AECOM

Submitted to:
Marquette Board of Light and Power
Shiras Steam Plant
Marquette, Michigan

Submitted by:
AECOM
Marquette, Michigan
Project No. 60445171
October 2016

Initial Inflow Design Flood Control System Plan – Holding Pond

Marquette Board of Light and Power
Shiras Steam Plant

Contents

Appendices

1.0 Introduction

The Coal Combustion Residual (CCR) Rule published on April 17, 2015 contains requirements for CCR surface water impoundments with respect to managing peak flows resulting from the inflow design flood (IDF). This plan has been prepared to satisfy the 40 CFR §257.82 requirements for surface water impoundments for the Marquette Board of Light and Power (MBLP) Shiras Steam Plant located in the City of Marquette, Michigan. The plant has one surface water impoundment (WDS ID# 478988), which is a holding pond located on the north side of the plant property on the shore of Lake Superior. This is the first (initial) IDF Control System Plan for this impoundment to be performed under the CCR Rule.

1.1 Plan Content

Regulatory Citation: 40 CFR §257.82 (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 (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 §257.105(g)(4).

The purpose of the assessment presented in this plan is to document that the requirements specified in 40 CFR §257.82 have been met to support the certification required under each of those regulatory provisions for the MBLP Shiras Steam Plant Holding Pond. The Holding Pond is an existing CCR surface impoundment as defined by 40 CFR §257.53. A certification statement from a qualified professional engineer verifying that this initial plan meets the requirements of this section §257.82 is provided in **Appendix A**. Engineering calculations supporting this plan are provided in **Appendix C**. In accordance with § 257.82(c)(2), this plan will be amended each time there is a change in conditions that substantially affect the written plan in effect.

The Holding Pond has been evaluated to determine whether the IDF Control system requirements are met. The sections listed in **Table 1-1** below summarize the evaluations performed and the results from the analyses.

Table 1-1 – CCR Rule Cross Reference Table		
Plan Section	**Title**	**CCR Rule Reference**
4.1	Inflow Analysis	§257.82 (a)(1)
4.2	Outflow Analysis	§257.82 (a)(2)
4.3	IDF	§257.82 (a)(3)
4.4	Discharge handled in accordance with *§257.3 – 3*	§257.82 (b)

This plan presents the Initial IDF Control System Plan as prepared by AECOM for the Holding Pond at the Shiras Steam Plant. This hydrologic and hydraulic (H&H) analysis was completed in response to the Environmental Protection Agency (EPA) adopting the Federal Register 40 CFR Parts 257 and 261 to regulate the disposal of CCR as solid waste in April of 2015. As required by §257.82, no later than October 17, 2016, owners and operators of existing or new CCR surface impoundments must develop an Initial IDF Control System Plan in accordance with the following:

Regulatory Citation: 40 CFR §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 (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 §257.73(a)(2) or §257.74(a)(2), the probable maximum flood;

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

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

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

Regulatory Citation: 40 CFR §257.82 (b); Discharge from the CCR unit must be handled in accordance with the surface water requirements under §257.3-3.

Analyses completed for the hydrologic and hydraulic assessments of the Holding Pond are described in this plan. Background information, design basis information, and other data used in preparing this plan have been provided to AECOM by the MBLP or obtained from publicly available sources. AECOM is not responsible for the accuracy of the documents reviewed, and has prepared this plan by practicing good engineering judgement based upon the best available information.

The results of this analysis will be used by AECOM to confirm that the Holding Pond meets the hydrologic and hydraulic capacity requirements of the rules referenced above for CCR surface impoundments. The analysis approach and results of the hydrologic and hydraulic analyses are presented in following sections.

1.2 Brief Description of the Site

The Shiras Steam Plant is a coal-fired power plant located in Marquette, Michigan. The Plant is situated on the shoreline of Lake Superior with the Holding Pond positioned on the north side of the generating station. An aerial image showing the Holding Pond and surrounding areas is in **Figure 1** of **Appendix B**.

The holding pond is composed of 5 interconnected cells which are enclosed by steel sheet pile walls and are in hydraulic communication via a set of weirs built into the walls. Its overall configuration is shown in **Figure 2** in **Appendix B**. It has been expanded and modified a number of times since constructed. The south and west boundaries of the holding pond are formed by the shoreline of the lake. The east and north boundaries of the holding pond are formed by sheet pile walls which were constructed in 1981. Because of the poor condition of the north wall, an additional wall was constructed to replace it in 2013. The new wall was placed inside of the existing north wall, which remains but no longer provides containment. The walls for the inner cells 1, 2, and 3 were constructed in 1990. There are also some abandoned sheet pile walls in place from previous configurations.

There are several ramps on the south shore of the impoundment which allow loaders to enter the cells to remove solids which have settled out of the impounded water. The cells are periodically drained to allow this cleanout operation. The residuals are primarily composed of bottom ash but also contain components from other waste streams including coal pile runoff and storm water. The residuals are removed to an off-site landfill.

The impoundment is operated as a zero-discharge facility during normal conditions. Water from the holding pond is pumped to a 300,000 gallon equalization/reuse storage tank. Low, medium and high service water pumps recycle the reclaimed water for plant use, including sluicing activities. It is reported by facility staff that approximately 0.5 million gallons per day are cycled through this loop. Discharge of water from the holding pond through two weirs along the east wall is regulated via a NPDES permit through a permitted outfall (#004A). However, discharge from the pond has been reserved for emergency situations and there have reportedly been only three to five discharges in the last fifteen years.

In addition to rain that falls directly into the Holding Pond, there are upstream areas that contribute runoff to the impoundment. Approximately 10.5 acres drain to the Holding Pond from the power plant property.

The surface area of the holding pond is approximately 0.59 acres. The normal operating level of the holding pond varies, but is approximately 606.0 feet. According to historical as-built drawings (**Appendix B, Figures 3 & 4**), the outfall weir elevation is 606.6 feet and the emergency overflow weir elevation is 607.4 feet, both of which discharge through the east wall directly into Lake Superior. The north and east perimeter sheet pile wall top elevation is 609.0 feet. The average water surface elevation of Lake Superior is approximately 601.8 feet. All elevations are given according to the International Great Lakes Datum of 1985 (IGLD85), unless noted otherwise.

2.0 Hydrologic Analysis

2.1 Design Storm

The Holding Pond has been categorized as a "Significant Hazard Potential CCR Impoundment", which indicates that the IDF is the 1,000-year return frequency design storm event. The documentation for this classification determination is included in the Hazard Classification Assessment Letter for the Holding Pond at the Shiras Steam Plant.

2.2 Rainfall Data

The rainfall information used in the analysis was based on the National Oceanic and Atmospheric Administration (NOAA) Atlas 14, Volume 8, Version 2 which provides rainfall data for storm events with average recurrence intervals ranging from 1 to 1,000 years and durations ranging from 5 minutes to 60 days. The design storm rainfall depth, obtained from the NOAA website, is 6.68 inches for the 1,000-year, 24-hour storm (see **Appendix C**).

2.3 Runoff Computations

The drainage areas for the Holding Pond were determined using a computer-aided design (CAD) analysis of topographic information obtained from a historic site plan drawing dated 1984 and aerial imagery obtained from Google Earth. In addition to rain that falls directly into the pond, there are upstream areas that contribute runoff to the pond. Approximately 10.5 acres drain to the Holding Pond from upstream areas.

Runoff was calculated using the SCS Curve Number Method, where curve numbers (CN) were assigned to each subcatchment based on the type of land cover and soil type present. CN values for the land cover were selected from the CN Table available in HydroCAD. This data was obtained from the SCS NRCS Technical Release-55 (TR-55) publication. Paved areas, power plant facilities, coal storage area, and water surface land covers that are located within the drainage watershed were all determined to have a CN value of 98. A small vegetated area immediately surrounding the Holding Pond to the west and south was determined to have a CN value of 74.

The time of concentration is commonly defined as the time required for runoff to travel from the most hydrologically distant point to the point of collection. Calculations for the time of concentration for each sub-watershed were performed in HydroCAD and are included in **Appendix C**.

Stormwater runoff from the 1000-year event into the Holding Pond has a peak inflow of 99.3 cubic feet per second (cfs) and inflow volume of 5.87 acre-feet (ac-ft). Refer to **Appendix C** for HydroCAD results.

3.0 Hydraulic Analyses

3.1 Process Flows

As previously discussed, the Holding Pond is operated as a zero-discharge facility during normal operating conditions. The process flow from the plant was not considered in the analysis because it is recirculated back to the plant via pumping operations, essentially cancelling itself out in the storm event water balance for the Holding Pond.

3.2 Storage Capacity

The storage volume for the Holding Pond was determined using a computer-aided design (CAD) analysis using data obtained by an AECOM survey crew on October 15, 2015. The volume of storage is calculated by determining the surface area at various elevations and multiplying the area by the difference in elevation. Refer to **Appendix C** for storage volume details.

3.3 Discharge Analysis

A hydraulic model was created in HydroCAD (version 10.00) to assess the capacity of the Holding Pond to safely store and pass flows generated by the IDF. HydroCAD has the capability to evaluate each pond within the network, to respond to variable tailwater, pumping rates, permit flow loops, and reversing flows. HydroCAD routing calculations reevaluate the pond systems' discharge capability at each time increment, making the program an efficient and dynamic tool for this evaluation.

The analyzed scenario assumes a starting water surface elevation (WSE) in the Holding Pond of 606.0 feet (IGLD85) however it was found that starting WSE variances within the probable range had an insignificant impact on the results. The storm water runoff collected and stored in the impoundment discharges through the pond outlet devices into Lake Superior. The discharge is permitted under NPDES Permit Number MI0006076.

4.0 Results

The hydrologic and hydraulic conditions of the Holding Pond were modeled with the peak discharge resulting from runoff generated by the IDF (1,000-year storm event).

Regulatory Citation: 40 CFR §257.82 (a); The owner or operator of an existing or new CCR surface impoundment or any lateral expansion of a CCR of a CCR surface impoundment must design, construct, operate, and maintain an IDF Control system as specified in paragraphs (a)(1) and (2) of this section.

4.1 Inflow Analysis

Regulatory Citation: 40 CFR §257.82 (a);

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

Background and Assessment

Runoff to the impoundment from the surrounding area and the power plant produces the total inflow to the Holding Pond. Using the HydroCAD model, the total inflow was stored and routed through the outlet devices of the Holding Pond to determine the peak water surface elevations.

As a result of the peak inflows for the IDF, the peak water surface elevation in the Holding Pond rises to 609.18 feet (IGLD85). This temporary (less than 1 hour) condition results in a 0.18 foot overtopping of the sheet pile wall crest (609.0 feet) to the north and east, flowing into Lake Superior. This peak elevation would not cause discharge or flooding inland.

Conclusion and Recommendation

No modifications are necessary or recommended to this unit for compliance with the CCR Rule.

There is adequate storage within the Holding Pond to manage the IDF, which meets the requirements in §257.82 (a)(1).

4.2 Outflow Analysis

Regulatory Citation: 40 CFR §257.82 (a);

- *(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 (3) of this section.*

Background and Assessment

Runoff to the impoundment from the plant area produces the total inflow to the Holding Pond. Using the HydroCAD model, the total inflow was stored and routed through the outlet devices of the Holding Pond to determine the peak flowrate and velocity through the outlet devices.

Table 4-1 (below) summarizes the peak flowrates and velocities through each of the outlet devices.

Table 4-1 - Summary of Outlet Devices 1,000-Year, 24-Hour Storm				
Outlet Device	Type and Size	Invert Elevation (feet)	Peak Flowrate (cfs)	Velocity at Peak Flowrate (fps)
Outfall Weir	1.5’ long x 1.0’ rise sharp crested weir	606.58	11.05	8.50
Emergency Overflow Weir	3.0’ long x 1.0’ breadth weir	607.40	23.54	4.41
Top of Sheet Pile Wall	298.0’ long x 1.0’ breadth weir	609.00	60.95	1.14

Conclusion and Recommendation

No modifications are necessary or recommended to this unit for compliance with the CCR Rule.

The Holding Pond adequately manages the peak discharge resulting from the IDF from the plant. As stated above, the peak water surface elevation of the Holding Pond is above the sheet pile wall, causing brief overtopping. However, this is not a concern because of the shallow depth and low velocity of flow over a structural steel wall and directly into Lake Superior. Thus the pond meets the requirements in §257.82 (a)(2).

4.3 Inflow Design Flood

Regulatory Citation: 40 CFR §257.82 (a);

– *(3) The inflow design flood is:*

  - *(i) For a high hazard potential CCR surface impoundment, as determined under §257.73(a)(2), the probable maximum flood;*
  - *(ii) For a significant hazard potential CCR surface impoundment, as determined under §257.73(a)(2), the 1,000-year flood;*
  - *(iii) For a low hazard potential CCR surface impoundment, as determined under §257.73(a)(2), the 100-year flood; or*
  - *(iv) For an incised CCR surface impoundment, the 25-year flood.*

Background and Assessment

The calculations for the IDF are based on the hazard potential given to the impoundment. The different classifications of the impoundment hazard potential are high, significant, and low.

Conclusion and Recommendation

No modifications are necessary or recommended to this unit for compliance with the CCR Rule.

As the impoundment was given a significant hazard potential, the 1,000 year design storm was utilized in the analysis, which meets the requirements in §257.82 (a)(3).

4.4 Discharge

Regulatory Citation: 40 CFR §257.82 (b); Discharge from the CCR unit must be handled in accordance with the surface water requirements under: §257.3 – 3.

Background and Assessment

The discharge from the Holding Pond outlet devices flows into Lake Superior. The discharge must meet the requirements of the NDPES under section 402 of the Clean Water Act to meet the CCR rule.

Conclusion and Recommendation

No modifications are necessary or recommended to this unit for compliance with the CCR Rule.

Runoff discharges the site through a permitted NPDES outfall. As per the current NPDES permit, discharged water is tested for pollutants to meet the minimum regulatory requirements of the permit. Therefore, the facility does not cause a discharge of pollutants into waters of the United States that is in violation of the requirements of the NPDES under section 402 of the Clean Water Act, and thereby meets the requirements in §257.82 (b).

5.0 Conclusion

The IDF Control system of the Holding Pond adequately manages flow into the CCR unit during and following the peak discharge of the 1,000-year frequency storm event inflow design flood. The IDF Control system of the Holding Pond adequately manages flow from the CCR unit to collect and control the peak discharge resulting from the 1,000-year frequency storm event inflow design flood. Therefore, the Holding Pond meets the requirements for certification.

The contents of this plan, specifically Section 1 through Section 4, represent the Initial IDF Control System Plan for this site.

6.0 Frequency for Revising the Plan

Regulatory Citation: 40 CFR §257.82 (c);(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 (c)(4), 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 §257.105(g)(4).

The MBLP will prepare periodic IDF control system plans every five years and will place the plan in the facility's operating record. The MBLP will obtain a certification from a qualified professional engineer stating that the periodic IDF control system plans meet the requirements of this section.

7.0 Limitations

Background information, design basis, and other data have been furnished to AECOM by the Marquette Board of Light and Power (MBLP), which AECOM has used in preparing this plan. AECOM has relied on this information as furnished, and is not responsible for the accuracy of this information. Our recommendations are based on available information from previous and current investigations. These recommendations may be updated as future investigations are performed.

The conclusions presented in this plan are intended only for the purpose, site location, and project indicated. The recommendations presented in this plan should not be used for other projects or purposes. Conclusions or recommendations made from these data by others are their responsibility. The conclusions and recommendations are based on AECOM's understanding of current plant operations, maintenance, stormwater handling, and ash handling procedures at the station, as provided by MBLP. Changes in any of these operations or procedures may invalidate the findings in this plan until AECOM has had the opportunity to review the findings, and revise the plan if necessary.

This hydrologic and hydraulic analysis was performed in accordance with the standard of care commonly used as state-of-practice in our profession. Specifically, our services have been performed in accordance with accepted principles and practices of the engineering profession. The conclusions presented in this plan are professional opinions based on the indicated project criteria and data available at the time this plan was prepared. Our services were provided in a manner consistent with the level of care and skill ordinarily exercised by other professional consultants under similar circumstances. No other representation is intended.

While the CCR unit adequately manages the inflow design flood, MBLP must perform routine maintenance on the CCR unit to continually manage flood events without failure. Outlet devices should be cleared of debris that could block or damage the device. Pipes and intake structures should be monitored and repaired if deterioration or deformation occurs.

8.0 References

AECOM. Holding Pond Annual Inspection Report at the Shiras Steam Plant dated January 15, 2016.

AECOM. Hazard Classification Assessment Letter for the Holding Pond at the Shiras Steam Plant dated October 2016.

HydroCAD Software Solutions LLC 2012. *HydroCAD*, Version 10.0-14 Computer Program.

Lutz, Daily & Brain, Consulting Engineers. Site Plan – Board of Light & Power – Marquette, Michigan – Utility System Improvements. January 9, 1984.

National Oceanic and Atmospheric Administration. NOAA Atlas 14 Point Precipitation Frequency Estimates, Volume 8, Version 2 dated 2016.

State of Michigan – Department of Environmental Quality. NPDES Permit No. MI0006076. October 15, 2013.

Sundberg, Carlson, and Associates, Inc. Cinder Pond Improvements – Board of Light & Power – City of Marquette – Demolition & Improvement Plans, Details. Rev 1 As-built, December 13, 1990.

U.S. Environmental Protection Agency. Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments. 40 CFR §257. Federal Register 80, Subpart D, April 17, 2015.

Appendix A

Final CCR Rule Engineer’s Certification

Certification Statement 40 CFR § 257.82(c)(5) – Initial Inflow Design Flood Control System Plan for an Existing CCR Surface Impoundment

CCR Unit: Marquette Board of Light and Power Shiras Steam Plant Holding Pond

I, Scott G. Hutsell, being a Registered Professional Engineer in good standing in the State of Michigan, do hereby certify, to the best of my knowledge, information, and belief, that the information contained in this certification has been prepared in accordance with the accepted practice of engineering. I certify, for the above-referenced CCR Unit, that the information contained in the initial inflow design flood control system plan dated October, 17, 2016 meets the requirements of 40 CFR § 257.82.

SCOTT G. HUTSELL

Printed Name

10/17/16

Date

STATE OF MICHIGAN
SCOTT G.
HUTSELL
ENGINEER
No.
43961
LICENSED PROFESSIONAL ENGINEER

Scott G. Hutsell

Appendix B

Figures

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PROJECT AREA
SHIRAS STEAM PLANT CCR COMPLIANCE
MARQUETTE BOARD OF LIGHT AND POWER
MARQUETTE, MICHIGAN

Legend

- Road
- River
- Project Area

0 100 200
Feet

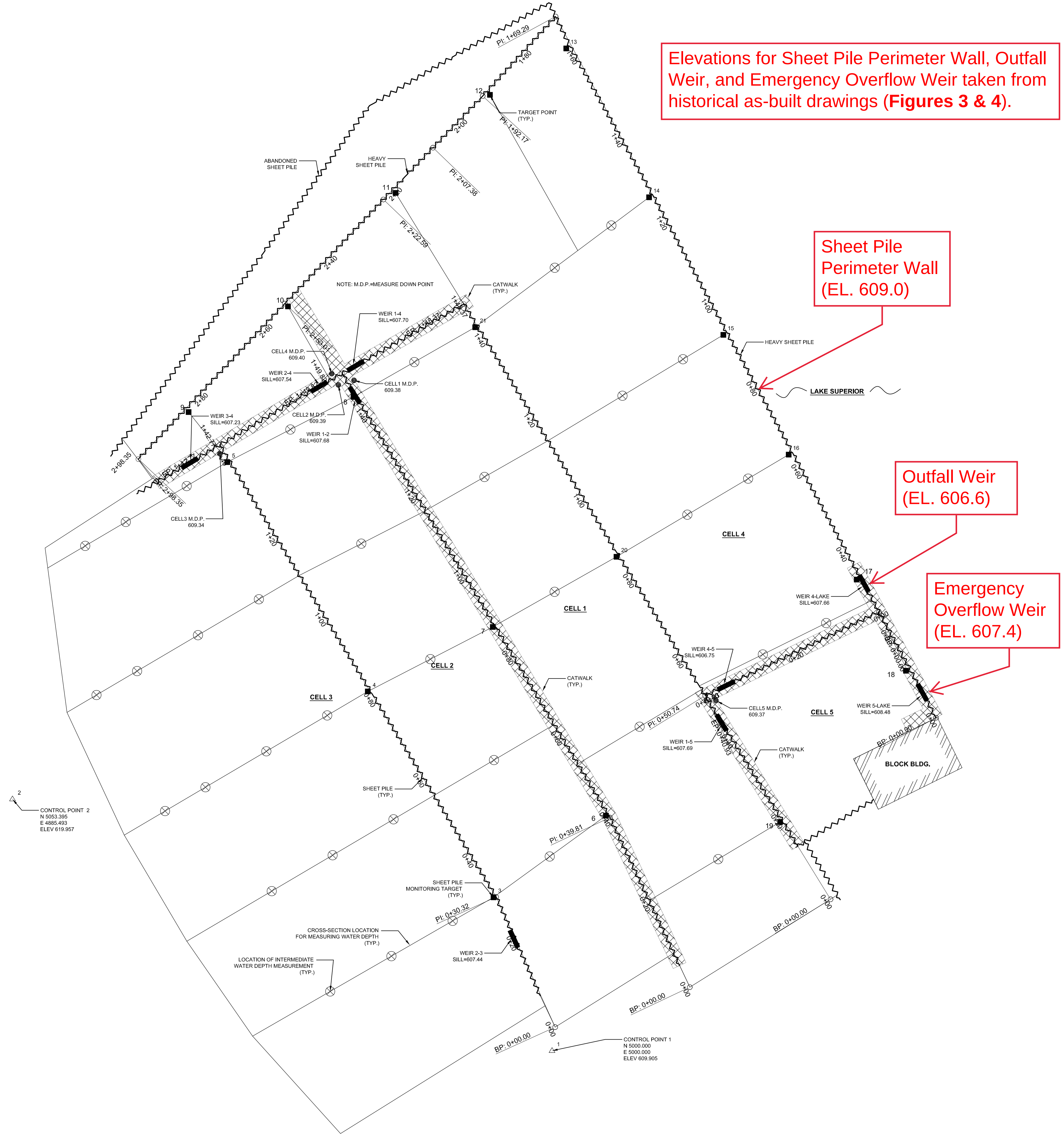
Drawn:	JW	10/6/2015
Approved:	IM	10/6/2015
Scale:	AS SHOWN	
PROJECT NUMBER	60445171	
FIGURE NUMBER	1	

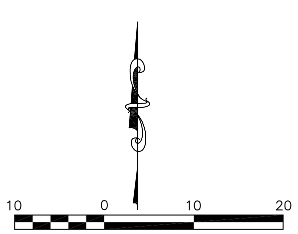
K:\Projects\60445171_MBLP_Shiras Steam Plant_CCR_Compliance\900_WorkingDocs_CAD\GIS\Fig1_Project_Area.mxd

DATE OF SURVEY: OCTOBER 15, 2015
ELEVATION DATUM IS NAVD88 AND ESTABLISHED BY DIFFERENTIAL LEVEL LOOP FROM NGS DISK LSC7B63 (RK0415) WHICH HAS A PUBLISHED ELEVATION OF 615.610'.
REFLECTIVE TARGET COORDINATES AND ELEVATIONS ESTABLISHED BY TURNING 2 SETS OF ANGLES FROM CONTROL POINTS 1 AND 2.
TARGET BENCHMARK ELEVATIONS ESTABLISHED BY DIFFERENTIAL LEVELING. SOME TARGET BENCHMARKS WERE INACCESSIBLE TO A LEVEL ROD AND HAD TO BE MEASURED DOWN TO FROM ABOVE.

TARGET	NORTH	EAST	TARGET ELEVATION	BENCH MARK ELEVATION
3	5032.562	4987.579	608.902	608.825
4	5076.237	4960.903	608.927	608.847
5	5124.911	4931.078	608.955	608.865
6	5049.888	5011.443	608.929	608.843
7	5089.939	4987.426	608.950	608.870
8	5138.743	4957.869	608.999	608.908
9	5135.519	4922.879	609.915	609.835
10	5157.940	4943.954	609.943	609.857
11	5182.039	4966.800	609.816	609.730
12	5202.844	4986.818	609.836	609.752
13	5212.675	5003.027	609.787	609.695
14	5181.111	5020.604	609.715	609.720
15	5151.909	5036.356	609.747	609.670
16	5126.503	5050.227	609.817	609.730
17	5099.988	5064.660	609.823	609.735
18	5080.634	5075.118	609.781	609.702
19	5048.539	5048.415	608.908	608.830
20	5104.828	5013.673	609.045	608.960
21	5153.524	4983.690	609.036	608.950

TYPICAL TARGET INSTALLATION





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MARQUETTE BOARD OF LIGHT AND POWER
SHIRAS STEAM PLANT
CCR COMPLIANCE

HOLDING POND PLAN

Issued

Rev Date Description

Designed:	CLC	10/19/2015
Drawn:	CLC	10/19/2015
Checked:	GHI	XX/XX/2008
Approved:	JKL	XX/XX/2008

PROJECT NUMBER
60445171

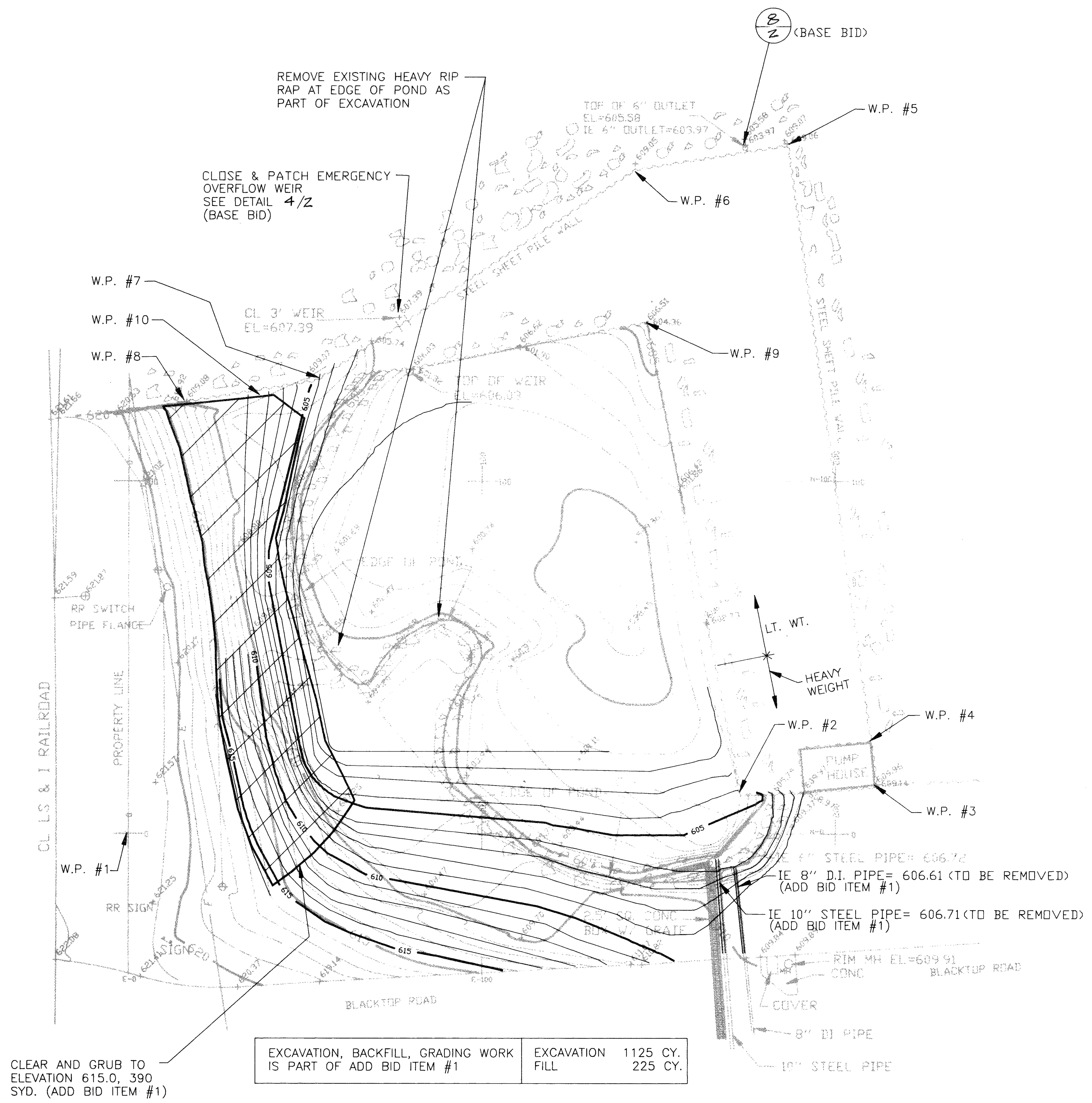
FIGURE 2

LEGEND

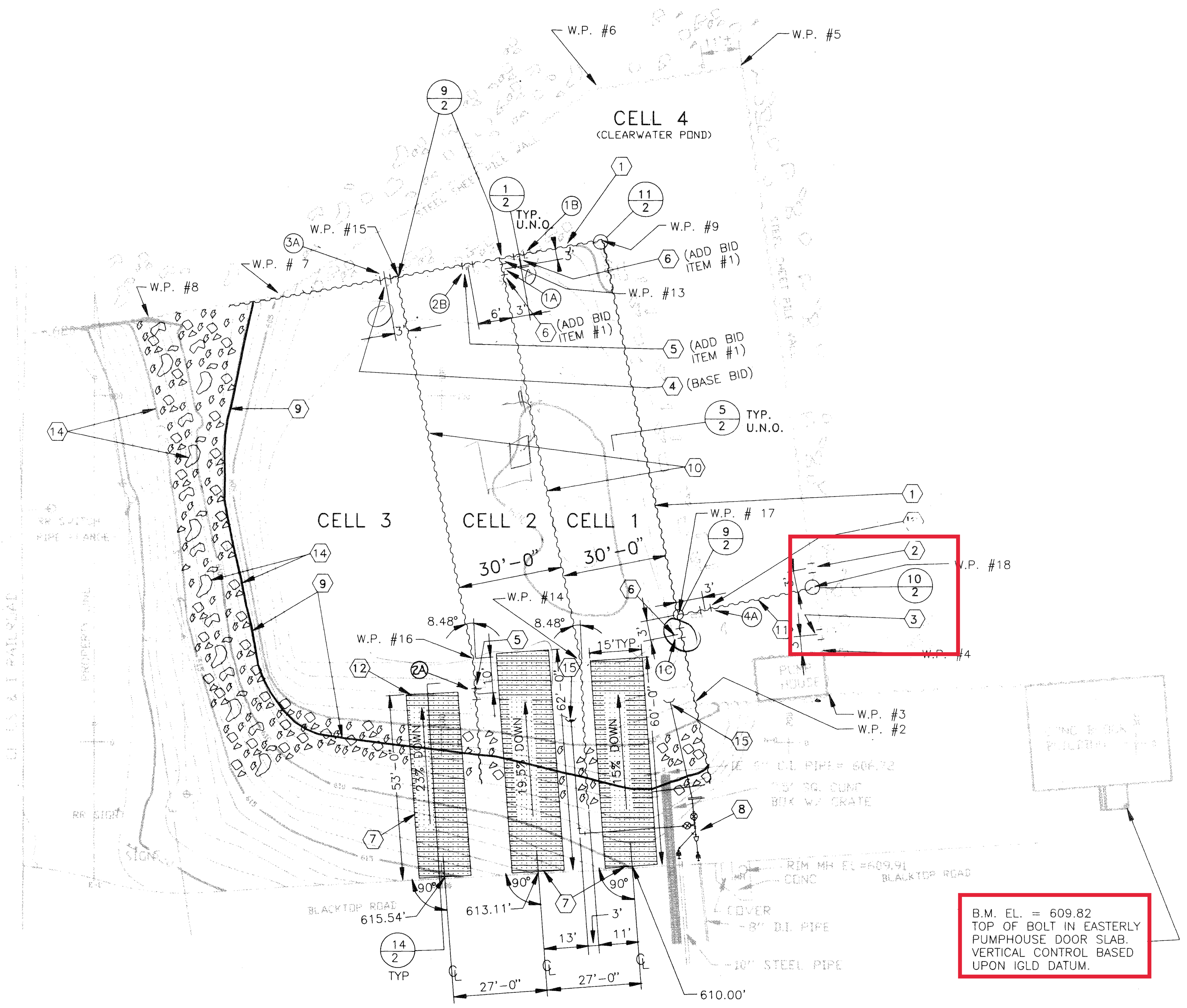
1X	SHEET PILE WALL
	WEIR & WEIR NUMBER
	RIPRAP
— E —	OVERHEAD POWER LINE
	GUY WIRE
	POWER POLE

NOTE

— FOR WEIR DETAILS SEE DETAILS 1,2&3 ON SHEET 2
— FOR PILE DETAIL SEE DETAIL 5 ON SHEET 2
— FOR EMERGENCY OVERFLOW WEIR AND OUTFALL WEIR, SEE DETAIL 8 ON SHT. 2



CINDER POND DEMOLITION / EXCAVATION PLAN
SCALE: 1" = 20'-0"



CINDER POND IMPROVEMENT PLAN
SCALE: 1' = 20'-0"

B.M. EL. = 609.82
TOP OF BOLT IN EASTERLY PUMPHOUSE DOOR SLAB. VERTICAL CONTROL BASED UPON IGLD DATUM.

KEYNOTES

1. 268 L.F. NEW SHEET PILE WALL CS-60 TO ELEV.= 584'-3" (BASE BID)
2. NEW OUTFALL WEIR, ELEV. = 606'-7" SEE DETAIL 13/2 (BASE BID)
3. EMERGENCY OWERFLOW WEIR, SEE DETAIL 12/2, ELEV.= 607'-4 3/4" (BASE BID)
4. WEIR ELEV. = 606'-3"
5. WEIR ELEV. = 606'-5"
6. WEIR ELEV. = 606'-7"
7. CONCRETE LOADER RAMPS (ADD BID ITEM #4)
8. FOR NEW PIPING DETAILS SEE DETAILS 6& 7 ON SHEET 2 (ADD BID ITEM #1)
9. EDGE OF POND
10. 310 L.F. NEW SHEET PILE WALL CS-60 TOE ELEV.= 584'-3" (ADD BID ITEM #1)
11. 41 L.F. NEW SHEET PILE WALL CS-60 TOE ELEV.= 584'-3"(ADD BID ITEM #2)
12. PLACE 15" WIDE x 10' LG. (5.6 SYD) OF PLAIN RIP RAP @ THE END OF THE LOADER RAMP INTO CELL 3.
13. WEIR ELEV. 604'-8"
14. 520 SYD PLAIN RIP RAP ON GEOTEXTILE FABRIC BETWEEN ELEVATION 605.0 AND 608.0 & BETWEEN 605.0 AND 615.0 AS SHOWN AND PER SPECIFICATIONS (ADD BID ITEM #1).
15. INSTALL PRECAST CONCRETE CULVERT END SECTION PER MDOT STANDARD PLAN. IV-86C PLACE 1 SYD PLAIN RIP RAP AT DISCHARGE OUTLET. (ADD BID ITEM #1)

GENERAL NOTES

1. WEIRS SHALL BE PART OF THE SAME BID ITEM AS THE SHEET PILE WALLS IN WHICH THEY ARE LOCATED, U.N.O.
2. WORK POINTS (W.P.) SHALL BE ON ℄'S OF SHEET PILE WALLS UNLESS NOTED OTHERWISE OR SHOWN OTHERWISE ON THE PLANS & DETAILS.
3. SHEET PILE WALLS SHALL BE TERMINATED WHERE THE GROUND ELEVATION IS 608.00'.

WORK POINTS

NUMBER	COORDINATES	
W.P. #1	N0 + 00	E0 + 00
W.P. #2	SEE DETAIL 15/3	
W.P. #3	N0 + 15.63	E2 + 10.39
W.P. #4	N0 + 26.10	E2 + 09.60
W.P. #5	N1 + 95.33	E1 + 86.27
W.P. #6	N1 + 89.46	E1 + 43.67
W.P. #7	N1 + 29.79	E0 + 51.26
W.P. #8	N1 + 23.23	E0 + 15.86
W.P. #9	N1 + 47.25	E1 + 47.81
W.P. #10	N1 + 27.20	E0 + 39.65
W.P. #11	NOT USED	
W.P. #12	NOT USED	
W.P. #13	N1 + 43.75	E1 + 17.95
W.P. #14	N0 + 25.76	E1 + 39.81
W.P. #15	N1 + 38.28	E0 + 88.45
W.P. #16	N0 + 25.20	E1 + 09.40
W.P. #17	N0 + 38.40	E1 + 67.99
W.P. #18	N0 + 45.50	E2 + 06.27

AECOM
FIGURE 3

Sundberg, Carlson and Associates, Inc.
Architects · Engineers · Land Surveyors · Planners

	INITIALS	DATE
DESIGN	G.W./H.W.H.	3/26/90
DRAWN	PRK.	5/3/90
CHECKED	G.W.	5/4/90
APPROVED	DAS	5/7/90

REFERENCE

CINDER POND IMPROVEMENTS
BOARD OF LIGHT & POWER
CITY OF MARQUETTE

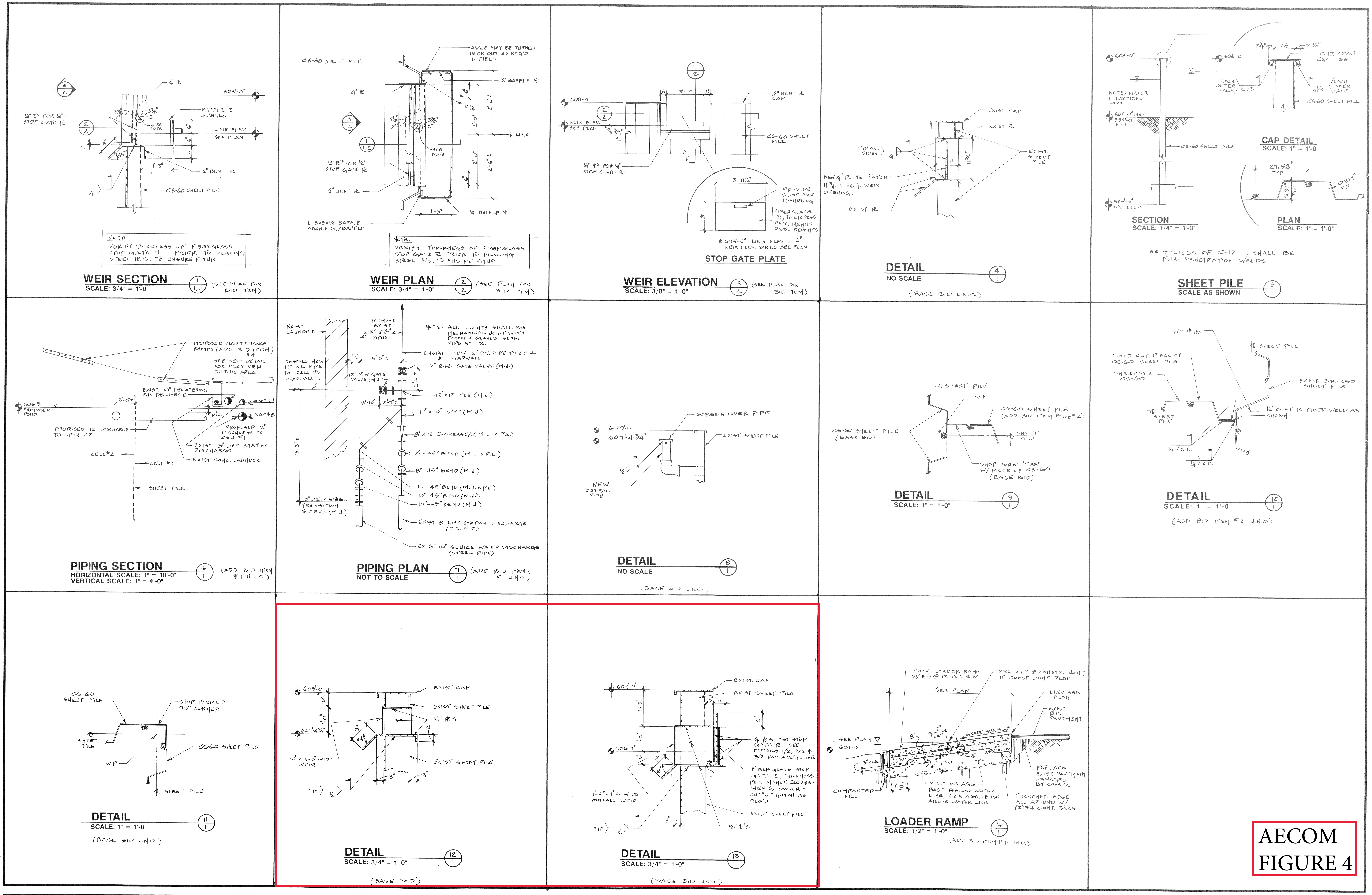
NO.	REVISIONS	BY	DATE
1	AS BUILT	G.W.	8/3/90
0	ISSUED FOR BIDS	G.W.	5/7/90
B	ISSUED FOR 95% REVIEW	G.W.	5/2/90
A	ISSUED FOR 35% REVIEW	G.W.	4/6/90

FIELD / CLIENT / DATE TO — CONTROL

DEMOLITION & IMPROVEMENT PLANS
PROJ. NO. 90-066
REV. NO. 1

1

MARQUETTE OFFICE · 914 WEST BARAGA AVENUE · PO BOX 100 · MARQUETTE, MICHIGAN 49855 · (906) 228-2333



AECOM
FIGURE 4

Sundberg, Carlson and Associates, Inc.
Architects · Engineers · Land Surveyors · Planners

	INITIALS	DATE
DESIGN	GW/HWH	3 26 90
DRAWN	CCW/P.D.K.	4/5/90
CHECKED	GW	4/6/90
APPROVED	DLS	5/7/90

REFERENCE

CINDER POND IMPROVEMENTS
BOARD OF LIGHT & POWER
CITY OF MARQUETTE

NO.	REVISIONS	BY	DATE
1	AS BUILT	GW	2 8 90
0	ISSUED FOR BIDS	GW	5 9 90
B	ISSUED FOR 95% REVIEW	GW	5 2 90
A	ISSUED FOR 35% REVIEW	GW	4 6 90

CONTROL: BIDDERS 5/7; FIELD; CLIENT 4/6 5/2 5/7 12/13; DATE TO A B C O 1 2 3 4 5

DETAILS

PROJ. NO. 90-066 REV. NO. 1

2

MARQUETTE OFFICE · 914 WEST BARAGA AVENUE · PO BOX 100 · MARQUETTE, MICHIGAN 49855 · (906) 228-2333

Appendix C

Hydrologic and Hydraulic Calculations

NOAA Precipitation Data
HydroCAD Output

NOAA Atlas 14, Volume 8, Version 2
Location name: Marquette, Michigan, USA*
Latitude: 46.532°, Longitude: -87.393°
Elevation: 607.93 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

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

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

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

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.285 (0.244–0.334)	0.335 (0.287–0.394)	0.417 (0.356–0.491)	0.484 (0.411–0.572)	0.577 (0.471–0.699)	0.647 (0.516–0.794)	0.718 (0.552–0.899)	0.789 (0.580–1.01)	0.882 (0.622–1.16)	0.952 (0.654–1.27)
10-min	0.417 (0.358–0.489)	0.491 (0.420–0.576)	0.610 (0.521–0.719)	0.709 (0.602–0.838)	0.844 (0.689–1.02)	0.948 (0.756–1.16)	1.05 (0.808–1.32)	1.16 (0.849–1.48)	1.29 (0.911–1.70)	1.39 (0.958–1.86)
15-min	0.508 (0.436–0.597)	0.598 (0.513–0.703)	0.744 (0.636–0.876)	0.865 (0.734–1.02)	1.03 (0.841–1.25)	1.16 (0.922–1.42)	1.28 (0.985–1.61)	1.41 (1.04–1.81)	1.57 (1.11–2.07)	1.70 (1.17–2.27)
30-min	0.681 (0.585–0.800)	0.804 (0.689–0.945)	1.00 (0.856–1.18)	1.17 (0.988–1.38)	1.39 (1.13–1.68)	1.55 (1.24–1.90)	1.72 (1.32–2.15)	1.88 (1.38–2.41)	2.10 (1.48–2.76)	2.26 (1.55–3.02)
60-min	0.852 (0.731–1.00)	1.00 (0.857–1.18)	1.25 (1.06–1.47)	1.45 (1.23–1.72)	1.74 (1.43–2.12)	1.97 (1.57–2.42)	2.20 (1.69–2.76)	2.44 (1.79–3.13)	2.75 (1.94–3.63)	3.00 (2.06–4.00)
2-hr	1.02 (0.883–1.19)	1.20 (1.03–1.40)	1.49 (1.28–1.74)	1.74 (1.49–2.05)	2.10 (1.73–2.54)	2.39 (1.92–2.92)	2.68 (2.08–3.35)	2.99 (2.22–3.82)	3.41 (2.42–4.47)	3.73 (2.58–4.95)
3-hr	1.14 (0.984–1.32)	1.32 (1.14–1.54)	1.64 (1.42–1.91)	1.92 (1.65–2.25)	2.33 (1.94–2.82)	2.66 (2.15–3.26)	3.01 (2.35–3.76)	3.38 (2.52–4.32)	3.89 (2.78–5.09)	4.30 (2.98–5.68)
6-hr	1.38 (1.20–1.58)	1.59 (1.38–1.83)	1.96 (1.70–2.26)	2.29 (1.97–2.66)	2.78 (2.33–3.35)	3.18 (2.59–3.87)	3.61 (2.83–4.48)	4.06 (3.05–5.17)	4.70 (3.39–6.12)	5.21 (3.64–6.84)
12-hr	1.68 (1.48–1.93)	1.94 (1.69–2.22)	2.37 (2.07–2.72)	2.75 (2.39–3.17)	3.31 (2.78–3.94)	3.76 (3.08–4.53)	4.23 (3.34–5.21)	4.73 (3.58–5.97)	5.43 (3.94–7.01)	5.98 (4.21–7.80)
24-hr	2.03 (1.79–2.30)	2.33 (2.05–2.64)	2.84 (2.49–3.23)	3.27 (2.85–3.73)	3.88 (3.28–4.58)	4.37 (3.60–5.22)	4.88 (3.87–5.95)	5.40 (4.10–6.75)	6.12 (4.46–7.83)	6.68 (4.73–8.65)
2-day	2.38 (2.11–2.68)	2.72 (2.41–3.07)	3.30 (2.91–3.72)	3.78 (3.32–4.29)	4.46 (3.78–5.21)	4.99 (4.13–5.90)	5.54 (4.41–6.69)	6.09 (4.65–7.54)	6.85 (5.02–8.69)	7.42 (5.29–9.55)
3-day	2.60 (2.32–2.92)	2.96 (2.63–3.32)	3.56 (3.15–4.01)	4.07 (3.58–4.60)	4.79 (4.08–5.57)	5.36 (4.45–6.31)	5.93 (4.75–7.14)	6.53 (5.01–8.06)	7.34 (5.40–9.28)	7.97 (5.70–10.2)
4-day	2.79 (2.49–3.12)	3.16 (2.82–3.54)	3.78 (3.36–4.24)	4.31 (3.80–4.85)	5.06 (4.32–5.87)	5.66 (4.71–6.65)	6.27 (5.04–7.53)	6.91 (5.32–8.51)	7.78 (5.75–9.82)	8.46 (6.07–10.8)
7-day	3.31 (2.97–3.68)	3.70 (3.31–4.12)	4.37 (3.90–4.87)	4.96 (4.39–5.54)	5.80 (4.98–6.70)	6.48 (5.43–7.57)	7.18 (5.81–8.59)	7.92 (6.13–9.71)	8.95 (6.65–11.2)	9.76 (7.04–12.4)
10-day	3.79 (3.41–4.19)	4.21 (3.78–4.66)	4.93 (4.41–5.47)	5.56 (4.94–6.19)	6.46 (5.58–7.44)	7.20 (6.06–8.39)	7.97 (6.46–9.49)	8.78 (6.82–10.7)	9.90 (7.38–12.4)	10.8 (7.81–13.7)
20-day	5.24 (4.74–5.75)	5.75 (5.19–6.31)	6.61 (5.95–7.28)	7.35 (6.57–8.12)	8.40 (7.28–9.57)	9.24 (7.82–10.7)	10.1 (8.25–11.9)	11.0 (8.61–13.3)	12.3 (9.20–15.2)	13.2 (9.64–16.6)
30-day	6.47 (5.87–7.07)	7.08 (6.42–7.74)	8.08 (7.30–8.85)	8.92 (8.01–9.81)	10.1 (8.76–11.4)	11.0 (9.33–12.6)	11.9 (9.76–14.0)	12.9 (10.1–15.5)	14.1 (10.6–17.4)	15.1 (11.1–18.9)
45-day	8.05 (7.33–8.76)	8.80 (8.01–9.58)	10.0 (9.07–10.9)	11.0 (9.90–12.0)	12.3 (10.7–13.8)	13.3 (11.3–15.1)	14.3 (11.7–16.6)	15.3 (12.0–18.2)	16.5 (12.5–20.2)	17.5 (12.8–21.8)
60-day	9.41 (8.59–10.2)	10.3 (9.39–11.2)	11.7 (10.6–12.7)	12.8 (11.6–14.0)	14.3 (12.4–15.9)	15.3 (13.1–17.4)	16.4 (13.5–18.9)	17.4 (13.7–20.6)	18.6 (14.1–22.7)	19.5 (14.4–24.3)

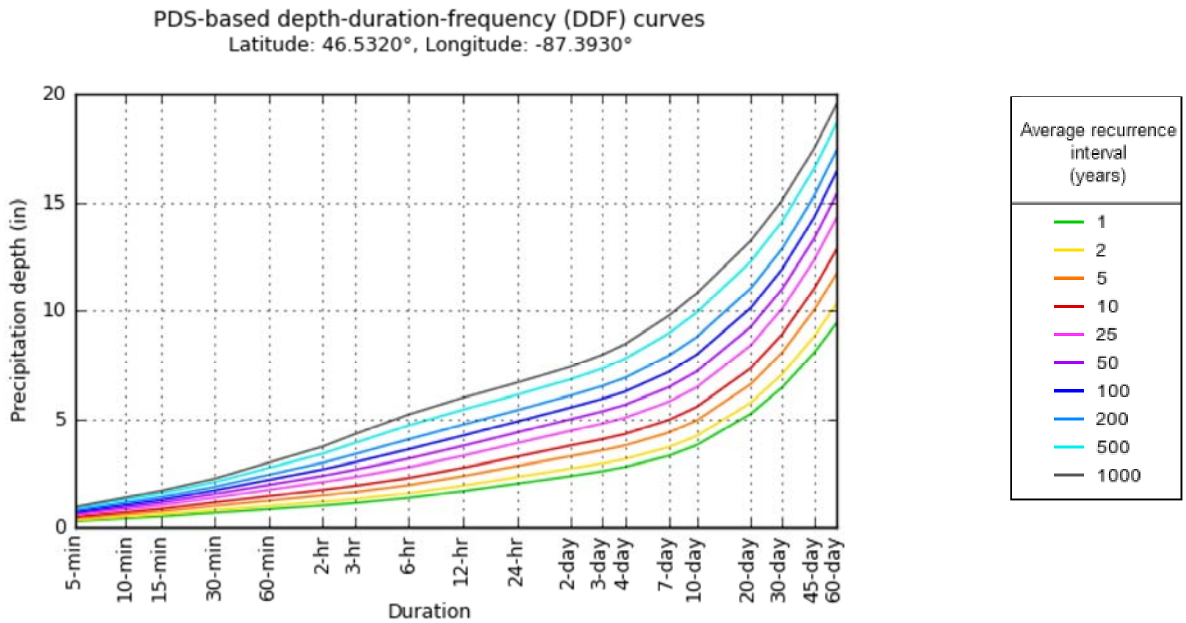
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

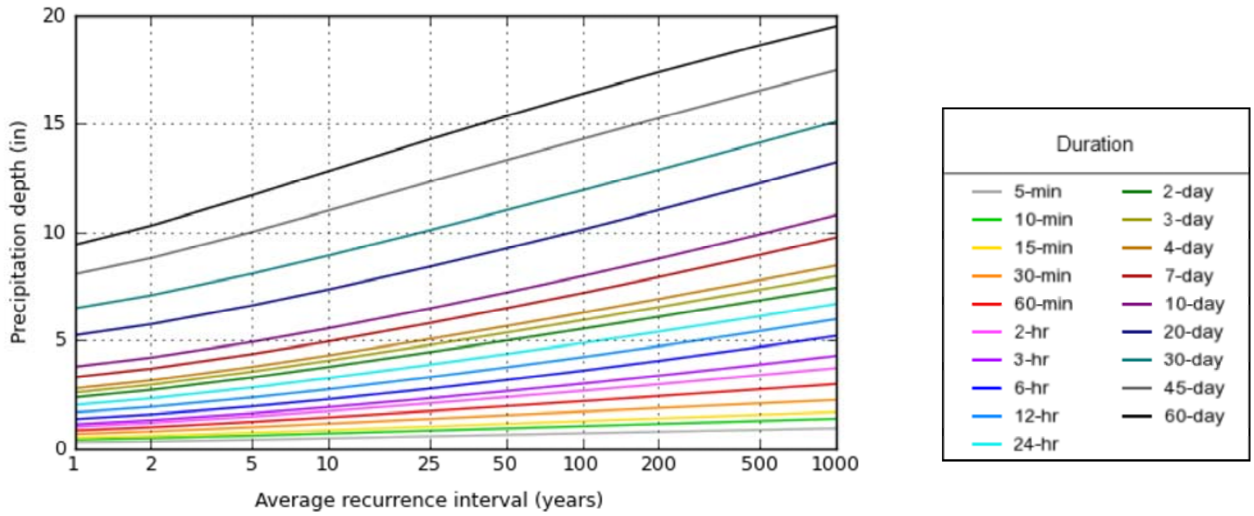
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper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

Please refer to NOAA Atlas 14 document for more information.

Back to Top

PF graphical



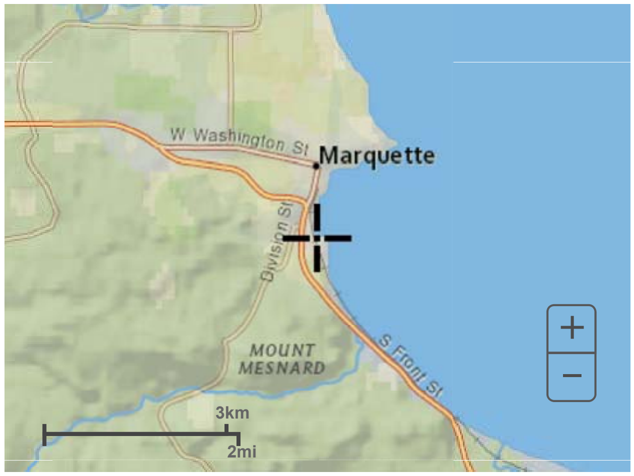


NOAA Atlas 14, Volume 8, Version 2 Created (GMT): Mon Oct 10 23:43:53 2016

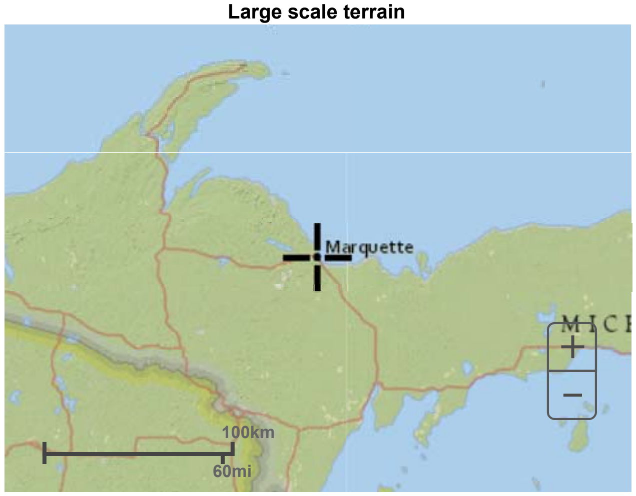
Back to Top

Maps & aerials

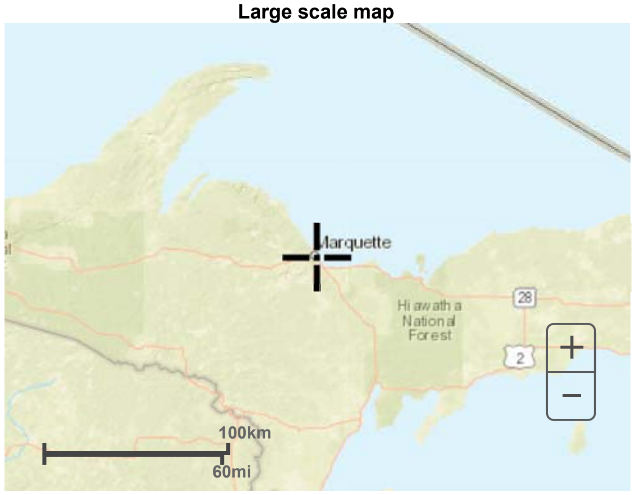
Small scale terrain



Large scale terrain



Large scale map



Large scale aerial

Back to Top

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National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
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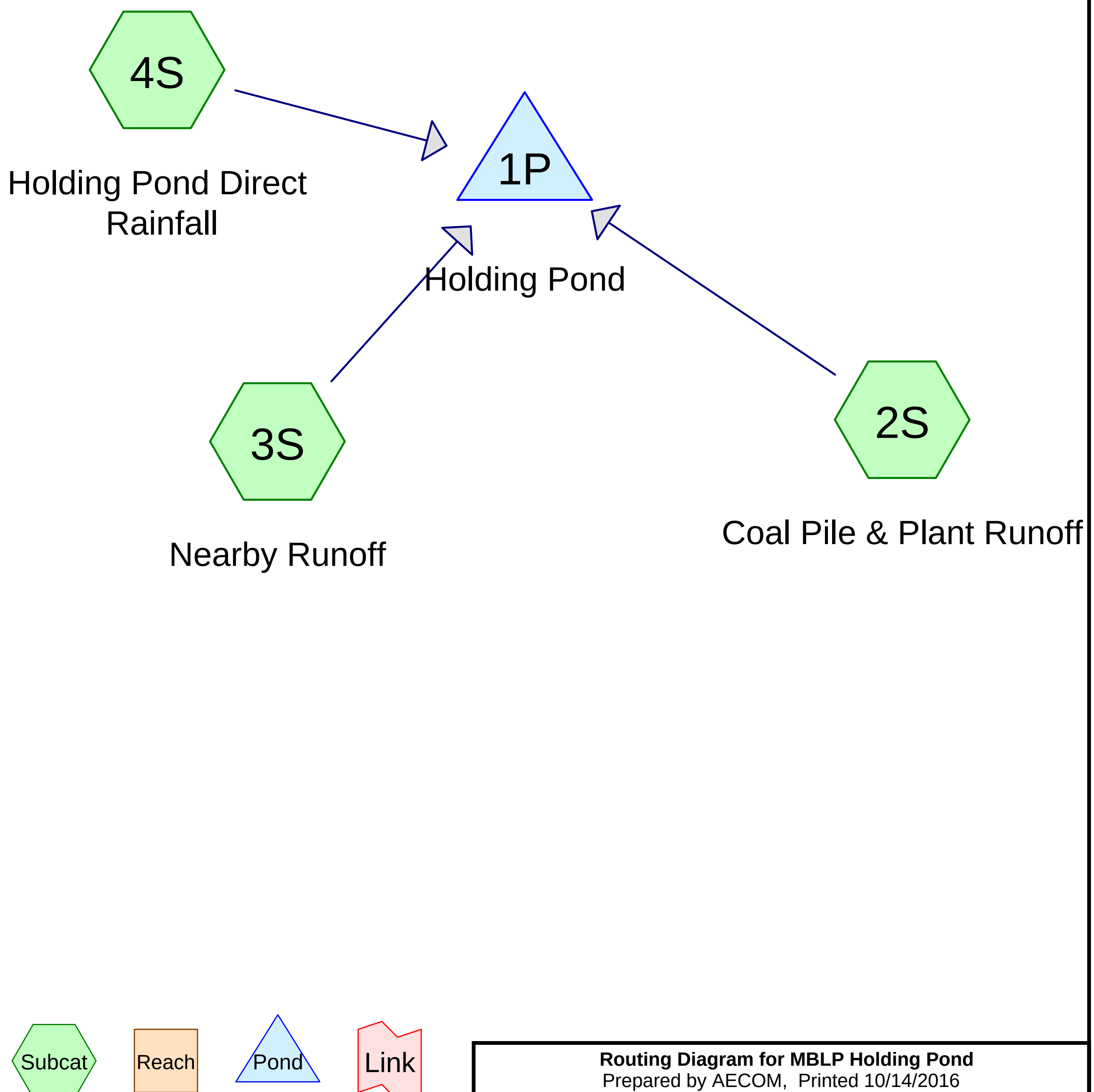


Routing Diagram for MBLP Holding Pond
Prepared by AECOM, Printed 10/14/2016
HydroCAD® 10.00-14 s/n 01723 © 2015 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.332	74	>75% Grass cover, Good, HSG C (3S)
0.344	98	Paved parking, HSG C (3S)
9.816	98	Power Plant, Coal Pile (2S)
0.594	98	Water Surface (4S)
11.086	**97**	**TOTAL AREA**

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 2S: Coal Pile & Plant Runoff Area=427,579 sf 100.00% Impervious Runoff Depth>6.44"
Flow Length=600' Tc=5.9 min CN=98 Runoff=91.32 cfs 5.265 af

Subcatchment 3S: Nearby Runoff Runoff Area=29,455 sf 50.93% Impervious Runoff Depth>5.06"
Flow Length=60' Slope=0.2000 '/' Tc=0.4 min CN=86 Runoff=6.49 cfs 0.285 af

Subcatchment 4S: Holding Pond Direct Runoff Area=25,856 sf 100.00% Impervious Runoff Depth>6.44"
Flow Length=170' Tc=0.4 min CN=98 Runoff=6.36 cfs 0.319 af

Pond 1P: Holding Pond Peak Elev=609.18' Storage=102,271 cf Inflow=99.30 cfs 5.868 af
Primary=11.07 cfs 3.474 af Secondary=23.66 cfs 1.314 af Tertiary=63.58 cfs 0.575 af Outflow=98.31 cfs 5.363 af

Total Runoff Area = 11.086 ac Runoff Volume = 5.868 af Average Runoff Depth = 6.35"
2.99% Pervious = 0.332 ac 97.01% Impervious = 10.754 ac

Summary for Subcatchment 2S: Coal Pile & Plant Runoff

[49] Hint: Tc<2dt may require smaller dt

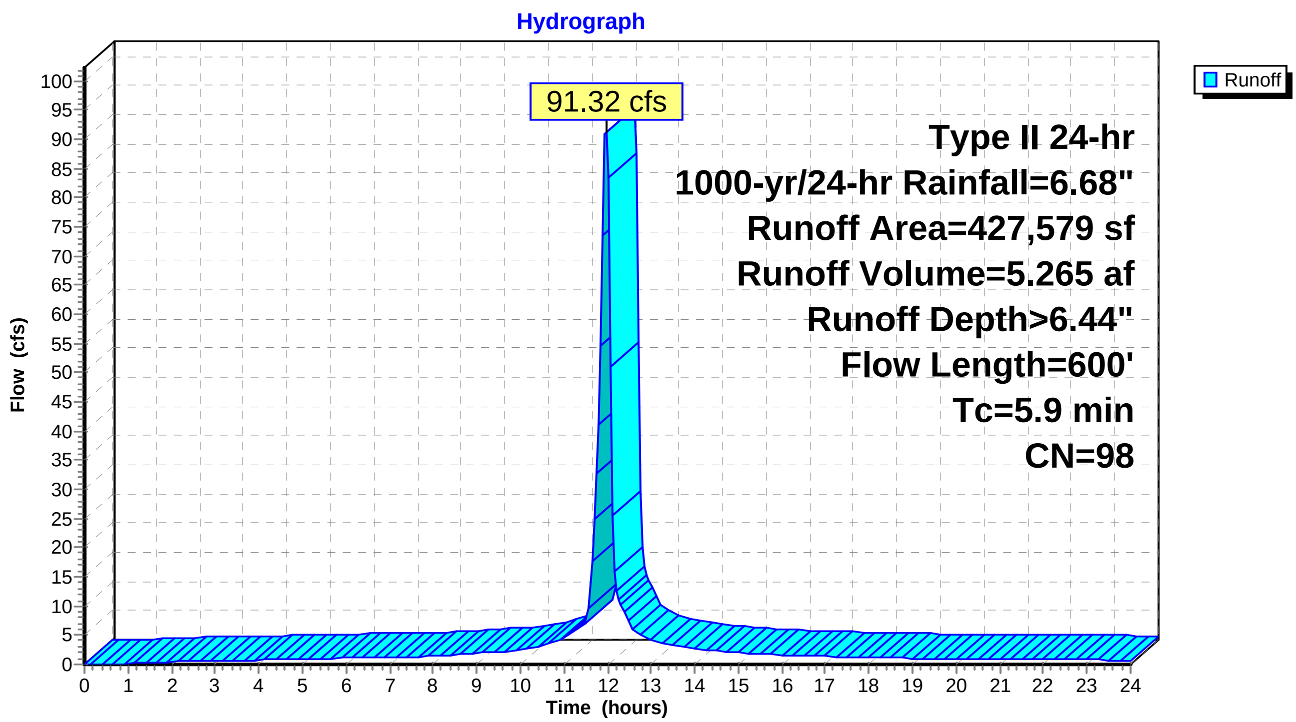
Runoff = 91.32 cfs @ 11.96 hrs, Volume= 5.265 af, Depth> 6.44"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 1000-yr/24-hr Rainfall=6.68"

	Area (sf)	CN	Description
*	427,579	98	Power Plant, Coal Pile
	427,579		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	100	0.2000	2.95		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.33"
5.3	500	0.0060	1.57		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
5.9	600	Total			

Subcatchment 2S: Coal Pile & Plant Runoff



Summary for Subcatchment 3S: Nearby Runoff

[49] Hint: Tc<2dt may require smaller dt

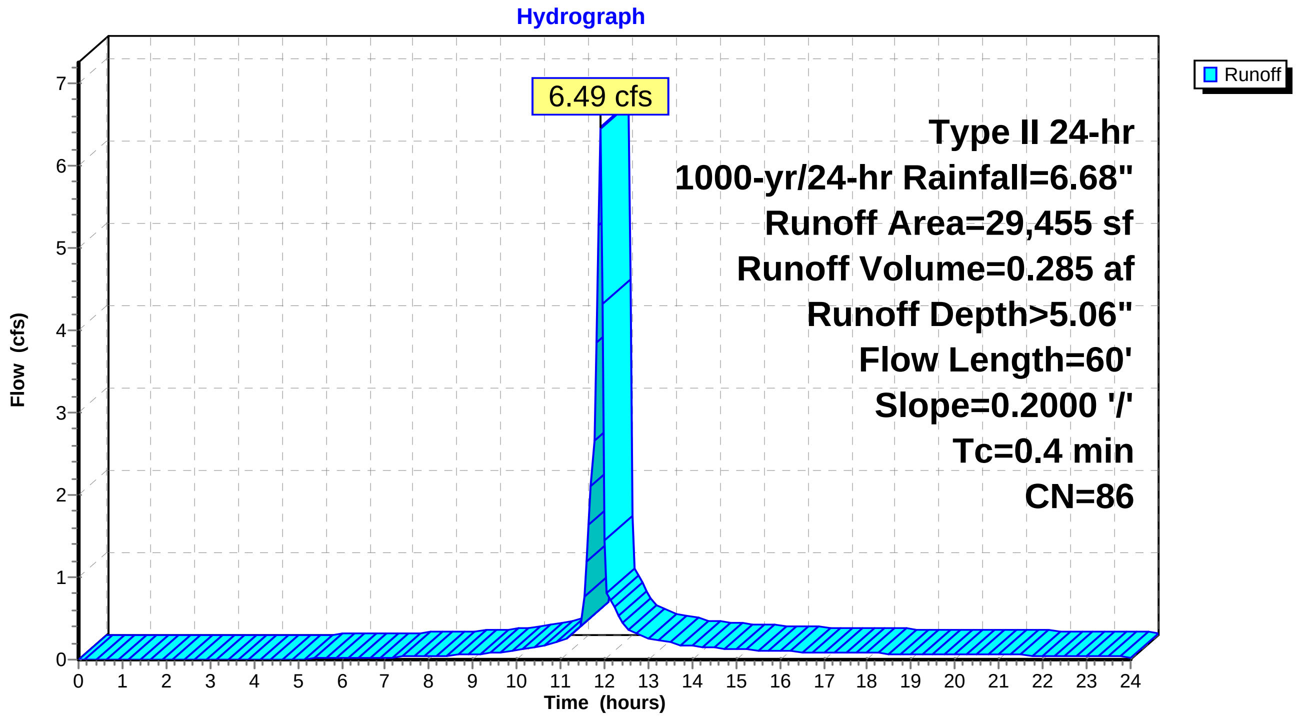
Runoff = 6.49 cfs @ 11.89 hrs, Volume= 0.285 af, Depth> 5.06"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 1000-yr/24-hr Rainfall=6.68"

Area (sf)	CN	Description
15,000	98	Paved parking, HSG C
14,455	74	>75% Grass cover, Good, HSG C
29,455	86	Weighted Average
14,455		49.07% Pervious Area
15,000		50.93% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	60	0.2000	2.66		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 2.33"

Subcatchment 3S: Nearby Runoff



Summary for Subcatchment 4S: Holding Pond Direct Rainfall

[49] Hint: Tc<2dt may require smaller dt

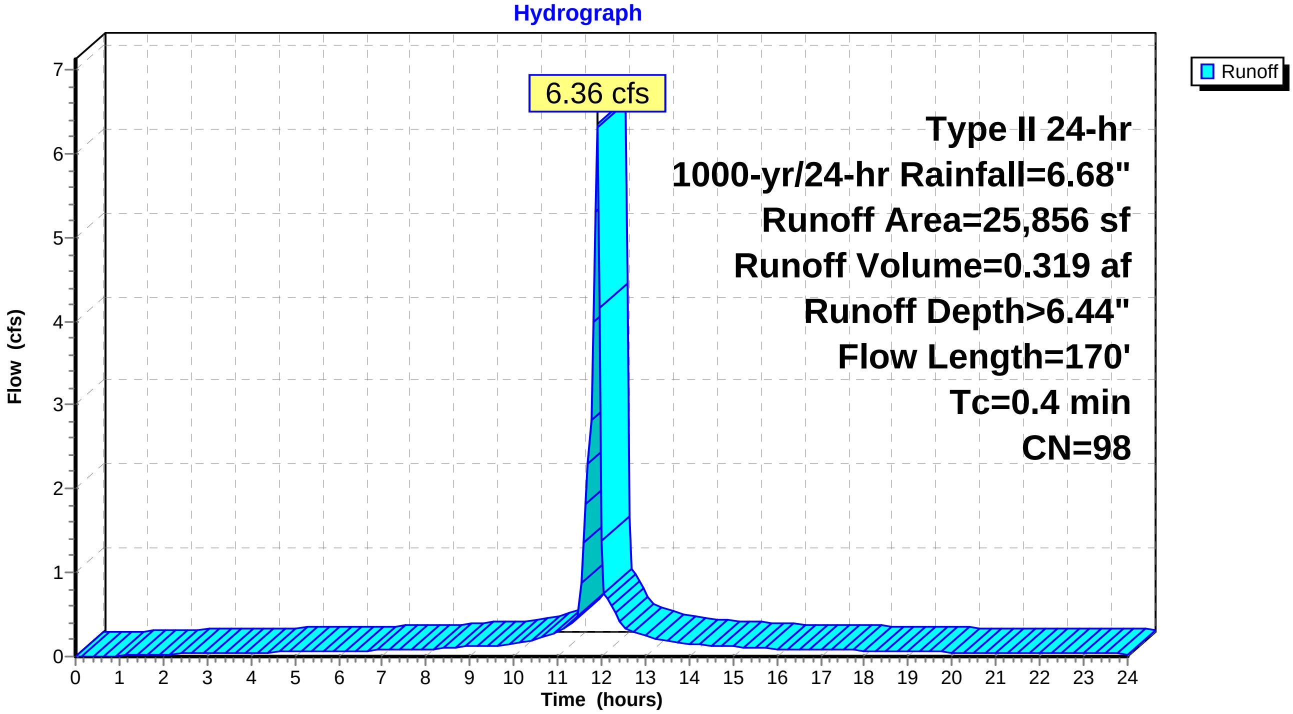
Runoff = 6.36 cfs @ 11.89 hrs, Volume= 0.319 af, Depth> 6.44"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type II 24-hr 1000-yr/24-hr Rainfall=6.68"

	Area (sf)	CN	Description
*	25,856	98	Water Surface
	25,856		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	170		8.02		**Lake or Reservoir,** Mean Depth= 2.00'

Subcatchment 4S: Holding Pond Direct Rainfall



Summary for Pond 1P: Holding Pond

[95] Warning: Outlet Device #1 rise exceeded
[58] Hint: Peaked 0.18' above defined flood level

Inflow Area = 11.086 ac, 97.01% Impervious, Inflow Depth > 6.35" for 1000-yr/24-hr event
Inflow = 99.30 cfs @ 11.95 hrs, Volume= 5.868 af
Outflow = 98.31 cfs @ 12.00 hrs, Volume= 5.363 af, Atten= 1%, Lag= 2.7 min
Primary = 11.07 cfs @ 11.99 hrs, Volume= 3.474 af
Secondary = 23.66 cfs @ 11.99 hrs, Volume= 1.314 af
Tertiary = 63.58 cfs @ 12.00 hrs, Volume= 0.575 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 3
Starting Elev= 606.00' Surf.Area= 22,864 sf Storage= 21,367 cf
Peak Elev= 609.18' @ 11.99 hrs Surf.Area= 25,918 sf Storage= 102,271 cf (80,903 cf above start)
Flood Elev= 609.00' Surf.Area= 25,900 sf Storage= 97,483 cf (76,116 cf above start)

Plug-Flow detention time= 172.7 min calculated for 4.862 af (83% of inflow)
Center-of-Mass det. time= 76.0 min (816.8 - 740.8)

Volume	Invert	Avail.Storage	Storage Description
#1	605.00'	123,433 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
605.00	19,871	0	0
607.00	25,856	45,727	45,727
609.00	25,900	51,756	97,483
610.00	26,000	25,950	123,433

Device	Routing	Invert	Outlet Devices
#1	Primary	606.58'	**1.5' long x 1.00' rise Outfall Weir** 2 End Contraction(s) 1.6' Crest Height
#2	Secondary	607.40'	**3.0' long x 1.0' breadth Emergency Overflow Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32
#3	Tertiary	609.00'	**298.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32

Primary OutFlow Max=11.05 cfs @ 11.99 hrs HW=609.18' (Free Discharge)
└─**1=Outfall Weir** (Orifice Controls 11.05 cfs @ 8.50 fps)

Secondary OutFlow Max=23.54 cfs @ 11.99 hrs HW=609.18' (Free Discharge)
└─**2=Emergency Overflow Weir** (Weir Controls 23.54 cfs @ 4.41 fps)

Tertiary OutFlow Max=60.95 cfs @ 12.00 hrs HW=609.18' (Free Discharge)
└─**3=Broad-Crested Rectangular Weir** (Weir Controls 60.95 cfs @ 1.14 fps)

Pond 1P: Holding Pond