# DETAILED HYDROLOGIC MODEL
# HERSHEY MILL DAM

*Prepared For:*

**East Goshen Township**
**1580 Paoli Pike**
**West Chester, PA**

*Prepared By:*

**Advanced GeoServices**
**Project No. 2009-2484-00**
**February 4, 2010**

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
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## EXECUTIVE SUMMARY

During the preparation of our proposals for this project, Advanced GeoServices reviewed the results of the existing hydrologic modeling of the watershed of Hershey Mill Dam that was performed by others. Based on this review, and our experience and knowledge of the area, we believed that the calculated 100-year discharge rate of the existing modeling is higher than what has actually been observed and experienced. We compared the 100-year discharge rate of the existing hydrologic modeling to that calculated by USGS Peak Flow Regression Equations; the 100-year discharge rate calculated by the USGS Peak Flow Regression Equations is about 24 percent lower. As a result, we recommended the performance of detailed hydrologic modeling to determine the nature of the design flows of the watershed.

The existing hydrologic modeling (performed by others) considered the watershed as a whole ("single-basin") and did not include specific conditions such as stormwater management basins, roadway culverts, and ponds along the drainage courses as well as subbasin areas. The consideration of such conditions/features in hydrologic analyses has generally shown lower peak discharge rates versus the results that are typically calculated by "single-basin" type analyses.

The Detailed Hydrologic Model developed by Advanced GeoServices divides the watershed of Hershey Mill Dam into 20 subbasin areas and includes the following hydraulic features:

- Stormwater management basins at/within Immaculata University, the Weston Corporate Campus, and the residential communities of Mill Valley and Malvern Golf Club.
- Culvert crossings of Hershey Mill Road, Tanglewood Drive, Mill Stream Road, Anthony Way, Morstein Road, and King Road.
- Ponds within the Hershey's Mill subdivision and those south of Morstein Road.

The preparation of the Detailed Hydrologic Model included obtaining a digital GIS map of the watershed from Chester County DCIS/GIS as well as plans of the residential/institutional developments within the watershed that were available from East Goshen and East Whiteland Townships. In addition, we performed a detailed reconnaissance of the watershed to collect information in the field associated with the drainage features/conditions of the watershed.

The topographical, hydrologic, and hydraulic information obtained from the GIS map, available development plans, and from the reconnaissance of the watershed was correlated to develop input data for entry into HEC-HMS 3.4 software to calculate the 100-year, 24-hour storm discharge of the watershed. The peak inflow of the 100-year, 24-hour storm to the reservoir of Hershey Mill Dam calculated by the Detailed

Hydrologic Model is 1,089 cubic feet per second (cfs). This peak inflow is about 1,000 cfs less than that calculated by others.

The results of the Detailed Hydrologic Model were calibrated and correlate to accepted hydrologic/hydraulic conditions as well as to observations reported by East Goshen Township officials and local residents. It is our engineering opinion that the Detailed Hydrologic Model was developed in accordance with accepted hydrologic practices and credible investigations and is suitable for the design of improvements to the Hershey Mill Dam.

## INTRODUCTION

The Hershey Mill Dam (Dam) is located along the West Branch of Ridley Creek approximately 200 feet upstream of Greenhill Road in East Goshen Township, Chester County, Pennsylvania. The Dam consists of a 400 +/- feet-long earthen embankment with a 22-feet wide masonry spillway. The height of the Dam at the spillway is about 12 feet. The Dam is classified as "C-2 non-high hazard" and the design flood criterion of the Dam is the 100-year storm. An "Existing Conditions Plan" of the Dam developed by Yerkes Associates, Inc. is provided in the Drawing Section of this report.

Hydrologic modeling of the watershed of the Dam has been performed by others. Based on our review of this modeling and our knowledge of the area, we believed that the calculated 100-year discharge rate is higher than what has actually been observed and experienced. We compared the 100-year discharge rate of the existing hydrologic modeling to that calculated by USGS Peak Flow Regression Equations (Scientific Investigations Report 2008-5102); the 100-year discharge rate calculated by the USGS Peak Flow Regression Equations is about 24 percent lower. As a result, we recommended the performance of detailed hydrologic modeling to determine the nature of the design flows of the watershed.

The existing hydrologic modeling (performed by others) considered the watershed as a whole ("single-basin") and did not include specific conditions such as stormwater management basins, roadway culverts, and ponds along the drainage courses as well as subbasin areas. In order to determine the nature of the design storm flows for the Dam with the consideration of these features/conditions, Advanced GeoServices developed a Detailed Hydrologic Model of the watershed. Details regarding the development of this model are discussed in the following sections.

## MAPPING AND FIELD DATA

Topographical information used in the Detailed Hydrologic Model was obtained/ interpolated from a digital GIS map of the watershed obtained from Chester County DCIS/GIS. The digital GIS map shows aerial photography, topographical information (5-foot contour interval), roadways, wetlands, streams, ponds, and soils information. Development plans of the residential/institutional developments within the watershed (available from East Goshen and East Whiteland Townships) were also collected to obtain details regarding stormwater management facilities within the watershed.

On December 30, 2009, Advanced GeoServices personnel performed a reconnaissance of the watershed to collect information in the field associated with the drainage features/conditions of the watershed. The reconnaissance included the observation of the ground cover (vegetation, asphalt, etc.) of the watershed, the roughness characteristics of the drainage features, and the measurement of the dimensions of these drainage features. When development plans were not available, we measured the cross-sectional areas, lengths, and other pertinent dimensions of the drainage structures in the watershed; the invert elevations of these structures were interpolated/estimated from the GIS map.

The watershed of the Dam is located in East Goshen, East Whiteland, and West Whiteland Townships and generally consists of farms and low-density residential areas. However, the northern portion contains Immaculata University, the Weston Corporate Campus, Villa Maria Academy, and William Henry Apartments. The area of the watershed is approximately 1.78 square miles.

# MODEL DEVELOPMENT

## MODELING SOFTWARE

HEC-HMS 3.4 software was used to develop the Detailed Hydrologic Model and to calculate the design storm flows of the watershed. A map (Drainage Plan) of the watershed is provided as Figure 1. Details regarding the model development are provided below.

## METEOROLOGY DESCRIPTION

### Meteorologic Model

A Frequency-Based Hypothetical Storm was used to develop the meteorologic model for the watershed. The objective of the Frequency-Based Hypothetical Storm included in the HEC-HMS software program is to define an event for which the precipitation depths for various durations within the storm have a consistent annual exceedance probability (AEP). The methodology of the Frequency-Based Hypothetical Storm in the software program is summarized below.

- The total point-precipitation depths for the selected annual exceedance probability for durations from 5 minutes through the desired total duration of the hypothetical storm are specified.

- Point precipitation estimates from depth-duration-frequency studies (such as those presented in NOAA Atlas 14) are point estimates. However, intense rainfall is unlikely to be distributed uniformly over a large watershed; for a specified frequency and duration, the average rainfall depth over an area is less than the depth at a point. Therefore, the software program applies an area correction factor to the specified point-precipitation depths.

- The software program interpolates to find depths for durations that are integer multiples of the time interval selected in the runoff modeling. Linear interpolation is used, with logarithmically transformed values of the specified depth and duration.

- The software program finds successive differences in the cumulative depths; thus computing a set of incremental precipitation depths, each of duration equal to the selected computation interval.

- The software program uses the alternating block method (Chow, Maidment, Mays, 1988) to develop a hyetograph from the incremental precipitation values (blocks). This method positions the block of maximum incremental depth at the middle of the required duration. The remaining blocks are arranged then in descending order, alternately before and after the central block.

### Rainfall Design Storm

The design rainfall of the Dam is the 100-year (0.01-AEP) storm with 24-hour duration. Therefore, the total point-precipitation depths for 0.01-AEP from 5 minutes through 24 hours were entered into the model. In addition, the total point-precipitation depths for the 2-, 5-, and 10-year design storms (24-hour duration) were also entered into the model to check model calibration. The point-precipitation depths were obtained from NOAA Atlas 14. A copy of the point-precipitation depths obtained from NOAA Atlas 14 is included as Appendix A.

The 50% intensity position was selected in the model to designate where in the storm the period of peak intensity will occur. At the 50% intensity position, the peak of a 24-hour storm will occur at 12 hours into the storm.

Snowmelt and evapotranspiration were not included in the meteorologic model.

## SUBBASIN ELEMENTS

The watershed was divided into 20 subbasins. The delineation of the subbasins is shown on Figures 1 through 3. A subbasin in the modeling software is defined as an element that has no inflow and only one outflow. Outflow from each subbasin was computed from the meteorologic model by subtracting losses and transforming excess precipitation. The presence of baseflow was not considered in the model. The methodology used to determine losses and to transform excess precipitation is described below.

### Loss Method

The SCS Curve Number method was utilized to calculate rainfall losses for each subbasin area. Areal photography and soils information obtained from Chester County DCIS/GIS was used to assist in the determination of a Curve Number (CN) for each cover type. The areal photograph and soils map of the watershed obtained from Chester County DCIS/GIS are provided as Figure 2 and Figure 3, respectively.

The land cover types and amount of area of each cover type in each subbasin was identified and delineated from the aerial photography, as augmented by the site reconnaissance. The cover types utilized in the model consist of Impervious; Contoured Row Crops, Good; Woods, Good; Open Space, Good; and Meadow. Assumptions regarding the determination of the impervious coverage area in the watershed are summarized below.

- The total area of roadway within each subbasin was calculated assuming a 24-foot wide cartway for all roads, with the length of the roadways measured from the areal photography.

- The impervious coverage within each residential lot was calculated by first dividing the watershed into eight (8) areas; these areas were delineated based on similar dwelling size and driveway length. The largest and smallest dwelling in each area was averaged to calculate a typical dwelling unit for each area. The same method was utilized to calculate an average driveway footprint for each area. An additional impervious line item was also used to account for walkways, patios, outbuildings, and dwellings that did not have similar footprints.

- The impervious footprints of the buildings and parking lots within the Weston Corporate Campus, Immaculata University, Villa Maria Academy, William Henry Apartments, and several large farms were measured directly from the aerial photography.

Curve Number values for each cover type were obtained from the "National Engineering Handbook: Hydrology" (210-VI-NEH, July 2004). These Curve Number values are based on an Initial Abstraction ratio ($\lambda=I_a/S$) of 0.2. Recent investigations of the Initial Abstraction ratio ($\lambda$) documented in "Curve Number Hydrology: State of Practice" prepared by the ASCE/EWRI Curve Number Hydrology Task Committee found that a value of $\lambda=0.05$ is more appropriate for runoff calculations. Accordingly, conjugate Curve Numbers for each cover type were calculated based on $\lambda=0.05$. The conjugate Curve Numbers were then used to calculate weighted CN values for each subbasin.

The Initial Abstraction ($I_a$) is defined as the amount of precipitation that must fall before surface excess results and was calculated for each subbasin as 0.05 times the potential retention (S) calculated from the weighted CN values.

Calculations for the conjugate Curve Numbers, weighted CN values, and Initial Abstraction are included in Appendix B.

Transforming Excess Precipitation

The SCS unit hydrograph method was used to transform the excess precipitation into outflow (runoff). The "Standard" shape hydrograph was used in the modeling.

In this method, the general hydrograph is scaled by the lag time to produce the unit hydrograph for use to calculate runoff. The standard lag is defined as the length of time between the centroid of precipitation mass and the peak flow of the resulting hydrograph.

The Curve Number method was used to calculate the lag time for each subbasin. Input parameters for the Curve Number Method are the hydraulic length, weighted CN, and average land slope of the subbasin. The Contour Length Method was used to calculate the average land slope. Calculations for the determination of the lag time for each subbasin are included as Appendix C. The hydraulic length of each subbasin used in these calculations is identified on Figure 1.

## REACH ELEMENTS

Drainage channels and streams in the watershed were modeled as reach elements. In the modeling software, a reach is an element with one or more inflow and only one outflow. When more than one inflow is present, all inflow is added together before computing the outflow of the reach.

For the modeling, inflows including the upstream subbasins and reservoirs (basin/ponds and road crossings) were routed through reaches, as appropriate. The Muskingum-Cunge routing method was used to calculate the runoff from each reach. This method is based on the combination of the conservation of mass and the diffusion representation of the conservation of momentum and requires the input of the following parameters:

- Reach length
- Slope (the average slope of the whole reach)
- Reach cross-section shape (in general the eight point method was used to define the main channel and overbank areas of each reach)
- Manning's n roughness coefficients

The length, slope, and cross-sectional shape of each reach were measured/calculated from the elevation contours shown on the GIS map, as augmented by the site reconnaissance. Values of Manning's n roughness coefficients were obtained from Chow (Chow, 1959); the winter season was assumed for the selection of the Manning's n values. A table listing the length, slope, and Manning's n roughness coefficients for each reach is provided in Appendix D.

## RESERVOIR ELEMENTS

A reservoir is an element with one or more inflow and one computed outflow and is used in the software program to model lakes, ponds, stormwater management basins, and other features that control the rate of runoff. When there is more than one inflow into the reservoir element, all inflow is added together before computing the outflow.

Selected stormwater management basins, ponds, and road crossings within the watershed were modeled as reservoirs as discussed below. The locations of these elements are shown on Figures 1 and 2.

- Inflow into these elements included upstream subbasins and reaches of the watershed.

- Storage of the stormwater management basins, ponds, and road crossings was computed using the elevation-area method. Areas were measured from the elevation contours shown on the GIS map. The reservoir storage calculations for each element are included in Appendix E.

- Outflow from the basins/ponds was modeled using a stage-discharge curve computed for each element. Inlet control was assumed for each basin/pond. Stage-discharge tables for each element are included in Appendix E. The elevation contours shown on the GIS map were used to develop the stage-discharge curves.

- Outflow at the road crossings was computed by modeling each culvert in the software program. A table summarizing the culvert information at each road crossing is provided in Appendix E.

Photographs of the stormwater basins, ponds, road crossings, and reaches are included as Appendix F.

## CALCULATED DESIGN STORM FLOW

The design flood criterion of the Dam is the 100-year storm. The peak inflow and outflow of the Hershey Mill reservoir as well as the overtopping elevation of the Dam for the 100-year design storm as calculated by the Detailed Hydrologic Model are listed below.

- Peak Inflow = 1,089 cfs
- Peak Outflow = 1,087 cfs
- Overtopping Elevation = 450.1 (Top-of-Dam Elevation = 449.6)

## MODEL CALIBRATION AND CONCLUSIONS

In order to check calibration of the Detailed Hydrologic Model, the following conditions were evaluated:

- Bank-full flow of the reaches
- Water surface elevations at the Dam and Road Crossings

The results of these evaluations are presented below.

## BANK-FULL FLOW

Bank-full flow in drainage features (streams, rivers, etc.) is generally considered to correspond to the 2-year storm event. In order to compare the top-of-bank elevations measured/observed at selected locations in the field to the water surface elevation of the 2-year storm event computed at these locations, the total point-precipitation depths for the 2-year rainfall event (24-hour duration) were entered into the model. The comparison of the top-of-bank elevations to the computed water surface elevations is provided in the following table.

| Reach Name | Top of Bank Elevation | Water Surface Elevation |
|---|---|---|
| 1 | 469.0 | 469.0 |
| 2 | 494.5 | 493.4 |
| 3 | 449.9 | 450.4 |
| 4 | 467.0 | 466.5 |
| 6 | 459.0 | 459.5 |
| 7 | 481.5 | 480.8 |
| 8 | 513.0 | 511.4 |
| 9 | 478.5 | 477.6 |
| Greenhill Road | 436.0 | 436.0 |

## WATER SURFACE ELEVATIONS AT THE DAM AND ROAD CROSSINGS

Water surface elevations at the Dam and Road Crossings for the 2-, 5-, 10-, and 100-year storm events were computed in the model in order to compare these elevations to PaDOT design standards as well as observations made by East Goshen Township Officials and local residents. The following table compares the computed water surface elevations for each storm event to the top-of-Dam/Road Crossing elevations.

| Structure | Description | Top of Structure | Water Surface Elevation | | | |
|---|---|---|---|---|---|---|
| | | | 100-yr | 10-yr | 5-yr | 2-yr |
| Road Crossing 1 | Tanglewood Dr | 490.0 | 483.3 | 481.3 | 480.2 | 479.9 |
| Road Crossing 2 | Tanglewood Dr | 472.5 | 469.4 | 467.1 | 466.4 | 465.4 |
| Road Crossing 3 | Mill Stream Rd | 485.0 | 478.0 | 475.6 | 474.8 | 473.7 |
| Road Crossing 4 | Anthony Rd | 501.0 | 495.0 | 492.8 | 492.0 | 491.0 |
| Road Crossing 5 | Hershey Mill Rd | 460.0 | 460.3 | 460.1 | 458.7 | 456.0 |
| Road Crossing 6 | King Rd | 544.5 | 543.8 | 542.0 | 451.5 | 540.7 |
| Road Crossing 7 | Morstein Rd | 502.5 | 500.9 | 498.9 | 498.3 | 497.5 |
| Greenhill Road | Greenhill Rd | 438.1 | 439.0 | 438.3 | 437.0 | 435.0 |
| Dam | Dam | 449.6 | 450.1 | 449.5 | 449.1 | 448.4 |

* Shaded areas denote overtopping

Based on our understanding of PaDOT roadway culvert design as well as discussions with Township Officials and local residents, we have the following comments regarding the above comparisons.

- East Goshen Township Officials report that overtopping at Morstein Road, Mill Stream Road, and Tanglewood Drive has not been observed. This observation is consistent with the computed water surface elevations at these locations.

- East Goshen Township Officials and local residents report that Hershey Mill Road has overtopped on occasion. In addition, during our field reconnaissance, we observed evidence of overtopping (bank erosion, etc.). The computed water surface elevations at this crossing show that storms greater than the 10-year event overtop the road; this is consistent with the Township/resident's reports.

- Greenhill Road is a State Road (S.R. 2018). We understand that a minimum design storm for PaDOT Roads is the 10-year storm. The computed water surface elevation for the 10-year storm overtops Greenhill Road by about 2 inches, indicating that the computed 10-year storm event correlates reasonably well with the expected minimum culvert capacity.

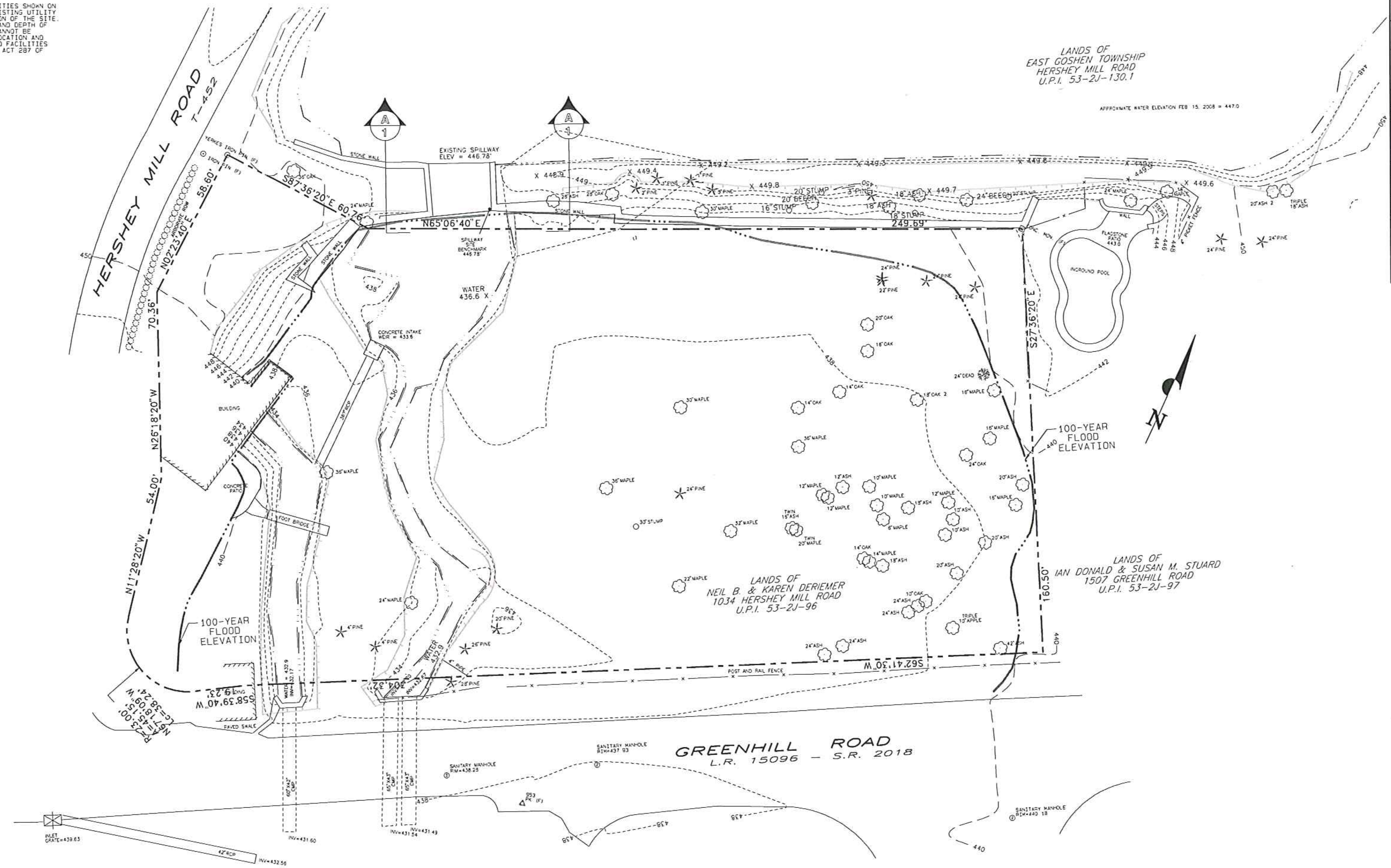
- Residents living adjacent to the Dam report that the Dam overtops about every 10-years. This report is consistent with the computed water surface elevations at the Dam.

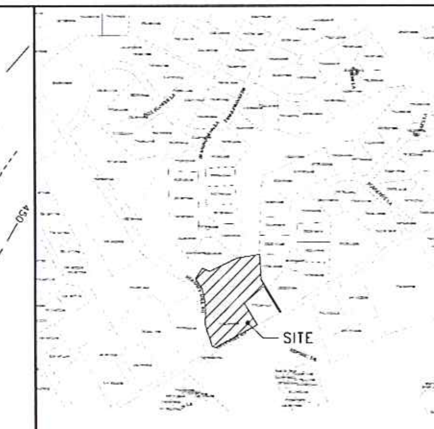
## CONCLUSIONS

It is our engineering opinion that the Detailed Hydrologic Model was developed in accordance with accepted hydrologic practices as well as credible investigations. In addition, the water surface elevations computed in the model correlate to accepted hydrologic/hydraulic conditions as wells as to observations reported by East Goshen Township officials and local residents. Therefore, we believe that the 100-year peak inflow of 1,089 cfs calculated by the Detailed Hydrologic Model is suitable for the design of improvements to the Hershey Mill Dam.

# DRAWING

NOTE: ALL LOCATIONS OF EXISTING UTILITIES SHOWN ON THIS PLAN HAVE BEEN DEVELOPED FROM EXISTING UTILITY RECORDS AND/OR ABOVE GROUND EXAMINATION OF THE SITE. COMPLETENESS OR ACCURACY OF LOCATION AND DEPTH OF UNDERGROUND UTILITIES OR STRUCTURES CANNOT BE GUARANTEED. CONTRACTOR MUST VERIFY LOCATION AND DEPTH OF ALL UNDERGROUND UTILITIES AND FACILITIES BEFORE START OF WORK PER PENNSYLVANIA ACT 287 OF 1974 AS AMENDED BY ACT 199 of 2004.
SERIAL #




LOCATION MAP

APPROX. SCALE: 1" = 800'

Copyright ADC The Map People Permitted Use Number 20020114


General Notes:

1. Reference Plans:

A. Plan of Property for Neil De Reimer, prepared by Chester Valley Engineers, Inc., dated July 7, 2004.

2. Topography and physical feature locations are based upon a field survey performed by Yerkes Associates, Inc. during February 2008. Site benchmark: 446.78', datum NAVD 1988.

3. Property lines shown have been developed from existing recorded deeds, plans, and, when available, according to field located monuments, iron pins, and iron pipes. No property line should be construed as actual boundary survey by this office.

4. All locations of existing utilities shown on this plan have been developed from utility records and/or above ground examination of the site. Completeness or accuracy of location and depth of underground utilities or structures cannot be guaranteed. Contractor must verify location and depth of underground utilities before start of work as per Act 38.

5. 100 year flood plain boundary per FEMA Flood Insurance Rate Map, panel 42029C0160F.

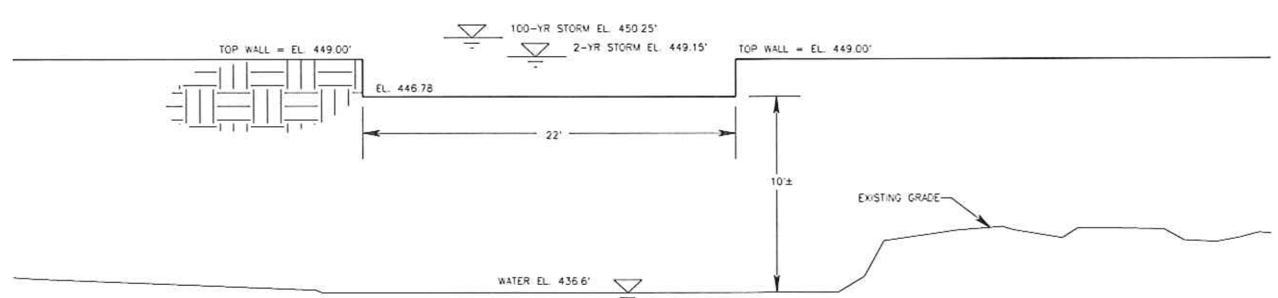
6. The site soils consist of Wehadkee Silt Loam (We) and Manor Loam (MgD2).

7. All excavations, trenching, and shoring operations shall comply with the requirements of the U.S. Department of Labor, O.S.H.A. "Construction Safety and Health Regulations", Vol. 39, No. 122, Sub-Part P and any amendment thereto.

8. All construction methods and materials must comply with the following appropriate specifications:

A. PENNDOT Pub. 408/94 "Specifications" with current revisions.

B. East Goshen Township constructions standards, specifications, and codes.




A-A / 1 EXISTING SPILLWAY
APPROX. SCALE: 1"=5'

| NO. | DATE | REVISION COMMENT |
|---|---|---|
| | | |
| | | |
| | | |

# EXISTING CONDITIONS

**PRELIMINARY**

**HERSHEY'S MILL DAM RESTORATION**

PREPARED FOR

**EAST GOSHEN TOWNSHIP**

East Goshen Township • Chester County • Pennsylvania

Yerkes

**YERKES ASSOCIATES, INC.**

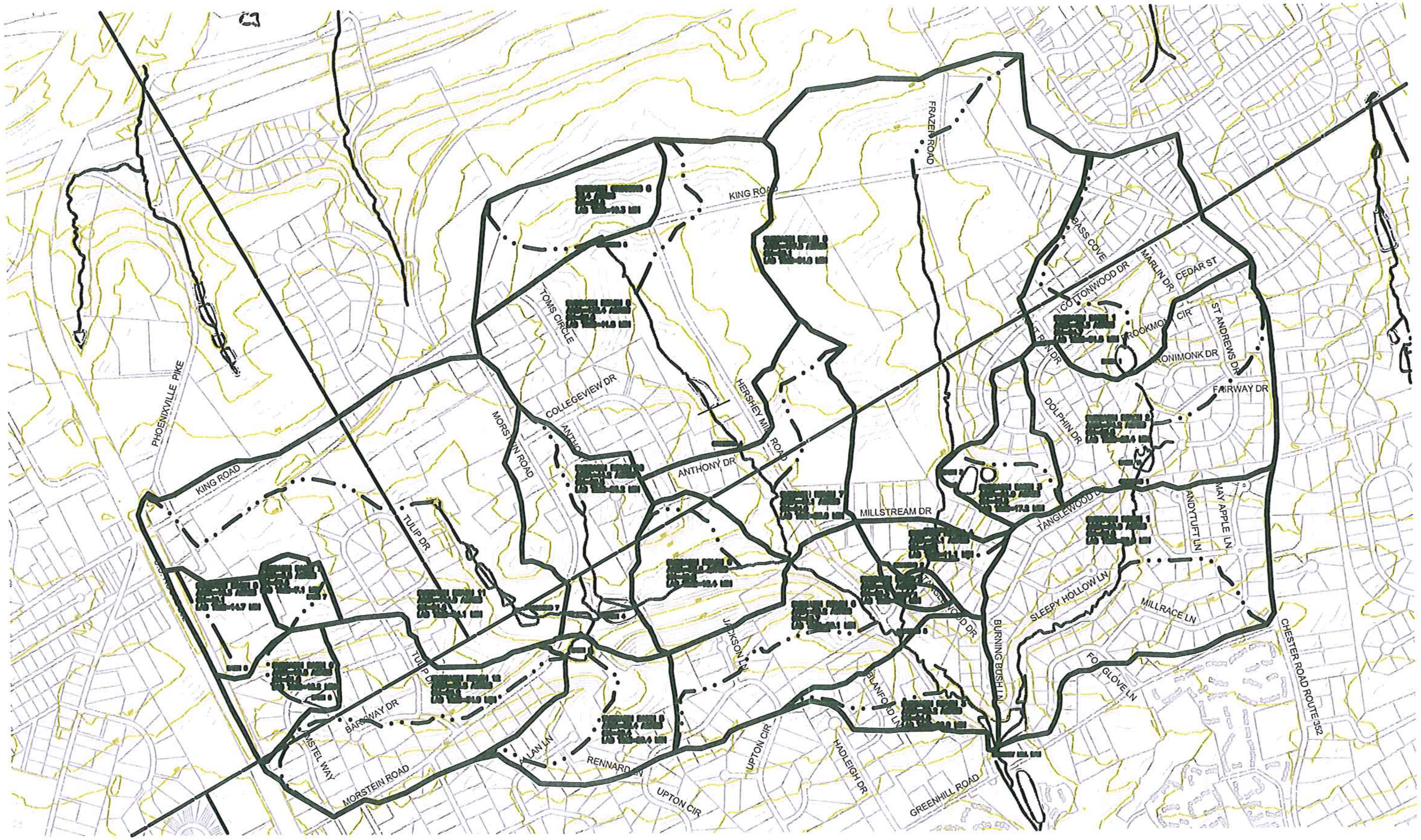
CONSULTING ENGINEERS • SITE PLANNERS • LAND SURVEYORS

1444 PHOENIXVILLE PIKE • P.O.BOX 1568 • WEST CHESTER, PA 19380
TEL: (610) 644-4254 • FAX: (610) 640-0771

PROJECT – W-08-4278-006
DATE – 3/28/2008
SCALE – 1" = 20'
DRAWN – FB
CHECKED – MC
CAD FILE– W4278-06.PRO
TAX PARCEL –
NOTEBOOK –
PLAN NO.

**SHEET 1 OF 4**

# FIGURES




NOTES:

1. ROADWAY, TOPOGRAPHICAL, LOT, STREAM, AND POND INFORMATION AND LOCATIONS OBTAINED FROM CHESTER COUNTY DCIS/GIS IN NOVEMBER 2009.

2. DELINEATION OF SUBBASIN BASIN 7 AND SUBBASIN BASIN 8 BASED ON A SITE RECONNAISSANCE PERFORMED ON DECEMBER 30, 2009.

**LEGEND**

- LAG TIME
- STREAM
- SUBBASIN AREA DIVIDE
- 5 FOOT CONTOURS
- 25 FOOT CONTOURS

NORTH

GRAPHIC SCALE

( IN FEET )
1 inch = 400 ft.

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1055 ANDREW DRIVE, SUITE A
WEST CHESTER, PENNSYLVANIA 19380

EAST GOSHEN TOWNSHIP
1580 PAOLI PIKE
WEST CHESTER, PENNSYLVANIA 19380

HERSHEY MILL DAM
DETAILED HYDROLOGIC MODEL

DRAINAGE PLAN

FIGURE 1

| | |
|---|---|
| Scale | 1" = 400' |
| Engineered By | |
| Drawn By | RA |
| Checked By | RRP |
| Project Mgr | TDT |
| Project No. | 20092484 |
| Sheet No. | 1 OF 3 |
| Issued | |

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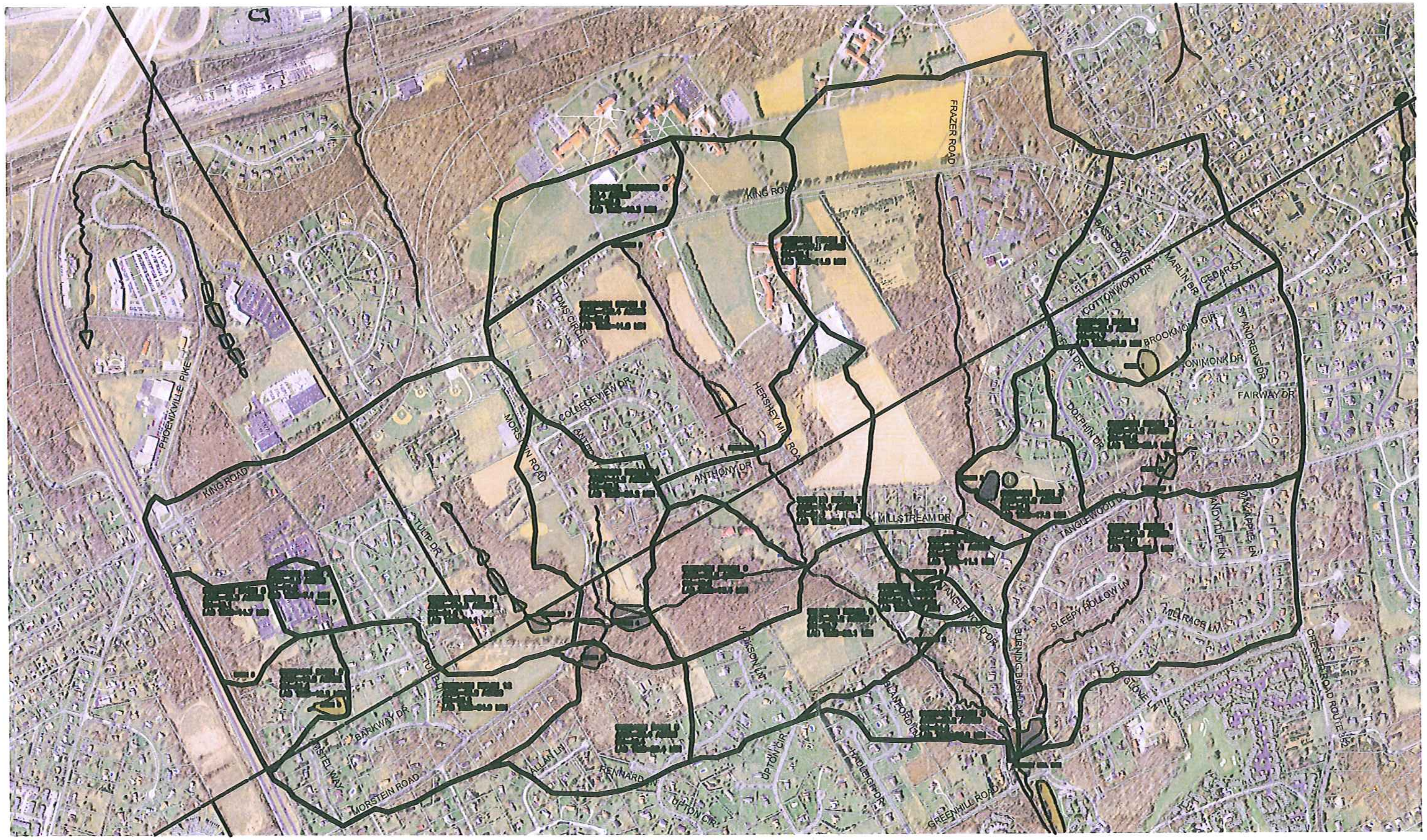


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2. DELINEATION OF SUBBASIN BASIN 7 AND SUBBASIN BASIN 8 BASED ON A SITE RECONNAISSANCE PERFORMED ON DECEMBER 30, 2009.

**LEGEND**

STREAM
SUBBASIN AREA DIVIDE

NORTH

GRAPHIC SCALE
( IN FEET )
1 inch = 400 ft.

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HERSHEY MILL DAM
DETAILED HYDROLOGIC MODEL

COVER TYPE PLAN

FIGURE 2

| | |
|---|---|
| Scale | 1" = 400' |
| Designed By | |
| Drawn By | RA |
| Checked By | RRP |
| Project Mgr | TDT |
| Project No. | 20092484 |
| Sheet No. | 2 OF 3 |

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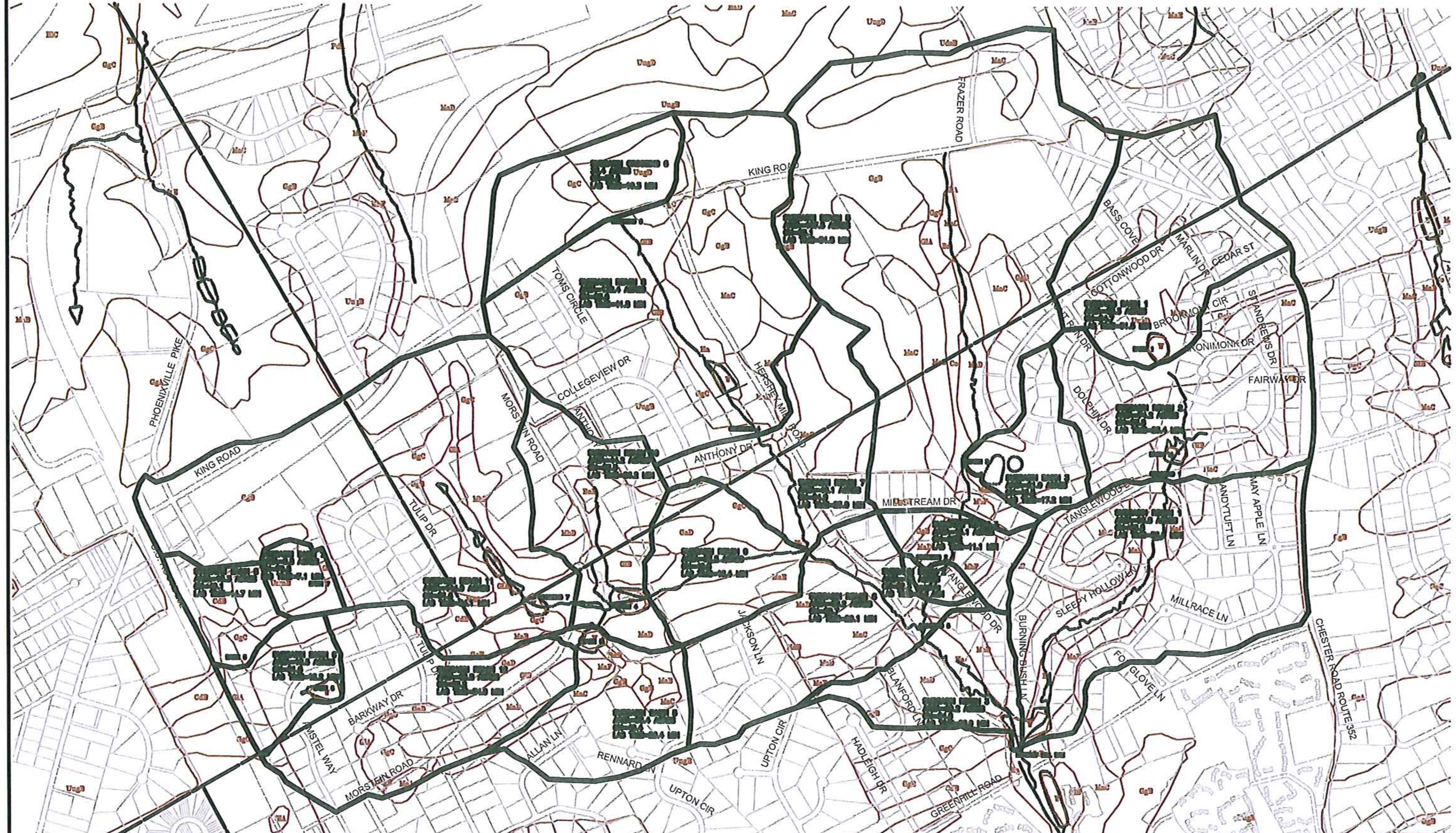


| SYMBOL | HYDROLOGIC GROUP | NAME |
|---|---|---|
| Ba | D | Baile silt loam |
| BaB | D | Baile silt loam, 3 to 8 percent slopes |
| CdA | B | Chester silt loam, 0 to 3 percent slopes |
| CdB | B | Chester silt loam, 3 to 8 percent slopes |
| Co | C | Codorus silt loam, 0 to 3 percent slopes |
| CGaD | B | Gaila silt loam, 15 to 25 percent slopes |
| GgA | A | Glenelg silt loam, 0 to 3 percent slopes |
| GgB | A | Glenelg silt loam, 3 to 8 percent slopes |
| GgC | A | Glenelg silt loam, 8 to 15 percent slopes |
| GgD | A | Glenelg silt loam, 15 to 25 percent slopes |
| GlA | C | Glenville silt loam, 0 to 3 percent slopes |
| GlB | C | Glenville silt loam, 15 to 25 percent slopes |
| Ha | D | Hatboro silt loam, 0 to 3 percent slopes |
| MaA | B | Manor loam, 0 to 3 percent slopes |
| MaB | B | Manor loam, 3 to 8 percent slopes |
| MaC | B | Manor loam, 8 to 15 percent slopes |
| MaD | B | Manor loam, 15 to 25 percent slopes |
| MaE | B | Manor loam, 25 to 35 percent slopes |
| MaF | B | Manor loam, 35 to 60 percent slopes |
| MbD | B | Manor loam, 8 to 25 percent slopes, very stoney |
| MbF | B | Manor loam, 0 to 3 percent slopes, very stoney |
| UdsB | B | Udorthents, schist and gneiss complex, 0 to 8 percent slopes |
| UrmB | B | Urban land–Glenelg complex, 0 to 8 percent slopes |
| UugB | B | Urban land–Udorthents, schist and gneiss complex, 0 to 8 percent slopes |
| UugD | B | Urban land–Udorthents, schist and gneiss complex, 8 to 25 percent slopes |
| W | D | Water |

## LEGEND

STREAM

SUBBASIN AREA DIVIDE

SOILS LIMITS

GRAPHIC SCALE

( IN FEET )
1 inch = 400 ft.

NORTH

NOTES:
1. ROADWAY, TOPOGRAPHICAL, LOT, STREAM, AND POND INFORMATION AND LOCATIONS OBTAINED FROM CHESTER COUNTY DCIS/GIS IN NOVEMBER 2009.

2. DELINEATION OF SUBBASIN BASIN 7 AND SUBBASIN BASIN 8 BASED ON A SITE RECONNAISSANCE PERFORMED ON DECEMBER 30, 2009.

| DATE | REVISION |
|---|---|
| | |

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1055 ANDREW DRIVE, SUITE A
WEST CHESTER, PENNSYLVANIA 19380

EAST GOSHEN TOWNSHIP
1580 PAOLI PIKE
WEST CHESTER, PENNSYLVANIA 19380

HERSHEY MILL DAM
DETAILED HYDROLOGIC MODEL

SOILS PLAN

FIGURE 3

| | |
|---|---|
| Scale | 1" = 400' |
| Designed By | |
| Drawn By | RA |
| Checked By | RRP |
| Project Mgr | TDT |
| Project No. | 20092484 |
| Sheet No. | 3 OF 3 |

# APPENDICES