.52	9.83	Open
Pipe 10	310.01	3.52	9.83	Open
Pipe 11	310.00	3.52	9.83	Open
Pipe 12	310.00	3.52	9.83	Open
Pipe 13	310.00	3.52	9.83	Open
Pipe 14	310.00	3.52	9.83	Open
Pipe 15	310.00	3.52	9.83	Open
Pipe 16	310.00	3.52	9.83	Open
Pipe 17	-553.00	6.27	28.72	Open
Pipe 18	-553.00	6.27	28.72	Open
Pipe 19	-553.00	6.28	28.72	Open
Pipe 20	-553.00	6.28	28.72	Open
Pipe 21	0.00	0.00	0.00	Open
Pipe 22	0.00	0.00	0.00	Open
Pipe 23	0.00	0.00	0.00	Open

863 gpm fire flow at MW-20 bench, diesel pump on, high water tank levels

Link ID	Flow GPM	Velocity fps	Unit Headloss ft/Kft	Status
Pipe 24	0.00	0.00	0.00	Open
Pipe 25	0.00	0.00	0.00	Open
Pipe 26	0.00	0.00	0.00	Open
Pipe 27	0.00	0.00	0.00	Open
Pipe 28	0.00	0.00	0.00	Open
Pipe 29	0.00	0.00	0.00	Open
Pipe 30	0.00	0.00	0.00	Open
Pipe 31	0.00	0.00	0.00	Open
Pipe 32	0.00	0.00	0.00	Open
Pipe 33	0.00	0.00	0.00	Open
Pipe 34	0.00	0.00	0.00	Open
Pipe 35	0.00	0.00	0.00	Open
Pipe 36	0.00	0.00	0.00	Open
Pipe 37	0.00	0.00	0.00	Open
Pipe 101	863.00	12.00	71.01	Open
Pipe 102	863.00	12.00	71.01	Open
Pipe 103	0.00	0.00	0.00	Open
Pump 4B	0.00	0.00	0.00	Closed
Pump 6B	863.01	0.00	-212.84	Open

863 gpm fire flow at MW-20 bench, diesel pump on, low water tank levels

Network Table - Nodes

Node ID	Demand GPM	Head ft	Pressure psi
Junc 3	0.00	673.63	0.71
Junc 4	0.00	668.36	17.92
Junc 4A	0.00	668.36	17.92
Junc 4B	0.00	869.65	105.14
Junc 5	0.00	869.65	105.14
Junc 6A	0.00	662.79	15.51
Junc 6B	0.00	875.63	107.73
Junc 6	0.00	666.98	17.32
Junc 7	0.00	870.26	105.40
Junc 8	0.00	869.30	107.59
Junc 9	0.00	866.70	106.46
Junc 10	0.00	865.38	107.62
Junc 11	0.00	864.71	107.33
Junc 12	0.00	859.91	102.65
Junc 13	0.00	859.91	102.65
Junc 14	0.00	856.83	102.18
Junc 15	0.00	855.50	102.04
Junc 16	0.00	854.43	102.88
Junc 17	0.00	853.92	102.66
Junc 18	0.00	857.31	104.12
Junc 19	0.00	859.29	104.12
Junc 20	0.00	865.95	106.14
Junc 21	0.00	865.38	119.32
Junc 22	0.00	865.38	119.32
Junc 70	0.00	869.30	105.42

863 gpm fire flow at MW-20 bench, diesel pump on, low water tank levels

Node ID	Demand GPM	Head ft	Pressure psi
Junc 71	0.00	865.95	103.97
Junc 72	0.00	866.70	106.03
Junc 73	0.00	859.29	101.08
Junc 74	0.00	857.31	101.96
Junc 75	0.00	853.92	100.49
Junc 76	0.00	854.43	99.41
Junc 77	0.00	855.50	101.18
Junc 78	0.00	856.83	100.45
Junc 79	0.00	859.91	100.92
Junc 80	0.00	864.71	105.17
Junc 81	0.00	865.38	116.72
Junc 82	0.00	865.38	119.32
Junc 83	0.00	865.38	117.16
Junc 101	0.00	785.33	109.77
Junc 102	863.00	576.29	33.06
Junc 103	0.00	785.33	101.97
Tank 1	-431.51	674.00	0.87
Tank 2	-431.51	674.00	0.87

863 gpm fire flow at MW-20 bench, diesel pump on, low water tank levels

Network Table - Links

Link ID	Flow GPM	Velocity fps	Unit Headloss ft/Kft	Status
Pipe 1	431.51	2.75	5.31	Open
Pipe 2	431.51	2.75	5.31	Open
Pipe 3	863.01	5.51	16.13	Open
Pipe 4A	0.00	0.00	0.00	Open
Pipe 4C	0.00	0.00	0.00	Open
Pipe 5	863.01	9.79	65.48	Open
Pipe 6A	863.01	9.79	65.48	Open
Pipe 6C	863.01	9.79	65.48	Open
Pipe 7	-553.00	6.28	28.72	Open
Pipe 8	310.01	3.52	9.83	Open
Pipe 9	310.01	3.52	9.83	Open
Pipe 10	310.01	3.52	9.83	Open
Pipe 11	310.00	3.52	9.83	Open
Pipe 12	310.00	3.52	9.83	Open
Pipe 13	310.00	3.52	9.83	Open
Pipe 14	310.00	3.52	9.83	Open
Pipe 15	310.00	3.52	9.83	Open
Pipe 16	310.00	3.52	9.83	Open
Pipe 17	-553.00	6.27	28.72	Open
Pipe 18	-553.00	6.27	28.72	Open
Pipe 19	-553.00	6.28	28.72	Open
Pipe 20	-553.00	6.28	28.72	Open
Pipe 21	0.00	0.00	0.00	Open
Pipe 22	0.00	0.00	0.00	Open
Pipe 23	0.00	0.00	0.00	Open

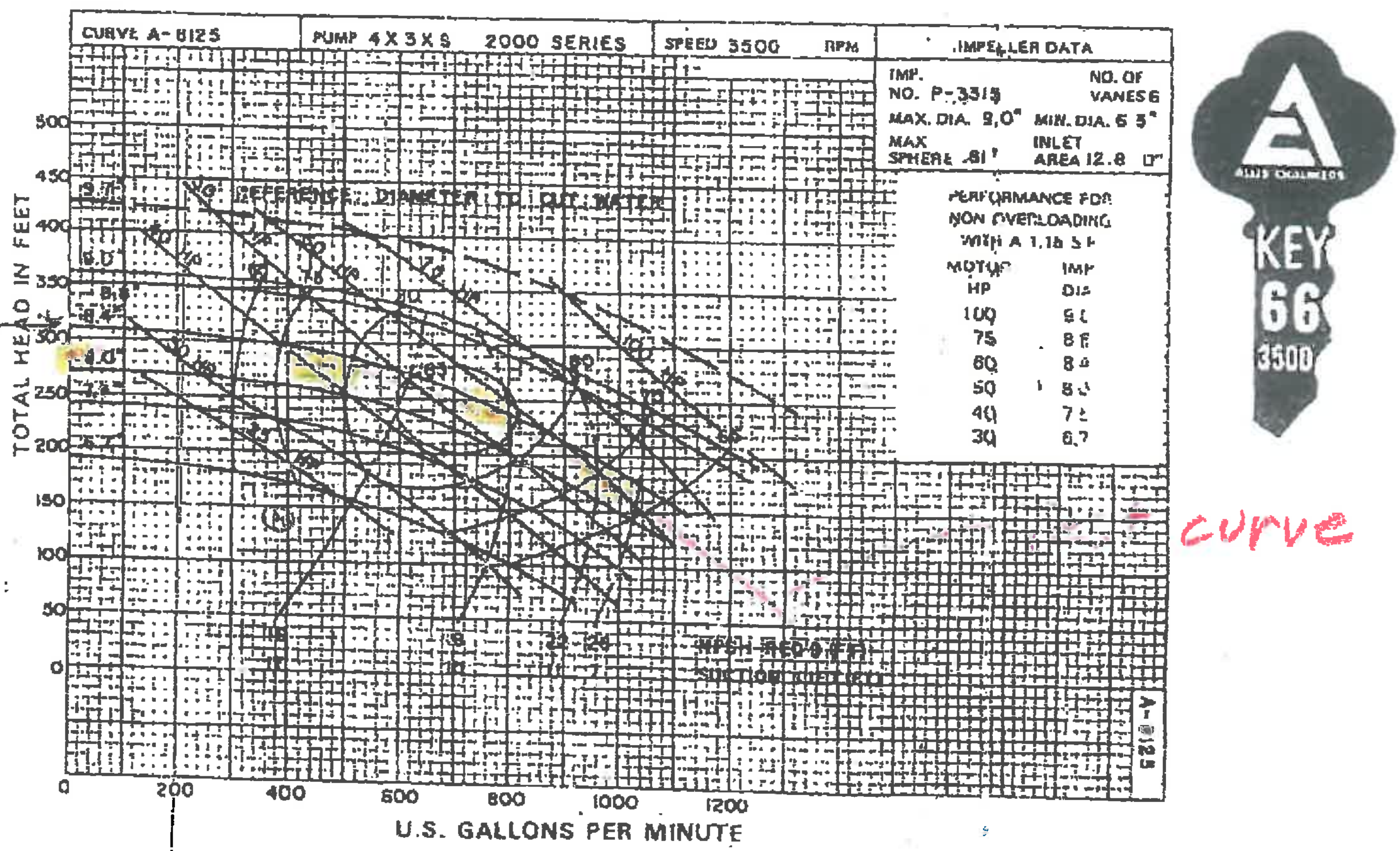
863 gpm fire flow at MW-20 bench, diesel pump on, low water tank levels

Link ID	Flow GPM	Velocity fps	Unit Headloss ft/Kft	Status
Pipe 24	0.00	0.00	0.00	Open
Pipe 25	0.00	0.00	0.00	Open
Pipe 26	0.00	0.00	0.00	Open
Pipe 27	0.00	0.00	0.00	Open
Pipe 28	0.00	0.00	0.00	Open
Pipe 29	0.00	0.00	0.00	Open
Pipe 30	0.00	0.00	0.00	Open
Pipe 31	0.00	0.00	0.00	Open
Pipe 32	0.00	0.00	0.00	Open
Pipe 33	0.00	0.00	0.00	Open
Pipe 34	0.00	0.00	0.00	Open
Pipe 35	0.00	0.00	0.00	Open
Pipe 36	0.00	0.00	0.00	Open
Pipe 37	0.00	0.00	0.00	Open
Pipe 101	863.00	12.00	71.01	Open
Pipe 102	863.00	12.00	71.01	Open
Pipe 103	0.00	0.00	0.00	Open
Pump 4B	0.00	0.00	0.00	Closed
Pump 6B	863.01	0.00	-212.84	Open

END SUCTION PUMPS

2000 Series — Single-Stage Close-Coupled or Frame Mounted with Mechanical Seals or Packing
Performance Curves — Key 66 — 3500 Rpm

TOPOCK ELECTRIC FIRE PUMP



ITT A-C Pump

A unit of ITT Corporation

DTP-F3

5808-0231

IMPELLER DWG.	IMPELLER DIA.	SPECIFIC GRAVITY	VISCOSITY
52-233-459-116	10.500 in.	1.000	32.0 SSU

Topock Diesel Fire Pump

CURVE NO. B94915-03-01-1E1

SIZE 6x4x10H-M TYPE 8100

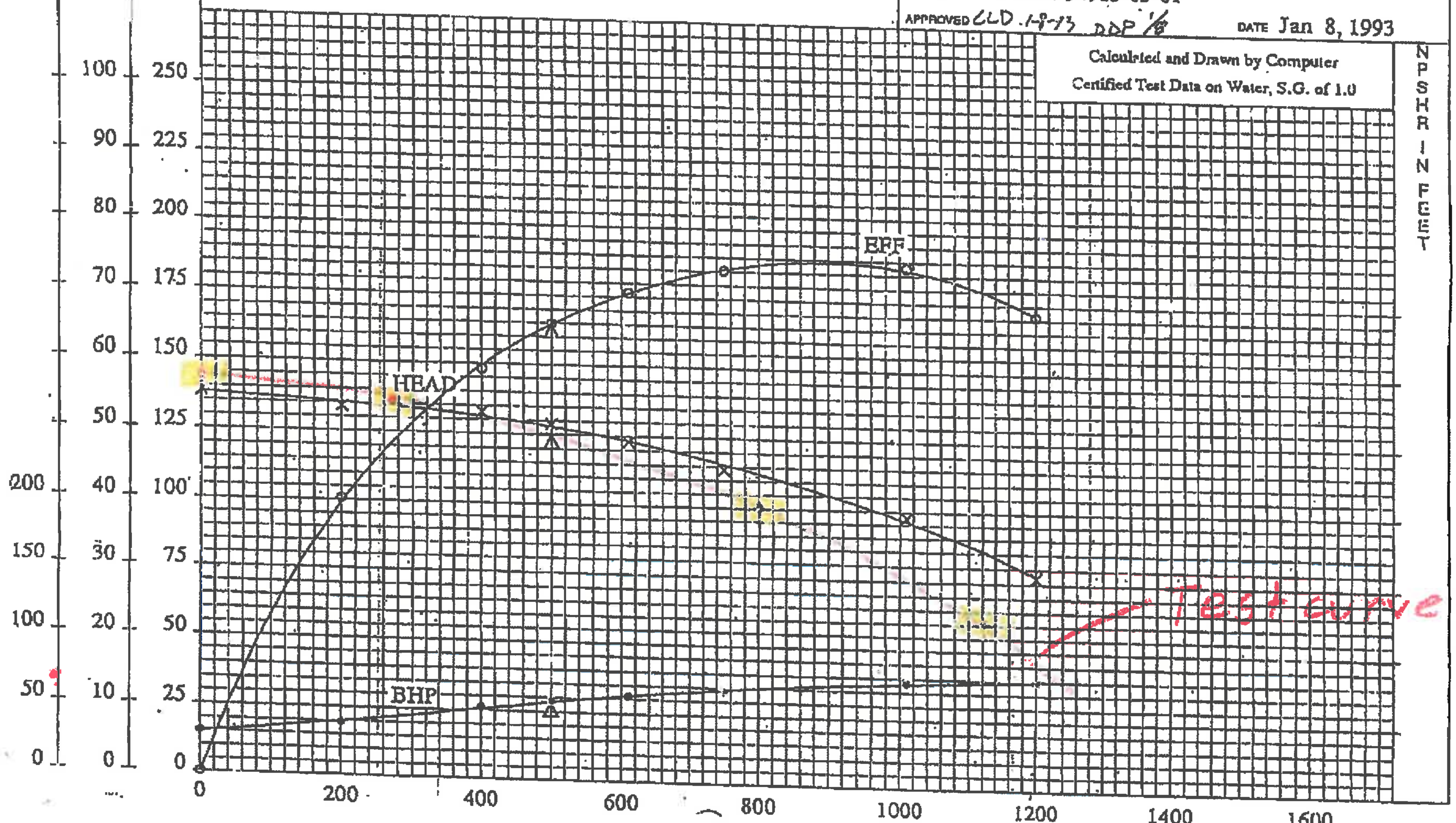
500 G.P.M. 125 P.S.I. 3000 R.P.M.

CUSTOMER PACIFIC GAS & ELECTRIC

ORDER 1-5224-94915-03-01*

APPROVED CLD 1-8-93 DDP 1/8 DATE Jan 8, 1993

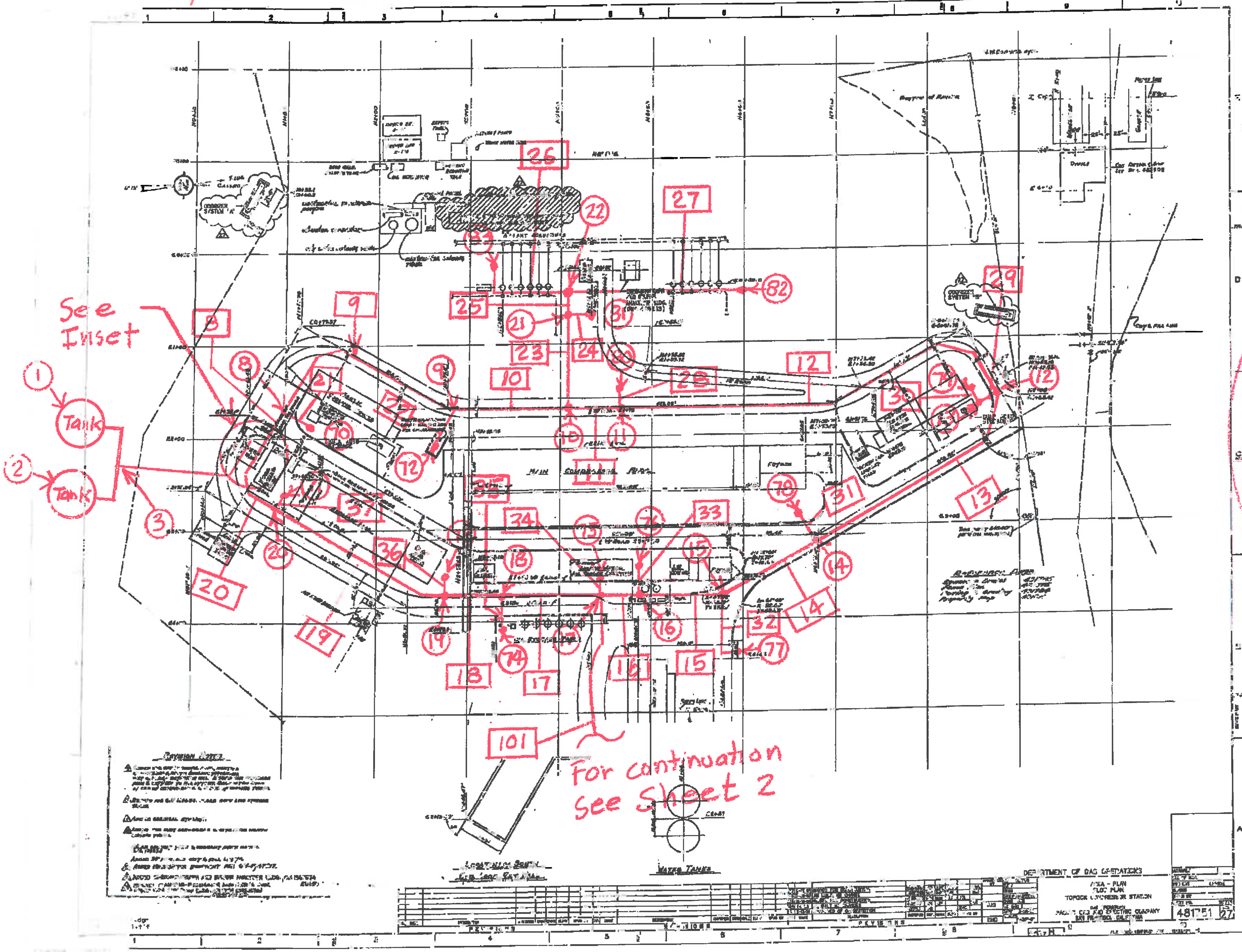
Calculated and Drawn by Computer
Certified Test Data on Water, S.G. of 1.0

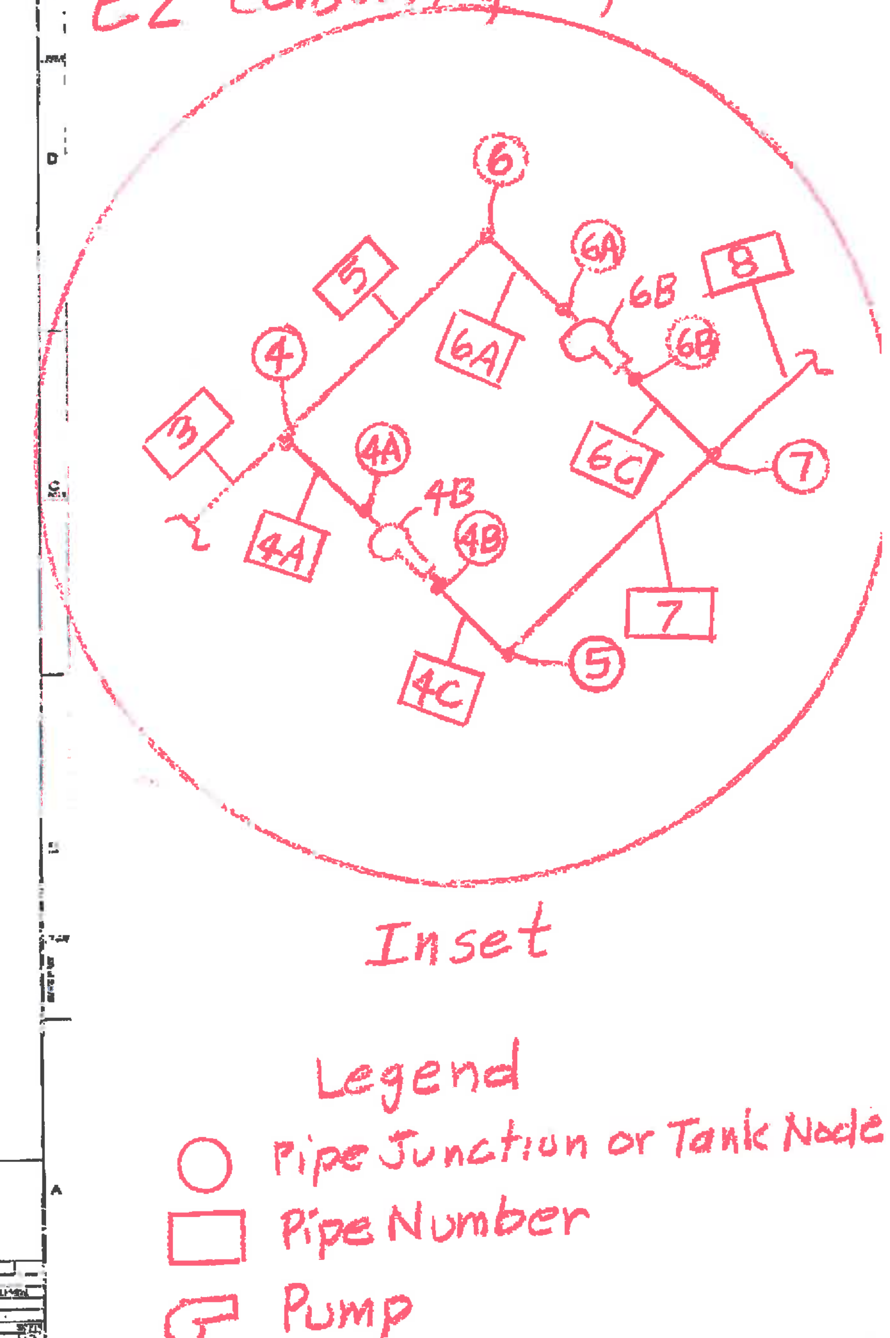


NO WARRANTY IS MADE EXCEPT RATED POINT

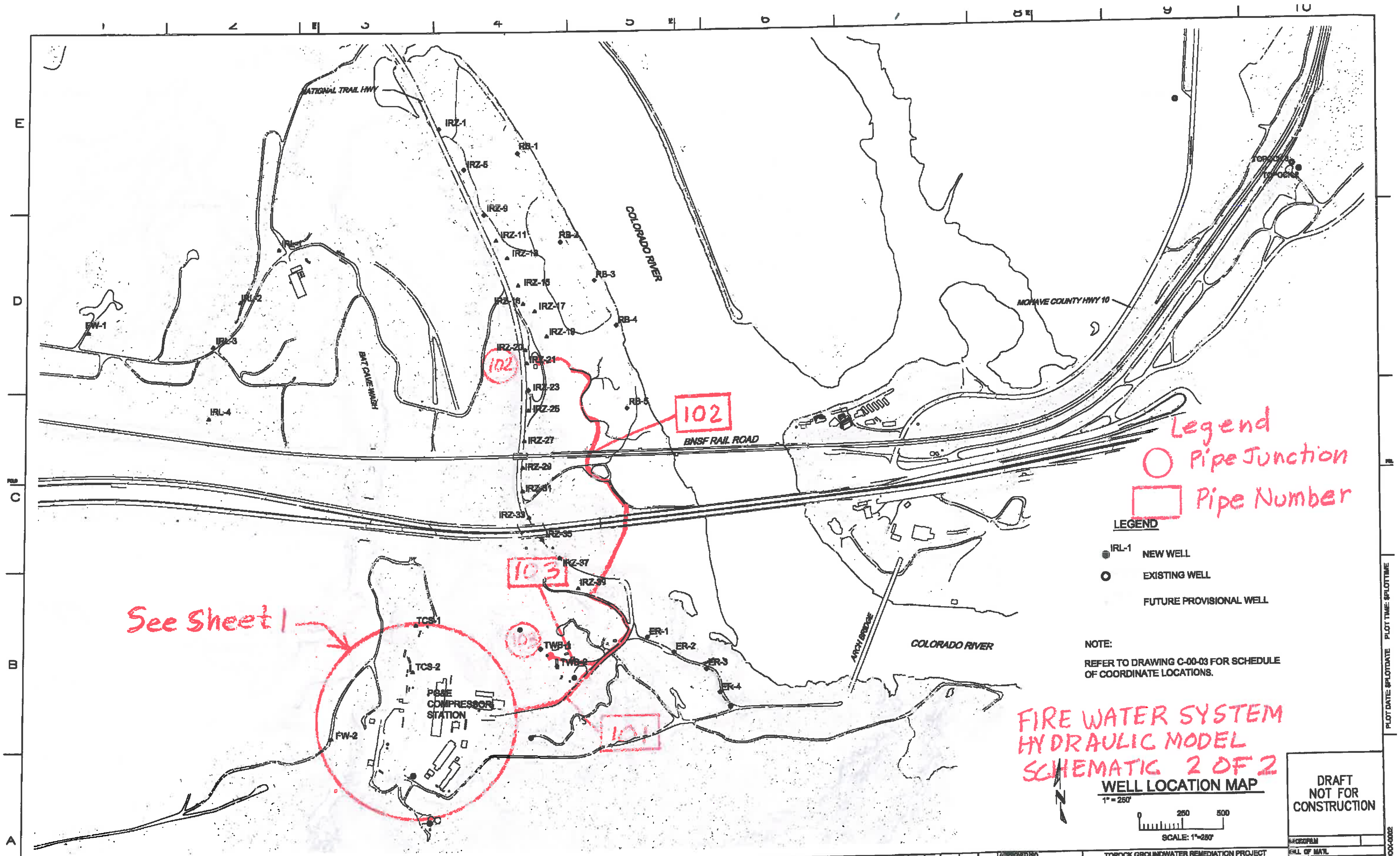
August 2014

Topock Remediation Design - Hydraulic Analysis of Fire Water System - By Paul Tjogas, EZ Consulting Engineers





FIRE WATER SYSTEM HYDRAULIC MODEL SCHEMATIC 1 OF 2



E2 Consulting Engineers, Inc.

CH2MHILL

REVISIONS

0 | INTERMEDIATE (30%) DESIGN SUBMITTAL

REVISIONS

TOPOCK GROUNDWATER REMEDIATION PROJECT

WELL LOCATION MAP

GAS TRANSMISSION & DISTRIBUTION
PACIFIC GAS AND ELECTRIC COMPANY
SAN FRANCISCO, CALIFORNIA

C-00-02