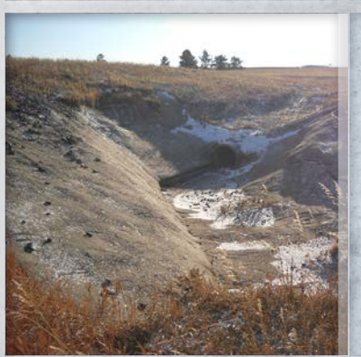
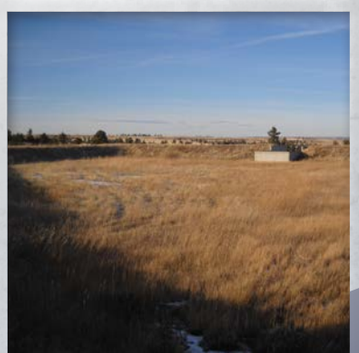
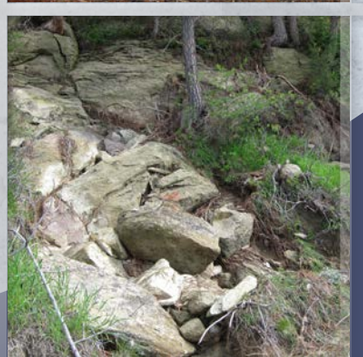
2012 Storm Drain Master Plan

Billings Logan
International Airport
Billings, Montana





March 2012

PREPARED BY: MORRISON MAIERLE, INC.
ENGINEERS • SURVEYORS • PLANNERS • SCIENTISTS

TABLE OF CONTENTS

2012 STORM DRAIN MASTER PLAN
BILLINGS LOGAN INTERNATIONAL AIRPORT
BILLINGS, MONTANA

LIST OF TABLES

APPENDICES

1.0 PURPOSE

The purpose of this Storm Drain Master Plan (SDMP) is to analyze the current drainage system at the Billings Logan International Airport and determine what improvements can be made. This study will provide on-site recommendations for storm water conveyance and detention.

2.0 SUMMARY

The first storm drainage system master plan for Billings Logan International Airport was completed in 1975. An update to the original master plan was completed in 1989 and again in 1996.

The 1975 Storm Drainage Master Plan prepared by Hurlbut, Kersich & McCullough addressed two alternate routes (Sun Valley Route and Moon Valley Route) for a storm drain outfall main from the airport property to Alkali Creek. The Moon Valley Route intercepted less surface drainage, however was determined to have a steeper outfall resulting in a smaller diameter pipe and thus a lower cost. This report also discussed the installation of a trunk main along the north side of Runway 10L/28R (old Runway 9L/27R). This report also recommended to construct an open ditch northerly into the coulee northwesterly of Runway 10L/28R. At this time the design criteria used for storm drain pipe was a five-year storm in accordance with FAA AC 150/5320-5B (1970). The design analysis for this report was based off the Rational Method. Rainfall intensities were taken from the MMI Storm Drain Improvement (1962).

In 1976 Ponds A, B, and C were constructed along with Pond D.

The 1989 Storm Drain Master Plan prepared by HKM Associates incorporated numerous changes including the construction of Runway 7/25, extension of Runway 10L/28R (old 9L/27R), the construction of Runway 10R/28L (old 9R/27L), regrading of the west end of the airport, and the purchase of additional property. This master plan also used a 5-year design storm to evaluate the storm drain pipe network in accordance with FAA AC 150/5320-5B (1970). This report states that based on correspondence with the FAA it was agreed that storage facilities would be evaluated using a 25-year storm. The other major purpose of this report was to utilize improved methods of storm drainage analysis that became available at this time. The design analysis was now able to utilize the U.S. Environmental Protection Agency Storm Water Management Model (SWMM) version PCSWMM 3rd ed., 1986. Rainfall amounts were obtained from the City of Billings Stormwater Management Manual (1986). This report concluded that detention ponds A, B, and C were oversized at that time. It noted the pipes that did not have adequate capacity and discussed the advantages this has to the downstream pipes and pond networks. This report proposed a new detention Pond E.

In 1988 Pond E was constructed.

The 1996 Storm Drainage System Master Plan Update prepared by Morrison Maierle, Inc. was a supplement and update to the 1989 drainage plan. Changes that were incorporated in this report include the west end T-hangar site, the west concrete parking apron, the terminal building expansion and parking, the east end commercial hangar area, and the projected future expansion of airport facilities. This report also used the 5-year design frequency to analyze the storm drainage pipes in accordance with FAA AC150/5320-5B. In accordance with the previous master

plans, this report used a 25-year storm to analyze the storm detention ponds. Like the previous report, the design analysis used the U.S. Environmental Protection Agency Storm Water Management Model (SWMM) version PCSWMM 3rd ed., 1986. Rainfall amounts were also obtained from the City of Billings Stormwater Management Manual (1986).

On June 20, 2010 and May 24, 2011 ponds A, B, and C overflowed the concrete overflow weir at dike C. There have been no other reported storm events that have overflowed Pond C since their construction in 1976. Temporary 2 feet weir extensions were placed by the airport on ponds A, B, and C in order to increase the storage should another large storm occur.

This report will incorporate major changes since the1996 SDMP including Taxiway J Construction, Cargo Apron Slots 1, 2, 3 Construction, Service Road Construction, Taxiway D Construction, Taxiway A straightening, Concrete Gate B-4 and added slotted drain, the Rental Car Quick Turn Around Site, Taxiway G relocation, and the MDT Airport Road project. This report will summarize the existing stormwater system at the airport, explain the modeling process used, and give the storm drainage analysis results along with recommended improvements.

3.0 EXISTING STORMWATER SYSTEM

The airport is situated on top of the Rimrocks, located within the City of Billings. The northern boundary of the airport includes steep sandstone cliffs and multiple natural drainages into the Alkali area. The southern boundary of the airport is along Montana Highway 3 that borders a steep sandstone cliff. See Exhibit 1 for the Overall Drainage System Site Plan. The following summarizes the four independent drainage systems at Billings Logan International Airport.

3.1 DRAINAGE SYSTEM 1

Drainage System 1 is the southeasterly side of the airport and includes detention Ponds A, B, and C and the pipe network that drains into these ponds. The airfield areas east of decommissioned runway 16/34 flow into the three ponds via the airport's pipe network and eventually discharge into Alkali Creek. This drainage system includes the Airport Terminal area and parking lots, Aircraft Rescue and Fire Fighting Facility, cargo ramps, General Aviation East Aprons, and runway and taxiways east of Taxiway "G". See Exhibit 2 for Drainage System 1 Site Plan.

Ponds A, B, and C were constructed in 1976. The 24 inch discharge pipe from the ponds to Alkali Creek was also constructed at this time. Design plans for the ponds and discharge pipe were prepared by Hurlbut, Kersich and McCullough. The ponds were designed to have 2.5:1 side slopes with a bentonite soil mix lining on inside/upstream faces. The 9 foot high earth dikes were designed with a keyed-in base. The concrete structures at dikes A and B have a 9 inch high x 12 inch wide opening located at the pond bottom elevation. The concrete overflow weirs (25 ft x 25 ft x 25 ft) were designed to be 6 feet higher than the bottom of the ponds with an additional 3.5 foot freeboard to the top of the wall. The concrete structure at dike C was designed to have a 24 inch RCP outflow with a concrete overflow weir located 3.25 feet above the top of the concrete slab with an additional 3.5 foot freeboard to the top of wall. The 24 inch x 2582 linear foot RCP discharge pipe drops 185 feet of elevation and was designed to have the last 851 feet enlarged to a 36 inch RCP, constructed with two (2) 56 foot segments of Energy Dissipator Rings before entering Alkali Creek. See Appendix B for selected as-built sheets from A.D.A.P. 07 for the design of Ponds A, B, and C.

According to the 1989 Storm Drain Master Plan for BLIA , based on correspondence with the FAA it was agreed that storage facilities would be evaluated using a 25-year storm. According to the 1996 Storm Drainage System Master Plan for BLIA the three ponds are capable of detaining the 25 year occurrence storm. Ponds A, B, and C overflowed on June 20, 2010 and May 24, 2011 during two major storm events estimated to be approximate 100-year storms. This overflow added to the downstream flooding along the Alkali Creek Area.

The storm conveyance piping systems at the airport have been previously analyzed using the 5-year design frequency in accordance with FAA AC 150/5320-5B. There are multiple pipes that are over capacity for the 5-year flow, however it has been noted in the 1996 SDMP that the ponding created by these undersized pipes is considered acceptable and that the majority of these pipes should not be enlarged in order to preserve the additional detention capacity provided by on site ponding. There are some areas on the airfield that did experience damage during these major storms due to the undersized pipes. However, until the ponds are enlarged the ponding due to the surcharged pipes is considered acceptable to the airport at this time.

3.2 DRAINAGE SYSTEM 2

Currently, Drainage System 2 includes detention Pond D and the area along decommissioned runway 4/22 that contributes to this pond. Design plans for Pond D were prepared by Hurlbut, Kersich and McCullough (see Appendix B for selected as-built sheets from A.D.A.P. 07). Pond D was designed to discharge through a 10 inch ductile pipe located at the floor of the pond. This discharge then surface flows down an existing natural ravine into Sun Valley Road. The overflow for the pond was designed with a 60 inch drop inlet (no grate) located 5 feet above the floor of the pond discharging to a 48 inch spillway. See Appendix B for selected as-built sheets from A.D.A.P. 07 for the design of Pond D.

According to the 1989 Storm Drain Master Plan for BLIA, based on correspondence with the FAA it was agreed that storage facilities would be evaluated using a 25-year storm. A 24 inch RCP originally discharged into this pond, but the pipe network was diverted in 1988 when runway 4/22 was decommissioned and the pavement surface was removed and reseeded to grass pasture. Pond D currently detains a small amount of surface runoff from the grass pasture areas. According to the 1996 Storm Drainage System Master Plan for BLIA, Drainage System 2 is substantially underutilized. There has been no reported storm events that have overflowed this pond system. The airport received complaints concerning water damage from residents who live on Sun Valley Road during the June 20, 2010 storm and the May 24, 2011 storm due to surface runoff. Almost all of the surface runoff contributing to Sun Valley Road is from unimproved grassed areas that naturally slope towards this subdivision.

3.3 DRAINAGE SYSTEM 3

Drainage System 3 is the area west of decommissioned runway 16/34 that drains into detention Pond E. This drainage system includes runway 10R/28L, the western half of runway 7/25, the western end of runway 10L/28R, the west end T-hangar site, the Rental Car Quick Turn Around Facility, and the grassed surfaces between these improved areas.

Design plans for Pond E were prepared by HKM Associates in 1988. The ponds were designed to have 2.5:1 side slopes with a membrane liner on inside/upstream faces. The concrete overflow weirs (25 ft x 25 ft x 25 ft) are 7 feet higher than the bottom of the ponds with an additional 3.5 foot

freeboard to the top of the wall. Pond E discharges through a 24 inch RCP located at the bottom of the pond with a 36 inch segment at the outlet and continues as surface flow down an existing natural ravine into an area of Alkali that is presently undeveloped. See Appendix B for selected "as-built" sheets from AIP 07 for the design of Pond E.

According to the 1996 SDMP, Pond E was designed to detain a 25-year occurrence storm and was capable of handling the existing flows at that time. There has been no reported storm events that have overflowed this pond system. The outfall of this discharge pipe does experience minor erosion during the larger storm events due to both surface runoff channeled to this outfall and the outfall from the pipe itself.

3.4 OFF-SITE DRAINAGES

The following are the areas of Airport property that are not intercepted by the existing pond systems and drain off-site. See Exhibit 4 for the Offsite Drainage Site Plan.

Areas A and B are located at the eastern end of the airport property. This area of land surface flows down into two natural ravines through property owned by the Billings Saddle Club that is mostly undeveloped. No projected airport improvements are planned for this area.

Area C includes subdivisions along Tumbleweed Drive and Pinon Drive. Some of the overflow from Pond C during the June 20, 2010 and May 24, 2011 storms cascaded down a natural ravine across two developed lots, then into Tumbleweed Drive where it discharged through a curb inlet. There are segments of dedicated drainage easements shown on the subdivision plats for Tumbleweed Drive and Pinon Drive, however the drainage easement does not extend through the two developed lots where the overflow runs. There is not a continuous drainage route from the airport property to Alkali Creek through this subdivision.

Area D includes subdivisions along Moon Valley Road and Moon Beam Lane. This area also includes the Business Park Complex off of Rimtop Drive. The majority of the overflow from Pond C during the June 20, 2010 and May 24, 201 storms cascaded down the rims across one developed lot, then into Moon Valley Road where it is joined with surface runoff as it continued down the dedicated street right of way to Moon Beam Lane crossing through multiple developed lots to Alkali Creek Road.

Area E includes subdivisions along Sun Valley Road, Evergreen Drive, and Pine Tree Drive. Area F includes subdivisions along Prickly Pear Drive, Sage Drive, Foothill Drive, Woodland Trail and Valley Heights Road. These subdivisions have had a history of stormwater issues that have repeatedly resulted in property damage.

The Valley Heights Road Extension and Sun Valley Road – RSID 691 Drainage Investigation Report prepared by Morrison Maierle in 2004 states that the Sun Valley Road drainage system consists of various sized driveway culverts and conveyance pipes on private properties on the eastern side of the road. At that time the culverts mostly ranged from 15 inch CMP to 24 inch CMP. In addition, the larger culverts were located upstream and got smaller as you move further down the basin. This report summarized the pipe capacities noting that the actual capacities were a fraction of the needed capacities for even a 2-year, 24-hour storm. The report estimates that for a 2-year, 24-hour storm the pipes should be at least 36 inch RCP and for a 10-year, 24-hour storm the pipes should be at least 48 inch RCP. Also, in 2003 Engineering Inc. designed RSID 691 that would provide storm drain improvements and street paving. A decision was made to proceed with

the project paving and not address the undersized storm system at that time. Any culverts that have not been enlarged will continue to see the washout problems that this subdivision often experiences.

The Valley Heights Road Extension and Sun Valley Road – RSID 691 Drainage Investigation Report prepared by Morrison Maierle in 2004 states that the lower portion of Valley Heights Road does not have a drainage system and that all runoff travels uncontrolled down the road until it reaches Alkali Creek Road. The upper portion does have a designed drainage system designed by KLJ, including two retention ponds that reportedly has adequate storage for the 2-year, 24-hour event.

Areas G and H are undeveloped areas northeast of decommissioned runway 16/34. All stormwater runoff is via surface flow down natural ground until it reaches Alkali Creek. These areas have a potential for subdivision and subsequent improvements, therefore it is very important to be instrumental in identifying needed drainage ways for both Yellowstone County and the City of Billings to ensure that the drainage routes are not lost to development.

Area I is west of the Runway 10L end. This area includes a short pipe network segment that discharges into a natural ravine and surface flows down to Alkali Creek. It also includes the discharge from Pond E.

Area J is a large, mostly undeveloped area at the northwest end of the airport property that was the old Logan Ranch property and includes the burn pit.

Areas K, M, N, and O are all areas on the west end of the airport property that drain to a culvert crossing under Highway 3 and discharge south over the Rims.

Area L is an area on the west end of the airport property that drains to a natural retention pond.

4.0 MODELING

4.1 STORMWATER MODELING

HydroCAD-10 was used to model the airport's storm drain system. The SCS Unit Hydrograph Method (SCS TR-20), with a Type II distribution was used. The pre-development subcatchment areas (before the airport was built) were delineated and modeled in HydroCAD using 20-ft contours based on the following Billings East USGS Quad Maps (1956, Photorevised in 1969 and 1975).

The post-development or current subcatchment areas were delineated and modeled using 2-ft contours stereodigitzed by MMI/CSSA in 1995. Aerial photography was used to estimate the amount of impervious areas outside the airport survey mapping. Previous data collected for the Billings Logan storm drainage system did not include elevation data since the SWMM software did not require it. Since the HydroCAD Stormwater Modeling software requires elevation data, this data was collected for all ponds, pipes, and channels in the model. Elevation data was taken from previous as-built plans adjusting older projects from the old NGVD29 datum to the current NAVD 88 datum (2.56 ft higher). Elevation data that could not be found on as-built plans was obtained through pick-up survey. Ponds A, B, C, D, and E were modeled using surveyed elevations.

4.2 PRECIPITATION DATA

The precipitation data for this SDMP was taken from the City of Billings Stormwater Management Manual (SWMM) dated February 2011. Table 3.4 of the SWMM, Intensity-duration for Billings, Montana, is attached in Appendix C. The storms modeled for this report are listed in Table 1 below.

Table 1. Rainfall Depths

Storm Frequency and Duration	Depth (inches)
2-year, 24-hour	1.44
5-year, 24-hour	1.90
10-year, 24-hour	2.20
25-year, 24-hour	2.70
50-year, 24-hour	3.03
100-year, 24-hour	3.38

Ponds A, B, and C overflowed the concrete overflow weir at dike C on June 20, 2010 and May 24, 2011. See Appendix C for the storm data related to these storms. According to the National Weather Service, the June 20, 2010 storm resulted in 2.24 inches of rainfall between the readings of 4:06 pm and 5:53 pm (span of 1 hour, 47 minutes). This rainstorm was characterized with high intensity rainfall, large hail, and a tornado that touched down on Main Street in the Billings Heights. According to Table 3-4 of the Billings SWMM (also in Appendix C), the 100-year, 2-hour storm for Billings has an intensity of 0.91 inches per hour (1.82 inches total). The May 24, 2011 Storm resulted in 3.32 inches of rainfall between the readings of 5:53 am on May 24 and 5:53 am on May 25 (span of 24 hours). The 100-year, 24-hour storm for Billings has an intensity of 3.38 inches per hour. In addition, the soil conditions were wetter than normal during the May storm which would have contributed to less infiltration and more runoff.

4.3 DESIGN CRITERIA

Billings Logan International Airport is a separate and isolated entity that is not specifically addressed in the local standards. However, in order to determine a design event, the local standards were addressed.

The Federal Aviation Administration (FAA) Advisory Circular, AC 150/5320-5C, dated 9/29/2006 states that for detention facilities “An auxiliary outlet must be provided to allow overflow that may result from excessive inflow or clogging of the main outlet. This outlet should be positioned such that overflows will follow a predetermined route.” [8-3.1.2] This AC’s guidance on a design event for detention facilities states that is must be consistent with applicable local requirements and notes that a more common recent criteria is to design a detention facility using multiple storm frequencies. According to the 1996 SDMP, the storm conveyance piping systems were analyzed with a 5-year frequency design storm in accordance with FAA 150/5320-5B. The current AC (150/5320-5C) states, “For airports, it is recommended that the 5-yr storm event be used with no encroachment of runoff on taxiway and runway pavements (including paved shoulders). The damage or inconvenience that may be caused by storms greater than the 5-yr event may not warrant the increased cost of a drainage system large enough to accommodate that storm.” Section 2-2.5 of AC 150/5320-5C states, “The center 50 percent of runways; the center 50 percent of taxiways serving these runways; and helipad surfaces along the centerline should be free from ponding resulting from storms of a 10-yr frequency and intensity determined by the geographic

location."

Circular DEQ 8, Montana Standard for Subdivision Storm Drainage, 2002 Edition states that "Detention ponds shall be sized for a 2-year event, but must also be analyzed for a 100-year event, to ensure that no home sites or drainfields are inundated during this event. If this analysis shows that the capacity of the pond will not hold the entire event, the analysis must include a description of where the excess water will go, and what the potential downstream damages may be. In this case, the analysis must also compare the pre-development situation with the proposed development situation." It also states, "For detention ponds, the design event should have a duration at least equal to twice the time of concentration, but never shorter than one hour."

The Stormwater Management Manual for Billings, Montana dated February 2011 states that Comprehensive Drainage Plan (CDP) Sites "will be required to size their on-site storm drain facilities based upon the 50-year, 24-hour storm and the assumption of no discharge to the City's storm drain system." And it states, "All subdivisions must evaluate the 100-year, 24-hour storm and ensure stormwater does not runoff subdivision at a rate greater than the natural conditions prior to subdividing land." And "Under no circumstances shall runoff generated from a commercial or industrial site leave that site and drain to a neighboring property." However, the airport is not categorized as a subdivision or a commercial or industrial site as mentioned in the above guidelines. Billings Logan International Airport is considered to be a separate entity and although the airport is located within city limits, the City of Billings did not include the airport in the Stormwater Management Manual. Our analysis will size the detention ponds for the more stringent design criteria using the 100-year, 24-hour storm.

The design criteria detailed above is summarized in Table 2 below.

Table 2. Design Criteria

Storm Event	Design Standard
2-Year	DEQ 8: Subdivisions – Detention Pond Sizing
5-Year	AC 150/5320-5C – Pipe Sizing w/ no TW/RW encroachment
10-Year	AC 150/5320-5C – Pipe Sizing w/ 50% TW/RW encroachment
25-Year	Previous SDMP Design Criteria – Detention Pond Sizing
50-Year	SWMM: Billings CDP Sites – On-Site Storm Drain Facility Sizing
100-Year	SWMM: Billings Subdivisions – Stormwater Runoff Evaluation DEQ 8: Subdivisions - Detention Pond Analysis

In summary, the ponds will be evaluated using the 100-year, 24-hour storm. This analysis will also include descriptions of the pond outfall routes for any excess water should a larger storm occur. Additional analysis was also completed for the 2-year, 5-year, 10-year, 25-year, and 50-year, 24-hour storms to address the above requirements. The stormwater pipe network will be analyzed using a 5-year, 24-hour storm and the 100-year, 24-hour storm.

5.0 STORM DRAINAGE ANALYSIS RESULTS

The subcatchments were modeled with one of the following SCS/NRCS (Soil Conservation Service/Natural Resources Conservation Service) curve numbers. A curve number of 70 was used for the unpaved areas and represent a soil group designation of "C", a description of "brush, brush/weed/grass mix", and of "fair" condition. A curve number of 98 was used for all impervious areas including the paved parking lots, runways, taxiways, roadways, and building roofs.

The pipes were modeled as either a reinforced concrete pipe with a Manning's "n" value of 0.012 or a corrugated metal pipe with a Manning's "n" value of 0.025. An entrance loss coefficient was applied to each inlet to indicate the degree of energy loss at the entrance. An entrance loss coefficient of 0.01 was used for all entrances within a pipe network representing a very smooth, efficient entrance. An entrance loss coefficient of 0.80 was used for all drop inlets representing a more turbulent, restricting entrance. For a pipe that has an entrance of both a drop inlet and also a connecting pipe, an entrance loss coefficient of 0.5 was used. For a RCP culvert with an end-section conforming to fill an entrance loss coefficient of 0.5 was used. The invert and rim elevations of each pipe was gathered from available as-built drawings and pick-up survey where needed. The elevation data, along with length, slope, and size was then entered into HydroCAD.

HydroCAD does not calculate the capacity of the pipes. Rather, HydroCAD routes the stormwater through the pipe and gives a warning message when the water elevation is higher than the defined flood elevation thus indicating when water spills out the manhole. Therefore, a spreadsheet calculating pipe capacity is included in Appendix H. Pipe capacity is calculated based on Manning's Equation. All pipes are assumed at 100% capacity, with an unsubmerged inlet and outlet. The HydroCAD model does not include all pipes within the airport storm drain system. For a full view of all airport pipes see Appendix A.

5.1 DRAINAGE SYSTEM 1

The subcatchments and pipes within Drainage System 1 flow into detention Ponds A, B, and C. Ponds A, B, and C outfall into Alkali Creek through a 24 inch RCP. The airport's pipe network includes many undersized pipes. These undersized pipes restrict the flow in the ponds and create more on-site detention areas. In some areas, the surcharged pipes created enough pressure to overflow and push the lids off the manholes. This creates surface stormwater to flow to areas of natural ponding. The ponding in these areas is considered acceptable and beneficial to the operation of the pond system. Once the peak is routed through these pipes, the natural ponding areas drain through the pipe network and into the ponds. The model was created to estimate these major areas of on-site storage. See Appendix D for the HydroCAD Routing Diagram.

The results for Ponds A, B, and C are also shown in Appendix G. These ponds have an inflow area of 336 acres that is approximately 53% impervious. See Table 3 below for a summary of Ponds A, B, and C for a 100-year, 24-hour storm. For this storm the model estimates that Ponds A, B, and C are capable of storing 12.0 acre-feet, 9.7 acre-feet, and 7.9 acre-feet (at peak elevation), respectively for a total of 29.5 acre-feet. The static volume of ponds A, B, and C (based on survey) to the top of the concrete overflow weir is 9.4 acre-feet, 8.4 acre-feet, and 6.9 acre-feet, respectively for a total of 24.7 acre-feet. HydroCAD estimates the amount of actual storage obtained for the storm being modeled taking into account the head, or depth of water, going over the weir. The model estimates that for a 100-year, 24-hour storm that the peak flow at Pond C will overflow 5 inches above the concrete weir at a rate of 58 cfs for a total volume of 6.1 acre-feet.

Table 3. Summary for Ponds A, B, and C

100-year, 24-hour storm							
	Pond A		Pond B		Pond C		Total
	Peak (cfs)	Volume (AF)	Peak (cfs)	Volume (AF)	Peak (cfs)	Volume (AF)	Volume (AF)
Static Volume (top of weir)		9.4		8.4		6.9	24.7
Inflow	292	54.3	248	54.3	174	54.2	
Primary Outflow (9"x12" Orifice for A/B or 24" outfall pipe for C)	9	20.2	9	27.2	35	48.0	
Secondary Outflow (concrete overflow weirs)	238	34.0	165	27.0	58	6.1	
Storage at Peak Elevation		12.0		9.7		7.9	29.5
Peak Elevation	13" above weir		11" above weir		5" above weir		

For a complete summary of results for Drainage System 1 see Appendices E through G. The HydroCAD output for the 5-year, 24-hour storm is included in Appendix E and the 100-year, 24 hour storm is included in Appendix F. Appendix G includes the HydroCAD output for the Ponds and includes the 2-year, 5-year, 10-year, 25-year, 50-year, and 100-year, 24-hour storms.

The two storms that caused Ponds A, B, and C to overflow were also analyzed in HydroCAD. The June 20, 2010 storm was estimated to be a 100-year, 2-hour storm. However, the closest approximation in HydroCAD for a Type II distributed storm is the 100-year, 6-hour storm. On that day, airport staff witnessed stormwater overflowing Pond C with an approximate depth of 4 inches over an approximate time span of 30 minutes. According to these observations, it is estimated that approximately 2 acre-feet of stormwater overflowed Pond C that day. HydroCAD estimates that a 100-year, 6-hour storm does not overflow the weir at Pond C. The overflow was most likely due to the very high intensity rainfall along with debris that washed downstream covering inlet grates and thus reducing the capacity of the overall stormdrain system.

The May 24, 2011 storm was approximated to be a 100-year, 24-hour storm. In addition, the ground conditions were wetter than usual. The storm was approximated in HydroCAD with the 100-year, 24-hour storm, but with an Antecedent Moisture Content (AMC) of 3 reflecting wet conditions instead of 2 for normal conditions. The AMC specifies the moisture level in the ground immediately prior to the storm. The airport had installed a 2 foot weir extension on Pond A prior to this storm in order to detain a larger volume of stormwater. On that day, airport staff witnessed stormwater overflowing Pond C with an approximate depth of 3 inches over an approximate time span of 3 hours. According to these observations, it is estimated that approximately 7 acre-feet of stormwater overflowed Pond C that day. For a 100-year, 24-hour storm with an AMC of 3 and a 2ft weir extension on A, HydroCAD estimates Pond C to overflow 15 acre-feet. For a 100-year, 24-hour storm with an AMC of 2 and a 2 feet weir extension on A, HydroCAD estimates Pond C to overflow 3 acre-feet. The moisture in the ground was most likely somewhere between an AMC of 2 and 3.

5.2 DRAINAGE SYSTEM 2

Pond D currently detains only a small amount of surface runoff. Pond D has an inflow area of only 23 acres and is 4% impervious. See Table 4 below for a summary of Pond D for a 100-year, 24-hour storm.

Table 4. Summary for Pond D

100-year, 24-hour storm		
	Pond D	
	Peak (cfs)	Volume (AF)
Static Volume (top if Drop Inlet)		1.2
Inflow	22	1.9
Primary Outflow (10" ductile iron)	3	1.9
Secondary Outflow (60" Drop Inlet)		
Storage at Peak Elevation		0.7
Peak Elevation	16" below inlet	

For a 100-year, 24-hour storm the model estimates that Pond D stores 0.7 acre-feet at the peak elevation. The peak elevation for the 100-year, 24-hour storm is 16 inches below the elevation of the top of the drop inlet, thus does not enter the overflow pipe. The static volume of Pond D to the top of the drop inlet is 1.2 acre-feet.

This drainage system is currently under-utilized and can accommodate future growth. In addition, this pond is located in an area that could be enlarged to accommodate even more runoff.

For a complete summary of results for Drainage System 2 see Appendices E through G. The HydroCAD output for the 5-year, 24-hour storm is included in Appendix E and the 100-year, 24 hour storm is included in Appendix F. Appendix G includes the HydroCAD output for Pond D and includes the 2-year, 5-year, 10-year, 25-year, 50-year, and 100-year, 24-hour storms.

5.3 DRAINAGE SYSTEM 3

Pond E has an inflow area of 255 acres and is 25% impervious. See Table 5 below for a summary of Pond E for a 100-year, 24-hour storm.

Table 5. Summary for Pond E

100-year, 24-hour storm		
	Pond E	
	Peak (cfs)	Volume (AF)
Static Volume (top of weir)		12.2
Inflow	198	29.1
Primary Outflow (24" RCP)	42	29.1
Secondary Outflow (concrete overflow weir)	0	0
Storage at Peak Elevation		12.0
Peak Elevation	1" below weir	

For this storm the model estimates that Pond E is very close to spilling over the concrete overflow weir. Based on survey, Pond E has a static volume of 12. 2 acre-feet to the top of the concrete weir. The model estimates that the pond is storing 12.0 acre-feet of stormwater at the peak elevation for a 100-year, 24-hour storm.

For a complete summary of results for Drainage System 3 see Appendices E through G. The HydroCAD output for the 5-year, 24-hour storm is included in Appendix E and the 100-year, 24 hour storm is included in Appendix F. Appendix G includes the HydroCAD output for Pond E and includes the 2-year, 5-year, 10-year, 25-year, 50-year, and 100-year, 24-hour storms.

5.4 OFF-SITE DRAINAGES

Exhibit 4 shows the current Areas A through O of Airport property that are not intercepted by an existing pond system.

Areas A through J drain off-site into the Alkali Creek area via natural ravines as they did prior to the airport's development. Exhibit 5 shows these same areas using 1957 contours prior to the airport's development. Before the airport was built, the pond systems described above did not exist and the entire drainage area from Airport Road surface flowed into Alkali Creek. Exhibit 5 shows the volume of stormwater along with the peak flow that is generated at the lowest point of each subcatchment prior to the airport development.

As the airport developed more areas were intercepted with inlets and conveyed through the expanding pipe network and eventually discharged to Ponds A, B, C, D, or E where the stormwater is detained and then discharged at a slower rate. A comparison of the drainage area sizes for each ravine is listed in Table 6 below.

Table 6. Reduction in Drainage Area Size Contributing to the Alkali Area

Drainage Area	Area Description	1957 Drainage Area Size	Current Drainage Area Size	Difference in Drainage Area Size	
		(Acres)	(Acres)	(Acres)	%
Area A	Saddle Club East	51	49	-2	-4%
Area B	Saddle Club West	67	67	0	0%
Area C	Tumbleweed	116	92	-24	-21%
Area D	Moon Valley	317	192	-125	-39%
Area E	Sun Valley	257	207	-50	-19%
Area F	Prickly Pear	357	208	-149	-42%
Area G	Taxiway "G"	463	247	-216	-47%
Area H	Decom. RW 16/34 east	179	101	-78	-44%
Area I	Runway 10L end	446	467	21	5%
Area J	Old Ranch Area	1544	1543	-1	0%
Area K	Rim discharge	74	74	0	0%
Area L	Natural Retention Pond	97	97	0	0%
Area M	Rim discharge	25	25	0	0%
Area N	Rim discharge	0	5	5	N/A
Area O	Rim discharge	0	5	5	N/A

Many of drainage areas that contribute to the downstream subdivisions have decreased in size over the years due to the development of the airport stormwater system.

Areas K through O are located on the western end of the airport property. This area generally slopes towards Highway 3 both before the airport was developed and currently.

Area K slopes towards a 24 inch CMP that crosses under Highway 3 and discharges over the Rims. The drainage area that contributes to this culvert is approximately 74 acres. HydroCAD estimates a runoff volume of approximately 6 acre-feet during a 100-year, 24-hour storm with a peak discharge rate of 25 cfs directed towards the 24 inch CMP.

Area L slopes towards a natural retention pond. This pond is estimated to have a storage volume of 10 acre-feet. HydroCAD estimates the drainage area that contributes to this pond to have a runoff volume of 8 acre-feet for a 100-year, 24-hour storm. This pond stores the storm runoff effectively for the 100-year, 24-hour storm and is currently in an undeveloped area approximately 1500 feet from the end of Runway 10R/28L. There have been no reports of waterfowl in this area. This area should be monitored for waterfowl during periods of frequent rainfall.

Area M slopes towards a 24 inch CMP that crosses under Highway 3. The drop inlet on this pipe is located 9.75 feet higher than the invert of the pipe and approximately 5 feet higher than the ground and has slits cut in the standpipe to allow for slow inflow into this crossing culvert. The drainage area slopes towards this low spot and is detained and slowly released through the slits until the peak elevation reaches the top of the standpipe and then flows into the open 24 inch standpipe.

Thus the 24 inch CMP does not flow full except during major storms. HydroCAD estimates this area to have a runoff volume of 3 acre-feet during a 100-year, 24-hour storm.

Area N slopes towards a 24 inch CMP crossing under Highway 3 and a 18 inch CMP that crosses under an airport approach and continues to Area O. This drainage area that contributes to this pipe is only 5 acres and HydroCAD estimates a runoff volume of 0.4 acre-feet for a 100-year, 24-hour storm.

Area O located south of the newly constructed Rental Car Wash Facility slopes towards two culverts. One culvert is a 24 inch CMP that crosses under Highway 3 and discharges over the Rims. The other is a 24 inch RCP that crosses under an airport approach and discharges into the northern road ditch. This drainage area that contributes to this pipe is only 5 acres and HydroCAD estimates a runoff volume of 0.4 acre-feet for a 100-year, 24-hour storm.

The following table shows the portion of the current off-site drainage areas that are on airport property. For Areas C-F, the portion of land that is not on airport property consists mostly of developed Alkali Creek subdivisions.

Table 7. Portion of Current Drainage Areas <u>on</u> Airport Property

Drainage Area	Area Description	Current Drainage Area	Portion of Current Drainage Areas <u>on</u> Airport Property	
		(Acres)	(Acres)	(%)
Area A	Saddle Club East	49	8	**16%**
Area B	Saddle Club West	67	35	**52%**
Area C	Tumbleweed	92	24	**26%**
Area D	Moon Valley	192	95	**49%**
Area E	Sun Valley	207	124	**60%**
Area F	Prickly Pear	208	87	**42%**
Area G	Taxiway "G"	247	62	**25%**
Area H	Decom. RW 16/34 east	101	11	**11%**
Area I	Runway 10L end	467	235	**50%**
Area J	Old Ranch Area	1543	442	**29%**
Area K	Rim discharge	74	4	**5%**
Area L	Natural Retention Pond	97	7	**7%**
Area M	Rim discharge	25	22	**88%**
Area N	Rim discharge	5	5	**100%**
Area O	Rim discharge	5	4	**80%**

Since the airport first began construction, there has been many improvements both on airport property and off airport property that has created more impermeable surfaces. Taxiways, runways, buildings, along with subdivisions, streets, homes, and driveways all result in more surfaces that do not allow water to penetrate into the soil causing a higher rate of surface runoff. The change in drainage area size in addition to the addition of impermeable surfaces were estimated in the HydroCAD model. The resulting peak flow that is generated at the lowest point of the

subcatchment is listed on Exhibit 4 – Current Offsite Drainage Site Plan. The peak flow is contributed by area that is both on and off airport property.

6.0 RECOMMENDED IMPROVEMENTS

The Master Plan prepared by Mead & Hunt dated March 2010 gives a brief summary of the existing stormwater system, providing recommendations for improvements. This report also describes the planned future development for the airport. The Master Plan detailing the planned future development, along with conversation with the airport about the past reported problems were evaluated in conjunction with the HydroCAD model results summarized above in order to develop a list of recommended improvements. Exhibit 6 – Recommended Improvements Site Plan under Appendix I summarizes the recommended improvements along with any major planned future development that would impact the storm drain system. Appendix J includes estimated cost estimates for the proposed improvements. These improvements are summarized below.

6.1 IMMEDIATE IMPROVEMENTS

The following recommended improvements are those determined to be the highest priority. It is recommended that the following improvements be planned as soon as possible.

6.1.1 Improve Ponds A, B, and C

It is recommended to increase the storage of Ponds A, B, and C in order to detain a 100-year, 24-hour storm. It is also recommended to design storage facilities with additional detention capacity if possible as a precaution for future rare but major storm events greater than the 100-year, 24-hour storm. The HydroCAD model estimates that if the overflow weirs and earth berms on Ponds A, B, and C were all raised two feet that the ponds could detain a 100-year, 24-hour storm. See Table 8 below. A minimum freeboard of two feet should be maintained.

Table 8. Summary for Ponds A, B, and C with 2 ft Weir Extensions

100-year, 24-hour storm							
	Pond A		Pond B		Pond C		Total
	Peak (cfs)	Volume (AF)	Peak (cfs)	Volume (AF)	Peak (cfs)	Volume (AF)	Volume (AF)
Static Volume (top of weir extension)		13.9		11.8		10.5	36.2
Inflow	292	54.3	207	54.2	90	54.2	
Primary Outflow (9"x12" Orifice for A/B or 24" outfall pipe for C)	11	25.6	10	36.1	35	54.1	
Secondary Outflow (concrete overflow weirs)	196	28.6	79	18.2	0	0.0	
Storage at Peak Elevation		16.0		12.8		7.9	36.7
Peak Elevation	12” above weir		7” above weir		19” below weir		

This pond system was constructed in 1976. Due to the age of this system it is recommended that the 24 inch outfall that extends from Pond C to Alkali Creek be video inspected in order to confirm the integrity of the pipe. It is imperative that this outfall pipe functions as designed.

It is also recommended that an auxiliary outfall route be defined for Ponds A, B, and C should the ponds overflow. See Exhibit 7 under Appendix G for Pond "C" Outfall Route Options. The existing 24 inch outfall could be paralleled with another outfall pipe to be used only in overflow conditions. This option would require a floodplain permit and most likely a Conditional Letter of Map Revision from FEMA since this outfall would increase the peak discharge into Alkali Creek during these major storms and would also require work in the floodplain. Another option is to define and purchase a drainage easement through the Moon Valley Subdivision. This is the route where the overflow naturally flows. However, this option would require improvements to Moon Valley Road along with the purchase of a developed lot just downstream from Pond C. In addition, this outfall route takes the overflow to Alkali Creek Road. This section of road is commonly flooded during major storm events. The City of Billings may require storm drain improvements to Alkali Creek Road with this option. These auxiliary outfall routes are intended to function only for storms larger than the 100-year, 24-storm or in the event that the 24 inch discharge pipe fails or becomes plugged.

6.1.2 Adopt a Stormwater Maintenance Plan

Proper maintenance is essential to the operation of the airport stormdrain system. It is recommended that the airport adopt a stormdrain system maintenance plan that includes at least the following guidelines.

The Federal Aviation Administration (FAA) Advisory Circular, AC 150/5320-5C, Section 8-2.3 dated 9/29/2006 describes the proper maintenance for storm water storage facilities. The ponds should be inspected during and after major storm events to ensure that the inlets and outlets are still functioning as designed, and that no damage or clogging has occurred. Pond bottoms should be mowed at least twice a year. Sediment, debris, and litter should be cleared from the ponds at least twice a year, especially around outlet structure to prevent clogging.

This AC states that "inlet and outlet devices and standpipe or riser structures have been known to deteriorate with time, and may have to be replaced. The actual life of a structural component will depend on individual, site-specific criteria, such as soil conditions." The outlet structures of each pond should be visually inspected at least once per year. It is recommended that the 24 inch outfall pipe that extends from Pond C to Alkali Creek should be inspected through video in order to determine its condition. It is imperative that all outfall devices function as designed.

6.1.3 Define Drainage Routes

Morrison Maierle, Inc. and Billings Logan International Airport have begun conversations with the City of Billings to explain the challenges presented when development occurs in a natural drainage way. As we move forward and development continues in the Alkali Creek area it is imperative that these natural drainage ways be defined and preserved. Coordination between the airport and the City of Billings and Yellowstone County needs to occur in order to determine the best way to define and preserve these drainage routes. One option would be to define the drainage ways and show them as drainage easements on all future subdivision plats and require that developers design around these drainage routes. The City of Billings Stormwater Management Manual dated February 2011 states that natural drainages shall be preserved to the maximum extent possible. It also states that all subdivisions will be required to evaluate and mitigate stormwater runoff entering

(or having the future potential to enter) and leaving subdivision and size facilities as such. Circular DEQ 8 – Montana Standards for Subdivision Storm Drainage dated 2002 states that for flows that originate outside the subdivision, provisions for passing these flows through the subdivision without flooding home sites or drain field sites for a 100-year storm shall be present in the engineering report for storm drains for subdivisions. The natural channels, swales, and ravines that naturally extend from the airport must be preserved in order to pass these flows through subdivision development. It is recommended that a drainage path be defined for each drainage area that drains to the Alkali Creek Area (See Areas A-J on Exhibit 4).

6.1.4 Pond E Improvements – Phase 1

As noted above, HydroCAD estimates that Pond E has a peak elevation one inch below the overflow weir for a 100-year, 24-hour storm. Pond E has 3.5 feet of freeboard from the top of the concrete overflow weir to the top of the berm. It is recommended that the concrete weir be raised one foot in order to provide additional storage. This would leave a 2.5 feet of freeboard. This will ensure that the 100-year, 24-hour storm can safely be detained in this pond. This pond will need to be further expanded in the future in order to accommodate more airport development.

It is recommended that a drainage easement be defined from the overflow structure at Pond E down to Alkali Creek. This drainage easement should be extended up to the airport property line near the discharge of the short pipe network segment. This ravine carries both the discharge from Pond E, the overflow from Pond E, and the surface runoff from Area I. This area is currently undeveloped, however it is recommended that a drainage easement be obtained as this area is expected to be developed in the near future. See Exhibit 9 under Appendix G for Pond “E” Outfall Route Options.

6.1.5 Permitting for Pond D Outfall Route

In order to keep up with continued airport development an enlarged pond system will eventually be needed. Pond D currently discharges through a 10 inch ductile iron pipe and continues through Sun Valley Road through surface flow. It is recommended to begin permitting applications as soon as possible for an outfall route in order to plan for the proposed enlargement of Pond D. In order to install a pipe from Pond D to Alkali Creek a City of Billings Floodplain Application must be submitted. Technical information will be processed through the Montana Department of Natural Resources and Conservation, Floodplain Section and /or the Federal Emergency Agency, as required. Upon review, a Conditional Letter of Map Revision may be required. Permitting for this type of work may require an extensive amount of effort and time. It is recommended to get this process started as soon as possible.

6.2 CIP IMPROVEMENTS

The following recommended improvements are those determined to be the next highest priority. It is recommended that the following improvements be planned into the 5-year Capital Improvement Plan for FY 2012-2017.

6.2.1 Bore Runway Pipe Crossing

The existing pipes crossing under Runway 10L/28R are over capacity for the 100-year, 24- hour storm. This excess runoff overflows the manholes and surface flows downstream and eventually into Ponds A, B, and C. In order to plan for future airport development and to route stormwater to the new enlarged Pond D a new runway pipe crossing is recommended. It is likely feasible to install two additional runway 10L28R large storm drain pipe of 36" diameter for future drainage improvements.

6.2.2 Enlarge On-Site Detention

The area east of Taxiway "A" East is currently acting as a mini-detention area. The 24 inch culvert crossing at the end of Runway 28 is undersized and restricting flow downstream, thus creating a small temporary pond on its south end during storm events and providing additional storage capacity for Ponds A, B, and C. The ponding that occurs in this location does not currently pose operational or safety problems. It is estimated that this area is currently capable of storing approximately 4 Acre-Feet of storm water that would otherwise be sent directly to Pond A, B, and C. This area could be enlarged for onsite detention and the 24 inch inlet restricted to provide a slower flow rate to Ponds A, B, and C. It is estimated that this storage volume could be almost doubled from 4 Acre-Feet to 8 Acre-Feet

6.2.3 Install Standpipe at Area K Highway 3 Crossing

It is recommended that a standpipe be installed at the entrance to the pipe that crosses under Highway 3 at the pipe that collects surface runoff from Area K. A standpipe entrance similar to Area M would slow down the peak discharge rate and slowly release it through the existing crossing culvert. However, this pipe is not an airport pipe and the majority of the runoff contributing to this crossing is not airport property. This improvement would need to be completed by the Montana Department of Transportation.

6.2.4 Pond D Improvements

It is recommended to enlarge Pond D to increase detention storage. One possible scenario would be to divert the outflow from Pipe 117 into Pond D. The enlarged Pond D would need to be expanded to detain an additional 13 acre-feet of runoff volume for a 100-year, 24-hour storm. The outflow from Pipe 356 could also be directed into enlarged Pond D. This would direct an additional 13 acre-feet from Ponds A, B, and C and into enlarged Pond D for a 100-year, 24-hour storm. The pond should be designed to detain the 100-year, 24-hour inflow.

The enlarged Pond D could be discharged through the existing 10 inch ductile pipe and continue to surface flow through Sun Valley Road. However, this subdivision is already in need of storm drain improvements. It is recommended to install a discharge pipe from Pond D to Alkali Creek once the outfall route is approved through the permitting process described above. It is also recommended that an auxiliary route be defined from Pond D down to Alkali Creek should the pond overflow.

See Exhibit 8 under Appendix G for Pond "D" Outfall Route Options. The Sun Valley Outfall Route is the approximate current outfall route of the existing 10 inch ductile iron pipe that drains Pond D. This is the preferred route for both the outfall and auxiliary outfall route for Pond D. The area north of Pond D downstream of the overflow pipe has numerous lots that have been subdivided but that are not yet built upon. The Pine Tree Outfall Route extends through mostly undeveloped land

down to Alkali Creek. The Prickley Pear Outfall Route extends through undeveloped land and into Prickley Pear Drive. Storm Drain Improvements to this street would be necessary if this route was used.

6.2.5 Redirect Stormwater into Pond D

Once Pond D is enlarged and an outfall route is installed, work can begin on redirecting stormwater into Pond D. This will involve installing pipe from the north side of Runway 10L/28R to Pond D. This would alleviate some of the stormwater inflow into Ponds A, B, and C and would add inflow into the new enlarged Pond D.

6.2.6 Glycol Treatment Improvements

BLIA uses glycol (Cryotech E36 Liquid runway Deicer) to deice airplanes in the winter. This de-icing occurs only in Drainage System One. Each spring the first major rainfall washes the glycols that have accumulated on the airport and carries it through the pipe network, through Ponds A, B, and C, and then discharges into Alkali Creek. In 2005, Morrison Maierle, Inc. prepared a Glycol Runoff Study for Drainage System One using MIKE SWMM in order to assist BLIA personnel in estimating when to sample storm water discharging from the pond outfall. This model included numerous updates to the storm drain system since the 1996 Storm Drain Master Plan. These changes include the Runway Incursion Prevention Road, New Taxiway J, new slotted drain, Cargo Apron Slots 1, 2, and 3, Taxiway D improvements, parking lot improvements, and a new tower This memo discusses options for methods to obtain storm water samples. Currently, airport staff obtains samples manually at the discharge of Ponds A, B, and C in Alkali Creek after the first major spring storm event.

Prior to the relocation of Taxiway “E” the area between Taxiway “E” and Taxiway “C” south of RW 10L/28R served as a mini-detention area and glycol surface treatment area. In 2009, this surface flow became pipe flow. This area collects most of the winter time glycol runoff. Additional treatment would be provided by allowing this runoff to surface travel to the inlet at Taxiway C. However, the preferred improvement would be to allow for surface treatment prior to discharge into new enlarged Pond D.

In 2013 Runway 10L/28R will be rehabilitated. The porous friction course will be milled off and replaced with a dense graded and grooved surface. The new surface will require the use of more de-icing products resulting in potentially more pollutant discharge into Alkali Creek. Although much of this runoff will be surface treated, the water quality readings will need to continue to be monitored to determine if a separator will be needed.

6.3 FUTURE IMPROVEMENTS

The following recommended improvements are those that will be needed as the airport develops. It is estimated that the following improvements should be planned for FY 2017-2032.

6.3.1 Pond E Improvements – Phase 2

As noted above, it is recommended that the concrete weir be raised one foot in order to provide additional storage immediately. However, as the airport continues to develop on the west end and more impervious surface is added, Pond E will eventually need further expansion. It is also

recommended to construct a small earth detention area (or series of detention areas) across this ravine to slow the peak discharge rate before it reaches downstream land.

6.3.2 Install Additional Pipe into Pond E

Additional stormwater pipe will need to be installed in order to get the stormwater into the new enlarged Pond E.

6.3.3 Slow Peak Discharge Rate for Area J Outfall

Area J consists of 1543 Acres of mostly undeveloped land. This area all naturally drains down to Alkali creek at a peak rate of 198 cfs and a runoff volume of 120 acre-feet during a 100-year, 24-hour storm. This is a substantial amount of runoff and a relatively high discharge rate. It is recommended that a series of small earth detention structures be constructed along the ravine in order to slow down the runoff rate. An easement should be obtained down this ravine from the airport property to Alkali Creek to ensure that this drainage path is preserved once development takes place downstream.

6.4 OFFSITE IMPROVEMENTS

Multiple homes in the Alkali Creek subdivisions located beneath the airport have experienced damage due to stormwater runoff. Many of these homes could benefit from enlarging their driveway culverts, as many are substantially undersized. Another off-site recommendation would be to ensure that each home has a 5 percent slope away from the foundation of the houses, which may require grading a small ditch or swale around the structure to provide a route for the stormwater runoff to continue downstream.

Over the years, multiple homes and subdivisions were built in natural drainage channels that have always existed between the airport and Alkali Creek. It is imperative that these drainage channels be defined and maintained as this Alkali Creek area continues to develop.

6.5 FUTURE DEVELOPMENT

There are immediate plans for commercial development south of Taxiway C and Taxiway B. This will add additional impervious area to Drainage System 1. Immediate improvements to Ponds A, B, and C are recommended as noted above.

Future development plans include the construction of Air Cargo Slot 4. This improvement would add more impervious surface along with additional storm drain that would tie into an already overloading system to Ponds A, B, and C. This runoff could be directed to Pond D or Pond E but would require a new crossing under runways and/or taxiways.

The airport also has plans to extend Runway 7/25 to the west, build new General Aviation (GA) hangars, and construct a new apron next to the GA hangars. This will add additional impervious areas that all drain into Pond E, which is already at capacity during a 100-year, 24-hour storm. As development continues on the west end of the airport, Pond E will need to be enlarged to handle the increased inflow.

BIBLIOGRAPHY

Advisory Circular 150/5320-5C-Surface Drainage Design, U.S. Department of Transportation Federal Aviation Administration, 9-29-2006.

BLIA Glycol Runoff Study, Morrison Maierle, Inc., January 5, 2005.

Circular DEQ 8, Montana Standards for Subdivision Storm Drainage, 2002 Edition.

Master Plan, Billings Logan International Airport, Mead & Hunt, March 2010.

Storm Drainage Master Plan for Billings Logan International Airport, Airport Commission, Billings, Montana, Hurlbut, Kersich & McCullough, April 1975.

Storm Drain Master Plan, Billings Logan International Airport, Billings, MT, AIP 3-30-0008-07, HKM Associates, January 1989.

Storm Drainage System Master Plan, Billings Logan International Airport, Morrison Maierle, Inc., March 1996.

Stormwater Management Manual, Public Works Department, City of Billings, Montana, February 2011.

Valley Heights Road Extension and Sun Valley Road – RSID 691 Drainage Investigation Report, Yellowstone County Department of Public Works, Morrison Maierle, Inc., December 1, 2004.

APPENDIX A

Storm Drainage System Site Plans

MORRISON-MAIERLE, INC

LEGEND

- SYSTEM BOUNDARY
- DRAINAGE AREA BOUNDARY
- SD — EXISTING STORM DRAIN
- AIRPORT PROPERTY BOUNDARY

OFF-SITE SYSTEM

SYSTEM 1

SYSTEM 2

SYSTEM 3

500 250 0 500 1000
SCALE IN FEET

OLD R/W 16-34

T/W "A"

T/W "A" WEST

T/W "B"

T/W "C"

T/W "D"

T/W "E"

T/W "F"

T/W "G"

T/W "H"

T/W "J"

POND D

PONDS A, B, C

HIGHWAY 3

N 27TH ST

HIGHWAY 318

VERIFY SCALE!
THESE PRINTS MAY BE REDUCED. LINE BELOW MEASURES ONE INCH ON ORIGINAL DRAWING.
MODIFY SCALE ACCORDINGLY!

REVISIONS			
NO.	DESCRIPTION	DATE	BY

V:\2447\085\ACAD\Exhibits\EXHIBIT-1.dwg Plotted by Kent Kuehn on 2/23/12

MORRISON MAIERLE, INC.
An Employee-Owned Company
Engineers
Surveyors
Scientists
Planners
315 N. 25th Street, Suite 102
Billings, MT 59101
Phone: (406) 656-6000
Fax: (406) 237-1201

DRAWN BY:
DSGN. BY:
APPR. BY:
DATE:
Q.C. REVIEW BY:
DATE:

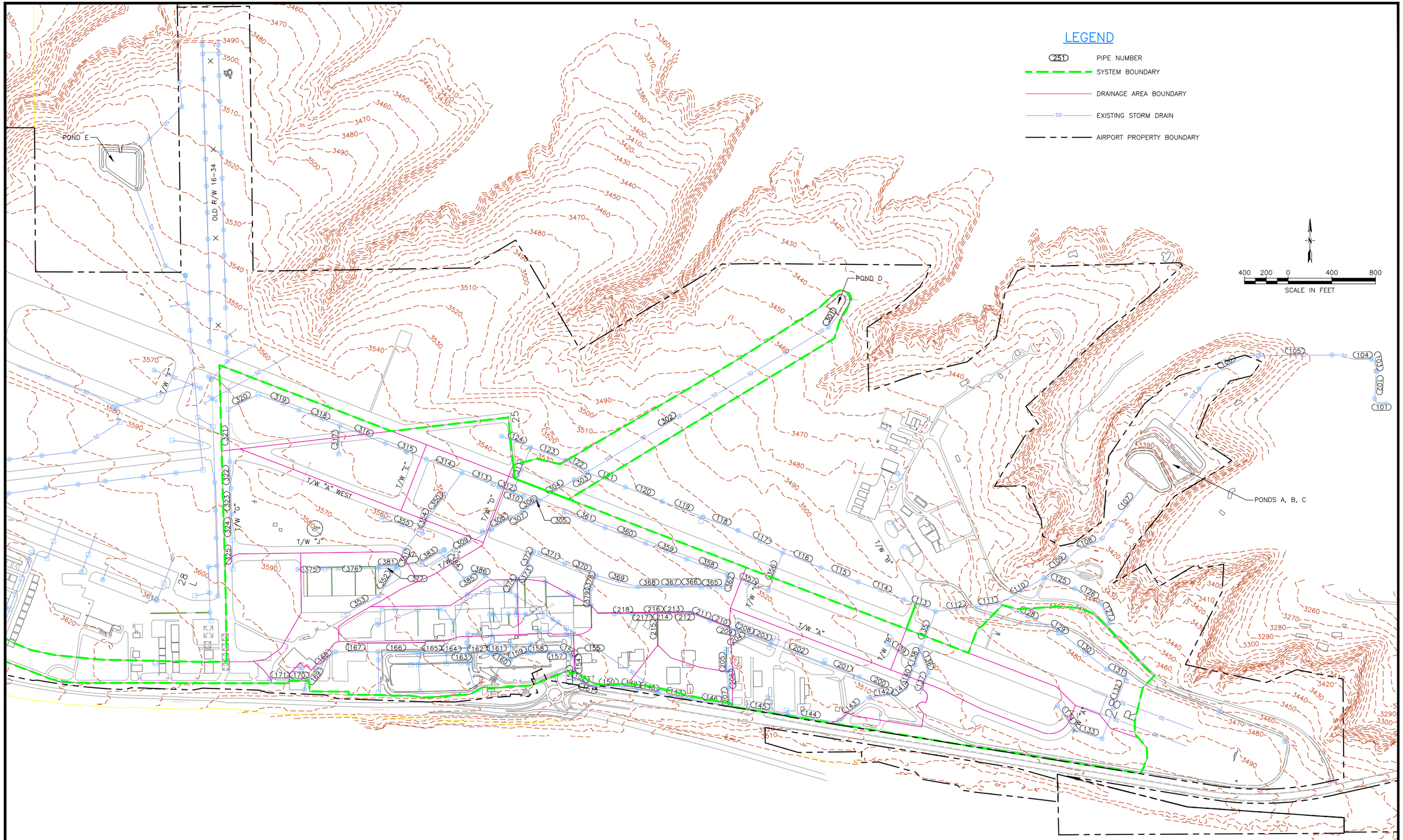
BILLINGS LOGAN INTERNATIONAL AIRPORT

OVERALL DRAINAGE SYSTEM SITE PLAN

PROJECT NUMBER

SHEET NUMBER

DRAWING NUMBER
EXH 1



VERIFY SCALE!

THESE PRINTS MAY BE REDUCED. LINE BELOW MEASURES ONE INCH ON ORIGINAL DRAWING.

MODIFY SCALE ACCORDINGLY!

REVISIONS			
NO.	DESCRIPTION	DATE	BY

V:\2447\085\ACAD\Exhibits\EXHIBIT-2.dwg Plotted by Kent Kuehn on 2/23/12

MORRISON MAIERLE, INC.
An Employee-Owned Company
Engineers
Surveyors
Scientists
Planners
315 N. 25th Street, Suite 102
Billings, MT 59101
Phone: (406) 656-6000
Fax: (406) 237-1201

DRAWN BY:
DSGN. BY:
APPR. BY:
DATE:

Q.C. REVIEW
BY:
DATE:

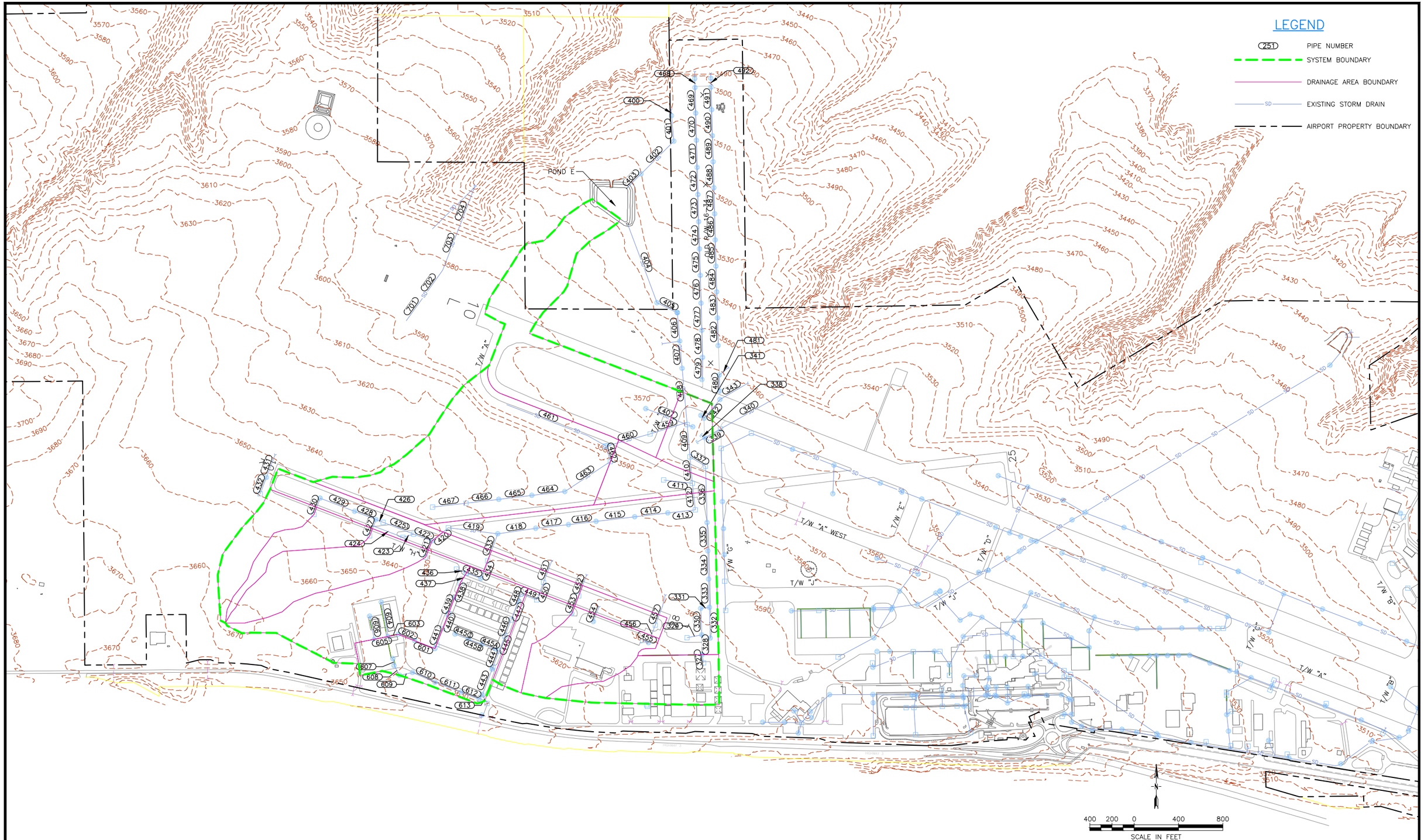
BILLINGS LOGAN INTERNATIONAL AIRPORT

DRAINAGE SYSTEM 1 & 2 SITE PLAN

PROJECT NUMBER

SHEET NUMBER

DRAWING NUMBER
EXH 2



VERIFY SCALE!

THESE PRINTS MAY BE REDUCED. LINE BELOW MEASURES ONE INCH ON ORIGINAL DRAWING.

MODIFY SCALE ACCORDINGLY!

REVISIONS			
NO.	DESCRIPTION	DATE	BY

V:\2447\085\ACAD\Exhibits\EXHIBIT-3.dwg Plotted by Kent Kuehn on 2/23/12

MORRISON MAIERLE, INC.
An Employee-Owned Company

Engineers
Surveyors
Scientists
Planners

315 N. 25th Street, Suite 102
Billings, MT 59101

Phone: (406) 656-6000
Fax: (406) 237-1201

DRAWN BY:
DSGN. BY:
APPR. BY:
DATE:

Q.C. REVIEW BY:
DATE:

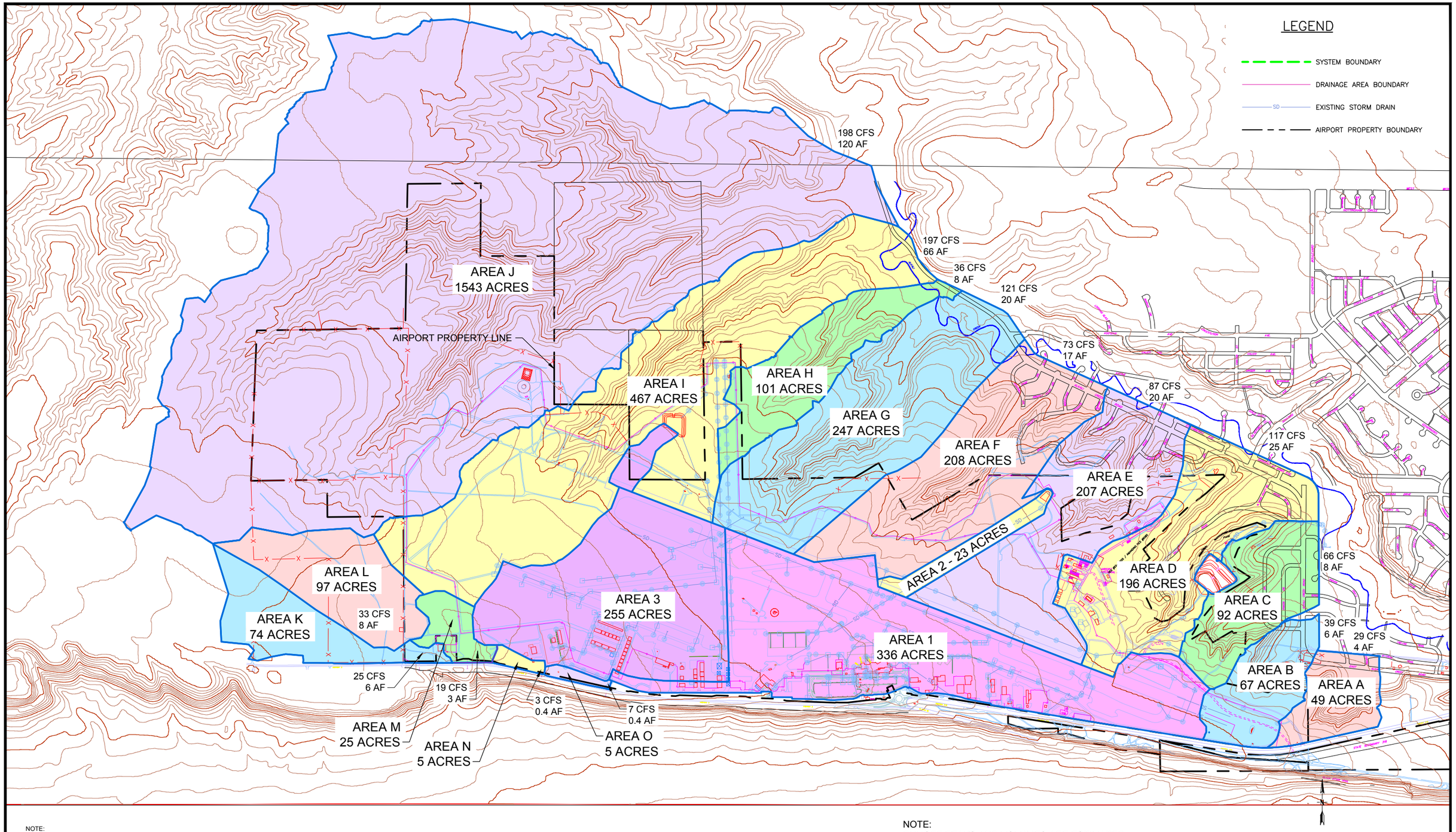
BILLINGS LOGAN INTERNATIONAL AIRPORT

DRAINAGE SYSTEM 3 SITE PLAN

PROJECT NUMBER

SHEET NUMBER

DRAWING NUMBER
EXH 3



NOTE:
TOPOGRAPHY BASED ON CITY OF BILLINGS AVIATION AND TRANSIT DEPARTMENT 1996 DIGITIZED CONTOURS.

NOTE:
RUNOFF PEAKS AND VOLUMES ARE ESTIMATED BASED ON A 100-YR, 24-HR STORM.

800 400 0 800 1600
SCALE IN FEET

VERIFY SCALE!
THESE PRINTS MAY BE REDUCED. LINE BELOW MEASURES ONE INCH ON ORIGINAL DRAWING.
MODIFY SCALE ACCORDINGLY!

REVISIONS			
NO.	DESCRIPTION	DATE	BY

V:\2447\085\ACAD\Exhibits\EXHIBIT-4.dwg Plotted by Kent Kuehn on 2/23/12

MORRISON MAIERLE, INC.
An Employee-Owned Company
Engineers
Surveyors
Scientists
Planners
315 N. 25th Street, Suite 102
Billings, MT 59101
Phone: (406) 656-6000
Fax: (406) 237-1201

DRAWN BY:
DSGN. BY:
APPR. BY:
DATE:
Q.C. REVIEW BY:
DATE:

BILLINGS LOGAN INTERNATIONAL AIRPORT
BILLINGS MONTANA
CURRENT OFFSITE DRAINAGE SITE PLAN

PROJECT NUMBER
SHEET NUMBER
DRAWING NUMBER
EXH 4

LEGEND

- SYSTEM BOUNDARY
- DRAINAGE AREA BOUNDARY
- SD — EXISTING STORM DRAIN
- AIRPORT PROPERTY BOUNDARY

AREA J
1543 ACRES

AIRPORT PROPERTY LINE

198 CFS
120 AF

103 CFS
35 AF

40 CFS
14 AF

108 CFS
36 AF

87 CFS
28 AF

69 CFS
20 AF

72 CFS
25 AF

52 CFS
9 AF

36 CFS
5 AF

26 CFS
4 AF

19 ACRES

AREA H
182 ACRES

13 ACRES

AREA I
453 ACRES

AREA G
463 ACRES

AREA F
357 ACRES

AREA E
257 ACRES

AREA D
317 ACRES

AREA C
116 ACRES

AREA L
97 ACRES

AREA K
74 ACRES

32 CFS
8 AF

AREA M
25 ACRES

23 CFS
6 AF

13 CFS
2 AF

AREA B
67 ACRES

AREA A
51 ACRES

N

500 400 0 800 1600
SCALE IN FEET

NOTE:
TOPOGRAPHY FROM AERIAL PHOTOGRAPHS BY MULTIPLEX METHODS AND PLANETABLE SURVEYS 1957.

NOTE:
RUNOFF PEAKS AND VOLUMES ARE ESTIMATED BASED ON A 100-YR, 24-HR STORM.

VERIFY SCALE!
THESE PRINTS MAY BE REDUCED. LINE BELOW MEASURES ONE INCH ON ORIGINAL DRAWING.
MODIFY SCALE ACCORDINGLY!

REVISIONS

NO.	DESCRIPTION	DATE	BY

V:\2447\085\ACAD\Exhibits\EXHIBIT-5.dwg Plotted by Kent Kuehn on 2/23/12

MORRISON MAIERLE, INC.
An Employee-Owned Company
Engineers
Surveyors
Scientists
Planners
315 N. 25th Street, Suite 102
Billings, MT 59101
Phone: (406) 656-6000
Fax: (406) 237-1201

DRAWN BY:
DSGN. BY:
APPR. BY:
DATE:
Q.C. REVIEW BY:
DATE:

BILLINGS LOGAN INTERNATIONAL AIRPORT
BILLINGS MONTANA

1957 OFFSITE DRAINAGE SITE PLAN

PROJECT NUMBER
SHEET NUMBER
DRAWING NUMBER
EXH 5

APPENDIX B

Record Drawings - Selected Plan Sheets

MORRISON-MAIERLE, INC

A.D.A.P.-07

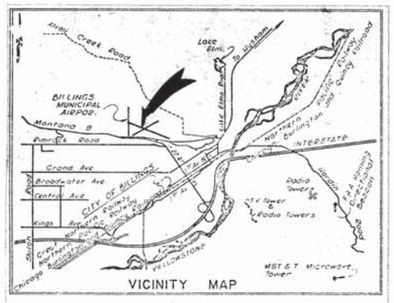
(Selected Sheets) for Ponds A, B, C, D, (1977)

MORRISON-MAIERLE, INC.

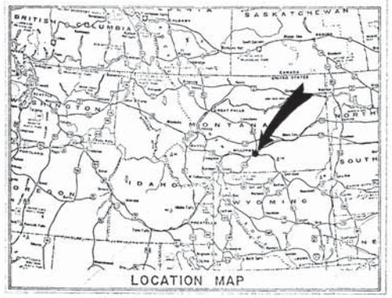
FA8

LOGAN FIELD
AIRPORT STORM SEWER
PHASE I AND II

Prepared By
HURLBUT, KERSICH & McCULLOUGH
CONSULTING ENGINEERS
937 GRAND AVE.
BILLINGS, MONTANA



VICINITY MAP



LOCATION MAP

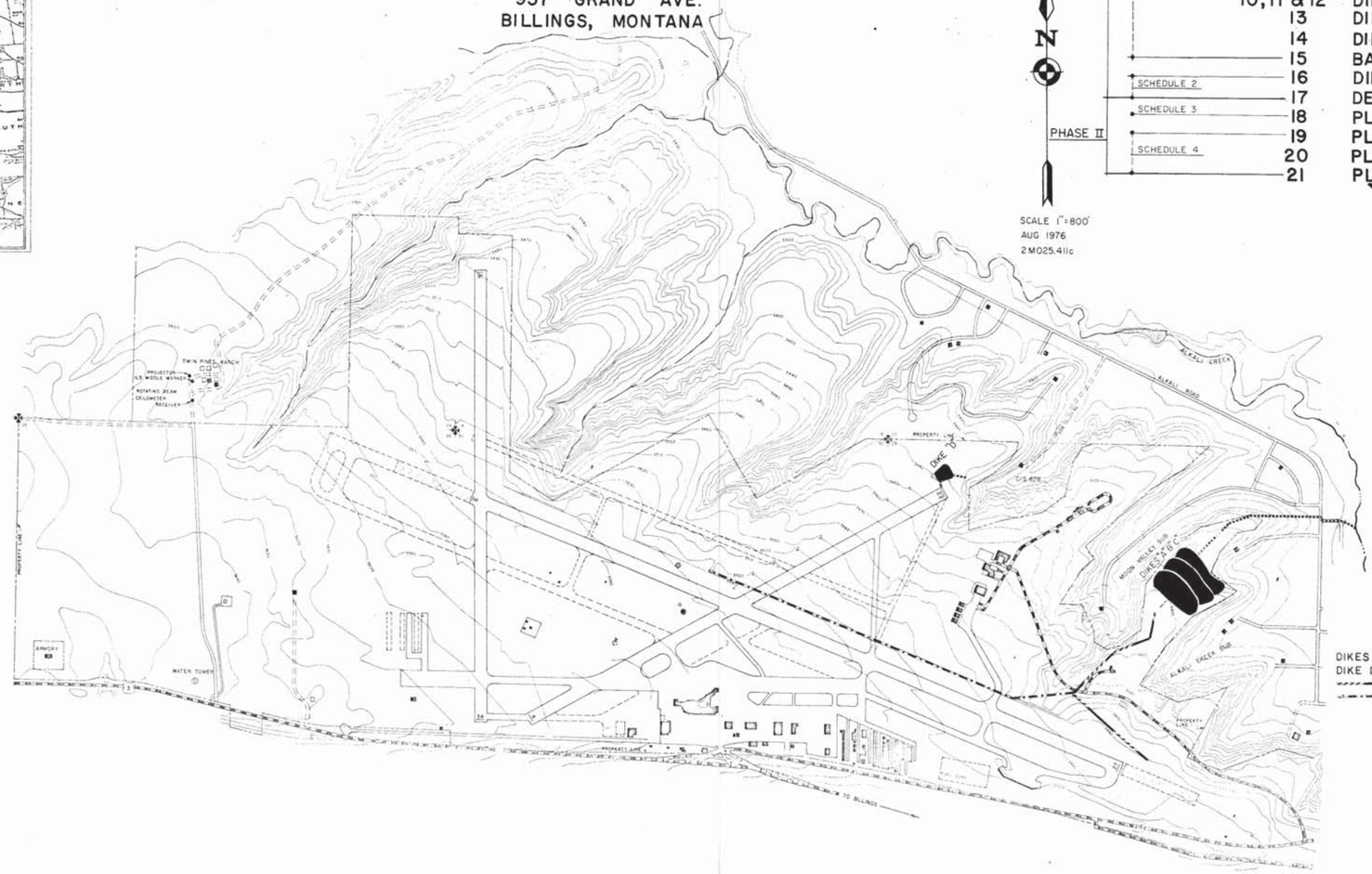
INDEX

SHEET NO.	DESCRIPTION
1	QUANTITY SUMMARY
2	PROJECT INDEX
3 & 4	OUTFALL LINE
5	TRASH RACK, VENT, OPEN CHANNEL AND ENERGY DISSIPATOR DETAILS
6	RETAINING COLLAR & OUTLET WORKS
7	DIKE A,B,C ORIENTATION & SOIL LOGS
8	DIKE A,B,C LAYOUT
9	DIKE A,B,C CROSS-SECTION INDEX
10, 11 & 12	DIKE A,B,C CROSS-SECTION
13	DIKE A,B,C DROP INLET SPILLWAY
14	DIKE A,B,C DROP INLET SPILLWAY DETAILS
15	BAFFLED IMPACT BASIN
16	DIKE NORTH OF RUNWAY 4-22
17	DETAILS FOR DIKE D
18	PLAN & PROFILE: MH. G21 TO HOLDING PONDS
19	PLAN & PROFILE: MH. G19 TO MH. G24
20	PLAN & PROFILE: MH. G16 TO MH. G20
21	PLAN & PROFILE: ~~MH. G9 TO MH. G14~~ DELETED FROM CONTRACT

PHASE I — SCHEDULE 1
PHASE II — SCHEDULE 2, SCHEDULE 3, SCHEDULE 4

N

SCALE 1"=800'
AUG 1976
2M025.41Ic

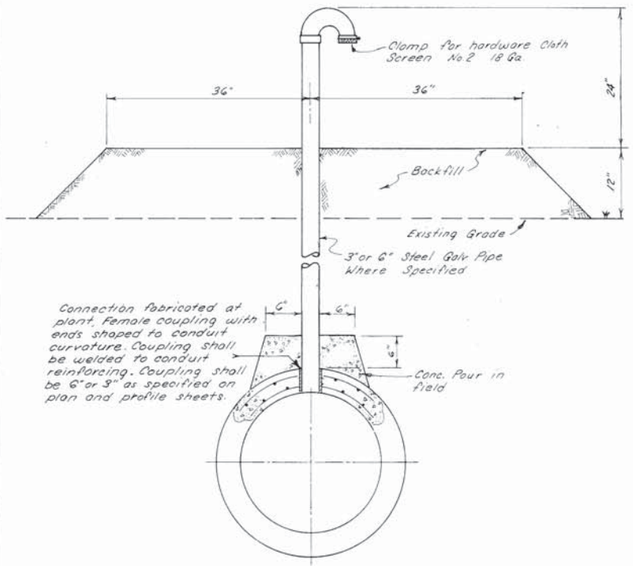


LEGEND

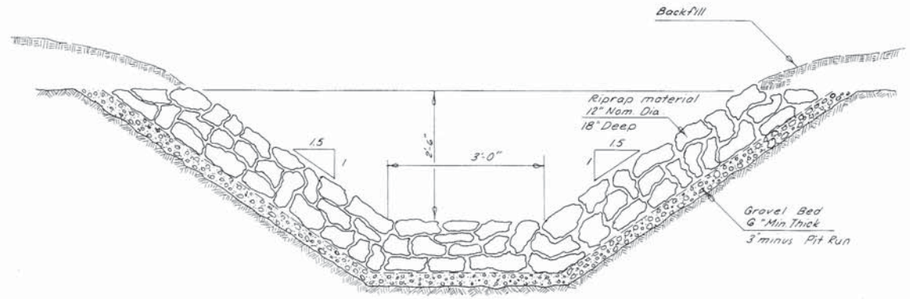
DIKES A,B,C ····· PHASE I , SCHEDULE-1
DIKE D ——— PHASE I , SCHEDULE-2
PHASE II , SCHEDULE-3
PHASE II , SCHEDULE-4

SET NUMBER

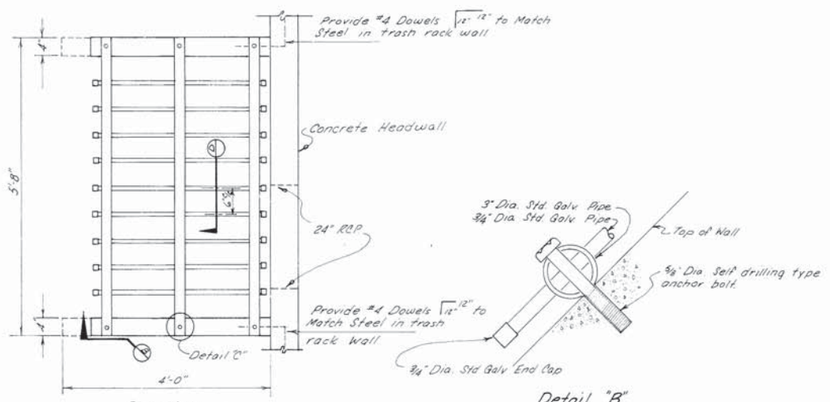
A.D.A.P -07 As Builts 1977



Air Vent Detail
Scale 1"=1'-0"

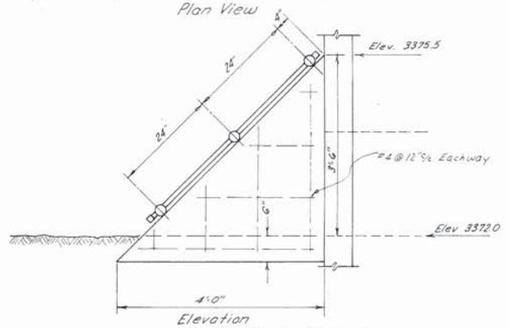


Typical Open Channel Section
No Scale
(Sta -4+70 to Sta -4+90)



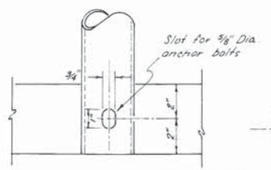
Plan View

Detail "B"
Scale 3"=1'-0"

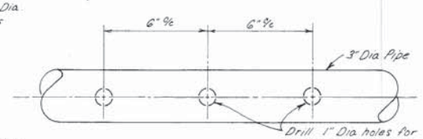


Elevation

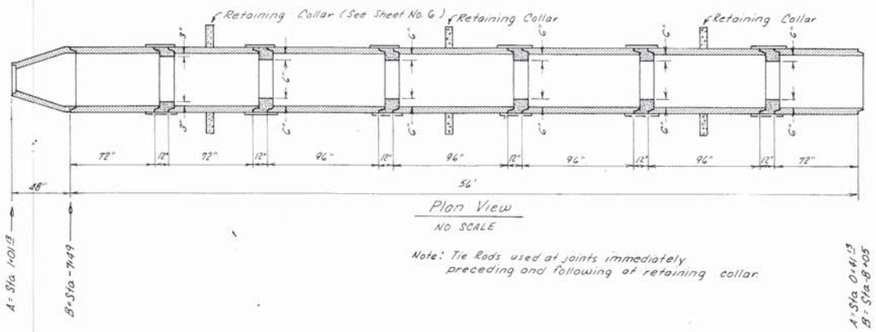
Trash Rock Detail
Scale 3/4"=1'-0"



Detail "C"
Scale 3"=1'-0"

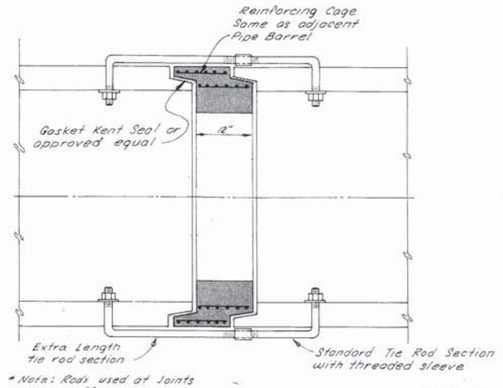


Detail "D"
Scale 3"=1'-0"

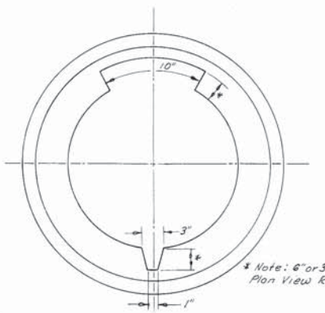


Plan View
NO SCALE

Note: Tie Rods used at joints immediately preceding and following of retaining collar.



* Note: Rods used at joints where baffles occur are Std. Length Plus 12"



* Note: 6" or 3" as Plan View Requires.

R.C.P. Energy Dissipators
No Scale

HURLBUT, KERSICH & McCULLOUGH
CONSULTING ENGINEERS
937 GRAND AVE.
BILLINGS, MONTANA

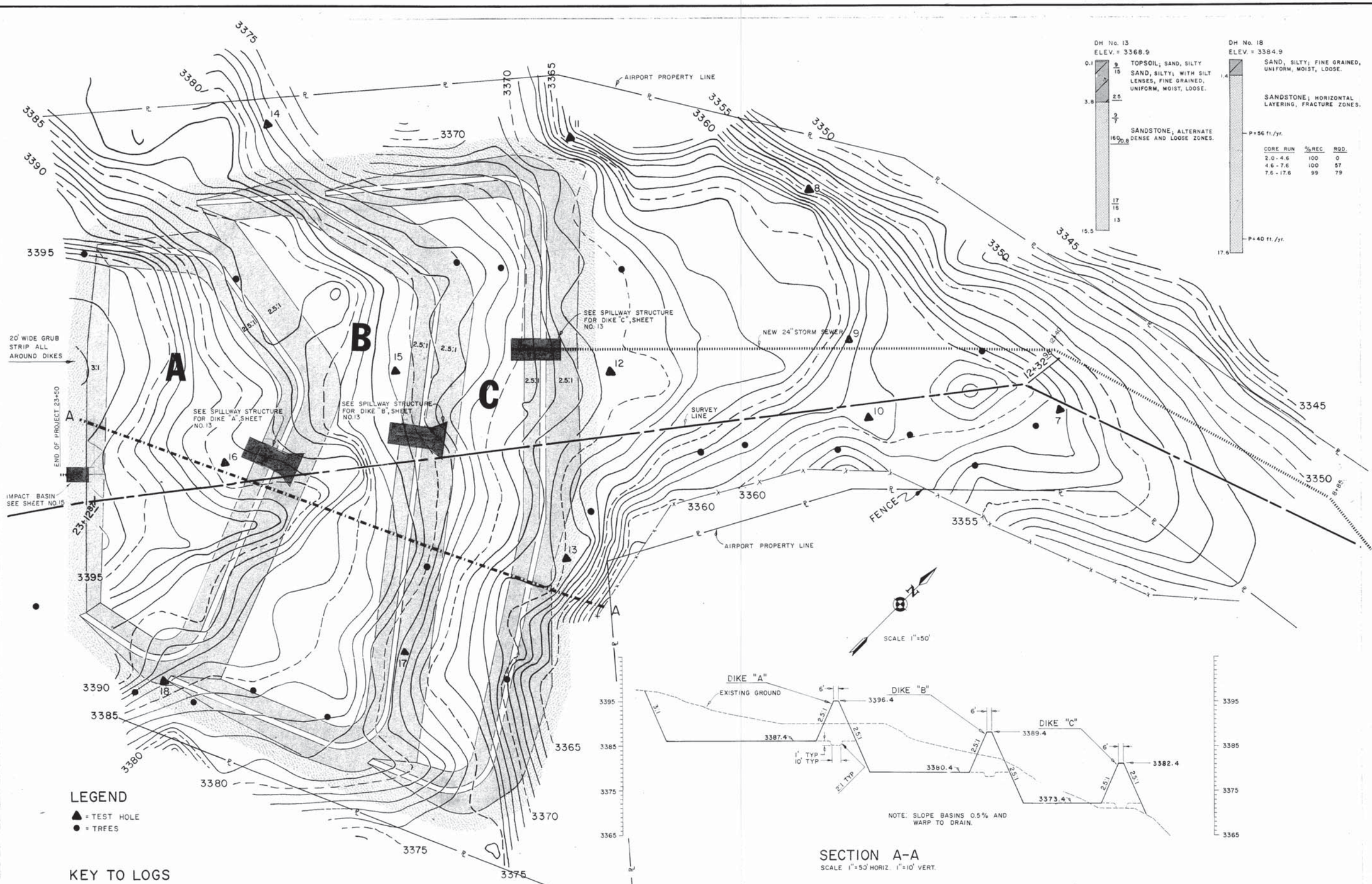
2M025.41lc

TRASH RACK, VENT, OPEN CHANNEL & ENERGY DISSIPATOR DETAILS PH-I
LOGAN FIELD AIRPORT
STORM SEWER

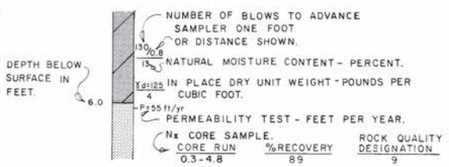
NO.	REVISIONS	DATE
1	As Built AD.AP-07	Jan.77

DRAWN BY: RJA | CHECKED BY: | DATE: -

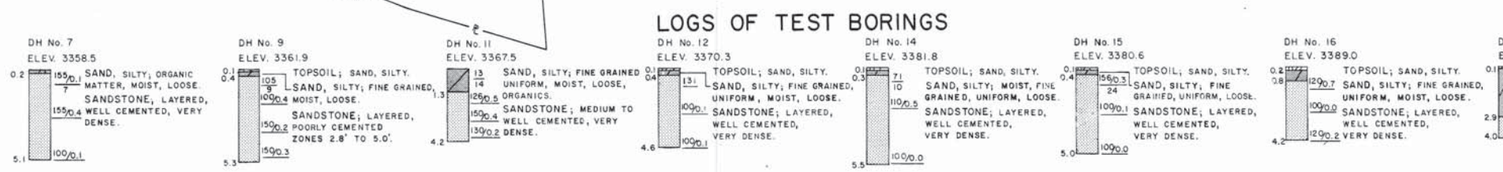
SHEET NO. 5 OF



KEY TO LOGS



LOGS OF TEST BORINGS



HURLBUT, KERSICH & McCULLOUGH
CONSULTING ENGINEERS
937 GRAND AVE.
BILLINGS, MONTANA

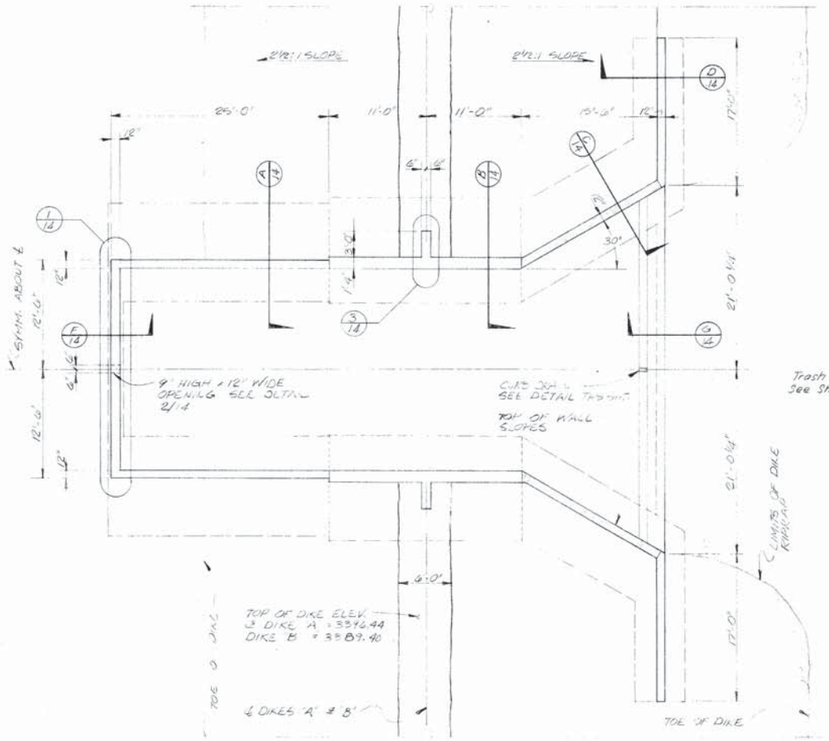
2M025.411c

DIKE A,B,C ORIENTATION & SOILS LOG
PHASE I
LOGAN FIELD AIRPORT
STORM SEWER

DRAWN BY: RJA
CHECKED BY:
DATE:

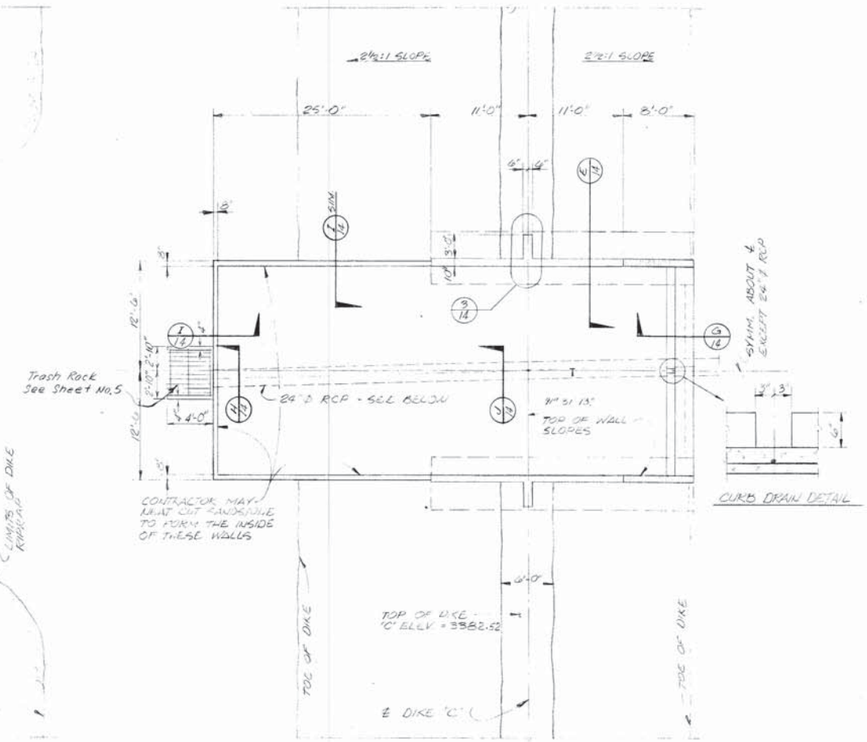
NO.	REVISIONS	DATE
1	As Built ADAP-07	Jan 77

SHEET NO. 7 OF



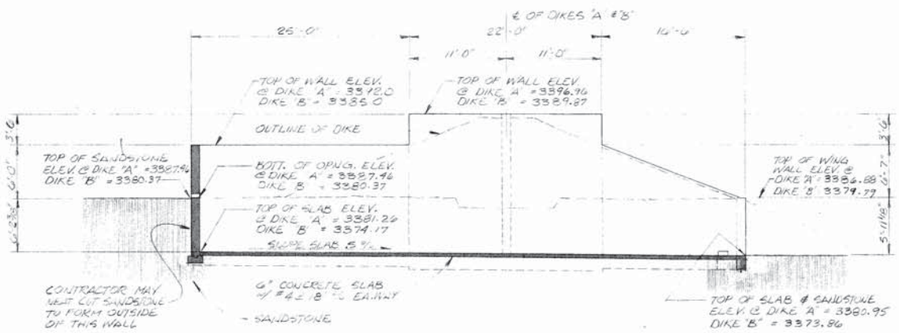
PLAN - DROP INLET SPILLWAY @ DIKES 'A' & 'B'

SCALE 1/8" = 1'-0"



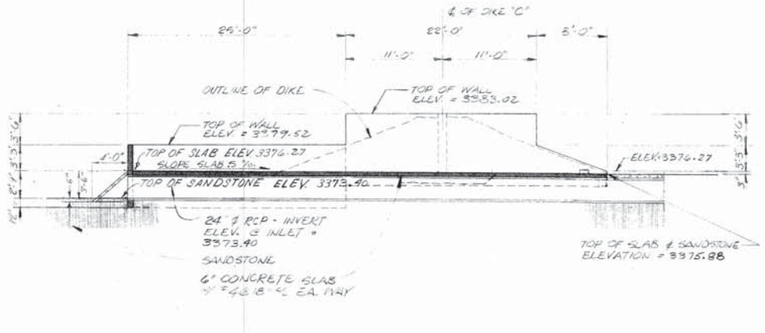
PLAN - DROP INLET SPILLWAY @ DIKE 'C'

SCALE 1/8" = 1'-0"



℄ ELEVATION OF STRUCTURE @ DIKES 'A' & 'B'

SCALE 1/8" = 1'-0"



℄ ELEVATION OF STRUCTURE @ DIKE 'C'

SCALE 1/8" = 1'-0"

GENERAL STRUCTURAL NOTES

CONCRETE:

1. ALL CONCRETE TO BE PREPARED, FORMED, PLACED & CURED AS PER ACI CODE OR AS SPECIFIED.
2. MINIMUM 28-DAY COMPRESSIVE STRENGTH FOR: CONCRETE WALLS & FOOTINGS = 4000 psi SLABS ON GRADE = 4000 psi
3. NO WATER IN ADDITION TO THAT SPECIFIED FOR MIX TO BE ADDED AT SITE UNLESS APPROVED.
4. MINIMUM CEMENT CONTENT = 6 SACKS/CU. YARD
5. POUR STOPS TO BE MADE AS DIRECTED WITH SUITABLE KEYS, BULKHEADS & REINFORCING.
6. OPENINGS IN CONCRETE WALLS WITH A DIMENSION OF 1'-0" OR GREATER IN EITHER DIRECTION, NOT SHOWN OTHERWISE TO HAVE TWO #5 BARS EACH SIDE EXTENDING 2'-0" BEYOND OPENING.
7. SPLICES IN REBAR TO LAP 30 BAR DIAMETERS, 12" MINIMUM.
8. PROVIDE ADEQUATE SUPPORT BARS & ACCESSORIES TO HOLD BARS FIRMLY IN PLACE.
9. MINIMUM CONCRETE COVER OVER BARS & TIES IN: FOOTINGS = 3", WALLS = 2"
10. CHAMFER ALL EXPOSED CONCRETE CORNERS AS DIRECTED
11. ALL REINFORCING BARS WITH A YIELD STRENGTH IN EXCESS OF 40,000 psi TO BE MARKED BY THE MILL IN SUCH A MANNER THAT THE GRADE CAN BE DETERMINED IN THE FIELD.
12. NO REINFORCING SHALL BE ENCLOSED IN SUCH A WAY AS TO PREVENT OBSERVATION BEFORE THE INSPECTOR HAS A CHANCE TO INSPECT IT.

FOUNDATIONS:

1. FOUNDATIONS & EXCAVATIONS TO BE PROTECTED FROM THE ACTION OF WATER OR FREEZING.
2. ALL BACKFILL TO BE PLACED STRICTLY ACCORDING TO NRS SPECIFICATIONS. WALLS TO BE PROPERLY BRACED BEFORE BACKFILL IS PLACED.
3. IF SOILS OR OTHER CONDITIONS ARE FOUND WHICH VARY FROM THE CONDITIONS INDICATED ON THE SOILS BORING LOGS, NOTIFY THE ENGINEER BEFORE PROCEEDING WITH WORK.
4. BRING ALL OVER-EXCAVATION BACK TO REQUIRED GRADE WITH COMPACTED GRAVEL AS PER SPECIFICATIONS.

NO.	REVISION	DATE
1	As Built A.D.A.P.-01	Jan 77

DIKE A, B & C DROP INLET SPILLWAY PHASE-I

LOGAN FIELD AIRPORT STORM SEWER

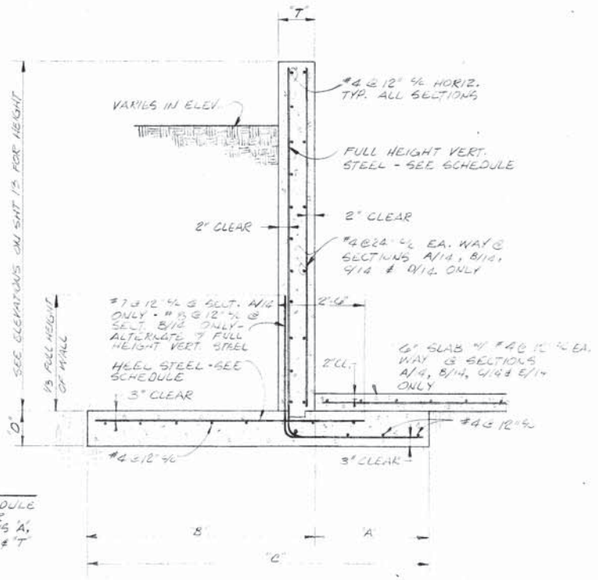
2M025.411c

HURLBUT, KERSICH & McCULLOUGH
CONSULTING ENGINEERS
937 Grand Ave. Billings, Montana

DWN DJS | CHK WEO | APPROV. | DATE

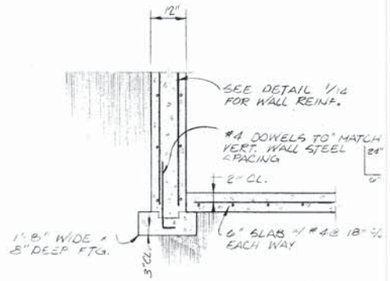
SHEET NO. 13

WALL SECT. ON PLAN	DIM. "T"	DIM. "A"	DIM. "B"	DIM. "C"	DIM. "D"	FULL HEIGHT VERT. STEEL	HEEL STEEL
A/14	12"	3'-9"	7'-6"	11'-3"	12"	#7@12"c/c	#7@8"c/c
B/14	16"	4'-0"	8'-8"	12'-8"	16"	#8@12"c/c	#7@6"c/c
C/14	12"	3'-3"	6'-6"	9'-9"	12"	#7@12"c/c	#7@10"c/c
D/14	12"	2'-0"	3'-9"	5'-9"	12"	#4@12"c/c	#4@12"c/c
E/14	10"	2'-0"	4'-0"	6'-0"	12"	#5@12"c/c	#4@12"c/c

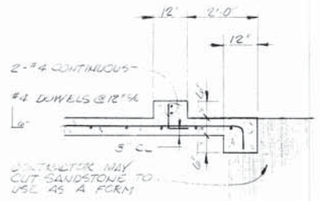


NOTE:
SEE SCHEDULE ABOVE FOR DIMENSIONS 'A', 'B', 'C', D & 'T'

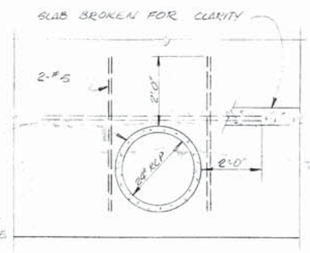
SECTION (A/14) (B/14) (C/14) (D/14) (E/14)
1/2" = 1'-0"



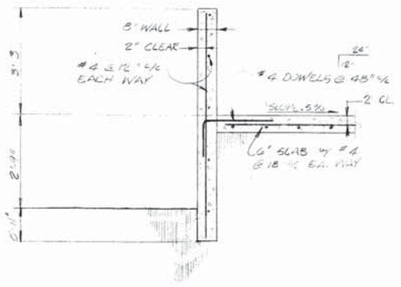
SECTION (9/16)
1/2" = 1'-0"



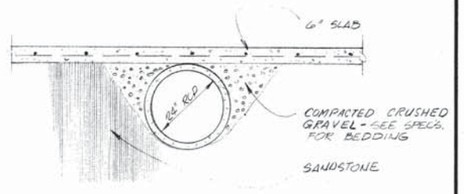
SECTION (10/16)
1/2" = 1'-0"



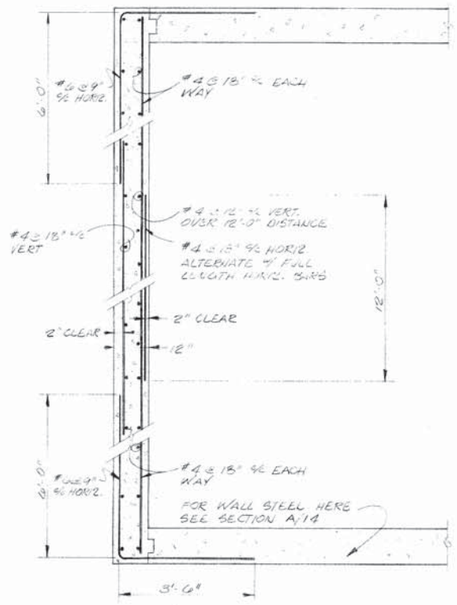
SECTION (11/16)
1/2" = 1'-0"



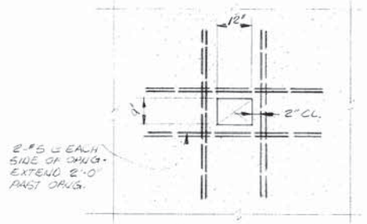
SECTION (12/16)
1/2" = 1'-0"



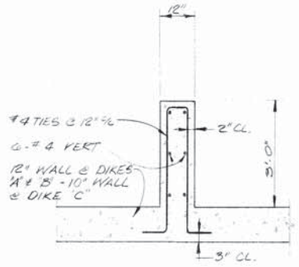
SECTION (13/16)
1/2" = 1'-0"



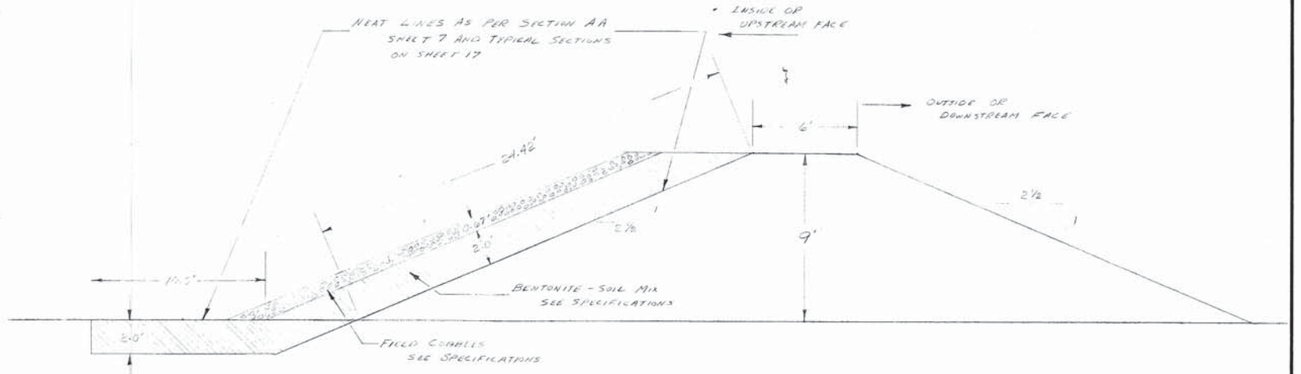
DETAIL (14/16)
1/2" = 1'-0"



DETAIL (15/16)
1/2" = 1'-0"



DETAIL (16/16)
1/2" = 1'-0"



TYPICAL DIKE LINING SECTION
PONDS "A" THRU "D"
SCALE: 1" = 4'

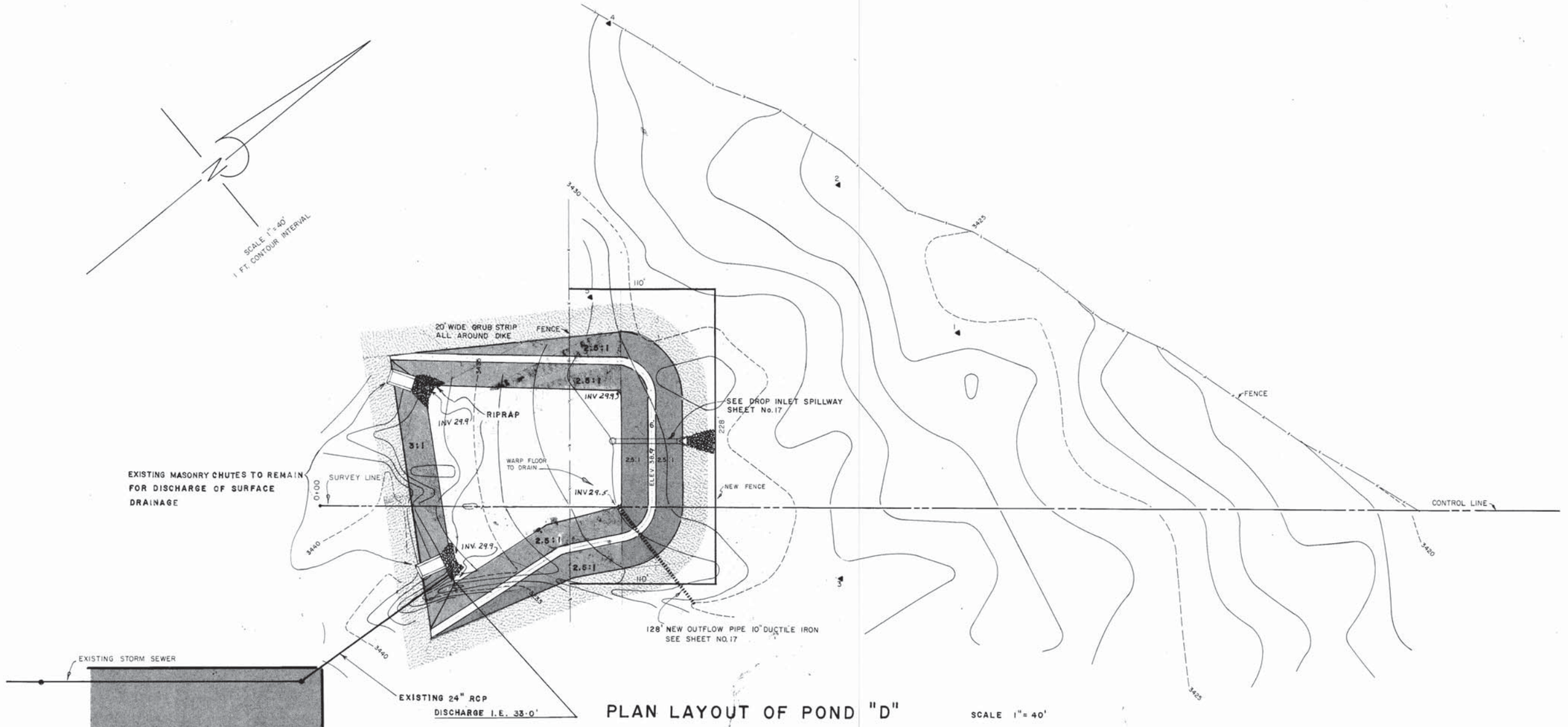
NO.	REVISION	DATE
1	AS BUILT A.D.A.P.-07	JAN77

DROP INLET SPILLWAY
A, B & C DIKES DETAIL
PHASE-I
LOGAN FIELD AIRPORT
STORM SEWER
2M025.411c

HURLBUT, KERSICH & McCULLOUGH
CONSULTING ENGINEERS
937 Grand Ave. Billings, Montana

DWN: WSJ | CHK: WKO | APPROV: | DATE:

SHEET NO. 14



PLAN LAYOUT OF POND "D"

SCALE 1"= 40'

LOG OF TEST BORINGS

DH No. 2
ELEV. = 3425.4

0.2 / 0.5 — 120/0.5, 14 — TOPSOIL; SAND, SILTY.
SAND, SILTY; FINE GRAINED, UNIFORM.
3.5 — 100/0.1 — SANDSTONE; LAYERED WITH SOME FRACTURES, VERY DENSE.

DH No. 3
ELEV. = 3429.1

0.1 / 0.3 — 100/0.5, 8 — TOPSOIL; SAND, SILTY
SAND, SILTY; FINE GRAINED UNIFORM, MOIST.
150/0.0, 10 — SANDSTONE; LAYERED, VERY WELL CEMENTED, MOIST.
7.5 — 100/0.1

DH No. 5
ELEV. = 3422.4

0.4 — SAND, SILTY; FINE GRAINED, UNIFORM, MOIST, LOOSE.
SANDSTONE; HORIZONTAL LAYERING, ALTERNATE HARD AND SOFT LAYERS.
P=20 ft./yr.

CORE RUN	%REC	RQD
1.2 - 5.0	90	11
5.0 - 10.6	95	0

7d+125 / 4 — P=36 ft./yr.
P=5 ft./yr.
10.6

DH No. 6
ELEV. = 3433.4

0.3 — 151/0.9, 6 — TOPSOIL; SAND, SILTY
SANDSTONE; VERY DENSE, WELL CEMENTED, LAYERED.
4.0 — 100/0.1

LEGEND
▲ = TEST HOLE

KEY TO LOGS

DEPTH BELOW SURFACE IN FEET. 6.0
130/0.8, 13 — NUMBER OF BLOWS TO ADVANCE SAMPLER ONE FOOT OR DISTANCE SHOWN. NATURAL MOISTURE CONTENT - PERCENT.
d=125 / 4 — IN PLACE DRY UNIT WEIGHT - POUNDS PER CUBIC FOOT.
P=55 ft/yr — PERMEABILITY TEST - FEET PER YEAR.
Nx CORE SAMPLE.

CORE RUN	% RECOVERY	ROCK QUALITY DESIGNATION
0.3 - 4.8	89	9

HURLBUT, KERSICH & McCULLOUGH
CONSULTING ENGINEERS
937 GRAND AVE.
BILLINGS, MONTANA

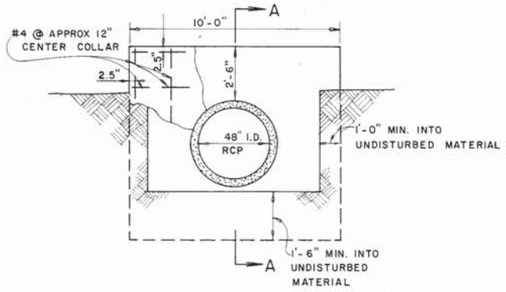
2 M 025.41 c

DIKE NORTH OF RUNWAY 4-22
PHASE-I
LOGAN FIELD AIRPORT
STORM SEWER

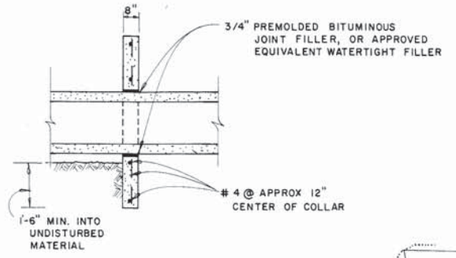
DRAWN BY: RJA
CHECKED BY:
DATE: 3/2/76

NO	REVISIONS	DATE
1	As Built ADAP-07	Jan 77

SHEET NO
16
OF

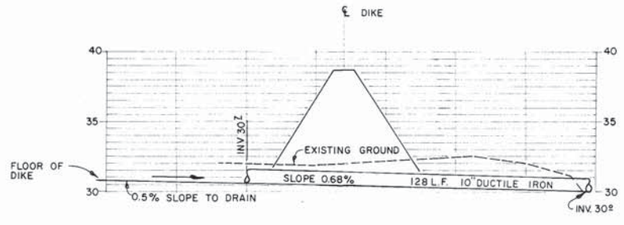


ELEVATION



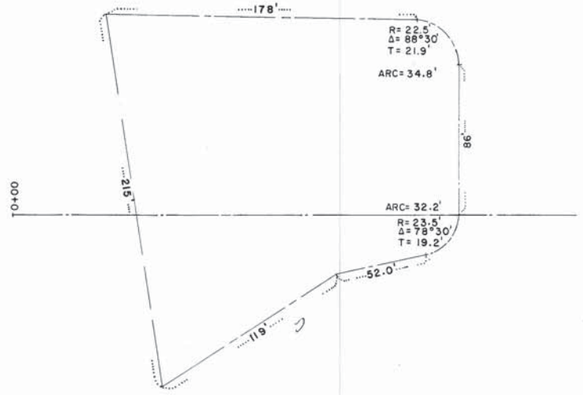
SECTION A-A

CUTOFF COLLAR DETAIL - DIKE "D"



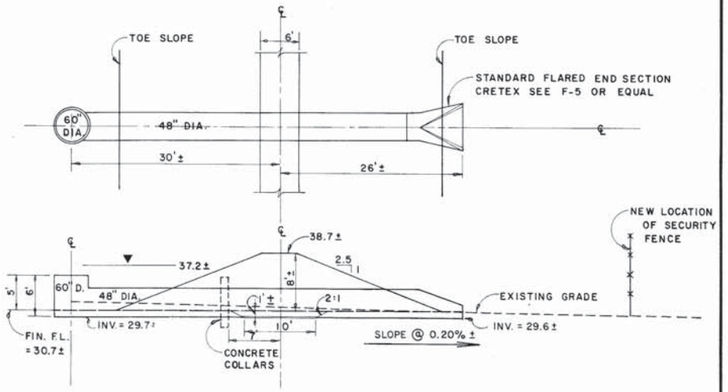
"D" DIKE OUTLET PIPE LINE

SCALE 1"=20' HORIZONTAL & 1"=5' VERTICAL



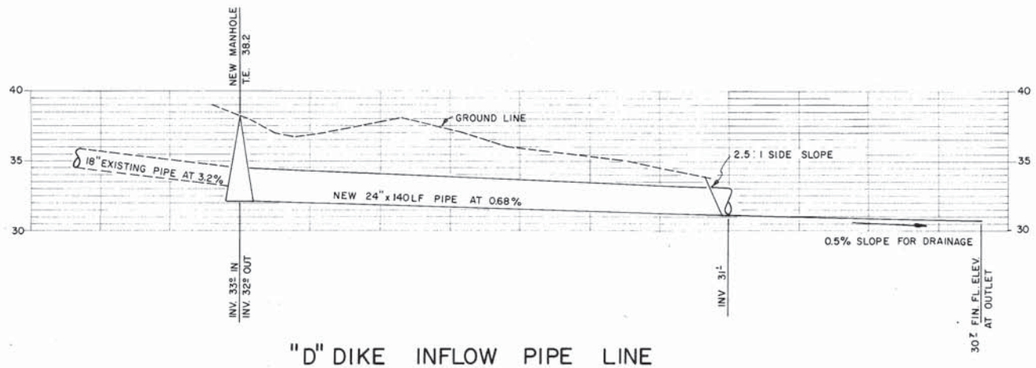
CONSTRUCTION LINE & TOP OF DIKE

SCALE 1" = 40'



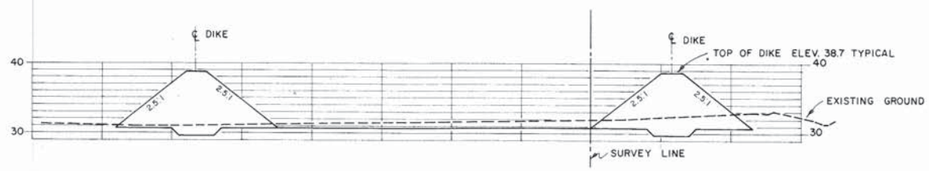
DROP INLET SPILLWAY TYPE-3

SCALE 1"= 10' HORIZ. & VERT.

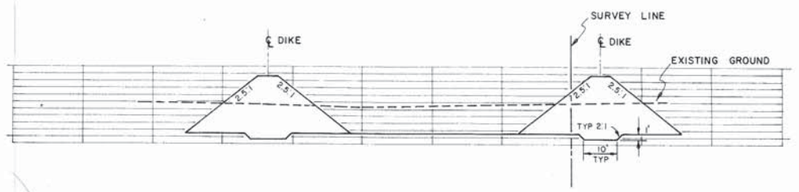


"D" DIKE INFLOW PIPE LINE

SCALE 1"=20' HORIZ. & 1"=5' VERT.



STA. 2+30



STA. 1+33

SCALE 1"=20' HORIZ. & 1"=10' VERT.

HURLBUT, KERSICH & McCULLOUGH
CONSULTING ENGINEERS
937 GRAND AVE.
BILLINGS, MONTANA

2M045.48c

DETAILS FOR DIKE "D"
PHASE-I
LOGAN FIELD AIRPORT
STORM SEWER

DRAWN BY: RJA
CHECKED BY:
DATE: 8/9/76

NO	REVISIONS	DATE
1	As Built ADAP-07	Jan 77

SHEET NO
17
OF

AIP 3-30-0008-07

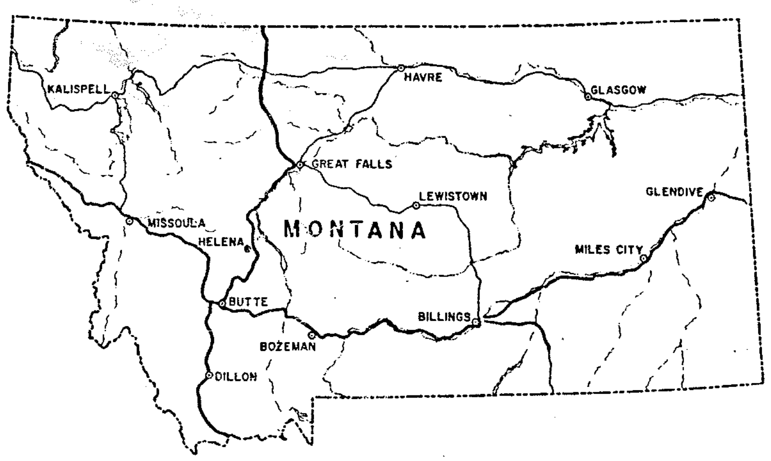
(Selected Sheets) for Pond E (1988)

MORRISON-MAIERLE, INC.

CITY OF BILLINGS

AVIATION AND TRANSIT DEPARTMENT

BILLINGS LOGAN INTERNATIONAL AIRPORT



LOCATION MAP

AIRPORT IMPROVEMENT PROGRAM

AIP PROJECT NO. 3–30–0008–07

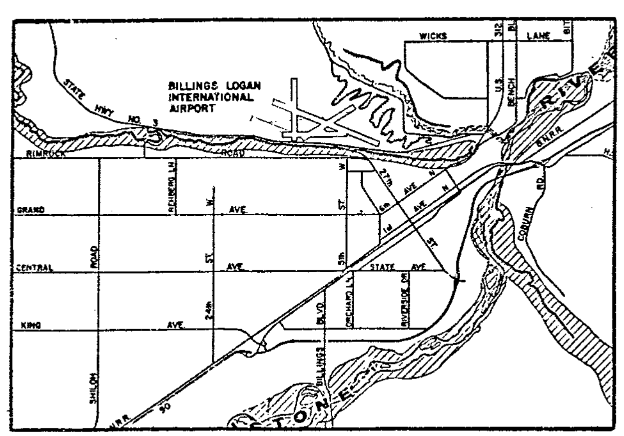
PHASE I EARTHWORK AND DRAINAGE

RUNWAY 7/25

STAR OF THE BIG SKY COUNTRY
BILLINGS
MONTANA

LEGEND

- NEW MANHOLE
- EXISTING INLET OR MANHOLE
- EXISTING RUNWAY OR TAXIWAY LIGHT
- TYPICAL BURIED UTILITY
- NEW STORM DRAIN
- EXISTING GROUND CONTOUR
- EXISTING RUNWAY OR TAXIWAY CENTERLINE
- PROPOSED RUNWAY OR TAXIWAY CENTERLINE
- 150' SAFETY AREA CONSTRUCTION LIMIT
- 300' SAFETY AREA CONSTRUCTION LIMIT
- DUMP SITE BOUNDARY



VICINITY MAP

INDEX OF SHEETS

HKM ASSOCIATES
ENGINEERS·PLANNERS

Airport Industrial Park
P.O. Box 31318
Billings, Montana 59107

Branch Offices:
• Bozeman, Montana
• Sheridan, Wyoming

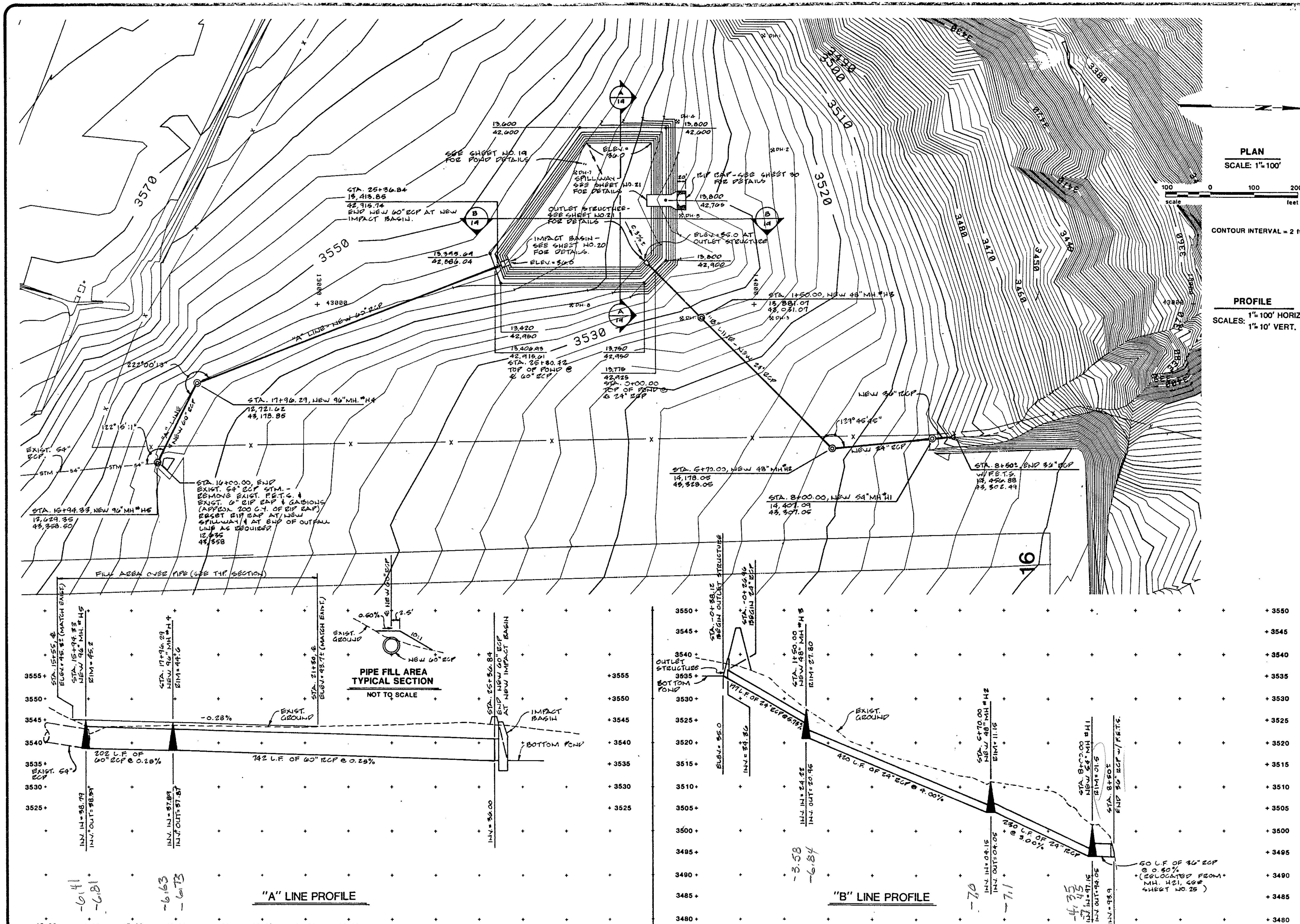
PRINCIPAL IN CHARGE

PROJECT MANAGER

2MO25.222
HKM JOB NO.

DATE

REDUCED PRINTS
APPROXIMATELY 1/2 SCALE



LOGAN FIELD - AIP 07 PHASE I

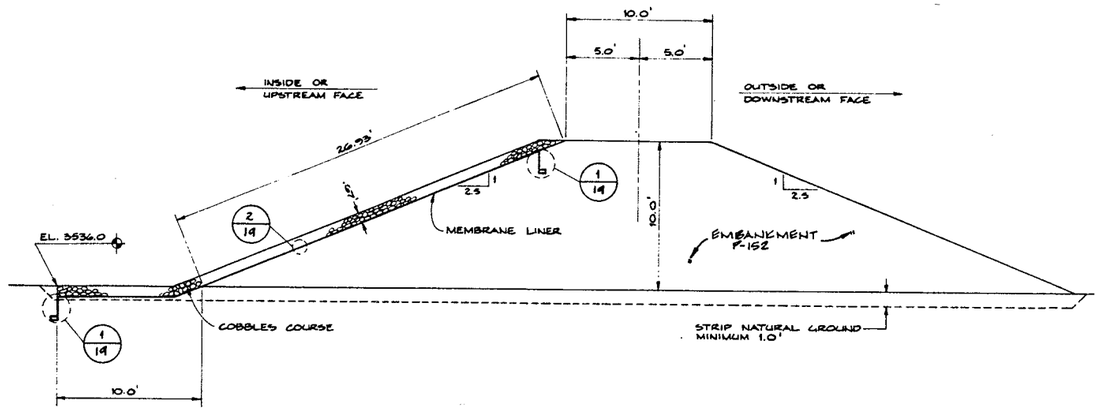
POND "E" LAYOUT
INLET AND OUTLET PIPE PROFILES

Project No 2M028.222 | I D No | Date JULY 1988 | Designed | Drawn | Checked | Approved

No	Revision	Date	By

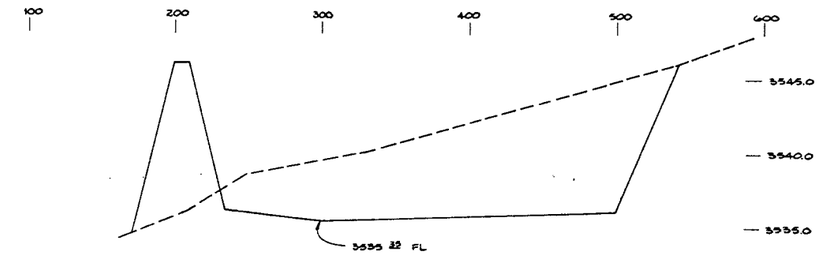
HKM ASSOCIATES
ENGINEERS·PLANNERS
Airport Industrial Park
P.O. Box 31318
Billings, Montana 59107
Branch Offices:
• Libby, Montana
• Sheridan, Wyoming

Sheet No 18 of 32



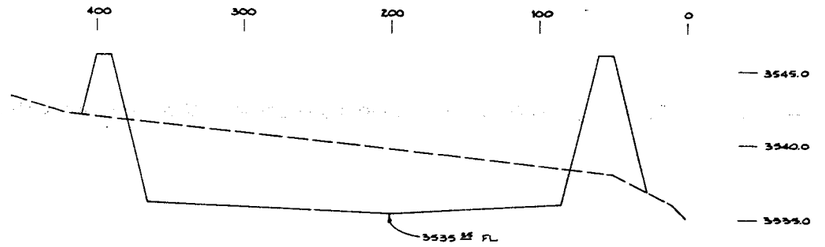
TYPICAL DIKE LINING SECTION

NOT TO SCALE



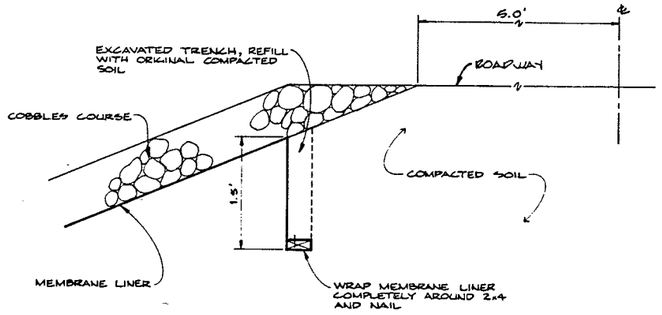
SECTION B - B (D/16)

NOT TO SCALE



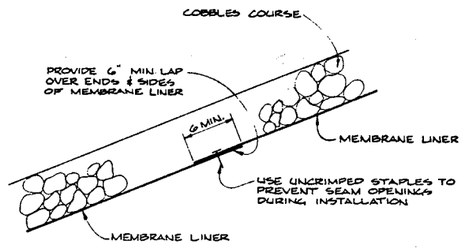
SECTION A - A (A/16)

NOT TO SCALE



DETAIL (1/14)

NOT TO SCALE



DETAIL (2/14)

NOT TO SCALE

Project No. 2M025.662 I.D. No. ..... Date July 1998 Designed ___ Drawn DM Checked ___ Approved ___

No.	Revision	By	Date

LOGAN FIELD – AIP 07 PHASE I

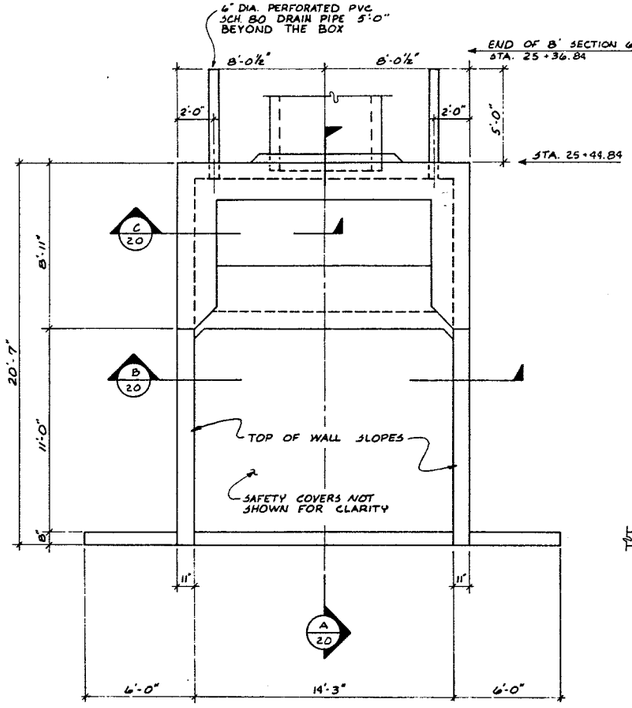
Sewer Utility

POND "E" TYPICAL SECTION AND CROSS SECTION

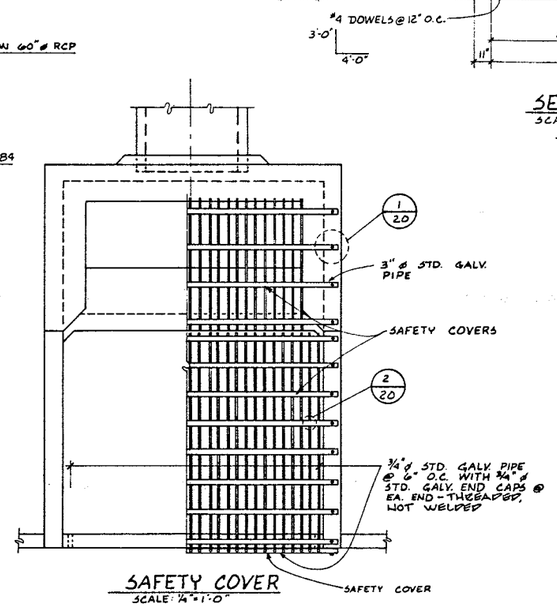
MONTANA * BENSON * EUGENE D. WASIA 3590 E. PROFESSIONAL

HKM ASSOCIATES
ENGINEERS-PLANNERS
Airport Industrial Park
P.O. Box 31318
Billings, Montana 59107
Branch Offices:
• Libby, Montana
• Sheridan, Wyoming

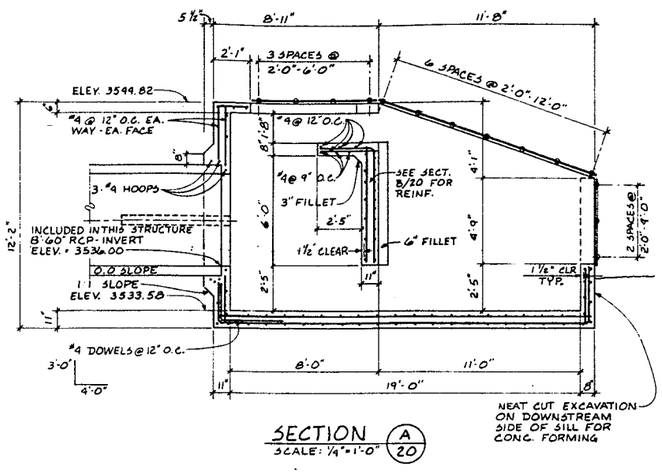
Sheet No. 19 of 32



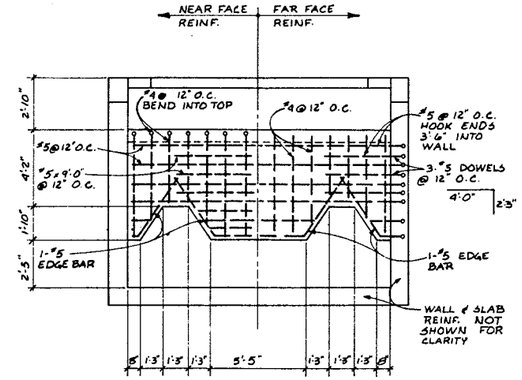
PLAN· IMPACT BASIN
SCALE: ¼"=1'-0"



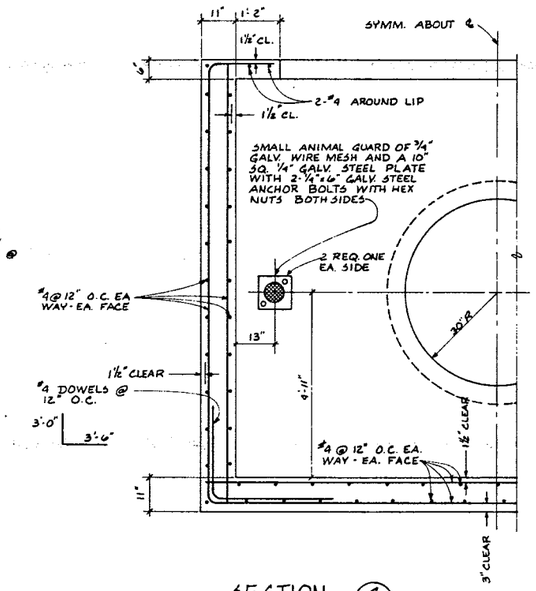
SAFETY COVER
SCALE: ¼"=1'-0"



SECTION A 20
SCALE: ¼"=1'-0"

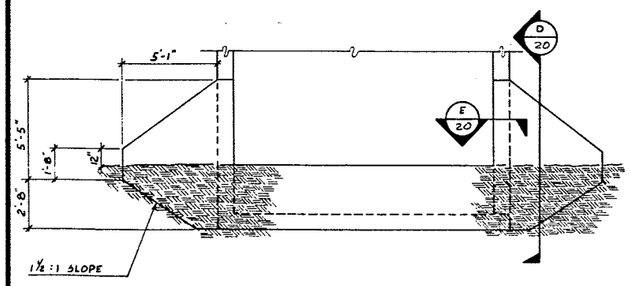


SECTION B 20
SCALE: ¼"=1'-0"

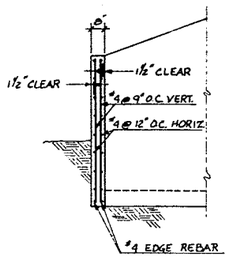


SECTION C 20
SCALE: ½"=1'-0"

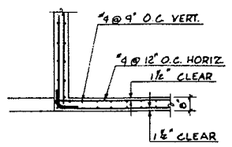
NOTE: PROVIDE CORNER BARS 2'-2" TO MATCH HORIZONTAL STEEL SIZE AND SPACING AT ALL CONC. WALL INTERSECTIONS.



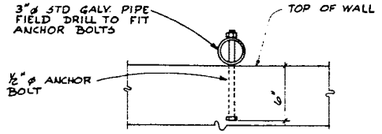
ELEVATION OF IMPACT BASIN
SCALE: ¼"=1'-0"



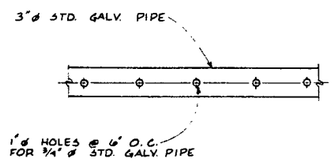
SECTION D 20
SCALE: ¼"=1'-0"



SECTION E 20
SCALE ¼"=1'-0"



DETAIL 1 20
SCALE: 1½"=1'-0"



DETAIL 2 20
SCALE: 1½"=1'-0"

LOGAN FIELD – AIP 07 PHASE I

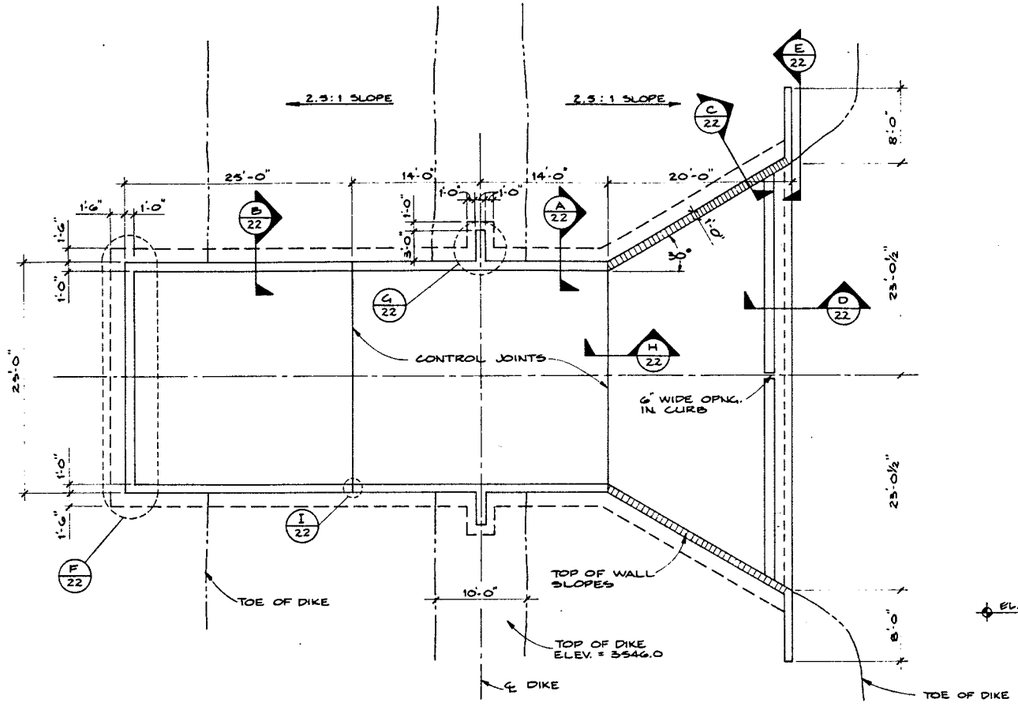
IMPACT BASIN POND "E"

Project No. 24029.222 I.D. No. Date July 1988 Designed ec Drawn RE Checked Approved

No.	Revision	By	Date

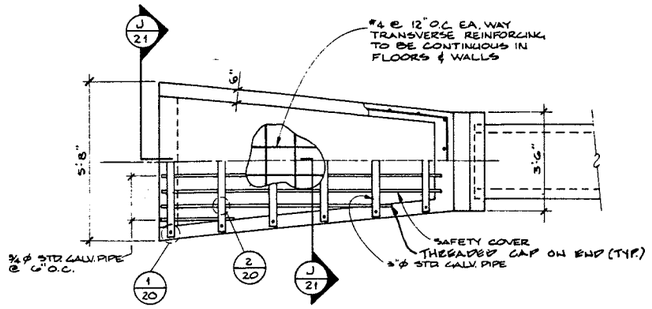
HKM ASSOCIATES
ENGINEERS·PLANNERS
Airport Industrial Park
P.O. Box 31318
Billings, Montana 59107
Branch Offices:
• Libby, Montana
• Sheridan, Wyoming

Sheet No. 20 of 32

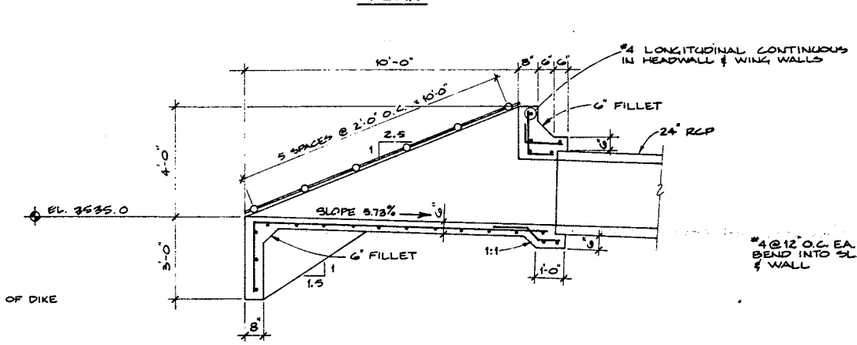


DROP INLET SPILLWAY PLAN

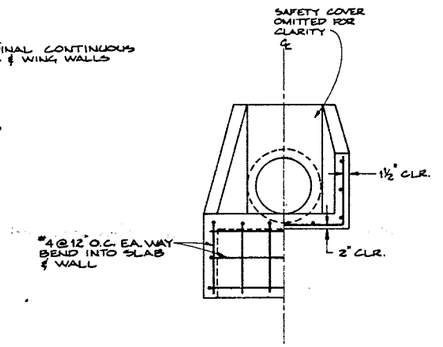
SCALE: ⅛" = 1'-0"



PLAN



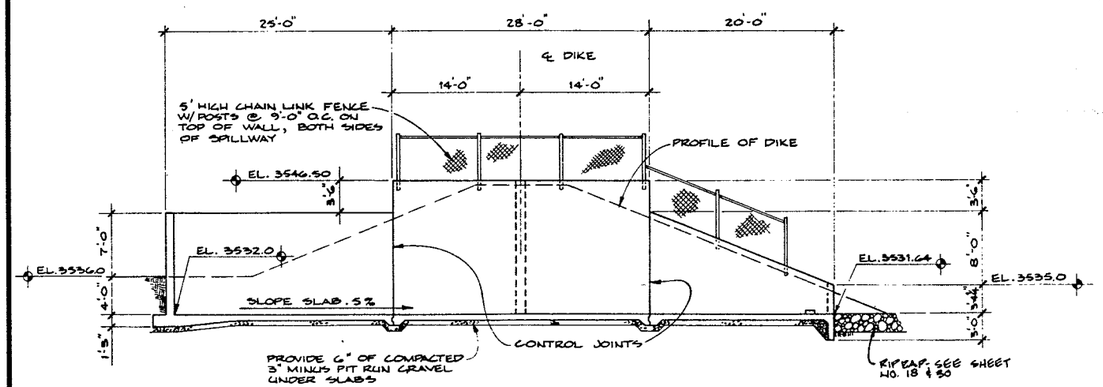
SECTION AT ℄



SECTION J-J 21

OUTLET STRUCTURE

SCALE: ⅜" = 1'-0"



ELEVATION AT ℄ OF SPILLWAY

SCALE: ⅛" = 1'-0"

Project No. 2M023.222 I.D. No. _____ Date July 1988 Designed GG Drawn DM Checked _____ Approved _____

No.	Revision	By	Date

LOGAN FIELD – AIP 07 PHASE 1

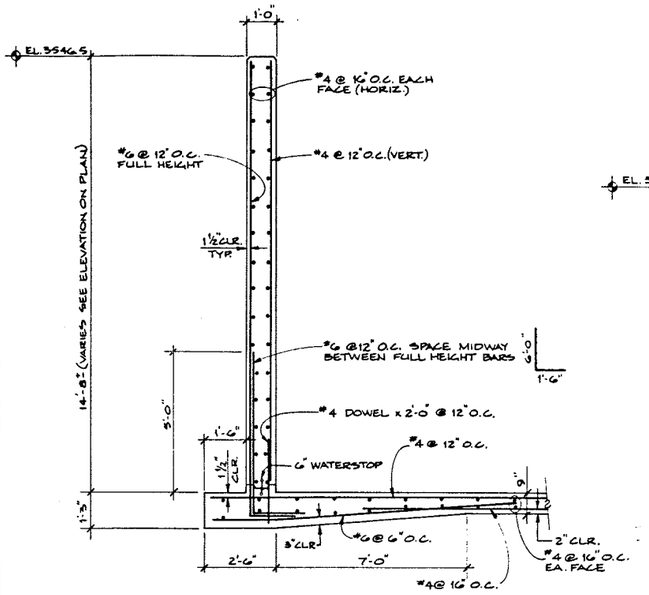
Project Title

SPILLWAY AND OUTLET STRUCTURE

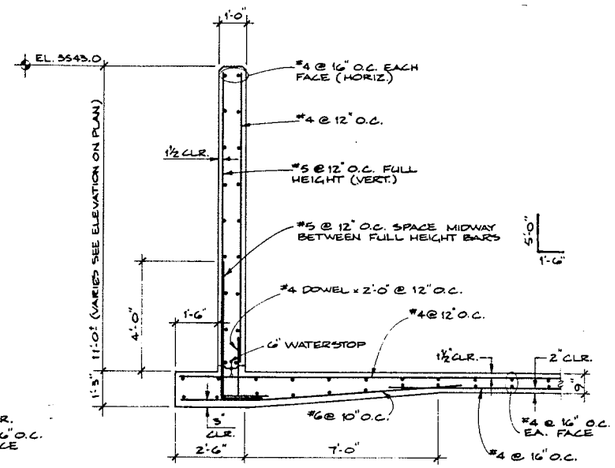
Sheet Title

HKM ASSOCIATES
ENGINEERS-PLANNERS
Airport Industrial Park
P.O. Box 31318
Billings, Montana 59107
Branch Offices:
• Libby, Montana
• Sheridan, Wyoming

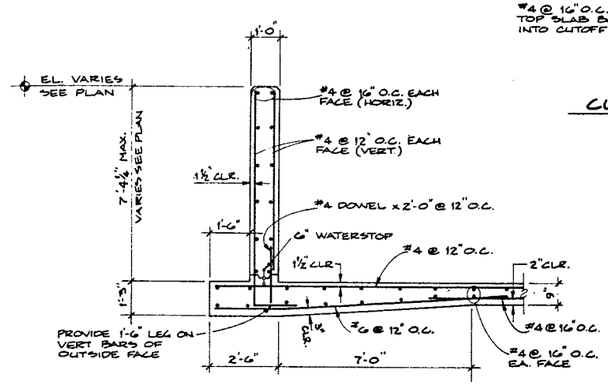
Sheet No. 21 of 32



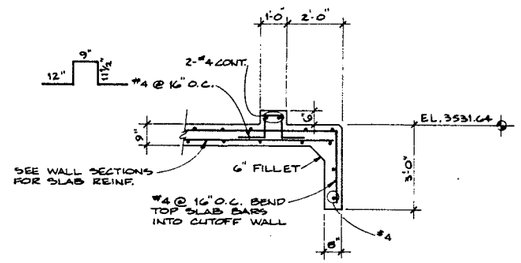
WALL SECTION (A/22)
SCALE: ⅜" = 1'-0"



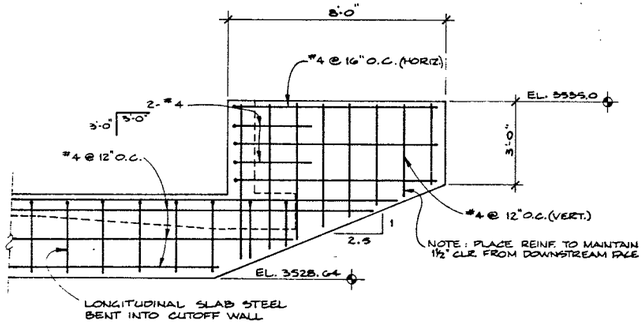
WALL SECTION (B/22)
SCALE: ⅜" = 1'-0"



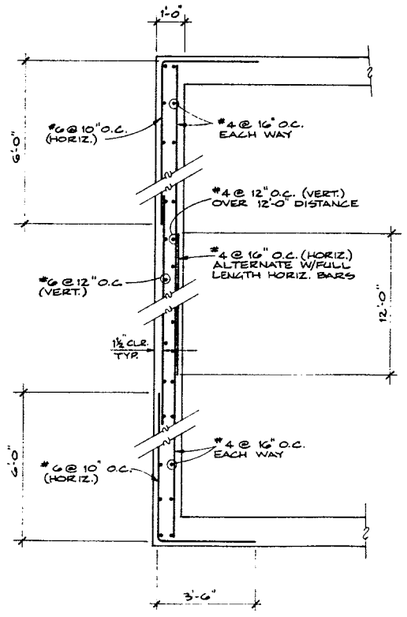
WALL SECTION (C/22)
SCALE: ⅜" = 1'-0"



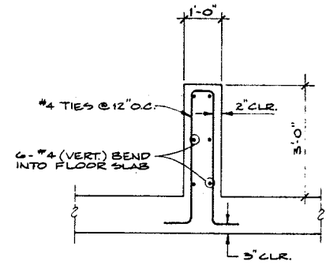
CUTOFF WALL DETAIL (D/22)
SCALE: ⅜" = 1'-0"



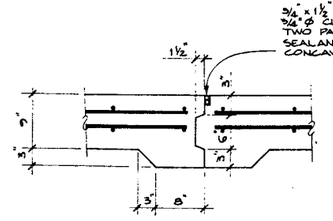
WING WALL ELEVATION (E/22)
SCALE: ⅜" = 1'-0"



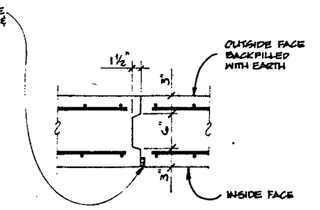
WALL SECTION (F/22)
SCALE: ⅜" = 1'-0"



CURB DETAIL (G/22)
SCALE: ½" = 1'-0"



FLOOR CONTROL JOINT (H/22)
SCALE: 1" = 1'-0"



WALL CONTROL JOINT (I/22)
SCALE: 1" = 1'-0"

Copyright © 1988 HKM Associates, All Rights Reserved

Project No. 2M025.222 I.D. No. ____ Date July 1988 Designed CS Drawn DL Checked ____ Approved ____

No.	Revision	By	Date

LOGAN FIELD – AIP 07 PHASE I

STRUCTURAL DETAILS POND "E"

Project Title

Sheet Title

HKM ASSOCIATES
ENGINEERS-PLANNERS
Airport Industrial Park
P.O. Box 31318
Billings, Montana 59107
Branch Offices:
• Libby, Montana
• Sheridan, Wyoming

Sheet No. 22 of 32

APPENDIX C

Precipitation Data

MORRISON-MAIERLE, INC

TABLE 3.4

Intensity-Duration for Billings, Montana, City of Billings Stormwater Management Manual

MORRISON-MAIERLE, INC.

Table 3-4. Intensity-duration for Billings, Montana

Time	Intensity in Inches per Hour at Selected Recurrence Intervals						
	WQual	2-year	5-year	10-year	25-year	50-year	100-year
5 min	1.26	2.82	4.54	5.66	7.09	8.15	9.20
10 min	0.88	2.08	3.20	3.95	4.89	5.58	6.28
15 min	0.72	1.68	2.62	3.24	4.03	4.62	5.20
20 min	0.63	1.45	2.29	2.84	3.54	4.06	4.57
25 min	0.54	1.23	1.95	2.43	3.04	3.50	3.95
30 min	0.45	1.00	1.62	2.03	2.55	2.94	3.32
35 min	0.42	0.93	1.50	1.87	2.35	2.71	3.06
40 min	0.38	0.85	1.37	1.71	2.14	2.47	2.79
45 min	0.35	0.78	1.25	1.55	1.95	2.24	2.53
50 min	0.31	0.7	1.12	1.40	1.74	2.00	2.26
55 min	0.27	0.63	1.00	1.24	1.54	1.77	2.00
1 hr	0.24	0.55	0.87	1.08	1.34	1.54	1.73
1.25 hr	0.21	0.49	0.77	0.95	1.19	1.36	1.53
1.5 hr	0.18	0.44	0.68	0.83	1.03	1.18	1.32
1.75 hr	0.16	0.38	0.58	0.71	0.88	0.99	1.16
2 hr	0.13	0.32	0.48	0.58	0.72	0.81	0.91
2.5 hr	0.11	0.28	0.42	0.50	0.62	0.70	0.79
3 hr	0.09	0.23	0.35	0.42	0.52	0.59	0.66
6 hr	0.06	0.15	0.21	0.24	0.30	0.34	0.37
24 hr	0.021	0.060	0.079	0.092	0.113	0.126	0.141

Values from 5 minutes to 3 hours from –

Mark M. Peterson, A Statistical Analysis of Short-Duration Precipitation for Billings, Montana, Montana State University, Bozeman, Winter 1985.

Values from 6 hour and 24 hour from –

National Weather Service, NOAA Atlas 2, Precipitation – Frequency Atlas of the Western United States, Volume 1 – Montana, Silver Springs, Maryland, 1973.

Values from water quality are approximate and were derived from average difference obtained from 2 year through 100-year storms.

JUNE 20, 2010

Storm Data

MORRISON-MAIERLE, INC.

SITE INFORMATION

ID: KBIL
NAME: Billings Logan International Airport
LATITUDE: 45.80694
LONGITUDE: -108.54222
ELEVATION: 3648 ft
MNET: NWS/FAA

(Click for topo/terrain map)
(Click for satellite)

SITE LINKS

Help
ROMAN
Metric Units
Greenwich Mean Time
Past Data
Station Information
Restrictions
Data in Spreadsheet Format

DATA COURTESY OF
National Weather Service

Past Weather Conditions for KBIL

Observations prior to selected time: June 21, 2010 - 12:00 MDT

Weather Conditions at June 21, 2010 - 11:53 MDT

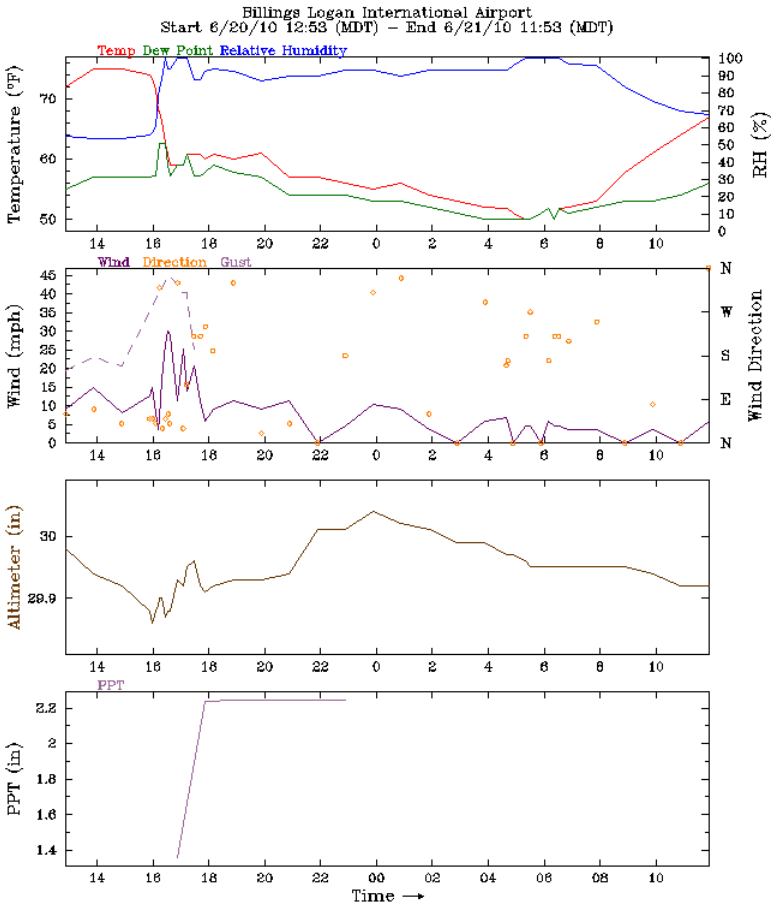
	11:53	24 Hour Max	24 Hour Min
Temperature	66.9° F	75.0 at 13:53	50.0 at 5:21
Dew Point	55.9° F	62.6 at 16:20	50.0 at 4:53
Relative Humidity	68%	100 at 16:27	54 at 13:53
Wind Speed	6 mph from N	30 at 16:33	0 at 21:53
Wind Gust	-	45 at 16:33	20 at 12:53
Pressure	26.18 in	26.28 at 23:53	26.13 at 15:59
Sea level pressure	29.86 in	29.98 at 23:53	29.81 at 15:53
Altimeter	29.92 in	30.04 at 23:53	29.86 at 15:59
Weather conditions	partly cloudy	-	-
Visibility	10.00 miles	10.00 at 12:53	0.25 at 4:42
Ceiling	-	10000 at 21:53	400 at 16:27

Precipitation variable accumulated	Since Midnight	In 24 Hours
Precipitation 1hr	0.00"	2.24"
Precipitation 6hr	0.00"	0.00"

Tabular Listing: June 20, 2010 - 11:00 through June 21, 2010 - 12:00 MDT

Time(MDT)	Temperature	Dew Point	Relative Humidity	Wind Speed	Wind Gust	Wind Direction	Quality check	Pressure	Sea level pressure	Altimeter	Weather conditions	Visibility	Precipitation 1hr	Precipitation 3hr	Precipitation 6hr	Precipitation 24hr	Ceiling
	° F	° F	%	mph	mph			in	in	in		miles	in	in	in	in	feet
11:53	66.9	55.9	68	6		N	OK	26.18	29.86	29.92	partly cloudy	10.00					
10:53	64.0	54.0	70	0			OK	26.18	29.87	29.92	partly cloudy	10.00					
9:53	61.0	53.1	75	3		E	OK	26.20	29.89	29.94	partly cloudy	10.00					
8:53	57.9	53.1	84	0			OK	26.21	29.91	29.95	partly cloudy	10.00					
7:53	53.1	52.0	96	3		WSW	OK	26.21	29.92	29.95	fog	10.00					
6:53	52.0	51.1	97	3		SSW	OK	26.21	29.91	29.95	fog	10.00					
6:31	51.8	51.8	100	5		SW	OK	26.21		29.95	fog	10.00					
6:23	50.0	50.0	100	5		SW	OK	26.21		29.95	fog	10.00					
6:10	51.8	51.8	100	6		S	OK	26.21		29.95	fog	0.50					
5:53	51.1	51.1	100	0			OK	26.21	29.92	29.95	fog	10.00				2.24	
5:30	50.0	50.0	100	5		W	OK	26.21		29.95	partly cloudy	10.00					
5:21	50.0	50.0	100	5		SW	OK	26.21		29.96	fog	1.00					
4:53	51.1	50.0	96	0			OK	26.22	29.94	29.97	fog	0.50					
4:42	51.8	50.0	94	6		S	OK	26.22		29.97	fog	0.25					
4:39	51.8	50.0	94	7		SSE	OK	26.22		29.97	fog	1.00					
3:53	52.0	50.0	93	6		WNW	OK	26.24	29.93	29.99	mostly clear	10.00					
2:53	53.1	51.1	93	0			OK	26.24	29.93	29.99	clear	10.00					
1:53	54.0	52.0	93	3		ENE	OK	26.26	29.94	30.01	clear	10.00					
0:53	55.9	53.1	90	9		NNW	OK	26.27	29.96	30.02	clear	10.00					
23:53	55.0	53.1	93	10		NW	OK	26.28	29.98	30.04	mostly clear	10.00			0.00		
22:53	55.9	54.0	93	5		S	OK	26.26	29.96	30.01	mostly cloudy	10.00	0.00				8000
21:53	57.0	54.0	89	0			OK	26.26	29.96	30.01	lt rain	10.00	0.00				10000
20:53	57.0	54.0	89	12		NE	OK	26.20	29.89	29.94	partly cloudy	10.00		0.00			
19:53	61.0	57.0	87	9		NNE	OK	26.19	29.88	29.93	partly cloudy	10.00					
18:53	60.1	57.9	93	12		NNW	OK	26.19	29.89	29.93	partly cloudy	10.00	0.00				
18:09	60.8	59.0	94	9		S	OK	26.18		29.92	lt rain	10.00	0.00				7000
17:53	60.1	57.9	93	6		WSW	OK	26.17	29.88	29.91	lt rain thunder shwr	9.00	0.88				4100
17:42	60.8	57.2	88	12		SW	OK	26.18		29.92	mod thunder shwr	4.00	0.86				3500
17:28	60.8	57.2	88	21	25	SW	OK	26.21		29.96	lt rain thunder shwr	5.00	0.78				2100
17:12	60.8	60.8	100	14	40	ESE	OK	26.21		29.95	mod thunder shwr, fog	2.00	0.77				2000
17:05	59.0	59.0	100	25	40	NNE	OK	26.18		29.92	hvy rain thunder shwr, mod hail, fog	0.50	0.57				600
16:53	59.0	59.0	100	12		NNW	OK	26.19	29.90	29.93	hvy rain thunder shwr, mod hail, fog	1.00	1.36				600
16:36	59.0	57.2	94	29	45	NE	OK	26.14		29.88	hvy rain thunder shwr, mod hail, fog	1.25	0.84				800
16:33	60.8	59.0	94	30	45	ENE	OK	26.14		29.88	hvy rain thunder shwr, mod hail, fog	0.75	0.79				400
16:27	62.6	62.6	100	26		NE	OK	26.14		29.87	hvy rain thunder shwr, mod hail, fog	0.50	0.64				400
16:20	66.2	62.6	88	17		NNE	OK	26.16		29.90	hvy rain thunder shwr, mod hail, fog	1.50	0.34				4200
16:14	68.0	62.6	83	7		NW	OK	26.16		29.90	hvy rain thunder shwr, mod hail	3.00	0.16				4000
16:11	68.0	60.8	78	3			OK	26.15		29.89	thunder, mod hail, mod rain	1.75	0.09				4200
16:06	71.6	57.2	61	8		NE	OK	26.14		29.88	thunder, mod hail, mod rain	7.00	0.01				4200
15:59	73.4	57.2	57	15		NE	OK	26.13		29.86	thunder	10.00					4500
15:53	73.9	57.0	56	13		NE	OK	26.14	29.81	29.88	mostly cloudy	10.00					4700
14:53	75.0	57.0	54	8	21	NE	OK	26.18	29.84	29.92	mostly cloudy	10.00					4700
13:53	75.0	57.0	54	15	23	ENE	OK	26.20	29.86	29.94	partly cloudy	10.00					
12:53	72.0	55.0	55	9	20	ENE	OK	26.23	29.91	29.98	partly cloudy	10.00					
11:53	70.0	53.1	55	9		NE	OK	26.24	29.93	29.99	mostly clear	10.00					

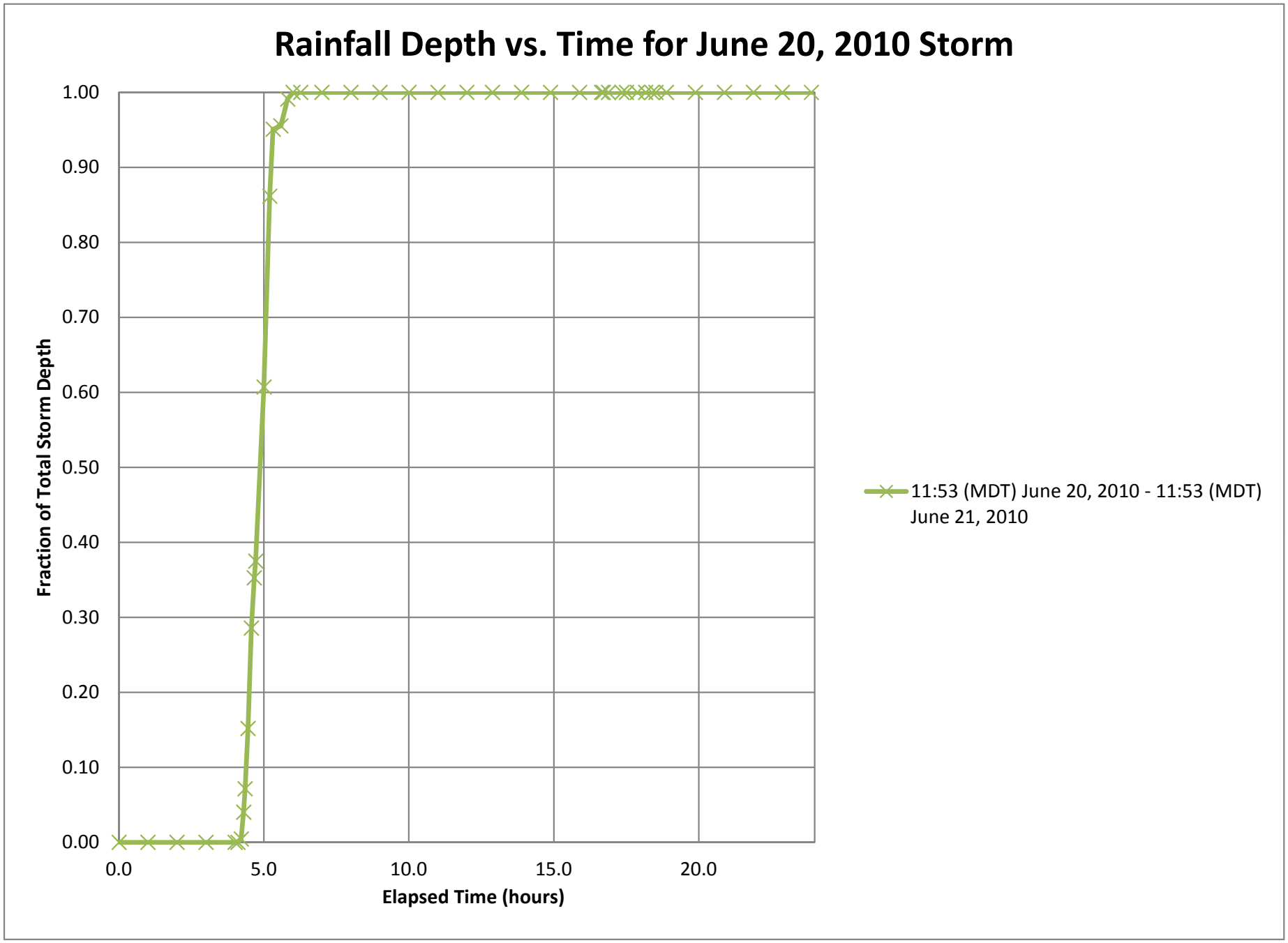
Select Previous Periods: 12 Hours 24 Hours 2 Days 5 Days 7 Days 10 Days 30 Days
Hodograph



June 2010 Storm Data
11:53 (MDT) June 20, 2010 - 11:53 (MDT) June 21, 2010
Billings Logan International Airport

NWS Time Readings (MDT)	**Elapsed Time (hours)**	NWS Precipitation Readings Accumulated Per 1 hour (in.)	Incremental Precipitation (inches)	Accumulated Precipitation (inches)	**Fraction of Total Storm Depth**
11:53	**0.0**	0.00	0.00	0.00	**0.00**
12:53	**1.0**	0.00	0.00	0.00	**0.00**
13:53	**2.0**	0.00	0.00	0.00	**0.00**
14:53	**3.0**	0.00	0.00	0.00	**0.00**
15:53	**4.0**	0.00	0.00	0.00	**0.00**
15:59	**4.1**	0.00	0.00	0.00	**0.00**
16:06	**4.2**	0.01	0.01	0.01	**0.00**
16:11	**4.3**	0.09	0.08	0.09	**0.04**
16:14	**4.4**	0.16	0.07	0.16	**0.07**
16:20	**4.5**	0.34	0.18	0.34	**0.15**
16:27	**4.6**	0.64	0.30	0.64	**0.29**
16:33	**4.7**	0.79	0.15	0.79	**0.35**
16:36	**4.7**	0.84	0.05	0.84	**0.38**
16:53	**5.0**	1.36	0.52	1.36	**0.61**
17:05	**5.2**	0.57	0.57	1.93	**0.86**
17:12	**5.3**	0.77	0.20	2.13	**0.95**
17:28	**5.6**	0.78	0.01	2.14	**0.96**
17:42	**5.8**	0.86	0.08	2.22	**0.99**
17:53	**6.0**	0.88	0.02	2.24	**1.00**
18:09	**6.3**	0.00	0.00	2.24	**1.00**
18:53	**7.0**	0.00	0.00	2.24	**1.00**
19:53	**8.0**	0.00	0.00	2.24	**1.00**
20:53	**9.0**	0.00	0.00	2.24	**1.00**
21:53	**10.0**	0.00	0.00	2.24	**1.00**
22:53	**11.0**	0.00	0.00	2.24	**1.00**
23:53	**12.0**	0.00	0.00	2.24	**1.00**
0:53	**12.9**	0.00	0.00	2.24	**1.00**
1:53	**13.9**	0.00	0.00	2.24	**1.00**
2:53	**14.9**	0.00	0.00	2.24	**1.00**
3:53	**15.9**	0.00	0.00	2.24	**1.00**
4:39	**16.7**	0.00	0.00	2.24	**1.00**
4:42	**16.7**	0.00	0.00	2.24	**1.00**
4:53	**16.9**	0.00	0.00	2.24	**1.00**
5:21	**17.4**	0.00	0.00	2.24	**1.00**
5:30	**17.5**	0.00	0.00	2.24	**1.00**
5:53	**17.9**	0.00	0.00	2.24	**1.00**

NWS Time Readings (MDT)	**Elapsed Time (hours)**	NWS Precipitation Readings Accumulated Per 1 hour (in.)	Incremental Precipitation (inches)	Accumulated Precipitation (inches)	**Fraction of Total Storm Depth**
6:10	**18.2**	0.00	0.00	2.24	**1.00**
6:23	**18.4**	0.00	0.00	2.24	**1.00**
6:31	**18.5**	0.00	0.00	2.24	**1.00**
6:53	**18.9**	0.00	0.00	2.24	**1.00**
7:53	**19.9**	0.00	0.00	2.24	**1.00**
8:53	**20.9**	0.00	0.00	2.24	**1.00**
9:53	**21.9**	0.00	0.00	2.24	**1.00**
10:53	**22.9**	0.00	0.00	2.24	**1.00**
11:53	**23.9**	0.00	0.00	2.24	**1.00**
			2.24		


Rainfall Depth vs. Time for June 20, 2010 Storm
Fraction of Total Storm Depth
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0.0
5.0
10.0
15.0
20.0
Elapsed Time (hours)
11:53 (MDT) June 20, 2010 - 11:53 (MDT) June 21, 2010

MAY 24, 2011

Storm Data

MORRISON-MAIERLE, INC.

SITE INFORMATION

ID: KBIL
NAME: Billings Logan International Airport
LATITUDE: 45.80694
LONGITUDE: -108.54222
ELEVATION: 3648 ft
MNET: NWS/FAA

(Click for topo/terrain map)
(Click for satellite)

SITE LINKS

Help
ROMAN
Metric Units
Greenwich Mean Time
Past Data
Station Information
Restrictions
Data in Spreadsheet Format

DATA COURTESY OF
National Weather Service

Past Weather Conditions for KBIL

Observations prior to selected time: May 25, 2011 - 06:00 MDT

Weather Conditions at May 25, 2011 - 5:53 MDT

	5:53	24 Hour Max	24 Hour Min
Temperature	46.9° F	55.4 at 11:06	46.4 at 23:34
Dew Point	46.9° F	54.0 at 7:53	46.4 at 23:34
Relative Humidity	100%	100 at 6:12	93 at 10:53
Wind Speed	9 mph from NE	20 at 15:27	0 at 9:53
Wind Gust	-	25 at 16:53	23 at 22:22
Pressure	26.32 in	26.32 at 5:53	26.01 at 6:12
Sea level pressure	30.07 in	30.07 at 5:53	29.68 at 7:53
Altimeter	30.08 in	30.08 at 5:53	29.73 at 6:12
Weather conditions	lt rain, fog	-	-
Visibility	0.50 miles	10.00 at 19:53	0.25 at 1:50
Ceiling	100 feet	3100 at 10:53	100 at 22:40

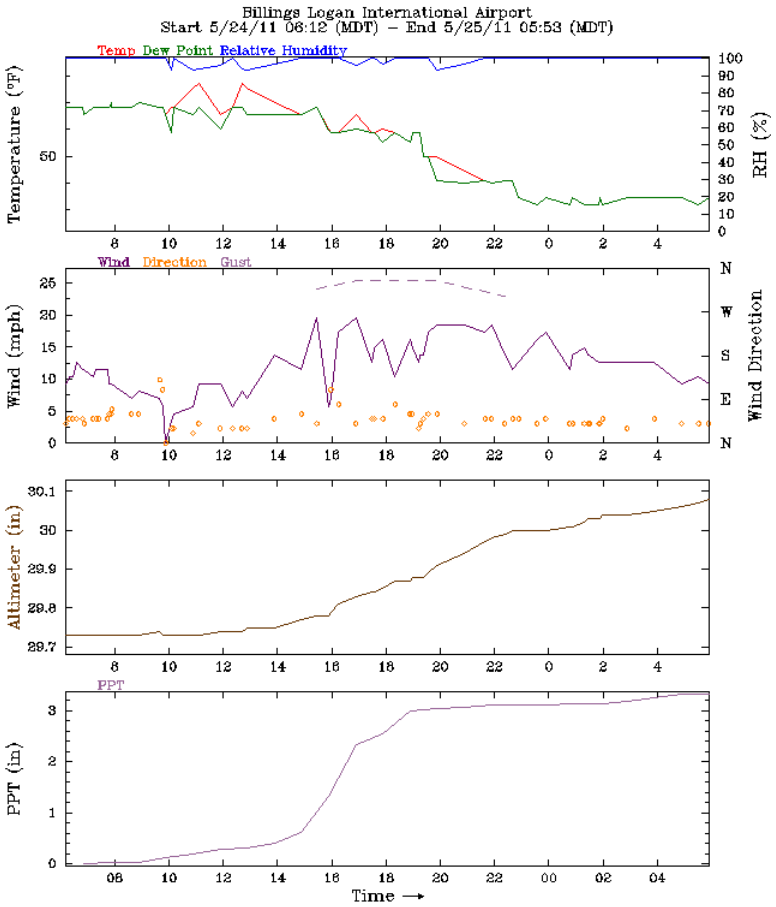
Precipitation variable accumulated	Since Midnight	In 24 Hours
Precipitation 1hr	0.21"	3.32"
Precipitation 6hr	0.00"	2.55"

Tabular Listing: May 24, 2011 - 5:00 through May 25, 2011 - 06:00 MDT

Time(MDT)	Temperature	Dew Point	Relative Humidity	Wind Speed	Wind Gust	Wind Direction	Quality check	Pressure	Sea level pressure	Altimeter	Weather conditions	Visibility	Precipitation 1hr	Precipitation 3hr	Precipitation 6hr	Precipitation 24hr	Ceiling
	° F	° F	%	mph	mph			in	in	in		miles	in	in	in	in	feet
5:53	46.9	46.9	100	9		NE	OK	26.32	30.07	30.08	lt rain, fog	0.50	0.01			3.32	100
5:31	46.4	46.4	100	10		NE	OK	26.31		30.07	fog	0.75	0.01				100
4:53	46.9	46.9	100	9		NE	OK	26.30	30.06	30.06	lt rain, fog	1.00	0.06				100
3:53	46.9	46.9	100	13		NE	OK	26.29	30.05	30.05	lt rain, fog	1.00	0.07				
2:53	46.9	46.9	100	13		NNE	OK	26.28	30.03	30.04	lt rain, fog	0.50	0.06				
1:59	46.4	46.4	100	13		NE	OK	26.28		30.04	lt rain, fog	0.50	0.00				
1:53	46.9	46.9	100	13		NE	OK	26.28	30.03	30.03	lt rain, fog	0.25	0.00				
1:50	46.4	46.4	100	13		NE	OK	26.28		30.03	lt rain, fog	0.25	0.00				
1:30	46.4	46.4	100	14		NE	OK	26.28		30.03	lt rain, fog	0.75	0.00				100
1:27	46.4	46.4	100	14		NE	OK	26.28		30.03	lt rain, fog	1.50	0.00				100
1:18	46.4	46.4	100	15		NE	OK	26.27		30.02	lt rain	7.00	0.00				100
0:53	46.9	46.9	100	14		NE	OK	26.26	30.00	30.01	lt rain, fog	0.50	0.01				100
0:46	46.4	46.4	100	12		NE	OK	26.26		30.01	lt rain, fog	0.50	0.01				100
23:53	46.9	46.9	100	17		NE	OK	26.25	30.00	30.00	lt rain, fog	1.00	0.00				100
23:34	46.4	46.4	100	16		NE	OK	26.25		30.00	lt rain, fog	2.00	0.00				100
22:53	46.9	46.9	100	13		NE	OK	26.25	30.00	30.00	lt rain, fog	1.00	0.01				100
22:40	48.2	48.2	100	12		NE	OK	26.25		30.00	lt rain, fog	1.00	0.01				100
22:22	48.2	48.2	100	14	23	NE	OK	26.24		29.99	fog	1.00	0.00				200
21:53	48.0	48.0	100	18		NE	OK	26.23	29.97	29.98	mod rain, fog	2.00	0.05				200
21:39	48.2	48.2	100	17		NE	OK	26.22		29.97	lt rain, fog	1.25	0.02				200
20:53	48.9	48.0	97	18		NE	OK	26.20	29.92	29.94	lt rain, fog	2.00	0.01	0.50			200
19:53	50.0	48.2	94	18	25	ENE	OK	26.17	29.89	29.91	overcast	10.00	0.04				200
19:33	50.0	50.0	100	17		ENE	OK	26.15		29.89	lt rain	9.00	0.04				200
19:23	50.0	50.0	100	14		NE	OK	26.14		29.88	lt rain, fog	5.00	0.03				600
19:16	51.8	51.8	100	14		NE	OK	26.14		29.88	lt rain, fog	1.00	0.03				400
19:12	51.8	51.8	100	13		NNE	OK	26.14		29.88	lt rain, fog	4.00	0.03				400
18:58	51.8	51.8	100	15		ENE	OK	26.14		29.88	mod rain, fog	4.00	0.00				1400
18:53	51.1	51.1	100	16		ENE	OK	26.14	29.86	29.87	mod rain, fog	2.00	0.45				1200
18:20	51.8	51.8	100	10		E	OK	26.14		29.87	hvy rain, fog	2.00	0.11				400
17:53	52.0	51.1	97	16		NE	OK	26.12	29.83	29.85	lt rain	9.00	0.21		2.28		400
17:34	51.8	51.8	100	15		NE	OK	26.11		29.84	mod rain, fog	5.00	0.19				400
17:29	51.8	51.8	100	13		NE	OK	26.11		29.84	lt rain, fog	2.00	0.18				800
16:53	53.1	52.0	96	20	25	NE	OK	26.10	29.80	29.83	hvy rain, fog	2.00	1.02				2000
16:15	51.8	51.8	100	17		E	OK	26.08		29.81	hvy rain, fog	2.00	0.67				2300
15:58	51.8	51.8	100	7		ESE	OK	26.07		29.79	hvy rain, fog	2.00	0.28				600
15:53	52.0	52.0	100	6			OK	26.06	29.75	29.78	hvy rain, fog	1.00	0.71				800
15:27	53.6	53.6	100	20	24	NE	OK	26.06		29.78	hvy rain, fog	2.00	0.12				900
14:53	53.1	53.1	100	12		ENE	OK	26.05	29.75	29.77	lt rain, fog	6.00	0.22				1500
13:53	54.0	53.1	97	14		NE	OK	26.03	29.72	29.75	lt rain	7.00	0.09				2300
12:53	55.0	53.1	93	7		NNE	OK	26.03	29.71	29.75	overcast	9.00	0.03				2100
12:41	55.4	53.6	94	8		NNE	OK	26.02		29.74	overcast	9.00	0.03				1500
12:21	53.6	53.6	100	6		NNE	OK	26.02		29.74	lt rain	8.00	0.03				3100
11:53	53.1	52.0	96	9		NNE	OK	26.02	29.72	29.74	mod rain, fog	5.00	0.09		0.27		800
11:06	55.4	53.6	94	9		NE	OK	26.01		29.73	lt rain	8.00	0.00				600
10:53	55.0	53.1	93	6		NNE	OK	26.01	29.69	29.73	lt rain	9.00	0.07				3100
10:11	53.6	53.6	100	5		NNE	OK	26.01		29.73	lt rain	8.00	0.06				3000
10:06	53.6	51.8	94	3		NNE	OK	26.01		29.73	mod rain, fog	5.00	0.05				1400
9:53	53.1	53.1	100	0			OK	26.01	29.69	29.73	mod rain, fog	3.00	0.09				400
9:46	53.6	53.6	100	6		ESE	OK	26.01		29.73	mod rain, fog	3.00	0.07				400
9:40	53.6	53.6	100	7		SE	OK	26.02		29.74	mod rain, fog	2.00	0.05				400
8:53	54.0	54.0	100	8		ENE	OK	26.01	29.69	29.73	overcast	7.00	0.00				300
8:37	53.6	53.6	100	7		ENE	OK	26.01		29.73	lt rain	7.00	0.00				300
7:54	53.6	53.6	100	9		ENE	OK	26.01		29.73	lt rain, fog	2.00	0.00				400
7:53	54.0	54.0	100	9		ENE	OK	26.01	29.68	29.73	lt rain, fog	4.00	0.02				400

7:48	53.6	53.6	100	9	ENE	OK	26.01	29.73	fog	3.00	0.02		400
7:44	53.6	53.6	100	12	NE	OK	26.01	29.73	fog	1.00	0.01		200
7:25	53.6	53.6	100	12	NE	OK	26.01	29.73	lt rain, fog	0.50	0.01		200
7:19	53.6	53.6	100	12	NE	OK	26.01	29.73	lt rain, fog	0.50	0.01		200
7:12	53.6	53.6	100	10	NE	OK	26.01	29.73	lt rain, fog	0.50	0.00		200
6:53	53.1	53.1	100	12	NE	OK	26.01	29.69 29.73	lt rain, fog	1.00	0.00		200
6:49	53.6	53.6	100	12	NE	OK	26.01	29.73	lt rain, fog	1.00	0.00		200
6:36	53.6	53.6	100	13	NE	OK	26.01	29.73	lt rain, fog	0.50	0.00		200
6:27	53.6	53.6	100	10	NE	OK	26.01	29.73	fog	0.50			200
6:19	53.6	53.6	100	10	NE	OK	26.01	29.73	fog	0.75			200
6:12	53.6	53.6	100	9	NE	OK	26.01	29.73	fog	1.00			200
5:53	53.1	52.0	96	8	NE	OK	26.01	29.68 29.73	fog	6.00	0.00	0.03	300
5:30	53.6	51.8	94	7	NNE	OK	26.00	29.72	overcast	7.00	0.00		300
5:10	53.6	53.6	100	6	N	OK	26.00	29.72	lt rain, fog	5.00	0.00		2000

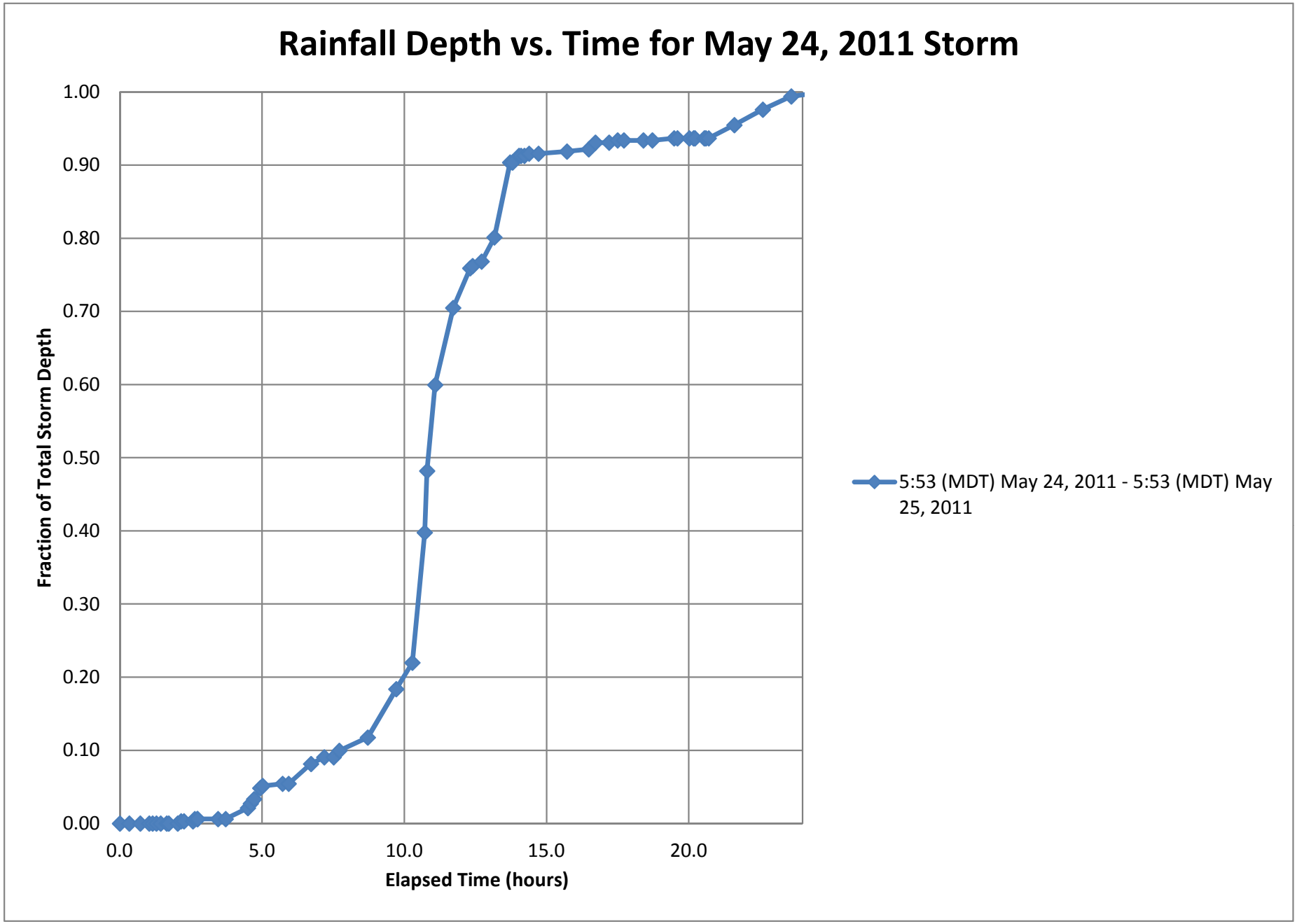
Select Previous Periods: 12 Hours 24 Hours 2 Days 5 Days 7 Days 10 Days 30 Days
Hodograph



May 2011 Storm Data
5:53 (MDT) May 24, 2011 - 5:53 (MDT) May 25, 2011
Billings Logan International Airport

NWS Time Readings (MDT)	**Elapsed Time (hours)**	NWS Precipitation Readings Accumulated Per 1 hour (in.)	Incremental Precipitation (inches)	Accumulated Precipitation (inches)	**Fraction of Total Storm Depth**
5:10	**0.0**	0.00	0.00	0.00	**0.00**
5:30	**0.3**	0.00	0.00	0.00	**0.00**
5:53	**0.7**	0.00	0.00	0.00	**0.00**
6:12	**1.0**	0.00	0.00	0.00	**0.00**
6:19	**1.2**	0.00	0.00	0.00	**0.00**
6:27	**1.3**	0.00	0.00	0.00	**0.00**
6:36	**1.4**	0.00	0.00	0.00	**0.00**
6:49	**1.7**	0.00	0.00	0.00	**0.00**
6:53	**1.7**	0.00	0.00	0.00	**0.00**
7:12	**2.0**	0.00	0.00	0.00	**0.00**
7:19	**2.2**	0.01	0.01	0.01	**0.00**
7:25	**2.3**	0.01	0.00	0.01	**0.00**
7:44	**2.6**	0.01	0.00	0.01	**0.00**
7:48	**2.6**	0.02	0.01	0.02	**0.01**
7:53	**2.7**	0.02	0.00	0.02	**0.01**
7:54	**2.7**	0.00	0.00	0.02	**0.01**
8:37	**3.5**	0.00	0.00	0.02	**0.01**
8:53	**3.7**	0.00	0.00	0.02	**0.01**
9:40	**4.5**	0.05	0.05	0.07	**0.02**
9:46	**4.6**	0.07	0.02	0.09	**0.03**
9:53	**4.7**	0.09	0.02	0.11	**0.03**
10:06	**4.9**	0.05	0.05	0.16	**0.05**
10:11	**5.0**	0.06	0.01	0.17	**0.05**
10:53	**5.7**	0.07	0.01	0.18	**0.05**
11:06	**5.9**	0.00	0.00	0.18	**0.05**
11:53	**6.7**	0.09	0.09	0.27	**0.08**
12:21	**7.2**	0.03	0.03	0.30	**0.09**
12:41	**7.5**	0.03	0.00	0.30	**0.09**
12:53	**7.7**	0.03	0.03	0.33	**0.10**
13:53	**8.7**	0.09	0.06	0.39	**0.12**
14:53	**9.7**	0.22	0.22	0.61	**0.18**
15:27	**10.3**	0.12	0.12	0.73	**0.22**
15:53	**10.7**	0.71	0.59	1.32	**0.40**

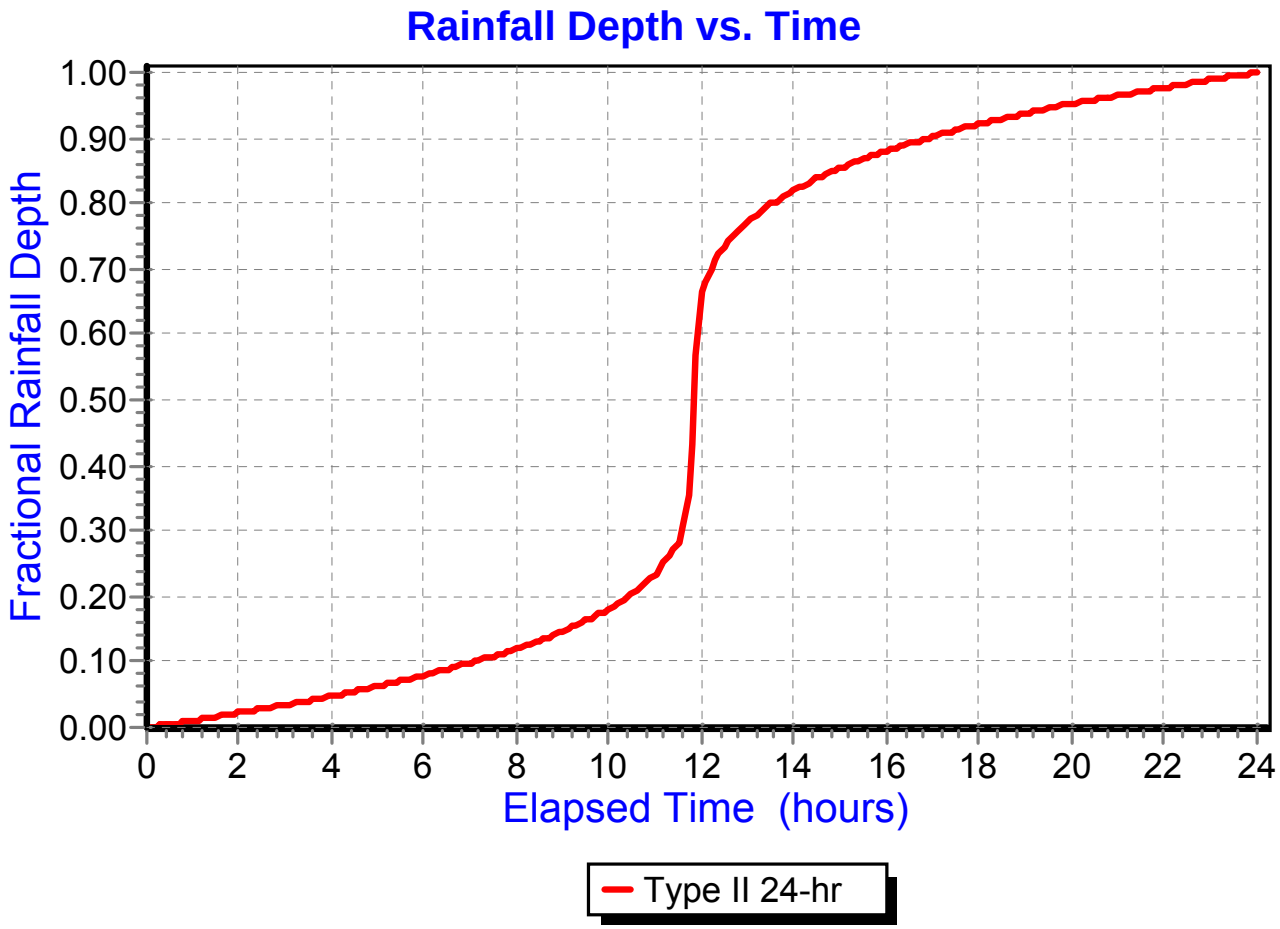
NWS Time Readings (MDT)	**Elapsed Time (hours)**	NWS Precipitation Readings Accumulated Per 1 hour (in.)	Incremental Precipitation (inches)	Accumulated Precipitation (inches)	**Fraction of Total Storm Depth**
15:58	**10.8**	0.28	0.28	1.60	**0.48**
16:15	**11.1**	0.67	0.39	1.99	**0.60**
16:53	**11.7**	1.02	0.35	2.34	**0.70**
17:29	**12.3**	0.18	0.18	2.52	**0.76**
17:34	**12.4**	0.19	0.01	2.53	**0.76**
17:53	**12.7**	0.21	0.02	2.55	**0.77**
18:20	**13.2**	0.11	0.11	2.66	**0.80**
18:53	**13.7**	0.45	0.34	3.00	**0.90**
18:58	**13.8**	0.00	0.00	3.00	**0.90**
19:12	**14.0**	0.03	0.03	3.03	**0.91**
19:16	**14.1**	0.03	0.00	3.03	**0.91**
19:23	**14.2**	0.03	0.00	3.03	**0.91**
19:33	**14.4**	0.04	0.01	3.04	**0.92**
19:53	**14.7**	0.04	0.00	3.04	**0.92**
20:53	**15.7**	0.01	0.01	3.05	**0.92**
21:39	**16.5**	0.02	0.01	3.06	**0.92**
21:53	**16.7**	0.05	0.03	3.09	**0.93**
22:22	**17.2**	0.00	0.00	3.09	**0.93**
22:40	**17.5**	0.01	0.01	3.10	**0.93**
22:53	**17.7**	0.01	0.00	3.10	**0.93**
23:34	**18.4**	0.00	0.00	3.10	**0.93**
23:53	**18.7**	0.00	0.00	3.10	**0.93**
0:46	**19.5**	0.01	0.01	3.11	**0.94**
0:53	**19.6**	0.01	0.00	3.11	**0.94**
1:18	**20.0**	0.00	0.00	3.11	**0.94**
1:27	**20.2**	0.00	0.00	3.11	**0.94**
1:30	**20.2**	0.00	0.00	3.11	**0.94**
1:50	**20.6**	0.00	0.00	3.11	**0.94**
1:53	**20.6**	0.00	0.00	3.11	**0.94**
1:59	**20.7**	0.00	0.00	3.11	**0.94**
2:53	**21.6**	0.06	0.06	3.17	**0.95**
3:53	**22.6**	0.07	0.07	3.24	**0.98**
4:53	**23.6**	0.06	0.06	3.30	**0.99**
5:31	**24.2**	0.01	0.01	3.31	**1.00**
5:53	**24.6**	0.01	0.01	3.32	**1.00**
		Total	3.32		


Rainfall Depth vs. Time for May 24, 2011 Storm
Fraction of Total Storm Depth
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0.0
5.0
10.0
15.0
20.0
Elapsed Time (hours)
5:53 (MDT) May 24, 2011 - 5:53 (MDT) May 25, 2011

100-YEAR, 24-HOUR STORM
Type II
HydroCAD Storm Curve

MORRISON-MAIERLE, INC.

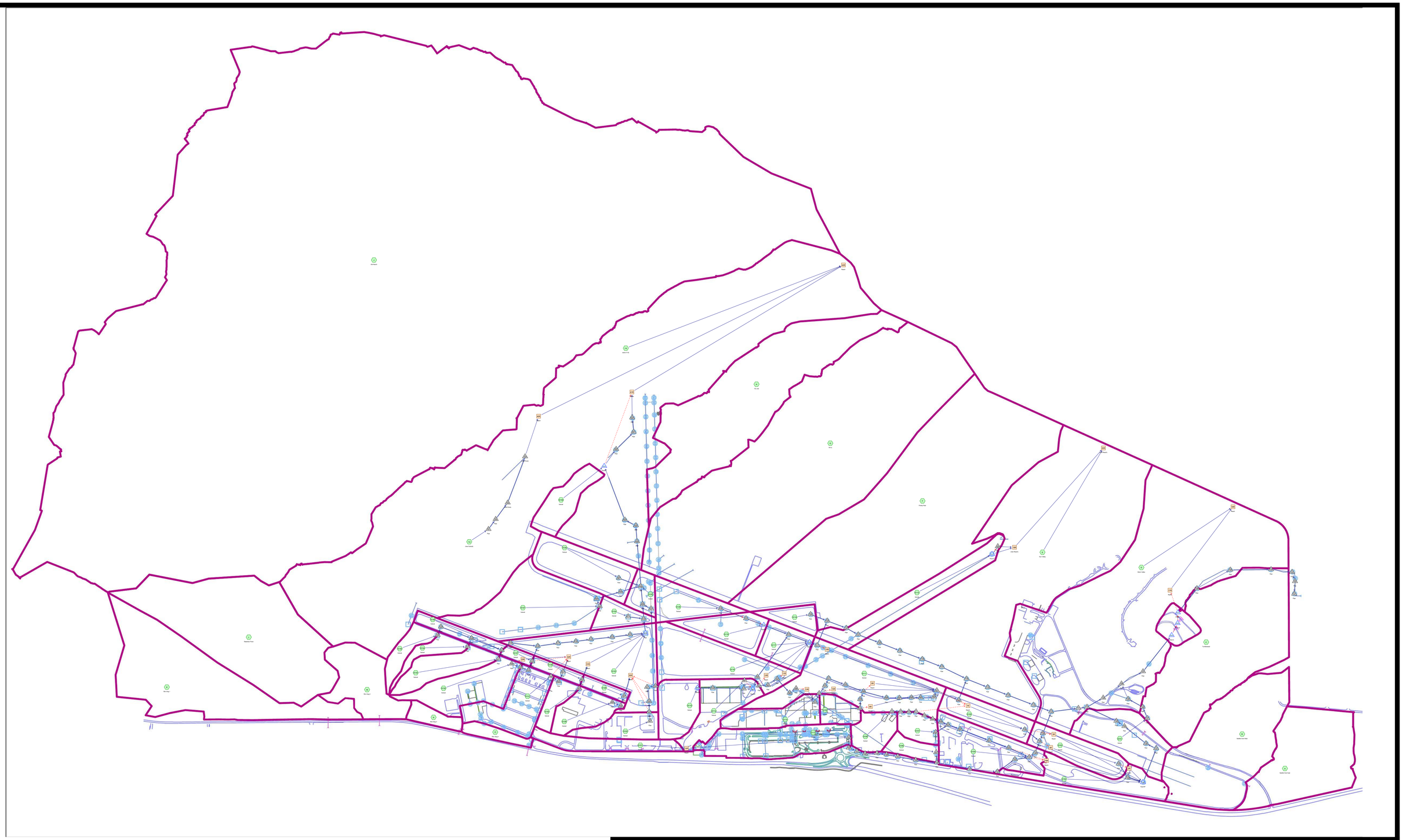
Storm Distribution Report



APPENDIX D

HydroCAD Routing Diagram

MORRISON-MAIERLE, INC



Subcat Reach Pond Link

Routing Diagram for BIL012512

Prepared by Microsoft, Printed 2/23/2012

APPENDIX E

HydroCAD Summary
5-Year, 24-Hour Storm

MORRISON-MAIERLE, INC

Time span=0.00-96.00 hrs, dt=0.01 hrs, 9601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment A: Saddle Club East Runoff Area=49.000 ac 2.04% Impervious Runoff Depth=0.23"
Flow Length=2,646' Tc=43.5 min CN=71 Runoff=4.30 cfs 0.927 af

Subcatchment B: Saddle Club West Runoff Area=67.000 ac 5.97% Impervious Runoff Depth=0.25"
Flow Length=3,022' Tc=49.7 min CN=72 Runoff=6.37 cfs 1.403 af

Subcatchment C: Tumbleweed Runoff Area=92.000 ac 8.70% Impervious Runoff Depth=0.25"
Flow Length=2,860' Tc=37.3 min CN=72 Runoff=10.58 cfs 1.927 af

Subcatchment D: Moon Valley Runoff Area=192.000 ac 13.02% Impervious Runoff Depth=0.30"
Flow Length=5,340' Tc=75.3 min CN=74 Runoff=18.58 cfs 4.869 af

Subcatchment E: Sun Valley Runoff Area=207.000 ac 6.28% Impervious Runoff Depth=0.25"
Flow Length=5,221' Tc=80.8 min CN=72 Runoff=14.33 cfs 4.335 af

Subcatchment F: Prickly Pear Runoff Area=208.000 ac 4.33% Impervious Runoff Depth=0.23"
Flow Length=6,238' Tc=88.1 min CN=71 Runoff=11.50 cfs 3.935 af

Subcatchment G: TW G Runoff Area=247.000 ac 2.83% Impervious Runoff Depth=0.23"
Flow Length=5,669' Tc=56.8 min CN=71 Runoff=18.25 cfs 4.673 af

Subcatchment H: 10L end Runoff Area=101.000 ac 2.97% Impervious Runoff Depth=0.23"
Flow Length=6,495' Tc=88.7 min CN=71 Runoff=5.64 cfs 1.911 af

Subcatchment I-a: (new Subcat) Runoff Area=154.000 ac 0.65% Impervious Runoff Depth=0.20"
Flow Length=4,000' Tc=75.5 min CN=70 Runoff=8.00 cfs 2.619 af

Subcatchment I-b: west of 10L Runoff Area=300.000 ac 3.33% Impervious Runoff Depth=0.23"
Flow Length=6,950' Slope=0.0250 '/' Tc=48.8 min CN=71 Runoff=24.45 cfs 5.675 af

Subcatchment J: Old Ranch Runoff Area=1,543.000 ac 0.00% Impervious Runoff Depth=0.20"
Flow Length=16,574' Tc=308.6 min CN=70 Runoff=35.01 cfs 26.244 af

Subcatchment K: Rim Xing 1 Runoff Area=74.000 ac 2.70% Impervious Runoff Depth=0.23"
Flow Length=4,400' Slope=0.0200 '/' Tc=94.0 min CN=71 Runoff=3.96 cfs 1.400 af

Subcatchment L: Retention Pond Runoff Area=97.000 ac 0.00% Impervious Runoff Depth=0.20"
Flow Length=3,889' Slope=0.0200 '/' Tc=85.4 min CN=70 Runoff=4.63 cfs 1.650 af

Subcatchment M: Rim Xing 2 Runoff Area=25.000 ac 20.00% Impervious Runoff Depth=0.36"
Flow Length=1,638' Tc=48.8 min CN=76 Runoff=4.25 cfs 0.757 af

Subcatchment N: Rim Xing 3 Runoff Area=5.000 ac 0.00% Impervious Runoff Depth=0.20"
Flow Length=1,044' Tc=40.7 min CN=70 Runoff=0.38 cfs 0.085 af

Subcatchment O: Rim Xing 4 Runoff Area=5.000 ac 0.00% Impervious Runoff Depth=0.20"
Flow Length=1,108' Slope=0.0140 '/' Tc=9.7 min CN=70 Runoff=0.98 cfs 0.085 af

Subcatchment S101: Subcat Runoff Area=24.000 ac 16.67% Impervious Runoff Depth=0.33"
Flow Length=1,303' Tc=12.6 min CN=75 Runoff=9.11 cfs 0.666 af

Subcatchment S102: Subcat Runoff Area=19.000 ac 31.58% Impervious Runoff Depth=0.47"
Flow Length=2,563' Tc=23.9 min CN=79 Runoff=7.70 cfs 0.736 af

Subcatchment S103: Subcat Runoff Area=16.000 ac 43.75% Impervious Runoff Depth=0.58"
Flow Length=1,610' Tc=17.8 min CN=82 Runoff=10.47 cfs 0.778 af

Subcatchment S104: Subcat Runoff Area=27.000 ac 51.85% Impervious Runoff Depth=0.72"
Flow Length=1,763' Tc=13.8 min CN=85 Runoff=25.94 cfs 1.626 af

Subcatchment S105: Subcat Runoff Area=14.000 ac 42.86% Impervious Runoff Depth=0.58"
Flow Length=1,480' Tc=14.0 min CN=82 Runoff=10.46 cfs 0.681 af

Subcatchment S106: Subcat Runoff Area=6.000 ac 100.00% Impervious Runoff Depth=1.68"
Flow Length=910' Tc=7.0 min CN=98 Runoff=15.31 cfs 0.838 af

Subcatchment S107: Subcat Runoff Area=7.000 ac 100.00% Impervious Runoff Depth=1.68"
Flow Length=676' Tc=5.7 min CN=98 Runoff=18.63 cfs 0.977 af

Subcatchment S108: Subcat Runoff Area=9.000 ac 100.00% Impervious Runoff Depth=1.68"
Flow Length=803' Slope=0.0200 '/' Tc=6.7 min CN=98 Runoff=23.19 cfs 1.256 af

Subcatchment S109: Subcat Runoff Area=6.000 ac 100.00% Impervious Runoff Depth=1.68"
Flow Length=564' Tc=5.2 min CN=98 Runoff=16.22 cfs 0.838 af

Subcatchment S110: Subcat Runoff Area=14.000 ac 92.86% Impervious Runoff Depth=1.48"
Flow Length=1,816' Tc=17.2 min CN=96 Runoff=24.08 cfs 1.724 af

Subcatchment S111: Subcat Runoff Area=46.000 ac 54.35% Impervious Runoff Depth=0.72"
Flow Length=3,618' Tc=28.9 min CN=85 Runoff=28.47 cfs 2.770 af

Subcatchment S112: Subcat Runoff Area=23.000 ac 4.35% Impervious Runoff Depth=0.23"
Flow Length=3,317' Tc=21.5 min CN=71 Runoff=3.26 cfs 0.435 af

Subcatchment S113: Subcat Runoff Area=26.000 ac 96.15% Impervious Runoff Depth=1.57"
Flow Length=2,541' Tc=19.4 min CN=97 Runoff=43.93 cfs 3.409 af

Subcatchment S114: Subcat Runoff Area=17.000 ac 82.35% Impervious Runoff Depth=1.22"
Flow Length=1,541' Tc=13.6 min CN=93 Runoff=27.93 cfs 1.733 af

Subcatchment S115: Subcat Runoff Area=14.000 ac 21.43% Impervious Runoff Depth=0.36"
Flow Length=1,114' Tc=12.7 min CN=76 Runoff=6.00 cfs 0.424 af

Subcatchment S116: Subcat Runoff Area=32.000 ac 31.25% Impervious Runoff Depth=0.47"
Flow Length=2,438' Tc=22.8 min CN=79 Runoff=13.39 cfs 1.240 af

Subcatchment S117: Subcat Runoff Area=12.000 ac 33.33% Impervious Runoff Depth=0.47"
Flow Length=926' Tc=11.1 min CN=79 Runoff=7.64 cfs 0.465 af

Subcatchment S118: Subcat Runoff Area=7.000 ac 42.86% Impervious Runoff Depth=0.58"
Flow Length=1,011' Tc=9.1 min CN=82 Runoff=6.35 cfs 0.341 af

Subcatchment S119: Subcat Runoff Area=14.000 ac 35.71% Impervious Runoff Depth=0.50"
Flow Length=1,540' Tc=13.3 min CN=80 Runoff=8.98 cfs 0.586 af

Subcatchment S120: Subcat Runoff Area=14.000 ac 42.86% Impervious Runoff Depth=0.58"
Flow Length=1,032' Tc=12.3 min CN=82 Runoff=11.16 cfs 0.681 af

Subcatchment S121: Subcat Runoff Area=12.000 ac 41.67% Impervious Runoff Depth=0.58"
Flow Length=1,945' Tc=17.3 min CN=82 Runoff=7.98 cfs 0.584 af

Subcatchment S122: Subcat Runoff Area=11.000 ac 63.64% Impervious Runoff Depth=0.89"
Flow Length=1,214' Tc=30.6 min CN=88 Runoff=8.24 cfs 0.812 af

Subcatchment S123: Subcat Runoff Area=43.000 ac 18.60% Impervious Runoff Depth=0.33"
Flow Length=2,468' Tc=40.3 min CN=75 Runoff=7.36 cfs 1.194 af

Subcatchment S124: Subcat Runoff Area=8.000 ac 37.50% Impervious Runoff Depth=0.54"
Flow Length=838' Tc=28.7 min CN=81 Runoff=3.49 cfs 0.361 af

Subcatchment S125: Subcat Runoff Area=6.000 ac 50.00% Impervious Runoff Depth=0.67"
Flow Length=410' Tc=4.6 min CN=84 Runoff=7.63 cfs 0.337 af

Subcatchment S126: Subcat Runoff Area=23.000 ac 34.78% Impervious Runoff Depth=0.50"
Flow Length=1,497' Tc=38.3 min CN=80 Runoff=7.42 cfs 0.963 af

Subcatchment S127: Subcat Runoff Area=44.000 ac 11.36% Impervious Runoff Depth=0.28"
Flow Length=2,892' Tc=41.3 min CN=73 Runoff=5.54 cfs 1.016 af

Subcatchment S128: Subcat Runoff Area=4.000 ac 25.00% Impervious Runoff Depth=0.40"
Flow Length=941' Tc=31.9 min CN=77 Runoff=1.05 cfs 0.132 af

Subcatchment S129: Subcat Runoff Area=13.000 ac 53.85% Impervious Runoff Depth=0.72"
Flow Length=1,221' Tc=31.4 min CN=85 Runoff=7.59 cfs 0.783 af

Subcatchment S130: Subcat Runoff Area=6.000 ac 33.33% Impervious Runoff Depth=0.47"
Flow Length=1,242' Tc=33.1 min CN=79 Runoff=1.94 cfs 0.233 af

Subcatchment S131: Subcat Runoff Area=20.000 ac 40.00% Impervious Runoff Depth=0.54"
Flow Length=1,656' Tc=11.9 min CN=81 Runoff=14.86 cfs 0.904 af

Subcatchment S132: Subcat Runoff Area=23.000 ac 30.43% Impervious Runoff Depth=0.47"
Flow Length=2,296' Tc=17.5 min CN=79 Runoff=11.42 cfs 0.891 af

Subcatchment S133: Subcat Runoff Area=14.000 ac 7.14% Impervious Runoff Depth=0.25"
Flow Length=2,027' Tc=36.1 min CN=72 Runoff=1.65 cfs 0.293 af

Subcatchment S134: Subcat Runoff Area=6.000 ac 0.00% Impervious Runoff Depth=0.20"
Flow Length=540' Tc=25.9 min CN=70 Runoff=0.61 cfs 0.102 af

Subcatchment S135: Subcat Runoff Area=8.000 ac 0.00% Impervious Runoff Depth=0.20"
Flow Length=1,582' Tc=33.7 min CN=70 Runoff=0.69 cfs 0.136 af

Subcatchment S136: Subcat Runoff Area=7.000 ac 42.86% Impervious Runoff Depth=0.58"
Flow Length=677' Tc=27.4 min CN=82 Runoff=3.47 cfs 0.341 af

Subcatchment S137: Subcat Runoff Area=2.000 ac 0.00% Impervious Runoff Depth=0.20"
Flow Length=534' Tc=6.0 min CN=70 Runoff=0.49 cfs 0.034 af

Subcatchment S138: Subcat Runoff Area=4.000 ac 25.00% Impervious Runoff Depth=0.40"
Flow Length=540' Tc=6.7 min CN=77 Runoff=2.53 cfs 0.132 af

Subcatchment S139: Subcat Runoff Area=13.000 ac 7.69% Impervious Runoff Depth=0.25"
Flow Length=1,350' Tc=19.0 min CN=72 Runoff=2.40 cfs 0.272 af

Reach 2R: Reach Avg. Flow Depth=0.01' Max Vel=0.19 fps Inflow=2.56 cfs 0.029 af
n=0.016 L=600.0' S=0.0034 '/' Capacity=227.83 cfs Outflow=0.36 cfs 0.029 af

Reach 3R: Reach Avg. Flow Depth=0.08' Max Vel=0.55 fps Inflow=2.57 cfs 0.016 af
n=0.025 L=2,000.0' S=0.0064 '/' Capacity=952.03 cfs Outflow=0.17 cfs 0.016 af

Reach 4R: Reach Avg. Flow Depth=0.00' Max Vel=0.00 fps Inflow=0.00 cfs 0.000 af
n=0.025 L=1,850.0' S=0.0087 '/' Capacity=1,105.76 cfs Outflow=0.00 cfs 0.000 af

Reach 7R: Reach Avg. Flow Depth=0.04' Max Vel=0.52 fps Inflow=0.49 cfs 0.002 af
n=0.025 L=1,200.0' S=0.0119 '/' Capacity=987.09 cfs Outflow=0.04 cfs 0.002 af

Reach 8R: Reach Avg. Flow Depth=0.01' Max Vel=0.81 fps Inflow=10.63 cfs 0.142 af
n=0.016 L=1,274.0' S=0.0251 '/' Capacity=616.42 cfs Outflow=3.16 cfs 0.142 af

Reach 9R: Reach Avg. Flow Depth=0.00' Max Vel=0.00 fps Inflow=0.00 cfs 0.000 af
n=0.025 L=1,200.0' S=0.0225 '/' Capacity=373.13 cfs Outflow=0.00 cfs 0.000 af

Reach 10R: Reach Avg. Flow Depth=0.02' Max Vel=0.76 fps Inflow=17.11 cfs 0.410 af
n=0.022 L=1,925.0' S=0.0201 '/' Capacity=400.43 cfs Outflow=5.25 cfs 0.410 af

Reach 11R: Reach Avg. Flow Depth=0.01' Max Vel=0.52 fps Inflow=1.88 cfs 0.099 af
n=0.022 L=800.0' S=0.0285 '/' Capacity=477.70 cfs Outflow=1.50 cfs 0.099 af

Reach 12R: Reach Avg. Flow Depth=0.00' Max Vel=0.29 fps Inflow=1.28 cfs 0.038 af
n=0.022 L=1,175.0' S=0.0266 '/' Capacity=461.24 cfs Outflow=0.33 cfs 0.038 af

Reach 13R: Reach Avg. Flow Depth=0.01' Max Vel=0.68 fps Inflow=2.20 cfs 0.164 af
n=0.013 L=380.0' S=0.0147 '/' Capacity=580.94 cfs Outflow=2.19 cfs 0.164 af

Reach 14R: Reach Avg. Flow Depth=0.67' Max Vel=7.64 fps Inflow=7.98 cfs 0.584 af
24.0" Round Pipe n=0.012 L=2,500.0' S=0.0140 '/' Capacity=29.04 cfs Outflow=7.12 cfs 0.584 af

Reach 15R: Reach Avg. Flow Depth=0.00' Max Vel=0.00 fps Inflow=0.00 cfs 0.000 af
n=0.025 L=2,105.0' S=0.0103 '/' Capacity=189.63 cfs Outflow=0.00 cfs 0.000 af

Reach 16R: Reach Avg. Flow Depth=0.43' Max Vel=2.26 fps Inflow=20.79 cfs 0.348 af
n=0.022 L=1,950.0' S=0.0087 '/' Capacity=628.29 cfs Outflow=10.45 cfs 0.348 af

Reach 17R: Reach Avg. Flow Depth=0.00' Max Vel=0.00 fps Inflow=0.00 cfs 0.000 af
n=0.016 L=2,700.0' S=0.0589 '/' Capacity=15,111,117.63 cfs Outflow=0.00 cfs 0.000 af

Reach 18R: Reach Avg. Flow Depth=0.79' Max Vel=10.66 fps Inflow=18.58 cfs 4.869 af
48.0" Round Pipe n=0.012 L=50.0' S=0.0200 '/' Capacity=220.07 cfs Outflow=18.57 cfs 4.869 af

Reach 19R: (new Reach) Avg. Flow Depth=0.00' Max Vel=23.08 fps Inflow=2.06 cfs 0.435 af
n=0.016 L=2,973.0' S=0.0633 '/' Capacity=11,441,841.62 cfs Outflow=2.06 cfs 0.435 af

Reach 20R: (new Reach) Avg. Flow Depth=0.71' Max Vel=10.06 fps Inflow=15.29 cfs 4.770 af
48.0" Round Pipe n=0.012 L=50.0' S=0.0200 '/' Capacity=220.07 cfs Outflow=15.29 cfs 4.770 af

Reach 30R: Reach Avg. Flow Depth=0.25' Max Vel=2.14 fps Inflow=11.47 cfs 0.975 af
n=0.025 L=910.0' S=0.0205 '/' Capacity=401.59 cfs Outflow=10.20 cfs 0.975 af

Reach 31R: Reach Avg. Flow Depth=0.17' Max Vel=1.54 fps Inflow=2.94 cfs 0.364 af
n=0.025 L=1,300.0' S=0.0185 '/' Capacity=751.64 cfs Outflow=2.11 cfs 0.364 af

Reach 32R: Reach Avg. Flow Depth=0.30' Max Vel=2.27 fps Inflow=14.86 cfs 0.904 af
n=0.025 L=1,455.0' S=0.0185 '/' Capacity=751.29 cfs Outflow=10.01 cfs 0.904 af

Reach 33R: Reach Avg. Flow Depth=0.00' Max Vel=0.00 fps Inflow=0.00 cfs 0.000 af
n=0.016 L=800.0' S=0.0188 '/' Capacity=193.73 cfs Outflow=0.00 cfs 0.000 af

Reach 40R: Reach Avg. Flow Depth=0.01' Max Vel=7.99 fps Inflow=8.00 cfs 2.619 af
n=0.030 L=7,250.0' S=0.0275 '/' Capacity=4,347,964.77 cfs Outflow=7.37 cfs 2.619 af

Reach 41R: Reach Avg. Flow Depth=0.02' Max Vel=9.74 fps Inflow=22.25 cfs 8.935 af
n=0.030 L=5,852.0' S=0.0404 '/' Capacity=5,730,418.04 cfs Outflow=22.08 cfs 8.935 af

Reach 42R: Reach Avg. Flow Depth=1.21' Max Vel=13.65 fps Inflow=43.69 cfs 17.229 af
48.0" Round Pipe n=0.012 L=50.0' S=0.0200 '/' Capacity=220.07 cfs Outflow=43.69 cfs 17.229 af

Pond 101: Pipe Peak Elev=3,203.87' Inflow=7.71 cfs 22.235 af
36.0" Round Culvert n=0.012 L=109.0' S=0.0927 '/' Outflow=7.71 cfs 22.235 af

Pond 102: Pipe Peak Elev=3,206.15' Inflow=7.71 cfs 22.235 af
36.0" Round Culvert n=0.012 L=256.0' S=0.0085 '/' Outflow=7.71 cfs 22.235 af

Pond 103: Pipe Peak Elev=3,209.47' Inflow=7.71 cfs 22.235 af
36.0" Round Culvert n=0.012 L=125.0' S=0.0274 '/' Outflow=7.71 cfs 22.235 af

Pond 104: Pipe Peak Elev=3,226.54' Inflow=7.71 cfs 22.235 af
36.0" Round Culvert n=0.012 L=366.0' S=0.0466 '/' Outflow=7.71 cfs 22.235 af

Pond 105: Pipe Peak Elev=3,346.44' Inflow=7.71 cfs 22.235 af
24.0" Round Culvert n=0.012 L=676.0' S=0.1772 '/' Outflow=7.71 cfs 22.235 af

Pond 106: Pipe Peak Elev=3,363.14' Inflow=7.71 cfs 22.235 af
24.0" Round Culvert n=0.012 L=645.0' S=0.0259 '/' Outflow=7.71 cfs 22.235 af

Pond 107: Pipe Peak Elev=3,415.29' Inflow=195.62 cfs 22.355 af
60.0" Round Culvert n=0.012 L=700.0' S=0.0195 '/' Outflow=195.62 cfs 22.355 af

Pond 108: Pipe Peak Elev=3,430.17' Inflow=195.62 cfs 22.355 af
54.0" Round Culvert n=0.012 L=400.0' S=0.0352 '/' Outflow=195.62 cfs 22.355 af

Pond 109: Pipe Peak Elev=3,437.80' Inflow=186.68 cfs 21.689 af
60.0" Round Culvert n=0.012 L=300.0' S=0.0286 '/' Outflow=186.68 cfs 21.689 af

Pond 110: Pipe Peak Elev=3,447.65' Inflow=186.68 cfs 21.689 af
66.0" Round Culvert n=0.012 L=374.0' S=0.0271 '/' Outflow=186.68 cfs 21.689 af

Pond 111: Pipe Peak Elev=3,452.65' Inflow=174.88 cfs 19.809 af
60.0" Round Culvert n=0.012 L=200.0' S=0.0246 '/' Outflow=174.88 cfs 19.809 af

Pond 112: Pipe Peak Elev=3,468.42' Inflow=174.88 cfs 19.809 af
60.0" Round Culvert n=0.012 L=390.0' S=0.0404 '/' Outflow=174.88 cfs 19.809 af

Pond 113: Pipe Peak Elev=3,488.81' Inflow=84.24 cfs 10.800 af
60.0" Round Culvert n=0.012 L=311.0' S=0.0100 '/' Outflow=84.24 cfs 10.800 af

Pond 114: Pipe Peak Elev=3,493.24' Inflow=84.24 cfs 10.800 af
60.0" Round Culvert n=0.012 L=449.0' S=0.0101 '/' Outflow=84.24 cfs 10.800 af

Pond 115: Pipe Peak Elev=3,498.73' Inflow=84.24 cfs 10.800 af
54.0" Round Culvert n=0.012 L=364.0' S=0.0141 '/' Outflow=84.24 cfs 10.800 af

Pond 116: Pipe Peak Elev=3,502.14' Inflow=84.24 cfs 10.800 af
60.0" Round Culvert n=0.012 L=376.0' S=0.0088 '/' Outflow=84.24 cfs 10.800 af

Pond 117: Pipe Peak Elev=3,505.86' Inflow=50.19 cfs 4.293 af
42.0" Round Culvert n=0.012 L=457.0' S=0.0089 '/' Outflow=50.19 cfs 4.293 af

Pond 118: Pipe Peak Elev=3,508.22' Inflow=50.19 cfs 4.293 af
42.0" Round Culvert n=0.012 L=343.0' S=0.0055 '/' Outflow=50.19 cfs 4.293 af

Pond 119: Pipe Peak Elev=3,510.80' Inflow=50.19 cfs 4.293 af
42.0" Round Culvert n=0.012 L=401.0' S=0.0069 '/' Outflow=50.19 cfs 4.293 af

Pond 120: Pipe Peak Elev=3,513.29' Inflow=50.19 cfs 4.293 af
42.0" Round Culvert n=0.012 L=360.0' S=0.0069 '/' Outflow=50.19 cfs 4.293 af

Pond 121: Pipe Peak Elev=3,518.00' Inflow=50.19 cfs 4.293 af
42.0" Round Culvert n=0.012 L=381.0' S=0.0134 '/' Outflow=50.19 cfs 4.293 af

Pond 122: Pipe Peak Elev=3,520.64' Inflow=50.19 cfs 4.293 af
42.0" Round Culvert n=0.012 L=223.0' S=0.0110 '/' Outflow=50.19 cfs 4.293 af

Pond 123: Pipe Peak Elev=3,524.32' Inflow=50.19 cfs 4.293 af
42.0" Round Culvert n=0.012 L=340.0' S=0.0111 '/' Outflow=50.19 cfs 4.293 af

Pond 124: Pipe Peak Elev=3,526.76' Inflow=6.35 cfs 0.341 af
24.0" Round Culvert n=0.012 L=289.0' S=0.0036 '/' Outflow=6.35 cfs 0.341 af

Pond 125: Pipe Peak Elev=3,434.84' Inflow=9.11 cfs 0.666 af
30.0" Round Culvert n=0.012 L=299.0' S=0.0235 '/' Outflow=9.11 cfs 0.666 af

Pond 126: Pipe Peak Elev=3,437.63' Inflow=9.11 cfs 0.666 af
30.0" Round Culvert n=0.012 L=271.0' S=0.0100 '/' Outflow=9.11 cfs 0.666 af

Pond 127: Pipe Peak Elev=3,439.79' Inflow=9.11 cfs 0.666 af
30.0" Round Culvert n=0.012 L=200.0' S=0.0100 '/' Outflow=9.11 cfs 0.666 af

Pond 128: Pipe Peak Elev=3,473.25' Inflow=14.00 cfs 1.879 af
30.0" Round Culvert n=0.012 L=567.0' S=0.0500 '/' Outflow=14.00 cfs 1.879 af

Pond 129: Pipe Peak Elev=3,473.92' Inflow=14.00 cfs 1.879 af
30.0" Round Culvert n=0.012 L=40.0' S=0.0075 '/' Outflow=14.00 cfs 1.879 af

Pond 130: Pipe Peak Elev=3,475.02' Inflow=14.00 cfs 1.879 af
30.0" Round Culvert n=0.012 L=550.0' S=0.0006 '/' Outflow=14.00 cfs 1.879 af

Pond 131: Pipe Peak Elev=3,477.50' Inflow=14.00 cfs 1.879 af
30.0" Round Culvert n=0.012 L=192.0' S=0.0188 '/' Outflow=14.00 cfs 1.879 af

Pond 132: Pipe/DP Peak Elev=3,486.56' Storage=6,496 cf Inflow=20.73 cfs 1.879 af
Primary=14.00 cfs 1.879 af Secondary=0.00 cfs 0.000 af Outflow=14.00 cfs 1.879 af

Pond 133: Pipe Peak Elev=3,486.94' Inflow=7.91 cfs 0.749 af
18.0" Round Culvert n=0.012 L=269.0' S=0.0055 '/' Outflow=7.91 cfs 0.749 af

Pond 134: Pipe Peak Elev=3,488.73' Inflow=10.47 cfs 0.778 af
Primary=7.91 cfs 0.749 af Secondary=2.56 cfs 0.029 af Outflow=10.47 cfs 0.778 af

Pond 135: Pipe Peak Elev=3,499.49' Inflow=97.12 cfs 9.017 af
Primary=94.60 cfs 9.009 af Secondary=2.53 cfs 0.008 af Outflow=97.12 cfs 9.017 af

Pond 138: Pipe Peak Elev=3,491.42' Inflow=97.12 cfs 9.017 af
Primary=97.12 cfs 9.017 af Secondary=0.00 cfs 0.000 af Outflow=97.12 cfs 9.017 af

Pond 139: Pipe Peak Elev=3,502.91' Inflow=10.46 cfs 0.683 af
Primary=9.25 cfs 0.675 af Secondary=1.21 cfs 0.008 af Outflow=10.46 cfs 0.683 af

Pond 140: Pipe Peak Elev=3,501.16' Inflow=88.36 cfs 8.342 af
42.0" Round Culvert n=0.012 L=213.0' S=0.0176 '/' Outflow=88.36 cfs 8.342 af

Pond 141: Pipe Peak Elev=3,505.20' Inflow=109.15 cfs 8.690 af
Primary=88.36 cfs 8.342 af Secondary=20.79 cfs 0.348 af Outflow=109.15 cfs 8.690 af

Pond 142: Pipe Peak Elev=3,506.73' Inflow=52.63 cfs 4.831 af
42.0" Round Culvert n=0.012 L=244.0' S=0.0188 '/' Outflow=52.63 cfs 4.831 af

Pond 143: Pipe Peak Elev=3,516.52' Inflow=52.63 cfs 4.831 af
42.0" Round Culvert n=0.012 L=349.0' S=0.0281 '/' Outflow=52.63 cfs 4.831 af

Pond 144: Pipe Peak Elev=3,521.41' Inflow=52.63 cfs 4.831 af
42.0" Round Culvert n=0.012 L=473.0' S=0.0101 '/' Outflow=52.63 cfs 4.831 af

Pond 145: Pipe Peak Elev=3,528.06' Inflow=52.63 cfs 4.831 af
42.0" Round Culvert n=0.012 L=529.0' S=0.0128 '/' Outflow=52.63 cfs 4.831 af

Pond 146: Pipe Peak Elev=3,531.58' Inflow=47.69 cfs 3.993 af
42.0" Round Culvert n=0.012 L=369.0' S=0.0094 '/' Outflow=47.69 cfs 3.993 af

Pond 147: Pipe Peak Elev=3,538.90' Inflow=47.69 cfs 3.993 af
42.0" Round Culvert n=0.012 L=297.0' S=0.0253 '/' Outflow=47.69 cfs 3.993 af

Pond 148: Pipe Peak Elev=3,541.62' Inflow=47.69 cfs 3.993 af
42.0" Round Culvert n=0.012 L=201.0' S=0.0130 '/' Outflow=47.69 cfs 3.993 af

Pond 149: Pipe Peak Elev=3,552.91' Inflow=47.69 cfs 3.993 af
42.0" Round Culvert n=0.012 L=134.0' S=0.0851 '/' Outflow=47.69 cfs 3.993 af

Pond 150: Pipe Peak Elev=3,555.32' Inflow=47.69 cfs 3.993 af
42.0" Round Culvert n=0.012 L=270.0' S=0.0075 '/' Outflow=47.69 cfs 3.993 af

Pond 151: Pipe Peak Elev=3,556.25' Inflow=47.69 cfs 3.993 af
42.0" Round Culvert n=0.012 L=100.0' S=0.0073 '/' Outflow=47.69 cfs 3.993 af

Pond 152: Pipe Peak Elev=3,557.14' Inflow=47.69 cfs 3.993 af
42.0" Round Culvert n=0.012 L=97.0' S=0.0038 '/' Outflow=47.69 cfs 3.993 af

Pond 153: Pipe Peak Elev=3,559.85' Inflow=47.69 cfs 3.993 af
42.0" Round Culvert n=0.012 L=73.0' S=0.0040 '/' Outflow=47.69 cfs 3.993 af

Pond 200: Pipe Peak Elev=3,505.70' Inflow=41.71 cfs 2.234 af
Primary=41.71 cfs 2.234 af Secondary=0.00 cfs 0.000 af Outflow=41.71 cfs 2.234 af

Pond 201: Pipe Peak Elev=3,509.20' Inflow=41.71 cfs 2.234 af
36.0" Round Culvert n=0.012 L=349.0' S=0.0108 '/' Outflow=41.71 cfs 2.234 af

Pond 202: Pipe Peak Elev=3,518.82' Inflow=41.71 cfs 2.234 af
36.0" Round Culvert n=0.012 L=516.0' S=0.0145 '/' Outflow=41.71 cfs 2.234 af

Pond 203: Pipe Peak Elev=3,523.49' Inflow=41.71 cfs 2.234 af
36.0" Round Culvert n=0.012 L=201.0' S=0.0182 '/' Outflow=41.71 cfs 2.234 af

Pond 204: Pipe Peak Elev=3,528.33' Inflow=18.63 cfs 0.977 af
24.0" Round Culvert n=0.012 L=258.0' S=0.0111 '/' Outflow=18.63 cfs 0.977 af

Pond 207: Pipe Peak Elev=3,536.80' Inflow=15.31 cfs 0.838 af
15.0" Round Culvert n=0.010 L=162.0' S=0.0048 '/' Outflow=15.31 cfs 0.838 af

Pond 208: Pipe Peak Elev=3,525.56' Inflow=23.19 cfs 1.256 af
36.0" Round Culvert n=0.012 L=140.0' S=0.0111 '/' Outflow=23.19 cfs 1.256 af

Pond 209: Pipe Peak Elev=3,528.40' Inflow=23.19 cfs 1.256 af
24.0" Round Culvert n=0.012 L=64.0' S=0.0233 '/' Outflow=23.19 cfs 1.256 af

Pond 210: Pipe Peak Elev=3,531.06' Inflow=23.19 cfs 1.256 af
24.0" Round Culvert n=0.012 L=190.0' S=0.0140 '/' Outflow=23.19 cfs 1.256 af

Pond 211: Pipe Peak Elev=3,534.06' Inflow=23.19 cfs 1.256 af
Primary=23.19 cfs 1.256 af Secondary=0.00 cfs 0.000 af Outflow=23.19 cfs 1.256 af

Pond 212: Pipe Peak Elev=3,536.04' Inflow=23.19 cfs 1.256 af
24.0" Round Culvert n=0.012 L=100.0' S=0.0198 '/' Outflow=23.19 cfs 1.256 af

Pond 213: Pipe Peak Elev=3,538.06' Inflow=23.19 cfs 1.256 af
24.0" Round Culvert n=0.012 L=100.0' S=0.0202 '/' Outflow=23.19 cfs 1.256 af

Pond 214: Pipe Peak Elev=3,542.32' Inflow=23.19 cfs 1.256 af
24.0" Round Culvert n=0.012 L=100.0' S=0.0194 '/' Outflow=23.19 cfs 1.256 af

Pond 300: Pipe Peak Elev=3,433.00' Inflow=0.00 cfs 0.000 af
48.0" Round Culvert n=0.012 L=56.0' S=0.0105 '/' Outflow=0.00 cfs 0.000 af

Pond 311: Pipe Peak Elev=3,536.89' Inflow=44.99 cfs 3.953 af
Primary=44.99 cfs 3.953 af Secondary=0.00 cfs 0.000 af Outflow=44.99 cfs 3.953 af

Pond 312: Pipe/DP Peak Elev=3,542.42' Storage=73 cf Inflow=45.02 cfs 3.953 af
36.0" Round Culvert n=0.025 L=137.0' S=0.0129 '/' Outflow=44.99 cfs 3.953 af

Pond 313: Pipe Peak Elev=3,543.56' Inflow=28.06 cfs 2.110 af
36.0" Round Culvert n=0.025 L=362.0' S=0.0152 '/' Outflow=28.06 cfs 2.110 af

Pond 314: Pipe/DP Peak Elev=3,549.33' Storage=34 cf Inflow=20.08 cfs 1.267 af
30.0" Round Culvert n=0.025 L=350.0' S=0.0094 '/' Outflow=20.06 cfs 1.267 af

Pond 315: Pipe Peak Elev=3,549.65' Inflow=11.16 cfs 0.681 af
Primary=11.16 cfs 0.681 af Secondary=0.00 cfs 0.000 af Outflow=11.16 cfs 0.681 af

Pond 316: Pipe Peak Elev=3,553.67' Inflow=11.16 cfs 0.681 af
Primary=11.16 cfs 0.681 af Secondary=0.00 cfs 0.000 af Outflow=11.16 cfs 0.681 af

Pond 327: Pipe Peak Elev=3,601.03' Inflow=8.24 cfs 0.812 af
18.0" Round Culvert n=0.012 L=75.0' S=0.0103 '/' Outflow=8.24 cfs 0.812 af

Pond 328: Pipe Peak Elev=3,599.50' Inflow=8.24 cfs 0.812 af
Primary=8.24 cfs 0.812 af Secondary=0.00 cfs 0.000 af Outflow=8.24 cfs 0.812 af

Pond 330: Pipe Peak Elev=3,601.16' Inflow=8.24 cfs 0.812 af
Primary=8.24 cfs 0.812 af Secondary=0.00 cfs 0.000 af Outflow=8.24 cfs 0.812 af

Pond 331: Pipe Peak Elev=3,595.18' Inflow=8.24 cfs 0.812 af
18.0" Round Culvert n=0.012 L=78.0' S=0.0133 '/' Outflow=8.24 cfs 0.812 af

Pond 333: Pipe Peak Elev=3,598.19' Inflow=8.24 cfs 0.812 af
Primary=5.37 cfs 0.751 af Secondary=2.87 cfs 0.060 af Outflow=8.24 cfs 0.812 af

Pond 337: Pipe Peak Elev=3,574.97' Inflow=5.37 cfs 0.751 af
12.0" Round Culvert n=0.012 L=164.0' S=0.0420 '/' Outflow=5.37 cfs 0.751 af

Pond 350: Pipe Peak Elev=3,556.81' Inflow=8.16 cfs 0.843 af
18.0" Round Culvert n=0.012 L=881.0' S=0.0164 '/' Outflow=8.16 cfs 0.843 af

Pond 351: Pipe/DP Peak Elev=3,574.08' Storage=11,571 cf Inflow=24.59 cfs 0.842 af
12.0" Round Culvert n=0.012 L=182.0' S=0.0330 '/' Outflow=8.16 cfs 0.843 af

Pond 356: Pipe Peak Elev=3,513.87' Inflow=40.32 cfs 6.507 af
Primary=40.32 cfs 6.507 af Secondary=0.00 cfs 0.000 af Outflow=40.32 cfs 6.507 af

Pond 357: Pipe Peak Elev=3,520.80' Inflow=40.81 cfs 6.509 af
Primary=40.32 cfs 6.507 af Secondary=0.49 cfs 0.002 af Outflow=40.81 cfs 6.509 af

Pond 362: Pipe Peak Elev=3,521.21' Inflow=16.29 cfs 3.186 af
18.0" Round Culvert n=0.012 L=116.0' S=0.0209 '/' Outflow=16.29 cfs 3.186 af

Pond 365: Pipe Peak Elev=3,525.34' Inflow=16.29 cfs 3.186 af
18.0" Round Culvert n=0.012 L=199.0' S=0.0221 '/' Outflow=16.29 cfs 3.186 af

Pond 366: Pipe Peak Elev=3,529.06' Inflow=16.29 cfs 3.186 af
18.0" Round Culvert n=0.012 L=166.0' S=0.0205 '/' Outflow=16.29 cfs 3.186 af

Pond 367: Pipe Peak Elev=3,533.18' Inflow=16.29 cfs 3.186 af
18.0" Round Culvert n=0.012 L=201.0' S=0.0201 '/' Outflow=16.29 cfs 3.186 af

Pond 368: Pipe Peak Elev=3,537.27' Inflow=16.29 cfs 3.186 af
18.0" Round Culvert n=0.012 L=203.0' S=0.0203 '/' Outflow=16.29 cfs 3.186 af

Pond 369: Pipe Peak Elev=3,545.86' Inflow=16.29 cfs 3.186 af
Primary=16.29 cfs 3.186 af Secondary=0.00 cfs 0.000 af Outflow=16.29 cfs 3.186 af

Pond 370: Pipe Peak Elev=3,548.50' Inflow=11.09 cfs 2.491 af
18.0" Round Culvert n=0.012 L=307.0' S=0.0088 '/' Outflow=11.09 cfs 2.491 af

Pond 371: Pipe Peak Elev=3,551.19' Inflow=11.09 cfs 2.491 af
18.0" Round Culvert n=0.012 L=307.0' S=0.0087 '/' Outflow=11.09 cfs 2.491 af

Pond 372: Pipe Peak Elev=3,554.71' Inflow=11.09 cfs 2.491 af
18.0" Round Culvert n=0.012 L=133.0' S=0.0329 '/' Outflow=11.09 cfs 2.491 af

Pond 373: Pipe Peak Elev=3,560.53' Inflow=28.20 cfs 2.901 af
Primary=11.09 cfs 2.491 af Secondary=17.11 cfs 0.410 af Outflow=28.20 cfs 2.901 af

Pond 374: Pipe Peak Elev=3,558.71' Inflow=4.50 cfs 1.177 af
15.0" Round Culvert n=0.012 L=130.0' S=0.0235 '/' Outflow=4.50 cfs 1.177 af

Pond 375: Pipe/DP Peak Elev=3,584.50' Storage=655 cf Inflow=6.00 cfs 0.424 af
12.0" Round Culvert n=0.012 L=246.0' S=0.0114 '/' Outflow=4.37 cfs 0.424 af

Pond 376: Pipe Peak Elev=3,581.44' Inflow=4.37 cfs 0.424 af
12.0" Round Culvert n=0.012 L=494.0' S=0.0115 '/' Outflow=4.37 cfs 0.424 af

Pond 377: Pipe Peak Elev=3,572.76' Inflow=4.37 cfs 0.424 af
12.0" Round Culvert n=0.012 L=159.0' S=0.0075 '/' Outflow=4.37 cfs 0.424 af

Pond 378: Pipe Peak Elev=3,548.71' Inflow=5.60 cfs 0.695 af
18.0" Round Culvert n=0.012 L=132.0' S=0.0328 '/' Outflow=5.60 cfs 0.695 af

Pond 379: Pipe Peak Elev=3,553.38' Inflow=16.22 cfs 0.838 af
Primary=5.60 cfs 0.695 af Secondary=10.63 cfs 0.142 af Outflow=16.22 cfs 0.838 af

Pond 381: Pipe Peak Elev=3,580.03' Inflow=27.93 cfs 1.733 af
Primary=7.67 cfs 1.315 af Secondary=20.26 cfs 0.418 af Outflow=27.93 cfs 1.733 af

Pond 382: Pipe Peak Elev=3,573.81' Inflow=7.67 cfs 1.315 af
Primary=6.39 cfs 1.276 af Secondary=1.28 cfs 0.038 af Outflow=7.67 cfs 1.315 af

Pond 383: Pipe Peak Elev=3,568.92' Inflow=6.39 cfs 1.276 af
12.0" Round Culvert n=0.012 L=195.0' S=0.0206 '/' Outflow=6.39 cfs 1.276 af

Pond 384: Pipe Peak Elev=3,565.42' Inflow=6.39 cfs 1.276 af
Primary=4.51 cfs 1.177 af Secondary=1.88 cfs 0.099 af Outflow=6.39 cfs 1.276 af

Pond 385: Pipe Peak Elev=3,561.67' Inflow=4.51 cfs 1.177 af
12.0" Round Culvert n=0.012 L=104.0' S=0.0064 '/' Outflow=4.51 cfs 1.177 af

Pond 386: Pipe Peak Elev=3,564.88' Inflow=4.51 cfs 1.177 af
Primary=2.31 cfs 1.012 af Secondary=2.20 cfs 0.164 af Outflow=4.51 cfs 1.177 af

Pond 400: Pipe Peak Elev=3,498.54' Inflow=22.25 cfs 8.935 af
36.0" Round Culvert n=0.012 L=50.0' S=0.0036 '/' Outflow=22.25 cfs 8.935 af

Pond 401: Pipe Peak Elev=3,508.56' Inflow=22.25 cfs 8.935 af
24.0" Round Culvert n=0.012 L=231.0' S=0.0301 '/' Outflow=22.25 cfs 8.935 af

Pond 402: Pipe Peak Elev=3,525.38' Inflow=22.25 cfs 8.935 af
24.0" Round Culvert n=0.012 L=418.0' S=0.0402 '/' Outflow=22.25 cfs 8.935 af

Pond 404: Pipe Peak Elev=3,543.30' Inflow=58.65 cfs 8.663 af
60.0" Round Culvert n=0.012 L=741.0' S=0.0025 '/' Outflow=58.65 cfs 8.663 af

Pond 405: Pipe Peak Elev=3,544.05' Inflow=58.65 cfs 8.663 af
60.0" Round Culvert n=0.012 L=203.0' S=0.0051 '/' Outflow=58.65 cfs 8.663 af

Pond 406: Pipe Peak Elev=3,550.74' Inflow=58.65 cfs 8.663 af
54.0" Round Culvert n=0.012 L=504.0' S=0.0142 '/' Outflow=58.65 cfs 8.663 af

Pond 407: Pipe Peak Elev=3,564.27' Inflow=7.42 cfs 0.963 af
24.0" Round Culvert n=0.012 L=400.0' S=0.0062 '/' Outflow=7.42 cfs 0.963 af

Pond 408: Pipe Peak Elev=3,558.31' Inflow=58.65 cfs 8.663 af
54.0" Round Culvert n=0.012 L=509.0' S=0.0138 '/' Outflow=58.65 cfs 8.663 af

Pond 409: Pipe Peak Elev=3,565.00' Inflow=45.35 cfs 6.346 af
42.0" Round Culvert n=0.012 L=291.0' S=0.0242 '/' Outflow=45.35 cfs 6.346 af

Pond 410: Pipe Peak Elev=3,570.57' Inflow=39.98 cfs 5.595 af
42.0" Round Culvert n=0.012 L=240.0' S=0.0238 '/' Outflow=39.98 cfs 5.595 af

Pond 411: Pipe Peak Elev=3,577.52' Inflow=3.49 cfs 0.361 af
24.0" Round Culvert n=0.012 L=259.0' S=0.0269 '/' Outflow=3.49 cfs 0.361 af

Pond 412: Pipe Peak Elev=3,580.46' Storage=247 cf Inflow=36.93 cfs 5.234 af
42.0" Round Culvert n=0.012 L=241.0' S=0.0193 '/' Outflow=36.93 cfs 5.234 af

Pond 413: Pipe Peak Elev=3,579.96' Inflow=15.76 cfs 1.797 af
36.0" Round Culvert n=0.012 L=250.0' S=0.0187 '/' Outflow=15.76 cfs 1.797 af

Pond 414: Pipe Peak Elev=3,585.67' Inflow=15.76 cfs 1.797 af
36.0" Round Culvert n=0.012 L=300.0' S=0.0187 '/' Outflow=15.76 cfs 1.797 af

Pond 415: Pipe Peak Elev=3,592.31' Inflow=15.76 cfs 1.797 af
36.0" Round Culvert n=0.012 L=350.0' S=0.0187 '/' Outflow=15.76 cfs 1.797 af

Pond 416: Pipe Peak Elev=3,596.77' Inflow=15.76 cfs 1.797 af
36.0" Round Culvert n=0.012 L=252.0' S=0.0173 '/' Outflow=15.76 cfs 1.797 af

Pond 417: Pipe Peak Elev=3,602.50' Inflow=15.76 cfs 1.797 af
36.0" Round Culvert n=0.012 L=297.0' S=0.0190 '/' Outflow=15.76 cfs 1.797 af

Pond 418: Pipe Peak Elev=3,608.83' Inflow=15.76 cfs 1.797 af
36.0" Round Culvert n=0.012 L=346.0' S=0.0180 '/' Outflow=15.76 cfs 1.797 af

Pond 419: Pipe Peak Elev=3,619.66' Inflow=5.97 cfs 0.872 af
36.0" Round Culvert n=0.012 L=451.0' S=0.0201 '/' Outflow=5.97 cfs 0.872 af

Pond 420: Pipe Peak Elev=3,621.20' Inflow=5.97 cfs 0.872 af
36.0" Round Culvert n=0.012 L=190.0' S=0.0072 '/' Outflow=5.97 cfs 0.872 af

Pond 421: Pipe Peak Elev=3,625.42' Inflow=1.65 cfs 0.293 af
21.0" Round Culvert n=0.012 L=157.0' S=0.0109 '/' Outflow=1.65 cfs 0.293 af

Pond 426: Pipe Peak Elev=3,628.95' Inflow=1.25 cfs 0.238 af
27.0" Round Culvert n=0.012 L=542.0' S=0.0153 '/' Outflow=1.25 cfs 0.238 af

Pond 427: Pipe Peak Elev=3,631.99' Inflow=0.61 cfs 0.102 af
21.0" Round Culvert n=0.012 L=157.0' S=0.0100 '/' Outflow=0.61 cfs 0.102 af

Pond 429: Pipe Peak Elev=3,637.20' Inflow=0.69 cfs 0.136 af
21.0" Round Culvert n=0.012 L=539.0' S=0.0140 '/' Outflow=0.69 cfs 0.136 af

Pond 430: Pipe Peak Elev=3,638.95' Inflow=0.69 cfs 0.136 af
21.0" Round Culvert n=0.012 L=157.0' S=0.0100 '/' Outflow=0.69 cfs 0.136 af

Pond 433: Pipe Peak Elev=3,618.07' Inflow=11.60 cfs 0.925 af
Primary=11.60 cfs 0.925 af Secondary=0.00 cfs 0.000 af Outflow=11.60 cfs 0.925 af

Pond 434: Pipe Peak Elev=3,619.07' Inflow=11.42 cfs 0.891 af
21.0" Round Culvert n=0.012 L=171.0' S=0.0033 '/' Outflow=11.42 cfs 0.891 af

Pond 435: Pipe Peak Elev=3,619.61' Inflow=11.42 cfs 0.891 af
21.0" Round Culvert n=0.012 L=138.0' S=0.0064 '/' Outflow=11.42 cfs 0.891 af

Pond 436: Pipe Peak Elev=3,621.11' Inflow=11.42 cfs 0.891 af
Primary=11.42 cfs 0.891 af Secondary=0.00 cfs 0.000 af Outflow=11.42 cfs 0.891 af

Pond 449: Pipe Peak Elev=3,615.32' Inflow=14.86 cfs 0.904 af
Primary=14.86 cfs 0.904 af Secondary=0.00 cfs 0.000 af Outflow=14.86 cfs 0.904 af

Pond 450: Pipe Peak Elev=3,613.00' Inflow=14.86 cfs 0.904 af
21.0" Round Culvert n=0.012 L=170.0' S=0.0123 '/' Outflow=14.86 cfs 0.904 af

Pond 451: Pipe Peak Elev=3,611.59' Inflow=14.86 cfs 0.904 af
Primary=14.86 cfs 0.904 af Secondary=0.00 cfs 0.000 af Outflow=14.86 cfs 0.904 af

Pond 452: Pipe Peak Elev=3,605.93' Inflow=2.94 cfs 0.364 af
24.0" Round Culvert n=0.012 L=197.0' S=0.0025 '/' Outflow=2.94 cfs 0.364 af

Pond 453: Pipe Peak Elev=3,608.36' Inflow=1.94 cfs 0.233 af
21.0" Round Culvert n=0.012 L=171.0' S=0.0111 '/' Outflow=1.94 cfs 0.233 af

Pond 455: Pipe Peak Elev=3,605.24' Inflow=7.59 cfs 0.783 af
18.0" Round Culvert n=0.012 L=57.0' S=0.0104 '/' Outflow=7.59 cfs 0.783 af

Pond 456: Pipe Peak Elev=3,604.01' Inflow=7.59 cfs 0.783 af
21.0" Round Culvert n=0.012 L=170.0' S=0.0148 '/' Outflow=7.59 cfs 0.783 af

Pond 457: Pipe Peak Elev=3,601.39' Inflow=8.63 cfs 0.915 af
24.0" Round Culvert n=0.012 L=283.0' S=0.0023 '/' Outflow=8.63 cfs 0.915 af

Pond 459: Pipe Peak Elev=3,560.62' Inflow=5.54 cfs 1.016 af
48.0" Round Culvert n=0.012 L=344.0' S=0.0120 '/' Outflow=5.54 cfs 1.016 af

Pond 460: Pipe Peak Elev=3,566.17' Inflow=5.54 cfs 1.016 af
48.0" Round Culvert n=0.012 L=400.0' S=0.0139 '/' Outflow=5.54 cfs 1.016 af

Pond 462: Pipe Peak Elev=3,583.34' Inflow=5.54 cfs 1.016 af
24.0" Round Culvert n=0.012 L=145.0' S=0.1159 '/' Outflow=5.54 cfs 1.016 af

Pond 701: Pipe Peak Elev=3,575.54' Inflow=8.00 cfs 2.619 af
48.0" Round Culvert n=0.012 L=20.0' S=0.0870 '/' Outflow=8.00 cfs 2.619 af

Pond 702: Pipe Peak Elev=3,573.65' Inflow=8.00 cfs 2.619 af
42.0" Round Culvert n=0.012 L=266.0' S=0.0874 '/' Outflow=8.00 cfs 2.619 af

Pond 703: (new Pond) Peak Elev=3,550.44' Inflow=8.00 cfs 2.619 af
36.0" Round Culvert n=0.012 L=1,006.0' S=0.0874 '/' Outflow=8.00 cfs 2.619 af

Pond 704: (new Pond) Peak Elev=3,462.35' Inflow=8.00 cfs 2.619 af
78.0" Round Culvert n=0.012 L=108.0' S=0.0200 '/' Outflow=8.00 cfs 2.619 af

Pond Pond A: Pond A Peak Elev=3,398.49' Storage=10.626 af Inflow=195.62 cfs 22.355 af
Primary=8.82 cfs 17.685 af Secondary=47.14 cfs 4.640 af Outflow=55.96 cfs 22.325 af

Pond Pond B: Pond B Peak Elev=3,390.07' Storage=6.584 af Inflow=55.96 cfs 22.325 af
Primary=7.71 cfs 22.307 af Secondary=0.00 cfs 0.000 af Outflow=7.71 cfs 22.307 af

Pond Pond C: Pond C Peak Elev=3,379.35' Storage=1.099 af Inflow=7.71 cfs 22.307 af
Primary=7.71 cfs 22.235 af Secondary=0.00 cfs 0.000 af Outflow=7.71 cfs 22.235 af

Pond Pond D: Pond D Peak Elev=3,434.43' Storage=0.024 af Inflow=3.26 cfs 0.435 af
Primary=2.06 cfs 0.435 af Secondary=0.00 cfs 0.000 af Outflow=2.06 cfs 0.435 af

Pond Pond E: Pond E Peak Elev=3,539.86' Storage=2.042 af Inflow=60.00 cfs 8.935 af
Primary=22.25 cfs 8.935 af Secondary=0.00 cfs 0.000 af Outflow=22.25 cfs 8.935 af

Total Runoff Area = 3,980.000 ac Runoff Volume = 94.218 af Average Runoff Depth = 0.28"
91.66% Pervious = 3,648.000 ac 8.34% Impervious = 332.000 ac

APPENDIX F

HydroCAD Summary
100-Year, 24-Hour Storm

MORRISON-MAIERLE, INC

Time span=0.00-96.00 hrs, dt=0.01 hrs, 9601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment A: Saddle Club East Runoff Area=49.000 ac 2.04% Impervious Runoff Depth=0.99"
Flow Length=2,646' Tc=43.5 min CN=71 Runoff=29.18 cfs 4.035 af

Subcatchment B: Saddle Club West Runoff Area=67.000 ac 5.97% Impervious Runoff Depth=1.04"
Flow Length=3,022' Tc=49.7 min CN=72 Runoff=38.89 cfs 5.825 af

Subcatchment C: Tumbleweed Runoff Area=92.000 ac 8.70% Impervious Runoff Depth=1.04"
Flow Length=2,860' Tc=37.3 min CN=72 Runoff=65.54 cfs 7.998 af

Subcatchment D: Moon Valley Runoff Area=192.000 ac 13.02% Impervious Runoff Depth=1.16"
Flow Length=5,340' Tc=75.3 min CN=74 Runoff=92.77 cfs 18.525 af

Subcatchment E: Sun Valley Runoff Area=207.000 ac 6.28% Impervious Runoff Depth=1.04"
Flow Length=5,221' Tc=80.8 min CN=72 Runoff=83.49 cfs 17.995 af

Subcatchment F: Prickly Pear Runoff Area=208.000 ac 4.33% Impervious Runoff Depth=0.99"
Flow Length=6,238' Tc=88.1 min CN=71 Runoff=73.02 cfs 17.130 af

Subcatchment G: TW G Runoff Area=247.000 ac 2.83% Impervious Runoff Depth=0.99"
Flow Length=5,669' Tc=56.8 min CN=71 Runoff=120.79 cfs 20.341 af

Subcatchment H: 10L end Runoff Area=101.000 ac 2.97% Impervious Runoff Depth=0.99"
Flow Length=6,495' Tc=88.7 min CN=71 Runoff=35.56 cfs 8.318 af

Subcatchment I-a: (new Subcat) Runoff Area=154.000 ac 0.65% Impervious Runoff Depth=0.93"
Flow Length=4,000' Tc=75.5 min CN=70 Runoff=56.35 cfs 11.997 af

Subcatchment I-b: west of 10L Runoff Area=300.000 ac 3.33% Impervious Runoff Depth=0.99"
Flow Length=6,950' Slope=0.0250 '/' Tc=48.8 min CN=71 Runoff=164.60 cfs 24.706 af

Subcatchment J: Old Ranch Runoff Area=1,543.000 ac 0.00% Impervious Runoff Depth=0.93"
Flow Length=16,574' Tc=308.6 min CN=70 Runoff=198.23 cfs 120.203 af

Subcatchment K: Rim Xing 1 Runoff Area=74.000 ac 2.70% Impervious Runoff Depth=0.99"
Flow Length=4,400' Slope=0.0200 '/' Tc=94.0 min CN=71 Runoff=24.64 cfs 6.094 af

Subcatchment L: Retention Pond Runoff Area=97.000 ac 0.00% Impervious Runoff Depth=0.93"
Flow Length=3,889' Slope=0.0200 '/' Tc=85.4 min CN=70 Runoff=32.50 cfs 7.556 af

Subcatchment M: Rim Xing 2 Runoff Area=25.000 ac 20.00% Impervious Runoff Depth=1.28"
Flow Length=1,638' Tc=48.8 min CN=76 Runoff=18.89 cfs 2.664 af

Subcatchment N: Rim Xing 3 Runoff Area=5.000 ac 0.00% Impervious Runoff Depth=0.93"
Flow Length=1,044' Tc=40.7 min CN=70 Runoff=2.91 cfs 0.390 af

Subcatchment O: Rim Xing 4 Runoff Area=5.000 ac 0.00% Impervious Runoff Depth=0.93"
Flow Length=1,108' Slope=0.0140 '/' Tc=9.7 min CN=70 Runoff=6.97 cfs 0.390 af

Subcatchment S101: Subcat Runoff Area=24.000 ac 16.67% Impervious Runoff Depth=1.22"
Flow Length=1,303' Tc=12.6 min CN=75 Runoff=40.35 cfs 2.435 af

Subcatchment S102: Subcat Runoff Area=19.000 ac 31.58% Impervious Runoff Depth=1.47"
Flow Length=2,563' Tc=23.9 min CN=79 Runoff=27.62 cfs 2.333 af

Subcatchment S103: Subcat Runoff Area=16.000 ac 43.75% Impervious Runoff Depth=1.68"
Flow Length=1,610' Tc=17.8 min CN=82 Runoff=31.93 cfs 2.245 af

Subcatchment S104: Subcat Runoff Area=27.000 ac 51.85% Impervious Runoff Depth=1.91"
Flow Length=1,763' Tc=13.8 min CN=85 Runoff=69.52 cfs 4.303 af

Subcatchment S105: Subcat Runoff Area=14.000 ac 42.86% Impervious Runoff Depth=1.68"
Flow Length=1,480' Tc=14.0 min CN=82 Runoff=31.60 cfs 1.965 af

Subcatchment S106: Subcat Runoff Area=6.000 ac 100.00% Impervious Runoff Depth=3.15"
Flow Length=910' Tc=7.0 min CN=98 Runoff=27.80 cfs 1.573 af

Subcatchment S107: Subcat Runoff Area=7.000 ac 100.00% Impervious Runoff Depth=3.15"
Flow Length=676' Tc=5.7 min CN=98 Runoff=33.80 cfs 1.836 af

Subcatchment S108: Subcat Runoff Area=9.000 ac 100.00% Impervious Runoff Depth=3.15"
Flow Length=803' Slope=0.0200 '/' Tc=6.7 min CN=98 Runoff=42.10 cfs 2.360 af

Subcatchment S109: Subcat Runoff Area=6.000 ac 100.00% Impervious Runoff Depth=3.15"
Flow Length=564' Tc=5.2 min CN=98 Runoff=29.43 cfs 1.573 af

Subcatchment S110: Subcat Runoff Area=14.000 ac 92.86% Impervious Runoff Depth=2.93"
Flow Length=1,816' Tc=17.2 min CN=96 Runoff=45.95 cfs 3.415 af

Subcatchment S111: Subcat Runoff Area=46.000 ac 54.35% Impervious Runoff Depth=1.91"
Flow Length=3,618' Tc=28.9 min CN=85 Runoff=78.33 cfs 7.330 af

Subcatchment S112: Subcat Runoff Area=23.000 ac 4.35% Impervious Runoff Depth=0.99"
Flow Length=3,317' Tc=21.5 min CN=71 Runoff=22.45 cfs 1.894 af

Subcatchment S113: Subcat Runoff Area=26.000 ac 96.15% Impervious Runoff Depth=3.04"
Flow Length=2,541' Tc=19.4 min CN=97 Runoff=81.81 cfs 6.576 af

Subcatchment S114: Subcat Runoff Area=17.000 ac 82.35% Impervious Runoff Depth=2.62"
Flow Length=1,541' Tc=13.6 min CN=93 Runoff=57.83 cfs 3.710 af

Subcatchment S115: Subcat Runoff Area=14.000 ac 21.43% Impervious Runoff Depth=1.28"
Flow Length=1,114' Tc=12.7 min CN=76 Runoff=24.73 cfs 1.492 af

Subcatchment S116: Subcat Runoff Area=32.000 ac 31.25% Impervious Runoff Depth=1.47"
Flow Length=2,438' Tc=22.8 min CN=79 Runoff=47.88 cfs 3.929 af

Subcatchment S117: Subcat Runoff Area=12.000 ac 33.33% Impervious Runoff Depth=1.47"
Flow Length=926' Tc=11.1 min CN=79 Runoff=26.16 cfs 1.473 af

Subcatchment S118: Subcat Runoff Area=7.000 ac 42.86% Impervious Runoff Depth=1.68"
Flow Length=1,011' Tc=9.1 min CN=82 Runoff=18.78 cfs 0.982 af

Subcatchment S119: Subcat Runoff Area=14.000 ac 35.71% Impervious Runoff Depth=1.54"
Flow Length=1,540' Tc=13.3 min CN=80 Runoff=29.54 cfs 1.799 af

Subcatchment S120: Subcat Runoff Area=14.000 ac 42.86% Impervious Runoff Depth=1.68"
Flow Length=1,032' Tc=12.3 min CN=82 Runoff=33.53 cfs 1.965 af

Subcatchment S121: Subcat Runoff Area=12.000 ac 41.67% Impervious Runoff Depth=1.68"
Flow Length=1,945' Tc=17.3 min CN=82 Runoff=24.35 cfs 1.684 af

Subcatchment S122: Subcat Runoff Area=11.000 ac 63.64% Impervious Runoff Depth=2.16"
Flow Length=1,214' Tc=30.6 min CN=88 Runoff=20.32 cfs 1.980 af

Subcatchment S123: Subcat Runoff Area=43.000 ac 18.60% Impervious Runoff Depth=1.22"
Flow Length=2,468' Tc=40.3 min CN=75 Runoff=35.24 cfs 4.363 af

Subcatchment S124: Subcat Runoff Area=8.000 ac 37.50% Impervious Runoff Depth=1.61"
Flow Length=838' Tc=28.7 min CN=81 Runoff=11.41 cfs 1.075 af

Subcatchment S125: Subcat Runoff Area=6.000 ac 50.00% Impervious Runoff Depth=1.83"
Flow Length=410' Tc=4.6 min CN=84 Runoff=20.57 cfs 0.917 af

Subcatchment S126: Subcat Runoff Area=23.000 ac 34.78% Impervious Runoff Depth=1.54"
Flow Length=1,497' Tc=38.3 min CN=80 Runoff=25.62 cfs 2.955 af

Subcatchment S127: Subcat Runoff Area=44.000 ac 11.36% Impervious Runoff Depth=1.10"
Flow Length=2,892' Tc=41.3 min CN=73 Runoff=31.19 cfs 4.032 af

Subcatchment S128: Subcat Runoff Area=4.000 ac 25.00% Impervious Runoff Depth=1.34"
Flow Length=941' Tc=31.9 min CN=77 Runoff=4.32 cfs 0.447 af

Subcatchment S129: Subcat Runoff Area=13.000 ac 53.85% Impervious Runoff Depth=1.91"
Flow Length=1,221' Tc=31.4 min CN=85 Runoff=20.96 cfs 2.072 af

Subcatchment S130: Subcat Runoff Area=6.000 ac 33.33% Impervious Runoff Depth=1.47"
Flow Length=1,242' Tc=33.1 min CN=79 Runoff=7.04 cfs 0.737 af

Subcatchment S131: Subcat Runoff Area=20.000 ac 40.00% Impervious Runoff Depth=1.61"
Flow Length=1,656' Tc=11.9 min CN=81 Runoff=46.44 cfs 2.687 af

Subcatchment S132: Subcat Runoff Area=23.000 ac 30.43% Impervious Runoff Depth=1.47"
Flow Length=2,296' Tc=17.5 min CN=79 Runoff=40.26 cfs 2.824 af

Subcatchment S133: Subcat Runoff Area=14.000 ac 7.14% Impervious Runoff Depth=1.04"
Flow Length=2,027' Tc=36.1 min CN=72 Runoff=10.21 cfs 1.217 af

Subcatchment S134: Subcat Runoff Area=6.000 ac 0.00% Impervious Runoff Depth=0.93"
Flow Length=540' Tc=25.9 min CN=70 Runoff=4.81 cfs 0.467 af

Subcatchment S135: Subcat Runoff Area=8.000 ac 0.00% Impervious Runoff Depth=0.93"
Flow Length=1,582' Tc=33.7 min CN=70 Runoff=5.35 cfs 0.623 af

Subcatchment S136: Subcat Runoff Area=7.000 ac 42.86% Impervious Runoff Depth=1.68"
Flow Length=677' Tc=27.4 min CN=82 Runoff=10.82 cfs 0.982 af

Subcatchment S137: Subcat Runoff Area=2.000 ac 0.00% Impervious Runoff Depth=0.93"
Flow Length=534' Tc=6.0 min CN=70 Runoff=3.26 cfs 0.156 af

Subcatchment S138: Subcat Runoff Area=4.000 ac 25.00% Impervious Runoff Depth=1.34"
Flow Length=540' Tc=6.7 min CN=77 Runoff=9.36 cfs 0.447 af

Subcatchment S139: Subcat Runoff Area=13.000 ac 7.69% Impervious Runoff Depth=1.04"
Flow Length=1,350' Tc=19.0 min CN=72 Runoff=14.62 cfs 1.130 af

Reach 2R: Reach Avg. Flow Depth=0.06' Max Vel=0.80 fps Inflow=21.01 cfs 0.527 af
n=0.016 L=600.0' S=0.0034 '/' Capacity=227.83 cfs Outflow=14.20 cfs 0.527 af

Reach 3R: Reach Avg. Flow Depth=0.65' Max Vel=2.25 fps Inflow=77.09 cfs 3.002 af
n=0.025 L=2,000.0' S=0.0064 '/' Capacity=952.03 cfs Outflow=47.39 cfs 3.002 af

Reach 4R: Reach Avg. Flow Depth=0.17' Max Vel=1.06 fps Inflow=12.03 cfs 0.066 af
n=0.025 L=1,850.0' S=0.0087 '/' Capacity=1,105.76 cfs Outflow=1.49 cfs 0.066 af

Reach 7R: Reach Avg. Flow Depth=0.59' Max Vel=2.88 fps Inflow=42.51 cfs 1.938 af
n=0.025 L=1,200.0' S=0.0119 '/' Capacity=987.09 cfs Outflow=38.21 cfs 1.938 af

Reach 8R: Reach Avg. Flow Depth=0.03' Max Vel=1.37 fps Inflow=22.91 cfs 0.395 af
n=0.016 L=1,274.0' S=0.0251 '/' Capacity=616.42 cfs Outflow=11.82 cfs 0.395 af

Reach 9R: Reach Avg. Flow Depth=0.00' Max Vel=0.19 fps Inflow=1.61 cfs 0.018 af
n=0.025 L=1,200.0' S=0.0225 '/' Capacity=373.13 cfs Outflow=0.11 cfs 0.018 af

Reach 10R: Reach Avg. Flow Depth=0.05' Max Vel=1.24 fps Inflow=35.92 cfs 1.124 af
n=0.022 L=1,925.0' S=0.0201 '/' Capacity=400.43 cfs Outflow=18.02 cfs 1.124 af

Reach 11R: Reach Avg. Flow Depth=0.01' Max Vel=0.56 fps Inflow=1.95 cfs 0.167 af
n=0.022 L=800.0' S=0.0285 '/' Capacity=477.70 cfs Outflow=1.79 cfs 0.167 af

Reach 12R: Reach Avg. Flow Depth=0.01' Max Vel=0.46 fps Inflow=3.96 cfs 0.109 af
n=0.022 L=1,175.0' S=0.0266 '/' Capacity=461.24 cfs Outflow=1.18 cfs 0.109 af

Reach 13R: Reach Avg. Flow Depth=0.01' Max Vel=0.68 fps Inflow=2.20 cfs 0.364 af
n=0.013 L=380.0' S=0.0147 '/' Capacity=580.94 cfs Outflow=2.20 cfs 0.364 af

Reach 14R: Reach Avg. Flow Depth=1.33' Max Vel=10.22 fps Inflow=24.35 cfs 1.684 af
24.0" Round Pipe n=0.012 L=2,500.0' S=0.0140 '/' Capacity=29.04 cfs Outflow=22.66 cfs 1.684 af

Reach 15R: Reach Avg. Flow Depth=0.27' Max Vel=1.60 fps Inflow=7.94 cfs 0.391 af
n=0.025 L=2,105.0' S=0.0103 '/' Capacity=189.63 cfs Outflow=5.94 cfs 0.391 af

Reach 16R: Reach Avg. Flow Depth=0.70' Max Vel=3.13 fps Inflow=52.72 cfs 1.544 af
n=0.022 L=1,950.0' S=0.0087 '/' Capacity=628.29 cfs Outflow=38.81 cfs 1.544 af

Reach 17R: Reach Avg. Flow Depth=0.02' Max Vel=22.22 fps Inflow=57.53 cfs 6.096 af
n=0.016 L=2,700.0' S=0.0589 '/' Capacity=15,111,117.63 cfs Outflow=56.90 cfs 6.096 af

Reach 18R: Reach Avg. Flow Depth=2.07' Max Vel=17.78 fps Inflow=116.99 cfs 24.621 af
48.0" Round Pipe n=0.012 L=50.0' S=0.0200 '/' Capacity=220.07 cfs Outflow=116.99 cfs 24.621 af

Reach 19R: (new Reach) Avg. Flow Depth=0.00' Max Vel=23.08 fps Inflow=3.40 cfs 1.894 af
n=0.016 L=2,973.0' S=0.0633 '/' Capacity=11,441,841.62 cfs Outflow=3.40 cfs 1.894 af

Reach 20R: (new Reach) Avg. Flow Depth=1.75' Max Vel=16.48 fps Inflow=86.89 cfs 19.889 af
48.0" Round Pipe n=0.012 L=50.0' S=0.0200 '/' Capacity=220.07 cfs Outflow=86.88 cfs 19.889 af

Reach 30R: Reach Avg. Flow Depth=0.41' Max Vel=2.97 fps Inflow=40.17 cfs 3.068 af
n=0.025 L=910.0' S=0.0205 '/' Capacity=401.59 cfs Outflow=38.09 cfs 3.068 af

Reach 31R: Reach Avg. Flow Depth=0.28' Max Vel=2.16 fps Inflow=11.69 cfs 1.184 af
n=0.025 L=1,300.0' S=0.0185 '/' Capacity=751.64 cfs Outflow=8.23 cfs 1.184 af

Reach 32R: Reach Avg. Flow Depth=0.50' Max Vel=3.22 fps Inflow=50.75 cfs 3.173 af
n=0.025 L=1,455.0' S=0.0185 '/' Capacity=751.29 cfs Outflow=40.81 cfs 3.173 af

Reach 33R: Reach Avg. Flow Depth=0.07' Max Vel=2.10 fps Inflow=19.89 cfs 0.386 af
n=0.016 L=800.0' S=0.0188 '/' Capacity=193.73 cfs Outflow=16.13 cfs 0.386 af

Reach 40R: Reach Avg. Flow Depth=0.08' Max Vel=7.99 fps Inflow=56.35 cfs 11.997 af
n=0.030 L=7,250.0' S=0.0275 '/' Capacity=4,347,964.77 cfs Outflow=51.04 cfs 11.997 af

Reach 41R: Reach Avg. Flow Depth=0.04' Max Vel=9.74 fps Inflow=42.49 cfs 29.106 af
n=0.030 L=5,852.0' S=0.0404 '/' Capacity=5,730,418.04 cfs Outflow=42.38 cfs 29.106 af

Reach 42R: Reach Avg. Flow Depth=2.96' Max Vel=19.81 fps Inflow=197.40 cfs 65.809 af
48.0" Round Pipe n=0.012 L=50.0' S=0.0200 '/' Capacity=220.07 cfs Outflow=197.39 cfs 65.809 af

Pond 101: Pipe Peak Elev=3,205.01' Inflow=35.50 cfs 48.055 af
36.0" Round Culvert n=0.012 L=109.0' S=0.0927 '/' Outflow=35.50 cfs 48.055 af

Pond 102: Pipe Peak Elev=3,207.47' Inflow=35.50 cfs 48.055 af
36.0" Round Culvert n=0.012 L=256.0' S=0.0085 '/' Outflow=35.50 cfs 48.055 af

Pond 103: Pipe Peak Elev=3,210.61' Inflow=35.50 cfs 48.055 af
36.0" Round Culvert n=0.012 L=125.0' S=0.0274 '/' Outflow=35.50 cfs 48.055 af

Pond 104: Pipe Peak Elev=3,227.68' Inflow=35.50 cfs 48.055 af
36.0" Round Culvert n=0.012 L=366.0' S=0.0466 '/' Outflow=35.50 cfs 48.055 af

Pond 105: Pipe Peak Elev=3,348.96' Inflow=35.50 cfs 48.055 af
24.0" Round Culvert n=0.012 L=676.0' S=0.1772 '/' Outflow=35.50 cfs 48.055 af

Pond 106: Pipe Peak Elev=3,365.66' Inflow=35.50 cfs 48.055 af
24.0" Round Culvert n=0.012 L=645.0' S=0.0259 '/' Outflow=35.50 cfs 48.055 af

Pond 107: Pipe Peak Elev=3,417.69' Inflow=292.18 cfs 54.278 af
60.0" Round Culvert n=0.012 L=700.0' S=0.0195 '/' Outflow=292.18 cfs 54.278 af

Pond 108: Pipe Peak Elev=3,433.81' Inflow=292.18 cfs 54.278 af
54.0" Round Culvert n=0.012 L=400.0' S=0.0352 '/' Outflow=292.18 cfs 54.278 af

Pond 109: Pipe Peak Elev=3,439.25' Inflow=251.92 cfs 51.843 af
60.0" Round Culvert n=0.012 L=300.0' S=0.0286 '/' Outflow=251.92 cfs 51.843 af

Pond 110: Pipe Peak Elev=3,448.59' Inflow=251.92 cfs 51.843 af
66.0" Round Culvert n=0.012 L=374.0' S=0.0271 '/' Outflow=251.92 cfs 51.843 af

Pond 111: Pipe Peak Elev=3,453.96' Inflow=238.34 cfs 43.367 af
60.0" Round Culvert n=0.012 L=200.0' S=0.0246 '/' Outflow=238.34 cfs 43.367 af

Pond 112: Pipe Peak Elev=3,469.72' Inflow=238.34 cfs 43.367 af
60.0" Round Culvert n=0.012 L=390.0' S=0.0404 '/' Outflow=238.34 cfs 43.367 af

Pond 113: Pipe Peak Elev=3,489.61' Inflow=126.32 cfs 25.799 af
60.0" Round Culvert n=0.012 L=311.0' S=0.0100 '/' Outflow=126.32 cfs 25.799 af

Pond 114: Pipe Peak Elev=3,494.00' Inflow=126.32 cfs 25.799 af
60.0" Round Culvert n=0.012 L=449.0' S=0.0101 '/' Outflow=126.32 cfs 25.799 af

Pond 115: Pipe Peak Elev=3,499.51' Inflow=126.32 cfs 25.799 af
54.0" Round Culvert n=0.012 L=364.0' S=0.0141 '/' Outflow=126.32 cfs 25.799 af

Pond 116: Pipe Peak Elev=3,502.97' Inflow=126.32 cfs 25.799 af
60.0" Round Culvert n=0.012 L=376.0' S=0.0088 '/' Outflow=126.32 cfs 25.799 af

Pond 117: Pipe Peak Elev=3,506.80' Inflow=79.97 cfs 12.803 af
42.0" Round Culvert n=0.012 L=457.0' S=0.0089 '/' Outflow=79.97 cfs 12.803 af

Pond 118: Pipe Peak Elev=3,509.49' Inflow=79.97 cfs 12.803 af
42.0" Round Culvert n=0.012 L=343.0' S=0.0055 '/' Outflow=79.97 cfs 12.803 af

Pond 119: Pipe Peak Elev=3,511.89' Inflow=79.97 cfs 12.803 af
42.0" Round Culvert n=0.012 L=401.0' S=0.0069 '/' Outflow=79.97 cfs 12.803 af

Pond 120: Pipe Peak Elev=3,514.39' Inflow=79.97 cfs 12.803 af
42.0" Round Culvert n=0.012 L=360.0' S=0.0069 '/' Outflow=79.97 cfs 12.803 af

Pond 121: Pipe Peak Elev=3,518.82' Inflow=79.97 cfs 12.803 af
42.0" Round Culvert n=0.012 L=381.0' S=0.0134 '/' Outflow=79.97 cfs 12.803 af

Pond 122: Pipe Peak Elev=3,521.59' Inflow=79.97 cfs 12.803 af
42.0" Round Culvert n=0.012 L=223.0' S=0.0110 '/' Outflow=79.97 cfs 12.803 af

Pond 123: Pipe Peak Elev=3,525.20' Inflow=79.97 cfs 12.803 af
42.0" Round Culvert n=0.012 L=340.0' S=0.0111 '/' Outflow=79.97 cfs 12.803 af

Pond 124: Pipe Peak Elev=3,529.14' Inflow=18.78 cfs 0.982 af
24.0" Round Culvert n=0.012 L=289.0' S=0.0036 '/' Outflow=18.78 cfs 0.982 af

Pond 125: Pipe Peak Elev=3,436.42' Inflow=40.35 cfs 2.435 af
30.0" Round Culvert n=0.012 L=299.0' S=0.0235 '/' Outflow=40.35 cfs 2.435 af

Pond 126: Pipe Peak Elev=3,439.39' Inflow=40.35 cfs 2.435 af
30.0" Round Culvert n=0.012 L=271.0' S=0.0100 '/' Outflow=40.35 cfs 2.435 af

Pond 127: Pipe Peak Elev=3,442.72' Inflow=40.35 cfs 2.435 af
30.0" Round Culvert n=0.012 L=200.0' S=0.0100 '/' Outflow=40.35 cfs 2.435 af

Pond 128: Pipe Peak Elev=3,473.29' Inflow=14.81 cfs 8.476 af
30.0" Round Culvert n=0.012 L=567.0' S=0.0500 '/' Outflow=14.81 cfs 8.476 af

Pond 129: Pipe Peak Elev=3,473.98' Inflow=14.81 cfs 8.476 af
30.0" Round Culvert n=0.012 L=40.0' S=0.0075 '/' Outflow=14.81 cfs 8.476 af

Pond 130: Pipe Peak Elev=3,475.11' Inflow=14.81 cfs 8.476 af
30.0" Round Culvert n=0.012 L=550.0' S=0.0006 '/' Outflow=14.81 cfs 8.476 af

Pond 131: Pipe Peak Elev=3,477.54' Inflow=14.81 cfs 8.476 af
30.0" Round Culvert n=0.012 L=192.0' S=0.0188 '/' Outflow=14.81 cfs 8.476 af

Pond 132: Pipe/DP Peak Elev=3,488.09' Storage=189,600 cf Inflow=119.71 cfs 9.190 af
Primary=14.81 cfs 8.476 af Secondary=15.62 cfs 0.110 af Outflow=30.43 cfs 8.587 af

Pond 133: Pipe Peak Elev=3,488.47' Inflow=10.91 cfs 1.718 af
18.0" Round Culvert n=0.012 L=269.0' S=0.0055 '/' Outflow=10.91 cfs 1.718 af

Pond 134: Pipe Peak Elev=3,490.41' Inflow=31.93 cfs 2.245 af
Primary=10.91 cfs 1.718 af Secondary=21.01 cfs 0.527 af Outflow=31.93 cfs 2.245 af

Pond 135: Pipe Peak Elev=3,514.24' Inflow=172.83 cfs 18.925 af
Primary=114.26 cfs 17.568 af Secondary=58.57 cfs 1.357 af Outflow=172.83 cfs 18.925 af

Pond 138: Pipe Peak Elev=3,503.15' Inflow=184.85 cfs 18.991 af
Primary=172.83 cfs 18.925 af Secondary=12.03 cfs 0.066 af Outflow=184.85 cfs 18.991 af

Pond 139: Pipe Peak Elev=3,506.42' Inflow=44.22 cfs 3.903 af
Primary=15.29 cfs 2.257 af Secondary=28.93 cfs 1.645 af Outflow=44.22 cfs 3.903 af

Pond 140: Pipe Peak Elev=3,507.95' Inflow=172.69 cfs 16.734 af
42.0" Round Culvert n=0.012 L=213.0' S=0.0176 '/' Outflow=172.69 cfs 16.734 af

Pond 141: Pipe Peak Elev=3,515.46' Inflow=225.41 cfs 18.277 af
Primary=172.69 cfs 16.734 af Secondary=52.72 cfs 1.544 af Outflow=225.41 cfs 18.277 af

Pond 142: Pipe Peak Elev=3,508.59' Inflow=107.47 cfs 9.834 af
42.0" Round Culvert n=0.012 L=244.0' S=0.0188 '/' Outflow=107.47 cfs 9.834 af

Pond 143: Pipe Peak Elev=3,518.38' Inflow=107.47 cfs 9.834 af
42.0" Round Culvert n=0.012 L=349.0' S=0.0281 '/' Outflow=107.47 cfs 9.834 af

Pond 144: Pipe Peak Elev=3,524.26' Inflow=107.47 cfs 9.834 af
42.0" Round Culvert n=0.012 L=473.0' S=0.0101 '/' Outflow=107.47 cfs 9.834 af

Pond 145: Pipe Peak Elev=3,529.92' Inflow=107.47 cfs 9.834 af
42.0" Round Culvert n=0.012 L=529.0' S=0.0128 '/' Outflow=107.47 cfs 9.834 af

Pond 146: Pipe Peak Elev=3,533.46' Inflow=99.68 cfs 8.260 af
42.0" Round Culvert n=0.012 L=369.0' S=0.0094 '/' Outflow=99.68 cfs 8.260 af

Pond 147: Pipe Peak Elev=3,540.55' Inflow=99.68 cfs 8.260 af
42.0" Round Culvert n=0.012 L=297.0' S=0.0253 '/' Outflow=99.68 cfs 8.260 af

Pond 148: Pipe Peak Elev=3,543.30' Inflow=99.68 cfs 8.260 af
42.0" Round Culvert n=0.012 L=201.0' S=0.0130 '/' Outflow=99.68 cfs 8.260 af

Pond 149: Pipe Peak Elev=3,554.56' Inflow=99.68 cfs 8.260 af
42.0" Round Culvert n=0.012 L=134.0' S=0.0851 '/' Outflow=99.68 cfs 8.260 af

Pond 150: Pipe Peak Elev=3,558.16' Inflow=99.68 cfs 8.260 af
42.0" Round Culvert n=0.012 L=270.0' S=0.0075 '/' Outflow=99.68 cfs 8.260 af

Pond 151: Pipe Peak Elev=3,558.75' Inflow=99.68 cfs 8.260 af
42.0" Round Culvert n=0.012 L=100.0' S=0.0073 '/' Outflow=99.68 cfs 8.260 af

Pond 152: Pipe Peak Elev=3,559.73' Inflow=99.68 cfs 8.260 af
42.0" Round Culvert n=0.012 L=97.0' S=0.0038 '/' Outflow=99.68 cfs 8.260 af

Pond 153: Pipe Peak Elev=3,564.70' Inflow=99.68 cfs 8.260 af
42.0" Round Culvert n=0.012 L=73.0' S=0.0040 '/' Outflow=99.68 cfs 8.260 af

Pond 200: Pipe Peak Elev=3,508.10' Inflow=67.53 cfs 4.141 af
Primary=67.53 cfs 4.141 af Secondary=0.00 cfs 0.000 af Outflow=67.53 cfs 4.141 af

Pond 201: Pipe Peak Elev=3,510.28' Inflow=67.53 cfs 4.141 af
36.0" Round Culvert n=0.012 L=349.0' S=0.0108 '/' Outflow=67.53 cfs 4.141 af

Pond 202: Pipe Peak Elev=3,519.91' Inflow=67.53 cfs 4.141 af
36.0" Round Culvert n=0.012 L=516.0' S=0.0145 '/' Outflow=67.53 cfs 4.141 af

Pond 203: Pipe Peak Elev=3,524.58' Inflow=67.53 cfs 4.141 af
36.0" Round Culvert n=0.012 L=201.0' S=0.0182 '/' Outflow=67.53 cfs 4.141 af

Pond 204: Pipe Peak Elev=3,533.34' Inflow=33.80 cfs 1.836 af
24.0" Round Culvert n=0.012 L=258.0' S=0.0111 '/' Outflow=33.80 cfs 1.836 af

Pond 207: Pipe Peak Elev=3,559.13' Inflow=27.80 cfs 1.573 af
15.0" Round Culvert n=0.010 L=162.0' S=0.0048 '/' Outflow=27.80 cfs 1.573 af

Pond 208: Pipe Peak Elev=3,526.01' Inflow=33.77 cfs 2.305 af
36.0" Round Culvert n=0.012 L=140.0' S=0.0111 '/' Outflow=33.77 cfs 2.305 af

Pond 209: Pipe Peak Elev=3,529.87' Inflow=33.77 cfs 2.305 af
24.0" Round Culvert n=0.012 L=64.0' S=0.0233 '/' Outflow=33.77 cfs 2.305 af

Pond 210: Pipe Peak Elev=3,533.76' Inflow=33.77 cfs 2.305 af
24.0" Round Culvert n=0.012 L=190.0' S=0.0140 '/' Outflow=33.77 cfs 2.305 af

Pond 211: Pipe Peak Elev=3,536.54' Inflow=42.10 cfs 2.360 af
Primary=33.77 cfs 2.305 af Secondary=8.33 cfs 0.055 af Outflow=42.10 cfs 2.360 af

Pond 212: Pipe Peak Elev=3,539.77' Inflow=42.10 cfs 2.360 af
24.0" Round Culvert n=0.012 L=100.0' S=0.0198 '/' Outflow=42.10 cfs 2.360 af

Pond 213: Pipe Peak Elev=3,541.75' Inflow=42.10 cfs 2.360 af
24.0" Round Culvert n=0.012 L=100.0' S=0.0202 '/' Outflow=42.10 cfs 2.360 af

Pond 214: Pipe Peak Elev=3,550.08' Inflow=42.10 cfs 2.360 af
24.0" Round Culvert n=0.012 L=100.0' S=0.0194 '/' Outflow=42.10 cfs 2.360 af

Pond 300: Pipe Peak Elev=3,433.00' Inflow=0.00 cfs 0.000 af
48.0" Round Culvert n=0.012 L=56.0' S=0.0105 '/' Outflow=0.00 cfs 0.000 af

Pond 311: Pipe Peak Elev=3,542.85' Inflow=69.87 cfs 12.212 af
Primary=61.93 cfs 11.821 af Secondary=7.94 cfs 0.391 af Outflow=69.87 cfs 12.212 af

Pond 312: Pipe/DP Peak Elev=3,544.78' Storage=35,538 cf Inflow=101.52 cfs 12.189 af
36.0" Round Culvert n=0.025 L=137.0' S=0.0129 '/' Outflow=69.87 cfs 12.212 af

Pond 313: Pipe Peak Elev=3,544.09' Inflow=37.45 cfs 6.511 af
36.0" Round Culvert n=0.025 L=362.0' S=0.0152 '/' Outflow=37.45 cfs 6.511 af

Pond 314: Pipe/DP Peak Elev=3,550.63' Storage=22,348 cf Inflow=62.93 cfs 3.763 af
30.0" Round Culvert n=0.025 L=350.0' S=0.0094 '/' Outflow=28.81 cfs 3.754 af

Pond 315: Pipe Peak Elev=3,554.08' Inflow=33.53 cfs 1.965 af
Primary=27.39 cfs 1.919 af Secondary=6.14 cfs 0.046 af Outflow=33.53 cfs 1.965 af

Pond 316: Pipe Peak Elev=3,558.80' Inflow=33.53 cfs 1.965 af
Primary=15.84 cfs 1.710 af Secondary=17.68 cfs 0.255 af Outflow=33.53 cfs 1.965 af

Pond 327: Pipe Peak Elev=3,607.90' Inflow=20.32 cfs 1.980 af
18.0" Round Culvert n=0.012 L=75.0' S=0.0103 '/' Outflow=20.32 cfs 1.980 af

Pond 328: Pipe Peak Elev=3,604.81' Inflow=20.32 cfs 1.980 af
Primary=19.24 cfs 1.971 af Secondary=1.09 cfs 0.009 af Outflow=20.32 cfs 1.980 af

Pond 330: Pipe Peak Elev=3,602.64' Inflow=19.24 cfs 1.971 af
Primary=9.23 cfs 1.659 af Secondary=10.00 cfs 0.312 af Outflow=19.24 cfs 1.971 af

Pond 331: Pipe Peak Elev=3,595.30' Inflow=9.23 cfs 1.659 af
18.0" Round Culvert n=0.012 L=78.0' S=0.0133 '/' Outflow=9.23 cfs 1.659 af

Pond 333: Pipe Peak Elev=3,598.25' Inflow=9.23 cfs 1.659 af
Primary=5.38 cfs 1.431 af Secondary=3.85 cfs 0.228 af Outflow=9.23 cfs 1.659 af

Pond 337: Pipe Peak Elev=3,574.97' Inflow=5.38 cfs 1.431 af
12.0" Round Culvert n=0.012 L=164.0' S=0.0420 '/' Outflow=5.38 cfs 1.431 af

Pond 350: Pipe Peak Elev=3,556.86' Inflow=8.69 cfs 2.757 af
18.0" Round Culvert n=0.012 L=881.0' S=0.0164 '/' Outflow=8.69 cfs 2.757 af

Pond 351: Pipe/DP Peak Elev=3,575.41' Storage=44,691 cf Inflow=52.02 cfs 2.757 af
12.0" Round Culvert n=0.012 L=182.0' S=0.0330 '/' Outflow=8.69 cfs 2.757 af

Pond 356: Pipe Peak Elev=3,514.75' Inflow=60.60 cfs 12.996 af
Primary=60.60 cfs 12.996 af Secondary=0.00 cfs 0.000 af Outflow=60.60 cfs 12.996 af

Pond 357: Pipe Peak Elev=3,528.62' Inflow=103.11 cfs 14.879 af
Primary=60.60 cfs 12.996 af Secondary=42.51 cfs 1.883 af Outflow=103.11 cfs 14.879 af

Pond 362: Pipe Peak Elev=3,522.17' Inflow=18.28 cfs 5.621 af
18.0" Round Culvert n=0.012 L=116.0' S=0.0209 '/' Outflow=18.28 cfs 5.621 af

Pond 365: Pipe Peak Elev=3,526.75' Inflow=18.28 cfs 5.621 af
18.0" Round Culvert n=0.012 L=199.0' S=0.0221 '/' Outflow=18.28 cfs 5.621 af

Pond 366: Pipe Peak Elev=3,530.28' Inflow=18.28 cfs 5.621 af
18.0" Round Culvert n=0.012 L=166.0' S=0.0205 '/' Outflow=18.28 cfs 5.621 af

Pond 367: Pipe Peak Elev=3,534.60' Inflow=18.28 cfs 5.621 af
18.0" Round Culvert n=0.012 L=201.0' S=0.0201 '/' Outflow=18.28 cfs 5.621 af

Pond 368: Pipe Peak Elev=3,538.69' Inflow=18.28 cfs 5.621 af
18.0" Round Culvert n=0.012 L=203.0' S=0.0203 '/' Outflow=18.28 cfs 5.621 af

Pond 369: Pipe Peak Elev=3,547.88' Inflow=19.89 cfs 5.639 af
Primary=18.28 cfs 5.621 af Secondary=1.61 cfs 0.018 af Outflow=19.89 cfs 5.639 af

Pond 370: Pipe Peak Elev=3,551.03' Inflow=14.53 cfs 4.461 af
18.0" Round Culvert n=0.012 L=307.0' S=0.0088 '/' Outflow=14.53 cfs 4.461 af

Pond 371: Pipe Peak Elev=3,553.72' Inflow=14.53 cfs 4.461 af
18.0" Round Culvert n=0.012 L=307.0' S=0.0087 '/' Outflow=14.53 cfs 4.461 af

Pond 372: Pipe Peak Elev=3,555.26' Inflow=14.53 cfs 4.461 af
18.0" Round Culvert n=0.012 L=133.0' S=0.0329 '/' Outflow=14.53 cfs 4.461 af

Pond 373: Pipe Peak Elev=3,564.89' Inflow=50.45 cfs 5.584 af
Primary=14.53 cfs 4.461 af Secondary=35.92 cfs 1.124 af Outflow=50.45 cfs 5.584 af

Pond 374: Pipe Peak Elev=3,558.71' Inflow=4.51 cfs 2.170 af
15.0" Round Culvert n=0.012 L=130.0' S=0.0235 '/' Outflow=4.51 cfs 2.170 af

Pond 375: Pipe/DP Peak Elev=3,584.94' Storage=18,235 cf Inflow=24.73 cfs 1.492 af
12.0" Round Culvert n=0.012 L=246.0' S=0.0114 '/' Outflow=4.70 cfs 1.492 af

Pond 376: Pipe Peak Elev=3,582.51' Inflow=4.70 cfs 1.492 af
12.0" Round Culvert n=0.012 L=494.0' S=0.0115 '/' Outflow=4.70 cfs 1.492 af

Pond 377: Pipe Peak Elev=3,573.16' Inflow=4.70 cfs 1.492 af
12.0" Round Culvert n=0.012 L=159.0' S=0.0075 '/' Outflow=4.70 cfs 1.492 af

Pond 378: Pipe Peak Elev=3,548.80' Inflow=6.52 cfs 1.178 af
18.0" Round Culvert n=0.012 L=132.0' S=0.0328 '/' Outflow=6.52 cfs 1.178 af

Pond 379: Pipe Peak Elev=3,555.03' Inflow=29.43 cfs 1.573 af
Primary=6.52 cfs 1.178 af Secondary=22.91 cfs 0.395 af Outflow=29.43 cfs 1.573 af

Pond 381: Pipe Peak Elev=3,588.06' Inflow=57.83 cfs 3.710 af
Primary=10.42 cfs 2.445 af Secondary=47.41 cfs 1.265 af Outflow=57.83 cfs 3.710 af

Pond 382: Pipe Peak Elev=3,573.98' Inflow=10.42 cfs 2.445 af
Primary=6.47 cfs 2.337 af Secondary=3.96 cfs 0.109 af Outflow=10.42 cfs 2.445 af

Pond 383: Pipe Peak Elev=3,569.07' Inflow=6.47 cfs 2.337 af
12.0" Round Culvert n=0.012 L=195.0' S=0.0206 '/' Outflow=6.47 cfs 2.337 af

Pond 384: Pipe Peak Elev=3,565.43' Inflow=6.47 cfs 2.337 af
Primary=4.51 cfs 2.170 af Secondary=1.95 cfs 0.167 af Outflow=6.47 cfs 2.337 af

Pond 385: Pipe Peak Elev=3,561.67' Inflow=4.51 cfs 2.170 af
12.0" Round Culvert n=0.012 L=104.0' S=0.0064 '/' Outflow=4.51 cfs 2.170 af

Pond 386: Pipe Peak Elev=3,564.88' Inflow=4.51 cfs 2.170 af
Primary=2.31 cfs 1.806 af Secondary=2.20 cfs 0.364 af Outflow=4.51 cfs 2.170 af

Pond 400: Pipe Peak Elev=3,499.61' Inflow=42.49 cfs 29.106 af
36.0" Round Culvert n=0.012 L=50.0' S=0.0036 '/' Outflow=42.49 cfs 29.106 af

Pond 401: Pipe Peak Elev=3,511.47' Inflow=42.49 cfs 29.106 af
24.0" Round Culvert n=0.012 L=231.0' S=0.0301 '/' Outflow=42.49 cfs 29.106 af

Pond 402: Pipe Peak Elev=3,527.99' Inflow=42.49 cfs 29.106 af
24.0" Round Culvert n=0.012 L=418.0' S=0.0402 '/' Outflow=42.49 cfs 29.106 af

Pond 404: Pipe Peak Elev=3,548.38' Inflow=191.76 cfs 27.976 af
60.0" Round Culvert n=0.012 L=741.0' S=0.0025 '/' Outflow=191.76 cfs 27.976 af

Pond 405: Pipe Peak Elev=3,547.29' Inflow=191.76 cfs 27.976 af
60.0" Round Culvert n=0.012 L=203.0' S=0.0051 '/' Outflow=191.76 cfs 27.976 af

Pond 406: Pipe Peak Elev=3,553.62' Inflow=191.76 cfs 27.976 af
54.0" Round Culvert n=0.012 L=504.0' S=0.0142 '/' Outflow=191.76 cfs 27.976 af

Pond 407: Pipe Peak Elev=3,568.71' Inflow=25.62 cfs 2.955 af
24.0" Round Culvert n=0.012 L=400.0' S=0.0062 '/' Outflow=25.62 cfs 2.955 af

Pond 408: Pipe Peak Elev=3,564.05' Inflow=191.76 cfs 27.976 af
54.0" Round Culvert n=0.012 L=509.0' S=0.0138 '/' Outflow=191.76 cfs 27.976 af

Pond 409: Pipe Peak Elev=3,568.41' Inflow=133.92 cfs 20.072 af
42.0" Round Culvert n=0.012 L=291.0' S=0.0242 '/' Outflow=133.92 cfs 20.072 af

Pond 410: Pipe Peak Elev=3,573.83' Inflow=128.54 cfs 18.641 af
42.0" Round Culvert n=0.012 L=240.0' S=0.0238 '/' Outflow=128.54 cfs 18.641 af

Pond 411: Pipe Peak Elev=3,578.46' Inflow=11.41 cfs 1.075 af
24.0" Round Culvert n=0.012 L=259.0' S=0.0269 '/' Outflow=11.41 cfs 1.075 af

Pond 412: Pipe Peak Elev=3,582.19' Storage=43,181 cf Inflow=159.88 cfs 17.571 af
42.0" Round Culvert n=0.012 L=241.0' S=0.0193 '/' Outflow=122.43 cfs 17.566 af

Pond 413: Pipe Peak Elev=3,581.07' Inflow=46.22 cfs 5.784 af
36.0" Round Culvert n=0.012 L=250.0' S=0.0187 '/' Outflow=46.22 cfs 5.784 af

Pond 414: Pipe Peak Elev=3,586.78' Inflow=46.22 cfs 5.784 af
36.0" Round Culvert n=0.012 L=300.0' S=0.0187 '/' Outflow=46.22 cfs 5.784 af

Pond 415: Pipe Peak Elev=3,593.42' Inflow=46.22 cfs 5.784 af
36.0" Round Culvert n=0.012 L=350.0' S=0.0187 '/' Outflow=46.22 cfs 5.784 af

Pond 416: Pipe Peak Elev=3,597.88' Inflow=46.22 cfs 5.784 af
36.0" Round Culvert n=0.012 L=252.0' S=0.0173 '/' Outflow=46.22 cfs 5.784 af

Pond 417: Pipe Peak Elev=3,603.61' Inflow=46.22 cfs 5.784 af
36.0" Round Culvert n=0.012 L=297.0' S=0.0190 '/' Outflow=46.22 cfs 5.784 af

Pond 418: Pipe Peak Elev=3,609.94' Inflow=46.22 cfs 5.784 af
36.0" Round Culvert n=0.012 L=346.0' S=0.0180 '/' Outflow=46.22 cfs 5.784 af

Pond 419: Pipe Peak Elev=3,620.72' Inflow=29.92 cfs 3.290 af
36.0" Round Culvert n=0.012 L=451.0' S=0.0201 '/' Outflow=29.92 cfs 3.290 af

Pond 420: Pipe Peak Elev=3,622.61' Inflow=29.92 cfs 3.290 af
36.0" Round Culvert n=0.012 L=190.0' S=0.0072 '/' Outflow=29.92 cfs 3.290 af

Pond 421: Pipe Peak Elev=3,626.80' Inflow=10.21 cfs 1.217 af
21.0" Round Culvert n=0.012 L=157.0' S=0.0109 '/' Outflow=10.21 cfs 1.217 af

Pond 426: Pipe Peak Elev=3,629.66' Inflow=9.81 cfs 1.091 af
27.0" Round Culvert n=0.012 L=542.0' S=0.0153 '/' Outflow=9.81 cfs 1.091 af

Pond 427: Pipe Peak Elev=3,632.74' Inflow=4.81 cfs 0.467 af
21.0" Round Culvert n=0.012 L=157.0' S=0.0100 '/' Outflow=4.81 cfs 0.467 af

Pond 429: Pipe Peak Elev=3,637.74' Inflow=5.35 cfs 0.623 af
21.0" Round Culvert n=0.012 L=539.0' S=0.0140 '/' Outflow=5.35 cfs 0.623 af

Pond 430: Pipe Peak Elev=3,639.75' Inflow=5.35 cfs 0.623 af
21.0" Round Culvert n=0.012 L=157.0' S=0.0100 '/' Outflow=5.35 cfs 0.623 af

Pond 433: Pipe Peak Elev=3,619.25' Inflow=21.55 cfs 2.594 af
Primary=17.12 cfs 2.494 af Secondary=4.43 cfs 0.101 af Outflow=21.55 cfs 2.594 af

Pond 434: Pipe Peak Elev=3,621.73' Inflow=20.37 cfs 2.438 af
21.0" Round Culvert n=0.012 L=171.0' S=0.0033 '/' Outflow=20.37 cfs 2.438 af

Pond 435: Pipe Peak Elev=3,621.82' Inflow=20.37 cfs 2.438 af
21.0" Round Culvert n=0.012 L=138.0' S=0.0064 '/' Outflow=20.37 cfs 2.438 af

Pond 436: Pipe Peak Elev=3,624.17' Inflow=40.26 cfs 2.824 af
Primary=20.37 cfs 2.438 af Secondary=19.89 cfs 0.386 af Outflow=40.26 cfs 2.824 af

Pond 449: Pipe Peak Elev=3,618.30' Inflow=46.44 cfs 2.687 af
Primary=23.91 cfs 2.341 af Secondary=22.53 cfs 0.345 af Outflow=46.44 cfs 2.687 af

Pond 450: Pipe Peak Elev=3,615.79' Inflow=23.91 cfs 2.341 af
21.0" Round Culvert n=0.012 L=170.0' S=0.0123 '/' Outflow=23.91 cfs 2.341 af

Pond 451: Pipe Peak Elev=3,612.46' Inflow=23.91 cfs 2.341 af
Primary=17.31 cfs 2.229 af Secondary=6.59 cfs 0.112 af Outflow=23.91 cfs 2.341 af

Pond 452: Pipe Peak Elev=3,606.97' Inflow=11.69 cfs 1.184 af
24.0" Round Culvert n=0.012 L=197.0' S=0.0025 '/' Outflow=11.69 cfs 1.184 af

Pond 453: Pipe Peak Elev=3,609.12' Inflow=7.04 cfs 0.737 af
21.0" Round Culvert n=0.012 L=171.0' S=0.0111 '/' Outflow=7.04 cfs 0.737 af

Pond 455: Pipe Peak Elev=3,612.83' Inflow=20.96 cfs 2.072 af
18.0" Round Culvert n=0.012 L=57.0' S=0.0104 '/' Outflow=20.96 cfs 2.072 af

Pond 456: Pipe Peak Elev=3,605.94' Inflow=20.96 cfs 2.072 af
21.0" Round Culvert n=0.012 L=170.0' S=0.0148 '/' Outflow=20.96 cfs 2.072 af

Pond 457: Pipe Peak Elev=3,605.58' Inflow=25.25 cfs 2.519 af
24.0" Round Culvert n=0.012 L=283.0' S=0.0023 '/' Outflow=25.25 cfs 2.519 af

Pond 459: Pipe Peak Elev=3,561.61' Inflow=31.19 cfs 4.032 af
48.0" Round Culvert n=0.012 L=344.0' S=0.0120 '/' Outflow=31.19 cfs 4.032 af

Pond 460: Pipe Peak Elev=3,567.14' Inflow=31.19 cfs 4.032 af
48.0" Round Culvert n=0.012 L=400.0' S=0.0139 '/' Outflow=31.19 cfs 4.032 af

Pond 462: Pipe Peak Elev=3,587.57' Inflow=31.19 cfs 4.032 af
24.0" Round Culvert n=0.012 L=145.0' S=0.1159 '/' Outflow=31.19 cfs 4.032 af

Pond 701: Pipe Peak Elev=3,577.45' Inflow=56.35 cfs 11.997 af
48.0" Round Culvert n=0.012 L=20.0' S=0.0870 '/' Outflow=56.35 cfs 11.997 af

Pond 702: Pipe Peak Elev=3,575.25' Inflow=56.35 cfs 11.997 af
42.0" Round Culvert n=0.012 L=266.0' S=0.0874 '/' Outflow=56.35 cfs 11.997 af

Pond 703: (new Pond) Peak Elev=3,552.30' Inflow=56.35 cfs 11.997 af
36.0" Round Culvert n=0.012 L=1,006.0' S=0.0874 '/' Outflow=56.35 cfs 11.997 af

Pond 704: (new Pond) Peak Elev=3,463.57' Inflow=56.35 cfs 11.997 af
78.0" Round Culvert n=0.012 L=108.0' S=0.0200 '/' Outflow=56.35 cfs 11.997 af

Pond Pond A: Pond A Peak Elev=3,399.17' Storage=12.003 af Inflow=292.18 cfs 54.278 af
Primary=9.31 cfs 20.210 af Secondary=238.38 cfs 34.036 af Outflow=247.69 cfs 54.246 af

Pond Pond B: Pond B Peak Elev=3,391.86' Storage=9.664 af Inflow=247.69 cfs 54.246 af
Primary=9.11 cfs 27.233 af Secondary=164.73 cfs 26.993 af Outflow=173.84 cfs 54.226 af

Pond Pond C: Pond C Peak Elev=3,384.63' Storage=7.892 af Inflow=173.84 cfs 54.226 af
Primary=35.50 cfs 48.055 af Secondary=57.53 cfs 6.096 af Outflow=93.03 cfs 54.151 af

Pond Pond D: Pond D Peak Elev=3,436.95' Storage=0.663 af Inflow=22.45 cfs 1.894 af
Primary=3.40 cfs 1.894 af Secondary=0.00 cfs 0.000 af Outflow=3.40 cfs 1.894 af

Pond Pond E: Pond E Peak Elev=3,545.59' Storage=12.026 af Inflow=197.76 cfs 29.106 af
Primary=42.49 cfs 29.106 af Secondary=0.00 cfs 0.000 af Outflow=42.49 cfs 29.106 af

Total Runoff Area = 3,980.000 ac Runoff Volume = 360.151 af Average Runoff Depth = 1.09"
91.66% Pervious = 3,648.000 ac 8.34% Impervious = 332.000 ac

APPENDIX G

HydroCAD Summary
Ponds A, B, C, D, and E

MORRISON-MAIERLE, INC

2-YEAR, 24-HOUR STORM

MORRISON-MAIERLE, INC.

Summary for Pond Pond A: Pond A

Inflow Area = 336.000 ac, 52.98% Impervious, Inflow Depth = 0.49" for 2-Year event
Inflow = 127.59 cfs @ 12.05 hrs, Volume= 13.817 af
Outflow = 7.77 cfs @ 15.68 hrs, Volume= 13.793 af, Atten= 94%, Lag= 217.8 min
Primary = 7.77 cfs @ 15.68 hrs, Volume= 13.793 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 3,397.15' @ 15.68 hrs Surf.Area= 1.872 ac Storage= 8.051 af
Flood Elev= 3,400.49' Surf.Area= 2.160 ac Storage= 14.769 af

Plug-Flow detention time= 616.8 min calculated for 13.793 af (100% of inflow)
Center-of-Mass det. time= 615.7 min (1,460.6 - 845.0)

Volume	Invert	Avail.Storage	Storage Description
#1	3,392.02'	14.769 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

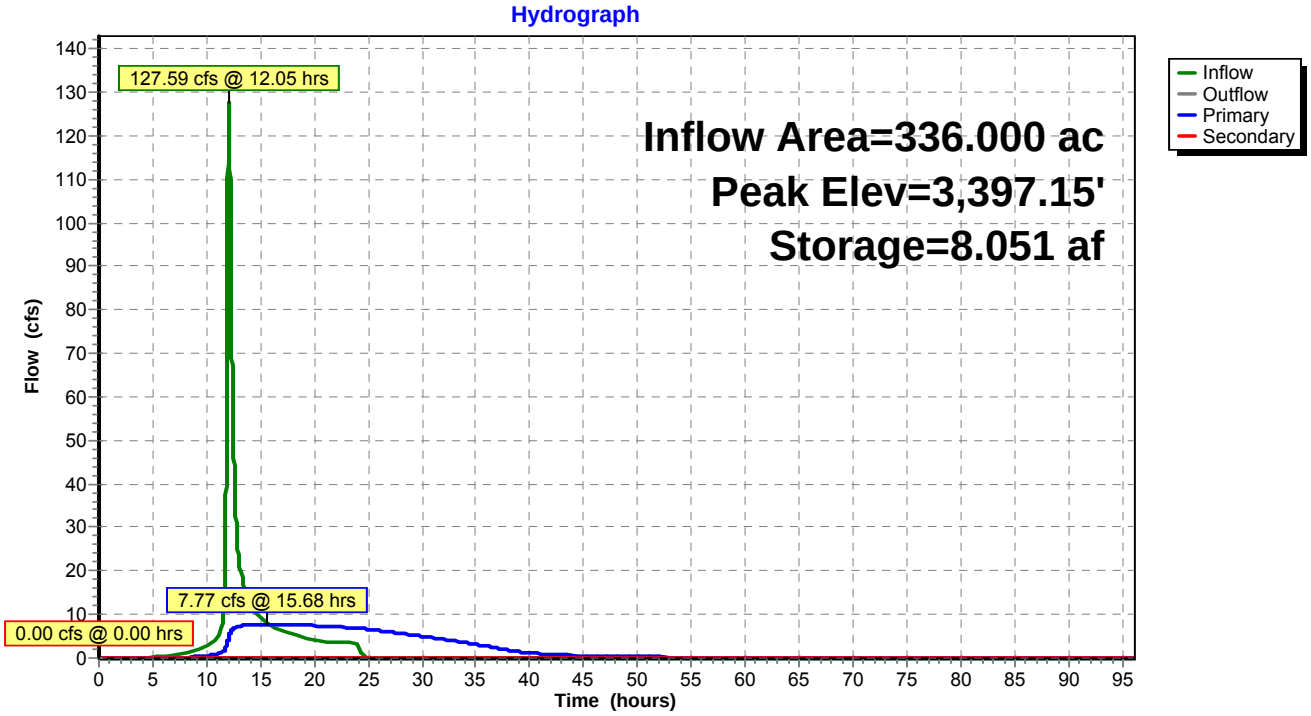
Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
3,392.02	1.210	1,096.0	0.000	0.000	1.210
3,393.00	1.210	1,096.0	1.186	1.186	1.235
3,394.00	1.590	1,124.0	1.396	2.581	1.351
3,395.00	1.690	1,158.0	1.640	4.221	1.495
3,396.00	1.770	1,190.0	1.730	5.951	1.635
3,397.00	1.860	1,223.0	1.815	7.766	1.783
3,398.00	1.940	1,252.0	1.900	9.666	1.917
3,399.00	2.030	1,280.0	1.985	11.651	2.050
3,399.50	2.070	1,295.0	1.025	12.676	2.122
3,400.49	2.160	1,322.0	2.094	14.769	2.255

Device	Routing	Invert	Outlet Devices
#1	Secondary	3,398.10'	**71.0' 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
#2	Primary	3,392.02'	**9.0" W x 12.0" H Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=7.77 cfs @ 15.68 hrs HW=3,397.15' (Free Discharge)
↑—**2=Orifice/Grate** (Orifice Controls 7.77 cfs @ 10.36 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=3,392.02' (Free Discharge)
↑—**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond Pond A: Pond A



Summary for Pond Pond B: Pond B

Inflow Area = 336.000 ac, 52.98% Impervious, Inflow Depth > 0.49" for 2-Year event
Inflow = 7.77 cfs @ 15.68 hrs, Volume= 13.793 af
Outflow = 5.76 cfs @ 27.62 hrs, Volume= 13.778 af, Atten= 26%, Lag= 716.3 min
Primary = 5.76 cfs @ 27.62 hrs, Volume= 13.778 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 3,388.05' @ 27.62 hrs Surf.Area= 1.444 ac Storage= 3.487 af
Flood Elev= 3,393.58' Surf.Area= 1.960 ac Storage= 12.890 af

Plug-Flow detention time= 370.4 min calculated for 13.778 af (100% of inflow)
Center-of-Mass det. time= 366.0 min (1,826.7 - 1,460.6)

Volume	Invert	Avail.Storage	Storage Description
#1	3,385.00'	12.890 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

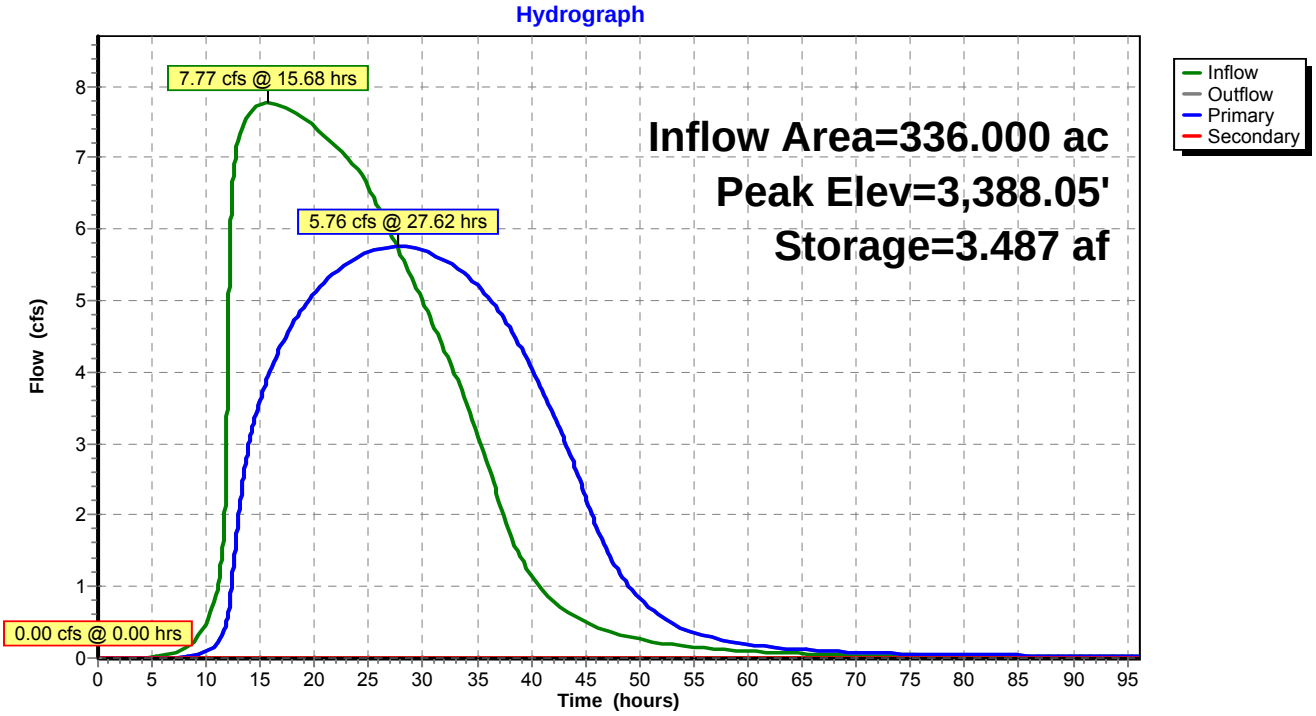
Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
3,385.00	0.450	906.0	0.000	0.000	0.450
3,386.00	1.160	1,554.0	0.777	0.777	3.362
3,387.00	1.340	1,542.0	1.249	2.026	3.439
3,388.00	1.440	1,585.0	1.390	3.416	3.687
3,389.00	1.530	1,614.0	1.485	4.901	3.861
3,390.00	1.620	1,644.0	1.575	6.476	4.043
3,391.00	1.720	1,671.0	1.670	8.145	4.211
3,392.00	1.810	1,701.0	1.765	9.910	4.400
3,392.50	1.860	1,718.0	0.917	10.828	4.508
3,393.58	1.960	1,752.0	2.063	12.890	4.727

Device	Routing	Invert	Outlet Devices
#1	Secondary	3,391.00'	**71.0' 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
#2	Primary	3,385.00'	**9.0" W x 12.0" H Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=5.76 cfs @ 27.62 hrs HW=3,388.05' (Free Discharge)
↑**2=Orifice/Grate** (Orifice Controls 5.76 cfs @ 7.68 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=3,385.00' (Free Discharge)
↑**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond Pond B: Pond B



Summary for Pond Pond C: Pond C

Inflow Area = 336.000 ac, 52.98% Impervious, Inflow Depth > 0.49" for 2-Year event
Inflow = 5.76 cfs @ 27.62 hrs, Volume= 13.778 af
Outflow = 5.74 cfs @ 28.79 hrs, Volume= 13.712 af, Atten= 0%, Lag= 69.9 min
Primary = 5.74 cfs @ 28.79 hrs, Volume= 13.712 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 3,379.16' @ 28.79 hrs Surf.Area= 0.911 ac Storage= 0.918 af
Flood Elev= 3,386.61' Surf.Area= 1.770 ac Storage= 11.199 af

Plug-Flow detention time= 148.4 min calculated for 13.712 af (100% of inflow)
Center-of-Mass det. time= 133.1 min (1,959.8 - 1,826.7)

Volume	Invert	Avail.Storage	Storage Description
#1	3,378.12'	11.199 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

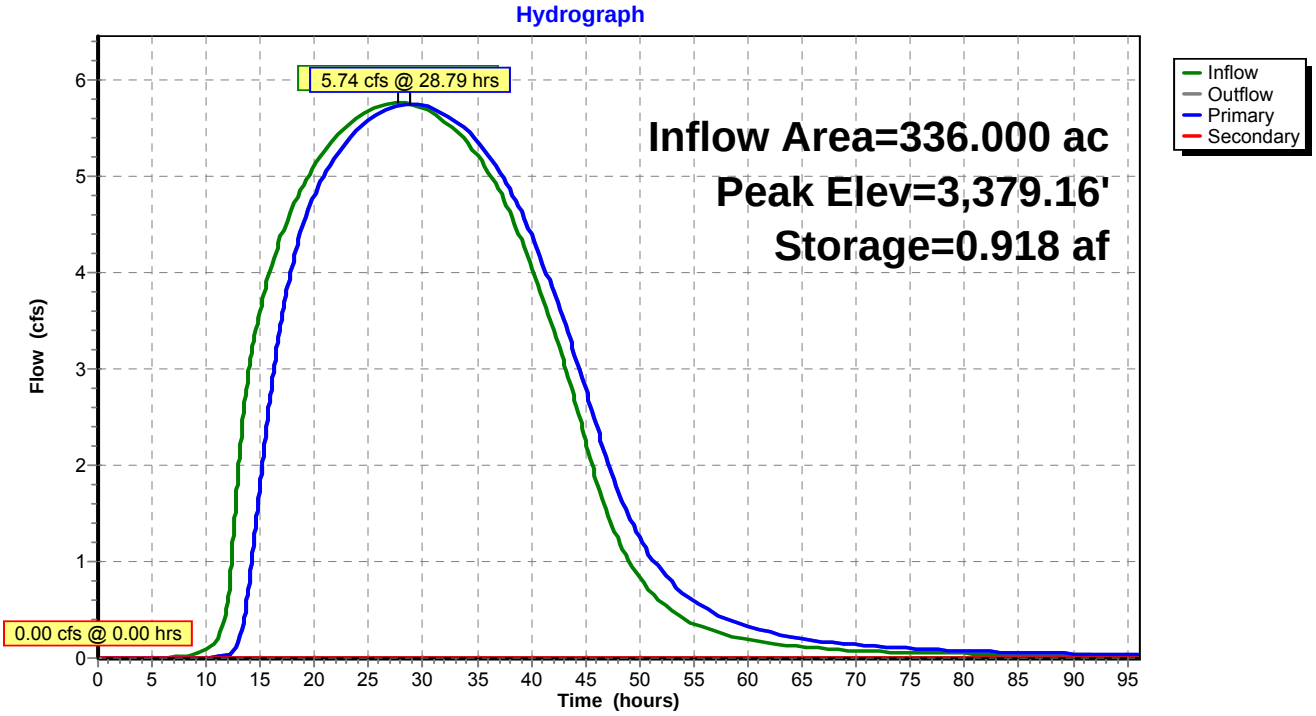
Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
3,378.12	0.880	1,462.0	0.000	0.000	0.880
3,379.00	0.880	1,462.0	0.774	0.774	0.910
3,380.00	1.080	1,574.0	0.978	1.753	1.532
3,381.00	1.190	1,649.0	1.135	2.887	1.975
3,382.00	1.300	1,687.0	1.245	4.132	2.210
3,383.00	1.400	1,720.0	1.350	5.482	2.419
3,384.00	1.500	1,752.0	1.450	6.931	2.626
3,385.00	1.600	1,765.0	1.550	8.481	2.718
3,385.50	1.660	1,780.0	0.815	9.296	2.818
3,386.61	1.770	1,815.0	1.903	11.199	3.052

Device	Routing	Invert	Outlet Devices
#1	Secondary	3,384.20'	**72.3' long x 0.7' 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 Coef. (English) 2.76 2.82 2.93 3.09 3.18 3.22 3.27 3.30 3.32 3.31 3.32
#2	Primary	3,378.12'	**24.0" Round Culvert** L= 464.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 3,378.12' / 3,362.61' S= 0.0334 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf

Primary OutFlow Max=5.74 cfs @ 28.79 hrs HW=3,379.16' (Free Discharge)
└**2=Culvert** (Inlet Controls 5.74 cfs @ 3.47 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=3,378.12' (Free Discharge)
└**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond Pond C: Pond C



Summary for Pond Pond D: Pond D

Inflow Area = 23.000 ac, 4.35% Impervious, Inflow Depth = 0.08" for 2-Year event
Inflow = 0.48 cfs @ 12.31 hrs, Volume= 0.158 af
Outflow = 0.48 cfs @ 12.31 hrs, Volume= 0.158 af, Atten= 0%, Lag= 0.2 min
Primary = 0.48 cfs @ 12.31 hrs, Volume= 0.158 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 3,433.40' @ 12.31 hrs Surf.Area= 0.001 ac Storage= 0.000 af
Flood Elev= 3,443.00' Surf.Area= 0.850 ac Storage= 3.671 af

Plug-Flow detention time= 0.1 min calculated for 0.158 af (100% of inflow)
Center-of-Mass det. time= 0.1 min (997.6 - 997.5)

Volume	Invert	Avail.Storage	Storage Description
#1	3,433.00'	3.671 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

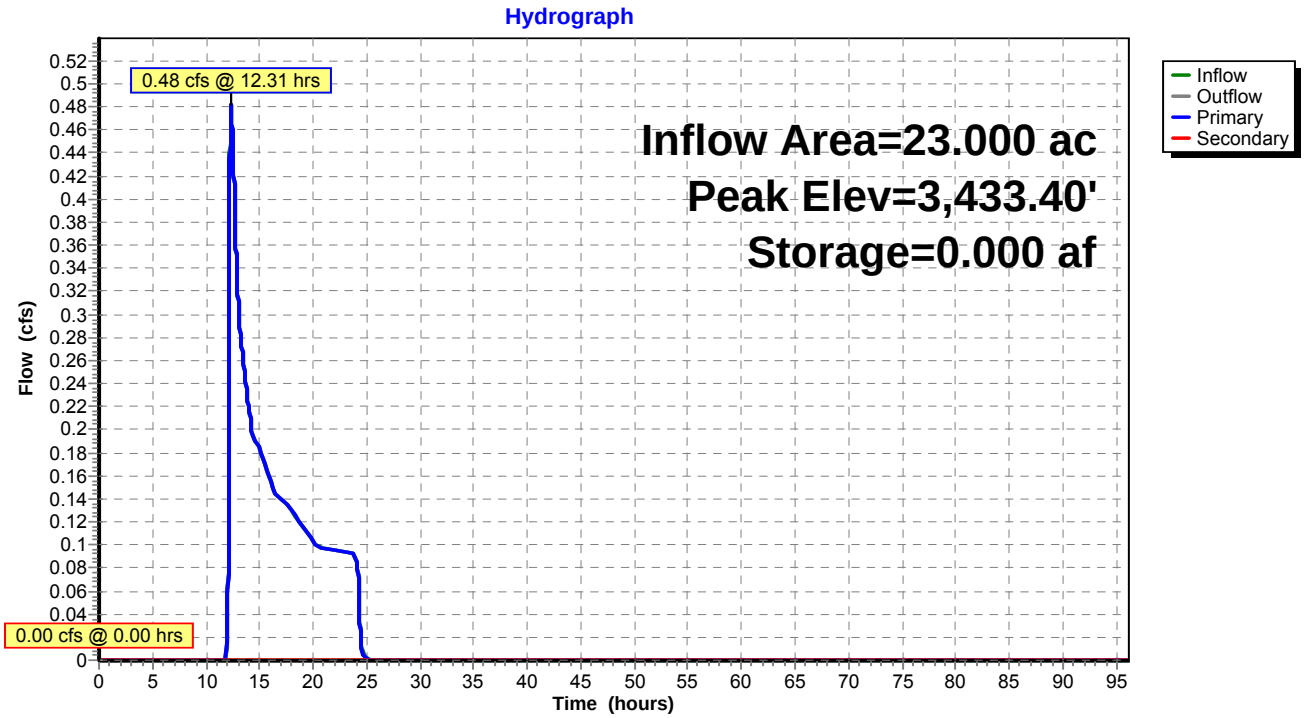
Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
3,433.00	0.000	0.0	0.000	0.000	0.000
3,433.50	0.001	44.0	0.000	0.000	0.004
3,434.00	0.020	127.0	0.004	0.004	0.029
3,434.50	0.090	260.0	0.025	0.030	0.124
3,435.00	0.170	370.0	0.064	0.094	0.250
3,435.50	0.260	434.0	0.107	0.200	0.344
3,436.00	0.310	481.0	0.142	0.343	0.423
3,436.50	0.340	529.0	0.162	0.505	0.512
3,437.00	0.360	540.0	0.175	0.680	0.534
3,437.50	0.380	556.0	0.185	0.865	0.567
3,438.00	0.400	585.0	0.195	1.060	0.628
3,438.50	0.420	590.0	0.205	1.265	0.640
3,439.00	0.440	598.0	0.215	1.480	0.659
3,439.50	0.460	613.0	0.225	1.705	0.693
3,440.00	0.480	639.0	0.235	1.940	0.753
3,440.50	0.510	666.0	0.247	2.188	0.818
3,441.00	0.530	694.0	0.260	2.448	0.888
3,441.50	0.550	721.0	0.270	2.718	0.958
3,442.00	0.580	755.0	0.282	3.000	1.050
3,442.50	0.630	806.0	0.302	3.302	1.196
3,443.00	0.850	826.0	0.369	3.671	1.256

Device	Routing	Invert	Outlet Devices
#1	Primary	3,433.00'	**10.0" Round Culvert** L= 128.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 3,433.00' / 3,432.13' S= 0.0068 '/' Cc= 0.900 n= 0.013 Cast iron, coated, Flow Area= 0.55 sf
#2	Secondary	3,438.31'	**60.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.48 cfs @ 12.31 hrs HW=3,433.40' (Free Discharge)
└**1=Culvert** (Barrel Controls 0.48 cfs @ 2.71 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=3,433.00' (Free Discharge)
└**2=Orifice/Grate** (Controls 0.00 cfs)

Pond Pond D: Pond D



Summary for Pond Pond E: Pond E

[79] Warning: Submerged Pond 404 Primary device # 1 OUTLET by 0.23'

Inflow Area = 255.000 ac, 25.49% Impervious, Inflow Depth = 0.21" for 2-Year event
Inflow = 23.74 cfs @ 12.40 hrs, Volume= 4.393 af
Outflow = 15.05 cfs @ 12.80 hrs, Volume= 4.393 af, Atten= 37%, Lag= 24.6 min
Primary = 15.05 cfs @ 12.80 hrs, Volume= 4.393 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 3,538.68' @ 12.80 hrs Surf.Area= 1.054 ac Storage= 0.401 af
Flood Elev= 3,545.65' Surf.Area= 1.951 ac Storage= 12.146 af

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 6.3 min (938.6 - 932.3)

Volume	Invert	Avail.Storage	Storage Description
#1	3,536.70'	15.883 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
3,536.70	0.000	0.0	0.000	0.000	0.000
3,537.50	0.020	12.0	0.005	0.005	0.000
3,538.00	0.060	271.0	0.019	0.024	0.134
3,538.50	0.900	814.0	0.199	0.223	1.211
3,539.00	1.350	996.0	0.559	0.782	1.812
3,539.50	1.490	1,032.0	0.710	1.492	1.946
3,540.00	1.560	1,070.0	0.762	2.254	2.093
3,540.50	1.590	1,083.0	0.787	3.042	2.145
3,541.00	1.620	1,098.0	0.802	3.844	2.206
3,541.50	1.660	1,111.0	0.820	4.664	2.260
3,542.00	1.690	1,122.0	0.837	5.501	2.307
3,542.50	1.730	1,134.0	0.855	6.356	2.358
3,543.00	1.760	1,146.0	0.872	7.229	2.410
3,543.50	1.800	1,158.0	0.890	8.119	2.462
3,544.00	1.830	1,169.0	0.907	9.026	2.511
3,544.50	1.870	1,180.0	0.925	9.951	2.560
3,545.00	1.900	1,191.0	0.942	10.894	2.609
3,545.50	1.940	1,202.0	0.960	11.854	2.659
3,547.50	2.090	1,244.0	4.029	15.883	2.855

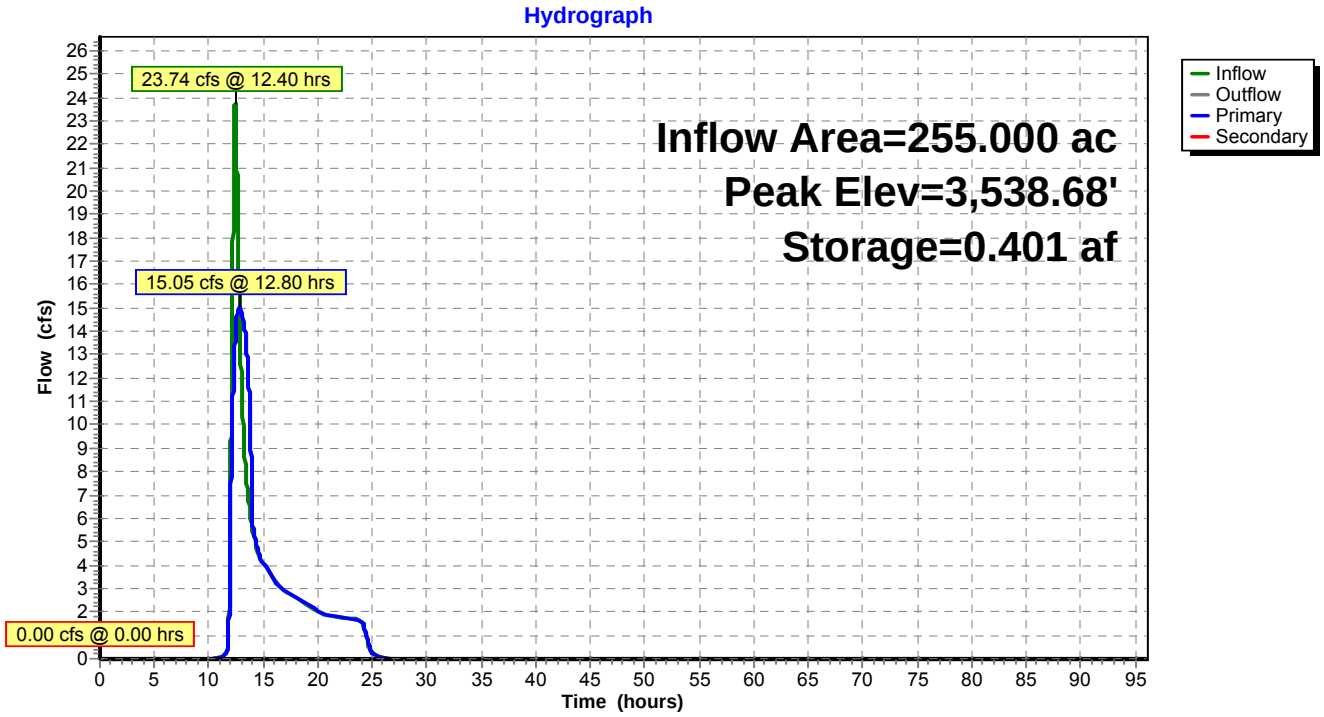
Device	Routing	Invert	Outlet Devices
#1	Primary	3,536.70'	**24.0" Round Culvert** L= 177.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 3,536.70' / 3,526.41' S= 0.0581 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#2	Secondary	3,545.65'	**71.0' long x 1.0' breadth 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=15.04 cfs @ 12.80 hrs HW=3,538.68' (Free Discharge)
└**1=Culvert** (Inlet Controls 15.04 cfs @ 4.79 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=3,536.70' (Free Discharge)
└**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond Pond E: Pond E



5-YEAR, 24-HOUR STORM

MORRISON-MAIERLE, INC.

Summary for Pond Pond A: Pond A

[79] Warning: Submerged Pond 107 Primary device # 1 OUTLET by 1.31'

Inflow Area = 336.000 ac, 52.98% Impervious, Inflow Depth = 0.80" for 5-Year event
Inflow = 195.62 cfs @ 12.06 hrs, Volume= 22.355 af
Outflow = 55.96 cfs @ 12.80 hrs, Volume= 22.325 af, Atten= 71%, Lag= 44.4 min
Primary = 8.82 cfs @ 12.80 hrs, Volume= 17.685 af
Secondary = 47.14 cfs @ 12.80 hrs, Volume= 4.640 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 3,398.49' @ 12.80 hrs Surf.Area= 1.984 ac Storage= 10.626 af
Flood Elev= 3,400.49' Surf.Area= 2.160 ac Storage= 14.769 af

Plug-Flow detention time= 545.8 min calculated for 22.323 af (100% of inflow)
Center-of-Mass det. time= 545.4 min (1,382.9 - 837.6)

Volume	Invert	Avail.Storage	Storage Description
#1	3,392.02'	14.769 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

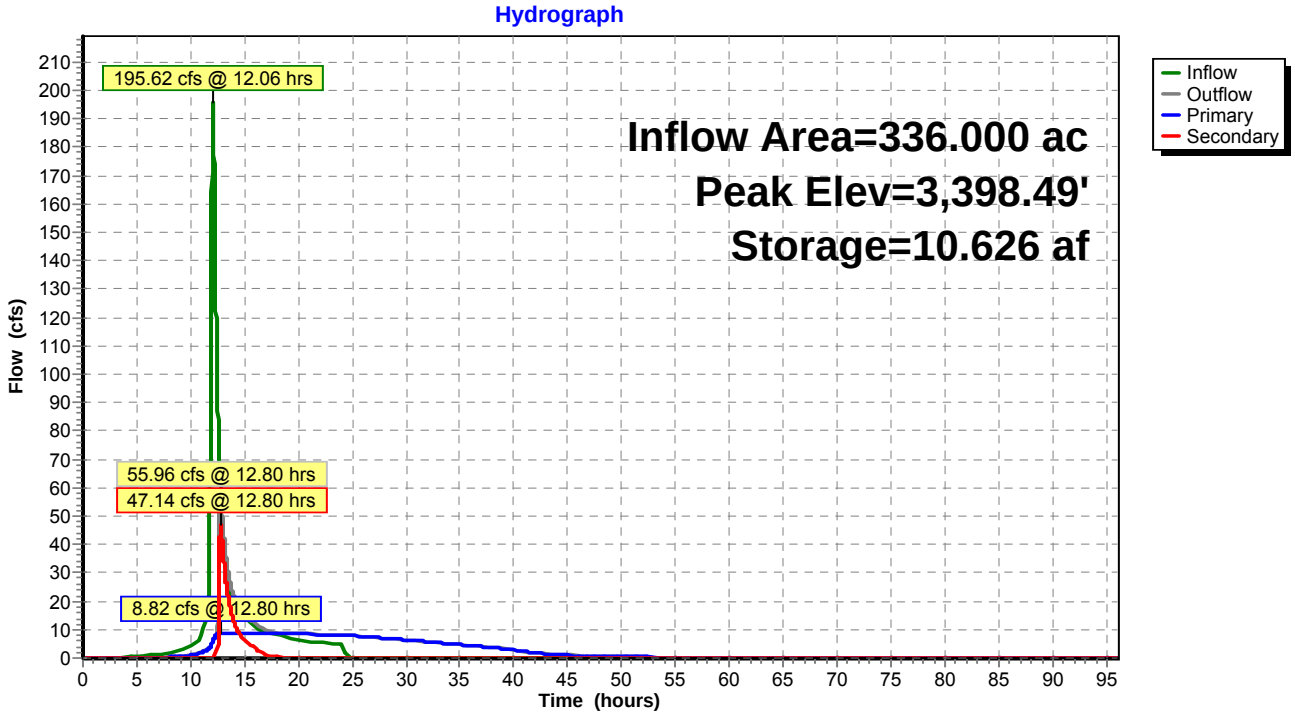
Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
3,392.02	1.210	1,096.0	0.000	0.000	1.210
3,393.00	1.210	1,096.0	1.186	1.186	1.235
3,394.00	1.590	1,124.0	1.396	2.581	1.351
3,395.00	1.690	1,158.0	1.640	4.221	1.495
3,396.00	1.770	1,190.0	1.730	5.951	1.635
3,397.00	1.860	1,223.0	1.815	7.766	1.783
3,398.00	1.940	1,252.0	1.900	9.666	1.917
3,399.00	2.030	1,280.0	1.985	11.651	2.050
3,399.50	2.070	1,295.0	1.025	12.676	2.122
3,400.49	2.160	1,322.0	2.094	14.769	2.255

Device	Routing	Invert	Outlet Devices
#1	Secondary	3,398.10'	**71.0' 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
#2	Primary	3,392.02'	**9.0" W x 12.0" H Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=8.82 cfs @ 12.80 hrs HW=3,398.49' (Free Discharge)
↑—**2=Orifice/Grate** (Orifice Controls 8.82 cfs @ 11.76 fps)

Secondary OutFlow Max=46.91 cfs @ 12.80 hrs HW=3,398.49' (Free Discharge)
↑—**1=Broad-Crested Rectangular Weir** (Weir Controls 46.91 cfs @ 1.70 fps)

Pond Pond A: Pond A



Summary for Pond Pond B: Pond B

Inflow Area = 336.000 ac, 52.98% Impervious, Inflow Depth > 0.80" for 5-Year event
Inflow = 55.96 cfs @ 12.80 hrs, Volume= 22.325 af
Outflow = 7.71 cfs @ 25.41 hrs, Volume= 22.307 af, Atten= 86%, Lag= 756.8 min
Primary = 7.71 cfs @ 25.41 hrs, Volume= 22.307 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 3,390.07' @ 25.41 hrs Surf.Area= 1.627 ac Storage= 6.584 af
Flood Elev= 3,393.58' Surf.Area= 1.960 ac Storage= 12.890 af

Plug-Flow detention time= 522.3 min calculated for 22.304 af (100% of inflow)
Center-of-Mass det. time= 519.0 min (1,901.9 - 1,382.9)

Volume	Invert	Avail.Storage	Storage Description
#1	3,385.00'	12.890 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

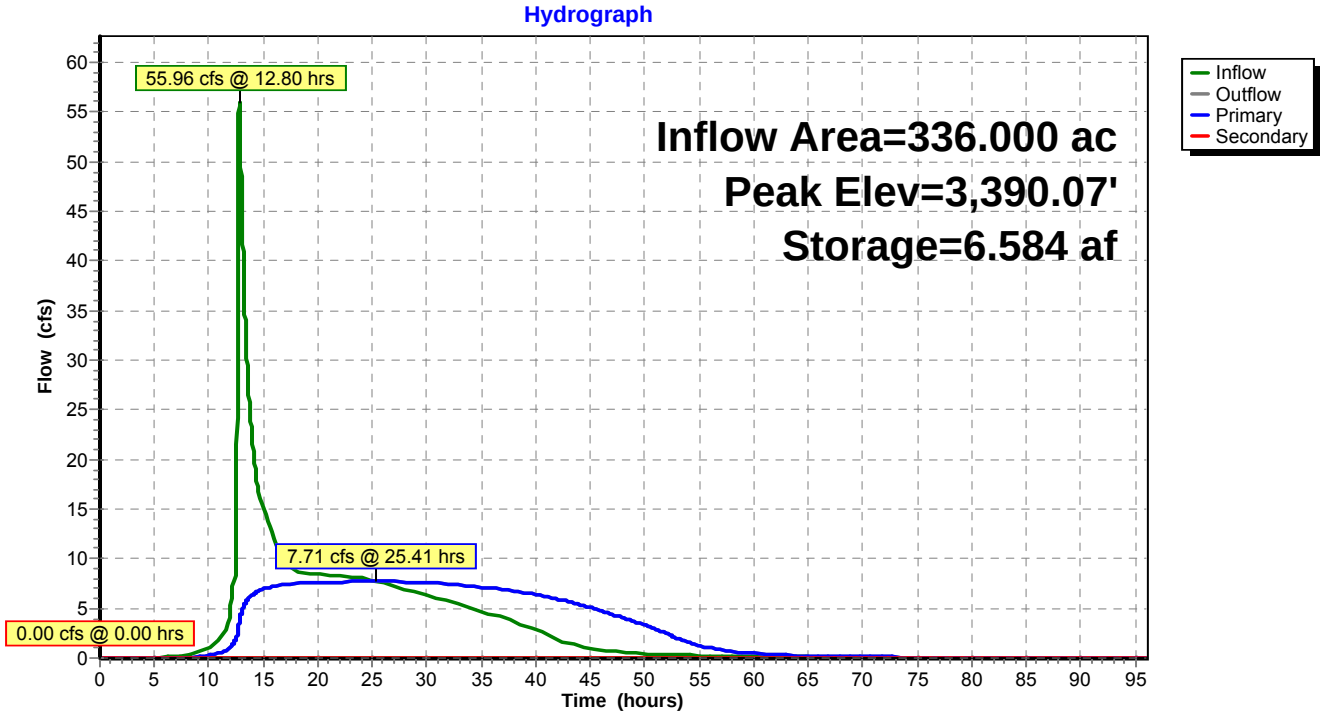
Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
3,385.00	0.450	906.0	0.000	0.000	0.450
3,386.00	1.160	1,554.0	0.777	0.777	3.362
3,387.00	1.340	1,542.0	1.249	2.026	3.439
3,388.00	1.440	1,585.0	1.390	3.416	3.687
3,389.00	1.530	1,614.0	1.485	4.901	3.861
3,390.00	1.620	1,644.0	1.575	6.476	4.043
3,391.00	1.720	1,671.0	1.670	8.145	4.211
3,392.00	1.810	1,701.0	1.765	9.910	4.400
3,392.50	1.860	1,718.0	0.917	10.828	4.508
3,393.58	1.960	1,752.0	2.063	12.890	4.727

Device	Routing	Invert	Outlet Devices
#1	Secondary	3,391.00'	**71.0' 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
#2	Primary	3,385.00'	**9.0" W x 12.0" H Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=7.71 cfs @ 25.41 hrs HW=3,390.07' (Free Discharge)
↑—**2=Orifice/Grate** (Orifice Controls 7.71 cfs @ 10.28 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=3,385.00' (Free Discharge)
↑—**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond Pond B: Pond B



Summary for Pond Pond C: Pond C

Inflow Area = 336.000 ac, 52.98% Impervious, Inflow Depth > 0.80" for 5-Year event
Inflow = 7.71 cfs @ 25.41 hrs, Volume= 22.307 af
Outflow = 7.71 cfs @ 26.43 hrs, Volume= 22.235 af, Atten= 0%, Lag= 61.3 min
Primary = 7.71 cfs @ 26.43 hrs, Volume= 22.235 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 3,379.35' @ 26.43 hrs Surf.Area= 0.949 ac Storage= 1.099 af
Flood Elev= 3,386.61' Surf.Area= 1.770 ac Storage= 11.199 af

Plug-Flow detention time= 124.2 min calculated for 22.235 af (100% of inflow)
Center-of-Mass det. time= 113.9 min (2,015.8 - 1,901.9)

Volume	Invert	Avail.Storage	Storage Description
#1	3,378.12'	11.199 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

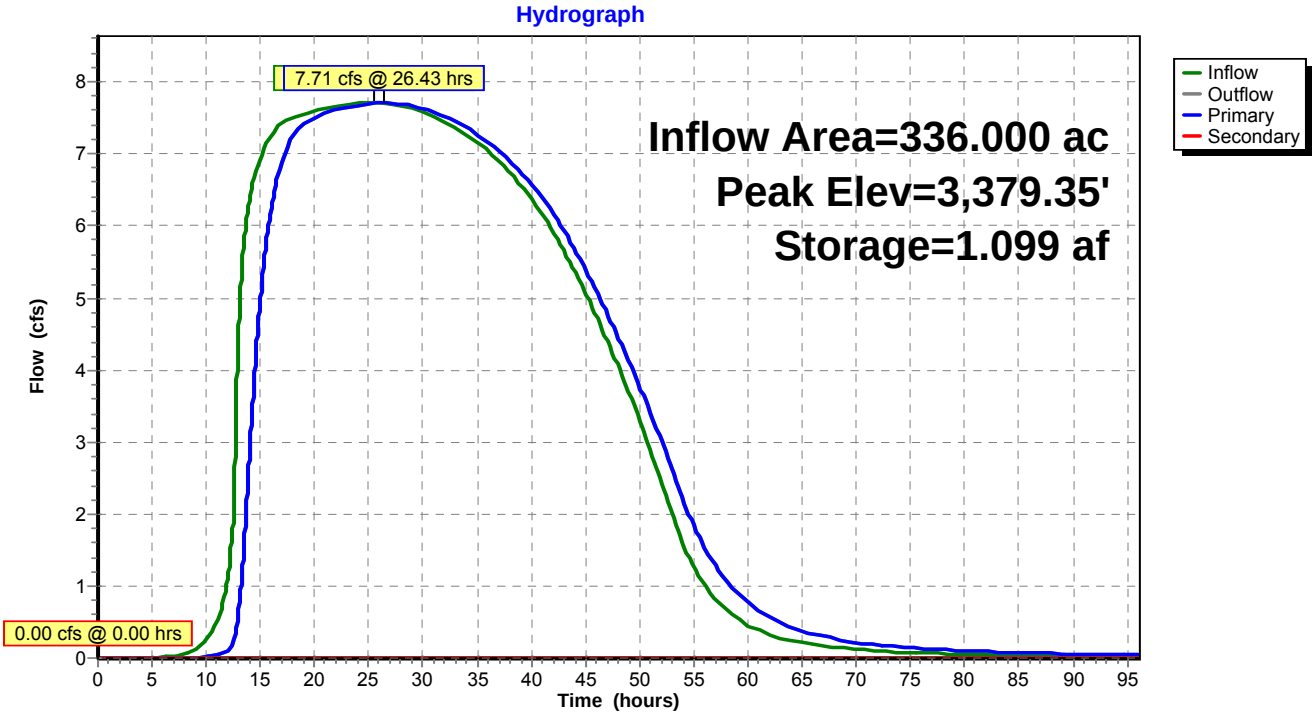
Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
3,378.12	0.880	1,462.0	0.000	0.000	0.880
3,379.00	0.880	1,462.0	0.774	0.774	0.910
3,380.00	1.080	1,574.0	0.978	1.753	1.532
3,381.00	1.190	1,649.0	1.135	2.887	1.975
3,382.00	1.300	1,687.0	1.245	4.132	2.210
3,383.00	1.400	1,720.0	1.350	5.482	2.419
3,384.00	1.500	1,752.0	1.450	6.931	2.626
3,385.00	1.600	1,765.0	1.550	8.481	2.718
3,385.50	1.660	1,780.0	0.815	9.296	2.818
3,386.61	1.770	1,815.0	1.903	11.199	3.052

Device	Routing	Invert	Outlet Devices
#1	Secondary	3,384.20'	**72.3' long x 0.7' 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 Coef. (English) 2.76 2.82 2.93 3.09 3.18 3.22 3.27 3.30 3.32 3.31 3.32
#2	Primary	3,378.12'	**24.0" Round Culvert** L= 464.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 3,378.12' / 3,362.61' S= 0.0334 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf

Primary OutFlow Max=7.70 cfs @ 26.43 hrs HW=3,379.35' (Free Discharge)
└**2=Culvert** (Inlet Controls 7.70 cfs @ 3.78 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=3,378.12' (Free Discharge)
└**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond Pond C: Pond C



Summary for Pond Pond D: Pond D

Inflow Area = 23.000 ac, 4.35% Impervious, Inflow Depth = 0.23" for 5-Year event
Inflow = 3.26 cfs @ 12.21 hrs, Volume= 0.435 af
Outflow = 2.06 cfs @ 12.42 hrs, Volume= 0.435 af, Atten= 37%, Lag= 12.6 min
Primary = 2.06 cfs @ 12.42 hrs, Volume= 0.435 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 3,434.43' @ 12.42 hrs Surf.Area= 0.077 ac Storage= 0.024 af
Flood Elev= 3,443.00' Surf.Area= 0.850 ac Storage= 3.671 af

Plug-Flow detention time= 1.8 min calculated for 0.435 af (100% of inflow)
Center-of-Mass det. time= 1.8 min (940.2 - 938.4)

Volume	Invert	Avail.Storage	Storage Description
#1	3,433.00'	3.671 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

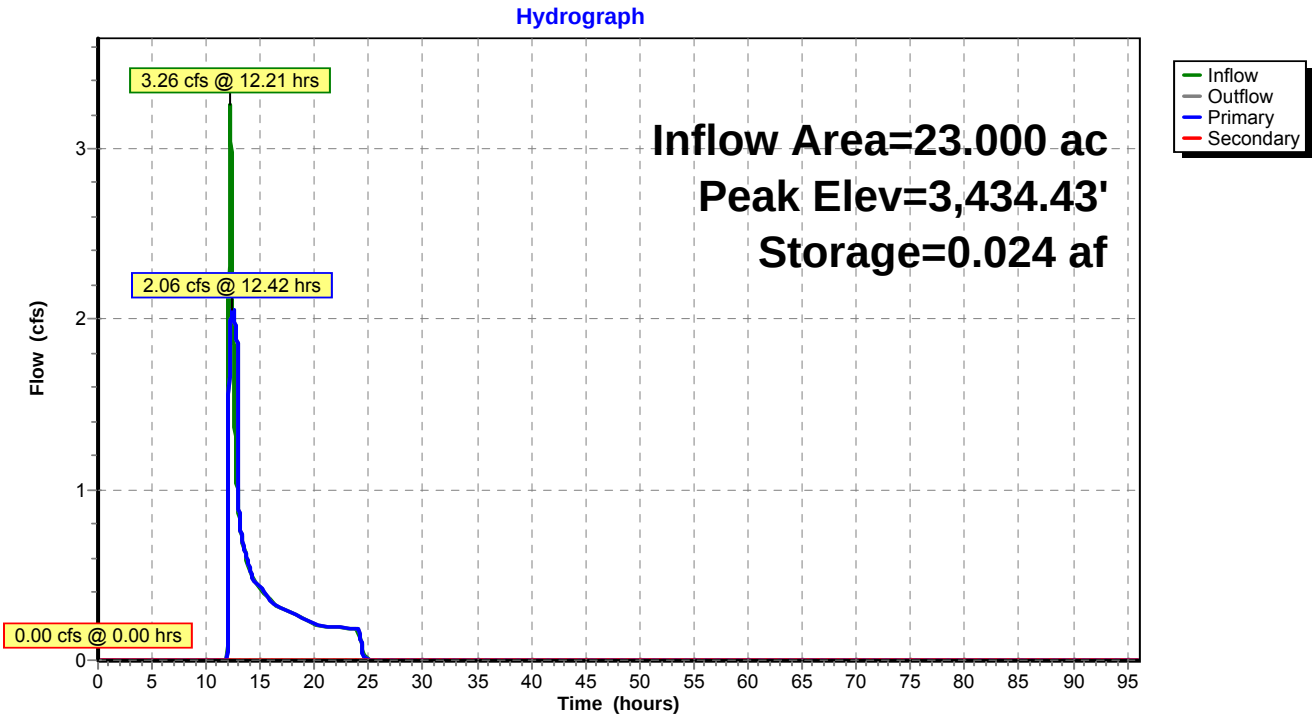
Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
3,433.00	0.000	0.0	0.000	0.000	0.000
3,433.50	0.001	44.0	0.000	0.000	0.004
3,434.00	0.020	127.0	0.004	0.004	0.029
3,434.50	0.090	260.0	0.025	0.030	0.124
3,435.00	0.170	370.0	0.064	0.094	0.250
3,435.50	0.260	434.0	0.107	0.200	0.344
3,436.00	0.310	481.0	0.142	0.343	0.423
3,436.50	0.340	529.0	0.162	0.505	0.512
3,437.00	0.360	540.0	0.175	0.680	0.534
3,437.50	0.380	556.0	0.185	0.865	0.567
3,438.00	0.400	585.0	0.195	1.060	0.628
3,438.50	0.420	590.0	0.205	1.265	0.640
3,439.00	0.440	598.0	0.215	1.480	0.659
3,439.50	0.460	613.0	0.225	1.705	0.693
3,440.00	0.480	639.0	0.235	1.940	0.753
3,440.50	0.510	666.0	0.247	2.188	0.818
3,441.00	0.530	694.0	0.260	2.448	0.888
3,441.50	0.550	721.0	0.270	2.718	0.958
3,442.00	0.580	755.0	0.282	3.000	1.050
3,442.50	0.630	806.0	0.302	3.302	1.196
3,443.00	0.850	826.0	0.369	3.671	1.256

Device	Routing	Invert	Outlet Devices
#1	Primary	3,433.00'	**10.0" Round Culvert** L= 128.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 3,433.00' / 3,432.13' S= 0.0068 '/' Cc= 0.900 n= 0.013 Cast iron, coated, Flow Area= 0.55 sf
#2	Secondary	3,438.31'	**60.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=2.06 cfs @ 12.42 hrs HW=3,434.43' (Free Discharge)
└**1=Culvert** (Barrel Controls 2.06 cfs @ 3.78 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=3,433.00' (Free Discharge)
└**2=Orifice/Grate** (Controls 0.00 cfs)

Pond Pond D: Pond D



Summary for Pond Pond E: Pond E

[79] Warning: Submerged Pond 404 Primary device # 1 OUTLET by 1.41'

Inflow Area = 255.000 ac, 25.49% Impervious, Inflow Depth = 0.42" for 5-Year event
Inflow = 60.00 cfs @ 12.37 hrs, Volume= 8.935 af
Outflow = 22.25 cfs @ 13.03 hrs, Volume= 8.935 af, Atten= 63%, Lag= 39.6 min
Primary = 22.25 cfs @ 13.03 hrs, Volume= 8.935 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 3,539.86' @ 13.03 hrs Surf.Area= 1.541 ac Storage= 2.042 af
Flood Elev= 3,545.65' Surf.Area= 1.951 ac Storage= 12.146 af

Plug-Flow detention time= 30.4 min calculated for 8.934 af (100% of inflow)
Center-of-Mass det. time= 30.4 min (936.2 - 905.8)

Volume	Invert	Avail.Storage	Storage Description
#1	3,536.70'	15.883 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
3,536.70	0.000	0.0	0.000	0.000	0.000
3,537.50	0.020	12.0	0.005	0.005	0.000
3,538.00	0.060	271.0	0.019	0.024	0.134
3,538.50	0.900	814.0	0.199	0.223	1.211
3,539.00	1.350	996.0	0.559	0.782	1.812
3,539.50	1.490	1,032.0	0.710	1.492	1.946
3,540.00	1.560	1,070.0	0.762	2.254	2.093
3,540.50	1.590	1,083.0	0.787	3.042	2.145
3,541.00	1.620	1,098.0	0.802	3.844	2.206
3,541.50	1.660	1,111.0	0.820	4.664	2.260
3,542.00	1.690	1,122.0	0.837	5.501	2.307
3,542.50	1.730	1,134.0	0.855	6.356	2.358
3,543.00	1.760	1,146.0	0.872	7.229	2.410
3,543.50	1.800	1,158.0	0.890	8.119	2.462
3,544.00	1.830	1,169.0	0.907	9.026	2.511
3,544.50	1.870	1,180.0	0.925	9.951	2.560
3,545.00	1.900	1,191.0	0.942	10.894	2.609
3,545.50	1.940	1,202.0	0.960	11.854	2.659
3,547.50	2.090	1,244.0	4.029	15.883	2.855

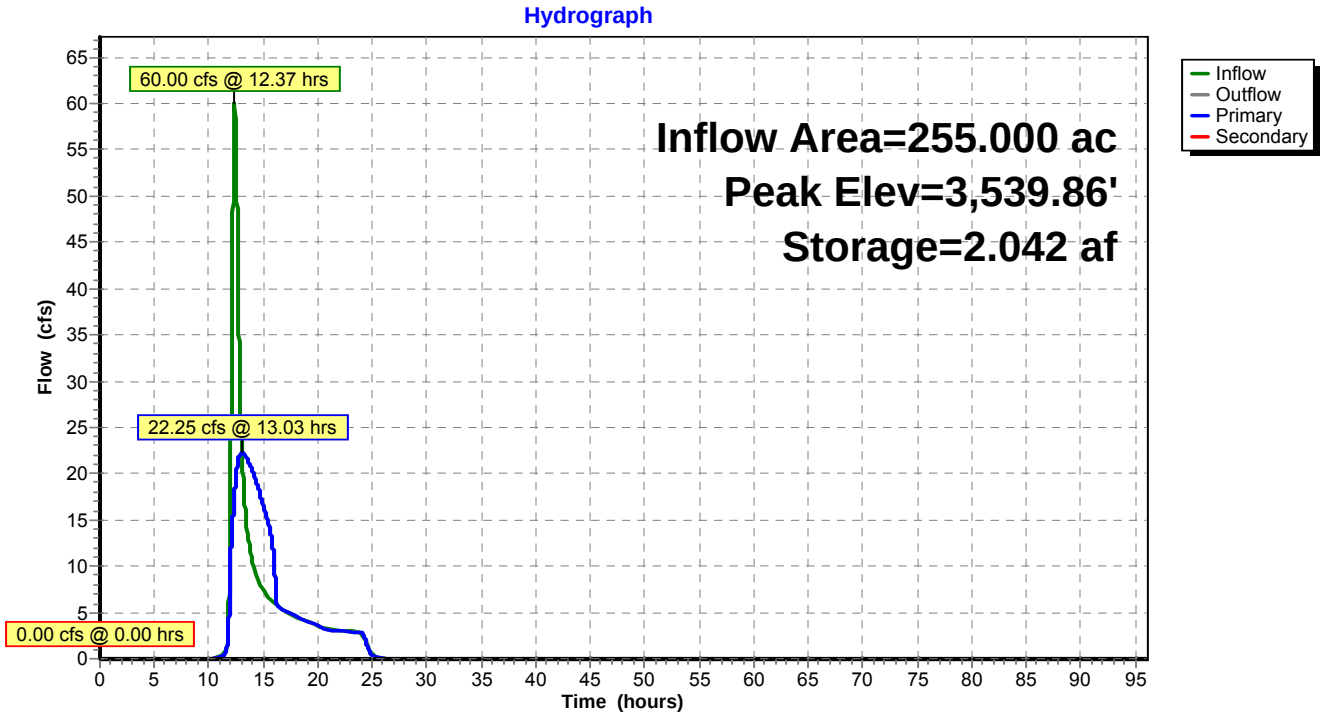
Device	Routing	Invert	Outlet Devices
#1	Primary	3,536.70'	**24.0" Round Culvert** L= 177.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 3,536.70' / 3,526.41' S= 0.0581 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#2	Secondary	3,545.65'	**71.0' long x 1.0' breadth 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=22.25 cfs @ 13.03 hrs HW=3,539.86' (Free Discharge)
└**1=Culvert** (Inlet Controls 22.25 cfs @ 7.08 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=3,536.70' (Free Discharge)
└**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond Pond E: Pond E



10-YEAR, 24-HOUR STORM

MORRISON-MAIERLE, INC.

Summary for Pond Pond A: Pond A

[79] Warning: Submerged Pond 107 Primary device # 1 OUTLET by 1.53'

Inflow Area = 336.000 ac, 52.98% Impervious, Inflow Depth = 1.02" for 10-Year event
Inflow = 229.76 cfs @ 12.06 hrs, Volume= 28.453 af
Outflow = 103.41 cfs @ 12.56 hrs, Volume= 28.423 af, Atten= 55%, Lag= 29.7 min
Primary = 8.99 cfs @ 12.56 hrs, Volume= 18.547 af
Secondary = 94.42 cfs @ 12.56 hrs, Volume= 9.875 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 3,398.71' @ 12.56 hrs Surf.Area= 2.004 ac Storage= 11.075 af
Flood Elev= 3,400.49' Surf.Area= 2.160 ac Storage= 14.769 af

Plug-Flow detention time= 454.5 min calculated for 28.423 af (100% of inflow)
Center-of-Mass det. time= 453.8 min (1,288.8 - 834.9)

Volume	Invert	Avail.Storage	Storage Description
#1	3,392.02'	14.769 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

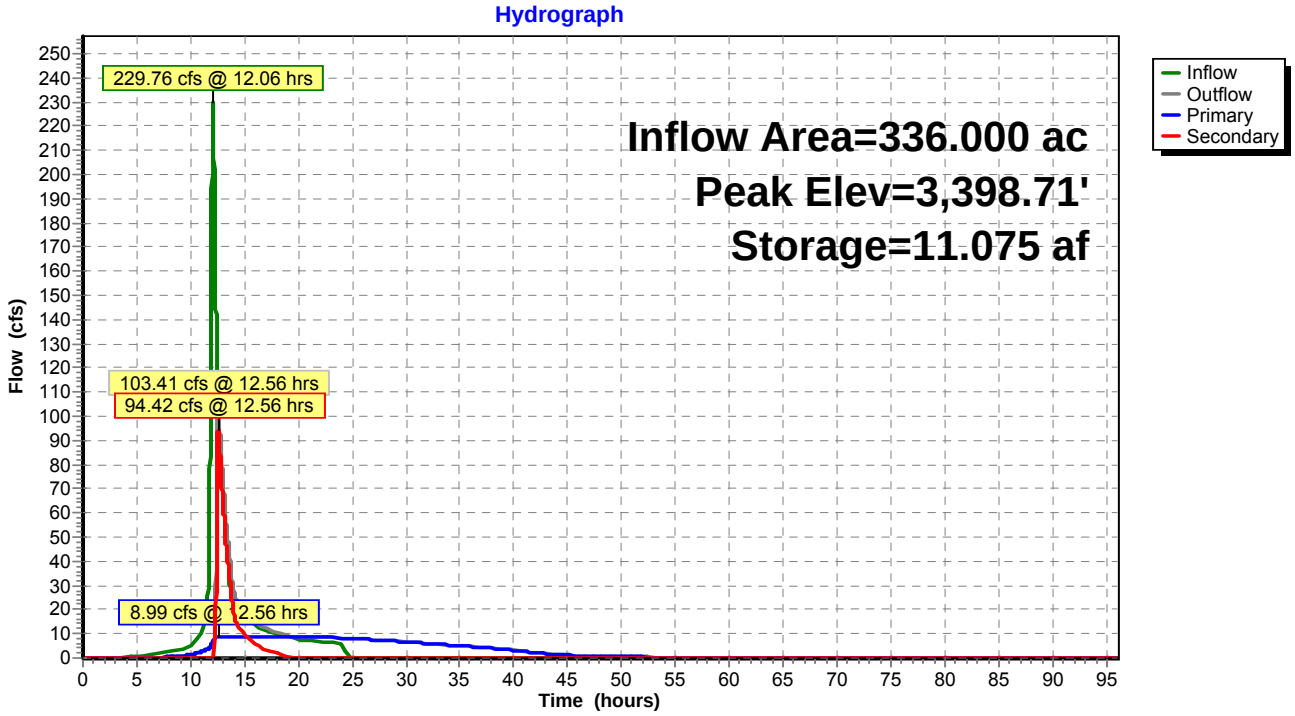
Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
3,392.02	1.210	1,096.0	0.000	0.000	1.210
3,393.00	1.210	1,096.0	1.186	1.186	1.235
3,394.00	1.590	1,124.0	1.396	2.581	1.351
3,395.00	1.690	1,158.0	1.640	4.221	1.495
3,396.00	1.770	1,190.0	1.730	5.951	1.635
3,397.00	1.860	1,223.0	1.815	7.766	1.783
3,398.00	1.940	1,252.0	1.900	9.666	1.917
3,399.00	2.030	1,280.0	1.985	11.651	2.050
3,399.50	2.070	1,295.0	1.025	12.676	2.122
3,400.49	2.160	1,322.0	2.094	14.769	2.255

Device	Routing	Invert	Outlet Devices
#1	Secondary	3,398.10'	**71.0' 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
#2	Primary	3,392.02'	**9.0" W x 12.0" H Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=8.99 cfs @ 12.56 hrs HW=3,398.71' (Free Discharge)
↑—**2=Orifice/Grate** (Orifice Controls 8.99 cfs @ 11.98 fps)

Secondary OutFlow Max=94.37 cfs @ 12.56 hrs HW=3,398.71' (Free Discharge)
↑—**1=Broad-Crested Rectangular Weir** (Weir Controls 94.37 cfs @ 2.16 fps)

Pond Pond A: Pond A



Summary for Pond Pond B: Pond B

Inflow Area = 336.000 ac, 52.98% Impervious, Inflow Depth > 1.02" for 10-Year event
Inflow = 103.41 cfs @ 12.56 hrs, Volume= 28.423 af
Outflow = 22.48 cfs @ 14.36 hrs, Volume= 28.403 af, Atten= 78%, Lag= 107.9 min
Primary = 8.60 cfs @ 14.36 hrs, Volume= 25.701 af
Secondary = 13.88 cfs @ 14.36 hrs, Volume= 2.703 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 3,391.17' @ 14.36 hrs Surf.Area= 1.735 ac Storage= 8.445 af
Flood Elev= 3,393.58' Surf.Area= 1.960 ac Storage= 12.890 af

Plug-Flow detention time= 534.3 min calculated for 28.400 af (100% of inflow)
Center-of-Mass det. time= 531.5 min (1,820.3 - 1,288.8)

Volume	Invert	Avail.Storage	Storage Description
#1	3,385.00'	12.890 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

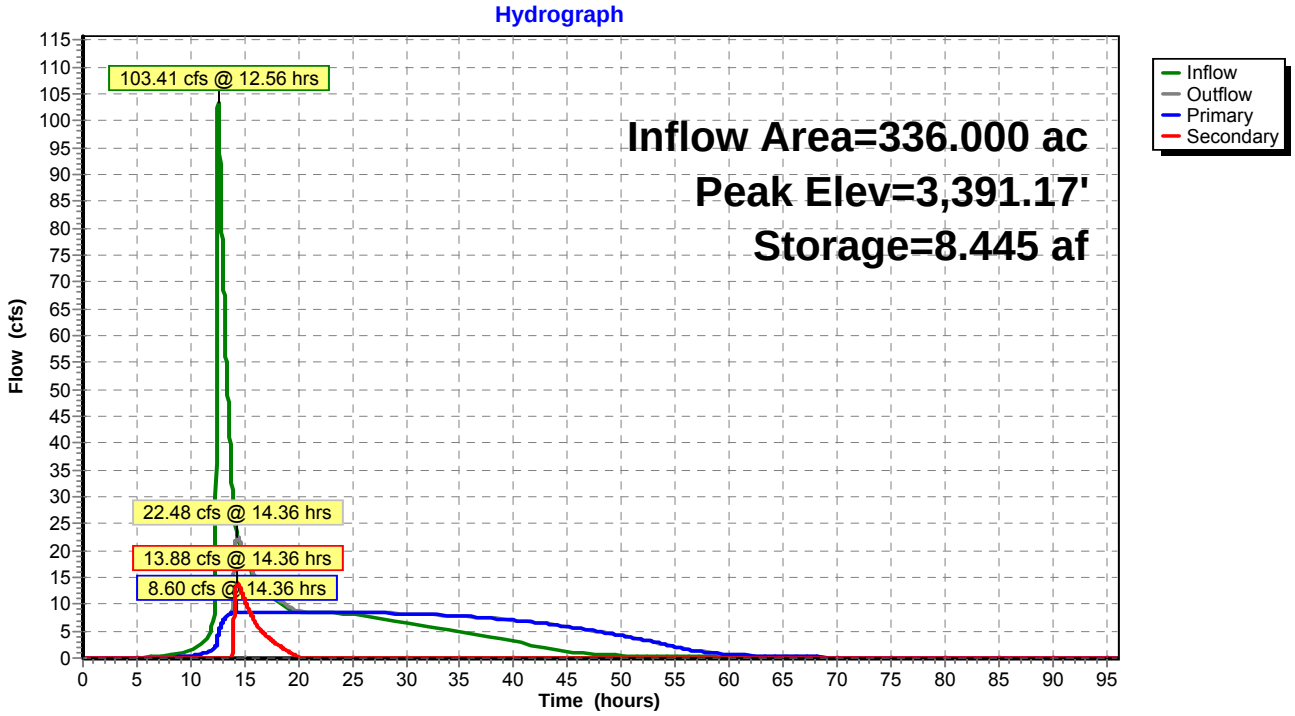
Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
3,385.00	0.450	906.0	0.000	0.000	0.450
3,386.00	1.160	1,554.0	0.777	0.777	3.362
3,387.00	1.340	1,542.0	1.249	2.026	3.439
3,388.00	1.440	1,585.0	1.390	3.416	3.687
3,389.00	1.530	1,614.0	1.485	4.901	3.861
3,390.00	1.620	1,644.0	1.575	6.476	4.043
3,391.00	1.720	1,671.0	1.670	8.145	4.211
3,392.00	1.810	1,701.0	1.765	9.910	4.400
3,392.50	1.860	1,718.0	0.917	10.828	4.508
3,393.58	1.960	1,752.0	2.063	12.890	4.727

Device	Routing	Invert	Outlet Devices
#1	Secondary	3,391.00'	**71.0' 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
#2	Primary	3,385.00'	**9.0" W x 12.0" H Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=8.60 cfs @ 14.36 hrs HW=3,391.17' (Free Discharge)
↑—**2=Orifice/Grate** (Orifice Controls 8.60 cfs @ 11.47 fps)

Secondary OutFlow Max=13.82 cfs @ 14.36 hrs HW=3,391.17' (Free Discharge)
↑—**1=Broad-Crested Rectangular Weir** (Weir Controls 13.82 cfs @ 1.12 fps)

Pond Pond B: Pond B



Summary for Pond Pond C: Pond C

Inflow Area = 336.000 ac, 52.98% Impervious, Inflow Depth > 1.01" for 10-Year event
Inflow = 22.48 cfs @ 14.36 hrs, Volume= 28.403 af
Outflow = 15.32 cfs @ 15.95 hrs, Volume= 28.330 af, Atten= 32%, Lag= 95.5 min
Primary = 15.32 cfs @ 15.95 hrs, Volume= 28.330 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 3,380.14' @ 15.95 hrs Surf.Area= 1.096 ac Storage= 1.910 af
Flood Elev= 3,386.61' Surf.Area= 1.770 ac Storage= 11.199 af

Plug-Flow detention time= 114.0 min calculated for 28.330 af (100% of inflow)
Center-of-Mass det. time= 105.5 min (1,925.8 - 1,820.3)

Volume	Invert	Avail.Storage	Storage Description
#1	3,378.12'	11.199 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

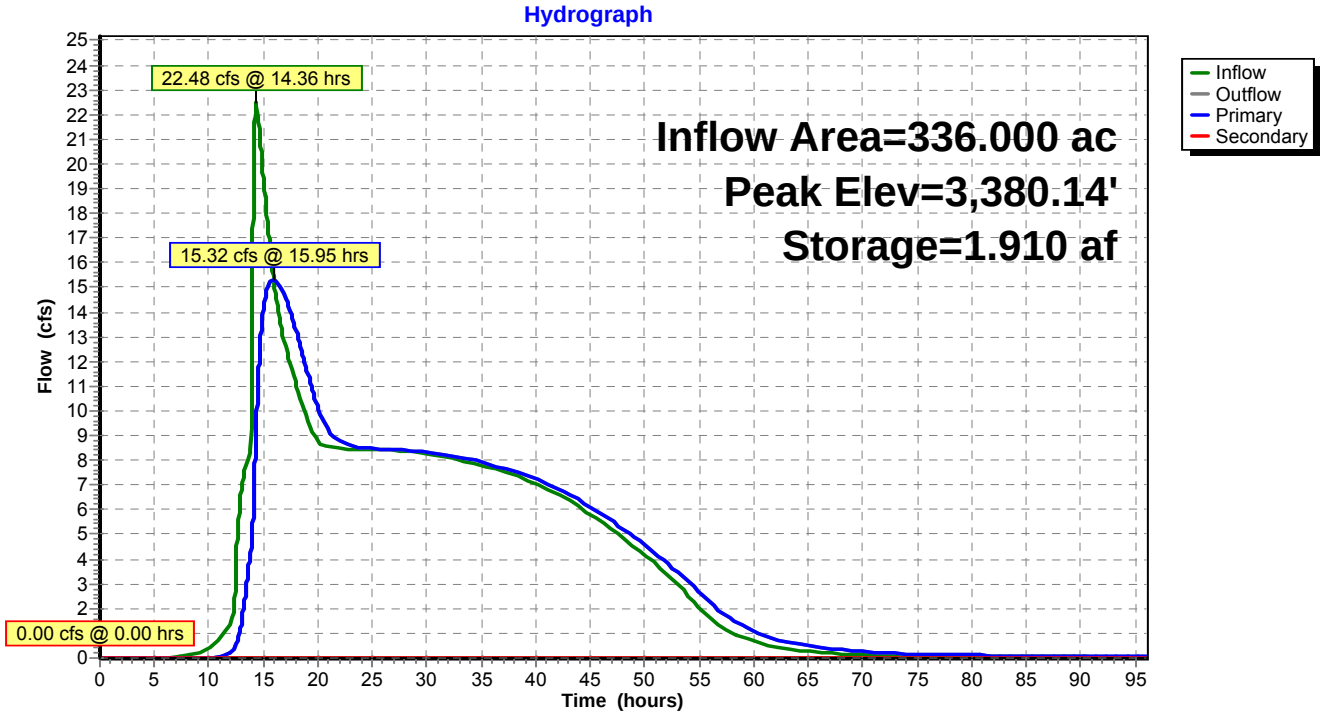
Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
3,378.12	0.880	1,462.0	0.000	0.000	0.880
3,379.00	0.880	1,462.0	0.774	0.774	0.910
3,380.00	1.080	1,574.0	0.978	1.753	1.532
3,381.00	1.190	1,649.0	1.135	2.887	1.975
3,382.00	1.300	1,687.0	1.245	4.132	2.210
3,383.00	1.400	1,720.0	1.350	5.482	2.419
3,384.00	1.500	1,752.0	1.450	6.931	2.626
3,385.00	1.600	1,765.0	1.550	8.481	2.718
3,385.50	1.660	1,780.0	0.815	9.296	2.818
3,386.61	1.770	1,815.0	1.903	11.199	3.052

Device	Routing	Invert	Outlet Devices
#1	Secondary	3,384.20'	**72.3' long x 0.7' 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 Coef. (English) 2.76 2.82 2.93 3.09 3.18 3.22 3.27 3.30 3.32 3.31 3.32
#2	Primary	3,378.12'	**24.0" Round Culvert** L= 464.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 3,378.12' / 3,362.61' S= 0.0334 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf

Primary OutFlow Max=15.31 cfs @ 15.95 hrs HW=3,380.14' (Free Discharge)
└**2=Culvert** (Inlet Controls 15.31 cfs @ 4.87 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=3,378.12' (Free Discharge)
└**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond Pond C: Pond C



Summary for Pond Pond D: Pond D

Inflow Area = 23.000 ac, 4.35% Impervious, Inflow Depth = 0.35" for 10-Year event
Inflow = 6.14 cfs @ 12.19 hrs, Volume= 0.671 af
Outflow = 2.43 cfs @ 12.57 hrs, Volume= 0.671 af, Atten= 60%, Lag= 22.8 min
Primary = 2.43 cfs @ 12.57 hrs, Volume= 0.671 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 3,435.01' @ 12.57 hrs Surf.Area= 0.172 ac Storage= 0.096 af
Flood Elev= 3,443.00' Surf.Area= 0.850 ac Storage= 3.671 af

Plug-Flow detention time= 8.9 min calculated for 0.671 af (100% of inflow)
Center-of-Mass det. time= 8.9 min (927.2 - 918.3)

Volume	Invert	Avail.Storage	Storage Description
#1	3,433.00'	3.671 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

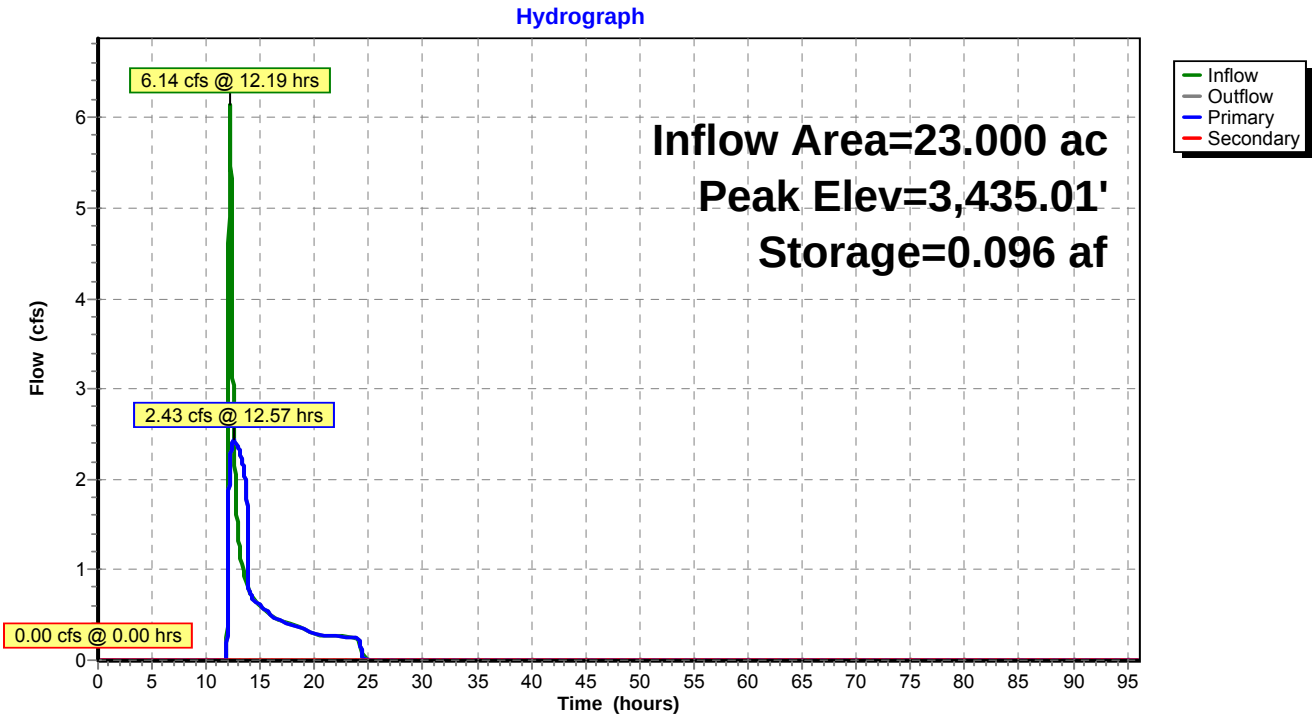
Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
3,433.00	0.000	0.0	0.000	0.000	0.000
3,433.50	0.001	44.0	0.000	0.000	0.004
3,434.00	0.020	127.0	0.004	0.004	0.029
3,434.50	0.090	260.0	0.025	0.030	0.124
3,435.00	0.170	370.0	0.064	0.094	0.250
3,435.50	0.260	434.0	0.107	0.200	0.344
3,436.00	0.310	481.0	0.142	0.343	0.423
3,436.50	0.340	529.0	0.162	0.505	0.512
3,437.00	0.360	540.0	0.175	0.680	0.534
3,437.50	0.380	556.0	0.185	0.865	0.567
3,438.00	0.400	585.0	0.195	1.060	0.628
3,438.50	0.420	590.0	0.205	1.265	0.640
3,439.00	0.440	598.0	0.215	1.480	0.659
3,439.50	0.460	613.0	0.225	1.705	0.693
3,440.00	0.480	639.0	0.235	1.940	0.753
3,440.50	0.510	666.0	0.247	2.188	0.818
3,441.00	0.530	694.0	0.260	2.448	0.888
3,441.50	0.550	721.0	0.270	2.718	0.958
3,442.00	0.580	755.0	0.282	3.000	1.050
3,442.50	0.630	806.0	0.302	3.302	1.196
3,443.00	0.850	826.0	0.369	3.671	1.256

Device	Routing	Invert	Outlet Devices
#1	Primary	3,433.00'	**10.0" Round Culvert** L= 128.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 3,433.00' / 3,432.13' S= 0.0068 '/' Cc= 0.900 n= 0.013 Cast iron, coated, Flow Area= 0.55 sf
#2	Secondary	3,438.31'	**60.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=2.43 cfs @ 12.57 hrs HW=3,435.01' (Free Discharge)
└**1=Culvert** (Barrel Controls 2.43 cfs @ 4.46 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=3,433.00' (Free Discharge)
└**2=Orifice/Grate** (Controls 0.00 cfs)

Pond Pond D: Pond D



Summary for Pond Pond E: Pond E

[79] Warning: Submerged Pond 404 Primary device # 1 INLET by 0.52'

Inflow Area = 255.000 ac, 25.49% Impervious, Inflow Depth = 0.59" for 10-Year event
Inflow = 90.01 cfs @ 12.34 hrs, Volume= 12.452 af
Outflow = 26.77 cfs @ 13.13 hrs, Volume= 12.452 af, Atten= 70%, Lag= 47.3 min
Primary = 26.77 cfs @ 13.13 hrs, Volume= 12.452 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 3,540.83' @ 13.13 hrs Surf.Area= 1.610 ac Storage= 3.573 af
Flood Elev= 3,545.65' Surf.Area= 1.951 ac Storage= 12.146 af

Plug-Flow detention time= 50.0 min calculated for 12.452 af (100% of inflow)
Center-of-Mass det. time= 50.0 min (944.6 - 894.6)

Volume	Invert	Avail.Storage	Storage Description
#1	3,536.70'	15.883 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
3,536.70	0.000	0.0	0.000	0.000	0.000
3,537.50	0.020	12.0	0.005	0.005	0.000
3,538.00	0.060	271.0	0.019	0.024	0.134
3,538.50	0.900	814.0	0.199	0.223	1.211
3,539.00	1.350	996.0	0.559	0.782	1.812
3,539.50	1.490	1,032.0	0.710	1.492	1.946
3,540.00	1.560	1,070.0	0.762	2.254	2.093
3,540.50	1.590	1,083.0	0.787	3.042	2.145
3,541.00	1.620	1,098.0	0.802	3.844	2.206
3,541.50	1.660	1,111.0	0.820	4.664	2.260
3,542.00	1.690	1,122.0	0.837	5.501	2.307
3,542.50	1.730	1,134.0	0.855	6.356	2.358
3,543.00	1.760	1,146.0	0.872	7.229	2.410
3,543.50	1.800	1,158.0	0.890	8.119	2.462
3,544.00	1.830	1,169.0	0.907	9.026	2.511
3,544.50	1.870	1,180.0	0.925	9.951	2.560
3,545.00	1.900	1,191.0	0.942	10.894	2.609
3,545.50	1.940	1,202.0	0.960	11.854	2.659
3,547.50	2.090	1,244.0	4.029	15.883	2.855

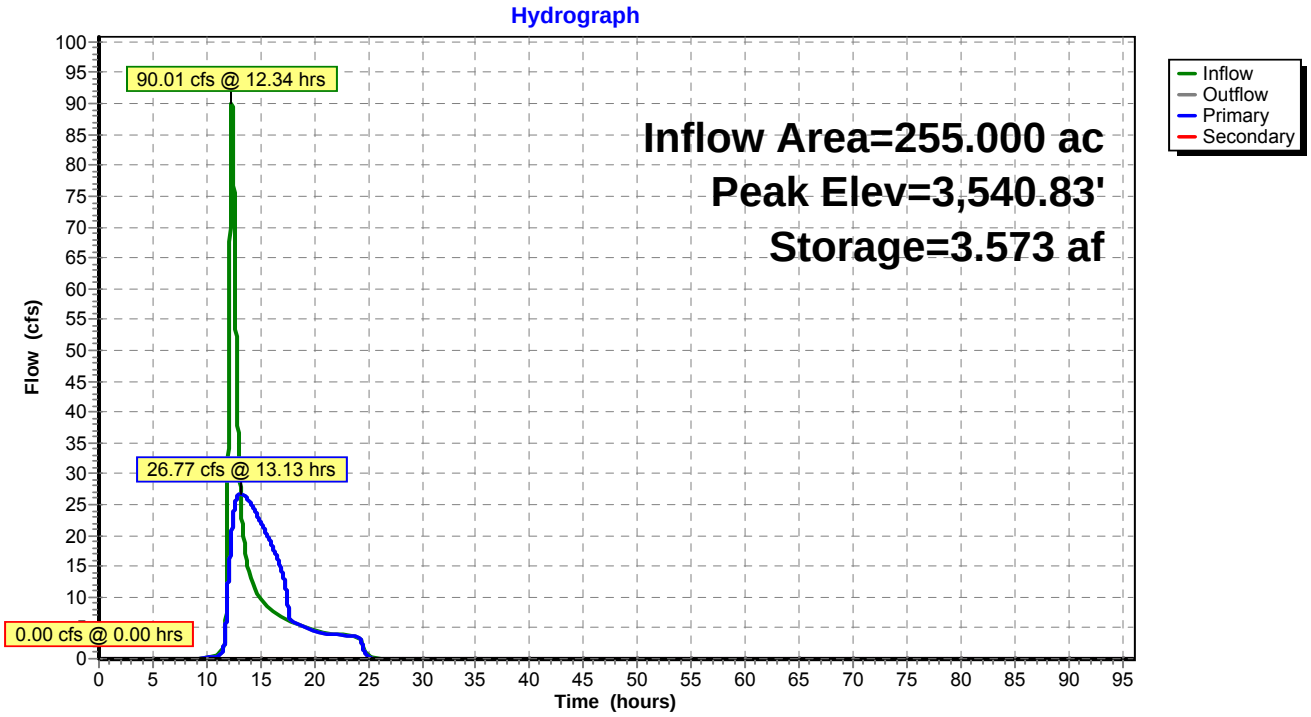
Device	Routing	Invert	Outlet Devices
#1	Primary	3,536.70'	**24.0" Round Culvert** L= 177.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 3,536.70' / 3,526.41' S= 0.0581 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#2	Secondary	3,545.65'	**71.0' long x 1.0' breadth 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=26.77 cfs @ 13.13 hrs HW=3,540.83' (Free Discharge)
└**1=Culvert** (Inlet Controls 26.77 cfs @ 8.52 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=3,536.70' (Free Discharge)
└**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond Pond E: Pond E



25-YEAR, 24-HOUR STORM

MORRISON-MAIERLE, INC.

Summary for Pond Pond A: Pond A

[79] Warning: Submerged Pond 107 Primary device # 1 OUTLET by 1.83'

Inflow Area = 336.000 ac, 52.98% Impervious, Inflow Depth = 1.40" for 25-Year event
Inflow = 255.26 cfs @ 12.04 hrs, Volume= 39.265 af
Outflow = 188.19 cfs @ 12.39 hrs, Volume= 39.233 af, Atten= 26%, Lag= 21.2 min
Primary = 9.20 cfs @ 12.39 hrs, Volume= 19.573 af
Secondary = 179.00 cfs @ 12.39 hrs, Volume= 19.660 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 3,399.01' @ 12.39 hrs Surf.Area= 2.031 ac Storage= 11.664 af
Flood Elev= 3,400.49' Surf.Area= 2.160 ac Storage= 14.769 af

Plug-Flow detention time= 350.1 min calculated for 39.229 af (100% of inflow)
Center-of-Mass det. time= 350.0 min (1,186.1 - 836.1)

Volume	Invert	Avail.Storage	Storage Description
#1	3,392.02'	14.769 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

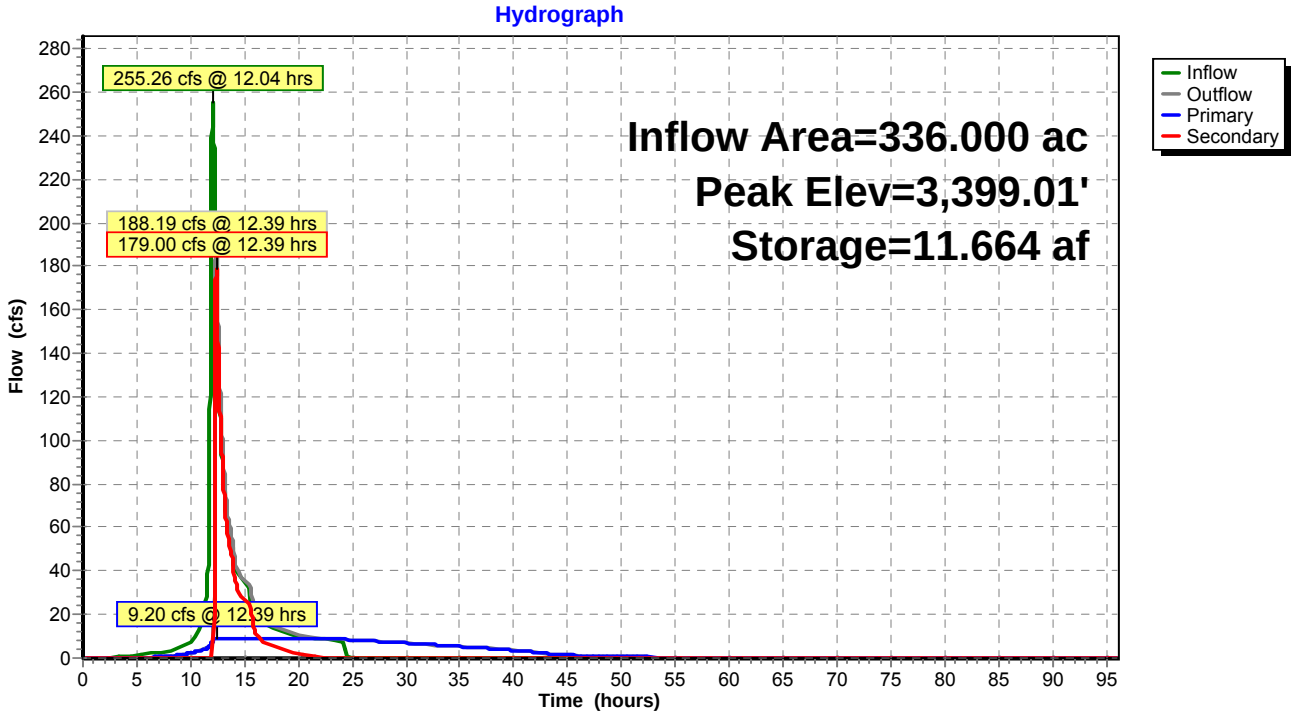
Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
3,392.02	1.210	1,096.0	0.000	0.000	1.210
3,393.00	1.210	1,096.0	1.186	1.186	1.235
3,394.00	1.590	1,124.0	1.396	2.581	1.351
3,395.00	1.690	1,158.0	1.640	4.221	1.495
3,396.00	1.770	1,190.0	1.730	5.951	1.635
3,397.00	1.860	1,223.0	1.815	7.766	1.783
3,398.00	1.940	1,252.0	1.900	9.666	1.917
3,399.00	2.030	1,280.0	1.985	11.651	2.050
3,399.50	2.070	1,295.0	1.025	12.676	2.122
3,400.49	2.160	1,322.0	2.094	14.769	2.255

Device	Routing	Invert	Outlet Devices
#1	Secondary	3,398.10'	**71.0' 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
#2	Primary	3,392.02'	**9.0" W x 12.0" H Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=9.20 cfs @ 12.39 hrs HW=3,399.01' (Free Discharge)
↑—**2=Orifice/Grate** (Orifice Controls 9.20 cfs @ 12.26 fps)

Secondary OutFlow Max=178.95 cfs @ 12.39 hrs HW=3,399.01' (Free Discharge)
↑—**1=Broad-Crested Rectangular Weir** (Weir Controls 178.95 cfs @ 2.78 fps)

Pond Pond A: Pond A



Summary for Pond Pond B: Pond B

Inflow Area = 336.000 ac, 52.98% Impervious, Inflow Depth = 1.40" for 25-Year event
Inflow = 188.19 cfs @ 12.39 hrs, Volume= 39.233 af
Outflow = 82.99 cfs @ 13.12 hrs, Volume= 39.213 af, Atten= 56%, Lag= 44.1 min
Primary = 8.86 cfs @ 13.12 hrs, Volume= 26.727 af
Secondary = 74.13 cfs @ 13.12 hrs, Volume= 12.486 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 3,391.53' @ 13.12 hrs Surf.Area= 1.767 ac Storage= 9.062 af
Flood Elev= 3,393.58' Surf.Area= 1.960 ac Storage= 12.890 af

Plug-Flow detention time= 407.2 min calculated for 39.213 af (100% of inflow)
Center-of-Mass det. time= 405.1 min (1,591.1 - 1,186.1)

Volume	Invert	Avail.Storage	Storage Description
#1	3,385.00'	12.890 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

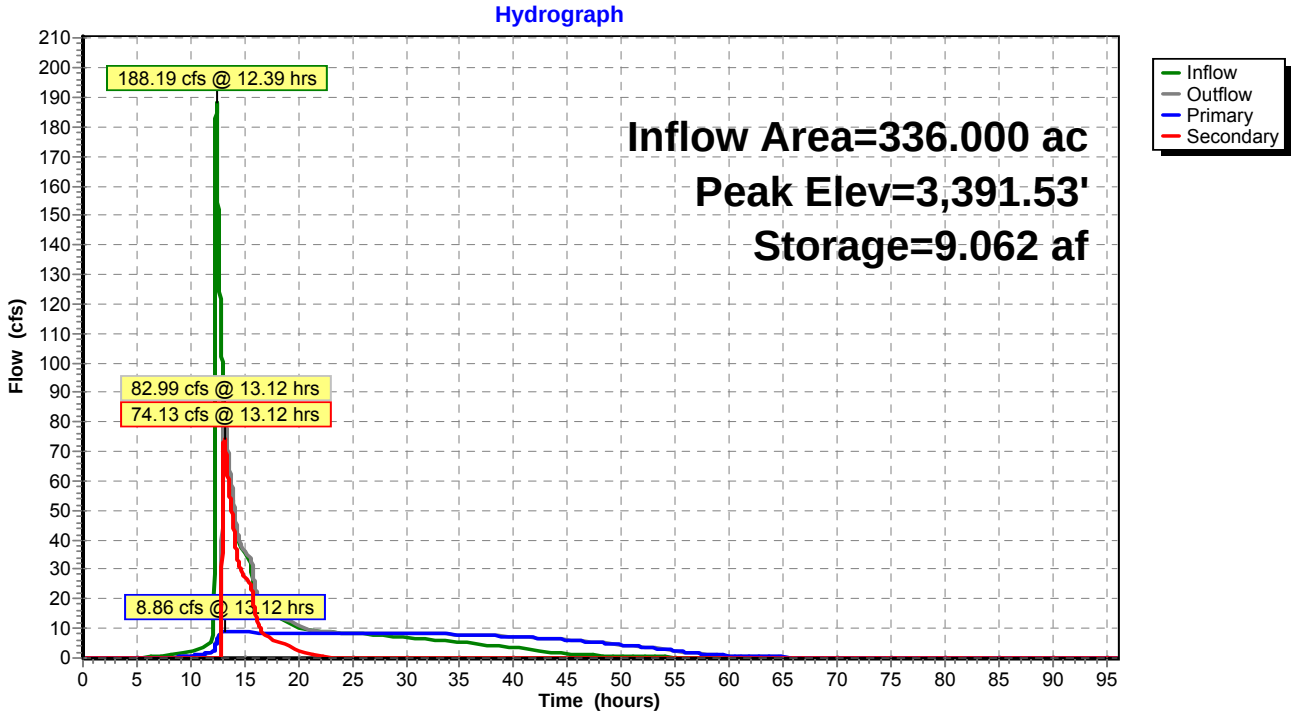
Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
3,385.00	0.450	906.0	0.000	0.000	0.450
3,386.00	1.160	1,554.0	0.777	0.777	3.362
3,387.00	1.340	1,542.0	1.249	2.026	3.439
3,388.00	1.440	1,585.0	1.390	3.416	3.687
3,389.00	1.530	1,614.0	1.485	4.901	3.861
3,390.00	1.620	1,644.0	1.575	6.476	4.043
3,391.00	1.720	1,671.0	1.670	8.145	4.211
3,392.00	1.810	1,701.0	1.765	9.910	4.400
3,392.50	1.860	1,718.0	0.917	10.828	4.508
3,393.58	1.960	1,752.0	2.063	12.890	4.727

Device	Routing	Invert	Outlet Devices
#1	Secondary	3,391.00'	**71.0' 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
#2	Primary	3,385.00'	**9.0" W x 12.0" H Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=8.86 cfs @ 13.12 hrs HW=3,391.53' (Free Discharge)
↑—**2=Orifice/Grate** (Orifice Controls 8.86 cfs @ 11.82 fps)

Secondary OutFlow Max=74.07 cfs @ 13.12 hrs HW=3,391.53' (Free Discharge)
↑—**1=Broad-Crested Rectangular Weir** (Weir Controls 74.07 cfs @ 1.99 fps)

Pond Pond B: Pond B



Summary for Pond Pond C: Pond C

Inflow Area = 336.000 ac, 52.98% Impervious, Inflow Depth > 1.40" for 25-Year event
Inflow = 82.99 cfs @ 13.12 hrs, Volume= 39.213 af
Outflow = 31.46 cfs @ 15.70 hrs, Volume= 39.138 af, Atten= 62%, Lag= 154.6 min
Primary = 31.46 cfs @ 15.70 hrs, Volume= 39.138 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 3,383.44' @ 15.70 hrs Surf.Area= 1.444 ac Storage= 6.113 af
Flood Elev= 3,386.61' Surf.Area= 1.770 ac Storage= 11.199 af

Plug-Flow detention time= 120.2 min calculated for 39.138 af (100% of inflow)
Center-of-Mass det. time= 113.5 min (1,704.6 - 1,591.1)

Volume	Invert	Avail.Storage	Storage Description
#1	3,378.12'	11.199 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

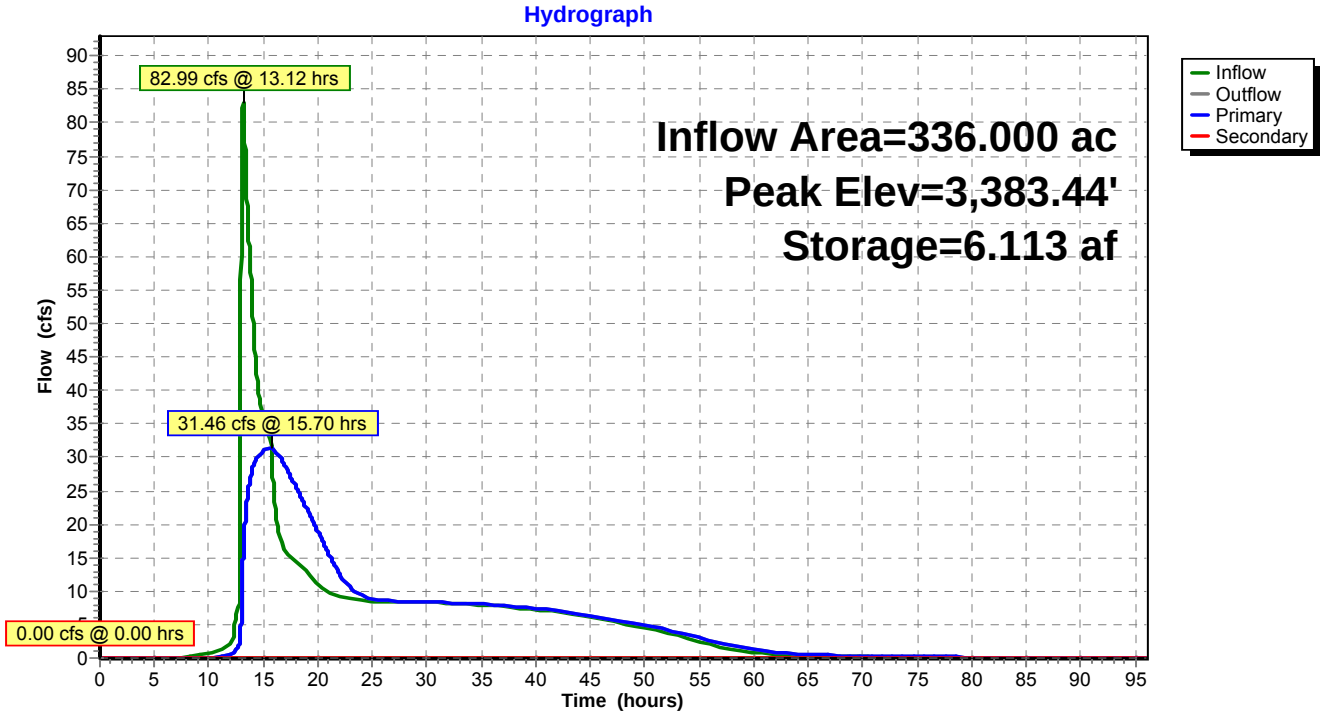
Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
3,378.12	0.880	1,462.0	0.000	0.000	0.880
3,379.00	0.880	1,462.0	0.774	0.774	0.910
3,380.00	1.080	1,574.0	0.978	1.753	1.532
3,381.00	1.190	1,649.0	1.135	2.887	1.975
3,382.00	1.300	1,687.0	1.245	4.132	2.210
3,383.00	1.400	1,720.0	1.350	5.482	2.419
3,384.00	1.500	1,752.0	1.450	6.931	2.626
3,385.00	1.600	1,765.0	1.550	8.481	2.718
3,385.50	1.660	1,780.0	0.815	9.296	2.818
3,386.61	1.770	1,815.0	1.903	11.199	3.052

Device	Routing	Invert	Outlet Devices
#1	Secondary	3,384.20'	**72.3' long x 0.7' 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 Coef. (English) 2.76 2.82 2.93 3.09 3.18 3.22 3.27 3.30 3.32 3.31 3.32
#2	Primary	3,378.12'	**24.0" Round Culvert** L= 464.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 3,378.12' / 3,362.61' S= 0.0334 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf

Primary OutFlow Max=31.46 cfs @ 15.70 hrs HW=3,383.44' (Free Discharge)
└**2=Culvert** (Inlet Controls 31.46 cfs @ 10.01 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=3,378.12' (Free Discharge)
└**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond Pond C: Pond C



Summary for Pond Pond D: Pond D

Inflow Area = 23.000 ac, 4.35% Impervious, Inflow Depth = 0.59" for 25-Year event
Inflow = 12.28 cfs @ 12.17 hrs, Volume= 1.139 af
Outflow = 2.88 cfs @ 12.75 hrs, Volume= 1.139 af, Atten= 77%, Lag= 35.0 min
Primary = 2.88 cfs @ 12.75 hrs, Volume= 1.139 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 3,435.83' @ 12.75 hrs Surf.Area= 0.292 ac Storage= 0.290 af
Flood Elev= 3,443.00' Surf.Area= 0.850 ac Storage= 3.671 af

Plug-Flow detention time= 31.2 min calculated for 1.139 af (100% of inflow)
Center-of-Mass det. time= 31.2 min (928.3 - 897.1)

Volume	Invert	Avail.Storage	Storage Description
#1	3,433.00'	3.671 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

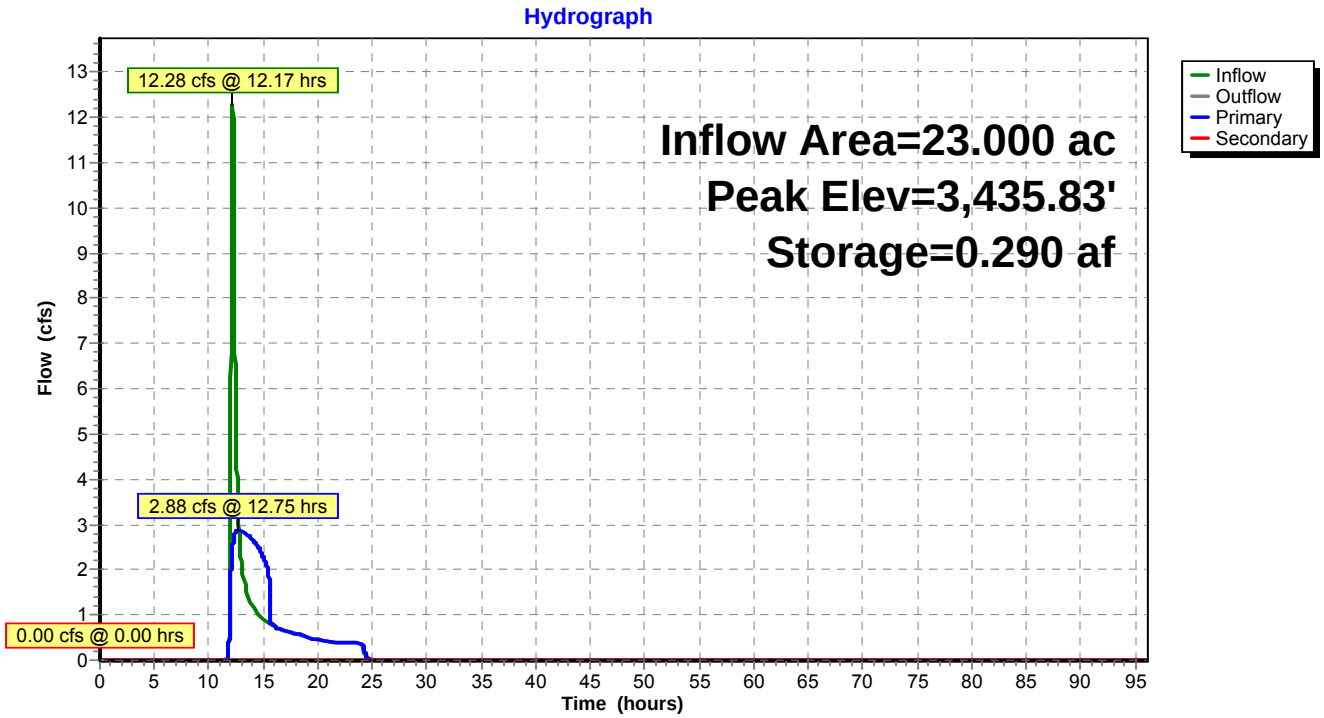
Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
3,433.00	0.000	0.0	0.000	0.000	0.000
3,433.50	0.001	44.0	0.000	0.000	0.004
3,434.00	0.020	127.0	0.004	0.004	0.029
3,434.50	0.090	260.0	0.025	0.030	0.124
3,435.00	0.170	370.0	0.064	0.094	0.250
3,435.50	0.260	434.0	0.107	0.200	0.344
3,436.00	0.310	481.0	0.142	0.343	0.423
3,436.50	0.340	529.0	0.162	0.505	0.512
3,437.00	0.360	540.0	0.175	0.680	0.534
3,437.50	0.380	556.0	0.185	0.865	0.567
3,438.00	0.400	585.0	0.195	1.060	0.628
3,438.50	0.420	590.0	0.205	1.265	0.640
3,439.00	0.440	598.0	0.215	1.480	0.659
3,439.50	0.460	613.0	0.225	1.705	0.693
3,440.00	0.480	639.0	0.235	1.940	0.753
3,440.50	0.510	666.0	0.247	2.188	0.818
3,441.00	0.530	694.0	0.260	2.448	0.888
3,441.50	0.550	721.0	0.270	2.718	0.958
3,442.00	0.580	755.0	0.282	3.000	1.050
3,442.50	0.630	806.0	0.302	3.302	1.196
3,443.00	0.850	826.0	0.369	3.671	1.256

Device	Routing	Invert	Outlet Devices
#1	Primary	3,433.00'	**10.0" Round Culvert** L= 128.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 3,433.00' / 3,432.13' S= 0.0068 '/' Cc= 0.900 n= 0.013 Cast iron, coated, Flow Area= 0.55 sf
#2	Secondary	3,438.31'	**60.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=2.88 cfs @ 12.75 hrs HW=3,435.83' (Free Discharge)
└**1=Culvert** (Barrel Controls 2.88 cfs @ 5.27 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=3,433.00' (Free Discharge)
└**2=Orifice/Grate** (Controls 0.00 cfs)

Pond Pond D: Pond D



Summary for Pond Pond E: Pond E

[81] Warning: Exceeded Pond 404 by 0.49' @ 13.80 hrs

Inflow Area = 255.000 ac, 25.49% Impervious, Inflow Depth = 0.90" for 25-Year event
Inflow = 148.98 cfs @ 12.31 hrs, Volume= 19.046 af
Outflow = 33.88 cfs @ 13.27 hrs, Volume= 19.046 af, Atten= 77%, Lag= 57.5 min
Primary = 33.88 cfs @ 13.27 hrs, Volume= 19.046 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 3,542.72' @ 13.27 hrs Surf.Area= 1.743 ac Storage= 6.731 af
Flood Elev= 3,545.65' Surf.Area= 1.951 ac Storage= 12.146 af

Plug-Flow detention time= 83.9 min calculated for 19.046 af (100% of inflow)
Center-of-Mass det. time= 83.9 min (965.3 - 881.4)

Volume	Invert	Avail.Storage	Storage Description
#1	3,536.70'	15.883 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
3,536.70	0.000	0.0	0.000	0.000	0.000
3,537.50	0.020	12.0	0.005	0.005	0.000
3,538.00	0.060	271.0	0.019	0.024	0.134
3,538.50	0.900	814.0	0.199	0.223	1.211
3,539.00	1.350	996.0	0.559	0.782	1.812
3,539.50	1.490	1,032.0	0.710	1.492	1.946
3,540.00	1.560	1,070.0	0.762	2.254	2.093
3,540.50	1.590	1,083.0	0.787	3.042	2.145
3,541.00	1.620	1,098.0	0.802	3.844	2.206
3,541.50	1.660	1,111.0	0.820	4.664	2.260
3,542.00	1.690	1,122.0	0.837	5.501	2.307
3,542.50	1.730	1,134.0	0.855	6.356	2.358
3,543.00	1.760	1,146.0	0.872	7.229	2.410
3,543.50	1.800	1,158.0	0.890	8.119	2.462
3,544.00	1.830	1,169.0	0.907	9.026	2.511
3,544.50	1.870	1,180.0	0.925	9.951	2.560
3,545.00	1.900	1,191.0	0.942	10.894	2.609
3,545.50	1.940	1,202.0	0.960	11.854	2.659
3,547.50	2.090	1,244.0	4.029	15.883	2.855

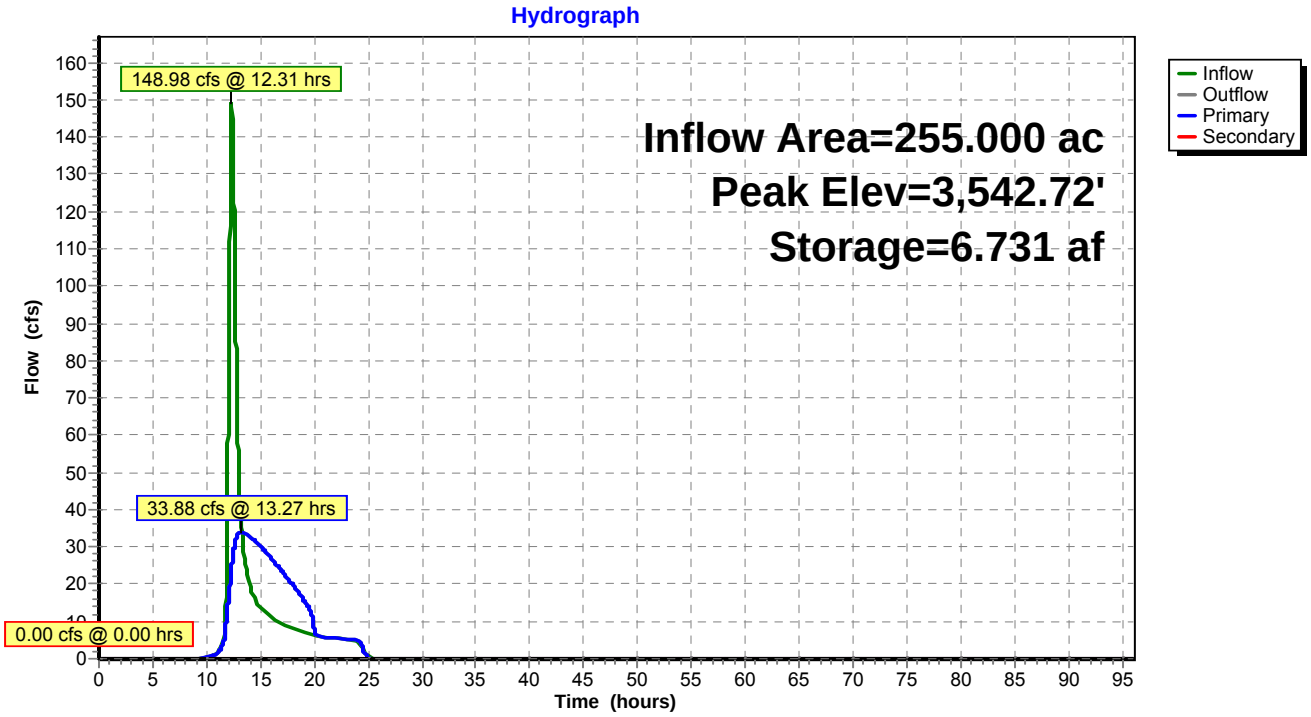
Device	Routing	Invert	Outlet Devices
#1	Primary	3,536.70'	**24.0" Round Culvert** L= 177.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 3,536.70' / 3,526.41' S= 0.0581 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#2	Secondary	3,545.65'	**71.0' long x 1.0' breadth 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=33.88 cfs @ 13.27 hrs HW=3,542.72' (Free Discharge)
└**1=Culvert** (Inlet Controls 33.88 cfs @ 10.78 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=3,536.70' (Free Discharge)
└**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond Pond E: Pond E



50-YEAR, 24-HOUR STORM

MORRISON-MAIERLE, INC.

Summary for Pond Pond A: Pond A

[79] Warning: Submerged Pond 107 Primary device # 1 OUTLET by 1.92'

Inflow Area = 336.000 ac, 52.98% Impervious, Inflow Depth = 1.67" for 50-Year event
Inflow = 273.73 cfs @ 12.03 hrs, Volume= 46.808 af
Outflow = 219.16 cfs @ 12.32 hrs, Volume= 46.776 af, Atten= 20%, Lag= 17.4 min
Primary = 9.26 cfs @ 12.32 hrs, Volume= 19.904 af
Secondary = 209.90 cfs @ 12.32 hrs, Volume= 26.872 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 3,399.10' @ 12.32 hrs Surf.Area= 2.038 ac Storage= 11.844 af
Flood Elev= 3,400.49' Surf.Area= 2.160 ac Storage= 14.769 af

Plug-Flow detention time= 298.9 min calculated for 46.771 af (100% of inflow)
Center-of-Mass det. time= 298.9 min (1,139.0 - 840.1)

Volume	Invert	Avail.Storage	Storage Description
#1	3,392.02'	14.769 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

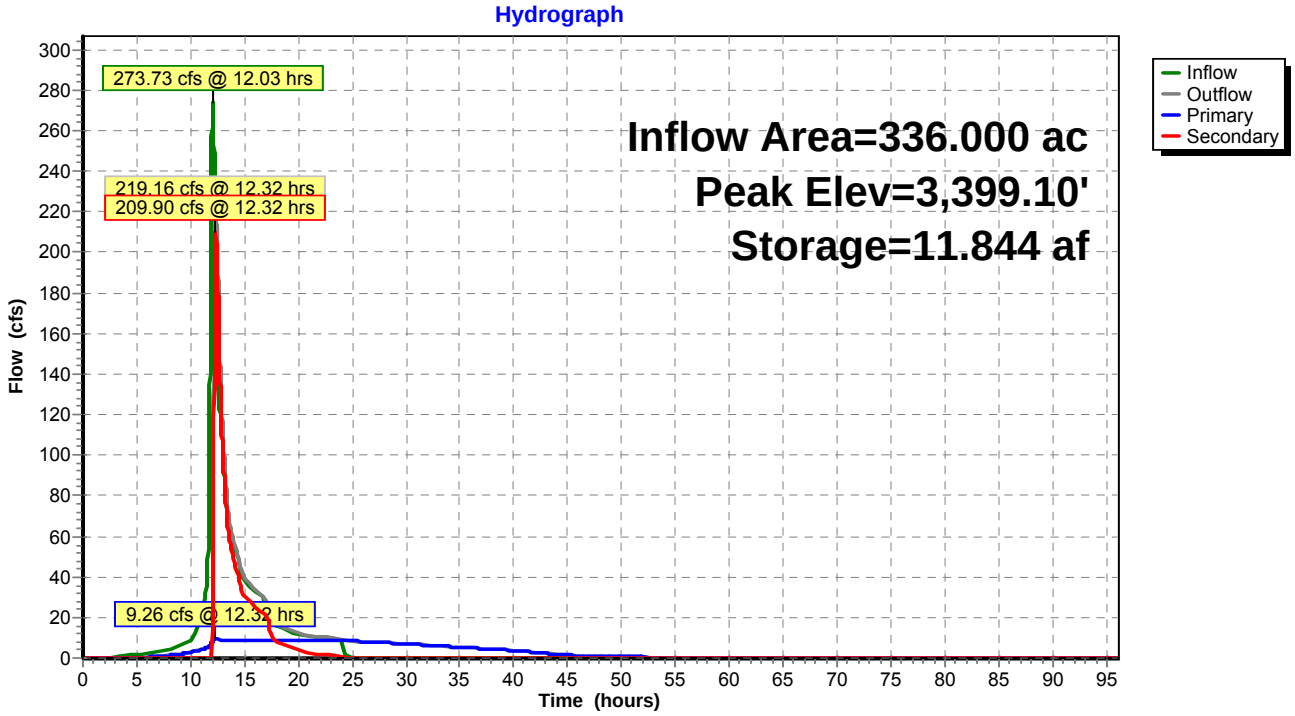
Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
3,392.02	1.210	1,096.0	0.000	0.000	1.210
3,393.00	1.210	1,096.0	1.186	1.186	1.235
3,394.00	1.590	1,124.0	1.396	2.581	1.351
3,395.00	1.690	1,158.0	1.640	4.221	1.495
3,396.00	1.770	1,190.0	1.730	5.951	1.635
3,397.00	1.860	1,223.0	1.815	7.766	1.783
3,398.00	1.940	1,252.0	1.900	9.666	1.917
3,399.00	2.030	1,280.0	1.985	11.651	2.050
3,399.50	2.070	1,295.0	1.025	12.676	2.122
3,400.49	2.160	1,322.0	2.094	14.769	2.255

Device	Routing	Invert	Outlet Devices
#1	Secondary	3,398.10'	**71.0' 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
#2	Primary	3,392.02'	**9.0" W x 12.0" H Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=9.26 cfs @ 12.32 hrs HW=3,399.10' (Free Discharge)
└**2=Orifice/Grate** (Orifice Controls 9.26 cfs @ 12.34 fps)

Secondary OutFlow Max=209.82 cfs @ 12.32 hrs HW=3,399.10' (Free Discharge)
└**1=Broad-Crested Rectangular Weir** (Weir Controls 209.82 cfs @ 2.97 fps)

Pond Pond A: Pond A



Summary for Pond Pond B: Pond B

Inflow Area = 336.000 ac, 52.98% Impervious, Inflow Depth = 1.67" for 50-Year event
Inflow = 219.16 cfs @ 12.32 hrs, Volume= 46.776 af
Outflow = 123.70 cfs @ 12.84 hrs, Volume= 46.756 af, Atten= 44%, Lag= 30.9 min
Primary = 8.98 cfs @ 12.84 hrs, Volume= 27.002 af
Secondary = 114.72 cfs @ 12.84 hrs, Volume= 19.754 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 3,391.69' @ 12.84 hrs Surf.Area= 1.782 ac Storage= 9.360 af
Flood Elev= 3,393.58' Surf.Area= 1.960 ac Storage= 12.890 af

Plug-Flow detention time= 345.9 min calculated for 46.751 af (100% of inflow)
Center-of-Mass det. time= 344.1 min (1,483.1 - 1,139.0)

Volume	Invert	Avail.Storage	Storage Description
#1	3,385.00'	12.890 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

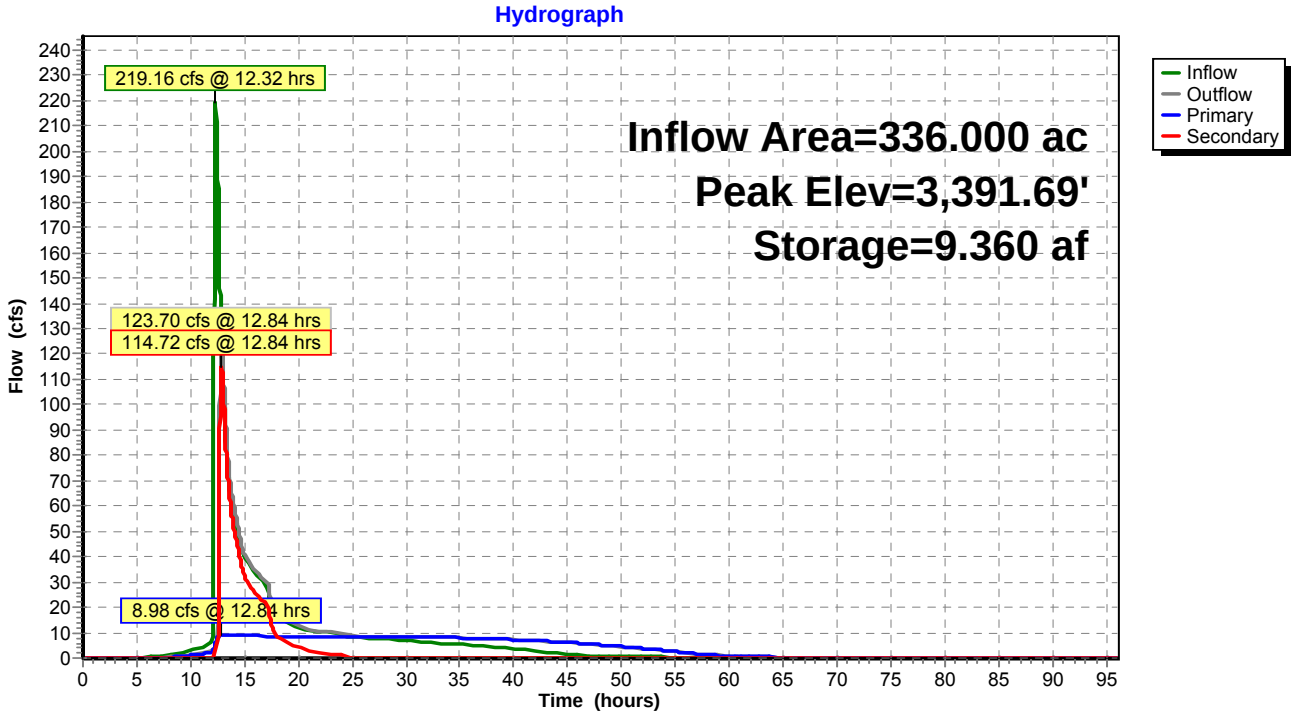
Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
3,385.00	0.450	906.0	0.000	0.000	0.450
3,386.00	1.160	1,554.0	0.777	0.777	3.362
3,387.00	1.340	1,542.0	1.249	2.026	3.439
3,388.00	1.440	1,585.0	1.390	3.416	3.687
3,389.00	1.530	1,614.0	1.485	4.901	3.861
3,390.00	1.620	1,644.0	1.575	6.476	4.043
3,391.00	1.720	1,671.0	1.670	8.145	4.211
3,392.00	1.810	1,701.0	1.765	9.910	4.400
3,392.50	1.860	1,718.0	0.917	10.828	4.508
3,393.58	1.960	1,752.0	2.063	12.890	4.727

Device	Routing	Invert	Outlet Devices
#1	Secondary	3,391.00'	**71.0' 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
#2	Primary	3,385.00'	**9.0" W x 12.0" H Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=8.98 cfs @ 12.84 hrs HW=3,391.69' (Free Discharge)
↑—**2=Orifice/Grate** (Orifice Controls 8.98 cfs @ 11.98 fps)

Secondary OutFlow Max=114.69 cfs @ 12.84 hrs HW=3,391.69' (Free Discharge)
↑—**1=Broad-Crested Rectangular Weir** (Weir Controls 114.69 cfs @ 2.33 fps)

Pond Pond B: Pond B



Summary for Pond Pond C: Pond C

Inflow Area = 336.000 ac, 52.98% Impervious, Inflow Depth > 1.67" for 50-Year event
Inflow = 123.70 cfs @ 12.84 hrs, Volume= 46.756 af
Outflow = 55.76 cfs @ 14.20 hrs, Volume= 46.681 af, Atten= 55%, Lag= 82.0 min
Primary = 34.83 cfs @ 14.20 hrs, Volume= 44.834 af
Secondary = 20.94 cfs @ 14.20 hrs, Volume= 1.847 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 3,384.42' @ 14.20 hrs Surf.Area= 1.542 ac Storage= 7.571 af
Flood Elev= 3,386.61' Surf.Area= 1.770 ac Storage= 11.199 af

Plug-Flow detention time= 123.5 min calculated for 46.676 af (100% of inflow)
Center-of-Mass det. time= 117.8 min (1,600.8 - 1,483.1)

Volume	Invert	Avail.Storage	Storage Description
#1	3,378.12'	11.199 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

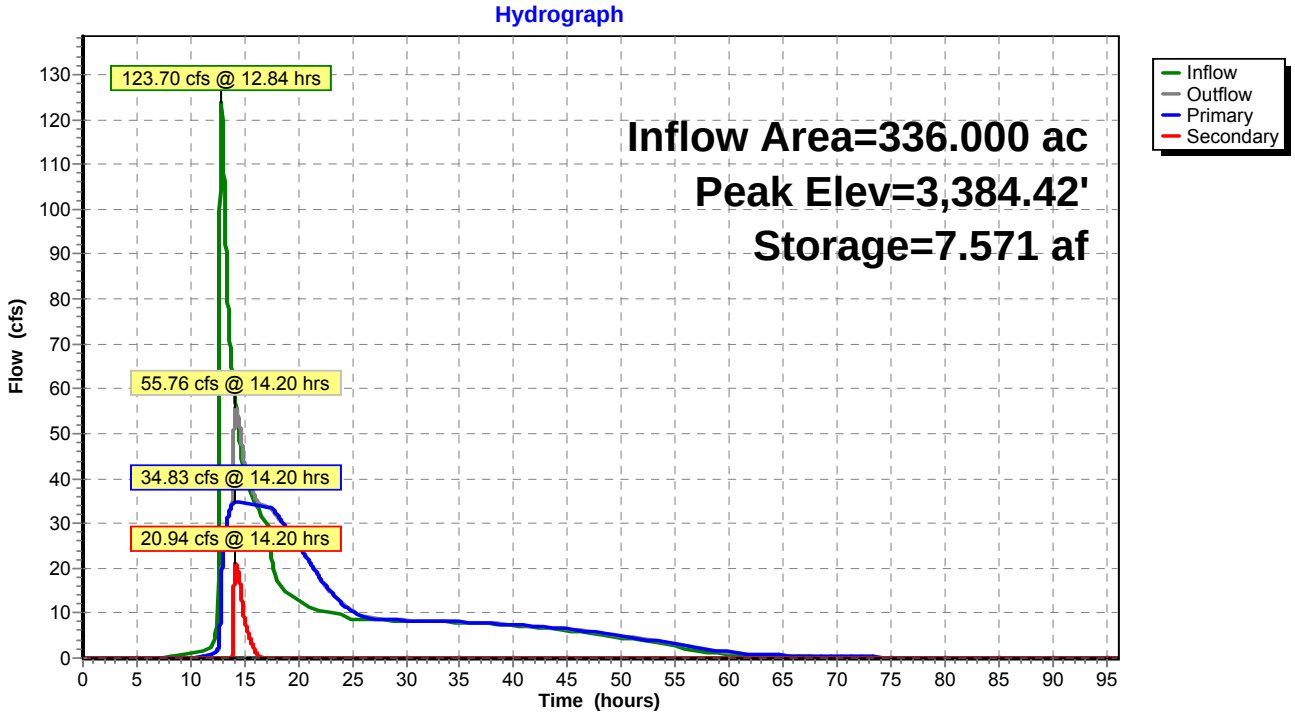
Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
3,378.12	0.880	1,462.0	0.000	0.000	0.880
3,379.00	0.880	1,462.0	0.774	0.774	0.910
3,380.00	1.080	1,574.0	0.978	1.753	1.532
3,381.00	1.190	1,649.0	1.135	2.887	1.975
3,382.00	1.300	1,687.0	1.245	4.132	2.210
3,383.00	1.400	1,720.0	1.350	5.482	2.419
3,384.00	1.500	1,752.0	1.450	6.931	2.626
3,385.00	1.600	1,765.0	1.550	8.481	2.718
3,385.50	1.660	1,780.0	0.815	9.296	2.818
3,386.61	1.770	1,815.0	1.903	11.199	3.052

Device	Routing	Invert	Outlet Devices
#1	Secondary	3,384.20'	**72.3' long x 0.7' 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 Coef. (English) 2.76 2.82 2.93 3.09 3.18 3.22 3.27 3.30 3.32 3.31 3.32
#2	Primary	3,378.12'	**24.0" Round Culvert** L= 464.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 3,378.12' / 3,362.61' S= 0.0334 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf

Primary OutFlow Max=34.83 cfs @ 14.20 hrs HW=3,384.42' (Free Discharge)
└**2=Culvert** (Inlet Controls 34.83 cfs @ 11.09 fps)

Secondary OutFlow Max=20.73 cfs @ 14.20 hrs HW=3,384.42' (Free Discharge)
└**1=Broad-Crested Rectangular Weir** (Weir Controls 20.73 cfs @ 1.30 fps)

Pond Pond C: Pond C



Summary for Pond Pond D: Pond D

Inflow Area = 23.000 ac, 4.35% Impervious, Inflow Depth = 0.78" for 50-Year event
Inflow = 17.03 cfs @ 12.16 hrs, Volume= 1.491 af
Outflow = 3.13 cfs @ 12.85 hrs, Volume= 1.491 af, Atten= 82%, Lag= 41.4 min
Primary = 3.13 cfs @ 12.85 hrs, Volume= 1.491 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 3,436.36' @ 12.85 hrs Surf.Area= 0.331 ac Storage= 0.458 af
Flood Elev= 3,443.00' Surf.Area= 0.850 ac Storage= 3.671 af

Plug-Flow detention time= 51.1 min calculated for 1.490 af (100% of inflow)
Center-of-Mass det. time= 51.1 min (938.6 - 887.5)

Volume	Invert	Avail.Storage	Storage Description
#1	3,433.00'	3.671 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

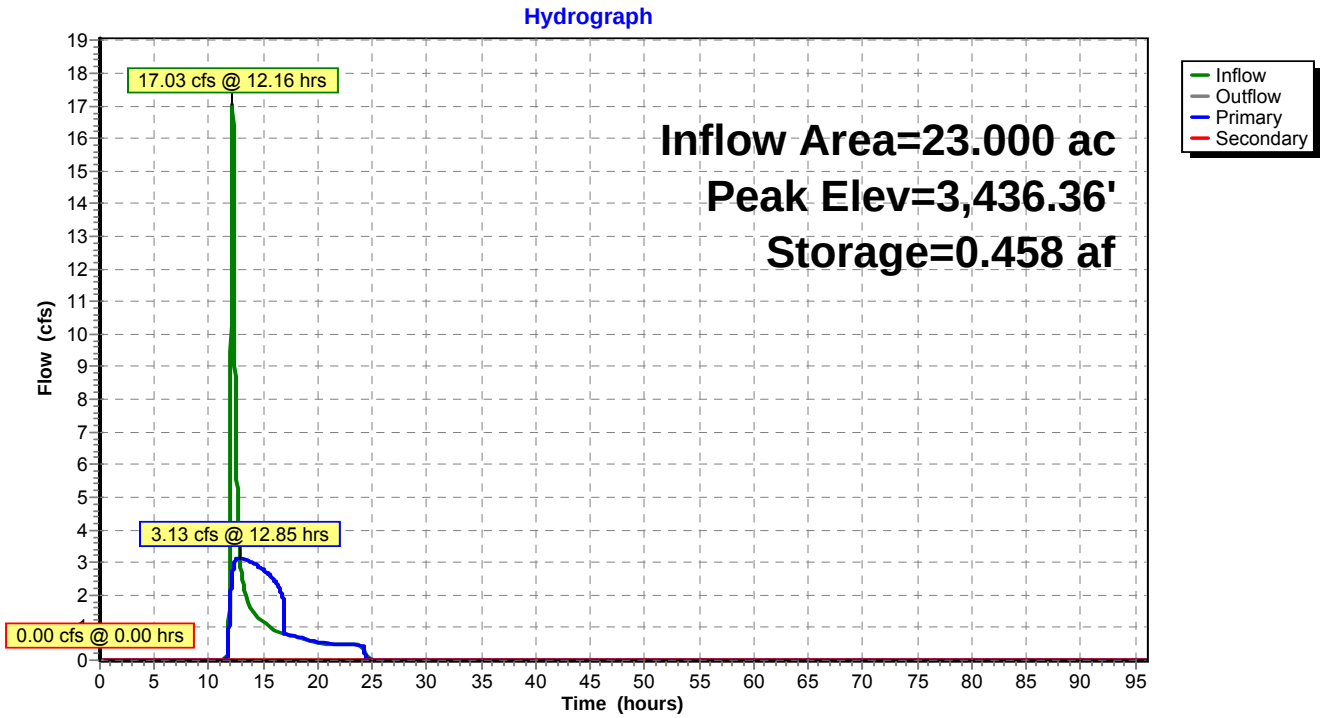
Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
3,433.00	0.000	0.0	0.000	0.000	0.000
3,433.50	0.001	44.0	0.000	0.000	0.004
3,434.00	0.020	127.0	0.004	0.004	0.029
3,434.50	0.090	260.0	0.025	0.030	0.124
3,435.00	0.170	370.0	0.064	0.094	0.250
3,435.50	0.260	434.0	0.107	0.200	0.344
3,436.00	0.310	481.0	0.142	0.343	0.423
3,436.50	0.340	529.0	0.162	0.505	0.512
3,437.00	0.360	540.0	0.175	0.680	0.534
3,437.50	0.380	556.0	0.185	0.865	0.567
3,438.00	0.400	585.0	0.195	1.060	0.628
3,438.50	0.420	590.0	0.205	1.265	0.640
3,439.00	0.440	598.0	0.215	1.480	0.659
3,439.50	0.460	613.0	0.225	1.705	0.693
3,440.00	0.480	639.0	0.235	1.940	0.753
3,440.50	0.510	666.0	0.247	2.188	0.818
3,441.00	0.530	694.0	0.260	2.448	0.888
3,441.50	0.550	721.0	0.270	2.718	0.958
3,442.00	0.580	755.0	0.282	3.000	1.050
3,442.50	0.630	806.0	0.302	3.302	1.196
3,443.00	0.850	826.0	0.369	3.671	1.256

Device	Routing	Invert	Outlet Devices
#1	Primary	3,433.00'	**10.0" Round Culvert** L= 128.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 3,433.00' / 3,432.13' S= 0.0068 '/' Cc= 0.900 n= 0.013 Cast iron, coated, Flow Area= 0.55 sf
#2	Secondary	3,438.31'	**60.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=3.13 cfs @ 12.85 hrs HW=3,436.36' (Free Discharge)
└**1=Culvert** (Barrel Controls 3.13 cfs @ 5.75 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=3,433.00' (Free Discharge)
└**2=Orifice/Grate** (Controls 0.00 cfs)

Pond Pond D: Pond D



Summary for Pond Pond E: Pond E

[81] Warning: Exceeded Pond 404 by 1.71' @ 13.88 hrs

Inflow Area = 255.000 ac, 25.49% Impervious, Inflow Depth = 1.12" for 50-Year event
Inflow = 175.05 cfs @ 12.35 hrs, Volume= 23.789 af
Outflow = 38.19 cfs @ 13.34 hrs, Volume= 23.789 af, Atten= 78%, Lag= 59.4 min
Primary = 38.19 cfs @ 13.34 hrs, Volume= 23.789 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 3,544.07' @ 13.34 hrs Surf.Area= 1.836 ac Storage= 9.164 af
Flood Elev= 3,545.65' Surf.Area= 1.951 ac Storage= 12.146 af

Plug-Flow detention time= 106.2 min calculated for 23.787 af (100% of inflow)
Center-of-Mass det. time= 106.1 min (981.2 - 875.1)

Volume	Invert	Avail.Storage	Storage Description
#1	3,536.70'	15.883 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
3,536.70	0.000	0.0	0.000	0.000	0.000
3,537.50	0.020	12.0	0.005	0.005	0.000
3,538.00	0.060	271.0	0.019	0.024	0.134
3,538.50	0.900	814.0	0.199	0.223	1.211
3,539.00	1.350	996.0	0.559	0.782	1.812
3,539.50	1.490	1,032.0	0.710	1.492	1.946
3,540.00	1.560	1,070.0	0.762	2.254	2.093
3,540.50	1.590	1,083.0	0.787	3.042	2.145
3,541.00	1.620	1,098.0	0.802	3.844	2.206
3,541.50	1.660	1,111.0	0.820	4.664	2.260
3,542.00	1.690	1,122.0	0.837	5.501	2.307
3,542.50	1.730	1,134.0	0.855	6.356	2.358
3,543.00	1.760	1,146.0	0.872	7.229	2.410
3,543.50	1.800	1,158.0	0.890	8.119	2.462
3,544.00	1.830	1,169.0	0.907	9.026	2.511
3,544.50	1.870	1,180.0	0.925	9.951	2.560
3,545.00	1.900	1,191.0	0.942	10.894	2.609
3,545.50	1.940	1,202.0	0.960	11.854	2.659
3,547.50	2.090	1,244.0	4.029	15.883	2.855

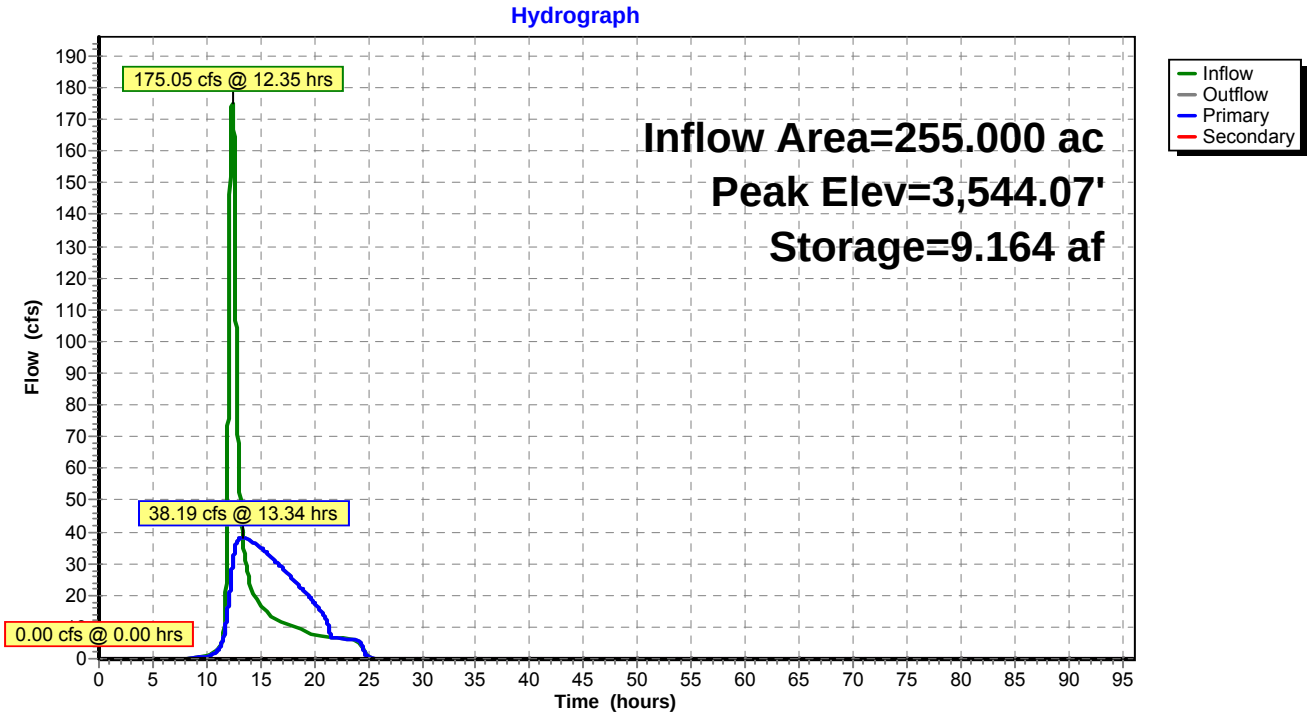
Device	Routing	Invert	Outlet Devices
#1	Primary	3,536.70'	**24.0" Round Culvert** L= 177.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 3,536.70' / 3,526.41' S= 0.0581 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#2	Secondary	3,545.65'	**71.0' long x 1.0' breadth 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=38.19 cfs @ 13.34 hrs HW=3,544.07' (Free Discharge)
└**1=Culvert** (Inlet Controls 38.19 cfs @ 12.16 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=3,536.70' (Free Discharge)
└**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond Pond E: Pond E



100-YEAR, 24-HOUR STORM

MORRISON-MAIERLE, INC.

Summary for Pond Pond A: Pond A

[79] Warning: Submerged Pond 107 Primary device # 1 OUTLET by 1.99'

Inflow Area = 336.000 ac, 52.98% Impervious, Inflow Depth = 1.94" for 100-Year event
Inflow = 292.18 cfs @ 12.05 hrs, Volume= 54.278 af
Outflow = 247.69 cfs @ 12.27 hrs, Volume= 54.246 af, Atten= 15%, Lag= 13.0 min
Primary = 9.31 cfs @ 12.27 hrs, Volume= 20.210 af
Secondary = 238.38 cfs @ 12.27 hrs, Volume= 34.036 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 3,399.17' @ 12.27 hrs Surf.Area= 2.044 ac Storage= 12.003 af
Flood Elev= 3,400.49' Surf.Area= 2.160 ac Storage= 14.769 af

Plug-Flow detention time= 262.3 min calculated for 54.246 af (100% of inflow)
Center-of-Mass det. time= 261.9 min (1,105.5 - 843.6)

Volume	Invert	Avail.Storage	Storage Description
#1	3,392.02'	14.769 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

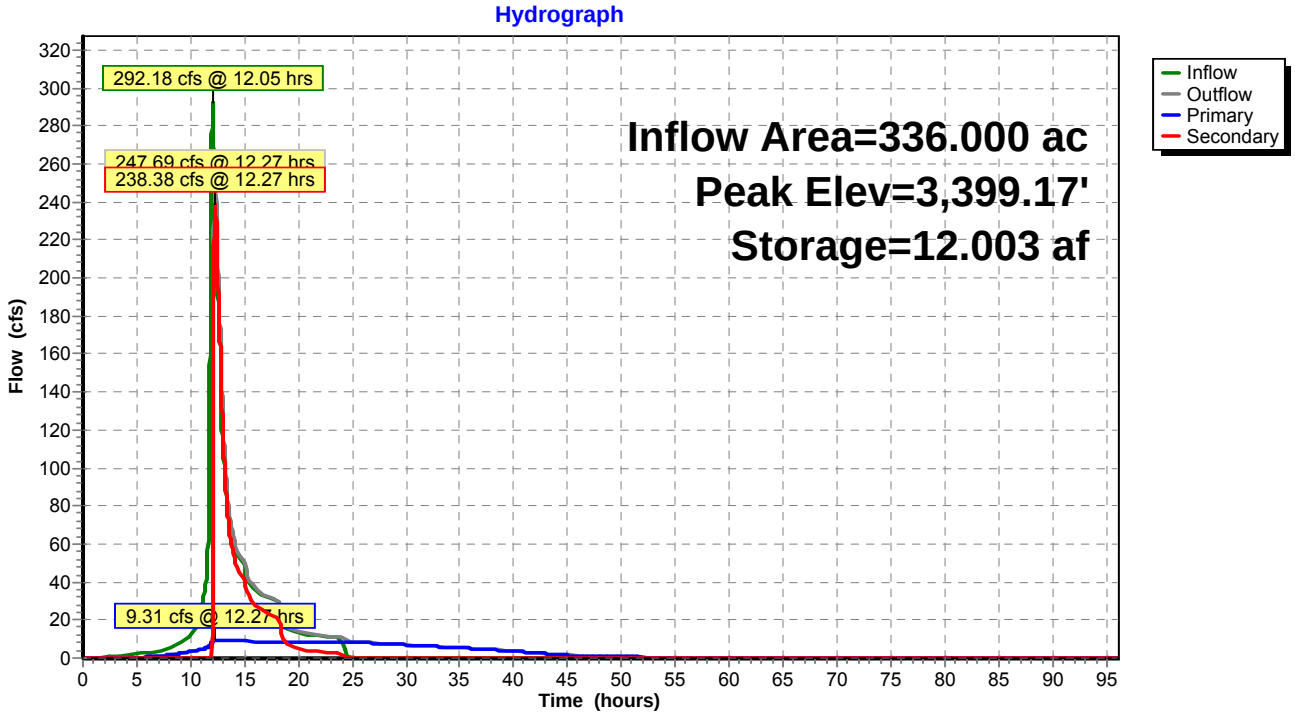
Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
3,392.02	1.210	1,096.0	0.000	0.000	1.210
3,393.00	1.210	1,096.0	1.186	1.186	1.235
3,394.00	1.590	1,124.0	1.396	2.581	1.351
3,395.00	1.690	1,158.0	1.640	4.221	1.495
3,396.00	1.770	1,190.0	1.730	5.951	1.635
3,397.00	1.860	1,223.0	1.815	7.766	1.783
3,398.00	1.940	1,252.0	1.900	9.666	1.917
3,399.00	2.030	1,280.0	1.985	11.651	2.050
3,399.50	2.070	1,295.0	1.025	12.676	2.122
3,400.49	2.160	1,322.0	2.094	14.769	2.255

Device	Routing	Invert	Outlet Devices
#1	Secondary	3,398.10'	**71.0' 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
#2	Primary	3,392.02'	**9.0" W x 12.0" H Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=9.31 cfs @ 12.27 hrs HW=3,399.17' (Free Discharge)
↑—**2=Orifice/Grate** (Orifice Controls 9.31 cfs @ 12.42 fps)

Secondary OutFlow Max=238.12 cfs @ 12.27 hrs HW=3,399.17' (Free Discharge)
↑—**1=Broad-Crested Rectangular Weir** (Weir Controls 238.12 cfs @ 3.13 fps)

Pond Pond A: Pond A



Summary for Pond Pond B: Pond B

Inflow Area = 336.000 ac, 52.98% Impervious, Inflow Depth = 1.94" for 100-Year event
Inflow = 247.69 cfs @ 12.27 hrs, Volume= 54.246 af
Outflow = 173.84 cfs @ 12.71 hrs, Volume= 54.226 af, Atten= 30%, Lag= 26.8 min
Primary = 9.11 cfs @ 12.71 hrs, Volume= 27.233 af
Secondary = 164.73 cfs @ 12.71 hrs, Volume= 26.993 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 3,391.86' @ 12.71 hrs Surf.Area= 1.798 ac Storage= 9.664 af
Flood Elev= 3,393.58' Surf.Area= 1.960 ac Storage= 12.890 af

Plug-Flow detention time= 301.2 min calculated for 54.220 af (100% of inflow)
Center-of-Mass det. time= 299.6 min (1,405.1 - 1,105.5)

Volume	Invert	Avail.Storage	Storage Description
#1	3,385.00'	12.890 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

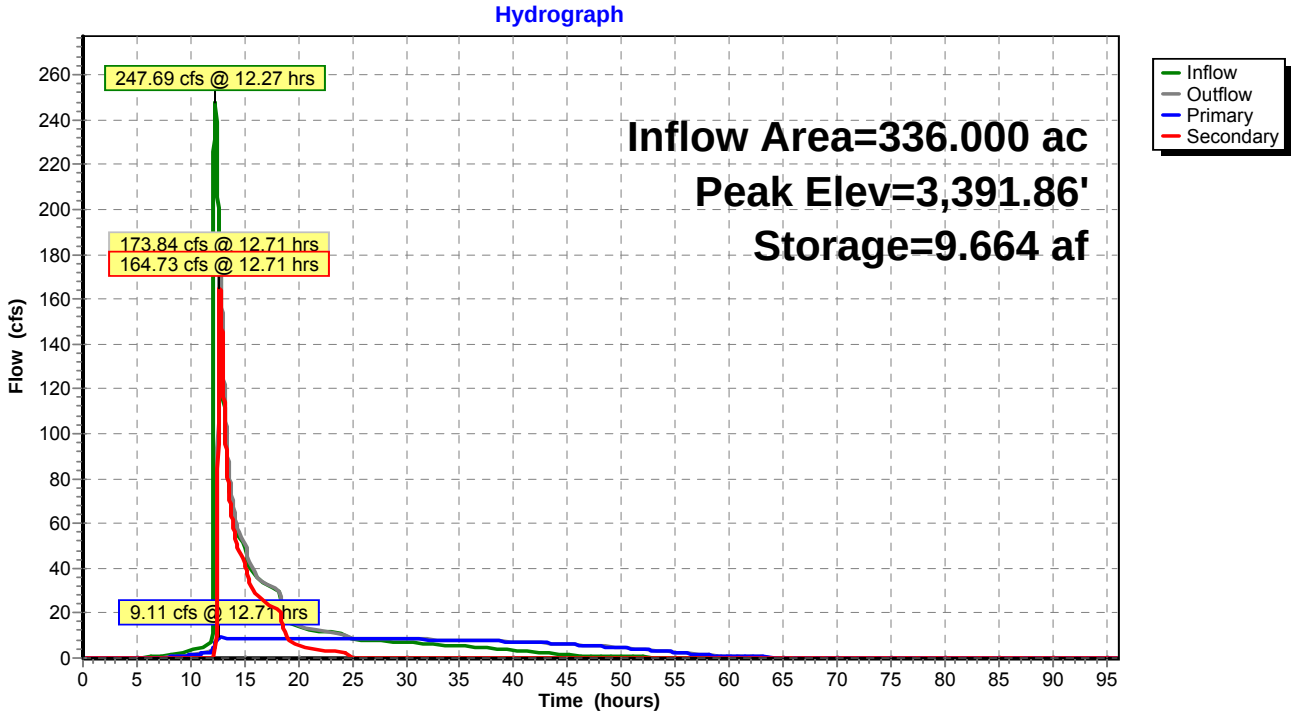
Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
3,385.00	0.450	906.0	0.000	0.000	0.450
3,386.00	1.160	1,554.0	0.777	0.777	3.362
3,387.00	1.340	1,542.0	1.249	2.026	3.439
3,388.00	1.440	1,585.0	1.390	3.416	3.687
3,389.00	1.530	1,614.0	1.485	4.901	3.861
3,390.00	1.620	1,644.0	1.575	6.476	4.043
3,391.00	1.720	1,671.0	1.670	8.145	4.211
3,392.00	1.810	1,701.0	1.765	9.910	4.400
3,392.50	1.860	1,718.0	0.917	10.828	4.508
3,393.58	1.960	1,752.0	2.063	12.890	4.727

Device	Routing	Invert	Outlet Devices
#1	Secondary	3,391.00'	**71.0' 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
#2	Primary	3,385.00'	**9.0" W x 12.0" H Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=9.11 cfs @ 12.71 hrs HW=3,391.86' (Free Discharge)
↑—**2=Orifice/Grate** (Orifice Controls 9.11 cfs @ 12.14 fps)

Secondary OutFlow Max=164.70 cfs @ 12.71 hrs HW=3,391.86' (Free Discharge)
↑—**1=Broad-Crested Rectangular Weir** (Weir Controls 164.70 cfs @ 2.69 fps)

Pond Pond B: Pond B



Summary for Pond Pond C: Pond C

Inflow Area = 336.000 ac, 52.98% Impervious, Inflow Depth > 1.94" for 100-Year event
Inflow = 173.84 cfs @ 12.71 hrs, Volume= 54.226 af
Outflow = 93.03 cfs @ 13.41 hrs, Volume= 54.151 af, Atten= 46%, Lag= 41.7 min
Primary = 35.50 cfs @ 13.41 hrs, Volume= 48.055 af
Secondary = 57.53 cfs @ 13.41 hrs, Volume= 6.096 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 3,384.63' @ 13.41 hrs Surf.Area= 1.562 ac Storage= 7.892 af
Flood Elev= 3,386.61' Surf.Area= 1.770 ac Storage= 11.199 af

Plug-Flow detention time= 117.1 min calculated for 54.151 af (100% of inflow)
Center-of-Mass det. time= 112.0 min (1,517.2 - 1,405.1)

Volume	Invert	Avail.Storage	Storage Description
#1	3,378.12'	11.199 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

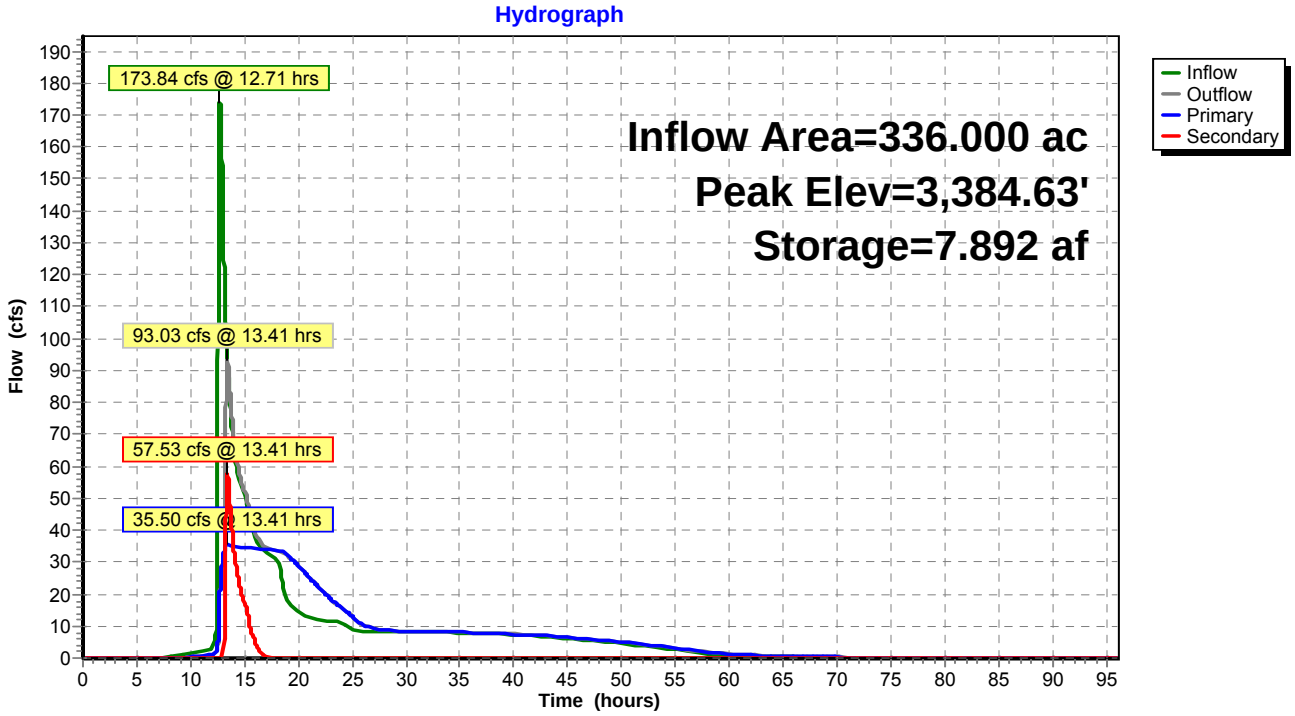
Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
3,378.12	0.880	1,462.0	0.000	0.000	0.880
3,379.00	0.880	1,462.0	0.774	0.774	0.910
3,380.00	1.080	1,574.0	0.978	1.753	1.532
3,381.00	1.190	1,649.0	1.135	2.887	1.975
3,382.00	1.300	1,687.0	1.245	4.132	2.210
3,383.00	1.400	1,720.0	1.350	5.482	2.419
3,384.00	1.500	1,752.0	1.450	6.931	2.626
3,385.00	1.600	1,765.0	1.550	8.481	2.718
3,385.50	1.660	1,780.0	0.815	9.296	2.818
3,386.61	1.770	1,815.0	1.903	11.199	3.052

Device	Routing	Invert	Outlet Devices
#1	Secondary	3,384.20'	**72.3' long x 0.7' 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 Coef. (English) 2.76 2.82 2.93 3.09 3.18 3.22 3.27 3.30 3.32 3.31 3.32
#2	Primary	3,378.12'	**24.0" Round Culvert** L= 464.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 3,378.12' / 3,362.61' S= 0.0334 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf

Primary OutFlow Max=35.50 cfs @ 13.41 hrs HW=3,384.63' (Free Discharge)
└**2=Culvert** (Inlet Controls 35.50 cfs @ 11.30 fps)

Secondary OutFlow Max=57.22 cfs @ 13.41 hrs HW=3,384.63' (Free Discharge)
└**1=Broad-Crested Rectangular Weir** (Weir Controls 57.22 cfs @ 1.85 fps)

Pond Pond C: Pond C



Summary for Pond Pond D: Pond D

Inflow Area = 23.000 ac, 4.35% Impervious, Inflow Depth = 0.99" for 100-Year event
Inflow = 22.45 cfs @ 12.16 hrs, Volume= 1.894 af
Outflow = 3.40 cfs @ 12.97 hrs, Volume= 1.894 af, Atten= 85%, Lag= 48.3 min
Primary = 3.40 cfs @ 12.97 hrs, Volume= 1.894 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 3,436.95' @ 12.97 hrs Surf.Area= 0.358 ac Storage= 0.663 af
Flood Elev= 3,443.00' Surf.Area= 0.850 ac Storage= 3.671 af

Plug-Flow detention time= 74.8 min calculated for 1.894 af (100% of inflow)
Center-of-Mass det. time= 74.8 min (954.3 - 879.5)

Volume	Invert	Avail.Storage	Storage Description
#1	3,433.00'	3.671 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

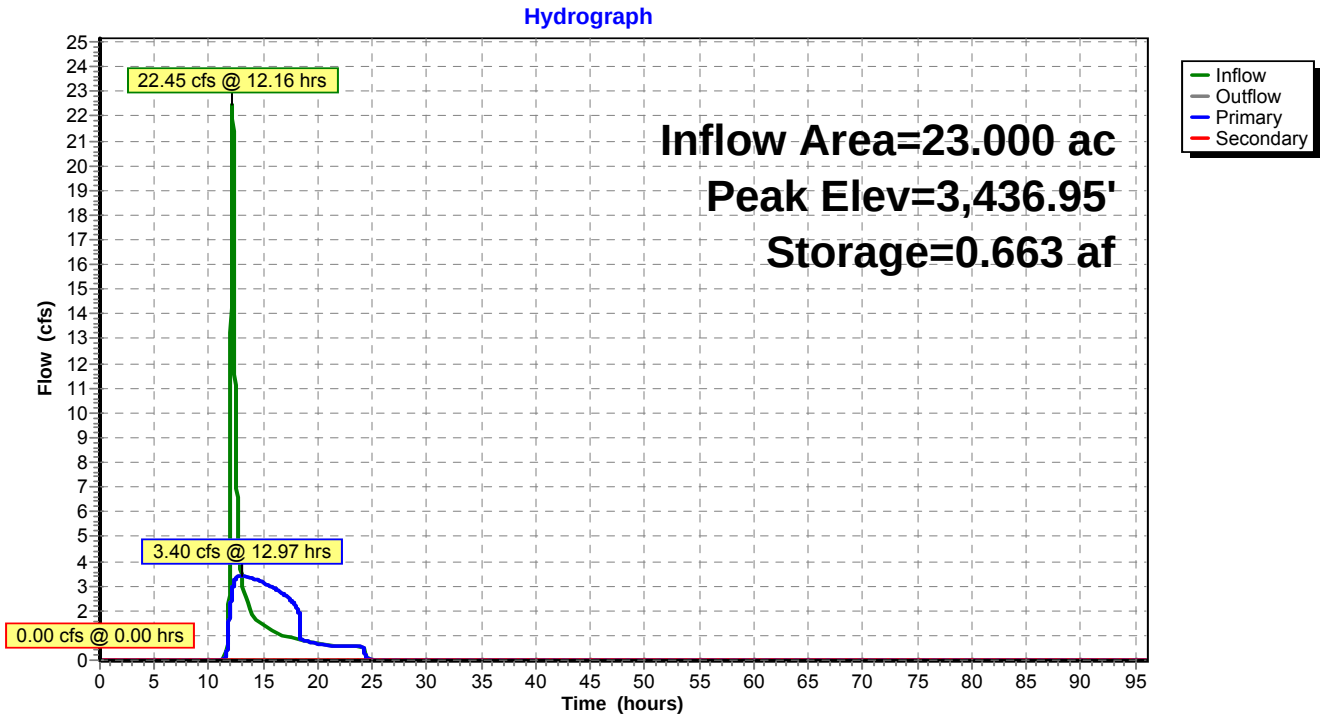
Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
3,433.00	0.000	0.0	0.000	0.000	0.000
3,433.50	0.001	44.0	0.000	0.000	0.004
3,434.00	0.020	127.0	0.004	0.004	0.029
3,434.50	0.090	260.0	0.025	0.030	0.124
3,435.00	0.170	370.0	0.064	0.094	0.250
3,435.50	0.260	434.0	0.107	0.200	0.344
3,436.00	0.310	481.0	0.142	0.343	0.423
3,436.50	0.340	529.0	0.162	0.505	0.512
3,437.00	0.360	540.0	0.175	0.680	0.534
3,437.50	0.380	556.0	0.185	0.865	0.567
3,438.00	0.400	585.0	0.195	1.060	0.628
3,438.50	0.420	590.0	0.205	1.265	0.640
3,439.00	0.440	598.0	0.215	1.480	0.659
3,439.50	0.460	613.0	0.225	1.705	0.693
3,440.00	0.480	639.0	0.235	1.940	0.753
3,440.50	0.510	666.0	0.247	2.188	0.818
3,441.00	0.530	694.0	0.260	2.448	0.888
3,441.50	0.550	721.0	0.270	2.718	0.958
3,442.00	0.580	755.0	0.282	3.000	1.050
3,442.50	0.630	806.0	0.302	3.302	1.196
3,443.00	0.850	826.0	0.369	3.671	1.256

Device	Routing	Invert	Outlet Devices
#1	Primary	3,433.00'	**10.0" Round Culvert** L= 128.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 3,433.00' / 3,432.13' S= 0.0068 '/' Cc= 0.900 n= 0.013 Cast iron, coated, Flow Area= 0.55 sf
#2	Secondary	3,438.31'	**60.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=3.40 cfs @ 12.97 hrs HW=3,436.95' (Free Discharge)
└**1=Culvert** (Barrel Controls 3.40 cfs @ 6.23 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=3,433.00' (Free Discharge)
└**2=Orifice/Grate** (Controls 0.00 cfs)

Pond Pond D: Pond D



Summary for Pond Pond E: Pond E

[81] Warning: Exceeded Pond 404 by 3.10' @ 13.97 hrs

Inflow Area = 255.000 ac, 25.49% Impervious, Inflow Depth = 1.37" for 100-Year event
Inflow = 197.76 cfs @ 12.38 hrs, Volume= 29.106 af
Outflow = 42.49 cfs @ 13.41 hrs, Volume= 29.106 af, Atten= 79%, Lag= 61.9 min
Primary = 42.49 cfs @ 13.41 hrs, Volume= 29.106 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 3,545.59' @ 13.41 hrs Surf.Area= 1.947 ac Storage= 12.026 af
Flood Elev= 3,545.65' Surf.Area= 1.951 ac Storage= 12.146 af

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 129.4 min (999.3 - 869.9)

Volume	Invert	Avail.Storage	Storage Description
#1	3,536.70'	15.883 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
3,536.70	0.000	0.0	0.000	0.000	0.000
3,537.50	0.020	12.0	0.005	0.005	0.000
3,538.00	0.060	271.0	0.019	0.024	0.134
3,538.50	0.900	814.0	0.199	0.223	1.211
3,539.00	1.350	996.0	0.559	0.782	1.812
3,539.50	1.490	1,032.0	0.710	1.492	1.946
3,540.00	1.560	1,070.0	0.762	2.254	2.093
3,540.50	1.590	1,083.0	0.787	3.042	2.145
3,541.00	1.620	1,098.0	0.802	3.844	2.206
3,541.50	1.660	1,111.0	0.820	4.664	2.260
3,542.00	1.690	1,122.0	0.837	5.501	2.307
3,542.50	1.730	1,134.0	0.855	6.356	2.358
3,543.00	1.760	1,146.0	0.872	7.229	2.410
3,543.50	1.800	1,158.0	0.890	8.119	2.462
3,544.00	1.830	1,169.0	0.907	9.026	2.511
3,544.50	1.870	1,180.0	0.925	9.951	2.560
3,545.00	1.900	1,191.0	0.942	10.894	2.609
3,545.50	1.940	1,202.0	0.960	11.854	2.659
3,547.50	2.090	1,244.0	4.029	15.883	2.855

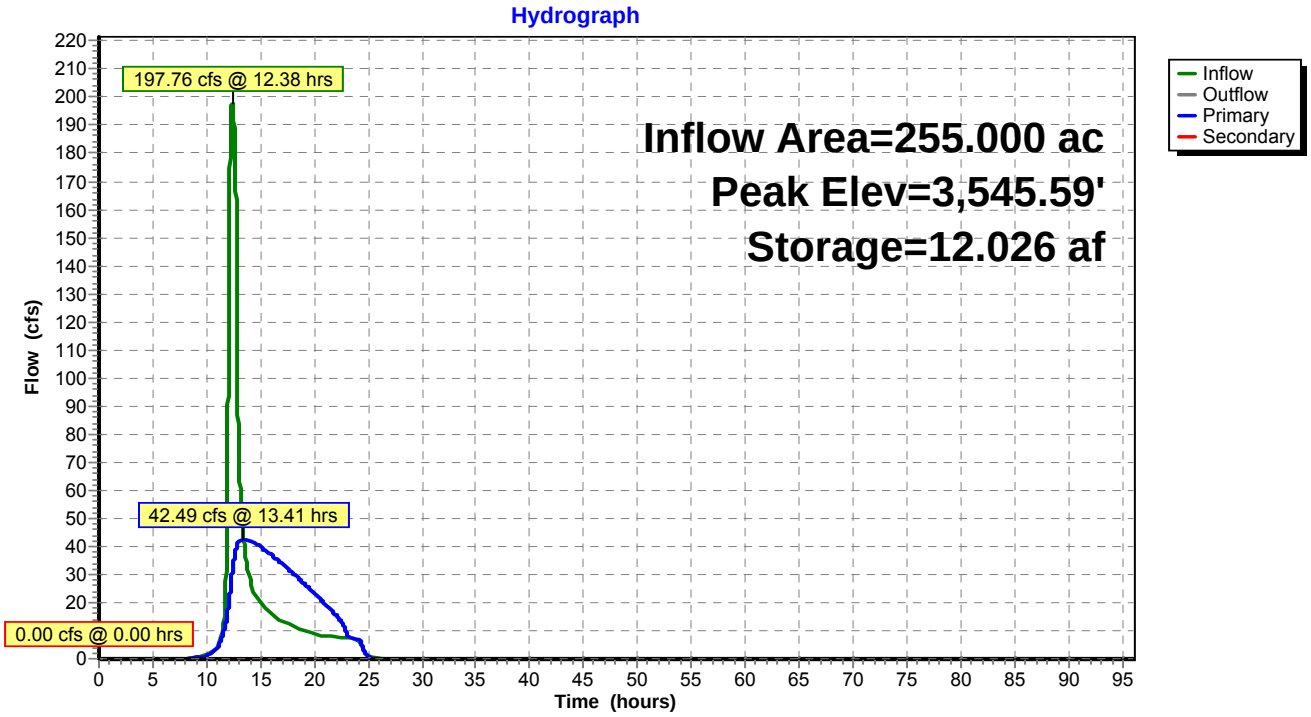
Device	Routing	Invert	Outlet Devices
#1	Primary	3,536.70'	**24.0" Round Culvert** L= 177.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 3,536.70' / 3,526.41' S= 0.0581 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#2	Secondary	3,545.65'	**71.0' long x 1.0' breadth 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=42.49 cfs @ 13.41 hrs HW=3,545.59' (Free Discharge)
└**1=Culvert** (Inlet Controls 42.49 cfs @ 13.52 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=3,536.70' (Free Discharge)
└**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond Pond E: Pond E



June 20, 2010 Storm Approximation: 100-YEAR, 6-HOUR STORM

MORRISON-MAIERLE, INC.

Summary for Pond Pond A: Pond A

[79] Warning: Submerged Pond 107 Primary device # 1 OUTLET by 1.69'

Inflow Area = 336.000 ac, 52.98% Impervious, Inflow Depth = 1.03" for June 2010 event
Inflow = 253.09 cfs @ 3.04 hrs, Volume= 28.845 af
Outflow = 145.22 cfs @ 3.50 hrs, Volume= 28.831 af, Atten= 43%, Lag= 27.5 min
Primary = 9.10 cfs @ 3.50 hrs, Volume= 13.043 af
Secondary = 136.12 cfs @ 3.50 hrs, Volume= 15.788 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 3,398.87' @ 3.50 hrs Surf.Area= 2.018 ac Storage= 11.388 af
Flood Elev= 3,400.49' Surf.Area= 2.160 ac Storage= 14.769 af

Plug-Flow detention time= 298.3 min calculated for 28.831 af (100% of inflow)
Center-of-Mass det. time= 298.0 min (531.9 - 233.9)

Volume	Invert	Avail.Storage	Storage Description
#1	3,392.02'	14.769 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

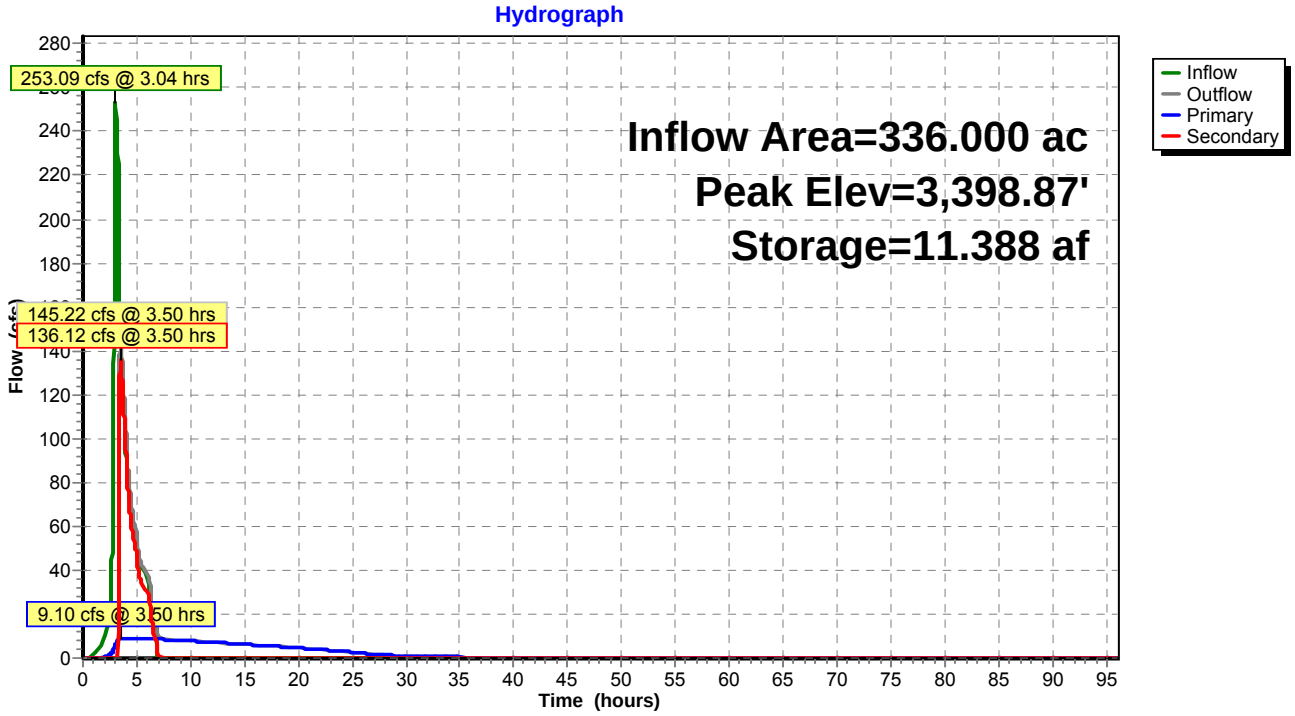
Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
3,392.02	1.210	1,096.0	0.000	0.000	1.210
3,393.00	1.210	1,096.0	1.186	1.186	1.235
3,394.00	1.590	1,124.0	1.396	2.581	1.351
3,395.00	1.690	1,158.0	1.640	4.221	1.495
3,396.00	1.770	1,190.0	1.730	5.951	1.635
3,397.00	1.860	1,223.0	1.815	7.766	1.783
3,398.00	1.940	1,252.0	1.900	9.666	1.917
3,399.00	2.030	1,280.0	1.985	11.651	2.050
3,399.50	2.070	1,295.0	1.025	12.676	2.122
3,400.49	2.160	1,322.0	2.094	14.769	2.255

Device	Routing	Invert	Outlet Devices
#1	Secondary	3,398.10'	**71.0' 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
#2	Primary	3,392.02'	**9.0" W x 12.0" H Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=9.10 cfs @ 3.50 hrs HW=3,398.87' (Free Discharge)
↑—**2=Orifice/Grate** (Orifice Controls 9.10 cfs @ 12.13 fps)

Secondary OutFlow Max=136.01 cfs @ 3.50 hrs HW=3,398.87' (Free Discharge)
↑—**1=Broad-Crested Rectangular Weir** (Weir Controls 136.01 cfs @ 2.49 fps)

Pond Pond A: Pond A



Summary for Pond Pond B: Pond B

Inflow Area = 336.000 ac, 52.98% Impervious, Inflow Depth = 1.03" for June 2010 event
Inflow = 145.22 cfs @ 3.50 hrs, Volume= 28.831 af
Outflow = 68.37 cfs @ 4.52 hrs, Volume= 28.822 af, Atten= 53%, Lag= 61.4 min
Primary = 8.81 cfs @ 4.52 hrs, Volume= 20.621 af
Secondary = 59.56 cfs @ 4.52 hrs, Volume= 8.201 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 3,391.45' @ 4.52 hrs Surf.Area= 1.761 ac Storage= 8.937 af
Flood Elev= 3,393.58' Surf.Area= 1.960 ac Storage= 12.890 af

Plug-Flow detention time= 409.0 min calculated for 28.819 af (100% of inflow)
Center-of-Mass det. time= 407.5 min (939.5 - 531.9)

Volume	Invert	Avail.Storage	Storage Description
#1	3,385.00'	12.890 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

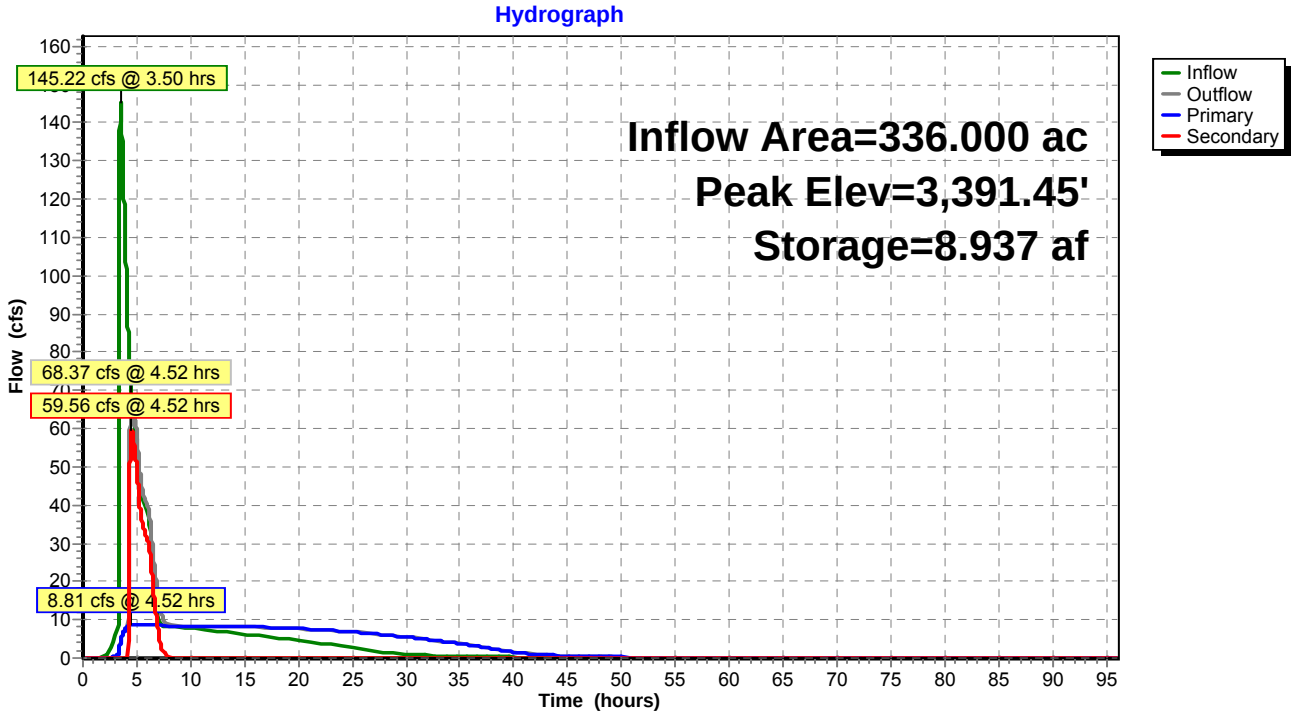
Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
3,385.00	0.450	906.0	0.000	0.000	0.450
3,386.00	1.160	1,554.0	0.777	0.777	3.362
3,387.00	1.340	1,542.0	1.249	2.026	3.439
3,388.00	1.440	1,585.0	1.390	3.416	3.687
3,389.00	1.530	1,614.0	1.485	4.901	3.861
3,390.00	1.620	1,644.0	1.575	6.476	4.043
3,391.00	1.720	1,671.0	1.670	8.145	4.211
3,392.00	1.810	1,701.0	1.765	9.910	4.400
3,392.50	1.860	1,718.0	0.917	10.828	4.508
3,393.58	1.960	1,752.0	2.063	12.890	4.727

Device	Routing	Invert	Outlet Devices
#1	Secondary	3,391.00'	**71.0' 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
#2	Primary	3,385.00'	**9.0" W x 12.0" H Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=8.81 cfs @ 4.52 hrs HW=3,391.45' (Free Discharge)
↑—**2=Orifice/Grate** (Orifice Controls 8.81 cfs @ 11.75 fps)

Secondary OutFlow Max=59.40 cfs @ 4.52 hrs HW=3,391.45' (Free Discharge)
↑—**1=Broad-Crested Rectangular Weir** (Weir Controls 59.40 cfs @ 1.84 fps)

Pond Pond B: Pond B



Summary for Pond Pond C: Pond C

Inflow Area = 336.000 ac, 52.98% Impervious, Inflow Depth > 1.03" for June 2010 event
Inflow = 68.37 cfs @ 4.52 hrs, Volume= 28.822 af
Outflow = 29.27 cfs @ 6.44 hrs, Volume= 28.772 af, Atten= 57%, Lag= 115.1 min
Primary = 29.27 cfs @ 6.44 hrs, Volume= 28.772 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 3,382.86' @ 6.44 hrs Surf.Area= 1.386 ac Storage= 5.292 af
Flood Elev= 3,386.61' Surf.Area= 1.770 ac Storage= 11.199 af

Plug-Flow detention time= 121.9 min calculated for 28.772 af (100% of inflow)
Center-of-Mass det. time= 115.0 min (1,054.5 - 939.5)

Volume	Invert	Avail.Storage	Storage Description
#1	3,378.12'	11.199 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

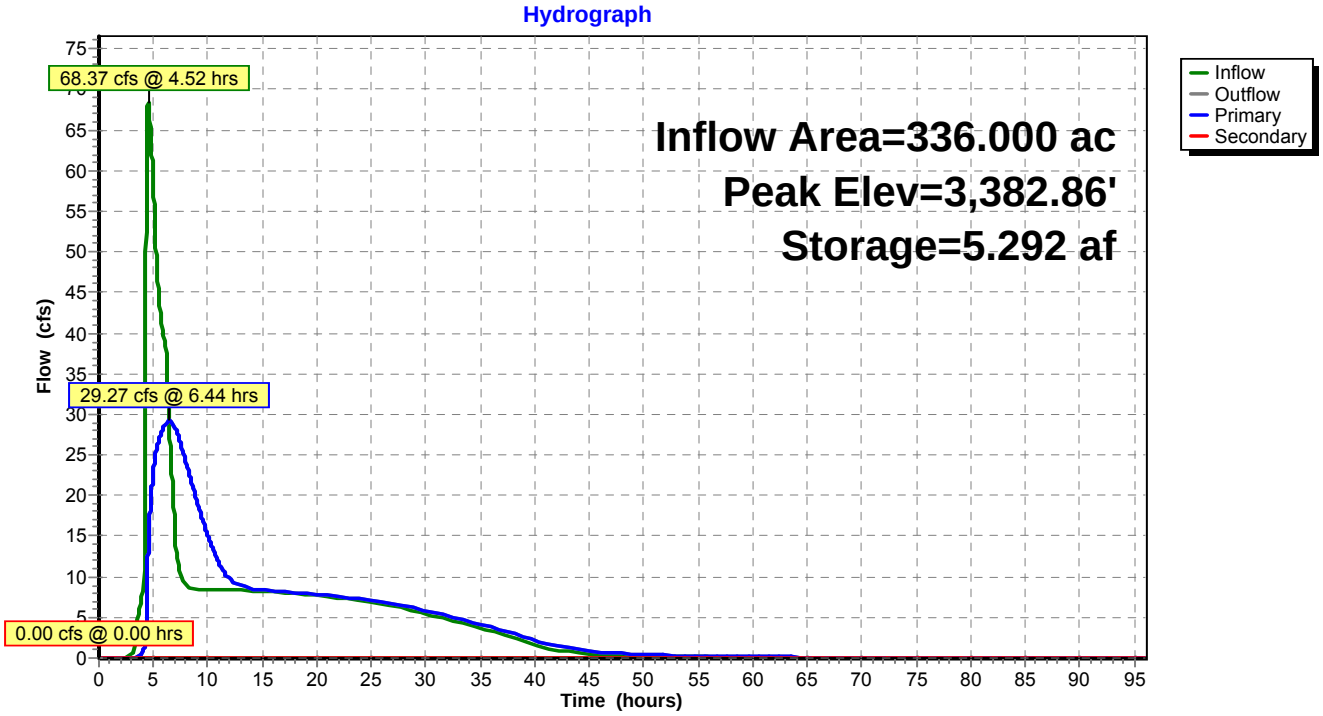
Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
3,378.12	0.880	1,462.0	0.000	0.000	0.880
3,379.00	0.880	1,462.0	0.774	0.774	0.910
3,380.00	1.080	1,574.0	0.978	1.753	1.532
3,381.00	1.190	1,649.0	1.135	2.887	1.975
3,382.00	1.300	1,687.0	1.245	4.132	2.210
3,383.00	1.400	1,720.0	1.350	5.482	2.419
3,384.00	1.500	1,752.0	1.450	6.931	2.626
3,385.00	1.600	1,765.0	1.550	8.481	2.718
3,385.50	1.660	1,780.0	0.815	9.296	2.818
3,386.61	1.770	1,815.0	1.903	11.199	3.052

Device	Routing	Invert	Outlet Devices
#1	Secondary	3,384.20'	**72.3' long x 0.7' 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 Coef. (English) 2.76 2.82 2.93 3.09 3.18 3.22 3.27 3.30 3.32 3.31 3.32
#2	Primary	3,378.12'	**24.0" Round Culvert** L= 464.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 3,378.12' / 3,362.61' S= 0.0334 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf

Primary OutFlow Max=29.27 cfs @ 6.44 hrs HW=3,382.86' (Free Discharge)
└**2=Culvert** (Inlet Controls 29.27 cfs @ 9.32 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=3,378.12' (Free Discharge)
└**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond Pond C: Pond C



Summary for Pond Pond D: Pond D

Inflow Area = 23.000 ac, 4.35% Impervious, Inflow Depth = 0.36" for June 2010 event
Inflow = 9.62 cfs @ 3.20 hrs, Volume= 0.688 af
Outflow = 2.74 cfs @ 3.80 hrs, Volume= 0.688 af, Atten= 72%, Lag= 36.3 min
Primary = 2.74 cfs @ 3.80 hrs, Volume= 0.688 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 3,435.55' @ 3.80 hrs Surf.Area= 0.265 ac Storage= 0.214 af
Flood Elev= 3,443.00' Surf.Area= 0.850 ac Storage= 3.671 af

Plug-Flow detention time= 36.0 min calculated for 0.688 af (100% of inflow)
Center-of-Mass det. time= 36.0 min (276.3 - 240.2)

Volume	Invert	Avail.Storage	Storage Description
#1	3,433.00'	3.671 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

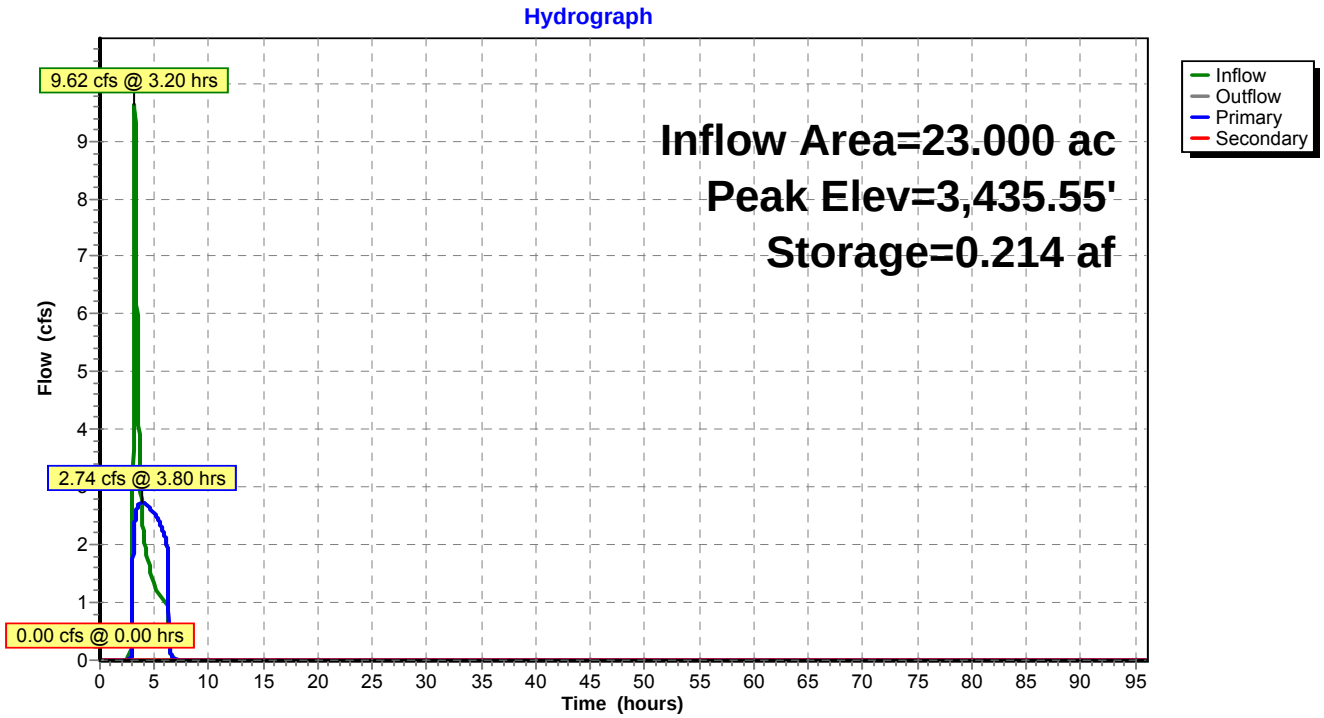
Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
3,433.00	0.000	0.0	0.000	0.000	0.000
3,433.50	0.001	44.0	0.000	0.000	0.004
3,434.00	0.020	127.0	0.004	0.004	0.029
3,434.50	0.090	260.0	0.025	0.030	0.124
3,435.00	0.170	370.0	0.064	0.094	0.250
3,435.50	0.260	434.0	0.107	0.200	0.344
3,436.00	0.310	481.0	0.142	0.343	0.423
3,436.50	0.340	529.0	0.162	0.505	0.512
3,437.00	0.360	540.0	0.175	0.680	0.534
3,437.50	0.380	556.0	0.185	0.865	0.567
3,438.00	0.400	585.0	0.195	1.060	0.628
3,438.50	0.420	590.0	0.205	1.265	0.640
3,439.00	0.440	598.0	0.215	1.480	0.659
3,439.50	0.460	613.0	0.225	1.705	0.693
3,440.00	0.480	639.0	0.235	1.940	0.753
3,440.50	0.510	666.0	0.247	2.188	0.818
3,441.00	0.530	694.0	0.260	2.448	0.888
3,441.50	0.550	721.0	0.270	2.718	0.958
3,442.00	0.580	755.0	0.282	3.000	1.050
3,442.50	0.630	806.0	0.302	3.302	1.196
3,443.00	0.850	826.0	0.369	3.671	1.256

Device	Routing	Invert	Outlet Devices
#1	Primary	3,433.00'	**10.0" Round Culvert** L= 128.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 3,433.00' / 3,432.13' S= 0.0068 '/' Cc= 0.900 n= 0.013 Cast iron, coated, Flow Area= 0.55 sf
#2	Secondary	3,438.31'	**60.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=2.74 cfs @ 3.80 hrs HW=3,435.55' (Free Discharge)
└**1=Culvert** (Barrel Controls 2.74 cfs @ 5.02 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=3,433.00' (Free Discharge)
└**2=Orifice/Grate** (Controls 0.00 cfs)

Pond Pond D: Pond D



Summary for Pond Pond E: Pond E

[81] Warning: Exceeded Pond 404 by 0.01' @ 5.01 hrs

Inflow Area = 255.000 ac, 25.49% Impervious, Inflow Depth = 0.60" for June 2010 event
Inflow = 130.82 cfs @ 3.35 hrs, Volume= 12.699 af
Outflow = 32.20 cfs @ 4.40 hrs, Volume= 12.699 af, Atten= 75%, Lag= 62.8 min
Primary = 32.20 cfs @ 4.40 hrs, Volume= 12.699 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 3,542.23' @ 4.40 hrs Surf.Area= 1.708 ac Storage= 5.893 af
Flood Elev= 3,545.65' Surf.Area= 1.951 ac Storage= 12.146 af

Plug-Flow detention time= 97.2 min calculated for 12.698 af (100% of inflow)
Center-of-Mass det. time= 97.2 min (340.2 - 243.0)

Volume	Invert	Avail.Storage	Storage Description
#1	3,536.70'	15.883 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
3,536.70	0.000	0.0	0.000	0.000	0.000
3,537.50	0.020	12.0	0.005	0.005	0.000
3,538.00	0.060	271.0	0.019	0.024	0.134
3,538.50	0.900	814.0	0.199	0.223	1.211
3,539.00	1.350	996.0	0.559	0.782	1.812
3,539.50	1.490	1,032.0	0.710	1.492	1.946
3,540.00	1.560	1,070.0	0.762	2.254	2.093
3,540.50	1.590	1,083.0	0.787	3.042	2.145
3,541.00	1.620	1,098.0	0.802	3.844	2.206
3,541.50	1.660	1,111.0	0.820	4.664	2.260
3,542.00	1.690	1,122.0	0.837	5.501	2.307
3,542.50	1.730	1,134.0	0.855	6.356	2.358
3,543.00	1.760	1,146.0	0.872	7.229	2.410
3,543.50	1.800	1,158.0	0.890	8.119	2.462
3,544.00	1.830	1,169.0	0.907	9.026	2.511
3,544.50	1.870	1,180.0	0.925	9.951	2.560
3,545.00	1.900	1,191.0	0.942	10.894	2.609
3,545.50	1.940	1,202.0	0.960	11.854	2.659
3,547.50	2.090	1,244.0	4.029	15.883	2.855

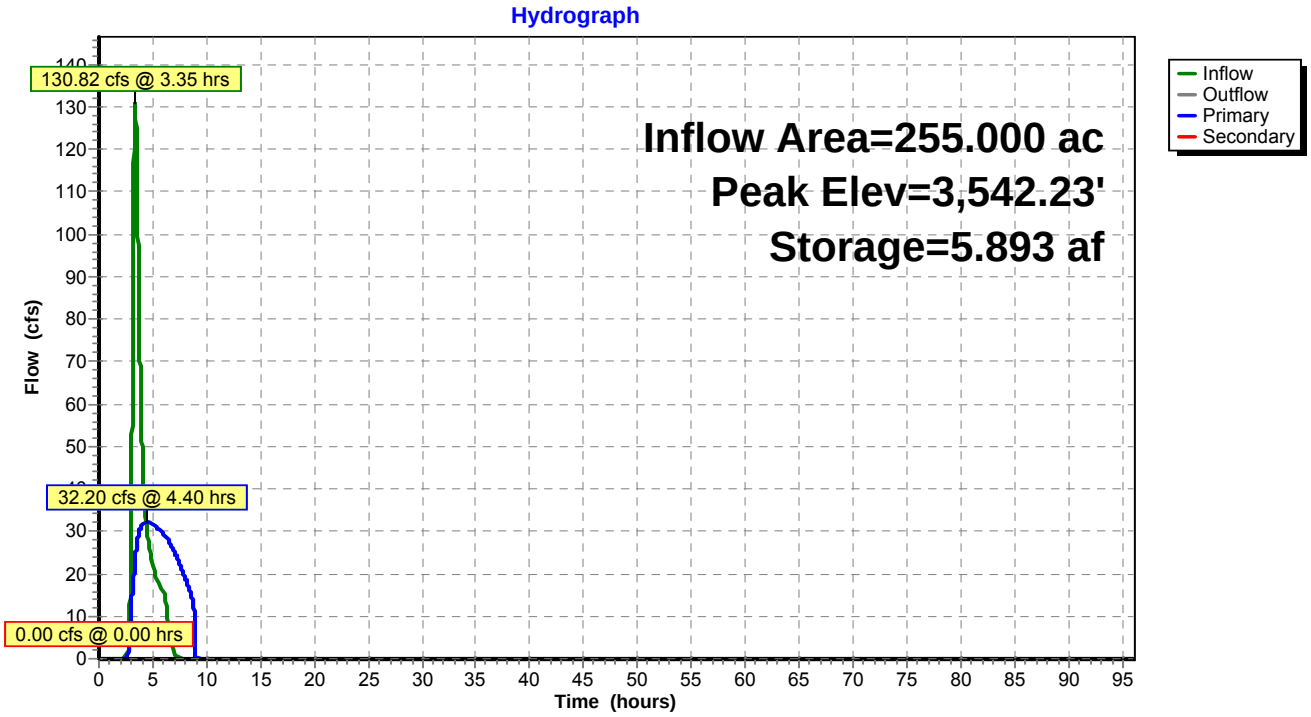
Device	Routing	Invert	Outlet Devices
#1	Primary	3,536.70'	**24.0" Round Culvert** L= 177.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 3,536.70' / 3,526.41' S= 0.0581 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#2	Secondary	3,545.65'	**71.0' long x 1.0' breadth 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=32.20 cfs @ 4.40 hrs HW=3,542.23' (Free Discharge)
└**1=Culvert** (Inlet Controls 32.20 cfs @ 10.25 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=3,536.70' (Free Discharge)
└**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond Pond E: Pond E



May 24, 2011 Storm Approximation: 100-YEAR, 24-HOUR STORM with AMC=3

MORRISON-MAIERLE, INC.

Summary for Pond Pond A: Pond A

[79] Warning: Submerged Pond 107 Primary device # 1 OUTLET by 2.20'

Inflow Area = 336.000 ac, 52.98% Impervious, Inflow Depth = 2.51" for May 2011 event
Inflow = 345.50 cfs @ 12.04 hrs, Volume= 70.293 af
Outflow = 331.97 cfs @ 12.10 hrs, Volume= 70.261 af, Atten= 4%, Lag= 3.5 min
Primary = 9.46 cfs @ 12.10 hrs, Volume= 21.579 af
Secondary = 322.51 cfs @ 12.10 hrs, Volume= 48.682 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 3,399.38' @ 12.10 hrs Surf.Area= 2.061 ac Storage= 12.432 af
Flood Elev= 3,400.49' Surf.Area= 2.160 ac Storage= 14.769 af

Plug-Flow detention time= 216.0 min calculated for 70.253 af (100% of inflow)
Center-of-Mass det. time= 216.1 min (1,034.6 - 818.5)

Volume	Invert	Avail.Storage	Storage Description
#1	3,392.02'	14.769 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

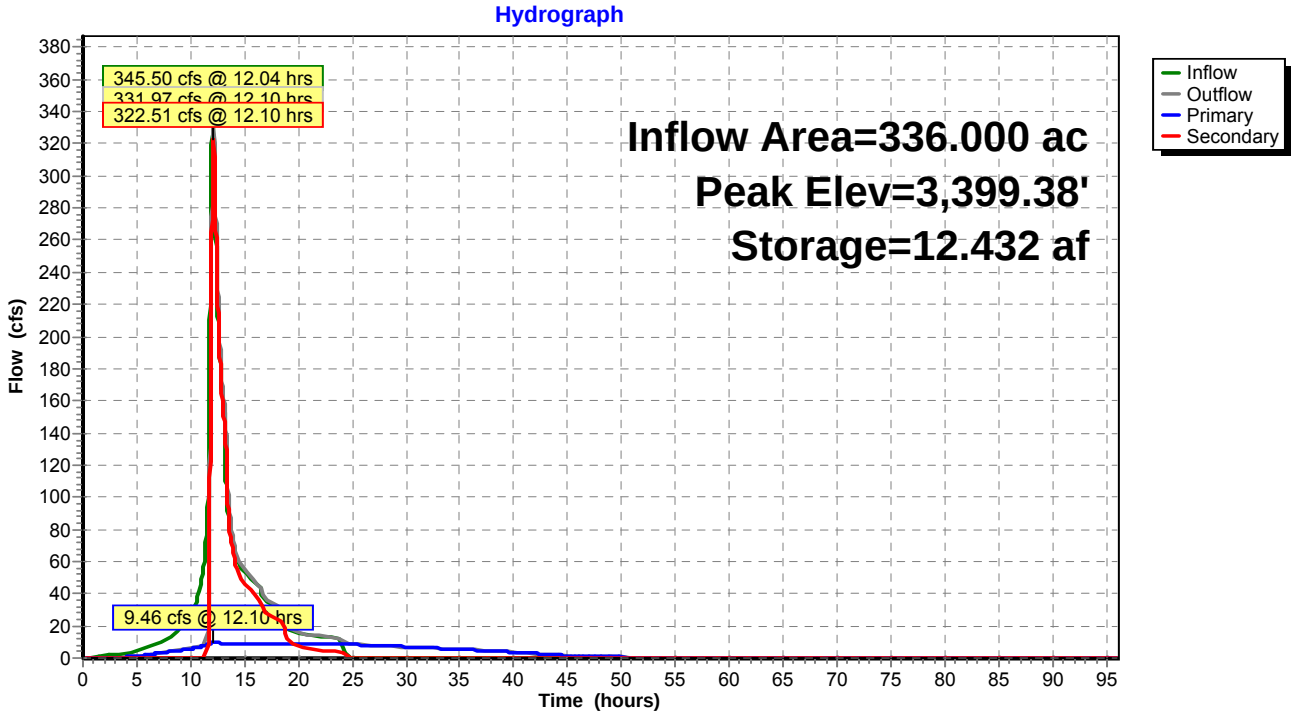
Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
3,392.02	1.210	1,096.0	0.000	0.000	1.210
3,393.00	1.210	1,096.0	1.186	1.186	1.235
3,394.00	1.590	1,124.0	1.396	2.581	1.351
3,395.00	1.690	1,158.0	1.640	4.221	1.495
3,396.00	1.770	1,190.0	1.730	5.951	1.635
3,397.00	1.860	1,223.0	1.815	7.766	1.783
3,398.00	1.940	1,252.0	1.900	9.666	1.917
3,399.00	2.030	1,280.0	1.985	11.651	2.050
3,399.50	2.070	1,295.0	1.025	12.676	2.122
3,400.49	2.160	1,322.0	2.094	14.769	2.255

Device	Routing	Invert	Outlet Devices
#1	Secondary	3,398.10'	**71.0' 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
#2	Primary	3,392.02'	**9.0" W x 12.0" H Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=9.46 cfs @ 12.10 hrs HW=3,399.38' (Free Discharge)
↑—**2=Orifice/Grate** (Orifice Controls 9.46 cfs @ 12.61 fps)

Secondary OutFlow Max=322.42 cfs @ 12.10 hrs HW=3,399.38' (Free Discharge)
↑—**1=Broad-Crested Rectangular Weir** (Weir Controls 322.42 cfs @ 3.54 fps)

Pond Pond A: Pond A



Summary for Pond Pond B: Pond B

[79] Warning: Submerged Pond Pond A Primary device # 2 by 0.15'

Inflow Area = 336.000 ac, 52.98% Impervious, Inflow Depth = 2.51" for May 2011 event
Inflow = 331.97 cfs @ 12.10 hrs, Volume= 70.261 af
Outflow = 283.40 cfs @ 12.31 hrs, Volume= 70.241 af, Atten= 15%, Lag= 12.5 min
Primary = 9.32 cfs @ 12.31 hrs, Volume= 28.081 af
Secondary = 274.08 cfs @ 12.31 hrs, Volume= 42.159 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 3,392.17' @ 12.31 hrs Surf.Area= 1.827 ac Storage= 10.212 af
Flood Elev= 3,393.58' Surf.Area= 1.960 ac Storage= 12.890 af

Plug-Flow detention time= 238.6 min calculated for 70.233 af (100% of inflow)
Center-of-Mass det. time= 237.4 min (1,272.0 - 1,034.6)

Volume	Invert	Avail.Storage	Storage Description
#1	3,385.00'	12.890 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

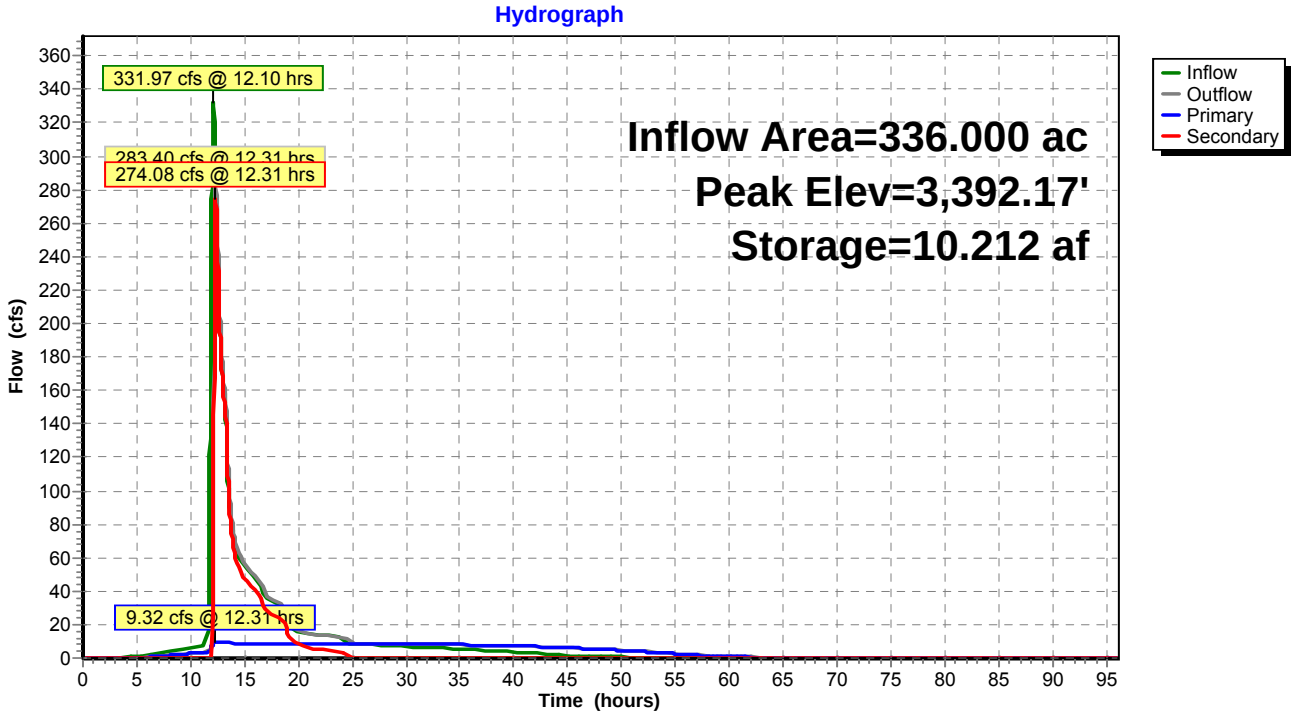
Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
3,385.00	0.450	906.0	0.000	0.000	0.450
3,386.00	1.160	1,554.0	0.777	0.777	3.362
3,387.00	1.340	1,542.0	1.249	2.026	3.439
3,388.00	1.440	1,585.0	1.390	3.416	3.687
3,389.00	1.530	1,614.0	1.485	4.901	3.861
3,390.00	1.620	1,644.0	1.575	6.476	4.043
3,391.00	1.720	1,671.0	1.670	8.145	4.211
3,392.00	1.810	1,701.0	1.765	9.910	4.400
3,392.50	1.860	1,718.0	0.917	10.828	4.508
3,393.58	1.960	1,752.0	2.063	12.890	4.727

Device	Routing	Invert	Outlet Devices
#1	Secondary	3,391.00'	**71.0' 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
#2	Primary	3,385.00'	**9.0" W x 12.0" H Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=9.32 cfs @ 12.31 hrs HW=3,392.17' (Free Discharge)
└**2=Orifice/Grate** (Orifice Controls 9.32 cfs @ 12.43 fps)

Secondary OutFlow Max=273.77 cfs @ 12.31 hrs HW=3,392.17' (Free Discharge)
└**1=Broad-Crested Rectangular Weir** (Weir Controls 273.77 cfs @ 3.31 fps)

Pond Pond B: Pond B



Summary for Pond Pond C: Pond C

[79] Warning: Submerged Pond Pond B Primary device # 2 by 0.04'

Inflow Area = 336.000 ac, 52.98% Impervious, Inflow Depth > 2.51" for May 2011 event
Inflow = 283.40 cfs @ 12.31 hrs, Volume= 70.241 af
Outflow = 210.68 cfs @ 12.68 hrs, Volume= 70.165 af, Atten= 26%, Lag= 22.2 min
Primary = 36.81 cfs @ 12.68 hrs, Volume= 51.534 af
Secondary = 173.87 cfs @ 12.68 hrs, Volume= 18.632 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 3,385.04' @ 12.68 hrs Surf.Area= 1.605 ac Storage= 8.548 af
Flood Elev= 3,386.61' Surf.Area= 1.770 ac Storage= 11.199 af

Plug-Flow detention time= 99.1 min calculated for 70.158 af (100% of inflow)
Center-of-Mass det. time= 95.1 min (1,367.1 - 1,272.0)

Volume	Invert	Avail.Storage	Storage Description
#1	3,378.12'	11.199 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

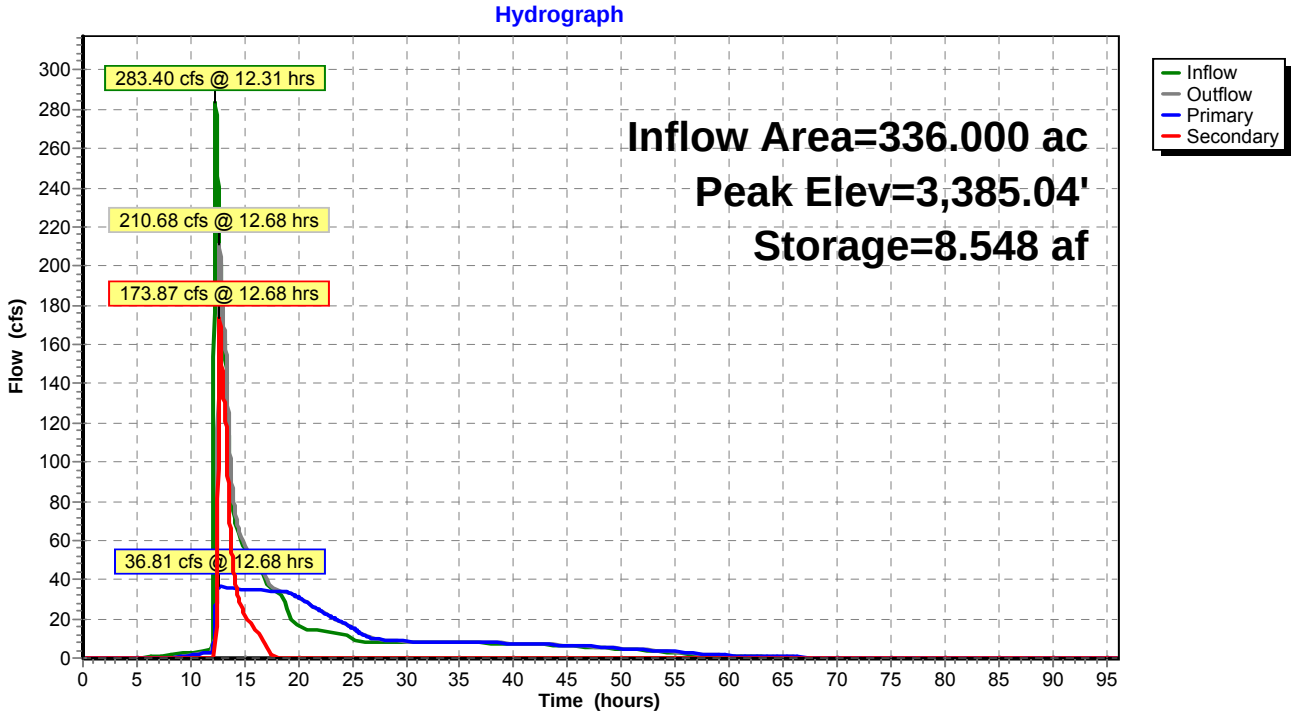
Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
3,378.12	0.880	1,462.0	0.000	0.000	0.880
3,379.00	0.880	1,462.0	0.774	0.774	0.910
3,380.00	1.080	1,574.0	0.978	1.753	1.532
3,381.00	1.190	1,649.0	1.135	2.887	1.975
3,382.00	1.300	1,687.0	1.245	4.132	2.210
3,383.00	1.400	1,720.0	1.350	5.482	2.419
3,384.00	1.500	1,752.0	1.450	6.931	2.626
3,385.00	1.600	1,765.0	1.550	8.481	2.718
3,385.50	1.660	1,780.0	0.815	9.296	2.818
3,386.61	1.770	1,815.0	1.903	11.199	3.052

Device	Routing	Invert	Outlet Devices
#1	Secondary	3,384.20'	**72.3' long x 0.7' 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 Coef. (English) 2.76 2.82 2.93 3.09 3.18 3.22 3.27 3.30 3.32 3.31 3.32
#2	Primary	3,378.12'	**24.0" Round Culvert** L= 464.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 3,378.12' / 3,362.61' S= 0.0334 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf

Primary OutFlow Max=36.81 cfs @ 12.68 hrs HW=3,385.04' (Free Discharge)
└**2=Culvert** (Inlet Controls 36.81 cfs @ 11.72 fps)

Secondary OutFlow Max=173.62 cfs @ 12.68 hrs HW=3,385.04' (Free Discharge)
└**1=Broad-Crested Rectangular Weir** (Weir Controls 173.62 cfs @ 2.85 fps)

Pond Pond C: Pond C



Summary for Pond Pond D: Pond D

Inflow Area = 23.000 ac, 4.35% Impervious, Inflow Depth = 1.99" for May 2011 event
Inflow = 48.90 cfs @ 12.14 hrs, Volume= 3.819 af
Outflow = 19.46 cfs @ 12.43 hrs, Volume= 3.819 af, Atten= 60%, Lag= 17.0 min
Primary = 4.09 cfs @ 12.43 hrs, Volume= 3.214 af
Secondary = 15.37 cfs @ 12.43 hrs, Volume= 0.605 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 3,438.76' @ 12.43 hrs Surf.Area= 0.430 ac Storage= 1.374 af
Flood Elev= 3,443.00' Surf.Area= 0.850 ac Storage= 3.671 af

Plug-Flow detention time= 109.7 min calculated for 3.819 af (100% of inflow)
Center-of-Mass det. time= 109.7 min (941.2 - 831.5)

Volume	Invert	Avail.Storage	Storage Description
#1	3,433.00'	3.671 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

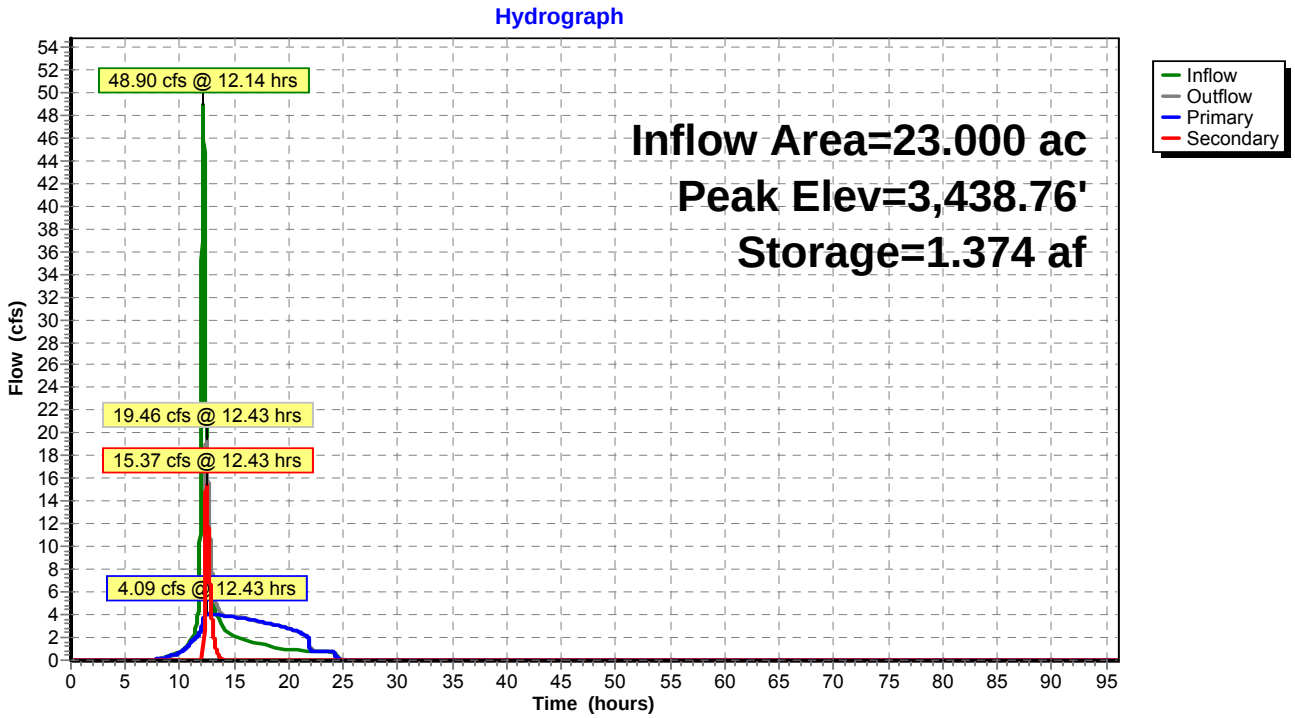
Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
3,433.00	0.000	0.0	0.000	0.000	0.000
3,433.50	0.001	44.0	0.000	0.000	0.004
3,434.00	0.020	127.0	0.004	0.004	0.029
3,434.50	0.090	260.0	0.025	0.030	0.124
3,435.00	0.170	370.0	0.064	0.094	0.250
3,435.50	0.260	434.0	0.107	0.200	0.344
3,436.00	0.310	481.0	0.142	0.343	0.423
3,436.50	0.340	529.0	0.162	0.505	0.512
3,437.00	0.360	540.0	0.175	0.680	0.534
3,437.50	0.380	556.0	0.185	0.865	0.567
3,438.00	0.400	585.0	0.195	1.060	0.628
3,438.50	0.420	590.0	0.205	1.265	0.640
3,439.00	0.440	598.0	0.215	1.480	0.659
3,439.50	0.460	613.0	0.225	1.705	0.693
3,440.00	0.480	639.0	0.235	1.940	0.753
3,440.50	0.510	666.0	0.247	2.188	0.818
3,441.00	0.530	694.0	0.260	2.448	0.888
3,441.50	0.550	721.0	0.270	2.718	0.958
3,442.00	0.580	755.0	0.282	3.000	1.050
3,442.50	0.630	806.0	0.302	3.302	1.196
3,443.00	0.850	826.0	0.369	3.671	1.256

Device	Routing	Invert	Outlet Devices
#1	Primary	3,433.00'	**10.0" Round Culvert** L= 128.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 3,433.00' / 3,432.13' S= 0.0068 '/' Cc= 0.900 n= 0.013 Cast iron, coated, Flow Area= 0.55 sf
#2	Secondary	3,438.31'	**60.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=4.09 cfs @ 12.43 hrs HW=3,438.76' (Free Discharge)
└**1=Culvert** (Barrel Controls 4.09 cfs @ 7.50 fps)

Secondary OutFlow Max=15.29 cfs @ 12.43 hrs HW=3,438.76' (Free Discharge)
└**2=Orifice/Grate** (Weir Controls 15.29 cfs @ 2.18 fps)

Pond Pond D: Pond D



Summary for Pond Pond E: Pond E

[58] Hint: Peaked 0.95' above defined flood level
[81] Warning: Exceeded Pond 404 by 3.17' @ 14.39 hrs

Inflow Area = 255.000 ac, 25.49% Impervious, Inflow Depth = 2.26" for May 2011 event
Inflow = 395.17 cfs @ 12.31 hrs, Volume= 47.937 af
Outflow = 240.48 cfs @ 12.60 hrs, Volume= 47.937 af, Atten= 39%, Lag= 17.4 min
Primary = 45.14 cfs @ 12.60 hrs, Volume= 36.544 af
Secondary = 195.35 cfs @ 12.60 hrs, Volume= 11.393 af

Routing by Stor-Ind method, Time Span= 0.00-96.00 hrs, dt= 0.01 hrs
Peak Elev= 3,546.60' @ 12.60 hrs Surf.Area= 2.022 ac Storage= 14.040 af
Flood Elev= 3,545.65' Surf.Area= 1.951 ac Storage= 12.146 af

Plug-Flow detention time= 102.6 min calculated for 47.932 af (100% of inflow)
Center-of-Mass det. time= 102.6 min (935.2 - 832.6)

Volume	Invert	Avail.Storage	Storage Description
#1	3,536.70'	15.883 af	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Perim. (feet)	Inc.Store (acre-feet)	Cum.Store (acre-feet)	Wet.Area (acres)
3,536.70	0.000	0.0	0.000	0.000	0.000
3,537.50	0.020	12.0	0.005	0.005	0.000
3,538.00	0.060	271.0	0.019	0.024	0.134
3,538.50	0.900	814.0	0.199	0.223	1.211
3,539.00	1.350	996.0	0.559	0.782	1.812
3,539.50	1.490	1,032.0	0.710	1.492	1.946
3,540.00	1.560	1,070.0	0.762	2.254	2.093
3,540.50	1.590	1,083.0	0.787	3.042	2.145
3,541.00	1.620	1,098.0	0.802	3.844	2.206
3,541.50	1.660	1,111.0	0.820	4.664	2.260
3,542.00	1.690	1,122.0	0.837	5.501	2.307
3,542.50	1.730	1,134.0	0.855	6.356	2.358
3,543.00	1.760	1,146.0	0.872	7.229	2.410
3,543.50	1.800	1,158.0	0.890	8.119	2.462
3,544.00	1.830	1,169.0	0.907	9.026	2.511
3,544.50	1.870	1,180.0	0.925	9.951	2.560
3,545.00	1.900	1,191.0	0.942	10.894	2.609
3,545.50	1.940	1,202.0	0.960	11.854	2.659
3,547.50	2.090	1,244.0	4.029	15.883	2.855

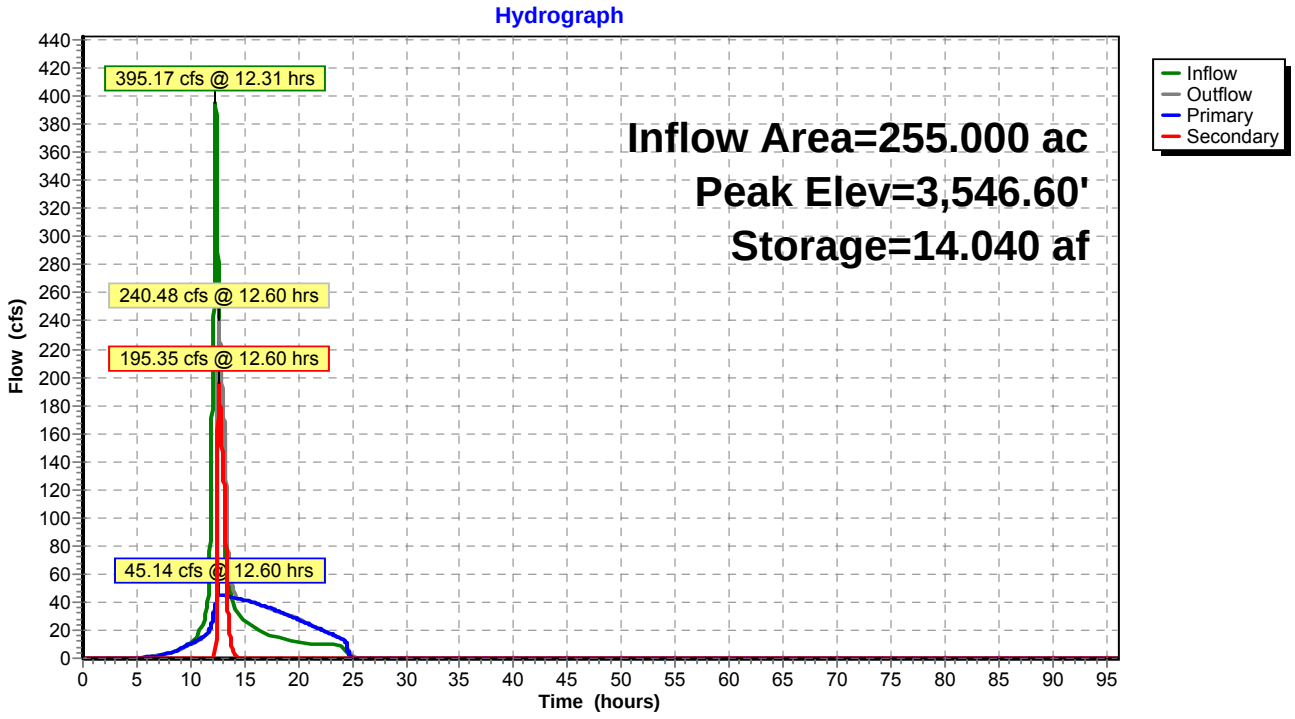
Device	Routing	Invert	Outlet Devices
#1	Primary	3,536.70'	**24.0" Round Culvert** L= 177.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 3,536.70' / 3,526.41' S= 0.0581 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 3.14 sf
#2	Secondary	3,545.65'	**71.0' long x 1.0' breadth 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=45.14 cfs @ 12.60 hrs HW=3,546.60' (Free Discharge)
└**1=Culvert** (Inlet Controls 45.14 cfs @ 14.37 fps)

Secondary OutFlow Max=194.98 cfs @ 12.60 hrs HW=3,546.60' (Free Discharge)
└**2=Broad-Crested Rectangular Weir** (Weir Controls 194.98 cfs @ 2.88 fps)

Pond Pond E: Pond E



APPENDIX H

Stormwater Pipe Capacity Tables

MORRISON-MAIERLE, INC

Billings Logan International Airport
Stormwater Pipe Network
Existing Pipe Capacity Tables

Pipe No.	Diameter (in)	Area (ft^2)	Wetted Perimeter	Hydraulic Radius (ft^2)	Manning's n-value	Slope (ft/ft)	Velocity (ft/s)	Full Capacity (cfs)	5yr, 24 hr Peak Inflow (cfs)
101	36	7.1	9.4	0.8	0.012	0.093	31.2	220.6	7.7
102	36	7.1	9.4	0.8	0.012	0.009	9.4	66.8	7.7
103	36	7.1	9.4	0.8	0.012	0.027	17.0	119.9	7.7
104	36	7.1	9.4	0.8	0.012	0.047	22.1	156.4	7.7
105	24	3.1	6.3	0.5	0.012	0.177	32.9	103.4	7.7
106	24	3.1	6.3	0.5	0.012	0.026	12.6	39.5	7.7
107	60	19.6	15.7	1.3	0.012	0.020	20.1	395.1	195.6
108	54	15.9	14.1	1.1	0.012	0.035	25.2	400.8	195.6
109	60	19.6	15.7	1.3	0.012	0.029	24.4	478.4	186.7
110	66	23.8	17.3	1.4	0.012	0.027	25.3	600.5	186.7
111	60	19.6	15.7	1.3	0.012	0.025	22.6	443.7	174.9
112	60	19.6	15.7	1.3	0.012	0.040	29.0	568.6	174.9
113	60	19.6	15.7	1.3	0.012	0.010	14.4	282.9	84.2
114	60	19.6	15.7	1.3	0.012	0.010	14.5	284.3	84.2
115	54	15.9	14.1	1.1	0.012	0.014	15.9	253.6	84.2
116	60	19.6	15.7	1.3	0.012	0.009	13.5	265.4	84.2
117	42	9.6	11.0	0.9	0.012	0.009	10.7	103.1	50.2
118	42	9.6	11.0	0.9	0.012	0.006	8.4	81.0	50.2
119	42	9.6	11.0	0.9	0.012	0.007	9.4	90.8	50.2
120	42	9.6	11.0	0.9	0.012	0.007	9.4	90.8	50.2
121	42	9.6	11.0	0.9	0.012	0.013	13.1	126.5	50.2
122	42	9.6	11.0	0.9	0.012	0.011	11.9	114.6	50.2
123	42	9.6	11.0	0.9	0.012	0.011	12.0	115.1	50.2
124	24	3.1	6.3	0.5	0.012	0.004	4.7	14.7	6.4
125	30	4.9	7.9	0.6	0.012	0.024	13.9	68.3	9.1
126	30	4.9	7.9	0.6	0.012	0.010	9.1	44.6	9.1
127	30	4.9	7.9	0.6	0.012	0.010	9.1	44.6	9.1
128	30	4.9	7.9	0.6	0.012	0.050	20.3	99.6	14.0
129	30	4.9	7.9	0.6	0.012	0.008	7.9	38.6	14.0
130	30	4.9	7.9	0.6	0.012	0.001	2.2	10.9	**14.0**
131	30	4.9	7.9	0.6	0.012	0.019	12.4	61.1	14.0
132	24	3.1	6.3	0.5	0.025	0.013	4.2	13.3	**20.7**
133	18	1.8	4.7	0.4	0.012	0.006	4.8	8.5	7.9
134	18	1.8	4.7	0.4	0.012	0.003	3.4	5.9	**10.5**
135	36	7.1	9.4	0.8	0.025	0.046	10.6	74.7	**97.1**
138	36	7.1	9.4	0.8	0.012	0.026	16.6	117.0	97.1
139	18	1.8	4.7	0.4	0.012	0.011	6.7	11.8	10.5
140	42	9.6	11.0	0.9	0.012	0.018	15.1	145.0	88.4
141	42	9.6	11.0	0.9	0.012	0.019	15.6	149.8	109.2
142	42	9.6	11.0	0.9	0.012	0.019	15.6	149.8	52.6

Pipe No.	Diameter (in)	Area (ft^2)	Wetted Perimeter	Hydraulic Radius (ft^2)	Manning's n-value	Slope (ft/ft)	Velocity (ft/s)	Full Capacity (cfs)	5yr, 24 hr Peak Inflow (cfs)
143	42	9.6	11.0	0.9	0.012	0.028	19.0	183.2	52.6
144	42	9.6	11.0	0.9	0.012	0.010	11.4	109.8	52.6
145	42	9.6	11.0	0.9	0.012	0.013	12.9	123.6	52.6
146	42	9.6	11.0	0.9	0.012	0.009	11.0	106.0	47.7
147	42	9.6	11.0	0.9	0.012	0.025	18.1	173.8	47.7
148	42	9.6	11.0	0.9	0.012	0.013	13.0	124.6	47.7
149	42	9.6	11.0	0.9	0.012	0.085	33.1	318.8	47.7
150	42	9.6	11.0	0.9	0.012	0.008	9.8	94.6	47.7
151	42	9.6	11.0	0.9	0.012	0.007	9.7	93.4	47.7
152	42	9.6	11.0	0.9	0.012	0.004	7.0	67.4	47.7
153	42	9.6	11.0	0.9	0.012	0.004	7.2	69.1	47.7
200	36	7.1	9.4	0.8	0.012	0.007	8.8	61.9	41.7
201	36	7.1	9.4	0.8	0.012	0.011	10.7	75.3	41.7
202	36	7.1	9.4	0.8	0.012	0.015	12.3	87.2	41.7
203	36	7.1	9.4	0.8	0.012	0.018	13.8	97.7	41.7
204	24	3.1	6.3	0.5	0.012	0.011	8.2	25.9	18.6
207	15	1.2	3.9	0.3	0.01	0.005	4.8	5.8	**15.3**
208	36	7.1	9.4	0.8	0.012	0.011	10.8	76.3	23.2
209	24	3.1	6.3	0.5	0.012	0.023	11.9	37.5	23.2
210	24	3.1	6.3	0.5	0.012	0.014	9.3	29.1	23.2
211	24	3.1	6.3	0.5	0.012	0.015	9.7	30.4	23.2
212	24	3.1	6.3	0.5	0.012	0.020	11.0	34.6	23.2
213	24	3.1	6.3	0.5	0.012	0.020	11.1	34.9	23.2
214	24	3.1	6.3	0.5	0.012	0.019	10.9	34.2	23.2
300	48	12.6	12.6	1.0	0.012	0.011	12.7	159.9	0.0
311	36	7.1	9.4	0.8	0.025	0.021	7.2	50.9	45.0
312	36	7.1	9.4	0.8	0.025	0.013	5.6	39.5	**45.0**
313	36	7.1	9.4	0.8	0.025	0.015	6.1	42.9	28.1
314	30	4.9	7.9	0.6	0.025	0.009	4.2	20.7	20.1
315	30	4.9	7.9	0.6	0.025	0.009	4.0	19.7	11.2
316	24	3.1	6.3	0.5	0.025	0.007	3.2	10.1	**11.2**
327	18	1.8	4.7	0.4	0.012	0.010	6.6	11.6	8.2
328	18	1.8	4.7	0.4	0.012	0.010	6.6	11.6	8.2
330	18	1.8	4.7	0.4	0.025	0.010	3.1	5.6	**8.2**
331	18	1.8	4.7	0.4	0.012	0.013	7.4	13.2	8.2
333	12	0.8	3.1	0.3	0.012	0.016	6.3	5.0	**8.2**
337	12	0.8	3.1	0.3	0.012	0.042	10.1	7.9	5.4
350	18	1.8	4.7	0.4	0.012	0.016	8.3	14.6	8.2
351	12	0.8	3.1	0.3	0.012	0.033	9.0	7.0	**24.6**
356	36	7.1	9.4	0.8	0.025	0.033	8.9	63.0	40.3
357	36	7.1	9.4	0.8	0.025	0.011	5.1	36.3	**40.8**
362	18	1.8	4.7	0.4	0.012	0.021	9.3	16.5	16.3
365	18	1.8	4.7	0.4	0.012	0.022	9.6	17.0	16.3
366	18	1.8	4.7	0.4	0.012	0.021	9.2	16.3	16.3

Pipe No.	Diameter (in)	Area (ft^2)	Wetted Perimeter	Hydraulic Radius (ft^2)	Manning's n-value	Slope (ft/ft)	Velocity (ft/s)	Full Capacity (cfs)	5yr, 24 hr Peak Inflow (cfs)
367	18	1.8	4.7	0.4	0.012	0.020	9.2	16.2	**16.3**
368	18	1.8	4.7	0.4	0.012	0.020	9.2	16.3	**16.3**
369	18	1.8	4.7	0.4	0.012	0.023	9.7	17.2	16.3
370	18	1.8	4.7	0.4	0.012	0.009	6.1	10.7	**11.1**
371	18	1.8	4.7	0.4	0.012	0.009	6.0	10.6	**11.1**
372	18	1.8	4.7	0.4	0.012	0.033	11.7	20.7	11.1
373	15	1.2	3.9	0.3	0.012	0.004	3.6	4.4	**28.2**
374	15	1.2	3.9	0.3	0.012	0.024	8.8	10.8	4.5
375	12	0.8	3.1	0.3	0.012	0.011	5.3	4.1	**6.0**
376	12	0.8	3.1	0.3	0.012	0.012	5.3	4.2	**4.4**
377	12	0.8	3.1	0.3	0.012	0.008	4.3	3.4	**4.4**
378	18	1.8	4.7	0.4	0.012	0.033	11.7	20.7	5.6
379	12	0.8	3.1	0.3	0.012	0.006	3.8	3.0	**16.2**
381	12	0.8	3.1	0.3	0.012	0.019	6.8	5.3	**27.9**
382	12	0.8	3.1	0.3	0.012	0.018	6.6	5.1	**7.7**
383	12	0.8	3.1	0.3	0.012	0.021	7.1	5.6	**6.4**
384	12	0.8	3.1	0.3	0.012	0.006	3.9	3.1	**6.4**
385	12	0.8	3.1	0.3	0.012	0.006	3.9	3.1	**4.5**
386	12	0.8	3.1	0.3	0.025	0.002	1.1	0.9	**4.5**
400	36	7.1	9.4	0.8	0.012	0.004	6.1	43.5	22.3
401	24	3.1	6.3	0.5	0.012	0.030	13.6	42.6	22.3
402	24	3.1	6.3	0.5	0.012	0.040	15.7	49.3	22.3
404	60	19.6	15.7	1.3	0.012	0.003	7.2	141.5	58.7
405	60	19.6	15.7	1.3	0.012	0.005	10.3	202.0	58.7
406	54	15.9	14.1	1.1	0.012	0.014	16.0	254.5	58.7
407	24	3.1	6.3	0.5	0.012	0.006	6.2	19.3	7.4
408	54	15.9	14.1	1.1	0.012	0.014	15.8	250.9	58.7
409	42	9.6	11.0	0.9	0.012	0.024	17.7	170.0	45.4
410	42	9.6	11.0	0.9	0.012	0.024	17.5	168.6	40.0
411	24	3.1	6.3	0.5	0.012	0.027	12.8	40.3	3.5
412	42	9.6	11.0	0.9	0.012	0.019	15.8	151.8	36.9
413	36	7.1	9.4	0.8	0.012	0.019	14.0	99.1	15.8
414	36	7.1	9.4	0.8	0.012	0.019	14.0	99.1	15.8
415	36	7.1	9.4	0.8	0.012	0.019	14.0	99.1	15.8
416	36	7.1	9.4	0.8	0.012	0.017	13.5	95.3	15.8
417	36	7.1	9.4	0.8	0.012	0.019	14.1	99.9	15.8
418	36	7.1	9.4	0.8	0.012	0.018	13.8	97.2	15.8
419	36	7.1	9.4	0.8	0.012	0.020	14.5	102.7	6.0
420	36	7.1	9.4	0.8	0.012	0.007	8.7	61.5	6.0
421	21	2.4	5.5	0.4	0.012	0.011	7.5	18.0	1.7
426	27	4.0	7.1	0.6	0.012	0.015	10.5	41.6	1.3
427	21	2.4	5.5	0.4	0.012	0.010	7.2	17.2	0.6
429	21	2.4	5.5	0.4	0.012	0.014	8.5	20.4	0.7
430	21	2.4	5.5	0.4	0.012	0.010	7.2	17.2	0.7

Pipe No.	Diameter (in)	Area (ft^2)	Wetted Perimeter	Hydraulic Radius (ft^2)	Manning's n-value	Slope (ft/ft)	Velocity (ft/s)	Full Capacity (cfs)	5yr, 24 hr Peak Inflow (cfs)
433	21	2.4	5.5	0.4	0.012	0.023	10.9	26.2	11.6
434	21	2.4	5.5	0.4	0.012	0.003	4.1	9.9	**11.4**
435	21	2.4	5.5	0.4	0.012	0.006	5.7	13.8	11.4
436	21	2.4	5.5	0.4	0.012	0.010	7.1	17.0	11.4
449	21	2.4	5.5	0.4	0.012	0.010	7.2	17.2	14.9
450	21	2.4	5.5	0.4	0.012	0.012	7.9	19.1	14.9
451	21	2.4	5.5	0.4	0.012	0.005	5.1	12.2	**14.9**
452	24	3.1	6.3	0.5	0.012	0.003	3.9	12.3	2.9
453	21	2.4	5.5	0.4	0.012	0.011	7.5	18.1	1.9
455	18	1.8	4.7	0.4	0.012	0.010	6.6	11.6	7.6
456	21	2.4	5.5	0.4	0.012	0.015	8.7	20.9	7.6
457	24	3.1	6.3	0.5	0.012	0.002	3.8	11.8	8.6
459	48	12.6	12.6	1.0	0.012	0.012	13.6	170.9	5.5
460	48	12.6	12.6	1.0	0.012	0.014	14.6	184.0	5.5
462	24	3.1	6.3	0.5	0.012	0.116	26.6	83.7	5.5
701	48	12.6	12.6	1.0	0.012	0.087	36.6	460.2	8.0
702	42	9.6	11.0	0.9	0.012	0.087	33.6	323.1	8.0
703	36	7.1	9.4	0.8	0.012	0.087	30.3	214.2	8.0
704	78	33.2	20.4	1.6	0.012	0.020	24.3	805.4	8.0
Pond C	24	3.1	6.3	0.5	0.012	0.033	14.3	44.9	7.7
Pond D	10	0.5	2.6	0.2	0.013	0.007	3.3	1.8	**3.3**
Pond E	24	3.1	6.3	0.5	0.012	0.058	18.9	59.2	**60.0**

Note: Full Capacity based on Mannings Equation: $Q=(1.49/n)AR_h^{2/3}S^{1/2}$

All pipes are assumed at 100% capacity, with unsubmerged inlet and outlet

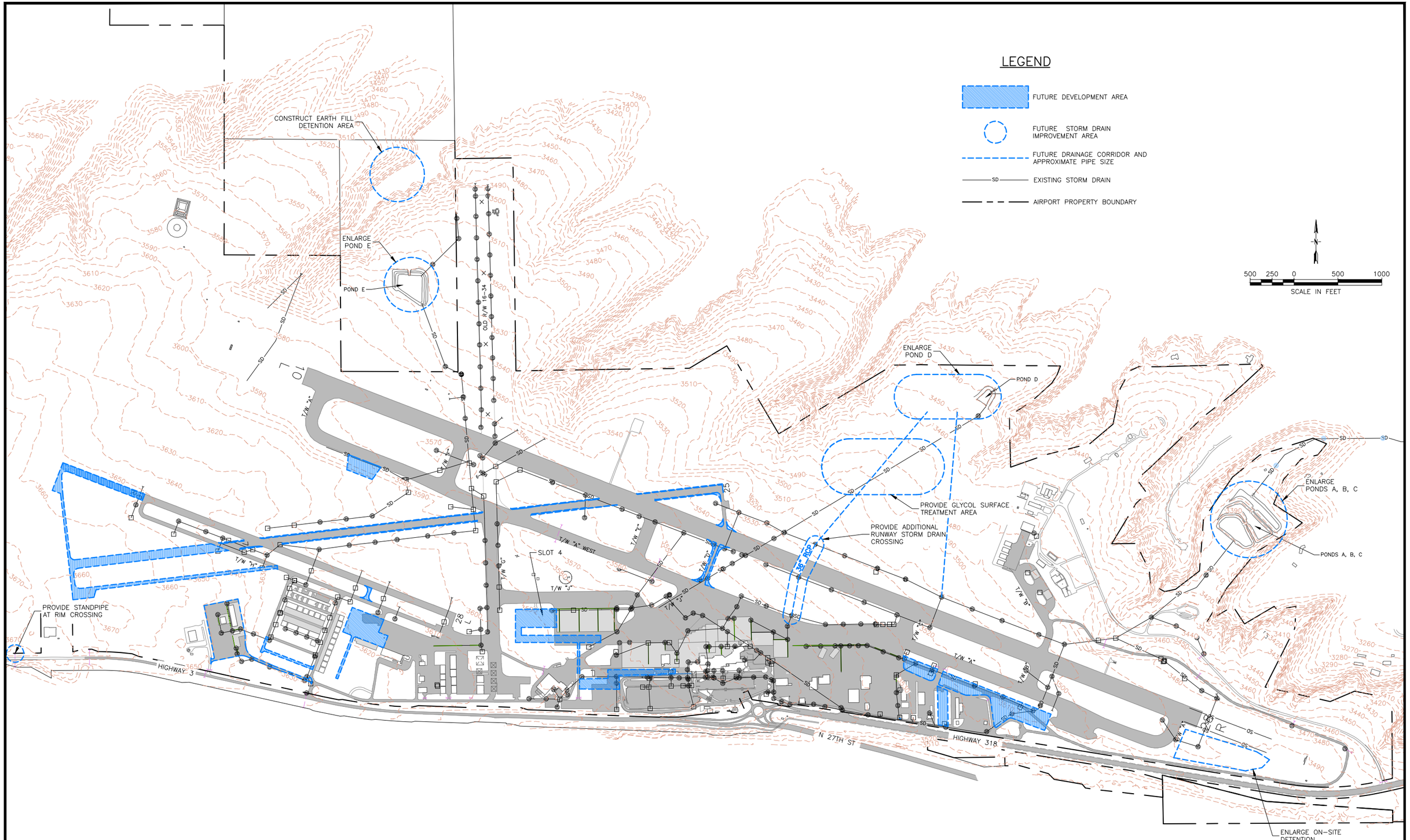
Assumed n-value of 0.012 is for a finished concrete pipe

Assumed n-value of 0.025 is for a corrugated metal pipe

APPENDIX I

Recommended Improvements

MORRISON-MAIERLE, INC



VERIFY SCALE!

THESE PRINTS MAY BE REDUCED. LINE BELOW MEASURES ONE INCH ON ORIGINAL DRAWING.

MODIFY SCALE ACCORDINGLY!

REVISIONS

NO.	DESCRIPTION	DATE	BY

V:\2447\085\ACAD\Exhibits\EXHIBIT-6.dwg Plotted by Kent Kuehn on 2/23/12

MORRISON MAIERLE, INC.
An Employee-Owned Company
Engineers
Surveyors
Scientists
Planners
315 N. 25th Street, Suite 102
Billings, MT 59101
Phone: (406) 656-6000
Fax: (406) 237-1201

DRAWN BY:
DSGN. BY:
APPR. BY:
DATE:

Q.C. REVIEW BY:
DATE:

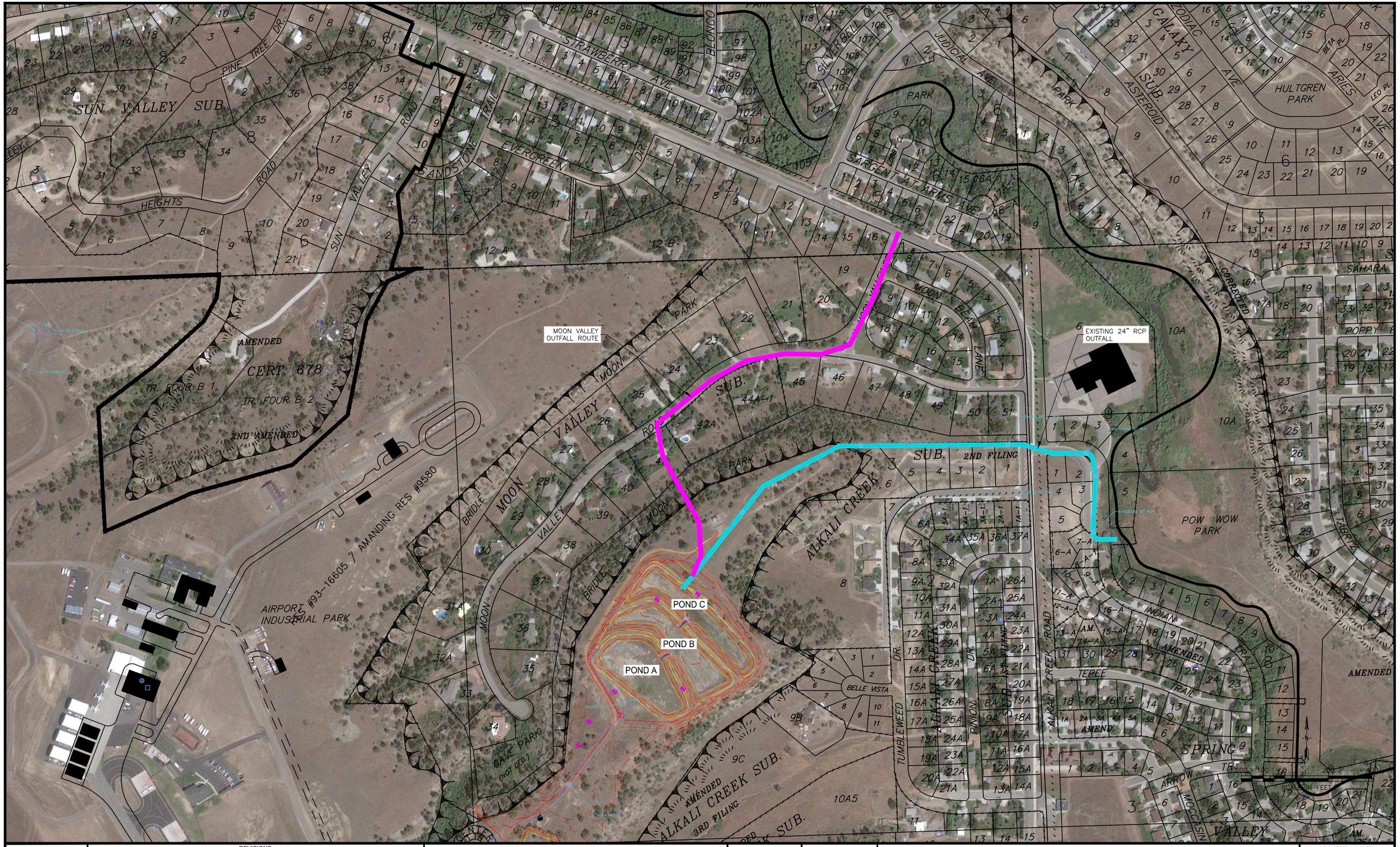
BILLINGS LOGAN INTERNATIONAL AIRPORT

RECOMMENDED IMPROVEMENTS
SITE PLAN

PROJECT NUMBER

SHEET NUMBER

DRAWING NUMBER
EXH 6



VERIFY SCALE!
THESE PRINTS MAY BE REDUCED. LINE BELOW MEASURES ONE INCH ON ORIGINAL DRAWING.
MODIFY SCALE ACCORDINGLY!

REVISIONS			
NO.	DESCRIPTION	DATE	BY

V:\2447\085\ACAD\Exhibits\POND-C-OUTFALL-OPTIONS.dwg Plotted by Kent Kuehn on 1/25/12

MORRISON MAIERLE, INC.
An Employee-Owned Company

Engineers
Surveyors
Scientists
Planners

315 N. 25th Street, Suite 102
Billings, MT 59101

Phone: (406) 656-6000
Fax: (406) 237-1201

DRAWN BY:
DSGN. BY:
APPR. BY:
DATE:

Q.C. REVIEW BY:
DATE:

BILLINGS LOGAN INTERNATIONAL AIRPORT

BILLINGS MONTANA

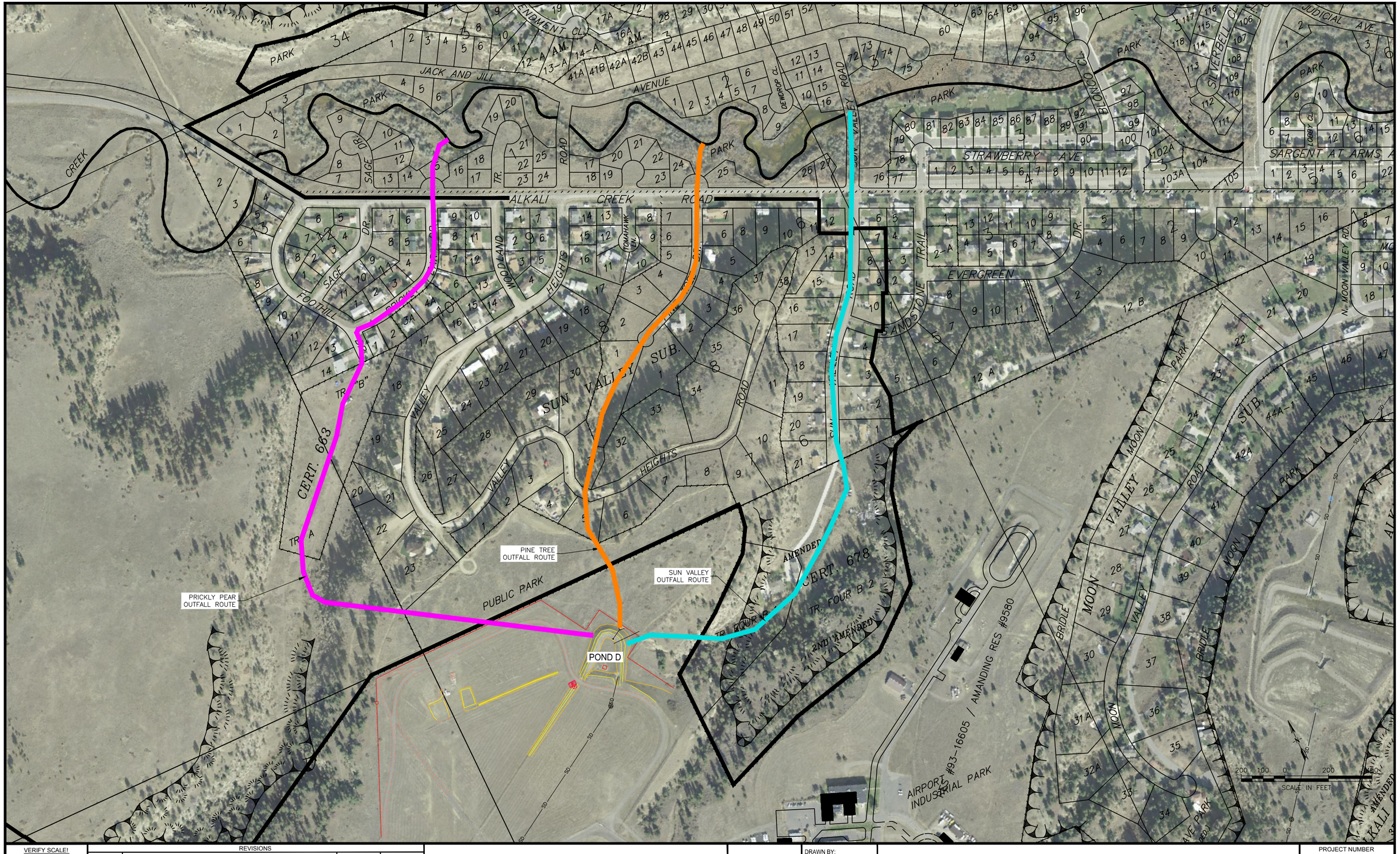
POND "C" OUTFALL ROUTE OPTIONS

PROJECT NUMBER

SHEET NUMBER

DRAWING NUMBER

EXH 7



VERIFY SCALE!

THESE PRINTS MAY BE REDUCED. LINE BELOW MEASURES ONE INCH ON ORIGINAL DRAWING.

MODIFY SCALE ACCORDINGLY!

REVISIONS

NO.	DESCRIPTION	DATE	BY

V:\2447\085\ACAD\Exhibits\POND-D-OUTFALL-OPTIONS.dwg Plotted by Kent Kuehn on 1/25/12

MORRISON MAIERLE, INC.
An Employee-Owned Company

Engineers
Surveyors
Scientists
Planners

315 N. 25th Street, Suite 102
Billings, MT 59101

Phone: (406) 656-6000
Fax: (406) 237-1201

DRAWN BY:
DSGN. BY:
APPR. BY:
DATE:

Q.C. REVIEW BY:
DATE:

BILLINGS LOGAN INTERNATIONAL AIRPORT

BILLINGS MONTANA

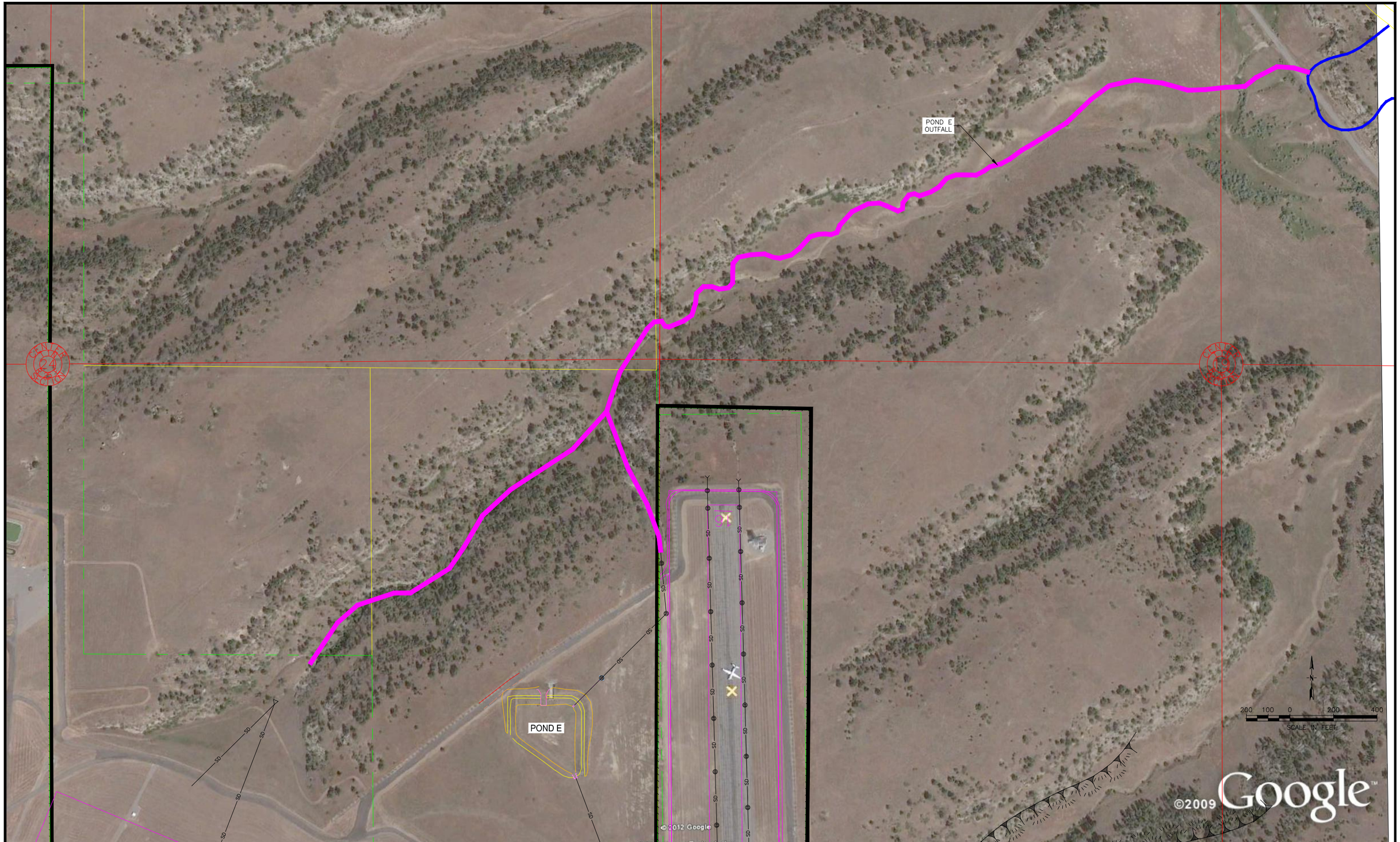
POND "D" OUTFALL ROUTE OPTIONS

PROJECT NUMBER

SHEET NUMBER

DRAWING NUMBER

EXH 8



VERIFY SCALE!

THESE PRINTS MAY BE REDUCED. LINE BELOW MEASURES ONE INCH ON ORIGINAL DRAWING.

MODIFY SCALE ACCORDINGLY!

REVISIONS

NO.	DESCRIPTION	DATE	BY

V:\2447\085\ACAD\Exhibits\POND-E-OUTFALL-OPTIONS.dwg Plotted by Kent Kuehn on 1/30/12

MORRISON MAIERLE, INC.
An Employee-Owned Company

Engineers
Surveyors
Scientists
Planners

315 N. 25th Street, Suite 102
Billings, MT 59101

Phone: (406) 656-6000
Fax: (406) 237-1201

DRAWN BY:
DSGN. BY:
APPR. BY:
DATE:

Q.C. REVIEW
BY:
DATE:

BILLINGS LOGAN INTERNATIONAL AIRPORT

BILLINGS MONTANA

POND "E" OUTFALL ROUTE OPTIONS

PROJECT NUMBER

SHEET NUMBER

DRAWING NUMBER

EXH 9

APPENDIX J

Cost Estimates for Recommended Improvements

MORRISON-MAIERLE, INC

ESTIMATED PROJECT COST

Project: 2012 Storm Drain Master Plan
Billings Logan International Airport

IMMEDIATE IMPROVEMENTS (2012)

	DESCRIPTION	Est'd Qty	Unit	Unit Price	Estimated Construction Cost	Estimated Engineering and Contingency	Total Project Cost
1a-1	**Improve Ponds A, B, C with 2' Weir Extend + 3' Blocks**						
Option 1	Mobilization	1	LS	$49,065	$49,065	$9,813	$58,878
2012	Precast Concrete Blocks	412	EACH	$600	$247,400	$49,480	$296,880
	Unclassified Excavation and Embankment	1,536	CY	$20	$30,722	$6,144	$36,867
	PCC-Weir Extension	35	CY	$300	$10,399	$2,080	$12,479
	Trashrack	1	EA	$10,000	$10,000	$2,000	$12,000
	Regrade Pond Bottoms	3	LS	$3,000	$9,000	$1,800	$10,800
	Video 24 inch outfall pipe	1	LS	$4,000	$4,000	$800	$4,800
	Omitted	0	CY	$40	$0	$0	$0
	Misc. Items	1	LS	$15,576	$15,576	$3,115	$18,691
	TOTAL				**$376,162**	**$75,232**	**$451,395**
1a-2	**Improve Ponds A, B, C with 2' Weir Extend + 2' freeboard**						
Option 2	Mobilization	1	LS	$11,212	$11,212	$2,242	$13,454
2012	Precast Concrete Blocks	0	EACH	$600	$0	$0	$0
	Omitted	0	CY	$20	$0	$0	$0
	PCC-Weir Extension	35	CY	$300	$10,399	$2,080	$12,479
	Trashrack	1	EA	$10,000	$10,000	$2,000	$12,000
	Regrade Pond Bottoms	3	LS	$3,000	$9,000	$1,800	$10,800
	Video 24 inch outfall pipe	1	LS	$4,000	$4,000	$800	$4,800
	Fill for Dikes Walls	630	CY	$60	$37,789	$7,558	$45,347
	Misc. Items	1	SY	$3,559	$3,559	$712	$4,271
	TOTAL				**$85,959**	**$17,192**	**$103,151**
1b-1	**Pond C Auxiliary Outfall - Parallel Existing Pipe**						
Option 1	36 Inch RCP	3,042	LF	$200	$608,350	$121,670	$730,020
2012	Misc. Items	1	LS	$121,670	$121,670	$24,334	$146,004
	TOTAL				**$730,020**	**$146,004**	**$876,024**
1b-2	**Pond C Auxiliary Outfall - Moon Valley Route - Preferred Option**						
Option 2	Mobilization	1	LS	$163,875	$163,875	$32,775	$196,650
2012	Moon Valley Street Improvements	1	LS	$500,000	$500,000	$100,000	$600,000
	Residential Lot Purchase	1	LS	$400,000	$400,000	$80,000	$480,000
	Plunge Pool	1	LS	$50,000	$50,000	$10,000	$60,000
	Misc. Items	1	LS	$142,500	$142,500	$28,500	$171,000
	TOTAL				**$1,256,375**	**$251,275**	**$1,507,650**
2	**Adopt a Stormwater Maintenance Plan**						
2012	Prepare Plan	0	LS	$0	$0	$3,000	$3,000
	TOTAL				**$0**	**$3,000**	**$3,000**
3	**Define Drainage Routes**						
2012	Coordination	0	LF	$0	$0	$3,000	$3,000
	TOTAL				**$0**	**$3,000**	**$3,000**
4	**Pond E Improvements - Phase 1**						
2012	Mobilization	1	LS	$604	$604	$121	$725
	PCC-Weir Extension	12	CY	$300	$3,501	$700	$4,201
	Misc. Items	1	LS	$525	$525	$105	$630
	TOTAL				**$4,630**	**$926**	**$5,556**
5	**Permitting for Pond D Outfall Route**						
2012	Flood Permit			$0	$0	$2,000	$2,000
	Conditional Letter of Map Revision			$0	$0	$40,000	$40,000
	TOTAL				**$0**	**$42,000**	**$42,000**

ESTIMATED PROJECT COST

Project: 2012 Storm Drain Master Plan
Billings Logan International Airport

CIP IMPROVEMENTS (2012-2017)

	DESCRIPTION	Est'd Qty	Unit	Unit Price	Estimated Construction Cost	Estimated Engineering and Contingency	Total Project Cost
1	**Bore Runway Pipe Crossing**	Cal.Days	30				
2013	Mobilization	1	LS	$159,517	$159,517	$31,903	$191,420
	Security Guard With Vehicle	202	HR	$41	$8,298	$1,660	$9,958
	36 Inch RCP	713	LF	$206	$146,878	$29,376	$176,254
	Pipe Boring	713	LF	$1,030	$734,390	$146,878	$881,268
	48-inch RCP Storm Drain Manhole	2	EA	$2,060	$4,738	$948	$5,686
	Misc. Items	1	LS	$138,170	$138,170	$27,634	$165,804
	TOTAL				**$1,191,991**	**$238,398**	**$1,430,390**
2	**On-Site Detention-TW A East**	Cal.Days	30				
2013	Mobilization	1	LS	$25,900	$25,900	$5,180	$31,080
	Security Guard With Vehicle	202	HR	$41	$8,298	$1,660	$9,958
	Unclassified Excavation and Embankment	7,809	CY	$15	$117,130	$23,426	$140,556
	Topsoiling	781	CY	$10	$7,809	$1,562	$9,370
	Seeding/Hydromulch	6	AC	$2,060	$11,965	$2,393	$14,358
	Misc. Items	1	LS	$22,434	$22,434	$4,487	$26,921
	TOTAL				**$193,535**	**$38,707**	**$232,242**
3	**Install Standpipe at Area K Highway 3 Crossing**						
2013	Mobilization	1	LS	$318	$318	$64	$382
	24 Inch CMP	12	LF	$155	$1,783	$357	$2,139
	Misc. Items	1	LS	$275	$275	$55	$330
	TOTAL				**$2,376**	**$475**	**$2,851**
4	**Pond D Improvements**	Cal.Days	90				
2014	Mobilization	1	LS	$149,357	$149,357	$29,871	$179,228
	Security Guard With Vehicle	748	HR	$42	$31,395	$6,279	$37,674
	Unclassified Excavation and Embankment	17,811	CY	$16	$284,979	$56,996	$341,975
	Topsoiling	1,484	CY	$11	$16,327	$3,265	$19,592
	Dike Erosion Matting Slopes	12,075	SY	$6	$72,450	$14,490	$86,940
	Seeding/Hydromulch	6	AC	$2,122	$11,713	$2,343	$14,056
	Slope Erosion Control Mat	8,694	SY	$5	$43,470	$8,694	$52,164
	36 Inch Drainage Culvert	2,300	LF	$133	$305,900	$61,180	$367,080
	Swale	8,694	SY	$5	$43,470	$8,694	$52,164
	Misc. Items	1	LS	$128,852	$128,852	$25,770	$154,622
	TOTAL				**$1,087,914**	**$217,583**	**$1,305,496**
4a	**Pond D Outfall - Sun Valley Route**						
2014	Mobilization	1	LS	$141,029	$141,029	$28,206	$169,235
	36 Inch RCP	3,606	LF	$212	$764,557	$152,911	$917,468
	Misc. Items	1	LS	$121,668	$121,668	$24,334	$146,002
	TOTAL				**$1,027,254**	**$205,451**	**$1,232,705**
4b	**Pond D Auxiliary Outfall - Sun Valley Route**						
2014	Mobilization	1	LS	$135,028	$135,028	$27,006	$162,034
	Sun Valley Street Improvements	1	LS	$636,540	$732,021	$146,404	$878,425
	Misc. Items	1	LS	$116,490	$116,490	$23,298	$139,788
	TOTAL				**$983,539**	**$196,708**	**$1,180,247**
5	**Redirect Stormwater into Pond D**						
2015	Mobilization	1	LS	$105,115	$105,115	$21,023	$126,138
	36 Inch RCP	2,300	LF	$219	$503,700	$100,740	$604,440
	Misc. Items Split Manhole etc.	1	LS	$137,602	$137,602	$27,520	$165,122
	TOTAL				**$746,417**	**$149,283**	**$895,700**
6	**Glycol Treatment Improvements**						
2015	Mobilization	1	LS	$23,973	$23,973	$4,795	$28,768
	Glycol Separator at Manhole	1	LF	$109,273	$125,664	$25,133	$150,797
	Misc. Items	1	LS	$20,597	$20,597	$4,119.40	$24,716
	TOTAL				**$170,234**	**$34,047**	**$204,281**

APPENDIX K

Scope of Work

MORRISON-MAIERLE, INC

2012 STORM DRAINAGE MASTER PLAN
FINAL SCOPE OF WORK
BILLINGS LOGAN INTERNATIONAL AIRPORT

Phase 1 – Data Collection

1. Collect current comprehensive data of the airport storm drain system.
Include updates to the airport storm system since the 1996 Storm Drainage System Master Plan. Also include most recent updates, including the Rental Car Quick Turn Around Facility, Taxiway "A" South, and the MDT Airport Road construction. Previous data collected for SWMM models did not include any elevation data. For the 2012 Storm Drainage Master Plan, the airport storm drain system will be imported into HydroCAD Stormwater Modeling software, which requires obtaining elevations of all pipes, channels, and ponds on the airport. Elevation data not found in as-built plans will be obtained through pick-up survey. Other data needed includes pipe length, size, and material, land surface description based on soil group and land use, channel dimensions, flow lengths and slopes, and pond/weir dimensions. Each subcatchment area will be analyzed to determine portions of sheet flow and shallow concentrated flow. The following major tasks of data collection of the airport storm drain system are outlined below.

a. Collect current data on all Storm Drain pipe on the airport property.
    i. Collect rim shots on all manholes. Measure down information will be gathered from as-built plans. Elevation data not found in as-built plans will be obtained through pick-up survey.
b. Collect current data on all Subcatchments on the airport property.
    i. Existing contours will be used to gather subcatchment slopes and elevations.
c. Collect current data on all Channels on airport property.
    i. Existing contours will be used to gather subcatchment slopes and elevations.
d. Collect current data on all Ponds on airport property.
    i. Elevation data not found in as-built plans will be obtained through pick-up survey.

2. Perform Geotechnical Investigation – Not included in this scope, to be added to design scope.
a. At new proposed pond locations
b. At tanker base area between Rimtop Drive and Pond A

3. Review current design criteria
a. City of Billings Stormwater Management Manual (SWMM) (Feb 2011)
b. Montana DEQ Circular 8 – Montana Standards for Subdivision Storm Drainage (2002)
c. FAA AC 150/5320-5C – Surface Drainage Design (2006, Rev. 2008)
d. FEMA - Determine if Conditional Letter of Map Revision is needed through FEMA for Alkali Creek floodplain if an outlet to the creek is added. Preparing the Conditional Letter of Map Revision is not included in this scope of work.

4. Review Billings Logan International Airport Master Plan
Review the Master Plan to incorporate planned future changes into analysis.

Phase 2 – Analysis

1. Input data into modeling software

Input airport storm drain data into "HydroCAD Stormwater Modeling" Software.

2. Run model for Ponds A, B, and C

Provide the estimated quantity of storm runoff based on the following criteria. Evaluate how existing pond system A, B, and C would perform during each of the following storms. Identify deficiencies.

a. 2-year, 24-hour storm
    i. MT Circular DEQ 8 (2002)
    "In order to detain the peak flow from a rainfall event, it is only necessary to slow down the runoff from high-intensity, short-duration events. For detention ponds, the design event should have a duration at least equal to twice the time of concentration, but never shorten than one hour" . . . "Detention ponds shall be sized for a 2-year event, but must also be analyzed for a 100-year event, to ensure that no home sites or drainfields are inundated during this event. If this analysis shows that the capacity of the pond will not hold the entire event, the analysis must include a description of where the excess water will go, and what the potential downstream damages may be. In this case, the analysis must also compare the pre-development situation with the proposed development situation."
b. 5-year, 24-hour storm
    i. FAA AC 150/5320-5C – 2-2.4.2
    "For airports, it is recommended that the 5-yr storm event be used with no encroachment of runoff on taxiway and runway pavements (including paved shoulders)."
    ii. According to the Billings Logan International Airport 1996 Storm Drainage System Master Plan, a 5-year frequency design storm was chosen as the critical storm in analyzing the storm conveyance piping systems in accordance with FAA 150/5320-5B.
c. 10-year, 24-hour storm
    i. FAA AC 150/5320-5C – 2-2.5
    "The center 50 percent of runways; the center 50 percent of taxiways serving these runways; and helipad surfaces along the centerline should be free from ponding resulting from storms of a 10-yr frequency and intensity determined by the geographic location."
d. 25-year, 24-hour storm
    i. According to the Billings Logan International Airport 1996 Storm Drainage System Master Plan, Ponds A, B, and C are capable of detaining the 25 year occurrence storm. Pond E was designed to detain a 25 year storm.
e. 50-year, 24-hour storm
    i. SWMM – City of Billings
    "[Comprehensive Drainage Plan] CDP Sites will be required to size their on-site storm drain facilities based upon the 50-year, 24-hour storm and the assumption of no discharge to the City's storm drain system."
f. 100-year, 24-hour storm
    i. MT Circular DEQ 8 (2002)

. . . "Detention ponds shall be sized for a 2-year event, but must also be analyzed for a 100-year event, to ensure that no home sites or drainfields are inundated during this event.

ii. SWMM – City of Billings
"All subdivisions must evaluate the 100-year, 24-hour storm and ensure stormwater does not runoff subdivision at a rate greater than the natural conditions prior to subdividing land."

g. Storm simulating approximate June 2010 storm
h. Storm simulating approximate May 2011 storm

3. Determine pre-development runoff for the 100-year, 24-hour storm event

Analyze the airport's surface runoff drainage areas that contributed to the storm runoff intercepted by Alkali Creek Road prior to airport development for the following areas:

a. Area 1 - Saddle Club East Drainage Area
b. Area 2 - Saddle Club West Drainage Area
c. Area 3 - Tumbleweed Drainage Area
d. Area 4 - Moon Valley Drainage Area
e. Area 5 - Sun Valley Drainage Area
f. Area 6 - Prickly Pear Drainage Area
g. Area 7 – Taxiway "G" Area
h. Area 8 – Area at Runway 10L end
i. Area 9 – Area west of Runway 10L end
j. Area 10 – Old ranch area
k. Area 11 – Windmill Area

4. Determine current runoff for the 5-year, 24-hour storm and the 100-year, 24-hour storm event

Analyze the airport's surface runoff drainage areas that currently contribute to the storm runoff intercepted by Alkali Creek Road. Compare results with pre-development runoff. Summarize current storm water deficiencies in Alkali Creek Area subdivisions that are currently developed.

a. Area 1 - Saddle Club East Drainage Area
b. Area 2 - Saddle Club West Drainage Area
c. Area 3 - Tumbleweed Drainage Area
d. Area 4 - Moon Valley Drainage Area
e. Area 5 - Sun Valley Drainage Area
f. Area 6 - Prickly Pear Drainage Area
g. Area 7 – Taxiway "G" Area
h. Area 8 – Area at Runway 10L end
i. Area 9 – Area west of Runway 10L end
j. Area 10 – Old ranch area
k. Area 11 – Windmill Area
l. Area 12 – Pond E Drainage Area
m. Area 13 – Airport Complex Area draining to Ponds A, B, C
n. Area 14 – MDT Maintenance Area

5. Glycol treatment Options

a. Evaluate current glycol treatment.
b. Evaluate areas for surface farming
c. Evaluate need for separator

6. **Model new Outfall Routes**
    a. Pond C auxiliary outfall
    b. Pond D (2 options for outfall routes)
    c. Prickly Pear outfall
    d. Area 7 – Taxiway "G" Area outfall
    e. Pond E Outfall /Area 9 – Area west of Runway 10L end
    f. Area 10 – Old ranch area
    g. Create map of current development around proposed outfall routes
    h. Identify current easement for existing 24 inch outfall to Alkali Creek.

7. **Model various modifications to Ponds A, B, and C based on deficiencies identified in Phase 2 – Analysis. Possible modifications include:**
    a. Model permanent weir extensions to Ponds A, B, and C
    b. Model increased orifice sizes at Ponds A, B, and C

8. **Model modifications in sizes to all Ponds**

Phase 3 – Results

1. **Storm Drain Recommendations by Drainage Area**
   Provide options and recommendations for onsite and offsite improvements to reduce the impact of a future major storm event. Include recommendations for improving airport storm drainage to comply with current standards.
   a. **Onsite recommendations**
      i. Area 1 - Saddle Club East Drainage Area
      ii. Area 2 - Saddle Club West Drainage Area
      iii. Area 3 - Tumbleweed Drainage Area
      iv. Area 4 - Moon Valley Drainage Area
      v. Area 5 - Sun Valley Drainage Area
      vi. Area 6 - Prickly Pear Drainage Area
      vii. Area 7 – Taxiway "G" Area
      viii. Area 8 – Area at Runway 10L end
      ix. Area 9 – Area west of Runway 10L end
      x. Area 10 – Old ranch area
      xi. Area 11 – Windmill Area
      xii. Area 12 – Pond E Drainage Area
      xiii. Area 13 – Airport Complex Area draining to Ponds A, B, C
      xiv. Area 14 – MDT Maintenance Area

   b. **Offsite guidance**
      i. Provide general guidance for subdivision improvements.
      ii. Provide general guidance for public property (Yellowstone County and City of Billings) for increasing culvert sizes or ditch sizes.

2. **Discharge South Under Highway 3**
   Provide recommendations for mitigation of the current storm water flow to the south side of Hwy 3. Currently there are two culverts that direct stormwater south under Highway 3.

3. **Identify a plan for overflow from detention ponds.**
   a. Ponds A, B, and C
   b. Pond D
   c. Pond D plus expansion
      i. Add outfalls in each valley to creek, limit size (12"?)
      ii. Add more cell storage
      iii. Add reverse pumping back to East pond system
   d. Pond E
      a. Add more storage cells to Pond E
   e. Future pond to the west

4. **Provide recommendations for Pond Sizing (Ponds A, B, C, D, and E)**

5. **Provide options for glycol treatment improvements.**
   a. Possibly in new pond near Pond D.
   b. Provide area for surface flow between TW "E" and TW "C"

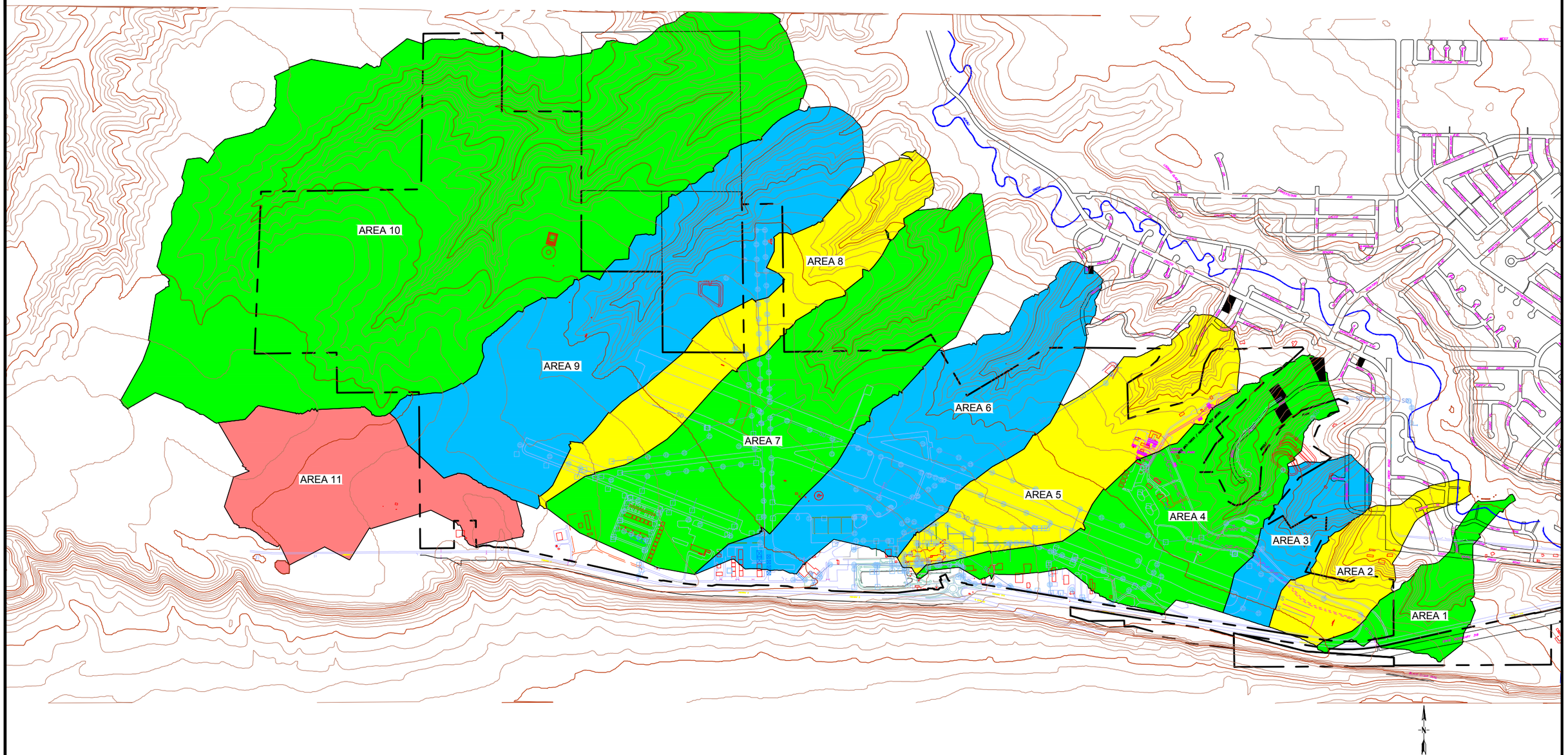
6. **Provide recommendations for new outfall routes**
    a. Pond C
    b. Pond D
    c. Prickly Pear outfall
    d. Area 7 – Taxiway “G” Area outfall
    e. Pond E Outfall /Area 9 – Area west of Runway 10L end
    f. Area 10 – Old ranch area

7. **Provide Preliminary Cost estimates for recommendations**
    a. Area 1 - Saddle Club East Drainage Area
    b. Area 2 - Saddle Club West Drainage Area
    c. Area 3 - Tumbleweed Drainage Area
    d. Area 4 - Moon Valley Drainage Area
    e. Area 5 - Sun Valley Drainage Area
    f. Area 6 - Prickly Pear Drainage Area
    g. Area 7 – Taxiway “G” Area
    h. Area 8 – Area at Runway 10L end
    i. Area 9 – Area west of Runway 10L end
    j. Area 10 – Old ranch area
    k. Area 11 – Windmill Area
    l. Area 12 – Pond E Drainage Area
    m. Area 13 – Airport Complex Area draining to Ponds A, B, C
    n. Area 14 – MDT Maintenance Area
    o. Glycol improvements
    p. New outfall routes (6)

8. **Prepare Report**
    a. Report
    b. Document data collected
    c. Document modeling output/results
    d. Prepare Figures and Drawings
    e. Prepare Cost Estimates

9. **QA/ QC Review of Report and Analysis**

10. **Agency Submittal and Permitting**
    a. Identify permitting needs for future construction
    b. Provide courtesy copy of 2012 SDMP to City of Billings, Yellowstone County, MDT District Office, Montana DEQ



NOTE:
TOPOGRAPHY FROM AERIAL
PHOTOGRAPHS BY MULTIPLEX METHODS
AND PLANETABLE SURVEYS 1957.

VERIFY SCALE!

THESE PRINTS MAY BE REDUCED. LINE BELOW MEASURES ONE INCH ON ORIGINAL DRAWING.

MODIFY SCALE ACCORDINGLY!

REVISIONS

NO.	DESCRIPTION	DATE	BY

V:\2447\084\ACAD\Exhibits\OLD EXHIBITS\EXHIBIT-2.dwg Plotted by Kent Kuehn on 6/23/11

MORRISON MAIERLE, INC.
An Employee-Owned Company

Engineers
Surveyors
Scientists
Planners

315 N. 25th Street, Suite 102
Billings, MT 59101

Phone: (406) 656-6000
Fax: (406) 237-1201

DRAWN BY:
DSGN. BY:
APPR. BY:
DATE:

Q.C. REVIEW
BY:
DATE:

BILLINGS LOGAN INTERNATIONAL AIRPORT

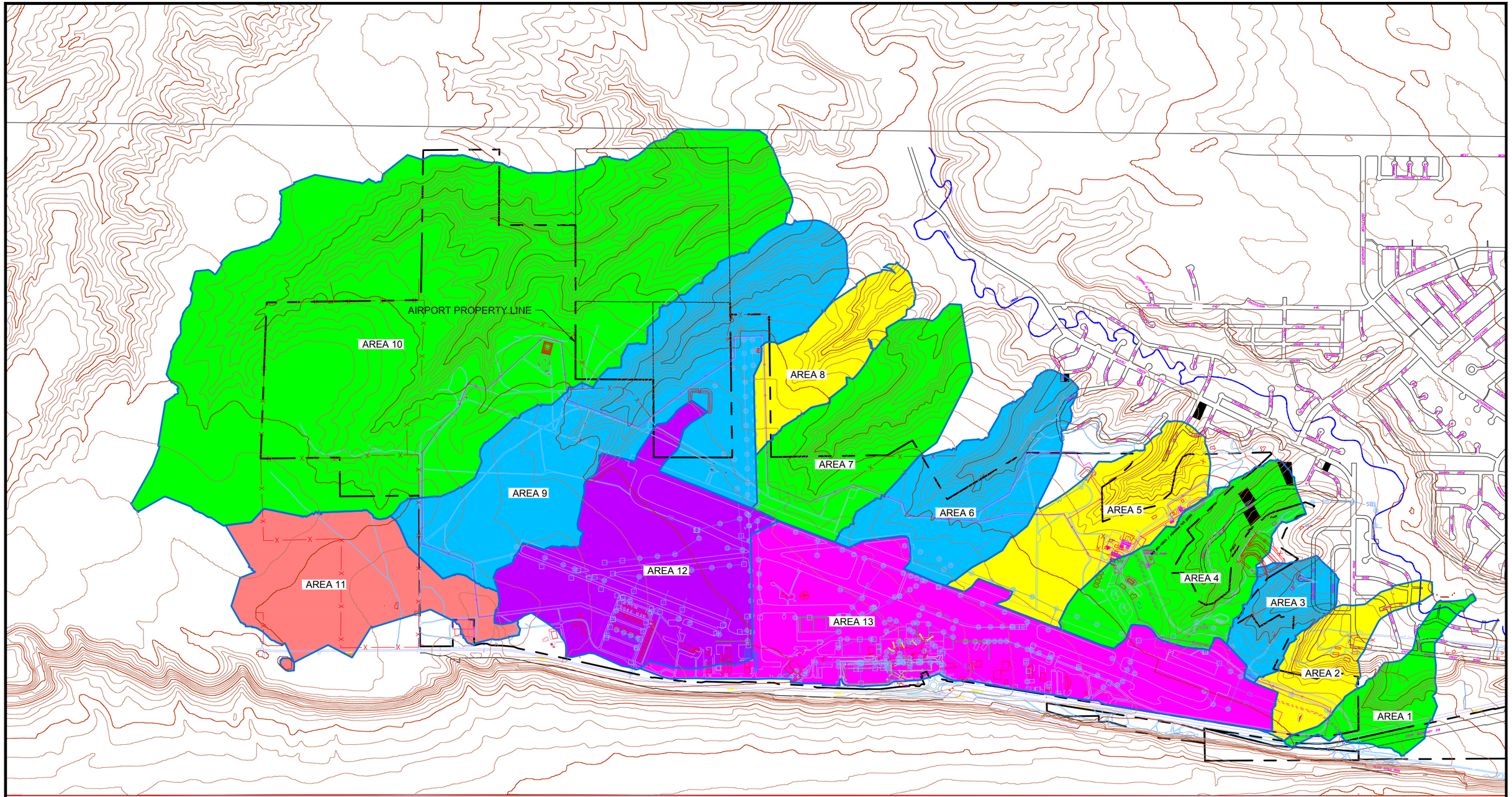
BILLINGS MONTANA

PRE-DEVELOPMENT CATCHMENT AREAS

PROJECT NUMBER

SHEET NUMBER

DRAWING NUMBER
1



NOTE:
TOPOGRAPHY BASED ON CITY OF BILLINGS AVIATION
AND TRANSIT DEPARTMENT 1996 DIGITIZED CONTOURS.

VERIFY SCALE!
THESE PRINTS MAY BE REDUCED. LINE BELOW MEASURES ONE INCH ON ORIGINAL DRAWING.
MODIFY SCALE ACCORDINGLY!

REVISIONS			
NO.	DESCRIPTION	DATE	BY

V:\2447\085\ACAD\Exhibits\EXHIBIT-2.dwg Plotted by Kent Kuehn on 6/23/11

MORRISON MAIERLE, INC.
An Employee-Owned Company
Engineers
Surveyors
Scientists
Planners
315 N. 25th Street, Suite 102
Billings, MT 59101
Phone: (406) 656-6000
Fax: (406) 237-1201

DRAWN BY:
DSGN. BY:
APPR. BY:
DATE:
Q.C. REVIEW BY:
DATE:

BILLINGS LOGAN INTERNATIONAL AIRPORT
BILLINGS MONTANA
CURRENT CATCHMENT AREAS

PROJECT NUMBER
SHEET NUMBER
DRAWING NUMBER 2

MORRISON MAIERLE, INC.
ENGINEERS • SURVEYORS • PLANNERS • SCIENTISTS

315 North 25th Street Suite 102
Billings, Montana 59101
P: 406.656.6000 | F: 406.237.1201