Initial Structural Stability and Safety Factor Assessment

Whelan Energy Center

WEC Temporary Ash Disposal Area

Hasting, Nebraska

November 30, 2020

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Professional Engineer Certification

"Based on the information provided to HDR by Hastings, information available on Hastings' CCR website, and HDR's visual observations and analysis, this Initial Structural Stability Assessment and Safety Factor Assessment was conducted in accordance with the requirements of the USEPA 40 CFR Part 257-Criteria for Classification of Solid Waste Disposal Facilities and Practices; Final Rule, April 17, 2015 (CCR Rule). Based on the information currently available, I hereby certify to the best of my knowledge, that this Initial Structural Stability Assessment and Safety Factor Assessment for the existing WEC Temporary Ash Disposal Area at the Whelan Energy Center, operated by Hastings Utilities / City of Hastings, Nebraska, meets the requirements of the CCR Rule 40 CFR §257.73(d) and (e) in accordance with professional standards of care for similar work. I am a duly licensed Professional Engineer under the laws of the State of Nebraska."

Print Name: Gregory M. Shafer

Signature:

Date: November 30, 2020

License #: E-11178

My license renewal date is December 31, 2020.

1 Introduction

On April 17, 2015 the U.S. Environmental Protection Agency (EPA) issued the final rule for the regulation and management of coal combustion residuals (CCR) under Subtitle D of the Resource Conservation and Recovery Act (RCRA) [40 CFR Part 257, Subpart D]. The federal CCR Rule requires owners or operators of an existing CCR surface impoundment that either 1) has a height of five feet or more and a storage volume of 20-acre feet or more; or 2) has a height of 20 feet or more, perform periodic structural stability assessments and periodic safety factor assessments.

HDR Engineering, Inc. (HDR) has prepared this Structural Stability and Safety Factor Assessment Report for the Whelan Energy Center (WEC) surface impoundment (WEC Temporary Ash Disposal Area) near Hastings, Nebraska. The WEC Temporary Ash Disposal Area, permitted with the state of Nebraska, consists of approximately 23.2 acres. However, only 11.3 acres (West Area) are currently used as a surface impoundment and typically half of that area is continuously dewatered for pond ash excavation and stockpiling for beneficial use markets. Since 2013, the East Area of the WEC Temporary Ash Disposal Area has been acting as a CCR landfill receiving moisture-conditioned scrubber ash and bottom ash. The majority of the WEC Temporary Ash Disposal Area is incised, that is to say the north, east and west sides are below the surrounding ground surface. The south side has an embankment above adjacent natural ground surface.

1.1 Assessment Objectives

The assessments are required to assess and document the structural integrity of existing CCR surface impoundments.

1. **40 CFR §257.73(d)** – Document whether the design, construction, operation, and maintenance of the CCR unit is consistent with recognized and generally accepted good engineering practices for the maximum volume of CCR and CCR wastewater which can be impounded therein.
2. **40 CFR §257.73(e)** – Document whether the calculated factors of safety for each CCR unit achieve the minimum safety factors specified in this section for the critical cross section of the embankment. The critical cross section is the cross section anticipated to be the most susceptible of all cross sections to structural failure based on appropriate engineering considerations, including loading conditions.

1.2 CCR Rule Requirements

The following sections of this Report address the required federal CCR regulations to document whether the CCR unit has been designed, constructed, operated, and maintained with the guidelines specified in 40 CFR 257.73(d)(1)(i) through (vii) and to document whether the calculated factors of safety achieve the minimum safety factors specified in this part for the critical cross section of the embankment.

- Structural Stability Assessment Section 3:
    - **Section 3.1: 40 CFR §257.73(d)(1)(i)** – Stable foundations and abutments.
    - **Section 3.2: 40 CFR §257.73(d)(1)(ii)** – Adequate slope protection to protect against surface erosion, wave action, and adverse effects of sudden drawdown.
    - **Section 3.3: 40 CFR §257.73(d)(1)(iii)** – Dikes mechanically compacted to a density sufficient to withstand the range of loading conditions in the CCR unit.

- **Section 3.4: 40 CFR §257.73(d)(1)(iv)** – Vegetated slopes of dikes and surrounding areas not to exceed a height of six inches above the slope of the dike, except for slopes which have an alternate form or forms of slope protection.
- **Section 3.5: 40 CFR §257.73(d)(1)(v)** – A single spillway or a combination of spillways configured as specified in paragraph (d)(1)(v)(A) of this section. The combined capacity of all spillways must be designed, constructed, operated, and maintained to adequately manage flow during and following the peak discharge from the event specified in paragraph (d)(1)(v)(B):
  - Spillways must be either of non-erodible construction and designed to carry sustained flows, or earth- or grass-lined and designed to carry short-term, infrequent flows at non-erosive velocities where sustained flows are not expected.
  - Combined capacity of all spillways must adequately manage flow during and following the peak discharge from a 100-year flood for a low hazard potential CCR surface impoundment.
- **Section 3.6: 40 CFR §257.73(d)(1)(vi)** – Hydraulic structures underlying the base of the CCR unit or passing through the dike of the CCR unit that maintain structural integrity and are free of significant deterioration, deformation, distortion, bedding deficiencies, sedimentation, and debris which may negatively affect the operation of the hydraulic structure.
- **Section 3.7: 40 CFR §257.73(d)(1)(vii)** – For CCR units with downstream slopes which can be inundated by the pool of an adjacent water body, such as a river, stream or lake, downstream slopes that maintain structural stability during low pool of the adjacent water body or sudden drawdown of the adjacent water body.
- **Section 3.8: 40 CFR §257.73(d)(2)** – The periodic assessment described in paragraph (d)(1) of this section must identify any structural stability deficiencies associated with the CCR unit in addition to recommending corrective measures. If a deficiency or a release is identified during the periodic assessment, the owner or operator must remedy the deficiency or release as soon as feasible and prepare documentation detailing the corrective measures taken.

- Safety Factor Assessment Section 4:
  - **40 CFR §257.73(e)(1)**– The owner or operator must conduct an initial and periodic safety factor assessment for each CCR unit and document whether the calculated factors of safety for each CCR unit achieve the minimum safety factors specified in paragraphs (e)(1)(i) through (iv) of this section for the critical cross section of the embankment. The critical cross section is the cross section anticipated to be the most susceptible of all cross sections to structural failure based on appropriate engineering considerations, including loading conditions. The safety factor assessments must be supported by appropriate engineering calculations.

2 Facility Description

The Whelan Energy Center, located in Hastings, Nebraska, has two coal fired electric generating units. WEC Units 1 and 2 have net capacity ratings of 77 megawatts and 220 megawatts, respectively. Figure 1 in Attachment 1 provides the location of WEC relative to City of Hastings. Hastings Utilities / City of Hastings, Nebraska (Hastings) is the owner and operator of WEC Unit

1 (WEC1) and the operating agent of WEC Unit 2 (WEC2) for Public Power Generation Agency (PPGA). The WEC Temporary Ash Disposal Area, located at WEC, is permitted under the Nebraska Department of Environmental Quality (NDEQ) [now referred to as the Nebraska Department of Environment and Energy (NDEE)] Title 132 – *Integrated Solid Waste Management Regulations*. Original Title 132 permitting efforts began in 1999 pursuant to NDEQ requirements. The federal CCR rule – effective on October 19, 2015 – and as subsequently amended, applies to the WEC Ash Disposal Area which is considered an existing CCR surface impoundment.

The WEC Temporary Ash Disposal Area is an unlined CCR surface impoundment of approximately 23.2 acres that has historically received CCR in sluiced and dry form for storage prior to removal for beneficial uses. Fossil fuel ash sluicing and disposal at this site began in 1981, the same year that WEC1 began commercial operation. The disposal area was constructed as an ash pond to provide storage for ash, sluice water, and other process waters with the option to recycle water back to the WEC. Due to ash pond size and evaporation, recycling water back to the plant did not occur. Over time, other process waters such as cooling tower blowdown were redirected away from the WEC Temporary Ash Disposal Area. With start-up of WEC2 commercial operations on May 1, 2011, scrubber ash was sluiced to the East Area and fly ash was periodically sluiced to the West Area. Sluicing of scrubber ash ended in 2013 after a pug mill was installed to load trucks with moistened scrubber ash for hauling and placement within the East Area of the WEC Temporary Ash Disposal Area.

The WEC Temporary Ash Disposal Area is permitted with the State of Nebraska as a fossil fuel ash disposal area and has a groundwater monitoring network. A facility site map, Figure 2 provided in Attachment 1 shows the locations of the plant, supporting facilities, WEC Temporary Ash Disposal Area, and groundwater monitoring wells.

2.1 CCR Waste-Streams

The WEC generates sluiced CCR and dry CCR materials. The CCR waste streams going into the WEC Temporary Ash Disposal Area are fossil fuel bottom ash and fly ash mixture (pond ash) in sluice form from WEC1, and bottom ash and scrubber ash in dry form from WEC2. Currently, all WEC2 fly ash is loaded out dry directly from the WEC2 silo by the fly ash marketer under contract.

Sluiced pond ash and dry scrubber ash are separated in the WEC Temporary Ash Disposal Area by a berm created from pond ash. This creates a West Area and East Area, respectively, as shown in Figure 3 (Attachment 1). Although the dry and sluiced CCR waste-streams are separated within the WEC Temporary Ash Disposal Area, the entire area is permitted with the NDEE as a fossil fuel combustion ash disposal area and considered one CCR unit.

2.2 Hydraulic Structures

WEC1 currently sluices their entire quantity of CCR into the West Area of the existing WEC Temporary Ash Disposal Area. The above-ground sluice inlets are located on the north side of the West Area as shown in Figure 3 (Attachment 1). WEC1 CCR flows are approximately 400,000 gallons per day into the West Area of the WEC Temporary Ash Disposal Area, as provided by Hastings. The ash marketer manages the routing of CCR flows and excavation of pond ash within the permitted limits of the disposal area.

In 2007, riser/spillway structures and the Leachate Pond were constructed to transfer water from the WEC Temporary Ash Disposal Area. These structures were required by NDEE in order to

maintain the depth of leachate within the disposal area at a depth of approximately 12 to 14 inches or less under normal operations during a 25-year, 24-hour storm event. Ash sluice is directed to flow southward for settlement of ash sediment while the free liquids generally flow along the surface. The free liquids then either drain by gravity to a clear area surrounding the risers or are pumped directly into the Leachate Pond with a portable pump and piping. Spillway invert elevations and general impoundment cross-sections are shown on Figure 3 and Figure 4, respectively, in Attachment 1.

With operational changes within the plant and ash management, the riser/spillway structures have not been used for several years.

- East Area risers and spillways – Discontinued use in 2013 when pug mill installed on scrubber ash silo for loading direct into dump trucks, hauled and placed within the East Area of the WEC Temporary Ash Disposal Area.
- West Area riser and spillways – Discontinued use in 2015 when operations began using a floating pump and flexible pipe to pump free liquids to the Leachate Pond.

Subsequently, pumping of water from the West Area into the Leachate Pond has been periodic since 2016 due to significant reductions in water use for WEC1 ash sluice pipe flushing and pond evaporation. Water in the Leachate Pond either evaporates or is used for CCR dust control. Although the Leachate Pond is currently dry, structural stability modeling described in Section 4 used the normal pool depths.

2.3 Previous Inspections

Hastings performs weekly and annual inspections for the entire WEC Temporary Ash Disposal Area and Leachate Pond. The weekly inspections are completed by qualified individuals to check for potentially hazardous conditions or structural weakness and the results of the inspections are documented on the Weekly Inspection Checklist Forms. The annual inspections are completed by a professional engineer registered in the State of Nebraska. Annual inspection reports are posted on the facility's CCR website.

There have been no reports of structural instability at the WEC Temporary Ash Disposal Area during previous inspections.

3 Structural Stability Assessment

Structural stability assessment requirements for existing CCR surface impoundments are detailed in 40 CFR 257.73: *Structural integrity criteria for existing CCR surface impoundments*. CCR Rule 40 CFR 257.73(d) states that the assessment must, at a minimum, document whether the CCR unit has been designed, constructed, operated, and maintained. The following sections document the visual observations and available site information for items specified in 40 CFR 257.73(d)(1)(i) through (vii).

3.1 Stable Foundations and Abutments

The geology and hydrogeology of the former Blaine Naval Ammunition Depot (NAD), which includes the WEC and surrounding area, have been studied extensively. The geology of the Hastings area is described by Keech and Dreeszen (1968), as reported in Layne GeoSciences (1997), as unconsolidated deposits of Pleistocene and Pliocene (Quaternary) age having a

combined thickness of about 100 to 500 feet, with a composition of the deposits consisting of clay, silt, sand, and gravel. The site geology is somewhat complex with eolian lean clay (loess), and eolian and/or alluvial fine sand, silt and clay sediments of Pleistocene age overlying thick sequences of Pliocene/Pleistocene sands and gravels, with occasional 2 to 3-foot clay seams, of alluvial origin. Data from the WEC production well boring logs indicates that the subsurface conditions in the vicinity of the site consist of the following (HDR 2006b):

- 55 to 80 feet of brown clay and lean clay (loess) beginning at the surface,
- followed by 30 to 40 feet of fine to medium-grained sand and silty clay (possibly Sappa Formation or basal Loveland Formation),
- followed by fine to coarse sand and gravel (with occasional 2 to 3 foot clay layers) to total depths ranging from 221 to 238 feet (Pliocene/Pleistocene aquifer),
- and finally white clay or gray shale beginning at depths ranging from 238 to 240 feet (Cretaceous Niobrara Formation).

The WEC Temporary Ash Disposal Area has a base elevation within in-situ lean clay material of Peoria loess with permeability of approximately 10^{-4} to 10^{-8} cm/sec (HDR 2006b). Underlying the Peoria layer and above the alluvial aquifer is the upper portion of Loveland loess and Sangamon material. The permeability of these materials is approximately 8.2×10^{-5} to 2.2×10^{-7} cm/s for the Loveland loess and 3.1×10^{-6} cm/sec for the Sangamon (HDR 2006b).

The South Embankment showed no signs of distress during the observations. There were no cracks or visible seepage.

3.2 Slope Protection

Interior slopes of WEC Temporary Ash Disposal Area contained vegetation on west, south and portions of the east and north sides. Stored CCR protected the remaining interior slopes up to the crest and provided several ingress/egress roads of compacted CCR into the WEC Temporary Ash Disposal Area for operations and ash management activities.

Weekly inspections performed by Hastings monitor the existing slopes for structural stability including erosion, breach of embankments, and liquids/CCR potential to overtop embankments. Hastings personnel observed no issues impacting the structural stability of the embankments. During the November 12, 2020 inspection performed by HDR, observations included:

- erosion and sloughing at the toe of South Embankment interior slope of the West Area resulting from wave action of pooling water;
- some animal burrow holes along the interior east side of the Leachate Retention Pond and west side of the interior slope of the West Area;
- small tree on interior slope near southwest corner of WEC Temporary Ash Disposal Area;
- scraggly and tall vegetation along east and south interior slopes; and
- adequate vegetation on south exterior slope to prevent erosion.

Recommended corrective actions for these items are included in Section 3.8. Currently, none of the slope observations above negatively impacted the structural stability of the embankments. In addition, no seepage was observed.

3.3 Embankment Compaction

The original ash pond was constructed for WEC1 and has been in operation since 1981. Record drawings of this existing CCR surface impoundment showed grading contours and limits of the impoundment (HDR 2016). Specifications and construction records were not available from Hastings to verify that embankments were mechanically compacted. Three sides of the WEC Temporary Ash Disposal Area are cut slopes to the CCR. The only embankment that extends above the natural ground is the South Embankment.

During the November 2020 inspection, soil probing along the South Embankment exterior slope showed soils consistent with the descriptions in the geotechnical boring logs throughout the various explorations completed previously. The compacted Peoria Loess material was blocky, firm to very firm, light grayish brown lean clay. A hand probe was inserted to depths ranging from one (1) to two (2) feet below existing ground surface at several locations along the south side of the South Embankment.

Specifications for construction of the Leachate Pond embankments required clay materials (on-site Peoria Loess), placed in 8-inch loose lifts and compacted to 95 percent of maximum dry density per ASTM D698. The same compaction requirements applied to carefully compacted backfill placed around the installed spillways through the South Embankment of the WEC Temporary Ash Disposal Area. Similar on-site clay soils and compaction efforts were assumed to apply to the original ash pond construction.

3.4 Slope Vegetation

The requirement of 40 CFR 257.73(d)(iv) requires vegetated slopes of dikes and surrounding areas not to exceed a height of six (6) inches above the slope of the dike. Vegetation along the perimeter roadway and near top of slopes appeared to be maintained at height of 6 inches or less. Where interior embankment slopes contained vegetation, the vegetation was sparse in some places and varied in height above 6 inches. A good stand of grass is difficult to grow on the slopes with the clay soils and active CCR excavation activities. Hastings is concerned that cutting existing vegetation down to six inches will harm the vegetation and cause erosion.

Recommended corrective actions for these items are included in Section 3.8.

3.5 Spillways Capacity

Per 40 CFR 257.73(d)(v), the combined capacity of all spillways must be designed, constructed, operated and maintained to adequately manage flow during and following the peak discharge. For the WEC Temporary Ash Disposal Area the peak discharge is a 100-year flood for a low hazard potential CCR surface impoundment. Spillways must be of non-erodible construction and designed to carry sustained flows.

The risers and spillways in the South Embankment of the WEC Temporary Ash Disposal Area are corrugated metal pipe (CMP). Construction specifications required pipe bedding and carefully compacted backfill for the spillway installations. Monitoring and maintenance of the riser areas and spillways is described in Hastings Operational Plan within the Title 132 Permit Renewal Application (HDR 2016). However, as noted in Section 2.2 above, the riser areas and spillways have not been used in normal operations for several years.

To determine whether the WEC Temporary Ash Disposal Area could retain the flow during and following the peak discharge from a 100-year flood event, HDR performed hydraulic analyses

evaluating ash sluice discharge, run-on and impounded depth during this event. Model runs were performed separately for the West Area and East Area, since only the West Area operates as a CCR surface impoundment. The results show that there is adequate storage within both areas of the WEC Temporary Ash Disposal Area without overtopping the embankment. Inputs and hydraulic model runs are provided in Attachment 2.

3.6 Hydraulic Structures Integrity

Hydraulic structures passing through the dike of the CCR surface impoundment are to maintain structural integrity and be free of significant deterioration, deformation, distortion, bedding deficiencies, sedimentation, and debris which may negatively affect the operation. During the November 2020 inspection performed by HDR, observations of the hydraulic structures included:

- West Area:
  - spillways partially or completely filled with sediment – furthest west spillway completely plugged;
  - vegetation and brush growing around inlets and outlets of West Area spillways; and
  - sediment covering orifice openings of risers.
- East Area:
  - spillways clear of sediment and vegetation at outlets;
  - vegetation and brush growing around inlet of East Area spillways; and
  - sediment covering orifice openings of risers.

Recommended corrective actions for these items are included in Section 3.8. Berms around the risers and spillway inlets prevent ash sluice and stormwater runoff from entering these structures. Only precipitation falling within the bermed area could potentially flow into the risers.

None of these hydraulic structures are currently in operation. East Area spillways are not required and have not been used since 2013. West Area spillways have not been utilized for ash sluice free liquids since 2015. When the ash sluice free liquids need to be transferred out of the West Area, Hastings personnel hook up a portable floating pump and piping to pump water into the Leachate Pond.

3.7 Downstream Slope Low Pool/Drawdown

No river, stream or lake exists adjacent to the WEC Temporary Ash Disposal Area. The only water body present on the downstream slope of the WEC Temporary Ash Disposal Area is the Leachate Pond. This Leachate Pond was specifically constructed to hold the free liquids gravity drained or pumped from the WEC Temporary Ash Disposal Area. Water in the Leachate Pond either evaporates or is used for CCR dust control. The Leachate Pond is currently dry.

The safety factor assessment in Section 4 evaluated the critical cross section of the South Embankment with the Leachate Pond completely dry and at normal water levels. Computed safety factors exceed the required minimums demonstrating structural stability.

Leachate Pond water is not subject to rapid drawdown, thus such condition was not considered a potential mechanism for structural instability of the South Embankment exterior slope of the WEC Temporary Ash Disposal Area.

3.8 Structural Stability Deficiencies and Corrective Measures

The following recommendations are provided for corrective measures for the various categories identified above:

- Slope Protection:
  - Repair erosion and sloughing at the toe of South Embankment interior slope of the West Area resulting from wave action of pooling water.
  - Fill any visible animal burrow holes along the interior east side of the Leachate Retention Pond and west side of the interior slope of the West Area.
  - Remove the small tree on interior slope near southwest corner of WEC Temporary Ash Disposal Area.
  - Continue to monitor vegetation and over-seed where required along east and south interior slopes.
  - Trim tall vegetation along east and south interior slopes.
- Slope Vegetation:
  - Where interior embankment slopes contained vegetation, the vegetation was sparse in some places and varied in height above 6 inches. A good stand of grass is difficult to grow on the slopes with the clay soils and active CCR excavation activities. Hastings is concerned that cutting existing vegetation down to six inches will harm the vegetation and cause erosion.
  - Trim tall vegetation along the interior slopes with sufficient height for vegetation to continue to bind the soil.
- Hydraulic Structures Integrity:
  - West Area:
    - Remove sediment from spillways especially the furthest west spillway.
    - Clear vegetation and brush growing around inlets and outlets of West Area spillways.
    - Remove sediment covering orifice openings of risers.
  - East Area:
    - Remove sediment from spillways.
    - Remove vegetation at outlets.
    - Remove vegetation and brush from around inlet of East Area spillways.
    - Remove sediment covering orifice openings of risers.

4 Safety Factor Assessment

This safety factor assessment is conducted in compliance with 40 CFR 257.73(e), supported by appropriate engineering calculations. Methodology, loading conditions and inputs are described in the sections below.

4.1 Stability Analysis Criteria

The CCR Rule does not stipulate the stability analysis methodology directly, although the minimum required factor of safety criteria were adopted from the U.S. Army Corp of Engineers (USACE) guidance manuals, and USACE Engineering Manual EM 1110-2-1902 is referred to by

the CCR Rule as a benchmark in the dam engineering community for slope stability analyses. The methodologies in EM 1110-2-1902 were used in this assessment of the static load cases.

4.2 Methodology

The slope stability analysis was conducted using the GeoStudio computer program Slope/W, Version 2019 (R2) which uses limit equilibrium methodologies to evaluate potential rotational and sliding block failure surfaces. For a given geometry and soil profile, the program evaluates potential failure surfaces and identifies the surface exhibiting the minimum factor of safety.

4.3 Critical Cross Section Geometry

With three sides of the WEC Temporary Ash Disposal Area incised, the south embankment was determined to be the critical cross section. Based on geometry, the critical cross section is shown in Figure 5 and described below.

The critical cross section extends from north to south through the South Embankment from the West Area to the Leachate Retention Pond. The original design provided for a 4H:1V slope into the West Area from the South Embankment. However, because of some erosion due to wave action at the time of the observations, that slope was modeled as a 3H:1V down 10 feet vertical to the floor of the WEC Temporary Ash Disposal Area. The approximate 45 feet wide top of the South Embankment is flat with a 4H:1V slope down approximately 18 feet vertical to the floor of the Leachate Retention Pond, elevation 1880. The top of the South Embankment is elevation 1898.

4.4 Loading Conditions, Pond Elevations and Phreatic Conditions

The loading conditions that were analyzed and the CCR Rule required minimum factors of safety are summarized in Table 1 below.

Table 1 – Loading Conditions and Minimum Required Factors of Safety

Loading Conditions	Pond Elevation	Minimum Factor of Safety	CCR Rule Requirement
Maximum Storage Pool	1895.0	1.5	§257.73(e)(1)(i)
Maximum Surcharge	1898.0	1.4	§257.73(e)(1)(ii)
Seismic	1895.0	1.0	§257.73(e)(1)(iii)
Post-Earthquake – Liquefaction	NA*	1.2	§257.73(e)(1)(iv)
*N/A = Not Applicable. See Section 4.7 Assessment of Liquefaction Potential			

The phreatic surfaces for the stability models were developed based on typical, Normal Pool Elevations and Maximum Storage Pool water levels conditions within the WEC Temporary Ash Disposal Area and Leachate Pond. The design pond levels were provided by Hastings.

The horizontal acceleration used was determined by looking up the site location on the USGS Seismic-Hazard Map for the Conterminous United States, 2014. The peak horizontal acceleration with 2 percent probability of exceedance in 50 years was determined to be 0.036g (See Attachment 6). The horizontal acceleration used for the analysis was half that value or 0.018g.

4.5 Material Properties

Borings and well log data indicate fairly consistent geology across the site. The topography at the site is generally level, with minimal elevation change. The general soil profile used for modeling was approximately 5 feet fill material from the excavated Leachate Retention Pond.

Below the fill material is approximately 20 feet (thickness) of Peoria Formation with 35 feet (thickness) of Loveland formation. The embankment stratigraphy is shown in Figure 5 and the material properties used for the slope stability analysis are presented in Table 2. The estimated material engineering properties were based on test results and boring logs from:

- Hydrogeologic Characterization for Whelan Energy Center Fossil Fuel Combustion Ash Temporary Ash Disposal Area. Original May 2001; and
- Supplemental Hydrogeologic Characterization for Whelan Energy Center Fossil Fuel Combustion Ash Temporary Ash Disposal Area. Prepared for Hastings Utilities. Original December 2001

Boring logs for the monitoring wells immediately surrounding the WEC Temporary Ash Disposal Area are provided in Attachment 3. Geotechnical testing results are provided in Attachment 4. HDR used undrained (short term) and drained (long term) shear strengths related to effective stresses, as recommended by the USACE.

Table 2 – Summary of Material Properties Used in Analysis

Material Types	Elevation (feet)	Unit Weight, y (pcf)	Short-Term (Undrained)		Long-Term (Drained)	
			Cohesion, c (psf)	Friction Angle, (degrees)	Cohesion, c (psf)	Friction Angle, (degrees)
CCR	1894	120	400	28	400	28
Fill/Embankment	1898	120	1200	0	100	28
Peoria Formation	1873-1898	115	1000	0	100	28
Loveland Formation	1838-1873	118	2000	0	150	30

4.6 Vehicle Loading

Access roads surround the WEC Temporary Ash Disposal Area at or near the top of slopes and on the crest of the South Embankment. These access roads are regularly used by WEC personnel, ash marketer, and CCR market customers. Vehicle loading was used in the loading conditions with the maximum pool elevations. The surcharge was applied to simulate haul trucks with tire pressure of 100 psi.

4.7 Assessment of Liquefaction Potential

The embankment is considered to be compacted fill from on-site clay soils (CL) with foundation soils of Peoria and Loveland Formations extending to a combined thickness of 55+ feet below ground surface. Typically, and as used in the slope stability, the Peoria is about 20 feet thick and the Loveland 35 feet thick. Per EM 1110-2-1902, “Most instances of liquefaction have been associated with saturated loose sandy or silty soils. Loose gravelly soil deposits are also vulnerable to liquefaction (e.g., Coulter and Migliaccio 1966; Chang 1978; Youd et al. 1984; and Harder 1988). Cohesive soils with more than 20 percent of particles larger than 0.005 mm in diameter, or with liquid limit (LL) of 34 or greater, or with plasticity index (PI) of 14 or greater are generally considered not susceptible to liquefaction.” Because the soils used for the South Embankment as well as the soils below are considered lean clays to a depth of approximately 50 feet or greater, the site would not be considered susceptible to liquefaction.

4.8 Factors of Safety and Conclusions

Analysis summary diagrams for each loading condition are provided in Attachment 5. Table 3 below also summarizes the results of the stability analysis.

Table 3 – Summary of Stability Analysis Results

Loading Condition	Minimum Factor of Safety	Computed Factor of Safety	Analysis Diagram
Normal Storage Pool Short Term Static	1.5	4.39	Attachment 5, Page 1
Normal Storage Pool Short Term Seismic	1.0	4.06	Attachment 5, Page 2
Normal Storage Pool Long Term Static	1.5	2.22	Attachment 5, Page 3
Normal Storage Pool Long Term Seismic	1.0	2.06	Attachment 5, Page 4
Maximum Storage Pool Short Term Static	1.5	4.59	Attachment 5, Page 5
Maximum Storage Pool Short Term Seismic	1.0	4.24	Attachment 5, Page 6
Maximum Storage Pool Long Term Static	1.5	2.20	Attachment 5, Page 7
Maximum Storage Pool Long Term Seismic	1.0	2.04	Attachment 5, Page 8
Maximum Storage Pool Long Term Static with Surcharge	1.4	1.53	Attachment 5, Page 9
Maximum Storage Pool Long Term Seismic with Surcharge	1.0	1.46	Attachment 5, Page 10
Normal Storage Pool Dry Leachate Pond Long Term Seismic with Surcharge	1.0	1.74	Attachment 5, Page 11
Post-Earthquake Liquefaction	1.0	NA*	NA*

*N/A = Not Applicable. See Section 4.7 Assessment of Liquefaction Potential

As presented in Table 3, the factors of safety against slope instability for failure surfaces that are capable of breaching the South Embankment satisfy the minimum requirements of the CCR Rule under all loading conditions.

5 References

Geotechnical Services, Inc., 2004. Report of Geotechnical Investigation. Retention Pond & Pump Station. Whelan Energy Center. Prepared for Hastings Utilities. December 29, 2004.

HDR, Inc., 2006a. Hydrogeologic Characterization for Whelan Energy Center Fossil Fuel Combustion Ash Temporary Ash Disposal Area. Prepared for Hastings Utilities. Original May 2001.

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Attachment 1

Figures

City of Hastings

WEC

LEGEND:

CITY OF HASTINGS

WHELAN ENERGY CENTER

Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community

C:\Users\cunningha\Desktop_Sheets\Figure 1.dwg, Plot, 11/24/2020 11:10:31 AM, LCUNNINGHA

public power generation agency

HASTINGS UTILITIES

HDR

GERALD T. WHELAN ENERGY CENTER

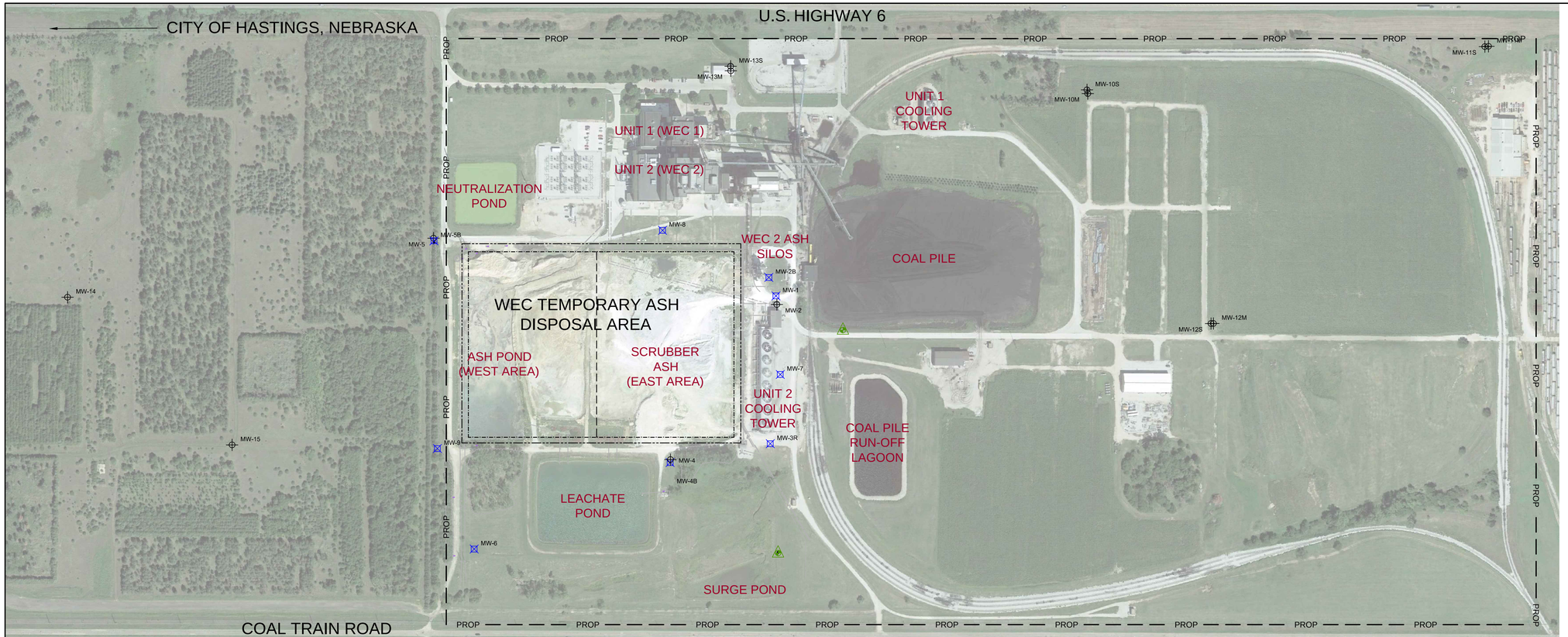
LOCATION OF WEC AND CITY OF HASTINGS

DATE

NOVEMBER 2020

FIGURE

1



N

1" = 250'

250' 125' 0' 250'

SCALE IN FEET

LEGEND

- MONITORING WELL
- CCR MONITORING WELL
- CONTROL POINT
- ASH DISPOSAL AREA BOUNDARY
- ORIGINAL TOE OF SLOPE
- SEPARATION BERM
- PROP — APPROXIMATE PROPERTY BOUNDARY

GROUNDWATER MONITORING WELLS

WELL DESIGNATION	NORTHING	EASTING	TOP OF CASING ELEVATION*	GROUND ELEVATION*	COMMENT
MW-1	334585.29	2330340.91	1903.16	1900.68	DETECTION MONITORING WELL
MW-2	334549.00	2330345.01	1903.18	1900.93	DRY
MW-2B	334663.85	2330310.77	1903.43	1900.60**	DETECTION MONITORING WELL
MW-3R	333955.95	2330316.80	1900.76	1897.98	DETECTION MONITORING WELL
MW-4	333888.31	2329891.68	1899.21	1895.19	DRY
MW-4B	333876.00	2329890.22	1897.55	1894.69**	DETECTION MONITORING WELL
MW-5	334830.77	2328882.44	1898.90	1897.60	DRY
MW-5B	334819.84	2328884.33	1899.84	1897.21**	DETECTION MONITORING WELL
MW-6	333507.64	2329055.42	1896.88	1893.54	DETECTION MONITORING WELL
MW-7	334250.89	2330359.26	1901.79	1899.14**	DETECTION MONITORING WELL
MW-8	334864.54	2329857.95	1903.93	1901.05**	DETECTION MONITORING WELL
MW-9	333935.57	2328898.85	1897.11	1894.31**	DETECTION MONITORING WELL
MW-10S	334585.29	2330340.91	1904.84	1904.16	DELINEATION WELL
MW-10M	334549.00	2330345.01	1905.18	1902.16	DELINEATION WELL
MW-11S	334663.85	2330310.77	1899.69	1897.13	DELINEATION WELL
MW-11M	333955.95	2330316.80	1899.66	1897.13	DELINEATION WELL
MW-12S	333888.31	2329891.68	1910.39	1907.3	DELINEATION WELL
MW-12M	333876.00	2329890.22	1910.15	1907.56	DELINEATION WELL
MW-13S	334830.77	2328882.44	1904.89	1902.34	DELINEATION WELL
MW-13M	334819.84	2328884.33	1905.04	1902.40	DELINEATION WELL
MW-14	333507.64	2329055.42	1897.46	1894.74	DELINEATION WELL
MW-15	334250.89	2330359.26	1897.64	1895.32	DELINEATION WELL

* TOP OF CASING AND GROUND ELEVATIONS PROVIDED BY HASTINGS UTILITIES JULY 23, 2019.
** DESIGNATED GROUND ELEVATIONS DEPICT THE ELEVATION OF THE TOP OF THE CONCRETE SLAB NEAREST TO THE CASING ON THE NORTH SIDE.
***NORTHING AND EASTING COORDINATES ARE APPROXIMATIONS AND WILL BE UPDATED ALONG WITH TOC AND GROUND SURFACE ELEVATIONS DURING THE NEXT SITE SURVEY.

NOTES:

1. AERIAL DATED 8/27/2017 OBTAINED FROM GOOGLE EARTH.
2. WEC 2 BOTTOM ASH AND SCRUBBER ASH ARE PLACED DRY IN WEC TEMPORARY ASH DISPOSAL AREA.

CONTROLS	NORTHING	EASTING	ELEVATION	LONG DESCRIPTION
25	334815.14	2328892.86	1896.51	BRASS CAP
26	334879.51	2330467.21	1900.86	BRASS CAP
27	333932.07	2330190.86	1894.46	BRASS CAP

*NOTE: STATE PLANE CONTROL IS BASED ON NEBRASKA SOUTH ZONE NAD 27. VERTICAL CONTROL IS BASED ON NGVD29.

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HASTINGS UTILITIES

GERALD T. WHELAN ENERGY CENTER

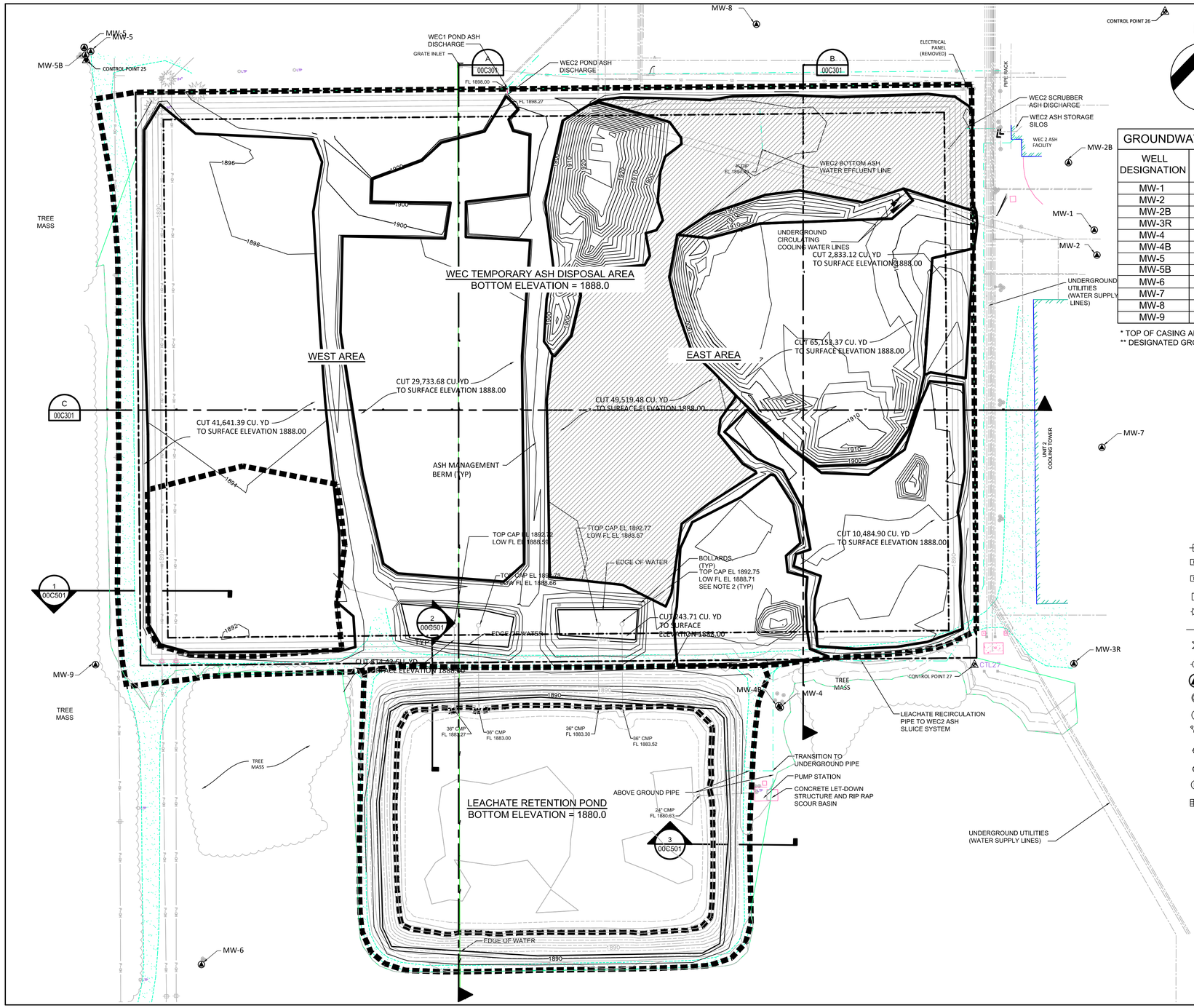
WEC CCR FACILITIES AND MONITORING WELL LOCATIONS

DATE

NOVEMBER 2020

FIGURE

2



GROUNDWATER MONITORING WELLS

WELL DESIGNATION	NORTHING	EASTING	TOP OF CASING ELEVATION*	GROUND ELEVATION*	COMMENT
MW-1	334585.29	2330340.91	1902.93	1900.68	DETECTION MONITORING WELL
MW-2	334549.00	2330345.01	1903.18	1900.93	DRY
MW-2B	334663.85	2330310.77	1902.96	1900.60**	DETECTION MONITORING WELL
MW-3R	333955.95	2330316.80	1900.45	1897.98	DETECTION MONITORING WELL
MW-4	333888.31	2329891.68	1899.21	1895.19	DRY
MW-4B	333876.00	2329890.22	1897.02	1894.69**	DETECTION MONITORING WELL
MW-5	334830.77	2328882.44	1898.90	1897.60	DRY
MW-5B	334819.84	2328884.33	1899.16	1897.21**	DETECTION MONITORING WELL
MW-6	333507.64	2329055.42	1896.72	1893.54	DETECTION MONITORING WELL
MW-7	334250.89	2330359.26	1901.23	1899.14**	DETECTION MONITORING WELL
MW-8	334864.54	2329857.95	1903.37	1901.05**	DETECTION MONITORING WELL
MW-9	333935.57	2328898.85	1896.54	1894.31**	DETECTION MONITORING WELL

* TOP OF CASING AND GROUND ELEVATIONS PROVIDED BY HASTINGS UTILITIES.
** DESIGNATED GROUND ELEVATIONS DEPICT THE ELEVATION OF THE TOP OF THE CONCRETE SLAB NEAREST TO THE CASING ON THE NORTH SIDE.

CONTROLS	NORTHING	EASTING	ELEVATION	LONG DESCRIPTION
25	334815.14	2328892.86	1896.51	BRASS CAP
26	334879.51	2330467.21	1900.86	BRASS CAP
27	333932.07	2330190.86	1894.46	BRASS CAP

*NOTE: STATE PLANE CONTROL IS BASED ON NEBRASKA SOUTH ZONE NAD 27. VERTICAL CONTROL IS BASED ON NGVD29.

LEGEND

- POWER POLE
- ELECTRICAL VAULT
- ELECTRICAL METER
- ELECTRICAL BOX
- LIGHT POLE
- GUY WIRE
- WATER VALVE
- FIRE HYDRANT
- MONITORING WELL
- WATER WELL
- UNKOWN MANHOLE
- POST INDICATOR VALVE
- STEEL POST
- BOLLARD
- STORM DRAIN MANHOLE
- GATE INLET
- CONIFEROUS TREE
- TREE MASS
- STORM SEWER LINE
- OVERHEAD ELECTRIC
- DISCHARGE PIPE
- EDGE OF GRAVEL
- EDGE OF CONCRETE
- EDGE OF WATER
- CONCRETE
- GRAVEL
- BUILDING LINE
- CONTROL POINT
- ASH DISPOSAL AREA BOUNDARY
- ORIGINAL TOE OF SLOPE

NOTES:
1. TOPOGRAPHIC SURVEY OF ASH DISPOSAL AREA AND LEACHATE DETENTION POND BY JEO CONSULTING PERFORMED ON 08/17/2016. SURROUNDING ROADWAYS AND STRUCTURES FROM TOPOGRAPHIC SURVEY BY OLSSON ASSOCIATES PERFORMED ON 07/14/2011.
2. RISER ELEVATIONS PROVIDED BY HASTINGS UTILITIES.

SOURCE: 2016 TITLE 132 PERMIT RENEWAL. FIGURE TO BE UPDATED WITH NDEE IN 2021.

public power generation agency

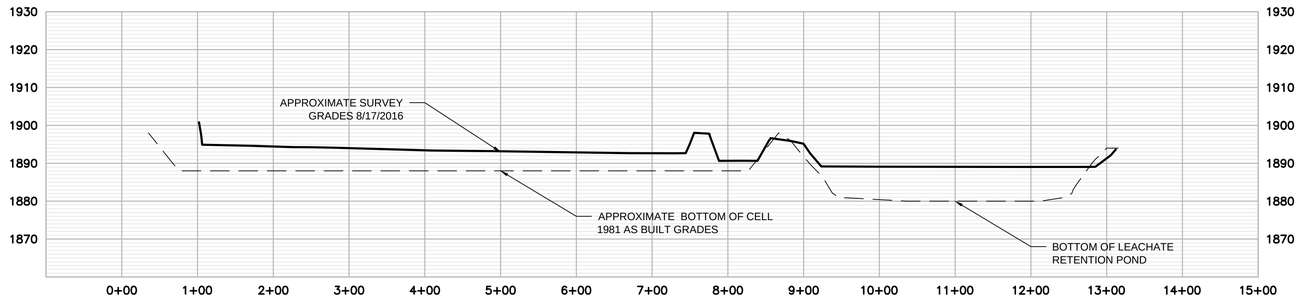
HASTINGS UTILITIES

GERALD T. WHELAN ENERGY CENTER

ASH DISPOSAL AREA PLAN

DATE
NOVEMBER 2020

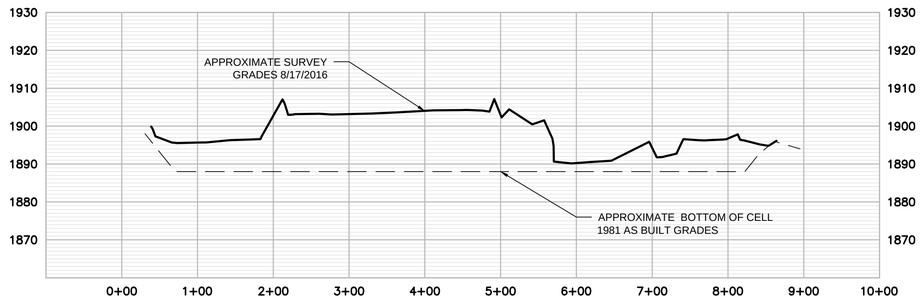
FIGURE
3



SECTION CUT

A
-

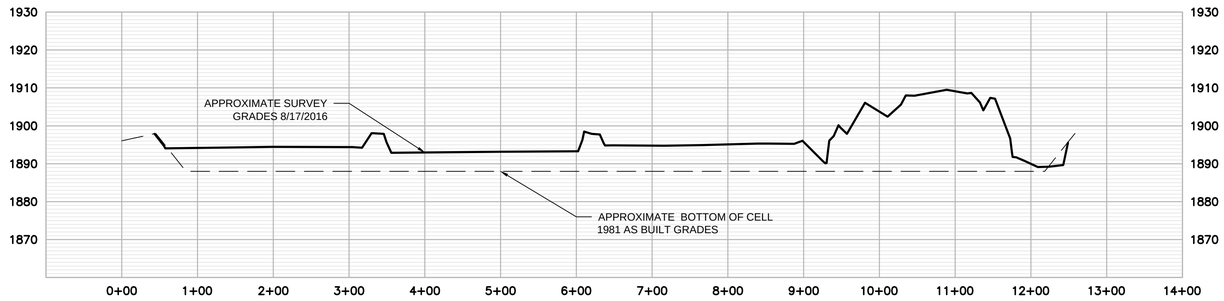
1" = 100' HORIZONTAL
1" = 20' VERTICAL



SECTION CUT

B
-

1" = 100' HORIZONTAL
1" = 20' VERTICAL



SECTION CUT

C
-

1" = 100' HORIZONTAL
1" = 20' VERTICAL

NOTES:

1. TOPOGRAPHIC SURVEY OF ASH DISPOSAL AREA AND LEACHATE RETENTION POND BY JEO CONSULTING PERFORMED 08/17/2016.

2. APPROXIMATE BASE GRADES OF WEC TEMPORARY ASH DISPOSAL AREA DEVELOPED BASED ON 1981 RECORD DRAWINGS FOR ORIGINAL ASH POND.

SOURCE: 2016 TITLE 132 PERMIT RENEWAL. FIGURE TO BE UPDATED WITH NDEE IN 2021.

public power generation agency

HASTINGS UTILITIES

GERALD T. WHELAN ENERGY CENTER

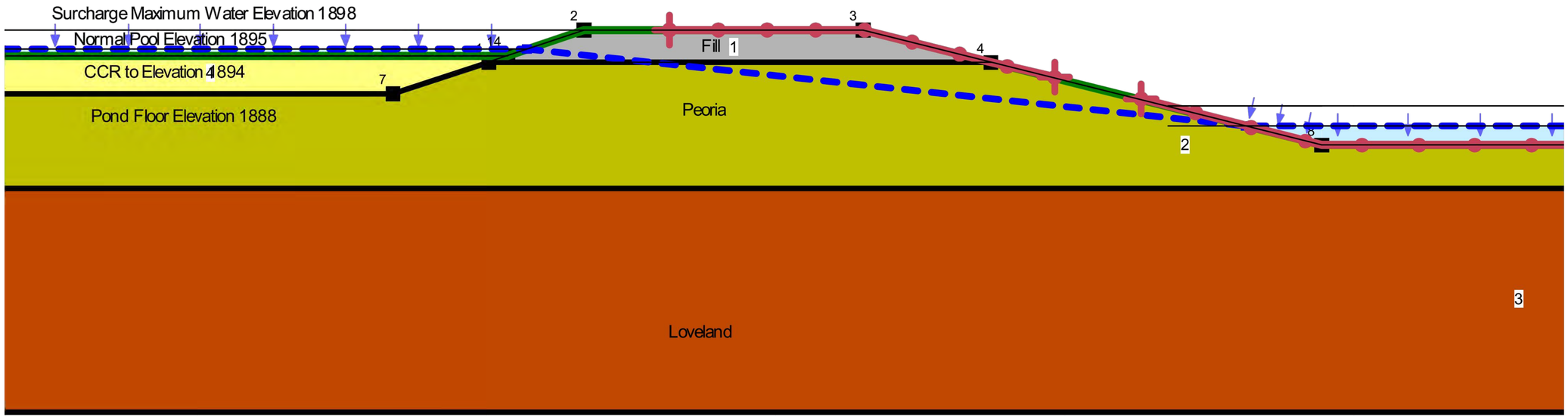
ASH DISPOSAL AREA PLAN

DATE

NOVEMBER 2020

FIGURE

4



GERALD T. WHELAN ENERGY CENTER

CRITICAL CROSS SECTION

DATE
NOVEMBER 2020

FIGURE
5

Attachment 2

Hydraulic Analyses

Objective: Demonstrate disposal areas can manage a 100-yr 24-hr storm event

References: Site data, historic calculations
Hydraflow, Mannings

Assumptions: 25-yr 24 hr storm event is 5.11-inches on site. (NOAA Atlas 14 Vol 8 Version 2)
100-yr 24 hr storm event is 6.70-inches on site. (NOAA Atlas 14 Vol 8 Version 2)

Calculations: *Drainage Areas*

n for smooth surfaces	0.011	0.015

	Sheet Flow (ft)*	Channel Flow (ft)*	Acres	Peak flow (cfs)	Total Volume (cf in 24-hrs)
North Runon	50	1500	4.7	46.8	117,881
WEC1 Ash Sluice**	na	na	10-in forcemain	0.62	53,568
WEC2 Fly Ash Sluice	na	na	10-in forcemain	0	0
West Disposal Area	300	600	11.3	102.36	267,957
			Totals for west disposal area	**149.78**	**439,406**
East Runon	100	0	2.3	23.44	52,442
East Disposal Area	300	400	11.9	107.8	282,184
			Totals for east disposal area	**131.24**	**334,626**

*slopes subject to change with operations. Generally low slope. Modeled with 0.5%.
**400,000 GPD

Current Conditions - No discharge

Under current conditions, there is estimated to be no discharge during the 100-yr 24-hr storm event. Operations change over time on site. In order to maintain no discharge for each area, the 100-YR 24-hr volume must be held within the disposal area with 1-ft of freeboard.

Current elevation of ponded water is estimated at elev. 1893 by the site:

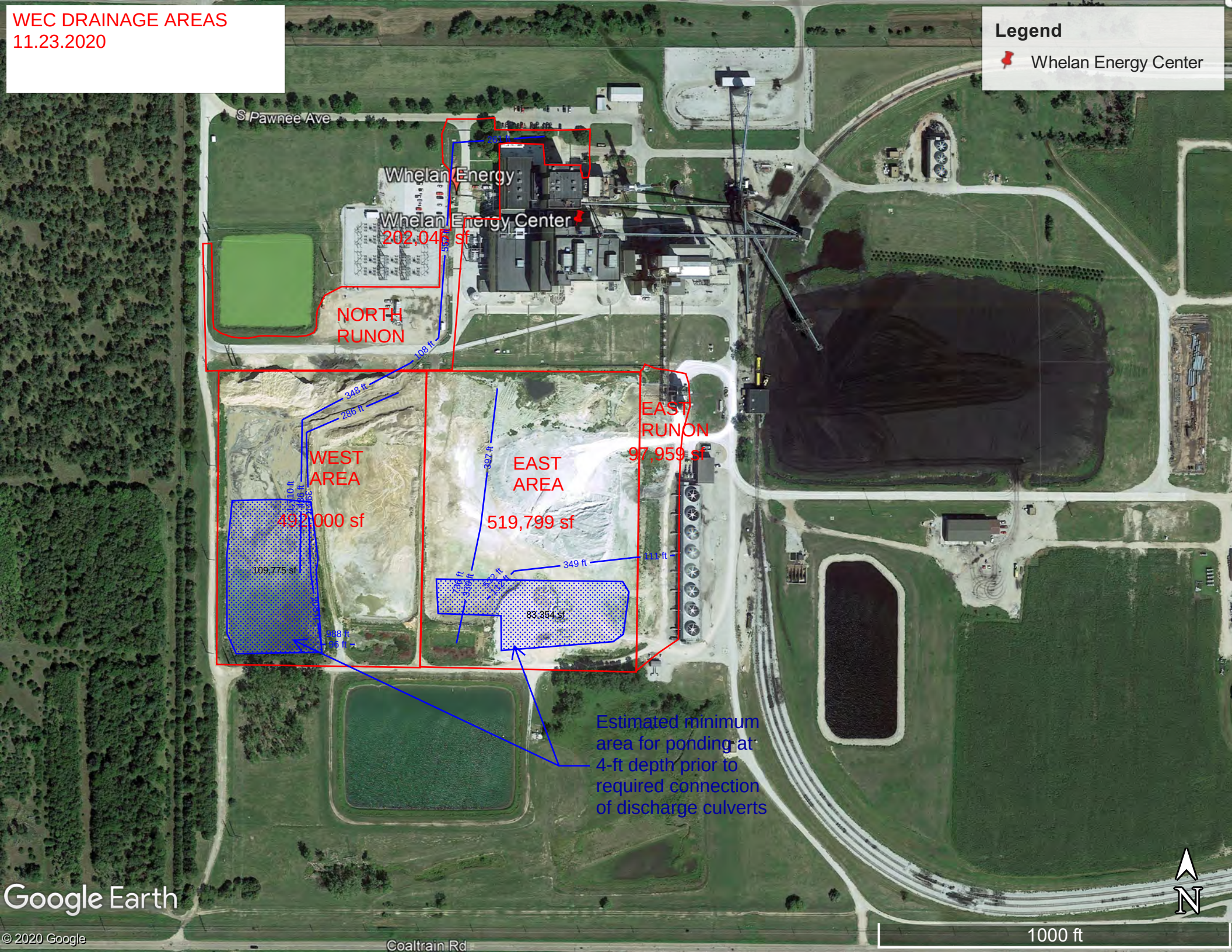
	Req. Storage (cf)	Area Req. if 4-ft deep (SF)
West Disposal Area	439,406	109,852
East Disposal Area	334,626	83,657

Future Conditions - Discharge to Leachate Pond
In the event the disposal area operations displace stormwater storage volume, the discharge structures will be utilized. Assumptions are as follows:

1. Starting pool elevation is 1892.5 (limited storage before riser discharge)
2. Storage is limited to 5,000-sf, 3:1 side slopes, and maximum elevation is 1898 (approx. inlet clear area)
3. Outflow culverts are modeled as 'dual barrel' to estimate peak storage.

Total flow to the leachate pond= 774,032 cf for 24-hrs
Leachate pond storage*= 1,568,160 cf
*Elevation 1884 to 1893, est. available for storage. Leachate Pond is 5.2 acres.

Conclusion: In the 100-yr storm event, the stormwater is contained within the disposal areas without overtopping. At such time that a disposal area no longer has the storage required, the discharge culverts will be hydraulically connected and utilized, and spillways reshaped. The discharge culverts are estimated to control the design storm without exceeding the berm elevation.


WEC DRAINAGE AREAS
11.23.2020
Legend
Whelan Energy Center
S Pawnee Ave
Whelan Energy
Whelan Energy Center
202,041 sf
NORTH
RUNON
108 ft
348 ft
286 ft
WEST
AREA
492,000 sf
109,775 sf
EAST
AREA
519,799 sf
397 ft
349 ft
83,354 sf
EAST
RUNON
97,959 sf
Estimated minimum
area for ponding at
4-ft depth prior to
required connection
of discharge culverts
Google Earth
© 2020 Google
Coaltrain Rd
1000 ft
N

NOAA Atlas 14, Volume 8, Version 2
Location name: Hastings, Nebraska, USA*
Latitude: 40.5791°, Longitude: -98.314°
Elevation: 1898.24 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffery Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.364** (0.290-0.466)	**0.431** (0.342-0.551)	**0.542** (0.429-0.695)	**0.637** (0.501-0.818)	**0.771** (0.588-1.01)	**0.877** (0.654-1.15)	**0.986** (0.711-1.31)	**1.10** (0.760-1.48)	**1.25** (0.834-1.71)	**1.37** (0.890-1.88)
10-min	**0.533** (0.424-0.683)	**0.631** (0.501-0.807)	**0.794** (0.628-1.02)	**0.932** (0.734-1.20)	**1.13** (0.861-1.48)	**1.28** (0.957-1.69)	**1.44** (1.04-1.92)	**1.61** (1.11-2.17)	**1.83** (1.22-2.50)	**2.01** (1.30-2.75)
15-min	**0.650** (0.517-0.832)	**0.769** (0.611-0.985)	**0.968** (0.766-1.24)	**1.14** (0.895-1.46)	**1.38** (1.05-1.80)	**1.57** (1.17-2.06)	**1.76** (1.27-2.34)	**1.96** (1.36-2.64)	**2.24** (1.49-3.05)	**2.45** (1.59-3.36)
30-min	**0.934** (0.743-1.20)	**1.11** (0.880-1.42)	**1.40** (1.11-1.79)	**1.65** (1.30-2.11)	**1.99** (1.52-2.60)	**2.26** (1.69-2.98)	**2.54** (1.83-3.38)	**2.83** (1.96-3.81)	**3.22** (2.14-4.39)	**3.52** (2.28-4.82)
60-min	**1.21** (0.958-1.54)	**1.43** (1.13-1.83)	**1.81** (1.43-2.32)	**2.14** (1.68-2.75)	**2.63** (2.01-3.45)	**3.02** (2.26-3.99)	**3.44** (2.48-4.59)	**3.87** (2.69-5.24)	**4.49** (2.99-6.14)	**4.97** (3.23-6.82)
2-hr	**1.48** (1.19-1.87)	**1.74** (1.40-2.20)	**2.21** (1.77-2.80)	**2.63** (2.10-3.34)	**3.26** (2.53-4.25)	**3.78** (2.86-4.94)	**4.33** (3.17-5.73)	**4.92** (3.46-6.59)	**5.75** (3.89-7.81)	**6.42** (4.22-8.72)
3-hr	**1.62** (1.31-2.04)	**1.91** (1.54-2.40)	**2.43** (1.96-3.05)	**2.91** (2.33-3.66)	**3.63** (2.85-4.72)	**4.24** (3.24-5.53)	**4.90** (3.61-6.46)	**5.61** (3.98-7.49)	**6.63** (4.52-8.96)	**7.46** (4.94-10.1)
6-hr	**1.88** (1.54-2.33)	**2.21** (1.80-2.73)	**2.80** (2.28-3.48)	**3.36** (2.72-4.18)	**4.21** (3.34-5.43)	**4.94** (3.82-6.37)	**5.73** (4.28-7.48)	**6.59** (4.73-8.72)	**7.83** (5.41-10.5)	**8.83** (5.92-11.8)
12-hr	**2.12** (1.76-2.60)	**2.52** (2.08-3.08)	**3.21** (2.65-3.94)	**3.83** (3.14-4.70)	**4.74** (3.79-6.00)	**5.50** (4.28-6.97)	**6.29** (4.74-8.09)	**7.14** (5.18-9.31)	**8.34** (5.82-11.0)	**9.29** (6.30-12.3)
24-hr	**2.45** (2.05-2.96)	**2.85** (2.38-3.44)	**3.56** (2.96-4.30)	**4.18** (3.46-5.07)	**5.11** (4.13-6.38)	**5.88** (4.64-7.37)	**6.70** (5.11-8.50)	**7.57** (5.55-9.75)	**8.80** (6.22-11.5)	**9.78** (6.72-12.8)
2-day	**2.80** (2.37-3.33)	**3.21** (2.71-3.82)	**3.93** (3.31-4.68)	**4.57** (3.82-5.46)	**5.52** (4.51-6.79)	**6.30** (5.02-7.79)	**7.13** (5.50-8.94)	**8.01** (5.95-10.2)	**9.26** (6.63-12.0)	**10.3** (7.14-13.3)
3-day	**3.02** (2.57-3.56)	**3.46** (2.94-4.08)	**4.22** (3.57-4.99)	**4.89** (4.12-5.80)	**5.87** (4.82-7.15)	**6.67** (5.35-8.17)	**7.51** (5.83-9.34)	**8.40** (6.28-10.6)	**9.63** (6.95-12.4)	**10.6** (7.45-13.7)
4-day	**3.21** (2.74-3.77)	**3.68** (3.14-4.32)	**4.48** (3.82-5.27)	**5.18** (4.39-6.11)	**6.19** (5.10-7.49)	**7.00** (5.64-8.53)	**7.85** (6.13-9.70)	**8.74** (6.56-11.0)	**9.97** (7.22-12.7)	**10.9** (7.72-14.1)
7-day	**3.78** (3.26-4.38)	**4.31** (3.71-5.00)	**5.19** (4.46-6.04)	**5.95** (5.09-6.94)	**7.02** (5.83-8.38)	**7.88** (6.40-9.47)	**8.75** (6.89-10.7)	**9.65** (7.32-12.0)	**10.9** (7.96-13.8)	**11.8** (8.45-15.1)
10-day	**4.31** (3.74-4.97)	**4.89** (4.24-5.64)	**5.86** (5.06-6.77)	**6.67** (5.73-7.73)	**7.81** (6.52-9.24)	**8.70** (7.11-10.4)	**9.61** (7.61-11.7)	**10.5** (8.04-13.0)	**11.8** (8.69-14.8)	**12.8** (9.17-16.2)
20-day	**5.87** (5.15-6.66)	**6.62** (5.81-7.53)	**7.85** (6.86-8.94)	**8.86** (7.71-10.1)	**10.2** (8.62-11.9)	**11.3** (9.32-13.2)	**12.3** (9.87-14.7)	**13.4** (10.3-16.2)	**14.7** (11.0-18.3)	**15.7** (11.5-19.8)
30-day	**7.17** (6.34-8.08)	**8.09** (7.15-9.13)	**9.57** (8.43-10.8)	**10.8** (9.43-12.2)	**12.4** (10.5-14.2)	**13.5** (11.2-15.7)	**14.7** (11.8-17.4)	**15.8** (12.3-19.1)	**17.3** (12.9-21.2)	**18.3** (13.4-22.9)
45-day	**8.82** (7.85-9.86)	**9.98** (8.88-11.2)	**11.8** (10.5-13.2)	**13.2** (11.7-14.9)	**15.1** (12.9-17.2)	**16.5** (13.8-19.0)	**17.8** (14.4-20.8)	**19.0** (14.8-22.7)	**20.5** (15.5-25.0)	**21.5** (16.0-26.7)
60-day	**10.2** (9.16-11.4)	**11.6** (10.4-12.9)	**13.7** (12.2-15.3)	**15.4** (13.6-17.2)	**17.5** (15.0-19.8)	**19.0** (16.0-21.7)	**20.4** (16.6-23.7)	**21.7** (17.0-25.8)	**23.3** (17.6-28.2)	**24.3** (18.1-30.0)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

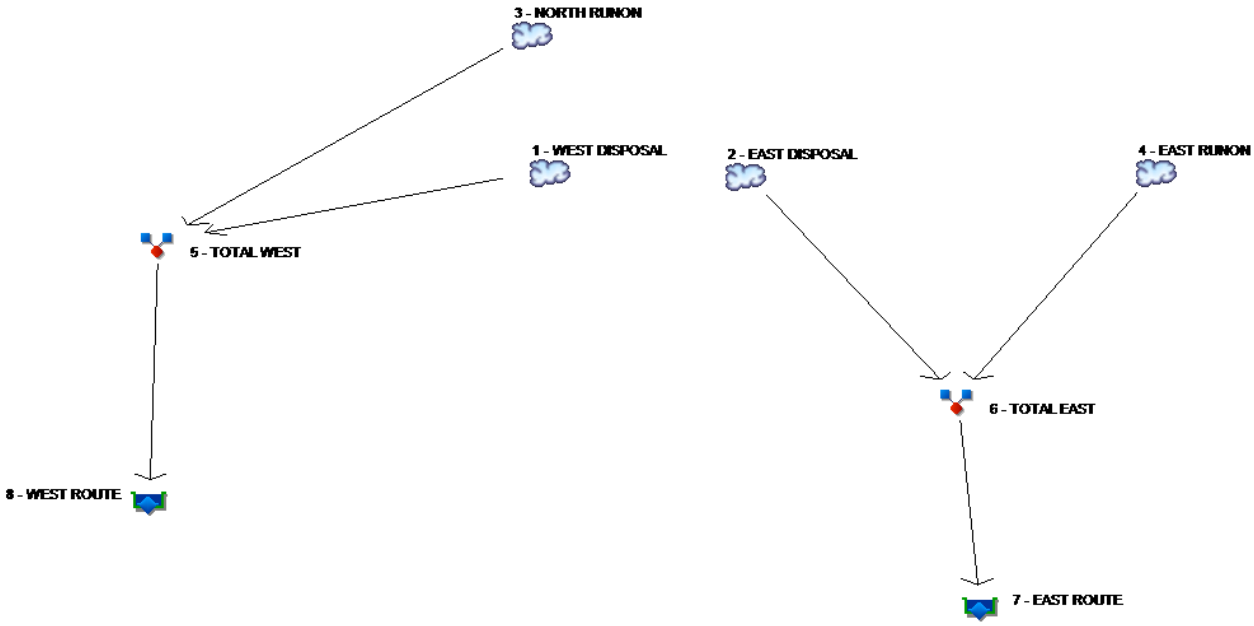
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Back to Top

PF graphical

Watershed Model Schematic



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

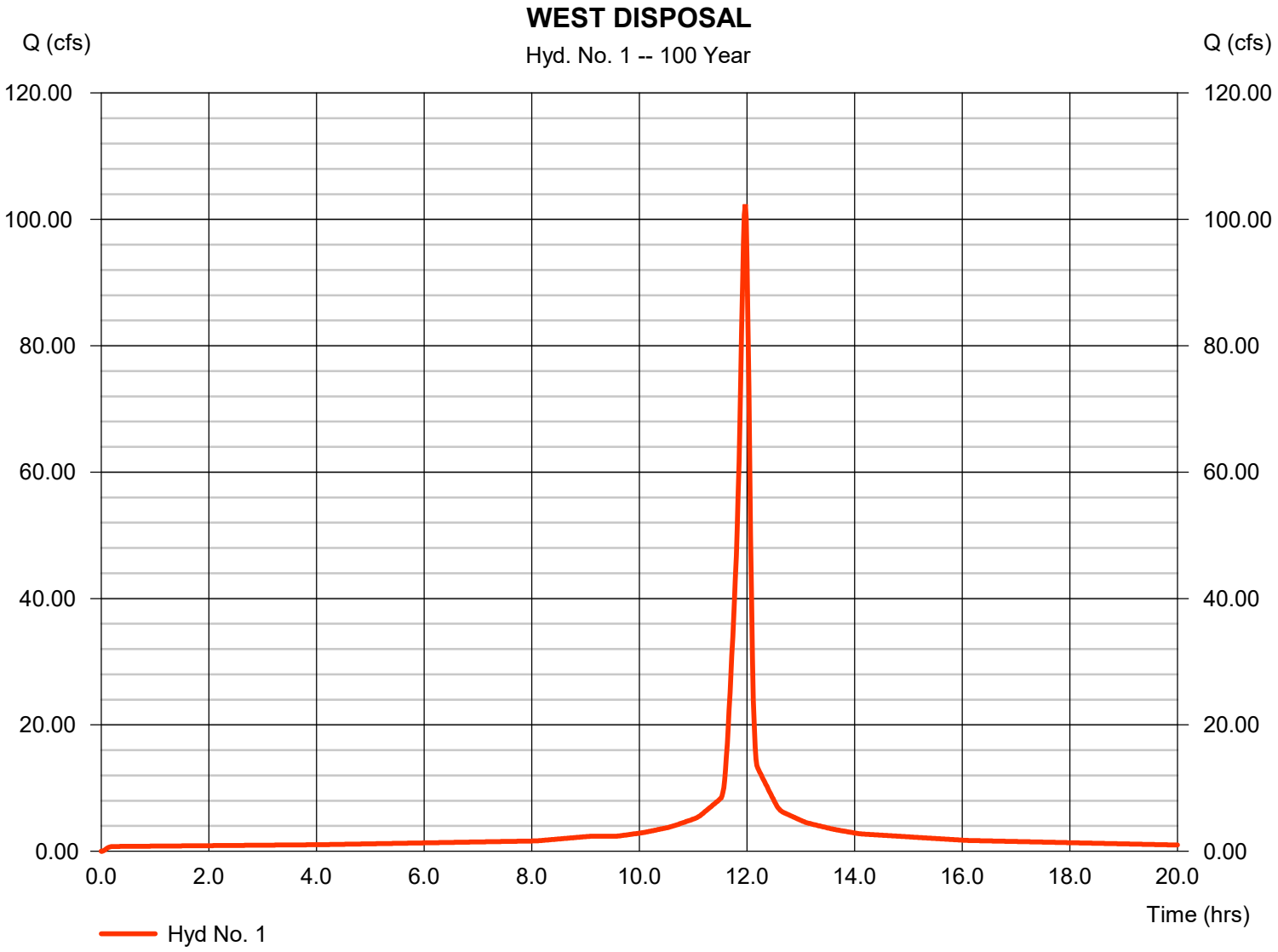
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	102.36	1	718	267,957	------	------	------	WEST DISPOSAL
2	SCS Runoff	107.80	1	718	282,184	------	------	------	EAST DISPOSAL
3	SCS Runoff	46.80	1	717	117,881	------	------	------	NORTH RUNON
4	SCS Runoff	23.44	1	715	52,442	------	------	------	EAST RUNON
5	Combine	148.48	1	718	385,838	1, 3,	------	------	TOTAL WEST
6	Combine	125.92	1	717	334,627	2, 4,	------	------	TOTAL EAST
7	Reservoir	93.54	1	721	320,978	6	1893.85	70,669	EAST ROUTE
8	Reservoir	110.92	1	721	376,722	5	1893.91	74,115	WEST ROUTE

Hydrograph Report

Hyd. No. 1

WEST DISPOSAL

Hydrograph type	=	SCS Runoff	Peak discharge	=	102.36 cfs
Storm frequency	=	100 yrs	Time to peak	=	11.97 hrs
Time interval	=	1 min	Hyd. volume	=	267,957 cuft
Drainage area	=	11.300 ac	Curve number	=	100
Basin Slope	=	0.5 %	Hydraulic length	=	900 ft
Tc method	=	TR55	Time of conc. (Tc)	=	7.60 min
Total precip.	=	6.70 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

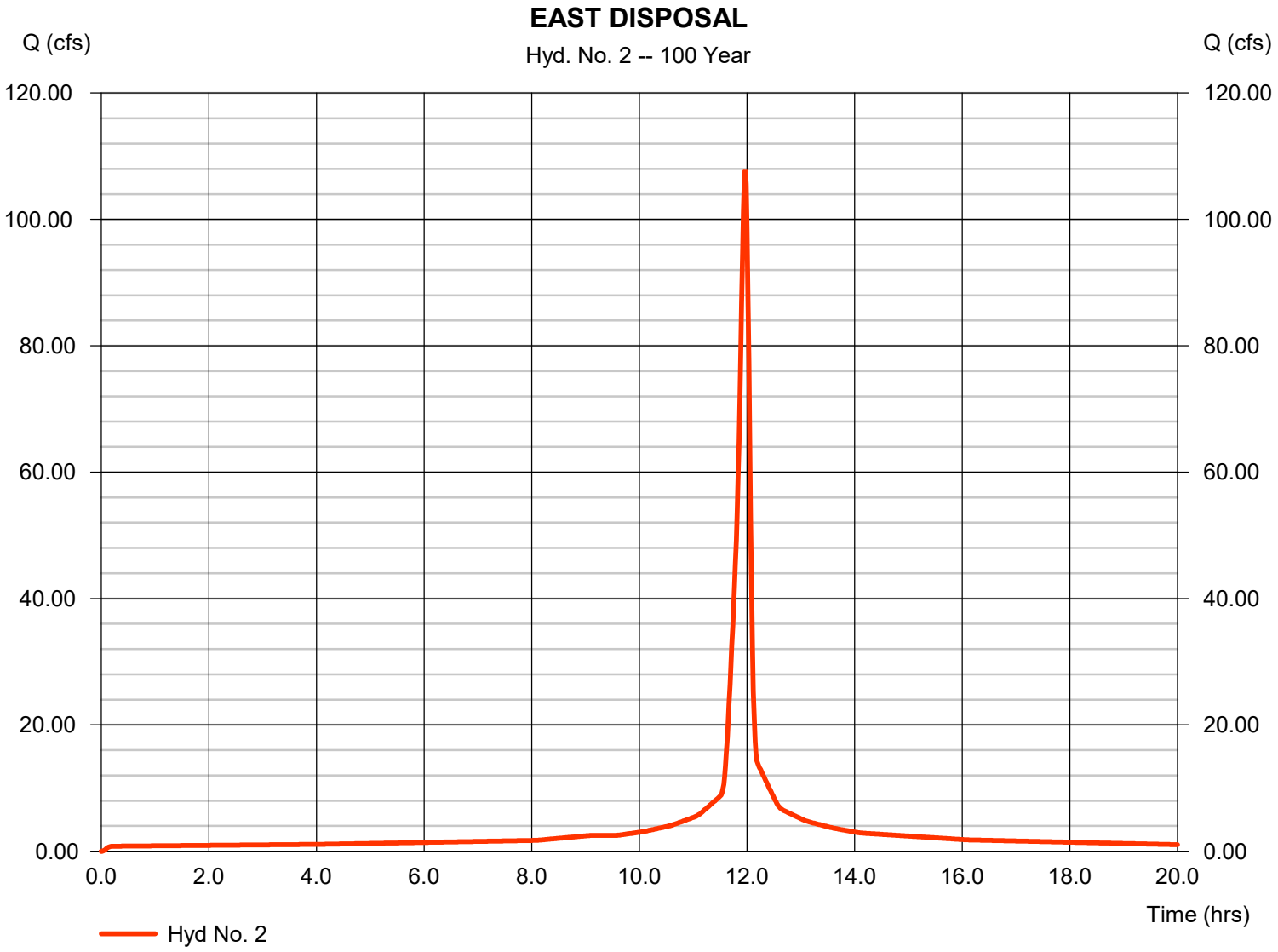


Hydrograph Report

Hyd. No. 2

EAST DISPOSAL

Hydrograph type	=	SCS Runoff	Peak discharge	=	107.80 cfs
Storm frequency	=	100 yrs	Time to peak	=	11.97 hrs
Time interval	=	1 min	Hyd. volume	=	282,184 cuft
Drainage area	=	11.900 ac	Curve number	=	100
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	7.10 min
Total precip.	=	6.70 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

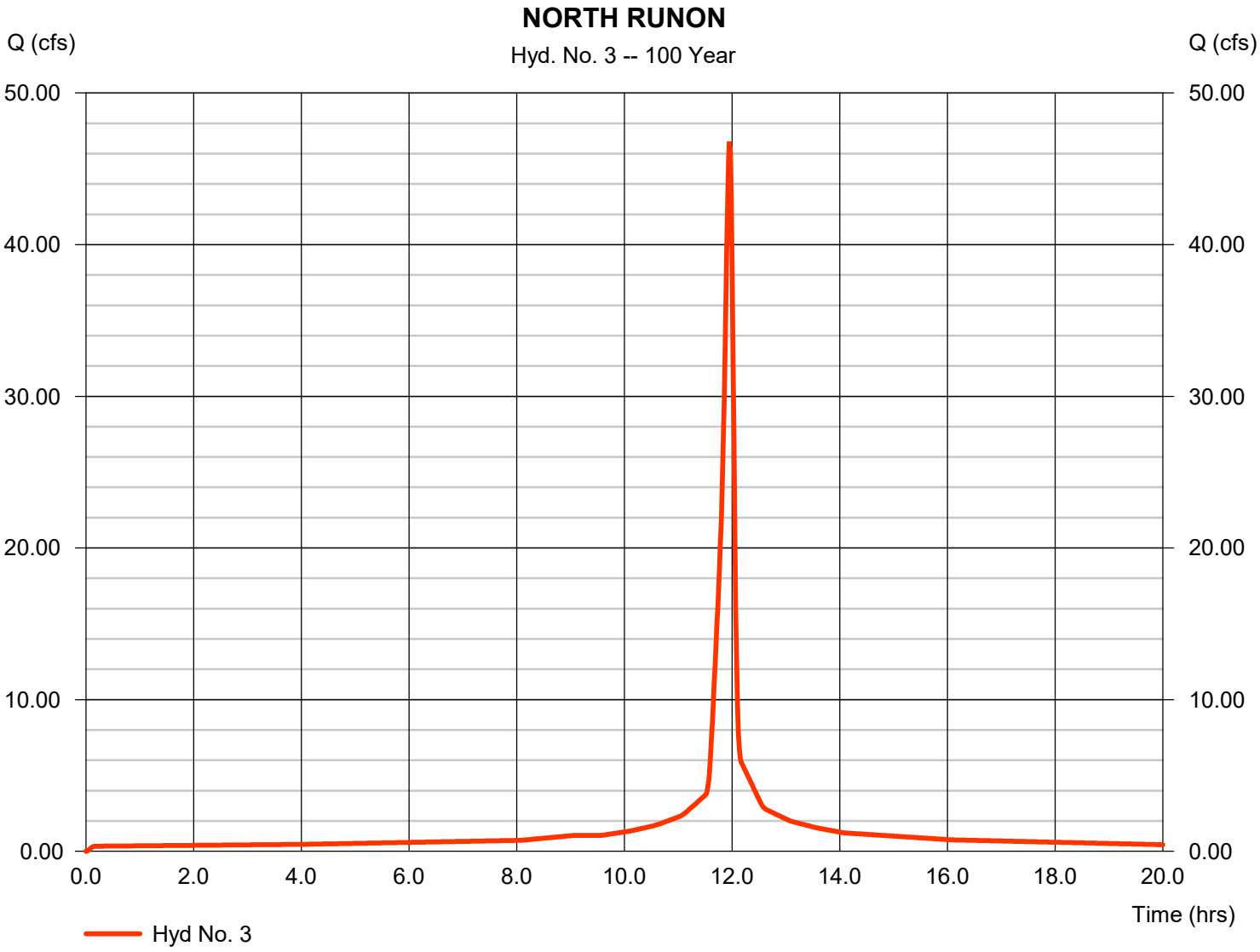


Hydrograph Report

Hyd. No. 3

NORTH RUNON

Hydrograph type	=	SCS Runoff	Peak discharge	=	46.80 cfs
Storm frequency	=	100 yrs	Time to peak	=	11.95 hrs
Time interval	=	1 min	Hyd. volume	=	117,881 cuft
Drainage area	=	4.700 ac	Curve number	=	100
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	5.02 min
Total precip.	=	6.70 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484

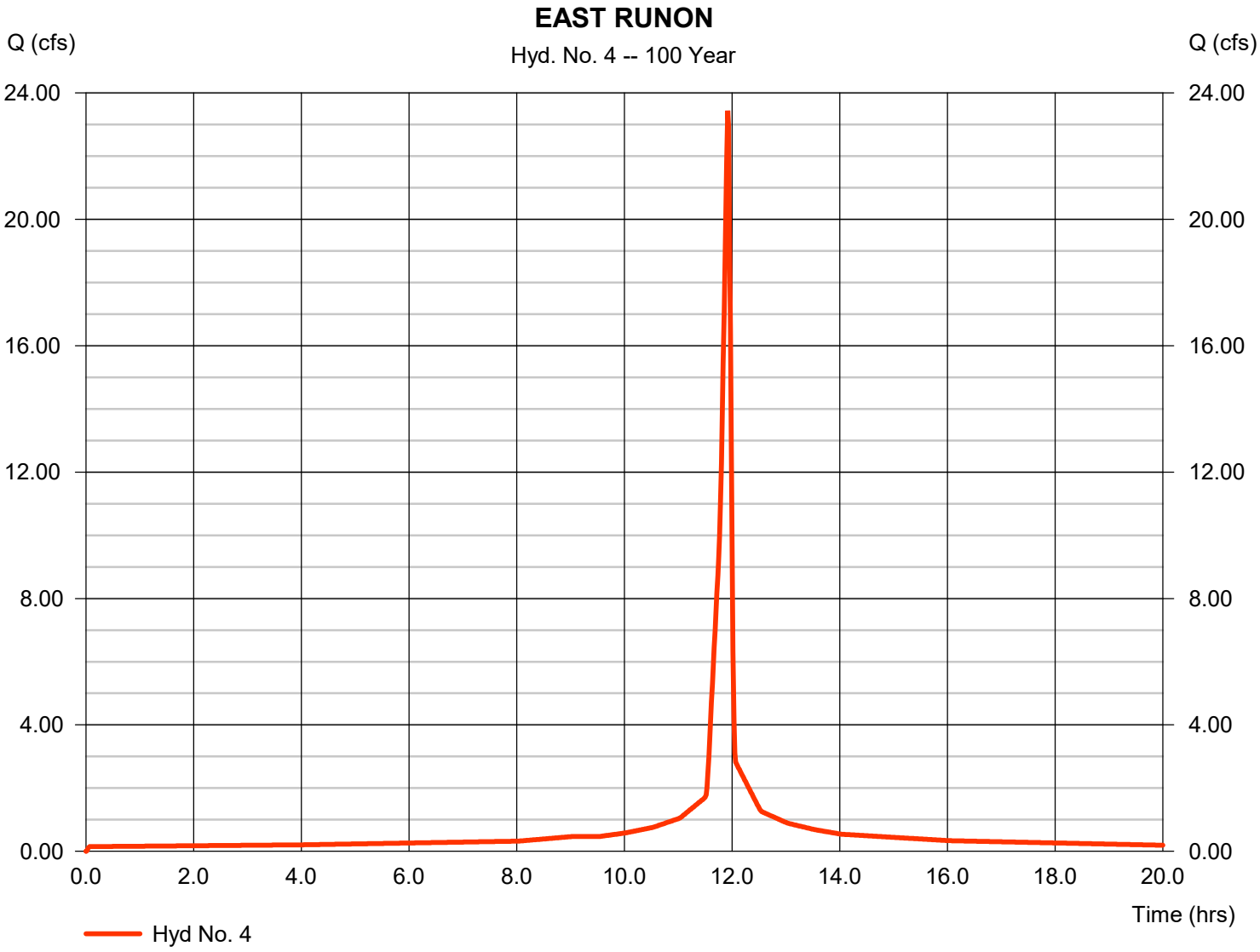


Hydrograph Report

Hyd. No. 4

EAST RUNON

Hydrograph type	=	SCS Runoff	Peak discharge	=	23.44 cfs
Storm frequency	=	100 yrs	Time to peak	=	11.92 hrs
Time interval	=	1 min	Hyd. volume	=	52,442 cuft
Drainage area	=	2.300 ac	Curve number	=	100
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	2.50 min
Total precip.	=	6.70 in	Distribution	=	Type II
Storm duration	=	24 hrs	Shape factor	=	484



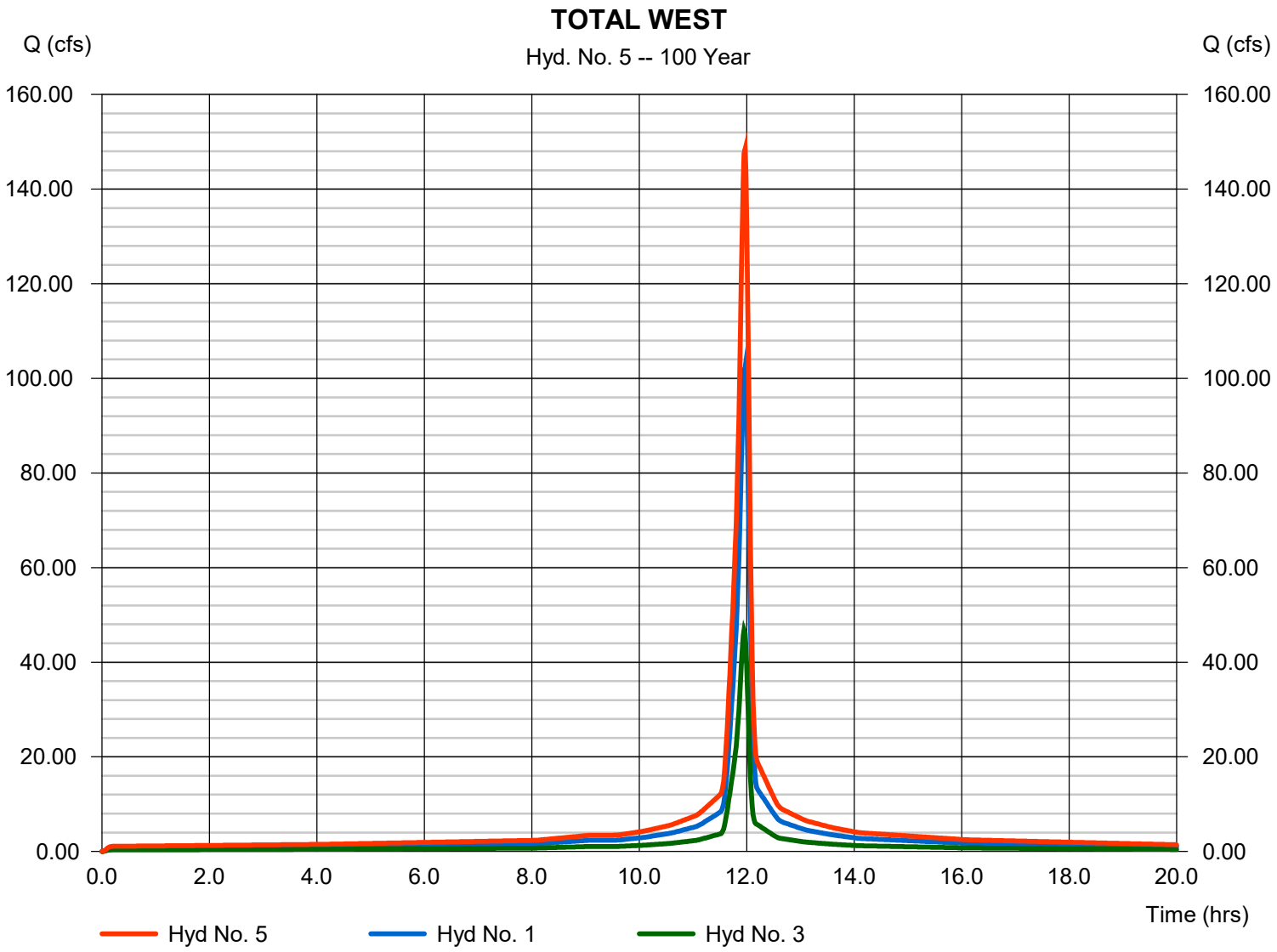
Hydrograph Report

Hyd. No. 5

TOTAL WEST

Hydrograph type	= Combine	Peak discharge	= 148.48 cfs
Storm frequency	= 100 yrs	Time to peak	= 11.97 hrs
Time interval	= 1 min	Hyd. volume	= 385,838 cuft
Inflow hyds.	= 1, 3	Contrib. drain. area	= 16.000 ac

+0.62-CFS BASE FLOW (WEC1 Ash Sluice) = 149.1-CFS

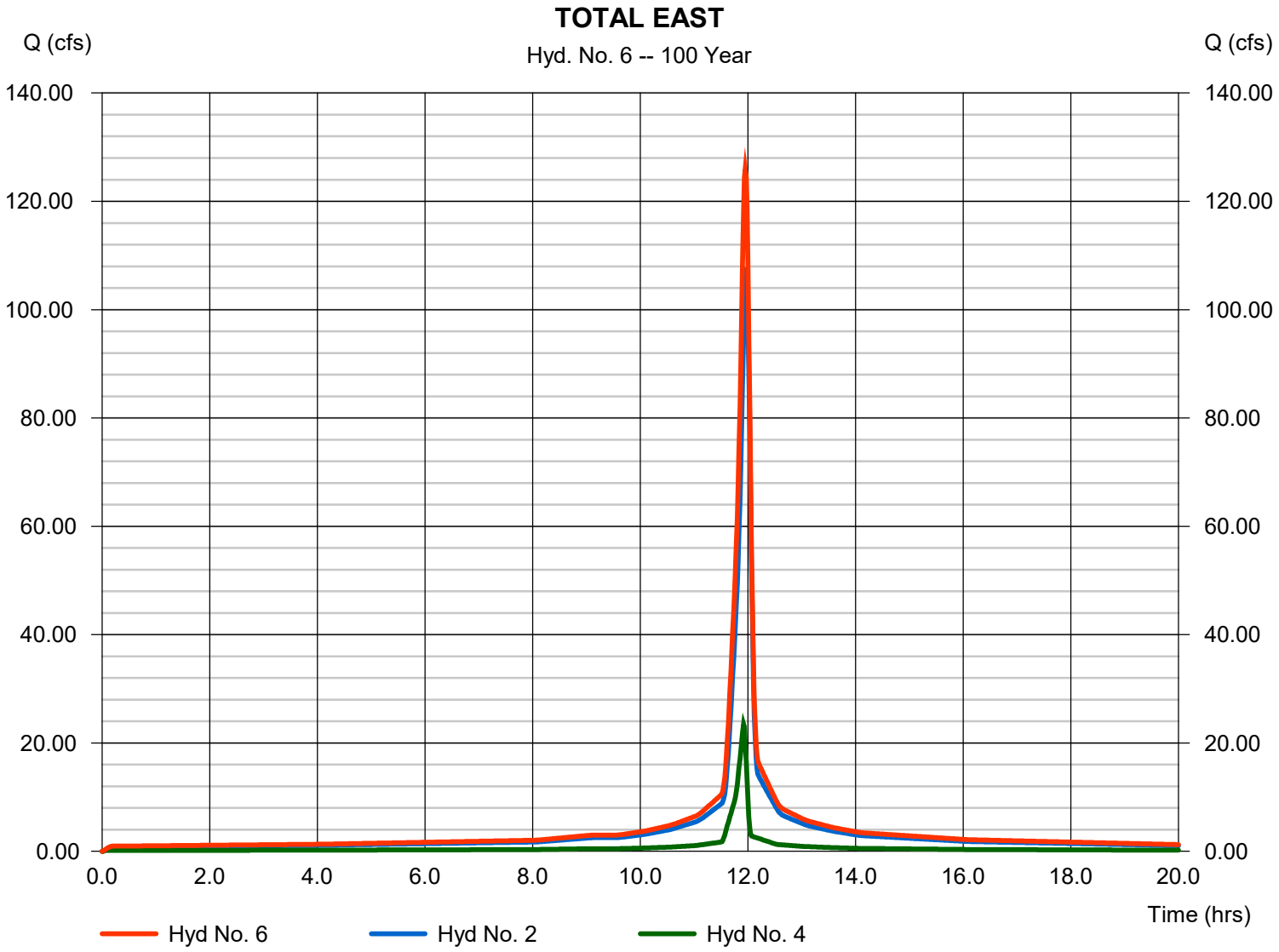


Hydrograph Report

Hyd. No. 6

TOTAL EAST

Hydrograph type	=	Combine	Peak discharge	=	125.92 cfs
Storm frequency	=	100 yrs	Time to peak	=	11.95 hrs
Time interval	=	1 min	Hyd. volume	=	334,627 cuft
Inflow hyds.	=	2, 4	Contrib. drain. area	=	14.200 ac



Hydrograph Report

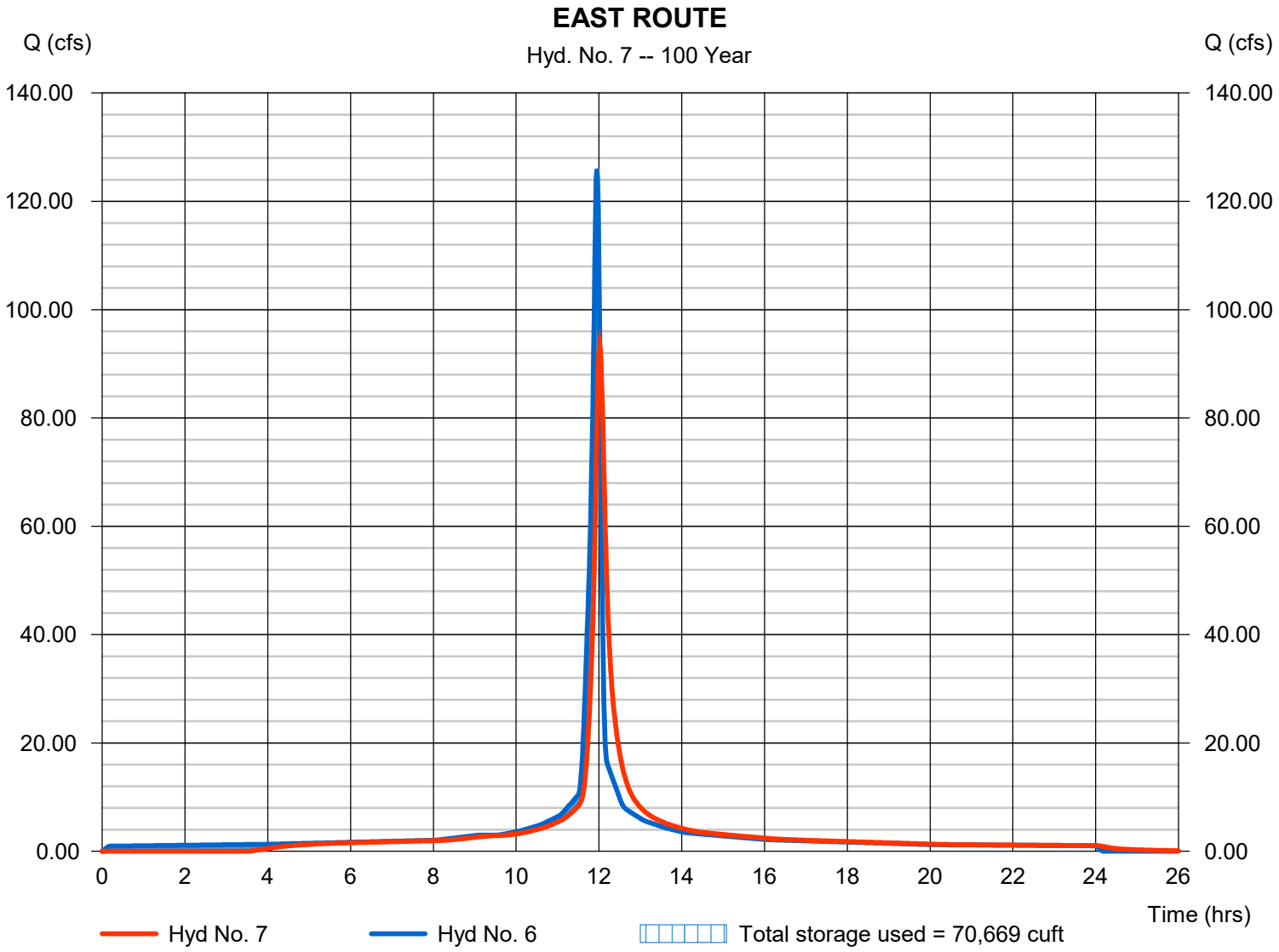
2X36" OUTLETS WITH 48" RISERS

Hyd. No. 7

EAST ROUTE

Hydrograph type	=	Reservoir	Peak discharge	=	93.54 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.02 hrs
Time interval	=	1 min	Hyd. volume	=	320,978 cuft
Inflow hyd. No.	=	6 - TOTAL EAST	Max. Elevation	=	1893.85 ft
Reservoir name	=	EAST OUTLET	Max. Storage	=	70,669 cuft

Storage Indication method used.



Pond Report

Pond No. 1 - EAST OUTLET

2X36" OUTLETS WITH 48" RISERS

Pond Data

Trapezoid -Bottom L x W = 100.0 x 50.0 ft, Side slope = 3.00:1, Bottom elev. = 1892.50 ft, Depth = 5.50 ft

Stage / Storage Table

CLEAR AREA ONLY

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	1892.50	5,000	0	0
0.55	1893.05	5,506	2,888	2,888
1.10	1893.60	6,034	3,172	6,060
1.65	1894.15	6,583	3,469	9,529
2.20	1894.70	7,154	3,777	13,306
2.75	1895.25	7,747	4,097	17,403
3.30	1895.80	8,362	4,429	21,832
3.85	1896.35	8,999	4,773	26,605
4.40	1896.90	9,657	5,129	31,734
4.95	1897.45	10,337	5,497	37,232
5.50	1898.00	11,039	5,877	43,109

INPUT APPROX. INVERT ELEV. AND LENGTHS TO MODEL DUAL CULVERT OUTFLOW

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 36.00	0.00	0.00	0.00
Span (in)	= 36.00	0.00	0.00	0.00
No. Barrels	= 2	0	0	0
Invert El. (ft)	= 1888.67	0.00	0.00	0.00
Length (ft)	= 125.00	0.00	0.00	0.00
Slope (%)	= 4.20	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

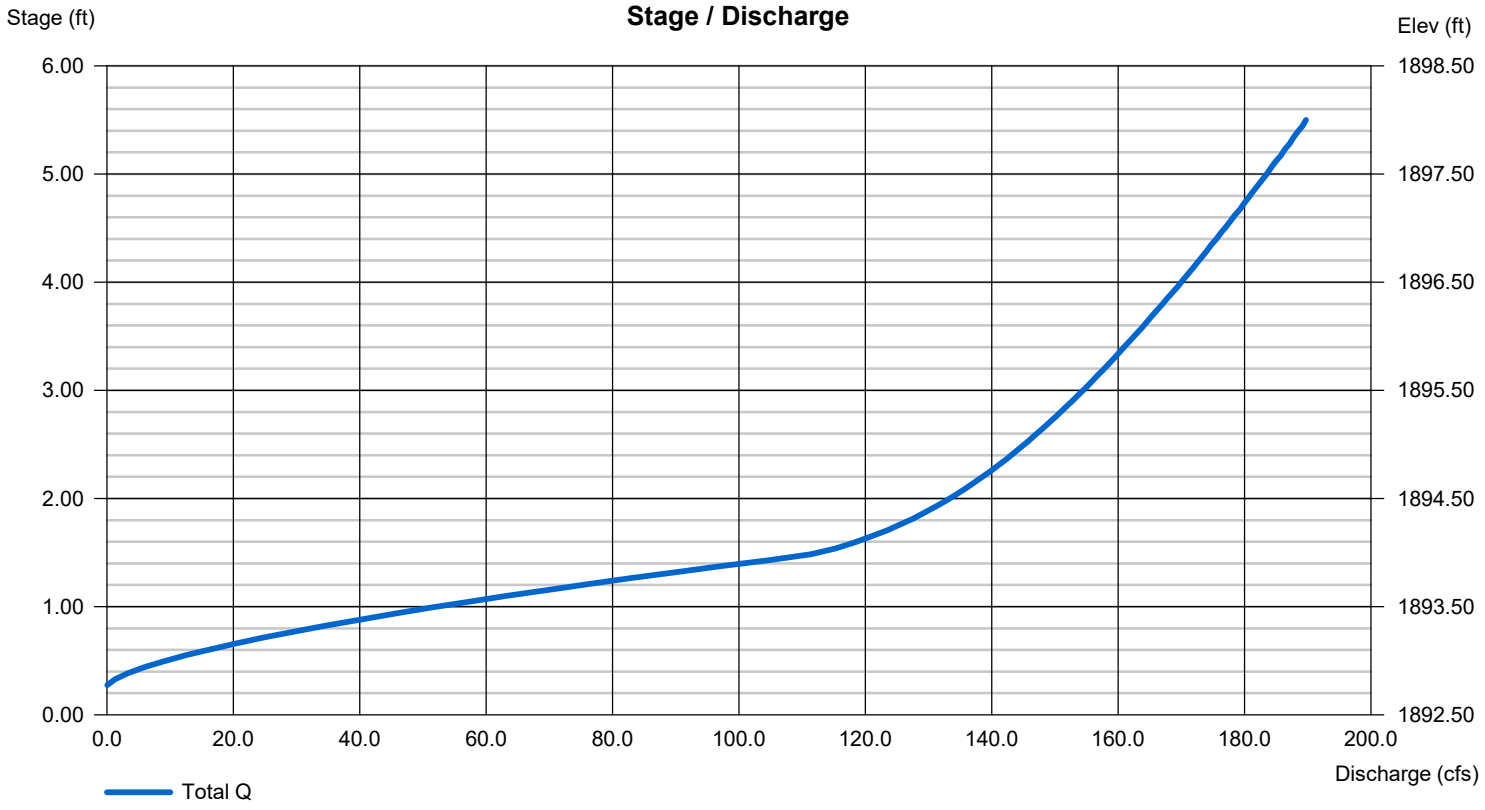
Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 25.14	0.00	0.00	0.00
Crest El. (ft)	= 1892.77	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	---	---	---
Multi-Stage	= Yes	No	No	No

Exfil.(in/hr) = 0.000 (by Contour)

TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



Hydrograph Report

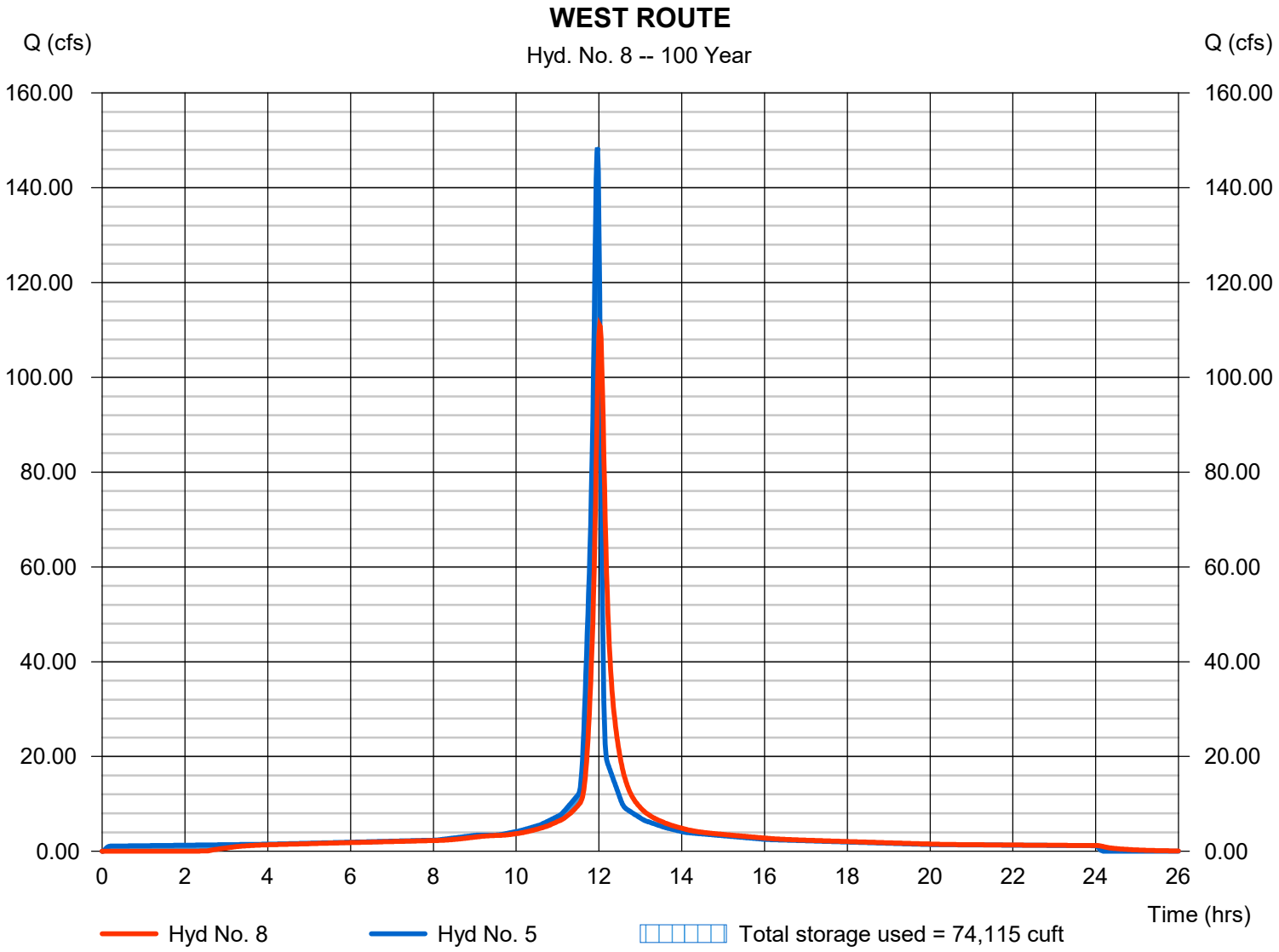
2X36" OUTLETS WITH 48" RISERS

Hyd. No. 8

WEST ROUTE

Hydrograph type	=	Reservoir	Peak discharge	=	110.92 cfs
Storm frequency	=	100 yrs	Time to peak	=	12.02 hrs
Time interval	=	1 min	Hyd. volume	=	376,722 cuft
Inflow hyd. No.	=	5 - TOTAL WEST	Max. Elevation	=	1893.91 ft
Reservoir name	=	WEST OUTLET	Max. Storage	=	74,115 cuft

Storage Indication method used.



Pond Report

Pond No. 2 - WEST OUTLET

2X36" OUTLETS WITH 48" RISERS

Pond Data

Trapezoid -Bottom L x W = 100.0 x 50.0 ft, Side slope = 3.00:1, Bottom elev. = 1892.50 ft, Depth = 5.50 ft

Stage / Storage Table

CLEAR AREA ONLY

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	1892.50	5,000	0	0
0.55	1893.05	5,506	2,888	2,888
1.10	1893.60	6,034	3,172	6,060
1.65	1894.15	6,583	3,469	9,529
2.20	1894.70	7,154	3,777	13,306
2.75	1895.25	7,747	4,097	17,403
3.30	1895.80	8,362	4,429	21,832
3.85	1896.35	8,999	4,773	26,605
4.40	1896.90	9,657	5,129	31,734
4.95	1897.45	10,337	5,497	37,232
5.50	1898.00	11,039	5,877	43,109

INPUT APPROX. INVERT ELEV. AND LENGTHS TO MODEL DUAL CULVERT OUTFLOW

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 36.00	Inactive	0.00	0.00
Span (in)	= 36.00	36.00	0.00	0.00
No. Barrels	= 2	1	0	0
Invert El. (ft)	= 1888.60	1888.60	0.00	0.00
Length (ft)	= 125.00	125.00	0.00	0.00
Slope (%)	= 4.48	4.48	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

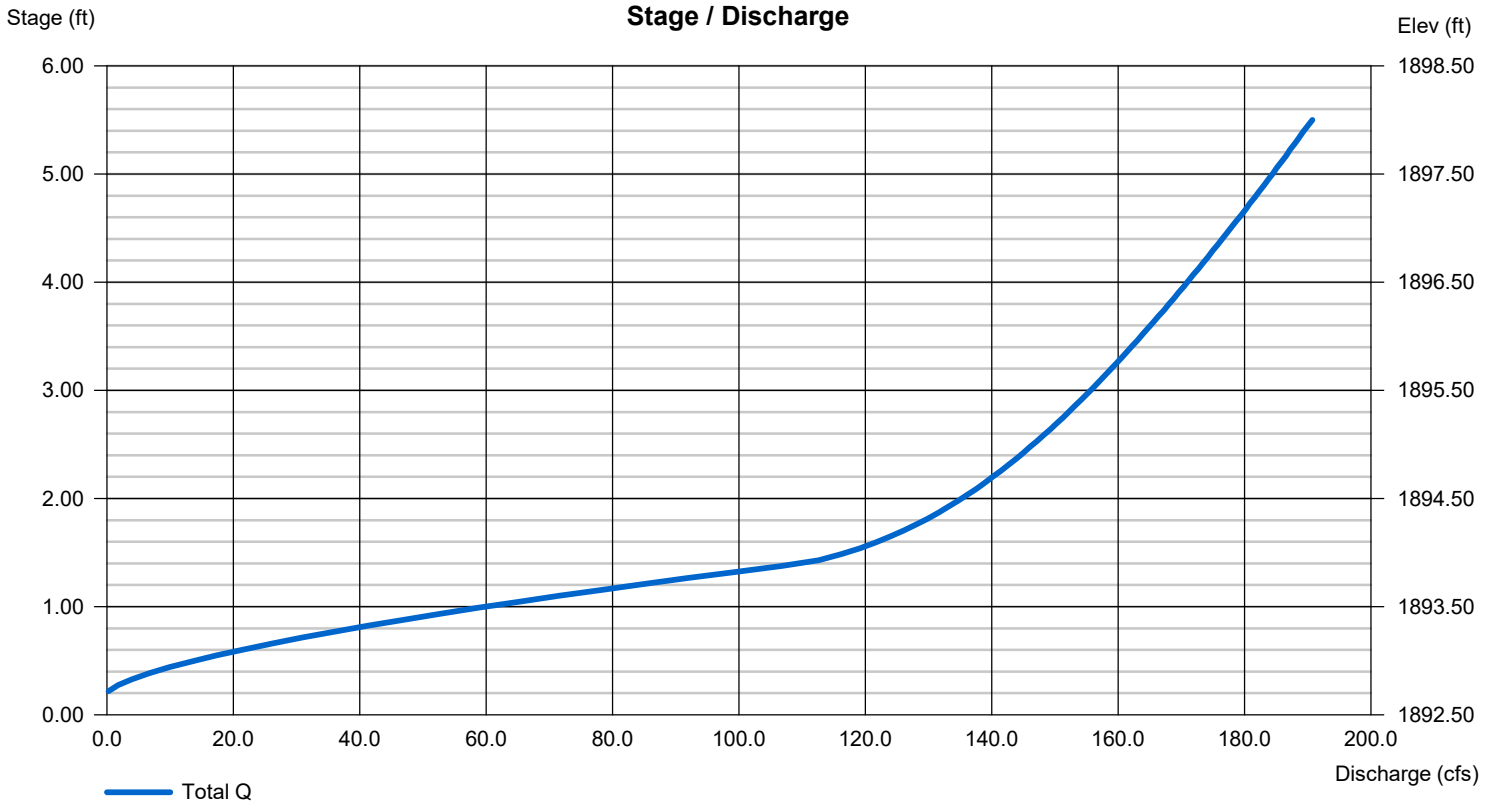
Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 25.14	0.00	0.00	0.00
Crest El. (ft)	= 1892.70	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= 1	---	---	---
Multi-Stage	= Yes	No	No	No

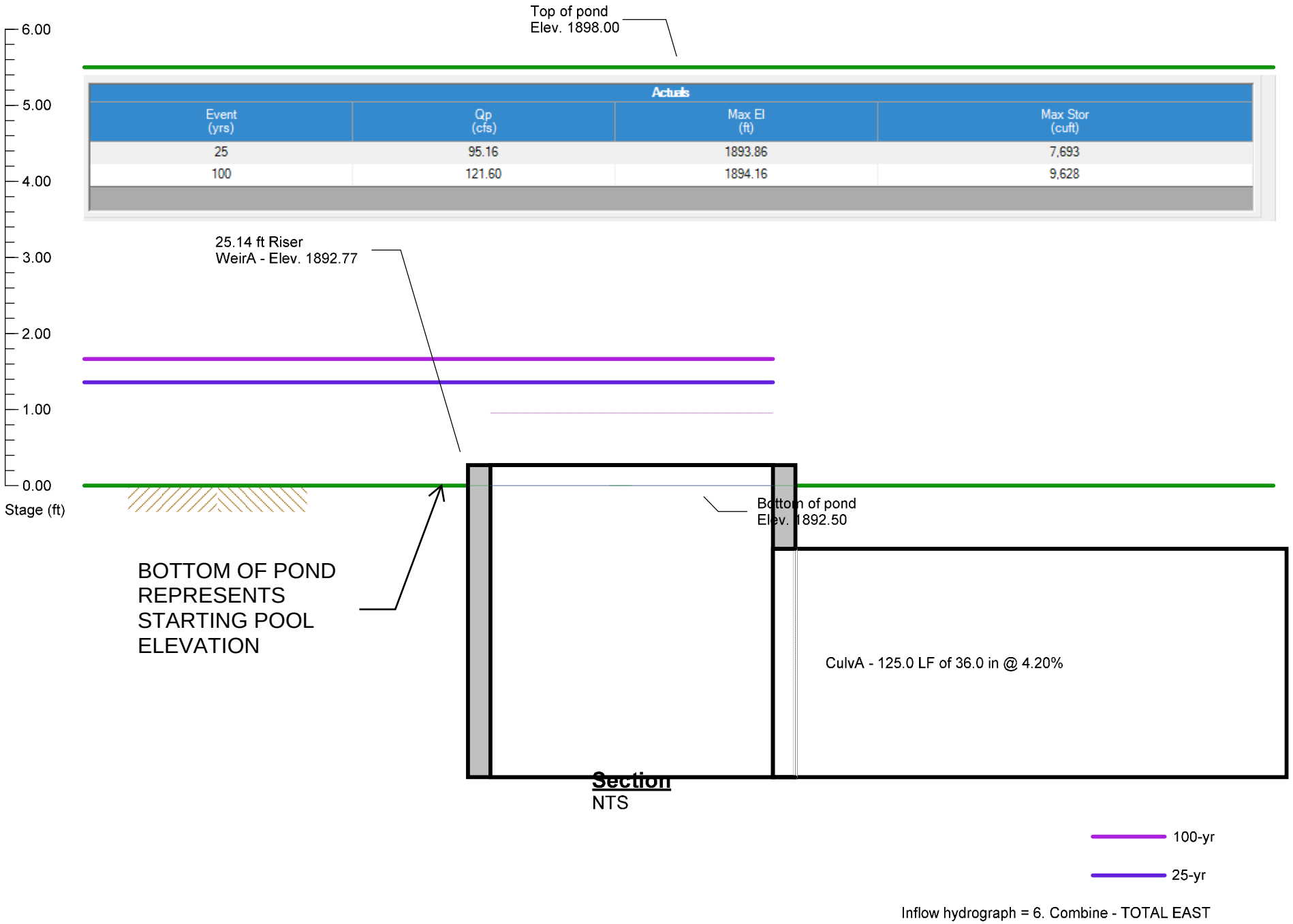
Exfil.(in/hr) = 0.000 (by Contour)

TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



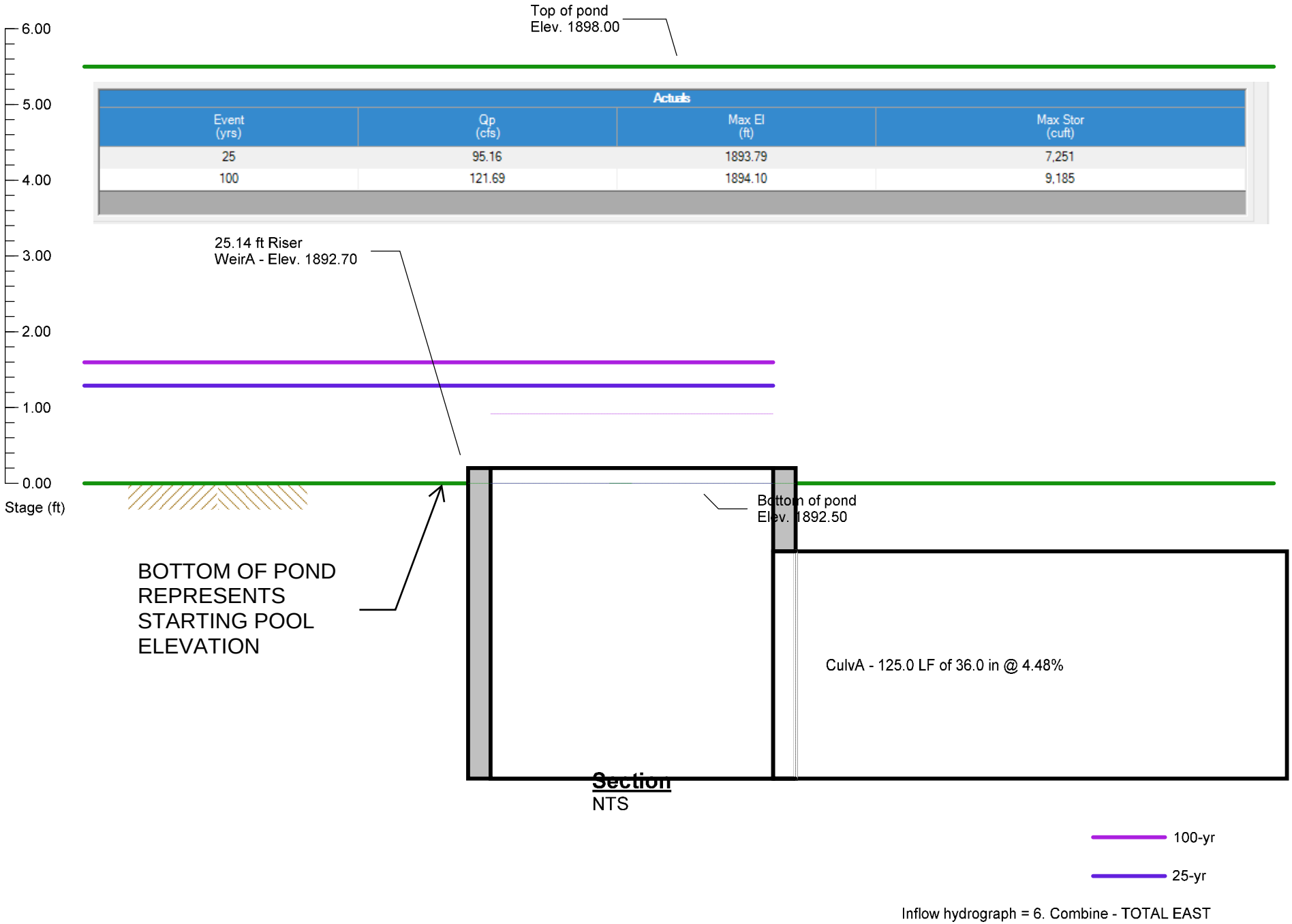
Pond No. 1 - EAST OUTLET



Actuals			
Event (yrs)	Qp (cfs)	Max El (ft)	Max Stor (cuft)
25	95.16	1893.86	7,693
100	121.60	1894.16	9,628

Inflow hydrograph = 6. Combine - TOTAL EAST

Pond No. 2 - WEST OUTLET



Actuals			
Event (yrs)	Qp (cfs)	Max El (ft)	Max Stor (cuft)
25	95.16	1893.79	7,251
100	121.69	1894.10	9,185

Inflow hydrograph = 6. Combine - TOTAL EAST

Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Friday, Nov 20 2020

Circular Culvert

Invert Elev Dn (ft)	=	1883.00
Pipe Length (ft)	=	125.00
Slope (%)	=	4.00
Invert Elev Up (ft)	=	1888.00
Rise (in)	=	36.0
Shape	=	Circular
Span (in)	=	36.0
No. Barrels	=	1
n-Value	=	0.019
Culvert Type	=	Circular Corrugate Metal Pipe
Culvert Entrance	=	Headwall
Coeff. K,M,c,Y,k	=	0.0078, 2, 0.0379, 0.69, 0.5

Max. flow for 1-culvert = 90-cfs. Max. flow for system is ~150-cfs. 2 culverts are required.

Embankment

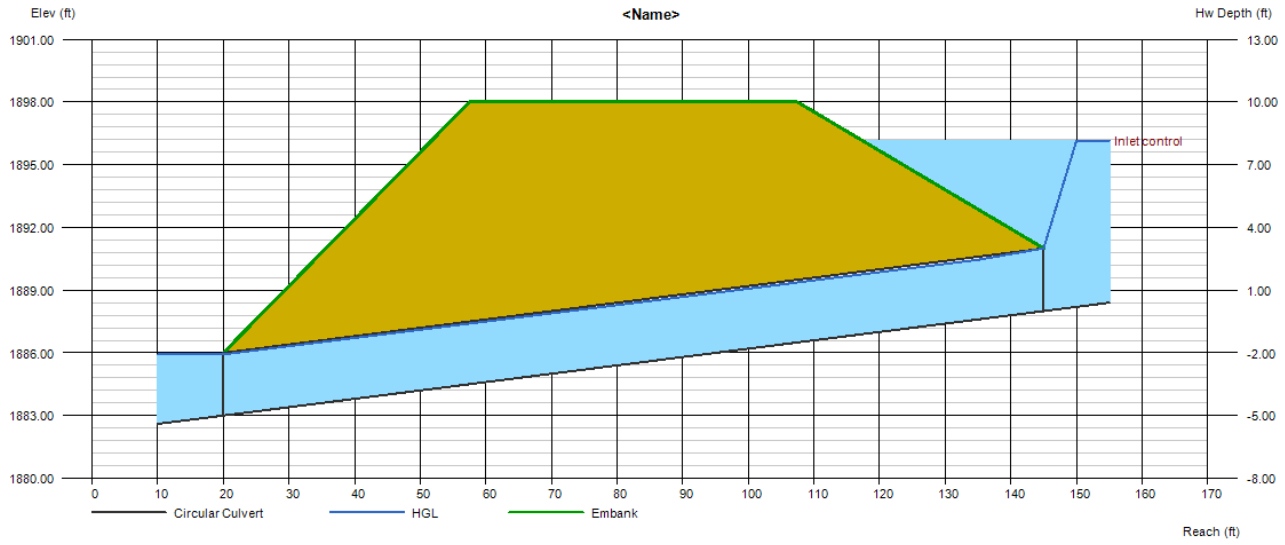
Top Elevation (ft)	=	1898.00
Top Width (ft)	=	50.00
Crest Width (ft)	=	50.00

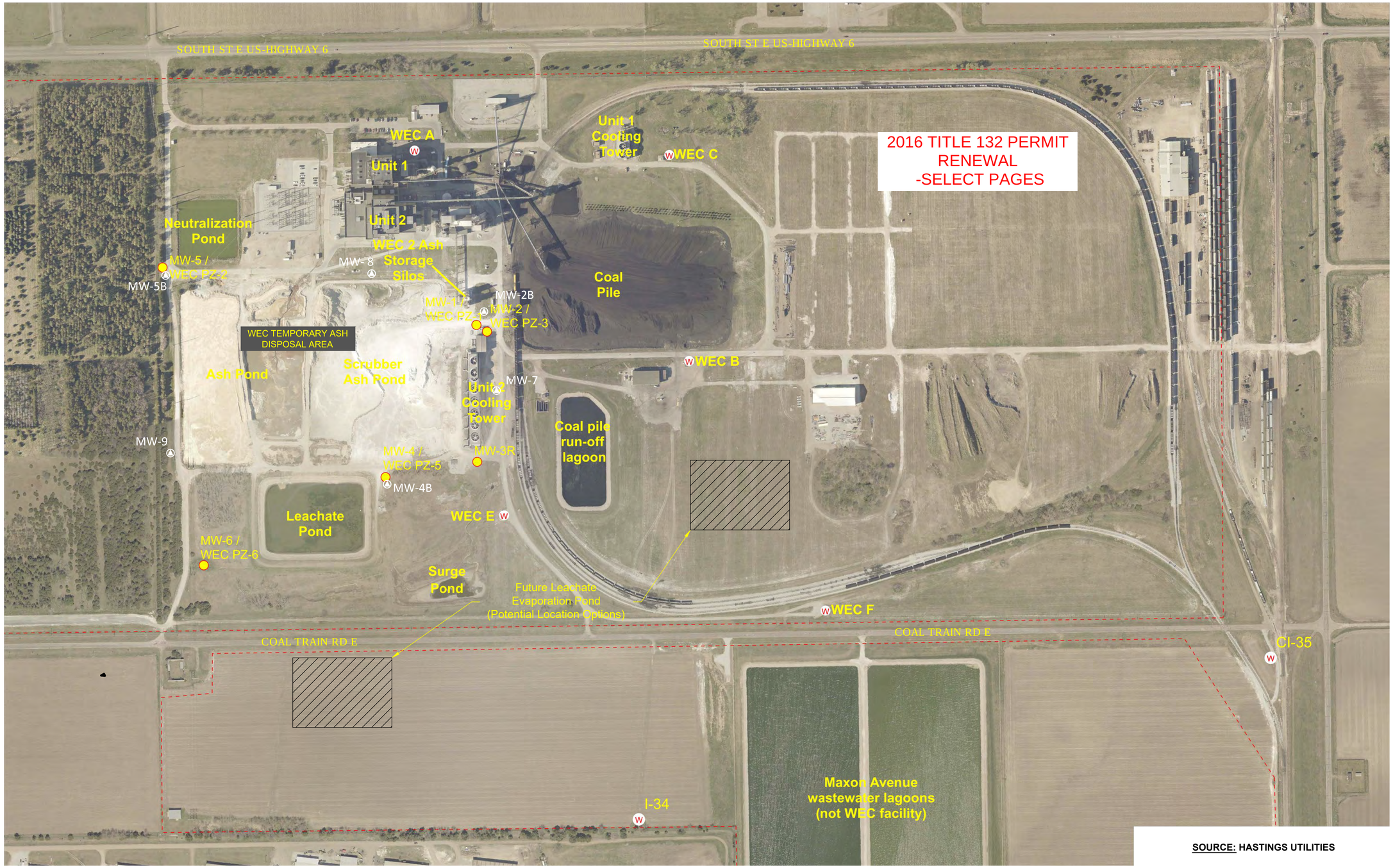
Calculations

Qmin (cfs)	=	0.00
Qmax (cfs)	=	110.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	90.00
Qpipe (cfs)	=	90.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	12.82
Veloc Up (ft/s)	=	12.99
HGL Dn (ft)	=	1885.92
HGL Up (ft)	=	1890.85
Hw Elev (ft)	=	1896.15
Hw/D (ft)	=	2.72
Flow Regime	=	Inlet Control





SOURCE: HASTINGS UTILITIES

ISSUE	DATE	DESCRIPTION
0	10/6/2016	NDEQ TITLE 132 PERMIT RENEWAL

PROJECT MANAGER L. CALUB

PROJECT NUMBER 000000010040278

PROFESSIONAL MECHANICAL ENGINEER
LORI J. CALUB
E-9881
STATE OF NEBRASKA

public power generation agency

HASTINGS UTILITIES

GERALD T. WHELAN ENERGY CENTER
WEC TEMPORARY ASH DISPOSAL AREA

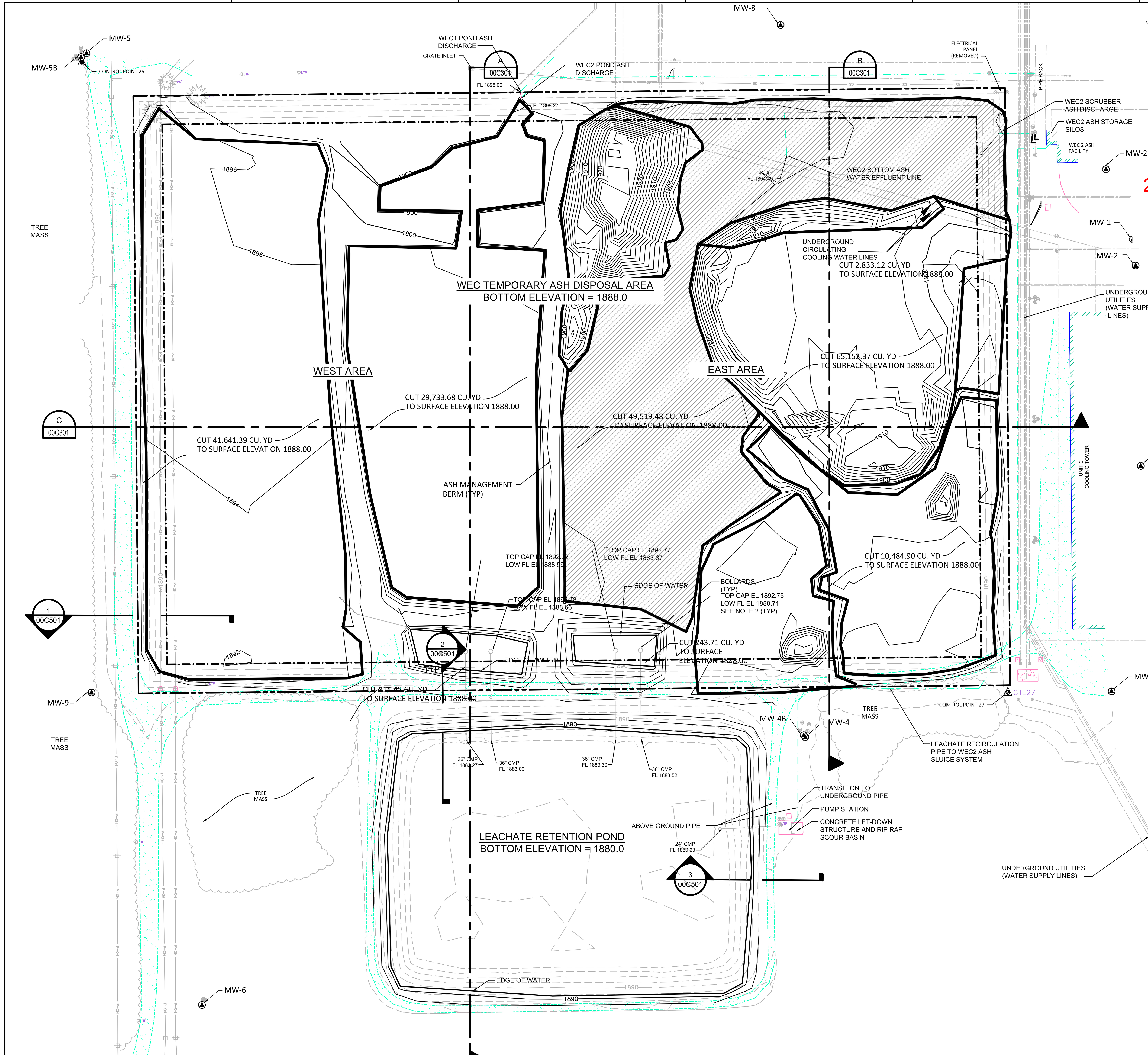
SITE PLAN

0 1" 2"

FILENAME 00C101.DWG

SCALE -

SHEET 00C101



2016 TITLE 132 PERMIT RENEWAL -SELECT PAGES

GROUNDWATER MONITORING WELLS					
WELL DESIGNATION	NORTHING	EASTING	TOP OF CASING ELEVATION*	GROUND ELEVATION*	COMMENT
[illegible]	[illegible]	[illegible]	1902.93	1900.68	DETECTION MONITORING WELL
[illegible]	[illegible]	[illegible]	1903.18	1900.93	DRY
[illegible]	[illegible]	[illegible]	1902.96	1900.60**	DETECTION MONITORING WELL
[illegible]	[illegible]	[illegible]	1900.45	1897.98	DETECTION MONITORING WELL
MW-4	333888.31	2329891.68	1899.21	1895.19	DRY
MW-4B	333876.00	2329890.22	1897.02	1894.69**	DETECTION MONITORING WELL
MW-5	334830.77	2328882.44	1898.90	1897.60	DRY
MW-5B	334819.84	2328884.33	1899.16	1897.21**	DETECTION MONITORING WELL
MW-6	333507.64	2329055.42	1896.72	1893.54	DETECTION MONITORING WELL
MW-7	334250.89	2330359.26	1901.23	1899.14**	DETECTION MONITORING WELL
MW-8	334864.54	2329857.95	1903.37	1901.05**	DETECTION MONITORING WELL
MW-9	333935.57	2328898.85	1896.54	1894.31**	DETECTION MONITORING WELL

* TOP OF CASING AND GROUND ELEVATIONS PROVIDED BY HASTINGS UTILITIES.
** DESIGNATED GROUND ELEVATIONS DEPICT THE ELEVATION OF THE TOP OF THE CONCRETE SLAB NEAREST TO THE CASING ON THE NORTH SIDE.

CONTROLS	NORTHING	EASTING	ELEVATION	LONG DESCRIPTION
25	334815.14	2328892.86	1896.51	BRASS CAP
26	334879.51	2330467.21	1900.86	BRASS CAP
27	333932.07	2330190.86	1894.46	BRASS CAP

*NOTE: STATE PLANE CONTROL IS BASED ON NEBRASKA SOUTH ZONE NAD 27. VERTICAL CONTROL IS BASED ON NGVD29.

LEGEND

- POWER POLE
- ELECTRICAL VAULT
- ELECTRICAL METER
- ELECTRICAL BOX
- LIGHT POLE
- GUY WIRE
- WATER VALVE
- FIRE HYDRANT
- MONITORING WELL
- WATER WELL
- UNKOWN MANHOLE
- POST INDICATOR VALVE
- STEEL POST
- BOLLARD
- STORM DRAIN MANHOLE
- GATE INLET
- CONIFEROUS TREE
- TREE MASS
- STORM SEWER LINE
- OVERHEAD ELECTRIC
- DISCHARGE PIPE
- EDGE OF GRAVEL
- EDGE OF CONCRETE
- EDGE OF WATER
- CONCRETE
- GRAVEL
- BUILDING LINE
- CONTROL POINT
- ASH DISPOSAL AREA BOUNDARY
- ORIGINAL TOE OF SLOPE

NOTES:

1. TOPOGRAPHIC SURVEY OF ASH DISPOSAL AREA AND LEACHATE DETENTION POND BY JEO CONSULTING PERFORMED ON 08/17/2016. SURROUNDING ROADWAYS AND STRUCTURES FROM TOPOGRAPHIC SURVEY BY OLSSON ASSOCIATES PERFORMED ON 07/14/2011.
2. RISER ELEVATIONS PROVIDED BY HASTINGS UTILITIES.

HDR

ISSUE	DATE	DESCRIPTION
1	11/3/2016	RESPONSE TO NDEQ COMMENTS
0	10/6/2016	NDEQ TITLE 132 PERMIT RENEWAL

PROJECT MANAGER L. CALUB

PROJECT NUMBER 000000010040278

PROFESSIONAL MECHANICAL ENGINEER LORI J. CALUB E-9881 STATE OF NEBRASKA

PPGA public power generation agency

HASTINGS UTILITIES

GERALD T. WHELAN ENERGY CENTER
WEC TEMPORARY ASH DISPOSAL AREA

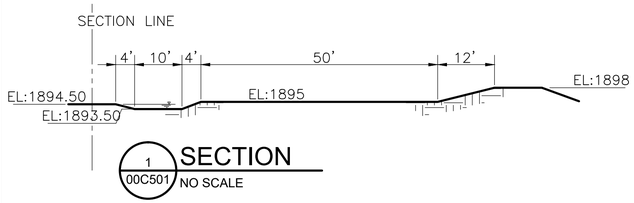
ASH DISPOSAL AREA PLAN

0 1" 2"

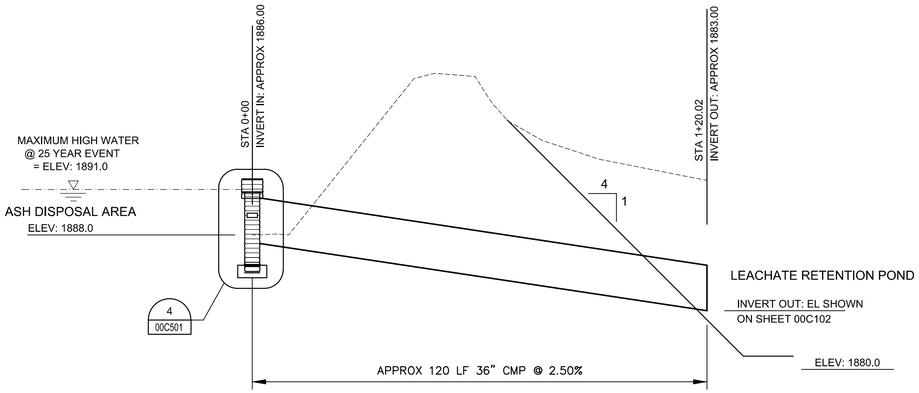
FILENAME 00C102.DWG

SCALE -

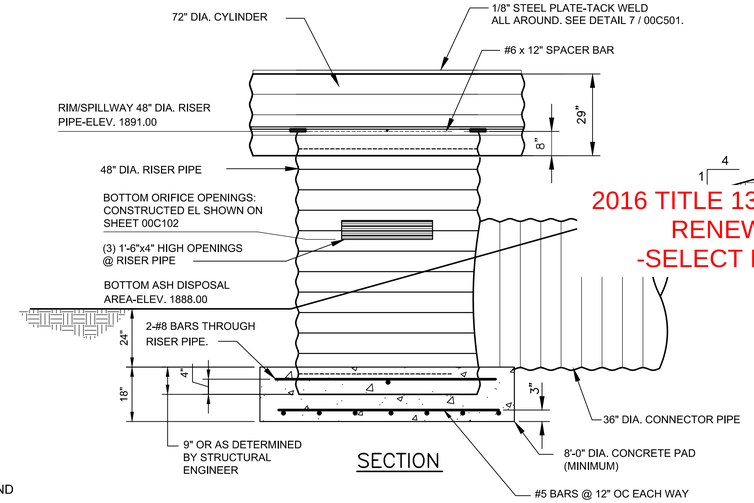
SHEET 00C102



1 / 00C501 SECTION
NO SCALE

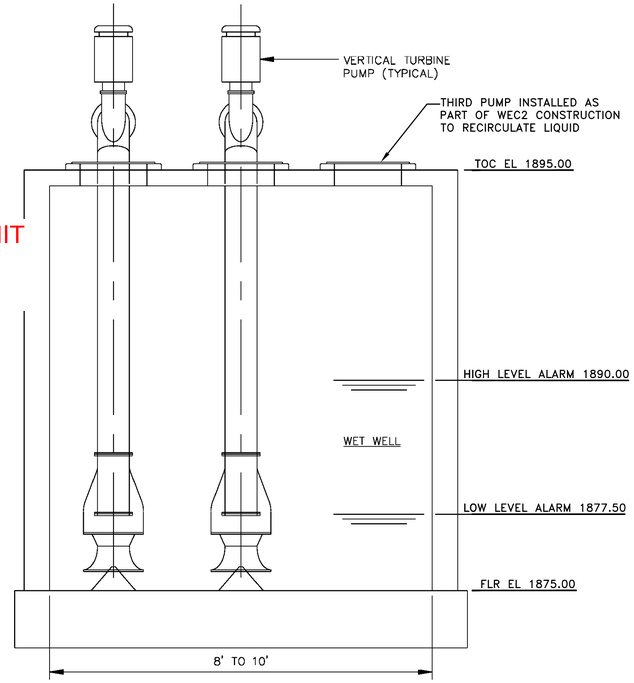


2 / 00C501 PIPE PROFILE @ ASH DISPOSAL AREA
HORIZONTAL SCALE: 1" = 20'
VERTICAL SCALE: 1" = 5'

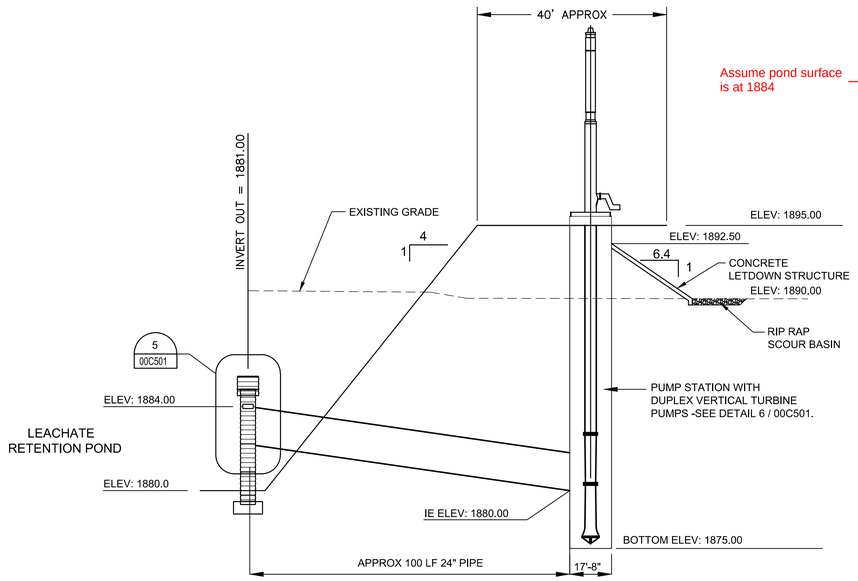


4 / 00C501 RISER INLET @ ASH DISPOSAL AREA
NO SCALE

2016 TITLE 132 PERMIT RENEWAL -SELECT PAGES

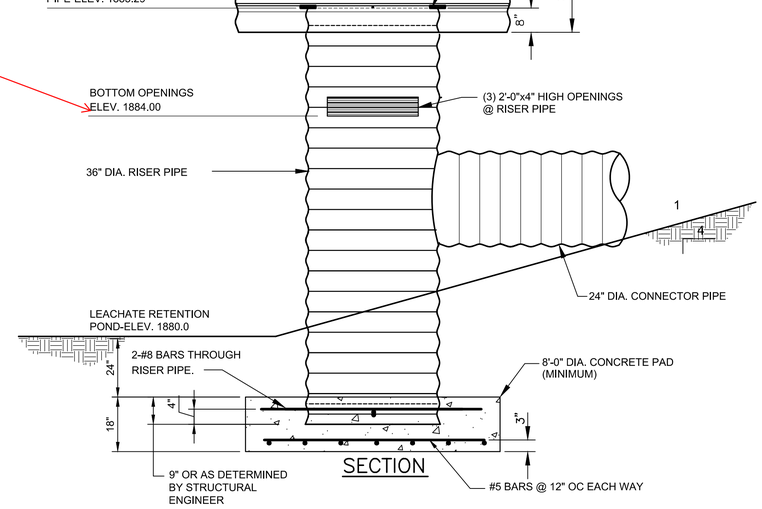


6 / 00C501 PUMP STATION DETAIL
NO SCALE

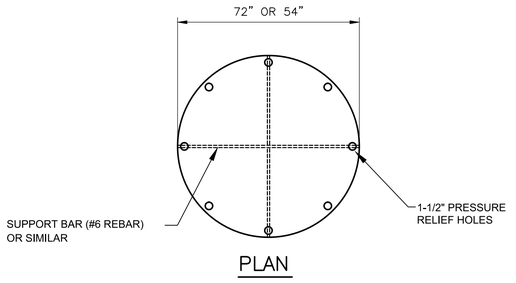


3 / 00C501 PIPE PROFILE @ LEACHATE RETENTION POND
NO SCALE

Assume pond surface is at 1884



5 / 00C501 RISER DETAIL @ LEACHATE RETENTION PUMP
NO SCALE



7 / 00C501 RISER BAFFLE DETAIL
NO SCALE

ISSUE	DATE	DESCRIPTION
1	11/3/2016	RESPONSE TO NDEQ COMMENTS
0	10/6/2016	NDEQ TITLE 132 PERMIT RENEWAL

PROJECT MANAGER L. CALUB
PROJECT NUMBER 000000010040278

PROFESSIONAL MECHANICAL ENGINEER
LORI J. CALUB
E-9881
STATE OF NEBRASKA

public power generation agency
HASTINGS UTILITIES

GERALD T. WHELAN ENERGY CENTER
WEC TEMPORARY ASH DISPOSAL AREA

LEACHATE MANAGEMENT DETAILS

0 1" 2"
FILENAME 00C501.DWG
SCALE AS SHOWN
SHEET 00C501

HISTORIC -SELECT PAGES

APPENDIX M
SITE DRAINAGE CALCULATIONS

A. SIZE LEACHATE RETENTION POND

1) Total Volume Quantities (process flows peak day flow on 24 hrs basis and include safety factor of 1.5)

Daily Durations (t)=	24 hrs	or	1440 min		
No. Discharge Days =	1 day	or	1440 min		
Factor of Safety (FS)=	1.5				
1cf =	7.48 gallons				
1 acre =	43,560 sf				
V =	FS*Q*t ac-ft				
a) Ash Sluice Water - Unit 1		Qsw =	600 gpm	Vsw=	3.98 ac-ft/day
a) Ash Sluice Water - Unit 2		Qfa =	831 gpm	Vfa=	5.51 ac-ft/day
c) Cooling Tower (1&2)		Qct =	0 gpm	Vct=	0.00 ac-ft/day
d) Scrubber Ash Sluicing - Unit 2		Qb =	534 gpm	Vb=	3.54 ac-ft/day
		Vt =	1965 gpm	Vt =	13.03 ac-ft/day

2) Size Leachate Retention Pond to completely retain 25yr, 24 hr rainfall and process flows

Total Rainfall =	4.9 in	NOAA
Evaporation =	0.15 in/day	Regional evaporation for Hastings (56 in/yr)
Vap =	10 ac-ft	Ash pond runoff = (total rainfall-evaporation)*(area of East & West Ash Ponds)
Vlr =	1.7 ac-ft	Leachate retention pond runoff =
Side Slopes	4H:1V	(total rainfall-evaporation)*(Top of Berm Area of Water Depth with +)

Leachate Retention Pond Design

		Floor			Top of Berm					
	Water Depth ft	W1 ft	L1 ft	A1 sf	W2 ft	L2 ft	A2 sf	Vrequired ac-ft	Vavailable ac-ft	Vavailable CF
	4	300	425	127,500	332	457	151,724	24.41	12.82	558,448
x	4.4	300	425	127,500	335	460	154,259	24.43	14.23	619,870
	5	300	425	127,500	364	489	177,996	24.65	17.53	763,740
	6	300	425	127,500	372	497	184,884	24.71	21.51	937,152
xx	7	300	425	127,500	380	505	191,900	24.77	25.66	1,117,900
	8	300	425	127,500	388	513	199,044	24.84	29.99	1,306,176
	9	300	425	127,500	396	521	206,316	24.90	34.49	1,502,172

1-indicates pond bottom dimensions and areas
2-indicates top of berm dimensions and areas
Vrequired = Vt + Vap + Vlr
x = pond dimensions to hold process water only.
xx = pond dimensions to hold process water and storm water.

Estimates are similar for leachate pond storage available

B. SIZE CONNECTOR PIPES (25-YEAR STORM): ASH PONDS

Rational Method; Q = CiA

1) C = Runoff Coefficient = 1.00

2) Tc = Time of Concentration
Since Tc ~ 0 for runoff at each Ash Pond, use Tc = 5 min.

3) Rainfall Intensity: i = 8.2 in/hour for 25 year storm event, Tc= 5 min Reference 1

4) Ash Pond (east) W=640ft H=860 ft Ae= 550,400 SF 12.64 acres
Ash Pond (west) W=640ft H=860 ft Aw= 550,400 SF 12.64 acres

5) Calculate Runoff for Tc = 5 min

	Q (cfs)	C	i(in/hr)	A (acres)
Ae	104	1	8.2	12.64
Aw	104	1	8.2	12.64

Q is higher for 100-yr storm

6) Maximum Daily Flows during normal operating conditions

a) Ash Sluice Water - Unit 1	Qsw =	600 gpm	1.3 cfs
b) Ash Sluice Water - Unit 2	Qfa =	831 gpm	1.9 cfs
c) Cooling Tower (1&2)	Qct =	0 gpm	0.0 cfs
d) Scrubber Ash Sluicing - Unit 2	Qb =	534 gpm	1.2 cfs
	Qt =	1965 gpm	4.4 cfs

Revised estimate is 400k GPD, 0.62-cfs

7) Determine Number of Connector Pipes to Each Pond Considering 5-minute Duration Storm

Max Q (from west pond) = Qw + Qsw + Qfa = 107 cfs
Assume number of pipes, n = 2
Qn = Q/n = 53.40 cfs
Verify Qn Provided Qn = 1.48*A*R^.67*S^.5/n A = Pipe Area
slope(S) = 0.025
mannings n = 0.024
diameter = 36 in
Qn provided = 57.28 cfs OK

Installed slope is higher

8) Size Ash Pond Spillway

Spillway to be reshaped with culvert connection

Head on Pipe Spillway (H)= Spillway crest elevation - design high water level of leachate retention pond
Spillway crest elevation = 1891.00 feet, from drawings
Design high water level of leachate retention pond = 1885.29 feet, from drawings
H = 5.71 feet

Table 2-8, ref. 4
For H = 5.71 Spillway capacity = 68.80 cfs > 53.40 cfs, OK

9) Spillway Capacity Considering Pipe length
Pipe length = 120 lf
Pipe diameter = 36 in

Table 2-8, ref. 4 Correct flow for Length of 120 lf
Correction factor from table = 0.86
So, corrected discharge capacity = 68.80 x 0.86 = 59.17 cfs
59.17 cfs > 53.40 cfs, OK

10) Determine Riser Size

Required Q = 53.40 cfs
Riser size = 48 in
From Figure 2-13, ref. 4: Max. head above the orifice crest when passing required Q = 1.2 ft
Elevation of orifice crest = 1888.67 ft, from drawings
Elevation of spillway crest = 1891.00 ft, from drawings
2.33 ft > 1.2 ft, OK

1.6-ft - OK

11) Area of Orifices Required

Asssume height (h) above crest of orifice = 2 inches = 0.17 ft

Qorifice = Cd*A*(2gh)^.5

Q=	Discharge = 1/2*Qt*FS/n =	1.64	cfs per outlet pipe
Cd=	Orifice Coefficient =	0.70	
h =	Height =	0.17	ft
g =	Gravity =	32.20	ft/sec^2
A =	Orifice Area =	0.72	sf
Assume 3	openings, A =	0.24	sf

Meets base flow from sluice

Assume orifice height = 4 inches = 0.33 ft
Orifice length = 0.72 ft

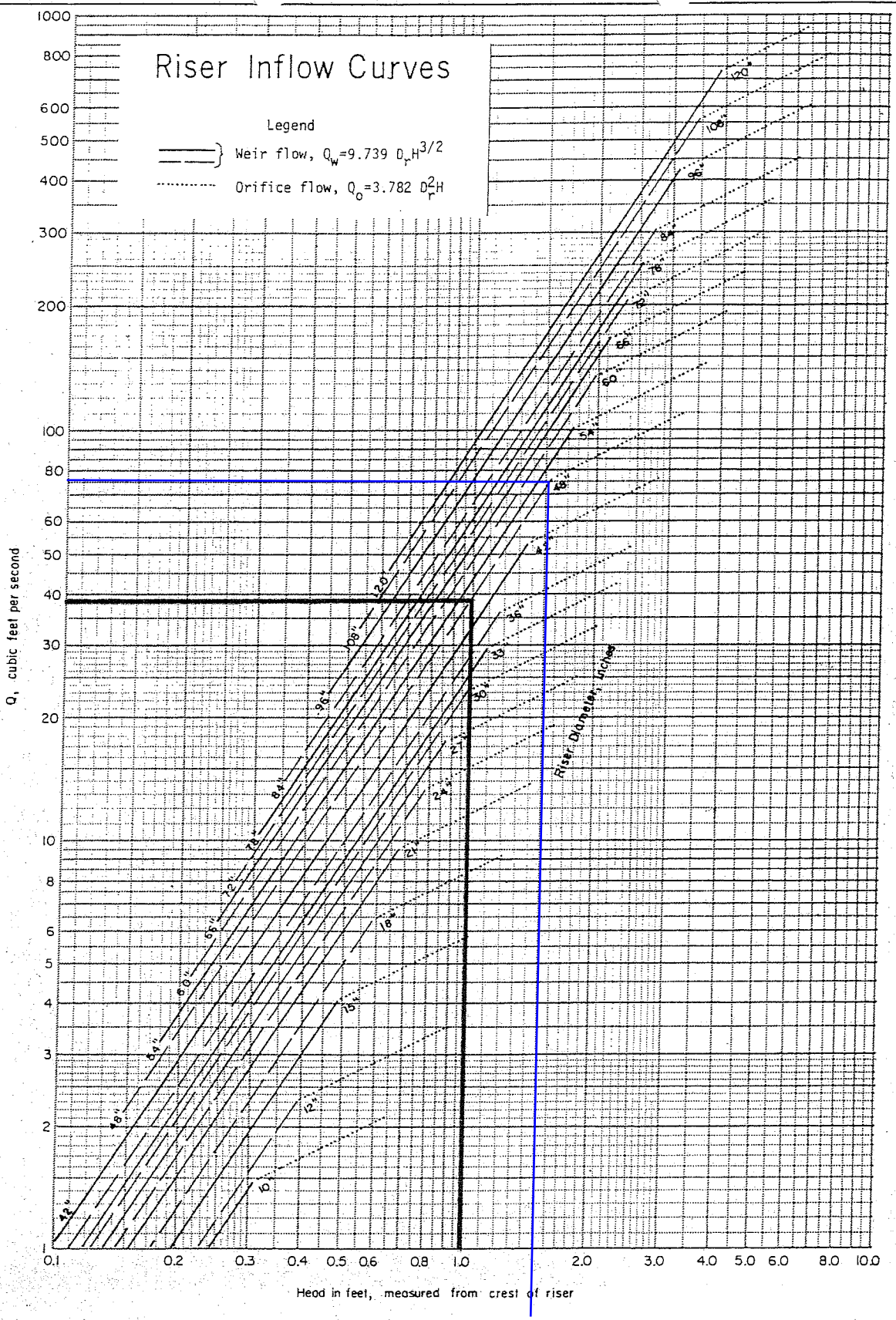
Use 3 openings 4 inch high by 1.50 ft long

12) Rise of Water in Ash Pond From 25-year 24-hour storm
From sheet 2, total rainfall from a 25-year 24-hour storm event = 4.9 in = 0.41 ft

See hydraflow output for clear areas.

11 (40)

Ref. 4



Source: Soil Conservation Service

Riser Inflow Curves
Sediment Basin

Date
JAN 1993

Figure
2-13

CITY OF OMAHA

Soil Erosion and Sediment Control

Attachment 3

Boring Logs and Well Construction Diagrams

MW-1

BORING LOG

DRILL HOLE NO.	LOCATION OF DRILL HOLE	ELEVATION	DATUM	DRILLER	LOGGER
WECPZ-1	See Boring Location Diagram			James Tinnell	Dave Petersen

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	____ HOURS	Grassy, Slopes to West	Mobil B-61 HDX
				DRILLING METHOD	TOTAL DEPTH
114'	114'	112'		4.25" I. D. Hollow Stem Augers	135.0'

DEP. Ft.	SAMPLE DATA: SAMPLE NO.& TYPE	"N" BLOWS /FT	% REC.	SOIL DESCRIPTION: COLOR	MOIST	CONS.	GROUP NAME	GEOLOGIC DESCRIPTION & OTHER REMARKS	LABORATORY DATA: Pene-trometer tsf	Torvane tsf	% MC	Dry Dens pcf	Class	DEP. FT.
				Brown	Moist	Firm	Lean clay	DEVELOPED ZONE/TOPSOIL					CL	
				Brown	Moist	Firm	Lean Clay	FILL/DEVELOPED ZONE					CL	
5	U-1		100						7.5	1.75	19.7	100.6		5
				Light Brown	Moist	Firm	Lean Clay	PEORIA FORMATION					CL	
10	U-2		30					Calcarious concretions	4.0	2.00	24.3	84.3		10
15	U-3		100			Very Firm		Manganese nodules	8.1	4.00				15
20	U-4		100	Gray Brown	Very Moist	Firm		Loess formation Iron staining Root holes	3.1	2.75				20
	U-5		100						4.4	1.25	23.5	90.8		
25	U-6		100	Very Dark Brown	Very Moist	Firm	Lean Clay	SANGAMON PALESOL With fine sand (organic)	5.0	1.25			CL	25
	U-7		100	Reddish Brown	Moist	Very Firm	Lean Clay	LOVELAND FORMATION/ TRANSITON Fine sand seams	21.3	4.5+			CL	
30	U-8		100					Root holes	10.0	3.50	13.0	111.4		30
35	U-9		100	Light Reddish Brown	Moist	Very Firm	Lean Clay	LOVELAND LOESS	10.0	2.25			CL	35

Geotechnical Services Inc.

Project	HASTINGS UTILITIES MONITORING WELL
Location	HASTINGS, NEBRASKA
Job No.	995833
Date	7/27/99

833MW1

MW-1

BORING LOG

DRILL HOLE NO.	LOCATION OF DRILL HOLE	ELEVATION	DATUM	DRILLER	LOGGER
WECPZ-1	See Boring Location Diagram			James Tinnell	Dave Petersen

DEP. Ft.	SAMPLE NO.& TYPE	"N" BLOWS /FT	% REC.	COLOR	MOIST	CONSIST	GROUP NAME	GEOLOGIC DESCRIPTION & OTHER REMARKS	Pene-trometer tsf	Torvane tsf	% MC	Dry Dens pcf	Class	DEP. FT.
				Light Reddish Brown	Moist	Very Firm	Lean Clay	LOVELAND LOESS					CL	
40	U-10		100					Carbon staining With more sand	10	2.50				40
45	U-11		100						8.1	4.25				45
50	U-12		100					With more sand	9.4	3.25				50
55	U-13		100	Reddish Brown	Slightly Moist	Loose	Sandy Silty Clay	BASAL LOVELAND FORMATION	0.75	1.00	5.5	110.0	CL-ML	55
60	S-14	19	100			Medium					10.9			60
65	S-15	25	100	Light Brown	Slightly Moist	Dense	Poorly Graded Sand						SP	65
70	S-16	15	100								4.9			70
75	S-17	18		Reddish Brown										75

Geotechnical Services Inc.

Project	HASTINGS UTILITIES MONITORING WELL
Location	HASTINGS, NEBRASKA
Job No.	995833
Date	7/27/99

833MW1P2

MW-1

BORING LOG

DRILL HOLE NO.	LOCATION OF DRILL HOLE	ELEVATION	DATUM	DRILLER	LOGGER
WECPZ-1	See Boring Location Diagram			James Tinnell	Dave Petersen

DEP. Ft.	SAMPLE NO.& TYPE	"N" BLOWS /FT	% REC.	COLOR	MOIST	CONSIST	GROUP NAME	GEOLOGIC DESCRIPTION & OTHER REMARKS	Pene-trometer tsf	Torvane tsf	% MC	Dry Dens pcf	Class	DEP. FT.
				Reddish Brown	Slightly Moist	Dense	Poorly Graded Sand	BASAL LOVELAND FORMATION					SP	
80	S-18	24	100											80
				Light Brown			Silty Clayey Sand				7.7		SC-SM	
85	S-19	37	100											85
				Light Brown	Slightly Moist	Very Dense	Well Graded Sand	PLEISTOCENE ALLUVIAL AQUIFER					SW	
90	S-20	84						With some gravel						90
95	S-21	50 in 5"						Carbon staining						95
100	S-22	35	100			Dense	Silty Sand	No gravel					SM	100
							Poorly Graded Sand with Silt						SP	
105	S-23	59		Light Gray		Very Dense		Very fine grained with some gravel						105
110	S-24	73					Well Graded Sand	Bottom of spoon - coarse sand Iron staining					SW	110
					Wet									
115	S-25	50 in 4"						Alternating coarse and fine sand						115

Geotechnical Services Inc.

Project	HASTINGS UTILITIES MONITORING WELL
Location	HASTINGS, NEBRASKA
Job No.	995833
Date	7/27/99

833MW1P3

MW-1

BORING LOG

DRILL HOLE NO.	LOCATION OF DRILL HOLE	ELEVATION	DATUM	DRILLER	LOGGER
WECPZ-1	See Boring Location Diagram			James Tinnell	Dave Petersen

DEP. Ft.	SAMPLE NO.& TYPE	"N" BLOWS /FT	% REC.	COLOR	MOIST	CONSIST	GROUP NAME	GEOLOGIC DESCRIPTION & OTHER REMARKS	Pene-trometer tsf	Torvane tsf	% MC	Dry Dens pcf	Class	DEP. FT.
120	S-26	39		Light Gray	Wet	Very Dense	Well Graded Sand	PLEISTOCENE ALLUVIAL AQUIFER Alternating layers of fine sand and coarse					SW	120
125				Reddish Brown			Silty Sand						SM	125
130	S-27							Very fine grained sand						130
135														135
								BOTTOM OF HOLE 135.0'						
140														140
145														145
150														150
155														155

Geotechnical Services Inc.

Project	HASTINGS UTILITIES MONITORING WELL
Location	HASTINGS, NEBRASKA
Job No.	995833
Date	7/27/99

833MW1P4

MW-1

MONITOR WELL SCHEMATIC

WELL NO.	LOCATION OF WELL	ELEVATION	DATUM	DRILLER	LOGGER
WECPZ-1	See Boring Location Diagram			James Tinnell	Dave Petersen

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	24 HOURS	Grassy	Mobil B-61 HDX
				DRILLING METHOD	TOTAL DEPTH
114'	114'	112'		4.25" I. D. Hollow Stem Augers	134.5'

PROTECTIVE COVER

Type: Steel
Size: 4" x 4" x 5'
Pad Size: 3' x 3' x 6"

GROUT

BENTONITE
Amount: 500 (lbs.)
Water: 150 (gal.)

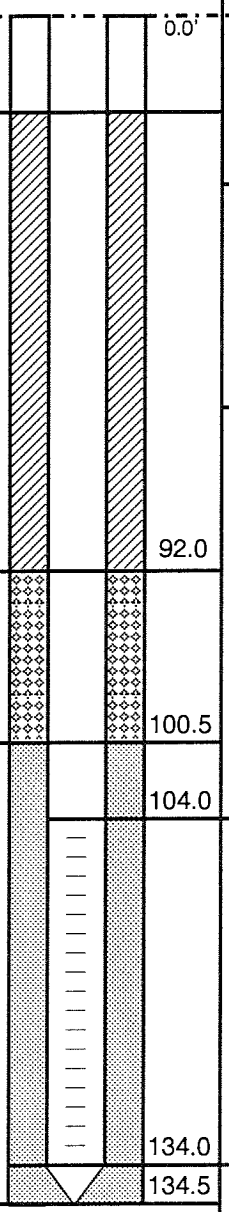
PORTLAND CEMENT
Type:
Amount: (lbs.)
Bentonite: (lbs.)
Water: (gal.)

WELL SEAL

Type: Bentonite chips
Amount: 125 (lbs.)
Water: 15 (gal.)

WELL PACK

Type: 16-30
Amount: 850 (lbs.)



INITIAL PUMP DATA

Rate
Drawdown

	Time	Water Level
Start		
Stop		

RISER

Type: PVC
Schedule: 40
Inside Diameter: 2"
Length: 10'
#: 11
Length:
#:

SCREEN

Type: PVC
Schedule: 40
Slot: 20
Inside Diameter: 0.010"
Length: 10'
#: 3
Length:
#:

END CAP

Type: PVC
Length: 0.4'

BRIEF GEOLOGIC DESCRIPTION

See Boring Log WECPZ-1

NOTES:

GS Geotechnical Services Inc.

Project: HASTINGS UTILITIES MONITORING WELL
Location: HASTINGS, NEBRASKA
Job No. 995833
Date 7/28/99

833W1

MW-2

BORING LOG

DRILL HOLE NO.	LOCATION OF DRILL HOLE	ELEV.	DATUM	DRILLER	LOGGER
WECPZ-3	See Site Map	1901.57		James Tinnell	Doug Janulewicz

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	8 Days	Grass / Weeds	Mobile B-61
			116.00	DRILLING METHOD: 4.25" I. D. Hollow Stem Augers	TOTAL DEPTH: 122.6

DEP. FT	SAMPLE DATA: SAMPLE NO. & TYPE	"N" BLOWS /FT	% REC.	HEAD SPACE READING	SOIL/SEDIMENT DESCRIPTION: COLOR	MOIST.	CONS.	GROUP NAME	GEOLOGIC DESCRIPTION AND OTHER REMARKS	DEP. FT
5					Black	Moist	Firm	Lean Clay	FILL MATERIAL Silty clay Root hairs and root holes	5
10	U-1				Light Brown	Moist	Firm	Lean Clay	PEORIAN LOESS Silty clay Carbon and rust stains Traces of fine sand	10
15										15
20	U-2				Light Tanish Brown				Silty clay Traces of fine sand Carbon filled root holes Fine sand pockets (1/8" diameter)	20
25										25
30	U-3				Dark Gray Black	Moist	Hard	Lean Clay	SANGAMON Silty clay Blocky Fine sand lenses	30
35										35

Geotechnical Services Inc.

Project: WHELAN ENERGY CENTER

Location: HASTINGS, NEBRASKA

Job No.: 995833

Date: 10/22/01

MW-2

BORING LOG

DRILL HOLE NO.	LOCATION OF DRILL HOLE	ELEV.	DATUM	DRILLER	LOGGER
WECPZ-3	See Site Map	1901.57		James Tinnell	Doug Janulewicz

DEP. FT	SAMPLE NO. & TYPE	"N" BLOWS/ FT	% REC.	HEAD SPACE READING	COLOR	MOIST.	CONS.	GROUP NAME	GEOLOGIC DESCRIPTION AND OTHER REMARKS	DEP. FT
40	U-4				Reddish Brown	Moist	Firm	Lean Clay	LOVELAND LOESS Silty clay Root holes Traces of fine sand Manganese nodules	40
45										45
50	U-5									50
55					Orangish Red			Poorly Graded Sand	Fine grained sand Intermixed silt and clays	55
60	S-6	28			Light Reddish Orange				Fine grained sand Intermixed silt and clays 1/4" thick silt and clay seams	60
65										65
70	S-7	32			Light Brown				Fine grained sand Intermixed silt and clays	70
75										75

Geotechnical Services Inc.

Project	WHELAN ENERGY CENTER
Location	HASTINGS, NEBRASKA
Job No.	995833
Date	10/22/01

MW-2

BORING LOG

DRILL HOLE NO.	LOCATION OF DRILL HOLE	ELEV.	DATUM	DRILLER	LOGGER
WECPZ-3	See Site Map	1901.57		James Tinnell	Doug Janulewicz

DEP. FT	SAMPLE NO. & TYPE	"N" BLOWS/ FT	% REC.	HEAD SPACE READING	COLOR	MOIST.	CONS.	GROUP NAME	GEOLOGIC DESCRIPTION AND OTHER REMARKS	DEP. FT
80	S-8	51			Brown	Moist	Firm	Poorly Graded Sand	Fine grained sand Intermixed silts and clays	80
85										85
90	S-9	68			Tan				Fine to medium grained sand 1/8" thick iron stained seams	90
95										95
100	S-10	70							Fine to medium Trace of coarse sand	100
105										105
110	S-11	54							Fine to medium	110
115	S-12	80				Wet			Fine to coarse sand	115

Geotechnical Services Inc.

Project	WHELAN ENERGY CENTER
Location	HASTINGS, NEBRASKA
Job No.	995833
Date	10/22/01

MW-2

BORING LOG

DRILL HOLE NO.	LOCATION OF DRILL HOLE	ELEV.	DATUM	DRILLER	LOGGER
WECPZ-3	See Site Map	1901.57		James Tinnell	Doug Janulewicz

DEP. FT	SAMPLE NO. & TYPE	"N" BLOWS/ FT	% REC.	HEAD SPACE READING	COLOR	MOIST.	CONS.	GROUP NAME	GEOLOGIC DESCRIPTION AND OTHER REMARKS	DEP. FT
120					Tan	Wet	Firm	Poorly Graded Sand		120
125									**BOTTOM OF HOLE 122.6'**	125
130										130
135										135
140										140
145										145
150										150
155										155

Geotechnical Services Inc.

Project	WHELAN ENERGY CENTER
Location	HASTINGS, NEBRASKA
Job No.	995833
Date	10/22/01

Boring Log MW-2B

Project Name	Project No.	Drilling Company
WEC MW Installation	1004517	GSI/GEOCORE
Location	**Client**	**Drilling Rig Type and Drilling Method**
HASTINGS, NE	Hastings Utilities /PPGA	3.25" Hollow Stem Auger

Sample	"N" blows/FT	Depth (feet)	Well Installation Details	Description (USCS)	Recovery (%)	Water Level Observations
			GROUT Type: Bentonite Amount: 650 lbs	Grassy surface Lean Clay (CL); grey; dry; firm to hard; low plasticity	No recovery, visual classification from cuttings	
				Dark brown; medium plasticity		
		10		Black; slightly moist; soft; low plasticity		
				Dark brown; slightly moist; soft		
		20		Brown		
				Very soft; high plasticity		
		30				
				Reddish brown; firm; medium plasticity		
		40		Soft		
				High plasticity		
		50		Firm; medium plasticity		
		60		Clayey sand (SC); reddish brown; slightly moist; firm; medium dense		
		70		Clayey sand (SC); reddish brown; slightly moist; medium dense		
		80		Brown		
				Poorly graded sand with clay (SP-SC); fine grained; brown; slightly moist; medium dense		
		90				

Boring Log MW-2B

Project Name	Project No.	Drilling Company
WEC MW Installation	1004517	GSI/GEOCORE
Location	**Client**	**Drilling Rig Type and Drilling Method**
HASTINGS, NE	Hastings Utilities /PPGA	3.25" Hollow Stem Auger

Sample	"N" blows/FT	Depth (feet)	Well Installation Details	Description (USCS)	Recovery (%)	Water Level Observations
S1	23, 27, 28	100		Well graded sand (SW); fine to medium grained; light brown; slightly moist; medium dense; traces of medium garvel	90	
				Dense; iron stains		
S2	27, 10, 10	105			90	
				Poorly graded sand (SP); fine to medium grained; very light brown; slightly moist; medium dense		
S3	10, 16, 29	110			100	
				Well graded sand (SW); medium to coarse grained; light brown; slightly moist; medium dense		
S4	13,, 18, 25	115		Dense; little gravel	100	
S5 (Sieve)	22, 41, 50	120			80	
				Poorly graded sand (SP); fine to medium grained; light		
				Poorly graded sand (SP); fine to medium grained; light brown; wet; medium dense		
S6	8, 10, 10	125		Wet	50	
S7	22, 34, 22	130		Fine grained	80	
S8 (Sieve)	23, 34, 32	135			90	
				Silty sand (SM); very fine grained; light brown; wet; loose		
S9	8,8,10	140			100	
				Well graded sand (SW); medium to coarse grained; light brown; wet; medium dense; iron staining		

Boring Log MW-2B

Project Name	Project No.	Drilling Company
WEC MW Installation	1004517	GSI/GEOCORE
Location	**Client**	**Drilling Rig Type and Drilling Method**
HASTINGS, NE	Hastings Utilities /PPGA	3.25" Hollow Stem Auger

Sample	"N" blows/FT	Depth (feet)	Well Installation Details	Description (USCS)	Recovery (%)	Water Level Observations
S10	8, 19, 36	145			50	
				Poorly graded sand (SP); coarse grained; light brown; wet; medium dense		
			WELL SEAL Bentonite Chips: 50 lbs			
S11	7, 10, 14	150	**WELL PACK** Type: 10-20 Amount: 450 lbs		50	
S12	28, 36, 47	155			75	
				Well graded sand (SW); coarse grained; light brown; wet; medium dense; some fine gravel		
			Screen Slot: 0.02 Screen Depth: 150'-160'			
S13	22, 16, 20	160	END CAP Bottom of well: 160.2'		80	
				Poorly graded sand (SP); medium grained; light brown; wet; medium dense; some fine gravel and clay layer, approx. 2'		
			***MW-2B was installed by GEOCORE 6 feet east of boring location using a mud rotary rig GP-1100R on 10/18/2016**			
S14	21, 24, 23	165			80	
				Lean Clay (CL); ligth brown; moist; soft to firm; medium plasticity		
S15	7, 7, 8	170			100	
				Poorly graded sand (SP); medium grained; light brown; wet; medium dense; light brown layer of clay, aprrox 3" at the end of spoon		
S16	6, 22, 30	175			50	
				Terminated Hollow Stem Auger boring @ 175 feet*		

The stratification lines represent the approximate boundary lines between soil and rock types. In-Situ transition may be gradual.

Water Level		Logged By/Sampled By:	Drilled By:
While Drilling:	After Drilling:	Gaoty Williams	James Tinnell/David Summers
124'	124.1'	Date Started: 10/17/2016	Date Completed: 10/17/2016

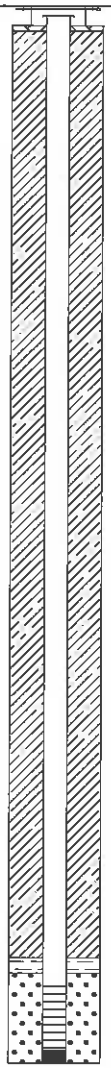
SOIL BORING LOG & MONITORING WELL CONSTRUCTION DIAGRAM

WELL NO.	LOCATION OF WELL	DATUM	TOC ELEVATION	SURFACE ELEVATION	DRILLER	LOGGER
MW-2B	Hastings, Nebraska		1902.96'		DAVID SUMMERS	HDR

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING			GRASS	GUS PECH GT1100R
				DRILLING METHOD	TOTAL DEPTH
124' ▽	124.1' ▽	▽	▽	ROTARY RIG	162'

NDEQ SPILL #	NDEQ IIS#	DRILLING START TIME	DRILLING STOP TIME

Depth (feet)	Well Construction Details	GRAPHIC LOG	Rock Formations, Soil, Color and Classifications, Observations (moisture, odor, etc.) First column for USCS	Depth (feet)
0				0
30				30
60				60
90				90
120				120
150				150
180			Bottom of Well @ 162'	180



PROTECTIVE COVER
Type: STEEL STICK-UP
Size: 6"X6"X5'
Pad Size: 32"X32"

WELL SEAL
Type: WYO-BEN
Amount: 700#
Water: 350 GAL
Type: 3/8" BENTONITE
Amount: 50#
Water: SET IN

WELL PACK
Type: 10/20 SILICA
Amount: 500#

RISER
Type: PVC
Schedule: 40
Inside Dia.: 4"
Length: 150.0'

SCREEN
Type: PVC
Schedule: 40
Slot: 0.02"
Inside Dia.: 4"
Length: 10.0'

END CAP
Type: PVC
Length: 0.2'

NOTES
ALL PIPE AND FITTING FLUSH THREADED. BOREHOLE DIAMETER 8.25"

APPROV. _____
BY: _____

* SS (split spoon) HS (hollow stem auger) HA (hand auger) MC (macro-core)

GSI Geotechnical Services, Inc.
2960 N. Diers Avenue, Grand Island, NE 68803
(308) 381-1987 Fax (308) 381-2467

Project: Gerald T. Whelan Energy Center
Location 4520 East South Street, Hastings, NE
Project No.: 165162
Date: 10/19/2016

MW-3

BORING LOG

DRILL HOLE NO.	LOCATION OF DRILL HOLE	ELEV.	DATUM	DRILLER	LOGGER
WECPZ-4	See Site Map	1894.32		James Tinnell	Doug Janulewicz

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	7 Days	Grass / Weeds	Mobile B-61
				DRILLING METHOD	TOTAL DEPTH
105.0'			108.35	4.25" I. D. Hollow Stem Augers	112.1

DEP. FT	SAMPLE DATA: SAMPLE NO. & TYPE	"N" BLOWS /FT	% REC.	HEAD SPACE READING	SOIL/SEDIMENT DESCRIPTION: COLOR	MOIST.	CONS.	GROUP NAME	GEOLOGIC DESCRIPTION AND OTHER REMARKS	DEP. FT
					Black	Moist	Firm	Lean Clay	DEVELOPED ZONE Silty clay Root hairs and root holes	
5					Light Brown	Moist	Firm	Lean Clay	PEORIAN Silty clay Traces of fine sand Root hairs and root holes Rust stains Carbon deposits	5
10	U-1									10
15										15
20	U-2				Black	Moist	Firm	Lean Clay	SANGAMON Silty clay Traces of fine sand Root hairs and root holes	20
25										25
30	U-3				Light Reddish Brown	Moist	Firm to Hard	Lean Clay	LOVELAND Silty clay Intermixed fine sand Manganese nodules	30
35										35

Geotechnical Services Inc.

Project	
WHELAN ENERGY CENTER	
Location	
HASTINGS, NEBRASKA	
Job No.	Date
995833	10/23/01

MW-3

BORING LOG

DRILL HOLE NO.	LOCATION OF DRILL HOLE	ELEV.	DATUM	DRILLER	LOGGER
WECPZ-4	See Site Map	1894.32		James Tinnell	Doug Janulewicz

DEP. FT	SAMPLE NO. & TYPE	"N" BLOWS/ FT	% REC.	HEAD SPACE READING	COLOR	MOIST.	CONS.	GROUP NAME	GEOLOGIC DESCRIPTION AND OTHER REMARKS	DEP. FT
					Light Reddish Brown	Moist	Firm to Hard	Lean Clay	LOVELAND Increasing fine sand content	
40	U-4				Reddish Brown				Sand with intermixed silts and clays Fine grained sand Poorly graded	40
45										45
					Light Brown to Brown					
50	S-5	24							2" thick fine to medium grained lenses at 49' Fine grained sand Intermixed silt and clays	50
55										55
60	S-6	22							Fine grained sand Intermixed silt and clays	60
65										65
70	S-7	22							Fine grained sand Intermixed silt and clays	70
75										75

GS Geotechnical Services Inc.

Project	WHELAN ENERGY CENTER
Location	HASTINGS, NEBRASKA
Job No.	995833
Date	10/23/01

MW-3

BORING LOG

DRILL HOLE NO.	LOCATION OF DRILL HOLE	ELEV.	DATUM	DRILLER	LOGGER
WECPZ-4	See Site Map	1894.32		James Tinnell	Doug Janulewicz

DEP. FT	SAMPLE NO. & TYPE	"N" BLOWS/ FT	% REC.	HEAD SPACE READING	COLOR	MOIST.	CONS.	GROUP NAME	GEOLOGIC DESCRIPTION AND OTHER REMARKS	DEP. FT
					Light Brown / Tan	Moist	Firm to Hard	Lean Clay	Fine grained sand Intermixed silts and clays	
80	S-8	51							Fine to medium grained sand Poorly graded	80
85										85
90	S-9	75							Fine to coarse sand Traces of fine gravel Poorly graded	90
95										95
100	S-10	97								100
105	S-11	85				Wet				105
110										110
									BOTTOM OF HOLE 112.1'	
115										115

Geotechnical Services Inc.

Project: WHELAN ENERGY CENTER

Location: HASTINGS, NEBRASKA

Job No.: 995833

Date: 10/23/01

SOIL BORING LOG & MONITORING WELL CONSTRUCTION DIAGRAM

WELL NO.	LOCATION OF WELL	DATUM	TOC ELEV.	GROUND SURF. ELEV.	DRILLER	LOGGER
MW-3R	See Boring Location Diagram				James Tinnell	Fred Jones

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING			Bare Frozen Muddy Ground	Mobile B-61
115' ▽	114.5' ▽	▽	▽	DRILLING METHOD	TOTAL DEPTH
				4 1/4" Hollow Stem Augers	126.7'

NDEQ SPILL #	NDEQ IIS#	DRILLING START DATE	DRILLING START TIME	DRILLING STOP DATE	DRILLING STOP TIME
		1/27/2011		1/29/2011	

Well Construction Details

PROTECTIVE COVER
Type: Steel Stick-up
Size: 6" Diameter
Pad Size: 36" Diameter

WELL SEAL
Type: Benseal &
Amount: 1300 Pounds
Water: 390 Gallons
Type: 3/8" Bentonite
Amount: 150 Pounds
Water: 15 Gallons

WELL PACK
Type: 16/30 Silica Sand
Amount: 700 Pounds

RISER
Type: PVC
Schedule: 40
Inside Dia.: 4"
Length: 111.5'

SCREEN
Type: PVC
Schedule: 40
Slot: 0.01
Inside Dia.: 4"
Length: 10'

END CAP
Type: PVC
Length: 0.2'

NOTES
All Pipes and Fittings are Flush Threaded
Borehole Diameter 8"

Depth (feet)	SAMPLE NO. & TYPE*	Rec. (%)	Head Space Reading	GRAPHIC LOG	Rock Formations, Soil, Color and Classifications, Observations (moisture, odor, etc.) First column for USCS
0					CL Frozen muddy ground Dark brown, saturated, soft, lean clay Peoria Loess Light brown
	S-1				Moist, firm
15	S-2				
	S-3				Sangamon Dark brown Loveland Formation
30	S-4				Reddish brown
45	S-5				SC Reddish brown, moist, firm, sandy clay to clayey sand
60	S-6				SP-SC Reddish brown, moist, medium dense, poorly graded fine sand with clay, silt-size particles
	S-7				SC Reddish brown, moist, medium dense, clayey sand, fine sand with silt
75	S-8				SP Reddish brown, moist, medium dense, poorly graded sand, fine sand
					Reddish brown to light brown
90	S-9				

* SS (split spoon) HS (hollow stem auger) HA (hand auger) MC (macro-core)

APPROV. _____

BY: _____

GSI Geotechnical Services, Inc.
2960 N. Diers Avenue, Grand Island, NE 68803
(308) 381-1987 Fax (308) 381-2467

Project: Hastings Utilities/Whelan Energy Center

Location Hastings, Nebraska

Project No.: 115012

Date: 3/29/2011

SOIL BORING LOG & MONITORING WELL CONSTRUCTION DIAGRAM

WELL NO.	LOCATION OF WELL	DATUM	TOC ELEV.	GROUND SURF. ELEV.	DRILLER	LOGGER
MW-3R	See Boring Location Diagram				James Tinnell	Fred Jones

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING			Bare Frozen Muddy Ground	Mobile B-61
115'	114.5'			DRILLING METHOD	TOTAL DEPTH
				4 1/4" Hollow Stem Augers	126.7'

NDEQ SPILL #	NDEQ IIS#	DRILLING START		DRILLING STOP	
		DATE	TIME	DATE	TIME
		1/27/2011		1/29/2011	

Depth (feet)	Well Construction Details	SAMPLE NO. & TYPE*	Rec. (%)	Head Space Reading	GRAPHIC LOG	Rock Formations, Soil, Color and Classifications, Observations (moisture, odor, etc.) First column for USCS	Depth (feet)
105	PROTECTIVE COVER Type: Steel Stick-up Size: 6" Diameter Pad Size: 36" Diameter WELL SEAL Type: Benseal &	S-10				Fine, medium, and some coarse sand with some silt	105
		S-11					
		S-12					
120	Amount: 1300 Pounds Water: 390 Gallons Type: 3/8" Bentonite Amount: 150 Pounds Water: 15 Gallons WELL PACK	S-13				Very moist Saturated, fine to coarse sand with silt	120
		S-14					
135	Type: 16/30 Silica Sand Amount: 700 Pounds RISER Type: PVC Schedule: 40 Inside Dia.: 4" Length: 111.5'					Bottom of Boring @ 126.7'	135
150	SCREEN Type: PVC Schedule: 40 Slot: 0.01 Inside Dia.: 4" Length: 10'						150
165	END CAP Type: PVC Length: 0.2'						165
180	NOTES All Pipes and Fittings are Flush Threaded Borehole Diameter 8"						180

APPROV. ____

BY: ____

* SS (split spoon) HS (hollow stem auger) HA (hand auger) MC (macro-core)

GSI Geotechnical Services, Inc.
2860 N. Diers Avenue, Grand Island, NE 68803
(308) 381-1987 Fax (308) 381-2467

Project: Hastings Utilities/Whelan Energy Center

Location Hastings, Nebraska

Project No.: 115012

Date: 3/29/2011

Boring Log MW- 4B

Project Name	Project No.	Drilling Company
WEC MW Installation	1004517	GSI/GEOCORE
Location	**Client**	**Drilling Rig Type and Drilling Method**
HASTINGS, NE	Hastings Utilities	3.25" Hollow Stem Auger

Sample	"N" blows/FT	Depth (feet)	Well Installation Details	Description (USCS)	Recovery (%)	Water Level Observations
			GROUT Type: Bentonite Amount: 400 lbs	Grassy surface Lean Clay (CL); very dark brown; dry; stiff; medium plasticity	No recovery, visual classification from cuttings	
		10		Slightly moist; firm; medium plasticity Brown; soft ; medium to high plasticity; silty clay		
		20		Very soft; high plasticity		
		30		Medium plasticity		
		40				
		50		Clayey sand (SC); reddish bown;slightly moist; medium density; some silt		
		60		Poorly graded sand with with clay (SP-SC); fine graided; reddish brown; slightly moist; medium dense		
		70		Poorly graded sand with with clay (SP-SC); fine grained; reddish brown; slightly moist; medium dense		
		80		Clayey sand (SC); reddish brown; slightly moist; medium dense		
				Poorly graded sand with with clay (SP-SC); fine grained; reddish brown; slightly moist; medium dense		
		90		Poorly graded sand (SP); fine grained; reddish brown; slightly moist; medium dense		
S1	26,28,29			Well graded sand (SW); medium to coarse grained; very light brown; slightly moist; medium dense; traces of coarse aggregate	90	
		100				

MW-4

BORING LOG

DRILL HOLE NO.	LOCATION OF DRILL HOLE	ELEV.	DATUM	DRILLER	LOGGER
WECPZ-5	See Site Map	1892.15		James Tinnell	Doug Janulewicz

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING	24 HOURS AFTER DRILLING	6 Days	Grass / Weeds	Mobile B-61
				DRILLING METHOD	TOTAL DEPTH
103.0'			104.15	4.25" I. D. Hollow Stem Augers	111.2

SAMPLE DATA					SOIL/SEDIMENT DESCRIPTION					
DEP. FT	SAMPLE NO. & TYPE	"N" BLOWS /FT	% REC.	HEAD SPACE READING	COLOR	MOIST.	CONS.	GROUP NAME	GEOLOGIC DESCRIPTION AND OTHER REMARKS	DEP. FT
					Black	Moist	Firm	Lean Clay	DEVELOPED ZONE Silty clay Root hairs Traces of fine sand	
5					Light Brown	Moist	Firm	Lean Clay	PEORIAN LOESS Silty clay Traces of fine sand Rust stains Carbon deposits	5
10	U-1								Carbon filled root holes	10
15										15
20	U-2				Dark Brown to Black	Moist	Firm	Lean Clay	SANGAMON Silty clay Blocky Intermixed fine sand lenses	20
25										25
30	U-3				Reddish Brown	Moist	Firm	Lean Clay	LOVELAND LOESS Sitly clay Root holes Manganese nodules	30
35										35

Geotechnical Services Inc.

Project	
WHELAN ENERGY CENTER	
Location	
HASTINGS, NEBRASKA	
Job No.	Date
995833	10/24/01

MW-4

BORING LOG

DRILL HOLE NO.	LOCATION OF DRILL HOLE	ELEV.	DATUM	DRILLER	LOGGER
WECPZ-5	See Site Map	1892.15		James Tinnell	Doug Janulewicz

DEP. FT	SAMPLE NO. & TYPE	"N" BLOWS/ FT	% REC.	HEAD SPACE READING	COLOR	MOIST.	CONS.	GROUP NAME	GEOLOGIC DESCRIPTION AND OTHER REMARKS	DEP. FT
					Reddish Brown	Moist	Firm	Lean Clay	LOVELAND LOESS	
40	U-4								Fine grained sand Intermixed silts and clays Carbon and manganese deposits	40
45										45
50	S-5	21							Fine grained sand Intermixed silts and clays Traces of medium sand	50
55										55
60	S-6	23							Sandy silty clay Fine sand	60
65									Increasing fine sand content	65
70	S-7	39							Fine grained sand Intermixed silts and clays	70
75										75

Geotechnical Services Inc.

Project	WHELAN ENERGY CENTER
Location	HASTINGS, NEBRASKA
Job No.	995833
Date	10/24/01

MW-4

BORING LOG

DRILL HOLE NO.	LOCATION OF DRILL HOLE	ELEV.	DATUM	DRILLER	LOGGER
WECPZ-5	See Site Map	1892.15		James Tinnell	Doug Janulewicz

DEP. FT	SAMPLE NO. & TYPE	"N" BLOWS/ FT	% REC.	HEAD SPACE READING	COLOR	MOIST.	CONS.	GROUP NAME	GEOLOGIC DESCRIPTION AND OTHER REMARKS	DEP. FT
80	S-8	93			Reddish Brown / Tan	Moist	Firm	Lean Clay	Fine to medium grained sand Poorly graded 1/8" thick iron and rust seams	80
85										85
90	S-9	45							Fine to coarse sand Poorly graded	90
95										95
100	S-10	74								100
105	S-11	37				Wet				105
110										110
115									**BOTTOM OF HOLE 111.2'**	115

Geotechnical Services Inc.

Project	WHELAN ENERGY CENTER
Location	HASTINGS, NEBRASKA
Job No.	995833
Date	10/24/01

Boring Log MW- 4B

Project Name	Project No.	Drilling Company
WEC MW Installation	1004517	GSI/GEOCORE
Location	**Client**	**Drilling Rig Type and Drilling Method**
HASTINGS, NE	Hastings Utilities	3.25" Hollow Stem Auger

Sample	"N" blows/FT	Depth (feet)	Well Installation Details	Description (USCS)	Recovery (%)	Water Level Observations
S2	18,34,36	105	**WELL SEAL** Bentonite Chips: 50 lbs	Poorly graded sand (SP); medium grained; light brown; moist; medium dense; few fine gravel	90	
S3	17,24,27	110	**WELL PACK** Type: 10-20 Amount: 450 lbs		90	
S4(Sieve)	17,32,35	115	Screen Slot: 0.02 Screen Depth: 109'-119'	Satuarted @111 feet; some coarse gravel	90	
S5		120	END CAP Bottom of well: 119.2'	**Terminated Hollow Stem Auger boring @ 120 feet***	100	
		125	***MW-4B was installed by GEOCORE 4 feet north of boring location using a mud rotary rig GP-1100R on 10/21/2016** Note: Well protective casing extends approximately 2.5 feet above concrete pad. Protective bollards installed around casing. See GSI records for Well construction diagram.			
		130				
		135				
		140				

The stratification lines represent the approximate boundary lines between soil and rock types. In-Situ transition may be gradual.

Water Level		Logged By/Sampled By:	Drilled By:
While Drilling:	After Drilling:	Gaoty Williams	James Tinnell/ David Summers
111'	110.7	Date Started: 10/18/2016	Date Completed: 10/18/2016

SOIL BORING LOG & MONITORING WELL CONSTRUCTION DIAGRAM

WELL NO.	LOCATION OF WELL	DATUM	TOC ELEVATION	SURFACE ELEVATION	DRILLER	LOGGER
MW-4B	Hastings, Nebraska		1897.02'		DAVID SUMMERS	HDR

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING			GRASS	GUS PECH GT1100R
				DRILLING METHOD	TOTAL DEPTH
111.0' ▽	110.7' ▽	▽	▽	ROTARY RIG	121.0'

NDEQ SPILL #	NDEQ IIS#	DRILLING START TIME	DRILLING STOP TIME

Depth (feet)	Well Construction Details	GRAPHIC LOG	Rock Formations, Soil, Color and Classifications, Observations (moisture, odor, etc.) First column for USCS	Depth (feet)
0				0
30				30
60				60
90				90
120			Bottom of Well @ 121'	120
150				150
180				180

PROTECTIVE COVER
Type: STEEL STICK-UP
Size: 6"X6"X5'
Pad Size: 32"X32"

WELL SEAL
Type: WYO-BEN
Amount:
Water:

BENTONITE
Type: 3/8" BENTONITE
Amount: 50#
Water: SET IN

WELL PACK
Type: 10/20 SILICA
Amount: #

RISER
Type: PVC
Schedule: 40
Inside Dia.: 4"
Length: 150.0'

SCREEN
Type: PVC
Schedule: 40
Slot: 0.02"
Inside Dia.: 4"
Length: 10.0'

END CAP
Type: PVC
Length: 0.2'

NOTES
ALL PIPE AND FITTING FLUSH THREADED. BOREHOLE DIAMETER 8.25"

APPROV. _____
BY: _____

* SS (split spoon) HS (hollow stem auger) HA (hand auger) MC (macro-core)

GSI Geotechnical Services, Inc.
2960 N. Diers Avenue, Grand Island, NE 68803
(308) 381-1987 Fax (308) 381-2467

Project: Gerald T. Whelan Energy Center
Location 4520 East South Street, Hastings, NE
Project No.: 165162
Date: 10/21/2016

Boring Log MW-5B

Project Name	Project No.	Drilling Company
WEC MW Installation	1004517	GSI
Location	**Client**	**Drilling Rig Type and Drilling Method**
HASTINGS, NE	Hastings Utilities /PPGA	6.25" Hollow Stem Auger

Sample	"N" blows/FT	Depth (feet)	Well Installation Details	Description (USCS)	Recovery (%)	Water Level Observations
			GROUT Type: Bentonite Amount: 950 lbs Water: 285 gal.	Grass at surface Lean Clay (CL); very dark brown; dry; stiff; medium plasticity	No recovery, visual classification from cuttings	
		10		Brown; slightly moist; firm		
		20		Dark brown		
		30				
		40		Reddish brown;low plasticity		
		50		Clayey sand (SC); reddish bown; moist; medium dense		
		60		Light brown to brown; slightly moist		
		70		Poorly graded sand (SP); fine grained; light brown; slightly moist; medium dense		

The stratification lines represent the approximate boundary lines between soil and rock types. In-Situ transition may be gradual.

Water Level		Logged By/Sampled By:	Drilled By:
		Gaoty Williams	James Tinnell
While Drilling: ▽ 114'	After Drilling: ▼ 114'	Date Started: 10/10/2016	Date Completed: 10/11/2016

Boring Log MW-5B

Project Name	Project No.	Drilling Company
WEC Well Installation	1004517	GSI
Location	**Client**	**Drilling Rig Type and Drilling Method**
Hastings, NE	Hastings Utilities /PPGA	6.25" Hollow Stem Auger

Sample	"N" blows/FT	Depth (feet)	Well Installation Details	Description (USCS)	Recovery (%)	Water Level Observations
				Poorly graded sand (SP); fine grained; light brown; slightly moist; medium dense	No recovery, visual classification from cuttings	
		80		Brown		
		90		Light brown		
S1	19, 33, 33			Well graded sand (SW); fine to coarse grained; light brown; slightly moist; medium dense; traces of fine garvel	90	
		100		Alternating layers of fine and medium grained; very light brown; dense; traces of fine gravel; iron stains		
S2	18, 35, 50	105			90	
			WELL SEAL Bentonite Chips: 100lbs Water: 10 gal.			
S3	13, 30, 27	110	**WELL PACK** Type: 16-30 Amount: 450 lbs	Medium grained; light brown; moist; traces of coarse agrregate	100	
S4(Sieve)	12, 13, 19	115		Poorly graded sand (SP-SM); fine grained; light brown; saturated; medium dense; some silt and little clay	100	
			Sreen Slot: 0.01			
S5	8, 23, 47	120			80	

The stratification lines represent the approximate boundary lines between soil and rock types. In-Situ transition may be gradual.

Water Level		Logged By/Sampled By:	Drilled By:
While Drilling:	After Drilling:	Gaoty Williams	James Tinnell
114'	114'	Date Started: 10/10/2016	Date Completed: 10/11/2016

Boring Log MW-5B

Project Name	Project No.	Drilling Company
WEC MW Installation	1004517	GSI
Location	**Client**	**Drilling Rig Type and Drilling Method**
HASTINGS, NE	Hastings Utilities /PPGA	6.25" Hollow Stem Auger

Sample	"N" blows/FT	Depth (feet)	Well Installation Details	Description (USCS)	Recovery (%)	Water Level Observations
S5	8, 23, 47	120	END CAP	Poorly graded sand (SP-SM); fine grained; light brown; saturated; medium dense; some silt and little lay	80 Cutting	
				Terminated Boring @ 121 feet **Bottom of well @ 122 feet** *Note: Well protective casing extends approximately 2.5 feet above concrete pad. Protective bollards installed around casing.		
		125				
		130				
		135				
		140				
		145				
		160				

The stratification lines represent the approximate boundary lines between soil and rock types. In-Situ transition may be gradual.

Water Level		Logged By/Sampled By:	Drilled By:
While Drilling: ▽ 114'	After Drilling: ▼ 114'	Gaoty Williams	James Tinnell
		Date Started: 10/10/2016	**Date Completed: 10/11/2016**

SOIL BORING LOG & MONITORING WELL CONSTRUCTION DIAGRAM

WELL NO	LOCATION OF WELL	DATUM	TOC ELEVATION	SURFACE ELEVATION	DRILLER	LOGGER
MW-5B	Hastings, Nebraska		1899.16'		JAMES TINNELL	HDR

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING			GRASS	MOBILE B-61
114' ▽	114' ▽	▽	▽	DRILLING METHOD	TOTAL DEPTH
				6.25" HOLLOW STEM AUGERS	122'

NDEQ SPILL #	NDEQ IIS#	DRILLING START TIME	DRILLING STOP TIME

Well Construction Details

PROTECTIVE COVER
Type: STEEL STICK-UP
Size: 6"X6"X5'
Pad Size: 32"X32"

WELL SEAL
Type: BH-20
Amount: 900#
Water: 270 GAL
Type: 3/8" BENTONITE
Amount: 100#
Water: 10 GAL

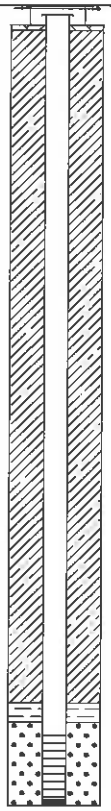
WELL PACK
Type: 16/30 SILICA
Amount: 450#

RISER
Type: PVC
Schedule: 40
Inside Dia.: 4"
Length: 111.0'

SCREEN
Type: PVC
Schedule: 40
Slot: 0.01"
Inside Dia.: 4"
Length: 10.0'

END CAP
Type: PVC
Length: 0.2'

NOTES
ALL PIPE AND FITTING FLUSH THREADED. BOREHOLE DIAMETER 10.25"



Rock Formations, Soil, Color and Classifications, Observations (moisture, odor, etc.) First column for USCS

Bottom of Well @ 122'

Depth (feet): 0, 30, 60, 90, 120, 150, 180

APPROV. _____

BY: _____

* SS (split spoon) HS (hollow stem auger) HA (hand auger) MC (macro-core)

GSI Geotechnical Services, Inc.
2960 N. Diers Avenue, Grand Island, NE 68803
(308) 381-1987 Fax (308) 381-2467

Project: Gerald T. Whelan Energy Center

Location 4520 East South Street, Hastings, NE

Project No.: 165162

Date: 10/11/2016

HDR

Boring Log

Project Name	Project Number	Drilling Company
Hastings Utilities		Geotechnical Services Inc.

Boring No.	Location	Casing El.	Drilling Rig Type and Drilling Method
MW-6	S.B.L.P.		B-61 HDX, 4.25" Hollow Stem Augers

Sample No.	HNU Reading (ppm)	Depth (feet)	Completion	Description	Elevation (feet)	Remarks
			See MWCD	Developed Zone, black silty clay, moist, firm, root hairs/holes		
		5		Brown silty clay, moist, firm, traces of fine sand, carbon deposits, Peorian Loess	5	
S-1		10		Root holes, carbon filled root holes, slightly moist to moist, layered, rust stains	10	
		15			15	
S-2		20		Dark brown-black silty clay, firm-hard, moist, Sangamon Intermixed fine sand pockets	20	
		25		Light reddish brown silty clay, firm, moist, traces of fine sand, Loveland Loess	25	
S-3		30			30	
		35			35	
S-4		40		Grey-brown motteled, blocky	40	

Water Level			Logged By	Sampled By
While Drilling:	After Drilling:	72 Hours After Drilling:	Doug Janulewicz	Doug Janulewicz
110'	103'		Date Started: 10/4/2004	Date Completed 10/5/2004

HDR

Boring Log

Project Name	Project Number	Drilling Company
Hastings Utilities		Geotechnical Services Inc.

Boring No.	Location	Casing El.	Drilling Rig Type and Drilling Method
MW-6	S.B.L.P.		B-61 HDX, 4.25" Hollow Stem Augers

Sample No.	HNU Reading (ppm)	Depth (feet)	Completion	Description	Elevation (feet)	Remarks
			See MWCD	Dark brown-grey motteled		
				Dark brown-black silty clay		
		45			45	
S-5				Light reddish brown silty clay,		
		50		firm, moist, fine sand pockets, manganese nodules	50	
		55			55	
S-6						
		60		Increasing fine sand content	60	
				Sand, fine grained, poorly graded, loose, moist, light brown		
		65			65	
S-7				Sand, fine grained, intermixed silt/		
		70		clays, rust staines, traces of medium sand	70	
				Sand, fine to medium grained, poorly graded		
		75			75	
S-8						
		80		Fine to coarse sand layer	80	

Water Level			Logged By	Sampled By
While Drilling:	After Drilling:	72 Hours After Drilling:	Doug Janulewicz	Doug Janulewicz
110'	103'		Date Started: 10/4/2004	Date Completed 10/5/2004

HDR

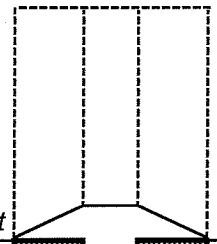
Boring Log

Project Name		Project Number		Drilling Company		
Hastings Utilities				Geotechnical Services Inc.		
Boring No.	Location	Casing El.		Drilling Rig Type and Drilling Method		
MW-6	S.B.L.P.			B-61 HDX, 4.25" Hollow Stem Augers		
Sample No.	HNU Reading (ppm)	Depth (feet)	Completion	Description	Elevation (feet)	Remarks
			See MWCD	Sand-fine to medium grained, poorly graded, moist, loose		
		85			85	
S-9				Fine-coarse sand, fine gravel layer		
		90		Brown silty clay layer, firm, moist	90	
				Sand, fine to medium grained, poorly graded, brown, moist		
		95			95	
S-10						
		100			100	
		105			105	
S-11						
		110		4" reddish orange clay seam at 109', wet	110	
				Bottom of Hole at 110'		
		115			115	
		120			120	

Water Level			Logged By	Sampled By
While Drilling:	After Drilling:	72 Hours After Drilling:	Doug Janulewicz	Doug Janulewicz
110'	103'		Date Started: 10/4/2004	Date Completed 10/5/2004

MONITORING WELL CONSTRUCTION DATA

Date: 10/05/04	Well/Boring No: MW-6	Well Type:
Drilling Company: G.S.I.	Project No:	Temporary Monitoring
Drill Crew: James and Jerold Tinnell	Project Name: Hastings Utilities	**Permanent Monitoring**
		Other



3' TOC Above Ground If Riser Box or Stick Up (0 feet)

0 Feet

Annular Backfill

Cement
Bentonite Chip
Bentonite Grout
Portland Grout
Silica Sand
Native Soil
Other

Amount
206 gallons
300 lbs chips
92.0'

Seal
6 Feet, 100 lbs
98.0'

Filter Pack
12 Feet

Type
16/35

Amount
350

Over Drill
0 Feet

Borehole Diameter
8.25"

Casing Diameter
2" Schedule 40

Bentonite Chip
Masonry Sand
Other

100.0'

Well Screen Length
10 Feet

110.0' B.O.S.
110.5' B.O.H.

Water Level-103'
10/5/04

Water Level-

Decontamination
Steam Clean | Soap Wash
High Pressure Hot Wash | **High Pressure Wash**
Other

Casing Type
PVC | Stainless Steel
Teflon | Steel
Other

Joints
Threaded | Welded
Coupled | Screwed
Other

Well Screen
PVC | Stainless Steel
Teflon | Continuous Wrap
Other

Diameter
2" 4" 6" Other

Slot
0.010 0.020 Other

Drilling Method (Diameter)
Solid Stem (inches) | **Hollow Stem (4.25")**
Direct Push | Mud Rotary
Hand Auger | Air Rotary
Other

Drilling Mud
Bentonite | Water
None
Other

Completion (size inches)
Flushmount (Diameter) | **Stickup 4"x4"x5'**
Riser Box | Other

Cuttings
Drummed | **Spread**

Development Method (Time)
Bailing | **Pumping**
Surge | Other

Amount (gallons)
150 gallons

Development Water
Drummed (#) | **Spread**
Water (before development) **Silty** Turbid Opaque Clear
Water (after development) Silty Turbid Opaque **Clear**

Notes Added 10 gallons of water when installing well

Boring Log MW-7

Project Name	Project No.	Drilling Company
WEC MW Installation	1004517	GSI
Location	**Client**	**Drilling Rig Type and Drilling Method**
HASTINGS, NE	Hastings Utilities /PPGA	6.25" Hollow Stem Auger

Sample	"N" blows/FT	Depth (feet)	Well Installation Details	Description (USCS)	Recovery (%)	Water Level Observations
			GROUT Type: Bentonite Amount: 900 lbs Water: 270 gal.	White crushed rock at surface Lean Clay (CL); dark brown; dry; firm; low plasticity	No recovery, visual classification from cuttings	
		10				
				Light brown; medium plasticity		
		20				
				Slightly moist		
		30		Dark brown; Soft		
				Reddish brown		
		40				
		50		Dark brown; low to medium plasticity		
				Clayey sand (SC); fine grained; reddish brown; dry to slightly moist; loose		
		60				
				Dark brown; medium dense		
		70		Poorly graded sand with clay (SC-SP); light brown; dry to slightly moist; medium dense		
		75		Poorly graded sand (SP) fine grained; light brown; dry to slightly moist; medium dense		
		80				

Boring Log MW-7

Project Name	Project No.	Drilling Company
WEC MW Installation	1004517	GSI
Location	**Client**	**Drilling Rig Type and Drilling Method**
HASTINGS, NE	Hastings Utilities /PPGA	6.25" Hollow Stem Auger

Sample	"N" blows/FT	Depth (feet)	Well Installation Details	Description (USCS)	Recovery (%)	Water Level Observations
		90				
S1	38, 24, 14			Well graded sand (SW); fine to coarse grained; light brown; slightly moist; medium dense	100	
		100		Poorly graded sand (SP); fine to coarse grained; very light brown; slightly moist; medium dense		
S2	11, 21, 30	105		Well graded sand (SW); alternating layers of fine to medium and medium to coarse grained with few subrounded gravel; very light brown; slightly moist; medium dense	100	
S3	15, 41, 42	110		Moist	90	
S4	19, 23, 41	115	**WELL SEAL** Bentonite Chips: 100lbs Water: 10 gal. **WELL PACK** Type: 16-30 Amount: 350 lbs	Medium to coarse grained with some silt and fine sand; saturated @120 feet	90	▼
S5(Sieve)	10, 26, 31	120	Screen Slot: 0.01 Screen Depth: 117'-127'	Some medium gravel	90	▽
S6	5, 19, 24	125	END CAP Bottom of well: 127.2'		100	
				Terminated Boring @ 128.5 feet		
S7	6, 12, 19	130		Note: Well protective casing extends approximately 2.5 feet above concrete pad. Protective bollards installed around casing. See GSI records for Well construction diagram.	100	
		135				

The stratification lines represent the approximate boundary lines between soil and rock types. In-Situ transition may be gradual.

Water Level		Logged By/Sampled By:	Drilled By:
		Gaoty Williams & Megan Seymour	James Tinnell
While Drilling: ▽	**After Drilling:** ▼	**Date Started: 10/5/2016**	**Date Completed: 10/7/2016**
120'	118.3'		

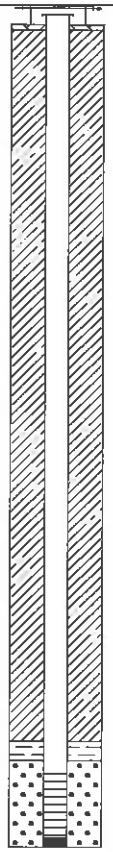
SOIL BORING LOG & MONITORING WELL CONSTRUCTION DIAGRAM

WELL NO	LOCATION OF WELL	DATUM	TOC ELEVATION	SURFACE ELEVATION	DRILLER	LOGGER
MW-7	Hastings, Nebraska		1901.23'		JAMES TINNELL	HDR

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING			WHITE ROCK	MOBILE B-61
				DRILLING METHOD	TOTAL DEPTH
120'	118.3'			6.25" HOLLOW STEM AUGERS	128.5'

NDEQ SPILL #	NDEQ IIS#	DRILLING START TIME	DRILLING STOP TIME

Depth (feet)	Well Construction Details	GRAPHIC LOG	Rock Formations, Soil, Color and Classifications, Observations (moisture, odor, etc.) First column for USCS	Depth (feet)
0				0
30				30
60				60
90				90
120				120
150				150
180				180



PROTECTIVE COVER
Type: STEEL STICK-UP
Size: 6"X6"X5'
Pad Size: 32"X32"

WELL SEAL
Type: BH-20
Amount: 1000#
Water: 300 GAL
Type: 3/8" BENTONITE
Amount: 100#
Water: 10 GAL

WELL PACK
Type: 16/30 SILICA
Amount: 350#

RISER
Type: PVC
Schedule: 40
Inside Dia.: 4"
Length: 117.0'

SCREEN
Type: PVC
Schedule: 40
Slot: 0.01"
Inside Dia.: 4"
Length: 10.0'

END CAP
Type: PVC
Length: 0.2'

NOTES
ALL PIPE AND FITTING FLUSH THREADED. BOREHOLE DIAMETER 10.25"

Bottom of Well @ 128.5'

APPROV. _____

BY: _____

* SS (split spoon) HS (hollow stem auger) HA (hand auger) MC (macro-core)

GSI Geotechnical Services, Inc.
2960 N. Diers Avenue, Grand Island, NE 68803
(308) 381-1987 Fax (308) 381-2467

Project: Gerald T. Whelan Energy Center

Location 4520 East South Street, Hastings, NE

Project No.: 165162

Date: 10/06/2016

Boring Log MW-8

Project Name	Project No.	Drilling Company
WEC MW Installation	1004517	GSI/ GEOCORE
Location	**Client**	**Drilling Rig Type and Drilling Method**
HASTINGS, NE	Hastings Utilities /PPGA	3.25" Hollow Stem Auger

Sample	"N" blows/FT	Depth (feet)	Well Installation Details	Description (USCS)	Recovery (%)	Water Level Observations
			GROUT Type: Bentonite Amount: 500 lbs	Grassy surface Lean Clay (CL); very dark brown; dry; stiff; medium plasticity	No recovery, visual classification from cuttings	
		10		Hard; low plasticity Brown; slightly moist; firm to hard; medium plasticity		
		20		Firm Dark brown; medium to high plasticity		
		30		Medium plasticity Soft to firm; low plasticity		
		40				
		50				
				Poorly graded sand with clay (SP-SC); reddish bown; slightly moist; medium dense		
		60				
		70		Clayey sand (SC); reddish brown; slightly moist; medium dense		
		80		Poorly graded sand with clay (SP-SC); reddish brown; slightly moist; medium dense		
				Poorly graded sand (SP); fine grained; brown; slightly moist; medium dense		
		90				
				Well graded sand (SW); fine, medium and coarse grained; light brown; slightly moist; medium dense; some fine gravel		
S1	16, 19, 20	100			100	
				Poorly graded		

Boring Log MW-8

Project Name	Project No.	Drilling Company
WEC MW Installation	1004517	GSI/ GEOCORE
Location	**Client**	**Drilling Rig Type and Drilling Method**
HASTINGS, NE	Hastings Utilities /PPGA	3.25" Hollow Stem Auger

Sample	"N" blows/FT	Depth (feet)	Well Installation Details	Description (USCS)	Recovery (%)	Water Level Observations
S2	21,33,37	105		Medium grained; very light brown; medium dense	100	
S3	31 ,38, 41	110		Medium to coarse grained; moist; dense	80	
S4	19, 10, 17	115	**WELL SEAL** Bentonite Chips: 50 lbs	Medium grained; light brown;saturated @ 119.5'; medium dense	80	
S5	11,34,43	120	**WELL PACK** Type: 10-20 Amount: 525 lbs Screen Slot: 0.02 Screen Depth: 117'-127'	Poorly graded sand (SP); medium to coarse grained; light brown; saturated; medium dense	90	▽ ▼
S6 (Sieve)	13, 21, 32	125	END CAP Bottom of well: 127.2'	**Terminated Hollow Stem Auger boring @ 125 feet***	80	
		130				
		135				
		140				

***MW-8 was installed by GEOCORE 5 feet north of boring location using a mud rotary rig GP-1100R on 10/20/2016.**

Note: Well protective casing extends approximately 2.5 feet above concrete pad. Protective bollards installed around casing. See GSI records for Well construction diagram.

The stratification lines represent the approximate boundary lines between soil and rock types. In-Situ transition may be gradual.

Water Level		Logged By/Sampled By:	Drilled By:
While Drilling: ▽	After Drilling: ▼	Gaoty Williams	James Tinnell/David Summers
119.5'	119.6	Date Started: 10/18/2016	Date Completed: 10/19/2016

SOIL BORING LOG & MONITORING WELL CONSTRUCTION DIAGRAM

WELL NO	LOCATION OF WELL	DATUM	TOC ELEVATION	SURFACE ELEVATION	DRILLER	LOGGER
MW-8	Hastings, Nebraska		1903.37'		DAVID SUMMERS	HDR

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING			GRASS	GUS PECH GT 1100R
119.5 ▽	119.6 ▽	▽	▽	DRILLING METHOD	TOTAL DEPTH
				ROTARY RIG	131.0'

NDEQ SPILL #	NDEQ IIS#	DRILLING START TIME	DRILLING STOP TIME

Well Construction Details

PROTECTIVE COVER
- Type: STEEL STICK-UP
- Size: 6"X6"X5'
- Pad Size: 32"X32"

WELL SEAL
- Type: WYO-BEN
- Amount: 600#
- Water: 300 GAL
- Type: 3/8" BENTONITE
- Amount: 50#
- Water: SET IN

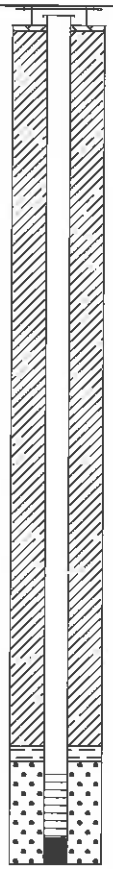
WELL PACK
- Type: 10/20 SILICA
- Amount: 525#

RISER
- Type: PVC
- Schedule: 40
- Inside Dia.: 4"
- Length: 117.0'

SCREEN
- Type: PVC
- Schedule: 40
- Slot: 0.02"
- Inside Dia.: 4"
- Length: 10.0'

END CAP
- Type: PVC
- Length: 0.2'

NOTES
ALL PIPE AND FITTING FLUSH THREADED. BOREHOLE DIAMETER 8.25"



Depth (feet): 0, 30, 60, 90, 120, 150, 180

GRAPHIC LOG

Rock Formations, Soil, Color and Classifications, Observations (moisture, odor, etc.) First column for USCS

Bottom of Well @ 131'

APPROV. _____

BY: _____

* SS (split spoon) HS (hollow stem auger) HA (hand auger) MC (macro-core)

GSI Geotechnical Services, Inc.
2960 N. Diers Avenue, Grand Island, NE 68803
(308) 381-1987 Fax (308) 381-2467

Project: Gerald T. Whelan Energy Center

Location 4520 East South Street, Hastings, NE

Project No.: 165162

Date: 10/20/2016

Boring Log MW-9

Project Name	Project No.	Drilling Company
WEC MW Installation	1004517	GSI
Location	**Client**	**Drilling Rig Type and Drilling Method**
HASTINGS, NE	Hastings Utilities /PPGA	6.25" Hollow Stem Auger

Sample	"N" blows/FT	Depth (feet)	Well Installation Details	Description (USCS)	Recovery (%)	Water Level Observations
			GROUT Type: Bentonite Amount: 1000 lbs Water: 300 gal.	Grassy surface Lean Clay (CL); very dark brown; dry; stiff; medium plasticity	No recovery, visual classification from cuttings	
		10		Slightly moist; soft to firm; medium plasticity		
				Sorft; High plasticity		
		20		Dark brown to brown		
		30		Soft to firn		
		40		Firm		
		50				
		60		Dark brown to brown; soft to firm		
				Clayey sand (SC); brown to dark brown; slightly moist, medium plasticity		
		70		Poorly graded sand with clay (SP-SC); brown; slightly moist, medium desne		
				Poorly graded sand with clay (SP-SC); brown; slightly moist, medium dense		
		80		Poorly graded sand (SP); fine to medium grained; brown; loose to medium dense		
		90		Few fine gravel; medium dense		

Boring Log MW-9

Project Name	Project No.	Drilling Company
WEC MW Installation	1004517	GSI
Location	**Client**	**Drilling Rig Type and Drilling Method**
HASTINGS, NE	Hastings Utilities /PPGA	6.25" Hollow Stem Auger

Sample	"N" blows/FT	Depth (feet)	Well Installation Details	Description (USCS)	Recovery (%)	Water Level Observations
				Light brown; iron stain and few fine gravel	80	
S1	10, 14, 22	100		Well graded sand (SW); fine to medium grained; light bown; moist; medium dense; some coarse sand		
			WELL SEAL Bentonite Chips: 100lbs Water: 10 gal.		70	
S2	8, 30, 24	105	**WELL PACK** Type: 16-30 Amount: 400 lbs	Wet	50	
S3(Sieve)	11, 17, 19	110	Screen Slot: 0.01 Screen Depth: 107'-117'	Saturated; some fine gravel	100	▽ ▼
S4	15, 23, 19	115	END CAP Bottom of well: 117.2'			
S5	7,9,33	120		**Terminated Boring @ 118.5 feet**		
		125		Note: Well protective casing extends approximately 2.5 feet above concrete pad. Protective bollards installed around casing. See GSI records for Well construction diagram.		
		130				
		135				
		140				

The stratification lines represent the approximate boundary lines between soil and rock types. In-Situ transition may be gradual.

Water Level		Logged By/Sampled By:	Drilled By:
While Drilling: ▽ 110'	After Drilling: ▼ 109.5	Gaoty Williams & Megan Seymour	James Tinnell
		Date Started: 10/7/2016	Date Completed: 10/10/2016

SOIL BORING LOG & MONITORING WELL CONSTRUCTION DIAGRAM

WELL NO.	LOCATION OF WELL	DATUM	TOC ELEVATION	SURFACE ELEVATION	DRILLER	LOGGER
MW-9	Hastings, Nebraska		1896.54'		JAMES TINNELL	HDR

WATER LEVEL OBSERVATIONS				TYPE OF SURFACE	DRILL RIG
WHILE DRILLING	END OF DRILLING			GRASS	MOBILE B-61
110.0' ▽	109.5' ▽	▽	▽	DRILLING METHOD	TOTAL DEPTH
				6.25" HOLLOW STEM AUGERS	118.5'

NDEQ SPILL #	NDEQ IIS#	DRILLING START TIME	DRILLING STOP TIME

Depth (feet)	Well Construction Details	GRAPHIC LOG	Rock Formations, Soil, Color and Classifications, Observations (moisture, odor, etc.) First column for USCS	Depth (feet)
0	**PROTECTIVE COVER** Type: STEEL STICK-UP Size: 6"X6"X5' Pad Size: 32"X32"			0
30	**WELL SEAL** Type: BH-20 Amount: 900# Water: 270 GAL Type: 3/8" BENTONITE Amount: 100# Water: 10 GAL			30
60	**WELL PACK** Type: 16/30 SILICA Amount: 400#			60
90	**RISER** Type: PVC Schedule: 40 Inside Dia.: 4" Length: 107.0'			90
120	**SCREEN** Type: PVC Schedule: 40 Slot: 0.01" Inside Dia.: 4" Length: 10.0'		Bottom of Well @ 118.5'	120
150	**END CAP** Type: PVC Length: 0.2'			150
180	**NOTES** ALL PIPE AND FITTING FLUSH THREADED. BOREHOLE DIAMETER 10.25"			180

APPROV. _____

BY: _____

* SS (split spoon) HS (hollow stem auger) HA (hand auger) MC (macro-core)

GSI Geotechnical Services, Inc.
2960 N. Diers Avenue, Grand Island, NE 68803
(308) 381-1987 Fax (308) 381-2467

Project: Gerald T. Whelan Energy Center

Location 4520 East South Street, Hastings, NE

Project No.: 165162

Date: 10/10/2016

Attachment 4

Geotechnical Testing Results

1. LABORATORY TESTING

The field boring logs were reviewed to outline the depth, thickness, and extent of the soil strata. The samples taken from the borings were examined in our laboratory and visually classified in general accordance with ASTM D2488-93, "*Description and Identification of Soils (Visual-Manual Procedure)*." A testing program was established to evaluate the engineering properties of the recovered samples. Specific tests that were performed include:

- Moisture Content (ASTM D2216-92, "*Laboratory Determination of Water (Moisture) Content of Soil and Rock*")
- Unit Weight (ASTM D2937-94, "*Density of Soil in Place by the Drive-Cylinder Method*")
- Atterberg Limits (ASTM D4318-95, "*Liquid Limit, Plastic Limit, and Plasticity Index of Soils*")
- Minus No. 200 Sieve Wash (ASTM D1140-92, "*Amount of Material in Soils Finer Than the No. 200 (75-μm) Sieve*")
- Sieve Analysis (ASTM D422-63, "*Particle-Size Analysis of Soils*")
- Pocket Penetrometer
- Pocket Torvane
- Hydraulic Conductivity (ASTM D5084-90, "*Measurement of Hydraulic Conductivity of Saturated, Porous Materials using a Flexible Wall Permeameter*")
- Specific Gravity (ASTM D854-92, "*Specific Gravity of Soils*")

All tests were conducted in general accordance with the current ASTM test procedures.

Drill Hole No.	Sample No.	Sample Depth (ft.)	Sample Dia. (in.)	Sample Length (in.)	Water Content (%)	Density		Void Ratio	Sat. (%)	Unconfined		Atterberg Limits			Cons. Test *	% Passing #200	Classification
						Wet (pcf)	Dry (pcf)			QU (tsf)	Strain (%)	LL	PL	PI			
WECPZ-1	U-1	3.5 - 5	2.85	5.59	19.7	120.4	100.6	0.662	80								Assumed SpG = 2.68
	U-2	8.5 - 10	2.85	1.75	24.3	104.8	84.3	0.983	66								Assumed SpG = 2.68
	U-3	13.5 - 15										33	18	14			SpG = 2.639 CL
	U-5	21 - 22.5	2.85	5.59	23.5	112.1	90.8	0.842	75								Assumed SpG = 2.68
	U-6	23.5 -25															Assumed SpG = 2.68
	U-7	26 - 27.5										35	15	20			Assumed SpG = 2.68 CL
	U-8	28.5 - 30	2.85	5.59	13.0	125.9	111.4	0.501	70								Assumed SpG = 2.68
	U-11	43.5 - 45										29	13	16			SpG = 2.696 CL
	U-13	53.5 - 55	2.85	5.59	5.5	116.0	110.0	0.520	28							14.0	Assumed SpG = 2.68
	S-14	58.5 - 60			10.9											55.4	
	S-16	68.5 - 70			4.7											5.6	
	S-19	83.5 - 85			7.7											30.2	
	S-21	93.5 - 95			3.0											6.9	
	S-23	103.5-105			4.7											7.2	
	S-25	113.5-115														7.0	
	S-26	118.5-120														7.2	
	S-27	128.5-130														16.5	

Geotechnical Services Inc.

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SUMMARY OF SOIL TESTS

Project
Hastings Utilities Fly Ash Utilization

Location
Hastings, Nebraska

Job Number 995833 Date 8/12/99

HYDROMETER ANALYSIS REPORT

Sample Identification: WECPZ-1, U-11, 43.5 - 45'

Sample Description: Light Reddish Brown, CL

Percent passing the No. 10 Sieve: 100.0

Percent passing the No. 200 Sieve: 73.0

Specific gravity of sample: 2.68 (assumed)

%FINER	D(mm)
55.3	0.0421
44.4	0.0256
41.9	0.0224
35.3	0.0119
31.1	0.0085
28.6	0.0061
26.9	0.0043
22.1	0.0022
20.2	0.0013

Lab No. _____

Test conducted according to ASTM D422-63.

Geotechnical Services Inc.
3826 Arch Ave. Grand Island, NE 68803 (308) 381-1987

Project	Hastings Utilities Fly Ash Utilization
Location	Hastings, Nebraska
Job Number	995833
Date	8/13/99

HYDROMETER ANALYSIS REPORT

Sample Identification: WECPZ-1, U-3, 13.5 - 15'

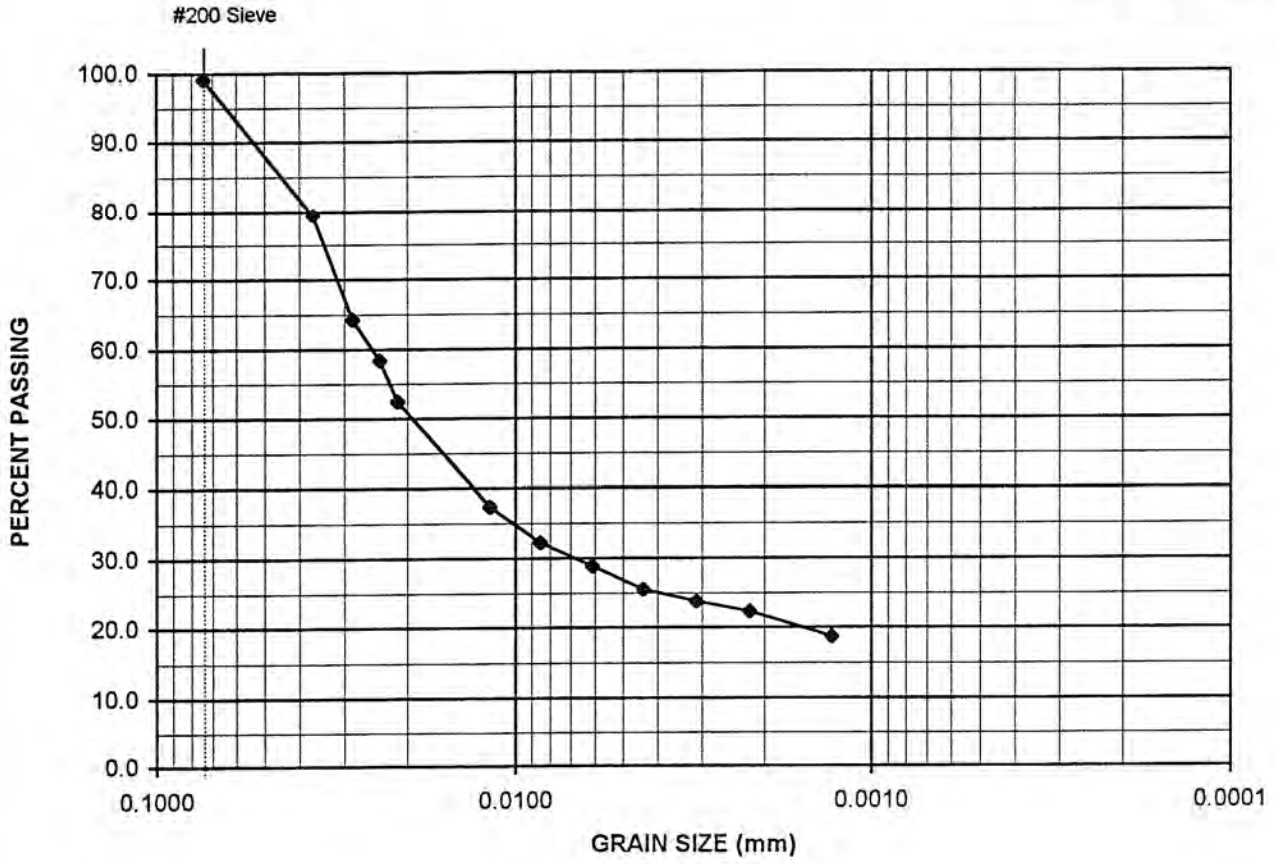
Sample Description: Light Brown, CL

Percent passing the No. 10 Sieve: 100.0

Percent passing the No. 200 Sieve: 99.2

Specific gravity of sample: 2.68 (assumed)

%FINER	D(mm)
79.5	0.0368
58.4	0.0239
52.5	0.0213
37.3	0.0118
32.3	0.0085
28.9	0.0061
25.5	0.0044
22.3	0.0022
18.7	0.0013

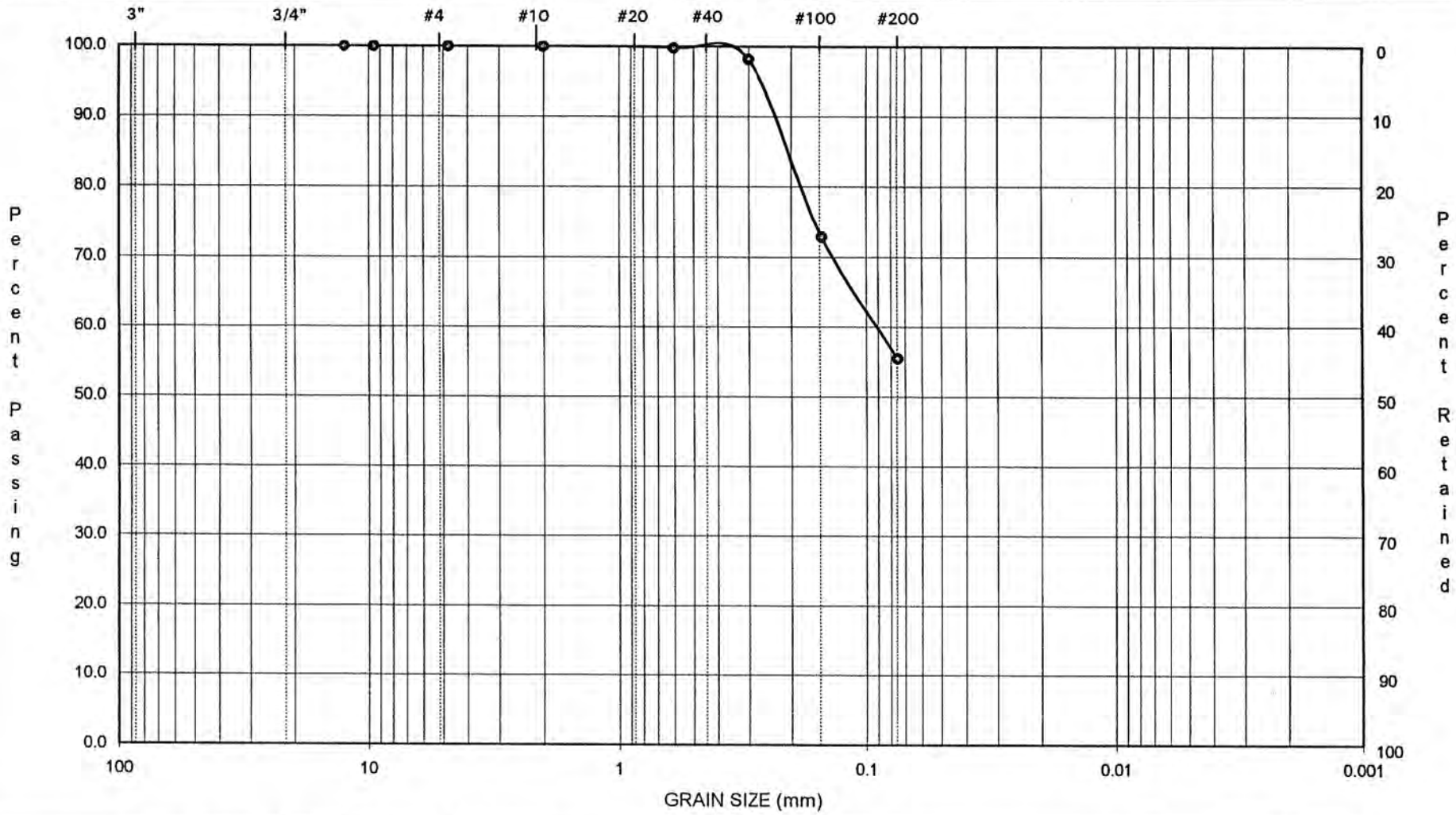


Lab No. _____

Test conducted according to ASTM D422-63.

Geotechnical Services Inc.
3826 Arch Ave. Grand Island, NE 68803 (308) 381-1987

Project	Hastings Utilities Fly Ash Utilization
Location	Hastings, Nebraska
Job Number	995833
Date	8/13/99



UNIFIED CLASSIFICATION SYSTEM	COARSE GRAVEL	FINE GRAVEL	COARSE SAND	MEDIUM SAND	FINE SAND	FINES	Cc 0.50 Cu 177.72

Sample Identification: WECPZ-1, S-14, 58.5 - 60'

Sample Description: Reddish Brown, Sandy Silty Clay

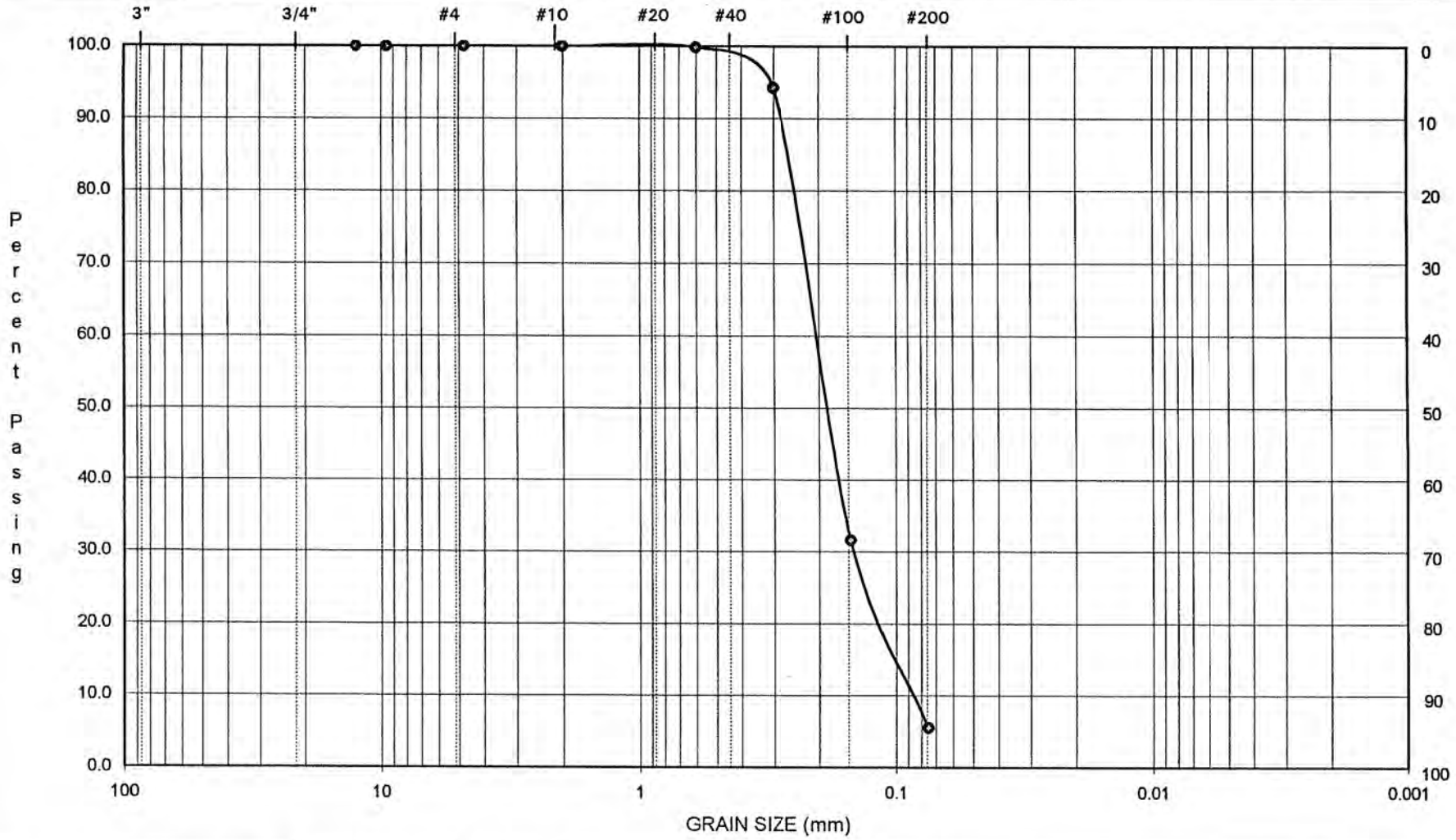
Lab No. s14

Geotechnical Services Inc.
3826 Arch Ave.; Grand Island, NE 68803 (308) 381-1987

GRAIN SIZE REPORT

ASTM D422

Project	Hastings Utilities Fly Ash Site
Location	Hastings, Nebraska
Job Number	995833
Date	8/13/99



UNIFIED CLASSIFICATION SYSTEM	COARSE GRAVEL	FINE GRAVEL	COARSE SAND	MEDIUM SAND	FINE SAND	FINES

Sample Identification: WECPZ-1, S-16, 68.5 - 70'

Sample Description: Light Brown, Poorly Graded Sand

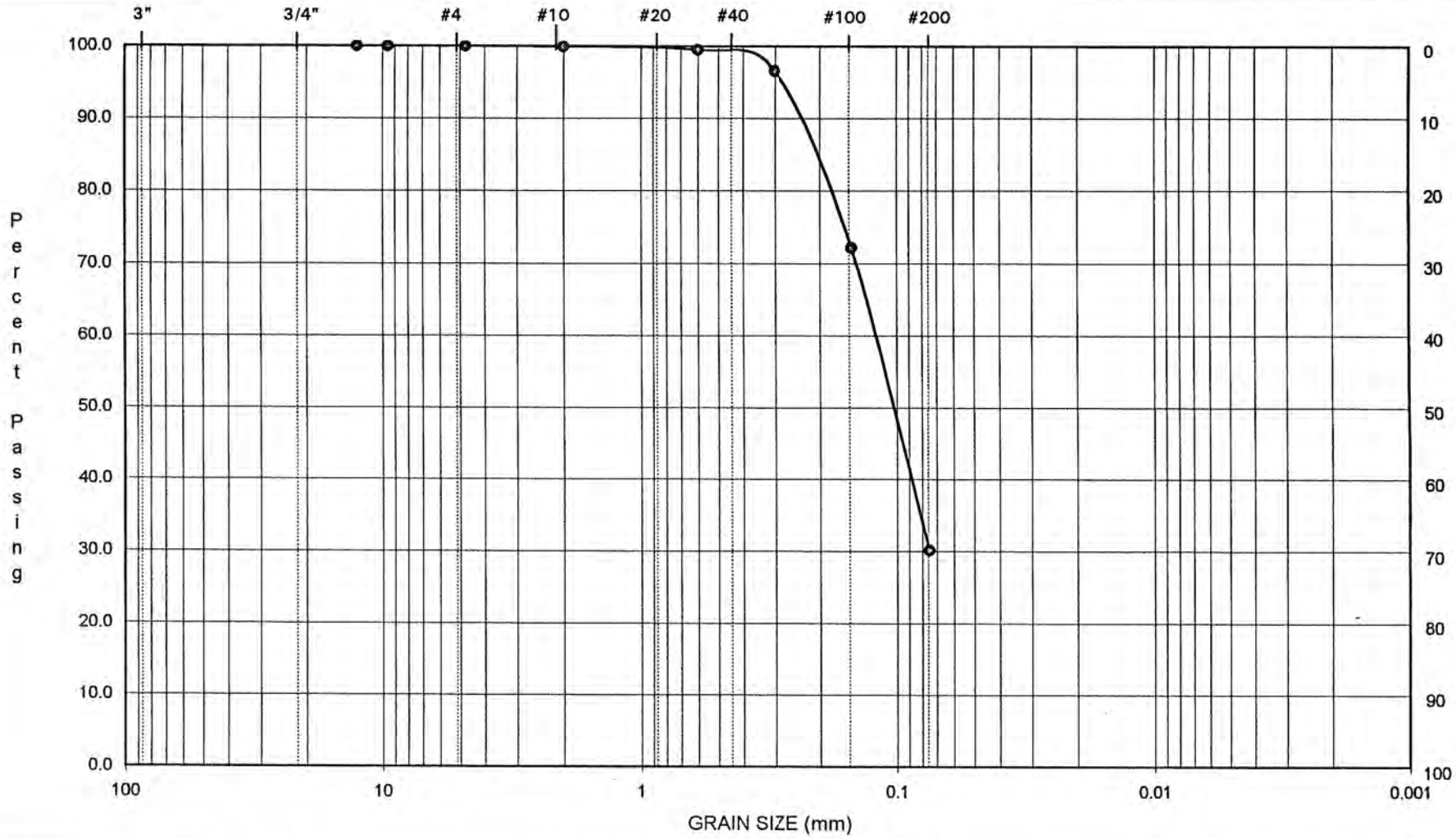
Lab No. s16

Geotechnical Services Inc.
3826 Arch Ave.; Grand Island, NE 68803 (308) 381-1987

GRAIN SIZE REPORT

ASTM D422

Project	Hastings Utilities Fly Ash Site
Location	Hastings, Nebraska
Job Number	995833
Date	8/13/99



UNIFIED CLASSIFICATION SYSTEM	COARSE GRAVEL	FINE GRAVEL	COARSE SAND	MEDIUM SAND	FINE SAND	FINES

Sample Identification: WECPZ-1, S-19, 83.5 - 85'

Sample Description: Light Brown, Silty Clayey Sand

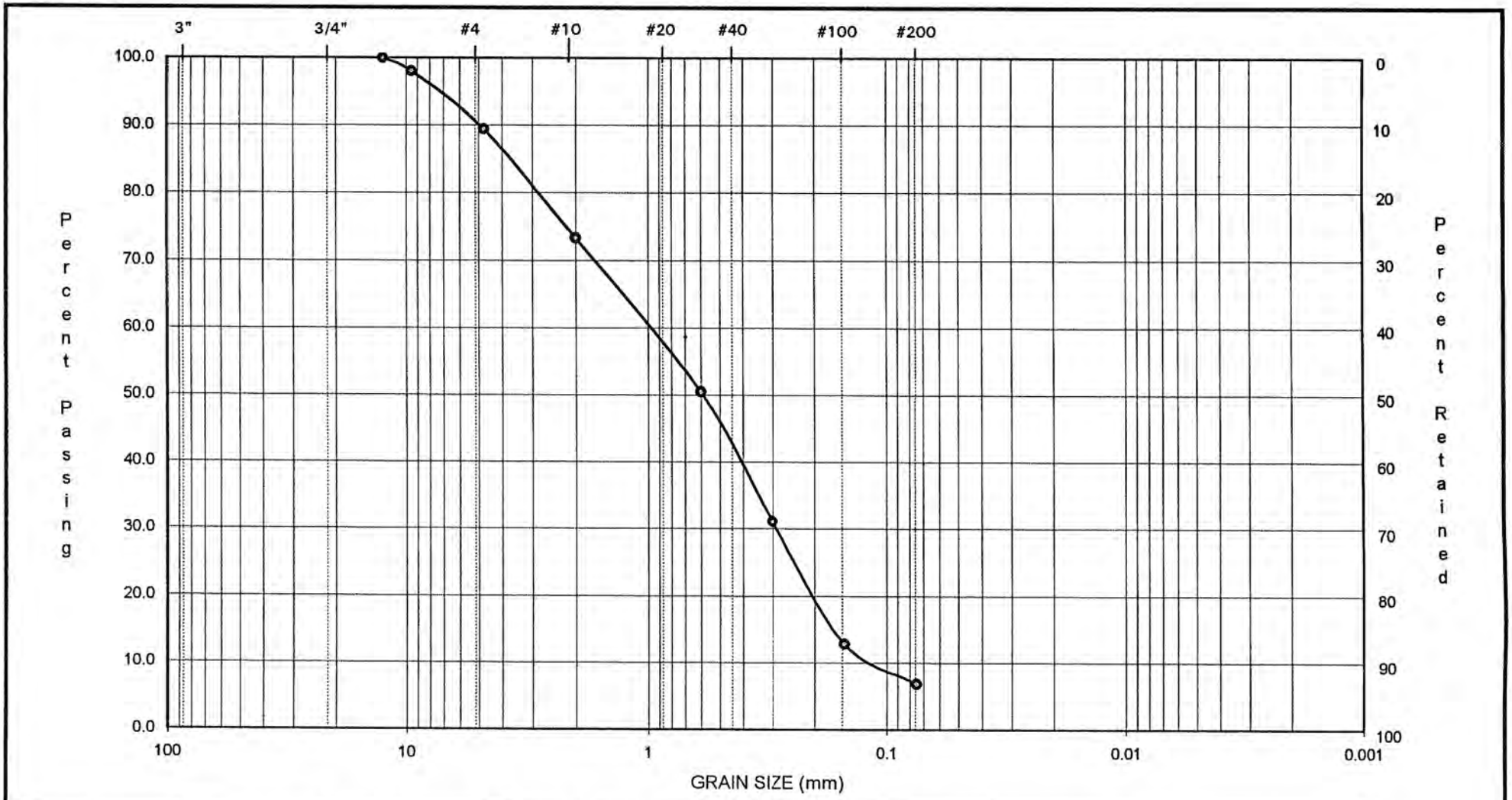
Lab No. s19

Geotechnical Services Inc.
3826 Arch Ave.; Grand Island, NE 68803 (308) 381-1987

GRAIN SIZE REPORT

ASTM D422

Project	Hastings Utilities Fly Ash Site
Location	Hastings, Nebraska
Job Number	995833
Date	8/13/99



UNIFIED CLASSIFICATION SYSTEM	COARSE GRAVEL	FINE GRAVEL	COARSE SAND	MEDIUM SAND	FINE SAND	FINES

Sample Identification: WECPZ-1, S-21, 93.5 - 95'

Sample Description: Light Brown, Well Graded Sand

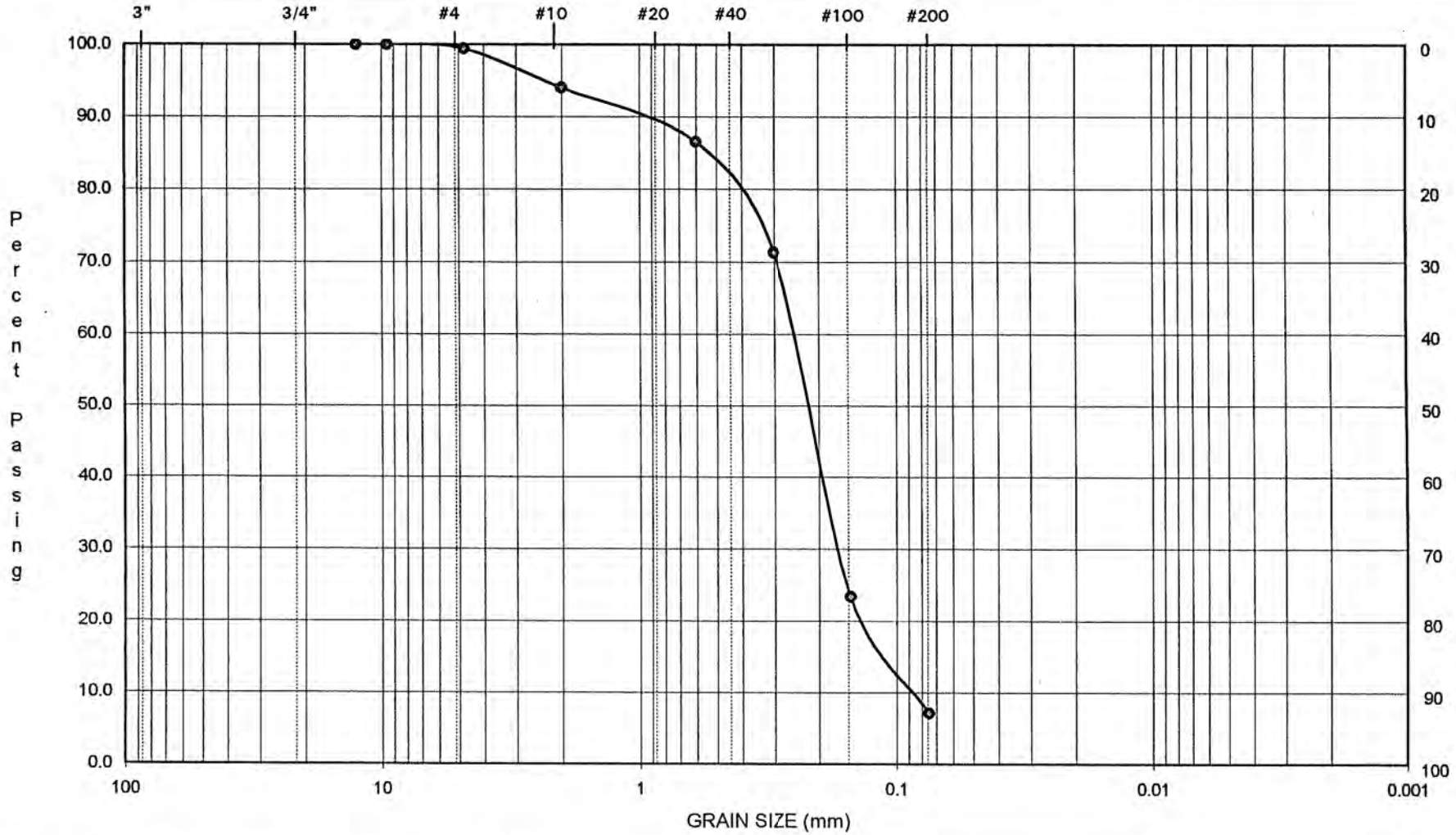
Lab No. s21

Geotechnical Services Inc.
3826 Arch Ave.; Grand Island, NE 68803 (308) 381-1987

GRAIN SIZE REPORT

ASTM D422

Project	Hastings Utilities Fly Ash Site
Location	Hastings, Nebraska
Job Number	995833
Date	8/13/99



UNIFIED CLASSIFICATION SYSTEM	COARSE GRAVEL	FINE GRAVEL	COARSE SAND	MEDIUM SAND	FINE SAND	FINES

Sample Identification: WECPZ-1, S-23, 103.5 - 105'

Sample Description: Light Brown, Poorly Graded Sand with Silt

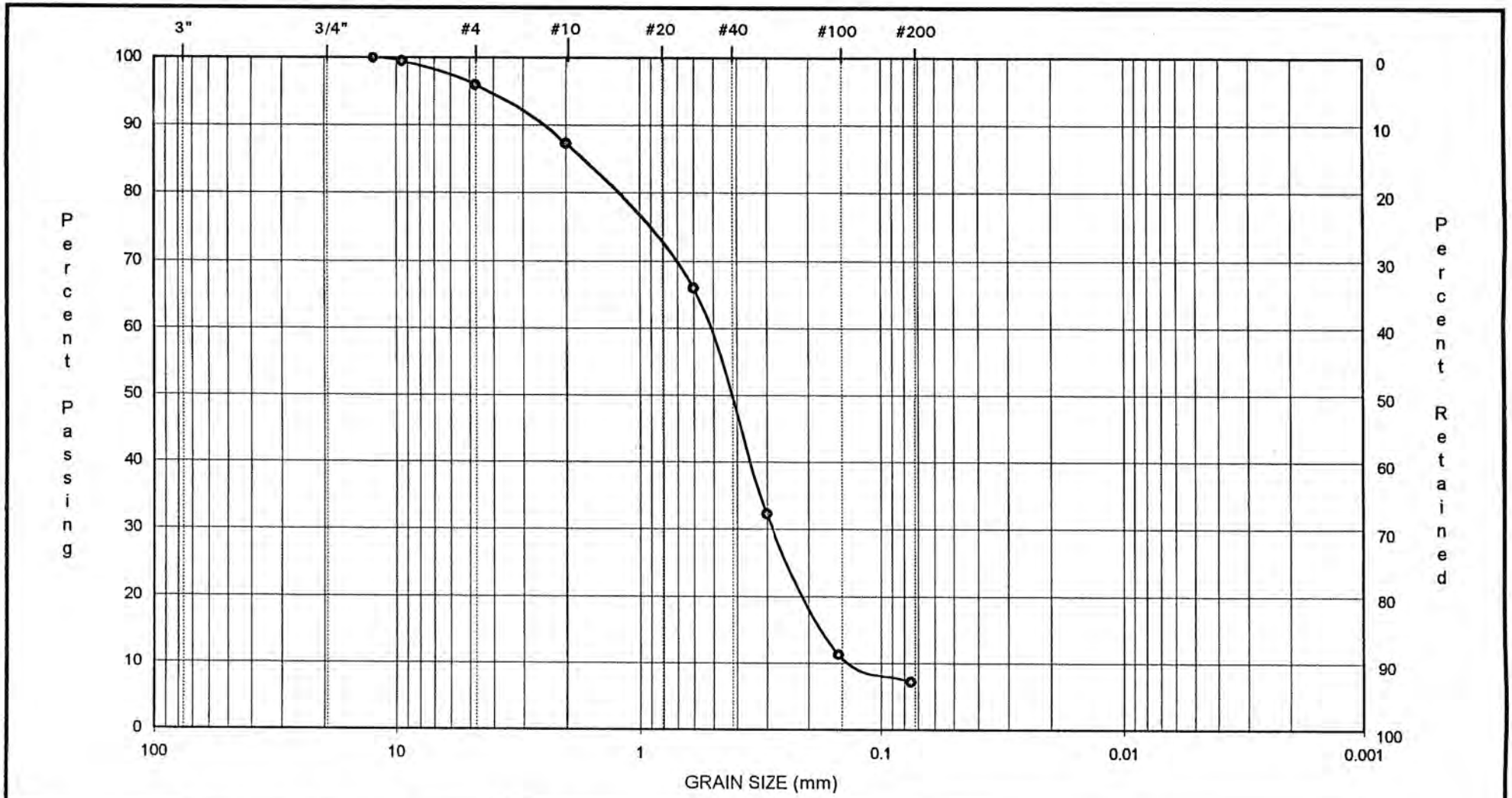
Lab No. s23

Geotechnical Services Inc.
3826 Arch Ave.; Grand Island, NE 68803 (308) 381-1987

GRAIN SIZE REPORT

ASTM D422

Project	Hastings Utilities Fly Ash Site
Location	Hastings, Nebraska
Job Number	995833
Date	8/13/99



UNIFIED CLASSIFICATION SYSTEM	COARSE GRAVEL	FINE GRAVEL	COARSE SAND	MEDIUM SAND	FINE SAND	FINES

Sample Identification: WECPZ-1, S-26, 118.5 - 120'

Sample Description: Light Gray, Well Graded Sand

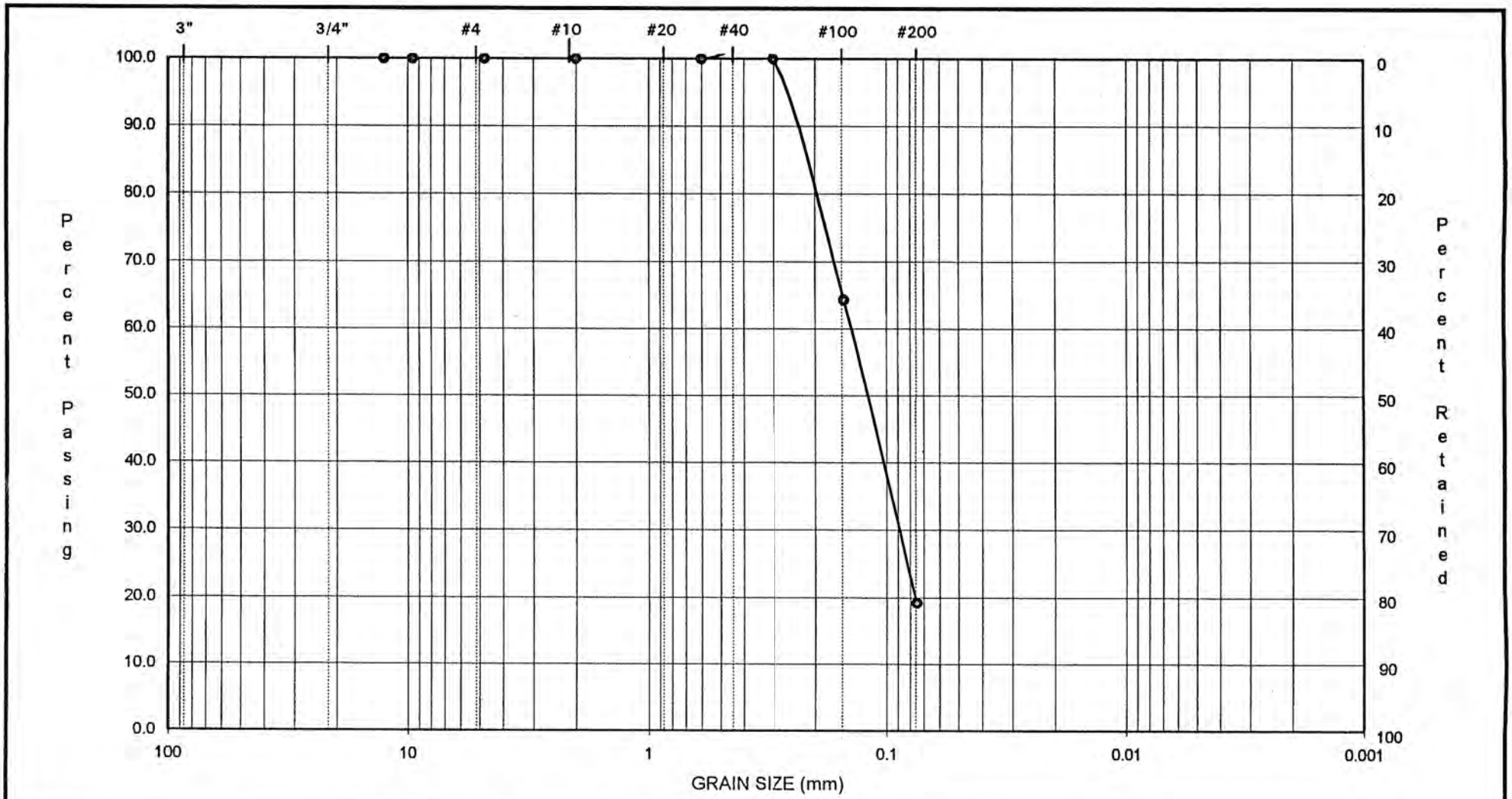
Lab No. s26

Geotechnical Services Inc.
3826 Arch Ave.; Grand Island, NE 68803 (308) 381-1987

GRAIN SIZE REPORT

ASTM D422

Project	Hastings Utilities Fly Ash Site
Location	Hastings, Nebraska
Job Number	995833
Date	8/13/99



UNIFIED CLASSIFICATION SYSTEM	COARSE GRAVEL	FINE GRAVEL	COARSE SAND	MEDIUM SAND	FINE SAND	FINES

Sample Identification: WECPZ-1, S-27, 128.5 - 130'

Sample Description: Reddish Brown, Silty Sand

Lab No. s27

Geotechnical Services Inc.
3826 Arch Ave.; Grand Island, NE 68803 (308) 381-1987

GRAIN SIZE REPORT

ASTM D422

Project	Hastings Utilities Fly Ash Site
Location	Hastings, Nebraska
Job Number	995833
Date	8/13/99

PERMEABILITY TEST REPORT

Sample Identification:
MW-1, U-3, 14 - 15'

Sample Description:
Light Brown Lean Clay with Root Holes
Peoria Formation

Preparation Remarks:
Thin Walled Tube Sample

SPECIMEN DATA

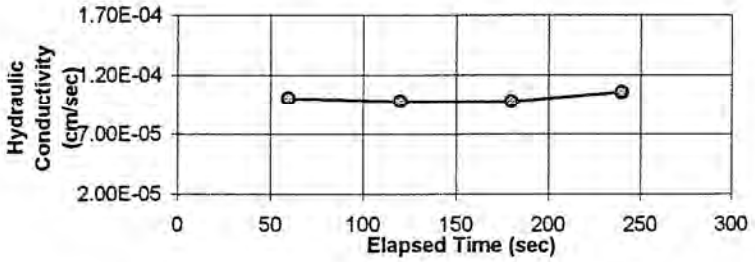
SAMPLE INFORMATION	WET UNIT WEIGHT (pcf)	DRY UNIT WEIGHT (pcf)	MOISTURE CONTENT (%)	VOID RATIO	SATURATION	POROSITY
INITIAL DATA	103.0	83.5	23.3	1.018	62%	0.504
DURING TEST DATA			37.7		100%	
FINAL DATA	112.7	83.0	35.9	1.031	94%	0.508

INITIAL SPECIMEN DIMENSIONS:	Diameter=	7.300	cm
	Length=	8.985	cm
FINAL SPECIMEN DIMENSIONS:	Diameter=	7.300	cm
	Length=	8.985	cm

TEST INFORMATION

PERMEANT LIQUID USED:		De-aired Water
MAGNITUDE OF TOTAL BACK PRESSURE:		10.0 psi
EFFECTIVE CONSOLIDATION STRESS:	MAX=	3.0 psi
	MIN=	2.3 psi
HYDRAULIC GRADIENT RANGE:	HIGH=	12.41
	LOW=	9.87

AVERAGE HYDRAULIC CONDUCTIVITY
corrected to 20°C
1.00E-04 cm/sec



Test conducted according to ASTM D5084-90.

Geotechnical Services Inc.
7050 South 110th Street, Omaha, Nebraska 68128 (402)339-6104

Project	Hastings Utilities Fly Ash Utilization
Location	Hastings, Nebraska
Job Number	995833
Date	8/26/99

FORM 316 3/97

PERMEABILITY TEST REPORT

Sample Identification:
MW-1, U-7; 26 - 26.5'

Sample Description:
Dark Brown, Lean Clay
Sangamon Paleosol Sample

Preparation Remarks:
Thin Walled Tube Sample

SPECIMEN DATA

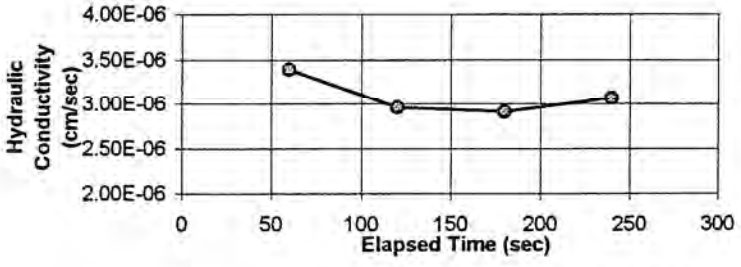
SAMPLE INFORMATION	WET UNIT WEIGHT (pcf)	DRY UNIT WEIGHT (pcf)	MOISTURE CONTENT (%)	VOID RATIO	SATURATION	POROSITY
INITIAL DATA	118.4	101.3	16.9	0.663	69%	0.399
DURING TEST DATA			24.6		100%	
FINAL DATA	122.3	98.5	24.1	0.710	92%	0.415

INITIAL SPECIMEN DIMENSIONS:	Diameter=	7.300	cm
	Length=	10.800	cm
FINAL SPECIMEN DIMENSIONS:	Diameter=	7.300	cm
	Length=	10.800	cm

TEST INFORMATION

PERMEANT LIQUID USED:		De-aired Water
MAGNITUDE OF TOTAL BACK PRESSURE:		10.0 psi
EFFECTIVE CONSOLIDATION STRESS:	MAX=	4.0 psi
	MIN=	2.4 psi
HYDRAULIC GRADIENT RANGE:	HIGH=	16.68
	LOW=	15.53

AVERAGE HYDRAULIC CONDUCTIVITY
corrected to 20°C
3.08E-06 cm/sec



Test conducted according to ASTM D5084-90.

Geotechnical Services Inc.
7050 South 110th Street, Omaha, Nebraska 68128 (402)339-6104

Project	Hastings Utilities Fly Ash Utilization
Location	Hastings, Nebraska
Job Number	995833
Date	8/27/99

PERMEABILITY TEST REPORT

Sample Identification:
MW-1, U-11; 44 - 45'

Sample Description:
Light Red Brown Lean Clay with Fine Sand
Loveland Formation Sediment

Preparation Remarks:
Thin Walled Tube Sample

SPECIMEN DATA

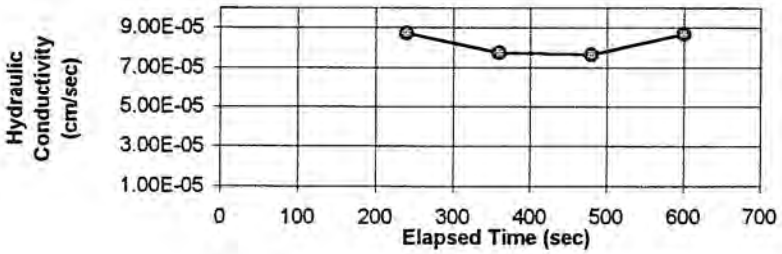
SAMPLE INFORMATION	WET UNIT WEIGHT (pcf)	DRY UNIT WEIGHT (pcf)	MOISTURE CONTENT (%)	VOID RATIO	SATURATION	POROSITY
INITIAL DATA	116.4	102.5	13.5	0.644	57%	0.392
DURING TEST DATA			23.8		100%	
FINAL DATA	120.3	101.7	18.3	0.657	75%	0.396

INITIAL SPECIMEN DIMENSIONS:	Diameter=	7.300	cm
	Length=	9.800	cm
FINAL SPECIMEN DIMENSIONS:	Diameter=	7.300	cm
	Length=	9.838	cm

TEST INFORMATION

PERMEANT LIQUID USED:		De-aired Water
MAGNITUDE OF TOTAL BACK PRESSURE:		10.0 psi
EFFECTIVE CONSOLIDATION STRESS:	MAX=	2.0 psi
	MIN=	1.7 psi
HYDRAULIC GRADIENT RANGE:	HIGH=	3.69
	LOW=	2.42

AVERAGE HYDRAULIC CONDUCTIVITY
corrected to 20°C
8.20E-05 cm/sec



Test conducted according to ASTM D5084-90.

Geotechnical Services Inc.
7050 South 110th Street, Omaha, Nebraska 68128 (402)339-6104

Project	Hastings Utilities Fly Ash Utilization
Location	Hastings, Nebraska
Job Number	995833
Date	8/27/99

SUPPLEMENTAL HYDROGEOLOGIC CHARACTERIZATION

FOR

WHELAN ENERGY CENTER
FOSSIL BUEL COMBUSTION ASH
TEMPORARY ASH DISPOSAL AREA
ADAMS COUNTY, NEBRASKA

PREPARED FOR:

HASTINGS UTILITIES

ISSUED: DECEMBER 2001
REVISED: OCTOBER 2005 AND NOVEMBER 2006
FOR NDEQ-REQUESTED INFORMATION
AND REFERENCE CLARIFICATION

PREPARED BY:

HDR ENGINEERING, INC.

Drill Hole No.	Sample No.	Sample Depth (ft.)	Sample Dia. (in.)	Sample Length (in.)	Water Content (%)	Density		Void Ratio	Sat. (%)	Unconfined		Atterberg Limits			Perm Test *	% Passing #200	Classification
						Wet (pcf)	Dry (pcf)			QU (tsf)	Strain (%)	LL	PL	PI			
PZ-2	U-2	18.5 – 20			22.6		99.0					33	18	15		96.2	Lean Clay (Peoria)
	U-4	38.5 – 40			18.4		110.2					33	16	18		90.4	Lean Clay (Loveland)
	S-7	68.5 – 70			7.3											15.3	See Grain Size Report
	S-9	88.5 – 90			1.2											3.8	See Grain Size Report
PZ-3	U-2	18.5 – 20										34	22	11	*	94.6	Lean Clay (Peoria)
	U-4	38.5 – 40			20.5		106.4					33	15	18		79.6	Lean Clay (Loveland)
PZ-4	U-1	8.5 – 10			24.7		87.4										Peoria
	U-3	28.5 – 30			18.2		113.1					34	15	20	*	69.8	Lean Clay (Loveland)
PZ-5	U-2	18.5 – 20			18.7		99.2					34	19	14		77.8	Lean Clay (Sangamon)

Geotechnical Services Inc.
3826 Arch Avenue * Grand Island, NE 68803 * Phone (308) 381-1987

SUMMARY OF SOIL TESTS

Project: WHELAN ENERGY CENTER

Location: HASTINGS, NEBRASKA

Job Number: 995833

Date: 11/16/01

PERMEABILITY TEST REPORT

Test conducted in general accordance with ASTM D5084-90.

Sample Location:
PZ-3, U-2, 18.5'-20'

Sample Description:
Light Olive Brown, Lean Clay (Peoria)

SPECIMEN DATA

SPECIMEN INFORMATION	Wet Unit Weight (lb/ft^3)	Dry Unit Weight (lb/ft^3)	Moisture Content (%)	Void Ratio	Saturation	Porosity
INITIAL DATA	120.0	96.1	24.9	0.754	89%	0.430
DURING TEST DATA					100%	
FINAL DATA	122.1	96.4	26.6	0.747	96%	0.428

AVERAGE INITIAL SPECIMEN DIMENSIONS: Diameter= 2.883 (in.)
Length= 2.453 (in.)

TEST INFORMATION

PERMEANT LIQUID USED: De-aired Water
MAGNITUDE OF TOTAL BACK PRESSURE: 90.0 (lb/in^2)
EFFECTIVE CONSOLIDATION STRESS: MAX= 4.0 (lb/in^2)
MIN= 2.0 (lb/in^2)
HYDRAULIC GRADIENT RANGE: HIGH= 28.57
LOW= 22.58

AVERAGE HYDRAULIC CONDUCTIVITY

7.8E-08 cm/sec.

This is a remolded sample and may not be indicative of actual in-situ conditions.

Geotechnical Services Inc.
8400 East 13th Terrace, Kansas City, Missouri 64126 (816)461-1205

Project: Whelan Energy Center
Identification: Hastings, NE
Job Number: 995833
Date: 11/23/01

PERMEABILITY TEST REPORT

Test conducted in general accordance with ASTM D5084-90.

Sample Location:
PZ-4, U-3, 28.5'-30'

Sample Description:
Reddish Brown, Lean Clay (Loveland)

SPECIMEN DATA

SPECIMEN INFORMATION	Wet Unit Weight (lb/ft^3)	Dry Unit Weight (lb/ft^3)	Moisture Content (%)	Void Ratio	Saturation	Porosity
INITIAL DATA	132.0	111.9	17.9	0.505	96%	0.336
DURING TEST DATA					100%	
FINAL DATA	134.2	113.2	18.6	0.489	100%	0.328

AVERAGE INITIAL SPECIMEN DIMENSIONS: Diameter= 2.873 (in.)
Length= 2.464 (in.)

TEST INFORMATION

PERMEANT LIQUID USED: De-aired Water
MAGNITUDE OF TOTAL BACK PRESSURE: 90.0 (lb/in^2)
EFFECTIVE CONSOLIDATION STRESS: MAX= 4.0 (lb/in^2)
MIN= 2.0 (lb/in^2)
HYDRAULIC GRADIENT RANGE: HIGH= 28.29
LOW= 27.97

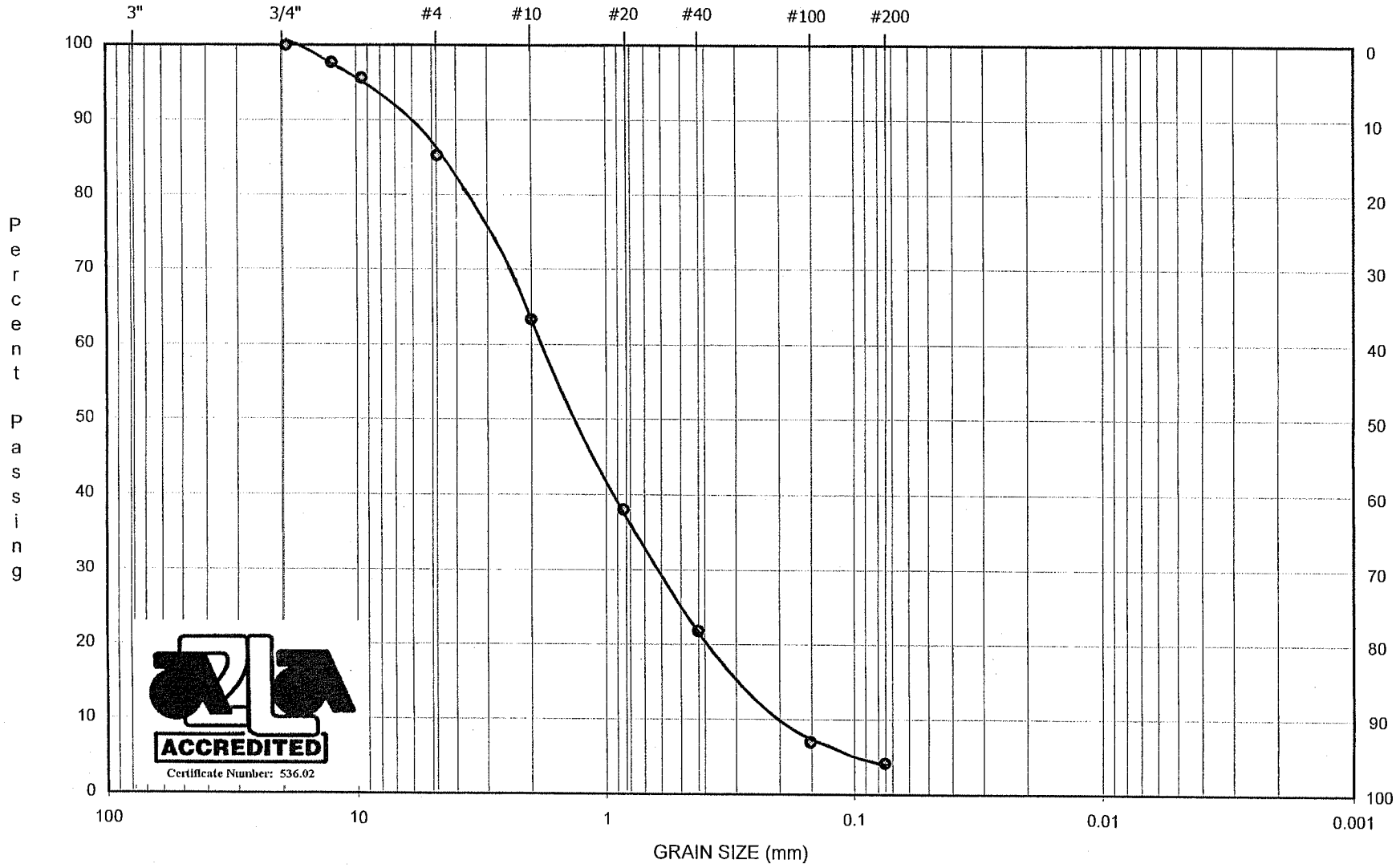
AVERAGE HYDRAULIC CONDUCTIVITY

2.2E-07 cm/sec.

This is a remolded sample and may not be indicative of actual in-situ conditions.

Geotechnical Services Inc.
8400 East 13th Terrace, Kansas City, Missouri 64126 (816)461-1205

Project: Whelan Energy Center
Identification: Hastings, NE
Job Number: 995833
Date: 11/23/01



UNIFIED CLASSIFICATION SYSTEM	COARSE GRAVEL	FINE GRAVEL	COARSE SAND	MEDIUM SAND	FINE SAND	FINES	Cc 1.09 Cu 9.62

Sample Identification: PZ-2,S-9,88.5-90

Sample Description: Light Brown Poorly Graded Sand

Lab No. _____

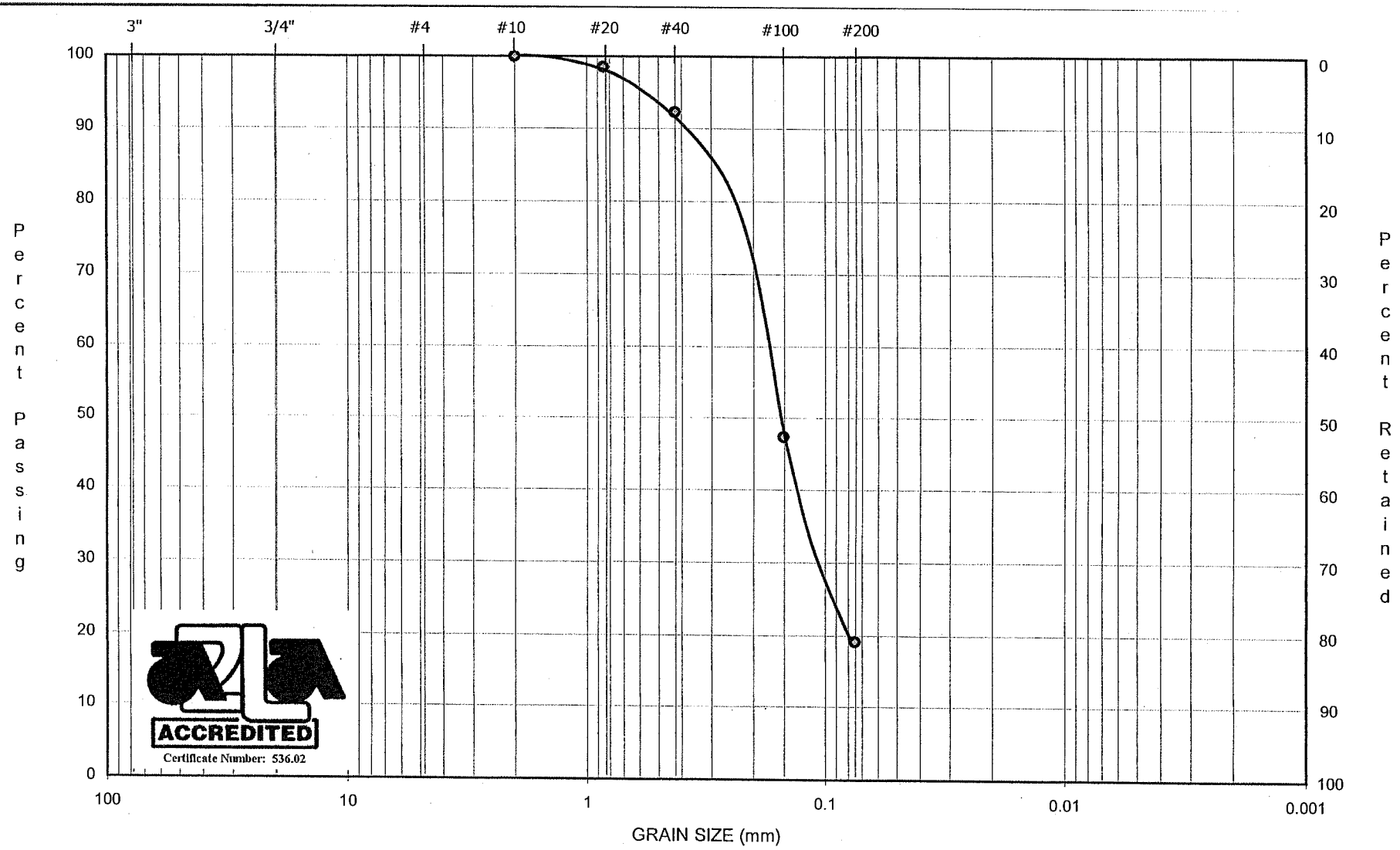
Geotechnical Services Inc.
3826 Arch Ave.; Grand Island, NE 68803 (308) 381-1987

GRAIN SIZE REPORT

ASTM D422

Project	Hastings Utilities
Location	Hastings, Nebraska
Job Number	995833
Date	11/27/01

Presented by J. Fred Jones, P.E.



UNIFIED CLASSIFICATION SYSTEM	COARSE GRAVEL	FINE GRAVEL	COARSE SAND	MEDIUM SAND	FINE SAND	FINES	Cc 0.89 Cu 3.74

Sample Identification: PZ-2,S-7,68.5-70

Sample Description: Light Brown Poorly Graded Sand

Lab No. _____ 0

Geotechnical Services Inc.
3826 Arch Ave.; Grand Island, NE 68803 (308) 381-1987

GRAIN SIZE REPORT

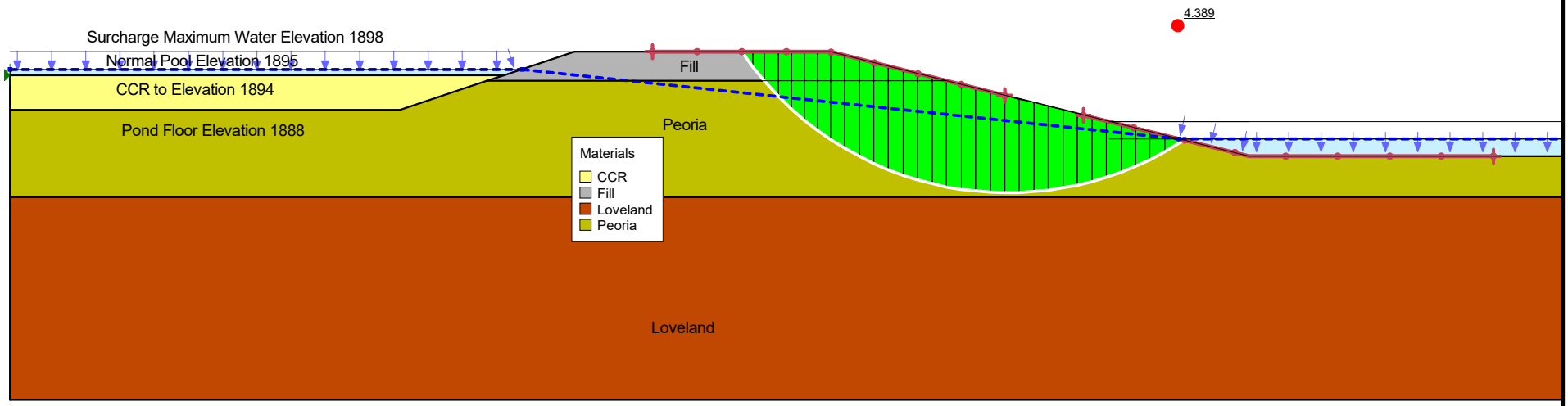
ASTM D422

Project	Hastings Utilities
Location	Hastings, Nebraska
Job Number	995833
Date	11/27/01

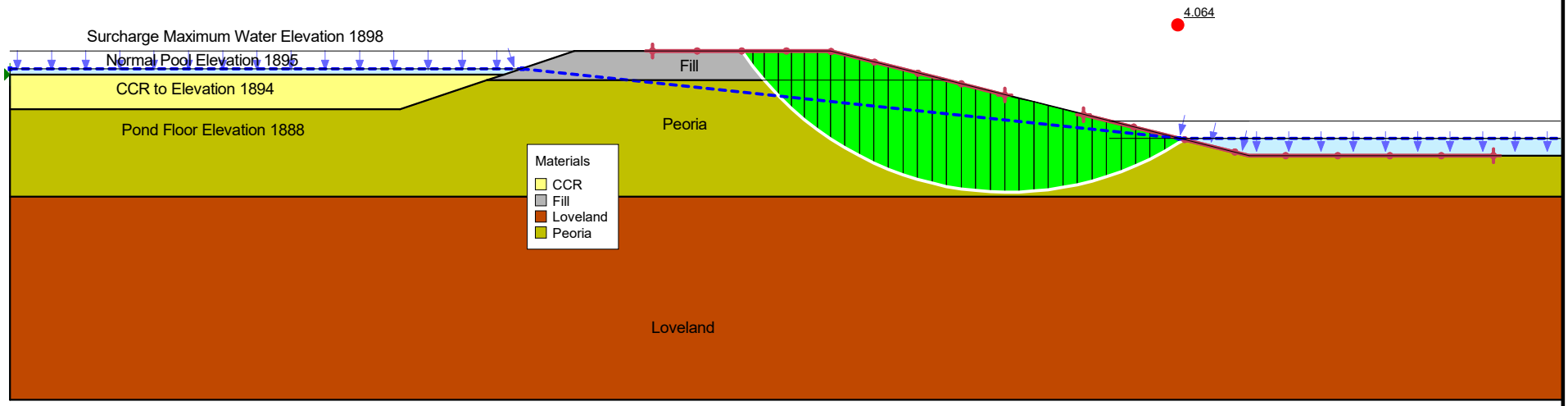
Presented by J. Fred Jones, P.E.

Attachment 5

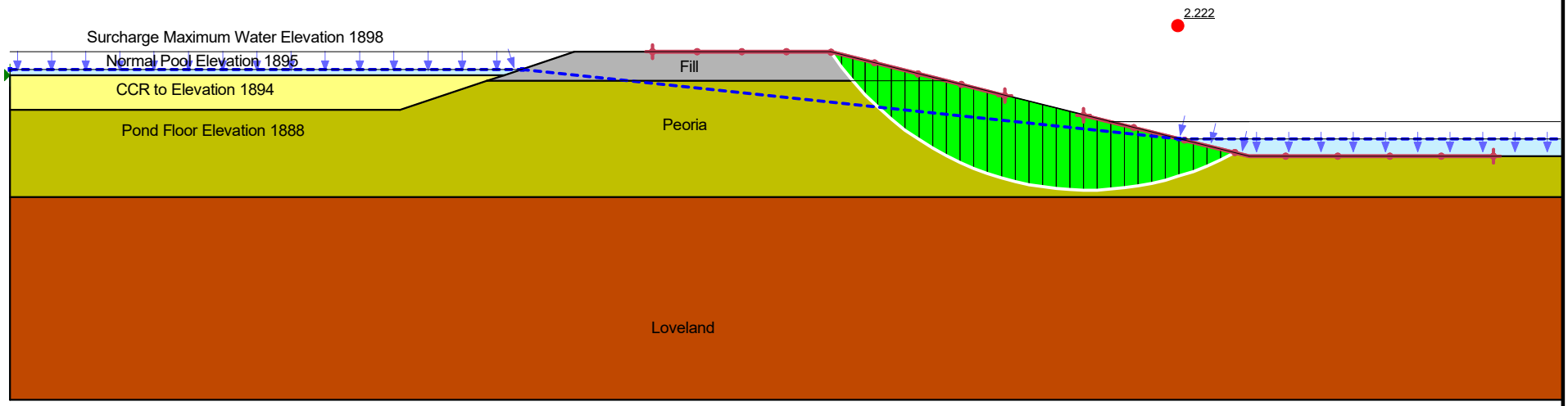
Stability Analysis Results



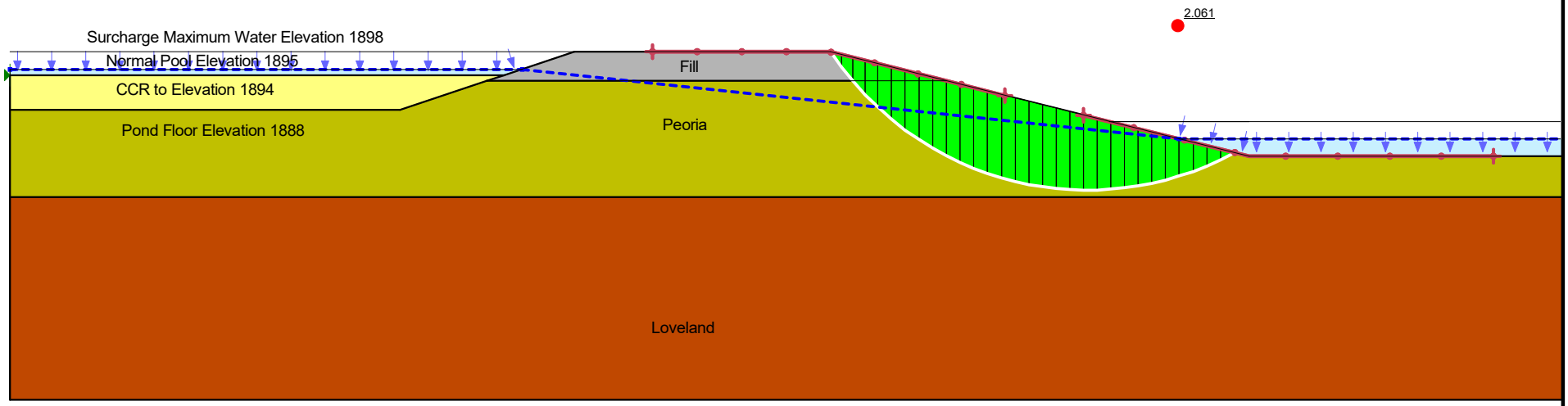
SLOPE/W Analysis	
Hastings CCR Normal Pool Short Term Static.gsz	
11/20/2020	1:325



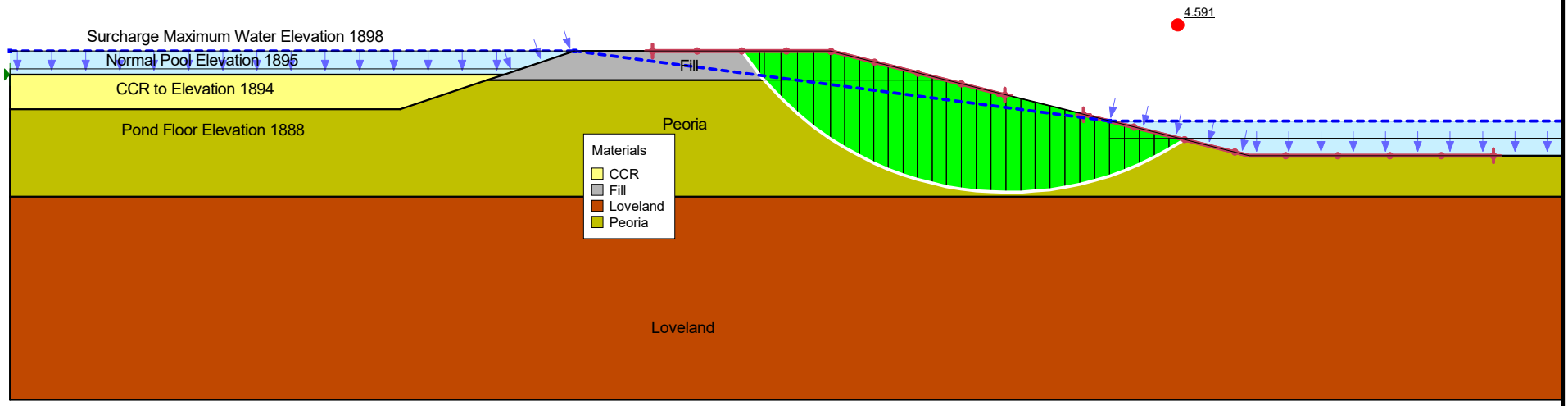
SLOPE/W Analysis	
Hastings CCR Normal Pool Short Term Seismic.gsz	
11/24/2020	1:325



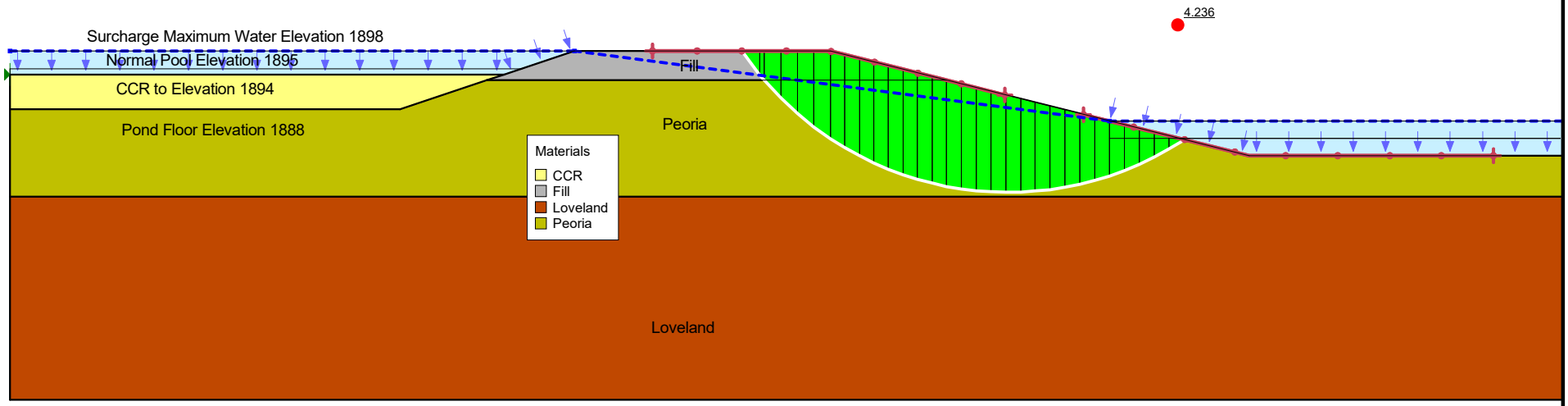
SLOPE/W Analysis
Hastings CCR Normal Pool Long Term Static.gsz
11/24/2020 1:325



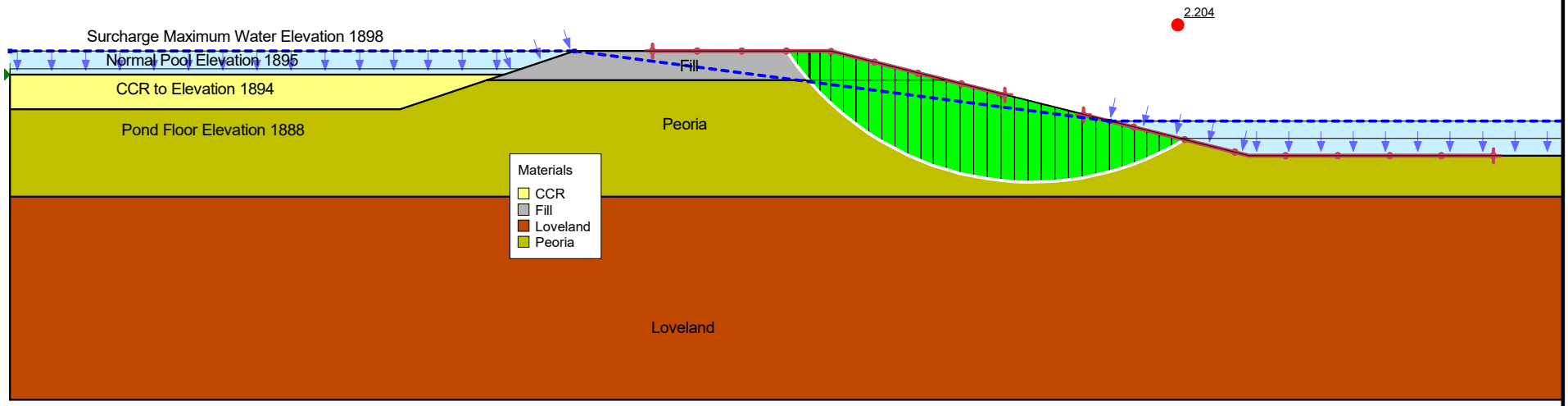
SLOPE/W Analysis	
Hastings CCR Normal Pool Long Term Seismic.gsz	
11/24/2020	1:325



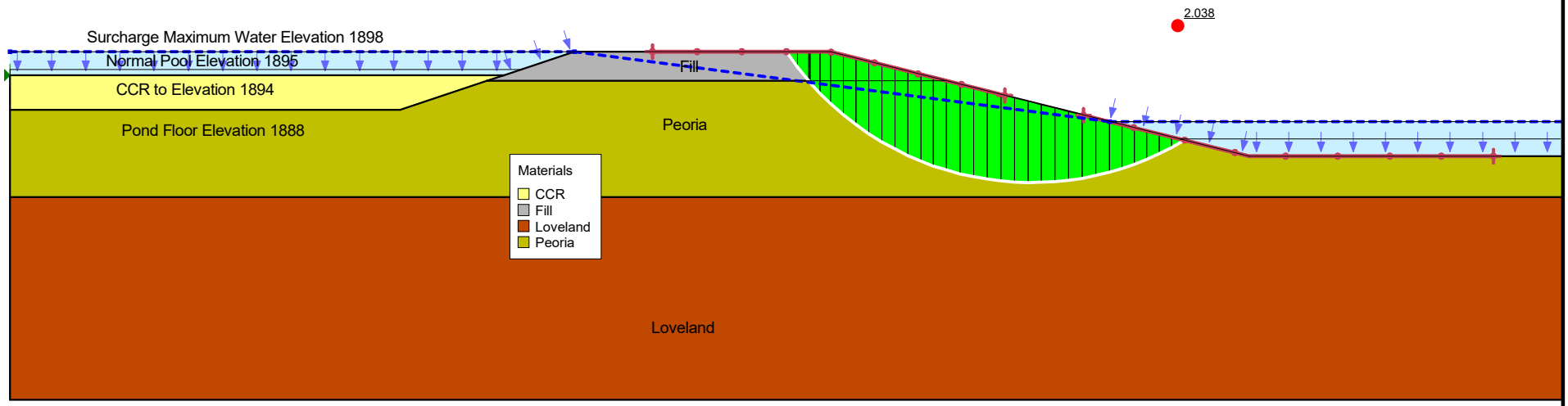
SLOPE/W Analysis
Hastings CCR Max Pool Short Term Static.gsz
11/24/2020 1:325



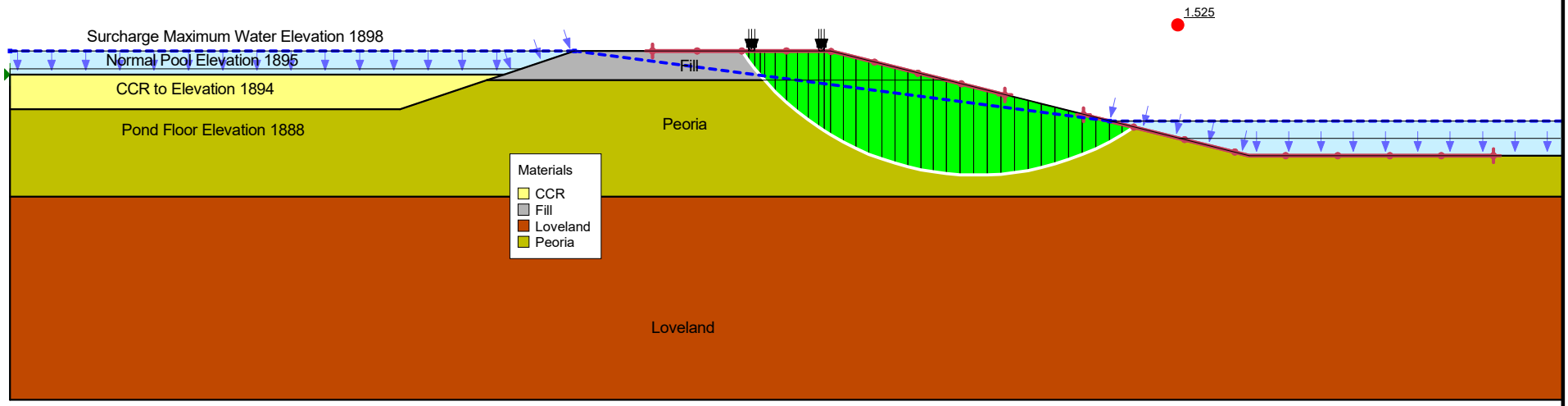
SLOPE/W Analysis	
Hastings CCR Max Pool Short Term Seismic.gsz	
11/24/2020	1:325



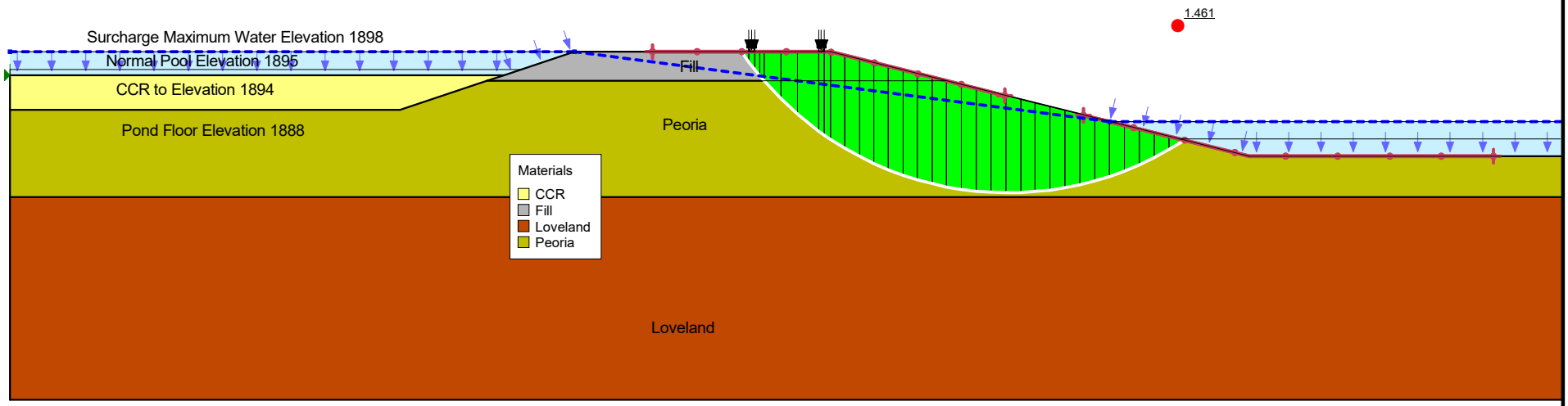
SLOPE/W Analysis
Hastings CCR Max Pool Long Term Static.gsz
11/24/2020 1:325



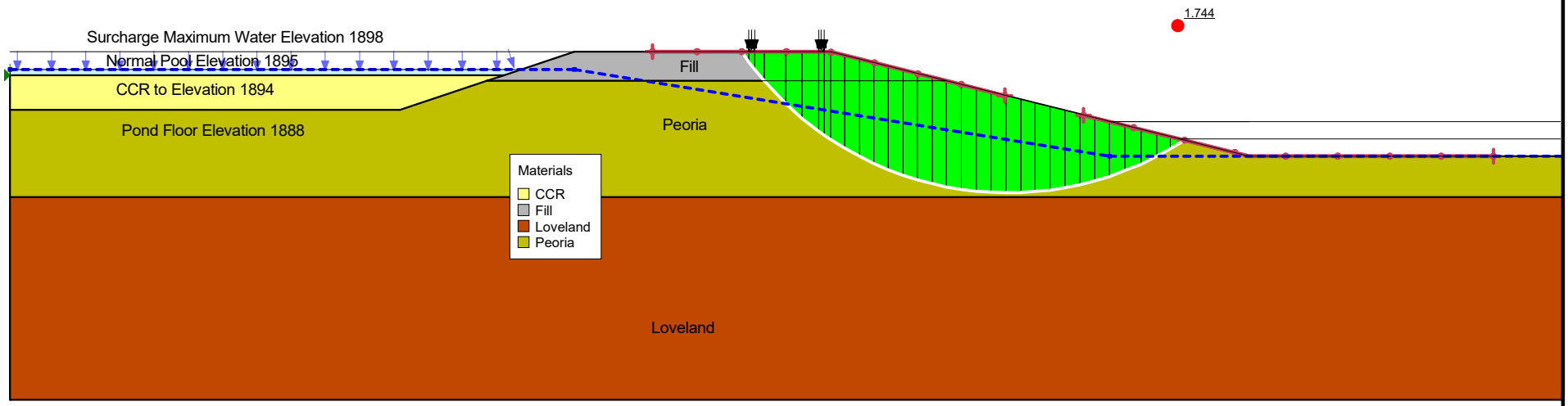
SLOPE/W Analysis
Hastings CCR Max Pool Long Term Seismic.gsz
11/24/2020 1:325



SLOPE/W Analysis
Hastings CCR Max Pool Long Term Static w_Surcharge.gsz
11/24/2020 1:325



SLOPE/W Analysis
Hastings CCR Max Pool Long Term Seismic w_Surcharge.gsz
11/24/2020 1:325

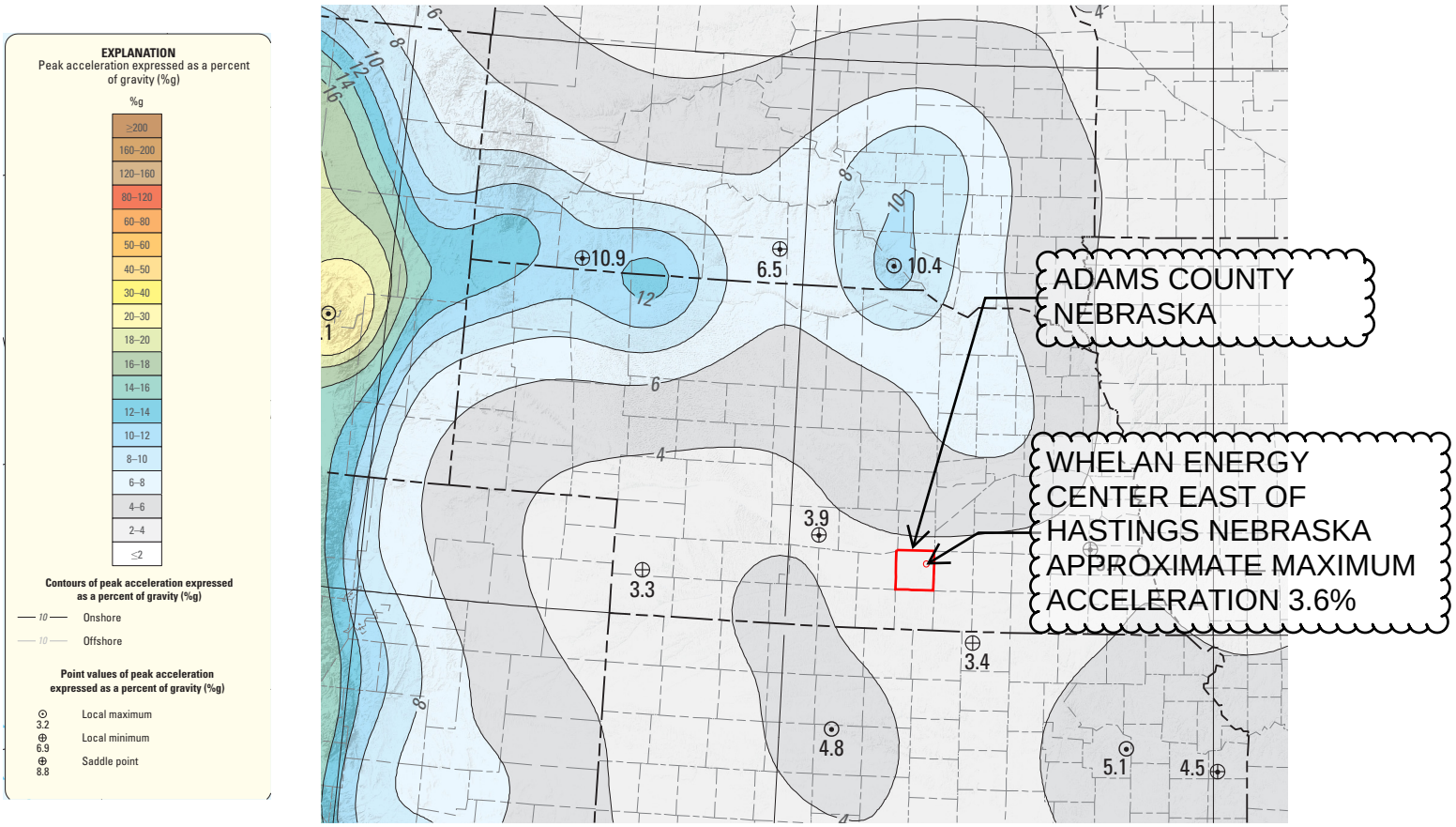


SLOPE/W Analysis
Hastings CCR Nrml Pl Dry Pond Lng Trm Seis w_Srchrge.gsz
11/25/2020 1:325

Attachment 6

Excerpt from USGS Seismic-Hazard Map, 2014

FIGURE 1: NEBRASKA EXCERPT OF 2014 PEAK HORIZONTAL ACCELERATION WITH 2 PERCENT PROBABILITY OF EXCEEDANCE IN 50 YEARS (10 PERCENT IN 250 YEARS)



Seismic-Hazard Maps for the Conterminous United States, 2014

Peak Horizontal Acceleration with 2 Percent Probability of Exceedance in 50 Years

By

Mark D. Petersen,[1] Morgan P. Moschetti,[1] Peter M. Powers,[1] Charles S. Mueller,[1] Kathleen M. Haller,[1]Arthur D. Frankel,[1] Yuehua Zeng,[1] Sanaz Rezaeian,[1] Stephen C. Harmsen,[1] Oliver S. Boyd,[1] Edward H. Field,[1] Rui Chen,[2] Nicolas Luco,[1]Russell L. Wheeler,[1] Robert A. Williams,[1] Anna H. Olsen,[1] and Kenneth S. Rukstales[1]

2015

[1]U.S. Geological Survey
[2]California Geological Survey, Sacramento, Calif.