# HISTORY OF CONSTRUCTION

CFR 257.74(c)(1)

East Bottom Ash Pond

Rockport Plant
Rockport, Indiana

October, 2023

Prepared for: Indiana Michigan Power - Rockport Plant

2791 North US 231

Rockport, Indiana 47635

Prepared by: Worley

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AMERICAN ELECTRIC POWER
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Attachments

## 1.0 OBJECTIVE

This report was prepared by Worley for AEP to fulfill requirements of CCR 257.74(c)(1) with an evaluation of the east bottom ash pond. The report also contains information for the pond complex as a whole, which is how it was evaluated previously, prior to retrofitting the east bottom ash pond.

## 2.0 DESCRIPTION OF CCR IMPOUNDMENTS

The Rockport plant is located near the City of Rockport, Spencer County, Indiana. It is owned by Indian Michigan Power Co. (I&M), a unit of American Electric Power. Historically, bottom ash was managed at the Rockport Plant, in two contiguous ponds, referred to the East and West BA Ponds. The West Bottom Ash Pond will commence closure when the retrofitted East Bottom Ash Pond goes into service and will then become a stormwater pond after closure.

The east bottom ash pond is lined with a textured 40-mil LLDPE geomembrane overtop a geosynthetic clay liner (GCL) overtop a 10 oz/sy non-woven geotextile and discharges to the east waste water pond.

There are six main ponds within the bottom ash pond complex as listed below.

*List of Main Ponds within the Bottom Ash Complex*
West Bottom Ash Pond (To commence closure October, 2023)
East Bottom Ash Pond
West Waste Water Pond
East Waste Water Pond
Reclaim Pond
Clear Water Pond

The west bottom ash pond dike is approximately 2000 feet long and is 13 feet high with a design crest width of 30 feet. The dike is a compacted soil earthen embankment. The top of the dike is at elevation 399 feet with the natural ground surface beneath the dikes at about elevation 390 feet. The exterior side slope of the embankment fill is designed to be 2.5:H to 1:V that transitions to 3:H to 1:V. The interior design side slopes are 2:H to 1:V. The bottom elevation of the west pond is at elevation 386 with a minimum operating pool elevation of 394 providing a CCR storage capacity of 211 ac-ft.

The east bottom ash pond is an incised pond with the surrounding ground at elevations above 399. The pond contains a concrete revetment lined forebay area to the north for collection and clean-out of CCR material. The forebay dike runs east-to-west at elevation 394 and is approximately 650 feet long. The east bottom ash pond also has interior design slopes of 2:H to 1:V, including the forebay dike slopes. The bottom elevation of the east bottom ash pond following retrofit is at elevation 378.5 at it's lowest point and slopes at 1% along the bottom to approximate elevation 382. The minimum operating pool elevation of 391 provides a CCR storage capacity of 280 ac-ft.

## 3.0 SUMMARY OF OWNERSHIP 257.74(C)(1)(I)

*[The name and address of the person(s) owning or operating the CCR unit: the name associated with the CCR unit: and the identification number of the CCR unit if one has been assigned by the state.]*

The Rockport Power Plant is located at 2791 North U.S. Hwy 231, Rockport, IN, 47635 near the City of Rockport, Indiana. It is owned and operated by I&M. When the retrofitted east bottom ash pond goes into service, the facility will operate one surface impoundment for storing CCR material. The second bottom ash pond (west bottom ash pond) will commence closure when the east bottom ash pond goes into service following retrofit. The State of Indiana does not require a dam permit for this facility.

## 4.0 LOCATION OF THE CCR UNIT 257.74 (C)(1)(II)

*[The location of the CCR unit identified on the most recent U.S. Geological Survey (USGS) 7 ½ minute or 15 minute topographic quadrangle map, or a topographic map of equivalent scale if a USGS map is not available.]*

A location map is included in Attachment A.

## 5.0 STATEMENT OF PURPOSE 257.74 (C)(1)(III)

*[A statement of the purpose for which the CCR unit is being used.]*

The east bottom ash pond is used for primary settling and storage of CCR material. The west bottom ash pond will commence closure when the east bottom ash pond goes into service following retrofit.

## 6.0 NAME AND SIZE OF WATERSHED THE CCR UNIT IS LOCATED 257.74 (C)(1)(IV)

*[The name and size in acres of the watershed within which the CCR unit is located.]*

The east bottom ash pond and west bottom ash pond are located within the Ohio River Water Shed (HUC 05140201) which is approximately 1,396.96 square miles (894,054 acres) (USGS).

The west bottom ash pond is comprised of diked embankments along the west side of the pond and a splitter dike with the east bottom ash pond and west waste water pond. Storm water is directed away from the west bottom ash pond and limits runoff to that which falls directly on the pond's water surface.

The east bottom ash pond is incised on the northern and eastern sides of the pond. A north-to-south trending splitter dike separates the east bottom ash pond from the west bottom ash pond and an east-to-west trending splitter dike separates the east bottom ash pond from the east waste water pond. Previously in the past, a small watershed area of 13 acres drained into the east bottom ash pond, but this area has been regraded and now drains away from the pond. Therefore, the only runoff to the east bottom ash pond is that which directly falls on the pond's water surface.

## 7.0 DESCRIPTION OF THE FOUNDATION AND ABUTMENT MATERIALS 257.74(c)(1)(v)

*[A description of the physical and engineering properties of the foundation and abutment materials on which the CCR unit is located.]*

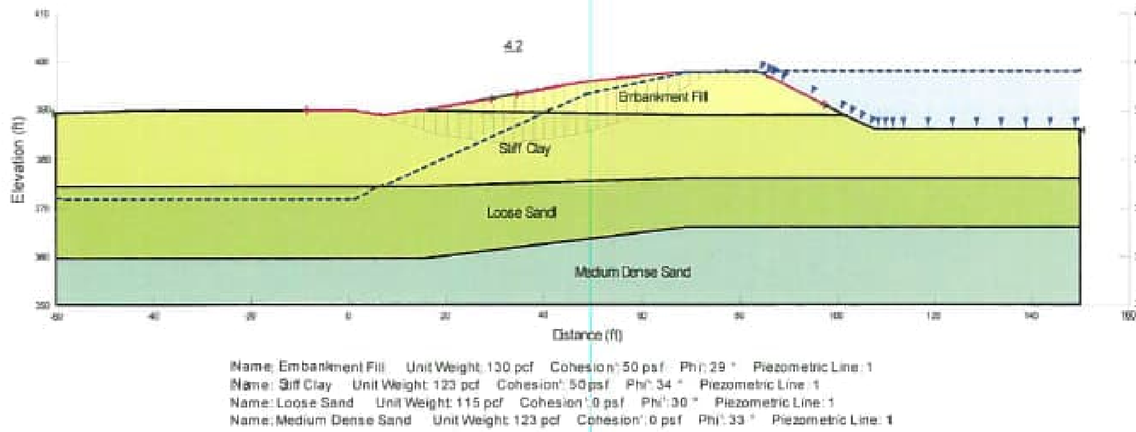
In 2022 and 2023, The east bottom ash pond was cleaned of all CCR material, plus at least an extra 12-inches below, to ensure removal of all CCR materials and potentially contaminated soils underlying the CCR materials. Some areas were excavated to a deeper depth to ensure all soils in the pond met background criteria. Cohesive soils from an on-site borrow area were tested and used for the east bottom ash pond subgrade and foundations and compacted to a minimum of 95% of the maximum density as determined by ASTM D698. Acceptable moisture was +/- 3% of the optimum moisture content. These compacted soils in conjunction with 2015 subsurface investigations, the relative density and description of the existing foundation materials are adequate for this CCR unit.

Two borings were drilled in 2015 along the embankment with Boring B-2, (located along the crest of the embankment) penetrating approximately 12 feet of embankment fill consisting of lean clay with varying amounts of sand, and sandy silt, to about elevation 389.5. The embankment fill consists of lean clay that overlies stiff lean clay. These clay soils overlie a layer of loose sand to sandy silt that grades into medium dense sand. Beneath the embankment fill, and within Boring B-1 (located along the outboard toe of the embankment), a layer of stiff fat and lean clay was encountered to elevations of approximately 372 to 376 feet. Below the clay, the soils contained a 1 to 2 foot thick transitional layer of loose clayey sand and sandy silt deposits, grading to deposits of loose to medium dense poorly graded sand and silty sand containing varying amounts of gravel to the termination depths of the borings.

See figure and material properties below:

| Material | Unit Weight (pcf) | Cohesion (psf) | Friction Angle (deg) |
|---|---|---|---|
| Embankment Fill | 130 | 50 | 29 |
| Stiff Clay | 123 | 50 | 34 |
| Loose sand | 115 | 0 | 30 |
| Medium dense sand | 123 | 0 | 33 |

## MAXIMUM SURCHARGE POOL WATER LEVEL: EXTERIOR




Reference: Terracon Consultants Inc., 2016, Geotechnical Engineering Report AEP Rockport Bottom Ash Complex

## <u>8.0</u> DESCRIPTION OF EACH CONSTRUCTED ZONE OR STAGE OF THE CCR UNIT 257.74 (c)(1)(vi)

*[A statement of the type, size, range, and physical and engineering properties of the materials used in constructing each zone or stage of the CCR unit; and the approximate dates of construction of each successive stage of construction of the CCR unit.]*

The original dike is a homogeneous embankment fill constructed of soil borrowed from the site. Geotechnical details of the original dike system are included in Attachment B. See previous table for soil properties.

In 2022 and 2023, The east bottom ash pond was cleaned of all CCR material, plus at least an extra 12-inches below, to ensure removal of all CCR materials and potentially contaminated soils underlying the CCR materials. Some areas were excavated to a deeper depth to ensure all soils in the pond met background criteria. Cohesive soils from an on-site borrow area were tested and used for the retrofit of the east bottom ash pond subgrade and foundations and compacted to a minimum of 95% of the maximum density as determined by ASTM D698. Acceptable moisture was +/- 3% of the optimum moisture content.

## <u>9.0</u> ENGINEERING STRUCTURES AND APPURTENANCES, 257.74 (c)(1)(vii)

*[At a scale that details engineering structures and appurtenances relevant to the design, construction, operation, and maintenance of the CCR unit, detailed dimensional drawings of the CCR unit, including a plan view and cross sections of the length and width of the CCR unit, showing all zones, foundation improvements, drainage provisions, spillways, diversion ditches, outlets, instrument locations, and slope protection...]*

Originally, the outlet works for the east bottom ash pond consisted of a wooded surface skimming structure constructed around a weir box that discharged through a 48-inch diameter fiberglass pipe. In addition to the primary discharge structure, there was a low water discharge structure with stop logs connected to 30-inch diameter fiberglass pipe. In 1992, the primary discharge structure fiberglass pipe was replaced with a 48-inch diameter polyethylene pipe. In 2023 as part of the east pond retrofit, the wooded surface skimming structure was demolished, the low water discharge structure with stop logs was demolished, and the connecting 30-inch low water discharge pipe was plugged with grout.

The outlet works of the east and west waste water ponds consist of a concrete weir. The weir discharges into a concrete chute which transitions into a box structure leading to a junction chamber equipped with a valve. The chamber controls flows from the waste water ponds into the reclaim pond and/or clear water pond through 30-inch diameter fiberglass pipes. A portion of the flow into the reclaim pond is pumped back to the plant for reuse. The remaining portion flows through a 42-inch diameter pipe or 30-inch diameter low water discharge pipe into the clear water pond. The outlet works for the clear water pond consists of a wooden skimmer /concrete weir. The weir discharges into a concrete structure connected to a 66-inch diameter CMP discharge pipe that conveys the discharge to the Ohio River.

The engineering drawings of the structures and appurtenances are included in Attachment C1.

Drainage is diverted around the Bottom Ash Pond Complex by sloping grade away from the ponds, natural drainage channels and grass lined ditches.

Slope protection along the outboard slope consists primarily of grass vegetation. Inboard slopes of the west bottom ash pond are currently protected by an 18-inch thick layer of Type 1 rip rap. After cleaning the west bottom ash pond the slopes will be protected by vegetation. Inboard slopes of the east bottom ash pond are protected by textured 40-mil LLDPE geomembrane liner for the main pond area and 3-inch thick concrete revetment for the forebay area.

No instrumentation exists for this facility.

## <u>10.0</u> SUMMARY OF POOL SURFACE ELEVATIONS, AND MAXIMUM DEPTH OF CCR, 257.74 (c)(1)(vii)

*[...in addition to the normal operating pool surface elevation and the maximum pool elevation following peak discharge from the inflow design flood, the expected maximum depth of CCR within the CCR surface impoundment.]*

The table below describes the normal pool elevations and maximum pool elevations as well as maximum depth of CCR within the impoundments. Note, the west bottom ash pond no longer receives CCR material and is scheduled to will commence closure when the east bottom ash pond goes in service following retrofit.

| | West Bottom Ash Pond | East Bottom Ash Pond |
|---|---|---|
| Minimum Operating Pool Stage | N/A (pond no longer in operation) previously 394 ft msl | 391 ft msl |
| Maximum Pool Stage following peak discharge from inflow design flood | N/A (pond no longer in operation) previously 396.6 ft msl | 396.45 ft msl |
| Expected maximum depth of CCR within the impoundment | 13 ft | 20.5 ft |

## 11.0 FEATURES THAT COULD ADVERSELY AFFECT OPERATION DUE TO MALFUNCTION OR MIS-OPERATION (257.74 (c)(1)(vii))

*[...and any identificable natural or manmade features that could adversely affect operations of the CCR runit due to malfunction or mis-operation]*

The east bottom ash pond could potentially be adversely affected due to a malfunction or mis-operation of any of the pond's appurtenances. These structures include discharge weir structures and piping between pond cells, effluent return piping and pump structures and influent sluicing piping. See design drawings in Attachment C2 for location and details of all appurtenances.

## 12.0 DESCRIPTION OF THE TYPE, PURPOSE AND LOCATION OF EXISTING INSTRUMENTATION 257.74 (c)(1)(viii)

*[A description of the type, purpose, and location of existing instrumentation.]*

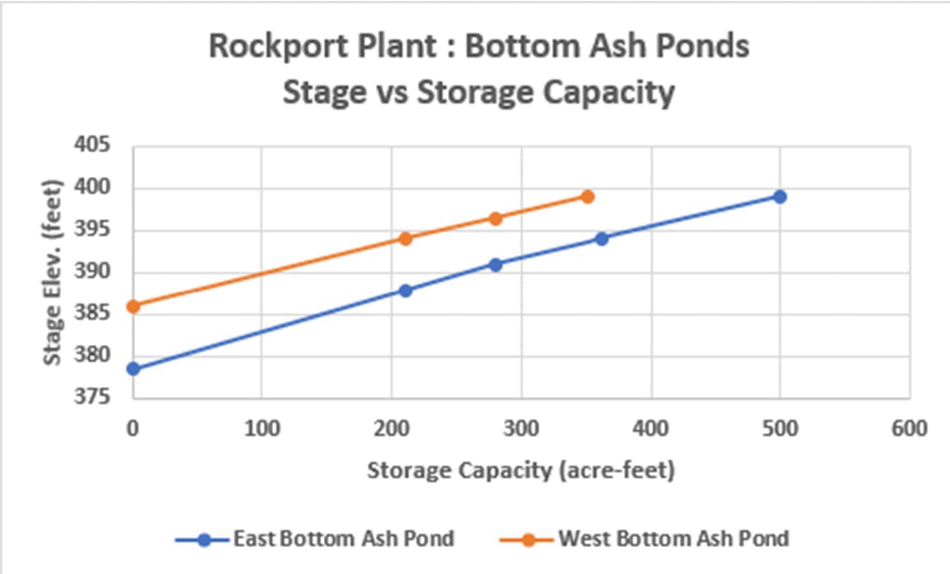
The east bottom ash pond and west bottom ash pond do not have instrumentation.

## 13.0 AREA – CAPACITY CURVES FOR THE CCR UNIT 257.74 (c)(1)(ix)

*[Area-capacity curves for the CCR unit.]*

The area capacity curves for the east bottom ash pond after retrofit and west bottom ash pond are listed in the following table and are illustrated below.

| | | | | | | |
|---|---|---|---|---|---|---|
| East Bottom Ash Pond | | | West Bottom Ash Pond | | | |
| | | | | | | |
| storage | stage | | storage | stage | | |
| ac-ft | ft | | ac-ft | ft | | |
| | | | | | | |
| 500 | 399 | | 352 | 399 | | |
| 362 | 394 | | 211 | 394 | | |
| 280 | 391 | | 0 | 386 | | |
| 0 | 378.5 | | | | | |




## 14.0 257.74 (c)(1)(x) DESCRIPTION OF EACH SPILLWAY AND DIVERSION

*[A description of each spillway and diversion design features and capacities and calculations used in their determination.]*

The outlet works for the east and west bottom ash ponds originally consisted of a wooded surface skimming structure constructed around a weir box that discharges through a 48-inch diameter fiberglass pipe. In 1992, the fiberglass discharge pipes were replaced with a 48-inch diameter polyethylene pipe. In addition to the primary discharge structure, the original design of the bottom ash ponds included a low water discharge structure with stop logs connected to 30-inch diameter fiberglass pipe.

As part of the 2023 east bottom ash pond liner retrofit, the low water discharge structure was demolished and the 30-inch pipe plugged with grout. The existing wood skimming structure around the concrete weir box was also demolished.

The west bottom ash pond will commence closure when the east bottom ash pond goes in service following retrofit. The closure will include removing the existing wood skimming structure around the concrete weir box and permanently plugging the main 48-inch discharge pipe and 30-inch low flow discharge pipe.

The outlet works of the waste water ponds consist of a concrete weir. The weir discharges into a concrete chute which transitions into a box structure leading to a junction chamber equipped with a valve. The chamber controls flows from the waste water ponds into the reclaim pond and/or clear water pond through 30 inch diameter fiberglass pipes. A portion of the flow into the reclaim pond is pumped back to the plant for reuse. The remaining portion flows through a 42-inch diameter pipe or 30-inch diameter low water discharge pipe into the clear water pond. The outlet works for the clear water pond consists of a wooden skimmer /concrete weir. The weir discharges into a concrete structure connected to a 66-inch diameter CMP discharge pipe that conveys the discharge to the Ohio River.

Original Hydrology and Hydraulic Analysis which includes calculations for each spillway structure are included in Attachment D1. Note, there is a report from 2015 prior to the east bottom ash pond retrofit which contains information relevant to all the complex ponds, except for the retrofitted east bottom ash pond. A separate report from 2023 is included in Attachment D2 indicating the Hydrology and Hydraulic Analysis for the east bottom ash pond following retrofit.

## 15.0 SUMMARY CONSTRUCTION SPECIFICATIONS AND PROVISIONS FOR SURVEILLANCE, MAINTENANCE AND REPAIR 257.74 (C)(1)(XI)

*[The construction specifications and provisions for surveillance, maintenance, and repair of the CCR unit.]*

Original construction of the Bottom Ash Complex was completed in around 1982. A Geotechnical Report by Casagrande Consultants completed in 1977 provided recommendations for construction of the Bottom Ash Ponds. This report has been provided in Attachment B. Additional borings were performed in 2015 through the pond embankments. The original east bottom ash pond was cleaned of all existing CCR material in 2023 and then retrofitted with a liner system which raised the bottom of the pond from 377 to 378.5 in order to maintain a 5-foot separation distance from high groundwater level of 373.5

As required by the CCR rules the bottom ash pond complex is inspected at least every 7 days by a qualified person. Also, as a requirement of the CCR rules the impoundment is also inspected annually by a professional engineer.

A Statement of Work construction specification for the East Bottom Ash Pond retrofit work is included in Attachment E, along with the construction specifications for LLDPE geomembrane liner, geosynthetic clay liner (GCL), and geotextile material. If repairs are found to be necessary during any inspection they will be completed as needed.

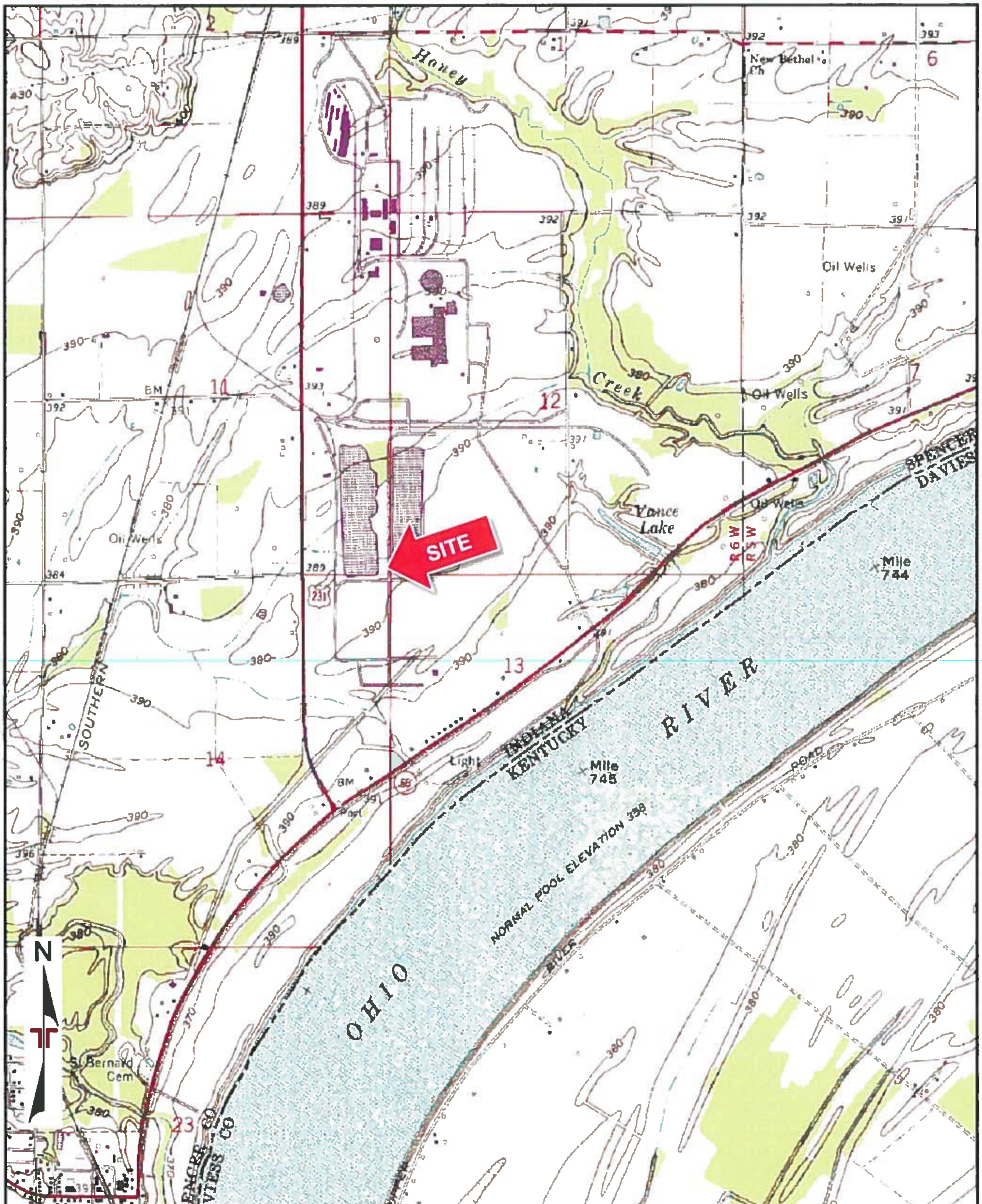
## 16.0 RECORD OR KNOWLEDGE OF STRUCTURAL INSTABILITY 257.74 (C)(1)(XII)

*[Any record or knowledge of the structural instability of the CCR unit.]*

To date there has been no record of knowledge of structural instability of the CCR unit.

ATTACHMENT A

LOCATION MAP




TOPOGRAPHIC MAP IMAGE COURTESY OF THE U.S. GEOLOGICAL SURVEY
QUADRANGLES INCLUDE: ROCKPORT, IN (1/1/1982).

| | | | | |
|---|---|---|---|---|
| Project Manager: MSF | Project No. N4155126 | Terracon<br>800 Morrison Rd.<br>Columbus, OH 43230 | SITE LOCATION MAP | Exhibit |
| Drawn by: AKB | Scale: 1:24,000 | | AEP Rockport Bottom Ash PE Certification<br>US Highway 231<br>Rockport, IN | A-2 |
| Checked by: KME | File Name: N4155126 | | | |
| Approved by: KME | Date: Dec. 2015 | | | |

# ATTACHMENT B

## ORIGINAL CONSTRUCTION DESIGN REPORT

Casagrande file

Arthur Casagrande
Leo Casagrande
Dirk R. Casagrande

**CASAGRANDE CONSULTANTS** *FOUNDATIONS & EARTHWORKS*

Report to

American Electric Power Service Corporation

on

# FOUNDATION INVESTIGATIONS FOR ROCKPORT SITE

April 25, 1977

40 Massachusetts Avenue, Arlington, Massachusetts 02174 Tel. (617) 648-3630
Pierce Hall, Cambridge, Massachusetts 02138 Tel. (617) 495-2843 or 648-3630

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# I. INTRODUCTION

The 300- and 400-series borings, carried out during the latter part of 1976 and early 1977, were made in response to the following recommendation in our report dated January 14, 1976:

> "It is possible that on the basis of additional borings which are made with special care, and also undisturbed sample borings, we may conclude that the low blowcount sands are actually much better than indicated by the available borings. We recommend such additional investigations."

It was later agreed that due to (1) the difficulty, (2) length of time and (3) expense of taking reliable undisturbed samples of sand, we would base our recommendations on the results of numerous, carefully executed split-spoon borings.

The 300-series borings were made by Law Engineering Testing Company, using three drill rigs. After a number of the 300-series borings had been completed, the location of the Plant was shifted 220 ft to the east. This meant that some of the completed borings were no longer within the Plant area. A new boring layout eliminated some of the 300-series borings that had not yet been made, shifted the locations of several others, and included the 400-series borings. The locations of all borings, including (1) several of the initial borings made in 1973, (2) the 200-series borings made in 1975, (3) the 300- and 400-series borings made in 1976 and 1977 and (4) eight undisturbed sample borings (designated ST-) made in 1977, are shown in Fig. 1. The logs of the 300- and 400-series borings and of the undisturbed sample borings are contained in Appendix II (in a separate volume).

During the period December 24, 1976, to March 24, 1977, we received (1) split-spoon samples from sixty-seven 300-series borings, (2) split-spoon samples from thirty-five 400-series borings, and (3) thirty-two undisturbed tube samples from the eight ST-series borings. Our description of the split-spoon samples and the results of classification tests are included in Tables 1 to 102 of Appendix I (in a separate volume).

The subsurface conditions are generally as described in our report dated January 14, 1976. However, the new borings give a more comprehensive picture of the conditions. All these borings, in combination with information on the design of the structures, including grade elevations for the base of the structures, permitted us to make specific recommendations for the design of the foundations as presented under the following headings.

## II. STUCTURES ON MAT FOUNDATIONS

### 1. Turbine Room

The base of the turbine room mat is at El. 367. This is about 27 ft below existing ground surface, which ranges from El. 392 to 396. The groundwater level in piezometer P-1 in mid-March, 1977, was at El. 368, i.e. about the same as the river level.

Figure 2 is a plot of the standard penetration resistance vs elevation and depth below El. 395, for the 400-series borings in the turbine room area; and Fig. 3 is a similar plot for the 200-series borings. These plots show a zone of low blowcounts between about El. 350 and 365; i.e., between about 2 and 17 ft below the base of the turbine room slab. The proximity of this low blowcount zone to the base of the turbine room would result in significant settlements. Therefore, we recommend that the area of the turbine room be overexcavated to El. 355 and backfilled with suitable granular material. Before backfilling, the surface of the excavation must be compacted by not less than 10 passes with a heavy smooth-drum vibratory roller.

On the basis of the split-spoon samples, the sand and gravel excavated from below the base of the turbine room would be suitable for use as structural backfill. If it is desired to use also fine sand and silty fine sand for structural backfill, the suitability of such materials for structural backfill would have to be investigated by means of a comprehensive test fill program.

The excavation slopes should not be steeper than 1 on 2. They must be protected against erosion without delay as excavation progresses. Effective protection could be provided by a layer of topsoil, not less than 8 in. thick, and seeding, or by a 6 in.

layer of topsoil and sodding. We recommend that the State Highway Department be consulted concerning the most effective protection of cut slopes in fine sand against erosion. Any erosion protection will require prompt maintenance whenever erosion channels develop.

For overexcavation to El. 355, a dewatering system will be required. The split-spoon samples of the granular stratum, which is about 90 ft thick, indicate that dewatering may be difficult, especially during high river stages. A pumping test should be carried out, as outlined in our letter of March 13, 1977.

2. Boiler Rooms

The existing ground surface in this area ranges between about El. 392 and El. 395. The base of the concrete mat for the boiler rooms is at El. 388, i.e. about 4 to 7 ft below existing ground surface. According to the 19 borings in this area, the thickness of the clay stratum varies from less than 3 ft (Boring 343) to about 20 ft (Boring 330). The bottom of the clay ranges from about El. 372 to El. 392. At 16 of the borings, the consistency of the samples of clay varied between stiff and hard. However, at Borings 338 and 339, the clay was firm, and at Borings 330 and 215 it was soft to firm.

Due to the large variation in thickness and character of the clay stratum, all clay should be excavated from under the boiler rooms. In addition, the plots of standard penetration resistance, N, vs elevation and depth below El. 395 in Figs. 4 to 7, indicate that some of the fine sand and silty fine sand directly beneath the clay may be in relatively loose condition. Therefore, we recommend a general overexcavation to El. 376, with local additional excavation where required to remove all clay which extends below El. 376. The excavated surface should be compacted by not less than 10 passes with a smooth-drum vibratory roller. Suitable granular fill should then be placed and compacted in 9 in. thick (loose) layers to grade elevation. This will provide a stiff, at least 20-ft thick granular mat between the base of the concrete mat and the relatively loose granular zone below about El. 365.

In soft to firm clay, the excavation slopes may have to be as flat as 1 on 3. All slopes should be protected against erosion as recommended under the preceding heading.

3. Precipitators

For precipitators designed on spread footings, the bottom of the mat is at El. 388.5. The existing ground surface in this area ranges from El. 392 to 397. Therefore, the required depth of excavation would be only 4 to 9 ft. However, as in the area for the boiler rooms, the elevation of the bottom of the clay stratum varies considerably. Also, the consistency of the clay samples from 24 of the 30 borings within this area was stiff to hard, but very soft to firm clay was encountered in the other 6 borings. The worst conditions appear to be at Borings 207, 326, 330 and 417, which form a line approximately in the center between the two precipitators for the South Unit. This suggests the presence of an old "oxbow" channel. The bottom of this channel is at about El. 373, and in Boring 326 a lens of soft clay was also sampled at about El. 362. Because the spacing of the borings varies from about 100 to 300 ft, the extent of this channel is not well-defined, and it is not known whether it extends also through the area of the south boiler room and turbine room. Also, there may be other channels located between borings.

The standard penetration resistances for the 24 split-spoon borings made in the area of the precipitators are plotted as a function of elevation and depth below El. 395 in Figs. 8 to 12. Most of these borings were made by the same boring crew using the same drill rig (Boyette crew using a Mayhew Jr. drill rig); and the blowcounts obtained by this crew were consistently higher than the blowcounts obtained by the other two crews. These other two crews used CME drill rigs. The magnitude of the difference in the blowcounts between the Mayhew rig and one of the CME rigs can be seen in Fig. 13, which is a plot of penetration resistance vs depth for two borings (323 and 323-A) made 5 ft apart.

On the basis of the split-spoon samples and the plots in Figs. 8 to 13, we recommend that the area of the precipitators be overexcavated to El. 379, and deeper where required to remove all clay. Fortunately, the "oxbow" channel in the area of the south precipitators is apparently confined to only the chevron area between the two precipitators, which is only lightly loaded by ductwork. Therefore, if locally pockets or lenses of clay within the granular stratum are overlooked and not excavated, they should not cause damage in this area.

The excavated surface should be compacted with at least 10 passes with a smooth-drum vibratory roller. Any areas which cannot be properly compacted will require investigation and excavation of unsuitable material.

The excavation slopes can be 1 on 2, except in soft clay, where slopes of 1 on 3 will be required for stability. The excavation slopes must be protected against erosion as recommended under a previous heading.

## 4. Stack

The bottom of the concrete mat for the stack is at El. 384, which is about 11 ft below existing ground surface. The thickness of the clay stratum in this area varies from less than 5 ft to about 20 ft.

In Figs. 14 and 15 we have plotted the standard penetration resistances, N, for the 8 borings in this area. These plots show that a relatively loose zone of granular material exists between about El. 355 and El. 365. Because of high edge pressures at the base of the concrete mat and because of rocking caused by wind loads, the relatively loose zone would have to be removed by excavation to El. 355. The bottom of the excavation would then have to be thoroughly compacted using a heavy, smooth-drum vibratory roller. Backfill would have to consist of suitable granular material. The excavated sand and gravel below a depth of about 30 ft (El.365) would be suitable for backfill.

The excavation slopes should not be steeper than 1 on 2, and they must be properly protected against erosion, as recommended for the turbine room excavation. Excavation to El. 355 will require dewatering of this area.

5. Cooling Towers

The base of the circumferential mat of the cooling towers is at El. 388, and the bottom of the basin slab is at El. 391 (assuming a 6 in. thick slab). Because of a considerable difference in the foundation conditions at the two cooling towers, their foundation design will be discussed separately.

a. South Cooling Tower: The existing ground surface ranges between about El. 390 and El. 393. The thickness of the clay stratum appears to be quite uniformly about 10 ft. The elevation of the bottom of the clay ranges from about El. 380 to 384. The consistency of the clay appears to be fairly uniform, ranging from stiff to hard, with only one sample of firm clay at a depth of 6 ft in Boring 344. For these reasons, we considered the possibility of excavating only to grade, El. 388, and placing the entire structure on spread foundation on the clay. Therefore, we requested that four undisturbed sample borings be made along the circumference of the tower to permit us to make a settlement analysis. However, after discovering in other areas of the Plant the existence of "oxbow" channels filled with soft clay, we concluded that only 6 split-spoon and 4 undisturbed sample borings made for this cooling tower are too few to eliminate the possibility that such a channel exists under this structure.

On the basis of the foregoing information and the plots of standard penetration resistance vs elevation and depth below El. 395 in Figs. 16 and 17, we recommend that the area for the circumferential mat be overexcavated to El. 380 and backfilled with suitable granular material. Locally, the required excavation may have to be deeper to remove all clay material. The excavation slopes should be not steeper than 1 on 2. The bottom of the excavation should be thoroughly compacted by not less than 10 passes with a smooth-drum vibratory roller.

These cooling towers will have no interior columns, and the load on the basin slab will be due to the depth of water in the basin, which will be a maximum of 750 lb/sq ft. Because of this small load and because the basin slab is not very sensitive to differential settlements, the clay under the slab need not be excavated.

b. North Cooling Tower: The existing ground surface ranges between El. 385 and El. 394, with the northern two-thirds of the area ranging between 385 and 388. Thus, a major portion of the structure will be founded above existing ground surface.

The thickness of the clay stratum varies from about 10 ft to 20 ft, with the bottom of this stratum between El. 368 to 385.

The consistency of the clay in the southern one-third of the area is stiff to hard; but in the northern two-thirds, the consistency decreases from stiff to hard near the surface to soft to firm in the lower portion of the stratum.

In Figs. 18 and 19 are plotted the standard penetration resistances vs elevation and depth below El. 395, for the 7 borings made in this area. On the basis of these plots, and the soft consistency of some of the clay, we recommend that the area of the circumferential mat be excavated to El. 372, and locally deeper where required to remove all clay. The side slopes should be not steeper than 1 on 2 within the southern one-third of the area, and not steeper than 1 on 3 in the northern two thirds. The total width of the bottom of the excavation should be not less than the width of the circumferential mat plus the depth of over-excavation. The surface at the bottom of the excavation must be compacted with at least 10 passes of a smooth-drum vibratory roller. Backfill should consist of suitable granular material placed and compacted in layers not exceeding 9 in. before compaction.

The interior basin slab will undergo significant total and differential settlement if the clay is not excavated. However, such settlements could be counteracted by mud-jacking, if necessary.

The drawings for the Marley cooling towers sent to us by Dennis Rubin with his letter of February 28, 1977, show a ribbed design for the base of the circumferential mat. For more uniform load distribution, a uniform thickness would be preferable.

6. Miscellaneous Lightly-Loaded Structures

Structures which are not sensitive to settlements may be founded on spread footings on the clay. Borings should be made in the areas of structures that could be somewhat sensitive to differential settlements, such as fuel oil tanks, to determine whether clay should be excavated beneath such structures.

## 7. Granular Material for Structural Backfill

When overexcavation and backfilling was considered in 1976, we were informed that (1) borrow pits cannot be excavated on the property for obtaining suitable granular material for backfill, and (2) the cost of importing granular material for backfill would be prohibitive. Therefore, we had agreed that all granular materials from the required excavations, including fine sand and silty fine sand, could be used as structural backfill if properly compacted. In order to determine the best method for placement and compaction, we had recommended that a comprehensive test fill program be carried out.

Since then, AEP has learned that a well-graded sand called "Grits" is readily available from a supplier at a reasonable cost. The gradation of a sample of this material, as determined by the AEP Civil Engineering Laboratory, is shown in Fig. 23 by the full-drawn curve. This material would be well-suited for structural backfill.

George Camporini informed us that it will be the contractor's responsibility to supply granular material for structural backfill. Therefore, he requested that we recommend limits for the gradation of granular material suitable for structural backfill, to be included in the specifications. The finer limit of the gradation should be approximately as shown by the dashed curve in Fig. 23. However, the granular material from below about El. 367 in the turbine room excavation consists generally of fine to medium sand or coarser material, and may be used as structural backfill with the exception of any clean fine sand or silty fine sand.

The upper limit of the gradation for structural backfill should not be specified, except that the material should have a maximum size of 4 in. The material should be durable and reasonably well-graded and it should be approved by the engineer.

The excavated fine sand could be used as fill under lightly-loaded structures, or as general fill to bring the area around the Plant to grade El. 399. If used for backfill under structures, the best method of placement and compaction should be investigated by means of a test fill.

The area between the west slope of the turbine room excavation and the turbine room wall, which will be overlain by a portion of the boiler rooms, may be backfilled using the same vibratory roller as used for the general structural backfill. Because the turbine room wall is 12 ft thick and only 11 ft high above the turbine room floor, it cannot be displaced even by a heavy vibratory roller when operating immediately adjacent to the wall.

Granular structural fill should be placed in lifts not exceeding 9 in., measured after spreading, and should be compacted with at least 6 passes of a self-propelled smooth-drum vibratory roller with a static weight not less than 10 tons. It may be necessary to apply water to the fill during compaction to achieve optimum results. This should be investigated by means of a test fill, preferably before filling operations commence. The relative density of the compacted fill should be checked by means of field density tests and laboratory maximum-minimum density tests.

To ensure satisfactory compaction of all structural backfill, we emphasize the great importance of rigorous enforcement of the placement and compaction specifications. The bidding contractors must be told in no uncertain terms that these specifications will be strictly enforeced and AEP must accept the responsibility of providing competent inspectors.

## III. STRUCTURES ON PILE FOUNDATIONS

It may be more economical to use pile foundations for some structures, rather than overexcavating unsuitable material. According to George Camporini, one such structure would be the stack, where the excavation would have to extend to El. 355. Bedrock at the stack is at about El. 285. Therefore, piles to bedrock would have to be at least 100 ft long. Because the surface of bedrock consists of soft shale, H-piles may penetrate several feet into bedrock before attaining the required driving resistance.

For friction piles, AEP proposed a design load of 100 tons. This is about 25 tons more than we have used so far for friction piles. Such a design load would require a 16 in. diameter shell, if cast-in-place concrete piles are used. Because of the erratic nature of the granular stratum at this site, we have serious doubts that 100 ton design load can be achieved consistently with cast-in-place friction piles. For such loads, the length of pile embedment in the compact bearing stratum would have to be at least 25 ft. The standard penetration resistances for the borings at the stack, plotted in Figs. 14 and 15, indicate that with a 25 ft embedment in the compact granular stratum, the tips of the piles may again be penetrating into a looser zone, but locally may meet refusal. Such differences will affect the load bearing capacity of each pile. Therefore, a number of load tests will have to be performed.

If cast-in-place concrete piles are to be used also for tensile loads, the steel reinforement will have to extend to the bottom of the piles, and the shells will have to be filled by tremie.

All cast-in-place shells must be inspected just before the reinforcing steel and concrete are placed. They must be free from excessive deformation and water or debris.

## IV. DEWATERING

For excavation to El. 355, the groundwater level at the center of the excavation should probably be lowered to about El. 350. Data in our files indicate that the normal groundwater level in the Plant area is at about El. 368. Therefore, the groundwater level at the edge of the excavation would have to be lowered at least 20 ft during normal pool stages of the river. However, AEP has informed us that the dewatering system will be designed for dewatering to river El. 396. For higher river levels the excavation will be permitted to be flooded.

At the time when AEP was comparing the cost of dewatering and overexcavation with the cost of using pile foundations, Wally Howard requested that we perform sieve analyses of the granular samples from Boring 209, so that a dewatering contractor could estimate the cost of dewatering. The grain size curves of the granular samples from Boring 209 were transmitted with our letter of January 25, 1977, and are reproduced in Figs. 20 to 22. These curves, together with the curve of standard penetration resistance vs depth in Fig. 12, illustrate the variable character of the granular stratum.

Due to the great thickness of the granular stratum at this site, we have recommended that a pumping test be carried out. The details of such a test were outlined in our letter of March 13, 1977, and during several telephone conversations with George Camporini.

If the pumping test indicates that some local water supply wells may be affected by the dewatering operation, then provision must be made to assure a continued water supply for those homes.

## V. BOTTOM ASH PONDS

During the meeting at your offices on April 4, 1977, we were informed that the design elevation of the crest of the dikes is limited to El. 399 because of river "backwater" restrictions. The existing ground surface at the 13 borings made in this area ranges between El. 388 and 394. Therefore, the height of the dikes will range between about 5 and 11 ft above existing ground surface.

The borings, which were made at 650 to 1000 ft spacing, show that the thickness of the clay stratum generally ranges from less than 5 ft (Boring 367) to about 15 ft. The consistency of the clay is generally stiff to hard. At Boring 365, the clay stratum extends to a depth of about 30 ft, and contains a layer or lens of fine sand between depths of about 10 ft and 20 ft. The clay above the sand is very stiff, and below the sand it is soft to firm, indicating that this may be an "oxbow" channel. However, because the required excavation will probably not extend into this soft clay, it should not cause problems.

After stripping and removal of any soft clay from the surface, all remaining clay should be suitable for support of such low dikes. Also, all excavated stiff to hard clay would be suitable for lining of the ponds. For this purpose, the clay should be stockpiled in a manner that will prevent rainwater from entering the fill and increasing its water content. A clay lining should be not less than 3 ft thick, and should be compacted in lifts not exceeding 9 in. before compaction, at water contents within ± 2% of standard optimum, using a heavy sheepsfoot roller (not a tamping roller!).

The slopes of the dikes should be not steeper than 1 on 2.5. The outside slope should be covered with topsoil and seeded.

## VI. COAL STORAGE AREA

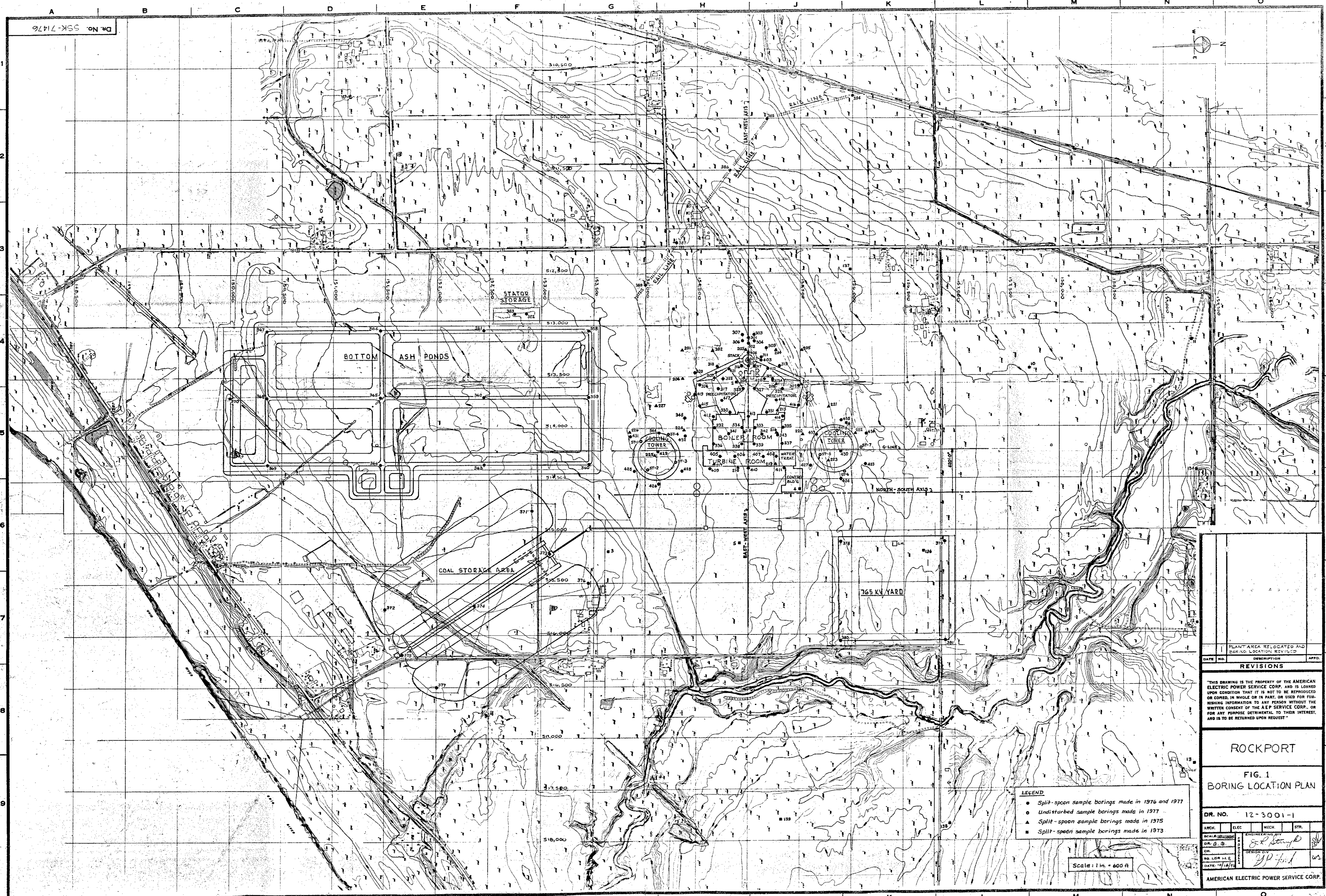
The existing ground surface at the seven borings in this area ranges between El. 391 and 397. The thickness of the clay stratum at the borings varies from less than 5 ft (Boring 376) to about 15 ft (Boring 372). The consistency of the clay ranges from stiff to hard. The groundwater level at piezometer P2, which is located just west of this area, was at about at El. 365 in March 1977.

To permit us to make recommendations concerning the foundations of the coal stacker, reclaim tunnels and conveyor stations, we would need the following information:

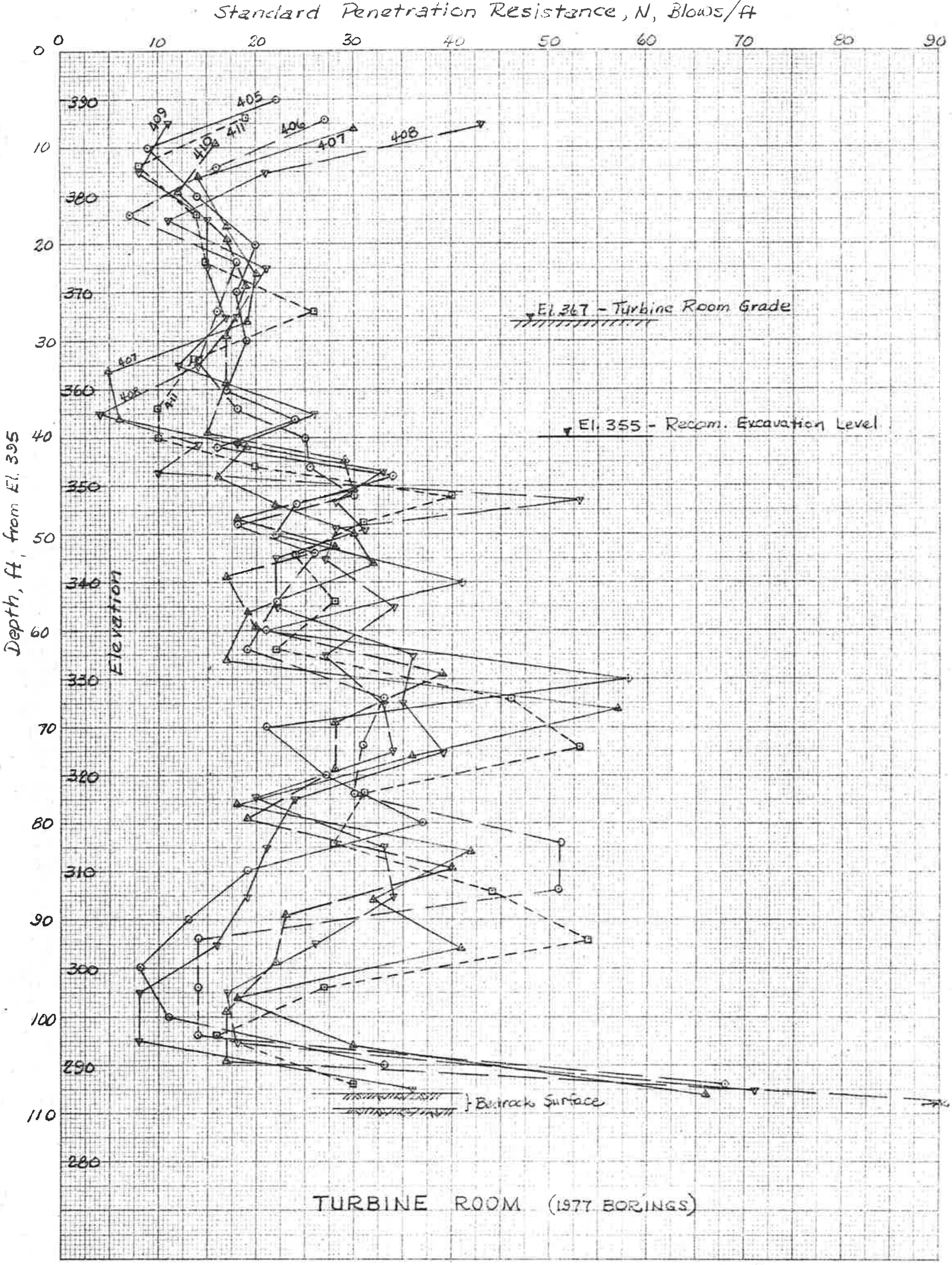
1. Borings at the locations of any structures where borings have not yet been made, and additional borings along the stacker. Split-spoon samples of the clay should be taken at 3 ft intervals.

2. The size, design, and grade elevations for all structures.

3. The sensitivity of each structure to total and differential settlement.



Dr. No. SSK-7476
RAIL LINE
EAST-WEST AXIS
NORTH-SOUTH AXIS
STATOR STORAGE
BOTTOM ASH PONDS
COOLING TOWER
BOILER ROOM
TURBINE ROOM
PRECIPITATOR
STACK
WATER TREAT.
CONTROL BLDG.
COOLING TOWER
COAL STORAGE AREA
765 KV YARD
LEGEND
Split-spoon sample borings made in 1976 and 1977
Undisturbed sample borings made in 1977
Split-spoon sample borings made in 1975
Split-spoon sample borings made in 1973
Scale : 1 in. = 600 ft
1 PLANT AREA RELOCATED AND BORING LOCATION REVISED
DATE NO. DESCRIPTION APPD.
REVISIONS
"THIS DRAWING IS THE PROPERTY OF THE AMERICAN ELECTRIC POWER SERVICE CORP. AND IS LOANED UPON CONDITION THAT IT IS NOT TO BE REPRODUCED OR COPIED, IN WHOLE OR IN PART, OR USED FOR FURNISHING INFORMATION TO ANY PERSON WITHOUT THE WRITTEN CONSENT OF THE AEP SERVICE CORP., OR FOR ANY PURPOSE DETRIMENTAL TO THEIR INTEREST, AND IS TO BE RETURNED UPON REQUEST"
ROCKPORT
FIG. 1
BORING LOCATION PLAN
DR. NO. 12-3001-1
ARCH. ELEC. MECH. STR.
DR. G. B.
CH.
APPROVED BY
ENGINEERING DIV
DESIGN DIV
DATE: 10/14/76
AMERICAN ELECTRIC POWER SERVICE CORP.



Standard Penetration Resistance, N, Blows/ft
0 10 20 30 40 50 60 70 80 90
Depth, ft, from El. 395
Elevation
0 10 20 30 40 50 60 70 80 90 100 110
390 380 370 360 350 340 330 320 310 300 290 280
405
406
407
408
409
410
411
El. 367 - Turbine Room Grade
El. 355 - Recom. Excavation Level
} Bedrock Surface
TURBINE ROOM (1977 BORINGS)


FIG. 2

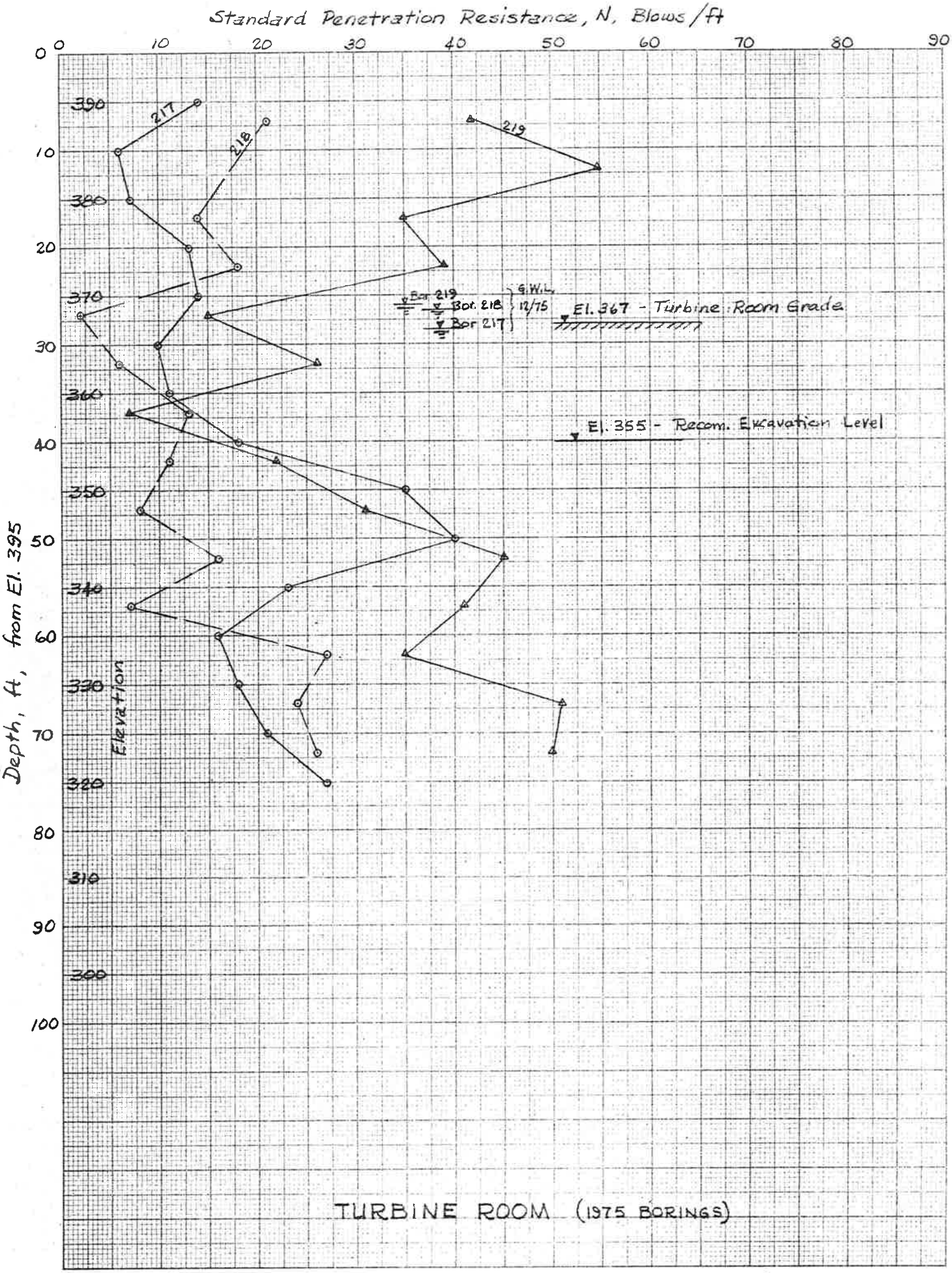

Standard Penetration Resistance, N, Blows/ft
0 10 20 30 40 50 60 70 80 90
Depth, ft, from El. 395
Elevation
0 10 20 30 40 50 60 70 80 90 100
390 380 370 360 350 340 330 320 310 300
217
218
219
Bor 219
Bor. 218
Bor 217
G.W.L. 12/75
El. 367 - Turbine Room Grade
El. 355 - Recom. Excavation Level
TURBINE ROOM (1975 BORINGS)

FIG. 3

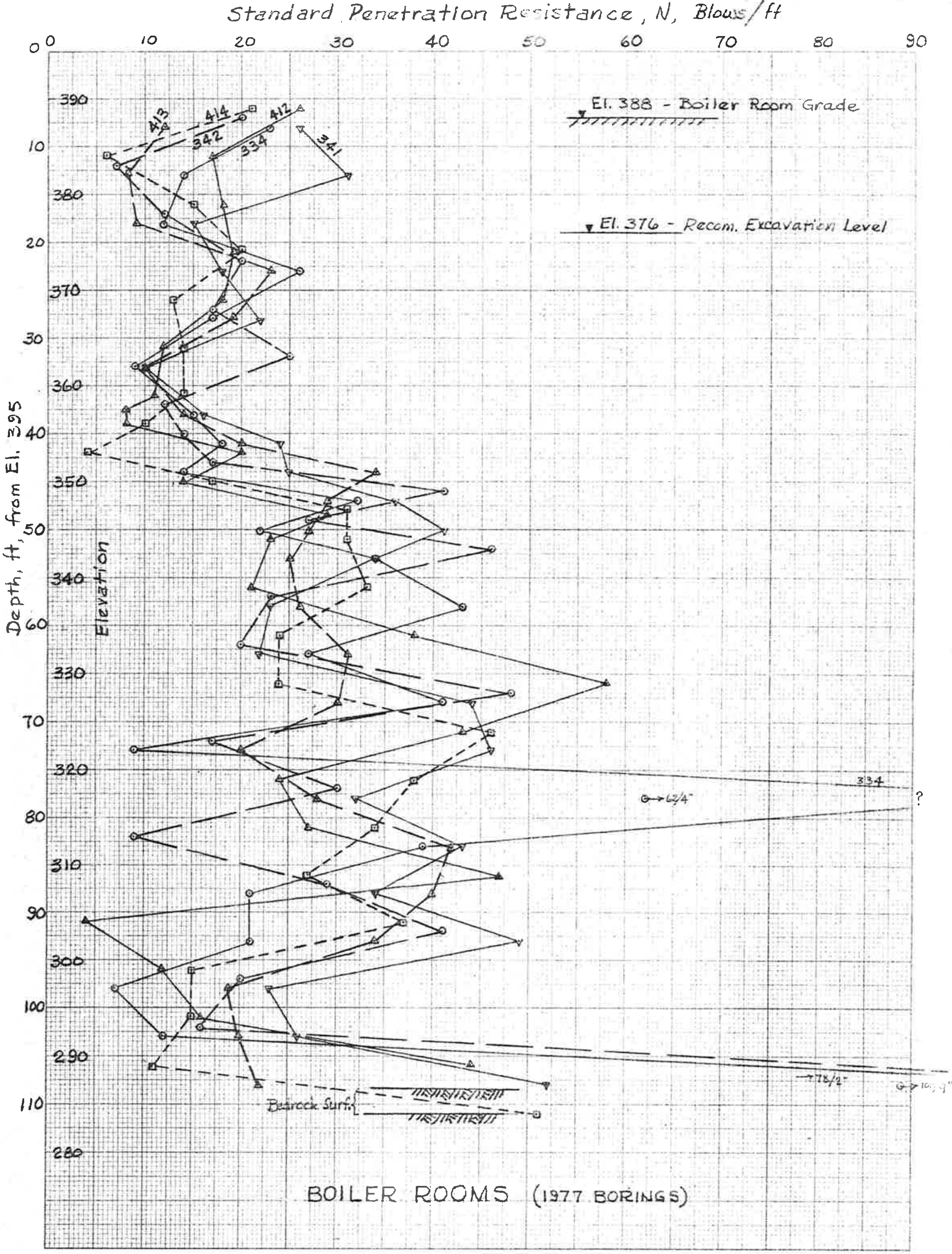
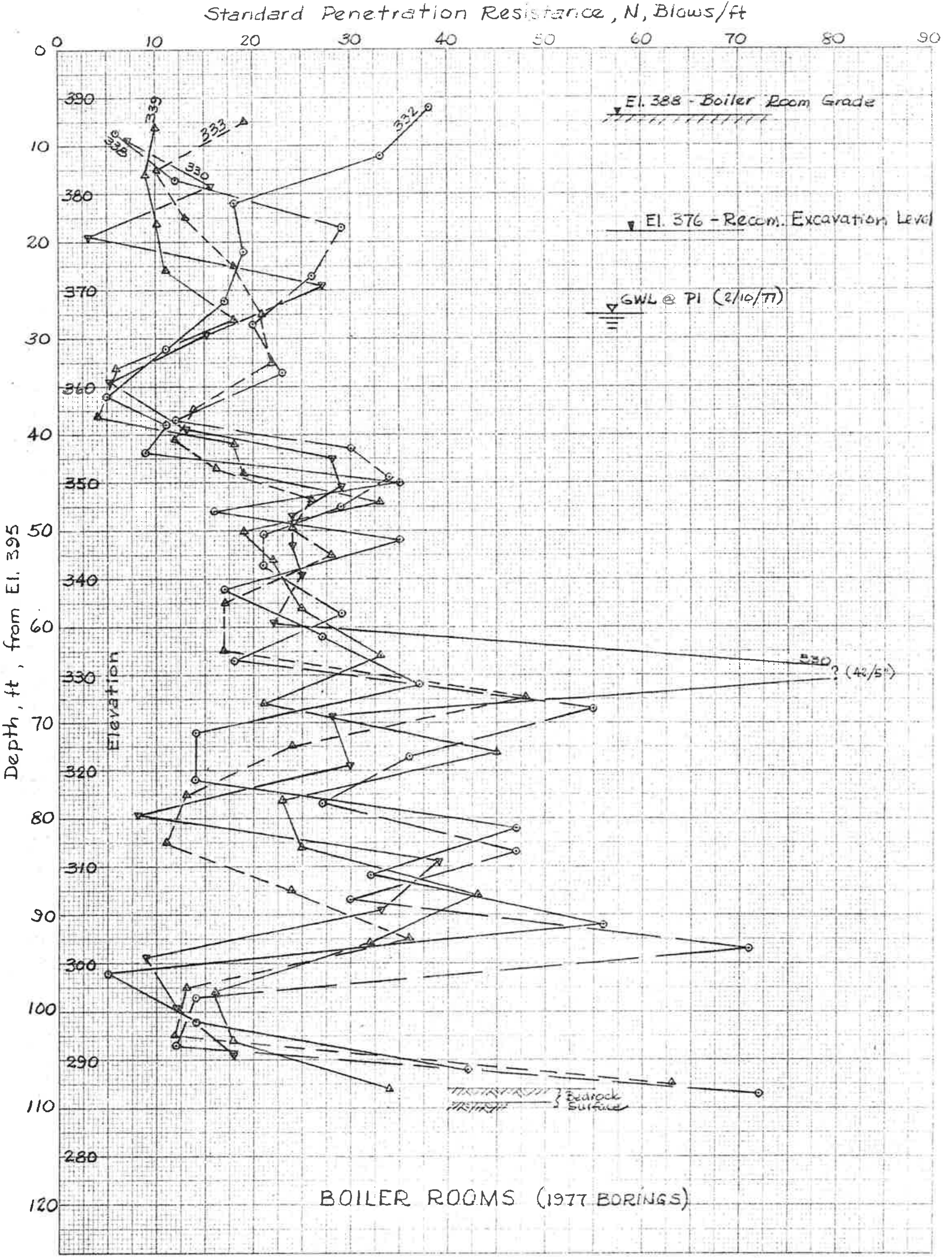
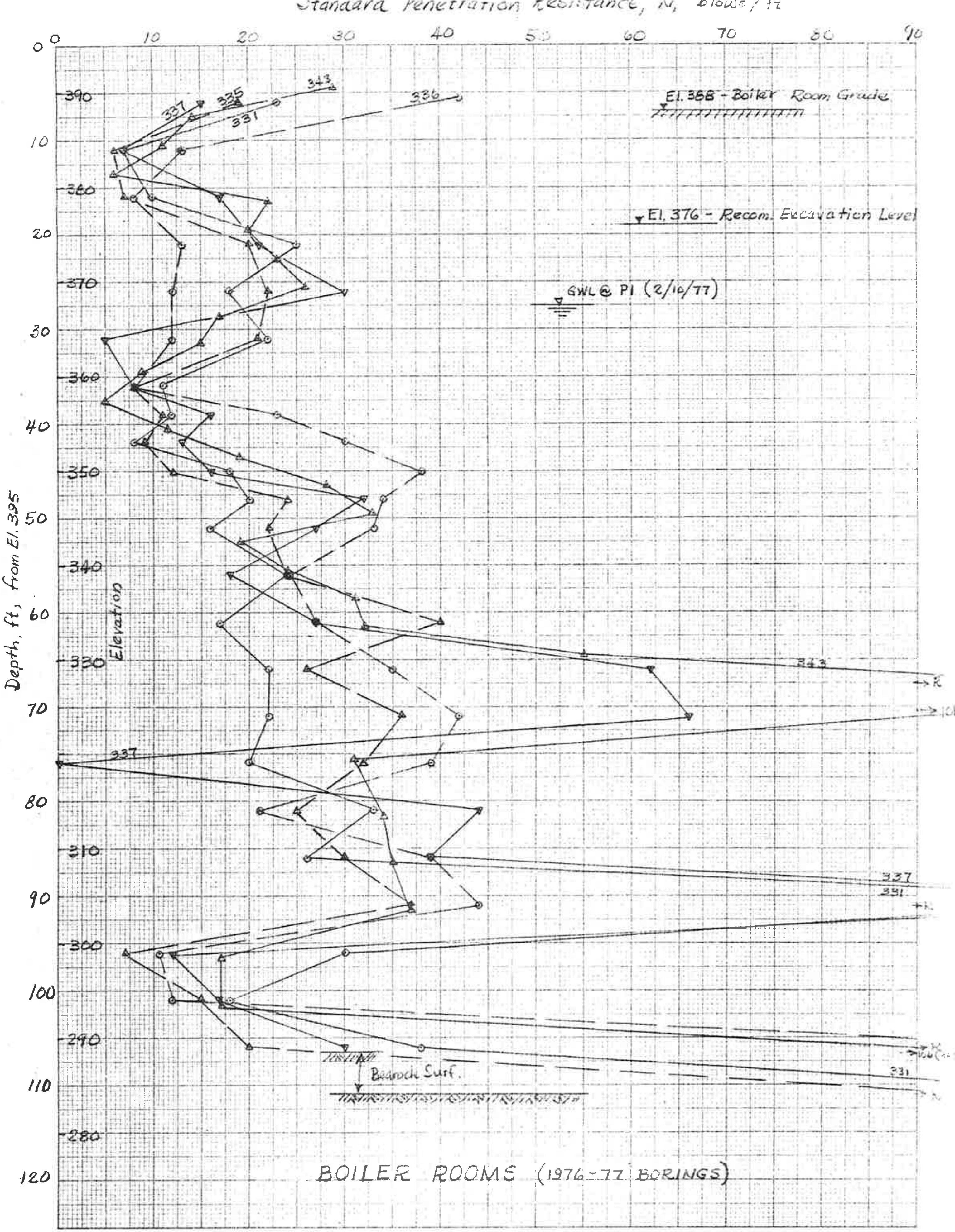

Standard Penetration Resistance, N, Blows/ft
0 10 20 30 40 50 60 70 80 90
Depth, ft, from El. 395
Elevation
0 10 20 30 40 50 60 70 80 90 100 110
390 380 370 360 350 340 330 320 310 300 290 280
413
414
342
412
334
341
El. 388 - Boiler Room Grade
El. 376 - Recom. Excavation Level
334
?
Bedrock Surf.
BOILER ROOMS (1977 BORINGS)

FIG. 4



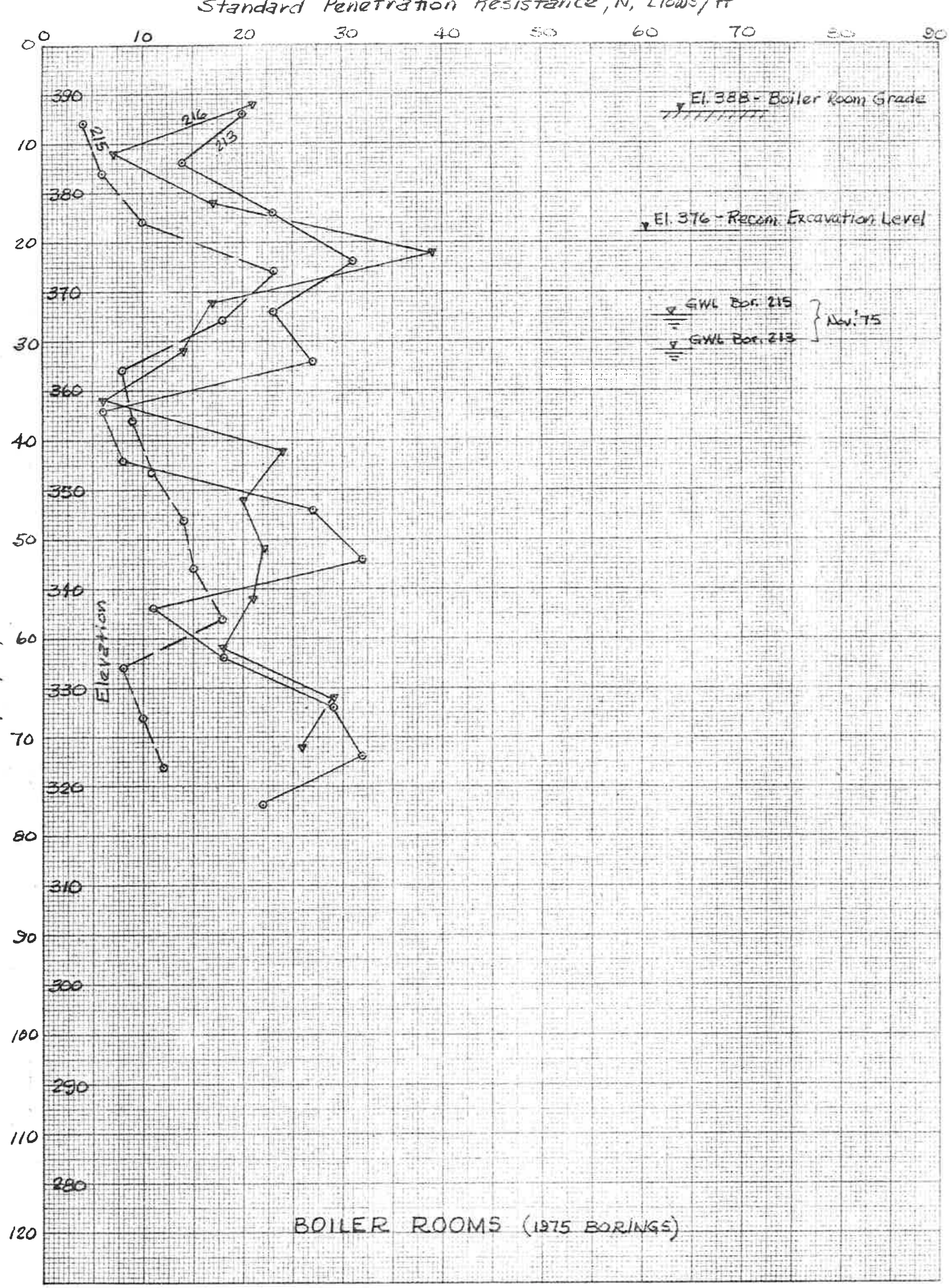
Standard Penetration Resistance, N, Blows/ft
Depth, ft, from El. 395
Elevation
El. 388 - Boiler Room Grade
El. 376 - Recom. Excavation Level
GWL @ PI (2/10/77)
332
333
339
338
330
? (42/5")
Bedrock Surface
BOILER ROOMS (1977 BORINGS)


FIG. 5



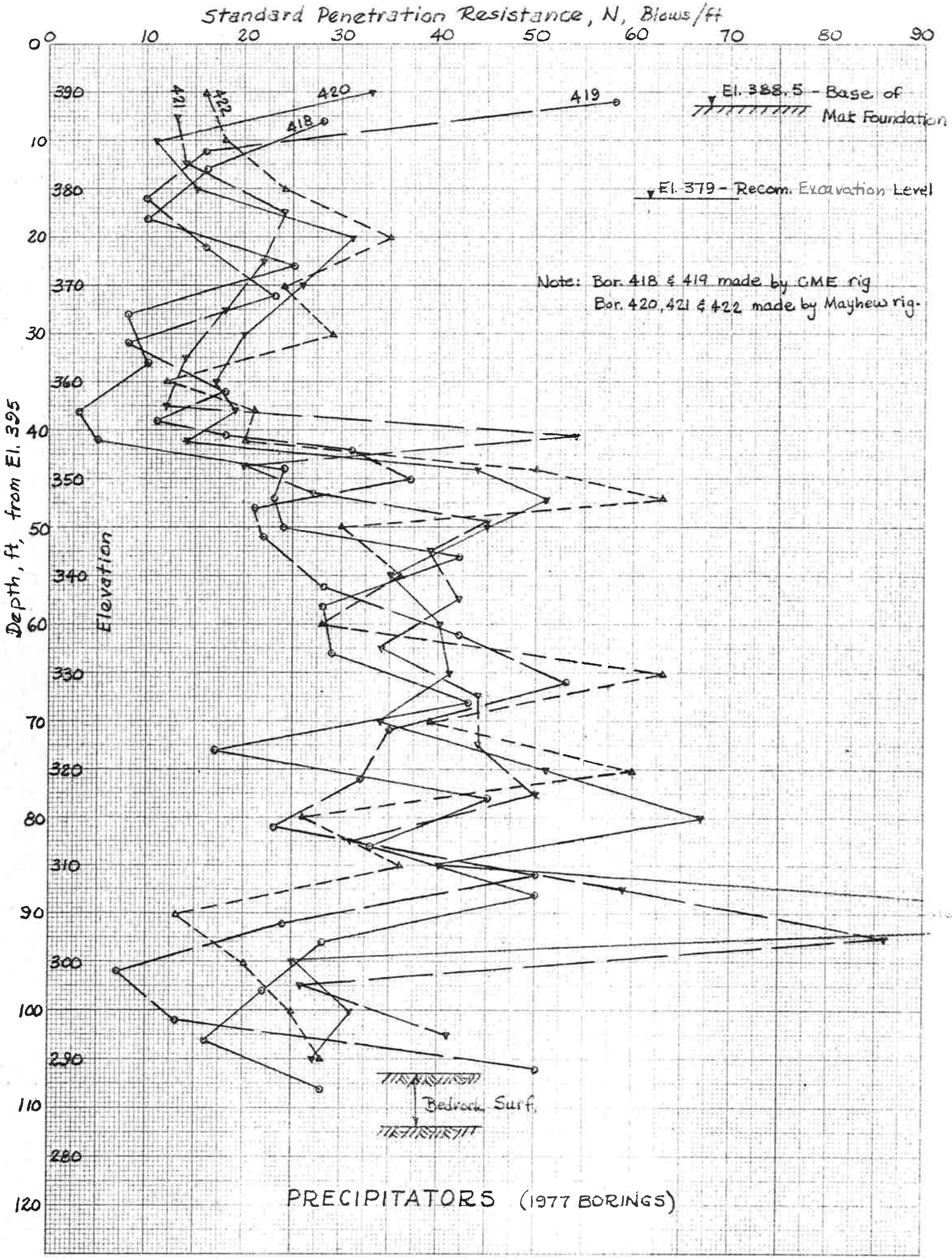
Standard Penetration Resistance, N, Blows/ft
Depth, ft, from El. 395
Elevation
El. 388 - Boiler Room Grade
El. 376 - Recom. Excavation Level
GWL @ P1 (2/10/77)
Bedrock Surf.
343
336
335
337
331
BOILER ROOMS (1976-77 BORINGS)


FIG. 6



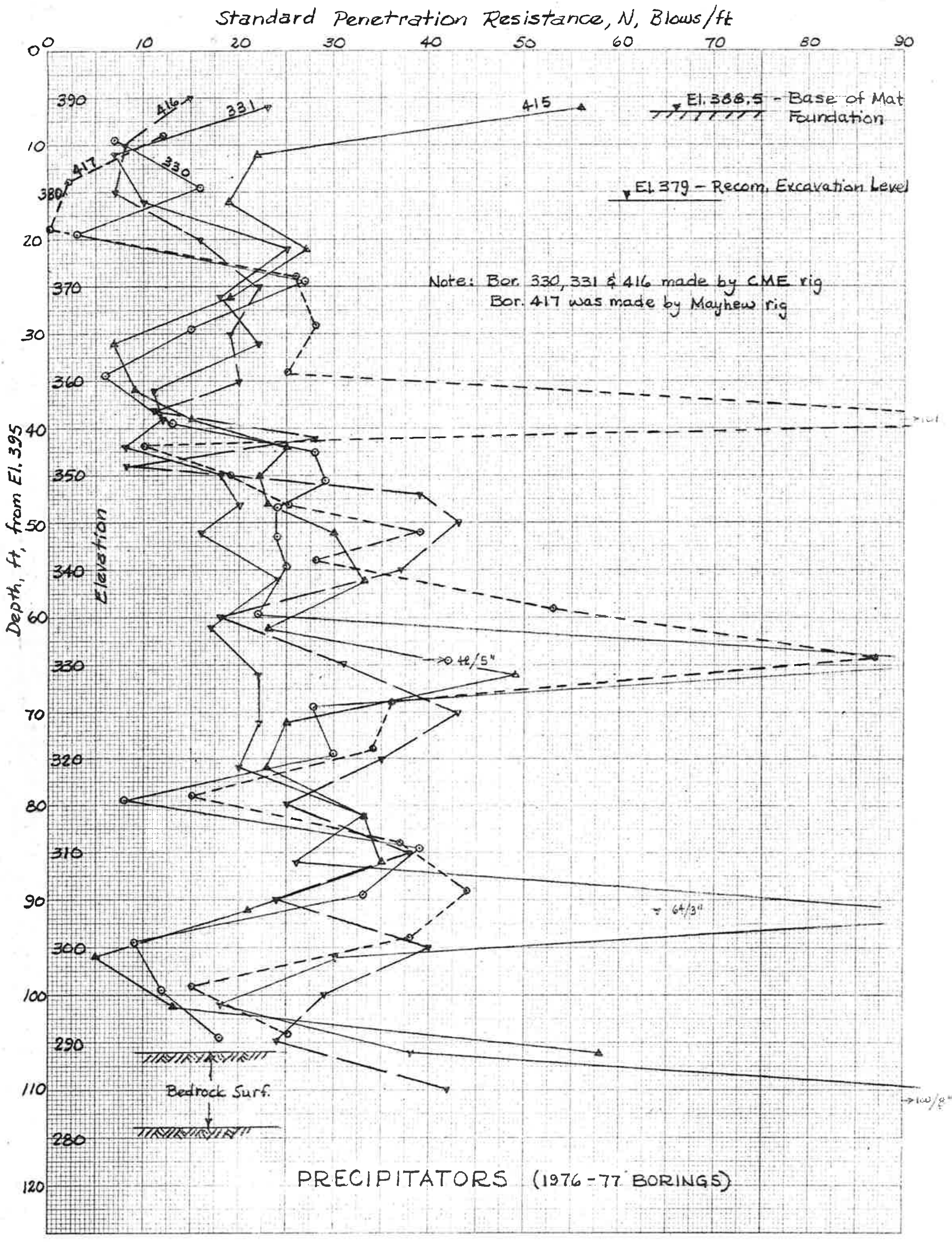
Standard Penetration Resistance, N, Blows/ft
0 10 20 30 40 50 60 70 80 90
Depth, ft, from El. 395
0 10 20 30 40 50 60 70 80 90 100 110 120
Elevation
390 380 370 360 350 340 330 320 310 300 290 280
216
213
215
El. 388 - Boiler Room Grade
El. 376 - Recom. Excavation Level
GWL Bor. 215
GWL Bor. 213
Nov. '75
BOILER ROOMS (1975 BORINGS)


FIG. 7



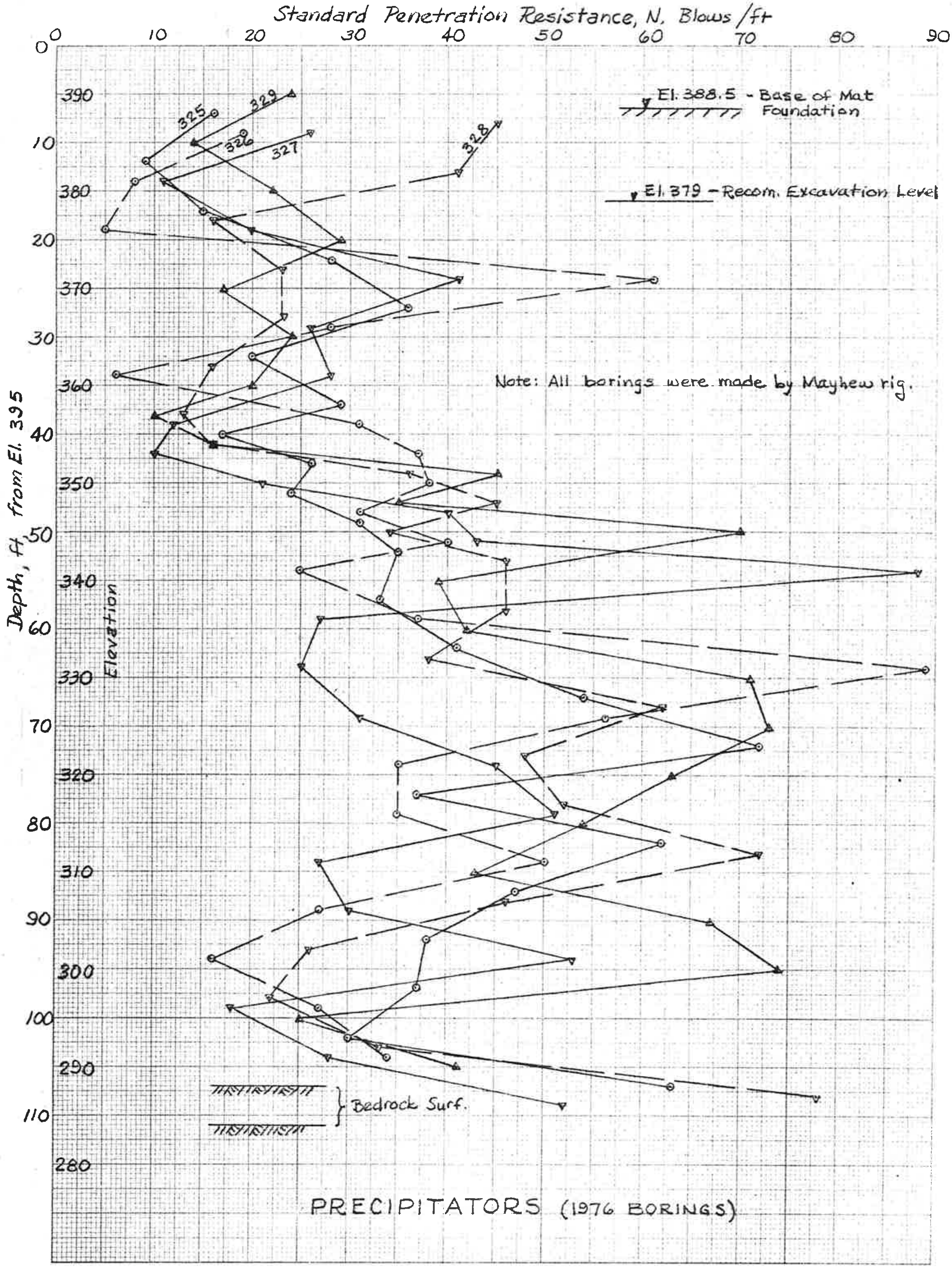
Standard Penetration Resistance, N, Blows/ft
0 10 20 30 40 50 60 70 80 90
Depth, ft, from El. 395
Elevation
420
419
418
421
422
El. 388.5 - Base of Mat Foundation
El. 379 - Recom. Excavation Level
Note: Bor. 418 & 419 made by CME rig
Bor. 420, 421 & 422 made by Mayhew rig.
Bedrock Surf.
PRECIPITATORS (1977 BORINGS)


FIG. 8




PRECIPITATORS (1976-77 BORINGS)

FIG. 9




PRECIPITATORS (1976 BORINGS)

FIG. 10

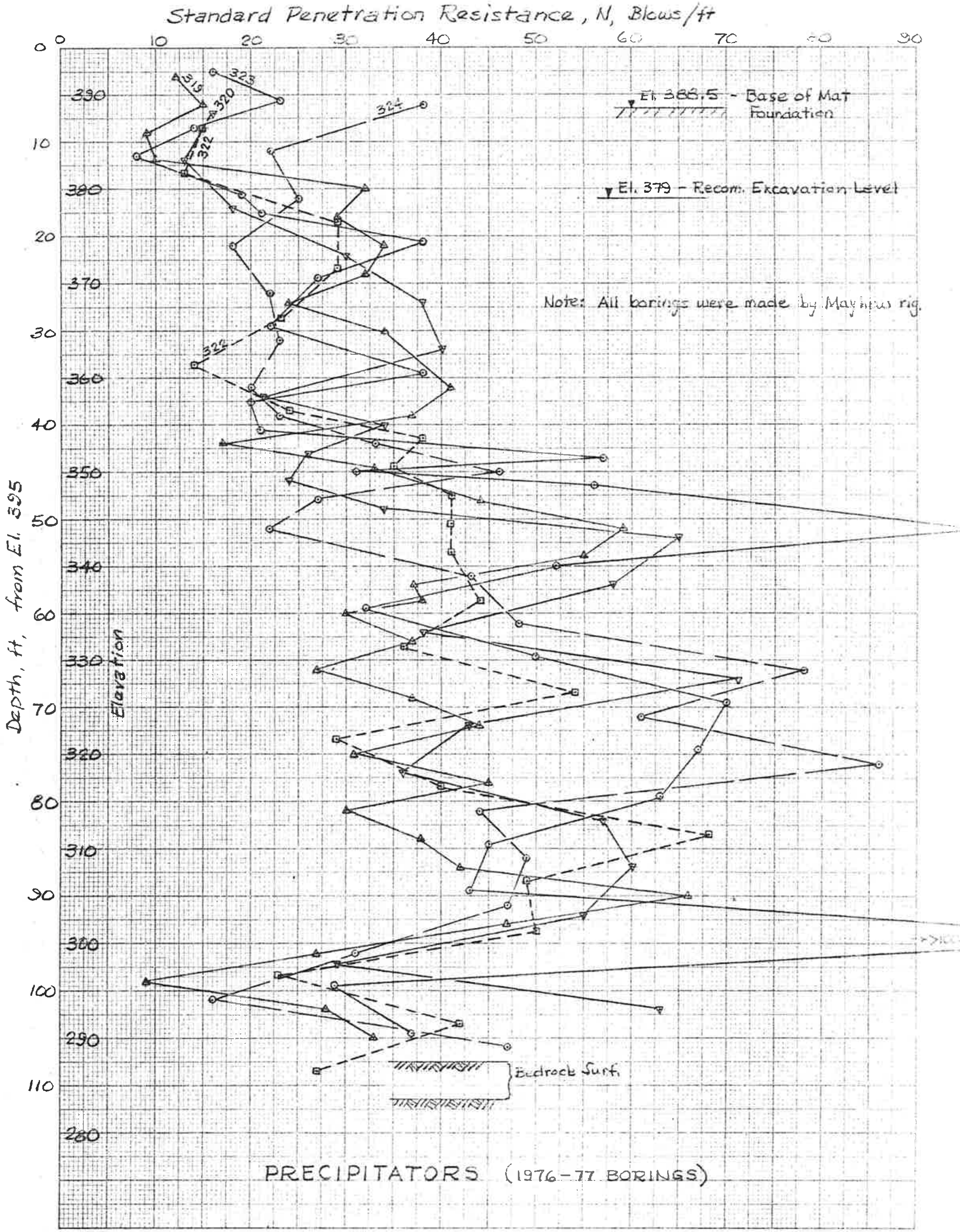

Standard Penetration Resistance, N, Blows/ft
0
10
20
30
40
50
60
70
80
90
Depth, ft, from El. 395
0
10
20
30
40
50
60
70
80
90
100
110
Elevation
390
380
370
360
350
340
330
320
310
300
290
280
319
323
320
324
322
El. 388.5 - Base of Mat Foundation
El. 379 - Recom. Excavation Level
Note: All borings were made by Mayhew rig.
Bedrock Surf.
PRECIPITATORS (1976-77 BORINGS)

FIG. 11

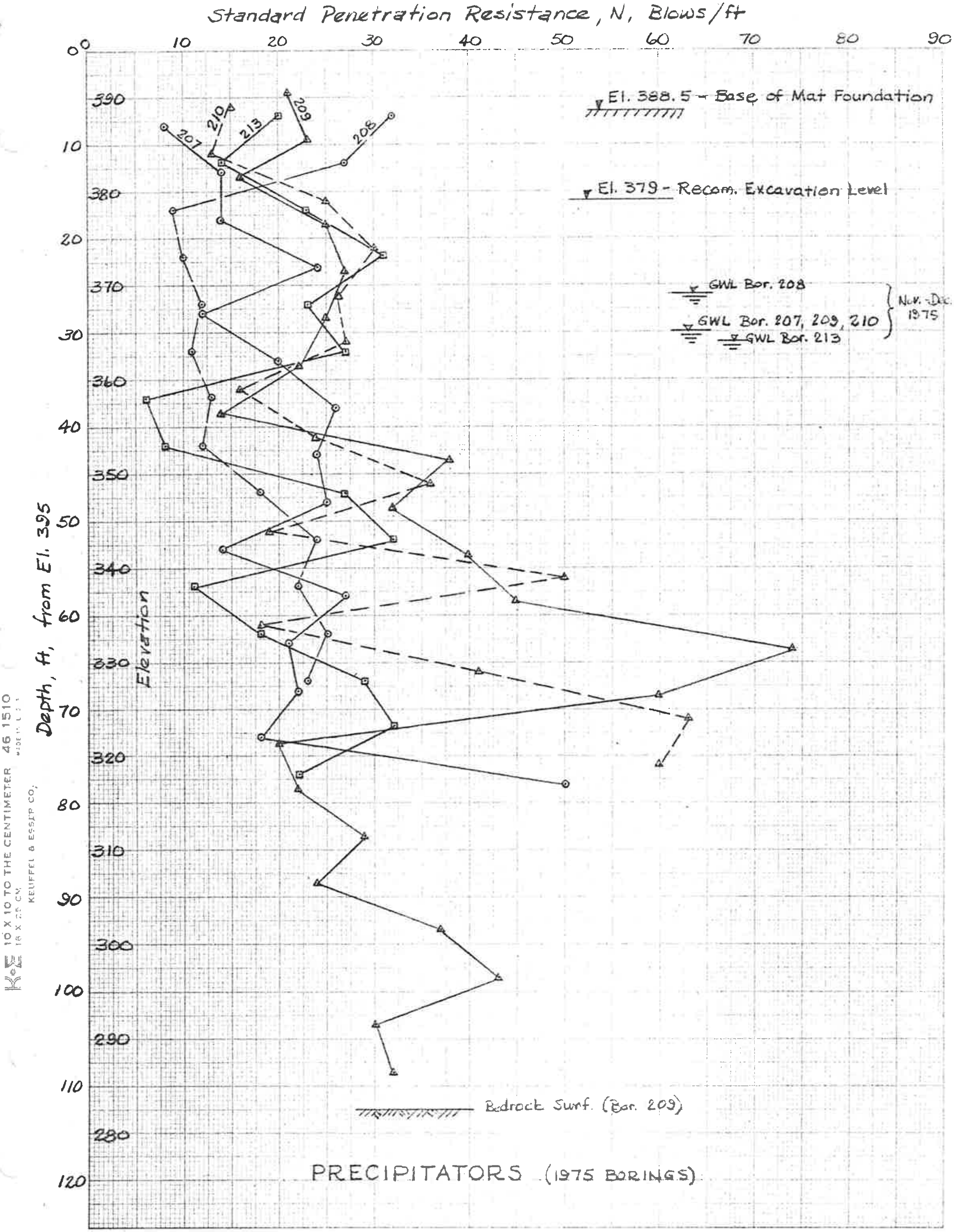
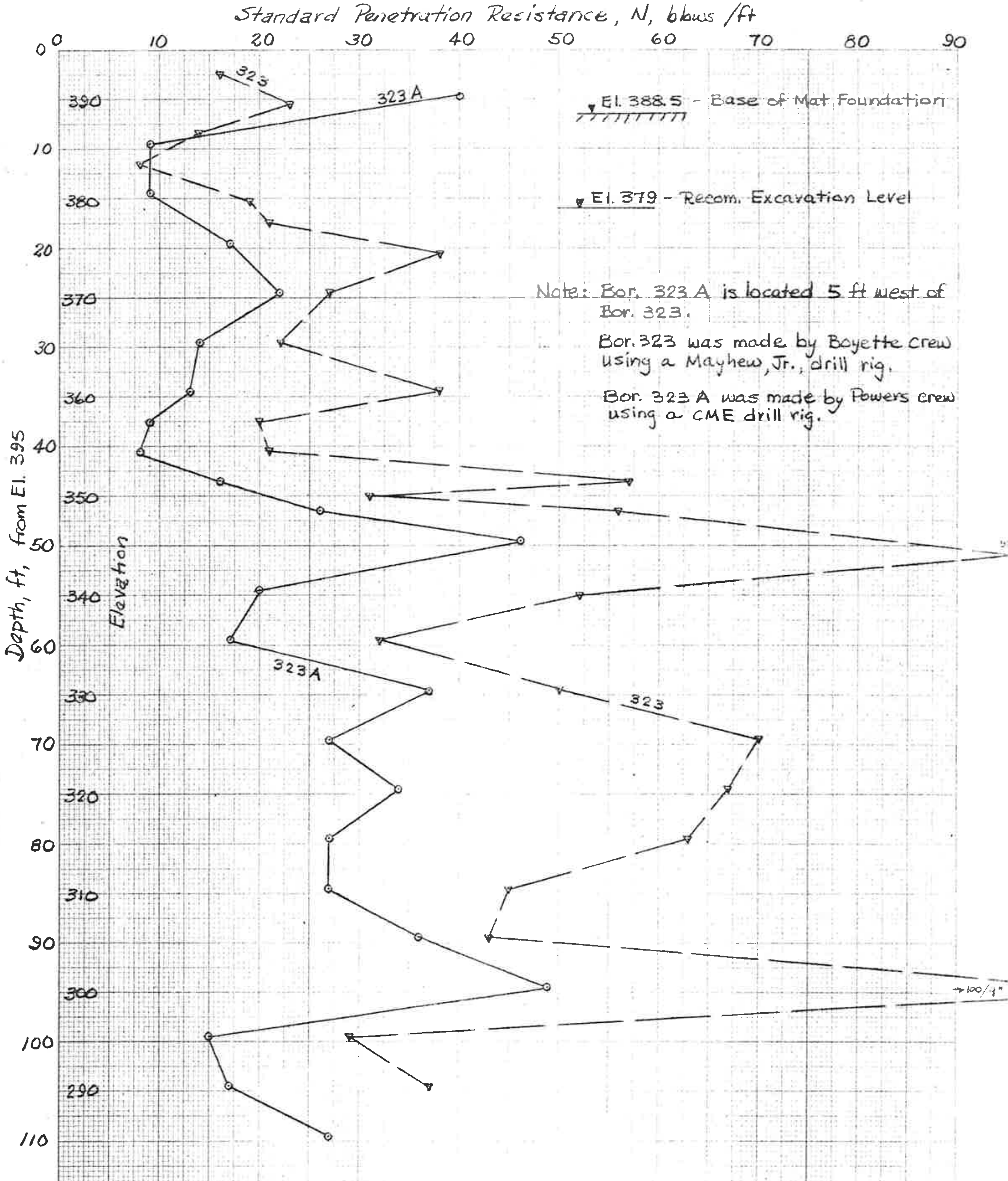

Standard Penetration Resistance, N, Blows/ft
0 10 20 30 40 50 60 70 80 90
Depth, ft, from El. 395
Elevation
0 10 20 30 40 50 60 70 80 90 100 110 120
390 380 370 360 350 340 330 320 310 300 290 280
207
210
213
209
208
El. 388.5 - Base of Mat Foundation
El. 379 - Recom. Excavation Level
GWL Bor. 208
GWL Bor. 207, 209, 210
GWL Bor. 213
Nov.-Dec. 1975
Bedrock Surf. (Bor. 209)
PRECIPITATORS (1975 BORINGS)

FIG. 12




PRECIPITATORS (1977 BORINGS)

COMPARISON OF PENETRATION RESISTANCES USING DIFFERENT DRILL RIGS

FIG. 13

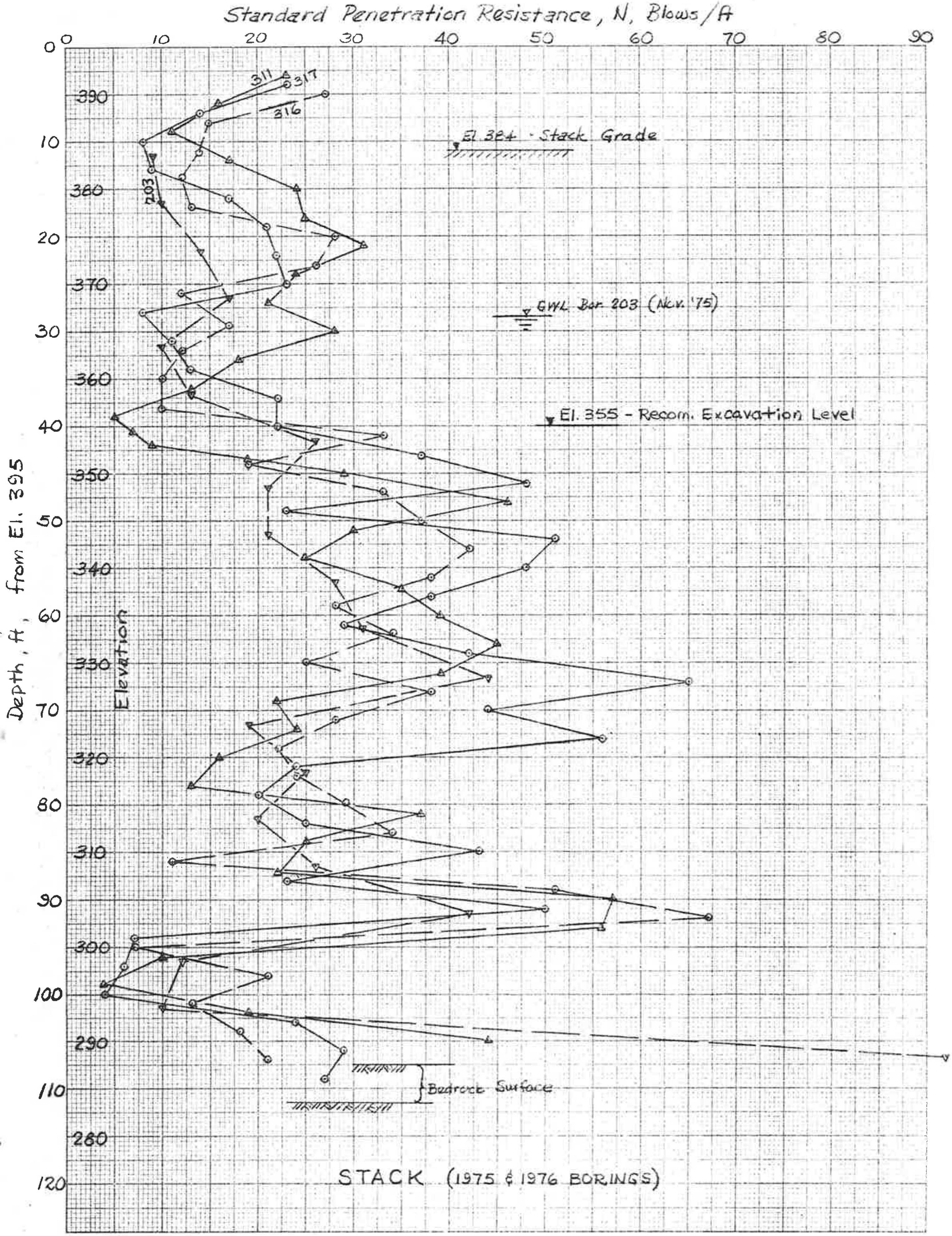

Standard Penetration Resistance, N, Blows/ft
0
10
20
30
40
50
60
70
80
90
0
10
20
30
40
50
60
70
80
90
100
110
120
390
380
370
360
350
340
330
320
310
300
290
280
Depth, ft, from El. 395
Elevation
311
317
316
203
El. 384 - Stack Grade
GWL Bor. 203 (Nov. '75)
El. 355 - Recom. Excavation Level
Bedrock Surface
STACK (1975 & 1976 BORINGS)

FIG. 14

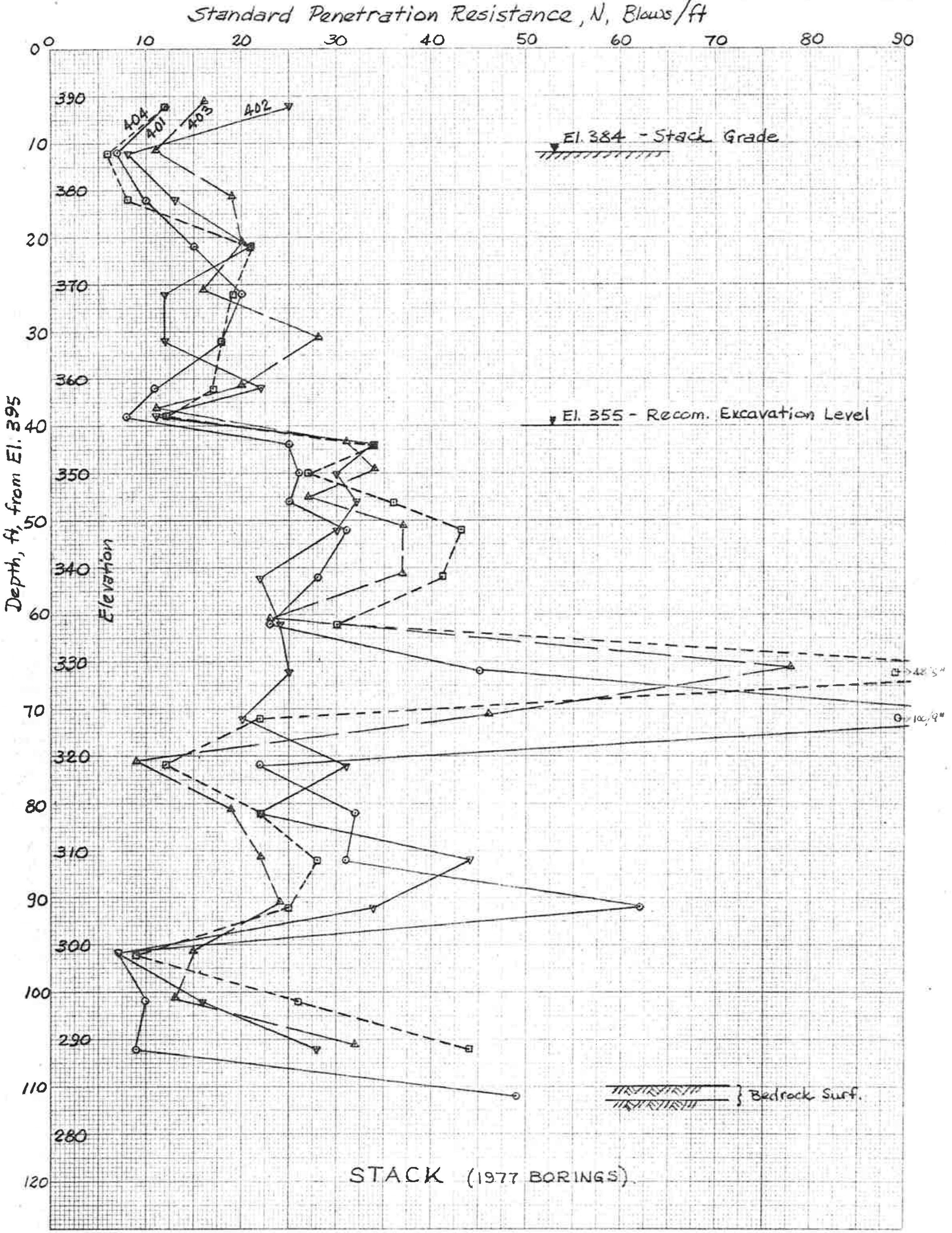
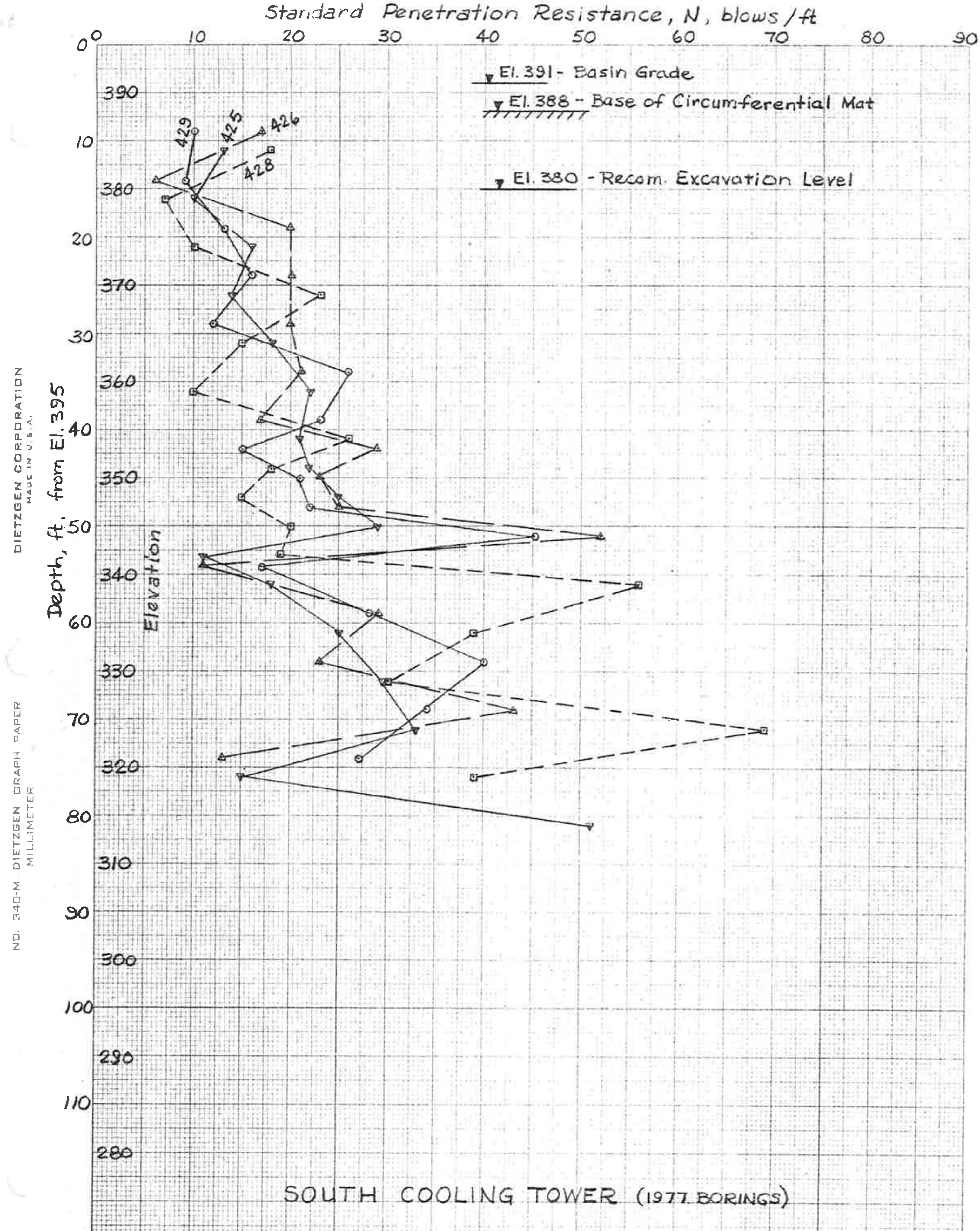

Standard Penetration Resistance, N, Blows/ft
0 10 20 30 40 50 60 70 80 90
Depth, ft, from El. 395
Elevation
390 380 370 360 350 340 330 320 310 300 290 280
0 10 20 30 40 50 60 70 80 90 100 110 120
404
401
403
402
El. 384 - Stack Grade
El. 355 - Recom. Excavation Level
Bedrock Surf.
STACK (1977 BORINGS)

FIG. 15




SOUTH COOLING TOWER (1977 BORINGS)

FIG. 16

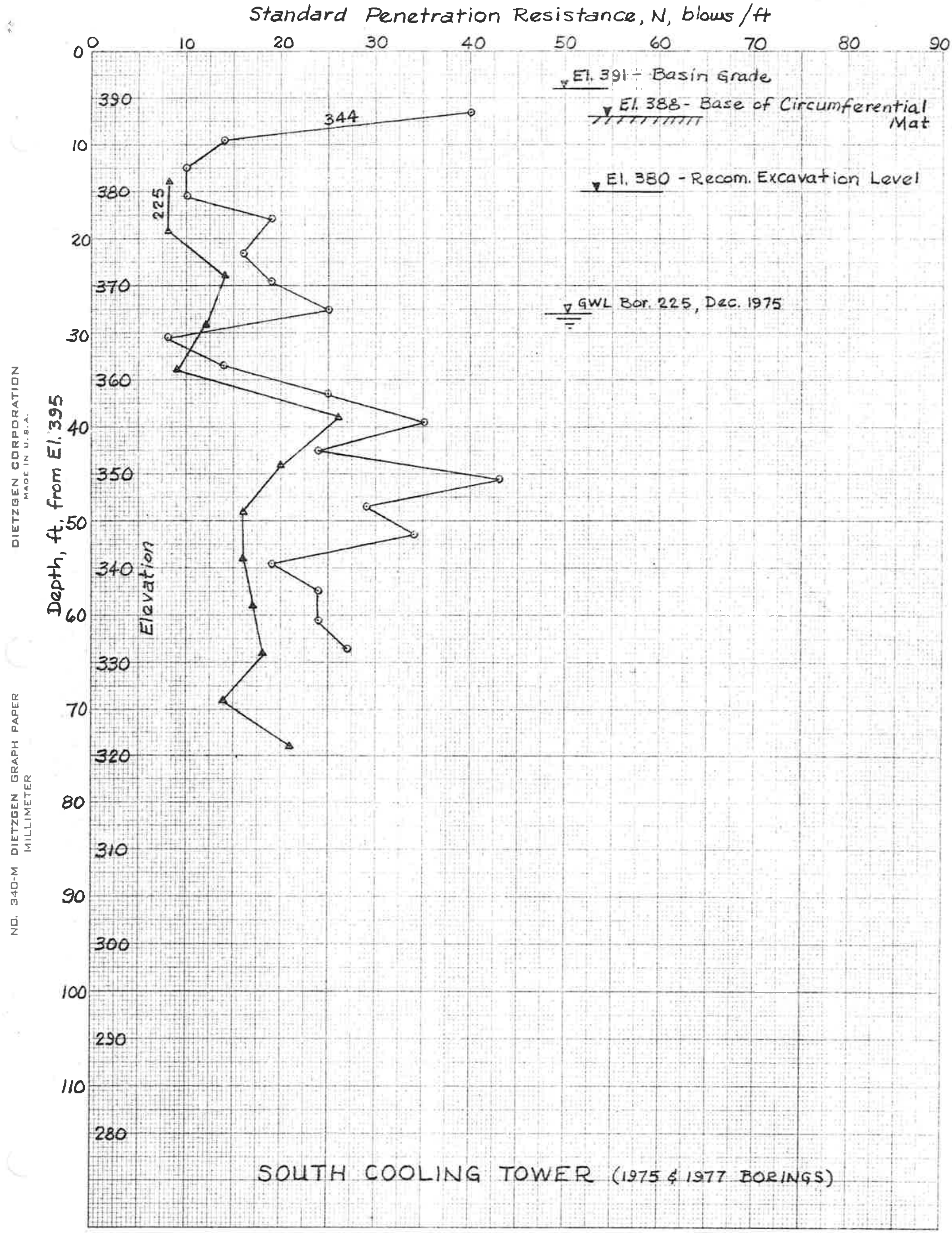
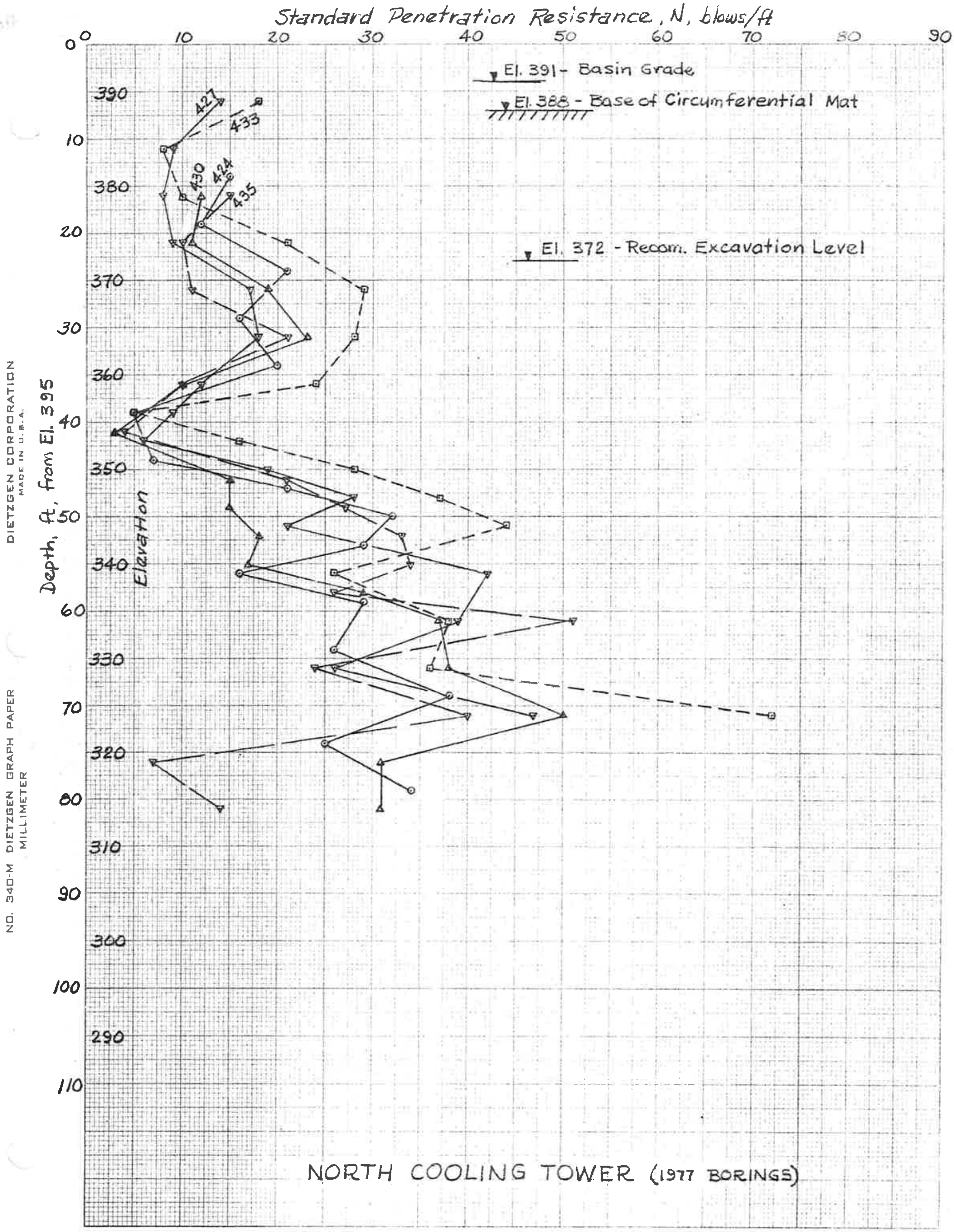
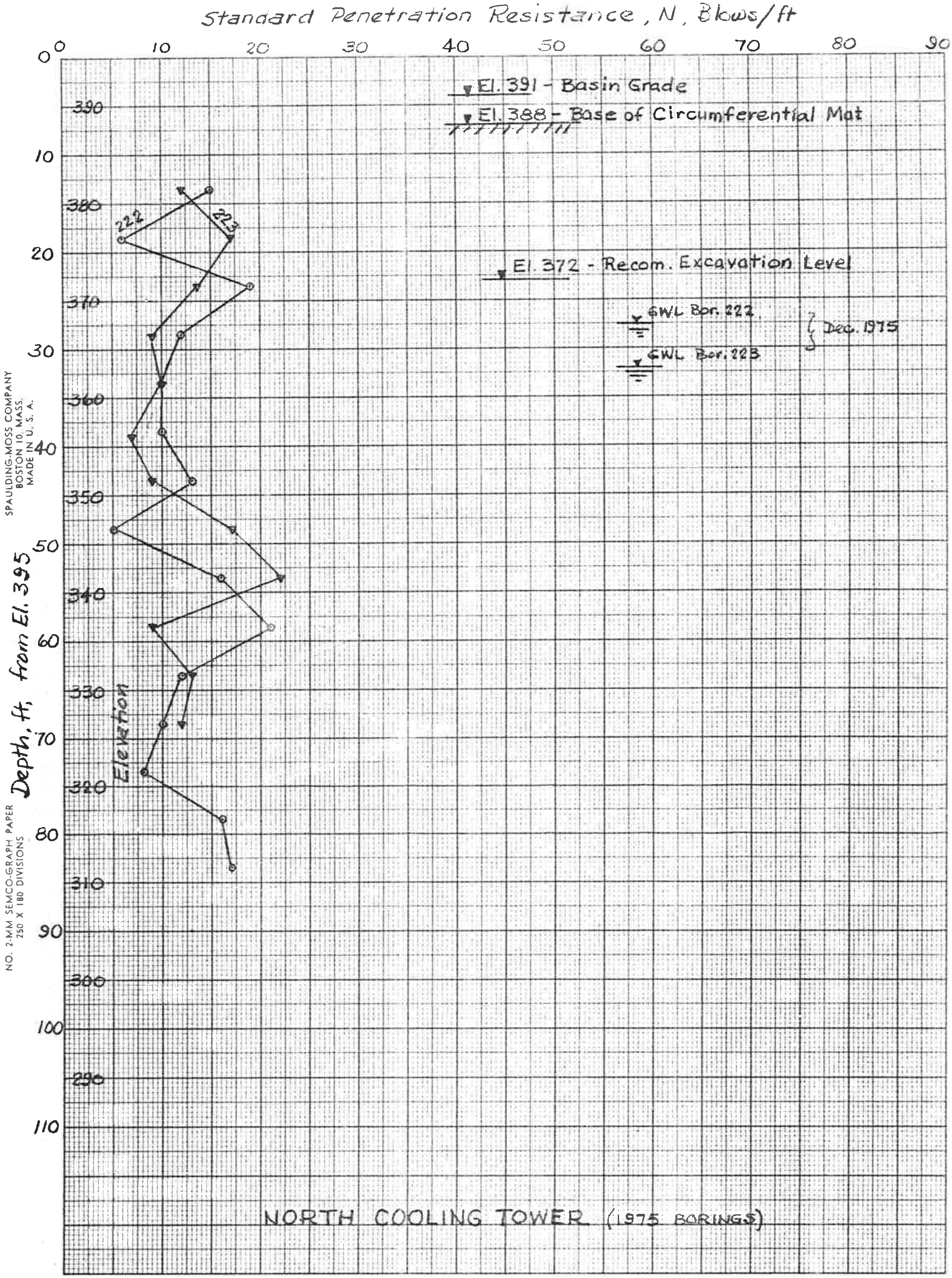

Standard Penetration Resistance, N, blows/ft
0
10
20
30
40
50
60
70
80
90
El. 391 - Basin Grade
El. 388 - Base of Circumferential Mat
El. 380 - Recom. Excavation Level
GWL Bor. 225, Dec. 1975
344
225
Depth, ft, from El. 395
Elevation
390
380
370
360
350
340
330
320
310
300
290
280
100
110
SOUTH COOLING TOWER (1975 & 1977 BORINGS)
NO. 340-M DIETZGEN GRAPH PAPER
MILLIMETER
DIETZGEN CORPORATION
MADE IN U.S.A.

FIG. 17



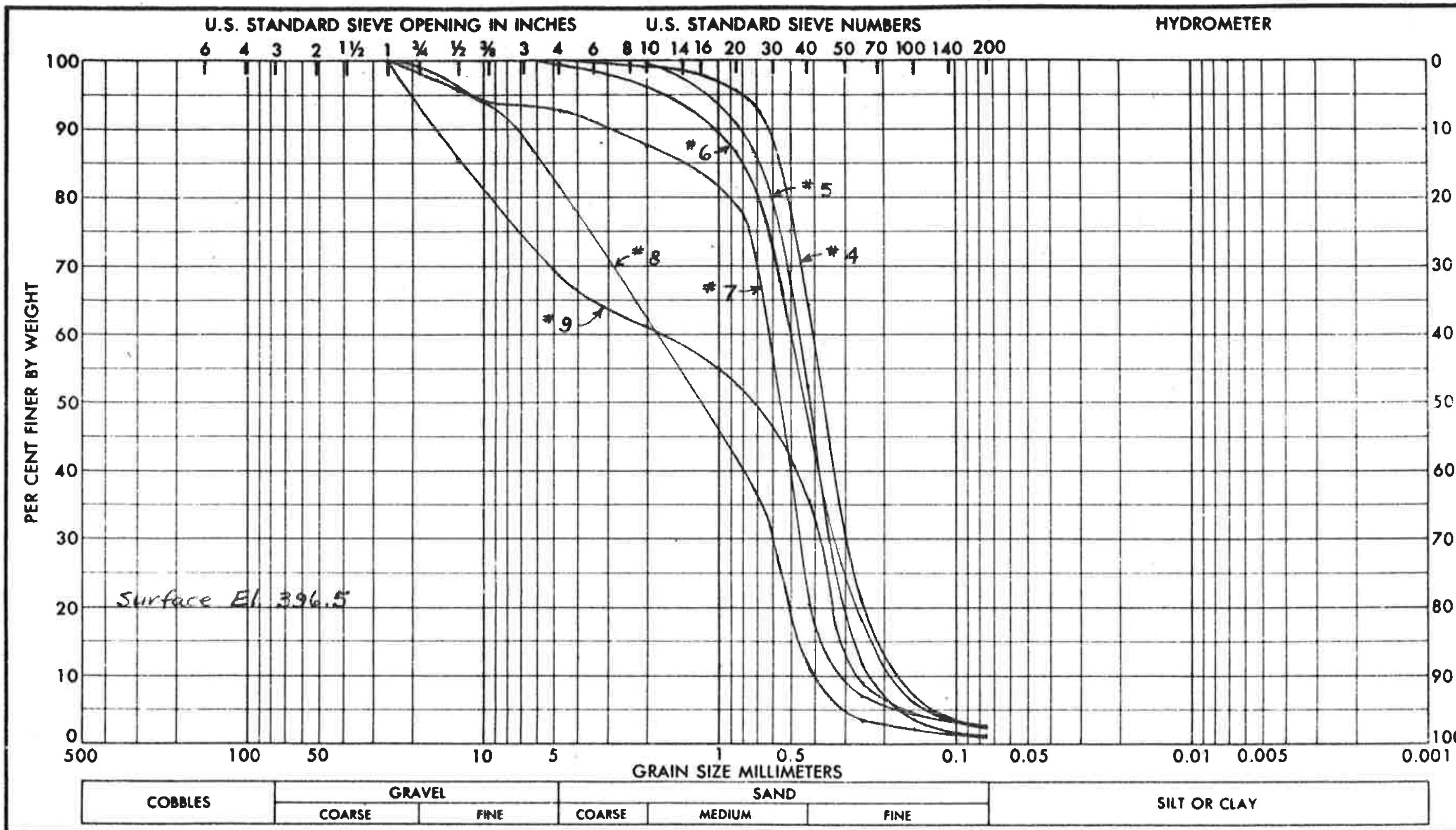

NORTH COOLING TOWER (1977 BORINGS)

FIG. 18



Standard Penetration Resistance, N, Blows/ft
0
10
20
30
40
50
60
70
80
90
El. 391 - Basin Grade
El. 388 - Base of Circumferential Mat
El. 372 - Recom. Excavation Level
GWL Bor. 222
GWL Bor. 223
Dec. 1975
222
223
Depth, ft, from El. 395
Elevation
390
380
370
360
350
340
330
320
310
300
290
100
110
SPAULDING-MOSS COMPANY BOSTON 10, MASS. MADE IN U.S.A.
NO. 2-MM SEMCO-GRAPH PAPER 250 X 180 DIVISIONS
NORTH COOLING TOWER (1975 BORINGS)


FIG. 19




| SAMPLE NO. | ~~ELEV OR~~ DEPTH, ft | CLASSIFICATION | NAT W% | LL | PL | PI |
|---|---|---|---|---|---|---|
| #4 | 19.0 - 20.5 | | | | | |
| #5 | 25.0 - 26.5 | | | | | |
| #6 | 29.0 - 30.5 | | | | | |
| #7 | 34.0 - 35.5 | | | | | |
| #8 | 39.0 - 40.5 | | | | | |
| #9 | 44.0 - 45.5 | **GRADATION CURVES** OF SPLIT-SPOON SAMPLES | | | | |

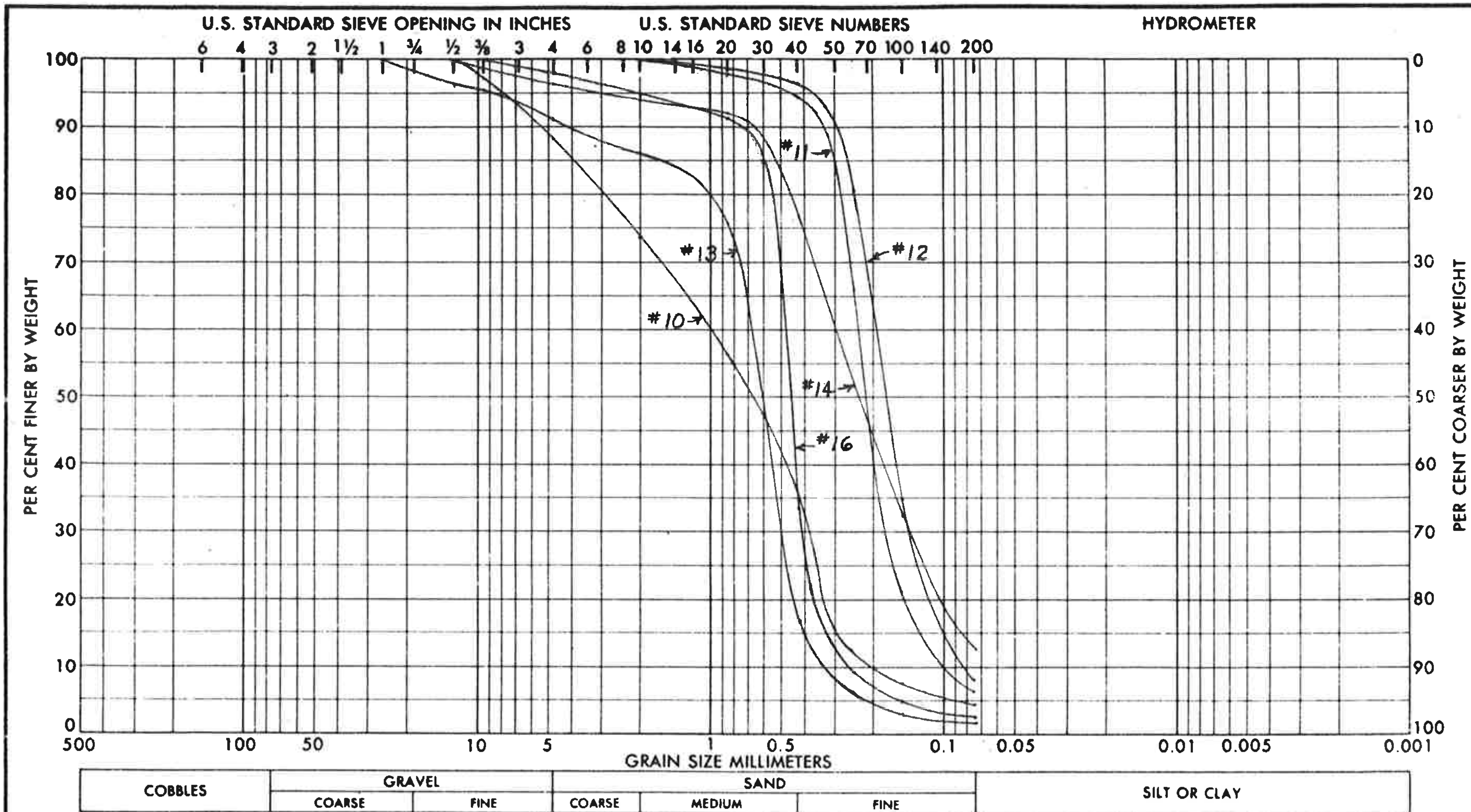
PROJECT ROCKPORT SITE

AREA

BORING NO. 209

DATE Jan. '77

FIG. 20




| SAMPLE NO. | ~~ELEV OR~~ DEPTH, ft | CLASSIFICATION | NAT W% | LL | PL | PI |
|---|---|---|---|---|---|---|
| # 10 | 49.0 - 50.5 | | | | | |
| # 11 | 54.0 - 55.5 | | | | | |
| # 12 | 59.0 - 60.5 | | | | | |
| # 13 | 64.0 - 65.5 | | | | | |
| # 14 | 69.0 - 70.5 | | | | | |
| # 16 | 79.0 - 80.5 | | | | | |

**GRADATION CURVES** OF SPLIT-SPOON SAMPLES

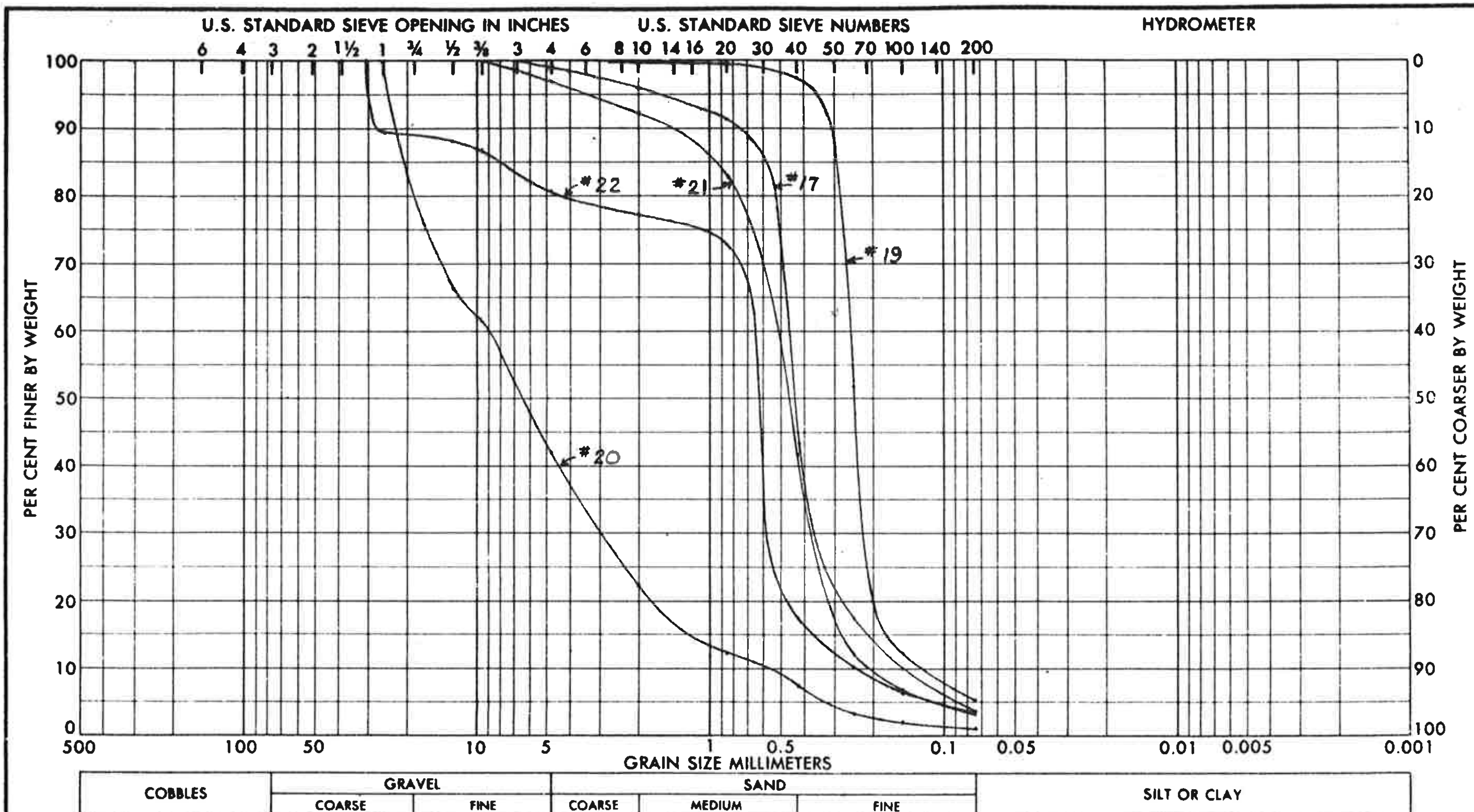
PROJECT ROCKPORT SITE

AREA

BORING NO. 209

DATE Jan. '77

FIG. 21




| SAMPLE NO. | ~~ELEV OR~~ DEPTH, ft | CLASSIFICATION | NAT W% | LL | PL | PI |
|---|---|---|---|---|---|---|
| # 17 | 84.0 - 85.5 | | | | | |
| # 19 | 94.0 - 95.5 | | | | | |
| # 20 | 99.0 - 100.5 | | | | | |
| # 21 | 104.0 - 105.5 | | | | | |
| # 22 | 109.0 - 110.5 | | | | | |

**GRADATION CURVES** OF SPLIT-SPOON SAMPLES

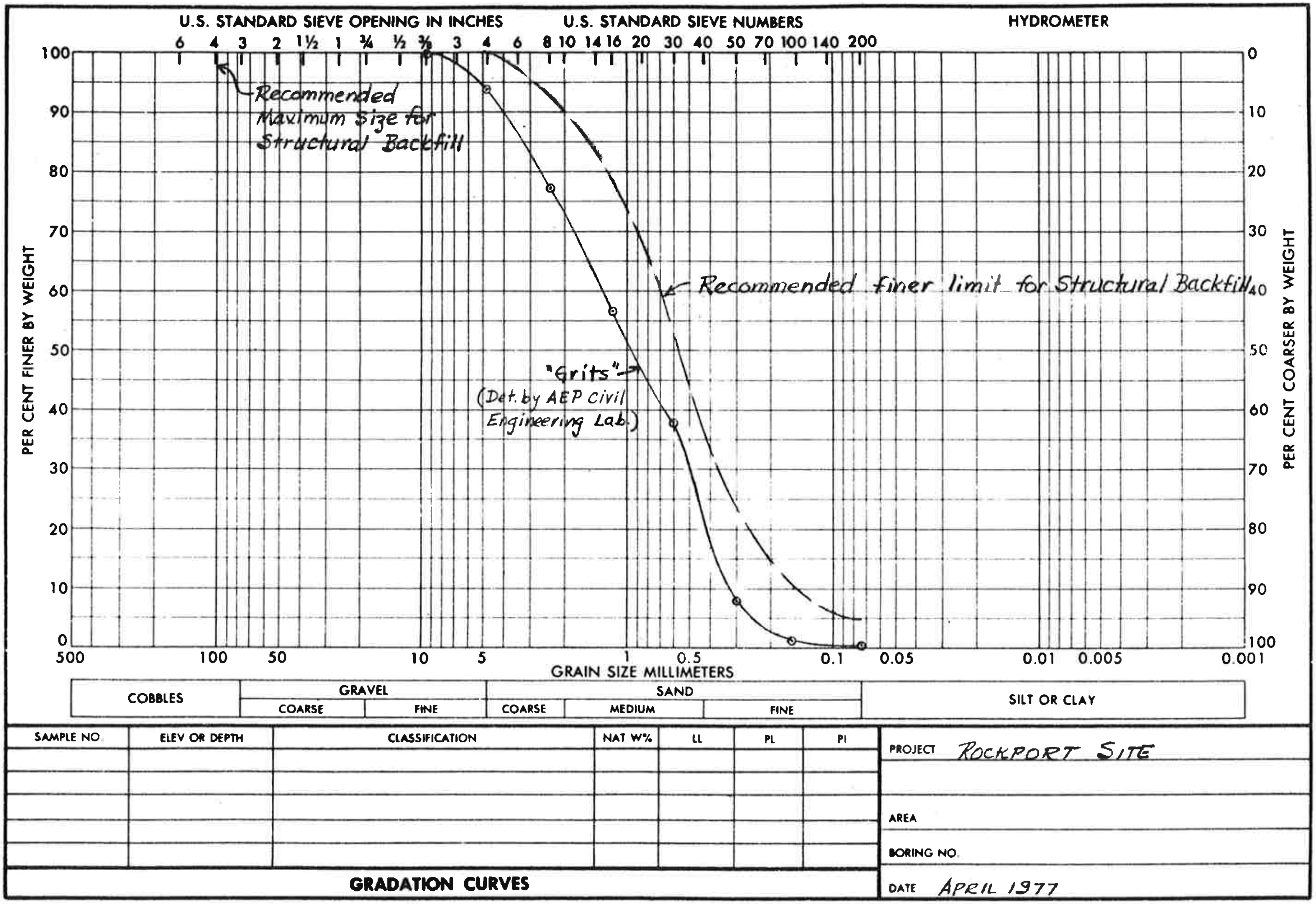
PROJECT ROCKPORT SITE

AREA

BORING NO. 209

DATE Jan. '77

FIG. 22

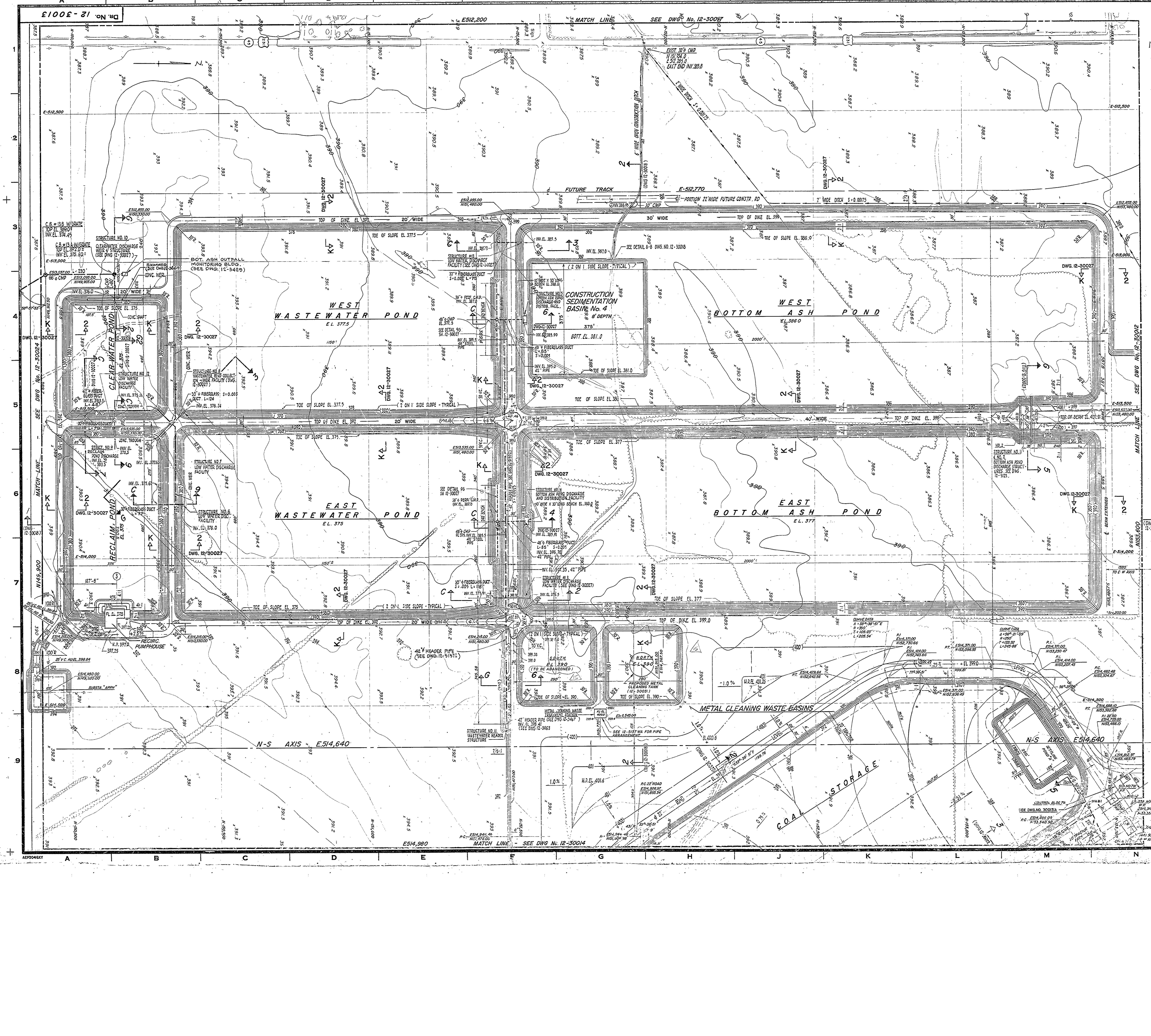



RECOMMENDED GRADATION FOR STRUCTURAL BACKFILL

FIG. 23

<u>ATTACHMENT C1</u>

ORIGINAL DESIGN DRAWINGS




## GENERAL NOTES

FOR PROFILE OF 66"ϕ CMP SEE SH-12-30028

WASTE WATER PONDS-EAST & WEST, RECLAIM, & CLEAR WATER PONDS, HAVE HAD 1 FT. OF CLAY PLACED ON BOTTOMS AND SIDES - BY FIELD.

| DATE | NO. | DESCRIPTION | APP'D. |
|---|---|---|---|
| 9/28/84 | 14 | ADDED MH#1, 18"Ø CMP & DITCH AT COAL STATIONS 7, 7E & 7W. AREA M-9. ACY | SF/TS |
| 4/25/84 | 13 | ADDED DET. "K-2" MARKS PER REVISION MADE ON DWG. 12-30027 - REGRADE & REDRESS ON SLOPES ON BOTTOM ASH, WASTEWATER, RECLAIM & CLEARWATER PONDS | SF/TS |
| 9/13/83 | 12 | ADDED BOT. ASH OUTFALL MONITORING BLDG. (4-B) ACY/G.S. | S.F. |
| 3/10/82 | 11 | AS PER RDR NO. ROCK 12-332, EXPANDED SETTLING POND "A" & REGRADED ACCORDINGLY. RD. INDICATED SKIMMER LOCATION PER. RDR #12-290 REVISED DIKE GRADING IN AREAS F-5 & F-6, LOCATION OF STRUCT. #11; ADDED SECT. G-3. | S.F. |
| 9/3/81 | 10 | REVISED DESCRIPTION OF STEEL PIPE TO "FIBERGLASS DUCT." RNS. DIST. TO STR. #11. | S.F. |
| 8/26/80 | 9 | REVISED LOCATION AND GRADING OF SUBSTATION "APPH" | SF |
| 8/11/80 | 8 | ADDED SUBSTATION "APPH" & ROAD NEAR RECLAIM POND, AND GRADED ACCORDINGLY A-8 REVISED ℄ TO ℄ DIMENSION TO 38', WAS 30' B-7.8. RNS | SF |
| 10/29/79 | 7 | REVISED OR ADDED PIPE LENGTHS @ SECT'S. C2, C3, C4, C6, C7, C9, & G3. R. | HTS |
| 9/26/79 | 6 | REVISED INV. ELS. 30" STEEL PIPE AT STRUCTURES #12 & #13. REVISED INV. ELS AT C.B. #13A & 13B RELOCATED RECIRCULATION PUMPHOUSE, AND REALIGNED BERM ROAD. REGRADED AREA ACCORDINGLY. (A-7) LABELED STRUCTURE #7 "LOW WAT. DISCH. FACILITY". RELOCATED STRUCT. #6 275' EAST OF ℄ DIKE BETWEEN CLEARWATER & RECLAIM PONDS. ADDED CONTROL BUILDING 7W & 4KV/600 OUTDOOR SUB-STA. (9-N). | HTS |

## REFERENCE DRAWINGS

- 12-30014 COAL STORAGE AREA - GRADING DRAINAGE & TRACK
- 12-30003 SEDIMENTATION BASINS LOCATION PLAN
- 12-30018 WASTEWATER & BOTTOM ASH POND AREA - SECTIONS & DETAILS
- 12-30022 COAL STORAGE AREA SECTIONS & DETAILS
- 12-30004 SEDIMENTATION BASINS - PLANS & DETAILS

| DATE | NO. | DESCRIPTION | APP'D. |
|---|---|---|---|
| 8/7/79 | 5 | REV. SECTIONS C-2, C-3, C-6, & G-3. RELOCATED STRUCT. # 6 & #12 & REVISED INV. ELEVS. RELOCATED STRUCT. #9 FROM CLEAR WATER POND TO RECLAIM POND. INCREAS. TO 42"ϕ REMOVED C.B. #13A, #13B & STRUCT #10 (SEC. G-2) AT RECLAIM POND AND RELOCATED TO CLEAR WATER POND. REMOVED 48"ϕ STEEL PIPE AT RECLAIM POND. ADDED 66"ϕ CMP AT CLEAR WATER POND. | HTS |
| 3/5/79 | 4 | AS PER RDR ROCK 12-055, REVISED COORDINATES OF P.I. FOR CURVE NEAR STA. 7W. ADDED 48"ϕ STEEL PIPE W/C.B.s FROM RECLAIM POND. - A-6 REV. COORD. FOR STA. 7W TO - E514,820.62 - N153,493.10. WAS E514,821.67 - N153,493.80. REVISED DIMENSION ℄ STA. 7 TO ℄ STA. 7W TO 117'-3", WAS 116'-0" - N-9 ADDED 48"ϕ CMP & SLIDE GATES TO SECTIONS C-4 & C-6. REGRADED COAL STOR. AREA. REV. ELEVS OF SETTLING POND "A"; DELETED 30"ϕ CMP FROM SETT. POND "A". RAISED ELEV. OF WEST BOTT. ASH POND TO EL. 386.0, WAS EL. 377.0. CHANGED STRUCTURE NO. 3 TO NO. 13, AND RAISED INVERTS TO EL. 378.5 & 385.5, WAS 376.0 & 376.5. RAISED ELEV. OF WEST WASTEWATER POND TO EL. 377.5, WAS 375.0 & RAISED INV. EL. TO 378.5 @ STRUCT NO. 6, WAS 375.5 | HTS |
| 11/7/78 | 3 | REVISED SIZE STEEL PIPE TO 30"ϕ WAS 18"ϕ REVISED LOC. OF SETTLING POND "A" & 30"ϕ CMP, ADDED DIMS, P.I.S FOR 22' ROAD & CURVES AROUND WEST COAL STOR. AREA | HTS |
| 4/11/78 | 2 | ADDED STRUCTURE NO. 12 (B5) REVISED GRADING & LOCATIONS OF ROAD & STATIONS 7, 7W AT WEST COAL STORAGE AREA. REVISED INV. 375.74 18"ϕ PIPE, WAS 375.5. ADDED RADII @ ALL PONDS. ADDED INV. ELS. TO 42" HEADER PIPE ALONG DIKE BETW. WASTEWATER & ASH PONDS (E4, 6, 7) | HTS |
| 1/16/90 | 15 | PER RDR-RP-00-03314, REVISED EXIST. NORTH METAL CLEANING POND & ABANDONED THE SOUTH POND. ALSO ADDED REF. NOTE TREATMENT STA. | |

REVISIONS



INDIANA & MICHIGAN ELECTRIC CO.
ROCKPORT SITE
ROCKPORT, INDIANA

# UNIT No. 1 & 2 WASTEWATER & BOTTOM ASH POND AREA GRADING & DRAINAGE

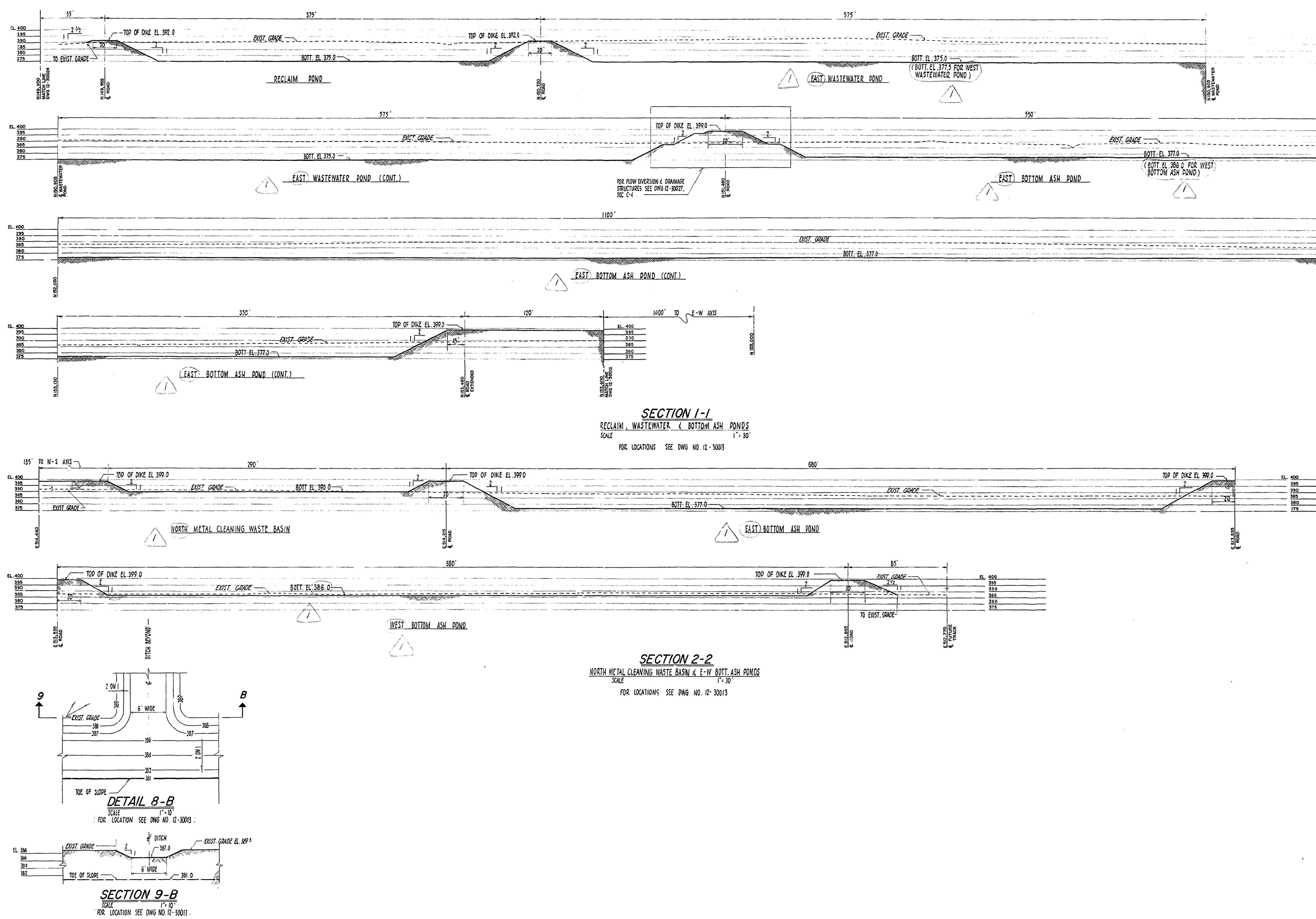
DR. NO. 12-30013-15

ARCH. | ELEC | MECH. | STR. S.F.

SCALE: 1"=100'
DR. R. N. SWINGLE
SQ. LDR W.B.
DATE: 7/18/77
APPROVED BY: ENGINEERING DIV; DESIGN DIV

AMERICAN ELECTRIC POWER SERVICE CORP.

Dr. No. 12-30018




## GENERAL NOTES

## REFERENCE DRAWINGS

12-30013 WASTEWATER & BOTTOM ASH POND AREA, GRADING & DRAINAGE
12-30003 SEDIMENTATION BASINS - LOCATION PLAN
12-30004 SEDIMENTATION BASINS - PLANS & DETAILS

| DATE | NO. | DESCRIPTION | APPD. |
|---|---|---|---|
| 1/10/79 | 1 | AS PER CIVIL ENGRG REQUEST. REVISED WEST BOTT. ASH POND EL. TO 386.0, WAS 377.0. ADDED NOTE: BOTT. EL. 377.5 FOR W.W.PD | HTS |
| 8/3/77 | 0 | RELEASED TO FIELD | HTS |

REVISIONS



INDIANA & MICHIGAN ELECTRIC CO.
ROCKPORT SITE
ROCKPORT, INDIANA

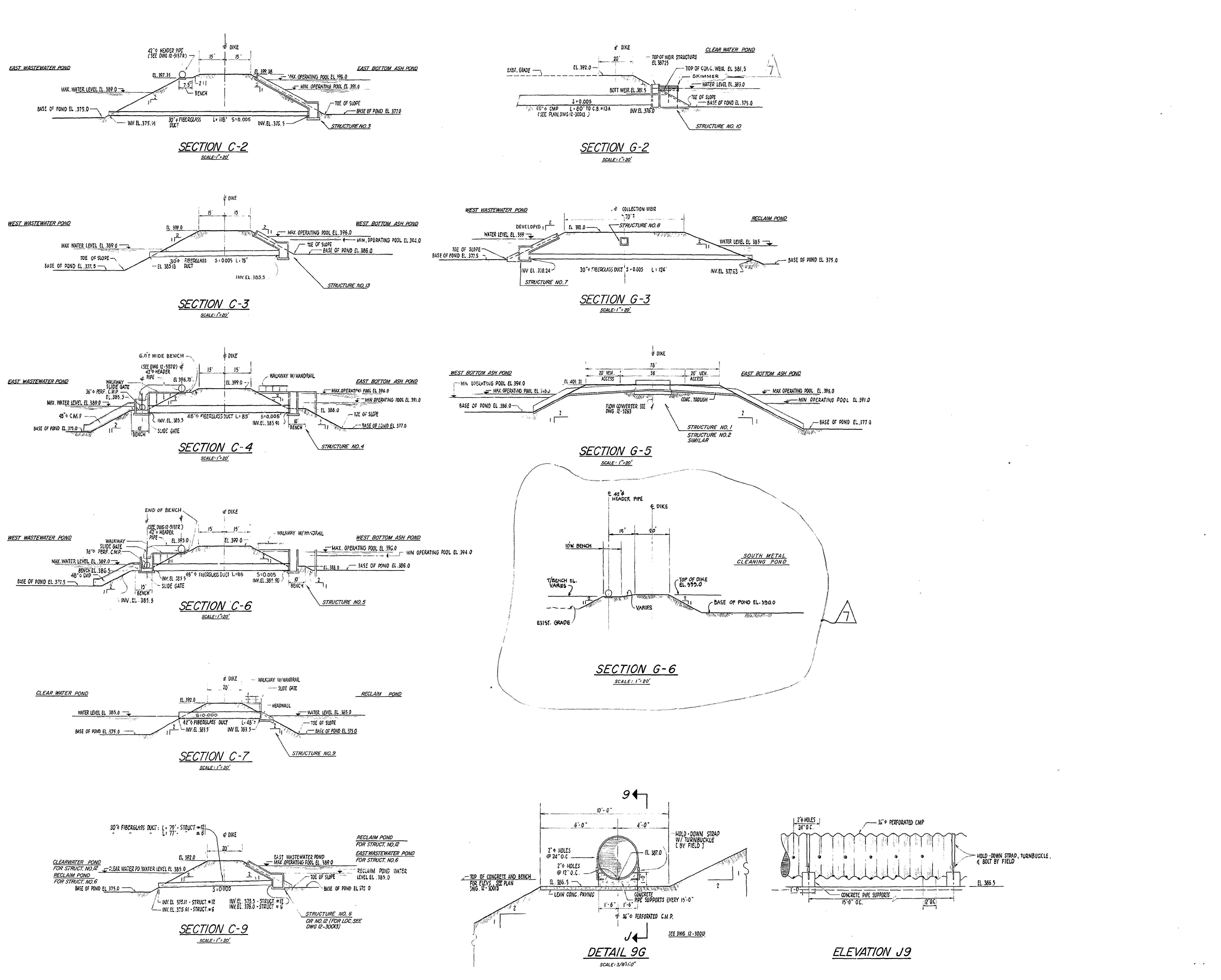
UNIT No. 1 & 2
WASTEWATER & BOTTOM ASH POND AREA – SECTIONS & DETAILS

DR. NO. 12-30018-1

ARCH. | ELEC | MECH. PJD | STR. S.F.
SCALE: AS NOTED
DR. R.N. SWINGLE
CH. —
SQ. LDR. W.B.
DATE: 7/18/77
APPROVED BY: ENGINEERING DIV / DESIGN DIV

AMERICAN ELECTRIC POWER SERVICE CORP.

DR. NO. 12-30027




## GENERAL NOTES

FOR CONTINUATION OF 66"φ CMP - SEC. G-2 SEE PROFILE SH. 12-30028.

## REFERENCE DRAWINGS

12-30013 WASTEWATER & BOTTOM ASH POND AREA GRADING & DRAINAGE
12-30024 AREA SOUTH OF RECLAIM POND - GRADING, DRAINAGE & TRACK LAYOUT

## REVISIONS

| DATE | NO. | DESCRIPTION | APPD. |
|---|---|---|---|
| 12/17/81 | 7 | ADDED SKIMMER - SECT. G-2 PER RDR ROCK# 12-270 ADDED SECTION 'G-G' | SF |
| 8/12/81 | 6 | REVISED DESCRIPTION OF STEEL PIPE TO FIBERGLASS DUCT. RWS | SF |
| 8/26/79 | 5 | REVISED PIPE LENGTH DIMS SEC. C-2, C-3, C-4 & C-6. REMOVED PIPE BENDS SECTION C-3 & C-9. ADDED LENGTH DIMENSION & REVISED INV. EL. OF 30"φ STEEL PIPES. REV. LENGTH DIM. OF 66"φ CMP TO 60'. WAS 100'. | HTS |
| 8/7/79 | 4 | RELOCATED STRUCT. # 6 & # 12 & REVISED INV. ELEV'S AND BASE OF POND ELEVATIONS. REVISED SECTIONS C-2, C-3, C-6 & G-3. RELOCATED STRUCT. # 9 FROM CLEAR WATER POND TO RECLAIM PD & REVERSED FLOW. | HTS |
| 7/6/79 | 3 | REVISED SECTION G-2, CHANGED PIPE SIZE 48"φ STEEL, WAS 30"φ. | HTS |
| 1/10/79 | 2 | ADDED 48"φ CMP & SLIDE GATES TO SECTIONS C-4 & C-6. RAISED WEST BOTTOM ASH POND EL. TO 386.0, WAS 377.0. RAISED WEST WASTEWATER POND EL. TO 377.5, WAS 375.0. CORRECTED PIPE SIZE ON SECTION G-3 TO 30"φ. ADDED HOLD-STRAPS WITH TURNBUCKLE TO DETAIL 9G | HTS |
| 11/11/78 | 1 | ADDED STRUCTURE NO. 12 TO SECTION C-9 | HTS |

NOTE:
GRADE ELEVATION HAS BEEN ESTABLISHED AS ELEVATION DATUM ADD TO CONVERT TO PLANT TO ELEVATIONS SHOWN.



INDIANA & MICHIGAN ELECTRIC CO.
ROCKPORT SITE
ROCKPORT, INDIANA

# UNIT No. 1 & 2 WASTEWATER & BOTTOM ASH POND AREA - SECTIONS & DETAILS

DR. NO. 12-30027-7

| ARCH. | ELEC. | MECH. | STR. |
|---|---|---|---|

SCALE: AS SHOWN
DR. R.N. SHINGLE
CH. HB
SQ. LDR. ASF
DATE: 3/31/78
APPROVED BY: ENGINEERING DIV. / DESIGN DIV.

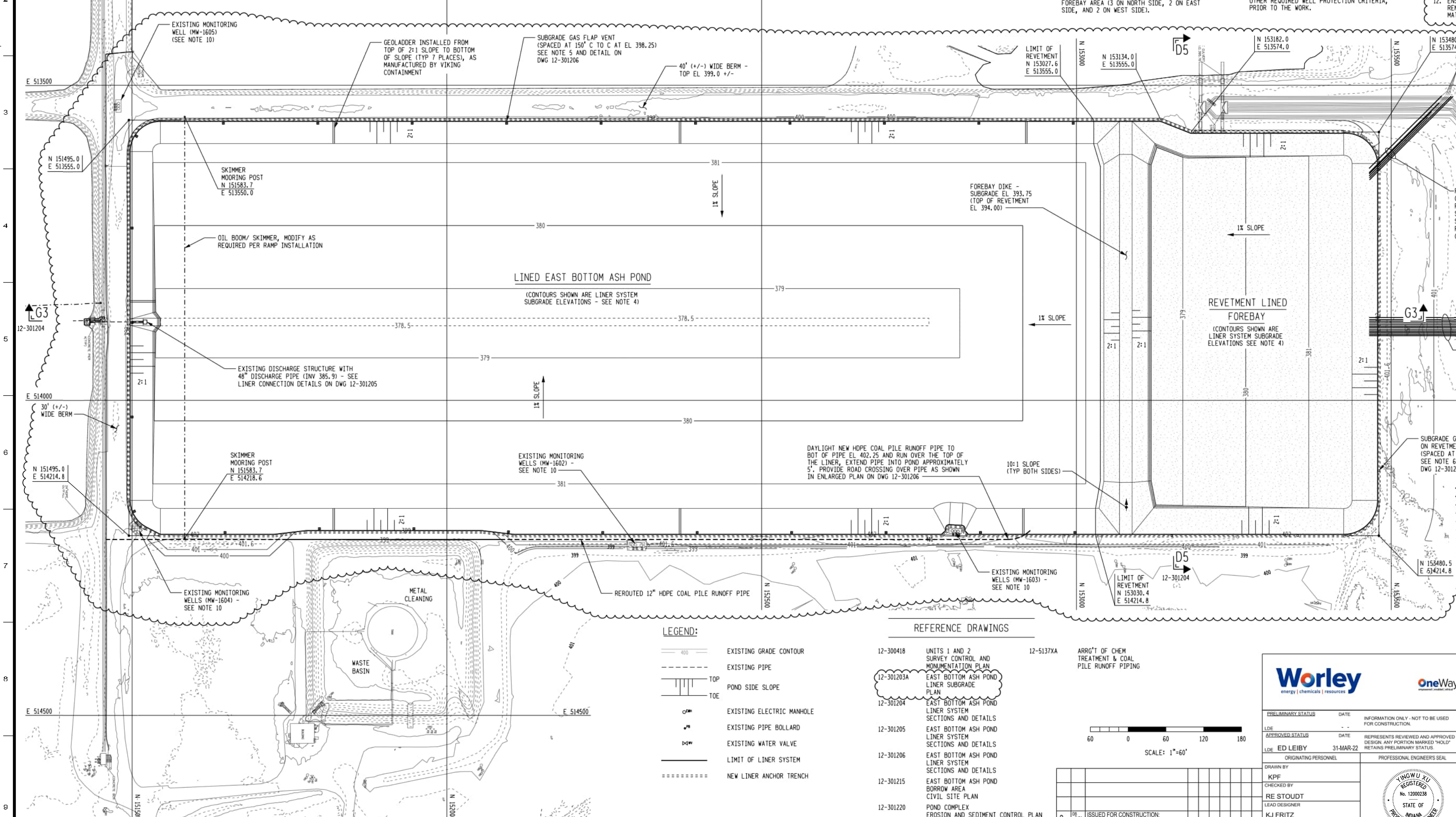
AMERICAN ELECTRIC POWER SERVICE CORP.
2 BROADWAY NEW YORK

ATTACHMENT C2

NEW DESIGN DRAWINGS

## GENERAL NOTES

1. BACKGROUND LAND SURFACE TOPOGRAPHY AND FEATURES ARE FROM A SURVEY BY PRECISION SURVEYING, INC. DATED 02-08-21. HORIZONTAL AND VERTICAL DATUM BASED ON AEP ROCKPORT SITE CONTROL SYSTEM.
2. COORDINATE GRID SHOWN IS SITE COORDINATE SYSTEM. FOR SITE MONUMENTATION SEE DRAWING 12-300418.
3. CONTRACTOR TO PLACE FILL MATERIALS IN EXISTING EAST BOTTOM ASH POND (EXCAVATED AND HAULED FROM ON-SITE BORROW AREA) TO ESTABLISH PREPARED LINER SYSTEM SUBGRADE, AS INDICATED ON LINER DETAILS (OPTION 1) ON REF. DWG 12-301205.
4. FOR LINER SYSTEM SUBGRADE ELEVATIONS SEE DRAWING 12-301203A.
5. INSTALL 25 GAS FLAP VENTS AROUND BOTTOM ASH POND (5 ON SOUTH SIDE, 10 ON EAST SIDE, AND 10 ON WEST SIDE).
6. INSTALL 7 GAS RISER VENTS AROUND POND FOREBAY AREA (3 ON NORTH SIDE, 2 ON EAST SIDE, AND 2 ON WEST SIDE).
7. ALL WORK SHALL BE PERFORMED IN ACCORDANCE WITH A SEQUENCE AND WORK PLAN SUBMITTED BY THE CONTRACTOR AND ACCEPTED BY THE OWNER AND ENGINEER.
8. WORK SHALL NOT BEGIN UNTIL ALL EXISTING EAST BOTTOM ASH POND INFLOWS/OUTFLOWS ARE DIVERTED OR PERMANENTLY PLUGGED.
9. POND LINER SYSTEM SHALL BE ATTACHED TO ALL EXISTING POND STRUCTURES, PIPES, ETC. TO ASSURE NO AREAS OF LEAKING EXIST FOR THE INSTALLED LINER SYSTEM. TYPICAL LINER CONNECTION DETAILS AREA INDICATED ON REF. DWG'S 12-301205 AND 12-301206.
10. MAINTAIN ACCESS TO AND PROTECT ALL EXISTING MONITORING WELLS DURING THE WORK. MAINTAIN A MINIMUM 10 FOOT BUFFER AROUND ANY WELL (NO EARTH DISTURBANCE) WHEN POSSIBLE. IF 10 FOOT BUFFER IS NOT POSSIBLE, GET DOCUMENTED APPROVAL FROM AEP ENVIRONMENTAL SERVICES ON ACCEPTABLE BUFFER, IF SHORING IS REQUIRED, OR ANY OTHER REQUIRED WELL PROTECTION CRITERIA, PRIOR TO THE WORK.
11. REFER TO AND COMPLY WITH THE FOLLOWING AEP SPECIFICATIONS UNLESS INDICATED OTHERWISE ON DRAWINGS:
    A. CE-004 EXCAVATION
    B. CE-006 FILL
    C. CE-006A EARTHWORK (BACKFILL) TESTING
    D. CE-008 SUBSURFACE DRAINAGE SYSTEMS
    E. CE-013A NON-WOVEN GEOTEXTILES
    F. CE-018 SURVEY SERVICES
    G. CE-021 AERIAL PHOTOGRAPHY AND TOPOGRAPHIC MAPPING
    H. CE-026LL GEOMEMBRANE (LLDPE)
    I. CE-035 GEOSYNTHETIC CLAY LINER
    J. CE-036 DEMOLITION REMOVALS AND ALTERATIONS
    K. CE-037 EXCAVATION AND BACKFILL FOR UNDERGROUND UTILITIES
    L. CE-038 FLOWABLE BACKFILL (CONTROLLED LOW-STRENGTH MATERIAL)
    M. CE-040 MATERIALS FOR UNDERGROUND PIPING AND SEWERS
    N. CE-042 INSTALLATION OF UNDERGROUND HDPE PRESSURE PIPING
12. ENSURE PIPES ARE OUT OF THE WAY FOR CCR REMOVAL FOR WEST BOTTOM ASH POND OR CCR MATERIAL IS REMOVED PRIOR TO PLACING PIPES.




## LEGEND:

| | |
|---|---|
| 400 | EXISTING GRADE CONTOUR |
| | EXISTING PIPE |
| TOP / TOE | POND SIDE SLOPE |
| | EXISTING ELECTRIC MANHOLE |
| | EXISTING PIPE BOLLARD |
| | EXISTING WATER VALVE |
| | LIMIT OF LINER SYSTEM |
| | NEW LINER ANCHOR TRENCH |

## REFERENCE DRAWINGS

| | |
|---|---|
| 12-300418 | UNITS 1 AND 2 SURVEY CONTROL AND MONUMENTATION PLAN |
| 12-301203A | EAST BOTTOM ASH POND LINER SUBGRADE PLAN |
| 12-301204 | EAST BOTTOM ASH POND LINER SYSTEM SECTIONS AND DETAILS |
| 12-301205 | EAST BOTTOM ASH POND LINER SYSTEM SECTIONS AND DETAILS |
| 12-301206 | EAST BOTTOM ASH POND LINER SYSTEM SECTIONS AND DETAILS |
| 12-301215 | EAST BOTTOM ASH POND BORROW AREA CIVIL SITE PLAN |
| 12-301220 | POND COMPLEX EROSION AND SEDIMENT CONTROL PLAN |
| 12-30027 | UNIT No. 1 & 2 WASTEWATER & BOTTOM ASH POND AREA SECTIONS & DETAILS |
| 12-5123 | YARD PIPING UNIT No. 1 & 2 SHEET No. 2 OF 39 |
| 12-5137XA | ARRG'T OF CHEM TREATMENT & COAL PILE RUNOFF PIPING |

60 0 60 120 180

SCALE: 1"=60'

| REV | DATE | DESCRIPTION | DRAWN | CHECKED | REVIEWED | LEAD DESIGNER | ENGINEER/TECH SPEC. | LEAD ENGINEER | PROJ. ENGR MANAGER |
|---|---|---|---|---|---|---|---|---|---|
| 2 | 08 JUN 23 | ISSUED FOR CONSTRUCTION; REVISED AS INDICATED | RES | KJF | EDL | KJF | EDL | EDL | MHN |
| 1 | 26 JUL 22 | ISSUED FOR CONSTRUCTION; REMOVED HOLD, REV DISCH STRUCT CALLOUT | KJF | EDL | EDL | KJF | EDL | EDL | MHN |
| 0 | 31 MAR 22 | ISSUED FOR CONSTRUCTION | KPF | RES | EDL | KJF | EDL | EDL | MHN |

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PRELIMINARY STATUS — DATE — INFORMATION ONLY - NOT TO BE USED FOR CONSTRUCTION.
LDE - -

APPROVED STATUS — DATE — REPRESENTS REVIEWED AND APPROVED DESIGN. ANY PORTION MARKED "HOLD" RETAINS PRELIMINARY STATUS.
LDE ED LEIBY 31-MAR-22

ORIGINATING PERSONNEL
DRAWN BY: KPF
CHECKED BY: RE STOUDT
LEAD DESIGNER: KJ FRITZ
ENGINEER/TECH SPECIALIST: ED LEIBY
PROJECT ENGINEERING MANAGER: MH NACEY

PROFESSIONAL ENGINEER'S SEAL
YINGWU XU REGISTERED No. 12000238 STATE OF INDIANA PROFESSIONAL ENGINEER

SEE WORLEY REVISION BLOCK

| DATE | NO. | DESCRIPTION | APPD. |
|---|---|---|---|

REVISIONS

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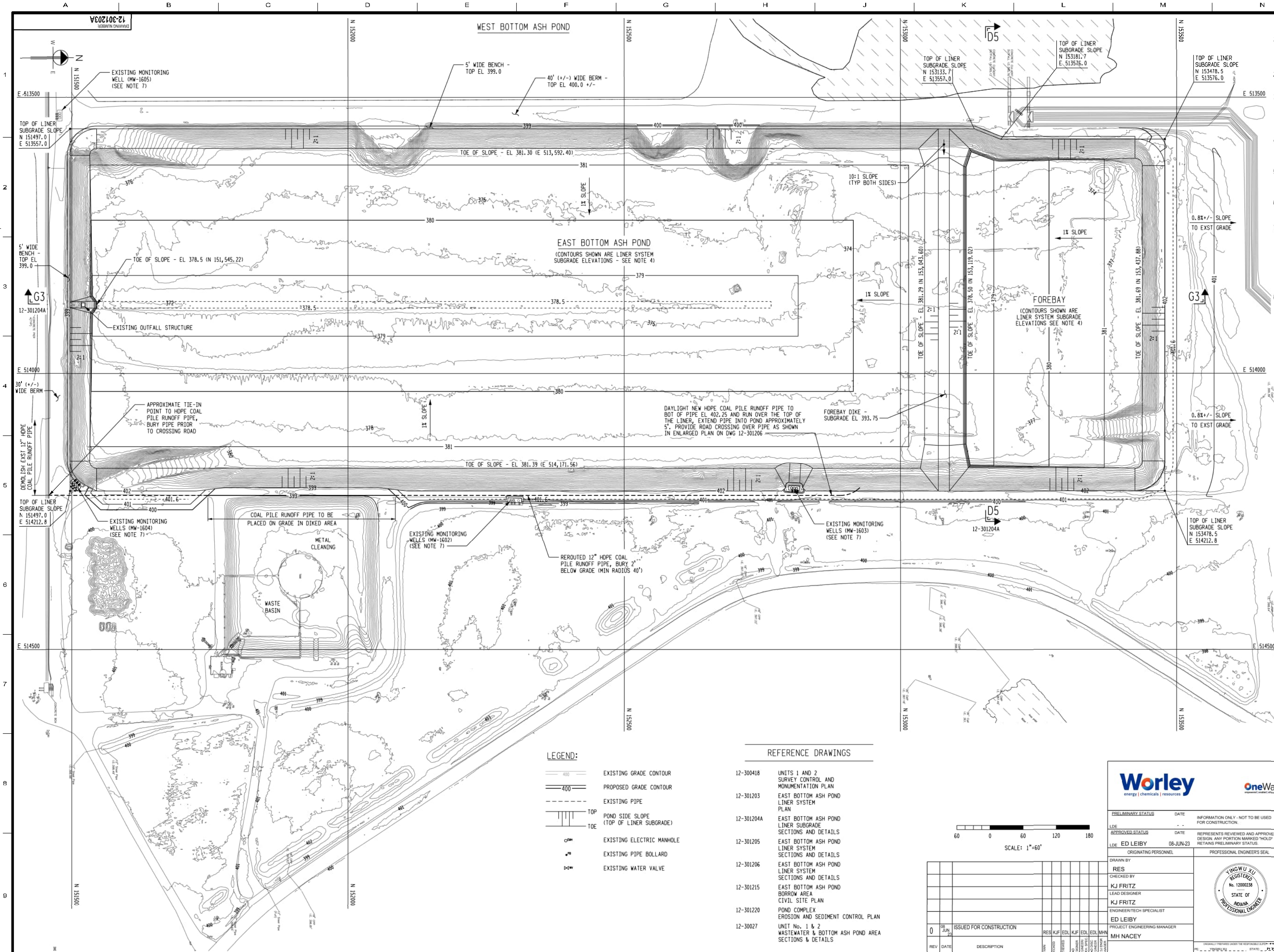
INDIANA MICHIGAN POWER COMPANY
ROCKPORT PLANT
ROCKPORT INDIANA
CCR/ELG PROJECT
**EAST BOTTOM ASH POND LINER SYSTEM PLAN**

UNIT: 12 | DRAWING NUMBER: 301203 | REV 2
SCALE: 1"=60' | CIVIL ENGINEERING
DOCUMENT PREPARED BY WORLEY
AMERICAN ELECTRIC POWER
AEP SERVICE CORP. 1 RIVERSIDE PLAZA COLUMBUS, OH 43215

12-301203

CROSS REFS:




## LEGEND:

| | |
|---|---|
| 400 (light) | EXISTING GRADE CONTOUR |
| 400 (heavy) | PROPOSED GRADE CONTOUR |
| - - - | EXISTING PIPE |
| TOP / TOE | POND SIDE SLOPE (TOP OF LINER SUBGRADE) |
| | EXISTING ELECTRIC MANHOLE |
| | EXISTING PIPE BOLLARD |
| | EXISTING WATER VALVE |

## REFERENCE DRAWINGS

| | |
|---|---|
| 12-300418 | UNITS 1 AND 2 SURVEY CONTROL AND MONUMENTATION PLAN |
| 12-301203 | EAST BOTTOM ASH POND LINER SYSTEM PLAN |
| 12-301204A | EAST BOTTOM ASH POND LINER SUBGRADE SECTIONS AND DETAILS |
| 12-301205 | EAST BOTTOM ASH POND LINER SYSTEM SECTIONS AND DETAILS |
| 12-301206 | EAST BOTTOM ASH POND LINER SYSTEM SECTIONS AND DETAILS |
| 12-301215 | EAST BOTTOM ASH POND BORROW AREA CIVIL SITE PLAN |
| 12-301220 | POND COMPLEX EROSION AND SEDIMENT CONTROL PLAN |
| 12-30027 | UNIT No. 1 & 2 WASTEWATER & BOTTOM ASH POND AREA SECTIONS & DETAILS |

## GENERAL NOTES

1. BACKGROUND LAND SURFACE TOPOGRAPHY AND FEATURES ARE FROM A AERIAL DRONE SURVEY PROVIDED BY AEP VIA CADD FILE; ACAD-230221 FLIGHT SURFACE-MODEL.DWG, DATED FEB. 21, 2023.
2. COORDINATE GRID SHOWN IS SITE COORDINATE SYSTEM. FOR SITE MONUMENTATION SEE DRAWING 12-300418.
3. CONTRACTOR TO PLACE FILL MATERIALS IN EXISTING EAST BOTTOM ASH POND (EXCAVATED AND HAULED FROM ON-SITE BORROW AREA) TO ESTABLISH PREPARED LINER SYSTEM SUBGRADE, AS INDICATED ON LINER DETAILS (OPTION 1) ON REF. DWG 12-301205.
4. LINER SYSTEM SUBGRADE ELEVATIONS SHOWN PROVIDE FOR THE BOTTOM OF THE POND LINER SYSTEM TO BE MINIMUM 5-FOOT SEPARATION FROM THE UPPERMOST AQUIFER AT EL 373.5.
5. ALL WORK SHALL BE PERFORMED IN ACCORDANCE WITH A SEQUENCE AND WORK PLAN SUBMITTED BY THE CONTRACTOR AND ACCEPTED BY THE OWNER AND ENGINEER.
6. WORK SHALL NOT BEGIN UNTIL ALL EXISTING EAST BOTTOM ASH POND INFLOWS/OUTFLOWS ARE DIVERTED OR PERMANENTLY PLUGGED.
7. MAINTAIN ACCESS TO AND PROTECT ALL EXISTING MONITORING WELLS DURING THE WORK. MAINTAIN A MINIMUM 10 FOOT BUFFER AROUND ANY WELL (NO EARTH DISTURBANCE) WHEN POSSIBLE. IF 10 FOOT BUFFER IS NOT POSSIBLE, GET DOCUMENTED APPROVAL FROM AEP ENVIRONMENTAL SERVICES ON ACCEPTABLE BUFFER, IF SHORING IS REQUIRED, OR ANY OTHER REQUIRED WELL PROTECTION CRITERIA, PRIOR TO THE WORK.
8. REFER TO AND COMPLY WITH THE FOLLOWING AEP SPECIFICATIONS UNLESS INDICATED OTHERWISE ON DRAWINGS:
   A. CE-004 EXCAVATION
   B. CE-006 FILL
   C. CE-006A EARTHWORK (BACKFILL) TESTING
   D. CE-008 SUBSURFACE DRAINAGE SYSTEMS
   E. CE-013A NON-WOVEN GEOTEXTILES
   F. CE-018 SURVEY SERVICES
   G. CE-021 AERIAL PHOTOGRAPHY AND TOPOGRAPHIC MAPPING
   H. CE-026LL GEOMEMBRANE (LLDPE)
   I. CE-035 GEOSYNTHETIC CLAY LINER
   J. CE-036 DEMOLITION REMOVALS AND ALTERATIONS
   K. CE-037 EXCAVATION AND BACKFILL FOR UNDERGROUND UTILITIES
   L. CE-038 FLOWABLE BACKFILL (CONTROLLED LOW-STRENGTH MATERIAL)
   M. CE-040 MATERIALS FOR UNDERGROUND PIPING AND SEWERS
   N. CE-042 INSTALLATION OF UNDERGROUND HDPE PRESSURE PIPING

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| | | |
|---|---|---|
| PRELIMINARY STATUS | DATE | INFORMATION ONLY - NOT TO BE USED FOR CONSTRUCTION |
| LDE | - - | |
| APPROVED STATUS | DATE | REPRESENTS REVIEWED AND APPROVED DESIGN. ANY PORTION MARKED "HOLD" RETAINS PRELIMINARY STATUS. |
| LDE ED LEIBY | 08-JUN-23 | |

ORIGINATING PERSONNEL: DRAWN BY RES; CHECKED BY KJ FRITZ; LEAD DESIGNER KJ FRITZ; ENGINEER/TECH SPECIALIST ED LEIBY; PROJECT ENGINEERING MANAGER MH NACEY

PROFESSIONAL ENGINEER'S SEAL: YINGWU XU, REGISTERED No. 12000238, STATE OF INDIANA, PROFESSIONAL ENGINEER

| REV | DATE | DESCRIPTION | DRAWN | CHECKED | REVIEWED | LEAD DESIGNER | ENG/TECH SPECIALIST | PROJECT ENG MANAGER |
|---|---|---|---|---|---|---|---|---|
| 0 | 08 JUN 23 | ISSUED FOR CONSTRUCTION | RES | KJF | EDL | KJF | EDL | MHN |

SEE WORLEY REVISION BLOCK

| DATE | NO. | DESCRIPTION | APPD. |
|---|---|---|---|

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INDIANA MICHIGAN POWER COMPANY

ROCKPORT PLANT

ROCKPORT — INDIANA

CCR/ELG PROJECT

**EAST BOTTOM ASH POND LINER SUBGRADE PLAN**

| UNIT: | DRAWING NUMBER: | REV. |
|---|---|---|
| 12 | 301203A | 0 |

SCALE: 1"=60' — CIVIL ENGINEERING

DOCUMENT PREPARED BY WORLEY

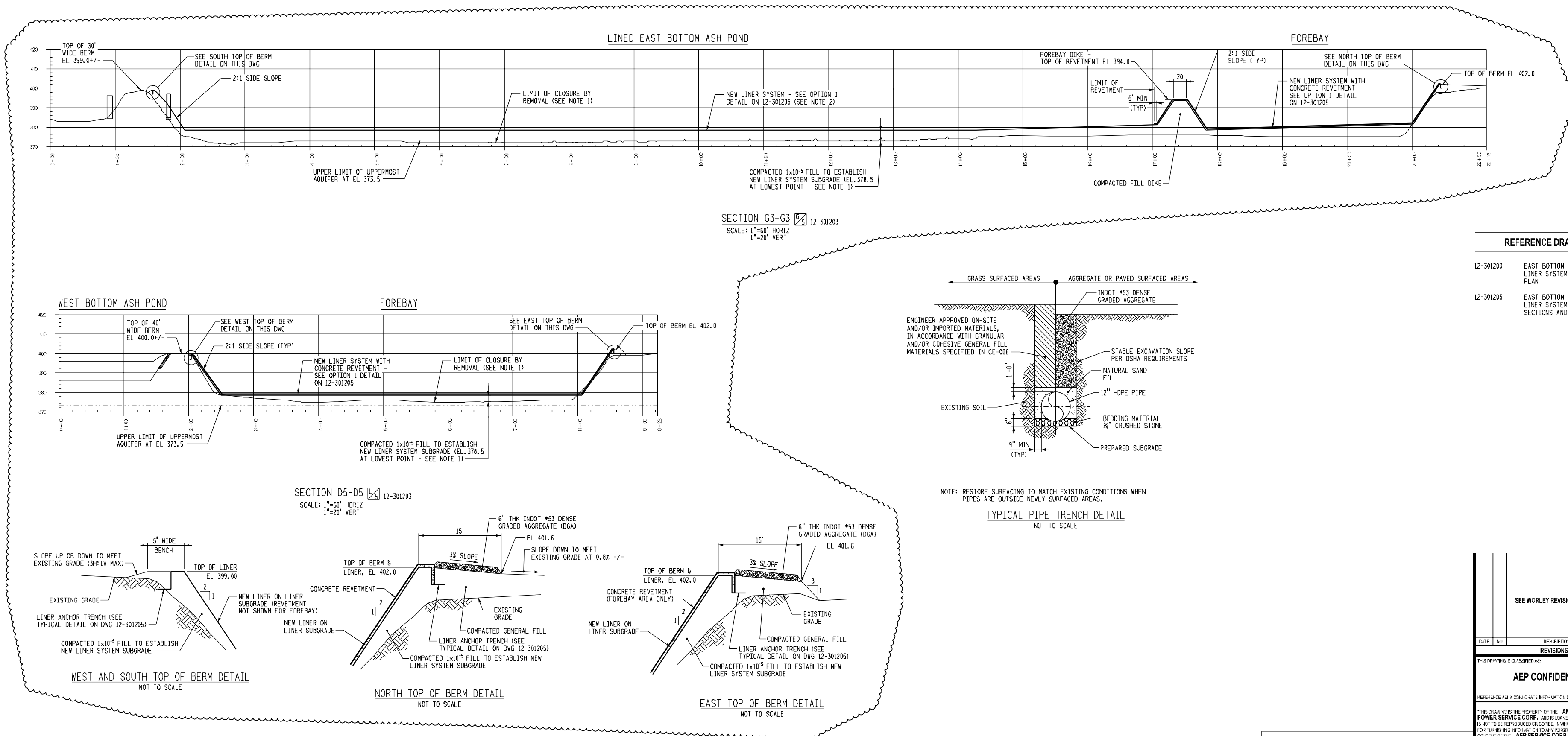
AEP SERVICE CORP.
1 RIVERSIDE PLAZA
COLUMBUS, OH 43215

CROSS REFS:

12-301204

## GENERAL NOTES

1. THE EXPECTED POND BOTTOM ELEVATION AFTER CLOSURE BY REMOVAL IS EL 376.0 (12-INCHES BELOW ORIGINAL POND BOTTOM), HOWEVER, IF THE CCR CLOSURE BY REMOVAL EXCAVATION/ VERIFICATION PROCESS EXTENDS BELOW EL 376.0, THEN ADDITIONAL FILL MATERIAL WILL BE REQUIRED, ACCORDINGLY, TO REACH THE NEW LINER SYSTEM SUBGRADE ELEVATION.
2. LINER SYSTEM SUBGRADE (EL 378.5 AT LOWEST POINT) PROVIDES FOR THE BOTTOM OF THE POND LINER SYSTEM TO BE MINIMUM 5-FOOT SEPARATION FROM THE UPPERMOST AQUIFER AT EL 373.5.




## REFERENCE DRAWINGS

| | |
|---|---|
| 12-301203 | EAST BOTTOM ASH POND LINER SYSTEM PLAN |
| 12-301205 | EAST BOTTOM ASH POND LINER SYSTEM SECTIONS AND DETAILS |

SCALE: 1"=60'

| REV | DATE | DESCRIPTION |
|---|---|---|
| 1 | JUL 22 | ISSUED FOR CONSTRUCTION; REVISED AS INDICATED |
| 0 | MAR 22 | ISSUED FOR CONSTRUCTION |

SEE WORLEY REVISION BLOCK

REVISIONS

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Worley — energy | chemicals | resources — OneWay

ED LEIBY 31-MAR-22

DRAWN BY: KPF
CHECKED BY: RE STOUDT
LEAD DESIGNER: KJ FRITZ
ENGINEER: ED LEIBY
PROJECT ENGINEERING MANAGER: MH NACEY

YINGWU XU REGISTERED No. 12000238 STATE OF INDIANA PROFESSIONAL ENGINEER

INDIANA MICHIGAN POWER COMPANY

ROCKPORT PLANT

ROCKPORT — INDIANA

CCR/ELG PROJECT

EAST BOTTOM ASH POND LINER SYSTEM SECTIONS AND DETAILS

UNIT: 12 | DRAWING NUMBER: 301204 | REV: 1

SCALE: AS NOTED | CIVIL ENGINEERING

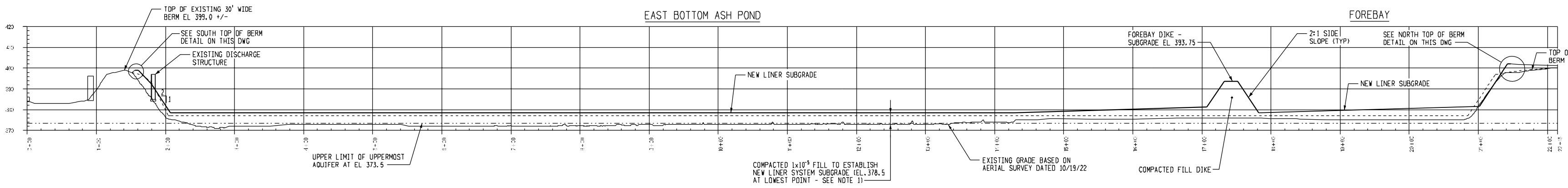
DOCUMENT PREPARED BY WORLEY

AEP SERVICE CORP. 1 RIVERSIDE PLAZA COLUMBUS, OH 43215

CROSS REFS:

## GENERAL NOTES

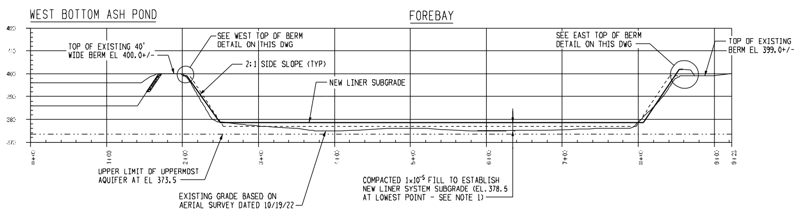
1. THE EXPECTED POND BOTTOM ELEVATION AFTER CLOSURE BY REMOVAL IS EL 376.0 (12-INCHES BELOW ORIGINAL POND BOTTOM), HOWEVER, IF THE CCR CLOSURE BY REMOVAL EXCAVATION/ VERIFICATION PROCESS EXTENDS BELOW EL 376.0, THEN ADDITIONAL FILL MATERIAL WILL BE REQUIRED, ACCORDINGLY, TO REACH THE NEW LINER SYSTEM SUBGRADE ELEVATION.
2. LINER SYSTEM SUBGRADE (EL 378.5 AT LOWEST POINT) PROVIDES FOR THE BOTTOM OF THE POND LINER SYSTEM TO BE MINIMUM 5-FOOT SEPARATION FROM THE UPPERMOST AQUIFER AT EL 373.5.



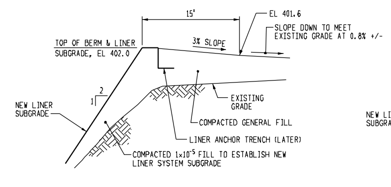

SECTION G3-G3 12-301203A
SCALE: 1"=60' HORIZ
1"=20' VERT

## REFERENCE DRAWINGS

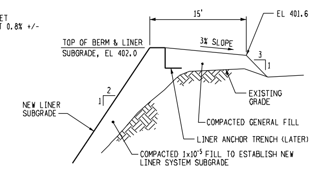
12-301203A EAST BOTTOM ASH POND LINER SUBGRADE PLAN



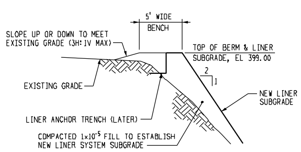

SECTION D5-D5 12-301203A
SCALE: 1"=60' HORIZ
1"=20' VERT




NORTH TOP OF BERM DETAIL
NOT TO SCALE




EAST TOP OF BERM DETAIL
NOT TO SCALE




WEST AND SOUTH TOP OF BERM DETAIL
NOT TO SCALE

SCALE: 1"=60'

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ISSUE: ED LEIBY 08-JUN-23

DRAWN BY: RES
CHECKED BY: KJ FRITZ
LEAD DESIGNER: KJ FRITZ
ENGINEER: ED LEIBY
PROJECT ENGINEERING MANAGER: MH NACEY

YINGWU XU REGISTERED No. 12000238 STATE OF INDIANA PROFESSIONAL ENGINEER

INDIANA MICHIGAN POWER COMPANY
ROCKPORT PLANT
ROCKPORT INDIANA
CCR/ELG PROJECT
EAST BOTTOM ASH POND LINER SUBGRADE SECTIONS AND DETAILS

UNIT: 12 DRAWING NUMBER: 301204A REV: 0
SCALE: AS NOTED CIVIL ENGINEERING
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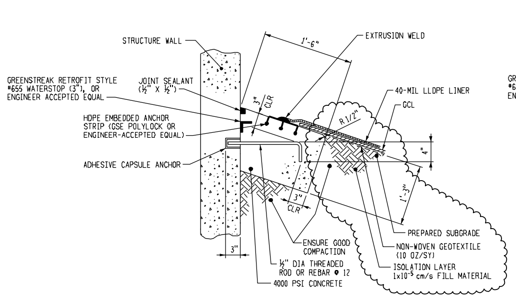
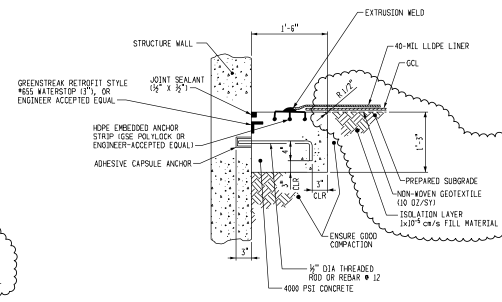
12-301204A

12-301205

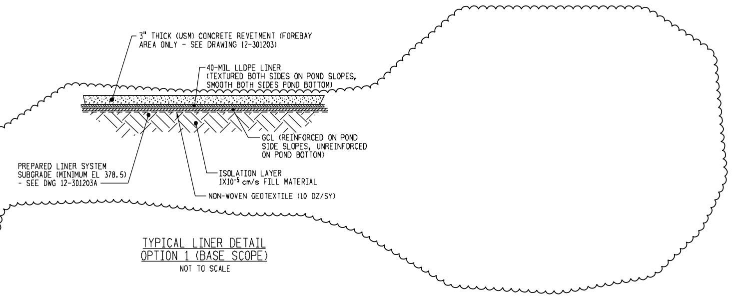



NORTH SIDE OF STRUCTURE
NOT TO SCALE

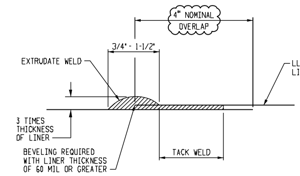



EAST AND WEST SIDES OF STRUCTURE
NOT TO SCALE

DISCHARGE/OUTFALL STRUCTURE
LINER CONNECTION DETAIL
OPTION 1 (BASE SCOPE)
NOT TO SCALE



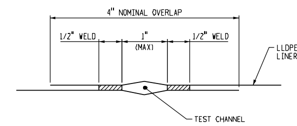

TYPICAL LINER DETAIL
OPTION 1 (BASE SCOPE)
NOT TO SCALE




NOTES:

1. LINER SHEETS SHALL BE TACK-WELDED TOGETHER AT OVERLAP TO FORM TEMPORARY BOND PRIOR TO WELDING.
2. GRINDING NOT TO EXCEED ¼" PAST "SQUEEZE-OUT" ON EITHER SIDE. PROPER CARE SHOULD BE TAKEN IN NOT REMOVING TOO MUCH MATERIAL WHEN GRINDING.
3. VACUUM TESTING SHALL BE THE NON-DESTRUCTIVE SEAM TEST METHOD FOR EXTRUSION WELDS.

EXTRUSION WELD
NOT TO SCALE




NOTES:

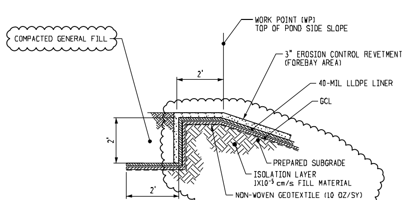
1. DOUBLE FUSION WELDING SHALL BE THE PRIMARY SEAMING TECHNIQUE USED.
2. AIR PRESSURE OR VACUUM TESTING SHALL BE THE NON-DESTRUCTIVE SEAM TEST METHODS FOR DOUBLE FUSION WELDS.

DOUBLE FUSION WELD
NOT TO SCALE

## GENERAL NOTES

## REFERENCE DRAWINGS

| | |
|---|---|
| 12-301203 | EAST BOTTOM ASH POND LINER SYSTEM PLAN |
| 12-301203A | EAST BOTTOM ASH POND LINER SUBGRADE PLAN |




TYPICAL ANCHOR TRENCH DETAIL
OPTION 1 (BASE SCOPE)
NOT TO SCALE

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| APPROVED STATUS | DATE | REPRESENTS REVIEWED AND APPROVED DESIGN. ANY PORTION MARKED "HOLD" RETAINS "PRELIMINARY" STATUS. |
| ED LEIBY | 31-MAR-22 | |
| ORIGINATING PERSONNEL | | PROFESSIONAL ENGINEER'S SEAL |

DRAWN BY: KPF
CHECKED BY: RE STOUDT
LEAD DESIGNER: KJ FRITZ
ENGINEERING SPECIALIST: ED LEIBY
PROJECT ENGINEERING MANAGER: MH NACEY

YINGWU XU — REGISTERED No. 12000238 — STATE OF INDIANA — PROFESSIONAL ENGINEER

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|---|---|---|---|---|---|---|---|---|---|
| 1 | 08-JUL-22 | ISSUED FOR CONSTRUCTION; REVISED AS INDICATED | RES | KJF | EJL | KJF | EJL | EJL | MHN |
| 0 | 31-MAR-22 | ISSUED FOR CONSTRUCTION | KPF | RES | EJL | KJF | EJL | EJL | MHN |

INDIANA MICHIGAN POWER COMPANY
**ROCKPORT PLANT**
ROCKPORT — INDIANA
CCR/ELG PROJECT
**EAST BOTTOM ASH POND LINER SYSTEM SECTIONS AND DETAILS**

| UNIT | DRAWING NUMBER | REV |
|---|---|---|
| 12 | 301205 | 1 |

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DOCUMENT PREPARED BY WORLEY

AEP SERVICE CORP.
1 RIVERSIDE PLAZA
COLUMBUS, OH 43215

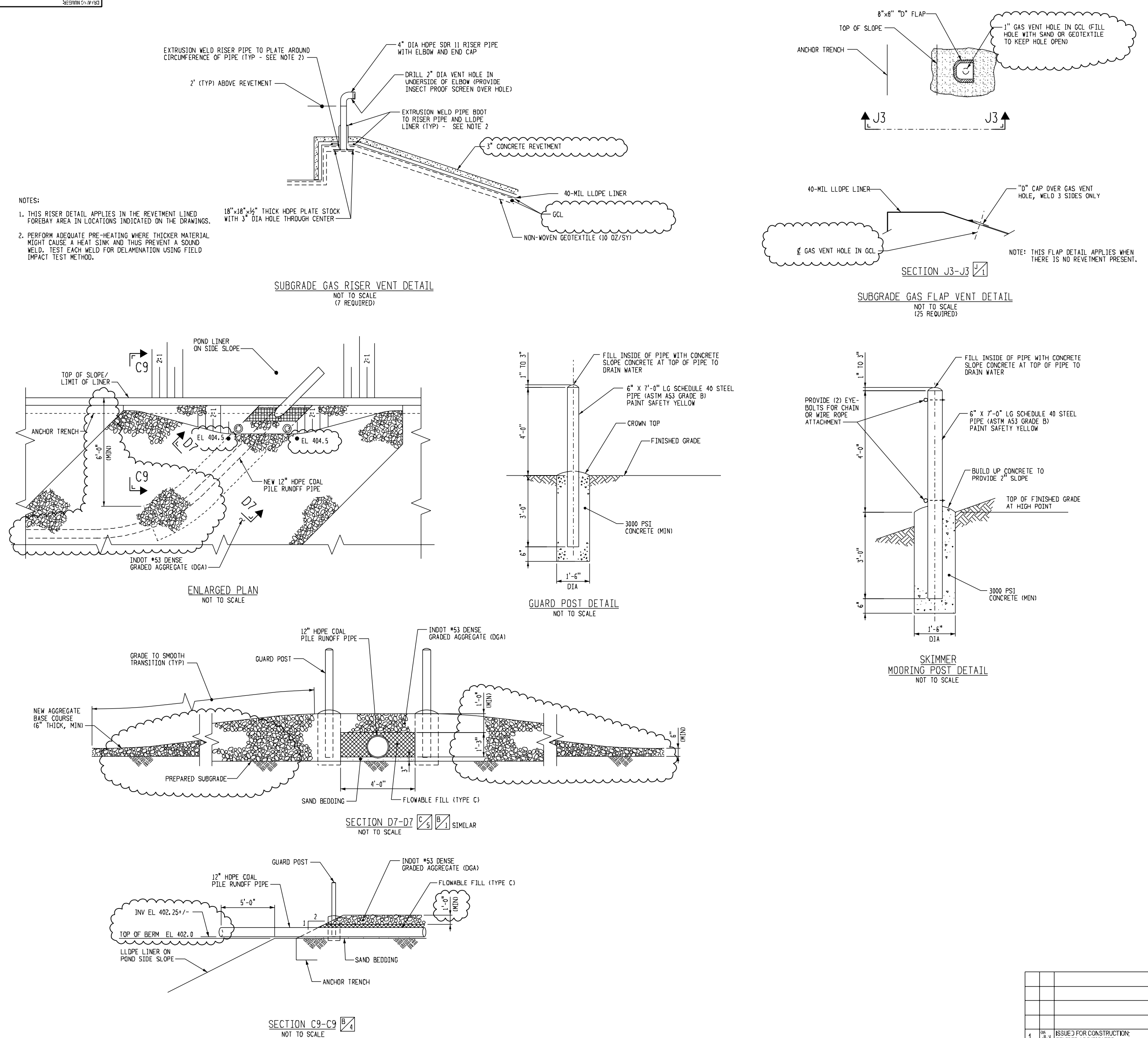
CROSS REFS:

12-301206

## GENERAL NOTES

NOTES:

1. THIS RISER DETAIL APPLIES IN THE REVETMENT LINED FOREBAY AREA IN LOCATIONS INDICATED ON THE DRAWINGS.
2. PERFORM ADEQUATE PRE-HEATING WHERE THICKER MATERIAL MIGHT CAUSE A HEAT SINK AND THUS PREVENT A SOUND WELD. TEST EACH WELD FOR DELAMINATION USING FIELD IMPACT TEST METHOD.




## REFERENCE DRAWINGS

| | |
|---|---|
| 12-301203 | EAST BOTTOM ASH POND LINER SYSTEM PLAN |

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| DATE | NO | DESCRIPTION | APPD |
|---|---|---|---|

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APPROVED STATUS — REPRESENTS REVIEWED AND APPROVED DESIGN.

EOR: ED LEIBY 31-MAR-22

ORIGINATING PERSONNEL / PROFESSIONAL ENGINEER SEAL

DRAWN BY: KPF
CHECKED BY: RE STOUDT
LEAD DESIGNER: KJ FRITZ
ENGINEERING SPECIALIST: ED LEIBY
PROJECT ENGINEERING MANAGER: MH NACEY

YINGWU XU — REGISTERED — No. 12000238 — STATE OF INDIANA — PROFESSIONAL ENGINEER

| REV | DATE | DESCRIPTION | DRAWN | CHECKED | REVIEWED | LEAD DESIGNER | ENG. SPECIALIST | PROJ ENG MGR |
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| 0 | 31-MAR-22 | ISSUED FOR CONSTRUCTION | KPF | RES | EDL | KJF | EDL | EDL | MHN |

INDIANA MICHIGAN POWER COMPANY

**ROCKPORT PLANT**

ROCKPORT — INDIANA

CCR/ELG PROJECT

**EAST BOTTOM ASH POND LINER SYSTEM SECTIONS AND DETAILS**

UNIT: 12 — DRAWING NUMBER: 301206 — REV: 1

SCALE: NONE — CIVIL ENGINEERING

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1 RIVERSIDE PLAZA
COLUMBUS, OH 43215

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# ATTACHMENT D1

## ORIGINAL HYDROLOGY AND HYDRAULIC REPORT

# Hydrologic and Hydraulic Analysis Report

**Rockport Plant Bottom Ash Pond Complex**

**Rockport, Indiana**

November 2015

Terracon Project Number: N4155126

**Prepared for:**

American Electric Power
1 Riverside Plaza
Columbus, Ohio

**Prepared by:**

Terracon Consultants, Inc.
Columbus, Ohio

November 5, 2015

American Electric Power
1 Riverside Plaza
Columbus, OH 43215

Attn: Mr. John Massey-Norton
P: [614] 716 2924
E: jtmasseynorton@aep.com

Re: Hydrologic and Hydraulic Analysis and P.E. Certification
Rockport Plant Bottom Ash Pond Complex, Rockport, Indiana
Terracon Project Number: N4155126

Dear Mr. Massey-Norton:

Terracon Consultants, Inc. is submitting the enclosed report for the Hydrologic and Hydraulic analysis and P.E. Certification for the AEP Rockport Plant Bottom Ash Pond Complex located at Rockport, Indiana. The report analyzes the impoundment's existing design and outlet structures for conformance with the recently mandated USEPA rule 40 CFR Part 257, Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities (CCR rules).and provides a profession engineer certification.

If you have any questions regarding this submittal, please contact me at (614) 328-5184.

Sincerely,
**Terracon Consultants, Inc.**

Baba M. Yahaya, P.E.
Project Engineer

Mohammad S. Finy, P.E
Department Manager, Geo-Environmental Services

Enclosure

## TABLE OF CONTENTS



## LIST OF EXHIBITS



## LIST OF ATTACHMENTS

# 1.0 INTRODUCTION

This report provides hydrologic and hydraulic analysis of the existing Bottom Ash Pond Complex (impoundment facility) of the Rockport Plant (plant) located in Rockport, Indiana. The site location is shown on Exhibit 1. The plant uses the impoundment facility to temporarily store Coal Combustion Residuals (CCR). The impoundment facility consists of a series of ponds, and a metal cleaning tank secondary containment basin as shown on Exhibit 2. Six of the ponds including: East Bottom Ash Pond, West Bottom Ash Pond, East Wastewater Pond, West Wastewater Pond, Reclaim Water Pond, and Clearwater Pond are interconnected and receive mainly CCR, wastewater, and stormwater runoff pumped from the plant to the system as its major external influent. The other source of influent is direct precipitation that falls within the perimeter of the impoundment facility during a storm event. The CCR is sluiced into the system at the Bottom Ash Ponds where they settle out, and the sluiced water is then decanted to the wastewater ponds. Effluent from the system eventually discharges through an outlet structure located in the Clearwater Pond.

The intent of this analysis is to determine whether or not the impoundment facility meets the April 17, 2015 USEPA mandated CCR rules requirements.

According to the CCR rules, CCR surface impoundments shall comply with the hydrologic and hydraulic capacity requirements specified under Section 257.82 of the rules and presented below:

Section 257.82

(a) The owner or operator of an existing or new CCR surface impoundment or any lateral expansion of a CCR surface impoundment must design, construct, operate, and maintain an inflow design flood control system as specified in paragraphs (a)(1) and (a)(2) of this section.

(1) The inflow design flood control system must adequately manage flow into the CCR unit during and following the peak discharge of the inflow design flood specified in paragraph (a)(3) of this section.

(2) The inflow design flood control system must adequately manage flow from the CCR unit to collect and control the peak discharge resulting from the inflow design flood specified in paragraph (a)(3) of this section.

(3) The inflow design flood is:

(i) For a high hazard potential CCR surface impoundment, as determined under section 257.73(a)(2) or section 257.74(a)(2), the probable maximum flood;

(ii) For a significant hazard potential CCR surface impoundment, as determined under section 257.73(a)(2) or section 257.74(a)(2), the 1,000-year flood;

(iii) For a low hazard potential CCR surface impoundment, as determined under section 257.73(a)(2) or section 257.74(a)(2), the 100-year flood; or

(iv) For an incised CCR surface impoundment, the 25-year flood.

(b) Discharge from the CCR unit must be handled in accordance with the surface water requirements under section 257.3-3.

(c) Inflow design flood control system plan.

(1) Content of the plan. The owner or operator must prepare initial and periodic inflow design flood control system plans for the CCR unit according to the timeframes specified in paragraphs (c)(3) and (c)(4) of this section. These plans must document how the inflow design flood control system has been designed and constructed to meet the requirements of this section. Each plan must be supported by appropriate engineering calculations. The owner or operator of the CCR unit has completed the inflow design flood control system plan when the plan has been placed in the facility's operating record as required by section 257.105(g)(4).

(2) Amendment of the plan. The owner or operator of the CCR unit may amend the written inflow design flood control system plan at any time provided the revised plan is placed in the facility's operating record as required by § 257.105(g)(4). The owner or operator must amend the written inflow design flood control system plan whenever there is a change in conditions that would substantially affect the written plan in effect.

(3) Timeframes for preparing the initial plan.

(i) Existing CCR surface impoundments. The owner or operator of the CCR unit must prepare the initial inflow design flood control system plan no later than October 17, 2016.

(ii) New CCR surface impoundments and any lateral expansion of a CCR surface impoundment. The owner or operator must prepare the initial inflow design flood control system plan no later than the date of initial receipt of CCR in the CCR unit.

(4) Frequency for revising the plan. The owner or operator must prepare periodic inflow design flood control system plans required by paragraph (c)(1) of this section every five years. The date of completing the initial plan is the basis for establishing the deadline to complete the first periodic plan. The owner or operator may complete any required plan prior to the required deadline provided the owner or operator places the completed plan into the facility's operating record within a reasonable amount of time. In all cases, the deadline for completing a subsequent plan is based on the date of completing the previous plan. For purposes of this paragraph, the owner or operator has completed an inflow design flood control system plan when the plan has been placed in the facility's operating record as required by section 257.105(g)(4).

(5) The owner or operator must obtain a certification from a qualified professional engineer stating that the initial and periodic inflow design flood control system plans meet the requirements of this section.

(d) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in section 257.105(g), the notification requirements specified in section 257.106(g), and the internet requirements specified in section 257.107(g).

## 2.0 INFLOW DESIGN FLOOD CONTROL SYSTEM

As mentioned in section 1.0, inflow into the impoundment facility include CCR, wastewater, and stormwater runoff from various sources pumped into the facility; and direct precipitation that falls within the perimeter of the facility. Water from the Bottom Ash Ponds flow to the Wastewater Ponds, which flow into a distribution structure and can be discharged into the Reclaim Water Pond or the Clearwater Pond. Discharge water from the Reclaim Water Pond is either pumped back to the plant for recirculation, or flows to the Clearwater Pond and then to the Ohio River via an outlet structure. The CCR, wastewater, and stormwater runoff are pumped into the facility through a series of pipes designed to handle the various required capacities. The pipes discharge into the facility through concrete vaults designed to handle the inflows. The water from the Bottom Ash Ponds flows into the Wastewater Ponds through a reinforced concrete vertical drop inlet connected to a 48 inch diameter fiberglass pipe located in the southern dikes of the Bottom Ash Ponds. The Wastewater Ponds drain to either the Reclaim Water Pond or the Clearwater Pond through a gated distribution structure. A 42 inch diameter fiberglass pipe connects the Reclaim Water Pond to the Clearwater Pond. Effluent from the impoundment facility is discharged through an outlet structure located in the Clearwater Pond. The outlet structure consists of a concrete overflow channel leading to a vault/riser with a 66-inch diameter CMP outflow pipe. The outflow pipe leads to catch basin and then on to an outfall at the Ohio River.

Water balance information provided by AEP indicates that influent is pumped into the facility at the rate of approximately 12 million gallons per day (MGD) (19 cfs) to the Bottom Ash Pond, and 13 MGD (20 cfs) to the Wastewater pond. Information on the influent is presented in Attachment 1. The additional inflow due to direct precipitation is dependent on the hazard potential classification of the facility. The facility is classified as a “low hazard potential” facility. The hazard potential classification approach is presented in Section 2.2 of this report. The additional inflow under this low hazard potential classification is the peak discharge during and following the 100-year flood. However, to be more conservative for the purpose of this analysis, the additional inflow is estimated as the peak discharge during and following the 1000-year flood The peak discharge from the 1000-year inflow design flood is estimated using Bentley’s PondPack software (see Section 2.3 of this report).

## 2.1 Hazard Potential Classification

Hazard potential classification means the possible adverse incremental consequences that result from the release of water or stored contents due to failure of the diked CCR surface impoundment or mis-operation of the diked CCR surface impoundment or its appurtenances. The hazardous potential classifications for CCR surface impoundments include high hazard potential, significant hazard potential, and low hazard potential.

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

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

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

The Rockport Plant impoundment facility is classified as a low hazard potential impoundment. This classification is in concurrence with the hazard potential assessment presented in the March 2011USEPA report titled "Dam Safety Assessment of CCW Impoundments, Rockport Power Plant". The report was prepared for the USEPA by O'Brien & Gere and presents safety assessment of the impoundment facility.

Pursuant to Section 257.73(a)(2) of the CCR rules, the hazard potential classification assessments of this facility will be performed every five years.

## 2.2 Computation Methods

The impoundment facility was modeled and analyzed for its adequacy to collect and control the peak discharge resulting from 1000-year design storm using Bentley's PondPack version 8i software released March 5, 2012 (PondPack).

PondPack is a versatile software program to model site drainage studies. The program can be used to model rainfall and runoff from watersheds to detention and retention facilities, outlet structures, and channels using various.

The SCS Hydrograph method was used to estimate the peak discharge (inflow) resulting from direct precipitation that falls within the perimeter of the each pond. PondPack computes the peak discharge using the equation:

$$q_p = q_u * A_m * Q * F_p$$

Where $q_p$ = Peak discharge (cfs)
$q_u$ = Unit peak discharge (csm/in)
$A_m$ = Drainage area ($mi^2$)
$Q$ = Runoff (in)
$F_p$ = Pond and swamp adjustment factor

Other applicable intermediate equations used by the model are included in the model output presented in Attachment 3.

The model requires precipitation depth, catchment area, runoff curve number and time of concentration as input to estimate the peak discharge. Hydraulically, development of the PondPack model requires input defining the facility's structural components, including pond, inlet, and outlet structures. Operationally, the east and west Bottom Ash/Wastewater Ponds operate in alternate sequences where the active set receives influent and the inactive set is cleaned out. For this analysis, a scenario in which water flows from the West Bottom Ash Pond to the West Wastewater Pond and to the Clearwater Pond is considered and modeled (See Exhibit 3). Each pond's surface area defines its catchment area (See Exhibit 2). A precipitation depth of 10.3 inches corresponding to the 1000 year storm (see Attachment 2) was used. A curve number of 100 was used since the rainfall will be direct runoff. A minimum time of concentration of 5 minutes was used. The water from the West Bottom Ash Pond flows into the West Wastewater Pond through a reinforced concrete vertical drop inlet connected to a 48 inch diameter fiberglass pipe located in the southern dike of the Bottom Ash Pond. The West Wastewater Pond drains to the Clearwater Pond through a gated distribution structure. A 66 inch diameter CMP pipe leads from the Clearwater Pond to a catch basin and eventually to an outfall at the Ohio River.

## 2.3 Results

From the PondPack analysis, the total volume of influent pumped into the system (77 acre-feet) in a 24 hour period is larger than the volume of precipitation (48 acre-feet) resulting from the 1000-year storm. However, the peak flows into the system due to the 1000-year storm are higher than the influent pumping rates. The Influent volumes and peak flow rates are summarized in the following tables 1 and 2.

**Table 1. Influent Volumes**

| Pond | Pumped Influent (Acre-feet) | 1000-year Storm (Acre-feet) |
|---|---|---|
| West Bottom Ash Pond | 37.7 | 29.2 |
| West Wastewater Pond | 39.7 | 15.4 |
| Clearwater Pond | 0 | 3.4 |

**Table 2. Peak Influent Flow Rate**

| Pond | Pumped Influent (cfs) | 1000-year Storm (cfs) |
|---|---|---|
| West Bottom Ash Pond | 19 | 451 |
| West Wastewater Pond | 20 | 227 |
| Clearwater Pond | 0 | 50 |

The maximum water surface elevation and freeboard resulting from the pumped influent and 1000-year storm are summarized in the table below:

**Table 3. Water Elevation and Freeboard**

| Pond | Maximum Water Elevation (ft) | Freeboard (ft) |
|---|---|---|
| West Bottom Ash Pond | 395.2 | 3.8 |
| West Wastewater Pond | 389.4 | 2.6 |
| Clearwater Pond | 382.0 | 10 |

The inflow and outflow hydrographs are included in the PondPack Model presented in Attachment 3.

It can be concluded from the above results that the Bottom Ash Pond Complex has adequate hydrologic and hydraulic capacity to collect and control the peak discharge resulting from the 1000-year inflow design flood and therefore meets the April 17, 2015 USEPA mandated CCR rules requirements.

## 3.0 DISCHARGE FROM THE IMPOUNDMENT FACILITY

The discharge from the impoundment facility to the Ohio River is handled in accordance with the Plant's NPDES Permit. This conforms to the requirements Section 257.82 (b) of the CCR rules.

## 4.0 INFLOW DESIGN FLOOD CONTROL SYSTEM PLAN

The inflow design flood control system plan will be prepared pursuant to Section 257.82 (c) of the CCR rules. The plan will document how the inflow design flood control system has been designed and constructed to meet the rules requirements.

## 5.0 RECORDKEEPING, NOTIFICATION, AND INTERNET REQUIREMENTS

Pursuant to Sections 257.105(g), 257.106(g) and 257.107(g), the initial and periodic inflow design flood control system plan as required by Section 257.82(c) will be placed in the facility's operating records, as well as published on the facility's CCR rule compliance data information website. AEP will notify the Director of Indiana Department of Environmental Protection when the information is placed in the operating record and on the website.

## 6.0 REFERENCES

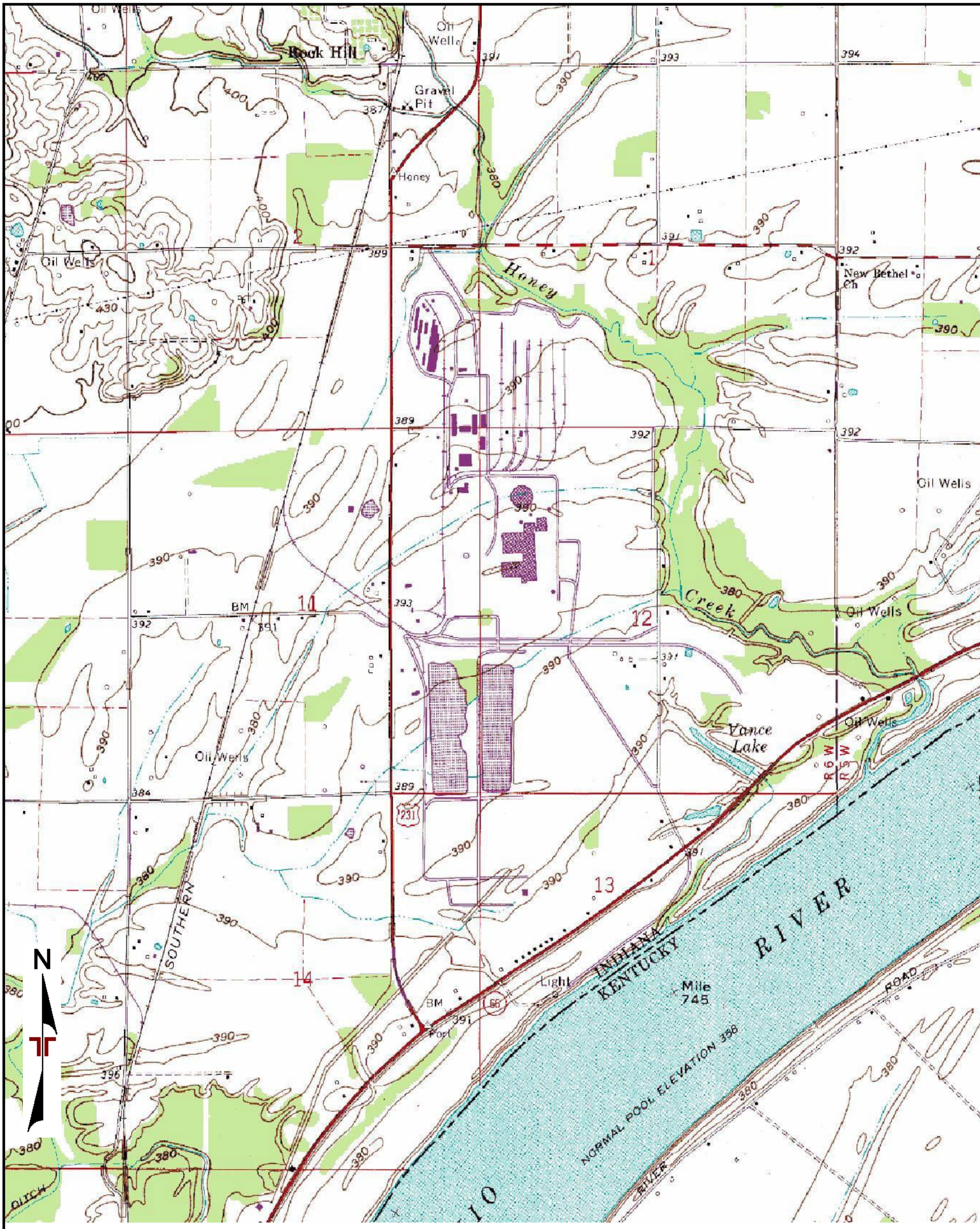
- AEP Project Drawing Numbers 12-30013-1,12-30013-15, and 12-30027-7, containing cross section and details for the Rockport Bottom Ash Pond Complex.
- Dam Safety Assessment of CCW Impoundments, Rockport Power Plant. Prepared for the USEPA. Prepared by O'Brien & Gere Engineers, Inc. March 24, 2011.

## 7.0 P.E. CERTIFICATION

Based on the site reconnaissance visit, hazard potential assessment, and the hydrologic and hydraulic analysis performed by Terracon personnel, I hereby certify that the significant hazard potential classification for the Rockport Plant Bottom Ash Pond Complex in this report was conducted in accordance with requirements of Section 257.73 of the CCR Rules and that the facility has adequate hydrologic and hydraulic capacity to collect and control the peak discharge resulting from 1000-year design storm.

Baba M. Yahaya, P.E.
Certifying Engineer
PE11500100

# EXHIBITS



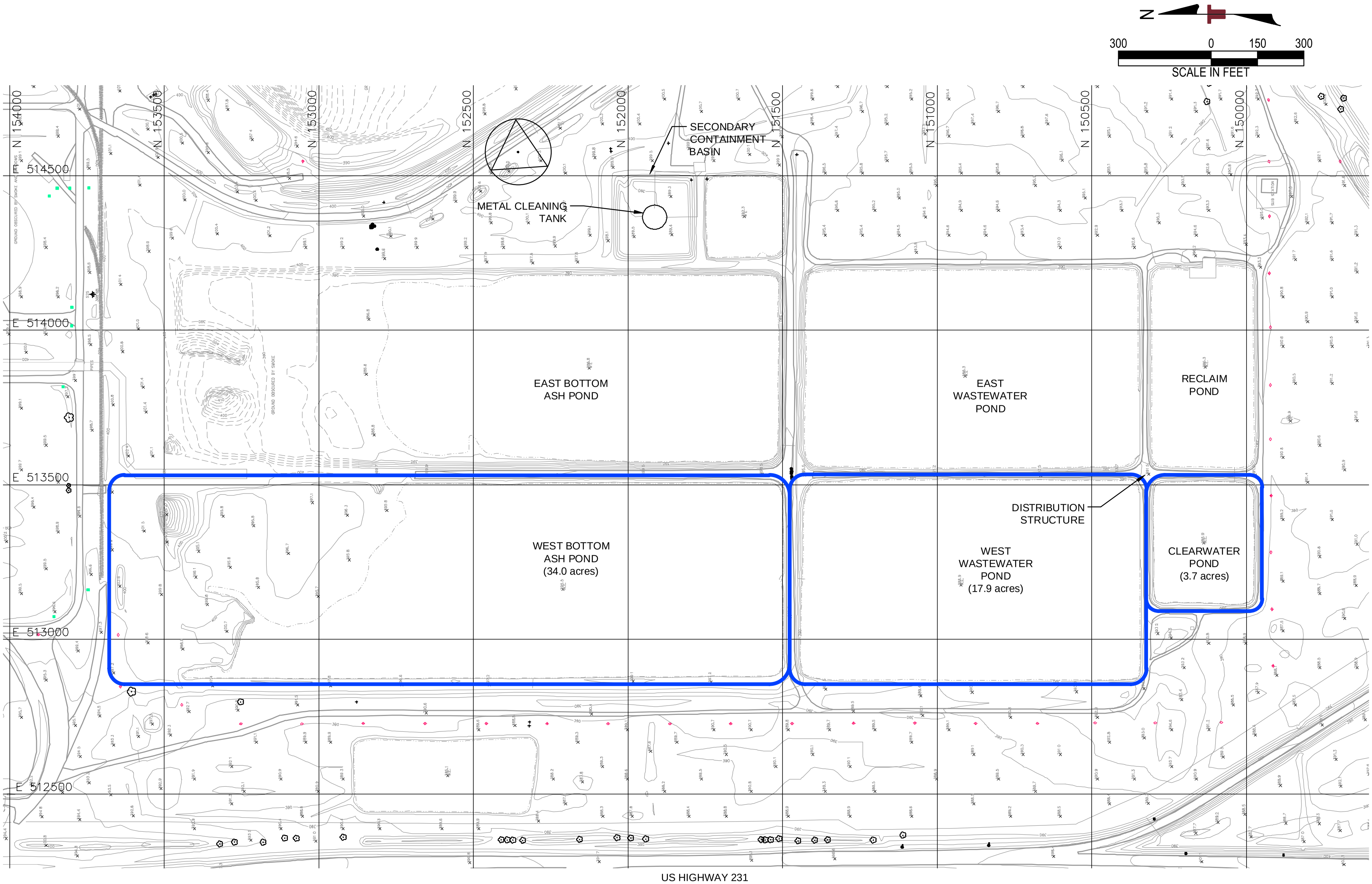

TOPOGRAPHIC MAP IMAGE COURTESY OF THE U.S. GEOLOGICAL SURVEY
QUADRANGLES INCLUDE: ROCKPORT, IN (1/1/1982).

| | | | | |
|---|---|---|---|---|
| Project Manager: BMY | Project No. E2135001 | Terracon | SITE LOCATION | Exhibit |
| Drawn by: DAB | Scale: 1"=24,000 SF | 51 Lost Mound Drive, Suite 135 | ROCKPORT PLANT | 1-A |
| Checked by: MSF | File Name: Siltloc3 | Chattanooga, Tennessee 37406 | AMERICAN ELECTRIC POWER | |
| Approved by: MSF | Date: 9/10/2015 | | ROCKPORT PLANT BOTTOM ASH POND COMPLEX | |


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

AERIAL PHOTOGRAPHY PROVIDED BY MICROSOFT BING MAPS

| | | | | |
|---|---|---|---|---|
| Project Manager: BMY | Project No. N4155126 | Terracon | SITE LOCATION MAP | Exhibit |
| Drawn by: DAB | Scale: AS SHOWN | 800 MORRISON ROAD<br>COLUMBUS, OHIO 43230 | ROCKPORT PLANT<br>AMERICAN ELECTRIC POWER<br>ROCKPORT PLANT BOTTOM ASH POND COMPLEX | 1-B |
| Checked by: MSF | File Name: Siltloc3 | | | |
| Approved by: MSF | Date: 9/10/2015 | | | |




LEGENG

POND CATCHMENT AREAS

NOTE

THE AERIAL TOPOGRAPHY WAS OBTAINED FROM HENDERSON AERIAL SURVEYS INC., DATED 11/10/2007.

| REV. | DATE | BY | DESCRIPTION |
|---|---|---|---|

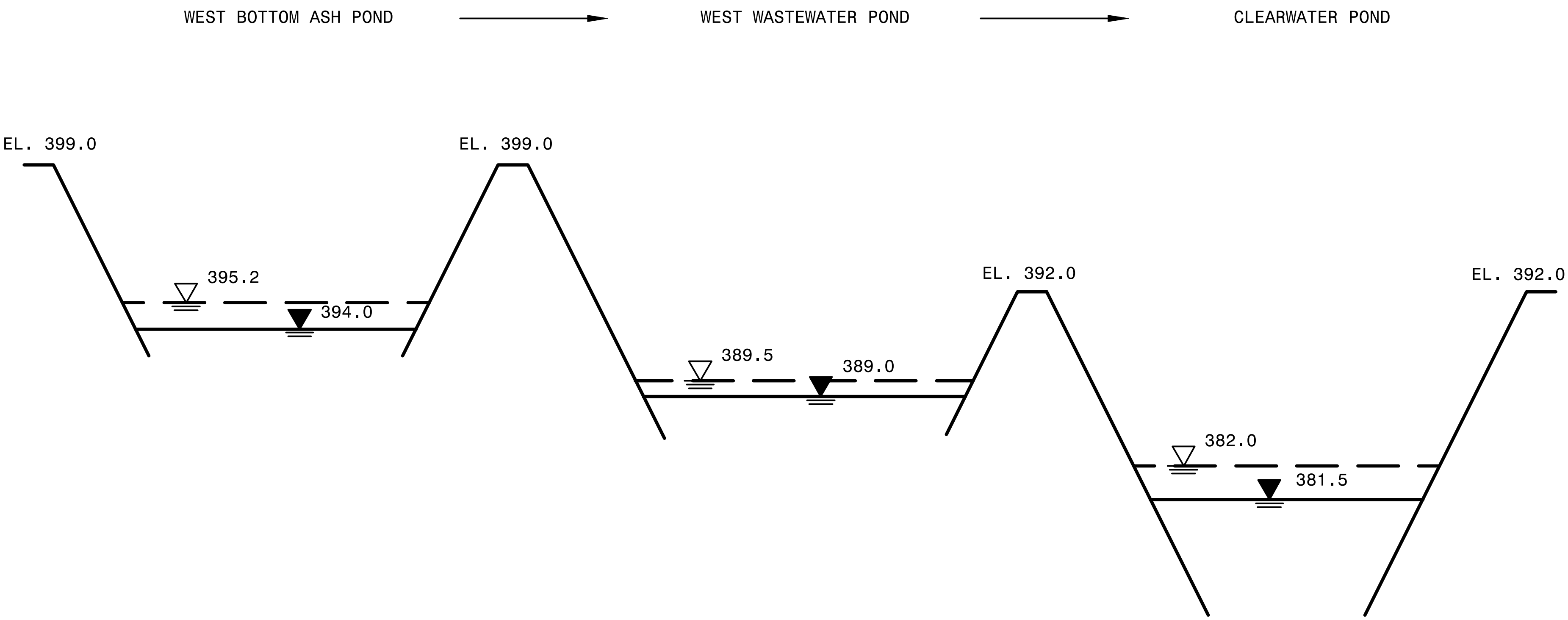
Terracon
Consulting Engineers and Scientists
800 MORRISON ROAD
COLUMBUS, OHIO 43230
PH. (614) 863-3113
FAX. (614) 863-0475

# SITE PLAN

ROCKPORT PLANT
AMERICAN ELECTRIC POWER
ROCKPORT PLANT BOTTOM ASH POND COMPLEX
ROCKPORT IN

EXHIBIT 2

| | |
|---|---|
| DESIGNED BY: | BMY |
| DRAWN BY: | DAB |
| APP'VD. BY: | MSF |
| SCALE: | 1"=300' |
| DATE: | 10/23/15 |
| JOB NO. | N4155126 |
| ACAD NO. | SET1 |
| SHEET NO.: | 2 OF 3 |




LEGEND

| | |
|---|---|
| ▽ 395.2 | MAX. RESULTANT POOL LEVELS DURING THE DESIGN STORM |
| ▼ 394.0 | NORMAL OPERATING POOL LEVELS |

NOTE:

EMBANKMENT CREST ELEVATIONS AND NORMAL OPERATING POOL LEVELS SHOWN WERE TAKEN FROM PROJECT DRAWING NUMBER 12-30027.

| REV. | DATE | BY | DESCRIPTION |
|---|---|---|---|

Terracon
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800 MORRISON ROAD COLUMBUS, OHIO 43230
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SITE PLAN
ROCKPORT PLANT
AMERICAN ELECTRIC POWER
ROCKPORT PLANT BOTTOM ASH POND COMPLEX
ROCKPORT IN

EXHIBIT 3

| | |
|---|---|
| DESIGNED BY: | BMY |
| DRAWN BY: | DAB |
| APPVD. BY: | MSF |
| SCALE: | 1"=300' |
| DATE: | 10/14/15 |
| JOB NO. | N4155126 |
| ACAD NO. | SET1 |
| SHEET NO.: | 3 OF 3 |

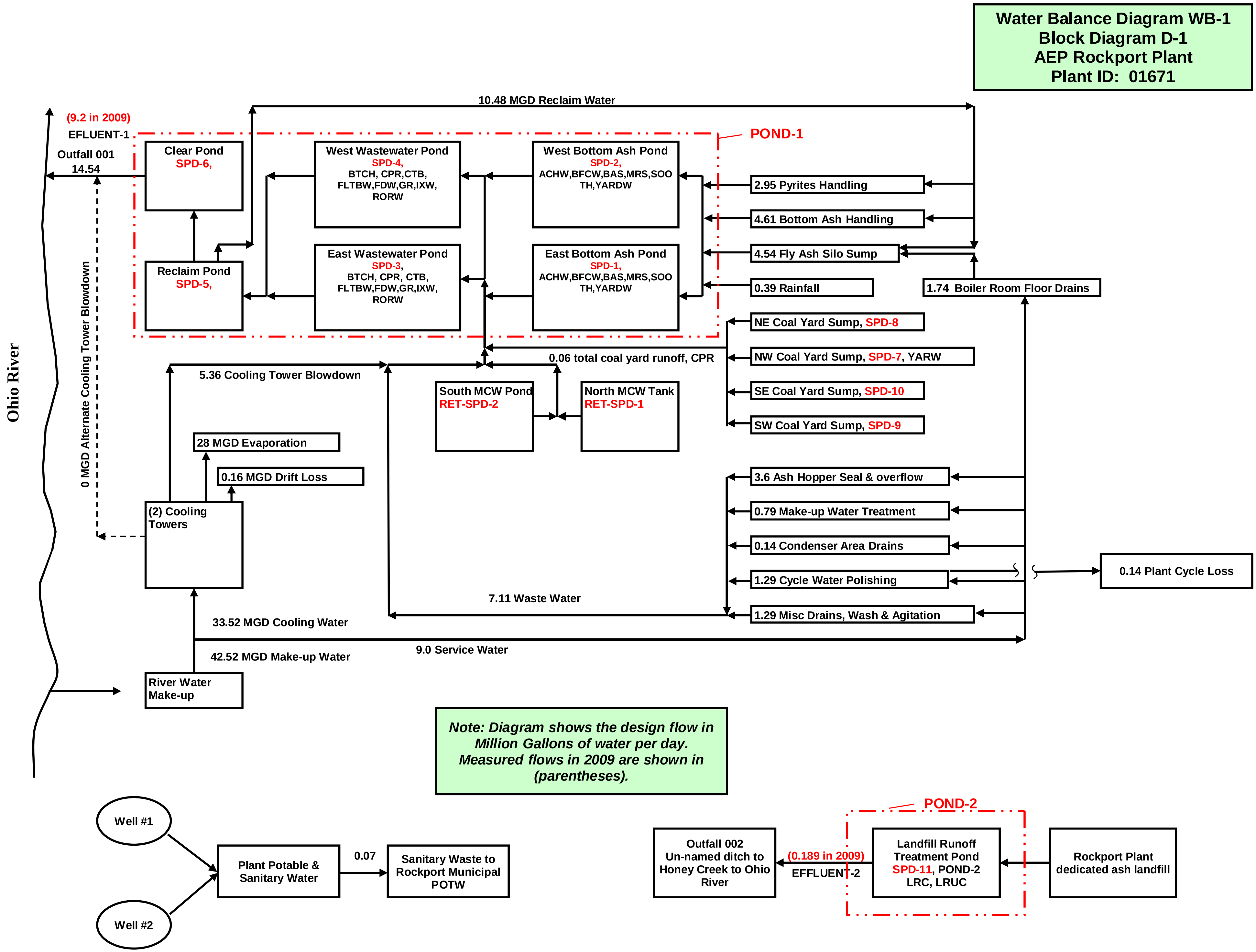
# ATTACHMENT 1

Pumped Influent and Water Balance Information

## Rockport Plant Bottom Ash Pond Complex
## Pumped Influent

| Influent Sources | Rate (mgd) | cfs |
|---|---|---|
| **To Bottom Ash Pond** | | |
| Pyrites Handling | 2.95 | |
| Bottom Ash Handling | 4.61 | |
| Fly Ash Silo Sump | 4.54 | |
| **Total** | **12.1** | **19** |
| **To Wastewater Pond** | | |
| Coal Yard Runoff | 0.06 | |
| Wastewater | 7.11 | |
| Cooling Tower Blowdown | 5.36 | |
| **Total** | **12.53** | **20** |

Note:
Influent pumped is compiled from the attached water balance data provided by AEP.



Water Balance Diagram WB-1
Block Diagram D-1
AEP Rockport Plant
Plant ID: 01671
10.48 MGD Reclaim Water
POND-1
(9.2 in 2009)
EFLUENT-1
Outfall 001
14.54
Clear Pond
SPD-6,
Reclaim Pond
SPD-5,
West Wastewater Pond
SPD-4,
BTCH, CPR,CTB,
FLTBW,FDW,GR,IXW,
RORW
East Wastewater Pond
SPD-3,
BTCH, CPR, CTB,
FLTBW,FDW,GR,IXW,
RORW
West Bottom Ash Pond
SPD-2,
ACHW,BFCW,BAS,MRS,SOOTH,YARDW
East Bottom Ash Pond
SPD-1,
ACHW,BFCW,BAS,MRS,SOOTH,YARDW
2.95 Pyrites Handling
4.61 Bottom Ash Handling
4.54 Fly Ash Silo Sump
0.39 Rainfall
1.74 Boiler Room Floor Drains
NE Coal Yard Sump, SPD-8
NW Coal Yard Sump, SPD-7, YARW
SE Coal Yard Sump, SPD-10
SW Coal Yard Sump, SPD-9
0.06 total coal yard runoff, CPR
5.36 Cooling Tower Blowdown
South MCW Pond
RET-SPD-2
North MCW Tank
RET-SPD-1
Ohio River
0 MGD Alternate Cooling Tower Blowdown
28 MGD Evaporation
0.16 MGD Drift Loss
(2) Cooling Towers
3.6 Ash Hopper Seal & overflow
0.79 Make-up Water Treatment
0.14 Condenser Area Drains
1.29 Cycle Water Polishing
0.14 Plant Cycle Loss
1.29 Misc Drains, Wash & Agitation
7.11 Waste Water
33.52 MGD Cooling Water
42.52 MGD Make-up Water
9.0 Service Water
River Water Make-up
Note: Diagram shows the design flow in Million Gallons of water per day. Measured flows in 2009 are shown in (parentheses).
Well #1
Well #2
Plant Potable & Sanitary Water
0.07
Sanitary Waste to Rockport Municipal POTW
POND-2
Outfall 002
Un-named ditch to Honey Creek to Ohio River
(0.189 in 2009)
EFFLUENT-2
Landfill Runoff Treatment Pond
SPD-11, POND-2
LRC, LRUC
Rockport Plant dedicated ash landfill

# ATTACHMENT 2

Precipitation Data

**NOAA Atlas 14, Volume 2, Version 3**
**Location name: Rockport, Indiana, US***
**Latitude: 37.9217°, Longitude: -87.0364°**
**Elevation: 399 ft***
* source: Google Maps

## POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

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 | 0.362 (0.331-0.396) | 0.427 (0.391-0.468) | 0.498 (0.456-0.545) | 0.556 (0.507-0.607) | 0.629 (0.572-0.687) | 0.686 (0.620-0.749) | 0.739 (0.665-0.807) | 0.795 (0.711-0.869) | 0.866 (0.768-0.947) | 0.919 (0.809-1.01) |
| 10-min | 0.571 (0.522-0.625) | 0.675 (0.618-0.740) | 0.790 (0.724-0.865) | 0.877 (0.800-0.959) | 0.985 (0.895-1.08) | 1.07 (0.966-1.17) | 1.15 (1.03-1.25) | 1.23 (1.10-1.34) | 1.33 (1.18-1.46) | 1.40 (1.24-1.54) |
| 15-min | 0.709 (0.648-0.776) | 0.841 (0.770-0.921) | 0.987 (0.904-1.08) | 1.10 (1.00-1.20) | 1.24 (1.12-1.35) | 1.34 (1.21-1.47) | 1.44 (1.30-1.58) | 1.54 (1.38-1.69) | 1.67 (1.48-1.82) | 1.76 (1.55-1.93) |
| 30-min | 0.960 (0.877-1.05) | 1.15 (1.05-1.26) | 1.38 (1.27-1.52) | 1.57 (1.43-1.71) | 1.80 (1.64-1.97) | 1.98 (1.79-2.17) | 2.16 (1.95-2.36) | 2.34 (2.10-2.56) | 2.58 (2.29-2.82) | 2.76 (2.44-3.03) |
| 60-min | 1.19 (1.09-1.30) | 1.43 (1.31-1.56) | 1.76 (1.61-1.93) | 2.02 (1.84-2.21) | 2.37 (2.16-2.59) | 2.66 (2.40-2.90) | 2.95 (2.65-3.21) | 3.25 (2.90-3.55) | 3.66 (3.24-4.00) | 3.98 (3.50-4.36) |
| 2-hr | 1.43 (1.31-1.56) | 1.73 (1.59-1.88) | 2.15 (1.97-2.34) | 2.49 (2.28-2.71) | 2.95 (2.69-3.20) | 3.32 (3.01-3.60) | 3.70 (3.34-4.02) | 4.10 (3.68-4.46) | 4.65 (4.13-5.06) | 5.09 (4.48-5.55) |
| 3-hr | 1.54 (1.42-1.68) | 1.86 (1.71-2.03) | 2.31 (2.12-2.52) | 2.68 (2.46-2.92) | 3.20 (2.91-3.47) | 3.62 (3.28-3.93) | 4.05 (3.65-4.40) | 4.51 (4.04-4.90) | 5.16 (4.56-5.61) | 5.67 (4.98-6.19) |
| 6-hr | 1.89 (1.74-2.07) | 2.28 (2.09-2.49) | 2.83 (2.60-3.09) | 3.29 (3.01-3.59) | 3.94 (3.58-4.28) | 4.47 (4.04-4.85) | 5.04 (4.53-5.47) | 5.64 (5.03-6.12) | 6.49 (5.71-7.06) | 7.19 (6.26-7.83) |
| 12-hr | 2.26 (2.07-2.47) | 2.72 (2.50-2.98) | 3.37 (3.09-3.69) | 3.91 (3.57-4.27) | 4.67 (4.24-5.10) | 5.30 (4.79-5.78) | 5.96 (5.36-6.50) | 6.67 (5.95-7.27) | 7.67 (6.76-8.38) | 8.48 (7.39-9.29) |
| 24-hr | 2.71 (2.52-2.93) | 3.26 (3.03-3.52) | 4.06 (3.77-4.38) | 4.71 (4.36-5.08) | 5.65 (5.19-6.08) | 6.42 (5.87-6.91) | 7.23 (6.56-7.81) | 8.09 (7.28-8.76) | 9.32 (8.27-10.1) | 10.3 (9.05-11.3) |
| 2-day | 3.25 (3.01-3.51) | 3.90 (3.61-4.22) | 4.85 (4.49-5.25) | 5.64 (5.21-6.10) | 6.78 (6.22-7.34) | 7.73 (7.05-8.38) | 8.75 (7.90-9.51) | 9.84 (8.81-10.7) | 11.4 (10.1-12.5) | 12.7 (11.1-14.1) |
| 3-day | 3.46 (3.22-3.74) | 4.15 (3.86-4.49) | 5.17 (4.79-5.59) | 6.01 (5.55-6.49) | 7.23 (6.64-7.82) | 8.25 (7.53-8.94) | 9.35 (8.46-10.2) | 10.5 (9.45-11.5) | 12.2 (10.8-13.5) | 13.7 (11.9-15.1) |
| 4-day | 3.68 (3.42-3.97) | 4.41 (4.10-4.76) | 5.48 (5.09-5.92) | 6.38 (5.90-6.89) | 7.68 (7.07-8.30) | 8.77 (8.02-9.51) | 9.95 (9.02-10.8) | 11.2 (10.1-12.3) | 13.1 (11.6-14.4) | 14.6 (12.8-16.2) |
| 7-day | 4.30 (3.98-4.67) | 5.15 (4.78-5.59) | 6.42 (5.94-6.97) | 7.51 (6.92-8.15) | 9.12 (8.35-9.90) | 10.5 (9.54-11.4) | 12.0 (10.8-13.1) | 13.7 (12.2-15.0) | 16.2 (14.1-17.9) | 18.3 (15.7-20.4) |
| 10-day | 4.85 (4.49-5.25) | 5.80 (5.38-6.29) | 7.20 (6.66-7.80) | 8.39 (7.73-9.09) | 10.1 (9.28-11.0) | 11.6 (10.6-12.6) | 13.2 (11.9-14.4) | 15.0 (13.4-16.4) | 17.6 (15.4-19.4) | 19.7 (17.1-21.9) |
| 20-day | 6.68 (6.27-7.13) | 7.93 (7.45-8.47) | 9.54 (8.94-10.2) | 10.8 (10.1-11.6) | 12.6 (11.8-13.5) | 14.1 (13.0-15.1) | 15.6 (14.3-16.7) | 17.1 (15.7-18.4) | 19.2 (17.4-20.9) | 20.9 (18.7-22.8) |
| 30-day | 8.23 (7.76-8.74) | 9.73 (9.17-10.3) | 11.5 (10.8-12.2) | 13.0 (12.2-13.7) | 14.9 (14.0-15.8) | 16.4 (15.3-17.5) | 18.0 (16.7-19.2) | 19.6 (18.1-20.9) | 21.7 (19.8-23.3) | 23.3 (21.1-25.2) |
| 45-day | 10.4 (9.84-11.0) | 12.2 (11.6-12.9) | 14.3 (13.5-15.0) | 15.8 (15.0-16.7) | 17.9 (16.9-18.9) | 19.5 (18.3-20.6) | 21.1 (19.7-22.4) | 22.6 (21.1-24.1) | 24.6 (22.8-26.3) | 26.1 (24.0-28.1) |
| 60-day | 12.4 (11.7-13.1) | 14.6 (13.8-15.4) | 16.9 (16.0-17.8) | 18.6 (17.6-19.6) | 20.8 (19.6-21.9) | 22.4 (21.1-23.7) | 23.9 (22.5-25.4) | 25.4 (23.8-27.0) | 27.3 (25.4-29.1) | 28.7 (26.6-30.7) |

[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.

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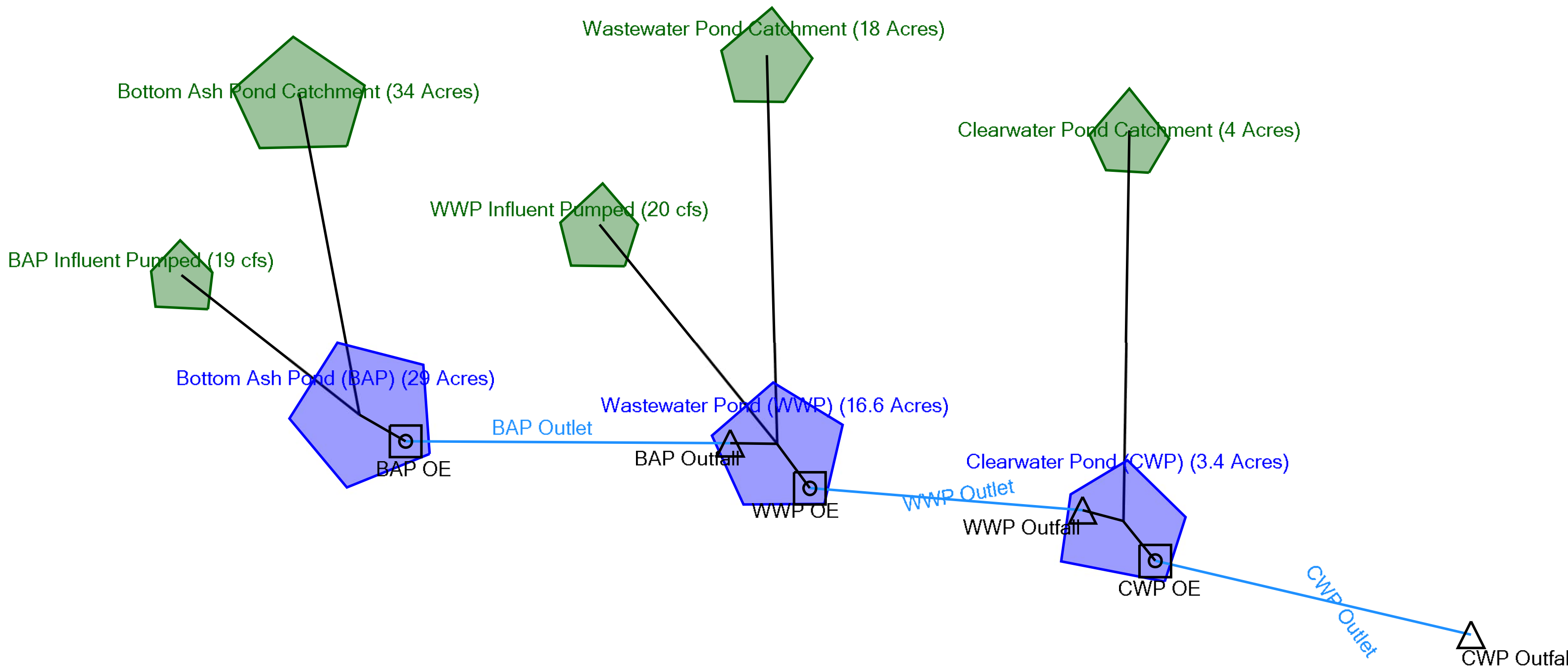
## PF graphical

# ATTACHMENT 3

PondPack Model and Output

Scenario:  Post-Development 1000 Year



# Table of Contents

## Table of Contents

Subsection: Master Network Summary

## Catchments Summary

| Label | Scenario | Return Event (years) | Hydrograph Volume (ac-ft) | Time to Peak (hours) | Peak Flow (ft³/s) |
|---|---|---|---|---|---|
| BAP Influent Pumped | Post-Development 1000 Year | 1,000 | 37.686 | 0.000 | 19.00 |
| Bottom Ash Pond Catchment | Post-Development 1000 Year | 1,000 | 29.162 | 11.900 | 450.92 |
| Clearwater Pond Catchment | Post-Development 1000 Year | 1,000 | 3.430 | 11.950 | 50.41 |
| WWP Influent Pumped | Post-Development 1000 Year | 1,000 | 39.669 | 0.000 | 20.00 |
| Wastewater Pond Catchment | Post-Development 1000 Year | 1,000 | 15.436 | 11.950 | 226.83 |

## Node Summary

| Label | Scenario | Return Event (years) | Hydrograph Volume (ac-ft) | Time to Peak (hours) | Peak Flow (ft³/s) |
|---|---|---|---|---|---|
| CWP Outfall | Post-Development 1000 Year | 1,000 | 94.142 | 12.100 | 123.59 |

## Pond Summary

| Label | Scenario | Return Event (years) | Hydrograph Volume (ac-ft) | Time to Peak (hours) | Peak Flow (ft³/s) | Maximum Water Surface Elevation (ft) | Maximum Pond Storage (ac-ft) |
|---|---|---|---|---|---|---|---|
| Bottom Ash Pond (BAP) (IN) | Post-Development 1000 Year | 1,000 | 66.848 | 11.900 | 469.92 | (N/A) | (N/A) |
| Bottom Ash Pond (BAP) (OUT) | Post-Development 1000 Year | 1,000 | 38.722 | 13.650 | 34.94 | 395.18 | 32.797 |
| Clearwater Pond (CWP) (IN) | Post-Development 1000 Year | 1,000 | 94.743 | 12.000 | 139.81 | (N/A) | (N/A) |
| Clearwater Pond (CWP) (OUT) | Post-Development 1000 Year | 1,000 | 94.142 | 12.100 | 123.59 | 381.95 | 2.573 |
| Wastewater Pond (WWP) (IN) | Post-Development 1000 Year | 1,000 | 93.828 | 11.950 | 273.13 | (N/A) | (N/A) |
| Wastewater Pond (WWP) (OUT) | Post-Development 1000 Year | 1,000 | 91.313 | 12.150 | 103.29 | 389.41 | 22.806 |

Subsection: Time-Depth Curve
Label: Time-Depth - 1

Return Event: 1,000 years
Storm Event: 1000 Year

| Time-Depth Curve: 1000 Year | |
|---|---|
| Label | 1000 Year |
| Start Time | 0.000 hours |
| Increment | 0.100 hours |
| End Time | 24.000 hours |
| Return Event | 1,000 years |

**CUMULATIVE RAINFALL (in)**
**Output Time Increment = 0.100 hours**
**Time on left represents time for first value in each row.**

| Time (hours) | Depth (in) | Depth (in) | Depth (in) | Depth (in) | Depth (in) |
|---|---|---|---|---|---|
| 0.000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 0.500 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| 1.000 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 |
| 1.500 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| 2.000 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 |
| 2.500 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| 3.000 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| 3.500 | 0.4 | 0.4 | 0.5 | 0.5 | 0.5 |
| 4.000 | 0.5 | 0.5 | 0.5 | 0.5 | 0.6 |
| 4.500 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 |
| 5.000 | 0.6 | 0.7 | 0.7 | 0.7 | 0.7 |
| 5.500 | 0.7 | 0.8 | 0.8 | 0.8 | 0.8 |
| 6.000 | 0.8 | 0.8 | 0.9 | 0.9 | 0.9 |
| 6.500 | 0.9 | 0.9 | 1.0 | 1.0 | 1.0 |
| 7.000 | 1.0 | 1.0 | 1.1 | 1.1 | 1.1 |
| 7.500 | 1.1 | 1.1 | 1.2 | 1.2 | 1.2 |
| 8.000 | 1.2 | 1.3 | 1.3 | 1.3 | 1.3 |
| 8.500 | 1.4 | 1.4 | 1.4 | 1.5 | 1.5 |
| 9.000 | 1.5 | 1.5 | 1.6 | 1.6 | 1.6 |
| 9.500 | 1.7 | 1.7 | 1.7 | 1.8 | 1.8 |
| 10.000 | 1.9 | 1.9 | 2.0 | 2.0 | 2.0 |
| 10.500 | 2.1 | 2.2 | 2.2 | 2.3 | 2.3 |
| 11.000 | 2.4 | 2.5 | 2.6 | 2.7 | 2.8 |
| 11.500 | 2.9 | 3.2 | 3.6 | 4.4 | 5.8 |
| 12.000 | 6.8 | 7.0 | 7.2 | 7.3 | 7.5 |
| 12.500 | 7.6 | 7.7 | 7.7 | 7.8 | 7.9 |
| 13.000 | 8.0 | 8.0 | 8.1 | 8.1 | 8.2 |
| 13.500 | 8.2 | 8.3 | 8.3 | 8.4 | 8.4 |
| 14.000 | 8.4 | 8.5 | 8.5 | 8.6 | 8.6 |
| 14.500 | 8.6 | 8.7 | 8.7 | 8.7 | 8.8 |
| 15.000 | 8.8 | 8.8 | 8.9 | 8.9 | 8.9 |
| 15.500 | 8.9 | 9.0 | 9.0 | 9.0 | 9.0 |
| 16.000 | 9.1 | 9.1 | 9.1 | 9.1 | 9.2 |
| 16.500 | 9.2 | 9.2 | 9.2 | 9.2 | 9.3 |
| 17.000 | 9.3 | 9.3 | 9.3 | 9.4 | 9.4 |

**CUMULATIVE RAINFALL (in)**
**Output Time Increment = 0.100 hours**
**Time on left represents time for first value in each row.**

| Time (hours) | Depth (in) | Depth (in) | Depth (in) | Depth (in) | Depth (in) |
|---|---|---|---|---|---|
| 17.500 | 9.4 | 9.4 | 9.4 | 9.4 | 9.5 |
| 18.000 | 9.5 | 9.5 | 9.5 | 9.5 | 9.6 |
| 18.500 | 9.6 | 9.6 | 9.6 | 9.6 | 9.6 |
| 19.000 | 9.7 | 9.7 | 9.7 | 9.7 | 9.7 |
| 19.500 | 9.7 | 9.7 | 9.8 | 9.8 | 9.8 |
| 20.000 | 9.8 | 9.8 | 9.8 | 9.8 | 9.9 |
| 20.500 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 |
| 21.000 | 9.9 | 9.9 | 10.0 | 10.0 | 10.0 |
| 21.500 | 10.0 | 10.0 | 10.0 | 10.0 | 10.1 |
| 22.000 | 10.1 | 10.1 | 10.1 | 10.1 | 10.1 |
| 22.500 | 10.1 | 10.1 | 10.1 | 10.2 | 10.2 |
| 23.000 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 |
| 23.500 | 10.2 | 10.3 | 10.3 | 10.3 | 10.3 |
| 24.000 | 10.3 | (N/A) | (N/A) | (N/A) | (N/A) |

## Unit Hydrograph Method (Computational Notes)
## Definition of Terms

| | |
|---|---|
| At | Total area (acres): At = Ai+Ap |
| Ai | Impervious area (acres) |
| Ap | Pervious area (acres) |
| CNi | Runoff curve number for impervious area |
| CNp | Runoff curve number for pervious area |
| fLoss | f loss constant infiltration (depth/time) |
| gKs | Saturated Hydraulic Conductivity (depth/time) |
| Md | Volumetric Moisture Deficit |
| Psi | Capillary Suction (length) |
| hK | Horton Infiltration Decay Rate (time^-1) |
| fo | Initial Infiltration Rate (depth/time) |
| fc | Ultimate(capacity)Infiltration Rate (depth/time) |
| Ia | Initial Abstraction (length) |
| dt | Computational increment (duration of unit excess rainfall)<br>Default dt is smallest value of 0.1333Tc, rtm, and th<br>(Smallest dt is then adjusted to match up with Tp) |
| UDdt | User specified override computational main time increment<br>(only used if UDdt is => .1333Tc) |
| D(t) | Point on distribution curve (fraction of P) for time step t |
| K | 2 / (1 + (Tr/Tp)): default K = 0.75: (for Tr/Tp = 1.67) |
| Ks | Hydrograph shape factor = Unit Conversions * K: = ((1hr/3600sec) * (1ft/12in) * ((5280ft)**2/sq.mi)) * K<br>Default Ks = 645.333 * 0.75 = 484 |
| Lag | Lag time from center of excess runoff (dt) to Tp: Lag = 0.6Tc |
| P | Total precipitation depth, inches |
| Pa(t) | Accumulated rainfall at time step t |
| Pi(t) | Incremental rainfall at time step t |
| qp | Peak discharge (cfs) for 1in. runoff, for 1hr, for 1 sq.mi. = (Ks * A * Q) / Tp (where Q = 1in. runoff, A=sq.mi.) |
| Qu(t) | Unit hydrograph ordinate (cfs) at time step t |
| Q(t) | Final hydrograph ordinate (cfs) at time step t |
| Rai(t) | Accumulated runoff (inches) at time step t for impervious area |
| Rap(t) | Accumulated runoff (inches) at time step t for pervious area |
| Rii(t) | Incremental runoff (inches) at time step t for impervious area |
| Rip(t) | Incremental runoff (inches) at time step t for pervious area |
| R(t) | Incremental weighted total runoff (inches) |
| Rtm | Time increment for rainfall table |
| Si | S for impervious area: Si = (1000/CNi) - 10 |
| Sp | S for pervious area: Sp = (1000/CNp) - 10 |
| t | Time step (row) number |
| Tc | Time of concentration |
| Tb | Time (hrs) of entire unit hydrograph: Tb = Tp + Tr |
| Tp | Time (hrs) to peak of a unit hydrograph: Tp = (dt/2) + Lag |
| Tr | Time (hrs) of receding limb of unit hydrograph: Tr = ratio of Tp |

## Unit Hydrograph Method
## Computational Notes
## Precipitation

| | |
|---|---|
| Column (1) | Time for time step t |
| Column (2) | D(t) = Point on distribution curve for time step t |
| Column (3) | Pi(t) = Pa(t) - Pa(t-1): Col.(4) - Preceding Col.(4) |
| Column (4) | Pa(t) = D(t) x P: Col.(2) x P |

## Pervious Area Runoff (using SCS Runoff CN Method)

| | |
|---|---|
| Column (5) | Rap(t) = Accumulated pervious runoff for time step t<br>If (Pa(t) is <= 0.2Sp) then use: Rap(t) = 0.0<br>If (Pa(t) is > 0.2Sp) then use:<br><br>Rap(t) = (Col.(4)-0.2Sp)**2 / (Col.(4)+0.8Sp) |
| Column (6) | Rip(t) = Incremental pervious runoff for time step t<br>Rip(t) = Rap(t) - Rap(t-1)<br>Rip(t) = Col.(5) for current row - Col.(5) for preceding row. |

## Impervious Area Runoff

| | |
|---|---|
| Column (7 & 8)... | Did not specify to use impervious areas. |

## Incremental Weighted Runoff

| | |
|---|---|
| Column (9) | R(t) = (Ap/At) x Rip(t) + (Ai/At) x Rii(t)<br>R(t) = (Ap/At) x Col.(6) + (Ai/At) x Col.(8) |

## SCS Unit Hydrograph Method

| | |
|---|---|
| Column (10) | Q(t) is computed with the SCS unit hydrograph method using R(t) and Qu(t). |

| | |
|---|---|
| Peak Discharge | 19.00 ft³/s |
| Time to Peak | 7.900 hours |
| Hydrograph Volume | 37.686 ac-ft |

**HYDROGRAPH ORDINATES (ft³/s)**
**Output Time Increment = 0.100 hours**
**Time on left represents time for first value in each row.**

| Time (hours) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) |
|---|---|---|---|---|---|
| 0.000 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 |
| 0.500 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 |
| 1.000 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 |
| 1.500 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 |
| 2.000 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 |
| 2.500 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 |
| 3.000 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 |
| 3.500 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 |
| 4.000 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 |
| 4.500 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 |
| 5.000 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 |
| 5.500 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 |
| 6.000 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 |
| 6.500 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 |
| 7.000 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 |
| 7.500 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 |
| 8.000 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 |
| 8.500 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 |
| 9.000 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 |
| 9.500 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 |
| 10.000 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 |
| 10.500 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 |
| 11.000 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 |
| 11.500 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 |
| 12.000 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 |
| 12.500 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 |
| 13.000 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 |
| 13.500 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 |
| 14.000 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 |
| 14.500 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 |
| 15.000 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 |
| 15.500 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 |
| 16.000 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 |
| 16.500 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 |
| 17.000 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 |
| 17.500 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 |
| 18.000 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 |
| 18.500 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 |
| 19.000 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 |

**HYDROGRAPH ORDINATES (ft³/s)**
**Output Time Increment = 0.100 hours**
**Time on left represents time for first value in each row.**

| Time (hours) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) |
|---|---|---|---|---|---|
| 19.500 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 |
| 20.000 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 |
| 20.500 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 |
| 21.000 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 |
| 21.500 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 |
| 22.000 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 |
| 22.500 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 |
| 23.000 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 |
| 23.500 | 19.00 | 19.00 | 19.00 | 19.00 | 19.00 |
| 24.000 | 19.00 | (N/A) | (N/A) | (N/A) | (N/A) |

| | |
|---|---|
| Storm Event | 1000 Year |
| Return Event | 1,000 years |
| Duration | 24.000 hours |
| Depth | 10.3 in |
| Time of Concentration (Composite) | 0.083 hours |
| Area (User Defined) | 34.000 acres |

| | |
|---|---|
| Computational Time Increment | 0.011 hours |
| Time to Peak (Computed) | 11.911 hours |
| Flow (Peak, Computed) | 457.92 ft³/s |
| Output Increment | 0.050 hours |
| Time to Flow (Peak Interpolated Output) | 11.900 hours |
| Flow (Peak Interpolated Output) | 450.92 ft³/s |

| Drainage Area | |
|---|---|
| SCS CN (Composite) | 100.000 |
| Area (User Defined) | 34.000 acres |
| Maximum Retention (Pervious) | 0.0 in |
| Maximum Retention (Pervious, 20 percent) | 0.0 in |

| Cumulative Runoff | |
|---|---|
| Cumulative Runoff Depth (Pervious) | 10.3 in |
| Runoff Volume (Pervious) | 29.184 ac-ft |

| Hydrograph Volume (Area under Hydrograph curve) | |
|---|---|
| Volume | 29.162 ac-ft |

| SCS Unit Hydrograph Parameters | |
|---|---|
| Time of Concentration (Composite) | 0.083 hours |
| Computational Time Increment | 0.011 hours |
| Unit Hydrograph Shape Factor | 483.432 |
| K Factor | 0.749 |
| Receding/Rising, Tr/Tp | 1.670 |
| Unit peak, qp | 462.28 ft³/s |
| Unit peak time, Tp | 0.056 hours |

| SCS Unit Hydrograph Parameters | |
|---|---|
| Unit receding limb, Tr | 0.222 hours |
| Total unit time, Tb | 0.278 hours |

| | |
|---|---|
| Storm Event | 1000 Year |
| Return Event | 1,000 years |
| Duration | 24.000 hours |
| Depth | 10.3 in |
| Time of Concentration (Composite) | 0.083 hours |
| Area (User Defined) | 34.000 acres |

**HYDROGRAPH ORDINATES ($ft^3/s$)**
**Output Time Increment = 0.050 hours**
**Time on left represents time for first value in each row.**

| Time (hours) | Flow ($ft^3/s$) | Flow ($ft^3/s$) | Flow ($ft^3/s$) | Flow ($ft^3/s$) | Flow ($ft^3/s$) |
|---|---|---|---|---|---|
| 0.000 | 0.00 | 1.34 | 3.03 | 3.44 | 3.54 |
| 0.250 | 3.59 | 3.63 | 3.63 | 3.64 | 3.66 |
| 0.500 | 3.70 | 3.71 | 3.71 | 3.73 | 3.77 |
| 0.750 | 3.78 | 3.78 | 3.80 | 3.84 | 3.85 |
| 1.000 | 3.85 | 3.88 | 3.91 | 3.92 | 3.92 |
| 1.250 | 3.95 | 3.98 | 3.99 | 3.99 | 4.02 |
| 1.500 | 4.05 | 4.06 | 4.06 | 4.09 | 4.12 |
| 1.750 | 4.13 | 4.13 | 4.16 | 4.19 | 4.20 |
| 2.000 | 4.20 | 4.23 | 4.26 | 4.27 | 4.27 |
| 2.250 | 4.30 | 4.33 | 4.34 | 4.34 | 4.37 |
| 2.500 | 4.40 | 4.41 | 4.41 | 4.44 | 4.47 |
| 2.750 | 4.48 | 4.48 | 4.51 | 4.54 | 4.55 |
| 3.000 | 4.55 | 4.58 | 4.62 | 4.62 | 4.63 |
| 3.250 | 4.65 | 4.69 | 4.69 | 4.70 | 4.72 |
| 3.500 | 4.76 | 4.76 | 4.77 | 4.79 | 4.83 |
| 3.750 | 4.84 | 4.84 | 4.86 | 4.90 | 4.91 |
| 4.000 | 4.91 | 4.93 | 4.97 | 5.00 | 5.04 |
| 4.250 | 5.07 | 5.11 | 5.14 | 5.18 | 5.21 |
| 4.500 | 5.25 | 5.29 | 5.32 | 5.36 | 5.39 |
| 4.750 | 5.43 | 5.46 | 5.50 | 5.53 | 5.57 |
| 5.000 | 5.60 | 5.64 | 5.67 | 5.71 | 5.74 |
| 5.250 | 5.78 | 5.82 | 5.85 | 5.89 | 5.92 |
| 5.500 | 5.96 | 5.99 | 6.03 | 6.06 | 6.10 |
| 5.750 | 6.13 | 6.17 | 6.20 | 6.24 | 6.27 |
| 6.000 | 6.31 | 6.34 | 6.38 | 6.42 | 6.45 |
| 6.250 | 6.49 | 6.52 | 6.56 | 6.59 | 6.63 |
| 6.500 | 6.66 | 6.70 | 6.73 | 6.77 | 6.80 |
| 6.750 | 6.84 | 6.87 | 6.91 | 6.95 | 6.98 |
| 7.000 | 7.02 | 7.05 | 7.09 | 7.12 | 7.16 |
| 7.250 | 7.19 | 7.23 | 7.26 | 7.30 | 7.33 |
| 7.500 | 7.37 | 7.40 | 7.44 | 7.47 | 7.51 |
| 7.750 | 7.55 | 7.58 | 7.62 | 7.65 | 7.69 |
| 8.000 | 7.72 | 7.81 | 7.91 | 8.07 | 8.24 |
| 8.250 | 8.42 | 8.60 | 8.77 | 8.95 | 9.12 |

**HYDROGRAPH ORDINATES (ft³/s)**
**Output Time Increment = 0.050 hours**
**Time on left represents time for first value in each row.**

| Time (hours) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) |
|---|---|---|---|---|---|
| 8.500 | 9.30 | 9.48 | 9.65 | 9.83 | 10.01 |
| 8.750 | 10.18 | 10.36 | 10.54 | 10.71 | 10.89 |
| 9.000 | 11.07 | 11.18 | 11.27 | 11.29 | 11.30 |
| 9.250 | 11.30 | 11.30 | 11.30 | 11.30 | 11.30 |
| 9.500 | 11.30 | 11.41 | 11.54 | 11.78 | 12.06 |
| 9.750 | 12.34 | 12.62 | 12.90 | 13.19 | 13.47 |
| 10.000 | 13.75 | 14.09 | 14.44 | 14.84 | 15.26 |
| 10.250 | 15.68 | 16.11 | 16.53 | 16.96 | 17.38 |
| 10.500 | 17.80 | 18.33 | 18.89 | 19.56 | 20.26 |
| 10.750 | 20.96 | 21.67 | 22.37 | 23.08 | 23.79 |
| 11.000 | 24.49 | 25.57 | 26.75 | 28.31 | 29.98 |
| 11.250 | 31.66 | 33.36 | 35.05 | 36.75 | 38.44 |
| 11.500 | 40.14 | 56.87 | 77.58 | 114.03 | 154.85 |
| 11.750 | 203.17 | 253.87 | 346.60 | 450.92 | 421.08 |
| 12.000 | 356.88 | 240.08 | 108.67 | 73.28 | 61.97 |
| 12.250 | 56.32 | 52.12 | 48.11 | 44.07 | 40.06 |
| 12.500 | 36.02 | 33.18 | 30.61 | 29.29 | 28.28 |
| 12.750 | 27.34 | 26.42 | 25.51 | 24.59 | 23.67 |
| 13.000 | 22.75 | 21.99 | 21.27 | 20.72 | 20.22 |
| 13.250 | 19.72 | 19.22 | 18.73 | 18.24 | 17.74 |
| 13.500 | 17.25 | 16.81 | 16.38 | 16.01 | 15.65 |
| 13.750 | 15.30 | 14.94 | 14.59 | 14.24 | 13.88 |
| 14.000 | 13.53 | 13.27 | 13.03 | 12.87 | 12.72 |
| 14.250 | 12.61 | 12.50 | 12.37 | 12.23 | 12.11 |
| 14.500 | 12.00 | 11.87 | 11.73 | 11.62 | 11.51 |
| 14.750 | 11.38 | 11.24 | 11.12 | 11.02 | 10.88 |
| 15.000 | 10.74 | 10.63 | 10.52 | 10.39 | 10.25 |
| 15.250 | 10.14 | 10.03 | 9.89 | 9.75 | 9.64 |
| 15.500 | 9.53 | 9.40 | 9.26 | 9.15 | 9.04 |
| 15.750 | 8.91 | 8.77 | 8.65 | 8.54 | 8.41 |
| 16.000 | 8.27 | 8.18 | 8.11 | 8.05 | 8.00 |
| 16.250 | 7.96 | 7.92 | 7.87 | 7.82 | 7.78 |
| 16.500 | 7.74 | 7.70 | 7.64 | 7.60 | 7.57 |
| 16.750 | 7.52 | 7.47 | 7.43 | 7.39 | 7.34 |
| 17.000 | 7.29 | 7.25 | 7.21 | 7.17 | 7.11 |
| 17.250 | 7.07 | 7.04 | 6.99 | 6.94 | 6.90 |
| 17.500 | 6.86 | 6.81 | 6.76 | 6.72 | 6.69 |
| 17.750 | 6.64 | 6.58 | 6.55 | 6.51 | 6.46 |
| 18.000 | 6.41 | 6.37 | 6.33 | 6.28 | 6.23 |
| 18.250 | 6.19 | 6.16 | 6.11 | 6.05 | 6.02 |
| 18.500 | 5.98 | 5.93 | 5.88 | 5.84 | 5.80 |
| 18.750 | 5.75 | 5.70 | 5.66 | 5.63 | 5.58 |
| 19.000 | 5.53 | 5.49 | 5.45 | 5.40 | 5.35 |

**HYDROGRAPH ORDINATES ($ft^3/s$)**
**Output Time Increment = 0.050 hours**
**Time on left represents time for first value in each row.**

| Time (hours) | Flow ($ft^3/s$) | Flow ($ft^3/s$) | Flow ($ft^3/s$) | Flow ($ft^3/s$) | Flow ($ft^3/s$) |
|---|---|---|---|---|---|
| 19.250 | 5.31 | 5.27 | 5.22 | 5.17 | 5.13 |
| 19.500 | 5.10 | 5.05 | 5.00 | 4.96 | 4.92 |
| 19.750 | 4.87 | 4.82 | 4.78 | 4.74 | 4.69 |
| 20.000 | 4.64 | 4.62 | 4.60 | 4.58 | 4.56 |
| 20.250 | 4.56 | 4.56 | 4.54 | 4.53 | 4.52 |
| 20.500 | 4.52 | 4.51 | 4.49 | 4.49 | 4.48 |
| 20.750 | 4.47 | 4.45 | 4.45 | 4.45 | 4.44 |
| 21.000 | 4.42 | 4.42 | 4.41 | 4.40 | 4.38 |
| 21.250 | 4.38 | 4.38 | 4.37 | 4.35 | 4.34 |
| 21.500 | 4.34 | 4.33 | 4.31 | 4.31 | 4.31 |
| 21.750 | 4.29 | 4.28 | 4.27 | 4.27 | 4.26 |
| 22.000 | 4.24 | 4.24 | 4.24 | 4.22 | 4.21 |
| 22.250 | 4.20 | 4.20 | 4.19 | 4.17 | 4.17 |
| 22.500 | 4.17 | 4.15 | 4.14 | 4.13 | 4.13 |
| 22.750 | 4.12 | 4.10 | 4.10 | 4.10 | 4.08 |
| 23.000 | 4.07 | 4.06 | 4.06 | 4.05 | 4.03 |
| 23.250 | 4.03 | 4.03 | 4.01 | 4.00 | 3.99 |
| 23.500 | 3.99 | 3.98 | 3.96 | 3.96 | 3.96 |
| 23.750 | 3.94 | 3.92 | 3.92 | 3.92 | 3.92 |
| 24.000 | 3.92 | (N/A) | (N/A) | (N/A) | (N/A) |

| | |
|---|---|
| Storm Event | 1000 Year |
| Return Event | 1,000 years |
| Duration | 24.000 hours |
| Depth | 10.3 in |
| Time of Concentration (Composite) | 0.100 hours |
| Area (User Defined) | 4.000 acres |

| | |
|---|---|
| Computational Time Increment | 0.013 hours |
| Time to Peak (Computed) | 11.920 hours |
| Flow (Peak, Computed) | 52.32 ft³/s |
| Output Increment | 0.050 hours |
| Time to Flow (Peak Interpolated Output) | 11.950 hours |
| Flow (Peak Interpolated Output) | 50.41 ft³/s |

## Drainage Area

| | |
|---|---|
| SCS CN (Composite) | 100.000 |
| Area (User Defined) | 4.000 acres |
| Maximum Retention (Pervious) | 0.0 in |
| Maximum Retention (Pervious, 20 percent) | 0.0 in |

## Cumulative Runoff

| | |
|---|---|
| Cumulative Runoff Depth (Pervious) | 10.3 in |
| Runoff Volume (Pervious) | 3.433 ac-ft |

## Hydrograph Volume (Area under Hydrograph curve)

| | |
|---|---|
| Volume | 3.430 ac-ft |

## SCS Unit Hydrograph Parameters

| | |
|---|---|
| Time of Concentration (Composite) | 0.100 hours |
| Computational Time Increment | 0.013 hours |
| Unit Hydrograph Shape Factor | 483.432 |
| K Factor | 0.749 |
| Receding/Rising, Tr/Tp | 1.670 |
| Unit peak, qp | 45.32 ft³/s |
| Unit peak time, Tp | 0.067 hours |

| SCS Unit Hydrograph Parameters | |
|---|---|
| Unit receding limb, Tr | 0.267 hours |
| Total unit time, Tb | 0.333 hours |

| | |
|---|---|
| Storm Event | 1000 Year |
| Return Event | 1,000 years |
| Duration | 24.000 hours |
| Depth | 10.3 in |
| Time of Concentration (Composite) | 0.100 hours |
| Area (User Defined) | 4.000 acres |

**HYDROGRAPH ORDINATES ($ft^3/s$)**
**Output Time Increment = 0.050 hours**
**Time on left represents time for first value in each row.**

| Time (hours) | Flow ($ft^3/s$) | Flow ($ft^3/s$) | Flow ($ft^3/s$) | Flow ($ft^3/s$) | Flow ($ft^3/s$) |
|---|---|---|---|---|---|
| 0.000 | 0.00 | 0.11 | 0.31 | 0.39 | 0.41 |
| 0.250 | 0.42 | 0.43 | 0.43 | 0.43 | 0.43 |
| 0.500 | 0.43 | 0.44 | 0.44 | 0.44 | 0.44 |
| 0.750 | 0.44 | 0.44 | 0.45 | 0.45 | 0.45 |
| 1.000 | 0.45 | 0.45 | 0.46 | 0.46 | 0.46 |
| 1.250 | 0.46 | 0.47 | 0.47 | 0.47 | 0.47 |
| 1.500 | 0.48 | 0.48 | 0.48 | 0.48 | 0.48 |
| 1.750 | 0.49 | 0.49 | 0.49 | 0.49 | 0.49 |
| 2.000 | 0.49 | 0.50 | 0.50 | 0.50 | 0.50 |
| 2.250 | 0.50 | 0.51 | 0.51 | 0.51 | 0.51 |
| 2.500 | 0.52 | 0.52 | 0.52 | 0.52 | 0.53 |
| 2.750 | 0.53 | 0.53 | 0.53 | 0.53 | 0.54 |
| 3.000 | 0.54 | 0.54 | 0.54 | 0.54 | 0.54 |
| 3.250 | 0.55 | 0.55 | 0.55 | 0.55 | 0.55 |
| 3.500 | 0.56 | 0.56 | 0.56 | 0.56 | 0.57 |
| 3.750 | 0.57 | 0.57 | 0.57 | 0.58 | 0.58 |
| 4.000 | 0.58 | 0.58 | 0.58 | 0.59 | 0.59 |
| 4.250 | 0.60 | 0.60 | 0.60 | 0.61 | 0.61 |
| 4.500 | 0.62 | 0.62 | 0.63 | 0.63 | 0.63 |
| 4.750 | 0.64 | 0.64 | 0.65 | 0.65 | 0.65 |
| 5.000 | 0.66 | 0.66 | 0.67 | 0.67 | 0.67 |
| 5.250 | 0.68 | 0.68 | 0.69 | 0.69 | 0.70 |
| 5.500 | 0.70 | 0.70 | 0.71 | 0.71 | 0.72 |
| 5.750 | 0.72 | 0.72 | 0.73 | 0.73 | 0.74 |
| 6.000 | 0.74 | 0.75 | 0.75 | 0.75 | 0.76 |
| 6.250 | 0.76 | 0.77 | 0.77 | 0.77 | 0.78 |
| 6.500 | 0.78 | 0.79 | 0.79 | 0.80 | 0.80 |
| 6.750 | 0.80 | 0.81 | 0.81 | 0.82 | 0.82 |
| 7.000 | 0.82 | 0.83 | 0.83 | 0.84 | 0.84 |
| 7.250 | 0.84 | 0.85 | 0.85 | 0.86 | 0.86 |
| 7.500 | 0.87 | 0.87 | 0.87 | 0.88 | 0.88 |
| 7.750 | 0.89 | 0.89 | 0.89 | 0.90 | 0.90 |
| 8.000 | 0.91 | 0.92 | 0.93 | 0.94 | 0.97 |
| 8.250 | 0.98 | 1.01 | 1.03 | 1.05 | 1.07 |

**HYDROGRAPH ORDINATES (ft³/s)**
**Output Time Increment = 0.050 hours**
**Time on left represents time for first value in each row.**

| Time (hours) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) |
|---|---|---|---|---|---|
| 8.500 | 1.09 | 1.11 | 1.13 | 1.15 | 1.17 |
| 8.750 | 1.19 | 1.21 | 1.23 | 1.26 | 1.27 |
| 9.000 | 1.30 | 1.31 | 1.32 | 1.33 | 1.33 |
| 9.250 | 1.33 | 1.33 | 1.33 | 1.33 | 1.33 |
| 9.500 | 1.33 | 1.34 | 1.35 | 1.38 | 1.41 |
| 9.750 | 1.44 | 1.48 | 1.51 | 1.54 | 1.57 |
| 10.000 | 1.61 | 1.65 | 1.69 | 1.73 | 1.78 |
| 10.250 | 1.83 | 1.88 | 1.93 | 1.98 | 2.03 |
| 10.500 | 2.08 | 2.14 | 2.21 | 2.28 | 2.37 |
| 10.750 | 2.44 | 2.53 | 2.61 | 2.70 | 2.77 |
| 11.000 | 2.86 | 2.97 | 3.12 | 3.28 | 3.48 |
| 11.250 | 3.66 | 3.88 | 4.06 | 4.28 | 4.46 |
| 11.500 | 4.70 | 6.12 | 8.61 | 12.13 | 17.20 |
| 11.750 | 22.20 | 28.52 | 37.49 | 50.28 | 50.41 |
| 12.000 | 43.39 | 32.29 | 16.19 | 10.02 | 7.82 |
| 12.250 | 6.91 | 6.26 | 5.80 | 5.29 | 4.86 |
| 12.500 | 4.34 | 4.01 | 3.67 | 3.50 | 3.36 |
| 12.750 | 3.25 | 3.13 | 3.03 | 2.92 | 2.82 |
| 13.000 | 2.70 | 2.62 | 2.52 | 2.46 | 2.39 |
| 13.250 | 2.34 | 2.27 | 2.22 | 2.16 | 2.11 |
| 13.500 | 2.04 | 1.99 | 1.94 | 1.90 | 1.85 |
| 13.750 | 1.81 | 1.77 | 1.73 | 1.68 | 1.65 |
| 14.000 | 1.60 | 1.57 | 1.54 | 1.52 | 1.50 |
| 14.250 | 1.49 | 1.47 | 1.46 | 1.44 | 1.43 |
| 14.500 | 1.42 | 1.40 | 1.38 | 1.37 | 1.36 |
| 14.750 | 1.34 | 1.33 | 1.31 | 1.30 | 1.29 |
| 15.000 | 1.27 | 1.25 | 1.24 | 1.23 | 1.21 |
| 15.250 | 1.20 | 1.18 | 1.17 | 1.15 | 1.14 |
| 15.500 | 1.12 | 1.11 | 1.09 | 1.08 | 1.07 |
| 15.750 | 1.05 | 1.04 | 1.02 | 1.01 | 0.99 |
| 16.000 | 0.98 | 0.97 | 0.96 | 0.95 | 0.94 |
| 16.250 | 0.94 | 0.93 | 0.93 | 0.92 | 0.92 |
| 16.500 | 0.91 | 0.91 | 0.90 | 0.90 | 0.89 |
| 16.750 | 0.89 | 0.88 | 0.88 | 0.87 | 0.87 |
| 17.000 | 0.86 | 0.85 | 0.85 | 0.84 | 0.84 |
| 17.250 | 0.83 | 0.83 | 0.82 | 0.82 | 0.81 |
| 17.500 | 0.81 | 0.80 | 0.80 | 0.79 | 0.79 |
| 17.750 | 0.78 | 0.78 | 0.77 | 0.77 | 0.76 |
| 18.000 | 0.76 | 0.75 | 0.75 | 0.74 | 0.73 |
| 18.250 | 0.73 | 0.73 | 0.72 | 0.71 | 0.71 |
| 18.500 | 0.70 | 0.70 | 0.69 | 0.69 | 0.68 |
| 18.750 | 0.68 | 0.67 | 0.67 | 0.66 | 0.66 |
| 19.000 | 0.65 | 0.65 | 0.64 | 0.64 | 0.63 |

**HYDROGRAPH ORDINATES ($ft^3/s$)**
**Output Time Increment = 0.050 hours**
**Time on left represents time for first value in each row.**

| Time (hours) | Flow ($ft^3/s$) | Flow ($ft^3/s$) | Flow ($ft^3/s$) | Flow ($ft^3/s$) | Flow ($ft^3/s$) |
|---|---|---|---|---|---|
| 19.250 | 0.63 | 0.62 | 0.62 | 0.61 | 0.61 |
| 19.500 | 0.60 | 0.60 | 0.59 | 0.58 | 0.58 |
| 19.750 | 0.57 | 0.57 | 0.56 | 0.56 | 0.55 |
| 20.000 | 0.55 | 0.54 | 0.54 | 0.54 | 0.54 |
| 20.250 | 0.54 | 0.54 | 0.53 | 0.53 | 0.53 |
| 20.500 | 0.53 | 0.53 | 0.53 | 0.53 | 0.53 |
| 20.750 | 0.53 | 0.52 | 0.52 | 0.52 | 0.52 |
| 21.000 | 0.52 | 0.52 | 0.52 | 0.52 | 0.52 |
| 21.250 | 0.52 | 0.52 | 0.51 | 0.51 | 0.51 |
| 21.500 | 0.51 | 0.51 | 0.51 | 0.51 | 0.51 |
| 21.750 | 0.51 | 0.50 | 0.50 | 0.50 | 0.50 |
| 22.000 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 |
| 22.250 | 0.49 | 0.49 | 0.49 | 0.49 | 0.49 |
| 22.500 | 0.49 | 0.49 | 0.49 | 0.49 | 0.49 |
| 22.750 | 0.48 | 0.48 | 0.48 | 0.48 | 0.48 |
| 23.000 | 0.48 | 0.48 | 0.48 | 0.48 | 0.47 |
| 23.250 | 0.47 | 0.47 | 0.47 | 0.47 | 0.47 |
| 23.500 | 0.47 | 0.47 | 0.47 | 0.47 | 0.47 |
| 23.750 | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 |
| 24.000 | 0.46 | (N/A) | (N/A) | (N/A) | (N/A) |

| | |
|---|---|
| Storm Event | 1000 Year |
| Return Event | 1,000 years |
| Duration | 24.000 hours |
| Depth | 10.3 in |
| Time of Concentration (Composite) | 0.100 hours |
| Area (User Defined) | 18.000 acres |

| | |
|---|---|
| Computational Time Increment | 0.013 hours |
| Time to Peak (Computed) | 11.920 hours |
| Flow (Peak, Computed) | 235.44 ft³/s |
| Output Increment | 0.050 hours |
| Time to Flow (Peak Interpolated Output) | 11.950 hours |
| Flow (Peak Interpolated Output) | 226.83 ft³/s |

| Drainage Area | |
|---|---|
| SCS CN (Composite) | 100.000 |
| Area (User Defined) | 18.000 acres |
| Maximum Retention (Pervious) | 0.0 in |
| Maximum Retention (Pervious, 20 percent) | 0.0 in |

| Cumulative Runoff | |
|---|---|
| Cumulative Runoff Depth (Pervious) | 10.3 in |
| Runoff Volume (Pervious) | 15.450 ac-ft |

| Hydrograph Volume (Area under Hydrograph curve) | |
|---|---|
| Volume | 15.436 ac-ft |

| SCS Unit Hydrograph Parameters | |
|---|---|
| Time of Concentration (Composite) | 0.100 hours |
| Computational Time Increment | 0.013 hours |
| Unit Hydrograph Shape Factor | 483.432 |
| K Factor | 0.749 |
| Receding/Rising, Tr/Tp | 1.670 |
| Unit peak, qp | 203.95 ft³/s |
| Unit peak time, Tp | 0.067 hours |

| SCS Unit Hydrograph Parameters | |
|---|---|
| Unit receding limb, Tr | 0.267 hours |
| Total unit time, Tb | 0.333 hours |

| | |
|---|---|
| Storm Event | 1000 Year |
| Return Event | 1,000 years |
| Duration | 24.000 hours |
| Depth | 10.3 in |
| Time of Concentration (Composite) | 0.100 hours |
| Area (User Defined) | 18.000 acres |

**HYDROGRAPH ORDINATES (ft³/s)**
**Output Time Increment = 0.050 hours**
**Time on left represents time for first value in each row.**

| Time (hours) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) |
|---|---|---|---|---|---|
| 0.000 | 0.00 | 0.50 | 1.41 | 1.75 | 1.85 |
| 0.250 | 1.89 | 1.91 | 1.92 | 1.92 | 1.94 |
| 0.500 | 1.95 | 1.96 | 1.96 | 1.97 | 1.99 |
| 0.750 | 2.00 | 2.00 | 2.01 | 2.03 | 2.03 |
| 1.000 | 2.04 | 2.05 | 2.07 | 2.07 | 2.07 |
| 1.250 | 2.08 | 2.10 | 2.11 | 2.11 | 2.12 |
| 1.500 | 2.14 | 2.15 | 2.15 | 2.16 | 2.18 |
| 1.750 | 2.18 | 2.19 | 2.20 | 2.22 | 2.22 |
| 2.000 | 2.22 | 2.23 | 2.25 | 2.26 | 2.26 |
| 2.250 | 2.27 | 2.29 | 2.30 | 2.30 | 2.31 |
| 2.500 | 2.33 | 2.33 | 2.34 | 2.35 | 2.36 |
| 2.750 | 2.37 | 2.37 | 2.38 | 2.40 | 2.41 |
| 3.000 | 2.41 | 2.42 | 2.44 | 2.45 | 2.45 |
| 3.250 | 2.46 | 2.48 | 2.48 | 2.49 | 2.50 |
| 3.500 | 2.51 | 2.52 | 2.52 | 2.53 | 2.55 |
| 3.750 | 2.56 | 2.56 | 2.57 | 2.59 | 2.60 |
| 4.000 | 2.60 | 2.61 | 2.63 | 2.64 | 2.66 |
| 4.250 | 2.68 | 2.70 | 2.72 | 2.74 | 2.76 |
| 4.500 | 2.78 | 2.79 | 2.81 | 2.83 | 2.85 |
| 4.750 | 2.87 | 2.89 | 2.90 | 2.92 | 2.94 |
| 5.000 | 2.96 | 2.98 | 3.00 | 3.02 | 3.04 |
| 5.250 | 3.05 | 3.07 | 3.09 | 3.11 | 3.13 |
| 5.500 | 3.15 | 3.17 | 3.19 | 3.20 | 3.22 |
| 5.750 | 3.24 | 3.26 | 3.28 | 3.30 | 3.32 |
| 6.000 | 3.34 | 3.35 | 3.37 | 3.39 | 3.41 |
| 6.250 | 3.43 | 3.45 | 3.47 | 3.49 | 3.50 |
| 6.500 | 3.52 | 3.54 | 3.56 | 3.58 | 3.60 |
| 6.750 | 3.62 | 3.64 | 3.65 | 3.67 | 3.69 |
| 7.000 | 3.71 | 3.73 | 3.75 | 3.76 | 3.78 |
| 7.250 | 3.80 | 3.82 | 3.84 | 3.86 | 3.88 |
| 7.500 | 3.90 | 3.91 | 3.93 | 3.95 | 3.97 |
| 7.750 | 3.99 | 4.01 | 4.03 | 4.05 | 4.06 |
| 8.000 | 4.08 | 4.12 | 4.18 | 4.25 | 4.34 |
| 8.250 | 4.43 | 4.53 | 4.62 | 4.72 | 4.80 |

Subsection: Unit Hydrograph (Hydrograph Table) Return Event: 1,000 years
Label: Wastewater Pond Catchment Storm Event: 1000 Year

**HYDROGRAPH ORDINATES (ft³/s)**
**Output Time Increment = 0.050 hours**
**Time on left represents time for first value in each row.**

| Time (hours) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) |
|---|---|---|---|---|---|
| 8.500 | 4.90 | 4.99 | 5.09 | 5.18 | 5.28 |
| 8.750 | 5.36 | 5.46 | 5.55 | 5.65 | 5.74 |
| 9.000 | 5.84 | 5.90 | 5.95 | 5.97 | 5.98 |
| 9.250 | 5.98 | 5.98 | 5.98 | 5.98 | 5.98 |
| 9.500 | 5.98 | 6.02 | 6.09 | 6.20 | 6.35 |
| 9.750 | 6.49 | 6.65 | 6.79 | 6.95 | 7.09 |
| 10.000 | 7.25 | 7.40 | 7.60 | 7.79 | 8.03 |
| 10.250 | 8.23 | 8.48 | 8.68 | 8.93 | 9.13 |
| 10.500 | 9.38 | 9.62 | 9.93 | 10.25 | 10.64 |
| 10.750 | 10.98 | 11.39 | 11.73 | 12.14 | 12.48 |
| 11.000 | 12.88 | 13.36 | 14.03 | 14.74 | 15.67 |
| 11.250 | 16.49 | 17.46 | 18.28 | 19.25 | 20.08 |
| 11.500 | 21.13 | 27.53 | 38.73 | 54.59 | 77.41 |
| 11.750 | 99.89 | 128.36 | 168.70 | 226.25 | 226.83 |
| 12.000 | 195.25 | 145.32 | 72.86 | 45.09 | 35.21 |
| 12.250 | 31.11 | 28.15 | 26.12 | 23.82 | 21.87 |
| 12.500 | 19.55 | 18.03 | 16.53 | 15.74 | 15.10 |
| 12.750 | 14.63 | 14.10 | 13.65 | 13.12 | 12.68 |
| 13.000 | 12.15 | 11.77 | 11.35 | 11.06 | 10.77 |
| 13.250 | 10.52 | 10.24 | 10.00 | 9.71 | 9.47 |
| 13.500 | 9.19 | 8.97 | 8.72 | 8.54 | 8.33 |
| 13.750 | 8.16 | 7.95 | 7.78 | 7.58 | 7.41 |
| 14.000 | 7.21 | 7.07 | 6.93 | 6.84 | 6.75 |
| 14.250 | 6.69 | 6.63 | 6.57 | 6.49 | 6.43 |
| 14.500 | 6.37 | 6.31 | 6.23 | 6.17 | 6.11 |
| 14.750 | 6.04 | 5.97 | 5.91 | 5.84 | 5.78 |
| 15.000 | 5.70 | 5.65 | 5.58 | 5.52 | 5.44 |
| 15.250 | 5.38 | 5.32 | 5.26 | 5.18 | 5.12 |
| 15.500 | 5.06 | 5.00 | 4.92 | 4.86 | 4.80 |
| 15.750 | 4.74 | 4.66 | 4.60 | 4.54 | 4.47 |
| 16.000 | 4.40 | 4.35 | 4.30 | 4.27 | 4.24 |
| 16.250 | 4.22 | 4.20 | 4.18 | 4.15 | 4.13 |
| 16.500 | 4.10 | 4.08 | 4.05 | 4.03 | 4.01 |
| 16.750 | 3.99 | 3.96 | 3.94 | 3.92 | 3.90 |
| 17.000 | 3.87 | 3.85 | 3.82 | 3.80 | 3.77 |
| 17.250 | 3.75 | 3.73 | 3.71 | 3.68 | 3.66 |
| 17.500 | 3.64 | 3.61 | 3.59 | 3.57 | 3.54 |
| 17.750 | 3.52 | 3.49 | 3.47 | 3.45 | 3.43 |
| 18.000 | 3.40 | 3.38 | 3.36 | 3.33 | 3.31 |
| 18.250 | 3.28 | 3.26 | 3.24 | 3.21 | 3.19 |
| 18.500 | 3.17 | 3.15 | 3.12 | 3.10 | 3.08 |
| 18.750 | 3.05 | 3.02 | 3.00 | 2.98 | 2.96 |
| 19.000 | 2.93 | 2.91 | 2.89 | 2.87 | 2.84 |

**HYDROGRAPH ORDINATES (ft³/s)**
**Output Time Increment = 0.050 hours**
**Time on left represents time for first value in each row.**

| Time (hours) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) |
|---|---|---|---|---|---|
| 19.250 | 2.82 | 2.80 | 2.77 | 2.74 | 2.72 |
| 19.500 | 2.70 | 2.68 | 2.65 | 2.63 | 2.61 |
| 19.750 | 2.59 | 2.56 | 2.54 | 2.52 | 2.49 |
| 20.000 | 2.46 | 2.45 | 2.44 | 2.43 | 2.42 |
| 20.250 | 2.41 | 2.41 | 2.41 | 2.40 | 2.39 |
| 20.500 | 2.39 | 2.39 | 2.38 | 2.38 | 2.37 |
| 20.750 | 2.37 | 2.36 | 2.36 | 2.36 | 2.35 |
| 21.000 | 2.34 | 2.34 | 2.34 | 2.33 | 2.32 |
| 21.250 | 2.32 | 2.32 | 2.31 | 2.30 | 2.30 |
| 21.500 | 2.30 | 2.29 | 2.29 | 2.28 | 2.28 |
| 21.750 | 2.28 | 2.27 | 2.26 | 2.26 | 2.26 |
| 22.000 | 2.25 | 2.24 | 2.24 | 2.24 | 2.23 |
| 22.250 | 2.23 | 2.22 | 2.22 | 2.21 | 2.21 |
| 22.500 | 2.21 | 2.20 | 2.19 | 2.19 | 2.19 |
| 22.750 | 2.18 | 2.17 | 2.17 | 2.17 | 2.16 |
| 23.000 | 2.15 | 2.15 | 2.15 | 2.14 | 2.14 |
| 23.250 | 2.13 | 2.13 | 2.13 | 2.12 | 2.11 |
| 23.500 | 2.11 | 2.11 | 2.10 | 2.10 | 2.09 |
| 23.750 | 2.09 | 2.08 | 2.08 | 2.08 | 2.08 |
| 24.000 | 2.08 | (N/A) | (N/A) | (N/A) | (N/A) |

| | |
|---|---|
| Peak Discharge | 20.00 ft³/s |
| Time to Peak | 7.900 hours |
| Hydrograph Volume | 39.669 ac-ft |

**HYDROGRAPH ORDINATES (ft³/s)**
**Output Time Increment = 0.100 hours**
**Time on left represents time for first value in each row.**

| Time (hours) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) |
|---|---|---|---|---|---|
| 0.000 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| 0.500 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| 1.000 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| 1.500 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| 2.000 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| 2.500 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| 3.000 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| 3.500 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| 4.000 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| 4.500 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| 5.000 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| 5.500 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| 6.000 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| 6.500 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| 7.000 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| 7.500 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| 8.000 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| 8.500 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| 9.000 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| 9.500 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| 10.000 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| 10.500 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| 11.000 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| 11.500 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| 12.000 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| 12.500 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| 13.000 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| 13.500 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| 14.000 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| 14.500 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| 15.000 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| 15.500 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| 16.000 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| 16.500 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| 17.000 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| 17.500 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| 18.000 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| 18.500 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| 19.000 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |

Subsection: Read Hydrograph | Return Event: 1,000 years
Label: WWP Influent Pumped | Storm Event: 1000 Year

**HYDROGRAPH ORDINATES ($ft^3/s$)**
**Output Time Increment = 0.100 hours**
**Time on left represents time for first value in each row.**

| Time (hours) | Flow ($ft^3/s$) | Flow ($ft^3/s$) | Flow ($ft^3/s$) | Flow ($ft^3/s$) | Flow ($ft^3/s$) |
|---|---|---|---|---|---|
| 19.500 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| 20.000 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| 20.500 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| 21.000 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| 21.500 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| 22.000 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| 22.500 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| 23.000 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| 23.500 | 20.00 | 20.00 | 20.00 | 20.00 | 20.00 |
| 24.000 | 20.00 | (N/A) | (N/A) | (N/A) | (N/A) |

## Summary for Hydrograph Addition at 'CWP Outfall'

| Upstream Link | Upstream Node |
|---|---|
| CWP Outlet | Clearwater Pond (CWP) |

## Node Inflows

| Inflow Type | Element | Volume (ac-ft) | Time to Peak (hours) | Flow (Peak) ($ft^3/s$) |
|---|---|---|---|---|
| Flow (From) | CWP Outlet | 94.142 | 12.100 | 123.59 |
| Flow (In) | CWP Outfall | 94.142 | 12.100 | 123.59 |

| | |
|---|---|
| Peak Discharge | 34.94 ft³/s |
| Time to Peak | 13.650 hours |
| Hydrograph Volume | 38.722 ac-ft |

**HYDROGRAPH ORDINATES (ft³/s)**
**Output Time Increment = 0.050 hours**
**Time on left represents time for first value in each row.**

| Time (hours) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) |
|---|---|---|---|---|---|
| 0.000 | 0.00 | 0.06 | 0.12 | 0.18 | 0.24 |
| 0.250 | 0.30 | 0.37 | 0.43 | 0.49 | 0.55 |
| 0.500 | 0.62 | 0.68 | 0.74 | 0.80 | 0.87 |
| 0.750 | 0.93 | 0.99 | 1.05 | 1.11 | 1.17 |
| 1.000 | 1.23 | 1.30 | 1.36 | 1.42 | 1.48 |
| 1.250 | 1.54 | 1.60 | 1.66 | 1.72 | 1.78 |
| 1.500 | 1.84 | 1.90 | 1.96 | 2.02 | 2.08 |
| 1.750 | 2.14 | 2.20 | 2.26 | 2.32 | 2.37 |
| 2.000 | 2.43 | 2.49 | 2.55 | 2.61 | 2.67 |
| 2.250 | 2.73 | 2.78 | 2.84 | 2.90 | 2.96 |
| 2.500 | 3.02 | 3.07 | 3.13 | 3.19 | 3.24 |
| 2.750 | 3.30 | 3.36 | 3.42 | 3.47 | 3.53 |
| 3.000 | 3.59 | 3.64 | 3.70 | 3.75 | 3.81 |
| 3.250 | 3.87 | 3.92 | 3.98 | 4.03 | 4.09 |
| 3.500 | 4.15 | 4.20 | 4.26 | 4.31 | 4.37 |
| 3.750 | 4.42 | 4.48 | 4.53 | 4.59 | 4.64 |
| 4.000 | 4.69 | 4.75 | 4.80 | 4.86 | 4.91 |
| 4.250 | 4.96 | 5.02 | 5.07 | 5.13 | 5.18 |
| 4.500 | 5.23 | 5.29 | 5.34 | 5.40 | 5.45 |
| 4.750 | 5.50 | 5.56 | 5.61 | 5.66 | 5.72 |
| 5.000 | 5.77 | 5.82 | 5.88 | 5.93 | 5.98 |
| 5.250 | 6.04 | 6.09 | 6.14 | 6.19 | 6.25 |
| 5.500 | 6.30 | 6.35 | 6.40 | 6.46 | 6.51 |
| 5.750 | 6.56 | 6.62 | 6.67 | 6.72 | 6.77 |
| 6.000 | 6.82 | 6.88 | 6.93 | 6.98 | 7.03 |
| 6.250 | 7.09 | 7.14 | 7.19 | 7.24 | 7.29 |
| 6.500 | 7.34 | 7.40 | 7.45 | 7.50 | 7.55 |
| 6.750 | 7.60 | 7.65 | 7.71 | 7.76 | 7.81 |
| 7.000 | 7.86 | 7.91 | 7.96 | 8.01 | 8.07 |
| 7.250 | 8.12 | 8.17 | 8.22 | 8.27 | 8.32 |
| 7.500 | 8.37 | 8.42 | 8.47 | 8.52 | 8.57 |
| 7.750 | 8.63 | 8.68 | 8.73 | 8.78 | 8.83 |
| 8.000 | 8.88 | 8.93 | 8.98 | 9.03 | 9.08 |
| 8.250 | 9.13 | 9.18 | 9.24 | 9.29 | 9.34 |
| 8.500 | 9.40 | 9.45 | 9.50 | 9.57 | 9.67 |
| 8.750 | 9.77 | 9.87 | 9.97 | 10.07 | 10.17 |
| 9.000 | 10.27 | 10.38 | 10.48 | 10.58 | 10.68 |
| 9.250 | 10.78 | 10.88 | 10.98 | 11.08 | 11.18 |
| 9.500 | 11.28 | 11.38 | 11.48 | 11.58 | 11.68 |

**HYDROGRAPH ORDINATES ($ft^3/s$)**
**Output Time Increment = 0.050 hours**
**Time on left represents time for first value in each row.**

| Time (hours) | Flow ($ft^3/s$) | Flow ($ft^3/s$) | Flow ($ft^3/s$) | Flow ($ft^3/s$) | Flow ($ft^3/s$) |
|---|---|---|---|---|---|
| 9.750 | 11.78 | 11.88 | 11.98 | 12.08 | 12.19 |
| 10.000 | 12.29 | 12.40 | 12.51 | 12.61 | 12.73 |
| 10.250 | 12.84 | 12.95 | 13.07 | 13.18 | 13.30 |
| 10.500 | 13.42 | 13.54 | 13.67 | 13.79 | 13.92 |
| 10.750 | 14.06 | 14.19 | 14.33 | 14.47 | 14.61 |
| 11.000 | 14.76 | 14.91 | 15.07 | 15.23 | 15.40 |
| 11.250 | 15.58 | 15.76 | 15.95 | 16.15 | 16.36 |
| 11.500 | 16.58 | 16.84 | 17.20 | 17.70 | 18.40 |
| 11.750 | 19.33 | 20.50 | 22.04 | 24.08 | 26.30 |
| 12.000 | 28.62 | 30.53 | 31.60 | 32.12 | 32.48 |
| 12.250 | 32.78 | 33.05 | 33.28 | 33.49 | 33.68 |
| 12.500 | 33.83 | 33.96 | 34.07 | 34.17 | 34.26 |
| 12.750 | 34.35 | 34.42 | 34.49 | 34.55 | 34.61 |
| 13.000 | 34.66 | 34.71 | 34.74 | 34.78 | 34.81 |
| 13.250 | 34.84 | 34.86 | 34.88 | 34.90 | 34.91 |
| 13.500 | 34.92 | 34.93 | 34.94 | 34.94 | 34.94 |
| 13.750 | 34.93 | 34.93 | 34.92 | 34.91 | 34.90 |
| 14.000 | 34.89 | 34.87 | 34.85 | 34.83 | 34.81 |
| 14.250 | 34.79 | 34.77 | 34.75 | 34.72 | 34.70 |
| 14.500 | 34.68 | 34.65 | 34.63 | 34.60 | 34.57 |
| 14.750 | 34.55 | 34.52 | 34.49 | 34.46 | 34.43 |
| 15.000 | 34.40 | 34.37 | 34.34 | 34.31 | 34.27 |
| 15.250 | 34.24 | 34.21 | 34.17 | 34.14 | 34.10 |
| 15.500 | 34.06 | 34.03 | 33.99 | 33.95 | 33.91 |
| 15.750 | 33.87 | 33.83 | 33.79 | 33.75 | 33.71 |
| 16.000 | 33.67 | 33.63 | 33.58 | 33.54 | 33.50 |
| 16.250 | 33.45 | 33.41 | 33.37 | 33.33 | 33.28 |
| 16.500 | 33.24 | 33.20 | 33.15 | 33.11 | 33.07 |
| 16.750 | 33.02 | 32.98 | 32.94 | 32.89 | 32.85 |
| 17.000 | 32.81 | 32.77 | 32.72 | 32.68 | 32.64 |
| 17.250 | 32.59 | 32.55 | 32.51 | 32.46 | 32.42 |
| 17.500 | 32.38 | 32.33 | 32.29 | 32.25 | 32.20 |
| 17.750 | 32.16 | 32.12 | 32.07 | 32.03 | 31.99 |
| 18.000 | 31.94 | 31.90 | 31.86 | 31.81 | 31.77 |
| 18.250 | 31.73 | 31.68 | 31.64 | 31.60 | 31.55 |
| 18.500 | 31.51 | 31.47 | 31.42 | 31.38 | 31.34 |
| 18.750 | 31.29 | 31.25 | 31.21 | 31.16 | 31.12 |
| 19.000 | 31.08 | 31.03 | 30.99 | 30.95 | 30.90 |
| 19.250 | 30.86 | 30.82 | 30.77 | 30.73 | 30.69 |
| 19.500 | 30.64 | 30.60 | 30.56 | 30.51 | 30.47 |
| 19.750 | 30.43 | 30.38 | 30.34 | 30.30 | 30.25 |
| 20.000 | 30.21 | 30.17 | 30.12 | 30.08 | 30.04 |
| 20.250 | 29.99 | 29.95 | 29.91 | 29.87 | 29.82 |

**HYDROGRAPH ORDINATES (ft³/s)**
**Output Time Increment = 0.050 hours**
**Time on left represents time for first value in each row.**

| Time (hours) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) |
|---|---|---|---|---|---|
| 20.500 | 29.78 | 29.74 | 29.70 | 29.66 | 29.62 |
| 20.750 | 29.58 | 29.54 | 29.50 | 29.46 | 29.42 |
| 21.000 | 29.38 | 29.34 | 29.30 | 29.26 | 29.22 |
| 21.250 | 29.18 | 29.14 | 29.11 | 29.07 | 29.03 |
| 21.500 | 28.99 | 28.96 | 28.92 | 28.88 | 28.84 |
| 21.750 | 28.81 | 28.77 | 28.74 | 28.70 | 28.66 |
| 22.000 | 28.63 | 28.59 | 28.56 | 28.52 | 28.49 |
| 22.250 | 28.45 | 28.42 | 28.38 | 28.35 | 28.31 |
| 22.500 | 28.28 | 28.25 | 28.21 | 28.18 | 28.15 |
| 22.750 | 28.11 | 28.08 | 28.05 | 28.01 | 27.98 |
| 23.000 | 27.95 | 27.92 | 27.88 | 27.85 | 27.82 |
| 23.250 | 27.79 | 27.76 | 27.73 | 27.69 | 27.66 |
| 23.500 | 27.63 | 27.60 | 27.57 | 27.54 | 27.51 |
| 23.750 | 27.48 | 27.45 | 27.42 | 27.39 | 27.36 |
| 24.000 | 27.33 | (N/A) | (N/A) | (N/A) | (N/A) |

| | |
|---|---|
| Peak Discharge | 34.94 ft³/s |
| Time to Peak | 13.650 hours |
| Hydrograph Volume | 38.722 ac-ft |

**HYDROGRAPH ORDINATES (ft³/s)**
**Output Time Increment = 0.050 hours**
**Time on left represents time for first value in each row.**

| Time (hours) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) |
|---|---|---|---|---|---|
| 0.000 | 0.00 | 0.06 | 0.12 | 0.18 | 0.24 |
| 0.250 | 0.30 | 0.37 | 0.43 | 0.49 | 0.55 |
| 0.500 | 0.62 | 0.68 | 0.74 | 0.80 | 0.87 |
| 0.750 | 0.93 | 0.99 | 1.05 | 1.11 | 1.17 |
| 1.000 | 1.23 | 1.30 | 1.36 | 1.42 | 1.48 |
| 1.250 | 1.54 | 1.60 | 1.66 | 1.72 | 1.78 |
| 1.500 | 1.84 | 1.90 | 1.96 | 2.02 | 2.08 |
| 1.750 | 2.14 | 2.20 | 2.26 | 2.32 | 2.37 |
| 2.000 | 2.43 | 2.49 | 2.55 | 2.61 | 2.67 |
| 2.250 | 2.73 | 2.78 | 2.84 | 2.90 | 2.96 |
| 2.500 | 3.02 | 3.07 | 3.13 | 3.19 | 3.24 |
| 2.750 | 3.30 | 3.36 | 3.42 | 3.47 | 3.53 |
| 3.000 | 3.59 | 3.64 | 3.70 | 3.75 | 3.81 |
| 3.250 | 3.87 | 3.92 | 3.98 | 4.03 | 4.09 |
| 3.500 | 4.15 | 4.20 | 4.26 | 4.31 | 4.37 |
| 3.750 | 4.42 | 4.48 | 4.53 | 4.59 | 4.64 |
| 4.000 | 4.69 | 4.75 | 4.80 | 4.86 | 4.91 |
| 4.250 | 4.96 | 5.02 | 5.07 | 5.13 | 5.18 |
| 4.500 | 5.23 | 5.29 | 5.34 | 5.40 | 5.45 |
| 4.750 | 5.50 | 5.56 | 5.61 | 5.66 | 5.72 |
| 5.000 | 5.77 | 5.82 | 5.88 | 5.93 | 5.98 |
| 5.250 | 6.04 | 6.09 | 6.14 | 6.19 | 6.25 |
| 5.500 | 6.30 | 6.35 | 6.40 | 6.46 | 6.51 |
| 5.750 | 6.56 | 6.62 | 6.67 | 6.72 | 6.77 |
| 6.000 | 6.82 | 6.88 | 6.93 | 6.98 | 7.03 |
| 6.250 | 7.09 | 7.14 | 7.19 | 7.24 | 7.29 |
| 6.500 | 7.34 | 7.40 | 7.45 | 7.50 | 7.55 |
| 6.750 | 7.60 | 7.65 | 7.71 | 7.76 | 7.81 |
| 7.000 | 7.86 | 7.91 | 7.96 | 8.01 | 8.07 |
| 7.250 | 8.12 | 8.17 | 8.22 | 8.27 | 8.32 |
| 7.500 | 8.37 | 8.42 | 8.47 | 8.52 | 8.57 |
| 7.750 | 8.63 | 8.68 | 8.73 | 8.78 | 8.83 |
| 8.000 | 8.88 | 8.93 | 8.98 | 9.03 | 9.08 |
| 8.250 | 9.13 | 9.18 | 9.24 | 9.29 | 9.34 |
| 8.500 | 9.40 | 9.45 | 9.50 | 9.57 | 9.67 |
| 8.750 | 9.77 | 9.87 | 9.97 | 10.07 | 10.17 |
| 9.000 | 10.27 | 10.38 | 10.48 | 10.58 | 10.68 |
| 9.250 | 10.78 | 10.88 | 10.98 | 11.08 | 11.18 |
| 9.500 | 11.28 | 11.38 | 11.48 | 11.58 | 11.68 |

**HYDROGRAPH ORDINATES (ft³/s)**
**Output Time Increment = 0.050 hours**
**Time on left represents time for first value in each row.**

| Time (hours) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) |
|---|---|---|---|---|---|
| 9.750 | 11.78 | 11.88 | 11.98 | 12.08 | 12.19 |
| 10.000 | 12.29 | 12.40 | 12.51 | 12.61 | 12.73 |
| 10.250 | 12.84 | 12.95 | 13.07 | 13.18 | 13.30 |
| 10.500 | 13.42 | 13.54 | 13.67 | 13.79 | 13.92 |
| 10.750 | 14.06 | 14.19 | 14.33 | 14.47 | 14.61 |
| 11.000 | 14.76 | 14.91 | 15.07 | 15.23 | 15.40 |
| 11.250 | 15.58 | 15.76 | 15.95 | 16.15 | 16.36 |
| 11.500 | 16.58 | 16.84 | 17.20 | 17.70 | 18.40 |
| 11.750 | 19.33 | 20.50 | 22.04 | 24.08 | 26.30 |
| 12.000 | 28.62 | 30.53 | 31.60 | 32.12 | 32.48 |
| 12.250 | 32.78 | 33.05 | 33.28 | 33.49 | 33.68 |
| 12.500 | 33.83 | 33.96 | 34.07 | 34.17 | 34.26 |
| 12.750 | 34.35 | 34.42 | 34.49 | 34.55 | 34.61 |
| 13.000 | 34.66 | 34.71 | 34.74 | 34.78 | 34.81 |
| 13.250 | 34.84 | 34.86 | 34.88 | 34.90 | 34.91 |
| 13.500 | 34.92 | 34.93 | 34.94 | 34.94 | 34.94 |
| 13.750 | 34.93 | 34.93 | 34.92 | 34.91 | 34.90 |
| 14.000 | 34.89 | 34.87 | 34.85 | 34.83 | 34.81 |
| 14.250 | 34.79 | 34.77 | 34.75 | 34.72 | 34.70 |
| 14.500 | 34.68 | 34.65 | 34.63 | 34.60 | 34.57 |
| 14.750 | 34.55 | 34.52 | 34.49 | 34.46 | 34.43 |
| 15.000 | 34.40 | 34.37 | 34.34 | 34.31 | 34.27 |
| 15.250 | 34.24 | 34.21 | 34.17 | 34.14 | 34.10 |
| 15.500 | 34.06 | 34.03 | 33.99 | 33.95 | 33.91 |
| 15.750 | 33.87 | 33.83 | 33.79 | 33.75 | 33.71 |
| 16.000 | 33.67 | 33.63 | 33.58 | 33.54 | 33.50 |
| 16.250 | 33.45 | 33.41 | 33.37 | 33.33 | 33.28 |
| 16.500 | 33.24 | 33.20 | 33.15 | 33.11 | 33.07 |
| 16.750 | 33.02 | 32.98 | 32.94 | 32.89 | 32.85 |
| 17.000 | 32.81 | 32.77 | 32.72 | 32.68 | 32.64 |
| 17.250 | 32.59 | 32.55 | 32.51 | 32.46 | 32.42 |
| 17.500 | 32.38 | 32.33 | 32.29 | 32.25 | 32.20 |
| 17.750 | 32.16 | 32.12 | 32.07 | 32.03 | 31.99 |
| 18.000 | 31.94 | 31.90 | 31.86 | 31.81 | 31.77 |
| 18.250 | 31.73 | 31.68 | 31.64 | 31.60 | 31.55 |
| 18.500 | 31.51 | 31.47 | 31.42 | 31.38 | 31.34 |
| 18.750 | 31.29 | 31.25 | 31.21 | 31.16 | 31.12 |
| 19.000 | 31.08 | 31.03 | 30.99 | 30.95 | 30.90 |
| 19.250 | 30.86 | 30.82 | 30.77 | 30.73 | 30.69 |
| 19.500 | 30.64 | 30.60 | 30.56 | 30.51 | 30.47 |
| 19.750 | 30.43 | 30.38 | 30.34 | 30.30 | 30.25 |
| 20.000 | 30.21 | 30.17 | 30.12 | 30.08 | 30.04 |
| 20.250 | 29.99 | 29.95 | 29.91 | 29.87 | 29.82 |

Subsection: Hydrograph
Label: Bottom Ash Pond (BAP) (OUT)

Return Event: 1,000 years
Storm Event: 1000 Year

**HYDROGRAPH ORDINATES (ft³/s)**
**Output Time Increment = 0.050 hours**
**Time on left represents time for first value in each row.**

| Time (hours) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) |
|---|---|---|---|---|---|
| 20.500 | 29.78 | 29.74 | 29.70 | 29.66 | 29.62 |
| 20.750 | 29.58 | 29.54 | 29.50 | 29.46 | 29.42 |
| 21.000 | 29.38 | 29.34 | 29.30 | 29.26 | 29.22 |
| 21.250 | 29.18 | 29.14 | 29.11 | 29.07 | 29.03 |
| 21.500 | 28.99 | 28.96 | 28.92 | 28.88 | 28.84 |
| 21.750 | 28.81 | 28.77 | 28.74 | 28.70 | 28.66 |
| 22.000 | 28.63 | 28.59 | 28.56 | 28.52 | 28.49 |
| 22.250 | 28.45 | 28.42 | 28.38 | 28.35 | 28.31 |
| 22.500 | 28.28 | 28.25 | 28.21 | 28.18 | 28.15 |
| 22.750 | 28.11 | 28.08 | 28.05 | 28.01 | 27.98 |
| 23.000 | 27.95 | 27.92 | 27.88 | 27.85 | 27.82 |
| 23.250 | 27.79 | 27.76 | 27.73 | 27.69 | 27.66 |
| 23.500 | 27.63 | 27.60 | 27.57 | 27.54 | 27.51 |
| 23.750 | 27.48 | 27.45 | 27.42 | 27.39 | 27.36 |
| 24.000 | 27.33 | (N/A) | (N/A) | (N/A) | (N/A) |

| | |
|---|---|
| Peak Discharge | 469.92 ft³/s |
| Time to Peak | 11.900 hours |
| Hydrograph Volume | 66.848 ac-ft |

**HYDROGRAPH ORDINATES (ft³/s)**
**Output Time Increment = 0.050 hours**
**Time on left represents time for first value in each row.**

| Time (hours) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) |
|---|---|---|---|---|---|
| 0.000 | 19.00 | 20.34 | 22.03 | 22.44 | 22.54 |
| 0.250 | 22.59 | 22.63 | 22.63 | 22.64 | 22.66 |
| 0.500 | 22.70 | 22.71 | 22.71 | 22.73 | 22.77 |
| 0.750 | 22.78 | 22.78 | 22.80 | 22.84 | 22.85 |
| 1.000 | 22.85 | 22.88 | 22.91 | 22.92 | 22.92 |
| 1.250 | 22.95 | 22.98 | 22.99 | 22.99 | 23.02 |
| 1.500 | 23.05 | 23.06 | 23.06 | 23.09 | 23.12 |
| 1.750 | 23.13 | 23.13 | 23.16 | 23.19 | 23.20 |
| 2.000 | 23.20 | 23.23 | 23.26 | 23.27 | 23.27 |
| 2.250 | 23.30 | 23.33 | 23.34 | 23.34 | 23.37 |
| 2.500 | 23.40 | 23.41 | 23.41 | 23.44 | 23.47 |
| 2.750 | 23.48 | 23.48 | 23.51 | 23.54 | 23.55 |
| 3.000 | 23.55 | 23.58 | 23.62 | 23.62 | 23.63 |
| 3.250 | 23.65 | 23.69 | 23.69 | 23.70 | 23.72 |
| 3.500 | 23.76 | 23.76 | 23.77 | 23.79 | 23.83 |
| 3.750 | 23.84 | 23.84 | 23.86 | 23.90 | 23.91 |
| 4.000 | 23.91 | 23.93 | 23.97 | 24.00 | 24.04 |
| 4.250 | 24.07 | 24.11 | 24.14 | 24.18 | 24.21 |
| 4.500 | 24.25 | 24.29 | 24.32 | 24.36 | 24.39 |
| 4.750 | 24.43 | 24.46 | 24.50 | 24.53 | 24.57 |
| 5.000 | 24.60 | 24.64 | 24.67 | 24.71 | 24.74 |
| 5.250 | 24.78 | 24.82 | 24.85 | 24.89 | 24.92 |
| 5.500 | 24.96 | 24.99 | 25.03 | 25.06 | 25.10 |
| 5.750 | 25.13 | 25.17 | 25.20 | 25.24 | 25.27 |
| 6.000 | 25.31 | 25.34 | 25.38 | 25.42 | 25.45 |
| 6.250 | 25.49 | 25.52 | 25.56 | 25.59 | 25.63 |
| 6.500 | 25.66 | 25.70 | 25.73 | 25.77 | 25.80 |
| 6.750 | 25.84 | 25.87 | 25.91 | 25.95 | 25.98 |
| 7.000 | 26.02 | 26.05 | 26.09 | 26.12 | 26.16 |
| 7.250 | 26.19 | 26.23 | 26.26 | 26.30 | 26.33 |
| 7.500 | 26.37 | 26.40 | 26.44 | 26.47 | 26.51 |
| 7.750 | 26.55 | 26.58 | 26.62 | 26.65 | 26.69 |
| 8.000 | 26.72 | 26.81 | 26.91 | 27.07 | 27.24 |
| 8.250 | 27.42 | 27.60 | 27.77 | 27.95 | 28.12 |
| 8.500 | 28.30 | 28.48 | 28.65 | 28.83 | 29.01 |
| 8.750 | 29.18 | 29.36 | 29.54 | 29.71 | 29.89 |
| 9.000 | 30.07 | 30.18 | 30.27 | 30.29 | 30.30 |
| 9.250 | 30.30 | 30.30 | 30.30 | 30.30 | 30.30 |
| 9.500 | 30.30 | 30.41 | 30.54 | 30.78 | 31.06 |

Subsection: Hydrograph
Label: Bottom Ash Pond (BAP) (IN)

Return Event: 1,000 years
Storm Event: 1000 Year

**HYDROGRAPH ORDINATES (ft³/s)**
**Output Time Increment = 0.050 hours**
**Time on left represents time for first value in each row.**

| Time (hours) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) |
|---|---|---|---|---|---|
| 9.750 | 31.34 | 31.62 | 31.90 | 32.19 | 32.47 |
| 10.000 | 32.75 | 33.09 | 33.44 | 33.84 | 34.26 |
| 10.250 | 34.68 | 35.11 | 35.53 | 35.96 | 36.38 |
| 10.500 | 36.80 | 37.33 | 37.89 | 38.56 | 39.26 |
| 10.750 | 39.96 | 40.67 | 41.37 | 42.08 | 42.79 |
| 11.000 | 43.49 | 44.57 | 45.75 | 47.31 | 48.98 |
| 11.250 | 50.66 | 52.36 | 54.05 | 55.75 | 57.44 |
| 11.500 | 59.14 | 75.87 | 96.58 | 133.03 | 173.85 |
| 11.750 | 222.17 | 272.87 | 365.60 | 469.92 | 440.08 |
| 12.000 | 375.88 | 259.08 | 127.67 | 92.28 | 80.97 |
| 12.250 | 75.32 | 71.12 | 67.11 | 63.07 | 59.06 |
| 12.500 | 55.02 | 52.18 | 49.61 | 48.29 | 47.28 |
| 12.750 | 46.34 | 45.42 | 44.51 | 43.59 | 42.67 |
| 13.000 | 41.75 | 40.99 | 40.27 | 39.72 | 39.22 |
| 13.250 | 38.72 | 38.22 | 37.73 | 37.24 | 36.74 |
| 13.500 | 36.25 | 35.81 | 35.38 | 35.01 | 34.65 |
| 13.750 | 34.30 | 33.94 | 33.59 | 33.24 | 32.88 |
| 14.000 | 32.53 | 32.27 | 32.03 | 31.87 | 31.72 |
| 14.250 | 31.61 | 31.50 | 31.37 | 31.23 | 31.11 |
| 14.500 | 31.00 | 30.87 | 30.73 | 30.62 | 30.51 |
| 14.750 | 30.38 | 30.24 | 30.12 | 30.02 | 29.88 |
| 15.000 | 29.74 | 29.63 | 29.52 | 29.39 | 29.25 |
| 15.250 | 29.14 | 29.03 | 28.89 | 28.75 | 28.64 |
| 15.500 | 28.53 | 28.40 | 28.26 | 28.15 | 28.04 |
| 15.750 | 27.91 | 27.77 | 27.65 | 27.54 | 27.41 |
| 16.000 | 27.27 | 27.18 | 27.11 | 27.05 | 27.00 |
| 16.250 | 26.96 | 26.92 | 26.87 | 26.82 | 26.78 |
| 16.500 | 26.74 | 26.70 | 26.64 | 26.60 | 26.57 |
| 16.750 | 26.52 | 26.47 | 26.43 | 26.39 | 26.34 |
| 17.000 | 26.29 | 26.25 | 26.21 | 26.17 | 26.11 |
| 17.250 | 26.07 | 26.04 | 25.99 | 25.94 | 25.90 |
| 17.500 | 25.86 | 25.81 | 25.76 | 25.72 | 25.69 |
| 17.750 | 25.64 | 25.58 | 25.55 | 25.51 | 25.46 |
| 18.000 | 25.41 | 25.37 | 25.33 | 25.28 | 25.23 |
| 18.250 | 25.19 | 25.16 | 25.11 | 25.05 | 25.02 |
| 18.500 | 24.98 | 24.93 | 24.88 | 24.84 | 24.80 |
| 18.750 | 24.75 | 24.70 | 24.66 | 24.63 | 24.58 |
| 19.000 | 24.53 | 24.49 | 24.45 | 24.40 | 24.35 |
| 19.250 | 24.31 | 24.27 | 24.22 | 24.17 | 24.13 |
| 19.500 | 24.10 | 24.05 | 24.00 | 23.96 | 23.92 |
| 19.750 | 23.87 | 23.82 | 23.78 | 23.74 | 23.69 |
| 20.000 | 23.64 | 23.62 | 23.60 | 23.58 | 23.56 |
| 20.250 | 23.56 | 23.56 | 23.54 | 23.53 | 23.52 |

**HYDROGRAPH ORDINATES (ft³/s)**
**Output Time Increment = 0.050 hours**
**Time on left represents time for first value in each row.**

| Time (hours) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) |
|---|---|---|---|---|---|
| 20.500 | 23.52 | 23.51 | 23.49 | 23.49 | 23.48 |
| 20.750 | 23.47 | 23.45 | 23.45 | 23.45 | 23.44 |
| 21.000 | 23.42 | 23.42 | 23.41 | 23.40 | 23.38 |
| 21.250 | 23.38 | 23.38 | 23.37 | 23.35 | 23.34 |
| 21.500 | 23.34 | 23.33 | 23.31 | 23.31 | 23.31 |
| 21.750 | 23.29 | 23.28 | 23.27 | 23.27 | 23.26 |
| 22.000 | 23.24 | 23.24 | 23.24 | 23.22 | 23.21 |
| 22.250 | 23.20 | 23.20 | 23.19 | 23.17 | 23.17 |
| 22.500 | 23.17 | 23.15 | 23.14 | 23.13 | 23.13 |
| 22.750 | 23.12 | 23.10 | 23.10 | 23.10 | 23.08 |
| 23.000 | 23.07 | 23.06 | 23.06 | 23.05 | 23.03 |
| 23.250 | 23.03 | 23.03 | 23.01 | 23.00 | 22.99 |
| 23.500 | 22.99 | 22.98 | 22.96 | 22.96 | 22.96 |
| 23.750 | 22.94 | 22.92 | 22.92 | 22.92 | 22.92 |
| 24.000 | 22.92 | (N/A) | (N/A) | (N/A) | (N/A) |

| | |
|---|---|
| Peak Discharge | 123.59 ft³/s |
| Time to Peak | 12.100 hours |
| Hydrograph Volume | 94.142 ac-ft |

**HYDROGRAPH ORDINATES (ft³/s)**
**Output Time Increment = 0.050 hours**
**Time on left represents time for first value in each row.**

| Time (hours) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) |
|---|---|---|---|---|---|
| 0.000 | 0.00 | 0.25 | 0.94 | 1.90 | 3.02 |
| 0.250 | 4.20 | 5.39 | 6.57 | 7.71 | 8.81 |
| 0.500 | 9.85 | 10.83 | 11.75 | 12.61 | 13.42 |
| 0.750 | 14.17 | 14.88 | 15.53 | 16.15 | 16.72 |
| 1.000 | 17.25 | 17.75 | 18.21 | 18.64 | 19.05 |
| 1.250 | 19.43 | 19.78 | 20.12 | 20.43 | 20.72 |
| 1.500 | 21.00 | 21.26 | 21.50 | 21.73 | 21.95 |
| 1.750 | 22.16 | 22.36 | 22.54 | 22.72 | 22.89 |
| 2.000 | 23.05 | 23.21 | 23.35 | 23.50 | 23.63 |
| 2.250 | 23.76 | 23.89 | 24.01 | 24.13 | 24.24 |
| 2.500 | 24.35 | 24.46 | 24.56 | 24.66 | 24.76 |
| 2.750 | 24.86 | 24.95 | 25.05 | 25.14 | 25.23 |
| 3.000 | 25.31 | 25.40 | 25.48 | 25.57 | 25.65 |
| 3.250 | 25.73 | 25.81 | 25.89 | 25.96 | 26.04 |
| 3.500 | 26.12 | 26.19 | 26.27 | 26.34 | 26.42 |
| 3.750 | 26.49 | 26.56 | 26.63 | 26.70 | 26.78 |
| 4.000 | 26.85 | 26.92 | 26.99 | 27.06 | 27.13 |
| 4.250 | 27.20 | 27.27 | 27.34 | 27.42 | 27.49 |
| 4.500 | 27.56 | 27.63 | 27.71 | 27.78 | 27.86 |
| 4.750 | 27.93 | 28.00 | 28.08 | 28.15 | 28.23 |
| 5.000 | 28.30 | 28.38 | 28.45 | 28.53 | 28.60 |
| 5.250 | 28.68 | 28.76 | 28.83 | 28.91 | 28.98 |
| 5.500 | 29.06 | 29.13 | 29.21 | 29.28 | 29.36 |
| 5.750 | 29.43 | 29.51 | 29.59 | 29.66 | 29.74 |
| 6.000 | 29.81 | 29.89 | 29.96 | 30.04 | 30.11 |
| 6.250 | 30.19 | 30.27 | 30.34 | 30.42 | 30.49 |
| 6.500 | 30.57 | 30.64 | 30.72 | 30.79 | 30.87 |
| 6.750 | 30.94 | 31.02 | 31.09 | 31.17 | 31.24 |
| 7.000 | 31.32 | 31.39 | 31.47 | 31.54 | 31.62 |
| 7.250 | 31.69 | 31.76 | 31.84 | 31.91 | 31.99 |
| 7.500 | 32.06 | 32.14 | 32.21 | 32.29 | 32.36 |
| 7.750 | 32.43 | 32.51 | 32.58 | 32.66 | 32.73 |
| 8.000 | 32.80 | 32.88 | 32.96 | 33.04 | 33.12 |
| 8.250 | 33.21 | 33.31 | 33.41 | 33.51 | 33.62 |
| 8.500 | 33.74 | 33.86 | 33.98 | 34.10 | 34.23 |
| 8.750 | 34.37 | 34.50 | 34.65 | 34.80 | 34.95 |
| 9.000 | 35.10 | 35.26 | 35.43 | 35.59 | 35.75 |
| 9.250 | 35.90 | 36.05 | 36.20 | 36.35 | 36.49 |
| 9.500 | 36.63 | 36.76 | 36.90 | 37.05 | 37.20 |

Subsection: Hydrograph
Label: Clearwater Pond (CWP) (OUT)

Return Event: 1,000 years
Storm Event: 1000 Year

**HYDROGRAPH ORDINATES (ft³/s)**
**Output Time Increment = 0.050 hours**
**Time on left represents time for first value in each row.**

| Time (hours) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) |
|---|---|---|---|---|---|
| 9.750 | 37.35 | 37.52 | 37.70 | 37.88 | 38.07 |
| 10.000 | 38.27 | 38.47 | 38.69 | 38.91 | 39.15 |
| 10.250 | 39.39 | 39.64 | 39.91 | 40.18 | 40.47 |
| 10.500 | 40.76 | 41.06 | 41.37 | 41.69 | 42.03 |
| 10.750 | 42.39 | 42.77 | 43.16 | 43.56 | 43.98 |
| 11.000 | 44.42 | 44.87 | 45.35 | 45.86 | 46.42 |
| 11.250 | 47.02 | 47.68 | 48.38 | 49.12 | 49.90 |
| 11.500 | 50.72 | 51.80 | 53.53 | 56.26 | 60.41 |
| 11.750 | 66.23 | 73.64 | 82.73 | 94.15 | 106.36 |
| 12.000 | 116.21 | 122.31 | 123.59 | 121.44 | 118.68 |
| 12.250 | 116.19 | 114.09 | 112.26 | 110.58 | 108.96 |
| 12.500 | 107.37 | 105.80 | 104.27 | 102.79 | 101.37 |
| 12.750 | 100.02 | 98.73 | 97.49 | 96.29 | 95.12 |
| 13.000 | 93.99 | 92.89 | 91.82 | 90.78 | 89.78 |
| 13.250 | 88.82 | 87.88 | 86.98 | 86.10 | 85.25 |
| 13.500 | 84.42 | 83.62 | 82.83 | 82.08 | 81.34 |
| 13.750 | 80.63 | 79.94 | 79.27 | 78.62 | 77.99 |
| 14.000 | 77.37 | 76.77 | 76.19 | 75.63 | 75.09 |
| 14.250 | 74.57 | 74.07 | 73.59 | 73.12 | 72.67 |
| 14.500 | 72.24 | 71.82 | 71.41 | 71.01 | 70.63 |
| 14.750 | 70.26 | 69.90 | 69.56 | 69.22 | 68.84 |
| 15.000 | 68.40 | 67.95 | 67.50 | 67.05 | 66.62 |
| 15.250 | 66.20 | 65.80 | 65.42 | 65.06 | 64.71 |
| 15.500 | 64.38 | 64.06 | 63.76 | 63.48 | 63.21 |
| 15.750 | 62.94 | 62.69 | 62.45 | 62.22 | 62.00 |
| 16.000 | 61.79 | 61.58 | 61.38 | 61.19 | 61.01 |
| 16.250 | 60.84 | 60.67 | 60.51 | 60.36 | 60.22 |
| 16.500 | 60.08 | 59.94 | 59.81 | 59.69 | 59.56 |
| 16.750 | 59.45 | 59.33 | 59.22 | 59.12 | 59.01 |
| 17.000 | 58.91 | 58.81 | 58.71 | 58.62 | 58.52 |
| 17.250 | 58.43 | 58.34 | 58.25 | 58.17 | 58.08 |
| 17.500 | 58.00 | 57.91 | 57.83 | 57.75 | 57.67 |
| 17.750 | 57.58 | 57.50 | 57.43 | 57.35 | 57.27 |
| 18.000 | 57.19 | 57.11 | 57.04 | 56.96 | 56.88 |
| 18.250 | 56.81 | 56.73 | 56.66 | 56.58 | 56.51 |
| 18.500 | 56.43 | 56.36 | 56.29 | 56.21 | 56.14 |
| 18.750 | 56.07 | 55.99 | 55.92 | 55.85 | 55.77 |
| 19.000 | 55.70 | 55.63 | 55.55 | 55.48 | 55.41 |
| 19.250 | 55.34 | 55.26 | 55.19 | 55.12 | 55.05 |
| 19.500 | 54.97 | 54.90 | 54.83 | 54.76 | 54.68 |
| 19.750 | 54.61 | 54.54 | 54.47 | 54.39 | 54.32 |
| 20.000 | 54.25 | 54.18 | 54.11 | 54.04 | 53.97 |
| 20.250 | 53.90 | 53.83 | 53.77 | 53.70 | 53.64 |

Subsection: Hydrograph  Return Event: 1,000 years
Label: Clearwater Pond (CWP) (OUT)  Storm Event: 1000 Year

**HYDROGRAPH ORDINATES (ft³/s)**
**Output Time Increment = 0.050 hours**
**Time on left represents time for first value in each row.**

| Time (hours) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) |
|---|---|---|---|---|---|
| 20.500 | 53.58 | 53.52 | 53.46 | 53.40 | 53.34 |
| 20.750 | 53.28 | 53.23 | 53.17 | 53.12 | 53.06 |
| 21.000 | 53.01 | 52.96 | 52.91 | 52.85 | 52.80 |
| 21.250 | 52.75 | 52.70 | 52.65 | 52.60 | 52.55 |
| 21.500 | 52.51 | 52.46 | 52.41 | 52.36 | 52.31 |
| 21.750 | 52.27 | 52.22 | 52.18 | 52.13 | 52.08 |
| 22.000 | 52.04 | 51.99 | 51.95 | 51.90 | 51.86 |
| 22.250 | 51.82 | 51.77 | 51.73 | 51.69 | 51.64 |
| 22.500 | 51.60 | 51.56 | 51.51 | 51.47 | 51.43 |
| 22.750 | 51.39 | 51.35 | 51.30 | 51.26 | 51.22 |
| 23.000 | 51.18 | 51.14 | 51.10 | 51.06 | 51.02 |
| 23.250 | 50.98 | 50.94 | 50.90 | 50.86 | 50.82 |
| 23.500 | 50.78 | 50.74 | 50.71 | 50.67 | 50.63 |
| 23.750 | 50.59 | 50.55 | 50.51 | 50.48 | 50.44 |
| 24.000 | 50.40 | (N/A) | (N/A) | (N/A) | (N/A) |

| | |
|---|---|
| Peak Discharge | 139.81 ft³/s |
| Time to Peak | 12.000 hours |
| Hydrograph Volume | 94.743 ac-ft |

## HYDROGRAPH ORDINATES (ft³/s)
## Output Time Increment = 0.050 hours
## Time on left represents time for first value in each row.

| Time (hours) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) |
|---|---|---|---|---|---|
| 0.000 | 0.00 | 1.71 | 3.44 | 4.98 | 6.37 |
| 0.250 | 7.65 | 8.84 | 9.93 | 10.95 | 11.89 |
| 0.500 | 12.76 | 13.57 | 14.32 | 15.02 | 15.67 |
| 0.750 | 16.28 | 16.84 | 17.36 | 17.85 | 18.31 |
| 1.000 | 18.73 | 19.13 | 19.50 | 19.85 | 20.18 |
| 1.250 | 20.48 | 20.78 | 21.05 | 21.30 | 21.54 |
| 1.500 | 21.77 | 21.99 | 22.19 | 22.38 | 22.57 |
| 1.750 | 22.74 | 22.91 | 23.07 | 23.22 | 23.37 |
| 2.000 | 23.51 | 23.64 | 23.77 | 23.90 | 24.02 |
| 2.250 | 24.13 | 24.25 | 24.36 | 24.46 | 24.56 |
| 2.500 | 24.67 | 24.76 | 24.86 | 24.95 | 25.05 |
| 2.750 | 25.14 | 25.22 | 25.31 | 25.40 | 25.48 |
| 3.000 | 25.56 | 25.64 | 25.72 | 25.80 | 25.88 |
| 3.250 | 25.96 | 26.04 | 26.11 | 26.19 | 26.26 |
| 3.500 | 26.34 | 26.41 | 26.48 | 26.55 | 26.63 |
| 3.750 | 26.70 | 26.77 | 26.84 | 26.91 | 26.98 |
| 4.000 | 27.05 | 27.12 | 27.19 | 27.26 | 27.33 |
| 4.250 | 27.41 | 27.48 | 27.55 | 27.63 | 27.70 |
| 4.500 | 27.77 | 27.85 | 27.92 | 28.00 | 28.07 |
| 4.750 | 28.14 | 28.22 | 28.29 | 28.37 | 28.44 |
| 5.000 | 28.52 | 28.60 | 28.67 | 28.75 | 28.82 |
| 5.250 | 28.90 | 28.97 | 29.05 | 29.12 | 29.20 |
| 5.500 | 29.28 | 29.35 | 29.43 | 29.50 | 29.58 |
| 5.750 | 29.65 | 29.73 | 29.80 | 29.88 | 29.95 |
| 6.000 | 30.03 | 30.11 | 30.18 | 30.26 | 30.33 |
| 6.250 | 30.41 | 30.48 | 30.56 | 30.63 | 30.71 |
| 6.500 | 30.78 | 30.86 | 30.93 | 31.01 | 31.08 |
| 6.750 | 31.16 | 31.23 | 31.31 | 31.38 | 31.46 |
| 7.000 | 31.53 | 31.61 | 31.68 | 31.76 | 31.83 |
| 7.250 | 31.91 | 31.98 | 32.05 | 32.13 | 32.20 |
| 7.500 | 32.28 | 32.35 | 32.43 | 32.50 | 32.57 |
| 7.750 | 32.65 | 32.72 | 32.80 | 32.87 | 32.94 |
| 8.000 | 33.02 | 33.10 | 33.18 | 33.27 | 33.37 |
| 8.250 | 33.48 | 33.59 | 33.70 | 33.83 | 33.95 |
| 8.500 | 34.07 | 34.20 | 34.34 | 34.47 | 34.61 |
| 8.750 | 34.76 | 34.91 | 35.07 | 35.23 | 35.39 |
| 9.000 | 35.56 | 35.73 | 35.89 | 36.05 | 36.20 |
| 9.250 | 36.34 | 36.49 | 36.62 | 36.76 | 36.89 |
| 9.500 | 37.02 | 37.16 | 37.31 | 37.47 | 37.64 |

Subsection: Hydrograph
Label: Clearwater Pond (CWP) (IN)

Return Event: 1,000 years
Storm Event: 1000 Year

**HYDROGRAPH ORDINATES (ft³/s)**
**Output Time Increment = 0.050 hours**
**Time on left represents time for first value in each row.**

| Time (hours) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) |
|---|---|---|---|---|---|
| 9.750 | 37.82 | 38.02 | 38.21 | 38.42 | 38.63 |
| 10.000 | 38.85 | 39.08 | 39.32 | 39.57 | 39.84 |
| 10.250 | 40.11 | 40.40 | 40.68 | 40.99 | 41.29 |
| 10.500 | 41.61 | 41.93 | 42.29 | 42.65 | 43.05 |
| 10.750 | 43.45 | 43.88 | 44.30 | 44.76 | 45.21 |
| 11.000 | 45.69 | 46.20 | 46.78 | 47.40 | 48.11 |
| 11.250 | 48.83 | 49.64 | 50.45 | 51.33 | 52.21 |
| 11.500 | 53.18 | 55.59 | 59.70 | 65.82 | 74.86 |
| 11.750 | 85.35 | 97.35 | 111.47 | 131.36 | 139.61 |
| 12.000 | 139.81 | 133.98 | 119.32 | 113.31 | 110.88 |
| 12.250 | 109.60 | 108.52 | 107.31 | 105.82 | 104.36 |
| 12.500 | 102.77 | 101.34 | 99.90 | 98.61 | 97.39 |
| 12.750 | 96.22 | 95.07 | 93.97 | 92.87 | 91.81 |
| 13.000 | 90.76 | 89.76 | 88.78 | 87.85 | 86.95 |
| 13.250 | 86.08 | 85.23 | 84.41 | 83.60 | 82.83 |
| 13.500 | 82.06 | 81.33 | 80.61 | 79.93 | 79.26 |
| 13.750 | 78.61 | 77.98 | 77.37 | 76.77 | 76.19 |
| 14.000 | 75.62 | 75.07 | 74.55 | 74.05 | 73.56 |
| 14.250 | 73.10 | 72.65 | 72.22 | 71.80 | 71.39 |
| 14.500 | 71.00 | 70.62 | 70.25 | 69.89 | 69.55 |
| 14.750 | 69.21 | 68.88 | 68.57 | 68.26 | 67.61 |
| 15.000 | 67.10 | 66.64 | 66.20 | 65.78 | 65.39 |
| 15.250 | 65.02 | 64.67 | 64.34 | 64.03 | 63.73 |
| 15.500 | 63.45 | 63.18 | 62.92 | 62.67 | 62.44 |
| 15.750 | 62.21 | 61.99 | 61.78 | 61.57 | 61.38 |
| 16.000 | 61.18 | 61.00 | 60.82 | 60.66 | 60.50 |
| 16.250 | 60.35 | 60.20 | 60.07 | 59.93 | 59.80 |
| 16.500 | 59.68 | 59.56 | 59.44 | 59.33 | 59.22 |
| 16.750 | 59.12 | 59.01 | 58.91 | 58.81 | 58.72 |
| 17.000 | 58.62 | 58.53 | 58.44 | 58.35 | 58.26 |
| 17.250 | 58.17 | 58.08 | 58.00 | 57.92 | 57.83 |
| 17.500 | 57.75 | 57.67 | 57.59 | 57.51 | 57.43 |
| 17.750 | 57.35 | 57.27 | 57.20 | 57.12 | 57.04 |
| 18.000 | 56.97 | 56.89 | 56.82 | 56.74 | 56.67 |
| 18.250 | 56.59 | 56.52 | 56.44 | 56.37 | 56.29 |
| 18.500 | 56.22 | 56.15 | 56.07 | 56.00 | 55.93 |
| 18.750 | 55.85 | 55.78 | 55.71 | 55.63 | 55.56 |
| 19.000 | 55.49 | 55.42 | 55.34 | 55.27 | 55.20 |
| 19.250 | 55.13 | 55.05 | 54.98 | 54.91 | 54.84 |
| 19.500 | 54.76 | 54.69 | 54.62 | 54.55 | 54.48 |
| 19.750 | 54.40 | 54.33 | 54.26 | 54.19 | 54.11 |
| 20.000 | 54.04 | 53.97 | 53.90 | 53.83 | 53.77 |
| 20.250 | 53.70 | 53.64 | 53.58 | 53.52 | 53.46 |

**HYDROGRAPH ORDINATES (ft³/s)**
**Output Time Increment = 0.050 hours**
**Time on left represents time for first value in each row.**

| Time (hours) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) |
|---|---|---|---|---|---|
| 20.500 | 53.40 | 53.34 | 53.29 | 53.23 | 53.18 |
| 20.750 | 53.12 | 53.07 | 53.01 | 52.96 | 52.91 |
| 21.000 | 52.86 | 52.81 | 52.76 | 52.71 | 52.66 |
| 21.250 | 52.61 | 52.56 | 52.51 | 52.46 | 52.41 |
| 21.500 | 52.37 | 52.32 | 52.27 | 52.22 | 52.18 |
| 21.750 | 52.13 | 52.09 | 52.04 | 52.00 | 51.95 |
| 22.000 | 51.91 | 51.86 | 51.82 | 51.78 | 51.73 |
| 22.250 | 51.69 | 51.65 | 51.60 | 51.56 | 51.52 |
| 22.500 | 51.48 | 51.43 | 51.39 | 51.35 | 51.31 |
| 22.750 | 51.27 | 51.23 | 51.18 | 51.15 | 51.10 |
| 23.000 | 51.06 | 51.02 | 50.98 | 50.94 | 50.90 |
| 23.250 | 50.86 | 50.83 | 50.79 | 50.75 | 50.71 |
| 23.500 | 50.67 | 50.63 | 50.59 | 50.55 | 50.52 |
| 23.750 | 50.48 | 50.44 | 50.40 | 50.37 | 50.33 |
| 24.000 | 50.30 | (N/A) | (N/A) | (N/A) | (N/A) |

| | |
|---|---|
| Peak Discharge | 103.29 ft³/s |
| Time to Peak | 12.150 hours |
| Hydrograph Volume | 91.313 ac-ft |

**HYDROGRAPH ORDINATES (ft³/s)**
**Output Time Increment = 0.050 hours**
**Time on left represents time for first value in each row.**

| Time (hours) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) |
|---|---|---|---|---|---|
| 0.000 | 0.00 | 1.60 | 3.12 | 4.59 | 5.96 |
| 0.250 | 7.23 | 8.41 | 9.51 | 10.52 | 11.46 |
| 0.500 | 12.33 | 13.14 | 13.89 | 14.58 | 15.23 |
| 0.750 | 15.83 | 16.39 | 16.92 | 17.40 | 17.86 |
| 1.000 | 18.28 | 18.67 | 19.05 | 19.39 | 19.72 |
| 1.250 | 20.02 | 20.31 | 20.58 | 20.83 | 21.07 |
| 1.500 | 21.30 | 21.51 | 21.71 | 21.90 | 22.08 |
| 1.750 | 22.26 | 22.42 | 22.58 | 22.73 | 22.87 |
| 2.000 | 23.01 | 23.14 | 23.27 | 23.40 | 23.51 |
| 2.250 | 23.63 | 23.74 | 23.85 | 23.95 | 24.05 |
| 2.500 | 24.15 | 24.25 | 24.34 | 24.43 | 24.52 |
| 2.750 | 24.61 | 24.69 | 24.78 | 24.86 | 24.94 |
| 3.000 | 25.02 | 25.10 | 25.18 | 25.26 | 25.34 |
| 3.250 | 25.41 | 25.49 | 25.56 | 25.63 | 25.71 |
| 3.500 | 25.78 | 25.85 | 25.92 | 25.99 | 26.06 |
| 3.750 | 26.13 | 26.20 | 26.27 | 26.34 | 26.40 |
| 4.000 | 26.47 | 26.54 | 26.61 | 26.67 | 26.74 |
| 4.250 | 26.81 | 26.88 | 26.95 | 27.02 | 27.09 |
| 4.500 | 27.16 | 27.23 | 27.30 | 27.37 | 27.44 |
| 4.750 | 27.51 | 27.58 | 27.65 | 27.72 | 27.79 |
| 5.000 | 27.86 | 27.93 | 28.00 | 28.08 | 28.15 |
| 5.250 | 28.22 | 28.29 | 28.36 | 28.43 | 28.50 |
| 5.500 | 28.58 | 28.65 | 28.72 | 28.79 | 28.86 |
| 5.750 | 28.93 | 29.00 | 29.08 | 29.15 | 29.22 |
| 6.000 | 29.29 | 29.36 | 29.43 | 29.50 | 29.57 |
| 6.250 | 29.65 | 29.72 | 29.79 | 29.86 | 29.93 |
| 6.500 | 30.00 | 30.07 | 30.14 | 30.21 | 30.28 |
| 6.750 | 30.35 | 30.43 | 30.50 | 30.57 | 30.64 |
| 7.000 | 30.71 | 30.78 | 30.85 | 30.92 | 30.99 |
| 7.250 | 31.06 | 31.13 | 31.20 | 31.27 | 31.34 |
| 7.500 | 31.41 | 31.48 | 31.55 | 31.62 | 31.69 |
| 7.750 | 31.76 | 31.83 | 31.90 | 31.97 | 32.04 |
| 8.000 | 32.11 | 32.18 | 32.25 | 32.33 | 32.41 |
| 8.250 | 32.49 | 32.58 | 32.68 | 32.78 | 32.88 |
| 8.500 | 32.98 | 33.09 | 33.21 | 33.32 | 33.44 |
| 8.750 | 33.57 | 33.70 | 33.83 | 33.97 | 34.12 |
| 9.000 | 34.27 | 34.42 | 34.57 | 34.72 | 34.87 |
| 9.250 | 35.02 | 35.16 | 35.30 | 35.43 | 35.56 |
| 9.500 | 35.69 | 35.82 | 35.95 | 36.09 | 36.23 |

Subsection: Hydrograph
Label: Wastewater Pond (WWP) (OUT)

Return Event: 1,000 years
Storm Event: 1000 Year

**HYDROGRAPH ORDINATES (ft³/s)**
**Output Time Increment = 0.050 hours**
**Time on left represents time for first value in each row.**

| Time (hours) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) |
|---|---|---|---|---|---|
| 9.750 | 36.38 | 36.54 | 36.71 | 36.88 | 37.06 |
| 10.000 | 37.24 | 37.43 | 37.63 | 37.84 | 38.05 |
| 10.250 | 38.28 | 38.51 | 38.75 | 39.00 | 39.26 |
| 10.500 | 39.52 | 39.80 | 40.08 | 40.37 | 40.68 |
| 10.750 | 41.01 | 41.34 | 41.70 | 42.06 | 42.44 |
| 11.000 | 42.83 | 43.23 | 43.66 | 44.12 | 44.62 |
| 11.250 | 45.17 | 45.76 | 46.39 | 47.05 | 47.75 |
| 11.500 | 48.48 | 49.47 | 51.10 | 53.69 | 57.65 |
| 11.750 | 63.15 | 68.83 | 73.98 | 81.08 | 89.21 |
| 12.000 | 96.42 | 101.68 | 103.13 | 103.29 | 103.06 |
| 12.250 | 102.69 | 102.26 | 101.51 | 100.52 | 99.50 |
| 12.500 | 98.43 | 97.33 | 96.22 | 95.12 | 94.03 |
| 12.750 | 92.97 | 91.94 | 90.93 | 89.95 | 88.99 |
| 13.000 | 88.06 | 87.15 | 86.26 | 85.39 | 84.55 |
| 13.250 | 83.74 | 82.95 | 82.19 | 81.44 | 80.72 |
| 13.500 | 80.02 | 79.34 | 78.67 | 78.03 | 77.40 |
| 13.750 | 76.80 | 76.21 | 75.64 | 75.08 | 74.54 |
| 14.000 | 74.02 | 73.50 | 73.01 | 72.53 | 72.06 |
| 14.250 | 71.61 | 71.18 | 70.76 | 70.36 | 69.96 |
| 14.500 | 69.59 | 69.22 | 68.87 | 68.52 | 68.19 |
| 14.750 | 67.87 | 67.56 | 67.25 | 66.96 | 66.32 |
| 15.000 | 65.84 | 65.38 | 64.96 | 64.56 | 64.18 |
| 15.250 | 63.83 | 63.49 | 63.18 | 62.88 | 62.59 |
| 15.500 | 62.32 | 62.07 | 61.82 | 61.59 | 61.37 |
| 15.750 | 61.16 | 60.95 | 60.75 | 60.56 | 60.38 |
| 16.000 | 60.20 | 60.03 | 59.87 | 59.71 | 59.56 |
| 16.250 | 59.41 | 59.27 | 59.14 | 59.01 | 58.89 |
| 16.500 | 58.77 | 58.65 | 58.54 | 58.43 | 58.33 |
| 16.750 | 58.23 | 58.13 | 58.03 | 57.94 | 57.85 |
| 17.000 | 57.76 | 57.67 | 57.59 | 57.50 | 57.42 |
| 17.250 | 57.34 | 57.26 | 57.18 | 57.10 | 57.02 |
| 17.500 | 56.94 | 56.87 | 56.79 | 56.72 | 56.64 |
| 17.750 | 56.57 | 56.50 | 56.43 | 56.35 | 56.28 |
| 18.000 | 56.21 | 56.14 | 56.07 | 56.00 | 55.93 |
| 18.250 | 55.86 | 55.79 | 55.72 | 55.65 | 55.58 |
| 18.500 | 55.52 | 55.45 | 55.38 | 55.31 | 55.24 |
| 18.750 | 55.18 | 55.11 | 55.04 | 54.97 | 54.90 |
| 19.000 | 54.84 | 54.77 | 54.70 | 54.63 | 54.57 |
| 19.250 | 54.50 | 54.43 | 54.37 | 54.30 | 54.23 |
| 19.500 | 54.16 | 54.10 | 54.03 | 53.96 | 53.90 |
| 19.750 | 53.83 | 53.76 | 53.69 | 53.63 | 53.56 |
| 20.000 | 53.49 | 53.43 | 53.36 | 53.30 | 53.23 |
| 20.250 | 53.17 | 53.11 | 53.05 | 52.99 | 52.93 |

**HYDROGRAPH ORDINATES ($ft^3/s$)**
**Output Time Increment = 0.050 hours**
**Time on left represents time for first value in each row.**

| Time (hours) | Flow ($ft^3/s$) | Flow ($ft^3/s$) | Flow ($ft^3/s$) | Flow ($ft^3/s$) | Flow ($ft^3/s$) |
|---|---|---|---|---|---|
| 20.500 | 52.87 | 52.81 | 52.76 | 52.70 | 52.65 |
| 20.750 | 52.60 | 52.54 | 52.49 | 52.44 | 52.39 |
| 21.000 | 52.34 | 52.29 | 52.24 | 52.19 | 52.14 |
| 21.250 | 52.09 | 52.04 | 52.00 | 51.95 | 51.90 |
| 21.500 | 51.86 | 51.81 | 51.76 | 51.72 | 51.67 |
| 21.750 | 51.63 | 51.58 | 51.54 | 51.50 | 51.45 |
| 22.000 | 51.41 | 51.36 | 51.32 | 51.28 | 51.24 |
| 22.250 | 51.19 | 51.15 | 51.11 | 51.07 | 51.03 |
| 22.500 | 50.99 | 50.94 | 50.90 | 50.86 | 50.82 |
| 22.750 | 50.78 | 50.74 | 50.70 | 50.66 | 50.62 |
| 23.000 | 50.58 | 50.55 | 50.51 | 50.47 | 50.43 |
| 23.250 | 50.39 | 50.35 | 50.31 | 50.28 | 50.24 |
| 23.500 | 50.20 | 50.16 | 50.13 | 50.09 | 50.05 |
| 23.750 | 50.02 | 49.98 | 49.94 | 49.91 | 49.87 |
| 24.000 | 49.84 | (N/A) | (N/A) | (N/A) | (N/A) |

| | |
|---|---|
| Peak Discharge | 273.13 ft³/s |
| Time to Peak | 11.950 hours |
| Hydrograph Volume | 93.828 ac-ft |

**HYDROGRAPH ORDINATES (ft³/s)**
**Output Time Increment = 0.050 hours**
**Time on left represents time for first value in each row.**

| Time (hours) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) |
|---|---|---|---|---|---|
| 0.000 | 20.00 | 20.56 | 21.53 | 21.93 | 22.09 |
| 0.250 | 22.19 | 22.28 | 22.35 | 22.42 | 22.49 |
| 0.500 | 22.57 | 22.64 | 22.70 | 22.78 | 22.86 |
| 0.750 | 22.93 | 22.99 | 23.06 | 23.14 | 23.21 |
| 1.000 | 23.27 | 23.34 | 23.42 | 23.49 | 23.55 |
| 1.250 | 23.62 | 23.70 | 23.77 | 23.83 | 23.90 |
| 1.500 | 23.98 | 24.05 | 24.11 | 24.18 | 24.26 |
| 1.750 | 24.32 | 24.38 | 24.45 | 24.53 | 24.60 |
| 2.000 | 24.66 | 24.73 | 24.80 | 24.87 | 24.93 |
| 2.250 | 25.00 | 25.07 | 25.14 | 25.20 | 25.27 |
| 2.500 | 25.34 | 25.41 | 25.47 | 25.53 | 25.61 |
| 2.750 | 25.67 | 25.73 | 25.80 | 25.87 | 25.94 |
| 3.000 | 26.00 | 26.06 | 26.14 | 26.20 | 26.26 |
| 3.250 | 26.33 | 26.40 | 26.46 | 26.52 | 26.59 |
| 3.500 | 26.66 | 26.72 | 26.78 | 26.84 | 26.92 |
| 3.750 | 26.98 | 27.04 | 27.10 | 27.17 | 27.24 |
| 4.000 | 27.29 | 27.36 | 27.43 | 27.50 | 27.57 |
| 4.250 | 27.65 | 27.72 | 27.79 | 27.86 | 27.94 |
| 4.500 | 28.01 | 28.08 | 28.15 | 28.23 | 28.30 |
| 4.750 | 28.37 | 28.44 | 28.51 | 28.59 | 28.66 |
| 5.000 | 28.73 | 28.80 | 28.88 | 28.95 | 29.02 |
| 5.250 | 29.09 | 29.16 | 29.23 | 29.31 | 29.38 |
| 5.500 | 29.45 | 29.52 | 29.59 | 29.66 | 29.73 |
| 5.750 | 29.80 | 29.88 | 29.95 | 30.02 | 30.09 |
| 6.000 | 30.16 | 30.23 | 30.30 | 30.37 | 30.44 |
| 6.250 | 30.51 | 30.59 | 30.65 | 30.73 | 30.80 |
| 6.500 | 30.87 | 30.94 | 31.01 | 31.08 | 31.15 |
| 6.750 | 31.22 | 31.29 | 31.36 | 31.43 | 31.50 |
| 7.000 | 31.57 | 31.64 | 31.71 | 31.78 | 31.85 |
| 7.250 | 31.92 | 31.99 | 32.06 | 32.13 | 32.20 |
| 7.500 | 32.27 | 32.34 | 32.41 | 32.48 | 32.55 |
| 7.750 | 32.61 | 32.69 | 32.75 | 32.82 | 32.89 |
| 8.000 | 32.96 | 33.05 | 33.16 | 33.28 | 33.43 |
| 8.250 | 33.56 | 33.71 | 33.85 | 34.01 | 34.14 |
| 8.500 | 34.30 | 34.44 | 34.59 | 34.74 | 34.94 |
| 8.750 | 35.13 | 35.33 | 35.52 | 35.72 | 35.91 |
| 9.000 | 36.11 | 36.27 | 36.43 | 36.55 | 36.66 |
| 9.250 | 36.76 | 36.87 | 36.97 | 37.06 | 37.16 |
| 9.500 | 37.26 | 37.40 | 37.57 | 37.78 | 38.03 |

**HYDROGRAPH ORDINATES ($ft^3/s$)**
**Output Time Increment = 0.050 hours**
**Time on left represents time for first value in each row.**

| Time (hours) | Flow ($ft^3/s$) | Flow ($ft^3/s$) | Flow ($ft^3/s$) | Flow ($ft^3/s$) | Flow ($ft^3/s$) |
|---|---|---|---|---|---|
| 9.750 | 38.26 | 38.53 | 38.77 | 39.03 | 39.27 |
| 10.000 | 39.54 | 39.80 | 40.11 | 40.41 | 40.76 |
| 10.250 | 41.07 | 41.43 | 41.75 | 42.11 | 42.43 |
| 10.500 | 42.80 | 43.16 | 43.60 | 44.04 | 44.57 |
| 10.750 | 45.04 | 45.58 | 46.06 | 46.61 | 47.09 |
| 11.000 | 47.64 | 48.28 | 49.10 | 49.97 | 51.07 |
| 11.250 | 52.06 | 53.22 | 54.24 | 55.41 | 56.44 |
| 11.500 | 57.71 | 64.37 | 75.93 | 92.29 | 115.81 |
| 11.750 | 139.21 | 168.86 | 210.74 | 270.33 | 273.13 |
| 12.000 | 243.87 | 195.84 | 124.46 | 97.20 | 87.69 |
| 12.250 | 83.89 | 81.20 | 79.40 | 77.32 | 75.54 |
| 12.500 | 73.38 | 71.99 | 70.60 | 69.91 | 69.37 |
| 12.750 | 68.98 | 68.52 | 68.14 | 67.68 | 67.29 |
| 13.000 | 66.82 | 66.47 | 66.09 | 65.84 | 65.58 |
| 13.250 | 65.36 | 65.10 | 64.88 | 64.61 | 64.39 |
| 13.500 | 64.11 | 63.90 | 63.66 | 63.47 | 63.27 |
| 13.750 | 63.09 | 62.88 | 62.70 | 62.49 | 62.31 |
| 14.000 | 62.09 | 61.94 | 61.78 | 61.67 | 61.57 |
| 14.250 | 61.48 | 61.40 | 61.32 | 61.21 | 61.13 |
| 14.500 | 61.05 | 60.96 | 60.86 | 60.77 | 60.68 |
| 14.750 | 60.59 | 60.49 | 60.40 | 60.31 | 60.22 |
| 15.000 | 60.11 | 60.02 | 59.92 | 59.83 | 59.72 |
| 15.250 | 59.62 | 59.53 | 59.43 | 59.32 | 59.22 |
| 15.500 | 59.12 | 59.03 | 58.91 | 58.81 | 58.71 |
| 15.750 | 58.61 | 58.49 | 58.39 | 58.29 | 58.19 |
| 16.000 | 58.06 | 57.97 | 57.89 | 57.81 | 57.74 |
| 16.250 | 57.67 | 57.61 | 57.54 | 57.47 | 57.41 |
| 16.500 | 57.34 | 57.28 | 57.21 | 57.14 | 57.08 |
| 16.750 | 57.01 | 56.94 | 56.88 | 56.81 | 56.75 |
| 17.000 | 56.67 | 56.61 | 56.55 | 56.48 | 56.41 |
| 17.250 | 56.34 | 56.28 | 56.21 | 56.14 | 56.08 |
| 17.500 | 56.01 | 55.95 | 55.88 | 55.81 | 55.75 |
| 17.750 | 55.68 | 55.61 | 55.55 | 55.48 | 55.42 |
| 18.000 | 55.34 | 55.28 | 55.21 | 55.15 | 55.08 |
| 18.250 | 55.01 | 54.95 | 54.88 | 54.81 | 54.75 |
| 18.500 | 54.68 | 54.62 | 54.54 | 54.48 | 54.41 |
| 18.750 | 54.35 | 54.28 | 54.21 | 54.15 | 54.08 |
| 19.000 | 54.01 | 53.94 | 53.88 | 53.81 | 53.74 |
| 19.250 | 53.68 | 53.61 | 53.55 | 53.47 | 53.41 |
| 19.500 | 53.35 | 53.28 | 53.21 | 53.14 | 53.08 |
| 19.750 | 53.01 | 52.94 | 52.88 | 52.81 | 52.75 |
| 20.000 | 52.67 | 52.61 | 52.56 | 52.51 | 52.45 |
| 20.250 | 52.41 | 52.36 | 52.31 | 52.26 | 52.22 |

**HYDROGRAPH ORDINATES ($ft^3/s$)**
**Output Time Increment = 0.050 hours**
**Time on left represents time for first value in each row.**

| Time (hours) | Flow ($ft^3/s$) | Flow ($ft^3/s$) | Flow ($ft^3/s$) | Flow ($ft^3/s$) | Flow ($ft^3/s$) |
|---|---|---|---|---|---|
| 20.500 | 52.18 | 52.13 | 52.08 | 52.03 | 51.99 |
| 20.750 | 51.95 | 51.90 | 51.85 | 51.81 | 51.77 |
| 21.000 | 51.72 | 51.68 | 51.64 | 51.59 | 51.54 |
| 21.250 | 51.50 | 51.46 | 51.42 | 51.37 | 51.33 |
| 21.500 | 51.29 | 51.25 | 51.20 | 51.16 | 51.13 |
| 21.750 | 51.08 | 51.04 | 51.00 | 50.96 | 50.92 |
| 22.000 | 50.88 | 50.84 | 50.80 | 50.76 | 50.72 |
| 22.250 | 50.68 | 50.64 | 50.60 | 50.56 | 50.52 |
| 22.500 | 50.49 | 50.45 | 50.40 | 50.37 | 50.33 |
| 22.750 | 50.29 | 50.25 | 50.22 | 50.18 | 50.14 |
| 23.000 | 50.10 | 50.07 | 50.03 | 50.00 | 49.96 |
| 23.250 | 49.92 | 49.89 | 49.85 | 49.81 | 49.78 |
| 23.500 | 49.75 | 49.71 | 49.67 | 49.64 | 49.60 |
| 23.750 | 49.57 | 49.53 | 49.50 | 49.47 | 49.44 |
| 24.000 | 49.41 | (N/A) | (N/A) | (N/A) | (N/A) |

| | |
|---|---|
| Peak Discharge | 103.29 ft³/s |
| Time to Peak | 12.150 hours |
| Hydrograph Volume | 91.313 ac-ft |

**HYDROGRAPH ORDINATES (ft³/s)**
**Output Time Increment = 0.050 hours**
**Time on left represents time for first value in each row.**

| Time (hours) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) |
|---|---|---|---|---|---|
| 0.000 | 0.00 | 1.60 | 3.12 | 4.59 | 5.96 |
| 0.250 | 7.23 | 8.41 | 9.51 | 10.52 | 11.46 |
| 0.500 | 12.33 | 13.14 | 13.89 | 14.58 | 15.23 |
| 0.750 | 15.83 | 16.39 | 16.92 | 17.40 | 17.86 |
| 1.000 | 18.28 | 18.67 | 19.05 | 19.39 | 19.72 |
| 1.250 | 20.02 | 20.31 | 20.58 | 20.83 | 21.07 |
| 1.500 | 21.30 | 21.51 | 21.71 | 21.90 | 22.08 |
| 1.750 | 22.26 | 22.42 | 22.58 | 22.73 | 22.87 |
| 2.000 | 23.01 | 23.14 | 23.27 | 23.40 | 23.51 |
| 2.250 | 23.63 | 23.74 | 23.85 | 23.95 | 24.05 |
| 2.500 | 24.15 | 24.25 | 24.34 | 24.43 | 24.52 |
| 2.750 | 24.61 | 24.69 | 24.78 | 24.86 | 24.94 |
| 3.000 | 25.02 | 25.10 | 25.18 | 25.26 | 25.34 |
| 3.250 | 25.41 | 25.49 | 25.56 | 25.63 | 25.71 |
| 3.500 | 25.78 | 25.85 | 25.92 | 25.99 | 26.06 |
| 3.750 | 26.13 | 26.20 | 26.27 | 26.34 | 26.40 |
| 4.000 | 26.47 | 26.54 | 26.61 | 26.67 | 26.74 |
| 4.250 | 26.81 | 26.88 | 26.95 | 27.02 | 27.09 |
| 4.500 | 27.16 | 27.23 | 27.30 | 27.37 | 27.44 |
| 4.750 | 27.51 | 27.58 | 27.65 | 27.72 | 27.79 |
| 5.000 | 27.86 | 27.93 | 28.00 | 28.08 | 28.15 |
| 5.250 | 28.22 | 28.29 | 28.36 | 28.43 | 28.50 |
| 5.500 | 28.58 | 28.65 | 28.72 | 28.79 | 28.86 |
| 5.750 | 28.93 | 29.00 | 29.08 | 29.15 | 29.22 |
| 6.000 | 29.29 | 29.36 | 29.43 | 29.50 | 29.57 |
| 6.250 | 29.65 | 29.72 | 29.79 | 29.86 | 29.93 |
| 6.500 | 30.00 | 30.07 | 30.14 | 30.21 | 30.28 |
| 6.750 | 30.35 | 30.43 | 30.50 | 30.57 | 30.64 |
| 7.000 | 30.71 | 30.78 | 30.85 | 30.92 | 30.99 |
| 7.250 | 31.06 | 31.13 | 31.20 | 31.27 | 31.34 |
| 7.500 | 31.41 | 31.48 | 31.55 | 31.62 | 31.69 |
| 7.750 | 31.76 | 31.83 | 31.90 | 31.97 | 32.04 |
| 8.000 | 32.11 | 32.18 | 32.25 | 32.33 | 32.41 |
| 8.250 | 32.49 | 32.58 | 32.68 | 32.78 | 32.88 |
| 8.500 | 32.98 | 33.09 | 33.21 | 33.32 | 33.44 |
| 8.750 | 33.57 | 33.70 | 33.83 | 33.97 | 34.12 |
| 9.000 | 34.27 | 34.42 | 34.57 | 34.72 | 34.87 |
| 9.250 | 35.02 | 35.16 | 35.30 | 35.43 | 35.56 |
| 9.500 | 35.69 | 35.82 | 35.95 | 36.09 | 36.23 |

**HYDROGRAPH ORDINATES (ft³/s)**
**Output Time Increment = 0.050 hours**
**Time on left represents time for first value in each row.**

| Time (hours) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) |
|---|---|---|---|---|---|
| 9.750 | 36.38 | 36.54 | 36.71 | 36.88 | 37.06 |
| 10.000 | 37.24 | 37.43 | 37.63 | 37.84 | 38.05 |
| 10.250 | 38.28 | 38.51 | 38.75 | 39.00 | 39.26 |
| 10.500 | 39.52 | 39.80 | 40.08 | 40.37 | 40.68 |
| 10.750 | 41.01 | 41.34 | 41.70 | 42.06 | 42.44 |
| 11.000 | 42.83 | 43.23 | 43.66 | 44.12 | 44.62 |
| 11.250 | 45.17 | 45.76 | 46.39 | 47.05 | 47.75 |
| 11.500 | 48.48 | 49.47 | 51.10 | 53.69 | 57.65 |
| 11.750 | 63.15 | 68.83 | 73.98 | 81.08 | 89.21 |
| 12.000 | 96.42 | 101.68 | 103.13 | 103.29 | 103.06 |
| 12.250 | 102.69 | 102.26 | 101.51 | 100.52 | 99.50 |
| 12.500 | 98.43 | 97.33 | 96.22 | 95.12 | 94.03 |
| 12.750 | 92.97 | 91.94 | 90.93 | 89.95 | 88.99 |
| 13.000 | 88.06 | 87.15 | 86.26 | 85.39 | 84.55 |
| 13.250 | 83.74 | 82.95 | 82.19 | 81.44 | 80.72 |
| 13.500 | 80.02 | 79.34 | 78.67 | 78.03 | 77.40 |
| 13.750 | 76.80 | 76.21 | 75.64 | 75.08 | 74.54 |
| 14.000 | 74.02 | 73.50 | 73.01 | 72.53 | 72.06 |
| 14.250 | 71.61 | 71.18 | 70.76 | 70.36 | 69.96 |
| 14.500 | 69.59 | 69.22 | 68.87 | 68.52 | 68.19 |
| 14.750 | 67.87 | 67.56 | 67.25 | 66.96 | 66.32 |
| 15.000 | 65.84 | 65.38 | 64.96 | 64.56 | 64.18 |
| 15.250 | 63.83 | 63.49 | 63.18 | 62.88 | 62.59 |
| 15.500 | 62.32 | 62.07 | 61.82 | 61.59 | 61.37 |
| 15.750 | 61.16 | 60.95 | 60.75 | 60.56 | 60.38 |
| 16.000 | 60.20 | 60.03 | 59.87 | 59.71 | 59.56 |
| 16.250 | 59.41 | 59.27 | 59.14 | 59.01 | 58.89 |
| 16.500 | 58.77 | 58.65 | 58.54 | 58.43 | 58.33 |
| 16.750 | 58.23 | 58.13 | 58.03 | 57.94 | 57.85 |
| 17.000 | 57.76 | 57.67 | 57.59 | 57.50 | 57.42 |
| 17.250 | 57.34 | 57.26 | 57.18 | 57.10 | 57.02 |
| 17.500 | 56.94 | 56.87 | 56.79 | 56.72 | 56.64 |
| 17.750 | 56.57 | 56.50 | 56.43 | 56.35 | 56.28 |
| 18.000 | 56.21 | 56.14 | 56.07 | 56.00 | 55.93 |
| 18.250 | 55.86 | 55.79 | 55.72 | 55.65 | 55.58 |
| 18.500 | 55.52 | 55.45 | 55.38 | 55.31 | 55.24 |
| 18.750 | 55.18 | 55.11 | 55.04 | 54.97 | 54.90 |
| 19.000 | 54.84 | 54.77 | 54.70 | 54.63 | 54.57 |
| 19.250 | 54.50 | 54.43 | 54.37 | 54.30 | 54.23 |
| 19.500 | 54.16 | 54.10 | 54.03 | 53.96 | 53.90 |
| 19.750 | 53.83 | 53.76 | 53.69 | 53.63 | 53.56 |
| 20.000 | 53.49 | 53.43 | 53.36 | 53.30 | 53.23 |
| 20.250 | 53.17 | 53.11 | 53.05 | 52.99 | 52.93 |

**HYDROGRAPH ORDINATES (ft³/s)**
**Output Time Increment = 0.050 hours**
**Time on left represents time for first value in each row.**

| Time (hours) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) |
|---|---|---|---|---|---|
| 20.500 | 52.87 | 52.81 | 52.76 | 52.70 | 52.65 |
| 20.750 | 52.60 | 52.54 | 52.49 | 52.44 | 52.39 |
| 21.000 | 52.34 | 52.29 | 52.24 | 52.19 | 52.14 |
| 21.250 | 52.09 | 52.04 | 52.00 | 51.95 | 51.90 |
| 21.500 | 51.86 | 51.81 | 51.76 | 51.72 | 51.67 |
| 21.750 | 51.63 | 51.58 | 51.54 | 51.50 | 51.45 |
| 22.000 | 51.41 | 51.36 | 51.32 | 51.28 | 51.24 |
| 22.250 | 51.19 | 51.15 | 51.11 | 51.07 | 51.03 |
| 22.500 | 50.99 | 50.94 | 50.90 | 50.86 | 50.82 |
| 22.750 | 50.78 | 50.74 | 50.70 | 50.66 | 50.62 |
| 23.000 | 50.58 | 50.55 | 50.51 | 50.47 | 50.43 |
| 23.250 | 50.39 | 50.35 | 50.31 | 50.28 | 50.24 |
| 23.500 | 50.20 | 50.16 | 50.13 | 50.09 | 50.05 |
| 23.750 | 50.02 | 49.98 | 49.94 | 49.91 | 49.87 |
| 24.000 | 49.84 | (N/A) | (N/A) | (N/A) | (N/A) |

| Elevation (ft) | Planimeter (ft²) | Area (acres) | A1+A2+sqr(A1*A2) (acres) | Volume (ac-ft) | Volume (Total) (ac-ft) |
|---|---|---|---|---|---|
| 394.00 | 0.0 | 27.747 | 0.000 | 0.000 | 0.000 |
| 395.00 | 0.0 | 27.980 | 83.590 | 27.863 | 27.863 |
| 396.00 | 0.0 | 28.213 | 84.288 | 28.096 | 55.959 |
| 397.00 | 0.0 | 28.447 | 84.989 | 28.330 | 84.289 |
| 398.00 | 0.0 | 28.681 | 85.691 | 28.564 | 112.853 |
| 399.00 | 0.0 | 28.916 | 86.395 | 28.798 | 141.651 |

Subsection: Elevation-Area Volume Curve | Return Event: 1,000 years
Label: Clearwater Pond (CWP) | Storm Event: 1000 Year

| Elevation (ft) | Planimeter (ft²) | Area (acres) | A1+A2+sqr(A1*A2) (acres) | Volume (ac-ft) | Volume (Total) (ac-ft) |
|---|---|---|---|---|---|
| 381.00 | 0.0 | 2.676 | 0.000 | 0.000 | 0.000 |
| 382.00 | 0.0 | 2.739 | 8.123 | 2.708 | 2.708 |
| 383.00 | 0.0 | 2.802 | 8.311 | 2.770 | 5.478 |
| 384.00 | 0.0 | 2.865 | 8.500 | 2.833 | 8.311 |
| 385.00 | 0.0 | 2.929 | 8.691 | 2.897 | 11.208 |
| 386.00 | 0.0 | 2.994 | 8.884 | 2.961 | 14.170 |
| 387.00 | 0.0 | 3.059 | 9.079 | 3.026 | 17.196 |
| 388.00 | 0.0 | 3.125 | 9.276 | 3.092 | 20.288 |
| 389.00 | 0.0 | 3.191 | 9.474 | 3.158 | 23.446 |
| 390.00 | 0.0 | 3.258 | 9.674 | 3.225 | 26.670 |
| 391.00 | 0.0 | 3.326 | 9.875 | 3.292 | 29.962 |
| 392.00 | 0.0 | 3.394 | 10.079 | 3.360 | 33.322 |

Subsection: Elevation-Area Volume Curve
Label: Wastewater Pond (WWP)

Return Event: 1,000 years
Storm Event: 1000 Year

| Elevation (ft) | Planimeter (ft²) | Area (acres) | A1+A2+sqr(A1*A2) (acres) | Volume (ac-ft) | Volume (Total) (ac-ft) |
|---|---|---|---|---|---|
| 388.00 | 0.0 | 16.003 | 0.000 | 0.000 | 0.000 |
| 389.00 | 0.0 | 16.159 | 48.241 | 16.080 | 16.080 |
| 390.00 | 0.0 | 16.315 | 48.710 | 16.237 | 32.317 |
| 391.00 | 0.0 | 16.472 | 49.181 | 16.394 | 48.711 |
| 392.00 | 0.0 | 16.630 | 49.653 | 16.551 | 65.262 |

| Requested Pond Water Surface Elevations | |
|---|---|
| Minimum (Headwater) | 394.00 ft |
| Increment (Headwater) | 0.50 ft |
| Maximum (Headwater) | 399.00 ft |

## Outlet Connectivity

| Structure Type | Outlet ID | Direction | Outfall | E1 (ft) | E2 (ft) |
|---|---|---|---|---|---|
| Inlet Box | BAP Riser | Forward | BAP Culvert | 394.00 | 399.00 |
| Culvert-Circular | BAP Culvert | Forward | TW | 385.90 | 399.00 |
| Tailwater Settings | Tailwater | | | (N/A) | (N/A) |

| Structure ID: BAP Riser<br>Structure Type: Inlet Box | |
|---|---|
| Number of Openings | 1 |
| Elevation | 394.00 ft |
| Orifice Area | 28.3 ft² |
| Orifice Coefficient | 0.600 |
| Weir Length | 9.00 ft |
| Weir Coefficient | 3.00 (ft^0.5)/s |
| K Reverse | 1.000 |
| Manning's n | 0.000 |
| Kev, Charged Riser | 0.000 |
| Weir Submergence | False |
| Orifice H to crest | False |

| Structure ID: BAP Culvert<br>Structure Type: Culvert-Circular | |
|---|---|
| Number of Barrels | 1 |
| Diameter | 48.0 in |
| Length | 85.00 ft |
| Length (Computed Barrel) | 85.00 ft |
| Slope (Computed) | 0.005 ft/ft |

| Outlet Control Data | |
|---|---|
| Manning's n | 0.013 |
| Ke | 0.900 |
| Kb | 0.005 |
| Kr | 0.900 |
| Convergence Tolerance | 0.00 ft |

| Inlet Control Data | |
|---|---|
| Equation Form | Form 1 |
| K | 0.0340 |
| M | 1.5000 |
| C | 0.0553 |
| Y | 0.5400 |
| T1 ratio (HW/D) | 0.000 |
| T2 ratio (HW/D) | 1.422 |
| Slope Correction Factor | -0.500 |

Use unsubmerged inlet control 0 equation below T1 elevation.
Use submerged inlet control 0 equation above T2 elevation

In transition zone between unsubmerged and submerged inlet control,
interpolate between flows at T1 & T2...

| | | | |
|---|---|---|---|
| T1 Elevation | 385.90 ft | T1 Flow | 87.96 ft³/s |
| T2 Elevation | 391.59 ft | T2 Flow | 100.53 ft³/s |

| Requested Pond Water Surface Elevations | |
|---|---|
| Minimum (Headwater) | 381.00 ft |
| Increment (Headwater) | 0.50 ft |
| Maximum (Headwater) | 392.00 ft |

## Outlet Connectivity

| Structure Type | Outlet ID | Direction | Outfall | E1 (ft) | E2 (ft) |
|---|---|---|---|---|---|
| Inlet Box | CWP Riser | Forward | CWP Culvert | 387.25 | 392.00 |
| Rectangular Weir | CWP Weir | Forward | CWP Culvert | 381.50 | 392.00 |
| Culvert-Circular | CWP Culvert | Forward | TW | 376.00 | 392.00 |
| Tailwater Settings | Tailwater | | | (N/A) | (N/A) |

| Structure ID: CWP Riser<br>Structure Type: Inlet Box | |
|---|---|
| Number of Openings | 1 |
| Elevation | 387.25 ft |
| Orifice Area | 28.3 ft² |
| Orifice Coefficient | 0.600 |
| Weir Length | 16.00 ft |
| Weir Coefficient | 3.00 (ft^0.5)/s |
| K Reverse | 1.000 |
| Manning's n | 0.000 |
| Kev, Charged Riser | 0.000 |
| Weir Submergence | False |
| Orifice H to crest | False |

| Structure ID: CWP Culvert<br>Structure Type: Culvert-Circular | |
|---|---|
| Number of Barrels | 1 |
| Diameter | 66.0 in |
| Length | 80.00 ft |
| Length (Computed Barrel) | 80.00 ft |
| Slope (Computed) | 0.005 ft/ft |

| Outlet Control Data | |
|---|---|
| Manning's n | 0.013 |
| Ke | 0.900 |
| Kb | 0.003 |
| Kr | 0.900 |
| Convergence Tolerance | 0.00 ft |

| Inlet Control Data | |
|---|---|
| Equation Form | Form 1 |
| K | 0.0340 |
| M | 1.5000 |
| C | 0.0553 |
| Y | 0.5400 |
| T1 ratio (HW/D) | 1.260 |
| T2 ratio (HW/D) | 1.422 |
| Slope Correction Factor | -0.500 |

Use unsubmerged inlet control 0 equation below T1 elevation.
Use submerged inlet control 0 equation above T2 elevation

In transition zone between unsubmerged and submerged inlet control,
interpolate between flows at T1 & T2...

| | | | |
|---|---|---|---|
| T1 Elevation | 382.93 ft | T1 Flow | 195.01 ft³/s |
| T2 Elevation | 383.82 ft | T2 Flow | 222.87 ft³/s |

| Structure ID: CWP Weir<br>Structure Type: Rectangular Weir | |
|---|---|
| Number of Openings | 1 |
| Elevation | 381.50 ft |
| Weir Length | 180.00 ft |
| Weir Coefficient | 3.00 (ft^0.5)/s |

| Structure ID: TW<br>Structure Type: TW Setup, DS Channel | |
|---|---|
| Tailwater Type | Free Outfall |

| Convergence Tolerances | |
|---|---|
| Maximum Iterations | 30 |
| Tailwater Tolerance (Minimum) | 0.01 ft |
| Tailwater Tolerance (Maximum) | 0.50 ft |
| Headwater Tolerance (Minimum) | 0.01 ft |
| Headwater Tolerance (Maximum) | 0.50 ft |
| Flow Tolerance (Minimum) | 0.001 $ft^3/s$ |
| Flow Tolerance (Maximum) | 10.000 $ft^3/s$ |

| Requested Pond Water Surface Elevations | |
|---|---|
| Minimum (Headwater) | 388.00 ft |
| Increment (Headwater) | 0.50 ft |
| Maximum (Headwater) | 392.00 ft |

## Outlet Connectivity

| Structure Type | Outlet ID | Direction | Outfall | E1 (ft) | E2 (ft) |
|---|---|---|---|---|---|
| Rectangular Weir | WWP Weir | Forward + Reverse | WWP Culvert | 389.00 | 392.00 |
| Culvert-Box | WWP Culvert | Forward | TW | 383.50 | 392.00 |
| Tailwater Settings | Tailwater | | | (N/A) | (N/A) |

| Structure ID: WWP Culvert<br>Structure Type: Culvert-Box | |
|---|---|
| Number of Barrels | 1 |
| Width | 3.00 ft |
| Height | 4.00 ft |
| Length | 50.00 ft |
| Length (Computed Barrel) | 50.00 ft |
| Slope (Computed) | 0.000 ft/ft |

| Outlet Control Data | |
|---|---|
| Manning's n | 0.013 |
| Ke | 0.000 |
| Kb | 0.006 |
| Kr | 0.000 |
| Convergence Tolerance | 0.00 ft |

| Inlet Control Data | |
|---|---|
| Equation Form | Form 2 |
| K | 0.5000 |
| M | 0.6670 |
| C | 0.0446 |
| Y | 0.6500 |
| T1 ratio (HW/D) | 1.153 |
| T2 ratio (HW/D) | 1.364 |
| Slope Correction Factor | -0.500 |

Use unsubmerged inlet control 1 equation below T1 elevation.
Use submerged inlet control 1 equation above T2 elevation

In transition zone between unsubmerged and submerged inlet control,
interpolate between flows at T1 & T2...

| | | | |
|---|---|---|---|
| T1 Elevation | 388.11 ft | T1 Flow | 84.00 ft³/s |
| T2 Elevation | 388.95 ft | T2 Flow | 96.00 ft³/s |

| Structure ID: WWP Weir<br>Structure Type: Rectangular Weir | |
|---|---|
| Number of Openings | 1 |
| Elevation | 389.00 ft |
| Weir Length | 250.00 ft |
| Weir Coefficient | 3.00 (ft^0.5)/s |

Subsection: Diverted Hydrograph
Label: CWP Outlet

Return Event: 1,000 years
Storm Event: 1000 Year

| | |
|---|---|
| Peak Discharge | 123.59 ft³/s |
| Time to Peak | 12.100 hours |
| Hydrograph Volume | 94.142 ac-ft |

**HYDROGRAPH ORDINATES (ft³/s)**
**Output Time Increment = 0.050 hours**
**Time on left represents time for first value in each row.**

| Time (hours) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) | Flow (ft³/s) |
|---|---|---|---|---|---|
| 0.000 | 0.00 | 0.25 | 0.94 | 1.90 | 3.02 |
| 0.250 | 4.20 | 5.39 | 6.57 | 7.71 | 8.81 |
| 0.500 | 9.85 | 10.83 | 11.75 | 12.61 | 13.42 |
| 0.750 | 14.17 | 14.88 | 15.53 | 16.15 | 16.72 |
| 1.000 | 17.25 | 17.75 | 18.21 | 18.64 | 19.05 |
| 1.250 | 19.43 | 19.78 | 20.12 | 20.43 | 20.72 |
| 1.500 | 21.00 | 21.26 | 21.50 | 21.73 | 21.95 |
| 1.750 | 22.16 | 22.36 | 22.54 | 22.72 | 22.89 |
| 2.000 | 23.05 | 23.21 | 23.35 | 23.50 | 23.63 |
| 2.250 | 23.76 | 23.89 | 24.01 | 24.13 | 24.24 |
| 2.500 | 24.35 | 24.46 | 24.56 | 24.66 | 24.76 |
| 2.750 | 24.86 | 24.95 | 25.05 | 25.14 | 25.23 |
| 3.000 | 25.31 | 25.40 | 25.48 | 25.57 | 25.65 |
| 3.250 | 25.73 | 25.81 | 25.89 | 25.96 | 26.04 |
| 3.500 | 26.12 | 26.19 | 26.27 | 26.34 | 26.42 |
| 3.750 | 26.49 | 26.56 | 26.63 | 26.70 | 26.78 |
| 4.000 | 26.85 | 26.92 | 26.99 | 27.06 | 27.13 |
| 4.250 | 27.20 | 27.27 | 27.34 | 27.42 | 27.49 |
| 4.500 | 27.56 | 27.63 | 27.71 | 27.78 | 27.86 |
| 4.750 | 27.93 | 28.00 | 28.08 | 28.15 | 28.23 |
| 5.000 | 28.30 | 28.38 | 28.45 | 28.53 | 28.60 |
| 5.250 | 28.68 | 28.76 | 28.83 | 28.91 | 28.98 |
| 5.500 | 29.06 | 29.13 | 29.21 | 29.28 | 29.36 |
| 5.750 | 29.43 | 29.51 | 29.59 | 29.66 | 29.74 |
| 6.000 | 29.81 | 29.89 | 29.96 | 30.04 | 30.11 |
| 6.250 | 30.19 | 30.27 | 30.34 | 30.42 | 30.49 |
| 6.500 | 30.57 | 30.64 | 30.72 | 30.79 | 30.87 |
| 6.750 | 30.94 | 31.02 | 31.09 | 31.17 | 31.24 |
| 7.000 | 31.32 | 31.39 | 31.47 | 31.54 | 31.62 |
| 7.250 | 31.69 | 31.76 | 31.84 | 31.91 | 31.99 |
| 7.500 | 32.06 | 32.14 | 32.21 | 32.29 | 32.36 |
| 7.750 | 32.43 | 32.51 | 32.58 | 32.66 | 32.73 |
| 8.000 | 32.80 | 32.88 | 32.96 | 33.04 | 33.12 |
| 8.250 | 33.21 | 33.31 | 33.41 | 33.51 | 33.62 |
| 8.500 | 33.74 | 33.86 | 33.98 | 34.10 | 34.23 |
| 8.750 | 34.37 | 34.50 | 34.65 | 34.80 | 34.95 |
| 9.000 | 35.10 | 35.26 | 35.43 | 35.59 | 35.75 |
| 9.250 | 35.90 | 36.05 | 36.20 | 36.35 | 36.49 |
| 9.500 | 36.63 | 36.76 | 36.90 | 37.05 | 37.20 |

Subsection: Diverted Hydrograph
Label: CWP Outlet

Return Event: 1,000 years
Storm Event: 1000 Year

**HYDROGRAPH ORDINATES ($ft^3/s$)**
**Output Time Increment = 0.050 hours**
**Time on left represents time for first value in each row.**

| Time (hours) | Flow ($ft^3/s$) | Flow ($ft^3/s$) | Flow ($ft^3/s$) | Flow ($ft^3/s$) | Flow ($ft^3/s$) |
|---|---|---|---|---|---|
| 9.750 | 37.35 | 37.52 | 37.70 | 37.88 | 38.07 |
| 10.000 | 38.27 | 38.47 | 38.69 | 38.91 | 39.15 |
| 10.250 | 39.39 | 39.64 | 39.91 | 40.18 | 40.47 |
| 10.500 | 40.76 | 41.06 | 41.37 | 41.69 | 42.03 |
| 10.750 | 42.39 | 42.77 | 43.16 | 43.56 | 43.98 |
| 11.000 | 44.42 | 44.87 | 45.35 | 45.86 | 46.42 |
| 11.250 | 47.02 | 47.68 | 48.38 | 49.12 | 49.90 |
| 11.500 | 50.72 | 51.80 | 53.53 | 56.26 | 60.41 |
| 11.750 | 66.23 | 73.64 | 82.73 | 94.15 | 106.36 |
| 12.000 | 116.21 | 122.31 | 123.59 | 121.44 | 118.68 |
| 12.250 | 116.19 | 114.09 | 112.26 | 110.58 | 108.96 |
| 12.500 | 107.37 | 105.80 | 104.27 | 102.79 | 101.37 |
| 12.750 | 100.02 | 98.73 | 97.49 | 96.29 | 95.12 |
| 13.000 | 93.99 | 92.89 | 91.82 | 90.78 | 89.78 |
| 13.250 | 88.82 | 87.88 | 86.98 | 86.10 | 85.25 |
| 13.500 | 84.42 | 83.62 | 82.83 | 82.08 | 81.34 |
| 13.750 | 80.63 | 79.94 | 79.27 | 78.62 | 77.99 |
| 14.000 | 77.37 | 76.77 | 76.19 | 75.63 | 75.09 |
| 14.250 | 74.57 | 74.07 | 73.59 | 73.12 | 72.67 |
| 14.500 | 72.24 | 71.82 | 71.41 | 71.01 | 70.63 |
| 14.750 | 70.26 | 69.90 | 69.56 | 69.22 | 68.84 |
| 15.000 | 68.40 | 67.95 | 67.50 | 67.05 | 66.62 |
| 15.250 | 66.20 | 65.80 | 65.42 | 65.06 | 64.71 |
| 15.500 | 64.38 | 64.06 | 63.76 | 63.48 | 63.21 |
| 15.750 | 62.94 | 62.69 | 62.45 | 62.22 | 62.00 |
| 16.000 | 61.79 | 61.58 | 61.38 | 61.19 | 61.01 |
| 16.250 | 60.84 | 60.67 | 60.51 | 60.36 | 60.22 |
| 16.500 | 60.08 | 59.94 | 59.81 | 59.69 | 59.56 |
| 16.750 | 59.45 | 59.33 | 59.22 | 59.12 | 59.01 |
| 17.000 | 58.91 | 58.81 | 58.71 | 58.62 | 58.52 |
| 17.250 | 58.43 | 58.34 | 58.25 | 58.17 | 58.08 |
| 17.500 | 58.00 | 57.91 | 57.83 | 57.75 | 57.67 |
| 17.750 | 57.58 | 57.50 | 57.43 | 57.35 | 57.27 |
| 18.000 | 57.19 | 57.11 | 57.04 | 56.96 | 56.88 |
| 18.250 | 56.81 | 56.73 | 56.66 | 56.58 | 56.51 |
| 18.500 | 56.43 | 56.36 | 56.29 | 56.21 | 56.14 |
| 18.750 | 56.07 | 55.99 | 55.92 | 55.85 | 55.77 |
| 19.000 | 55.70 | 55.63 | 55.55 | 55.48 | 55.41 |
| 19.250 | 55.34 | 55.26 | 55.19 | 55.12 | 55.05 |
| 19.500 | 54.97 | 54.90 | 54.83 | 54.76 | 54.68 |
| 19.750 | 54.61 | 54.54 | 54.47 | 54.39 | 54.32 |
| 20.000 | 54.25 | 54.18 | 54.11 | 54.04 | 53.97 |
| 20.250 | 53.90 | 53.83 | 53.77 | 53.70 | 53.64 |

Subsection: Diverted Hydrograph | Return Event: 1,000 years
Label: CWP Outlet | Storm Event: 1000 Year

**HYDROGRAPH ORDINATES ($ft^3/s$)**
**Output Time Increment = 0.050 hours**
**Time on left represents time for first value in each row.**

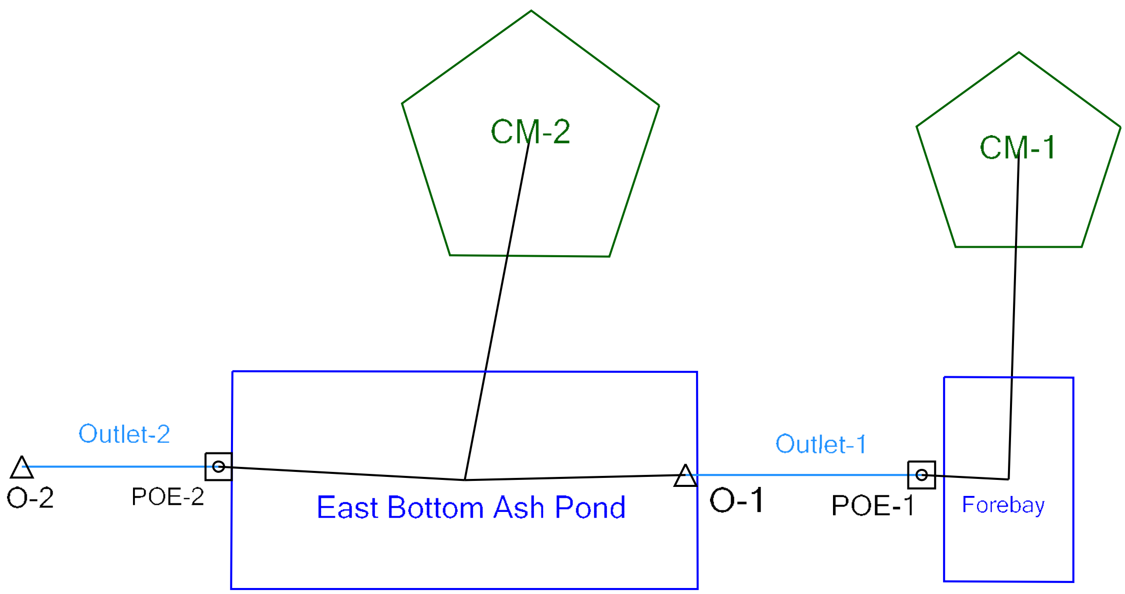
| Time (hours) | Flow ($ft^3/s$) | Flow ($ft^3/s$) | Flow ($ft^3/s$) | Flow ($ft^3/s$) | Flow ($ft^3/s$) |
|---|---|---|---|---|---|
| 20.500 | 53.58 | 53.52 | 53.46 | 53.40 | 53.34 |
| 20.750 | 53.28 | 53.23 | 53.17 | 53.12 | 53.06 |
| 21.000 | 53.01 | 52.96 | 52.91 | 52.85 | 52.80 |
| 21.250 | 52.75 | 52.70 | 52.65 | 52.60 | 52.55 |
| 21.500 | 52.51 | 52.46 | 52.41 | 52.36 | 52.31 |
| 21.750 | 52.27 | 52.22 | 52.18 | 52.13 | 52.08 |
| 22.000 | 52.04 | 51.99 | 51.95 | 51.90 | 51.86 |
| 22.250 | 51.82 | 51.77 | 51.73 | 51.69 | 51.64 |
| 22.500 | 51.60 | 51.56 | 51.51 | 51.47 | 51.43 |
| 22.750 | 51.39 | 51.35 | 51.30 | 51.26 | 51.22 |
| 23.000 | 51.18 | 51.14 | 51.10 | 51.06 | 51.02 |
| 23.250 | 50.98 | 50.94 | 50.90 | 50.86 | 50.82 |
| 23.500 | 50.78 | 50.74 | 50.71 | 50.67 | 50.63 |
| 23.750 | 50.59 | 50.55 | 50.51 | 50.48 | 50.44 |
| 24.000 | 50.40 | (N/A) | (N/A) | (N/A) | (N/A) |

# Index

<u>ATTACHMENT D2</u>

NEW HYDROLOGY AND HYDRAULIC REPORT

Scenario: Post-Development 1000 year



Subsection: Master Network Summary

## Catchments Summary

| Label | Scenario | Return Event (years) | Hydrograph Volume (ac-ft) | Time to Peak (hours) | Peak Flow (ft³/s) |
|---|---|---|---|---|---|
| CM-1 | Post-Development 100 year | 100 | 3.612 | 11.900 | 55.86 |
| CM-1 | Post-Development 200 year | 200 | 4.042 | 11.900 | 62.50 |
| CM-1 | Post-Development 500 year | 500 | 4.657 | 11.900 | 72.00 |
| CM-1 | Post-Development 1000 year | 1,000 | 5.146 | 11.900 | 79.57 |
| CM-2 | Post-Development 100 year | 100 | 14.450 | 11.900 | 223.42 |
| CM-2 | Post-Development 200 year | 200 | 16.168 | 11.900 | 250.00 |
| CM-2 | Post-Development 500 year | 500 | 18.627 | 11.900 | 288.01 |
| CM-2 | Post-Development 1000 year | 1,000 | 20.585 | 11.900 | 318.29 |

## Node Summary

| Label | Scenario | Return Event (years) | Hydrograph Volume (ac-ft) | Time to Peak (hours) | Peak Flow (ft³/s) |
|---|---|---|---|---|---|
| O-2 | Post-Development 100 year | 100 | 5.808 | 14.850 | 5.50 |
| O-2 | Post-Development 200 year | 200 | 6.599 | 14.850 | 6.19 |
| O-2 | Post-Development 500 year | 500 | 7.742 | 14.450 | 7.75 |
| O-2 | Post-Development 1000 year | 1,000 | 8.867 | 14.200 | 9.01 |

## Pond Summary

| Label | Scenario | Return Event (years) | Hydrograph Volume (ac-ft) | Time to Peak (hours) | Peak Flow (ft³/s) | Maximum Water Surface Elevation (ft) | Maximum Pond Storage (ac-ft) |
|---|---|---|---|---|---|---|---|
| Forebay (IN) | Post-Development 100 year | 100 | 3.612 | 11.900 | 55.86 | (N/A) | (N/A) |
| Forebay (OUT) | Post-Development 100 year | 100 | 0.000 | 0.050 | 0.07 | 396.45 | 77.250 |
| Forebay (IN) | Post-Development 200 year | 200 | 4.042 | 11.900 | 62.50 | (N/A) | (N/A) |
| Forebay (OUT) | Post-Development 200 year | 200 | 0.361 | 15.600 | 2.65 | 396.50 | 77.551 |

## Pond Summary

| Label | Scenario | Return Event (years) | Hydrograph Volume (ac-ft) | Time to Peak (hours) | Peak Flow (ft³/s) | Maximum Water Surface Elevation (ft) | Maximum Pond Storage (ac-ft) |
|---|---|---|---|---|---|---|---|
| Forebay (IN) | Post-Development 500 year | 500 | 4.657 | 11.900 | 72.00 | (N/A) | (N/A) |
| Forebay (OUT) | Post-Development 500 year | 500 | 0.012 | 21.700 | 1.26 | 396.57 | 77.935 |
| Forebay (Reverse) | Post-Development 500 year | 500 | -0.001 | 12.400 | -0.55 | (N/A) | (N/A) |
| Forebay (IN) | Post-Development 1000 year | 1,000 | 5.146 | 11.900 | 79.57 | (N/A) | (N/A) |
| Forebay (OUT) | Post-Development 1000 year | 1,000 | 0.000 | 0.050 | 0.10 | 396.63 | 78.245 |
| East Bottom Ash Pond (IN) | Post-Development 100 year | 100 | 14.450 | 11.900 | 223.42 | (N/A) | (N/A) |
| East Bottom Ash Pond (OUT) | Post-Development 100 year | 100 | 5.808 | 14.850 | 5.50 | 396.45 | 350.289 |
| East Bottom Ash Pond (IN) | Post-Development 200 year | 200 | 16.530 | 11.900 | 250.00 | (N/A) | (N/A) |
| East Bottom Ash Pond (OUT) | Post-Development 200 year | 200 | 6.599 | 14.850 | 6.19 | 396.50 | 351.544 |
| East Bottom Ash Pond (IN) | Post-Development 500 year | 500 | 18.636 | 11.900 | 288.01 | (N/A) | (N/A) |
| East Bottom Ash Pond (OUT) | Post-Development 500 year | 500 | 7.742 | 14.450 | 7.75 | 396.57 | 353.146 |
| East Bottom Ash Pond (IN) | Post-Development 1000 year | 1,000 | 20.586 | 11.900 | 318.29 | (N/A) | (N/A) |
| East Bottom Ash Pond (OUT) | Post-Development 1000 year | 1,000 | 8.867 | 14.200 | 9.01 | 396.63 | 354.440 |

| | |
|---|---|
| Storm Event | 100-Yr |
| Return Event | 100 years |
| Duration | 24.000 hours |
| Depth | 7.23 in |
| Time of Concentration (Composite) | 0.083 hours |
| Area (User Defined) | 6.000 acres |

| | |
|---|---|
| Computational Time Increment | 0.011 hours |
| Time to Peak (Computed) | 11.911 hours |
| Flow (Peak, Computed) | 56.72 ft³/s |
| Output Increment | 0.050 hours |
| Time to Flow (Peak Interpolated Output) | 11.900 hours |
| Flow (Peak Interpolated Output) | 55.86 ft³/s |

| Drainage Area | |
|---|---|
| SCS CN (Composite) | 100.000 |
| Area (User Defined) | 6.000 acres |
| Maximum Retention (Pervious) | 0.00 in |
| Maximum Retention (Pervious, 20 percent) | 0.00 in |

| Cumulative Runoff | |
|---|---|
| Cumulative Runoff Depth (Pervious) | 7.23 in |
| Runoff Volume (Pervious) | 3.615 ac-ft |

| Hydrograph Volume (Area under Hydrograph curve) | |
|---|---|
| Volume | 3.612 ac-ft |

| SCS Unit Hydrograph Parameters | |
|---|---|
| Time of Concentration (Composite) | 0.083 hours |
| Computational Time Increment | 0.011 hours |
| Unit Hydrograph Shape Factor | 483.432 |
| K Factor | 0.749 |
| Receding/Rising, Tr/Tp | 1.670 |
| Unit peak, qp | 81.58 ft³/s |
| Unit peak time, Tp | 0.056 hours |
| Unit receding limb, Tr | 0.222 hours |
| Total unit time, Tb | 0.278 hours |

| | |
|---|---|
| Storm Event | 200-Yr |
| Return Event | 200 years |
| Duration | 24.000 hours |
| Depth | 8.09 in |
| Time of Concentration (Composite) | 0.083 hours |
| Area (User Defined) | 6.000 acres |

| | |
|---|---|
| Computational Time Increment | 0.011 hours |
| Time to Peak (Computed) | 11.911 hours |
| Flow (Peak, Computed) | 63.47 ft³/s |
| Output Increment | 0.050 hours |
| Time to Flow (Peak Interpolated Output) | 11.900 hours |
| Flow (Peak Interpolated Output) | 62.50 ft³/s |

| Drainage Area | |
|---|---|
| SCS CN (Composite) | 100.000 |
| Area (User Defined) | 6.000 acres |
| Maximum Retention (Pervious) | 0.00 in |
| Maximum Retention (Pervious, 20 percent) | 0.00 in |

| Cumulative Runoff | |
|---|---|
| Cumulative Runoff Depth (Pervious) | 8.09 in |
| Runoff Volume (Pervious) | 4.045 ac-ft |

| Hydrograph Volume (Area under Hydrograph curve) | |
|---|---|
| Volume | 4.042 ac-ft |

| SCS Unit Hydrograph Parameters | |
|---|---|
| Time of Concentration (Composite) | 0.083 hours |
| Computational Time Increment | 0.011 hours |
| Unit Hydrograph Shape Factor | 483.432 |
| K Factor | 0.749 |
| Receding/Rising, Tr/Tp | 1.670 |
| Unit peak, qp | 81.58 ft³/s |
| Unit peak time, Tp | 0.056 hours |
| Unit receding limb, Tr | 0.222 hours |
| Total unit time, Tb | 0.278 hours |

| | |
|---|---|
| Storm Event | 500-Yr |
| Return Event | 500 years |
| Duration | 24.000 hours |
| Depth | 9.32 in |
| Time of Concentration (Composite) | 0.083 hours |
| Area (User Defined) | 6.000 acres |

| | |
|---|---|
| Computational Time Increment | 0.011 hours |
| Time to Peak (Computed) | 11.911 hours |
| Flow (Peak, Computed) | 73.12 ft³/s |
| Output Increment | 0.050 hours |
| Time to Flow (Peak Interpolated Output) | 11.900 hours |
| Flow (Peak Interpolated Output) | 72.00 ft³/s |

| Drainage Area | |
|---|---|
| SCS CN (Composite) | 100.000 |
| Area (User Defined) | 6.000 acres |
| Maximum Retention (Pervious) | 0.00 in |
| Maximum Retention (Pervious, 20 percent) | 0.00 in |

| Cumulative Runoff | |
|---|---|
| Cumulative Runoff Depth (Pervious) | 9.32 in |
| Runoff Volume (Pervious) | 4.660 ac-ft |

| Hydrograph Volume (Area under Hydrograph curve) | |
|---|---|
| Volume | 4.657 ac-ft |

| SCS Unit Hydrograph Parameters | |
|---|---|
| Time of Concentration (Composite) | 0.083 hours |
| Computational Time Increment | 0.011 hours |
| Unit Hydrograph Shape Factor | 483.432 |
| K Factor | 0.749 |
| Receding/Rising, Tr/Tp | 1.670 |
| Unit peak, qp | 81.58 ft³/s |
| Unit peak time, Tp | 0.056 hours |
| Unit receding limb, Tr | 0.222 hours |
| Total unit time, Tb | 0.278 hours |

| | |
|---|---|
| Storm Event | 1000-Yr |
| Return Event | 1,000 years |
| Duration | 24.000 hours |
| Depth | 10.30 in |
| Time of Concentration (Composite) | 0.083 hours |
| Area (User Defined) | 6.000 acres |

| | |
|---|---|
| Computational Time Increment | 0.011 hours |
| Time to Peak (Computed) | 11.911 hours |
| Flow (Peak, Computed) | 80.81 ft³/s |
| Output Increment | 0.050 hours |
| Time to Flow (Peak Interpolated Output) | 11.900 hours |
| Flow (Peak Interpolated Output) | 79.57 ft³/s |

### Drainage Area

| | |
|---|---|
| SCS CN (Composite) | 100.000 |
| Area (User Defined) | 6.000 acres |
| Maximum Retention (Pervious) | 0.00 in |
| Maximum Retention (Pervious, 20 percent) | 0.00 in |

### Cumulative Runoff

| | |
|---|---|
| Cumulative Runoff Depth (Pervious) | 10.30 in |
| Runoff Volume (Pervious) | 5.150 ac-ft |

### Hydrograph Volume (Area under Hydrograph curve)

| | |
|---|---|
| Volume | 5.146 ac-ft |

### SCS Unit Hydrograph Parameters

| | |
|---|---|
| Time of Concentration (Composite) | 0.083 hours |
| Computational Time Increment | 0.011 hours |
| Unit Hydrograph Shape Factor | 483.432 |
| K Factor | 0.749 |
| Receding/Rising, Tr/Tp | 1.670 |
| Unit peak, qp | 81.58 ft³/s |
| Unit peak time, Tp | 0.056 hours |
| Unit receding limb, Tr | 0.222 hours |
| Total unit time, Tb | 0.278 hours |

| | |
|---|---|
| Storm Event | 100-Yr |
| Return Event | 100 years |
| Duration | 24.000 hours |
| Depth | 7.23 in |
| Time of Concentration (Composite) | 0.083 hours |
| Area (User Defined) | 24.000 acres |

| | |
|---|---|
| Computational Time Increment | 0.011 hours |
| Time to Peak (Computed) | 11.911 hours |
| Flow (Peak, Computed) | 226.89 ft³/s |
| Output Increment | 0.050 hours |
| Time to Flow (Peak Interpolated Output) | 11.900 hours |
| Flow (Peak Interpolated Output) | 223.42 ft³/s |

| Drainage Area | |
|---|---|
| SCS CN (Composite) | 100.000 |
| Area (User Defined) | 24.000 acres |
| Maximum Retention (Pervious) | 0.00 in |
| Maximum Retention (Pervious, 20 percent) | 0.00 in |

| Cumulative Runoff | |
|---|---|
| Cumulative Runoff Depth (Pervious) | 7.23 in |
| Runoff Volume (Pervious) | 14.460 ac-ft |

| Hydrograph Volume (Area under Hydrograph curve) | |
|---|---|
| Volume | 14.450 ac-ft |

| SCS Unit Hydrograph Parameters | |
|---|---|
| Time of Concentration (Composite) | 0.083 hours |
| Computational Time Increment | 0.011 hours |
| Unit Hydrograph Shape Factor | 483.432 |
| K Factor | 0.749 |
| Receding/Rising, Tr/Tp | 1.670 |
| Unit peak, qp | 326.32 ft³/s |
| Unit peak time, Tp | 0.056 hours |
| Unit receding limb, Tr | 0.222 hours |
| Total unit time, Tb | 0.278 hours |

| | |
|---|---|
| Storm Event | 200-Yr |
| Return Event | 200 years |
| Duration | 24.000 hours |
| Depth | 8.09 in |
| Time of Concentration (Composite) | 0.083 hours |
| Area (User Defined) | 24.000 acres |

| | |
|---|---|
| Computational Time Increment | 0.011 hours |
| Time to Peak (Computed) | 11.911 hours |
| Flow (Peak, Computed) | 253.88 ft³/s |
| Output Increment | 0.050 hours |
| Time to Flow (Peak Interpolated Output) | 11.900 hours |
| Flow (Peak Interpolated Output) | 250.00 ft³/s |

| Drainage Area | |
|---|---|
| SCS CN (Composite) | 100.000 |
| Area (User Defined) | 24.000 acres |
| Maximum Retention (Pervious) | 0.00 in |
| Maximum Retention (Pervious, 20 percent) | 0.00 in |

| Cumulative Runoff | |
|---|---|
| Cumulative Runoff Depth (Pervious) | 8.09 in |
| Runoff Volume (Pervious) | 16.180 ac-ft |

| Hydrograph Volume (Area under Hydrograph curve) | |
|---|---|
| Volume | 16.168 ac-ft |

| SCS Unit Hydrograph Parameters | |
|---|---|
| Time of Concentration (Composite) | 0.083 hours |
| Computational Time Increment | 0.011 hours |
| Unit Hydrograph Shape Factor | 483.432 |
| K Factor | 0.749 |
| Receding/Rising, Tr/Tp | 1.670 |
| Unit peak, qp | 326.32 ft³/s |
| Unit peak time, Tp | 0.056 hours |
| Unit receding limb, Tr | 0.222 hours |
| Total unit time, Tb | 0.278 hours |

| | |
|---|---|
| Storm Event | 500-Yr |
| Return Event | 500 years |
| Duration | 24.000 hours |
| Depth | 9.32 in |
| Time of Concentration (Composite) | 0.083 hours |
| Area (User Defined) | 24.000 acres |

| | |
|---|---|
| Computational Time Increment | 0.011 hours |
| Time to Peak (Computed) | 11.911 hours |
| Flow (Peak, Computed) | 292.48 ft³/s |
| Output Increment | 0.050 hours |
| Time to Flow (Peak Interpolated Output) | 11.900 hours |
| Flow (Peak Interpolated Output) | 288.01 ft³/s |

| Drainage Area | |
|---|---|
| SCS CN (Composite) | 100.000 |
| Area (User Defined) | 24.000 acres |
| Maximum Retention (Pervious) | 0.00 in |
| Maximum Retention (Pervious, 20 percent) | 0.00 in |

| Cumulative Runoff | |
|---|---|
| Cumulative Runoff Depth (Pervious) | 9.32 in |
| Runoff Volume (Pervious) | 18.640 ac-ft |

| Hydrograph Volume (Area under Hydrograph curve) | |
|---|---|
| Volume | 18.627 ac-ft |

| SCS Unit Hydrograph Parameters | |
|---|---|
| Time of Concentration (Composite) | 0.083 hours |
| Computational Time Increment | 0.011 hours |
| Unit Hydrograph Shape Factor | 483.432 |
| K Factor | 0.749 |
| Receding/Rising, Tr/Tp | 1.670 |
| Unit peak, qp | 326.32 ft³/s |
| Unit peak time, Tp | 0.056 hours |
| Unit receding limb, Tr | 0.222 hours |
| Total unit time, Tb | 0.278 hours |

| | |
|---|---|
| Storm Event | 1000-Yr |
| Return Event | 1,000 years |
| Duration | 24.000 hours |
| Depth | 10.30 in |
| Time of Concentration (Composite) | 0.083 hours |
| Area (User Defined) | 24.000 acres |

| | |
|---|---|
| Computational Time Increment | 0.011 hours |
| Time to Peak (Computed) | 11.911 hours |
| Flow (Peak, Computed) | 323.24 ft³/s |
| Output Increment | 0.050 hours |
| Time to Flow (Peak Interpolated Output) | 11.900 hours |
| Flow (Peak Interpolated Output) | 318.29 ft³/s |

## Drainage Area

| | |
|---|---|
| SCS CN (Composite) | 100.000 |
| Area (User Defined) | 24.000 acres |
| Maximum Retention (Pervious) | 0.00 in |
| Maximum Retention (Pervious, 20 percent) | 0.00 in |

## Cumulative Runoff

| | |
|---|---|
| Cumulative Runoff Depth (Pervious) | 10.30 in |
| Runoff Volume (Pervious) | 20.600 ac-ft |

## Hydrograph Volume (Area under Hydrograph curve)

| | |
|---|---|
| Volume | 20.585 ac-ft |

## SCS Unit Hydrograph Parameters

| | |
|---|---|
| Time of Concentration (Composite) | 0.083 hours |
| Computational Time Increment | 0.011 hours |
| Unit Hydrograph Shape Factor | 483.432 |
| K Factor | 0.749 |
| Receding/Rising, Tr/Tp | 1.670 |
| Unit peak, qp | 326.32 ft³/s |
| Unit peak time, Tp | 0.056 hours |
| Unit receding limb, Tr | 0.222 hours |
| Total unit time, Tb | 0.278 hours |

Subsection: Time vs. Elevation
Label: East Bottom Ash Pond (IN)
Scenario: Post-Development 100 year

Return Event: 100 years
Storm Event: 100-Yr

## Time vs. Elevation (ft)

**Output Time increment = 0.050 hours**
**Time on left represents time for first value in each row.**

| Time (hours) | Elevation (ft) | Elevation (ft) | Elevation (ft) | Elevation (ft) | Elevation (ft) |
|---|---|---|---|---|---|
| 0.000 | 396.00 | 396.00 | 396.00 | 396.00 | 396.00 |
| 0.250 | 396.00 | 396.00 | 396.00 | 396.00 | 396.00 |
| 0.500 | 396.00 | 396.00 | 396.00 | 396.00 | 396.00 |
| 0.750 | 396.00 | 396.00 | 396.01 | 396.01 | 396.01 |
| 1.000 | 396.01 | 396.01 | 396.01 | 396.01 | 396.01 |
| 1.250 | 396.01 | 396.01 | 396.01 | 396.01 | 396.01 |
| 1.500 | 396.01 | 396.01 | 396.01 | 396.01 | 396.01 |
| 1.750 | 396.01 | 396.01 | 396.01 | 396.01 | 396.01 |
| 2.000 | 396.01 | 396.01 | 396.01 | 396.01 | 396.01 |
| 2.250 | 396.01 | 396.01 | 396.02 | 396.02 | 396.02 |
| 2.500 | 396.02 | 396.02 | 396.02 | 396.02 | 396.02 |
| 2.750 | 396.02 | 396.02 | 396.02 | 396.02 | 396.02 |
| 3.000 | 396.02 | 396.02 | 396.02 | 396.02 | 396.02 |
| 3.250 | 396.02 | 396.02 | 396.02 | 396.02 | 396.02 |
| 3.500 | 396.02 | 396.02 | 396.02 | 396.02 | 396.02 |
| 3.750 | 396.03 | 396.03 | 396.03 | 396.03 | 396.03 |
| 4.000 | 396.03 | 396.03 | 396.03 | 396.03 | 396.03 |
| 4.250 | 396.03 | 396.03 | 396.03 | 396.03 | 396.03 |
| 4.500 | 396.03 | 396.03 | 396.03 | 396.03 | 396.03 |
| 4.750 | 396.03 | 396.03 | 396.03 | 396.03 | 396.03 |
| 5.000 | 396.04 | 396.04 | 396.04 | 396.04 | 396.04 |
| 5.250 | 396.04 | 396.04 | 396.04 | 396.04 | 396.04 |
| 5.500 | 396.04 | 396.04 | 396.04 | 396.04 | 396.04 |
| 5.750 | 396.04 | 396.04 | 396.04 | 396.04 | 396.04 |
| 6.000 | 396.04 | 396.04 | 396.04 | 396.05 | 396.05 |
| 6.250 | 396.05 | 396.05 | 396.05 | 396.05 | 396.05 |
| 6.500 | 396.05 | 396.05 | 396.05 | 396.05 | 396.05 |
| 6.750 | 396.05 | 396.05 | 396.05 | 396.05 | 396.05 |
| 7.000 | 396.05 | 396.05 | 396.05 | 396.06 | 396.06 |
| 7.250 | 396.06 | 396.06 | 396.06 | 396.06 | 396.06 |
| 7.500 | 396.06 | 396.06 | 396.06 | 396.06 | 396.06 |
| 7.750 | 396.06 | 396.06 | 396.06 | 396.06 | 396.06 |
| 8.000 | 396.06 | 396.06 | 396.07 | 396.07 | 396.07 |
| 8.250 | 396.07 | 396.07 | 396.07 | 396.07 | 396.07 |
| 8.500 | 396.07 | 396.07 | 396.07 | 396.07 | 396.07 |
| 8.750 | 396.07 | 396.07 | 396.08 | 396.08 | 396.08 |
| 9.000 | 396.08 | 396.08 | 396.08 | 396.08 | 396.08 |
| 9.250 | 396.08 | 396.08 | 396.08 | 396.08 | 396.08 |
| 9.500 | 396.09 | 396.09 | 396.09 | 396.09 | 396.09 |
| 9.750 | 396.09 | 396.09 | 396.09 | 396.09 | 396.09 |
| 10.000 | 396.09 | 396.10 | 396.10 | 396.10 | 396.10 |
| 10.250 | 396.10 | 396.10 | 396.10 | 396.10 | 396.11 |
| 10.500 | 396.11 | 396.11 | 396.11 | 396.11 | 396.11 |
| 10.750 | 396.11 | 396.12 | 396.12 | 396.12 | 396.12 |
| 11.000 | 396.12 | 396.12 | 396.13 | 396.13 | 396.13 |
| 11.250 | 396.13 | 396.14 | 396.14 | 396.14 | 396.14 |

## Time vs. Elevation (ft)

### Output Time increment = 0.050 hours
### Time on left represents time for first value in each row.

| Time (hours) | Elevation (ft) | Elevation (ft) | Elevation (ft) | Elevation (ft) | Elevation (ft) |
|---|---|---|---|---|---|
| 11.500 | 396.15 | 396.15 | 396.16 | 396.17 | 396.18 |
| 11.750 | 396.19 | 396.21 | 396.24 | 396.27 | 396.31 |
| 12.000 | 396.35 | 396.37 | 396.39 | 396.39 | 396.40 |
| 12.250 | 396.40 | 396.41 | 396.41 | 396.41 | 396.42 |
| 12.500 | 396.42 | 396.42 | 396.42 | 396.42 | 396.43 |
| 12.750 | 396.43 | 396.43 | 396.43 | 396.43 | 396.43 |
| 13.000 | 396.43 | 396.43 | 396.44 | 396.44 | 396.44 |
| 13.250 | 396.44 | 396.44 | 396.44 | 396.44 | 396.44 |
| 13.500 | 396.44 | 396.44 | 396.44 | 396.44 | 396.44 |
| 13.750 | 396.44 | 396.44 | 396.44 | 396.44 | 396.45 |
| 14.000 | 396.45 | 396.45 | 396.45 | 396.45 | 396.45 |
| 14.250 | 396.45 | 396.45 | 396.45 | 396.45 | 396.45 |
| 14.500 | 396.45 | 396.45 | 396.45 | 396.45 | 396.45 |
| 14.750 | 396.45 | 396.45 | 396.45 | 396.45 | 396.45 |
| 15.000 | 396.45 | 396.45 | 396.45 | 396.45 | 396.45 |
| 15.250 | 396.45 | 396.45 | 396.45 | 396.45 | 396.45 |
| 15.500 | 396.45 | 396.45 | 396.45 | 396.45 | 396.45 |
| 15.750 | 396.45 | 396.45 | 396.44 | 396.44 | 396.44 |
| 16.000 | 396.44 | 396.44 | 396.44 | 396.44 | 396.44 |
| 16.250 | 396.44 | 396.44 | 396.44 | 396.44 | 396.44 |
| 16.500 | 396.44 | 396.44 | 396.44 | 396.44 | 396.44 |
| 16.750 | 396.44 | 396.44 | 396.44 | 396.44 | 396.44 |
| 17.000 | 396.44 | 396.44 | 396.44 | 396.44 | 396.44 |
| 17.250 | 396.44 | 396.44 | 396.44 | 396.44 | 396.44 |
| 17.500 | 396.44 | 396.43 | 396.43 | 396.43 | 396.43 |
| 17.750 | 396.43 | 396.43 | 396.43 | 396.43 | 396.43 |
| 18.000 | 396.43 | 396.43 | 396.43 | 396.43 | 396.43 |
| 18.250 | 396.43 | 396.43 | 396.43 | 396.43 | 396.43 |
| 18.500 | 396.43 | 396.43 | 396.43 | 396.43 | 396.43 |
| 18.750 | 396.43 | 396.43 | 396.42 | 396.42 | 396.42 |
| 19.000 | 396.42 | 396.42 | 396.42 | 396.42 | 396.42 |
| 19.250 | 396.42 | 396.42 | 396.42 | 396.42 | 396.42 |
| 19.500 | 396.42 | 396.42 | 396.42 | 396.42 | 396.42 |
| 19.750 | 396.42 | 396.42 | 396.42 | 396.41 | 396.41 |
| 20.000 | 396.41 | 396.41 | 396.41 | 396.41 | 396.41 |
| 20.250 | 396.41 | 396.41 | 396.41 | 396.41 | 396.41 |
| 20.500 | 396.41 | 396.41 | 396.41 | 396.41 | 396.41 |
| 20.750 | 396.41 | 396.41 | 396.41 | 396.40 | 396.40 |
| 21.000 | 396.40 | 396.40 | 396.40 | 396.40 | 396.40 |
| 21.250 | 396.40 | 396.40 | 396.40 | 396.40 | 396.40 |
| 21.500 | 396.40 | 396.40 | 396.40 | 396.40 | 396.40 |
| 21.750 | 396.40 | 396.40 | 396.40 | 396.39 | 396.39 |
| 22.000 | 396.39 | 396.39 | 396.39 | 396.39 | 396.39 |
| 22.250 | 396.39 | 396.39 | 396.39 | 396.39 | 396.39 |
| 22.500 | 396.39 | 396.39 | 396.39 | 396.39 | 396.39 |
| 22.750 | 396.39 | 396.39 | 396.39 | 396.39 | 396.38 |
| 23.000 | 396.38 | 396.38 | 396.38 | 396.38 | 396.38 |

## Time vs. Elevation (ft)

**Output Time increment = 0.050 hours**
**Time on left represents time for first value in each row.**

| Time (hours) | Elevation (ft) | Elevation (ft) | Elevation (ft) | Elevation (ft) | Elevation (ft) |
|---|---|---|---|---|---|
| 23.250 | 396.38 | 396.38 | 396.38 | 396.38 | 396.38 |
| 23.500 | 396.38 | 396.38 | 396.38 | 396.38 | 396.38 |
| 23.750 | 396.38 | 396.38 | 396.38 | 396.38 | 396.38 |
| 24.000 | 396.37 | (N/A) | (N/A) | (N/A) | (N/A) |

## Time vs. Elevation (ft)

**Output Time increment = 0.050 hours**
**Time on left represents time for first value in each row.**

| Time (hours) | Elevation (ft) | Elevation (ft) | Elevation (ft) | Elevation (ft) | Elevation (ft) |
|---|---|---|---|---|---|
| 0.000 | 396.00 | 396.00 | 396.00 | 396.00 | 396.00 |
| 0.250 | 396.00 | 396.00 | 396.00 | 396.00 | 396.00 |
| 0.500 | 396.00 | 396.00 | 396.00 | 396.00 | 396.00 |
| 0.750 | 396.00 | 396.01 | 396.01 | 396.01 | 396.01 |
| 1.000 | 396.01 | 396.01 | 396.01 | 396.01 | 396.01 |
| 1.250 | 396.01 | 396.01 | 396.01 | 396.01 | 396.01 |
| 1.500 | 396.01 | 396.01 | 396.01 | 396.01 | 396.01 |
| 1.750 | 396.01 | 396.01 | 396.01 | 396.01 | 396.01 |
| 2.000 | 396.01 | 396.01 | 396.02 | 396.02 | 396.02 |
| 2.250 | 396.02 | 396.02 | 396.02 | 396.02 | 396.02 |
| 2.500 | 396.02 | 396.02 | 396.02 | 396.02 | 396.02 |
| 2.750 | 396.02 | 396.02 | 396.02 | 396.02 | 396.02 |
| 3.000 | 396.02 | 396.02 | 396.02 | 396.02 | 396.02 |
| 3.250 | 396.02 | 396.02 | 396.03 | 396.03 | 396.03 |
| 3.500 | 396.03 | 396.03 | 396.03 | 396.03 | 396.03 |
| 3.750 | 396.03 | 396.03 | 396.03 | 396.03 | 396.03 |
| 4.000 | 396.03 | 396.03 | 396.03 | 396.03 | 396.03 |
| 4.250 | 396.03 | 396.03 | 396.03 | 396.03 | 396.03 |
| 4.500 | 396.03 | 396.04 | 396.04 | 396.04 | 396.04 |
| 4.750 | 396.04 | 396.04 | 396.04 | 396.04 | 396.04 |
| 5.000 | 396.04 | 396.04 | 396.04 | 396.04 | 396.04 |
| 5.250 | 396.04 | 396.04 | 396.04 | 396.04 | 396.04 |
| 5.500 | 396.04 | 396.04 | 396.05 | 396.05 | 396.05 |
| 5.750 | 396.05 | 396.05 | 396.05 | 396.05 | 396.05 |
| 6.000 | 396.05 | 396.05 | 396.05 | 396.05 | 396.05 |
| 6.250 | 396.05 | 396.05 | 396.05 | 396.05 | 396.05 |
| 6.500 | 396.05 | 396.06 | 396.06 | 396.06 | 396.06 |
| 6.750 | 396.06 | 396.06 | 396.06 | 396.06 | 396.06 |
| 7.000 | 396.06 | 396.06 | 396.06 | 396.06 | 396.06 |
| 7.250 | 396.06 | 396.06 | 396.06 | 396.06 | 396.07 |
| 7.500 | 396.07 | 396.07 | 396.07 | 396.07 | 396.07 |
| 7.750 | 396.07 | 396.07 | 396.07 | 396.07 | 396.07 |
| 8.000 | 396.07 | 396.07 | 396.07 | 396.07 | 396.07 |
| 8.250 | 396.07 | 396.08 | 396.08 | 396.08 | 396.08 |
| 8.500 | 396.08 | 396.08 | 396.08 | 396.08 | 396.08 |
| 8.750 | 396.08 | 396.08 | 396.08 | 396.09 | 396.09 |
| 9.000 | 396.09 | 396.09 | 396.09 | 396.09 | 396.09 |
| 9.250 | 396.09 | 396.09 | 396.09 | 396.09 | 396.10 |
| 9.500 | 396.10 | 396.10 | 396.10 | 396.10 | 396.10 |
| 9.750 | 396.10 | 396.10 | 396.10 | 396.10 | 396.10 |
| 10.000 | 396.11 | 396.11 | 396.11 | 396.11 | 396.11 |
| 10.250 | 396.11 | 396.11 | 396.11 | 396.12 | 396.12 |
| 10.500 | 396.12 | 396.12 | 396.12 | 396.12 | 396.13 |
| 10.750 | 396.13 | 396.13 | 396.13 | 396.13 | 396.14 |
| 11.000 | 396.14 | 396.14 | 396.14 | 396.14 | 396.15 |
| 11.250 | 396.15 | 396.15 | 396.16 | 396.16 | 396.16 |

**Time vs. Elevation (ft)**

**Output Time increment = 0.050 hours**
**Time on left represents time for first value in each row.**

| Time (hours) | Elevation (ft) | Elevation (ft) | Elevation (ft) | Elevation (ft) | Elevation (ft) |
|---|---|---|---|---|---|
| 11.500 | 396.17 | 396.17 | 396.18 | 396.19 | 396.20 |
| 11.750 | 396.22 | 396.24 | 396.27 | 396.31 | 396.35 |
| 12.000 | 396.39 | 396.42 | 396.43 | 396.44 | 396.45 |
| 12.250 | 396.45 | 396.45 | 396.46 | 396.46 | 396.47 |
| 12.500 | 396.47 | 396.47 | 396.47 | 396.47 | 396.48 |
| 12.750 | 396.48 | 396.48 | 396.48 | 396.48 | 396.48 |
| 13.000 | 396.49 | 396.49 | 396.49 | 396.49 | 396.49 |
| 13.250 | 396.49 | 396.49 | 396.49 | 396.49 | 396.49 |
| 13.500 | 396.49 | 396.49 | 396.50 | 396.50 | 396.50 |
| 13.750 | 396.50 | 396.50 | 396.50 | 396.50 | 396.50 |
| 14.000 | 396.50 | 396.50 | 396.50 | 396.50 | 396.50 |
| 14.250 | 396.50 | 396.50 | 396.50 | 396.50 | 396.50 |
| 14.500 | 396.50 | 396.50 | 396.50 | 396.50 | 396.50 |
| 14.750 | 396.50 | 396.50 | 396.50 | 396.50 | 396.50 |
| 15.000 | 396.50 | 396.50 | 396.50 | 396.50 | 396.50 |
| 15.250 | 396.50 | 396.50 | 396.50 | 396.50 | 396.50 |
| 15.500 | 396.50 | 396.50 | 396.50 | 396.50 | 396.50 |
| 15.750 | 396.50 | 396.50 | 396.50 | 396.50 | 396.50 |
| 16.000 | 396.50 | 396.50 | 396.50 | 396.50 | 396.50 |
| 16.250 | 396.50 | 396.50 | 396.50 | 396.50 | 396.50 |
| 16.500 | 396.50 | 396.50 | 396.50 | 396.50 | 396.50 |
| 16.750 | 396.50 | 396.50 | 396.50 | 396.50 | 396.50 |
| 17.000 | 396.50 | 396.50 | 396.50 | 396.50 | 396.50 |
| 17.250 | 396.50 | 396.50 | 396.50 | 396.50 | 396.50 |
| 17.500 | 396.50 | 396.50 | 396.50 | 396.50 | 396.50 |
| 17.750 | 396.50 | 396.50 | 396.50 | 396.50 | 396.50 |
| 18.000 | 396.50 | 396.50 | 396.50 | 396.50 | 396.50 |
| 18.250 | 396.50 | 396.49 | 396.49 | 396.49 | 396.49 |
| 18.500 | 396.49 | 396.49 | 396.49 | 396.49 | 396.49 |
| 18.750 | 396.49 | 396.49 | 396.49 | 396.49 | 396.49 |
| 19.000 | 396.49 | 396.49 | 396.49 | 396.49 | 396.49 |
| 19.250 | 396.49 | 396.48 | 396.48 | 396.48 | 396.48 |
| 19.500 | 396.48 | 396.48 | 396.48 | 396.48 | 396.48 |
| 19.750 | 396.48 | 396.48 | 396.48 | 396.48 | 396.48 |
| 20.000 | 396.48 | 396.48 | 396.48 | 396.47 | 396.47 |
| 20.250 | 396.47 | 396.47 | 396.47 | 396.47 | 396.47 |
| 20.500 | 396.47 | 396.47 | 396.47 | 396.47 | 396.47 |
| 20.750 | 396.47 | 396.47 | 396.47 | 396.47 | 396.47 |
| 21.000 | 396.46 | 396.46 | 396.46 | 396.46 | 396.46 |
| 21.250 | 396.46 | 396.46 | 396.46 | 396.46 | 396.46 |
| 21.500 | 396.46 | 396.46 | 396.46 | 396.46 | 396.46 |
| 21.750 | 396.46 | 396.46 | 396.45 | 396.45 | 396.45 |
| 22.000 | 396.45 | 396.45 | 396.45 | 396.45 | 396.45 |
| 22.250 | 396.45 | 396.45 | 396.45 | 396.45 | 396.45 |
| 22.500 | 396.45 | 396.45 | 396.45 | 396.45 | 396.45 |
| 22.750 | 396.44 | 396.44 | 396.44 | 396.44 | 396.44 |
| 23.000 | 396.44 | 396.44 | 396.44 | 396.44 | 396.44 |

## Time vs. Elevation (ft)

**Output Time increment = 0.050 hours**
**Time on left represents time for first value in each row.**

| Time (hours) | Elevation (ft) | Elevation (ft) | Elevation (ft) | Elevation (ft) | Elevation (ft) |
|---|---|---|---|---|---|
| 23.250 | 396.44 | 396.44 | 396.44 | 396.44 | 396.44 |
| 23.500 | 396.44 | 396.44 | 396.43 | 396.43 | 396.43 |
| 23.750 | 396.43 | 396.43 | 396.43 | 396.43 | 396.43 |
| 24.000 | 396.43 | (N/A) | (N/A) | (N/A) | (N/A) |

## Time vs. Elevation (ft)

**Output Time increment = 0.050 hours**
**Time on left represents time for first value in each row.**

| Time (hours) | Elevation (ft) | Elevation (ft) | Elevation (ft) | Elevation (ft) | Elevation (ft) |
|---|---|---|---|---|---|
| 0.000 | 396.00 | 396.00 | 396.00 | 396.00 | 396.00 |
| 0.250 | 396.00 | 396.00 | 396.00 | 396.00 | 396.00 |
| 0.500 | 396.00 | 396.00 | 396.00 | 396.00 | 396.01 |
| 0.750 | 396.01 | 396.01 | 396.01 | 396.01 | 396.01 |
| 1.000 | 396.01 | 396.01 | 396.01 | 396.01 | 396.01 |
| 1.250 | 396.01 | 396.01 | 396.01 | 396.01 | 396.01 |
| 1.500 | 396.01 | 396.01 | 396.01 | 396.01 | 396.01 |
| 1.750 | 396.01 | 396.01 | 396.02 | 396.02 | 396.02 |
| 2.000 | 396.02 | 396.02 | 396.02 | 396.02 | 396.02 |
| 2.250 | 396.02 | 396.02 | 396.02 | 396.02 | 396.02 |
| 2.500 | 396.02 | 396.02 | 396.02 | 396.02 | 396.02 |
| 2.750 | 396.02 | 396.02 | 396.02 | 396.02 | 396.03 |
| 3.000 | 396.03 | 396.03 | 396.03 | 396.03 | 396.03 |
| 3.250 | 396.03 | 396.03 | 396.03 | 396.03 | 396.03 |
| 3.500 | 396.03 | 396.03 | 396.03 | 396.03 | 396.03 |
| 3.750 | 396.03 | 396.03 | 396.03 | 396.03 | 396.03 |
| 4.000 | 396.04 | 396.04 | 396.04 | 396.04 | 396.04 |
| 4.250 | 396.04 | 396.04 | 396.04 | 396.04 | 396.04 |
| 4.500 | 396.04 | 396.04 | 396.04 | 396.04 | 396.04 |
| 4.750 | 396.04 | 396.04 | 396.04 | 396.04 | 396.04 |
| 5.000 | 396.05 | 396.05 | 396.05 | 396.05 | 396.05 |
| 5.250 | 396.05 | 396.05 | 396.05 | 396.05 | 396.05 |
| 5.500 | 396.05 | 396.05 | 396.05 | 396.05 | 396.05 |
| 5.750 | 396.05 | 396.05 | 396.05 | 396.06 | 396.06 |
| 6.000 | 396.06 | 396.06 | 396.06 | 396.06 | 396.06 |
| 6.250 | 396.06 | 396.06 | 396.06 | 396.06 | 396.06 |
| 6.500 | 396.06 | 396.06 | 396.06 | 396.06 | 396.07 |
| 6.750 | 396.07 | 396.07 | 396.07 | 396.07 | 396.07 |
| 7.000 | 396.07 | 396.07 | 396.07 | 396.07 | 396.07 |
| 7.250 | 396.07 | 396.07 | 396.07 | 396.07 | 396.08 |
| 7.500 | 396.08 | 396.08 | 396.08 | 396.08 | 396.08 |
| 7.750 | 396.08 | 396.08 | 396.08 | 396.08 | 396.08 |
| 8.000 | 396.08 | 396.08 | 396.08 | 396.08 | 396.09 |
| 8.250 | 396.09 | 396.09 | 396.09 | 396.09 | 396.09 |
| 8.500 | 396.09 | 396.09 | 396.09 | 396.09 | 396.09 |
| 8.750 | 396.10 | 396.10 | 396.10 | 396.10 | 396.10 |
| 9.000 | 396.10 | 396.10 | 396.10 | 396.10 | 396.10 |
| 9.250 | 396.11 | 396.11 | 396.11 | 396.11 | 396.11 |
| 9.500 | 396.11 | 396.11 | 396.11 | 396.11 | 396.11 |
| 9.750 | 396.12 | 396.12 | 396.12 | 396.12 | 396.12 |
| 10.000 | 396.12 | 396.12 | 396.12 | 396.13 | 396.13 |
| 10.250 | 396.13 | 396.13 | 396.13 | 396.13 | 396.14 |
| 10.500 | 396.14 | 396.14 | 396.14 | 396.14 | 396.14 |
| 10.750 | 396.15 | 396.15 | 396.15 | 396.15 | 396.16 |
| 11.000 | 396.16 | 396.16 | 396.16 | 396.17 | 396.17 |
| 11.250 | 396.17 | 396.18 | 396.18 | 396.18 | 396.19 |

**Time vs. Elevation (ft)**

**Output Time increment = 0.050 hours**
**Time on left represents time for first value in each row.**

| Time (hours) | Elevation (ft) | Elevation (ft) | Elevation (ft) | Elevation (ft) | Elevation (ft) |
|---|---|---|---|---|---|
| 11.500 | 396.19 | 396.20 | 396.20 | 396.21 | 396.23 |
| 11.750 | 396.25 | 396.27 | 396.31 | 396.35 | 396.40 |
| 12.000 | 396.45 | 396.48 | 396.50 | 396.51 | 396.51 |
| 12.250 | 396.52 | 396.52 | 396.53 | 396.53 | 396.54 |
| 12.500 | 396.54 | 396.54 | 396.54 | 396.55 | 396.55 |
| 12.750 | 396.55 | 396.55 | 396.55 | 396.55 | 396.56 |
| 13.000 | 396.56 | 396.56 | 396.56 | 396.56 | 396.56 |
| 13.250 | 396.56 | 396.56 | 396.56 | 396.57 | 396.57 |
| 13.500 | 396.57 | 396.57 | 396.57 | 396.57 | 396.57 |
| 13.750 | 396.57 | 396.57 | 396.57 | 396.57 | 396.57 |
| 14.000 | 396.57 | 396.57 | 396.57 | 396.57 | 396.57 |
| 14.250 | 396.57 | 396.57 | 396.57 | 396.57 | 396.57 |
| 14.500 | 396.57 | 396.57 | 396.57 | 396.57 | 396.57 |
| 14.750 | 396.57 | 396.57 | 396.57 | 396.57 | 396.57 |
| 15.000 | 396.57 | 396.57 | 396.57 | 396.57 | 396.57 |
| 15.250 | 396.57 | 396.57 | 396.57 | 396.57 | 396.57 |
| 15.500 | 396.57 | 396.57 | 396.57 | 396.57 | 396.57 |
| 15.750 | 396.57 | 396.57 | 396.57 | 396.57 | 396.56 |
| 16.000 | 396.56 | 396.56 | 396.56 | 396.56 | 396.56 |
| 16.250 | 396.56 | 396.56 | 396.56 | 396.56 | 396.56 |
| 16.500 | 396.56 | 396.56 | 396.56 | 396.56 | 396.56 |
| 16.750 | 396.56 | 396.56 | 396.56 | 396.56 | 396.56 |
| 17.000 | 396.56 | 396.55 | 396.55 | 396.55 | 396.55 |
| 17.250 | 396.55 | 396.55 | 396.55 | 396.55 | 396.55 |
| 17.500 | 396.55 | 396.55 | 396.55 | 396.55 | 396.55 |
| 17.750 | 396.55 | 396.55 | 396.55 | 396.55 | 396.55 |
| 18.000 | 396.54 | 396.54 | 396.54 | 396.54 | 396.54 |
| 18.250 | 396.54 | 396.54 | 396.54 | 396.54 | 396.54 |
| 18.500 | 396.54 | 396.54 | 396.54 | 396.54 | 396.54 |
| 18.750 | 396.54 | 396.54 | 396.54 | 396.53 | 396.53 |
| 19.000 | 396.53 | 396.53 | 396.53 | 396.53 | 396.53 |
| 19.250 | 396.53 | 396.53 | 396.53 | 396.53 | 396.53 |
| 19.500 | 396.53 | 396.53 | 396.53 | 396.53 | 396.52 |
| 19.750 | 396.52 | 396.52 | 396.52 | 396.52 | 396.52 |
| 20.000 | 396.52 | 396.52 | 396.52 | 396.52 | 396.52 |
| 20.250 | 396.52 | 396.52 | 396.52 | 396.52 | 396.51 |
| 20.500 | 396.51 | 396.51 | 396.51 | 396.51 | 396.51 |
| 20.750 | 396.51 | 396.51 | 396.51 | 396.51 | 396.51 |
| 21.000 | 396.51 | 396.51 | 396.51 | 396.51 | 396.51 |
| 21.250 | 396.50 | 396.50 | 396.50 | 396.50 | 396.50 |
| 21.500 | 396.50 | 396.50 | 396.50 | 396.50 | 396.50 |
| 21.750 | 396.50 | 396.50 | 396.50 | 396.50 | 396.50 |
| 22.000 | 396.50 | 396.50 | 396.49 | 396.49 | 396.49 |
| 22.250 | 396.49 | 396.49 | 396.49 | 396.49 | 396.49 |
| 22.500 | 396.49 | 396.49 | 396.49 | 396.49 | 396.49 |
| 22.750 | 396.49 | 396.49 | 396.49 | 396.49 | 396.48 |
| 23.000 | 396.48 | 396.48 | 396.48 | 396.48 | 396.48 |

## Time vs. Elevation (ft)

### Output Time increment = 0.050 hours
### Time on left represents time for first value in each row.

| Time (hours) | Elevation (ft) | Elevation (ft) | Elevation (ft) | Elevation (ft) | Elevation (ft) |
|---|---|---|---|---|---|
| 23.250 | 396.48 | 396.48 | 396.48 | 396.48 | 396.48 |
| 23.500 | 396.48 | 396.48 | 396.48 | 396.48 | 396.48 |
| 23.750 | 396.48 | 396.47 | 396.47 | 396.47 | 396.47 |
| 24.000 | 396.47 | (N/A) | (N/A) | (N/A) | (N/A) |

**Time vs. Elevation (ft)**

**Output Time increment = 0.050 hours**
**Time on left represents time for first value in each row.**

| Time (hours) | Elevation (ft) | Elevation (ft) | Elevation (ft) | Elevation (ft) | Elevation (ft) |
|---|---|---|---|---|---|
| 0.000 | 396.00 | 396.00 | 396.00 | 396.00 | 396.00 |
| 0.250 | 396.00 | 396.00 | 396.00 | 396.00 | 396.00 |
| 0.500 | 396.00 | 396.00 | 396.00 | 396.01 | 396.01 |
| 0.750 | 396.01 | 396.01 | 396.01 | 396.01 | 396.01 |
| 1.000 | 396.01 | 396.01 | 396.01 | 396.01 | 396.01 |
| 1.250 | 396.01 | 396.01 | 396.01 | 396.01 | 396.01 |
| 1.500 | 396.01 | 396.01 | 396.01 | 396.01 | 396.02 |
| 1.750 | 396.02 | 396.02 | 396.02 | 396.02 | 396.02 |
| 2.000 | 396.02 | 396.02 | 396.02 | 396.02 | 396.02 |
| 2.250 | 396.02 | 396.02 | 396.02 | 396.02 | 396.02 |
| 2.500 | 396.02 | 396.02 | 396.02 | 396.02 | 396.03 |
| 2.750 | 396.03 | 396.03 | 396.03 | 396.03 | 396.03 |
| 3.000 | 396.03 | 396.03 | 396.03 | 396.03 | 396.03 |
| 3.250 | 396.03 | 396.03 | 396.03 | 396.03 | 396.03 |
| 3.500 | 396.03 | 396.03 | 396.03 | 396.04 | 396.04 |
| 3.750 | 396.04 | 396.04 | 396.04 | 396.04 | 396.04 |
| 4.000 | 396.04 | 396.04 | 396.04 | 396.04 | 396.04 |
| 4.250 | 396.04 | 396.04 | 396.04 | 396.04 | 396.04 |
| 4.500 | 396.04 | 396.04 | 396.05 | 396.05 | 396.05 |
| 4.750 | 396.05 | 396.05 | 396.05 | 396.05 | 396.05 |
| 5.000 | 396.05 | 396.05 | 396.05 | 396.05 | 396.05 |
| 5.250 | 396.05 | 396.05 | 396.05 | 396.05 | 396.06 |
| 5.500 | 396.06 | 396.06 | 396.06 | 396.06 | 396.06 |
| 5.750 | 396.06 | 396.06 | 396.06 | 396.06 | 396.06 |
| 6.000 | 396.06 | 396.06 | 396.06 | 396.06 | 396.07 |
| 6.250 | 396.07 | 396.07 | 396.07 | 396.07 | 396.07 |
| 6.500 | 396.07 | 396.07 | 396.07 | 396.07 | 396.07 |
| 6.750 | 396.07 | 396.07 | 396.07 | 396.08 | 396.08 |
| 7.000 | 396.08 | 396.08 | 396.08 | 396.08 | 396.08 |
| 7.250 | 396.08 | 396.08 | 396.08 | 396.08 | 396.08 |
| 7.500 | 396.08 | 396.08 | 396.09 | 396.09 | 396.09 |
| 7.750 | 396.09 | 396.09 | 396.09 | 396.09 | 396.09 |
| 8.000 | 396.09 | 396.09 | 396.09 | 396.09 | 396.09 |
| 8.250 | 396.10 | 396.10 | 396.10 | 396.10 | 396.10 |
| 8.500 | 396.10 | 396.10 | 396.10 | 396.10 | 396.10 |
| 8.750 | 396.11 | 396.11 | 396.11 | 396.11 | 396.11 |
| 9.000 | 396.11 | 396.11 | 396.11 | 396.11 | 396.12 |
| 9.250 | 396.12 | 396.12 | 396.12 | 396.12 | 396.12 |
| 9.500 | 396.12 | 396.12 | 396.12 | 396.13 | 396.13 |
| 9.750 | 396.13 | 396.13 | 396.13 | 396.13 | 396.13 |
| 10.000 | 396.14 | 396.14 | 396.14 | 396.14 | 396.14 |
| 10.250 | 396.14 | 396.14 | 396.15 | 396.15 | 396.15 |
| 10.500 | 396.15 | 396.15 | 396.16 | 396.16 | 396.16 |
| 10.750 | 396.16 | 396.16 | 396.17 | 396.17 | 396.17 |
| 11.000 | 396.17 | 396.18 | 396.18 | 396.18 | 396.19 |
| 11.250 | 396.19 | 396.19 | 396.20 | 396.20 | 396.21 |

Subsection: Time vs. Elevation
Label: East Bottom Ash Pond (IN)
Scenario: Post-Development 1000 year

Return Event: 1,000 years
Storm Event: 1000-Yr

**Time vs. Elevation (ft)**

**Output Time increment = 0.050 hours**
**Time on left represents time for first value in each row.**

| Time (hours) | Elevation (ft) | Elevation (ft) | Elevation (ft) | Elevation (ft) | Elevation (ft) |
|---|---|---|---|---|---|
| 11.500 | 396.21 | 396.22 | 396.22 | 396.24 | 396.25 |
| 11.750 | 396.27 | 396.30 | 396.34 | 396.39 | 396.44 |
| 12.000 | 396.49 | 396.53 | 396.55 | 396.56 | 396.57 |
| 12.250 | 396.57 | 396.58 | 396.58 | 396.59 | 396.59 |
| 12.500 | 396.59 | 396.60 | 396.60 | 396.60 | 396.60 |
| 12.750 | 396.61 | 396.61 | 396.61 | 396.61 | 396.61 |
| 13.000 | 396.61 | 396.62 | 396.62 | 396.62 | 396.62 |
| 13.250 | 396.62 | 396.62 | 396.62 | 396.62 | 396.62 |
| 13.500 | 396.62 | 396.62 | 396.62 | 396.63 | 396.63 |
| 13.750 | 396.63 | 396.63 | 396.63 | 396.63 | 396.63 |
| 14.000 | 396.63 | 396.63 | 396.63 | 396.63 | 396.63 |
| 14.250 | 396.63 | 396.63 | 396.63 | 396.63 | 396.63 |
| 14.500 | 396.63 | 396.63 | 396.63 | 396.63 | 396.63 |
| 14.750 | 396.63 | 396.63 | 396.63 | 396.63 | 396.63 |
| 15.000 | 396.63 | 396.62 | 396.62 | 396.62 | 396.62 |
| 15.250 | 396.62 | 396.62 | 396.62 | 396.62 | 396.62 |
| 15.500 | 396.62 | 396.62 | 396.62 | 396.62 | 396.62 |
| 15.750 | 396.62 | 396.62 | 396.62 | 396.62 | 396.62 |
| 16.000 | 396.62 | 396.62 | 396.62 | 396.62 | 396.62 |
| 16.250 | 396.61 | 396.61 | 396.61 | 396.61 | 396.61 |
| 16.500 | 396.61 | 396.61 | 396.61 | 396.61 | 396.61 |
| 16.750 | 396.61 | 396.61 | 396.61 | 396.61 | 396.61 |
| 17.000 | 396.61 | 396.61 | 396.60 | 396.60 | 396.60 |
| 17.250 | 396.60 | 396.60 | 396.60 | 396.60 | 396.60 |
| 17.500 | 396.60 | 396.60 | 396.60 | 396.60 | 396.60 |
| 17.750 | 396.60 | 396.60 | 396.60 | 396.59 | 396.59 |
| 18.000 | 396.59 | 396.59 | 396.59 | 396.59 | 396.59 |
| 18.250 | 396.59 | 396.59 | 396.59 | 396.59 | 396.59 |
| 18.500 | 396.59 | 396.59 | 396.58 | 396.58 | 396.58 |
| 18.750 | 396.58 | 396.58 | 396.58 | 396.58 | 396.58 |
| 19.000 | 396.58 | 396.58 | 396.58 | 396.58 | 396.58 |
| 19.250 | 396.58 | 396.57 | 396.57 | 396.57 | 396.57 |
| 19.500 | 396.57 | 396.57 | 396.57 | 396.57 | 396.57 |
| 19.750 | 396.57 | 396.57 | 396.57 | 396.57 | 396.57 |
| 20.000 | 396.56 | 396.56 | 396.56 | 396.56 | 396.56 |
| 20.250 | 396.56 | 396.56 | 396.56 | 396.56 | 396.56 |
| 20.500 | 396.56 | 396.56 | 396.56 | 396.55 | 396.55 |
| 20.750 | 396.55 | 396.55 | 396.55 | 396.55 | 396.55 |
| 21.000 | 396.55 | 396.55 | 396.55 | 396.55 | 396.55 |
| 21.250 | 396.55 | 396.54 | 396.54 | 396.54 | 396.54 |
| 21.500 | 396.54 | 396.54 | 396.54 | 396.54 | 396.54 |
| 21.750 | 396.54 | 396.54 | 396.54 | 396.54 | 396.54 |
| 22.000 | 396.53 | 396.53 | 396.53 | 396.53 | 396.53 |
| 22.250 | 396.53 | 396.53 | 396.53 | 396.53 | 396.53 |
| 22.500 | 396.53 | 396.53 | 396.53 | 396.53 | 396.53 |
| 22.750 | 396.52 | 396.52 | 396.52 | 396.52 | 396.52 |
| 23.000 | 396.52 | 396.52 | 396.52 | 396.52 | 396.52 |

## Time vs. Elevation (ft)

### Output Time increment = 0.050 hours
### Time on left represents time for first value in each row.

| Time (hours) | Elevation (ft) | Elevation (ft) | Elevation (ft) | Elevation (ft) | Elevation (ft) |
|---|---|---|---|---|---|
| 23.250 | 396.52 | 396.52 | 396.52 | 396.52 | 396.52 |
| 23.500 | 396.51 | 396.51 | 396.51 | 396.51 | 396.51 |
| 23.750 | 396.51 | 396.51 | 396.51 | 396.51 | 396.51 |
| 24.000 | 396.51 | (N/A) | (N/A) | (N/A) | (N/A) |

Subsection: Elevation-Area Volume Curve
Label: East Bottom Ash Pond
Scenario: Post-Development 1000 year

Return Event: 1,000 years
Storm Event: 1000-Yr

| Elevation (ft) | Planimeter ($ft^2$) | Area (acres) | A1+A2+sqr (A1*A2) (acres) | Volume (ac-ft) | Volume (Total) (ac-ft) |
|---|---|---|---|---|---|
| 378.50 | 0.0 | 0.336 | 0.000 | 0.000 | 0.000 |
| 379.00 | 0.0 | 3.227 | 4.604 | 0.767 | 0.767 |
| 380.00 | 0.0 | 9.821 | 18.678 | 6.226 | 6.993 |
| 381.00 | 0.0 | 17.351 | 40.226 | 13.409 | 20.402 |
| 382.00 | 0.0 | 20.111 | 56.142 | 18.714 | 39.116 |
| 383.00 | 0.0 | 20.303 | 60.621 | 20.207 | 59.323 |
| 384.00 | 0.0 | 20.497 | 61.200 | 20.400 | 79.723 |
| 385.00 | 0.0 | 20.690 | 61.780 | 20.593 | 100.316 |
| 390.00 | 0.0 | 21.671 | 63.536 | 105.893 | 206.209 |
| 392.00 | 0.0 | 22.069 | 65.609 | 43.739 | 249.949 |
| 394.00 | 0.0 | 22.469 | 66.806 | 44.537 | 294.486 |
| 395.00 | 0.0 | 22.786 | 67.882 | 22.627 | 317.113 |
| 396.00 | 0.0 | 22.960 | 68.619 | 22.873 | 339.986 |
| 397.00 | 0.0 | 23.134 | 69.141 | 23.047 | 363.033 |
| 398.00 | 0.0 | 23.308 | 69.663 | 23.221 | 386.254 |
| 399.00 | 0.0 | 23.483 | 70.186 | 23.395 | 409.650 |

Subsection: Elevation-Area Volume Curve
Label: Forebay
Scenario: Post-Development 1000 year

Return Event: 1,000 years
Storm Event: 1000-Yr

| Elevation (ft) | Planimeter (ft²) | Area (acres) | A1+A2+sqr (A1*A2) (acres) | Volume (ac-ft) | Volume (Total) (ac-ft) |
|---|---|---|---|---|---|
| 378.50 | 0.0 | 0.000 | 0.000 | 0.000 | 0.000 |
| 379.00 | 0.0 | 0.631 | 0.631 | 0.105 | 0.105 |
| 380.00 | 0.0 | 1.933 | 3.668 | 1.223 | 1.328 |
| 381.00 | 0.0 | 3.254 | 7.695 | 2.565 | 3.893 |
| 382.00 | 0.0 | 4.193 | 11.141 | 3.714 | 7.607 |
| 383.00 | 0.0 | 4.275 | 12.702 | 4.234 | 11.840 |
| 384.00 | 0.0 | 4.357 | 12.948 | 4.316 | 16.156 |
| 385.00 | 0.0 | 4.441 | 13.197 | 4.399 | 20.555 |
| 390.00 | 0.0 | 4.868 | 13.959 | 23.264 | 43.820 |
| 392.00 | 0.0 | 5.044 | 14.867 | 9.911 | 53.731 |
| 394.00 | 0.0 | 5.223 | 15.400 | 10.266 | 63.998 |
| 395.00 | 0.0 | 5.427 | 15.974 | 5.325 | 69.322 |
| 396.00 | 0.0 | 5.491 | 16.377 | 5.459 | 74.781 |
| 397.00 | 0.0 | 5.555 | 16.569 | 5.523 | 80.304 |
| 398.00 | 0.0 | 5.619 | 16.761 | 5.587 | 85.891 |
| 399.00 | 0.0 | 5.684 | 16.954 | 5.651 | 91.543 |

| Requested Pond Water Surface Elevations | |
|---|---|
| Minimum (Headwater) | 378.50 ft |
| Increment (Headwater) | 0.50 ft |
| Maximum (Headwater) | 399.00 ft |

## Outlet Connectivity

| Structure Type | Outlet ID | Direction | Outfall | E1 (ft) | E2 (ft) |
|---|---|---|---|---|---|
| Rectangular Weir | Weir - 1 | Forward | TW | 394.00 | 399.00 |
| Tailwater Settings | Tailwater | | | (N/A) | (N/A) |

Structure ID: Weir - 1
Structure Type: Rectangular Weir

| | |
|---|---|
| Number of Openings | 1 |
| Elevation | 394.00 ft |
| Weir Length | 510.00 ft |
| Weir Coefficient | 3.00 (ft^0.5)/s |

| Requested Pond Water Surface Elevations | |
|---|---|
| Minimum (Headwater) | 378.50 ft |
| Increment (Headwater) | 0.50 ft |
| Maximum (Headwater) | 399.00 ft |

## Outlet Connectivity

| Structure Type | Outlet ID | Direction | Outfall | E1 (ft) | E2 (ft) |
|---|---|---|---|---|---|
| Rectangular Weir | Weir - 2A | Forward | Culvert - 1 | 396.00 | 399.00 |
| Inlet Box | Riser - 1 | Forward | Culvert - 1 | 397.00 | 399.00 |
| Rectangular Weir | Weir - 2B | Forward | Culvert - 1 | 396.00 | 399.00 |
| Culvert-Circular | Culvert - 1 | Forward | TW | 385.90 | 399.00 |
| Tailwater Settings | Tailwater | | | (N/A) | (N/A) |

| Structure ID: Culvert - 1<br>Structure Type: Culvert-Circular | |
|---|---|
| Number of Barrels | 1 |
| Diameter | 48.0 in |
| Length | 85.00 ft |
| Length (Computed Barrel) | 85.00 ft |
| Slope (Computed) | 0.005 ft/ft |

| Outlet Control Data | |
|---|---|
| Manning's n | 0.013 |
| Ke | 0.200 |
| Kb | 0.005 |
| Kr | 0.000 |
| Convergence Tolerance | 0.00 ft |

| Inlet Control Data | |
|---|---|
| Equation Form | Form 1 |
| K | 0.0045 |
| M | 2.0000 |
| C | 0.0317 |
| Y | 0.6900 |
| T1 ratio (HW/D) | 1.093 |
| T2 ratio (HW/D) | 1.195 |
| Slope Correction Factor | -0.500 |

Use unsubmerged inlet control 0 equation below T1 elevation.
Use submerged inlet control 0 equation above T2 elevation

In transition zone between unsubmerged and submerged inlet control,
interpolate between flows at T1 & T2...

| | | | |
|---|---|---|---|
| T1 Elevation | 390.27 ft | T1 Flow | 87.96 ft³/s |
| T2 Elevation | 390.68 ft | T2 Flow | 100.53 ft³/s |

Structure ID: Riser - 1
Structure Type: Inlet Box

| | |
|---|---|
| Number of Openings | 1 |
| Elevation | 397.00 ft |
| Orifice Area | 16.0 ft² |
| Orifice Coefficient | 0.600 |
| Weir Length | 16.00 ft |
| Weir Coefficient | 3.00 (ft^0.5)/s |
| K Reverse | 1.000 |
| Manning's n | 0.000 |
| Kev, Charged Riser | 0.000 |
| Weir Submergence | False |
| Orifice H to crest | False |

Structure ID: Weir - 2A
Structure Type: Rectangular Weir

| | |
|---|---|
| Number of Openings | 1 |
| Elevation | 396.00 ft |
| Weir Length | 2.90 ft |
| Weir Coefficient | 3.00 (ft^0.5)/s |

Structure ID: Weir - 2B
Structure Type: Rectangular Weir

| | |
|---|---|
| Number of Openings | 1 |
| Elevation | 396.00 ft |
| Weir Length | 2.90 ft |
| Weir Coefficient | 3.00 (ft^0.5)/s |

## ATTACHMENT E

## CONSTRUCTION SPECIFICATIONS FOR EAST BOTTOM ASH POND RETROFIT

AMERICAN ELECTRIC POWER

**SPECIFICATION COVER SHEET**

**Specification Number: CE-026LL**
**Revision: 0**
**Date: January 2016**

TITLE: SPECIFICATION FOR LINEAR LOW DENSITY POLYETHYLENE GEOMEMBRANE (LLDPE)

**SPECIFICATION FOR LIINEAR LOW DENSITY POLYETHYLENE GEOMEMBRANE (LLDPE)**

**CE-026LL**

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**SPECIFICATION FOR LIINEAR LOW DENSITY POLYETHYLENE GEOMEMBRANE (LLDPE)**

**CE-026LL**

## 1.0 GENERAL

### 1.1 Purpose

The purpose of this specification is to define the technical requirements for furnishing and installation of PVC geomembrane.

### 1.2 Scope of Work

Unless otherwise specified, the Contractor shall furnish all labor, materials, tools, supervision, and installation equipment necessary to complete installation of LLDPE, including all necessary and incidental items, in accordance with the CQA plan, as shown in the drawings and as specified herein.

The contractor shall install LLDPE in conjunction with the earthwork and other components of the liner system.

The work addressed in this section shall include, but not be limited to placement of the LLDPE geomembrane in a single or composite liner system and all other areas identified on the drawings.

## 2.0 CODES AND STANDARDS

The work covered by this document shall conform to all applicable requirements of the listed codes and standards, unless otherwise indicated in the contract documents or on the design drawings.

### 2.1 ASTM Standards

The latest revision of the following standards of the American Society of Testing and Materials (ASTM) are hereby made a part of these specifications.

D 792 Specific Gravity (Relative Density) and Density of Plastics by Displacement

D 1004 Test Method for Initial Tear Resistance of Plastics Film and Sheeting

D 1238 Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer

D 1505 Test Method for Density of Plastics by the Density-Gradient Technique

D 1603 Test Method for Carbon Black in Olefin Plastics

D 3895 Test Method for Oxidative Induction Time of Polyolefins by Thermal Analysis

D 4218 Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique

D 4833 Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products

D 5199 Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes

D 5323 Practice for Determination of 2% Secant Modulus for Polyethylene Geomembranes

D 5596 Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics

D 5617 Test Method for Multi-Axial Tension Test for Geosynthetics

D 5721 Practice for Air-Oven Aging of Polyolefin Geomembranes

D 5885 Test method for Oxidative Induction Time of Polyolefin Geosynthetics by High Pressure Differential Scanning Calorimetry

D 5994 Test Method for Measuring the Core Thickness of Textured Geomembranes

D 6370 Standard Test Method for Rubber-Compositional Analysis by Thermogravimetry (TGA)

D6392 Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods

D 6693 Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes

D 7238 Test Method for Effect of Exposure of Unreinforced Polyolefin Geomembrane Using Fluorescent Condensation Device

D7747 Standard Test Method for Determining Integrity of Seams Produced Using Thermo-Fusion Methods for Reinforced Geomembranes by the Strip Tensile Method

2.2 GRI Standards

The latest revision of the following standards of the Geosynthetic Institute (GRI) are hereby made a part of these specifications.

- GRI GM17 Test Properties, Testing Frequency and Recommended Warranted for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes
- GRI GM19 Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes

## 3.0 RELATED SPECIFICATIONS (NOT USED)

## 4.0 SUBMITTALS

4.1 Shop Drawings:

Submit shop drawings identified herein for approval a minimum of 30 days prior to shipping.

4.1.1 Shop drawings shall be submitted in accordance shall include:

a. Drawings showing proposed panel layouts of liner, anchor trench and other tie-in details, and pipe penetration details. Panel layout diagrams shall indicate the location of pre-assembled panels and identify each sheet and panel by number.

b. A detailed description of roll deployment procedures including equipment to be utilized, methods to ensure protection of underlying subgrade and/or underlying synthetics, deployment timing relative to other geosynthetic layers, etc.

c. Complete description of field seaming procedures.

d. Work plan for geomembrane installation including manpower and equipment requirements.

e. Detailed description of field testing methods to be performed.

f. Manufacturer's and installer's Quality Assurance Plan for material manufacturing and installation (including cold weather installation).

4.1.2 Certificate of Compliance:

a. A certificate certifying that all geomembrane materials furnished for this project (reference project title and number) comply with all requirements specified in the Contract Documents.

b. No geomembrane material shall be shipped until the certificate is submitted to the Project Engineer.

4.1.3 Test Reports: Provide three copies of all factory and field quality control test reports.

a. A copy of the product specification sheet listing all test methods and property values as identified in the CQA Plan.

a. Copies of quality control certificates issued by the raw material supplier and a Mill Certificate stating that the material meets the physical and manufacturing requirements stated in the CQA Plan.

4.1.4 Construction Quality Assurance Plan:

a. Contractor shall submit a Construction Quality Control Plan governing the laboratory and field testing of the geomembrane.

b. The Construction Quality Control Plan may supersede portions of these specifications, where the requirements of the Quality Assurance Plan are more stringent and approved by the Owner.

## 5.0 TECHNICAL REQUIREMENTS

### 5.1 Material Requirements

#### 5.1.1 LLDPE

a. All material for the construction of the membrane liner must be obtained from a single material supplier and shall be manufactured by a single manufacturer.

b. The geomembrane manufacturer shall be a specialist in the manufacturing of polyethylene liners and geomembranes. The manufacturer shall have manufactured at least 10 million square feet of polyethylene liner during the last 5 years.

c. The LLDPE flexible membrane geomembrane shall be manufactured from pure, linear low density polyethylene resin. The pure resin shall be mixed with the specified amount of carbon black. The carbon black is to be pre-blended according to specifications of the manufacturer.

d. The resin used for extrusion bonded seams shall be identical in all respects to the LLDPE resin used to manufacture the liner sheets.

e. The LLDPE geomembrane materials shall be formulated from the appropriate polymers and compounding ingredients to form a sheet material that meets all requirements for use as a geomembrane for a municipal waste landfill. The sheet material shall be geomembrane capable of being bonded to itself by thermal bonding in accordance with the sheet manufacturer's recommendations and instructions.

f. Any geomembrane sheet that has repair patches upon delivery to the site shall not be accepted.

g. Each roll shall be identified by a roll and lot number and date of manufacture.

h. The complete sheet, upon thorough quality control testing specified herein, must demonstrate the properties listed in the most current revision of GRI-GM17 unless approved by the Project Engineer.

i. Textured sheets shall have uniform texturing with no visible variation in the height and frequency of texturing across the width of the sheet. Smooth edges to allow for easier fusion welding will be allowed.

j. Geomembrane Installer's Qualifications and Experience:

Geomembrane installer shall be a specialist in the installation of polyethylene liners and geomembranes and shall have at least 5 years of experience in the installation of polyethylene liners and geomembranes. Geomembrane installer shall have installed at least 10 million square feet of polyethylene liner during the last 5 years.

5.1.2 Liner Penetration Materials

a. Extrusion Joining Resin: Resin used for extrusion joining sheets and sheet to pipes shall be produced from the same resin as the sheet resin. Physical properties shall be the same as those of the resin used in the manufacture of the geomembrane. The resin shall be supplied in black.

b. Sponge Rubber Sheeting: Sponge rubber sheeting shall be type SCE-41, Neoprene/EPT/SBR, Closed Cell Medium, 1/4-inch thick, one side adhesive.

c. Neoprene Adhesive: Neoprene adhesive such as PYTHON shall be used for gluing sponge rubber sheeting to LLDPE surfaces.

d. Metal Clamping Bands: Shall be Type 304 stainless steel. Width of bands shall be 2 inches minimum, thickness shall be 1/8 inch minimum.

5.1.3 Repair of Damaged LLDPE Geomembrane

Any geomembrane surface showing injury due to scuffing, penetration by foreign objects, factory defects, damage from rough subgrade, fisheyes, or distress shall, as directed by the Owner's Engineer or QA/QC Inspector, be replaced or covered and sealed with an additional layer of geomembrane material. Sealing shall be with extrusion welding. The patch must extend a minimum of 6 in. in each direction. The edge of the patch should be rounded with no corners. The cause of damage to the geomembrane shall be determined and corrected. Any wrinkles shall be smoothed out. Necessary repairs caused by negligence of the Contractor or geomembrane Installer shall be at the Contractor's expense. No soil materials shall be placed over the geomembrane until acceptance by the Owner's Engineer. The Owner's Engineer reserves the right to accept portions of the project prior to completion of the entire project.

## 6.0 EXECUTION REQUIREMENTS

### 6.1 Product Delivery, Storage, and Handling

Delivery, including unloading, storage, and handling, shall be performed in accordance with the manufacturer's recommendations and shall be done in such a manner as to prevent damage to the geomembrane material. If the Owner's Engineer determines that the geomembrane has been damaged during transit or by handling the Contractor shall replace the material at no additional cost to the Owner.

Contractor shall provide all labor and equipment required to assist the Owner's Engineer in inspection of materials upon delivery to the site.

### 6.2 Installation

#### 6.2.1 Preparation of Closure Geomembrane Installation

a. Prepare subgrade material to receive the geomembrane in accordance with geomembrane manufacturer's recommendations and the Drawings.

b. Subgrade shall be field surveyed and inspected and approved by the Owner's Engineer and geomembrane installer prior to placement of the geomembrane liner.

6.2.2 Placement of Geomembrane Sheets

a. The layout of geomembrane sheets shall minimize the length of field seaming required and locate seams where applied stresses will be minimal. Sheet layout shall take into consideration any expansion and contraction anticipated due to ambient temperature variations.

b. Placement of geomembrane sheets shall be in accordance with the approved panel layout diagram. Any variation shall be approved by the Owner's Engineer and noted on the "As-built" layout diagram. The Contractor shall avoid the use of horizontal seams. In the event that horizontal seams are necessary and approved by the Owner's Engineer, no two adjacent panels shall be placed such that their horizontal seams are continuous. All panels that require horizontal seams must be staggered a minimum distance of 10 feet above or below the location of the horizontal seam of the adjacent panel. The Contractor shall maintain an as-built of all deployed geomembranes, seams, patches, testing locations, etc.

c. Placement of geomembrane sheets shall result in a good fit in all corners and grade changes, without bridging. Excessive slack shall be avoided to minimize rippling of the geomembrane during placement of the overlying geocomposite drainage net and final cover soils.

d. All geomembrane rolls shall be deployed by unrolling rather than dragging. Geomembrane may not be deployed by dragging the sheet across the subgrade or underlying geosynthetics. Material can be deployed with the aid of ultra low ground pressure equipment approved by the manufacturer of any underlying geosynthetic material. Any damage caused to the subgrade caused by Contractor's deployment method shall be repaired or replaced at the Contractor's expense. Conditions which interfere with geomembrane placement include, but are not limited to, wind, precipitation, temperature, high humidity and blowing dust or snow. The Contractor shall be responsible for monitoring working conditions and suspend geomembrane installation as conditions warrant.

e. The amount of material unrolled and placed daily, shall be limited to the amount of material that can be properly seamed during a one day operation. Tack or spot welding does not constitute a completed seam as described in Paragraph 6.3 of this Section.

f. The Contractor shall anchor all geomembrane materials adequately to prevent uplift or movement by wind. Anchoring shall consist of the placement of sandbags on the liner. Liner sections uplifted or moved by the wind shall be rejected at the discretion of the Owner's Engineer.

6.2.3 Field Seaming

a. The general seaming techniques typically used to bond the sheets of LLDPE shall be hot wedge fusion. Other field seams shall be constructed, as necessary, by extrusion bonded type produced by extruding molten parent material between or over the edge of two overlapped geomembrane sheets to create a homogeneous joint. All field seam strengths shall meet the requirements in the most current version of GRI GM-19 for peel and shear.

b. All geomembrane sheet surfaces to be seamed shall be free of dust, dirt and moisture. Water shall be prevented from ponding on the geomembrane.

c. All geomembrane sheet surfaces to be extrusion welded shall be roughened with a sander or other suitable means prior to seaming to remove surface oxidation. Minimum overlap of geomembrane sheets shall be 4 in.

d. The seaming process shall include softening of the geomembrane material using heated air immediately before extruding the molten parent material between or over the edge of the two overlapped geomembrane sheets. The seaming equipment used shall be capable of adjusting the temperature of the heated air and temperature of the molten extradite to optimum levels. The Contractor shall maintain an as-built of all deployed geomembranes, seams, patches, testing locations, etc. In addition, the Contractor shall maintain a written record of all seam details, including seam testing, repairs, patches, seam lengths, etc.

e. Geomembrane sheet edges to be seamed shall lay flat against each other during seaming until the seam has reached specified strength.

f. The Contractor shall place the geocomposite drainage layer and cap cover soil layer over the geomembrane only after field seams have been tested in accordance with these specifications and accepted by the Owner's Engineer. Any geocomposite drainage layer and/or cap cover soil layer that are placed over the geomembrane prior to acceptance by the Owner's Engineer shall be at the Contractor's risk.

6.2.4 Geomembrane Penetration Sealing System

a. Provide submittal for a geomembrane penetration sealing system. Include item penetrating geomembrane, flashing, apron pieces, batten strips, studs, bolts, adhesives, sealants, and other miscellaneous items as required.

b. Seal penetration through the geomembrane with flashing and apron pieces welded to a LLDPE boot attached to the item penetrating the geomembrane using an extrusion welder.

c. LLDPE pipe flashings and apron pieces for pipe penetrations shall be shop fabricated unless approved by the Owner's Engineer. Boots attached to other items penetrating the geomembrane shall be attached per LLDPE manufacturer's specifications.

d. Pipe penetration shall be constructed with geomembrane material of the same thickness as the geomembrane. Flashing and apron material shall be field welded to the geomembrane material to prevent leakage.

## 7.0 QUALITY ASSURANCE/QUALITY CONTROL

### 7.1 QA/QC Requirements

#### 7.1.1 Geomembrane Properties and Quality Control Testing

The geomembrane shall be tested according to the test methods and frequencies listed in the CQA Plan.

#### 7.1.2 Geomembrane Installer's Field Services and Reports:

a. Quality Control Laboratory Testing:
   1. Geomembrane manufacturer shall perform quality control testing per GRI-GM17 testing frequencies.
   2. The Contractor shall provide the Owner's Engineer with certified copies of the manufacturer's test results.
   3. The Owner, at their discretion, may employ and pay for an independent testing laboratory to perform additional testing of the geomembrane materials. This testing may also include all properties specified in GRI-GM17 and need not be limited to the testing performed by the manufacturer. The Contractor shall, at no additional cost, provide samples to the Owner's Engineer as required. A minimum of 10 samples shall be assumed by the Contractor.

b. The Contractor shall be solely responsible to the Owner for the quality of the material provided. Should any of the tests performed on the material yield unsatisfactory results, the Contractor will be responsible for replacing the material with satisfactory material without delaying the total project time and without any additional cost to the Owner.

c. Installer's Field QA/QC

1. Contractor to retain services of a geosynthetics QA/QC Personnel with demonstrated ability and experience in the field seaming, field testing and all other pertinent aspects of LLDPE installation to perform the services listed below:

   - Inspect the subgrade and approve suitability for the geomembrane. Prepare an inspection report indicating approval.
   - Supervise the unloading, handling, and storage of all geomembrane sheets.
   - Supervise the handling, unrolling, and placement of all geomembrane sheets.
   - Supervise all field seaming and testing of geomembrane.
   - Supervise all repairs to damaged geomembrane sections.

d. Report

1. Prepare a written report at the completion of the above mentioned work which includes not less than the following:

   - Complete identification of flexible membrane geomembrane, including but not limited to, resin type, physical properties, and other pertinent data.
   - Complete description of field seaming system used, including material roll number, equipment and seaming personnel, temperatures, seam overlap width, verification of testing, and cure or aging time. During field seaming, a daily report shall be submitted to the Owner's Engineer within one day of that portion of the installation being documented with the information noted for review. No liner shall be placed unless documents are updated to the satisfaction of the Owner's Engineer.
   - Complete description of field sampling and testing including test equipment used, location of field tests, copy of test results, conditioning procedure prior to destructive seam testing, method of recording loading and determining average load for destructive test methods and type of

failure in tests (i.e., within the seam, within the sheet material, clamp edge, seam edge).

- "As-built" drawings showing actual layout of geomembrane sheets, pipe penetration details, and anchor trench and other tie-in details.
- An affidavit of compliance from the membrane liner installer, containing the following wording:

  "I (name and title), as the duly authorized representative of (Company name), hereby certify that the installation of the LLDPE flexible membrane closure geomembrane has been completed in accordance with the terms and conditions of the Contract Documents."

7.1.3 Field Quality Control During Installation

a. The geomembrane installer will be required to conduct both destructive and non-destructive testing as part of the field quality control program.

b. Trial Welds
   1. Perform trial welds on geomembrane samples to verify welding equipment is operating properly.
   2. Make trial welds under the same surface and environmental conditions as the production welds, i.e., in contact with subgrade and similar ambient temperature.
   3. Minimum of two trial welds per day, per welding apparatus, one made prior to the start of work and one completed at mid shift.
   4. Trial welds should also be performed anytime a wedge welder is turned off for more than 5 minutes, technicians are switched, or the wedge welder undergoes repairs.
   5. Cut five, one-inch wide by six-inch long test strips from the trial weld.
   6. Trial welds should be tested using a tensiometer with a current calibration certificate.
   7. Quantitative test specimens for peel adhesion per GRI GM-19.
   8. The break, when peel testing, occurs in the liner material itself, not through peel separation (FTB).

9. The break is ductile.
10. Test results of 4 out of 5 specimens should meet or be greater than the GRI GM -19 requirements and the 5th specimen's result can be as low as 80% of the required value.
11. Repeat the trail weld, in its entirety, when any of the trial weld samples fail in peel.
12. No welding equipment or welder shall be allowed to perform production welds until equipment and welders have successfully completed trial weld.

c. Destructive Testing
   1. Location and Frequency of Testing
      a. Collect destructive test samples at a frequency of one per every 500 lineal feet of seam length. (See CQA Plan for reduction of frequency).
      b. Test locations will be determined by the Owner's Engineer after seaming.

d. Sampling Procedures are performed as follows:
   1. Installer shall cut samples at locations designated by the Owner's Engineer as the seaming progresses in order to obtain field laboratory test results before the geomembrane is covered.
   2. Owner's Engineer will number each sample, and the location will be noted on the installation as-built.
   3. Samples shall be twelve (12) inches wide by a minimal length with the seam centered lengthwise.
   4. Cut a 12-inch wide strip from the end of the sample for field-testing.
   5. Cut the remaining sample into two parts for distribution as follows:
      a. One portion for Archive, 12-inches by 12-inches. Archive is to be maintained by Owner.
      b. One portion for the Third Party testing laboratory, 12-inches by 12-inches.
      c. Additional samples may be archived.

e. Destructive testing shall be performed in accordance with ASTM D 6392.

1. Two field samples (tested at both ends) shall be tested for peel adhesion per GRI GM-19. Any specimen that fails either through the weld, or in FTB at a tensile value less than the minimum specified value, is considered a failure.
2. The Owner's Engineer shall package and ship the laboratory sample to the independent geosynthetics tasting laboratory.
3. Test methods for the field and laboratory shall be the same with the same passing criteria.
   a. Laboratory shall notify Owner's Engineer and Contractor of test results as soon as they become available.
   b. All of the samples must pass. Any failure of the specimens will constitute a failure of the seam.
   c. Installer shall repair all holes in the geomembrane resulting from destructive sampling.
   d. Repair and test the continuity of the repair in accordance with these Specifications.

f. Failed Seam Procedures
   1. If the seam fails, Installer shall follow one of two options:
      a. Reconstruct the seam between any two passed test locations.
      b. Trace the weld to intermediate location at least 10 feet minimum or where the seam ends in both directions from the location of the failed test.
         1) The next seam weld using the same welding device is required to obtain an additional sample, i.e., if one side of the seam is less than 10 feet long.

         2) If sample passes, then the seam shall be reconstructed or capped between the passing test sample locations.

         3) If any sample fails, the process shall be repeated to establish the zone in which the seam shall be reconstructed.

g. A log shall be maintained by the geomembrane installer for the purpose of recording all test results. All welds will have attained their full strength within six (6) hours after they have been completed. In addition, should the Owner's Engineer, at any time during the installation, believe the seaming process may not be performed adequately, he may, to avoid destructive sampling of the actual liner system, request additional test strips. This shall be done by the Contractor at no additional cost.

h. Nondestructive seam continuity testing

1. The Installer shall nondestructively test all welding seams over their full length using a vacuum test unit, air pressure testing, or other method approved by the Owner. The purpose of a nondestructive test is to check the continuity of the welded seams. Nondestructive testing procedures cannot be correlated to the peel strength of the welded seam. Nondestructive seam continuity testing shall be carried out as the seam welding operations progress, not at the completion of all field seam welding operations.
2. Extrusion fillet-welded seams shall be nondestructively tested with a pressurized vacuum box. For vacuum box testing, the equipment shall be comprised of the following:
    a) A vacuum box assembly consisting of a rigid housing, a clean transparent viewing window, a soft leak-proof neoprene gasket, which is not cracked or otherwise deteriorated in any way, attached to the bottom, port hole of valve assembly, and a gauge to indicate chamber vacuum. Vacuum box assemblies shall be adequately sized to properly test welded seams surrounding and adjoining designed appurtenances.
    b) A steel vacuum tank and pump assembly equipped with a pressure controller and pipe connections.
    c) A rubber pressure/vacuum hose with fittings and connections.
    d) A bucket and wide brush or spray assembly.
    e) A soapy water solution.
    f) Testing equipment which is not properly maintained will be rejected at the discretion of the Owner's Engineer. Unusable equipment shall be promptly repaired or replaced at no expense to the Owner and with no delay to the contract schedule.
3. The following procedures shall be followed when nondestructively testing fillet welded seams:

a) Energized the vacuum pump and reduce the tank pressure to a minimum 5 psi (10 inches of Hg) gauge:
b) Adequately wet a section of welded seam with the soapy water solution.
c) Place the vacuum box over the wetted area.
d) Close the bleed valve and open the vacuum valve.
e) Ensure that a leak tight seal is created.
   1) For a period of approximately 10 seconds, examine the extrusion fillet welded seam through the viewing window for the presence of soap bubbles along the edges of the welded seam or within the extrusion fillet bead.
   2) If no bubble appears after 10 seconds, close the vacuum valve and open the bleed valve, move the vacuum box over the next adjoining welded seam area with a minimum of 3 inch overlap from the previously tested area, and repeat the process.
   3) All areas where soap bubbles appear shall be adequately marked and repaired as follows:
   4) Grind down fillet weld in the failed area and apply a new fillet weld. Vacuum test the new fillet weld. If a passing test cannot be obtained remove the entire seam and place a new repair cap.
   5) Vacuum-tested, extrusion fillet-welded seam results shall be recorded on the Installer daily QC log.

4. Dual-track hot-wedge welded seams shall be nondestructively tested with an approved air-pressure device. Equipment for air-pressure testing welded seams shall be comprised of the following:
   a) An air pump (manual or motor driven) equipped with pressure gauge capable of generating and sustaining a pressure of between 20 and 30 psi. The Installer shall not use Freon gas to pressurize the welded seam.
   b) A rubber hose with appropriate fittings and connections.
   c) A sharp, hallow needle, or other approved pressure feed device.
5. The following procedures shall be followed when nondestructively testing dual-tract hot-wedge welded seams:

a) Adequately seal both ends of the welded seam to be tested with vice grip clamps or by heating and melting the air channel shut so as to prevent air from leaking for either end of the welded seam.

b) Insert needle or other approved pressure feed device into the air channel created by the dual-tract, hot-wedge at one end of the welded seam.

c) Energize the air pump to a minimum pressure of 20 psi, close valve, and sustain pressure for a minimum of five (5) minutes.

d) Once the air pressure is maintained for the 5-minute test period, the Installer shall then cut the air channel at the opposite end of the rested span from where the pressure feed device is inserted. The entire seam length shall be accepted upon the Owner's Engineer visual and audible observation of air pressure being released from the cut. The cut in the air channel shall subsequently be repaired with an extrusion bead and nondestructively tested by the Installer.

e) If loss of pressure exceeds 3 psi or pressure does not stabilize, the dual track weld shall be considered failed, and the faulty area of the welded seam shall be located as follows:

    1) The entire welded seam length shall be divided in half and both halves shall be retested, (i.e., the air channel shall be sealed, be appropriate means, at the location of half its original length, and both halves shall be tested as separate seams.) The air channel of the welded seam shall be repeatedly divided in this manner until the faulty portion of the welded seam is isolated for repair according to the above specifications or until the Owner's Engineer directs the Installer to cap strip the entire faulty length of welded seam with an extrusion- welded patch at no additional cost to the Owner. All punctures within the air channel made by either the pressure feed device, air-pressure release cut, or melting of the air channel itself, shall be properly repaired by an extrudate bead and nondestructively tested at the

expense of the Contractor. Such corrective action will not constitute grounds for a contract time extension.

i. The Contractor shall maintain an as-built of all deployed geomembranes, seams, patches, testing locations, etc.

j. A minimum of 12 inches of compacted soil material shall be kept between the geosynthetic materials and any machinery or equipment at all times except during geosynthetic deployment as noted preciously. A minimum of 30 inches of compacted soil material shall be kept between the geosynthetic materials and any tandem haul trucks at all times. All equipment operating on soil material overlying the geosynthetic materials shall be low ground pressure equipment, complying with the following:

| Maximum Equipment Ground Pressure | Thickness of Overlying Compacted Fill |
|---|---|
| <5 psi | 1.0 ft |
| <10 psi | 1.5 ft |
| >10 psi | 2.0 ft |

7.1.4 <u>Owner's Quality Assurance Program</u>

The Owner may conduct a quality assurance (QA) program and the Contractor shall make accommodations for it as requested. The QA program may include both destructive and non-destructive testing and conformance testing. Contractor is responsible assisting Owner personnel as required and for repairing geomembrane after testing procedures at the Contractor's sole expense.

## 8.0 ATTACHMENTS

8.1 Table 26LL.1 – Smooth LLDPE Properties

8.2 Table 26LL.2 – Textured LLDPE Properties

8.3 Table 26LL.3 – Seam Strength Requirements for LLDPE

## Table 26LL.1 Smooth LLDPE Properties (GRI-GM17)

| Properties | Test Method | Test Value | | | | | | | | Testing Frequency (minimum) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 20 mils | 30 mils | 40 mils | 50 mils | 60 mils | 80 mils | 100 mils | 120 mils | |
| Thickness - mils (min. ave.) | D5199 | nom. | nom. | nom. | nom. | nom. | nom. | nom. | nom. | per roll |
| □ lowest individual of 10 values | | -10% | -10% | -10% | -10% | -10% | -10% | -10% | -10% | |
| Density g/ml (max.) | D 1505/D 792 | 0.939 | 0.939 | 0.939 | 0.939 | 0.939 | 0.939 | 0.939 | 0.939 | 200,00 lb |
| Tensile Properties *(1)* (min. ave.)<br>□ break strength | D 6693<br>Type IV | 76<br>800 | 114<br>800 | 152<br>800 | 190<br>800 | 228<br>800 | 304<br>800 | 380<br>800 | 456<br>800 | 20,000 lb |
| 2% Modulus – lb/in. (max.) | D 5323 | 1200 | 1800 | 2400 | 3000 | 3600 | 4800 | 6000 | 7200 | per formulation |
| Tear Resistance - lb (min. ave.) | D 1004 | 11 | 16 | 22 | 27 | 33 | 44 | 55 | 66 | 45,000 lb |
| Puncture Resistance - lb (min. ave.) | D 4833 | 28 | 42 | 56 | 70 | 84 | 112 | 140 | 168 | 45,000 lb |
| Axi-Symmetric Break Resistance Strain - % (min.) | D 5617 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | per formulation |
| Carbon Black Content - % | D 4218 *(2)* | 2.0-3.0 | 2.0-3.0 | 2.0-3.0 | 2.0-3.0 | 2.0-3.0 | 2.0-3.0 | 2.0-3.0 | 2.0-3.0 | 45,000 lb |
| Carbon Black Dispersion | D 5596 | note *(3)* | note *(3)* | note *(3)* | note *(3)* | note *(3)* | note *(3)* | note *(3)* | note *(3)* | 45,000 lb |
| Oxidative Induction Time (OIT) *(4)*<br>(a) Standard OIT (min. ave.)<br>— or —<br>(b) High Pressure OIT (min. ave.) | D 3895<br><br>D 5885 | 100<br><br>400 | 100<br><br>400 | 100<br><br>400 | 100<br><br>400 | 100<br><br>400 | 100<br><br>400 | 100<br><br>400 | 100<br><br>400 | 200,000 lb |
| Oven Aging at 85°C *(5)*<br>(a) Standard OIT (min. ave.) - % retained after 90 days<br>— or —<br>(b) High Pressure OIT (min. ave.) - % retained after 90 | D 5721<br>D 3895<br><br>D 5885 | 35<br><br>60 | 35<br><br>60 | 35<br><br>60 | 35<br><br>60 | 35<br><br>60 | 35<br><br>60 | 35<br><br>60 | 35<br><br>60 | per formulation |
| UV Resistance *(6)*<br>(a) Standard OIT (min. ave.)<br>—<br>o | D 7238<br>D 3895<br><br>D 5885 | N. R. *(7)*<br><br>35 | N.R. *(7)*<br><br>35 | N.R. *(7)*<br><br>35 | N.R. *(7)*<br><br>35 | N.R. *(7)*<br><br>35 | N.R. *(7)*<br><br>35 | N.R. *(7)*<br><br>35 | N.R. *(7)*<br><br>35 | per formulation |

*(1)* Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
- Break elongation is calculated using a gage length of 2.0 in. at 2.0 in./min.

*(2)* Other methods such as D 1603 (tube furnace) or D 6370 (TGA) are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.

*(3)* Carbon black dispersion (only near spherical agglomerates) for 10 different views:
- 9 in Categories 1 or 2 and 1 in Category 3

*(4)* The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

*(5)* It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

*(6)* The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

*(7)* Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

*(8)* UV resistance is based on percent retained value regardless of the original HP-OIT value.

## Table 26LL.2 Textured LLDPE Properties (GRI-GM17)

| Properties | Test Method | Test Value | | | | | | | | Testing Frequency (minimum) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 20 mils | 30 mils | 40 mils | 50 mils | 60 mils | 80 mils | 100 mils | 120 mils | |
| Thickness mils (min. ave.)<br>• lowest individual for 8 out of 10 values<br>• lowest individual for any of the 10 values | D 5994 | nom. (-5%)<br>-10%<br>-15% | nom. (-5%)<br>-10%<br>-15% | nom. (-5%)<br>-10%<br>-15% | nom. (-5%)<br>-10%<br>-15% | nom. (-5%)<br>-10%<br>-15% | nom. (-5%)<br>-10%<br>-15% | nom. (-5%)<br>-10%<br>-15% | nom. (-5%)<br>-10%<br>-15% | per roll |
| Asperity Height mils (min. ave.) | D 7466 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | Every 2nd roll *(1)* |
| Density g/ml (max.) | D 1505/D 792 | 0.939 | 0.939 | 0.939 | 0.939 | 0.939 | 0.939 | 0.939 | 0.939 | 200,000 lb |
| Tensile Properties *(2)* (min. ave.)<br>• break strength – lb/in.<br>• break elongation - % | D 6693<br>Type IV | 30<br>250 | 45<br>250 | 60<br>250 | 75<br>250 | 90<br>250 | 120<br>250 | 150<br>250 | 180<br>250 | 20,000 lb |
| 2% Modulus – lb/in. (max.) | D 5323 | 1200 | 1800 | 2400 | 3000 | 3600 | 4800 | 6000 | 7200 | per formulation |
| Tear Resistance – lb (min. ave.) | D 1004 | 11 | 16 | 22 | 27 | 33 | 44 | 55 | 66 | 45,000 lb |
| Puncture Resistance – lb (min. ave.) | D 4833 | 22 | 33 | 44 | 55 | 66 | 88 | 110 | 132 | 45,000 lb |
| Axi-Symmetric Break Resistance Strain - % (min.) | D 5617 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | per formulation |
| Carbon Black Content - % | D 4218 *(3)* | 2.0-3.0 | 2.0-3.0 | 2.0-3.0 | 2.0-3.0 | 2.0-3.0 | 2.0-3.0 | 2.0-3.0 | 2.0-3.0 | 45,000 lb |
| Carbon Black Dispersion | D 5596 | note *(4)* | note *(4)* | note *(4)* | note *(4)* | note *(4)* | note *(4)* | note *(4)* | note *(4)* | 45,000 lb |
| Oxidative Induction Time (OIT) *(5)*<br>(e) Standard OIT (min. ave.)<br>— or —<br>(f) High Pressure OIT (min. ave.) | D 3895<br><br>D 5885 | 100<br><br>400 | 100<br><br>400 | 100<br><br>400 | 100<br><br>400 | 100<br><br>400 | 100<br><br>400 | 100<br><br>400 | 100<br><br>400 | 200,000 lb |
| Oven Aging at 85°C *(6)*<br>(a) Standard OIT (min. ave.) - % retained after 90 days<br>— or —<br>(b) High Pressure OIT (min. ave.) - % retained after 90 days | D 5721<br>D 3895<br><br>D 5885 | 35<br><br>60 | 35<br><br>60 | 35<br><br>60 | 35<br><br>60 | 35<br><br>60 | 35<br><br>60 | 35<br><br>60 | 35<br><br>60 | per formulation |
| UV Resistance *(7)*<br>(a) Standard OIT (min. ave.)<br>— or —<br>(b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(9)* | D 7238<br>D 3895<br><br>D 5885 | N. R. *(8)*<br><br>35 | N.R. *(8)*<br><br>35 | N.R. *(8)*<br><br>35 | N.R. *(8)*<br><br>35 | N.R. *(8)*<br><br>35 | N.R. *(8)*<br><br>35 | N.R. *(8)*<br><br>35 | N.R. *(8)*<br><br>35 | per formulation |

*(1)* Alternate the measurement side for double sided textured sheet

*(2)* Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.

- Break elongation is calculated using a gage length of 2.0 in. at 2.0 in./min.

*(3)* Other methods such as D 1603 (tube furnace) or D 6370 (TGA) are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.

*(4)* Carbon black dispersion (only near spherical agglomerates) for 10 different views:

- 9 in Categories 1 or 2 and 1 in Category 3

*(5)* The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

*(6)* It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

*(7)* The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

*(8)* Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

*(9)* UV resistance is based on percent retained value regardless of the original HP-OIT value.

Table 26LL.3 Seam Strength Requirements for LLDPE (GRI – GM19)

| Geomembrane Nominal Thickness | 20 mils | 30 mils | 40 mils | 50 mils | 60 mils | 80 mils | 100 mils | 120 mils |
|---|---|---|---|---|---|---|---|---|
| Hot Wedge Seams[1] | | | | | | | | |
| shear strength[2], lb/in. | 30 | 45 | 60 | 75 | 90 | 120 | 150 | 180 |
| shear elongation[3], % | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 |
| peel strength[2], lb/in. | 25 | 38 | 50 | 63 | 75 | 100 | 125 | 150 |
| peel separation, % | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| Extrusion Fillet Seams | | | | | | | | |
| shear strength[2], lb/in. | 30 | 45 | 60 | 75 | 90 | 120 | 150 | 180 |
| shear elongation[3], % | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 |
| peel strength[2], lb/in. | 22 | 34 | 44 | 57 | 66 | 88 | 114 | 136 |
| peel separation, % | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |

Notes for Tables 2(a) and 2(b):
1. Also for hot air and ultrasonic seaming methods
2. Values listed for shear and peel strengths are for 4 out of 5 test specimens; the 5th specimen can be as low as 80% of the listed values
3. Elongation measurements should be omitted for field testing

## SECTION 035

## GEOSYNTHETIC CLAY LINER (GCL)

**Revision 2**
**February, 2023**

**SECTION 035**

**GEOSYNTHETIC CLAY LINER (GCL)**

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## SECTION 035

## GEOSYNTHETIC CLAY LINER (GCL)

1.0 GENERAL

1.1 Scope of Work

Unless otherwise is specified, the Contractor shall furnish all labor, materials, tools, supervision, and installation equipment necessary to complete installation of Geosynthetic Clay Layer (GCL), including all necessary and incidental items, in accordance with the CQA plan, as shown in the drawings and as specified herein.

The contractor shall install GCL in conjunction with the earthwork and other components of the composite liner system.

1.2 Reference Standards

The latest revision of the following standards of the American Society of Testing and Materials (ASTM) are hereby made a part of these specifications.

ASTM D 2216, “Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass”

ASTM D 4354, “Standard Practice for Sampling of Geosynthetics for Testing”

ASTM D 4632, "Standard Test Method for Grab Breaking Load and Elongation of Geotextiles"

ASTM D 4759, “Standard Practice for Determining the Specifications Conformance of Geosynthetics”

ASTM D 5084, “Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter”

ASTM D 5261, “Standard Test Method for Measuring Mass Per Unit Area of Geotextiles”

ASTM D 5321, “Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method”

ASTM D 5887, "Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter"

ASTM D 5888, “Standard Guide for Storage and Handling of Geosynthetic Clay Liners”

ASTM D 5889, “Standard Practice for Quality Control of Geosynthetic Clay Liners”

ASTM D 5890, “Standard Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners”

ASTM D 5891, “Standard Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners”

ASTM D 5993, “Standard Test Method for Measuring the Mass per Unit Area of Geosynthetic Clay Liners”

ASTM D 6072, “Standard Guide for Obtaining Samples of Geosynthetic Clay Liners”

ASTM D 6102, “Standard Guide for Installation of Geosynthetic Clay Liners”

ASTM D 6243, “Standard Test Method for Determining the Internal and Interface Shear Resistance of Geosynthetic Clay Liner by the Direct Shear Method”

ASTM D 6495, “Standard Guide for Acceptance Testing Requirements for Geosynthetic Clay Liners”

ASTM D 6496, “Standard Test Method for Determining Average Bonding Peel Strength Between the Top and Bottom Layers of Needle-Punched Geosynthetic Clay Liners”

ASTM D 6766, “Standard Test Method for Evaluation of Hydraulic Properties of Geosynthetic Clay Liners Permeated with Potentially Incompatible Aqueous Solutions”

ASTM D 6768, “Standard Test Method for Tensile Strength of Geosynthetic Clay Liners”

## 2.0 LABELING, SHIPPING, HANDLING AND STORAGE

The GCL labeling, shipment, handling and storage shall follow the guidelines described in ASTM D 5888 standard.

2.1 Wrapping and Labeling: Each GCL roll shall be wrapped with or sleeved in an impermeable and opaque material that will protect the GCL roll, including the ends of the roll, from damage due to shipment, water, sunlight, contaminants, dust, puncture, or other damaging or deleterious conditions. The protective wrapping/ sleeve shall be maintained during periods of shipment and storage. The cardboard cores shall be sufficiently strong to resist collapse during transit and handling.

Prior to shipment, the manufacturer shall label each roll, both on the GCL roll and on the surface of the protective wrapping/ sleeve. Labels shall be resistant to fading and moisture degradation to ensure legibility at the time of the installation. At a minimum the roll labels shall identify the following:

- Manufacturer or supplier name
- Product identification
- Length and width of roll
- Total weight of roll
- Production lot number and individual roll number

Each shipping document shall include a notation certifying that the material is in accordance with the manufacturer’s certificate.

If any special handling or installation is required, it shall be so marked by the manufacturer on the geotextile component, e.g., “This Side Up” or “This Side Against Soil” preferably in both English and Spanish languages.

2.2 Shipping: Transportation of the GCL is the responsibility of the GCL supplier. The GCL supplier shall be liable for all damage to the materials incurred prior to and during transportation to the site. The contractor shall be responsible and held liable for all damages to the material once the material is on site. The GCL may be shipped by flatbed truck or by closed trailer/container.

GCL material shall be delivered to the site at least 14 days before planned date of deployment to allow for the CQA activities performed either by a third party consultant or by the contractor.

2.3 Handling and Storage: All unloading activities should take place away from main roadways and high-traffic areas at the site. The designated unloading area should be flat, dry, and stable, and should provide adequate peripheral access for the unloading equipment.

Upon delivery at the job site, the contractor shall ensure that the GCL rolls are handled and stored in accordance with the manufacturer’s instructions as to prevent any damages to the material. The contractor shall be liable for all damages to the materials incurred prior to final acceptance of the contractor’s work by the owner and /or the CQA consultant.

A dedicated area on site should be identified for the storage of GCL. This area should be level, dry, well drained, and located away from high-traffic areas of the job site.

During storage, GCL rolls shall be elevated off the ground and adequately covered to protect them from precipitation, extended ultraviolet radiation, chemicals that are strong acids or strong bases, flames including welding sparks, temperatures in excess of 160°F (71°C), and any other environmental condition that may damage the property values of the geotextile.

For reasons of safety and material integrity, GCL rolls must never be stored on end where the roll be in a vertical position. Rolls should be stored horizontally, in small stacks not to exceed three to four rolls in height. It is preferred that the bottom rolls be placed on plywood, on an arrangement of pallets, or on some other man-made surface, to promote drainage and to prevent damage by contact with the ground surface. It is good practice to cover the stored rolls with a tarpaulin or plastic sheeting for supplemental protection from the elements.

The wrapping/ sleeves of the GCL rolls should be examined for any obvious rips or tears. Damage should be repaired immediately with adhesive tape or additional plastic sheeting. At this time, it is also recommended that the labels be examined and taped to the roll if they were displaced in transit.

Bagged bentonite material (if needed) shall be stored and tarped next to GCL rolls unless other more protective measures are available. Bags shall be stored on pallets or other suitably dry surface which will prevent undue prehydration.

## 3. 0 MATERIALS

The GCLs covered in this specification consist of a layer of natural sodium bentonite clay encapsulated between two layers of geotextile. This specification covers both Reinforced and Unreinforced GCL types. The GCL product supplied to the project shall be in full compliance with the requirements of this section.

The Reinforced GCL shall be manufactured by mechanically bonding the geotextiles using a needle-punching process to enhance frictional and internal shear strength characteristics. No glues, adhesives or other means of bonding shall be used. Reinforced GCL shall not be heat burnished. Unreinforced GCL shall be used on slopes not exceeding 10H:1V.

The Owner has initiated lab testing for GCL hydraulic conductivity flow rate from three (3) different GCL manufacturers (Solmax, Agru, and Cetco) using site leachate and various GCL's. Acceptable GCL's are to result in a hydraulic conductivity no greater than $1.86 \times 10^{-9}$ cm/sec with the following test performance/termination criteria:

a. Testing lab shall be a certified laboratory.
b. ASTM D6766 Scenario 2 – Hydrated/Saturated with test liquid (worst case) should be used.
c. Conduct testing in accordance with parameters for site specific effective stress

and gradient.

d. At least two (2) pore volumes of flow is passed through the specimen.
e. Equilibrium has been achieved between the inflow and outflow, within acceptable tolerance limits, for both electrical conductivity and pH. Equilibrium for electrical conductivity is established when the ratio of outflow-to-inflow electrical conductivity (EC) is 1.0 +/- 0.1

Contractor submittals for GCL material shall include verification that all the above performance/testing criteria have been successfully achieved, in addition to verification of the material properties listed in Table 35.1. The specific GCL's undergoing testing are as follows:

1. Solmax (Bentoliner CAR NSL and Bentoliner CAR Plus NSL)
2. Agru (Geoclay NN66-7-3E)
3. Cetco (Resistex U20 DN and Resistex 100 DN)

## 4.0 SUBMITTALS

Prior to shipping to the site, the GCL Manufacturer shall submit the following to the Engineer or the Contractor:

### 4.1 Mill Certificate

a. A mill certificate or affidavit signed by a legally authorized official of the manufacturer of the GCL stating the name of the manufacturer, product name, style number, chemical composition, and other pertinent information to fully describe the GCL.

b. Quality control certificates issued for the bentonite and the geotextiles by their suppliers. The certificates shall include the dates and origin of production of the bentonite and geotextiles used to manufacture GCL rolls for the project.

c. The manufacturer's certificate shall state that the furnished GCL meets and exceeds the requirements stated in these specifications as evaluated under the manufacturer's quality control program.

### 4.2 Sample

Unless otherwise is specified, the contractor shall submit at least one sample (12" x 12") of the GCL to be used. The sample shall be labeled with the product name and be accompanied by the Manufacturer's specifications.

### 4.3 Shipping, Handling, and Storage Instructions

The Manufacturer's plan for shipping, handling, and storage shall be submitted for review.

4.4 Manufacturer Quality Control Certificates

4.4.1 The manufacturer is responsible for establishing and maintaining a quality control program to assure compliance with the requirements of the specification. Documentation describing the quality control program shall be made available upon request.

4.4.2 For the GCL rolls delivered to the site, quality control certificates, signed by the Manufacturer's quality assurance manager shall be provided for every roll of GCL. Each certification shall have the roll identification number(s), test methods, frequency, and test results.

4.4.3 At a minimum, all test results shall meet or exceed the properties identified in the GCL specifications and at testing frequency as shown in Table 35.1.

4.4.4 Either mislabeling or misrepresentation of materials shall be reason to reject the GCL products.

5. CONSTRUCTION QUALITY ASSURANCE

a. The CQA engineer or the owner representative shall examine the GCL rolls upon delivery to the site and report any deviations from project specifications to the contractor or the GCL manufacturer.

b. The owner engineer may decide to arrange for Quality Assurance of the rolls delivered to the site to be monitored and tested prior to installation either by the contractor or a third party CQA consultant. Quality Assurance will be provided as outlined in the accompanying project Construction Quality Assurance Plan (CQAP).

c. Unless otherwise is specified in the CQA Plan, GCL samples are taken at a minimum frequency of one sample per 40,000 square feet with a minimum of one per lot for Bentonite, Mass/ Unit Area and at a minimum frequency of one sample per 100,000 square feet with a minimum of one per lot for Swell Index and Fluid Loss. Other conformance testing may be required as outlined in the CQA Plan or determined by the owner and the design engineer.

d. Unless otherwise is specified in the CQA Plan, samples of GCL shall be three feet (along roll length) by roll width according. The samples shall be properly marked, wrapped and sent to an independent laboratory selected by the owner for conformance testing. The pass or fail of the conformance test results shall be determined according to ASTM Practice D 4759. In case of failing, the material shall be repaired or replaced at no cost to the owner.

e. Any GCL sample that doesn't comply with the specifications will result in rejection of the roll from which the sample was obtained. "Blocking" tests on before and after the failing roll(s) shall continue to be conducted to identify the affected rolls in the lot. The non-conforming rolls shall be excluded from the lot in consideration at no additional cost to the owner.

f. The GCL manufacturer shall be responsible for any additional sample testing may be performed to more closely identifying the non-conforming rolls and/or to qualify individual rolls.

g. The contractor and the GCL installer shall be aware of the activities outlined in the CQA Plan and shall account for these activities in the installation schedule.

## TABLE 35.1 REQUIRED MANUFACTURER TESTING FREQUENCY AND GCL PROPERTIES [1]

| PROPERTY | TEST METHOD ASTM | TESTING FREQUENCY | UNITS | GCL (Unreinforced) | GCL (Reinforced) |
|---|---|---|---|---|---|
| ***Geotextile*** Top, Mass/Area[1] (min) | D 5261 | 200,000 sf | $oz/yd^2$ | 3.0 (Nonwoven) | 6.0 (Nonwoven) |
| Bottom, Mass/Area[1] (min) | D 5261 | 200,000 sf | $oz/yd^2$ | 3.2 (Woven) | 6.0 (Nonwoven) |
| ***Bentonite Properties*** Bentonite Swell Index[2] (min) | D 5890 | 100,000 lb | ml/ 2g | 24 | 24 |
| Bentonite Moisture Content[2] (max) | D 2216 | 100,000 lb | % | 12 | 12 |
| Bentonite Fluid Loss[2] (max) | D 5891 | 100,000 lb | ml | 18 | 18 |
| Bentonite Mass/Area[3] (min) | D 5993 | 40,000 sf | $lb/ft^2$ | 0.75 | 0.75 |
| ***Finished GCL Properties*** Total Mass/Area[3] (min) | D 5993 | 40,000 sf | $lb/ft^2$ | 0.79 | 0.83 |
| GCL Moisture Content[3] (max) | D 5993 | 40,000 sf | % | 35 | 35 |
| GCL Grab Strength[4] (min) | D 6768 | 200,000 sf | lb/in | 30 | 50 |
| GCL Peel Strength (min) | D 6496 | 40,000 sf | lb/in | 1.0 | 3.5 |
| GCL Hydraulic Conductivity[5] (max) | D 5887 | 250,000 sf | cm/sec | 1.86 E-09 | 1.86 E-09 |
| GCL Hydrated Internal Shear Strength[6] | D 6243 | 1,000,000 sf | psf/psf | 150 / 200 | 500 / 200 |

[1] Geotextile property tests performed on the geotextile components before they are incorporated into the finished GCL product.
[2] Bentonite property tests performed before the bentonite is incorporated into the finished GCL product.
[3] Reported at 0 percent moisture content.
[4] All tensile strength testing is performed in the machine direction using ASTM D 6768.
[5] Index flux and hydraulic conductivity testing with deaired distilled/deionized water at 80 psi (550 kPa) cell pressure, 77 psi (530 kPa) headwater pressure and 75 psi (515 kPa) tailwater pressure.
[6] Peak values measured at 200 psf (9.6 kPa) normal stress for a specimen hydrated for 48 hours. Site-specific materials, GCL products, and test conditions must be used to verify internal and interface strength of the proposed design.

## 6.0 CONSTRUCTION

### 6.1 Preparation

a. After the underlying layer has been installed/ constructed, tested and approved by the engineer, and immediately prior to GCL deployment the surface shall be cleaned, final-graded and ensured to be free of excess dirt and debris. All voids or cracks shall be filled and then smooth-rolled to provide the best practicable surface for the GCL. At completion of this activity, no wheel ruts, footprints or other irregularities shall exist in the underlying surface. Furthermore, all protrusions extending more than one-half inch (12 mm) from the surface shall either be removed, crushed or pushed into the surface with a smooth-drum compactor.

b. On a continuing basis, the project CQA inspector shall certify acceptance of the underlying surface before GCL placement.

c. At the top of sloped areas of the job site, an anchor trench for the GCL shall be excavated or an equivalent runout shall be utilized in accordance with the project plans and specifications and as approved by the CQA consultant. When utilizing an anchor trench design, the trench shall be excavated and approved by the CQA consultant prior to GCL placement. No loose soil shall be allowed at the bottom of the trench and no sharp corners or protrusions shall exist anywhere within the trench.

### 6.2 Placement

a. Unreinforced GCL shall be placed on the pond bottom areas; reinforced GCL shall be placed on the 2:1 pond side slopes as indicated on the drawings. The Installer and Engineer shall review and agree upon which GCL shall be placed on these areas prior to installation.

b. GCL rolls should be delivered to the working area of the site in their original packaging. Immediately prior to deployment, the packaging should be carefully removed without damaging the GCL. The orientation of the GCL (i.e., which side faces up) should be in accordance with the Engineer's recommendations.

c. Equipment, which could damage the GCL, shall not be allowed to travel directly on it. If the installation equipment causes rutting of the underlying layer, the underlying layer must be restored to its originally accepted condition before placement continues.

d. Care must be taken to minimize the extent to which the GCL is dragged across the underlying surface in order to avoid damage to the bottom surface of the GCL. A temporary geosynthetic layer commonly known as a slip sheet or rub sheet may be used in between the GCL and the underlying surface to reduce friction damage during placement.

e. The GCL panels shall be placed parallel to the direction of the slope, unless otherwise is indicated on the drawings or agreed upon by the Engineer.

f. All GCL panels should lie flat on the underlying surface, with no wrinkles or fold, especially at the exposed edges of the panels.

g. Only as much GCL shall be deployed as can be covered at the end of the working day with a geomembrane, or a temporary waterproof tarpaulin. The GCL shall not be left uncovered overnight. Necessary measures shall be taken to avoid hydration of the GCL when no confining stress is present. If the GCL is hydrated when no confining stress is present, it may be necessary to remove and replace the hydrated material. The project Engineer, CQA consultant, and GCL supplier should be consulted for specific guidance if premature hydration occurs.

h. The GCL shall be sealed around penetrations and embedded structures embedded in accordance with the design drawings and the GCL Manufacturer instructions.

i. Cutting the GCL should be performed using a sharp utility knife. Frequent blade changes are recommended to avoid damage to the geotextile components of the GCL during the cutting process.

6.3 Anchorage

As directed by the project drawings and specifications, the end of the GCL roll shall be placed in an anchor trench at the top of the slope or an equivalent runout design shall be utilized. When utilizing an anchor trench design, the front edge of the trench should be rounded so as to eliminate any sharp corners. Loose soil should be removed from the floor of the trench. The GCL should cover the entire trench floor but does not extend up the rear trench wall.

6.4 Seams and Overlap

a. The GCL seams are constructed by overlapping their adjacent edges. Seams at the ends of the panels should be constructed such that they are shingled in the direction of the grade to prevent the potential for runoff flow to enter the overlap zone. Care should be taken to ensure that the overlap zone is not contaminated with loose soil or other debris.

b. The minimum dimension of the longitudinal overlap should be 6 inches (12 inches for reinforced GCL). If the GCL is manufactured with a grooved cut in the nonwoven geotextile that allows bentonite to freely extrude into the longitudinal overlap then no bentonite-enhanced seam is required for this overlap. If the GCL does not have a grooved cut in one of the nonwoven geotextiles in the longitudinal overlap, then bentonite-enhanced seams are required as described below. End-of-roll overlapped seams should be constructed with a minimum overlap of 24 inches. End-of-roll overlapped seams for all reinforced GCL seams require bentonite-enhanced seams as described below.

c. Bentonite-enhanced seams are constructed between the overlapping adjacent where the underlying edge of the longitudinal overlap is exposed and then a continuous bead of granular sodium bentonite is applied along a zone defined by the edge of the underlying panel and the 6-inch line. The granular bentonite shall be applied at a minimum application rate of one quarter pound per lineal foot. A similar bead of granular sodium bentonite is applied at the end-of-roll overlap.

d. Accessory bentonite used for sealing seams, penetrations, or repairs shall be of the same polymer-enhanced granular bentonite as used in the production of the GCL itself.

e. All overlapped seams of reinforced GCL shall be heat-tacked with a quick application of a flame torch, followed by a quick application of light pressure (foot pressure, sandbag, or other Engineer-approved means). Heat tacking shall be continuous along all seams of reinforced GCL.

6.5 Repair

If the GCL is damaged (torn, punctured, perforated, etc.) during installation, it may be possible to repair it by cutting a patch to fit over the damaged area. The patch shall be obtained from a new GCL roll and shall be cut to size such that a minimum overlap of 12 inches is achieved around all of the damaged area. Granular bentonite or bentonite mastic should be applied around the damaged area prior to placement of the patch. It may be desirable to use an adhesive to affix the patch in place so that it is not displaced during cover placement.

6.6 Cover Material Placement

a. Cover soils (if applicable) shall be free of angular stones or other foreign matter that could damage the GCL. Cover soils should be approved the project Engineer with respect to particle size, uniformity and chemical compatibility. Cover soils with high concentrations of calcium (e.g., limestone, dolomite) are not acceptable.

b. Soil cover (if applicable) shall be placed over the GCL using construction equipment that minimizes stresses on the GCL. A minimum thickness of 1-foot of cover should be maintained between the equipment tires/tracks and the GCL at all times during the covering process. This thickness recommendation does not apply to frequently trafficked areas or roadways, for which a minimum thickness of 2 feet is required.

c. Although direct vehicular contact with the GCL is to be avoided, lightweight, low ground pressure vehicles (such as 4-wheel all-terrain vehicles) may be used to facilitate the installation of any geosynthetic material placed over the GCL. The GCL supplier or CQA engineer should be contacted with specific recommendations on the appropriate procedures in this situation.

d. Soil cover should be placed in a manner that prevents the soil from entering the GCL overlap zones. Cover soil shall be pushed up slopes, not down slopes, to minimize tensile forces on the GCL.

e. When a rough surfaced material; ex. textured geomembrane is installed over the GCL, a temporary geosynthetic covering known as a slip sheet or rub sheet should be used to minimize friction during placement and the vehicle shall be driven in a manner not to damage the GCL.

END OF SECTION

# SPECIFICATION FOR NONWOVEN GEOTEXTILES

# CE - 013A

**Revision 8**
**September, 2005**

**SPECIFICATION FOR NONWOVEN GEOTEXTILES**

**CE - 013A**

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# CE - 013A

## 1.0 GENERAL

### 1.1 Scope of Work

Unless otherwise is specified, the Contractor shall furnish all labor, materials, tools, supervision, thread and installation equipment necessary to complete installation of geotextile, including all necessary and incidental items, in accordance with the CQA plan, as shown in the drawings and as specified herein.

The contractor shall install geotextile in conjunction with the earthwork and other components of the liner system.

The work addressed in this section shall include, but not limited to, placement of the geotextile separator, geotextile cushion, geotextile filter layer in a liner system (either separate or as a geocomposite component), access roads, sedimentation basins, drainage ditches, and all other areas identified on the drawings.

### 1.2 Reference Standards

The latest revision of the following standards of the American Society of Testing and Materials (ASTM) are hereby made a part of these specifications.

ASTM D 4354, Standard Practice for Sampling of Geosynthetics for Testing

ASTM D 4355 Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus)

ASTM D 4491, Standard Test Method for Water Permeability of Geotextiles by the Permitivity Method.

ASTM D 4533, Standard Test Method for Trapezoid Tearing Strength of Geotextiles.

ASTM D 4632, Standard Test Method for Breaking Load and Elongation of Geotextiles (Grab Method).

ASTM D 4751, Standard Test Method for Determining Apparent Opening Size of a Geotextile.

ASTM D 4759, Standard Practice for Determining the Specifications Conformance of Geosynthetics

ASTM D 4833, Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.

ASTM D 4873 Guide for Identification, Storage and Handling of Geotextiles

ASTM D 5199, Standard Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes.

ASTM D 5261, Standard Test Method for Measuring Mass per Unit Area of Geotextiles

## 2.0 LABELING, SHIPPING, HANDLING AND STORAGE

Geotextile labeling, storage and handling shall follow the guidelines described in ASTM D 4873 standard.

2.1 Wrapping and Labeling: Each Geotextile roll shall be wrapped with or sleeved in an impermeable and opaque material that will protect the Geotextile roll, including the ends of the roll, from damage due to shipment, water, sunlight, contaminants, dust, puncture, or other damaging or deleterious conditions. The protective wrapping/ sleeve shall be maintained during periods of shipment and storage. The cardboard cores shall be sufficiently strong to resist collapse during transit and handling.

Prior to shipment, the manufacturer shall label each roll, both on the Geotextile roll and on the surface of the protective wrapping/ sleeve. Labels shall be resistant to fading and moisture degradation to ensure legibility at the time of the installation. At a minimum the roll labels shall identify the following:

- Manufacturer or supplier name
- Product identification
- Length and width of roll
- Production lot number and individual roll number

Each shipping document shall include a notation certifying that the material is in accordance with the manufacturer's certificate.

2.1 Shipping: Transportation of the geotextile is the responsibility of the geotextile supplier. The geotextile supplier shall be liable for all damage to the materials incurred prior to and during transportation to the site. The contractor shall be responsible and held liable for all damages to the material once the material is on site.

Geotextile material shall be delivered to the site at least 14 days before planned date of deployment to allow for the CQA activities performed either by a third party consultant or by the contractor.

2.2 <u>Handling and Storage</u>: All unloading activities should take place away from main roadways and high-traffic areas at the site. The designated unloading area should be flat, dry, and stable, and should provide adequate peripheral access for the unloading equipment.

Upon delivery at the job site, the contractor shall ensure that the geotextile rolls are handled and stored in accordance with the manufacturer's instructions as to prevent any damages to the material. The contractor shall be liable for all damages to the materials incurred prior to final acceptance of the contractor's work by the owner and /or the CQA consultant.

During storage, geotextile rolls shall be elevated off the ground and adequately covered to protect them from precipitation, extended ultraviolet radiation, chemicals that are strong acids or strong bases, flames including welding sparks, temperatures in excess of 160°F (71°C), and any other environmental condition that may damage the property values of the geotextile.

For reasons of safety and material integrity, geotextile rolls must never be stored on end where the roll be in a vertical position. Rolls should be stored horizontally, in small stacks not to exceed three to four rolls in height. It is preferred that the bottom rolls be placed on plywood, on an arrangement of pallets, or on some other man-made surface, to promote drainage and to prevent damage by contact with the ground surface. It is good practice to cover the stored rolls with a tarpaulin or plastic sheeting for supplemental protection from the elements.

## 3. 0 MATERIALS

3.1 The nonwoven geotextile specified herein shall be made from needle punched or heat-bonded polypropylene or polyester staple or continuous fiber. Alternative to these materials and manufacturing processes may be approved by the owner's engineer.

3.2 The Geotextile shall be manufactured from first quality virgin polymer.

3.3 The Geotextile supplier shall submit documentation that the geotextile rolls delivered to the site shall be:

a. able to withstand direct exposure to ultraviolet radiation from sun for up to 15 days without any noticeable effect on index or performance properties.

b. inert to commonly encountered chemicals and hydrocarbons, be mildew and rot resistant, and be resistant to insects and rodents.

3.4 The geotextile shall meet or exceed all material properties listed in Table 13.1 as adopted by AASHTO M288 and GRI-GT12 guidelines <u>unless otherwise is</u>

specified by the design engineer. The weight of the geotextile shall be specified in the drawings.

## 4.0 SUBMITTALS

Prior to shipping to the site, the geotextile Manufacturer shall submit the following to the Engineer or the Contractor:

4.1 Mill Certificate

A mill certificate or affidavit signed by a legally authorized official of the Manufacturer of the Geotextile stating the name of the manufacturer, product name, style number, chemical composition of the filaments or yarns, and other pertinent information to fully describe the Geotextile. The manufacturer's certificate shall state that the furnished geotextile meets MARV requirements stated in these specifications as evaluated under the manufacturer's quality control program. If the MARV of the lot data supplied does not meet the intended MARV specification requirement, then the manufacturer will share its yearly MARV data to show conformance to the MARV specification.

4.2 Sample

Unless otherwise is specified, the contractor shall submit at least one sample (12" x 12") of the Geotextile to be used. The sample shall be labeled with the product name and be accompanied by the Manufacturer's specifications.

4.3 Shipping, Handling, and Storage Instructions

The Manufacturer's plan for shipping, handling, and storage shall be submitted for review.

4.4 Manufacturer Quality Control Certificates

The manufacturer is responsible for establishing and maintaining a quality control program to assure compliance with the requirements of the specification. Documentation describing the quality control program shall be made available upon request. For the Geotextile delivered to the site, quality control certificates, signed by the Manufacturer's quality control manager shall be provided for every roll of Geotextile. Each certification shall have the roll identification number(s), test methods, frequency, and test results. At a minimum, the test results and testing frequency shall be as shown in Table 13.1 of this section. Either mislabeling or misrepresentation of materials shall be reason to reject those geotextile products.

## 5. CONSTRUCTION QUALITY ASSURANCE

a. The CQA engineer or the owner representative shall examine the geotextile rolls upon delivery to the site and report any deviations from project specifications to the contractor or the geotextile manufacturer. The owner engineer may decide to arrange for Quality Assurance of the rolls delivered to the site to be monitored and tested prior to installation either by the contractor or a third party CQA consultant. Quality Assurance will be provided as outlined in the accompanying project Construction Quality Assurance (CQA) Plan.

b. Unless otherwise is specified in the CQA Plan or instructed by the owner or design engineer, samples are taken at a minimum frequency of one sample every 100,000 square feet with a minimum of one per lot. Samples shall be three feet (along roll length) by roll width according to ASTM Practice D 4354. The samples shall be properly marked, wrapped and sent to an independent laboratory selected by the owner for conformance testing (all listed properties except for UV Resistance). All properties indicated in Table 13.1 shall be a part of the conformance testing unless otherwise indicated.

c. The pass or fail of the conformance test results shall be determined according to ASTM Practice D 4759. The average of the test results should be reported per the assigned testing standard and then compared to the required listed MARV value. In case of a test result lying below the required listed value, the affected material shall be replaced at no cost to the owner.

d. The contractor and the geotextile installer shall be aware of the activities outlined in the CQA Plan and shall account for these activities in the installation schedule.

**TABLE 13.1 REQUIRED NON-WOVEN GEOTEXTILE TESTING FREQUNCY AND PROPERTIES (MARV)[1]**

| PROPERTY | TEST METHOD ASTM | TESTING FREQUENCY | UNITS | VALUE | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Mass Per Unit Area | D5261 | 100,000 $ft^2$ | oz/sy | 4 | 6 | 8 | 10 | 12 | 16 | 24 | 32 |
| AOS (MaxARV)[2] | D4751 | 540,000 $ft^2$ | (mm) | 0.43 | 0.22 | 0.18 | 0.15 | N/A | N/A | N/A | N/A |
| Permittivity[2] | D4491 | 540,000 $ft^2$ | $sec^{-1}$ | 0.5 | 0.4 | 0.25 | 0.1 | N/A | N/A | N/A | N/A |
| Grab Tensile Strength | D4632 | 100,000 $ft^2$ | lbs | 115 | 160 | 200 | 230 | 300 | 370 | 450 | 500 |
| Trapezoid Tear | D4533 | 100,000 $ft^2$ | lbs | 40 | 60 | 80 | 95 | 115 | 145 | 200 | 215 |
| Puncture (pin) Strength | D4833 | 100,000 $ft^2$ | lbs | 40 | 60 | 80 | 120 | 140 | 170 | 250 | 300 |
| CBR Puncture Strength | D6241 | 540,000 $ft^2$ | lbs | 230 | 320 | 440 | 700 | 800 | 900 | 1100 | 1700 |
| UV Resistance (MIN) @500 Hours | D4355 | 1/ Formulation | % | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 |

[1] Properties are based on AASHTO M288-00, GRI-GT12 and common industry standards

[2] Default values are specified for filtration properties. In addition, design engineer may require geotextile performance testing based on design criteria for drainage system especially if one or more of the following problematic soil environments are encountered: unstable or highly erodable soils such as non-cohesive silts; gap graded soils; dispersive clays; or rock flour.

N/A: Not Applicable

## 6.0 CONSTRUCTION

### 6.1 Handling and Placement

a. After the underlying layer has been installed/ constructed, tested and approved by the engineer, the surface shall be cleaned and free of excess dirt and debris.

b. The contractor and the installer shall handle the geotextile in such a manner as to ensure it is not damaged in any way. Necessary precautions shall also be taken to prevent damage to adjacent or underlying layers during placement of the geotextile.

c. The geotextile shall be installed to the lines and grades as shown on the contract drawings and as described herein.

d. The contractor shall not use heavy equipment to traffic above the geotextile without approved protection

e. The geotextile shall be rolled down the slope in such a manner as to continuously keep the geotextile in tension by self weight. To resist sliding, the geotextile shall be securely anchored in an anchor trench where applicable, or by other approved or specified methods. Anchor trench compacting equipment shall not come into direct contact with the geotextile.

f. If the project contains long, steep slopes, special care shall be taken so that only full-length rolls are used at the top of the slope.

g. In the presence of wind, all geotextiles shall be weighted by sandbags or approved equivalent. Such anchors shall be installed during placement and shall remain in place until replaced with cover material.

h. If necessary, the geotextile shall be positioned by hand after being unrolled to minimize wrinkles.

i. During placement of the geotextile, care shall be taken not to entrap soil, stones or excessive moisture that could hamper subsequent seaming of the geotextile as judged by the engineer.

j. The geotextile shall not be exposed to precipitation prior to being installed. The geotextile shall be covered as soon as possible after installation and approval. Installed geotextile shall not be left exposed for more than 15 days.

k. If there are any obstructions (such as outlet pipes or monitoring wells) while deploying the geotextile, the geotextile shall be cut to fit around the obstruction. Care shall be taken as to make sure there is no gap between the obstruction and the geotextile.

l. If white colored geotextile is used, precautions shall be taken against "snowblindness" of personnel.

6.2 Seams and Overlaps

a. The geotextile shall be seamed using heat seaming or stitching methods as recommended by the manufacturer and approved by the engineer. Sewn seams shall be made using polymeric thread with chemical resistance equal to or exceeding that of the geotextile. All sewn seams shall be continuous.

b. Seams shall be oriented down slope perpendicular to grading contours, no horizontal seams shall be allowed on slopes steeper than 10 H: 1V unless otherwise is approved by the engineer. For heat seaming, fusion welding techniques recommended by the manufacturer shall be used.

c. Geotextiles shall be overlapped a minimum of 4 inches prior to seaming or heat bonding, geotextile sewn seams to be used are Prayer, Modified Prayer, "J", or Butterfly, as shown in Figure 13.1. The seam shall be a two-thread, double-lock stitch, or a double row of single-thread, chain stitch. If heat bonding is to be used, care must be taken to avoid burn through of the geotextile.

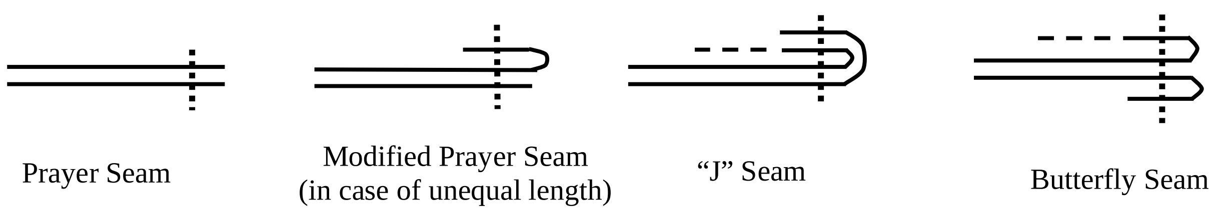


**Figure 13.1** Geotextile Sewing Seams

6.3 Repair

a. Any small holes or tears in the geotextile shall be patched with a geotextile patch that extends 8" beyond the edge of the hole/ tear. The patching geotextile shall be the same as the original one The patch shall be secured either by heat bonding or by applying an adhesive spray to one side of the geotextile patch and pressing over the repaired area.

b. Should the damaged area of the geotextile exceed 10 percent of the width of the roll, or if it's thought of as unaccepted by the engineer, the roll shall be removed and replaced with a new one.

6.4 Cover Soil Placement

a. Material overlying the geotextile shall be carefully placed to avoid wrinkling or damage to the geotextile.

b. Placement of the cover soil is recommended to proceed immediately following placement and inspection of the geotextile.

c. In applying fill material, no equipment shall drive directly across the geotextile, unless otherwise is approved by the engineer. If a vehicle has to be driven on top of the geotextile the vehicle shall be driven in a manner not to damage the geotextile. Acceleration or deceleration shall be in a smooth and gentle manner, no sudden turns or stops shall be allowed. If any tear or local damage occurs to the geotextile, patching technique as described in the above section shall be used.

d. The specified fill material shall be placed and spread utilizing vehicles with a low ground pressure (LGP). The cover soil shall be placed on the geotextile from the bottom of the slope proceeding upwards and in a manner, which prevents instability of the cover soil or damage to the geotextile. Unless otherwise specified by the engineer, all equipment for spreading fill material overlying the geotextile shall comply with the following:

| Maximum Equipment Ground Pressure (psi) | Minimum Separation Thickness (ft) |
|---|---|
| < 5 | 1.0 |
| 5 - 10 | 1.5 |
| 10 - 20 | 2.0 |
| > 20 | 3.0 |

e. Compaction of the initial lift placed over the geotextile must be performed in a manner that does not damage the geotextile.

## F. MEASUREMENT AND PAYMENT

All work required for Geotextile shall be included for payment in the contract as in Item **X.X**.

END OF SECTION

# Statement of Work - LCA21/LCA22 Pond Closure and Repurposing Construction Package

## Rockport CCR Compliance Project

Document No RKP-PR-0-100-E0-SWA-001 - Rev 0

25 July 2022

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PROFESSIONAL ENGINEER

| Rev | Description | Originator | Reviewer | Approver | Revision Date |
|---|---|---|---|---|---|
| 0 | Conformed | E. Leiby | F. Wood | E. Leiby | 25 July 2022 |
| | | | | | |
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## Figures



## Appendices

# 1. General

This statement of Work, together with the Technical Scope Documents listed in Appendix A, covers performing West Bottom Ash Pond Closure, East Bottom Ash Pond Repurposing, and West Wastewater Pond Sediment Removal Work at the AEP Rockport Plant located in Rockport, Indiana. Technical Reference Documents also are listed in Appendix A.

## 1.1 Purpose

The purpose of this project is to ensure compliance with the requirements set forth in the Coal Combustion Residual (CCR) Rule 40 CFR Part 257, Subpart D (CCR Rule). Additionally, compliance with Section 329 IAC 10-9-1(c) of the Indiana Administrative Code as it relates to IDEM will also be adhered to.

The scope of the Bottom Ash Pond Closure and Repurposing Project includes implementing a phased pond closure and repurposing plan for the East and West Bottom Ash Ponds. Initially, the East Bottom Ash Pond (EBAP) will be retrofitted with a new composite liner system within the footprint of the previously closed pond, and the East Wastewater Pond will operate as it currently exists, without any improvements, and TSS limits will be monitored over time to see how efficiently the pond is operating.

In the next phase of Work, the West Bottom Ash Pond (WBAP) will be closed by removing all CCR material. The West Wastewater Pond will be cleaned of sediments, connected to the East Wastewater Pond, and the improvements shown on the East and West Wastewater Pond drawings will be implemented. The scope also includes performing other miscellaneous related Work as outlined in this Statement of Work and the Technical Scope Documents listed in Appendix A.

## 1.2 Division of Work

AEP is responsible for the Construction Management of the WBAP closure, construction of the lined repurposed EBAP, as well as the sediment removal from the West Wastewater Pond. The following generally defines the Division of Work between AEP, the Construction Contractor, and Others.

Owner: AEP. AEP personnel will include a Construction Site Manager and Construction Site Coordinators as required. The role of the Construction Site Manager is to provide overall management and planning of the project to ensure that the project is completed according to the written closure plan, pond closure, repurposing and sediment removal design drawings, technical specifications, schedule, and construction budget. AEP Construction Site Coordinators will be responsible for the visual observation and completeness of the construction work, which includes coordination with the Plant, Construction Contractor, CQA contractor, consultants, suppliers, vendors, and site visitors.

Engineer: Worley. Worley is the Engineer contracted to AEP. Worley is responsible for providing design drawings governing the WBAP closure, repurposed lined EBAP construction activities and West Wastewater Pond sediment removal.

Construction Contractor: LCA21/LCA22 Contractor. The Construction Contractor (Contractor) is responsible for performing the Work outlined in this Statement of Work, either directly or indirectly through subcontractors, geosynthetics installers, suppliers, manufacturers, and consultants such as construction quality control testing agencies and surveying personnel. The Construction Contractor will be responsible for providing a third-party surveyor (registered in the State of Indiana) to perform field surveys prior to, during, and after CCR removal for pond closure, lined pond construction activities, and wastewater pond sediment cleanout, including as-built surveys.

CQA (Construction Quality Assurance) Contractor: GAI. The CQA contractor will observe pond closure and lined pond construction, collect samples and perform soils and geosynthetic testing specific to lined pond construction, inform AEP personnel of the ongoing progress, construction activities, survey progress, data collection, issues, inconsistencies, deviations, and testing related to the written closure plan, design drawings, construction CQA Plan, and project specifications.

# 2. Equipment and Services by the Contractor

The Contractor shall perform the following items as part of the Work, which may not be a complete listing, in accordance with Technical Scope Documents included in Appendix A:

## 2.1 Surveying

Surveying work shall include:

1. Establishing benchmarks and verifying lines and grades from the existing site monuments.
2. Performing all construction layout required for the Work.
3. Performing "True-up" surveys monthly (or more frequently when needed) to verify payment quantities.
4. Maintaining an up-to-date set of redline Drawings in the Contractor's construction office for access by the Owner, and submitting a final set of redline as-built Drawings.
5. Providing a third-party surveyor (registered in the State of Indiana) to perform field surveys prior to, during, and after CCR removal for pond closure, lined pond construction and wastewater pond sediment cleanout, including all as-built certification surveys required.
6. Finished survey to also include pond features such as pipes, structures, etc.
7. Surveying of borrow area features.

## 2.2 Erosion and Sediment Control

Erosion and sediment control work shall include the following:

1. Complying with the applicable regulations of the state of Indiana and the U.S. Environmental Protection Agency.
2. Complying with the Storm Water Pollution Prevention Plan (SWPPP).
3. Furnishing and installing erosion and sediment control measures as indicated on the Drawings, in accordance with AEP Specification CE-007, or Indiana Storm Water Quality Manual if not otherwise specified.
4. Inspecting and maintaining erosion and sediment control measures throughout the duration of the Work.
5. Maintaining soil and riprap stockpiles, borrow, staging and laydown areas used in the Work, including providing positive drainage and temporary seeding.
6. Removing temporary erosion and sediment control measures upon stabilization of the Work area and completion of all Work, when directed by the Owner.
7. Permanent seeding as indicated on the drawings, and of all areas disturbed during the Work unless otherwise surfaced with aggregate.

## 2.3 Demolition, Removals and Alterations

Demolition, removal, and alterations Work includes:

1. Following applicable regulations, including U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) 2207, Construction Industry, 29 CFR 1926, Subpart T, "Demolition."
2. Ceasing operations immediately and notifying the Owner if adjacent facilities appear to be in danger.
3. Demolishing and disposing off-site ~~onsite (in dumpster provided by Owner)~~ of any concrete, asphalt, rebar, wires, trash, or other deleterious materials encountered in the course of the Work.
4. Removing and storing onsite where directed by the Owner of any items that must be removed to perform the Work but that otherwise may be salvaged.
5. Demolishing and disposing off-site ~~onsite (in dumpsters provided by Owner)~~ the following structures and piping, at a minimum (or altering, where indicated):

    a. Demolition & Removal of Existing Wood Skimmer Surrounding Structure #5 (West Bottom Ash Pond)
    b. Demolition & Removal of Existing Wood Skimmer Surrounding Structure #4 (East Bottom Ash Pond)
    c. Demolition & Removal of Existing Low Volume Discharge Structure #3, Excluding 30" discharge pipe which remains (East Bottom Ash Pond). (Note: if a small portion of the existing 30" pipe extends into the proposed lined slope of the pond, then the pipe shall be cut back (and permanently plugged as indicated in Section 2.8) so the slope can be lined without the pipe sticking into the lined area.
    d. Demolition & Removal of a Portion of Existing 10" HDPE Pipe Pumped from West Stormwater Pond (West Bottom Ash Pond)
    e. Demolition & Removal of a Portion of Existing 12" HDPE Coal Pile Runoff Pipe (South End of Bottom Ash Ponds)
    f. Demolition & Removal of (2) Existing CMP Casing Pipes around 12" HDPE Coal Pile Runoff Pipe (South End of Bottom Ash Ponds)
    ~~f.~~g. Demolition & Removal of concrete inlet trough structures (East Bottom Ash Pond)

6. Removal and disposal of approximate 450 feet length of gabion baskets, expected to be 2 courses tall, but could be taller (West Bottom Ash Pond). The disposal of the wire baskets and the stones shall be to an offsite MSW landfill or C&D landfill, approved by the Owner.

## 2.4 Excavation and Fill

Excavation and fill Work includes:

1. Coordinating all Work through AEP plant personnel and obtaining a dig permit prior to initiating all excavations (AEP Permit – Excavation).
2. Locating existing utilities, including soft digging as required to isolate excavations, and protecting utilities from damage or rerouting utilities as necessary to perform the Work.
3. Stripping topsoil from within areas to be excavated or to receive fill, where present.
4. Excavating to the required lines and grades including segregating of suitable and unsuitable materials,

hauling, and stockpiling of materials in onsite stockpile areas as required by the Owner.

5. Designing, providing, installing, and removing any temporary excavation support (sheeting or shoring) when required to perform the Work while maintaining a safe Work environment and/or to protect adjacent structures or equipment.
6. Preparing subgrade in cut areas, or preparing subgrade and compacting fill to the required lines and grade in fill areas.
7. Moisture conditioning, plowing, disking, and turning soils during subgrade preparation, when required to meet project specifications.
8. Constructing East Bottom Ash Pond forebay dike.
9. Excavating, compacting fill, and fine grading areas as required to achieve final grades shown on Drawings.
10. Performing excavation and compacting fill as required to support sitework activities.
11. Excavating, loading, and hauling soil from borrow area to the Work areas.
12. Moisture conditioning, plowing, disking, turning, etc. as required to make fill materials suitable for use.

## 2.5 Borrow Area Development

Borrow area development Work shall include:

1. Complying with the applicable regulations of the state of Indiana and the U.S. Environmental Protection Agency.
2. Complying with the Storm Water Pollution Prevention Plan (SWPPP).
3. Furnishing, installing, inspecting, and maintaining erosion and sediment control measures as indicated on the Drawings, in accordance with AEP Specification CE-007, or Indiana Storm Water Quality Manual if not otherwise specified.
4. Stripping topsoil across the borrow area and stockpiling within the limits of disturbance.
5. Excavating, segregating, and stockpiling (when material is not directly loaded and hauled to the Work area) excavated material by type and intended use, including topsoil, pond fill materials, and unsuitable soil.
6. Loading, and hauling materials within the free haul distance, which includes from the borrow area to the ash pond complex, as required to perform fill activities associated with lined East Bottom Ash Pond construction.
7. Maintaining soil stockpiles and temporary seeding as required.
8. Preventing earth disturbance outside the limits of disturbance.
9. Maintaining access along area roads at all times.
10. Re-establishing gravel roads used during construction, at completion of the Project.
11. Performing final stabilization, where suitable, with permanent seeding for areas disturbed during the Work, unless otherwise surfaced with aggregate.

~~11.~~12. Topsoil and unsuitable material stockpiles shall be left as permanently seeded stockpiles (not respread) at conclusion of the Work.

~~12.~~13. Removing temporary erosion and sediment control measures upon stabilization of the Work area and completion of all Work.

## 2.6 West Bottom Ash Pond Closure by Removal of CCR

The scope includes closing the existing West Bottom Ash Pond by removal of CCR in accordance with 40 CFR 257.102(c). Ash pond closure by removal Work shall include:

1. Managing water, including stormwater and pond dewatering effluent as required to perform closure by removal.
2. Demolishing existing pond structure and piping as indicated in Section 2.3, and as shown on the Drawings.
3. Permanently plugging existing 30" Fiberglass discharge pipe as shown on the Drawings. Additional pond inflow/outflow pipes may exist that are not shown on the Drawings. If additional pipes are found, Contractor shall notify Owner to obtain approval before plugging/capping.
4. Developing means and methods to decant or otherwise mix/treat/process existing CCR (including any other silty sludge material) and native soil within the Work area as required to consistently pass a paint filter test (EPA Method 9095B) when it arrives at the landfill, periodically testing the waste to ensure it passes a paint filter test prior to leaving the pond area and prior to placement in the landfill, and adjusting means and methods when required to meet the test, including obtaining Owner and (when required) IDEM approval of any proposed treatment additives.
5. Adding Quicklime (@ 5%) or Owner-supplied flyash (@ 50%) admixture to the CCR, if required, and as required, to remove the CCR (including any other silty sludge material) that may prove difficult to dewater, load and haul otherwise. Contractor may find site conditions warrant varying proportions of admixture to effectively dewater and load the material, percentages provided are for planning and estimating purposes only. Any admixture proportion changes throughout the Work shall be communicated to and coordinated with the Owner.
6. Mechanically excavating, stacking, dewatering, loading, and hauling all existing CCR from within the West Bottom Ash Pond to the AEP landfill (for placement by Others).
7. Cleaning existing riprap on pond sideslopes (to take place within existing pond area), excavating, loading, and hauling clean riprap to the clean riprap storage area and stockpiling as shown on the project drawings. The riprap may not be able to be thoroughly cleaned (i.e., removal of attached CCR material particles from riprap) where it currently sits on the pond sideslopes, therefore, Contractor may have to move riprap to another working area within the pond where it can be thoroughly cleaned prior to loading and hauling. Temporary riprap stockpiling operations taking place within the WBAP shall be on flatter pond bottom areas as opposed to pond sideslopes.
8. Clean riprap will be replaced on the pond sideslopes once all CCR material has been removed and the pond has been certified as clean by the CQA Contractor. Riprap is not an approved waste for the AEP landfill, except for residual stone particles of 6" and less which is acceptable to go to the landfill.
9. Contractor shall maintain 2:1 finished pond slopes after CCR removal is complete.
10. Coordinating with CQA Contractor and ceasing pond excavation when the perceived bottom of waste has been reached based on visual observation in order to allow CQA Contractor to inspect the pond bottom, including pond sideslopes.
11. Removing additional CCR until native soil is reached in areas where inspection by the CQA Contractor reveals CCR extending to a greater depth. The Drawings include estimated lines and grades of closure by

removal for estimating and planning purposes only. Actual limit or removal will be based in part on visual observation that CCR has been removed completely. Coordinate with the Owner and CQA Contractor when it appears that existing CCR extends beyond the estimated limit or depth of closure.

12. Mechanically excavating, loading, and hauling 12" (min) of additional native soil underlying the formerly impounded CCR (or riprap) as part of the closure certification effort, upon visual verification by the CQA Contractor that all impounded CCR has been removed.
13. Mechanically excavating, loading, and hauling additional material (below the 12" of native soil underlying the waste) as part of the closure certification effort, when soil sampling indicates additional removal is required. Final limit of removal will be based on acceptable laboratory test results on soil samples obtained after the visual verification effort is complete.
14. Adding Quicklime (@ 5%) or Owner-supplied flyash (@ 50%) admixture to the underlying native soils, if required, and as required, to remove the native soil (including any other silty sludge material) that may prove difficult to dewater, load and haul otherwise. Contractor may find site conditions warrant varying proportions of admixture to effectively dewater and load the material, percentages provided are for planning and estimating purposes only. Any admixture proportion changes throughout the Work shall be communicated to and coordinated with the Owner.
15. Permanently seeding pond bottom upon final certification that all CCR material has been removed.
16. Performing as-built survey of the closed impoundment and providing CQA Contractor with this survey to be included in the final closure certification report.
17. Protecting and maintaining access to existing monitoring wells around the pond area that may be affected by the Work.

## 2.7 West Wastewater Pond Sediment Removal

West Wastewater Pond Sediment Removal Work shall include:

1. Managing water, including stormwater and pond dewatering effluent as required to remove pond sediment waste to the elevation 1-foot above original pond bottom as indicated on the Drawings.
2. Temporary plugging existing 30" Fiberglass discharge pipe and permanently plugging existing 30" Fiberglass inflow pipe, as shown on the Drawings. Additional pond inflow/outflow pipes may exist that are not shown on the Drawings. If additional pipes are found, Contractor shall notify Owner to obtain approval before plugging/capping.
3. Developing means and methods to decant or otherwise mix/treat/process existing pond sediment waste (including any other silty sludge material) within the Work area as required to consistently pass a paint filter test (EPA Method 9095B) when it arrives at the landfill, periodically testing the waste to ensure it passes a paint filter test prior to leaving the pond area and prior to placement in the landfill, and adjusting means and methods when required to meet the test, including obtaining Owner and (when required) IDEM approval of any proposed treatment additives.
4. Adding Quicklime (@ 6%) admixture to the pond sediment waste, if required, and as required, to remove pond sediment waste (including any other silty sludge material) that may prove difficult to dewater, load and haul otherwise. Contractor may find site conditions warrant varying proportions of admixture to

effectively dewater and load the material, percentages provided are for planning and estimating purposes only. Any admixture proportion changes throughout the Work shall be communicated to and coordinated with the Owner.

5. Mechanically excavating, stacking, dewatering, loading, and hauling existing sediment waste from within the West Wastewater Pond to the AEP landfill (for placement by Others).
6. Existing riprap material on West Wastewater Pond sideslopes shall Not be removed or comingled with pond sediment waste material, as riprap is not an approved waste for the AEP landfill, except for stone particles of 6" and less which is acceptable to go to the landfill.
7. Performing as-built survey of the West Wastewater Pond to verify sediments have been removed to the elevation 1-foot above original pond bottom.
8. Protecting and maintaining access to existing monitoring wells around the West Wastewater Pond that may be affected by the Work.

## 2.8 East Bottom Ash Pond Lined Retrofit Construction

East Bottom Ash Pond Lined Retrofit Construction Work shall include:

1. Managing water, including stormwater and pond dewatering effluent as required to construct lined East Bottom Ash Pond, along with associated compacted fill materials.
2. Demolishing existing pond structures and pipes as indicated in Section 2.3, and as shown on the Drawings.
3. Permanently plugging existing 30" Fiberglass discharge pipe as shown on the Drawings. Additional pond inflow/outflow pipes may exist that are not shown on the Drawings. If additional pipes are found, Contractor shall notify the Owner to obtain approval before plugging/capping.
4. Preparing/grading existing pond bottom to receive fill materials toward establishing liner system subgrade.
5. Placing and compacting fill materials (obtained from on-site borrow area) required to establish liner system subgrade, including fill for dike area.
6. Preparing liner system subgrade by removing any protrusions extending out of the top surface of the subgrade soil and fine grading and rolling completed surface to remove all ruts and abrupt grade changes as required to provide a smooth subgrade.
7. Completing and submitting subgrade surface acceptance logs for all subgrades on which the liner system is installed.
8. Furnishing and Installing non-woven geotextile as shown on the Drawings and in accordance with the Technical Specifications and CQA Plan.
9. Furnishing and Installing GCL as shown on the Drawings and in accordance with the Technical Specifications and CQA Plan, including but not limited to:
    a. Submitting certifications, tests results, panel layouts and all other items indicated in the Technical Specifications and CQA Plan.
    b. Installing GCL, including all overlaps and granular bentonite associated with overlaps, and concrete structure attachment areas.
10. Furnishing and Installing flexible membrane liner (LLDPE) as shown on the Drawings and in accordance with

the Technical Specifications and CQA Plan, including but not limited to:

a. Submitting LLDPE panel layouts, test results, and all other items indicated in the Technical Specifications and CQA Plan.
b. Installing LLDPE liner, including all liner attachments, as well as all overlaps between adjacent panels and continuous welding seams.

11. Receiving and storing geosynthetic materials in accordance with the Technical Specifications and the CQA Plan.
12. Furnishing and installing concrete erosion control revetment as shown on Drawings.
13. Constructing and backfilling liner system and concrete revetment anchor trenches as shown on the Drawings.
14. Furnishing and installing Pond Geoladders (white on black, as manufactured by Viking Containment, or approved equal) as shown on the Drawings.
15. Furnishing and installing gas riser and flap vent locations as shown on the Drawings.
16. Furnishing and installing concrete discharge structure(s) liner attachments as shown on the Drawings.
17. Rerouting of 16 pond influent pipes as indicated on Figure 1, using flanged HDPE SDR11 piping.

## 2.9 Water Management

Water Management Work shall include:

1. Coordinating with AEP Rockport plant operations to divert process water inflows away from given Bottom Ash or Wastewater Pond, prior to being worked on.
2. Dewatering standing water from within given Bottom Ash and Wastewater Pond after they have been isolated and removed from service, including providing and operating all related pumps and temporary piping. The West Bottom Ash and West Wastewater Pond will be pumped to the East Bottom Ash Pond. The water shall be pumped at a maximum rate of 2,500 gpm and measures implemented to minimize suspended solids being pumped.
3. Ongoing dewatering of CCR and sediment material as it decants during excavation operations, including providing and operating all related pumps and temporary piping to collect and convey the water to the indicated ponds as mentioned above.
4. Collecting and controlling direct rainfall and over-land stormwater surface runoff entering given Pond excavation areas and conveying such water to the indicated ponds as mentioned above.
5. Implementing suitable Best Management Practices (BMPs) such as sump areas with geotextile-wrapped stone filters, skimmers, and floating suctions, as well as discharge points using sediment filter bags (when applicable) as required to minimize suspended solids in dewatering effluent to levels that will not cause an exceedance at the permitted pond system outfall. For bid purposes, this is assumed to be a TSS of 100 mg/L, but this must be verified by type of dewatering effluent and flowrate.
6. Furnishing and installing cofferdam, as required, for installation of two 48” HDPE Spirolite pipes connecting East and West Wastewater Ponds.

## 2.10 Temporary Shoring

Temporary shoring Work includes: (If required)

1. Designing, furnishing, installing, and removing temporary shoring if required to perform the Work, or as required to protect adjacent facilities during excavations.
   a. Submitting sheet pile design calculations (sealed by Indiana PE) including required sheet piling material dimensions and properties.
   b. Maintaining all dimensional tolerances required by the design calculation and requirements for locating, leveling, plumbing, and squaring of the sheet piling, as applicable. Replacing all materials damaged during handling and erection such that the dimensional tolerances can be achieved.
   c. Performing surveying of sheet piling upon installation and as required to monitor deflection during adjacent excavation and fill activities to ensure the system is safely performing as designed.

## 2.11 Included as Part of the Work

1. Receiving, unloading, sorting, inspecting, storing, removing from storage, hauling, handling, protecting and erecting all equipment, material, and supplies required to complete the Work.
2. Providing all equipment, material, labor, and services necessary to erect, install, and remove temporary facilities required for the Work.
3. Providing certifications and test reports for all materials used in the Work.
4. Maintaining all dimensional tolerances and requirements for leveling, plumbing, and squaring of the Work. Replacing materials damaged during handling and installation such that the dimensional tolerances can be achieved.
5. Ventilating enclosed working areas, if required. Providing respiratory protection if threshold limits of gases, vapors, fumes, dusts, and/or mist are exceeded.
6. Furnishing, installing, maintaining, and removing temporary lighting for safe access to the Work.
7. Providing for safe transportation, including by foot, of Contractor's employees to and from the Work and office areas, which includes snow and ice removal and road upkeep.
8. Providing construction cleanup daily and at completion of the Work.
9. Providing barricades and control of a safe Work area.
10. Coordinating with AEP Plant in advance of any road closures to maintain plant access as required, and providing traffic control, signs, and barriers as required to maintain a safe Work area during road closure.
11. Providing cranage and hoisting required for the Work.
12. Preparing and maintaining any laydown areas.
13. Maintaining trafficability of plant roads in the Work area.
14. Furnish temporary construction power to support the Work.
15. Providing and operating a water truck and continually watering all roads used during the Work to minimize generation of fugitive dust. Dust control also includes having a vacuum sweeper available as needed to ensure that solid materials tracked onto the roads are not left on or adjacent to the roads.

## 2.12 Sitework

1. Furnishing and installing 10” HDPE Stormwater pipe to West Wastewater Pond as shown on the Drawings.
2. Furnishing and installing 12” HDPE Coal Pile Runoff pipe to East Bottom Ash Pond as shown on the Drawings.
3. Furnishing and installing (2) 48” Spirolite pipes at E/W Wastewater Ponds Splitter Dike as shown on the Drawings.
4. Performing butt-fusion welds to adjoin all new HDPE piping.
5. Performing hydrostatic testing/cleaning/flushing of all new HDPE piping.
6. Furnishing and installing Baffle Curtain in East Wastewater Pond as shown on the Drawings.
7. Installing temporary plug for 30” Fiberglass pipe discharging from East Wastewater Pond as shown on the Drawings.
8. Furnishing and installing Oil Boom Skimmers (Abasco Beta 1C, 18-inch height, or approved equal) as shown on the Drawings.
9. Installing new 48” slide gate to control flow from East Wastewater Pond concrete discharge weir as shown on the Drawings.
10. Furnishing and installing boat ramp in East Wastewater Pond as shown on the Drawings.

# 3. Options and Alternatives

## 3.1 Option 2 Liner System (East Bottom Ash Pond)

Two different liner system options are being proposed for the project. Option 1 (Base Scope) includes a GCL as indicated in Section 2.8. Option 2 (Optional Scope) includes a 2-foot clay layer in lieu of the GCL layer. Therefore, Contractor shall include optional pricing for the Option 2 liner system as shown on the Drawings. Also, note that the top 12-inches of fill material underneath the GCL in Option 1 is 12-inches of $< 1x10^{-7}$ cm/sec fill, overtop $< 1x10^{-6}$ cm/sec fill for remainder of fill; while all fill underneath the 2-foot clay layer in Option 2 is $< 1x10^{-6}$ cm/sec fill, so this shall be included in the Option 2 liner system pricing.

## 3.2 Temporary Reroute of Piping (Stormwater and Coal Pile Runoff)

The Contractor shall include pricing to reroute the existing 10" and 14" Stormwater pipes from a point at southern end of the laydown/warehouse/construction trailer area, to the East Wastewater Pond. Additionally, Contractor shall also include pricing to reroute the existing 12" coal pile runoff pipes (located at southern end of the Bottom Ash Ponds) to the East Wastewater Pond. This temporary reroute will be required if the East Bottom Ash Pond is not operational by February 28, 2023.

# 4. Equipment and Services by Others

## 4.1 Surveying Monuments

Permanent surveying monuments have been established on the site. Appendix A lists documents that provide information on these monuments.

## 4.2 Access to Work Area

AEP Plant will move miscellaneous temporary plant equipment/supplies interfering with completion of the Work. Contractor shall contact plant personnel prior to needing something moved and shall not move plant equipment themselves.

## 4.3 CQA Testing, Inspection and Certification of Pond Closure

AEP will retain the services of a 3rd party CQA Consultant for the purpose of certifying closure by removal for the West Bottom Ash Pond and performing soils and geosynthetics CQA inspection and testing services during East Bottom Ash Pond lined retrofit as outlined in the CQA Plan. Contractor shall support and assist the CQA Consultant.

## 4.4 Permits

The following permits and approvals will be provided by Others:

1. Closure plan associated with the existing West Bottom Ash Pond
2. IDEM Permit for East Bottom Ash Pond lined retrofit
3. Stormwater permitting, as applicable

Figure 1 – Rerouted Piping to EBAP Forebay

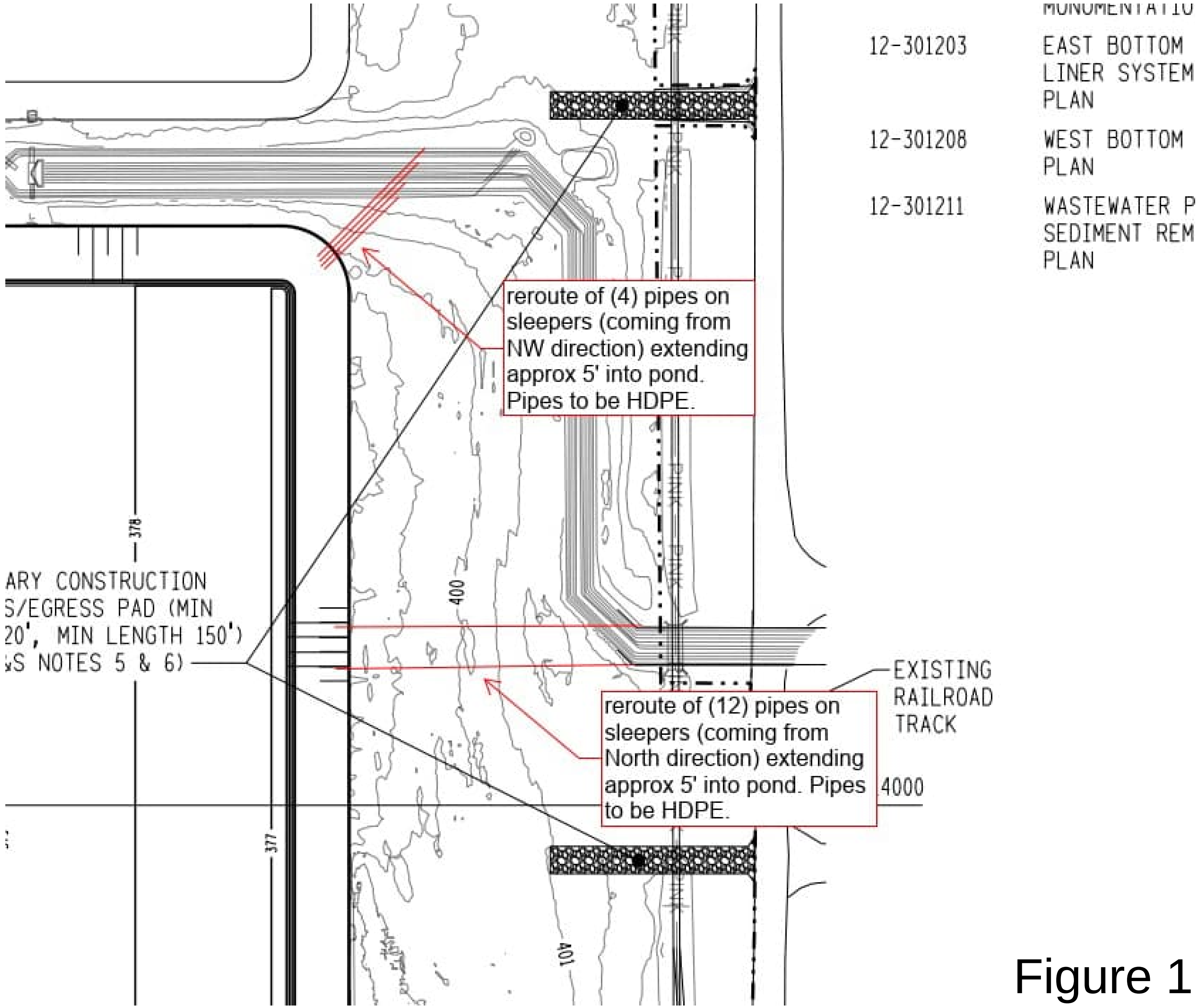
MONUMENTATIO
12-301203
EAST BOTTOM LINER SYSTEM PLAN
12-301208
WEST BOTTOM PLAN
12-301211
WASTEWATER P SEDIMENT REM PLAN
reroute of (4) pipes on sleepers (coming from NW direction) extending approx 5' into pond. Pipes to be HDPE.
reroute of (12) pipes on sleepers (coming from North direction) extending approx 5' into pond. Pipes to be HDPE.
EXISTING RAILROAD TRACK
4000
ARY CONSTRUCTION
S/EGRESS PAD (MIN
20', MIN LENGTH 150')
&S NOTES 5 & 6)
378
377
400
401
PINK

Figure 1

# Appendix A. Technical Scope and Reference Document List

# Appendix A - Contract Document List

Statement of Work - LCA21/LCA22 Pond Closure and Repurposing Construction Package
RKP-PR-0-100-E0-SWA-001

| Document No | Rev | Title | Status | Document Identifier | Discipline | Type |
|---|---|---|---|---|---|---|
| RKP-PR-0-100-E0-SWA-001 | 0 | Statement of Work - LCA21/LCA22 Pond Closure and Repurposing Construction Package | Conformed | SWA - Scope of Work | EC - Engineering & Design Civil | Scope |
| RKP-PR-0-100-E0-SDR-001 | 0 | Seller Data Requirements (SDR) List for Pond Closure and Repurposing | IFU - Issued for Use | SDR - Supplier Data Requirements List | EC - Engineering & Design Civil | Scope |
| RKP-12-301203 | 1 | EAST BOTTOM ASH POND - LINER SYSTEM - PLAN | IFC - Issued for Construction | 717 - Final Site Development Drawing | EC - Engineering & Design Civil | Scope |
| RKP-12-301204 | 0 | EAST BOTTOM ASH POND - LINER SYSTEM - SECTIONS AND DETAILS | IFC - Issued for Construction | 720 - Final Site Development Sections & Details | EC - Engineering & Design Civil | Scope |
| RKP-12-301205 | 0 | EAST BOTTOM ASH POND - LINER SYSTEM - SECTIONS AND DETAILS | IFC - Issued for Construction | 720 - Final Site Development Sections & Details | EC - Engineering & Design Civil | Scope |
| RKP-12-301206 | 0 | EAST BOTTOM ASH POND - LINER SYSTEM - SECTIONS AND DETAILS | IFC - Issued for Construction | 720 - Final Site Development Sections & Details | EC - Engineering & Design Civil | Scope |
| RKP-12-301208 | 1 | WEST BOTTOM ASH POND - CLOSURE BY REMOVAL - PLAN | IFC - Issued for Construction | 717 - Final Site Development Drawing | EC - Engineering & Design Civil | Scope |
| RKP-12-301209 | 0 | WEST BOTTOM ASH POND - CLOSURE BY REMOVAL - SECTIONS AND DETAILS | IFC - Issued for Construction | 720 - Final Site Development Sections & Details | EC - Engineering & Design Civil | Scope |
| RKP-12-301211 | 1 | WASTEWATER PONDS - SEDIMENT REMOVAL - PLAN | IFC - Issued for Construction | 717 - Final Site Development Drawing | EC - Engineering & Design Civil | Scope |
| RKP-12-301212 | 0 | WASTEWATER PONDS - SEDIMENT REMOVAL - SECTIONS AND DETAILS | IFC - Issued for Construction | 720 - Final Site Development Sections & Details | EC - Engineering & Design Civil | Scope |
| RKP-12-301213 | 1 | WASTEWATER PONDS - LINER SYSTEM - SECTIONS AND DETAILS | IFC - Issued for Construction | 720 - Final Site Development Sections & Details | EC - Engineering & Design Civil | Scope |
| RKP-12-301215 | 0 | EAST BOTTOM ASH POND - BORROW AREA - CIVIL SITE PLAN | IFC - Issued for Construction | 717 - Final Site Development Drawing | EC - Engineering & Design Civil | Scope |
| RKP-12-301220 | 0 | POND COMPLEX - CLOSURE BY REMOVAL - EROSION AND SEDIMENT CONTROL - PLAN | IFC - Issued for Construction | 716 - Initital Site Development Drawing | EC - Engineering & Design Civil | Scope |
| RKP-00-0-100-EC-TSA-001 | 1 | Construction Quality Assurance (CQA) Plan for East Bottom Ash Pond Retrofit | IFC - Issued for Construction | TSA - Technical Specification | EC - Engineering & Design Civil | Scope |
| CE-003 | 1 | Specification for Stripping | IFU - Issued for Use | CDC - Client Document | EC - Engineering & Design Civil | Scope |
| CE-004 | 3 | Specification for Excavation | IFU - Issued for Use | CDC - Client Document | EC - Engineering & Design Civil | Scope |
| CE-006 | 1 | Specification for Fill | IFU - Issued for Use | CDC - Client Document | EC - Engineering & Design Civil | Scope |
| CE-006A | 0 | Earthwork (Backfill) Testing | IFU - Issued for Use | CDC - Client Document | EC - Engineering & Design Civil | Scope |
| CE-007 | 1 | Specification for Erosion and Sediment Control | IFU - Issued for Use | CDC - Client Document | EC - Engineering & Design Civil | Scope |
| CE-008 | 0 | Specification for Surface Drainage | IFU - Issued for Use | CDC - Client Document | EC - Engineering & Design Civil | Scope |
| CE-013 | 3 | Specification for Geotextile | IFU - Issued for Use | CDC - Client Document | EC - Engineering & Design Civil | Scope |
| CE-013A | 8 | Specification for Nonwoven Geotextiles | IFU - Issued for Use | CDC - Client Document | EC - Engineering & Design Civil | Scope |
| CE-018 | 2 | Specification for Surveying Services | IFU - Issued for Use | CDC - Client Document | EC - Engineering & Design Civil | Scope |
| CE-021 | 9 | Specification for Aerial Photography and Topographic Mapping | IFU - Issued for Use | CDC - Client Document | EC - Engineering & Design Civil | Scope |
| CE-026LL | 0 | Specification for LLDPE Geomembrane | IFU - Issued for Use | CDC - Client Document | EC - Engineering & Design Civil | Scope |
| CE-035 | 1 | Specification for Geosynthetic Clay Liner (GCL) | IFU - Issued for Use | CDC - Client Document | EC - Engineering & Design Civil | Scope |
| CE-036 | 1 | Specification for Demolition Removals and Alterations | IFU - Issued for Use | CDC - Client Document | EC - Engineering & Design Civil | Scope |
| CE-037 | 0 | Excavation and Backfill for Underground Utilities | IFU - Issued for Use | CDC - Client Document | EC - Engineering & Design Civil | Scope |
| CE-038 | 0 | Specification - Flowable Backfill (Controlled Low-Strength material) | IFU - Issued for Use | CDC - Client Document | EC - Engineering & Design Civil | Scope |
| CE-040 | 0 | Materials for Underground Piping and Sewers | IFU - Issued for Use | CDC - Client Document | EM - Engineering & Design Mechanical | Scope |
| CE-041 | 0 | INSTALLATION OF UNDERGROUND GRAVITY SEWERS | IFU - Issued for Use | CDC - Client Document | EC - Engineering & Design Civil | Scope |
| CE-042 | 0 | Specification for Installation of Underground HDPE Pressure Piping | IFU - Issued for Use | CDC - Client Document | EC - Engineering & Design Civil | Scope |
| RKP-PR-0-100-E0-TSA-02276 | 0 | Technical Specification Addendums - LCA21/LCA22 Pond Closure and Repurposing Construction | IFC - Issued for Construction | TSA - Technical Specification | EC - Engineering & Design Civil | Scope |
| E-OI-730.02.01 | 1 | CAD File Management | IFU - Issued for Use | CDC - Client Document | E0 - Engineering & Design Common | Scope |
| E-OI-730.02.02 | 1 | CAD Application Management | IFU - Issued for Use | CDC - Client Document | E0 - Engineering & Design Common | Scope |
| EG-730.02.01.01 | 0 | CAD File Approval | IFU - Issued for Use | CDC - Client Document | E0 - Engineering & Design Common | Scope |
| EG-730.02.01.02 | 1 | CAD Specification (Title Block Standards) | IFU - Issued for Use | CDC - Client Document | E0 - Engineering & Design Common | Scope |
| EG-730.02.01.03 | 1 | CAD Specification (File Project Structure) | IFU - Issued for Use | CDC - Client Document | E0 - Engineering & Design Common | Scope |
| EG-730.02.01.04 | 1 | CAD File Transfers | IFU - Issued for Use | CDC - Client Document | E0 - Engineering & Design Common | Scope |
| EG-730.02.01.05 | 1 | CAD Specification (File External Access) | IFU - Issued for Use | CDC - Client Document | E0 - Engineering & Design Common | Scope |
| EG-730.02.02.01 | 0 | Engineering Guideline CAD Application AutoCAD Configuration | IFU - Issued for Use | CDC - Client Document | E0 - Engineering & Design Common | Scope |
| EG-730.02.02.02 | 1 | CAD Specification (Application MicroStation Config) | IFU - Issued for Use | CDC - Client Document | E0 - Engineering & Design Common | Scope |
| EG-730.02.02.03 | 1 | CAD Specification (Application Supplemental Title Blocks) | IFU - Issued for Use | CDC - Client Document | E0 - Engineering & Design Common | Scope |
| EG-730.02.02.04 | 1 | CAD Specification (Application Translations) | IFU - Issued for Use | CDC - Client Document | E0 - Engineering & Design Common | Scope |
| EG-730.02.02.05 | 1 | CAD Specification (Application Distribution) | IFU - Issued for Use | CDC - Client Document | E0 - Engineering & Design Common | Scope |
| EG-730.02.05 | 2 | AEPSC - Drawing Content Guideline | IFU - Issued for Use | CDC - Client Document | E0 - Engineering & Design Common | Scope |
| RKP-12-30013 | 15 | Unit No.1 & 2 Wastewater & Bottom Ash Pond Area Grading & Drainage | IFU - Issued for Use | CDC - Client Document | EC - Engineering & Design Civil | Reference |
| RKP-12-30018 | 1 | Unit No.1 & 2 Wastewater & Bottom Ash Pond Area - Sections & Details | IFU - Issued for Use | CDC - Client Document | EC - Engineering & Design Civil | Reference |
| RKP-12-30027 | 8 | Unit No.1 & 2 Wastewater & Bottom Ash Pond Area - Sections & Details | IFU - Issued for Use | CDC - Client Document | EC - Engineering & Design Civil | Reference |
| RKP-12-5123 | 7 | Yard Piping Units No. 1 & 2 Sheet No. 2 of 39 | IFU - Issued for Use | CDC - Client Document | EC - Engineering & Design Civil | Reference |
| RKP-12-5263 | 4 | Bottom Ash & Pyrites Removal Piping in Yard Deatails Units No. 1 & 2 Sheet No. 2 of 2 | IFU - Issued for Use | CDC - Client Document | EC - Engineering & Design Civil | Reference |
| 12-300418 | 2 | SCR RETROFIT UNITS 1 AND 2 SURVEY CONTROL AND MONUMENTATION | IFU - Issued for Use | CDC - Client Document | EC - Engineering & Design Civil | Reference |
| 12-507000 | 3 | SCR RETROFIT OVERALL SITE PLOT PLAN | IFU - Issued for Use | CDC - Client Document | EC - Engineering & Design Civil | Reference |
| 12-5137XA | 4 | Arrg't of Chem Treatment & Coal Pile Runoff Piping | IFU - Issued for Use | CDC - Client Document | EC - Engineering & Design Civil | Reference |
| Bathymetric Surveys for BA & WW Ponds | 0 | Bathymetric Surveys for BA & WW Ponds | IFU - Issued for Use | CDC - Client Document | EC - Engineering & Design Civil | Reference |
| Pond Complex - Borings & Monitoring Well Data | 0 | Pond Complex - Borings & Monitoring Well Data | IFU - Issued for Use | CDC - Client Document | EC - Engineering & Design Civil | Reference |
| Soil Borrow Area Reference Documents | 0 | Soil Borrow Area Reference Documents | IFU - Issued for Use | CDC - Client Document | EC - Engineering & Design Civil | Reference |