**INFLOW DESIGN FLOOD CONTROL SYSTEM PLAN**
**PLANT GREENE COUNTY ASH POND**
**ALABMA POWER COMPANY**

Section §257.82 of EPA's regulations requires the owner or operator of an existing or new CCR surface impoundment or any lateral expansion of a CCR surface impoundment to design, construct, operate and maintain an inflow design flood control system capable of safely managing flow during and following the peak discharge of the specified inflow design flood. The owner or operator also has to prepare a written plan documenting how the inflow flood control system has been designed and constructed to meet the requirements of this section of the rule.

The existing CCR surface impoundment referred to as the Plant Greene County Ash Pond is located at Alabama Power Company's Plant Greene County. The facility consists of a 489 acre storage area. The inflow design flood consists primarily of the rainfall that falls within the limits of the surface impoundment, along with a nominal amount (relative to the rainfall) of process flows. Stormwater is temporarily stored within the limits of the surface impoundment and discharged through a 60-inch diameter concrete riser which outlets to a 30 inch fiberglass-lined concrete pipe discharging into the Black Warrior River.

The inflow design flood has been calculated using the Natural Resources Conservation Service method (also known as the Soil Conservation Service (SCS) method) using the 1,000-yr event required for a significant hazard potential facility. Runoff curve number data was determined using Table 2-2A from the Urban Hydrology for Small Watersheds (TR-55). Appendix A and B from the TR-55 were used to determine the rainfall distribution methodology. Precipitation values were determined from NOAA's Precipitation Frequency Data Server (Atlas-14).

The NRCS provided information on the soil characteristics and hydrologic groups present at the site. It was determined that the hydrological group "C" should be used to best reflect the characteristics of the soils on site. This information was placed into Hydraflow Hydrographs and used to generate appropriate precipitation curves, storm basin routing information, and resulting rating curves to evaluate surface impoundment capacity.

Calculations indicate the unit can safely store and pass the inflow design storm. Supporting calculations are attached for reference.

The facility is operated subject to and in accordance with § 257.3-3 of EPA's regulations.

I hereby certify that the inflow design flood control system plan meets the requirements of 40 C.F.R. Part 257.82.

10/17/16

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**Inflow Design Control System Plan:**
**Hydrologic and Hydraulic Calculation Summary**

for

***Plant Greene County Ash Pond***

Prepared by:

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Approval: ______________________ 10/12/16
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## 1.0 Purpose of Calculation

The purpose of this report is to demonstrate the hydraulic capacity of the subject CCR impoundment in order to prepare an inflow design flood control plan as required by the United States Environmental Protection Agency's (EPA) final rule for Disposal of CCR from Electric Utilities (EPA 40 CFR 257).

## 2.0 Summary of Conclusions

A hydrologic and hydraulic model was developed for the Plant Greene County Ash Pond to determine the hydraulic capacity of the impoundment. The design storm for the Plant Greene Ash Pond is a 1,000-year rainfall event. Southern Company has selected a storm length of 24-hours for all inflow design flood control plans. The results of routing a 1,000 year, 24-hour rainfall event through the impoundment are presented in Table 1 below:

Table 1-Flood Routing Results for Plant Greene County Ash Pond

| Plant Greene County | Normal Pool El (ft) | Top of embankment El (ft) | Emergency Spillway Crest El (ft) | Peak Water Surface Elevation (ft) | Freeboard* (ft) | Peak Inflow (cfs) | Peak Outflow (cfs) |
|---|---|---|---|---|---|---|---|
| Ash Pond | 87.5 | 95.5 | N/A | 92.28 | 3.22 | 2,307.5 | 79.3 |

*Freeboard is measured from the top of embankment to the peak water surface elevation

## 3.0 Methodology

### 3.1 HYDROLOGIC ANALYSES

The Plant Greene County Ash Pond is classified as a significant hazard structure. The design storm for a significant hazard structure is a 1000-year rainfall event. A summary of the design storm parameters and rainfall distribution methodology for these calculations is summarized below in Table 2.

Table 2. Plant Greene County Ash Pond Storm Distribution

| Hazard Classification | Return Frequency (years) | Storm Duration (hours) | Rainfall Total (Inches) | Rainfall Source | Storm Distribution |
|---|---|---|---|---|---|
| Significant | 1,000 | 24 | 13.4 | NOAA Atlas 14 | SCS Type III |

The drainage area for the Plant Greene County Ash Pond is delineated as the pond area itself. No contributing areas outside the pond drain into the pond. The topography is based on LiDAR data acquired for the plant in 2016. Runoff characteristics were developed based on the Soil Conservation Service (SCS) methodologies as outlined in TR-55. An overall SCS curve number for the drainage area was developed based on the National Engineering Handbook Part 630, Chapter 9. Land use areas were delineated based on aerial photography. Time of Concentration and Lag Time calculations were developed based on methods as described in paragraph 4.3.

A table of the pertinent basin characteristics of the Ash Pond is provided below in Table 3.

Table 3—Ash Pond Hydrologic Information

| | |
|---|---|
| Drainage Basin Area (acres) (pond area) | 489 |
| Hydrologic Curve Number, CN | 93 |
| Hydrologic Methodology | SCS Method |
| Time of Concentration (minutes) | 34.5 |
| Hydrologic Software | NRCS TR-20, AutoCAD Hydraflow |

Runoff values were determined by importing the characteristics developed above into a hydrologic model with the NRCS and AutoCAD programs along with manual calculations.

Process flows from Plant Greene County were considered in this analysis. Based on normal plant operations, the Ash Pond receives an additional 7 MGD (10.75 cfs) of inflow from the plant.

### 3.2 HYDRAULIC ANALYSES

Storage values for the Ash Pond were determined by developing a stage-storage relationship utilizing contour data. The spillway system at the Plant Greene County Ash Pond consists of a primary riser pipe (60 inch diameter). The primary riser pipe has a crested riser weir length of 15.71 feet which conveys flow to a concrete conduit. The top of the riser sets the normal pool elevation of 87.50 feet. The conduit is 30 inches in diameter and has a length of approximately 169 feet at a continuous slope of 1.4 percent.

Based on the spillway characteristics, a rating curve was developed using engineering calculations and inserted into the hydrologic programs to determine the pond performance during the design storm. Results are shown in section 4.4.

## 4.0 SUPPORTING INFORMATION

### 4.1 CURVE NUMBER

The pond has no other contributing drainage area, hence the curve number for the DA is calculated using area of exposed ash (CN 90) and curve number of water surface (CN100) for a composite curve number of 93. See diagram in paragraph 4.5.

## 4.2 STAGE-STORAGE TABLE

| Pool Elevation | Storage, cubic feet (S) | Storage, acre-feet |
|---|---|---|
| 87.50 | 0 | 0.000 |
| 88.00 | 1,841,079 | 42.265 |
| 88.50 | 3,770,053 | 86.549 |
| 89.00 | 5,699,026 | 130.832 |
| 89.50 | 7,695,837 | 176.672 |
| 90.00 | 9,692,647 | 222.513 |
| 90.50 | 11,772,343 | 270.256 |
| 91.00 | 13,852,039 | 317.999 |
| 91.50 | 16,070,233 | 368.922 |
| 92.00 | 18,288,427 | 419.845 |
| 92.50 | 20,883,443 | 479.418 |
| 93.00 | 23,478,458 | 538.991 |
| 93.50 | 26,331,108 | 604.479 |
| 94.00 | 29,183,759 | 669.967 |
| 94.50 | 29,183,759 | 669.967 |
| 95.00 | 36,145,084 | 829.777 |

## 4.3 TIME OF CONCENTRATION

| Methods for estimating Time of Concentration (see map paragraph 4.5): | | | | |
|---|---|---|---|---|
| For TR55 Tc estimate (SCS Velocity Tc): | 1.553 | hours | 93.2 | mins |
| For Rational method Tc estimate (Kirpich Tc): | 0.509 | hours | 30.6 | mins |
| For Rational method Tc estimate FAA Tc (C = 0.93) : | 0.676 | hours | 40.6 | mins |
| For Rational method Tc estimate DoD Tc (C = 0.93) : | 0.540 | hours | 32.4 | mins |

The SCS Velocity Method relies on observations or assumptions made about the flow types along the hydraulic path, i.e. sheet flow, shallow concentrated flow, and channel flow to estimate the Tc. Kirpich, the FAA and the DoD methods are methods used to estimate Tc using overall characteristics of the flow path, slope, length and ground cover (or runoff C factor). The SCS method produced a Tc much longer than the other three, to be conservative it was not used in the average of the methods shown below.

The runoff C factor was estimated from the CN of 93 and a rain depth of 13.40 inches (1,000 Year, 24 hour depth): At CN = 93, S (inches of potential storage) = (1000/CN - 10) = 0.79 inches, and Q (runoff inches of rain in 24 hours) = ((P-0.2*S)^2)/(P+0.8*S) = 12.50 inches. Assumed runoff C = Q/P = 0.93

CN = 93 Bare Soil, Soil Group C
P (1,000 Year) = 13.40 inches
Q = 12.50 inches of runoff
Calculated C = 12.50/13.40 = 0.93

FAA method: Tc mins = $1.8 * (1.1 – C) * (L^{0.5})/(S\%^{0.33})$
L = length in feet, S% = slope in percent

DoD method: Tc mins = $0.225 * (L^{0.42})/(C * Sf^{0.19})$
L = length in feet, Sf = slope in ft/ft

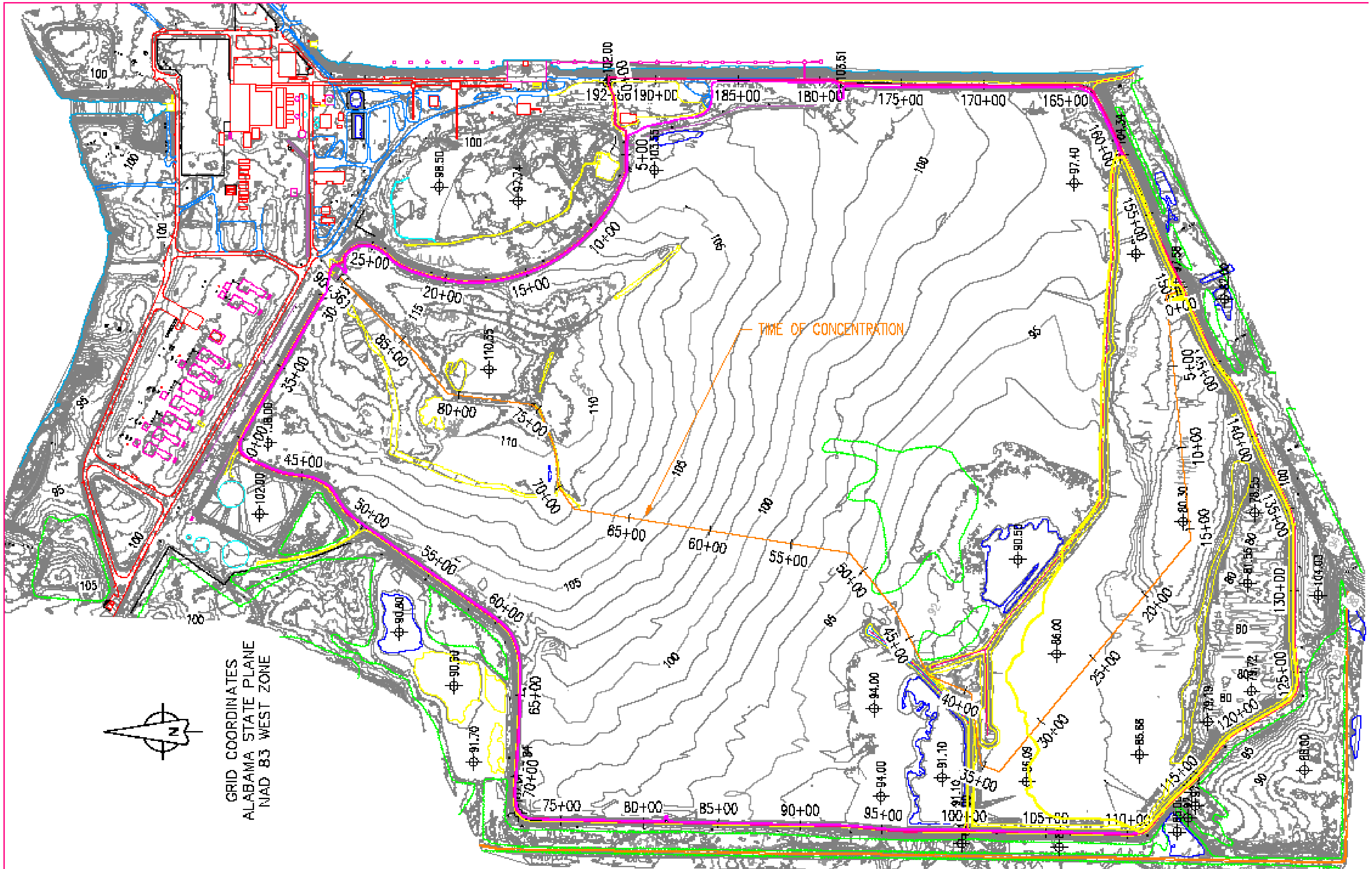
| Tc Averages (excluding SCS): |
|---|
| ***0.575 hours*** |
| ***34.5 mins*** |

## 4.4 RATING CURVE

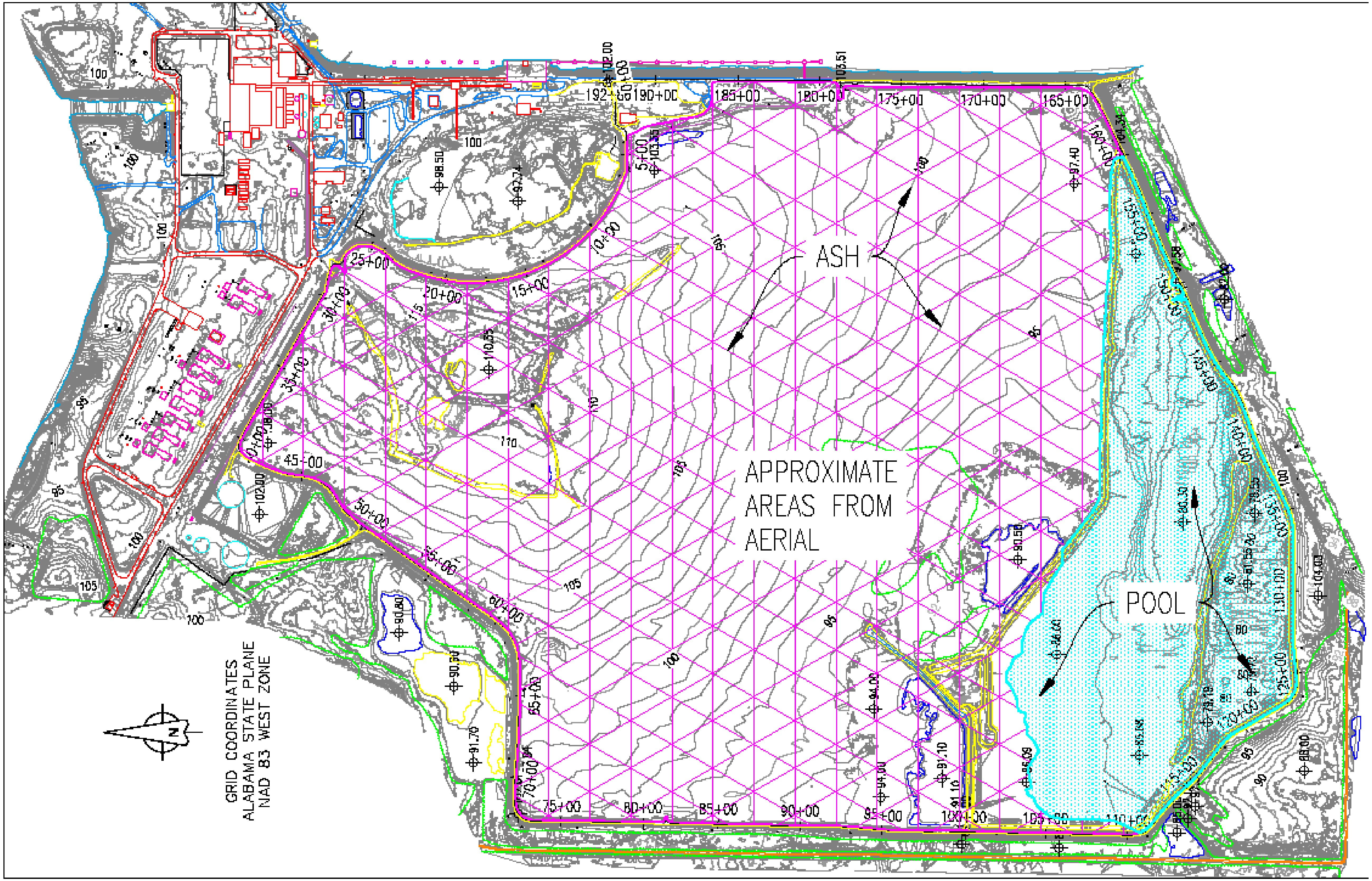
The pond discharge is controlled by the combination of a 60 inch riser pipe discharging into a 30 inch diameter outlet pipe. The limiting flow at any given stage is either the riser pipe modeled as a weir, the riser pipe modeled as an orifice, discharging against the outlet pipe headwater (tailwater control to the riser pipe). The most constraining flow thus calculated is the controlling discharge at any given stage.

| | Conditions if no backwater from outlet pipe HW (maximum theoretical) | | | | | With Outlet HW Considered | |
|---|---|---|---|---|---|---|---|
| Pool Elevation | Storage, acre-feet | Riser 1 Head | Riser 1 Theoretical Weir Flow | Riser 1 Theoretical Orifice Flow | Riser Flow (W or O): 60.0 inch dia, Top El. 87.50 (no TW considered) | Outlet pipe (30.00 inch dia.) HW Elev | **Total Discharge, cfs** |
| 87.50 | 0.000 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** |
| 88.00 | 42.265 | 0.50 | 18.05 | 66.85 | 18.05 | 81.15 < Pool El | **18.05** |
| 88.50 | 86.549 | 1.00 | 51.05 | 94.54 | 51.05 | 84.96 < Pool El | **51.05** |
| 89.00 | 130.832 | 1.50 | 93.79 | 115.79 | 93.79 | 88.95 < Pool El | **69.89** |
| 89.50 | 176.672 | 2.00 | 144.39 | 133.70 | 133.70 | 89.50 = Pool El | **71.84** |
| 90.00 | 222.513 | 2.50 | 201.80 | 149.48 | 149.48 | 90.00 = Pool El | **73.57** |
| 90.50 | 270.256 | 3.00 | 265.27 | 163.75 | 163.75 | 90.50 = Pool El | **75.25** |
| 91.00 | 317.999 | 3.50 | 334.28 | 176.87 | 176.87 | 91.00 = Pool El | **76.91** |
| 91.50 | 368.922 | 4.00 | 408.41 | 189.08 | 189.08 | 91.50 = Pool El | **78.53** |
| 92.00 | 419.845 | 4.50 | 487.33 | 200.55 | 200.55 | 92.00 = Pool El | **80.11** |
| 92.50 | 479.418 | 5.00 | 570.77 | 211.40 | 211.40 | 92.50 = Pool El | **81.66** |
| 93.00 | 538.991 | 5.50 | 658.49 | 221.72 | 221.72 | 93.00 = Pool El | **83.18** |
| 93.50 | 604.479 | 6.00 | 750.29 | 231.58 | 231.58 | 93.50 = Pool El | **84.68** |
| 94.00 | 669.967 | 6.50 | 846.01 | 241.04 | 241.04 | 94.00 = Pool El | **86.15** |
| 94.50 | 669.967 | 7.00 | 945.48 | 250.13 | 250.13 | 94.50 = Pool El | **87.59** |
| 95.00 | 829.777 | 7.50 | 1,048.56 | 258.91 | 258.91 | 95.00 = Pool El | **89.02** |
| 95.00 | 829.777 | 7.50 | 1,048.56 | 258.91 | 258.91 | 95.00 = Pool El | **89.02** |
| 95.00 | 829.777 | 7.50 | 1,048.56 | 258.91 | 258.91 | 95.00 = Pool El | **89.02** |
| 95.00 | 829.777 | 7.50 | 1,048.56 | 258.91 | 258.91 | 95.00 = Pool El | **89.02** |
| 95.00 | 829.777 | 7.50 | 1,048.56 | 258.91 | 258.91 | 95.00 = Pool El | **89.02** |
| 95.00 | 829.777 | 7.50 | 1,048.56 | 258.91 | 258.91 | 95.00 = Pool El | **89.02** |
| 95.00 | 829.777 | 7.50 | 1,048.56 | 258.91 | 258.91 | 95.00 = Pool El | **89.02** |
| 95.00 | 829.777 | 7.50 | 1,048.56 | 258.91 | 258.91 | 95.00 = Pool El | **89.02** |
| 95.00 | 829.777 | 7.50 | 1,048.56 | 258.91 | 258.91 | 95.00 = Pool El | **89.02** |

4.5 DRAINAGE BASIN TIME OF CONCENTRATION



4.6 DRAINAGE BASIN LAND USE



4.7 DRAINAGE BASIN AERIAL PHOTO