Appendix H
Stormwater Management Report

DRAFT – Stormwater Management Report

Aquabella at Rancho Belago

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1 Introduction

The Aquabella project site is located in the City of Moreno Valley, Riverside County, California. The project site encompasses 673 acres which will be primarily composed of multi-family residential areas, and supporting land uses such as open space, parks, schools, and roads. The site will include approximately 40 acres of lakes and ponds which will serve as multi-purpose stormwater management facilities. The project was the subject of engineering analyses in 2005, including detailed analyses of hydrology/hydraulics, water quality, and lake design. Although some features of the project have changed, notably the inclusion of more residential units per acre, from a hydrologic standpoint the project remains much like the project proposed and evaluated in 2005 and again in 2019. The higher density of residential units in the current plan will be accomplished through buildings with more floors than previously envisioned, and this change will be accompanied by the use of parking structures in many areas rather than reliance only on parking lots. These changes will result in approximately the same imperviousness as the previous plan, and relatively minor changes to runoff volumes, flow rates, and water quality. Therefore, the runoff from the current proposed conditions is shown herein to remain similar to the proposed conditions examined in the 2005 WQMP.

Aquabella is located in the Santa Ana River Watershed and the project site is included in the Moreno Area Drainage Plan and Moreno Master Drainage Plan prepared by the Riverside County Flood Control and Water Conservation District (RCFCWCD). Riverside County Flood Control & Water Conservation District (RCFC&WCD) administers the NPDES MS4 Permit program for the project site, thus the site is required to follow design guidelines of the “Design Handbook for Low Impact Development Best Management Practices” (RCFCWCD 9/2011). BMPs, primarily consisting of lakes but including various other BMPs, will be used to enhance water quality of runoff leaving the site, and lake systems will be used for flood control to ensure the peak flow of post development conditions does not exceed the peak flow of pre-development conditions.

Aquabella will be designed to provide stormwater runoff treatment for water quality through the manmade lakes and other BMPs and route stormwater flow through the lake system for flood control. The majority of the site will drain toward approximately 5 manmade lakes totaling approximately 40 acres in surface area. In some portions of the site BMPs, such as bio-retention basins, will be used to reduce and treat site runoff before stormwater is discharged to the lakes or into public waterways. This will improve water quality by reducing non-point source pollutant loads to meet Total Maximum Daily Loads (TMDLs) and NPDES stormwater regulations. The lakes will be designed to detain all runoff and release at a rate that will not impact offsite drainage facilities. Proposed storm drains will convey runoff from drainage areas and proposed development into the lakes. The lakes will be used as stormwater detention basins to attenuate the peak runoff before releasing to offsite drainage facilities. The implementation of the lakes and BMPs will reduce flow rates, volumes and pollutants from post development runoff.

2 Site Hydrology

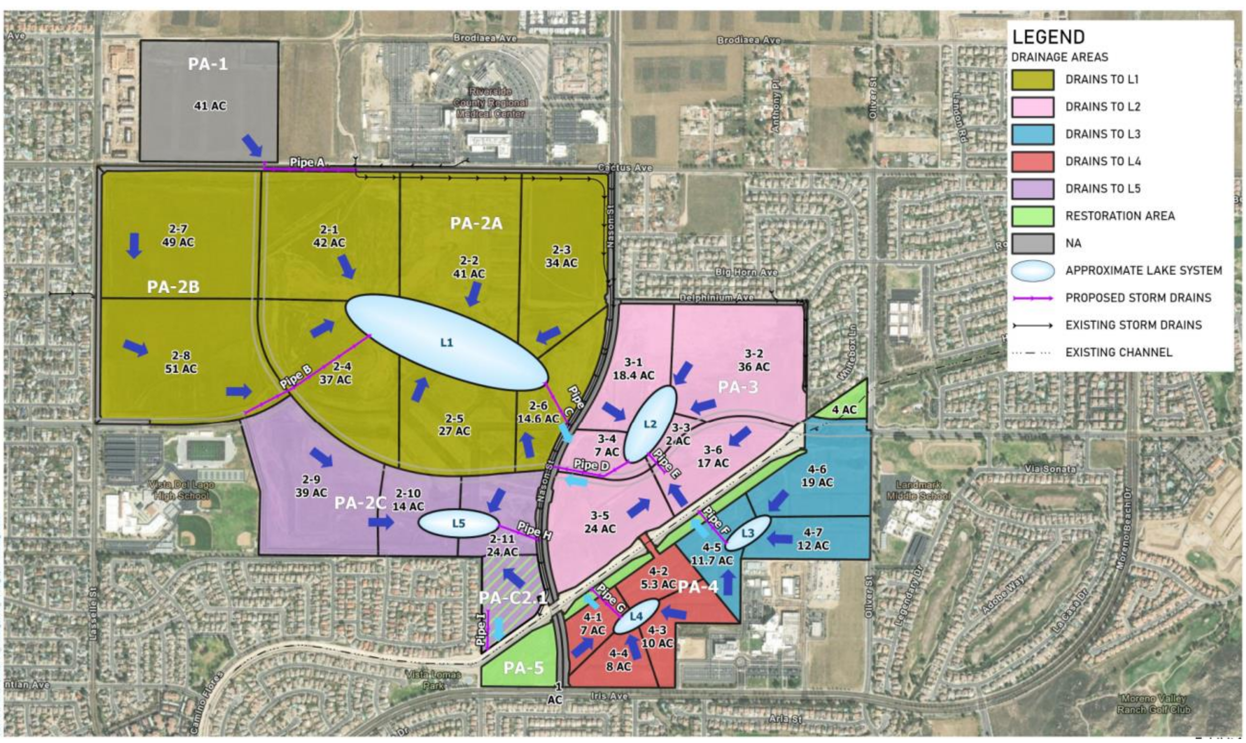
2.1 Existing Site Conditions

The Aquabella project site was partially graded to previous drainage design plans in 2006, and grades remain relatively unchanged since 2006. Since that time the site has remained fallow, and a variety of grasses and herbaceous plants are now present on the graded site. Runoff from the site overflows throughout the land and drains south into existing channel, storm drain Line F. Offsite flow is conveyed by an existing storm drain that runs through Nason Street (MADP J-10) and discharges into Line F. Line F is a concrete trapezoidal channel that is maintained by RCFC&WCD and conveys captured runoff to Lake Elsinore.

2.2 Proposed Hydrology and Drainage Facilities

The proposed project will be designed so that stormwater drains to a system of lakes to detain runoff created from the development of the Aquabella project. There will be five lakes located throughout the site, as shown in **Figure 2-1**. Lake 1 and Lake 5 are located within PA-2 and will be approximately 25 acres and 5 acres, respectively. Lake 2 is located in PA-3 and will be approximately 5 acres. Lake 3 and Lake 4 are located in PA-4 and each lake will be approximately 2.5 acres. A portion of PA2C, labeled PA2C.1 in Figure 2-1, slopes away from the lakes and will be equipped with a separate BMP to meet MS4 permit requirements.

Figure 2-1 Aquabella Project Site



A hydrologic analysis of the project site was performed following the RCFC&WCD Hydrology Manual. The Synthetic Unit Hydrograph Method was used to create a flood hydrograph for each of the lakes. To determine the amount of runoff being captured by the lakes the project site was divided into twenty-four sub-watersheds. Each sub-watershed is a drainage area to one of the lakes. The developed land will include multi-family residential areas, roads, schools and other supporting residential land uses that will affect the imperviousness of the site and thus affect runoff volume. Within PA-2A there is a proposed Town Center that will have a higher percentage of impervious cover than other land uses and will discharge into Lake 1.

Lake 1 and Lake 5 will be located in PA-2. Lake 1 will receive runoff from a 295.6-acre drainage area of PA-2A and PA-2B. Lake 5 will capture runoff from a 66-acre drainage area of PA-2C. Lake 2 will receive runoff from a 104.4-acre drainage area of PA-3. Lake 3 and Lake 4 will both be located in PA-4. Lake 3 will receive runoff from a 42.7-acre drainage area of PA-4 and Lake 4 will receive runoff from a 30.3-acre drainage area of PA-4. **Table 3-1** shows the watershed characteristics for the Aquabella project site.

The runoff at the project site is dependent on the existing soil type, land use, loss rates and precipitation depth data. The hydrologic soil group for Aquabella is Group B having moderate infiltration with a moderate rate of water transmission. The land use for the proposed conditions will include multiple family residential development, mainly comprised of apartments. The loss rate was determined utilizing the runoff index corresponding to the land cover and the Antecedent Moisture Conditions. The adjusted loss rate was calculated using the equation on page E-7 of the RCFC&WCD Hydrology Manual to account for impervious surfaces. **Table 3-2** lists the values of the infiltration parameters. The precipitation depth data was obtained from NOAA Atlas 14 (Point Precipitation Frequency Estimates, March 31, 2023). The flood hydrographs follow the trend of the Rainfall Patterns in Percent of the RCFC&WCD Hydrology Manual Plate E 5.9. **Appendix A** shows the flood hydrographs for each of the Aquabella lakes.

Runoff from PA-2A and PA-2B will drain into Lake 1. Runoff will reach the lake through standard stormwater infrastructure including gutters along roads and streets as well as storm drain pipes. Runoff from PA-2B will be discharged into Lake 1 through Pipe B. Water will be released from Lake 1 through Pipe C to the Nason Street existing storm drain and be discharged into Line F. Lake 2 will capture runoff from PA-3 through standard stormwater infrastructure including gutters along roads and streets as well as storm drain pipes and through Pipe E. Water will be released from Lake 2 through Pipe D to the Nason Street existing storm drain and be discharged into Line F. Runoff from PA-4 will drain into Lake 3 and Lake 4 through standard stormwater infrastructure including gutters along roads and streets as well as storm drain pipes. Water will be released from Lake 3 and Lake 4 through Pipe F and Pipe G, respectively, and discharged into Line F. Runoff from most of PA-2C will drain into Lake 5 through standard stormwater infrastructure including gutters along roads and streets as well as storm drain pipes and be released through Pipe H to the Nason Street existing storm drain and be discharged into Line F. A portion of PA2C, labeled PA 2C.1 on Exhibit 1, slopes away from Lake 5 and will drain to a stormwater BMP that will improve water quality before releasing the runoff to Line F. **Exhibit 1** shows the drainage areas corresponding to each lake, the direction of flow into the lakes and the proposed storm drains that will discharge outflows to Line F.

Table 2-1: Sub-Watershed Characteristics

Lake	Sub-Watershed	Land Use	Acres	Percent Impervious
Lake 1		Open Water	25	100
	PA2_1	Multi-Family	42	80
	PA2_2	Multi-Family	41	80
	PA2_3	Multi-Family	34	80
	PA2_4	Multi-Family	37	80
	PA2_5	Town Center	27	90
	PA2_6	Multi-Family	14.6	80
	PA2_7	Multi-Family	49	80
	PA2_8	Multi-Family	51	80
PA-2A & PA-2B Total Acres			295.6	
Lake 2		Open Water	5	100
	PA3_1	Multi-Family	18.4	80
	PA3_2	Multi-Family	36	80
	PA3_3	Multi-Family	2	80
	PA3_4	Multi-Family	7	80
	PA3_5	Multi-Family	24	80
	PA3_6	Multi-Family	17	80
PA-3 Total Acres			104.4	
Lake 3		Open Water	2.5	100
	PA4_5	Multi-Family	11.7	80
	PA4_6	Multi-Family	19	80
	PA4_7	Multi-Family	12	80
PA-4 Total Acres			42.7	
Lake 4		Open Water	2.5	100
	PA4_1	Multi-Family	7	80
	PA4_2	Multi-Family	5.3	80
	PA4_3	Multi-Family	10	80
	PA4_4	Multi-Family	8	80
PA-4 Total Acres			30.3	
Lake 5		Open Water	5	100
	PA2_9	Multi-Family	39	80
	PA2_10	Multi-Family	14	80
	PA2_11	Multi-Family	13	80
PA-2C Total Acres			66	

Notes:
1. Percent impervious values for type of development were obtained from the RCFC&WCD Hydrology Manual 1978.
2. The lakes are assumed to be 100% impervious since all rainfall contributes to the lake.

Table 2-2: Project Site Infiltration Parameters

Infiltration Parameters	
Hydrologic Soil Group	B
Soil Cover Type	Good
Land Use	Multiple Family Residential-Apartments
Antecedent Moisture Conditions	II
Runoff Index	56
Loss Rate	0.51
Adjusted Loss Rate	0.142

3 Stormwater Hydraulics

Stormwater hydraulics of the Aquabella Lakes has been performed using XPSWMM to estimate the discharges into the lakes, the maximum storage depth of each lake and the outflow from each lake to Line F. The stormwater routing demonstrates that the peak discharge of post development conditions does not exceed the peak discharge of pre-development conditions.

The stormwater routing presented herein is based on full capture of the 100-year storm runoff volumes. The lakes proposed for Aquabella provide enough stormwater detention capacity to capture and hold all of the 100-year storm runoff, allowing designers to choose drawdown times for the 100-year stormwater volume and design the spillway/outlet to drain in the chosen drawdown time.

Some portions of the specific plan area drain directly to Line F (e.g. the riparian areas and mitigation areas adjacent Line F), or drain to other existing storm infrastructure (e.g. the existing portions of several roads that are part of the specific plan area but will not be altered by the project) and these areas are not included in the hydraulic analyses presented in this section. This section addresses only those portions of the project site that will be altered and thus have an impact on project flood infrastructure and discharges from the project site to adjacent facilities such as Line F.

3.1 Overview

Hydraulic modeling was performed for a 100-year storm for a duration of 3 hours and 24 hours. The rainfall intensity is higher at the 3-hour; therefore, the three-hour storm produces the higher peak runoff discharge rate and the rainfall depth is higher at the 24-hour so the 24-hour storm produces a larger runoff volume. Both storm durations were analyzed to determine the optimal outlet size for each lake, and to analyze maximum water surface elevation and discharge rates of each lake.

The Aquabella lakes will be built with enough storage capacity to capture and detain all runoff volume from a 100-year storm. The detained runoff will begin to discharge immediately, with the discharge rate leaving the lake significantly lower than the discharge from the project land surfaces into the lake. Lake spillway structures will be designed to reduce peak flow rates and reduce peak discharges to not exceed pre-project peak discharges.

3.2 Lake Routing

The XPSWMM model uses the area of the lakes to calculate runoff volumes and the maximum storage depth. The corresponding stage-storage curve for each lake allows the lakes to act as flood control. In practice the lakes will be designed to overtop their shorelines during large storm events, temporarily inundating open space adjacent the lakes and increasing the area available to store stormwater. This will have the effect of reducing the peak depth shown in this report. A chosen drawdown time was used to determine the outflow from the lakes, this time can be chosen since all runoff volume will be captured by the lakes. The drawdown time controls the rate of outflow therefore a time was chosen that will reduce peak flow rates and prevent impacts to Line F. For the 100-year 3-hour storm a drawdown time of 24 hours was chosen; that is, the lake will return to approximately pre-storm water surface elevation within 24 hours after the 3-hour storm ends. For the 100-year, 24-hour storm a drawdown time of 48 hours was chosen to represent a reasonable time for the lake to return to normal after a significant rainfall event.

3.3 Results and Discussion

The results of the hydraulic modeling are summarized in **Table 3-1**. The 100-year 3-hour storm has a higher peak inflow compared to the 100-year 24-hour storm, whereas the 24-hour storm has a higher runoff volume compared to the 3-hour storm. The lake outlets are sized to control peak discharge from both storms; outlets are sized for the 3-hour and the 24-hour storm, and the smaller outlet size is selected as the controlling size. The water surface elevations in the lakes are then evaluated with the selected outlet orifice size for the 3-hour and the 24-hour storm (see **Appendix A** for orifice dimensions).

The maximum storage depth varies for each of the lakes and storm duration. The maximum storage depth during the 3-hour storm for Lake 1 is 1.42 feet, Lake 2 is 1.70 feet, Lake 3 is 1.47 feet, Lake 4 is 1.21 feet and Lake 5 is 1.23 feet. For the 24-hour storm the maximum storage depth for Lake 1 is 1.72 feet, Lake 2 is 1.30 feet, Lake 3 is 1.49 feet, Lake 4 is 1.20 feet and Lake 5 is 1.04 feet (see **Table 3-1**). The maximum storage depths show the water elevation will rise above the lake during the 100-year storm. This flooding will inundate open space near the lake shore; the open space will be designed to accommodate occasional inundation without damage.

The peak discharge from the lakes is similar for the 3-hour storm and 24-hour storm. The discharge from each lake is controlled by the outlet orifice size, which in turn controls the drawdown time. The drawdown time was evaluated to verify that storm detention would not have an unacceptable impact on land uses in areas outside the lakes that will be inundated by storm detention. All outflow hydrographs are shown in **Appendix A**, along with the inflow and outflow hydrographs combined. The combined inflow and outflow hydrographs show the peak discharge of post development conditions is reduced compared to pre-development conditions.

Table 3-1: Stormwater Routing: 100-Year Storm

Drainage Area		Lakes		2023 100-yr 3 hr Values				2023 100-yr 24 hr Values				Design Discharge
				Inflow	Detained Runoff		Outflow	Inflow	Detained Runoff		Outflow	
Area	acres	Lake	acres	Q (cfs)	V (ac-ft)	Max Storage Depth (ft)	cfs	Q (cfs)	V (ac-ft)	Max Storage Depth (ft)	cfs	cfs
PA-1*	41	-	-	-	-	-	-	-	-	-	-	-
PA-2A & PA-2B	295.6	1	25	554	42.3	1.42	46	163	64.4	1.72	57	**57**
PA-3	104.4	2	5	192	16.1	1.70	46	57	24.0	1.30	36	**46**
PA-4	42.7	3	2.5	76	6.3	1.47	10	23	9.5	1.49	10	**10**
PA-4	30.3	4	2.5	60	4.9	1.21	8	18	7.4	1.20	8	**8**
PA-2C	66	5	5	123	10.1	1.23	27	36	15.2	1.04	22	**27**
PA-2C BMP	11	-	-	-	-	-	-	-	-	-	-	-
Non-Developable	42	-	-	-	-	-	-	-	-	-	-	-
Total	**633**		**40**				**137**				**134**	
Total Project Site Acres			**673**									

Notes:

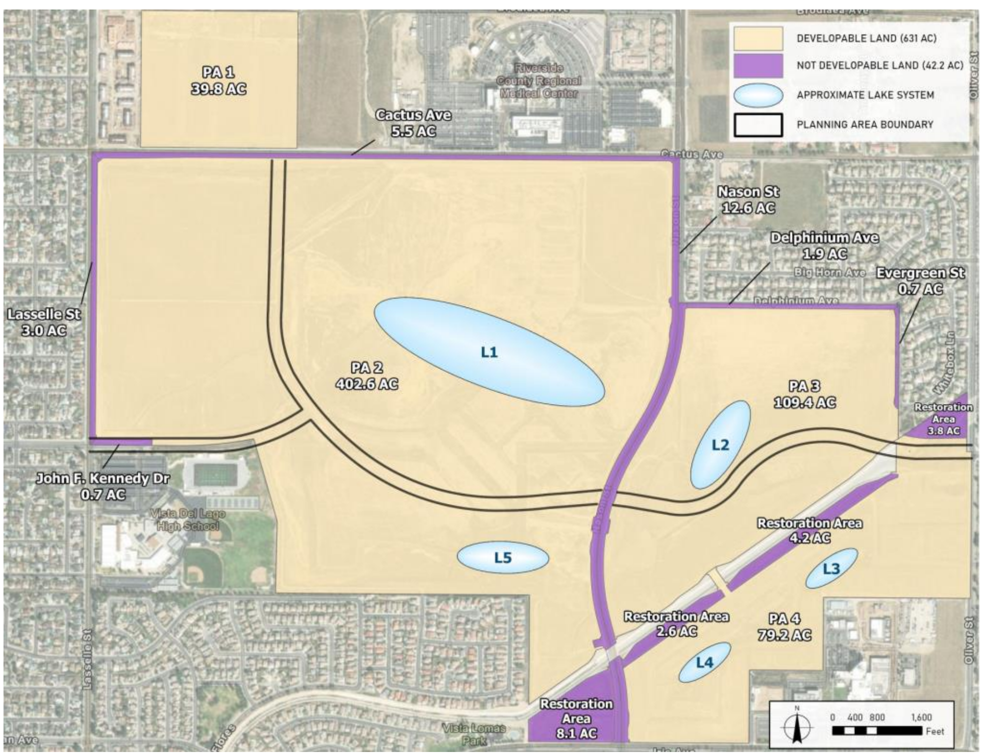
3. Inflow rates were determined using the RCFC&WCD Hydrology Manual Synthetic Unit Hydrograph Method.
4. Outflow rates and volumes found by using XPSWMM hydraulic modeling.
5. Peak flow rates are assumed to occur at the same time.
6. PA-1* is treated as a separate project however, it is included within the total project site area.

4 Water Quality

4.1 Water Quality Introduction

The Aquabella project is proposed for a 673-acre site in the City of Moreno Valley, Riverside County, California. The 673-acre site will be developed into approximately 631 acres of developed land and approximately 40 acres of manmade lakes. The developed land will include a mix of multi-family residential, urban center, parks, open space, roads, and other land uses that support residential areas such as schools, fire stations, and others as appropriate. In addition, the site will include approximately 40 acres of lakes and ponds and BMPs which are the subject of this report. The lakes will comprise approximately five separate lakes, and each will serve as a multi-functional integrated water resources management facility for the portion of the project that is tributary to it. The lakes will provide flood peak attenuation, stormwater conveyance, in some lake's irrigation water supply and storage, and they will also serve as stormwater quality treatment facilities, which is the subject of this chapter. In addition to the lakes, one area of the site comprising approximately 11 acres of land will drain to a BMP which is anticipated to be a Bioretention BMP as described in the Design Handbook for Low Impact Development Best Management Practices. The remaining 42 acres of the site consist of not developable land which includes existing streets and restoration areas. The existing streets generate runoff that drains offsite and the restoration areas are self-contained therefore these areas are not of concern for the project's water quality. It should be noted that any publicly owned roads within the project will have trash-control BMPs to meet applicable requirements. **Figure 4-1** shows the developable land and not developable land within the planning area.

Figure 4-1 Aquabella Planning Area



Aquabella will be designed to provide stormwater runoff treatment that meets or exceeds applicable requirements, and will reuse runoff and nuisance flows extensively. Several man-made lakes will be centrally located within the project site, and the land surfaces within the project will drain toward the lakes. The lakes will function as wet pond stormwater treatment BMPs with stormwater treatment enhancements that will provide better stormwater treatment than a standard wet pond. This drainage arrangement, coupled with a program of state-of-the-art site-design and source-control Best Management Practices (BMPs) will minimize stormwater runoff and non-point source pollutant loads from the site and maximize water reuse. The water level in the lakes will be maintained during dry weather by the addition of water from onsite wells. One or more of the lakes will serve as an irrigation water source for the project. Water will be withdrawn from the lake for landscape irrigation, and that water will be replaced with stormwater runoff or well water when stormwater is insufficient.

Aquabella is located in the San Jacinto watershed, which terminates in Lake Elsinore. Unlike most watersheds, this one does not eventually discharge to the ocean, but rather discharges first to Canyon Lake, which receives runoff from over 90% of the watershed, then to Lake Elsinore, which is the terminal receiving water for the entire watershed. The fact that these lakes rarely (as with Canyon Lake) or never (as with Lake Elsinore) discharge surface water means that these lakes are prone to accumulations of pollutants carried by runoff. Both of these lakes have experienced water quality problems and both are the subject of Total Maximum Daily Loads (TMDLs). TMDLs are regulations that set limits on the discharge of pollutants to receiving waters. In the San Jacinto watershed, TMDLs have been set for Total Phosphorus (Total P) and Total Nitrogen (Total N), as well as several pollutants intended to be measured only within Lakes Canyon and Elsinore. The TMDL documents set limits on Total P and Total N, a County-wide implementation program has been adopted. (The TMDL adopted by the Santa Ana Regional Water Quality Control Board was approved by USEPA on December 5, 2013.)

This report presents a simple model that estimates the stormwater runoff and non-point source pollutant loads from the proposed project and compares them to the corresponding values from both existing conditions and from a variety of alternative development schemes. The model indicates that the proposed Aquabella project will produce smaller loads and lower concentrations of nutrients than alternative developments or the existing vacant / formerly agricultural land use. Thus, the model demonstrates that Aquabella will help the City of Moreno Valley meet TMDL and NPDES stormwater regulations.

The model presented in this report simulates the change in runoff and nonpoint source pollutants from the entire 673-acre project site.

4.2 Water Quality and Pollutants of Concern

The proposed Aquabella project is located in Riverside County's San Jacinto River Watershed upstream of Canyon Lake which, in turn, is about five miles upstream of Lake Elsinore. Almost all of the water that enters Lake Elsinore comes from overflows from Canyon Lake.

Protection of water quality in this area is the charge of the Santa Ana Regional Water Quality Control Board which maintains a Water Quality Control Plan, called a "Basin Plan," that specifies beneficial uses, water quality objectives and various water quality control policies and practices for the region. The Basin Plan designates specific beneficial uses for San Jacinto

River, Canyon Lake and Lake Elsinore. In addition to identifying beneficial uses for waterbodies, the Basin Plan includes numerical (quantitative) and narrative (qualitative) water quality objectives. These beneficial uses include water recreation and habitat.

Water quality concerns in the watershed include summer lake algal blooms, fish kills, bacterial quality, lake water level management, nitrogen and TDS in groundwater, and impacts from confined animal feeding operations and agriculture fertilizer use in the watershed. The pollutants of concern include phosphorous, nitrogen and sediments, and organic enrichment of Lake Elsinore.

Per Resolution No. R8-2004-037 (December 2004), the Santa Ana River Basin Plan is being amended to include Nutrient TMDL provisions for Lake Elsinore and Canyon Lake. Section 303(d) requires the allocation of the TMDL among the nutrient sources. Targets for Total Phosphorus and Total Nitrogen for Canyon Lake are average annual concentrations no greater than 0.1 mg/L and 0.75 mg/L (to be achieved by the year 2020), respectively. It has been found that nutrient loading to Canyon Lake and Lake Elsinore varies depending on San Jacinto watershed's hydrologic conditions. As part of the TMDL development, three hydrologic conditions (wet, moderate, and dry) were analyzed and allocations were presented in terms of 10-year running flow weighted average nutrient loads.

Therefore, based on concerns for other lakes within the San Jacinto watershed, pollutants of concern for the Aquabella Lakes projects include Total Nitrogen (Total N) and Total Phosphorous (Total P). The model presented in this report simulates loads and concentrations of Total N and Total P for the proposed project, the existing agricultural land use, and several alternative development scenarios.

4.3 Existing Hydrology and Drainage Facilities

The Aquabella project site is currently vacant, and was formerly used for agriculture, and its hydrology and drainage facilities are typical of agricultural areas. Runoff from the site is collected in typical agricultural ditches which discharge to the existing trapezoidal soft-bottom channel, storm drain Line F. Surface slopes at the project site are moderate and erosion does not appear to be a significant concern on the site. The runoff from the site is characterized herein as typical of row-crop agricultural land-use in Southern California, and therefore, typical agricultural runoff pollutant loads, based on data gathered by the LA County NPDES Stormwater Monitoring program, have been used to represent the existing project site in the model included in this report.

4.4 Proposed Hydrology and Drainage Facilities

The proposed project will be designed to drain to a system of centrally-located lakes and BMPs. All surface runoff either will be collected in standard urban drainage facilities or transferred through bioswales. Runoff then will be delivered to specially-designed forebays that will pre-treat all runoff before the runoff enters the lake. In the lake, water will be continually treated by a water quality system that will include circulation, aeration, and facilities to remove sediments, suspended materials, nutrients, and a variety of other pollutants. Final design of the water quality systems is not yet complete, but the target in-lake water quality results of the system are represented in this report. This system is designed to maintain the highest possible level of water quality in the lakes for the sake of both the environment and the aesthetics of the lakes. The system that will be designed for the Aquabella lakes is based on systems that have successfully operated in similar man-made residential lakes for many years, maintaining excellent water quality despite inflows of nuisance flow, urban runoff, and other nutrient-laden waters.

The Aquabella lakes will be built with enough reserve storage capacity to eliminate all dry-weather discharges and most discharges during rain events. Dry weather flows will never leave the site, but will instead be captured and retained within the lakes. During most rainfall events, all runoff will be retained in the lakes. In the 85th percentile storm used for stormwater quality design (0.67 inches of rainfall), which happens approximately one to two times per year on average, some water from the lakes will be discharged downstream. In larger storms, a larger fraction of the stormwater volume will be released from the lake downstream, but the dilution, detention, and treatment the water receives within the lakes will result in significantly reduced nutrient loads compared to the stormwater that enters the lake. This nutrient load reduction is modeled in this report. Thus, the Aquabella Lakes will be designed to both greatly reduce the volume and significantly improve the quality of runoff from the site, and will help Moreno Valley meet TMDL goals for Total P and Total N.

Discharges from the Aquabella Lakes will discharge to the Line F storm drain that crosses the project site. Site discharges will be designed to prevent increased erosion and prevent impacts on proposed wetland mitigation areas adjacent to Line-F. The Aquabella Lakes project site represents a relatively small portion of the watershed of Line F, and will have only a minor impact, if any, on velocity and peak discharge in Line F; hydraulic impacts of the discharge to Line F are addressed in a separate report.

Within PA2 there will be a non-lake BMP to treat runoff generated from 11 acres of developed land. This BMP will be designed according to the guidelines of the Design Handbook for Low Impact Development Best Management Practices, and is modeled herein as a standard/typical BMP based on available data. The water will be treated before discharging into Line F through Pipe I (see **Exhibit 1**). It should be noted that other smaller BMPs may be needed throughout the project site to insure all runoff is captured and treated before being discharged.

4.5 Water Quality Modeling

A water quality model of the Aquabella Lakes has been prepared to estimate the discharges of nutrients from the lake, and demonstrate that the project represents a significant improvement over other alternative types of land use. Although the not developable land within the project site does not affect the water quality of the project the existing streets that generate runoff were also modeled and reported.

4.5.1 Model Overview

The model presented in this report simulates the runoff from the project site in four simple steps. The first step simulates runoff water quality based on existing or proposed land uses and typical concentrations of water quality constituents measured for similar land uses. The second step simulates the effect of mixing site runoff with lake water. The third step simulates the removal of constituents by in-lake processes. The fourth step simulates impacts of lake storage on the volume of runoff that is discharged from the site. Depending on which site conditions is being simulated, not all steps are used in each model.

4.5.2 Model Input

Several types of input data are used in the lake model including estimates of runoff volume, measured typical runoff pollutant concentrations, lake water quality measured in a man-made lake similar to the proposed Aquabella lakes, lake design values, and typical BMP treatment efficiencies.

The 85th percentile storm depth (0.67) is obtained from the Design Manual for Low Impact Development Best Management Practices (LID BMP Manual) (Riverside County Flood Control and Water Conservation District, 2011) Runoff estimates are based on project acreage, soil types, existing and proposed land uses, and drainage patterns. The runoff coefficients were obtained from the Riverside County Hydrology Manual. Existing undeveloped conditions are assumed to include 15% impervious cover, proposed conditions are assumed to include 80% impervious cover, and the existing streets are assumed to be 100% impervious.

Runoff pollutant concentrations are represented by Event Mean Concentration (EMC) data collected by the Los Angeles County NPDES Stormwater Monitoring Program. These data are organized by land use. The project site as it exists today is modeled as agricultural land use, while the proposed site is modeled as High-Density Residential land use.

Several project design values are used in estimating pollutant discharge. These values include acreages of various land uses and lake storage volume, and are based on preliminary design plans for the project. The anticipated water quality in the lakes before a storm event is based on several years of monthly monitoring data collected at Bridgeport Lake in Santa Clarita, California. Bridgeport Lake incorporates the same water quality systems as Aquabella Lakes and has been reliably monitored for a long period of time. Water quality in a standard lake without the water quality systems proposed for the Aquabella Lakes is estimated based on typical data from lakes that lack the advanced water quality systems that will be incorporated into the Aquabella Lakes. The treatment efficiency of the lakes is modeled based on average efficiency of wet ponds and wetlands through the US. Although due to the water quality systems the Aquabella lakes will have significantly improved treatment capability compared to standard wet ponds, they are modeled as standard wet ponds to provide a conservative estimate of pollutant discharges.

The total site area is 673 acres including 40 acres of lakes. Each of the 5 lakes have a differing area that drains from the site; Lake 1 has a drainage area of 276.4 acres, Lake 2 has a drainage area of 104.4 acres, Lake 3 has a drainage area of 33.8 acres, Lake 4 has a drainage area of 30.3 acres and Lake 5 has a drainage area of 65.2 acres. These areas were used in the Proposed Standard BMPs, Proposed Standard Lakes, and Proposed Advanced Treatment Lakes models to generate runoff. This is based on the planned inclusion of 40 acres of lakes in the proposed lakes conditions and 40 acres of stormwater quality BMPs in the Proposed Standard BMPs condition. The Existing Conditions and Proposed No BMPs models used a site area consisting of the drainage area to each lake and the area of the correlating lake. This models conditions with no lakes or BMPs. **Table 4-1** shows the model input data for the 5 lakes.

Table 4-1: Model Input Data for the Aquabella Lakes

Lake	85th %ile 24-hr Rainfall Depth (in)	Lake Area (acres)	Drainage Area (acres)	Site Area (acres)
1	0.67	25	276.4	301.4
2	0.67	5	104.4	109.4
3	0.67	2.5	33.8	36.3
4	0.67	2.5	30.3	32.8
5	0.67	5	65.2	70.2

NOTE: Site area is the drainage area plus the surface area of the lake.

Table 4-2 shows the model input data for the BMPs. The BMP model for PA 2.1 simulates the water quality for the portion of the proposed site with a standard BMP. The site area used for the PA 2.1 BMP was 11 acres. The BMP models for the schools were analyzed based on the assumption that they will drain into Line F using standard BMPs. Each school is assumed to be 10 acres, including a BMP of 0.5 acres. The inputs for these models are the same as the inputs for the lakes with the exception of the incorporation of a lake.

Table 4-2: Model Input Data for BMPs

BMP	85th %ile 24-hr Rainfall Depth (in)	Lake Area (acres)	Drainage Area (acres)	Site Area (acres)
PA 2.1	0.67	-	-	11
S 2.1	0.67	-	-	10
S 2.2	0.67	-	-	10
S 3.1	0.67	-	-	10

NOTE: For the BMP sub-watershed the site area and drainage area will be the same.

The not developable land was modeled for the existing streets within the project site. It simulates the water quality of runoff generated from the existing streets. **Table 4-3** shows the model input data for the existing streets the generate runoff that drains offsite.

Table 4-3: Model Input Data for the Not Developable Land

Existing Street	85th %ile 24-hr Rainfall Depth (in)	Lake Area (acres)	Drainage Area (acres)	Site Area (acres)
John F. Kennedy Dr	0.67	-	-	0.7
Lasselle St	0.67	-	-	3.0
Cactus Ave	0.67	-	-	5.5
Nason St	0.67	-	-	12.6
Delphinium Ave	0.67	-	-	1.9
Evergreen St	0.67	-	-	0.7
Restoration Areas	N/A	N/A	N/A	17.7

4.5.3 Model Calculations

The calculations used in the water quality model are described below in four steps or "conditions" as they are called in the model. The four conditions described are all found in the model titled "Proposed Advanced Treatment Lake". Other versions of the model used to predict runoff from existing conditions or proposed conditions with alternative stormwater management scenarios may not include all four scenarios. For example, the scenarios without a lake do not include the lake mixing condition (condition 2) of the model.

All condition calculations are based on the 85th percentile 24-hour storm event. The 85th percentile storm is based on data from local rain gages and is presented because it is a standard storm used in stormwater quality studies. The 85th percentile storm is a storm which is larger than 85% of all measurable storms at local rain gaging sites. The 24-hour duration storms are used because the lakes are limited by the volume they can treat; peak discharge rate into the lake is not a limiting factor determining the performance of the lakes. Therefore, the relatively long duration 24-hour storms are used instead of shorter duration storms (e.g. 1-hours storm) used in the design of facilities whose sizing is controlled by peak discharge rate rather than volume.

Condition 1 calculates the volume of runoff generated by the project site and the expected concentrations and loads of Total N and Total P for each of the four design storms. The first column, Runoff Depth, is based on calculations prepared by PACE following the Riverside County Hydrology Manual. The second column, Runoff Volume, contains water volumes calculated by multiplying the runoff depth in feet times the watershed area correlating to each alternative type of land use and tributary to each lake. The next two columns, Runoff Total P and Runoff Total N (mg/l) contain values for event mean concentration measured by LA County for the appropriate land use. For all proposed scenarios, the appropriate land use is high-density residential development. For existing conditions, the land use is agricultural. The Aquabella site was most recently used as an agricultural experiment station by the University of California Riverside, and despite the several years of fallow conditions, agricultural land use is the most appropriate representation of the site in its current condition.

In addition to agricultural runoff data the existing conditions model presents data for vacant (undeveloped) land for comparison (see appendix), and therefore the existing conditions model contains extra columns. LA County monitoring data is used because data from Riverside County are not available in the format needed for this model. LA County was chosen as a data source because LA County is near the project location and has a large amount of available data. The last two columns of Condition 1 are Runoff Total P (lbs.) and Runoff Total N (lbs.). These columns contain the loads of the two constituents calculated by multiplying the Runoff Volume by the event mean concentrations and converting the results into pounds of pollutant.

Condition 1 calculations are based on the 85th percentile storm depth. The 85th percentile storm depth is the storm for which stormwater quality management facilities such as the Aquabella lakes are designed, and is generally used as the standard storm for evaluation and comparison of water quality facilities and water quality impacts. Although the lakes are not required to treat the additional runoff generated by larger storm events, all runoff will pass through the lakes and receive a significant level of treatment due to the large size of the proposed Aquabella lakes relative to the project site area, Condition 2 simulates the effect of mixing urban runoff from the site with lake water, which is generally less polluted than the runoff. The first column contains the lake volume in acre-feet. This volume is based on the various proposed lake areas and an average depth of ten feet for Lake 1 and six feet for Lake 2, Lake 3, Lake 4 and Lake 5. The lakes will reach a maximum depth of at least 15 feet in the center, but will average approximately six to ten feet deep. A deeper average depth is used for Lake 1 because lake 1 will be larger, with more of its area exhibiting the maximum depth and relatively less of the lake occupied by shallower depths near shore.

The next two columns, Lake Total P and Lake Total N contain average in-lake concentrations of the two constituents measured in Bridgeport Lake in Santa Clarita, CA. Bridgeport Lake is an advanced treatment lake similar to the proposed Aquabella lakes, receives urban runoff from a development similar to the proposed Aquabella project, and has been monitored for a number of years. Therefore, Bridgeport is chosen to simulate the expected water quality in Aquabella Lakes. The "Proposed with Standard Lake" model contains Lake Total P and Lake Total N concentrations estimated for a typical urban lake lacking the water quality enhancements proposed for the Aquabella Lakes and is presented for comparison with the Aquabella results. The last two columns in Condition 2 are Diluted Total P and Diluted Total N. These values are calculated based on complete mixing of the lake water and runoff water without any reduction in the total load of constituents. Complete mixing of runoff with lake water is reasonable to assume because runoff will enter the lake at numerous points spread around the lake perimeter and the lake will include aeration and pumping equipment to provide constant mixing of water within the lake.

Condition 3 simulates the removal of P and N expected in the proposed lakes or BMPs. The Proposed Advanced Treatment Lake is modeled based on a similar, well-designed wet pond BMP as explained below. The Proposed Standard Lakes and Proposed Standard BMP conditions are modeled based on average wet pond treatment rates taken from a nationwide compilation of wet pond pollutant removal efficiency prepared by the federal government's Chesapeake Bay Program.

The nutrient removal performance of the Aquabella lakes is simulated based on the performance of a stormwater detention pond known as St. Elmo's, in Austin, Texas. St. Elmo's pond has many similarities to the proposed Aquabella lakes, and is therefore an appropriate object of comparison. St. Elmo's pond is in a similar climate to Aquabella; both are in semi-arid climates with dry summers. The watershed at St. Elmo's is more than 66% impervious, and Aquabella has been modeled as 80% impervious.

Both St. Elmo's and Aquabella will have relatively large storage capacities compared to the size of their watersheds, and both are significantly larger than the average wet pond BMP. St. Elmo's pond includes a permanent pool and extended detention (temporary detention) that amounts to approximately 1.8 inches of runoff over the watershed. Aquabella will have significantly more detention, varying among the lakes. The draw-down time for the extended detention at St. Elmo's pond is one to three days, while the drawdown for the extended detention at Aquabella will be approximately three days.

Both St. Elmo's pond and Aquabella lakes will include design features intended to improve water quality treatment. Both include pre-treatment facilities. St. Elmo's pond includes forebays separated from the rest of the pond by rock gabions, while Aquabella lakes will include pre-treatment wetlands that will capture solids as well as remove dissolved constituents within the gravel substrate of the wetland. Both of the facilities include both shallow areas and deeper pools. Although St. Elmo's pond and Aquabella lakes share many design characteristics and will both perform significantly better than average wet pond BMPs, it is anticipated that Aquabella will perform much better than St. Elmo's because Aquabella will include several mechanized systems that will significantly improve stormwater treatment performance. These systems include aeration, in-lake circulation, and mechanical filters. Aquabella may also include provisions for enhanced flocculation or other advanced water quality treatment features. The performance of these systems is implicitly represented in the Proposed Advanced Treatment Lakes model within Condition 2 –Lake Mixing. In Condition 2 the stormwater runoff is mixed with much cleaner lake water. The clean lake water is possible because of the mechanical enhancements to the lake, these same mechanical systems operate in Bridgeport Lake, the model used in the simulation of lake water quality.

Condition 4 simulates the effect of lake detention capacity on the discharge of water and waterborne pollutants. The first column, Lake Storage Capacity, is the excess storage capacity of the lake that is available to capture stormwater runoff based on the proposed lake design. The next column presents the Volume of Water Discharged during the storm event, which is calculated by subtracting the Lake Storage Capacity from the Runoff Volume shown in Condition 1. Total P Discharged (mg/l) is the same concentration as Treated Total P shown in Condition 3, and the same is true for Total N Discharged (mg/l). Total P Discharged (lbs.) and Total N Discharged (lbs.) are the loads obtained by multiplying the Volume of Water Discharged by the concentrations of Total P Discharged (mg/l) and Total N Discharged (mg/l) respectively, and converting units to pounds of pollutants. These loads are the quantities of pollutants that are discharged from the project site during the storm event and can be used to compare one proposed scenario with another, or to compare the proposed Aquabella project with existing conditions. For the purposes of this report each lake is assumed to capture and retain 3 inches of extra water during a storm event. In practice this will be a minimum capture depth, with additional capture depth typical of larger lakes and lakes in windy environments such as Aquabella.

4.5.4 Model Results and Discussion

The model presented here shows that Aquabella will discharge lower concentrations (mg/l) of pollutants and smaller loads (lbs.) of pollutants than alternative developments or the existing agricultural land use. **Table 4-4** Aquabella Lakes Model Results Summary Table summarizes the results of the model of the lakes. In **Table 4-4** it can be seen that the Aquabella Lakes will release lower concentration and loads of Total N and Total P than other development options, and lower than the existing agricultural land use. For example, during the 85th percentile storm Lakes 1, 3, 4, and 5 will not discharge any water, representing a 100% reduction in nutrient loads to the receiving water from the portions of the project site draining to each of these lakes. In the same storm those lakes will result in significant reductions in the concentrations of nutrients in lake water (which is the water that would be discharged, if discharge were to occur) compared to agricultural runoff. Thus, in larger storms when discharge will occur there will still be a significant reduction in nutrient concentration and load compared to existing conditions. For example, in Lake 1 the concentration of P will be reduced 91% and the concentration of N will be reduced 57% compared to existing conditions.

Lake 2 is projected to discharge water during the 85th percentile storm, with the discharge volume similar to the discharge volume experienced under existing conditions. There will be a reduction in nutrients concentration due to the lakes, thus the load of Nitrogen and Phosphorous will be reduced, with an 88% reduction in P and a 49% reduction in N projected.

Compared to a similar residential development with standard stormwater quality BMPs the proposed Aquabella project will discharge significantly less nutrients. The loads of nutrients are significantly reduced by the stormwater retention capacity of the lakes, with most lakes discharging no nutrients in the 85th percentile storm. The retention capacity obscures the excellent nutrient reduction achieved in the lakes, which is evident if we examine the nutrient concentrations, rather than discharge loads for the lakes. For example, in Lake 1 the concentration of P is reduced more than 940 and the concentration of N reduced approximately 67% compared to similar development with standard BMPs. The high level of P removal is unparalleled among stormwater BMPs, making lakes an ideal choice for the Canyon Lake/Lake Elsinore watershed. Thus, it is clear that Aquabella represents a step toward TMDL compliance for the City of Moreno Valley and the San Jacinto watershed.

In conclusion, the Water Quality Model presented here demonstrates that Aquabella will discharge significantly smaller loads and concentrations of nutrients nitrogen (N) and phosphorous (P) than alternate development schemes or the existing agricultural land use. The Aquabella lakes represent the best available water treatment technology for residential development and the project will serve as a model for water quality sensitive development in the region.

Table 4-4: Aquabella Lakes Model Results Summary Table

Aquabella Lakes, Moreno Valley, CA

A simple model for estimating the discharge of Total Phosphorous (Total P) and Total Nitrogen (Total N) from the project site during storm

Lake 1

85th Percentile, 24-hour Storm Event	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Existing (Agricultural Land)	2.5	0.16	1.89	1.1	13.0
Proposed w/o BMPs	10.1	0.39	3.90	10.7	107.1
Proposed w/ Std. BMPs	9.3	0.31	2.73	7.9	68.8
Proposed w/ Std. Lake	0.0	0.49	3.47	0.0	0.0
Proposed w/ Advanced Treatment Lake	0.0	0.01	0.80	0.0	0.0
Reduction in Discharge (Proposed vs Existing)				100%	100%

Lake 2

85th Percentile, 24-hour Storm Event	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Existing (Agricultural Land)	0.9	0.16	1.89	0.4	4.7
Proposed w/o BMPs	3.7	0.39	3.90	3.9	38.9
Proposed w/ Std. BMPs	3.5	0.31	2.73	3.0	26.0
Proposed w/ Std. Lake	1.0	0.47	3.42	1.3	9.3
Proposed w/ Advanced Treatment Lake	1.0	0.02	0.89	0.0	2.4
Reduction in Discharge (Proposed vs Existing)				88%	49%

Lake 3

85th Percentile, 24-hour Storm Event	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Existing (Agricultural Land)	0.3	0.16	1.89	0.1	1.6
Proposed w/o BMPs	1.2	0.39	3.90	1.3	12.9
Proposed w/ Std. BMPs	1.1	0.31	2.73	1.0	8.4
Proposed w/ Std. Lake	0.0	0.48	3.45	0.0	0.0
Proposed w/ Advanced Treatment Lake	0.0	0.02	0.84	0.0	0.0
Reduction in Discharge (Proposed vs Existing)				100%	100%

Lake 4

85th Percentile, 24-hour Storm Event	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Existing (Agricultural Land)	0.3	0.16	1.89	0.1	1.4
Proposed w/o BMPs	1.1	0.39	3.90	1.2	11.7
Proposed w/ Std. BMPs	1.0	0.31	2.73	0.9	7.5
Proposed w/ Std. Lake	0.0	0.48	3.45	0.0	0.0
Proposed w/ Advanced Treatment Lake	0.0	0.02	0.84	0.0	0.0
Reduction in Discharge (Proposed vs Existing)				100%	100%

Lake 5

85th Percentile, 24-hour Storm Event	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Existing (Agricultural Land)	0.6	0.16	1.89	0.3	3.0
Proposed w/o BMPs	2.4	0.39	3.90	2.5	24.9
Proposed w/ Std. BMPs	2.2	0.31	2.73	1.9	16.2
Proposed w/ Std. Lake	0.0	0.48	3.45	0.0	0.0
Proposed w/ Advanced Treatment Lake	0.0	0.02	0.84	0.0	0.0
Reduction in Discharge (Proposed vs Existing)				100%	100%

The results for the BMP Models, shown in **Table 4-5**, shows the effectiveness of treatment of a standard BMP on site runoff before discharging water into Line F.

Table 4-5: BMP Model Results Summary Table

Aquabella Lakes, Moreno Valley, CA

A simple model for estimating the discharge of Total Phosphorous (Total P) and Total Nitrogen (Total N) from the project site during storm

PA2 BMP

85th Percentile, 24-hour Storm Event	Discharge Parameters Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Proposed w/ Std. BMPs	0.4	0.31	2.73	0.3	2.7

85th Percentile, 24-hour Storm Event	Discharge Parameters Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Existing (Agricultural Land)	0.1	0.16	1.89	0.0	0.4
Proposed w/ Std. BMPs	0.3	0.31	2.73	0.3	2.4

Table 4-6: Overall Project Total Discharge Summary Table

Project Total Discharge Summary

85th Percentile, 24-hour Storm Event	Discharge Parameters Volume of Water Discharged (AF)	Total P Discharged (mg/l)	Total N Discharged (mg/l)*	Total P Discharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Existing (Agricultural Land)	5.0	0.17	0.20	2.3	26.4
Proposed w/o BMPs	18.8	0.39	0.10	19.9	198.2
Proposed w/ Std. BMPs	17.5	0.31	0.07	14.8	129.6
Proposed w/ Std. Lake	1.4	0.43	0.74	1.6	12.0
Proposed w/ Advanced Treatment Lake	1.4	0.10	0.74	0.4	5.1

The results for the model of the not developable land are shown in **Table 4-7**. The existing streets generate runoff consisting of a pollutant load associated with high density residential development. Pre-development and post development conditions are the same for the existing streets therefore the amount of pollutant discharge will remain the same. Since the runoff drains offsite Aquabella is not responsible for treatment of the discharge.

Table 4-7: Existing Streets Model Results Summary Table

Aquabella Lakes, Moreno Valley, CA
A simple model for estimating the discharge of Total Phosphorous (Total P) and Total Nitrogen (Total N) from the project site during storm

85th Percentile, 24-hour Storm Event
John F. Kennedy Dr

	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Existing Street	0.04	0.39	3.90	0.04	0.38

85th Percentile, 24-hour Storm Event
Lasselle St

	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Existing Street	0.15	0.39	3.90	0.16	1.60

85th Percentile, 24-hour Storm Event
Cactus Ave

	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Existing Street	0.27	0.39	3.90	0.29	2.91

85th Percentile, 24-hour Storm Event
Nason St

	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Existing Street	0.63	0.39	3.90	0.67	6.72

85th Percentile, 24-hour Storm Event
Delphinium Ave

	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Existing Street	0.10	0.39	3.90	0.10	1.01

85th Percentile, 24-hour Storm Event
Evergreen St

	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Existing Street	0.03	0.39	3.90	0.04	0.35

5 Lake Design

The lakes at Aquabella will be a critical component of the stormwater management system, and contain a variety of features that are unfamiliar to the general public. Therefore, this chapter is included to present key features of the lakes. This report provides a preliminary evaluation of the following available information: lake liner geotechnical considerations, lake geometry, lake grading, conceptual storm drain routing to the lake, lake water demand, and lake water quality management systems.

The lakes' water surface will typically be maintained at a near constant level by providing well water to make up water lost to evaporation and irrigation withdrawal. Freeboard will be provided to retain on-site stormwater runoff from the proposed development. Nuisance flow runoff due to irrigation, miscellaneous washing, etc. from property within the development will be retained in the lake where pollutants will undergo conversion and treatment.

Landscape areas within the proposed development are anticipated to be irrigated directly from the lakes. Thus, the lakes will also serve as an irrigation storage reservoir. Along with multiple designed lake treatment mechanisms, the lake serving as an irrigation reservoir will provide a high degree of lake circulation and decrease overall hydraulic retention time. This turnover has been found to generally correlate with improved water quality in manmade lakes. A portion of the stormwater runoff entering the lakes will be retained for use as irrigation water, and any capture of stormwater or dry weather discharge will offset the need for makeup water, making the lakes a fully integrated water resources facility.

The proposed system employs the use of multiple layers of treatment to facilitate water quality improvement through:

1. Lake water quality measures (circulation, filtration, aeration, and potentially other treatment processes);
2. Urban storm water runoff controls (vegetated water quality filters and wetland planter basins); and
3. Lake retention for dry weather runoff as well as detention for nuisance and storm water runoff.

These water quality elements work either through management of urban storm water runoff or through lake water quality maintenance to ensure that the water within the lake and any discharge from the development to the storm drain outlet is of the same or better quality than that discharged prior to development. The 40-acre lakes will receive runoff from the tributary residential watershed area. The lakes are designed to accommodate temporary storage through surcharge or rise in the lake level runoff from storms as large as the 100-year, 24-hour storm.

Application of a large-scale manmade lake system within residential development offers an innovative and effective approach to address water quality treatment rather than relying on conventional structural BMPs that have only limited pollutant removal effectiveness. Additional advantages of the lake system include:

- Continuous year-round treatment process with the permanent high-quality water body
- Enhanced rates of treatment
- Better integration with the land use plan

- Reduced amount of closed conduit storm drainage infrastructure
- Community landscape and aesthetic appeal
- Natural ecosystem benefits (open space)
- Recreational benefits to the community

Based on conceptual land plans used to develop the specific plan, the lakes will have the characteristics shown in Table 5-1.

Table 5-1: Summary of Manmade Lake Properties

Operating Volume	Approximately 400 AF
Average Depth	8 to 12 feet
Perimeter	(to be provided at a later design stage)
Lake Bottom Slope	4:1
Shoreline Depth	18-inches
Surface Area	40 acres
Lake Liner	Geomembrane

5.1 Chapter Objectives

A variety of engineering analysis and tasks were associated with the preliminary design report. These major task areas of study reflected the various objectives of the study and included the following:

1. Lake data calculations – Including lake area, volume, length of shoreline etc.
2. Data collection/coordination – Soliciting base files and design information from various project consultants.
3. Lake water balance analysis – Projected lake water demand analysis based on historical weather data and irrigation demand assumptions.
4. Water quality treatment elements assessment – Preliminary sizing of lake water quality treatment elements based on expected loading rates and reactions.
5. Preliminary probable construction cost estimation – Quantity take off for various lake components based on known design.
6. Preliminary probable operating and maintenance program.

5.2 Lake Geometry and Shoreline Alternatives

The plan view layout of the lakes will be determined in conjunction with land use planning. At this stage, several features of the lakes can be determined. This includes the geometry of the lake, including the horizontal layout, average operating lake depth, and lake cross section, which have a significant influence on the overall quality and design of the lake and thus, is considered and are discussed below.

Like other community lake systems, the Aquabella Lakes may be designed to maximize the amount of lake water front via a lake shoreline configuration of numerous “fingers.” In addition, the design will attempt to optimize opportunities for public views of the lake, thus adding aesthetic qualities and added value to the community. However, a layout with “fingers” could develop uncirculated areas or “dead corners”, which will create issues relating to poor water quality. To offset these issues, generally, a more extensive plumbing infrastructure and pumping design is required.

Another geometric characteristic relating to lake water quality is lake depth. The biggest influence that lake depth has is influence on water temperature, which influences the rate of most biological and chemical reactions. Typically, the rate of reaction increases as temperature increases. Lake depth plays a vital role in maintaining water clarity, which is directly influenced by excessive growth of plant material including nuisance algae. Sunlight is the driving force for photosynthesis, which provides energy for growth of aquatic plants. The ability for sunlight to penetrate a lake's water column through its upper layers depends mostly on the clarity of the water. In general, sunlight can penetrate through 4 to 6 feet of water column in relatively clear water, which is the region where plants thrive and grow most effectively. Depths exceeding approximately 6 feet generally do not allow the penetration of sunlight and therefore limit the growth of photosynthetic biology in the lake. Aquatic plants attached to the lake bottom will be minimized in areas with depths greater than approximately 6 to 8 feet. Algae can also be greatly reduced in deeper areas when coupled with extensive mixing and recirculation. In general, an average lake operating depth between 8 to 10 feet would optimize water quality by eliminating light penetration, maintaining lower average water temperature, minimizing lake stratification, and minimizing evaporation. Maximum lake depth with be approximately 15 to 20 feet in a few of the widest areas of the lake.

Safety issues concerning public accessibility to open water bodies needed to be addressed. A proposed submerged roughened concrete shoreline around the perimeter, which extends approximately 10 feet from the lake edge and 3 feet below the water level, would be installed to address safety concerns and provide protection for the membrane liner in the shallow areas. A steepened shoreline edge extends 6 inches above the normal operating water level to provide a lined freeboard. The remainder of the lake bottom section would be constructed at a 4:1 slope.

5.2.1 Shoreline Options

There are several shoreline design options that are commonly used for manmade lakes, including eroded concrete, natural edge, and grass shorelines. The various shorelines will differ in added aesthetic lake values, construction costs, and maintenance required.

A commonly used lake edge for this type of development is an eroded concrete shoreline. The shoreline is comprised of a 4-inch-thick concrete, reinforced with an octagonal wire mesh over membrane liner that extends 24 inches vertically at a slope of 0.5 to 1. The top of the shoreline extends 6 inches above the normal operating water surface and acts as a freeboard to accommodate lake level variations. Variations of (+) 4 to (-) 12 inches will not affect the integrity of the lake edge. The steep portion of the shoreline will also be sculptured to give a natural erosion effect and is also stained to match the existing landscape. Turf or grass can be planted up to the lake edge. The shoreline also features a 2-inch-thick concrete veneer shelf that extends 8 to10 feet wide at a slope of 4 to 1 to provide added protection to the membrane liner against sunlight. With regards to maintenance, eroded concrete shorelines typically require the least compared to other shorelines. The erosion potential is also minimized with an eroded concrete shoreline. A disadvantage of having an eroded concrete shoreline is that the concrete will be exposed as the lake level fluctuates, which can have a negative impact on the aesthetic of the shoreline.

Another popular shoreline is the naturalized lake shoreline, which does not have a vertical edge. Instead, the lake edge is sloped to match the existing grade so that the water surface comes right up to the grass line. The shoreline consists of a 2-inch-thick concrete veneer with wire reinforcement and an 8'x8' concrete keyway to stabilize the underlying membrane liner. The concrete veneer extends 6 inches above the water level at a slope varying from 1:1 to 4:1

depending on the existing grade. A layer of cobble is embedded on top of the concrete starting from the keyway to the top of the shoreline. A natural soil groundcover is overlain on top of the embedded cobble from the normal water surface elevation and beyond. Dense native vegetation will be planted directly above the sloping natural groundcover to provide stabilization of the overlying soil and provide water quality enhancement of overland flows. It is anticipated that wind action causing waves to crash along the shoreline may cause erosion along specific areas of natural soil cover. As the soil erodes, the concrete and cobble shoreline will be exposed giving off a natural appearance. The operating water surface shall vary slightly (<2") during non-storm events for prolonged periods of time during lake fill using make-up water. During major winter storm events when the level temporarily increases, the vegetation above the shoreline embankment will be temporarily submerged for a period of days. The lake will return to normal elevation once the storm water recedes. This should not impact the vegetation negatively. The natural shoreline option can be blended with surrounding landscape smoothly. Generally, the construction cost is higher than eroded concrete shoreline, however, maintenance is relatively low.

Numerous other lake shoreline options exist. Shorelines will be coordinated with the proposed land uses adjacent the lake. Examples are shown in **Figure 5-1**.

5.2.2 Lake Liner Options

There are two common types of liner system used for manmade lakes. The first is a synthetic membrane liner. Commonly used are 30 mil polyvinyl chloride (PVC) liners, although other materials are also available. A second option for lake lining is the use of chemically treated soil or clay, called "soil liner". Soil liner requires low permeability properties from the soil used. "Environmental Soil Sealant" (ESS-13), which is a spray-on-liner, is a liquid polymer emulsion that can either be poured into the water directly or mixed with the soil and compacted. Preliminary testing will be required for the seepage rate of the existing soil on site. Testing can be conducted by Seepage Control, Inc.

Figure 5-1: Shoreline Options

5.2.3 Storm Drain Lake Outfall Structures

Depending on the invert elevations of the storm drain outlets can be "day-lighted" to a water quality filter or forebay if the invert elevation of the pipe is above lake water surface elevation. If the invert elevation is below the lake water surface elevation, then an outfall box will need to be incorporated along with a submersible pump. This box will be a precast concrete box that will be placed underground and can be accessed through a hatch. The water will need to be pumped out to prevent water from sitting in the box for a long period of time and will prevent mosquito infestation in these boxes. These boxes will also have a screen to catch branches, leaves, debris, etc. to prevent objects from entering the suction side of the pump.

Due to the locations and invert elevation of the storm drain pipes to the lake, outfall structures will be necessary for the connections of these pipes to the lake. This is to prevent the lake water from backing into the storm drain system since all the storm drain pipes are situated at elevations well below the normal lake water level. Additionally, isolating the storm drain would prevent vector problems and other water quality issues. The outfall structures will be located at the end of each storm drain pipe to the lake. The outfall structure consists of a concrete weir box with a covered top. The top of the weir is located 6" above the normal water surface where stormwater overflows out to the water quality filter and into the lake. Nuisance water is also routed and collected in the outfall structure. As nuisance water reaches a certain depth inside the outfall structure, a sump pump located inside each box would pump out the nuisance water re-routing it equally to nearby water quality filters where it is retained for 24 hours undergoing extensive water quality treatment. Other equivalent designs may be used.

5.3 Lake Water Quality Management Systems

Treatment of runoff and management of water quality relies on re-creation of the natural chemical and biological processes within the lake system resulting from a unique combination of different layers of treatment. The general treatment processes for the different target pollutants include:

1. Filtering suspended solids in pretreatment wetlands or forebays
2. Reduced concentration of dissolved pollutants, nutrients, and salts through flushing of the lake water volume by utilizing the lake as the irrigation supply source
3. Reduction of nutrient concentrations from inflows, Nitrogen and Phosphorous, and prevention of algal blooms by filtration or biological treatment of the lake water.
4. Maintaining oxygen levels through aeration promoting oxygen exchange to prevent anaerobic conditions which allows natural process to occur such as denitrification for removal of nitrogen
5. Reduction of BOD (biological oxygen demand) and heavy metals through filtration, coagulation, or sedimentation.
6. Collection of large sediments and floating debris at centralized outfall boxes to the lake system with debris collection facilities and sediment traps, or through catch basins inserts or trash screens in storm drains.

The Aquabella Development will require a system of controls that will address urban stormwater runoff both prior to it entering the lake and once the runoff is actually in the lake. The systems ultimately developed are based on the best available data for best management practices in the field of water resources, as some of these types of projects and research are still in the evaluation stage. The system may include: water quality filters, biofilters, mechanical filtration, coagulation, aeration, and vegetated wetland planters. These systems will work in conjunction to treat urban and nuisance inflows while maintaining the overall aquatic health within the lake.

The first line of stormwater treatment will occur in the wetland water quality filters situated at the outfall from each drainage area. The large filters are comprised of organic-rich sediment with beneficial submergent and emergent macrophytes. Adequate detention in the filters will provide primary treatment of first flush storm (low flow) and nuisance flow. **Figure 5-2** provides empirical data of an extended dry detention basin from the State of Minnesota BMP Handbook. Detention time exceeding 6 hours is minimal and time of 24 hours is preferable. The outfalls from the drainage areas will discharge to water quality filter basins (extended detention basin BMPs) for a quantity of time exceeding 24 hours.

Each water quality filter will vary in size depending on the watershed of the storm drain that outfalls into the water quality filter. Water quality filters are typically 3 feet in depth. Portions of the project's storm drain system may discharge into the water quality filters via small diameter force main lines from the pump discharges in the storm drain outlet boxes. The inverts of these pipes sit on top of the gravel so the outlet is submerged within the gravel bed. Fill is placed around the pipe to ensure a 2-foot minimum soil depth within the filter. The storm drain pipes will terminate in a drainage outlet structure that acts in a manner similar to that of a bottomless overflow box. The outlet structure is positioned vertically, so that nuisance flows (low flows) are directed downward into the gravel, and high flows overflow the top of the box into the water quality filter basin (see **Figure 5-3** for details). Variations on the design described above may be used at Aquabella.

Figure 5-2: Pollutant Removal Effectiveness vs. Detention Time

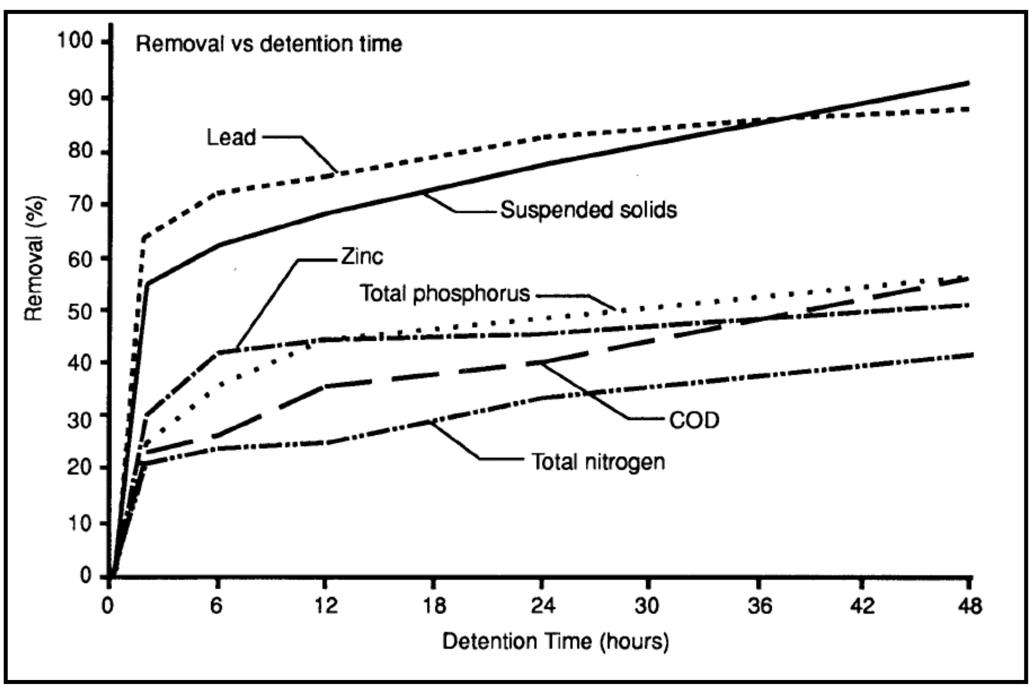
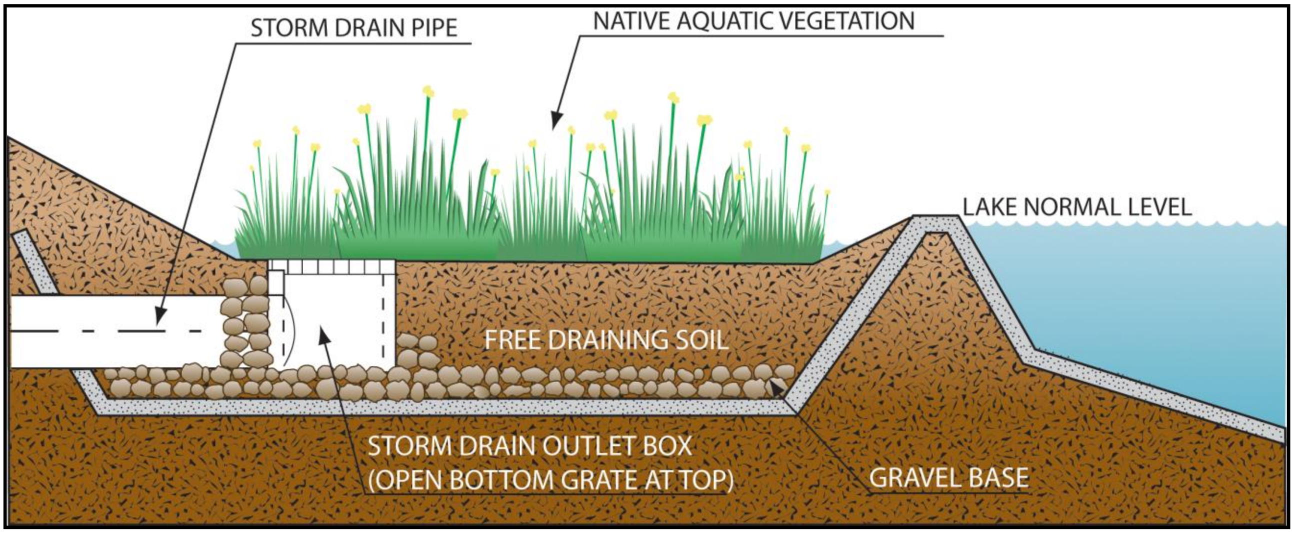


Figure 5-3: Concept Water Quality Filter (Stormwater Extended Detention Basin)



The water quality filters are designed to retain low flow storm runoff and dry weather flow and retain it long enough for the majority of pollutants within the runoff to be removed. These pollutants, introduced into the runoff through overland flow, will be substantially reduced within the water quality filters through the processes of sedimentation, adsorption, and filtration.

i. Sedimentation is the separation of particles from water via gravitational settling. This process removes suspended solids, particulate nitrogen, oils, chlorinated hydrocarbons, and most heavy metals from the water column.

ii. Adsorption is the process whereby dissolved pollutants adhere to suspended solids, bottom sediments, or vegetation and are removed from the water column. Ammonium ions, phosphate, heavy metals, and viruses are removed via adsorption as stormwater percolates through the filtration media.

iii. Filtration occurs as particulate pollutants are filtered through sediments or vegetation, removing organic matter, phosphorous, bacteria and suspended material.

The water quality filters remove pollutants similarly to extended dry detention basins. However, whereas extended dry detention basins rely only on solids settling processes for pollutant removal, the utilization of adsorption mechanisms makes water quality filters more efficient. Typically, extended dry detention basins have removal efficiencies of 20 to 30% for both total phosphorous and total nitrogen, 80 to 90% for total suspended solids, 70 to 80% for lead, 40 to 50% for zinc and 20 to 40% for BOD (*Design of Urban Runoff Water Quality Controls*, edited by Rosner, Urbana's and Sonnen, 1989).

5.3.1 Mechanical Filtration

The lakes will be equipped with pumped circulation systems to move water horizontally throughout the lakes. The pump stations offer the opportunity for mechanical filtration of lake water, and Aquabella may include filters of several possible designs. Filters remove suspended particulates, and with those particulates remove nutrients, metals, bacteria, and a wide variety of other pollutants. Typical filters are automatically backwashed into the sanitary sewer system if local sewer agency (EMWD) allows.

5.3.2 Aeration

Aeration for the Aquabella Lakes will be provided via a fine bubble diffusion system placed at the bottom of the lake. Fine bubble, bottom-laid aeration serves a dual purpose: first, it introduces air and oxygen throughout the lake, and second, it enhances the natural convection movement of water (i.e., vertical recirculation of the water column) within the lake itself. The subsequent increases in both the dissolved oxygen levels in the lake water and in destratification of the lake's vertical water column serve to reduce water surface temperature, a primary condition leading to undesirable thermal stratification and potential algae bloom. In addition to the obvious lake benefits of enhanced conditions for lake biology, specific metals are less toxic and less bio-available when oxidized. Limiting nutrient phosphorus tends to remain in its solid state in lake sediment and does not dissolve efficiently under the presence of oxygen.

Oxidized conditions within the lake column are important for aesthetic reasons. In aerobic conditions odorous compounds such as gaseous sulfur and methane will be reduced. Sulfur typically remains in a precipitated state in lake sediment under the presence of oxygen. Methane may be produced by biological fermentation under anaerobic (reduced or non-oxidized) conditions. In addition, the solubility of iron and manganese, dark colored compounds present in northern California waters, is significantly reduced under oxidized conditions. This will function to enhance water clarity and color.

This aeration system will utilize a series of compressors or blowers, which deliver air to aeration disks. The aeration system is sized to turn over the lake every 5-8 hours, assuming 24-hour/day aeration. A stabilized biological lake system requires maintenance of dissolved oxygen levels. By ensuring that adequate dissolved oxygen levels are achieved within the lake, the potential for odor problems and other lake maintenance concerns will be minimized

5.3.3 Vegetated Wetland Planters

Lake water quality is further enhanced and supported by submerged wetland planter areas placed along the lake edge. This water quality enhancement measure is unique and desirable in that they promote and enhance water quality through naturally occurring biological processes, without the input of energy (i.e.

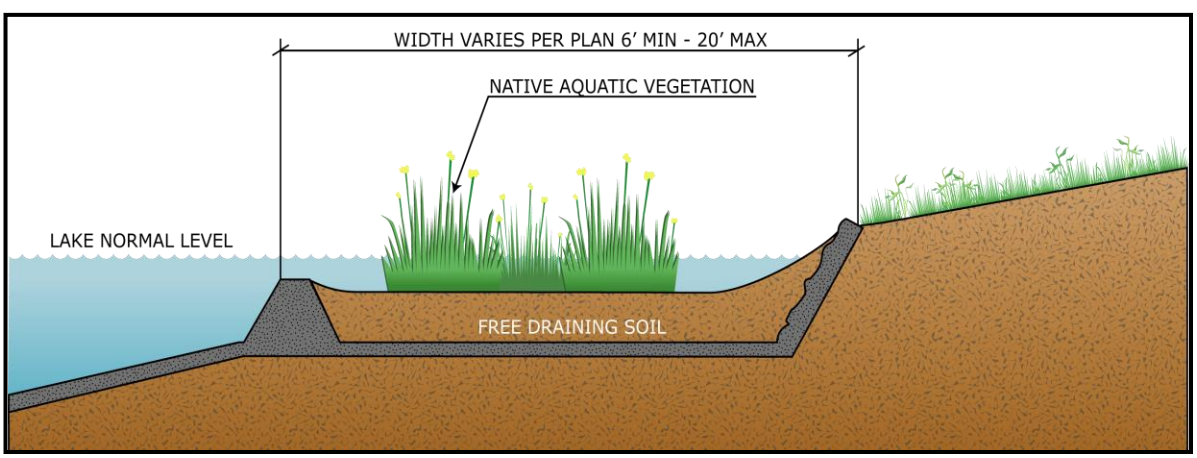
electric power) or any chemicals.

The in-lake wetland planters provide aesthetic benefits, ecosystem value, removal of nutrients, and filtration of turbid waters. A brief discussion of the treatment process for dissolved pollutants is provided. Nitrogen in lake water (i.e. ammonia, nitrate, and organic nitrogen) is converted from nitrate to nitrogen gas by anoxic bacteria in wetland sediment. Phosphorus undergoes attachment and settling to the wetland sediment. Also, both nitrogen and phosphorus are incorporated into cell tissue by wetland plants. Nitrogen and phosphorus are important to water quality as they are generally in too low (i.e. limited) quantity to produce exponential growth of aquatic plants, algae, etc. in lake water. Once nitrogen and phosphorus are introduced to an otherwise limited system, however, rapid increases in growth of nuisance aquatic plants and algae will be present. Overgrowth of nuisance aquatic plants and algae is referred to as eutrophication. A eutrophic lake is one which has an excess of nutrients which causes exponential growth in the lake. A mesotrophic lake has quantities of nutrients which will generally sustain constant growth and an oligotrophic lake is characterized as deficient in nutrients which results in essentially no aquatic plant growth. Aquatic plant growth may include nuisance algae and free-floating suspended aquatic plants, as well as submerged and emergent macrophytes.

Eutrophic water bodies not only result in aesthetically unpleasing water characteristics, but will undergo critical oxygen depletion when the plant matter respires. Plants will respire oxygen (consume it) when covered by other plant material or during night time when photosynthesis is not possible. Hence, after significant overabundant growth during the daytime, the algae bloom may exert critical oxygen demand during the nighttime. As oxygen levels depress, nutrients may become soluble and become more readily available for further eutrophication and blooms. This may often result in a pattern of increasing water quality problems which become difficult to reverse.

In general, concentrations of total nitrogen and total phosphorus exceeding 1 mg/L and 0.1 mg/L, respectively, may begin to result in a eutrophic lake (lakes characterized with problematic aquatic growth due to nutrients within the lake). It should be noted that any natural ecological system of this relatively small size will contain waterfowl and fish which will introduce significant nutrients approaching or exceeding these values. A certain amount of biological growth is unavoidable without disinfection (chlorination, bromination, etc.) and/or eradication. The lake treatment mechanisms described herein will be used to combat these increases and provide for a balanced biological ecosystem. A detail of a typical wetland planter can be seen on **Figure 5-4**.

Figure 5-4: Conceptual Vegetated Wetland Planter



5.4 Lake Irrigation Water Demand Water Balance

A maximum 30-day recirculation turnover is generally tolerated and will allow for some nutrient build-up. Approximately, 7-day turnover (not considering irrigation turnover) will be designed to provide a more active treatment system. This will decrease the quantity of stagnant water and process greater flows through the described nutrient removal mechanisms. Closed system aquascapes with clean source water that do not integrate flushing will generally require an annual replacement of the entire water during the fall to maintain the water quality. As the lakes at Aquabella will serve a dual function as an irrigation storage reservoir, the stored water will be withdrawn from the aquascape for irrigation use, indirectly resulting in flushing of the system. Irrigation lakes allow for a high turnover or replacement of the water volume and multiple lakes can be interconnected to achieve the maximum benefits. It is also desirable to achieve "plug flow" circulation in order improve the benefits of flushing. Plug flow will eliminate stratification from the incoming flow and ensure complete turnover. Correctly locating the inlet and outlet at opposite ends of the water body and with the direction of the wind will assist in achieving plug flow to maximize horizontal circulation benefits.

A preliminary lake water balance analysis was conducted to assess the overall water demand and minimum required fill rate in order to sustain a normal operating lake water level. The entire 40-acre lake will serve as the storage impoundment for irrigation in the Aquabella Development. In addition to irrigation, evaporative losses were also projected to provide a more accurate estimate on the water consumption. Water from onsite wells will be used as the primary source for lake make-up water demand. Other sources such as other local wells may be used as backup.

A water balance analysis was completed for the project, which evaluated the anticipated water inputs and outputs within the development. Lake inputs considered were precipitation (direct and on-site runoff) and nuisance runoff. Nuisance water, also called dry weather flow, is defined as run-offs from residential areas resulting from over irrigation, car washes, etc. For lake outputs, evaporation and irrigation were considered. For the purpose of this report, losses due to infiltration through the liner are considered negligible.

Irrigation water for the proposed areas within the project will be stored in the lake and drawn daily per the demand. An evaluation of the lake inputs and outputs provided a basis for the projected water demand and is presented herein on a monthly basis.

5.4.1 Precipitation and Evapotranspiration

Weather data from two sources were used in this report. The first source is from a handbook developed by the California Department of Water Resources, "Landscape Water Management Handbook" version 4.1, which showed that the annual Et0 in the City of Lancaster, CA was 71.10 inches in 1989. The second source is from the Western Regional Climate Center database, which provided the monthly average precipitation from the period of 5/1/1974 to 9/30/2005. Data from both sources can be seen in Appendix A.

5.4.2 Definitions and Calculations

System Inputs:

A. Direct Precipitation (DP) is the average inches of rainfall over the lake surface and was calculated using the following formula:

DP = Lake Area * Precipitation (inches); converted to acre-feet

B. On-site storm runoff (SR) within the project area will be conveyed to the lake for extended retention and treatment and was based on the following formula, converted to AF/month:

SR = Site Area *Precipitation * Runoff Coefficient

C. Nuisance Runoff (NR), defined as water generated due to over-irrigation of lawns, runoffs from carwash, etc. was calculated assuming an average daily generation of 20 gallons per day per single family lot, which was used to estimate overall nuisance flow from the project site. Single family lots were used to estimate dry weather discharge because reliable data for multi-family residential areas and apartment complexes is not available, although anecdotal observations suggest apartments tend to have similar nuisance flows as single-family residential areas. The following formula was used to determine the nuisance volume, converted to AF/month:

NR = 20 gpd/Lot * Number of single-family Lots that would fit within each sub watershed.

The average daily flow per lot was based on data from developments that were located in the cities of Fillmore and Palmdale, California, which has similar weather conditions. Typical numbers ranged from 48 gpd/home to 110 gpd/home. A conservative estimate of 20 gpd/home was used for this report.

System Outputs:

A. Lake evaporation was calculated using the following formula:

Direct Evap. = Lake Area * Et_o Rate * (1'/12")

B. The Irrigation volume and peak demand required was based on the following assumptions.

1. The Project was assumed to have 106 acres of irrigated landscaped area, representing 16% of the site.

2. Spray irrigation, was assumed for all irrigated areas. An irrigation efficiency (IE) of 75% was assumed for spray irrigation. A plant coefficient of 0.6 was used for all irrigated areas, since turf areas in California, in general, are typically listed as 0.6.

3. Peak irrigation requires a peak flow of 1765 gpm assuming a duration of eight hours.

4. Average daily loss due to evaporation during a peak month is approximately 185 gpm.

5. The total irrigation demand volume was estimated using the following equation

Irrigation Demand = [(Et_o* C) - Precipitation] * Area * (1' / 12")

Et_o = Referenced Evapotranspiration Rate[1] (inches)
Precipitation = Precipitation[1] (inches)
Area = Landscape Area to be Irrigated (Acres)

C = Adjustment Factor (Plant Coefficient / Irrigation Efficiency)
Notes:

5.4.3 Water Balance Conclusion

For the three water balance models, with nuisance flow, without nuisance flow, and drought condition, an estimated annual water demand of 564, 586, and 640 AF, respectively, is required. Assuming worst case, approximately 847,000 gallons of water is required per day for irrigation, assuming an hour irrigation window. The lake will also be anticipated to lose approximately 265,000 gallons per day during peak conditions.

5.5 Source Water Quality and Quantity Available

At this time, it is assumed that 100% of the makeup water for the lakes, and thus also 100% of the site irrigation water, will consist of groundwater from onsite wells.

5.6 Lake Operations and Maintenance Program

Proper maintenance is a primary requirement to achieve great water quality. The key to ensuring the continued aesthetic appeal of the lake system will be regular care and maintenance. This maintenance must be consistent and performed in accordance to a regular schedule that provides for the flexibility of additional maintenance in high loading events such as wind storms, etc. Careless cleaning, for instance, can only lead to later nutrients loading of the lake system.

Leaf and landscape debris outside on the lakes should be removed as soon as possible after a wind event or when the material is being shed. It is best to put maximum effort into cleanup of this material before it gets into the lake systems, since cleanup is considerably easier in the dry as opposed to the wet environment. Effort should be put into meeting with the project members responsible for landscape maintenance to determine if certain trees and shrubs can be thinned or trimmed before they generate significant amounts of debris.

A landscape maintenance log that records the time and durations of cleanup should be maintained to document required maintenance as well as develop historical data that can be used to determine if adequate levels of effort are being used.

The following maintenance activities will be part of the lake O&M program:

5.6.1 Debris Removal

The servicing technician should physically remove any floating or shoreline debris from the lakes. Any larger branches from trees in the water or other debris too far from the shore should be removed with the use of a service boat. All debris should be bagged and placed in a designated dumpster on site.

5.6.2 Algae Control

If uncontrolled algae growth is observed it should be treated with the use of algaecides directly on the filamentous algae along the shorelines or sprayed on the lake surface for planktonic algae. A water colorant, Aquashade, may be applied on an as needed basis to minimize the growth of algae and aquatic weeds by reducing the ultraviolet light penetration.

5.6.3 Aquatic Weed Control

Aquatic weed growth may occur in the lakes. The weeds may be allowed to flourish until they come within six inches of the water surface or eight feet from the shoreline. At this time, mitigation procedures should be employed. To remove the unwanted vegetation, chemicals may be applied to reduce the re-growth potentials.

5.6.4 Pump Maintenance

All pumps should be inspected monthly. A maintenance log should be located in the pump house and each maintenance visit should be noted in the log. The technician should automatically perform all annual and semi-annual maintenance.

5.6.5 Filter Maintenance

Each type of filter is maintained according to manufacturer's recommendations.

5.6.6 Water Quality Filter Maintenance

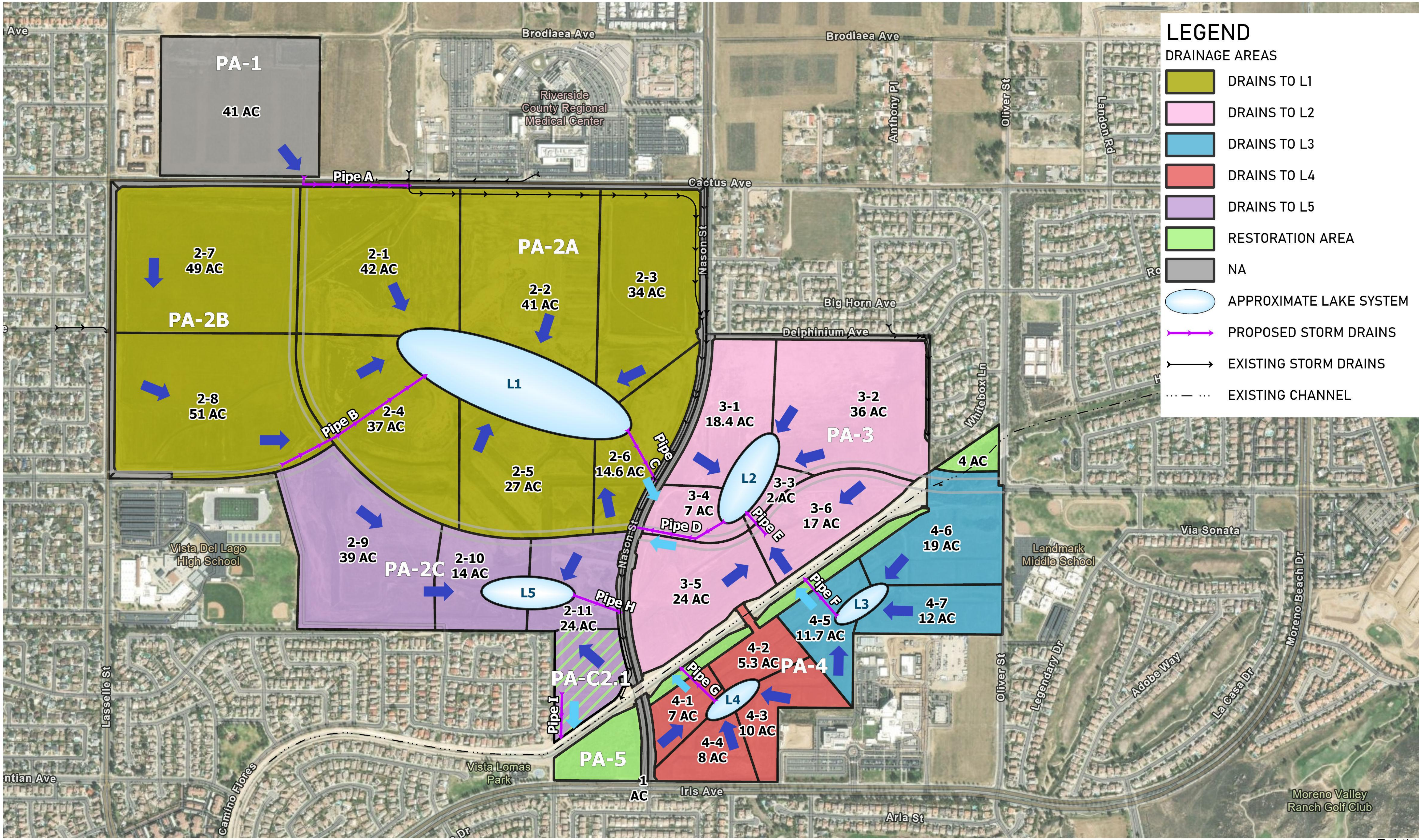
A majority of the initial storm runoff will end up at the lake, and it will enter through the water quality filters. The maintenance procedure for the water quality filters is as follows:

- Inspect water quality filters daily and remove all debris as required.
- After every large storm, remove any debris.
- Inspect WQ filters for excess silt that forms and remove.

5.6.7 Aeration System Maintenance

The aeration system pumps should be inspected each month. Necessary routine maintenance should be performed at that time. Aeration pumps with air filters should have the air filters cleaned monthly or more frequently as needed. Aeration disks should be inspected annually.

EXHIBIT



R:\B796\6-GIS\Projects\B796_Working\B796_Working.aprx - Drainage Areas

Exhibit 1

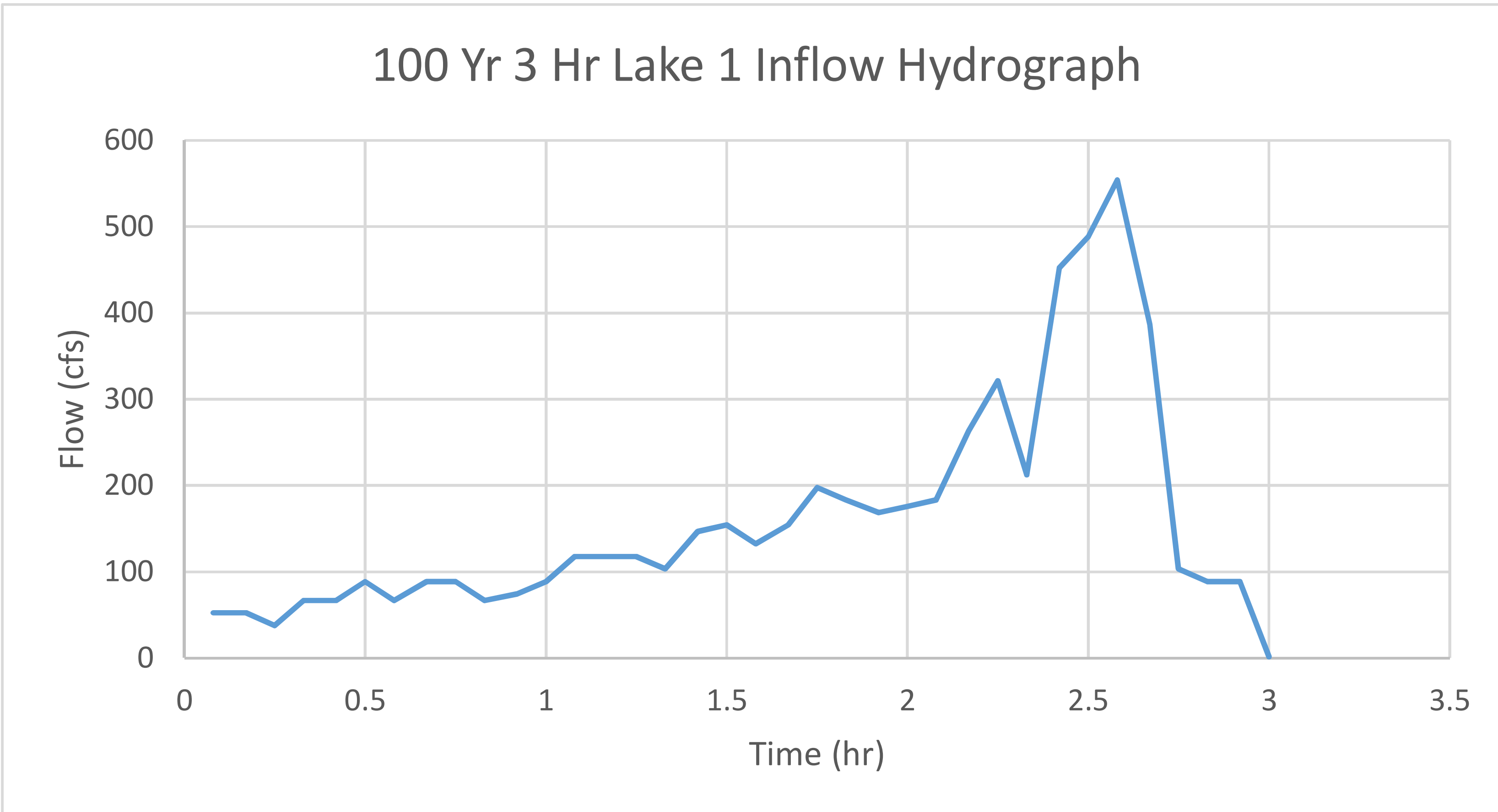
Drainage Areas

N

0 400 800 1,600 Feet

March, 2023

APPENDIX A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600
500
400
300
200
100
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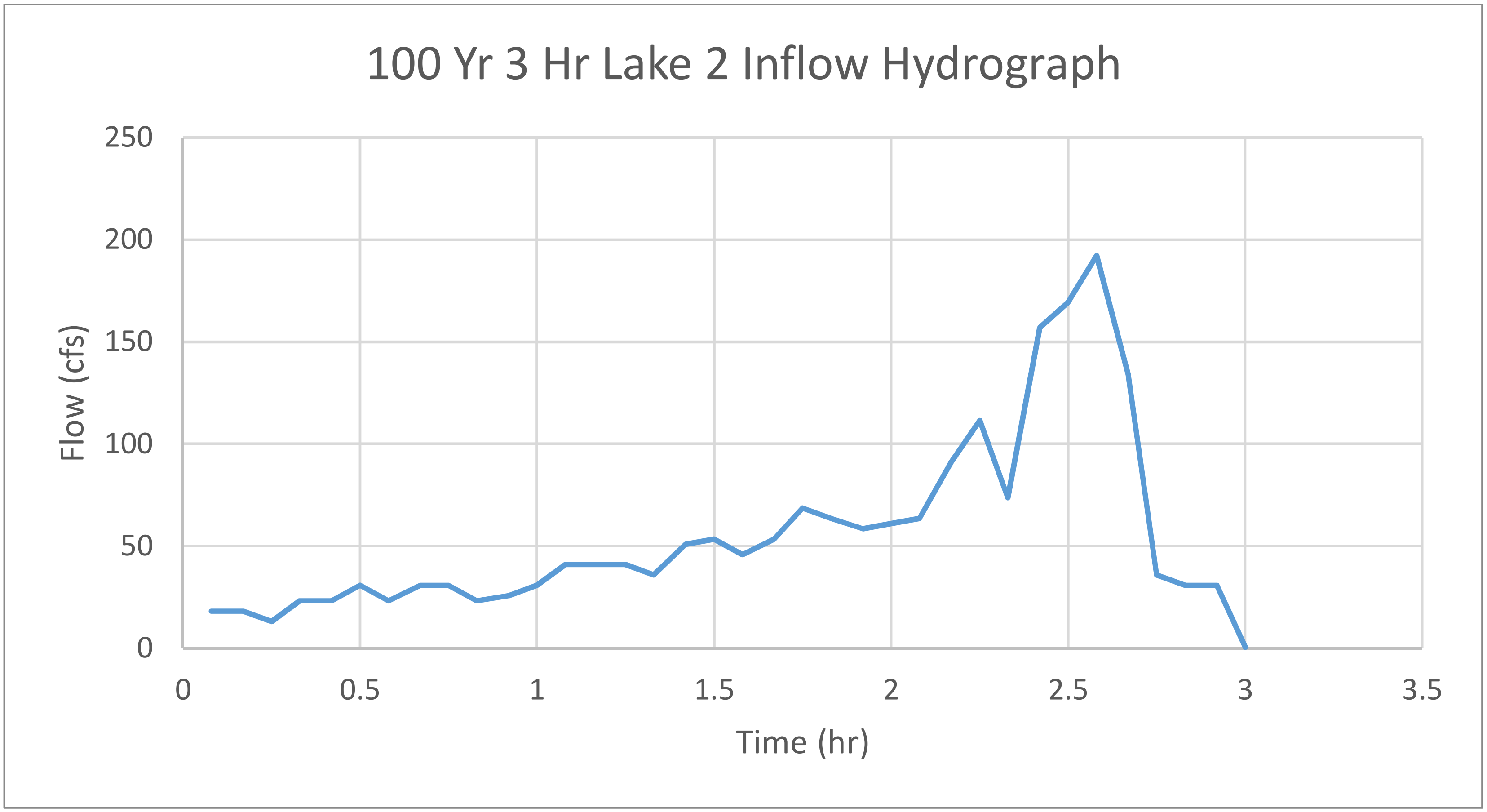
1
1.5
2
2.5
3
3.5
Time (hr)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Flow (cfs)
250
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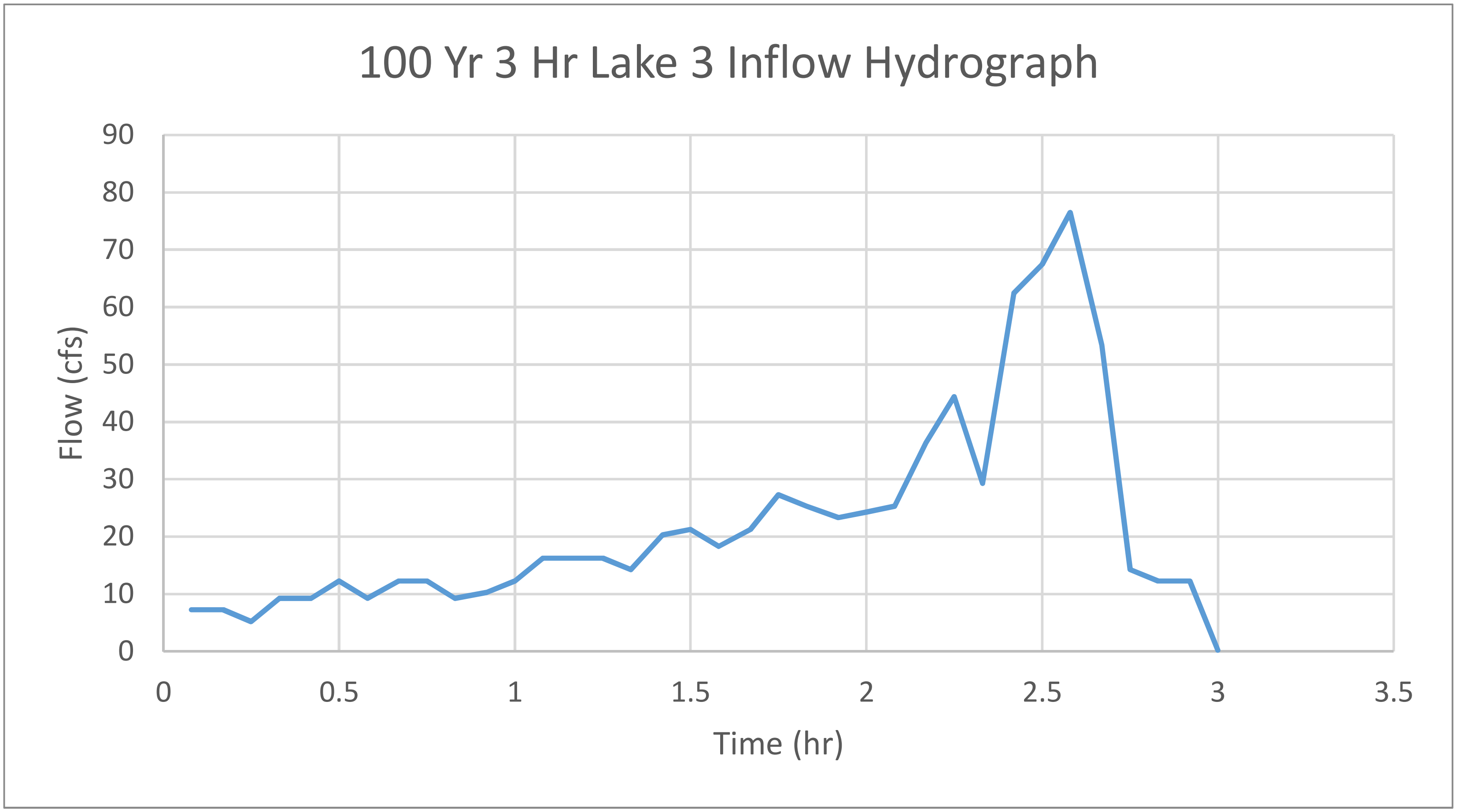
150
100
50
0
0
0.5
1
1.5
2
2.5
3
3.5
Time (hr)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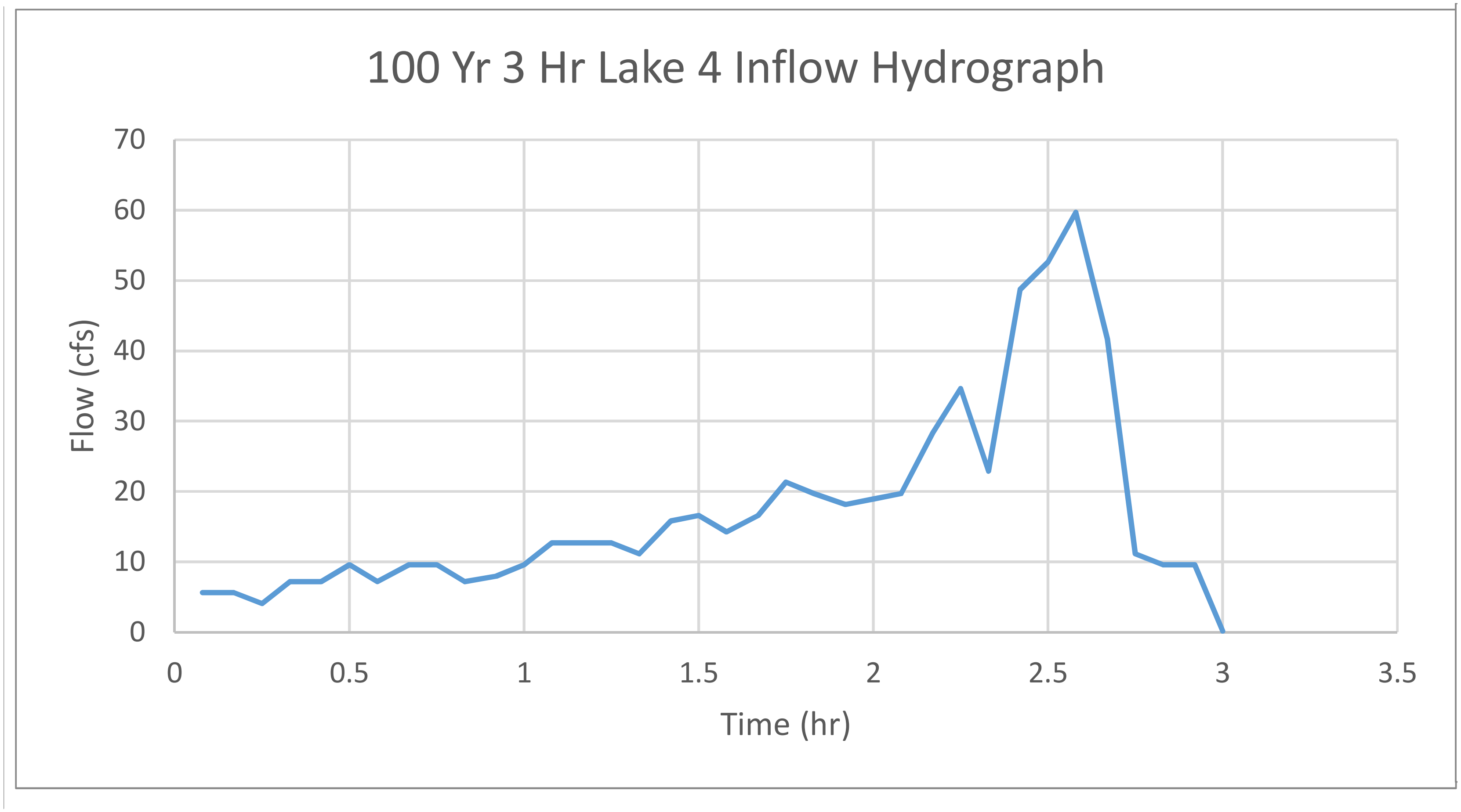
Flow (cfs)
0
10
20
30
40
50
60
70
80
90
0
0.5
1
1.5
2
2.5
3
3.5
Time (hr)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Flow (cfs)
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50
40
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20
10
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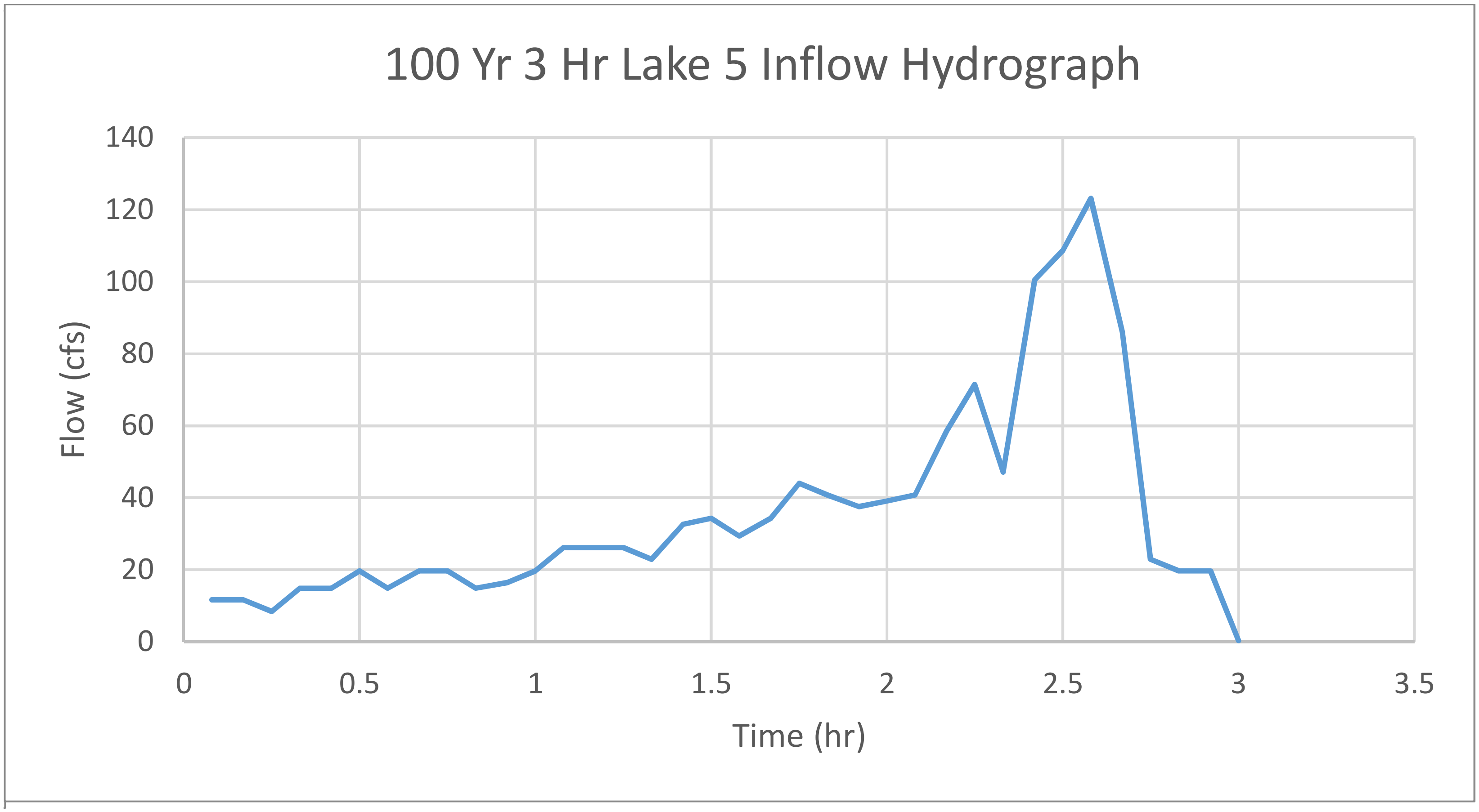
2
2.5
3
3.5
Time (hr)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Flow (cfs)
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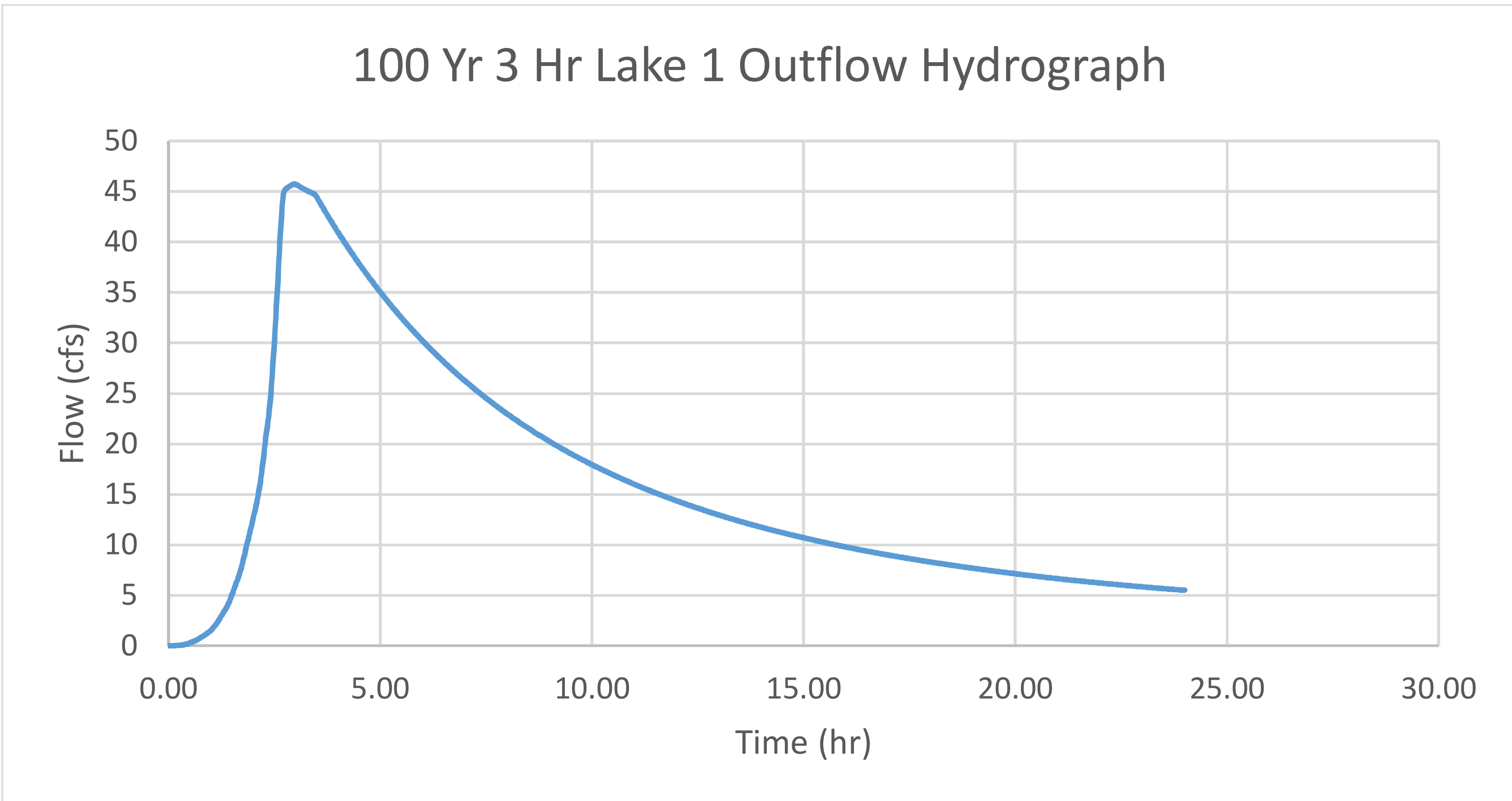
40
60
80
100
120
140
0
0.5
1
1.5
2
2.5
3
3.5
Time (hr)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Flow (cfs)
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45
40
35
30
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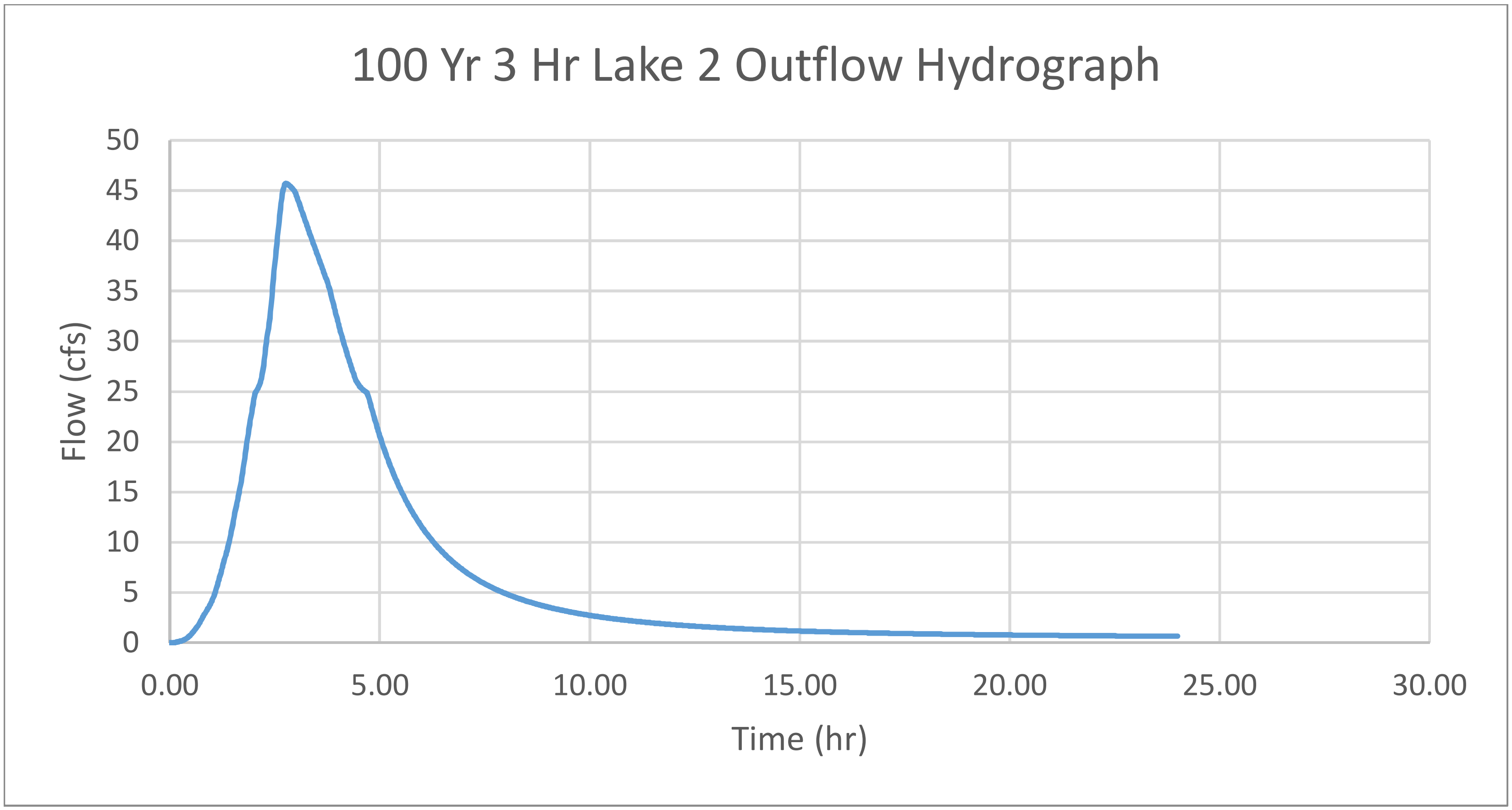
25.00
30.00
Time (hr)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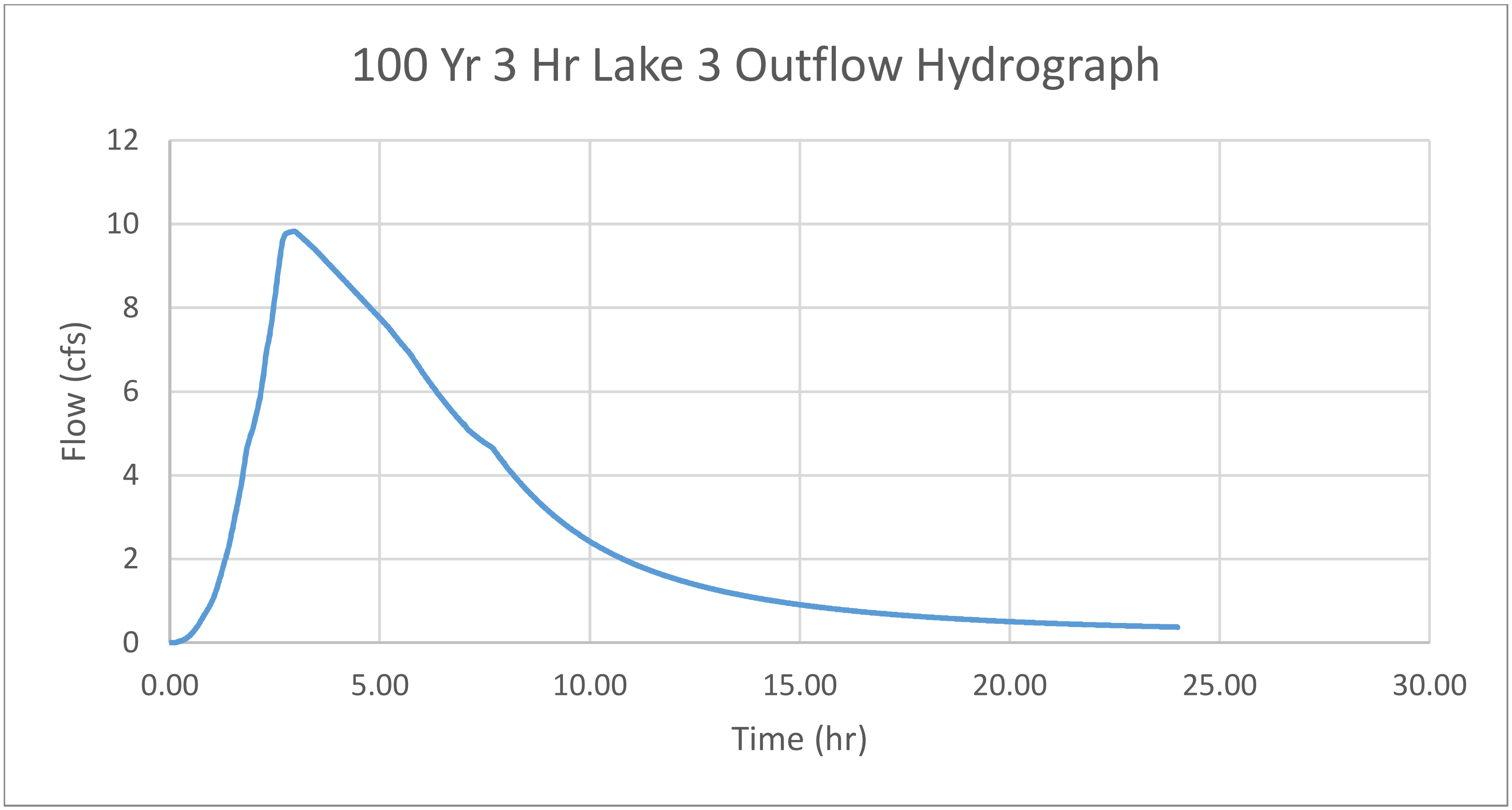
25.00
30.00
Time (hr)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Flow (cfs)
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2
4
6
8
10
12
Time (hr)
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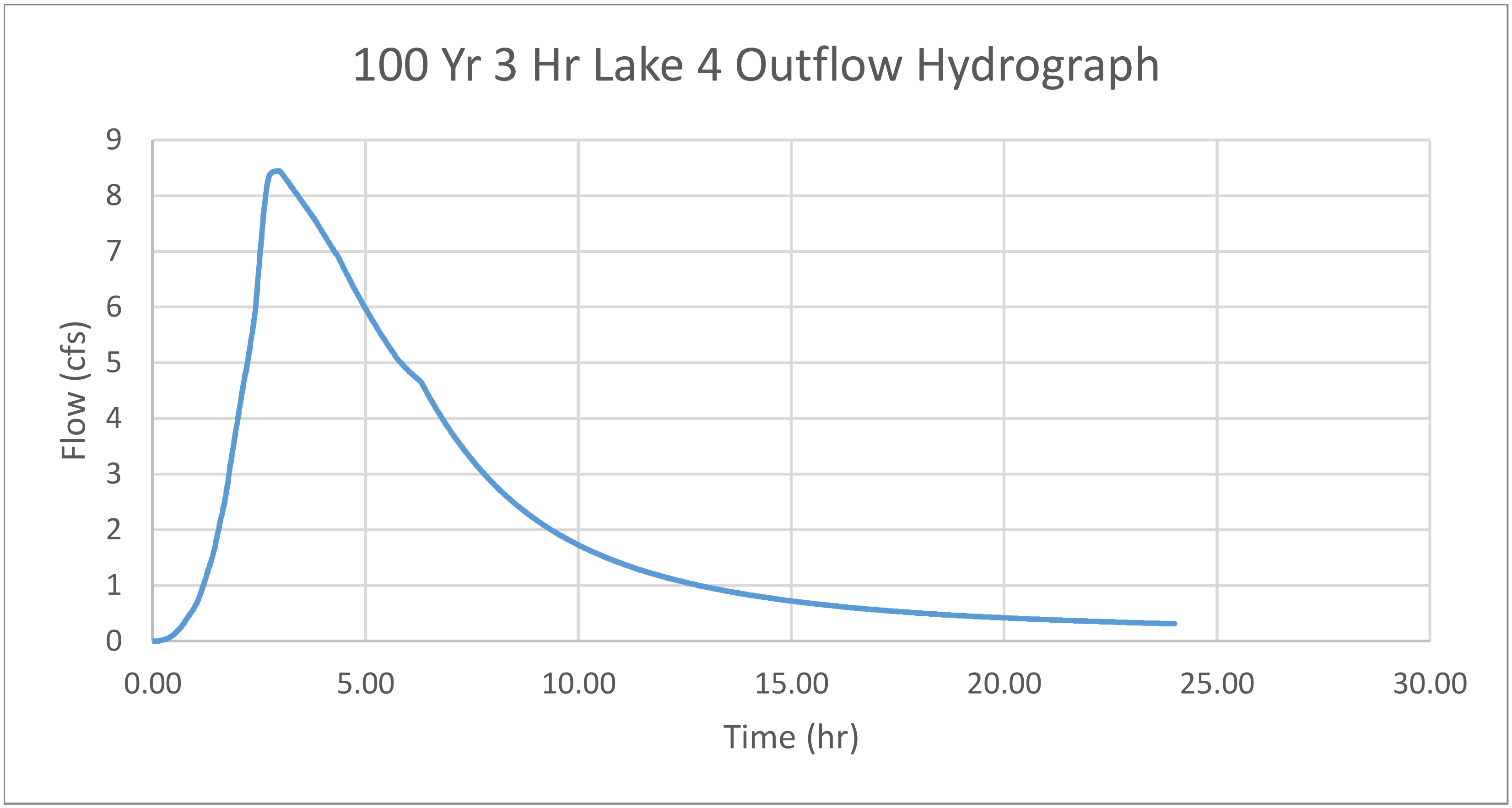
20.00
25.00
30.00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Flow (cfs)
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8
7
6
5
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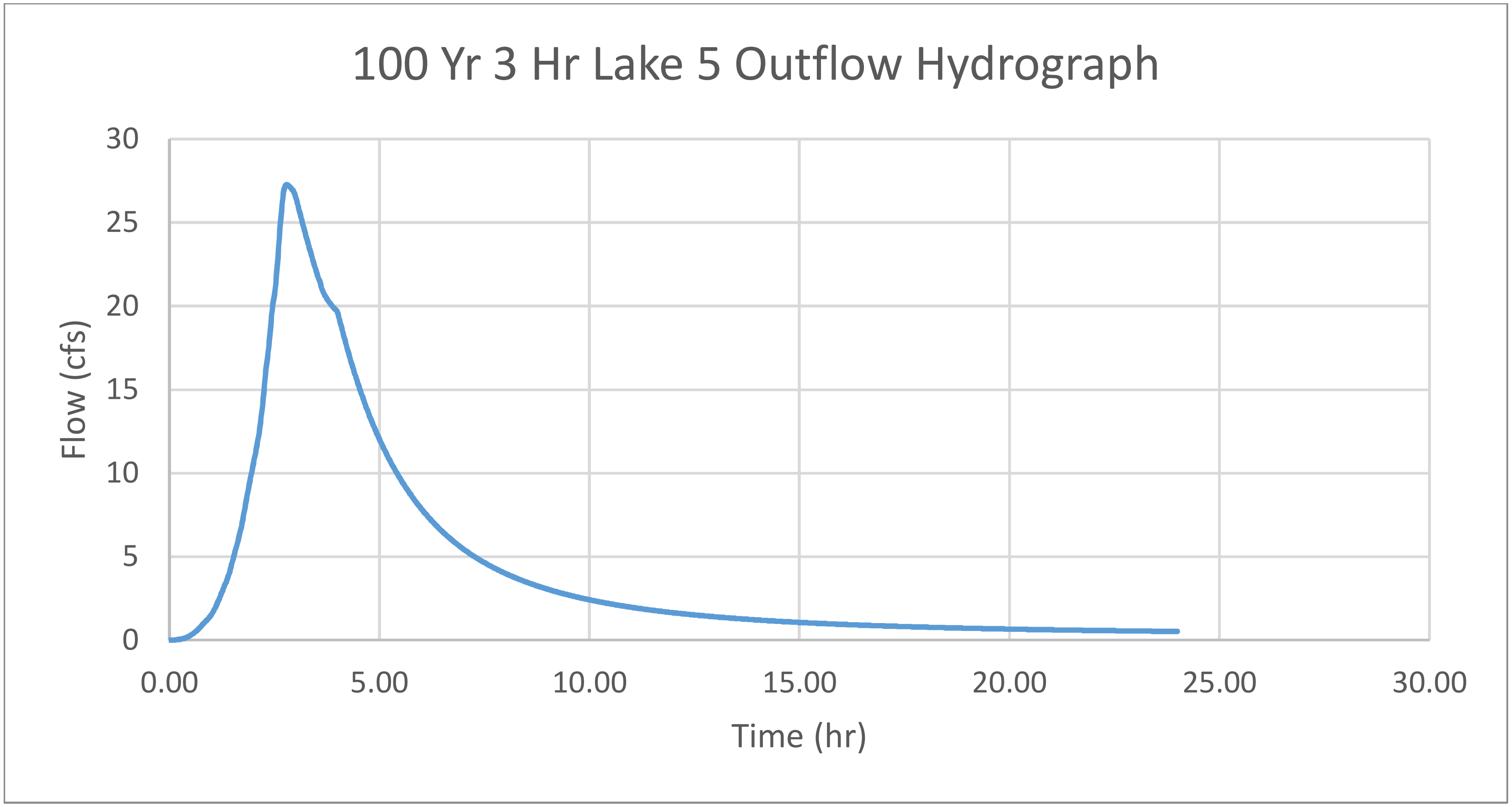
25.00
30.00
Time (hr)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Flow (cfs)
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25
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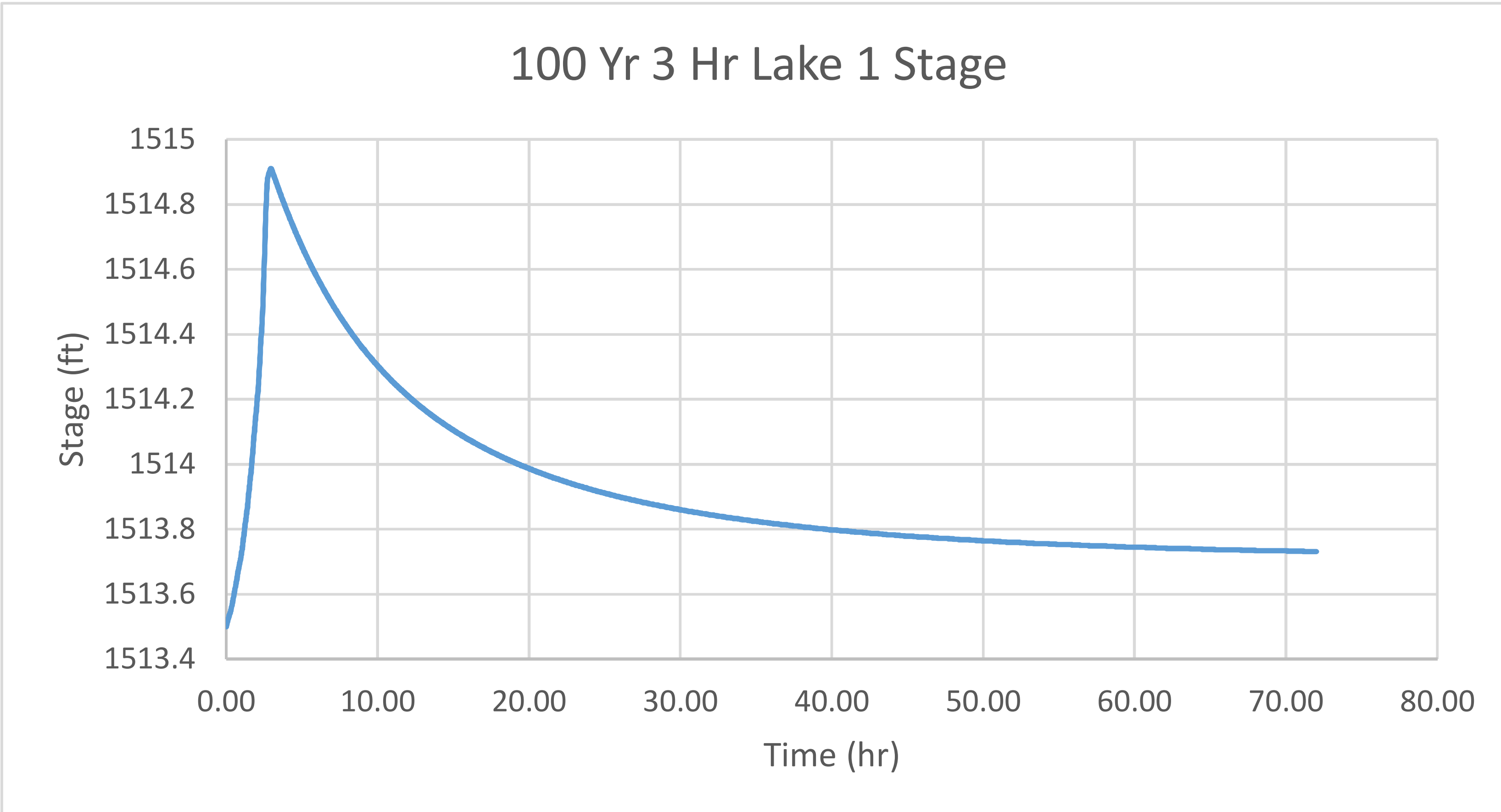
30.00
Time (hr)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Stage (ft)
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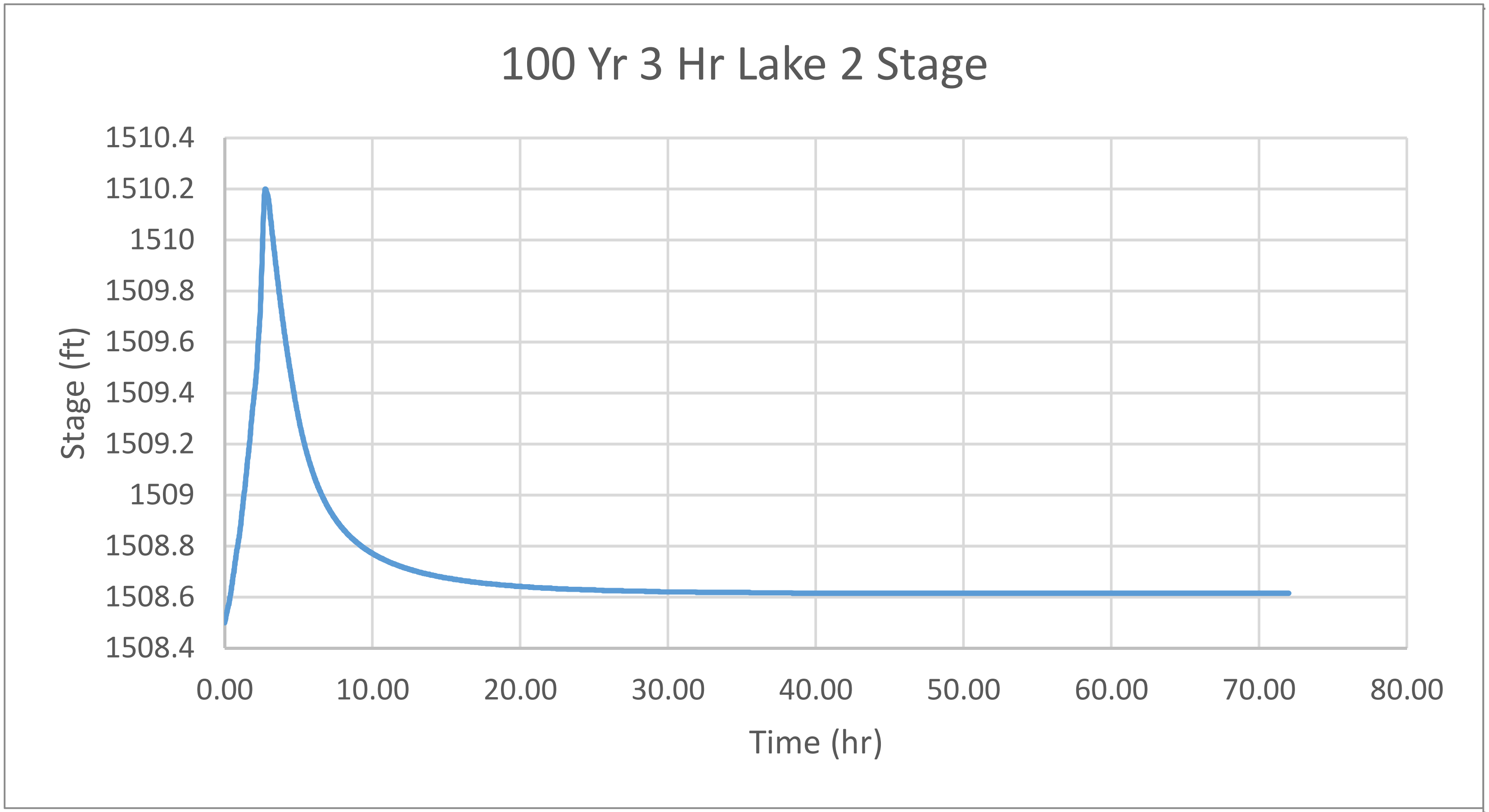
1514.8
1514.6
1514.4
1514.2
1514
1513.8
1513.6
1513.4
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
Time (hr)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Stage (ft)
1510.4
1510.2
1510
1509.8
1509.6
1509.4
1509.2
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1508.8
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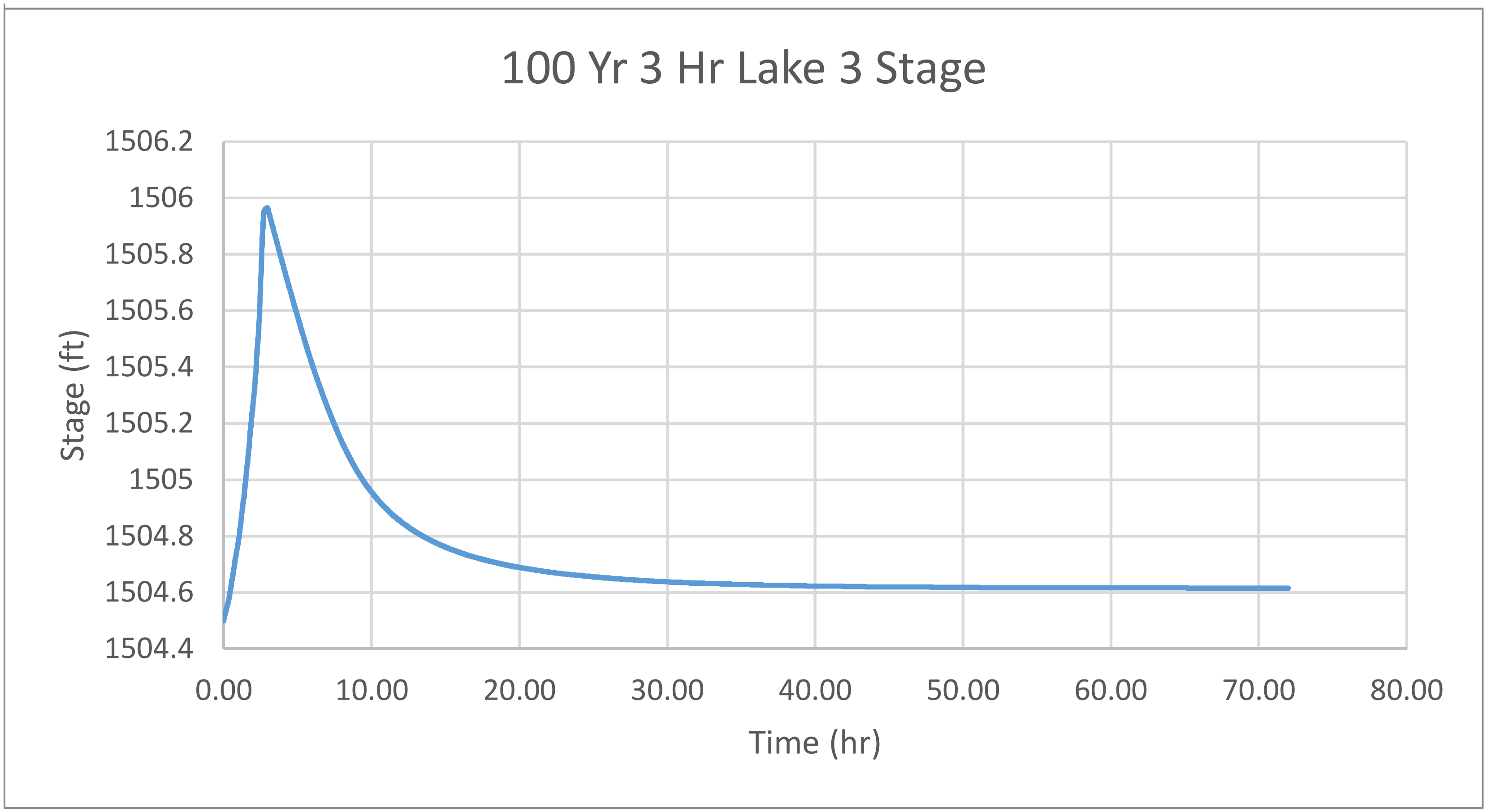
70.00
80.00
Time (hr)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Stage (ft)
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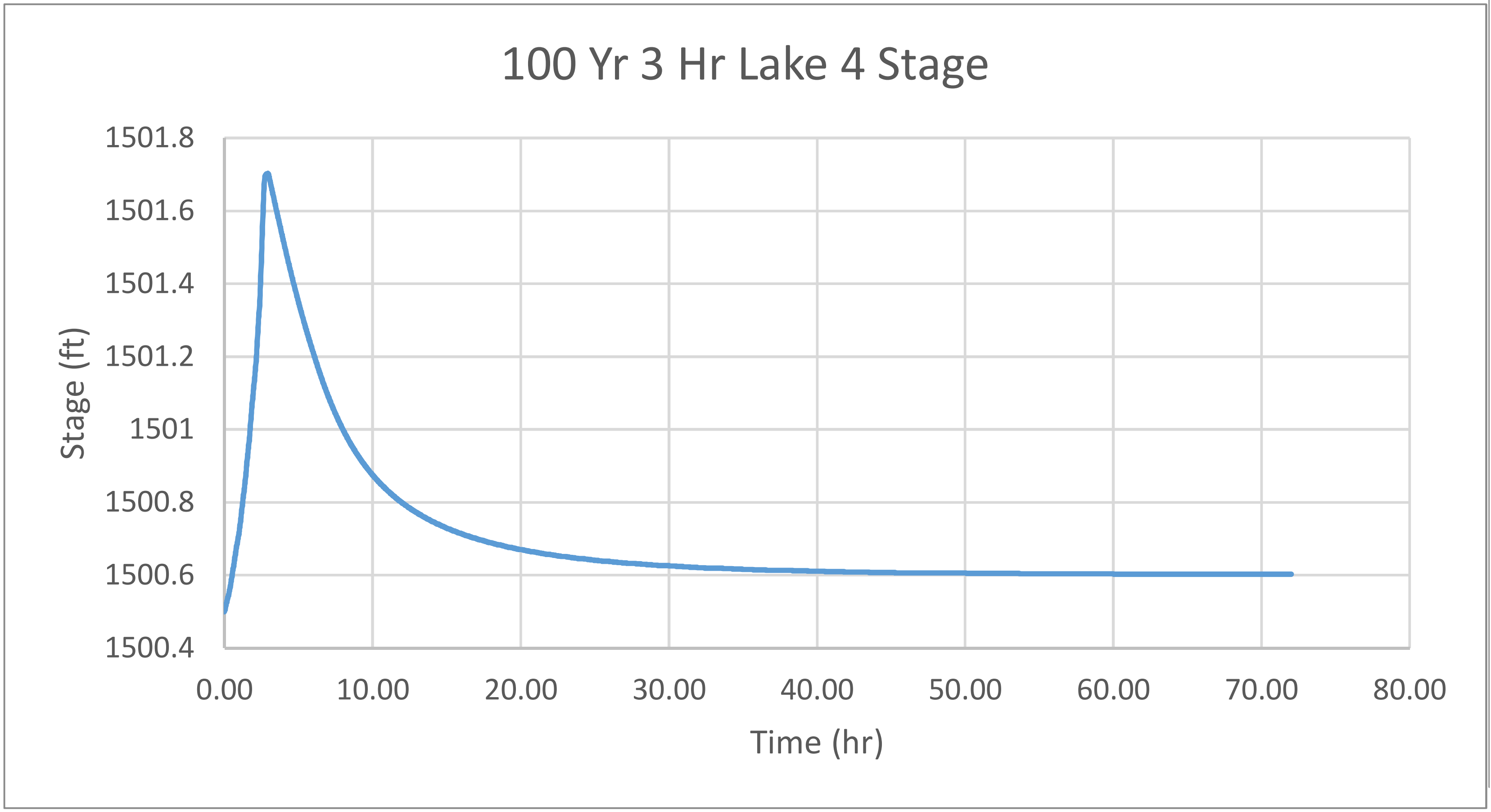
1505.6
1505.4
1505.2
1505
1504.8
1504.6
1504.4
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
Time (hr)


100 Yr 3 Hr Lake 4 Stage
Stage (ft)
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1501.6
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1501.2
1501
1500.8
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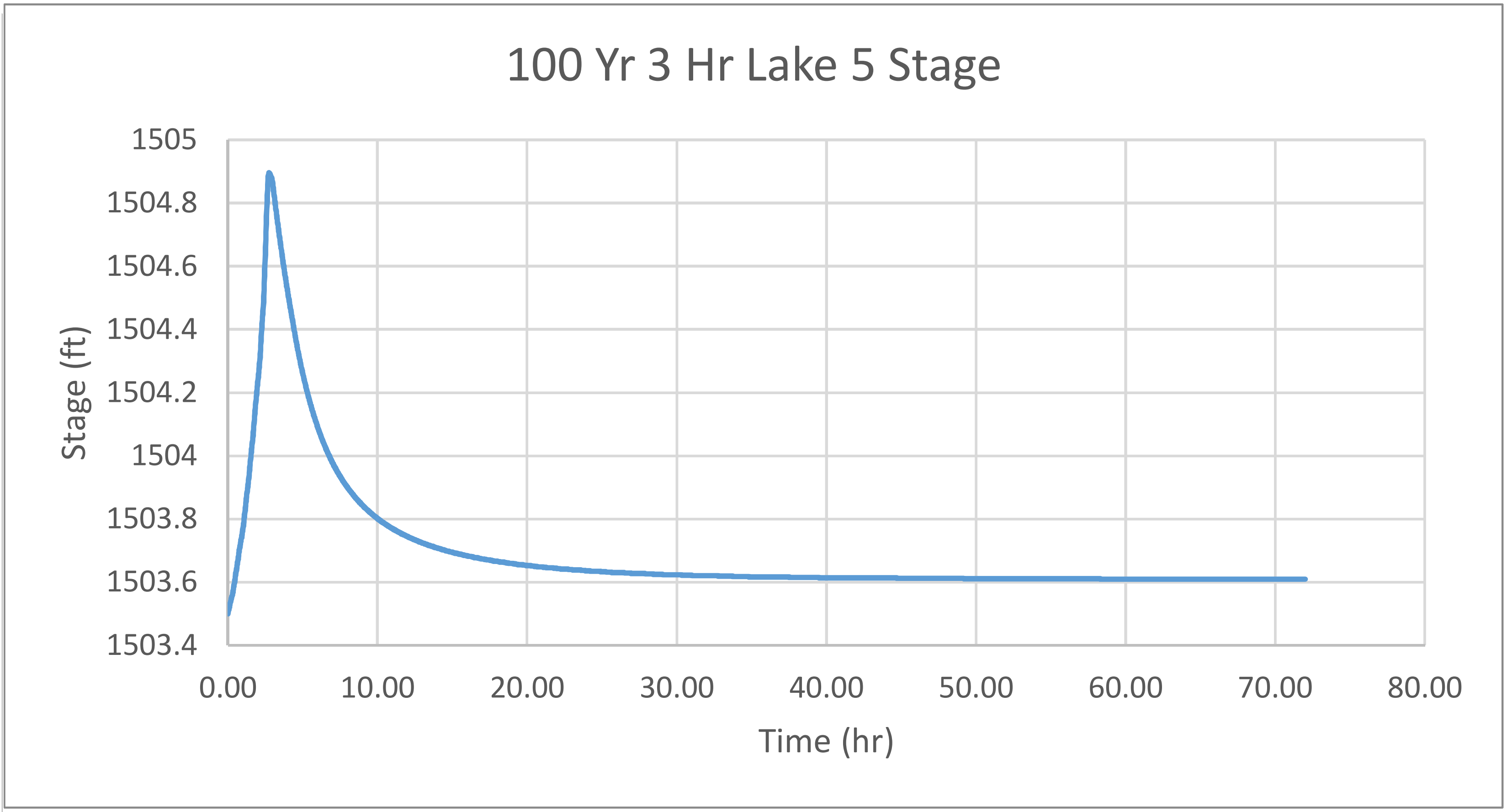
30.00
40.00
50.00
60.00
70.00
80.00
Time (hr)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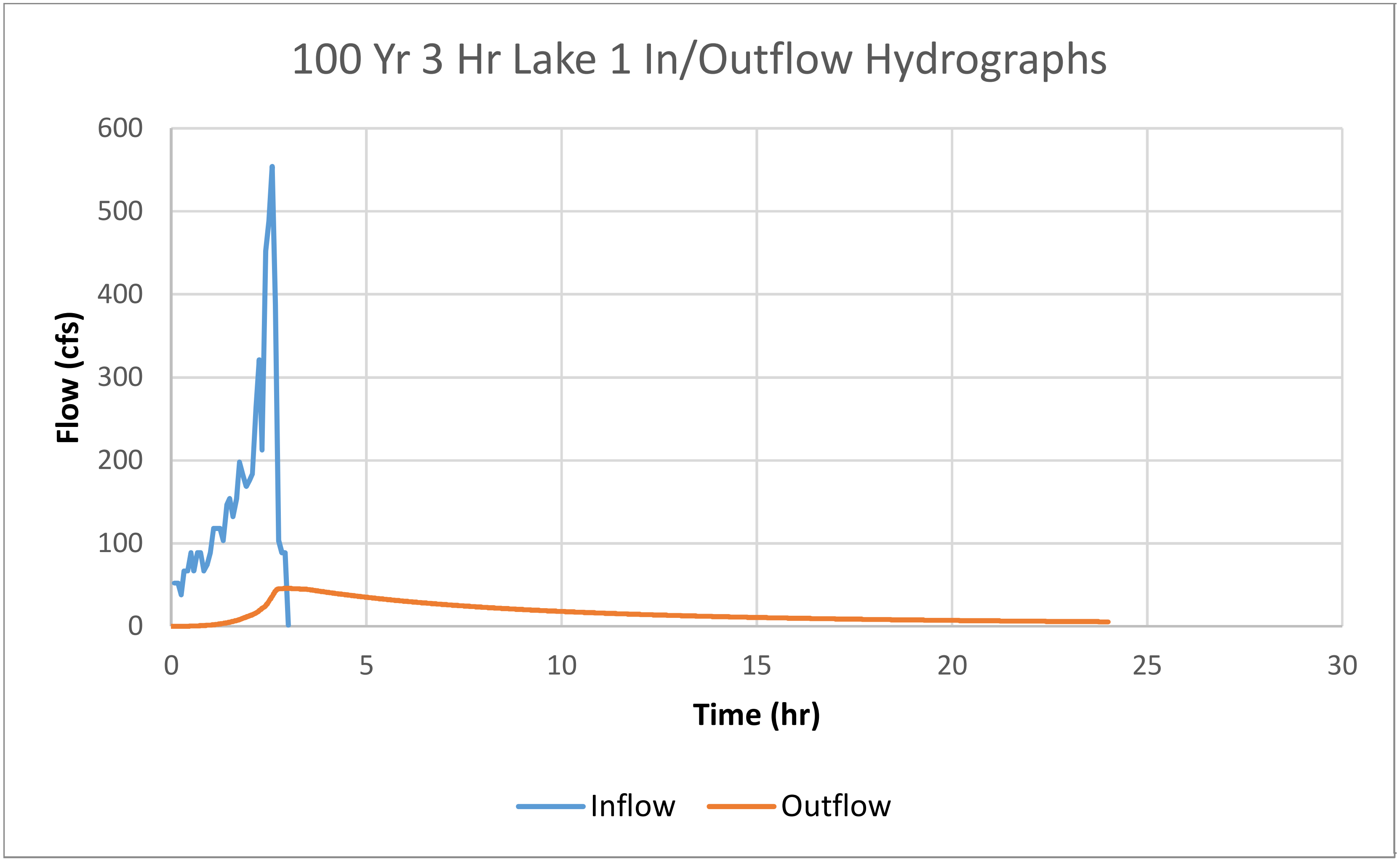
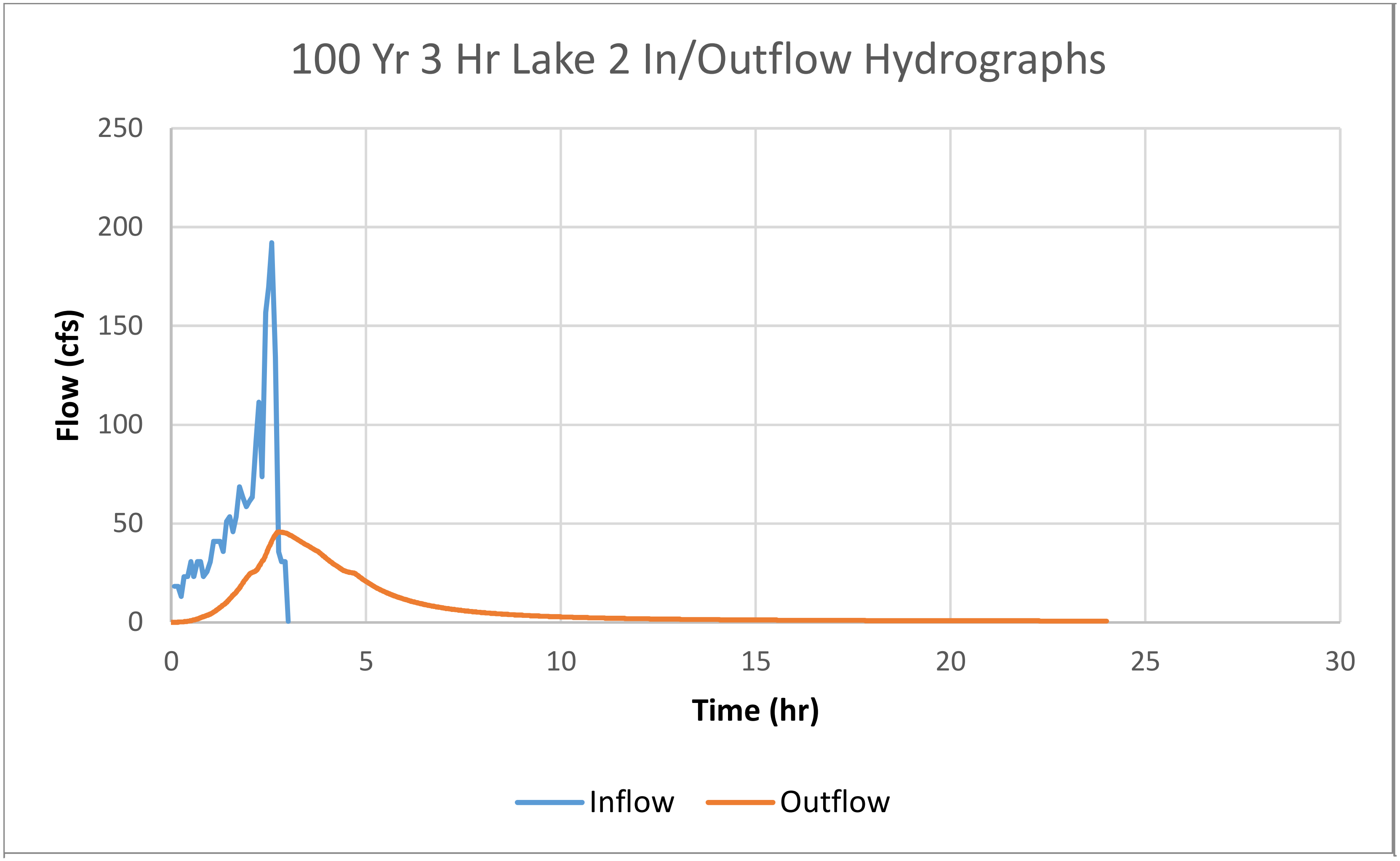
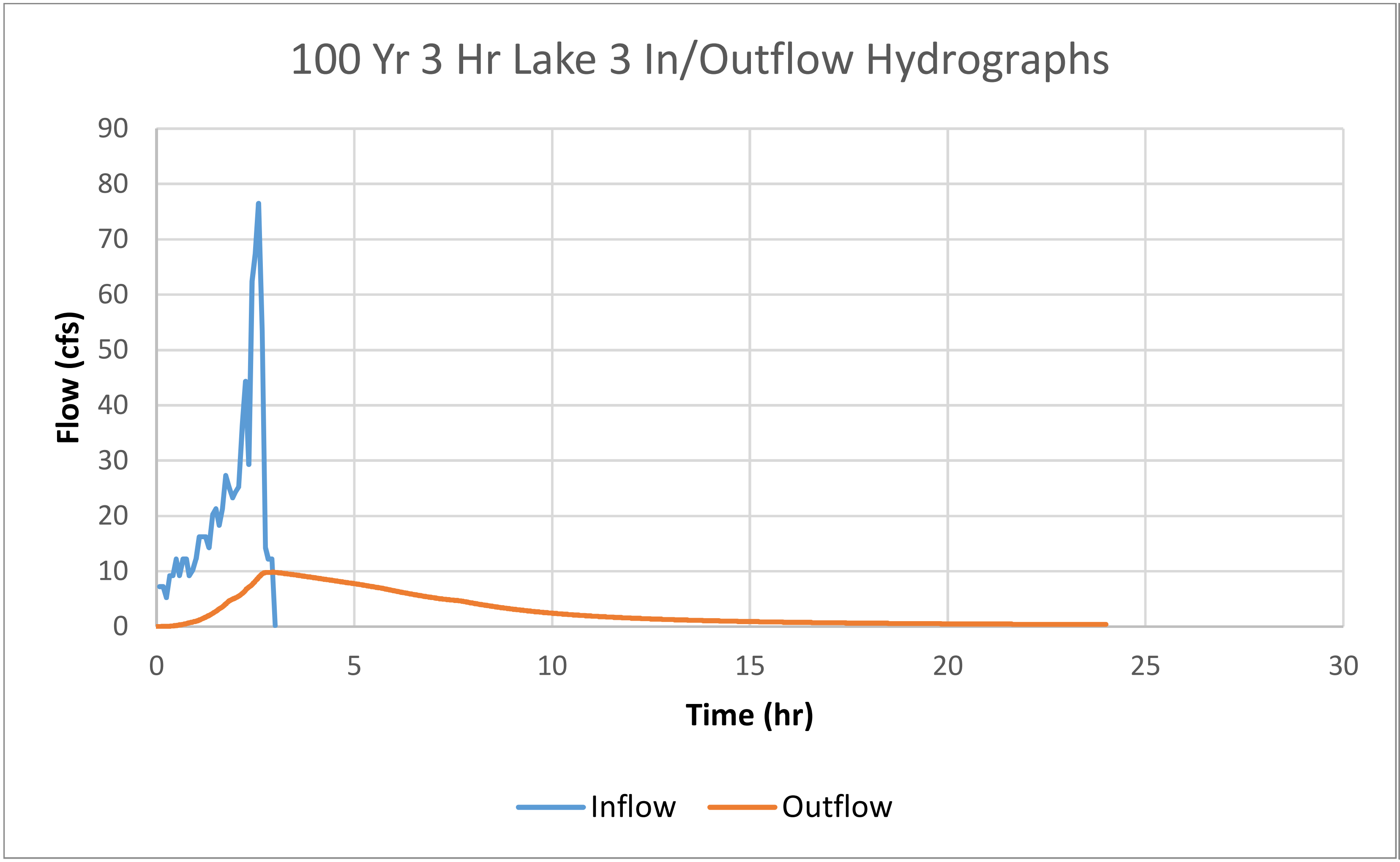
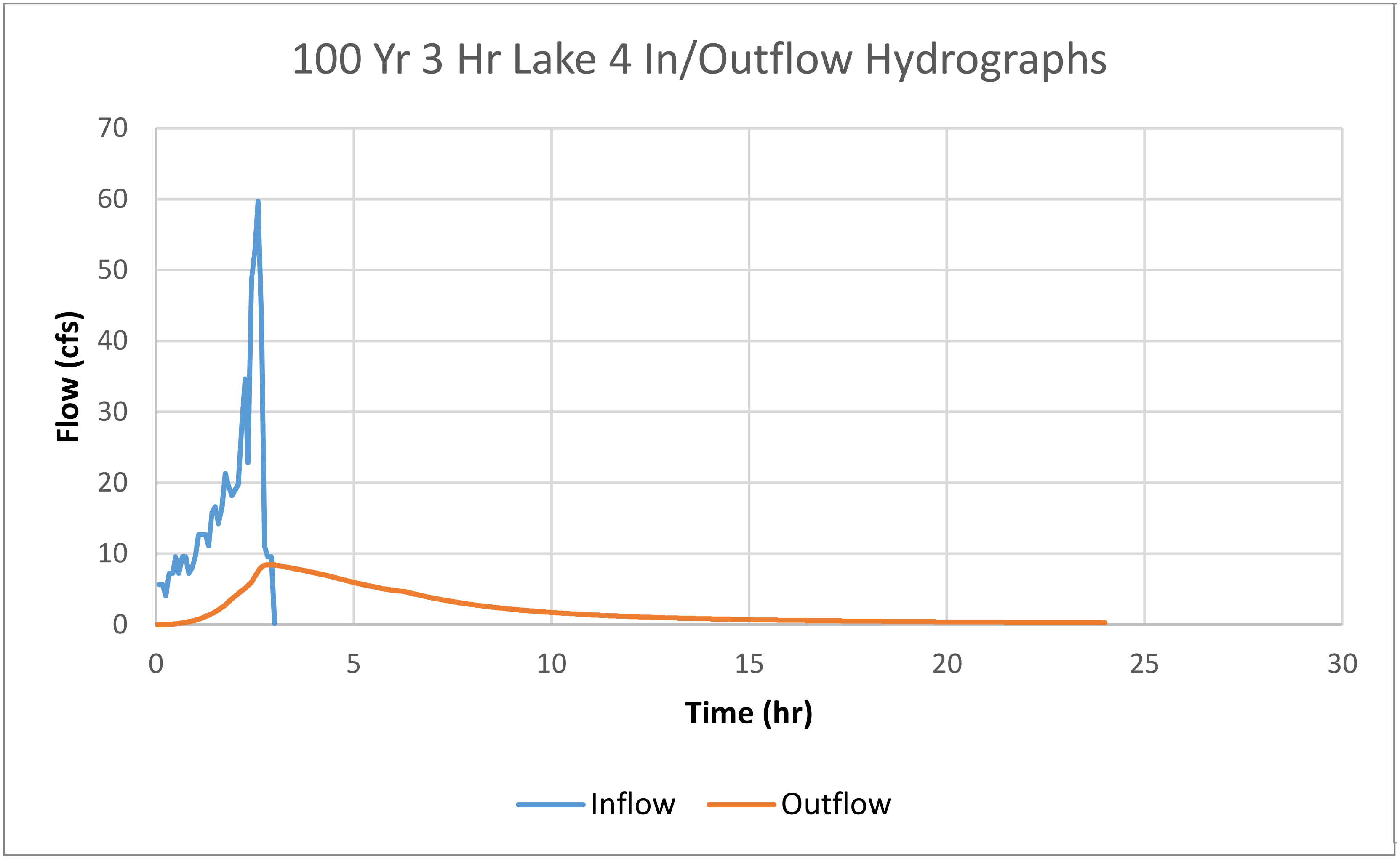
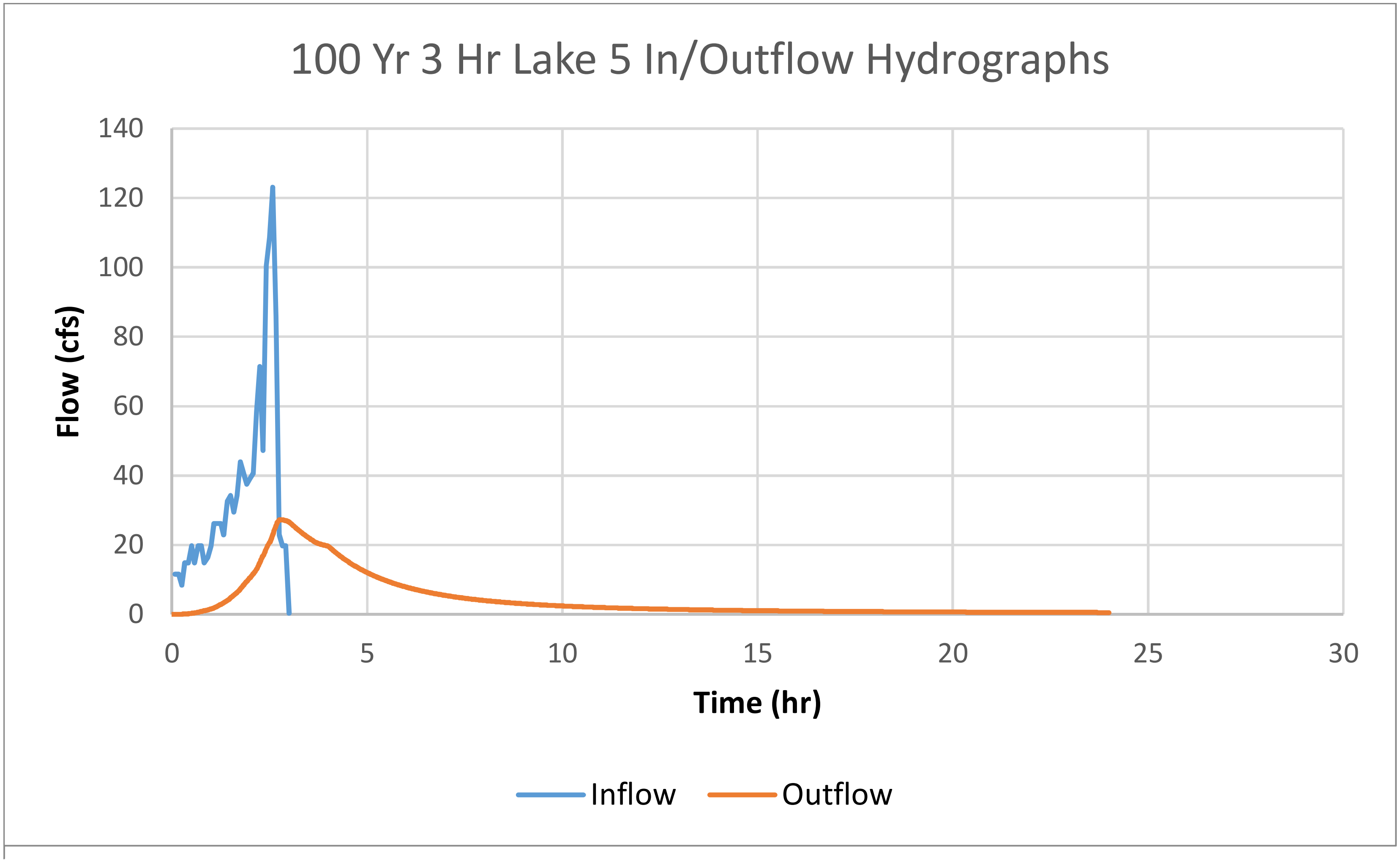
1504.8
1504.6
1504.4
1504.2
1504
1503.8
1503.6
1503.4
Stage (ft)
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
Time (hr)

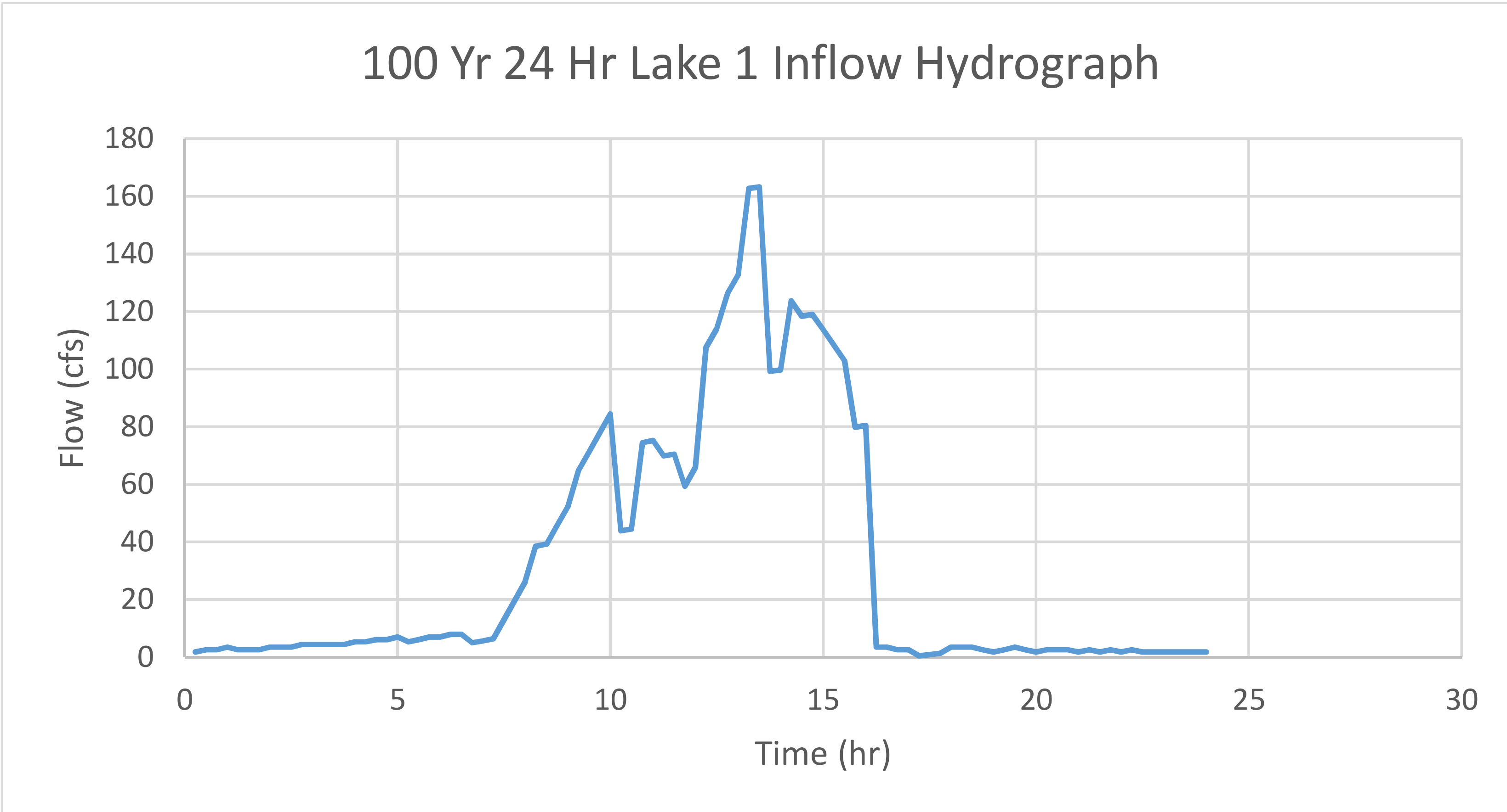

100 Yr 3 Hr Lake 1 In/Outflow Hydrographs
600
500
400
300
200
100
0
Flow (cfs)
0
5
10
15
20
25
30
Time (hr)
Inflow
Outflow

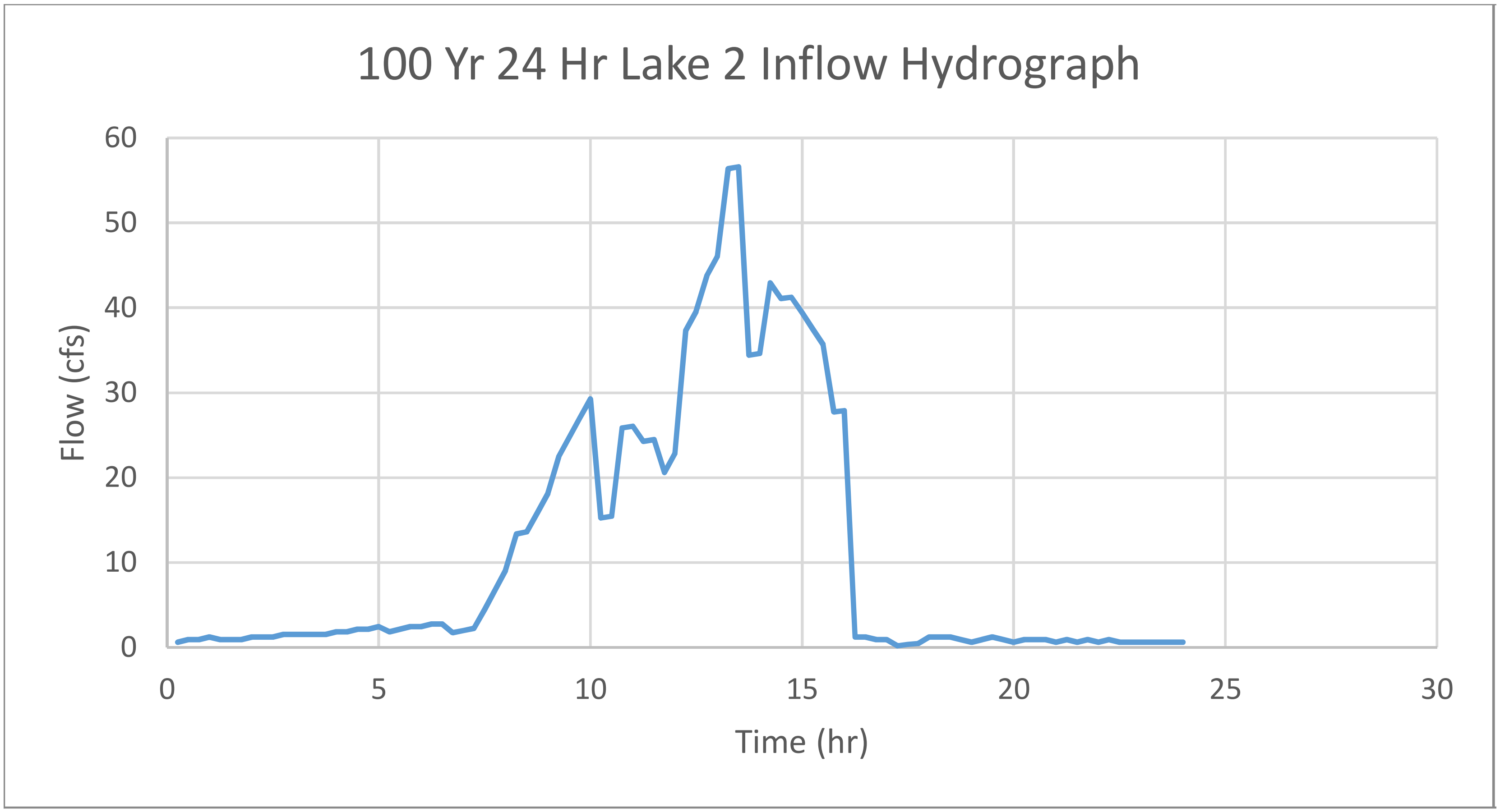

100 Yr 3 Hr Lake 2 In/Outflow Hydrographs
Flow (cfs)
250
200
150
100
50
0
0
5
10
15
20
25
30
Time (hr)
Inflow
Outflow

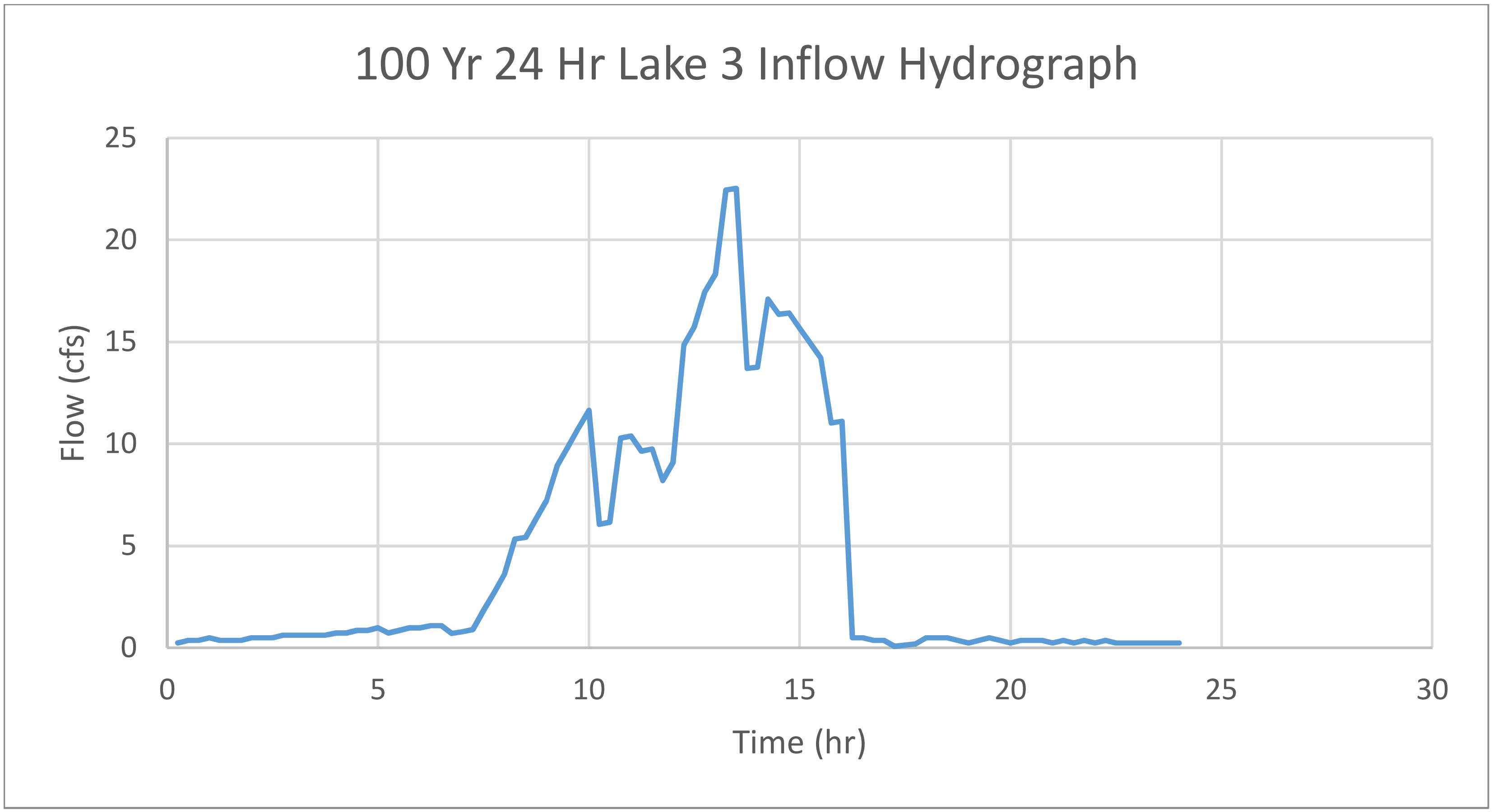

100 Yr 3 Hr Lake 3 In/Outflow Hydrographs
Flow (cfs)
90
80
70
60
50
40
30
20
10
0
0
5
10
15
20
25
30
Time (hr)
Inflow
Outflow

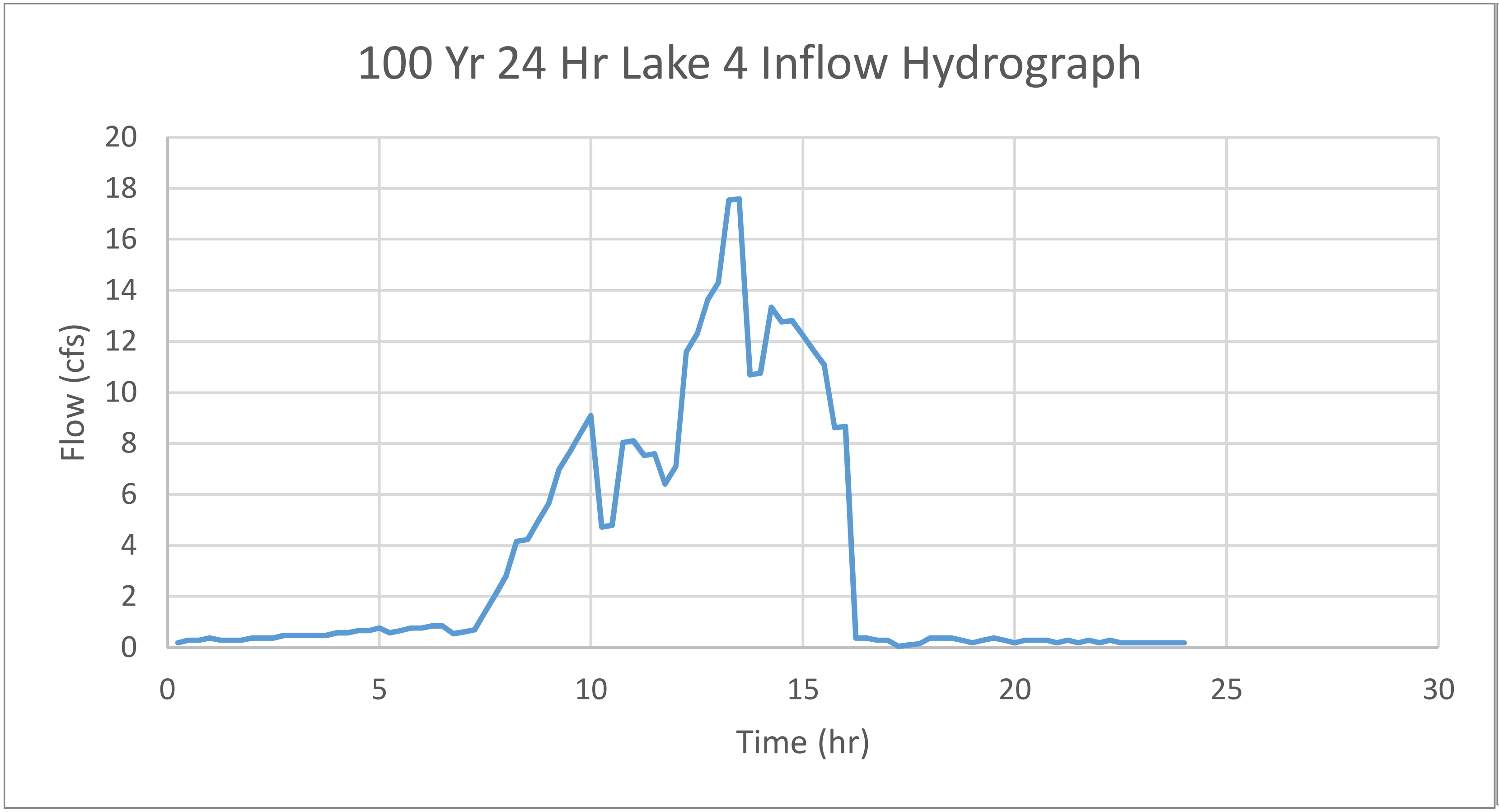

100 Yr 3 Hr Lake 4 In/Outflow Hydrographs
Flow (cfs)
70
60
50
40
30
20
10
0
0
5
10
15
20
25
30
Time (hr)
Inflow
Outflow

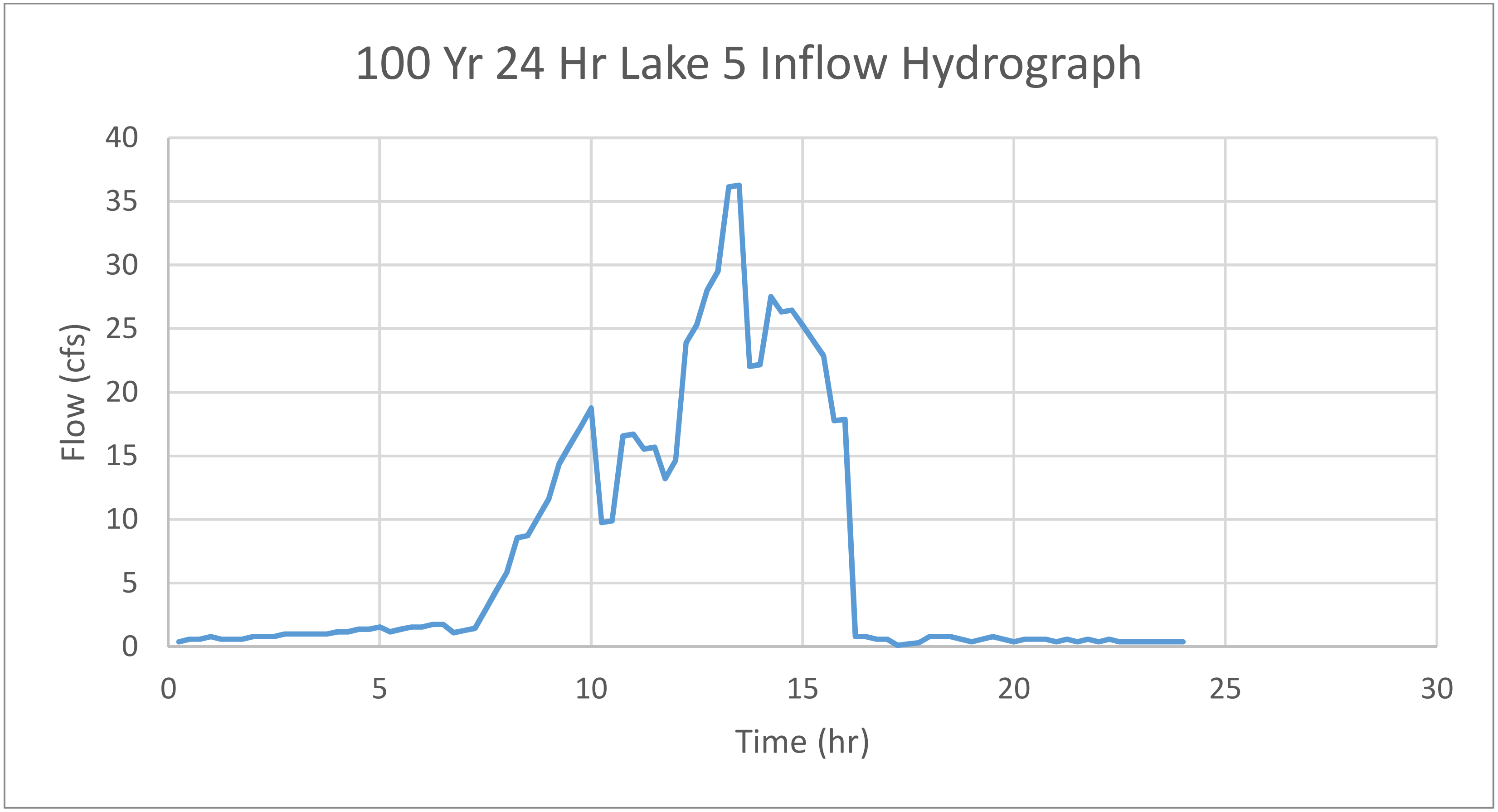

100 Yr 3 Hr Lake 5 In/Outflow Hydrographs
140
120
100
80
60
40
20
0
Flow (cfs)
0
5
10
15
20
25
30
Time (hr)
Inflow
Outflow

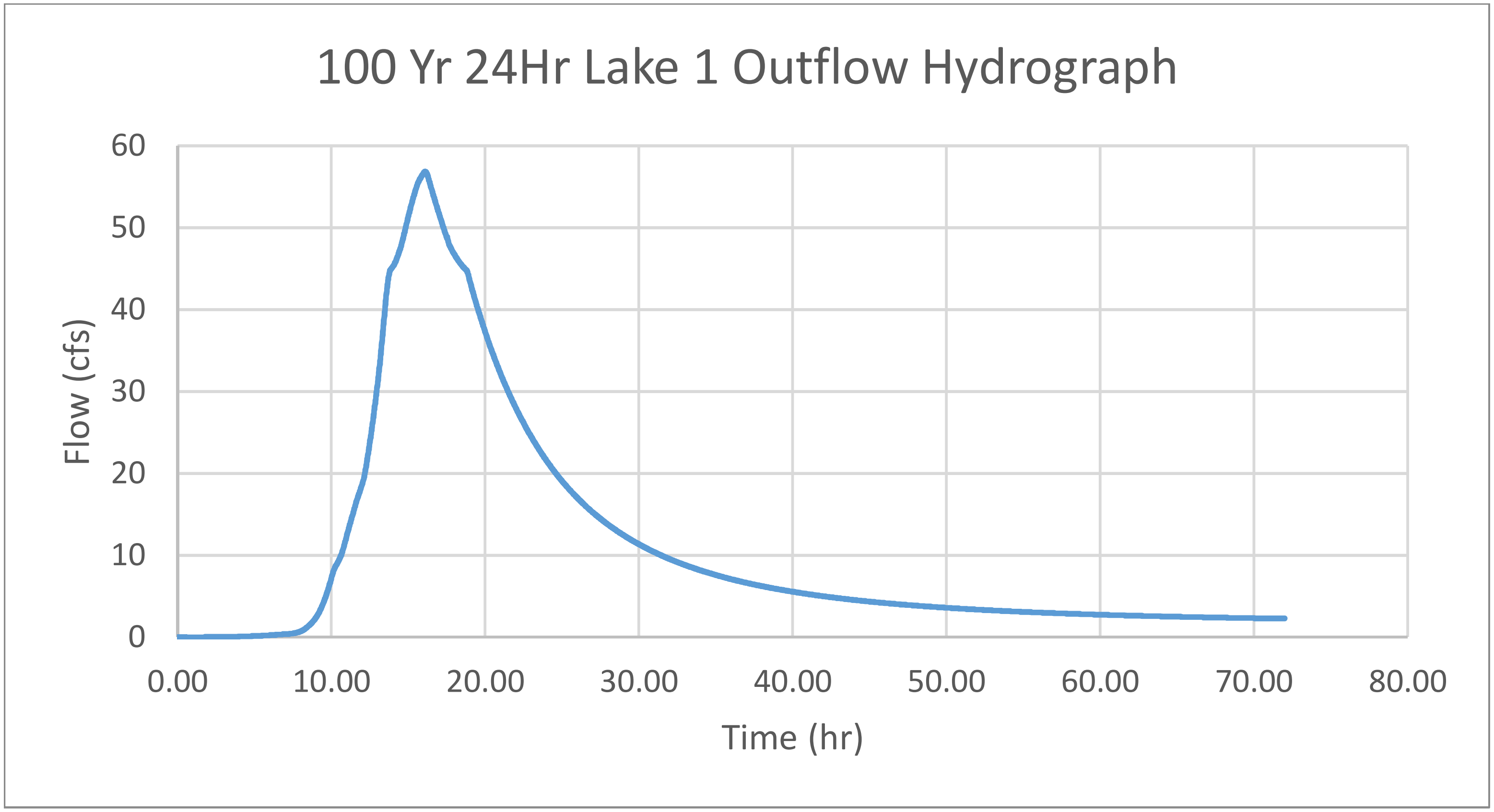

100 Yr 24 Hr Lake 1 Inflow Hydrograph
Flow (cfs)
180
160
140
120
100
80
60
40
20
0
0
5
10
15
20
25
30
Time (hr)

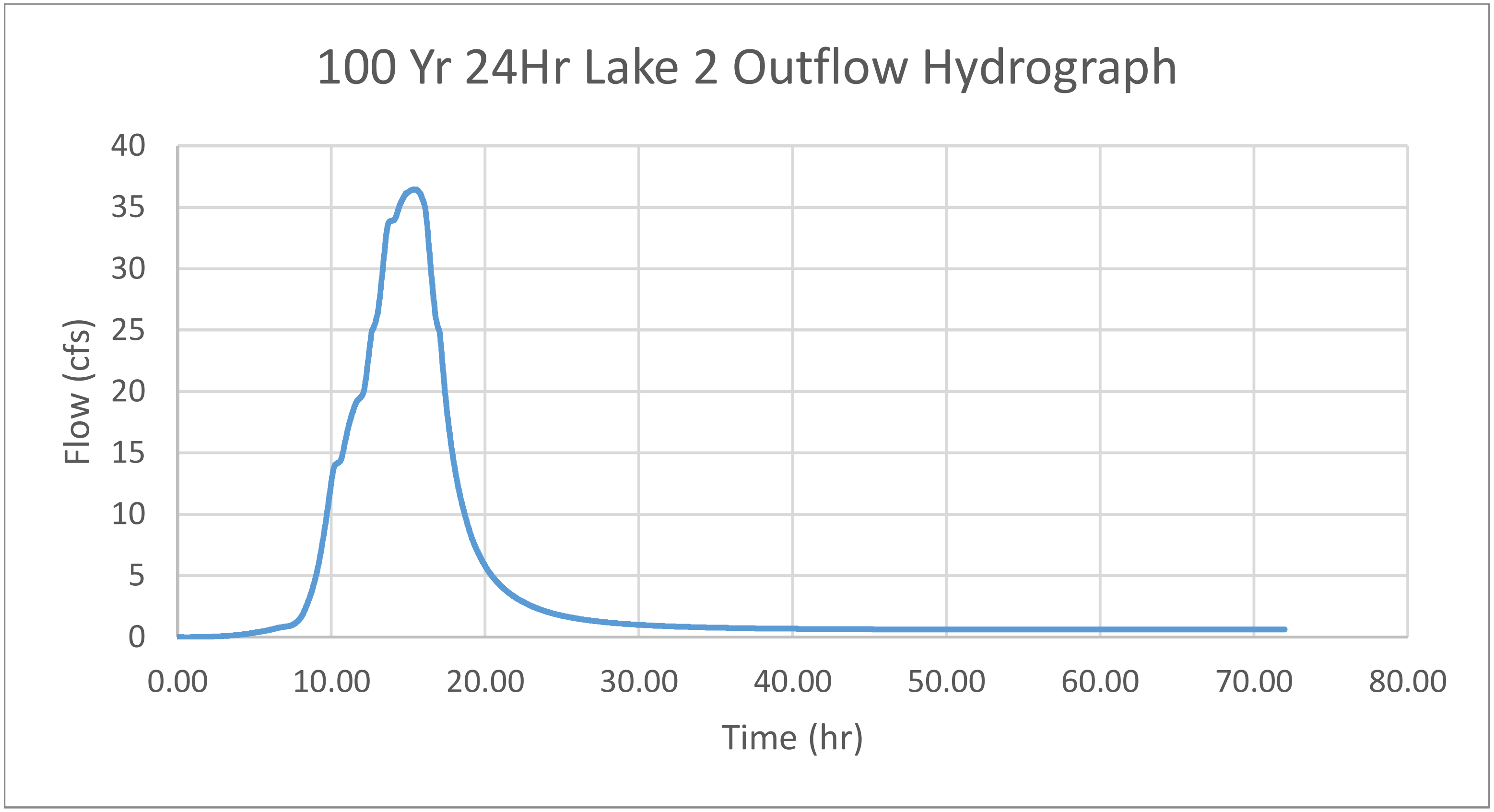

100 Yr 24 Hr Lake 2 Inflow Hydrograph
Flow (cfs)
0
10
20
30
40
50
60
0
5
10
15
20
25
30
Time (hr)

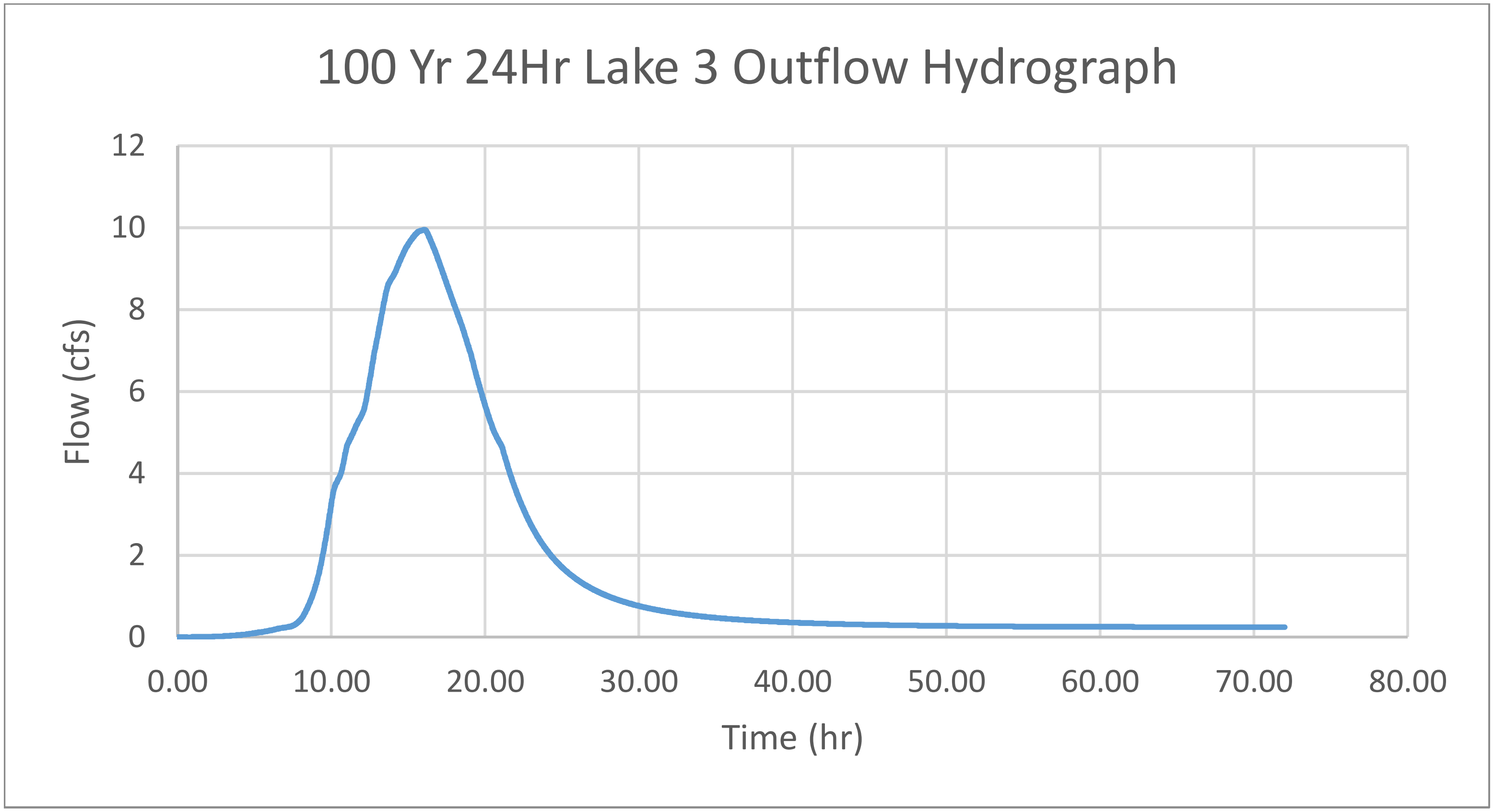

100 Yr 24 Hr Lake 3 Inflow Hydrograph
Flow (cfs)
25
20
15
10
5
0
0
5
10
15
20
25
30
Time (hr)

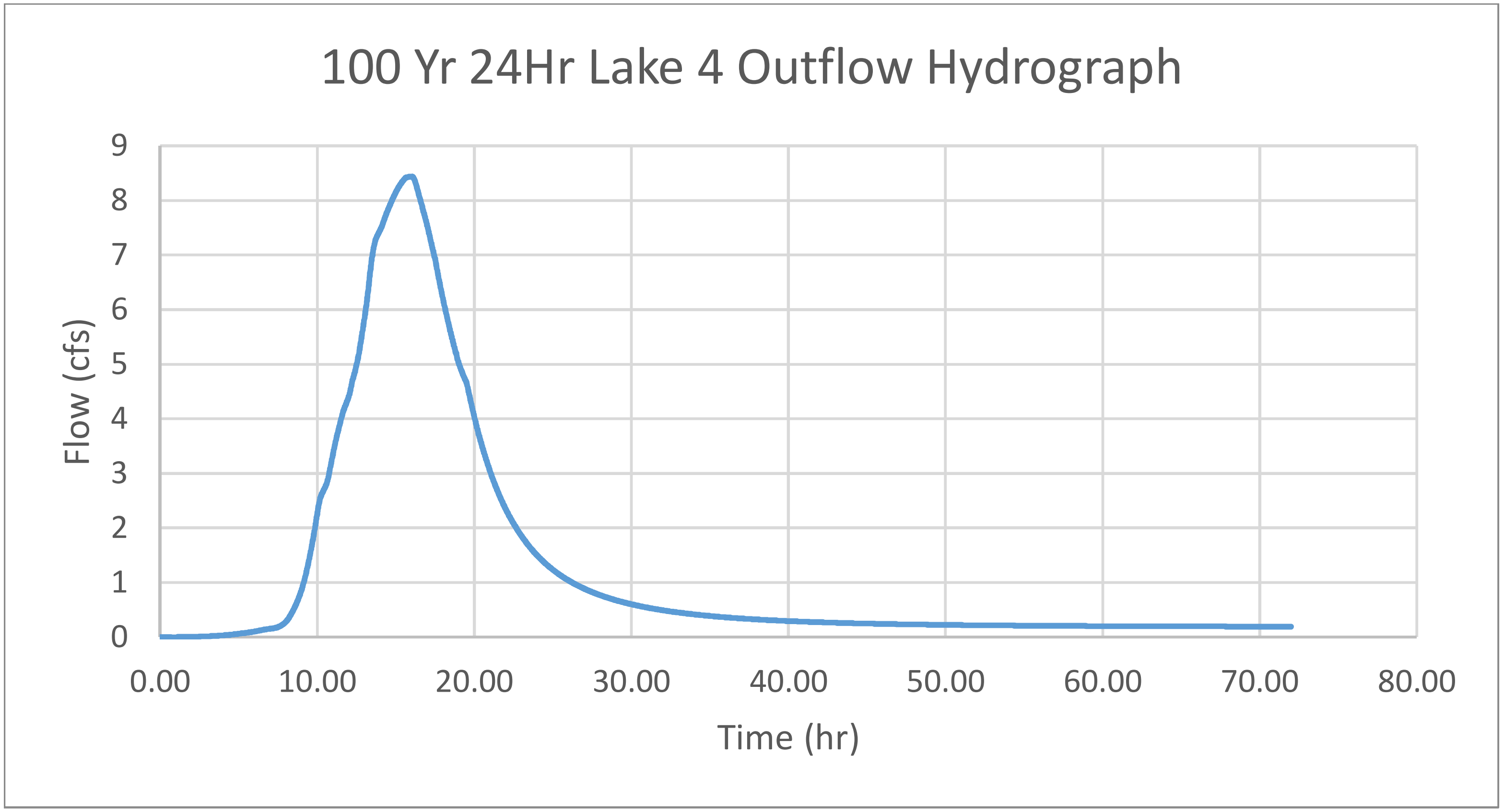

100 Yr 24 Hr Lake 4 Inflow Hydrograph
Flow (cfs)
20
18
16
14
12
10
8
6
4
2
0
0
5
10
15
20
25
30
Time (hr)

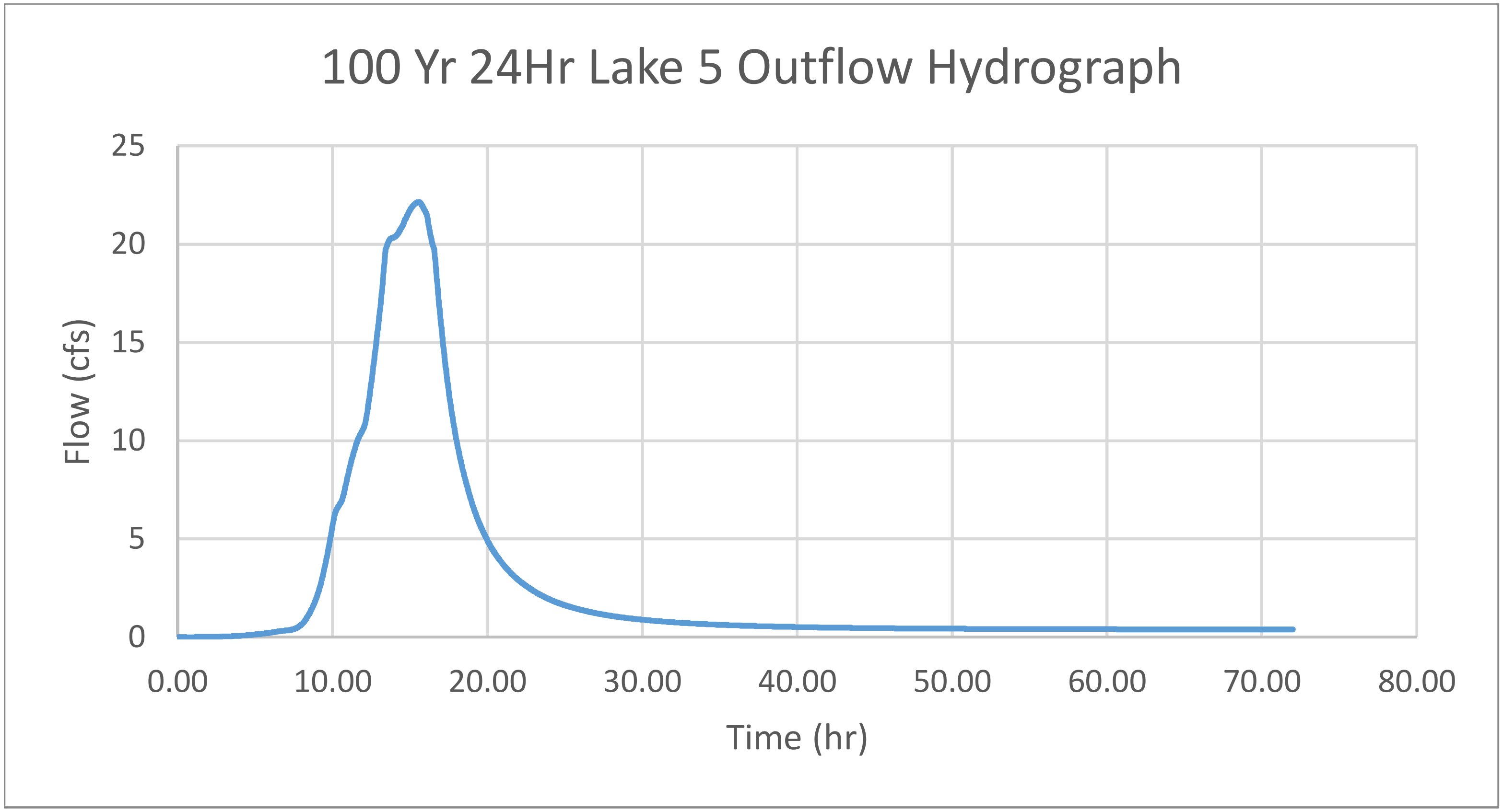

100 Yr 24 Hr Lake 5 Inflow Hydrograph
Flow (cfs)
40
35
30
25
20
15
10
5
0
0
5
10
15
20
25
30
Time (hr)

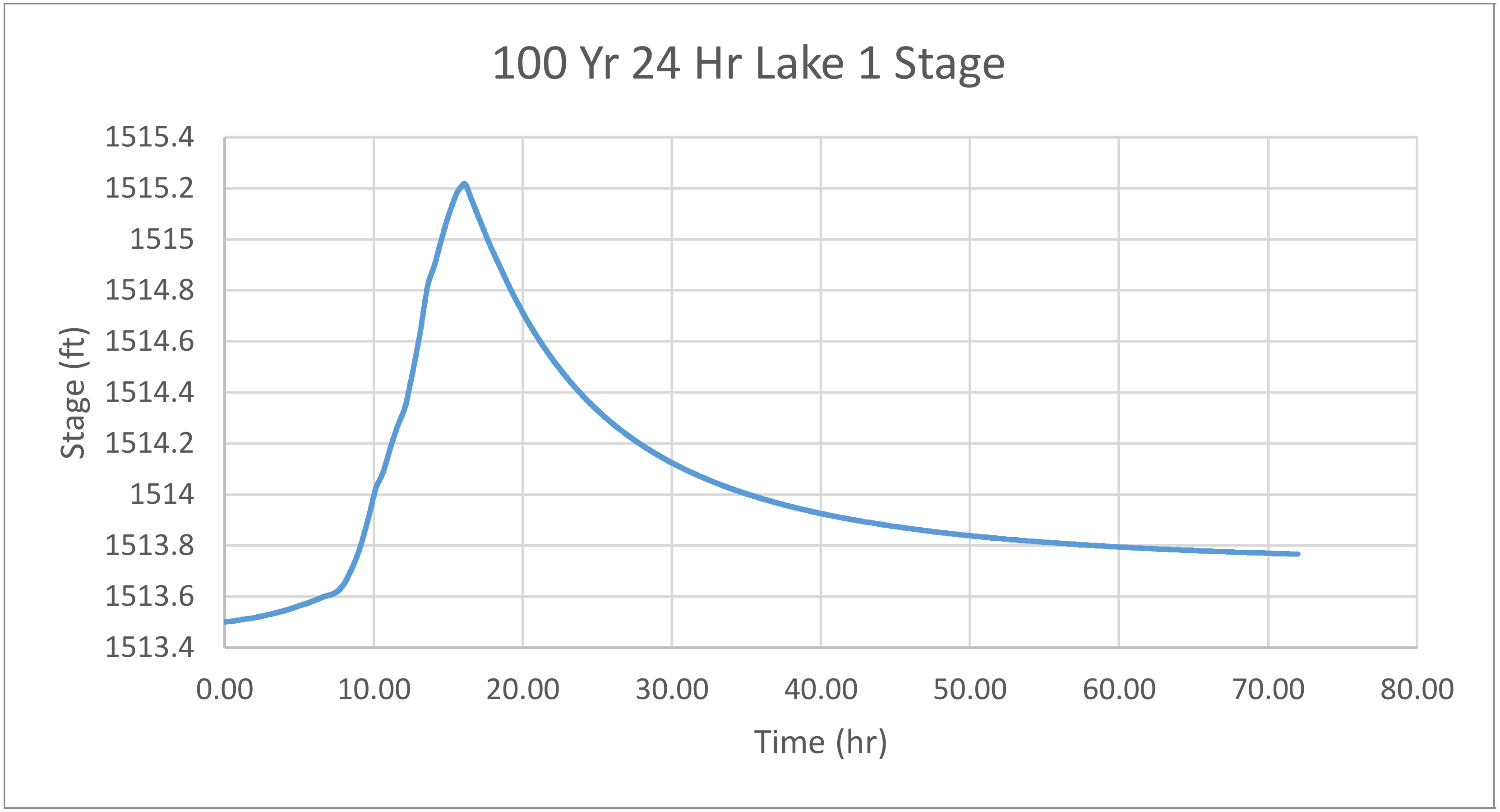

100 Yr 24Hr Lake 1 Outflow Hydrograph
Flow (cfs)
0
10
20
30
40
50
60
Time (hr)
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00

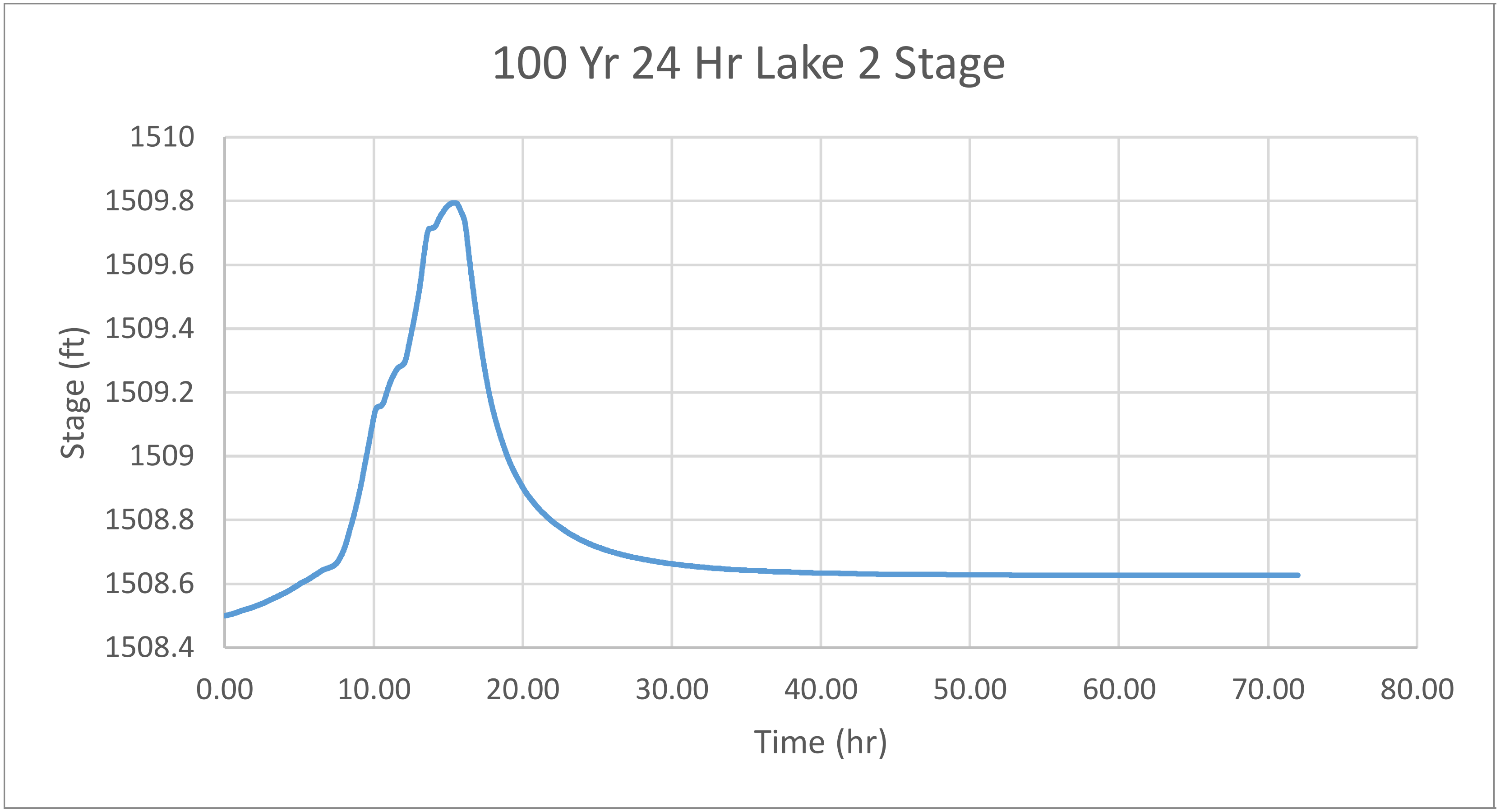

100 Yr 24Hr Lake 2 Outflow Hydrograph
Flow (cfs)
40
35
30
25
20
15
10
5
0
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
Time (hr)

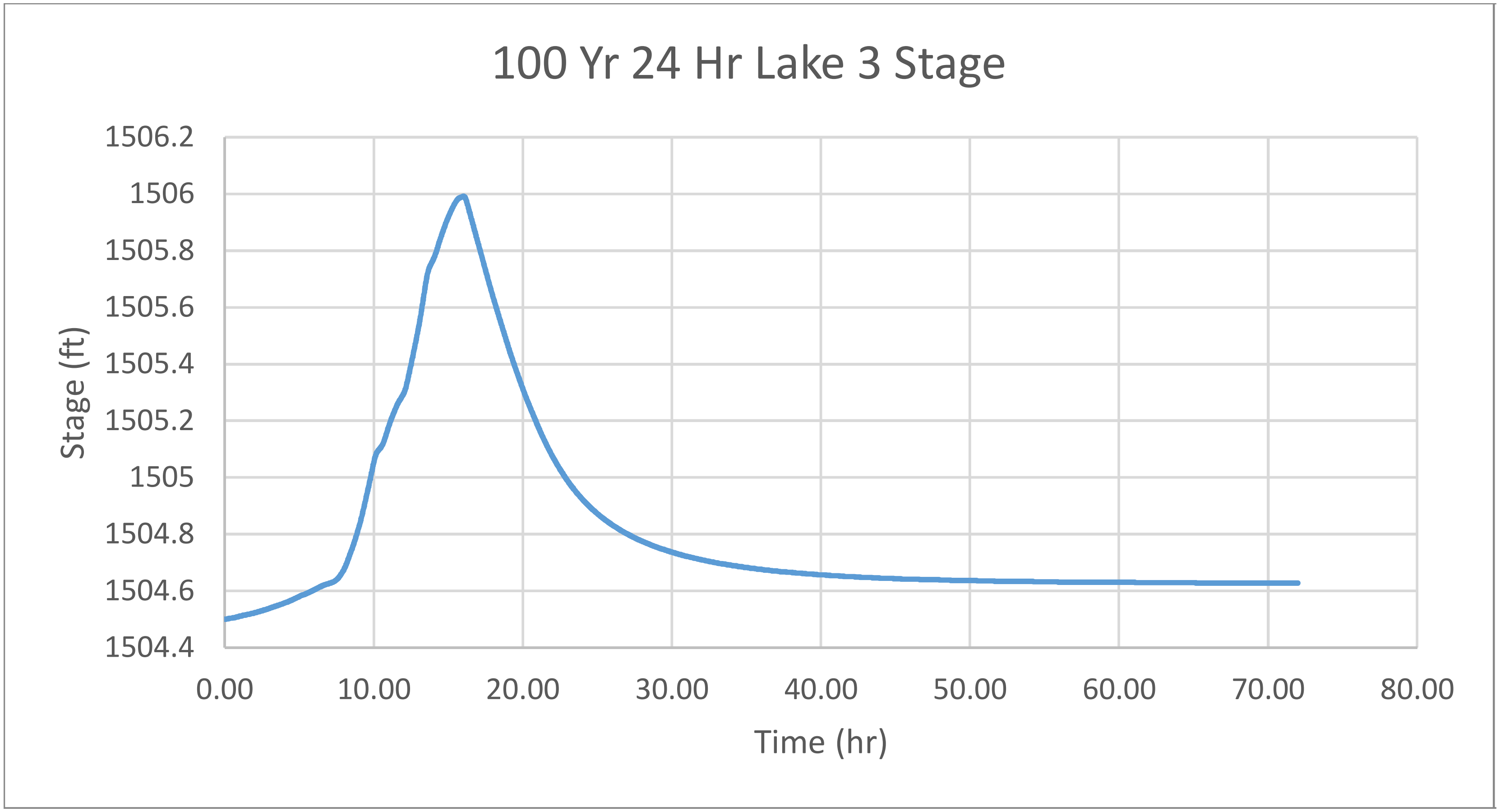

100 Yr 24Hr Lake 3 Outflow Hydrograph
Flow (cfs)
0
2
4
6
8
10
12
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
Time (hr)

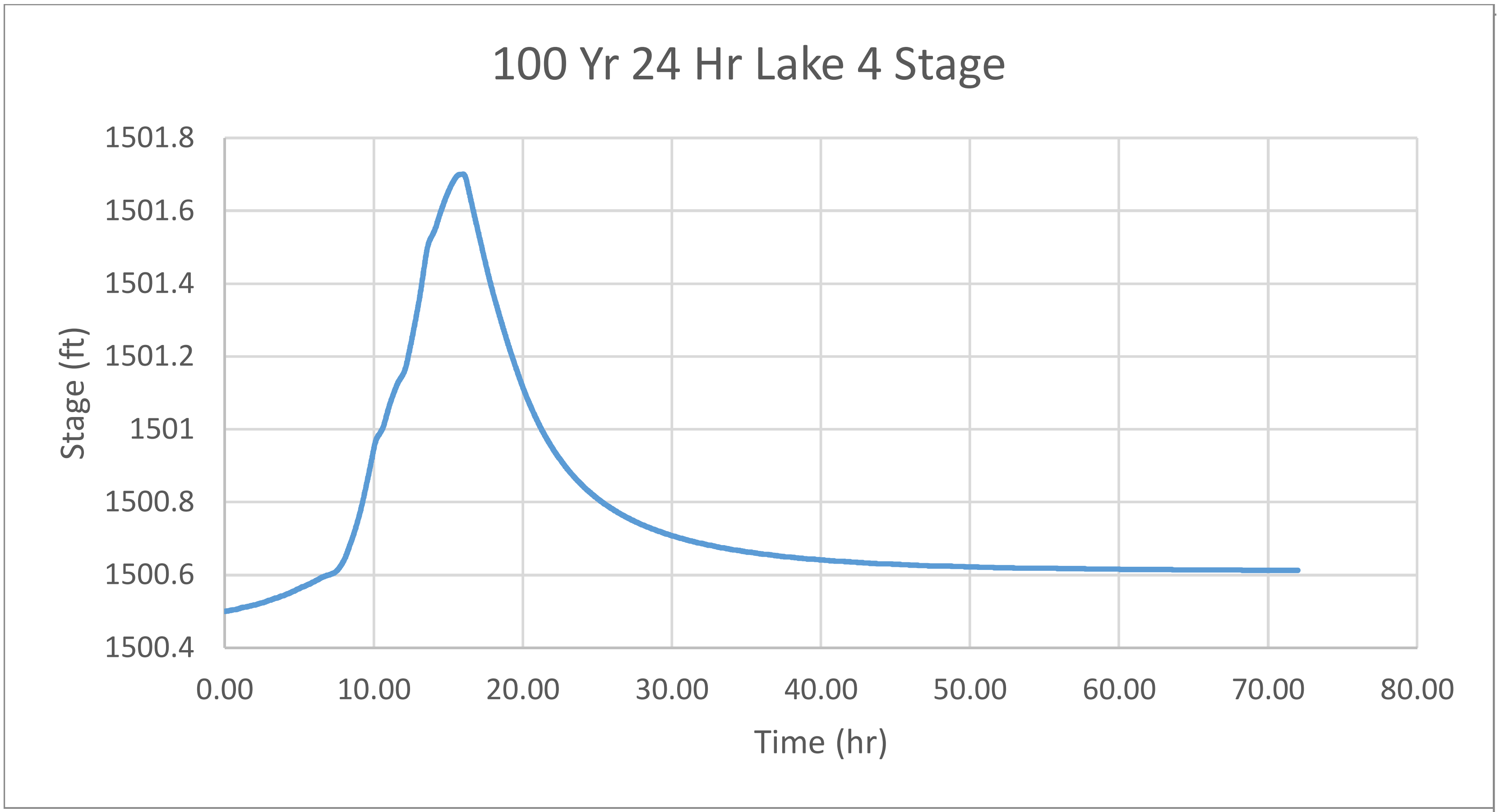

100 Yr 24Hr Lake 4 Outflow Hydrograph
Flow (cfs)
9
8
7
6
5
4
3
2
1
0
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
Time (hr)

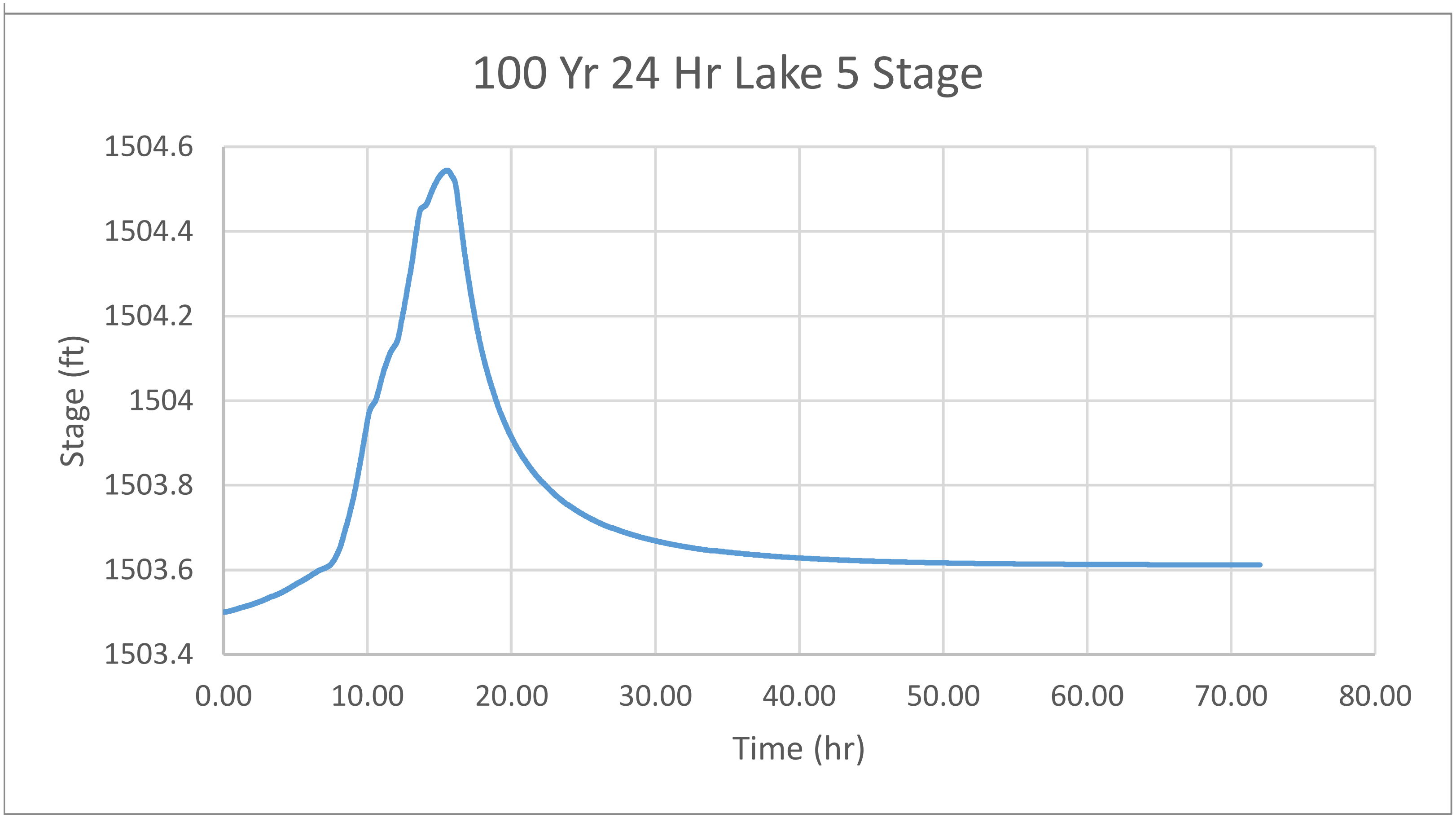

100 Yr 24Hr Lake 5 Outflow Hydrograph
Flow (cfs)
25
20
15
10
5
0
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
Time (hr)

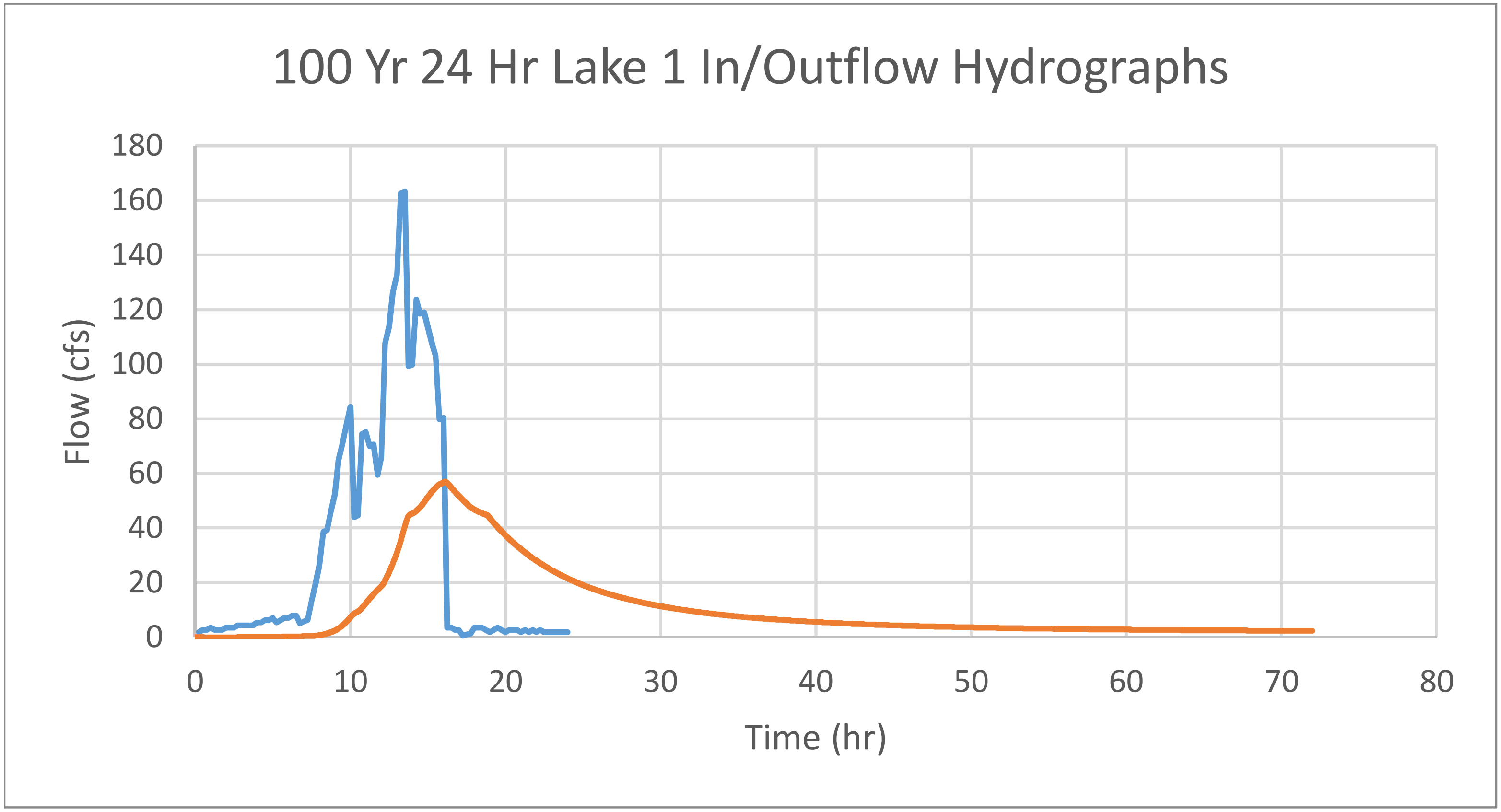

100 Yr 24 Hr Lake 1 Stage
Stage (ft)
1515.4
1515.2
1515
1514.8
1514.6
1514.4
1514.2
1514
1513.8
1513.6
1513.4
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
Time (hr)

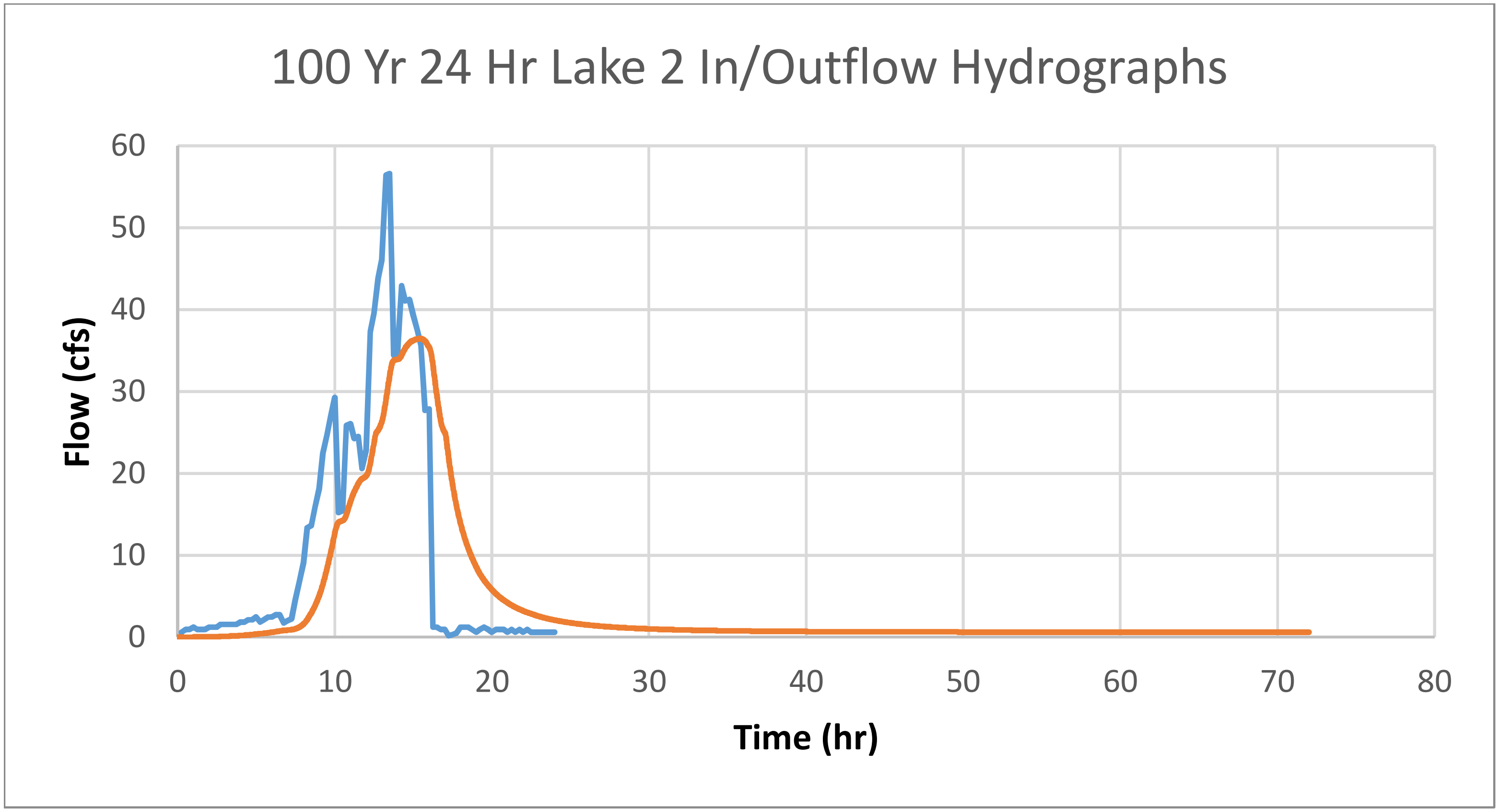

100 Yr 24 Hr Lake 2 Stage
Stage (ft)
1510
1509.8
1509.6
1509.4
1509.2
1509
1508.8
1508.6
1508.4
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
Time (hr)

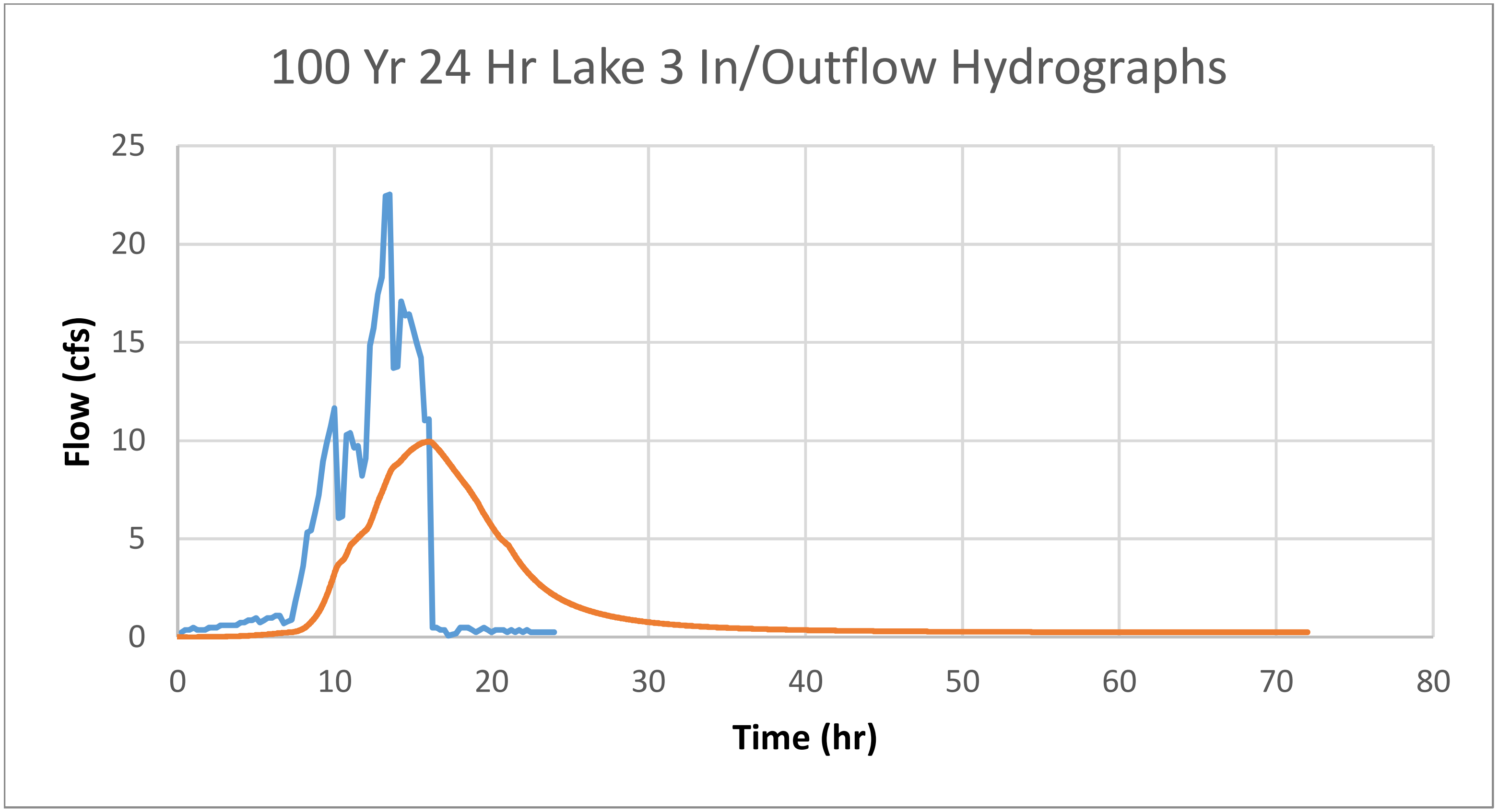

100 Yr 24 Hr Lake 3 Stage
Stage (ft)
1506.2
1506
1505.8
1505.6
1505.4
1505.2
1505
1504.8
1504.6
1504.4
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
Time (hr)

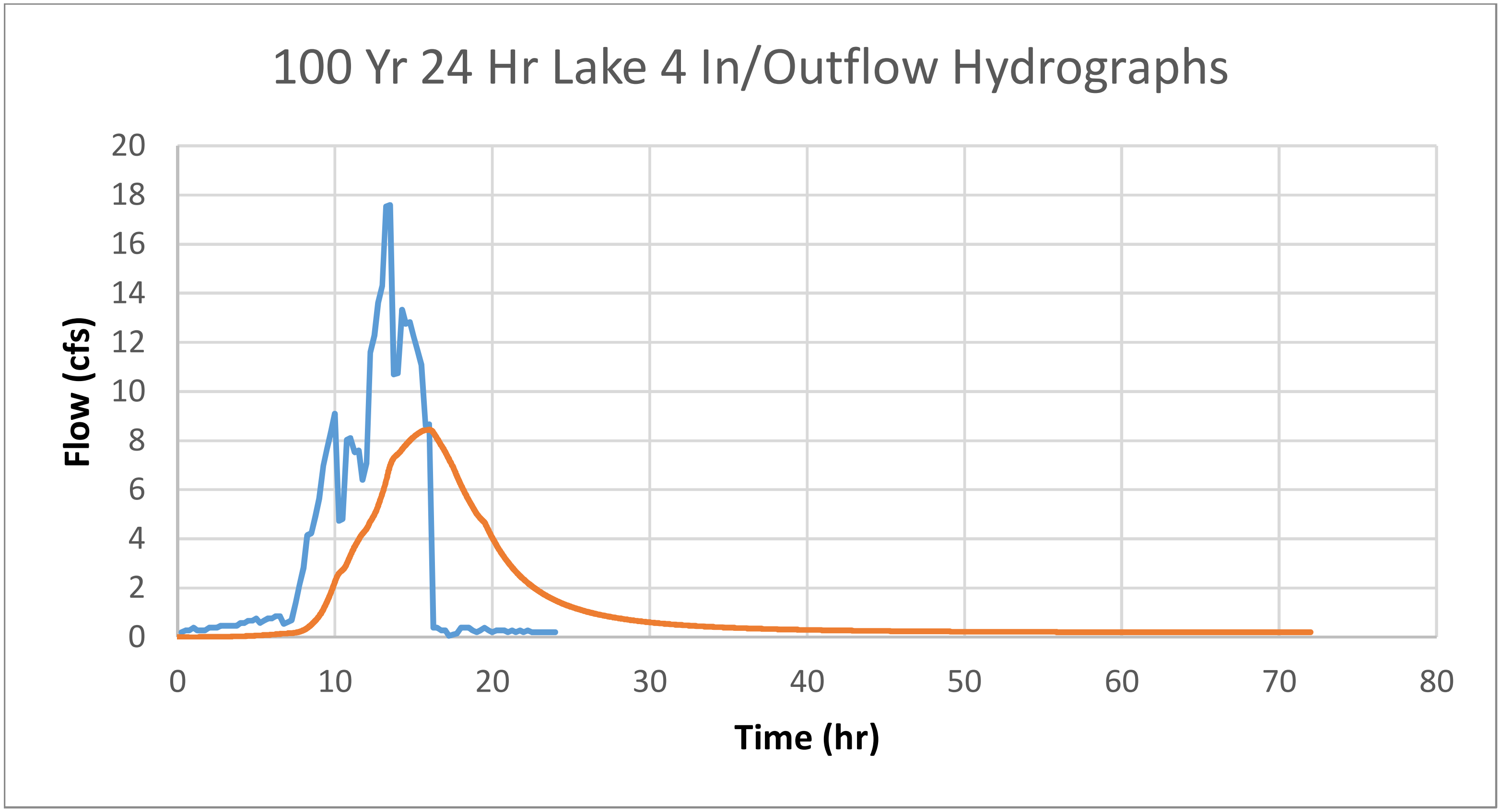

100 Yr 24 Hr Lake 4 Stage
Stage (ft)
1501.8
1501.6
1501.4
1501.2
1501
1500.8
1500.6
1500.4
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
Time (hr)

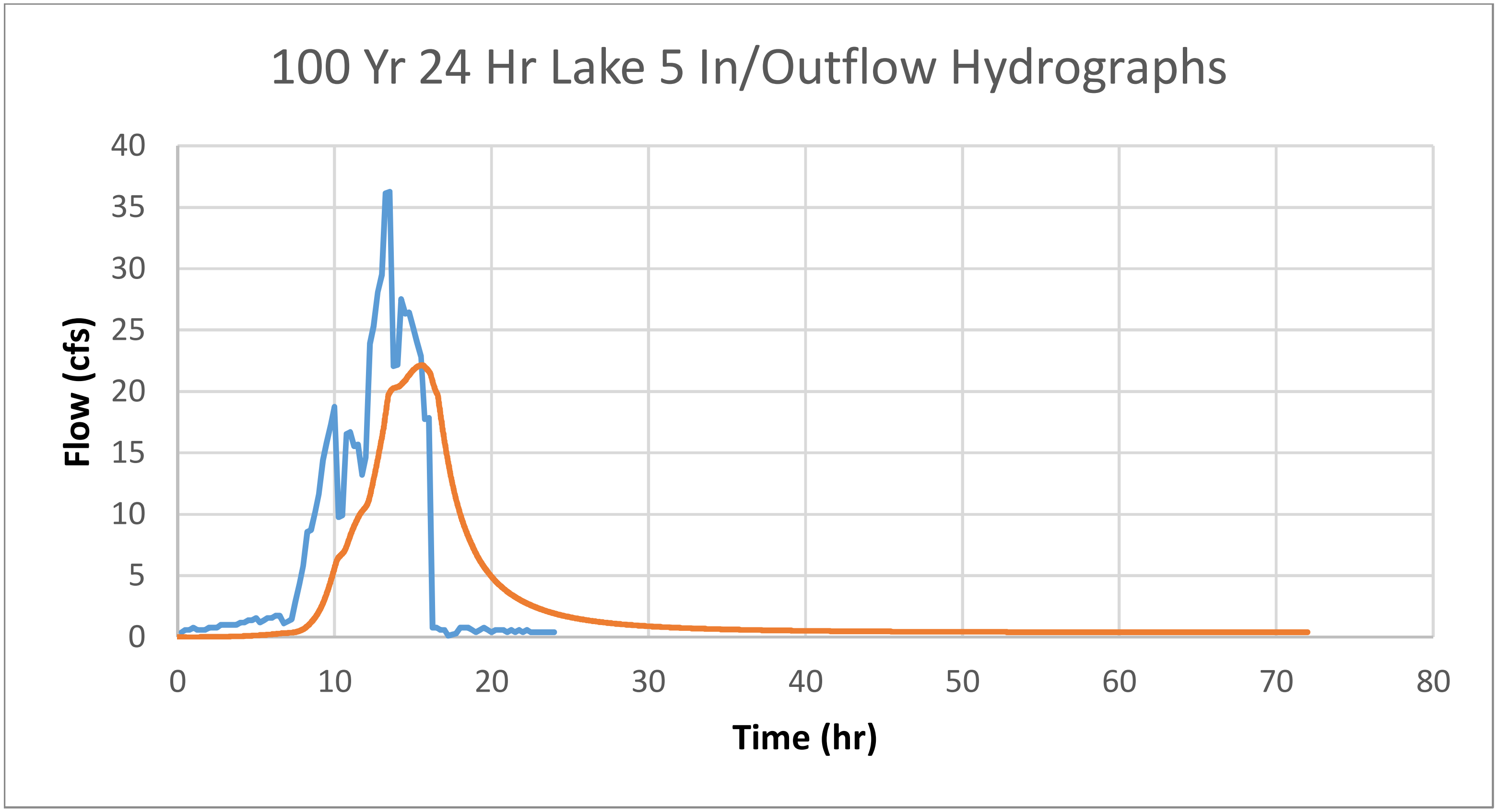

100 Yr 24 Hr Lake 5 Stage
Stage (ft)
1504.6
1504.4
1504.2
1504
1503.8
1503.6
1503.4
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
Time (hr)


100 Yr 24 Hr Lake 1 In/Outflow Hydrographs
Flow (cfs)
180
160
140
120
100
80
60
40
20
0
0
10
20
30
40
50
60
70
80
Time (hr)

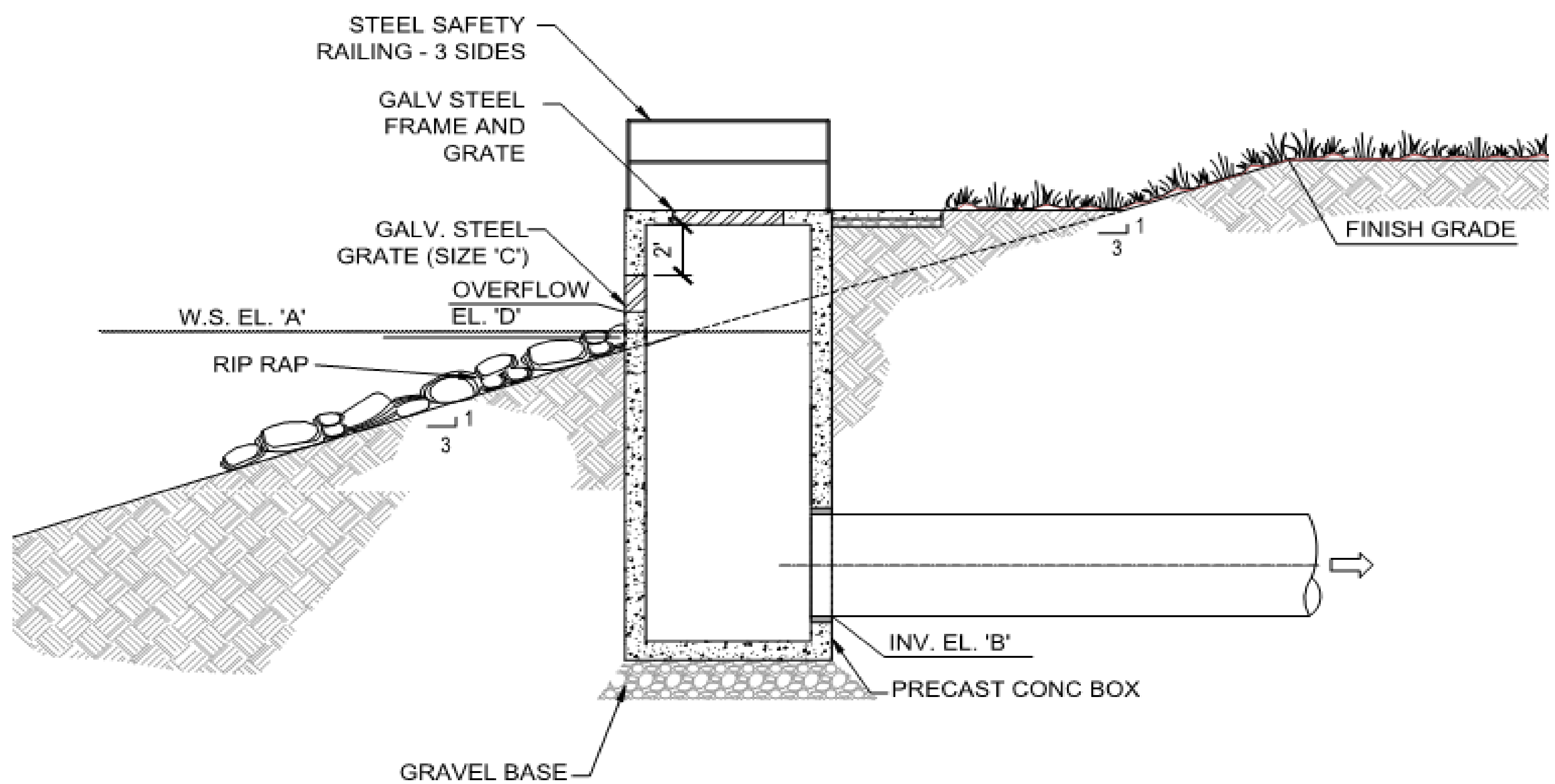

100 Yr 24 Hr Lake 2 In/Outflow Hydrographs
Flow (cfs)
60
50
40
30
20
10
0
0
10
20
30
40
50
60
70
80
Time (hr)


100 Yr 24 Hr Lake 3 In/Outflow Hydrographs
Flow (cfs)
25
20
15
10
5
0
0
10
20
30
40
50
60
70
80
Time (hr)


100 Yr 24 Hr Lake 4 In/Outflow Hydrographs
Flow (cfs)
0
2
4
6
8
10
12
14
16
18
20
Time (hr)
0
10
20
30
40
50
60
70
80


100 Yr 24 Hr Lake 5 In/Outflow Hydrographs
Flow (cfs)
40
35
30
25
20
15
10
5
0
0
10
20
30
40
50
60
70
80
Time (hr)

	Normal WSE (A)	Orifice Height (D)	3 hr Max 100 Yr WSE	24 hr Max 100 Yr WSE	Orifice Dimensions (C')	Top of Box	Box Outlet Inv. (B)	3 Hr Peak Inflow	3 Hr Peak Outflow	24 Hr Peak Inflow	24 Hr Peak Outflow
	ft	ft	ft	ft	H ft x L ft	ft	ft	cfs	cfs	cfs	cfs
Lake 1	1512.5	1513.0	1514.9	1515.2	1.5 x 2.5	1516.0	1510.0	554.0	45.7	163.2	56.9
Lake 2	1507.5	1508.0	1510.2	1509.8	1 x 2.5	1511.0	1505.0	192.1	45.7	56.6	36.5
Lake 3	1503.5	1504.0	1506.0	1506.0	.75 x .75	1507.0	1501.0	76.5	9.8	22.5	10.0
Lake 4	1499.5	1500.0	1501.7	1501.7	.75 x .75	1503.0	1797.0	59.7	8.4	17.6	8.4
Lake 5	1502.5	1503.0	1504.9	1504.7	1 x 2	1506.0	1500.0	143.6	31.0	42.3	25.9



LAKE OUTFALL EXAMPLE

NO SCALE

APPENDIX B

100 Yr - 3 Hr Rainfall Percent Patterns (E-5.9 RCFCWCD)
5 Min Period Percentages

100 Yr / 3 Hr Rain (in)	2.04
Adjusted Loss Rate (in/hr)	0.142
Total Area (Ac)	297
Hydrograph Sampling Period (min)	5

Peak Flow (cfs) 554.01

3 hr Storm 5 Min Period Percentages

Period #	Percent	Q in/hr	Max Loss	Low Loass	Eff. Rate	H-G cfs	T (hrs)	Q (cfs)
1	1.3	0.31824	0.142	0	0.17624	52.34	0.08	52.34
2	1.3	0.31824	0.142	0	0.17624	52.34	0.17	52.34
3	1.1	0.26928	0.142	0	0.12728	37.80	0.25	37.80
4	1.5	0.3672	0.142	0	0.2252	66.88	0.33	66.88
5	1.5	0.3672	0.142	0	0.2252	66.88	0.42	66.88
6	1.8	0.44064	0.142	0	0.29864	88.70	0.50	88.70
7	1.5	0.3672	0.142	0	0.2252	66.88	0.58	66.88
8	1.8	0.44064	0.142	0	0.29864	88.70	0.67	88.70
9	1.8	0.44064	0.142	0	0.29864	88.70	0.75	88.70
10	1.5	0.3672	0.142	0	0.2252	66.88	0.83	66.88
11	1.6	0.39168	0.142	0	0.24968	74.15	0.92	74.15
12	1.8	0.44064	0.142	0	0.29864	88.70	1.00	88.70
13	2.2	0.53856	0.142	0	0.39656	117.78	1.08	117.78
14	2.2	0.53856	0.142	0	0.39656	117.78	1.17	117.78
15	2.2	0.53856	0.142	0	0.39656	117.78	1.25	117.78
16	2	0.4896	0.142	0	0.3476	103.24	1.33	103.24
17	2.6	0.63648	0.142	0	0.49448	146.86	1.42	146.86
18	2.7	0.66096	0.142	0	0.51896	154.13	1.50	154.13
19	2.4	0.58752	0.142	0	0.44552	132.32	1.58	132.32
20	2.7	0.66096	0.142	0	0.51896	154.13	1.67	154.13
21	3.3	0.80784	0.142	0	0.66584	197.75	1.75	197.75
22	3.1	0.75888	0.142	0	0.61688	183.21	1.83	183.21
23	2.9	0.70992	0.142	0	0.56792	168.67	1.92	168.67
24	3	0.7344	0.142	0	0.5924	175.94	2.00	175.94
25	3.1	0.75888	0.142	0	0.61688	183.21	2.08	183.21
26	4.2	1.02816	0.142	0	0.88616	263.19	2.17	263.19
27	5	1.224	0.142	0	1.082	321.35	2.25	321.35
28	3.5	0.8568	0.142	0	0.7148	212.30	2.33	212.30
29	6.8	1.66464	0.142	0	1.52264	452.22	2.42	452.22
30	7.3	1.78704	0.142	0	1.64504	488.58	2.50	488.58
31	8.2	2.00736	0.142	0	1.86536	554.01	2.58	554.01
32	5.9	1.44432	0.142	0	1.30232	386.79	2.67	386.79
33	2	0.4896	0.142	0	0.3476	103.24	2.75	103.24
34	1.8	0.44064	0.142	0	0.29864	88.70	2.83	88.70
35	1.8	0.44064	0.142	0	0.29864	88.70	2.92	88.70
36	0.6	0.14688	0.142	0	0.00488	1.45	3.00	1.45

100 Yr - 24 Hr Rainfall Percent Patterns (E-5.9 RCFCWCD)
15 Min Period Percentages

100 Yr / 24 Hr Rain (in)	4.94
Adjusted Loss Rate (in/hr)	0.142
Minimum Loss Rate Value (in/hr) (0.5* Adj Lo	0.071
Total Area (Ac)	297
Hydrograph Sampling Period (min)	15

Peak Flow (cfs) 163.23

24 hr Storm 15 Min Period Percentages

Period #	Percent	Q in/hr	Max Loss	Low Loss	Eff. Rate	H-G cfs	T (hrs)	Q (cfs)
1	0.2	0.03952	0.250753	0.033592	0.005928	1.76	0.25	1.76
2	0.3	0.05928	0.247844	0.050388	0.008892	2.64	0.50	2.64
3	0.3	0.05928	0.244952	0.050388	0.008892	2.64	0.75	2.64
4	0.4	0.07904	0.242077	0.067184	0.011856	3.52	1.00	3.52
5	0.3	0.05928	0.239219	0.050388	0.008892	2.64	1.25	2.64
6	0.3	0.05928	0.236378	0.050388	0.008892	2.64	1.50	2.64
7	0.3	0.05928	0.233554	0.050388	0.008892	2.64	1.75	2.64
8	0.4	0.07904	0.230747	0.067184	0.011856	3.52	2.00	3.52
9	0.4	0.07904	0.227958	0.067184	0.011856	3.52	2.25	3.52
10	0.4	0.07904	0.225187	0.067184	0.011856	3.52	2.50	3.52
11	0.5	0.0988	0.222432	0.08398	0.01482	4.40	2.75	4.40
12	0.5	0.0988	0.219696	0.08398	0.01482	4.40	3.00	4.40
13	0.5	0.0988	0.216977	0.08398	0.01482	4.40	3.25	4.40
14	0.5	0.0988	0.214277	0.08398	0.01482	4.40	3.50	4.40
15	0.5	0.0988	0.211594	0.08398	0.01482	4.40	3.75	4.40
16	0.6	0.11856	0.208929	0.100776	0.017784	5.28	4.00	5.28
17	0.6	0.11856	0.206282	0.100776	0.017784	5.28	4.25	5.28
18	0.7	0.13832	0.203654	0.117572	0.020748	6.16	4.50	6.16
19	0.7	0.13832	0.201044	0.117572	0.020748	6.16	4.75	6.16
20	0.8	0.15808	0.198452	0.134368	0.023712	7.04	5.00	7.04
21	0.6	0.11856	0.195879	0.100776	0.017784	5.28	5.25	5.28
22	0.7	0.13832	0.193325	0.117572	0.020748	6.16	5.50	6.16
23	0.8	0.15808	0.190789	0.134368	0.023712	7.04	5.75	7.04
24	0.8	0.15808	0.188272	0.134368	0.023712	7.04	6.00	7.04
25	0.9	0.17784	0.185775	0.151164	0.026676	7.92	6.25	7.92
26	0.9	0.17784	0.183296	0.151164	0.026676	7.92	6.50	7.92
27	1	0.1976	0.180837	0	0.016763	4.98	6.75	4.98
28	1	0.1976	0.178397	0	0.019203	5.70	7.00	5.70
29	1	0.1976	0.175977	0	0.021623	6.42	7.25	6.42
30	1.1	0.21736	0.173576	0	0.043784	13.00	7.50	13.00
31	1.2	0.23712	0.171195	0	0.065925	19.58	7.75	19.58
32	1.3	0.25688	0.168834	0	0.088046	26.15	8.00	26.15
33	1.5	0.2964	0.166493	0	0.129907	38.58	8.25	38.58
34	1.5	0.2964	0.164172	0	0.132228	39.27	8.50	39.27
35	1.6	0.31616	0.161872	0	0.154288	45.82	8.75	45.82
36	1.7	0.33592	0.159592	0	0.176328	52.37	9.00	52.37
37	1.9	0.37544	0.157332	0	0.218108	64.78	9.25	64.78
38	2	0.3952	0.155094	0	0.240106	71.31	9.50	71.31
39	2.1	0.41496	0.152876	0	0.262084	77.84	9.75	77.84
40	2.2	0.43472	0.15068	0	0.28404	84.36	10.00	84.36
41	1.5	0.2964	0.148504	0	0.147896	43.93	10.25	43.93
42	1.5	0.2964	0.146351	0	0.150049	44.56	10.50	44.56
43	2	0.3952	0.144218	0	0.250982	74.54	10.75	74.54
44	2	0.3952	0.142108	0	0.253092	75.17	11.00	75.17
45	1.9	0.37544	0.14002	0	0.23542	69.92	11.25	69.92
46	1.9	0.37544	0.137953	0	0.237487	70.53	11.50	70.53
47	1.7	0.33592	0.13591	0	0.20001	59.40	11.75	59.40

48	1.8	0.35568	0.133889	0	0.221791	65.87	12.00	65.87
49	2.5	0.494	0.13189	0	0.36211	107.55	12.25	107.55
50	2.6	0.51376	0.129915	0	0.383845	114.00	12.50	114.00
51	2.8	0.55328	0.127963	0	0.425317	126.32	12.75	126.32
52	2.9	0.57304	0.126034	0	0.447006	132.76	13.00	132.76
53	3.4	0.67184	0.124129	0	0.547711	162.67	13.25	162.67
54	3.4	0.67184	0.122248	0	0.549592	163.23	13.50	163.23
55	2.3	0.45448	0.120391	0	0.334089	99.22	13.75	99.22
56	2.3	0.45448	0.118558	0	0.335922	99.77	14.00	99.77
57	2.7	0.53352	0.116751	0	0.416769	123.78	14.25	123.78
58	2.6	0.51376	0.114968	0	0.398792	118.44	14.50	118.44
59	2.6	0.51376	0.11321	0	0.40055	118.96	14.75	118.96
60	2.5	0.494	0.111479	0	0.382521	113.61	15.00	113.61
61	2.4	0.47424	0.109773	0	0.364467	108.25	15.25	108.25
62	2.3	0.45448	0.108093	0	0.346387	102.88	15.50	102.88
63	1.9	0.37544	0.10644	0	0.269	79.89	15.75	79.89
64	1.9	0.37544	0.104814	0	0.270626	80.38	16.00	80.38
65	0.4	0.07904	0.103215	0.067184	0.011856	3.52	16.25	3.52
66	0.4	0.07904	0.101643	0.067184	0.011856	3.52	16.50	3.52
67	0.3	0.05928	0.1001	0.050388	0.008892	2.64	16.75	2.64
68	0.3	0.05928	0.098586	0.050388	0.008892	2.64	17.00	2.64
69	0.5	0.0988	0.0971	0	0.0017	0.50	17.25	0.50
70	0.5	0.0988	0.095644	0	0.003156	0.94	17.50	0.94
71	0.5	0.0988	0.094217	0	0.004583	1.36	17.75	1.36
72	0.4	0.07904	0.092821	0.067184	0.011856	3.52	18.00	3.52
73	0.4	0.07904	0.091456	0.067184	0.011856	3.52	18.25	3.52
74	0.4	0.07904	0.090123	0.067184	0.011856	3.52	18.50	3.52
75	0.3	0.05928	0.088822	0.050388	0.008892	2.64	18.75	2.64
76	0.2	0.03952	0.087554	0.033592	0.005928	1.76	19.00	1.76
77	0.3	0.05928	0.086319	0.050388	0.008892	2.64	19.25	2.64
78	0.4	0.07904	0.085118	0.067184	0.011856	3.52	19.50	3.52
79	0.3	0.05928	0.083953	0.050388	0.008892	2.64	19.75	2.64
80	0.2	0.03952	0.082824	0.033592	0.005928	1.76	20.00	1.76
81	0.3	0.05928	0.081732	0.050388	0.008892	2.64	20.25	2.64
82	0.3	0.05928	0.080678	0.050388	0.008892	2.64	20.50	2.64
83	0.3	0.05928	0.079663	0.050388	0.008892	2.64	20.75	2.64
84	0.2	0.03952	0.078689	0.033592	0.005928	1.76	21.00	1.76
85	0.3	0.05928	0.077757	0.050388	0.008892	2.64	21.25	2.64
86	0.2	0.03952	0.076868	0.033592	0.005928	1.76	21.50	1.76
87	0.3	0.05928	0.076025	0.050388	0.008892	2.64	21.75	2.64
88	0.2	0.03952	0.075229	0.033592	0.005928	1.76	22.00	1.76
89	0.3	0.05928	0.074484	0.050388	0.008892	2.64	22.25	2.64
90	0.2	0.03952	0.073791	0.033592	0.005928	1.76	22.50	1.76
91	0.2	0.03952	0.073154	0.033592	0.005928	1.76	22.75	1.76
92	0.2	0.03952	0.072578	0.033592	0.005928	1.76	23.00	1.76
93	0.2	0.03952	0.072069	0.033592	0.005928	1.76	23.25	1.76
94	0.2	0.03952	0.071635	0.033592	0.005928	1.76	23.50	1.76
95	0.2	0.03952	0.071287	0.033592	0.005928	1.76	23.75	1.76
96	0.2	0.03952	0.071052	0.033592	0.005928	1.76	24.00	1.76

APPENDIX C

Aquabella Lakes, Moreno Valley, CA

A simple model for estimating the discharge of Total Phosphorous (Total P) and Total Nitrogen (Total N) from the project site during storm

Lake 1

85th Percentile, 24-hour Storm Event	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Existing (Agricultural Land)	2.5	0.16	1.89	1.1	13.0
Proposed w/o BMPs	10.1	0.39	3.90	10.7	107.1
Proposed w/ Std. BMPs	9.3	0.31	2.73	7.9	68.8
Proposed w/ Std. Lake	0.0	0.49	3.47	0.0	0.0
Proposed w/ Advanced Treatment Lake	0.0	0.01	0.80	0.0	0.0
Reduction in Discharge (Proposed vs Existing)				100%	100%

Lake 2

85th Percentile, 24-hour Storm Event	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Existing (Agricultural Land)	0.9	0.16	1.89	0.4	4.7
Proposed w/o BMPs	3.7	0.39	3.90	3.9	38.9
Proposed w/ Std. BMPs	3.5	0.31	2.73	3.0	26.0
Proposed w/ Std. Lake	1.0	0.47	3.42	1.3	9.3
Proposed w/ Advanced Treatment Lake	1.0	0.02	0.89	0.0	2.4
Reduction in Discharge (Proposed vs Existing)				88%	49%

Lake 3

85th Percentile, 24-hour Storm Event	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Existing (Agricultural Land)	0.3	0.16	1.89	0.1	1.6
Proposed w/o BMPs	1.2	0.39	3.90	1.3	12.9
Proposed w/ Std. BMPs	1.1	0.31	2.73	1.0	8.4
Proposed w/ Std. Lake	0.0	0.48	3.45	0.0	0.0
Proposed w/ Advanced Treatment Lake	0.0	0.02	0.84	0.0	0.0
Reduction in Discharge (Proposed vs Existing)				100%	100%

Lake 4

85th Percentile, 24-hour Storm Event	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Existing (Agricultural Land)	0.3	0.16	1.89	0.1	1.4
Proposed w/o BMPs	1.1	0.39	3.90	1.2	11.7
Proposed w/ Std. BMPs	1.0	0.31	2.73	0.9	7.5
Proposed w/ Std. Lake	0.0	0.48	3.45	0.0	0.0
Proposed w/ Advanced Treatment Lake	0.0	0.02	0.84	0.0	0.0
Reduction in Discharge (Proposed vs Existing)				100%	100%

Lake 5

85th Percentile, 24-hour Storm Event	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Existing (Agricultural Land)	0.6	0.16	1.89	0.3	3.0
Proposed w/o BMPs	2.4	0.39	3.90	2.5	24.9
Proposed w/ Std. BMPs	2.2	0.31	2.73	1.9	16.2
Proposed w/ Std. Lake	0.0	0.48	3.45	0.0	0.0
Proposed w/ Advanced Treatment Lake	0.0	0.02	0.84	0.0	0.0
Reduction in Discharge (Proposed vs Existing)				100%	100%

Project Total Discharge Summary

85th Percentile, 24-hour Storm Eve

	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Discharged (mg/l)	Total N Discharged (mg/l)*	Total P Discharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Existing (Agricultural Land)	5.0	0.17	0.20	2.3	26.4
Proposed w/o BMPs	18.8	0.39	0.10	19.9	198.2
Proposed w/ Std. BMPs	17.5	0.31	0.07	14.8	129.6
Proposed w/ Std. Lake	1.4	0.43	0.74	1.6	12.0
Proposed w/ Advanced Treatment Lal	1.4	0.10	0.74	0.4	5.1

Aquabella Lakes, Moreno Valley, CA

A simple model for estimating the discharge of Total Phosphorous (Total P) and Total Nitrogen (Total N) from the project site during storm events

PA2 BMP

85th Percentile, 24-hour Storm Event	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Proposed w/ Std. BMPs	0.4	0.31	2.73	0.3	2.7

Aquabella Lakes, Moreno Valley, CA
A simple model for estimating the discharge of Total Phosphorous (Total P) and Total Nitrogen (Total N) from the project site during storm events

85th Percentile, 24-hour Storm Event

	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Existing (Agricultural Land)	2.5	0.16	1.89	1.1	13.0
Proposed w/o BMPs	10.1	0.39	3.90	10.7	107.1
Proposed w/ Std. BMPs	9.3	0.31	2.73	7.9	68.8
Proposed w/ Std. Lake	0.0	0.49	3.47	0.0	0.0
Proposed w/ Advanced Treatment Lake	0.0	0.01	0.80	0.0	0.0

10-year, 24-hour Storm Event

	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Existing (Agricultural Land)	11.9	0.16	1.89	5.2	61.2
Proposed w/o BMPs	47.6	0.39	3.90	50.5	505.2
Proposed w/ Std. BMPs	43.7	0.31	2.73	37.1	324.3
Proposed w/ Std. Lake	31.2	0.45	3.39	38.5	287.1
Proposed w/ Advanced Treatment Lake	31.2	0.02	0.94	1.6	79.5

50-year, 24-hour Storm Event

	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Existing (Agricultural Land)	16.6	0.16	1.89	7.2	85.2
Proposed w/o BMPs	66.3	0.39	3.90	70.3	703.4
Proposed w/ Std. BMPs	60.8	0.31	2.73	51.6	451.6
Proposed w/ Std. Lake	48.3	0.44	3.35	57.9	440.1
Proposed w/ Advanced Treatment Lake	48.3	0.02	0.99	2.7	130.6

100-year, 24-hour Storm Event

	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Existing (Agricultural Land)	18.6	0.16	1.89	8.1	95.7
Proposed w/o BMPs	74.4	0.39	3.90	79.0	789.8
Proposed w/ Std. BMPs	68.3	0.31	2.73	57.9	507.0
Proposed w/ Std. Lake	55.8	0.43	3.33	65.9	505.9
Proposed w/ Advanced Treatment Lake	55.8	0.02	1.02	3.2	154.1

Aquabella Lakes, Moreno Valley, CA

A simple model for estimating the discharge of Total Phosphorous (Total P) and Total Nitrogen (Total N) from the lake during storm events

Condition 1: Onsite Runoff

Storm	Runoff Depth (in)*	Runoff Volume (AF)	Runoff Total P* (mg/l)	Runoff Total N* (mg/l)	Runoff Total P (lbs)	Runoff Total N (lbs)
85th %ile	0.4	9.3	0.39	3.9	10	98
10 yr	1.9	43.7	0.39	3.9	46	463
50 yr	2.6	60.8	0.39	3.9	65	645
100-yr	3.0	68.3	0.39	3.9	72	724

* Notes:
Runoff depths provided by P.A.C.E.
Runoff Total P is reported mean concentration from LA County Monitoring Data for High Density Residential Land Use
Runoff Total N is sum of Nitrate-N, Nitrite-N, and TKN reported by LA County for High Density Residential Land Use

Condition 2: Lake Mixing

2a: Lake at Normal Level prior to each event

Storm	Lake Volume (AF)	Lake Total P (mg/l)*	Lake Total N (mg/l)*	Diluted Total P (mg/l)	Diluted Total N (mg/l)
85th %ile	250	0.1	1.5	0.11	1.61
10 yr	250	0.1	1.5	0.14	1.88
50 yr	250	0.1	1.5	0.16	1.99
100-yr	250	0.1	1.5	0.16	2.03

* Notes:
Lake concentrations of Total P and Total N based on Monitoring data for Bridgeport Lake, 2002-2005
Lake concentrations of Total N include only NO_3. Total N data are not available.

Condition 3: Lake Treatment

Storm	Diluted Total P (mg/l)	Diluted Total N (mg/l)	P Removal Efficiency (%)*	N Removal Efficiency (%)*	Treated Total P (mg/l)	Treated Total N (mg/l)
85th %ile	0.11	1.61	87%	50%	0.01	0.80
10 yr	0.14	1.88	87%	50%	0.02	0.94
50 yr	0.16	1.99	87%	50%	0.02	0.99
100-yr	0.16	2.03	87%	50%	0.02	1.02

* Notes
Removal efficiencies based on average efficiencies for wet ponds and wetlands based on data compiled by the multi-state Chesapeake Bay Program

Condition 4: Lake Discharge

Storm	Lake Storage Capacity (AF)	Volume of Water Discharged (AF)	Total P Discharged (mg/l)	In-lake P TMDL Goal (mg/l)*	Total N Discharged (mg/l)*	In-lake N TMDL Goal (mg/l)	Total P Disharged (Lbs)	Total N Discharged (Lbs)
85th %ile	12.5	0.0	0.01	0.1	0.80	0.75	0.0	0.0
10 yr	12.5	31.2	0.02	0.1	0.94	0.75	1.6	79.5
50 yr	12.5	48.3	0.02	0.1	0.99	0.75	2.7	130.6
100-yr	12.5	55.8	0.02	0.1	1.02	0.75	3.2	154.1

* Notes
In-lake TMDL Goals refer to pollutant concentrations within Canyon Lake and Lake Elsinore. These goals are not necessarily the same as stormwater discharge goals for Aquabella Lakes.

Condition 1: Onsite Runoff (columns in bold print represent agricultural land)

Storm	Runoff Depth (in)*	Runoff Volume (AF)	Runoff Total P* (mg/l)	Runoff Total N* (mg/l)	Runoff Total P (lbs)	Runoff Total N (lbs)	**Runoff Total P* (mg/l)**	**Runoff Total N* (mg/l)**	**Runoff Total P (lbs)**	**Runoff Total N (lbs)**
85th %ile	0.10	2.5	0.16	1.89	1	13	**3.30**	**24.20**	**22.7**	**166.2**
10 yr	0.47	11.9	0.16	1.89	5	61	**3.30**	**24.20**	**106.9**	**783.7**
50 yr	0.66	16.6	0.16	1.89	7	85	**3.30**	**24.20**	**148.8**	**1091.2**
100-yr	0.74	18.6	0.16	1.89	8	96	**3.30**	**24.20**	**167.1**	**1225.2**

* Notes:
Runoff depths provided by P.A.C.E.
Runoff Total P is mean concentration reported by LA County for vacant Land
Runoff Total P (in bold) is mean concentration reported by Ventura County for agricultural land
Runoff Total N is sum of Nitrate-N, Nitrite-N, and TKN reported by LA County for vacant land
Runoff Total N (IN bold) is sum of Nitrate-N, Nitrite-N, and TKN reported by Ventura County for agricultural land
Columns in bold print represent data for agricultural land

Condition 2: Lake Mixing
none

Condition 3: Lake Treatment
none

Condition 4: Site Discharge

Storm	Lake Storage Capacity (AF)	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	In-lake P TMDL Goal (mg/l)*	Total N Discharged (mg/l)*	In-lake N TMDL Goal (mg/l)	Total P Disharged (Lbs)	Total N Discharged (Lbs)	**Total P Disharged (mg/l)**	**Total N Discharged (mg/l)***	**Total P Disharged (Lbs)**	**Total N Discharged (Lbs)**
85th %ile	0	2.5	0.16	0.1	1.89	0.75	1.1	13.0	**3.30**	**24.20**	**22.66**	**166.17**
10 yr	0	11.9	0.16	0.1	1.89	0.75	5.2	61.2	**3.30**	**24.20**	**106.87**	**783.71**
50 yr	0	16.6	0.16	0.1	1.89	0.75	7.2	85.2	**3.30**	**24.20**	**148.81**	**1091.24**
100-yr	0	18.6	0.16	0.1	1.89	0.75	8.1	95.7	**3.30**	**24.20**	**167.07**	**1225.16**

* Notes
In-lake TMDL Goals refer to pollutant concentrations within Canyon Lake and Lake Elsinore. These goals are not necessarily the same as stormwater
Columns in bold print represent data for agricultural land

Condition 1: Onsite Runoff

Storm	Runoff Depth (in)*	Runoff Volume (AF)	Runoff Total P* (mg/l)	Runoff Total N* (mg/l)	Runoff Total P (lbs)	Runoff Total N (lbs)
85th %ile	0.4	9.3	0.39	3.9	10	98
10 yr	1.9	43.7	0.39	3.9	46	463
50 yr	2.6	60.8	0.39	3.9	65	645
100-yr	3.0	68.3	0.39	3.9	72	724

* Notes:
Runoff depths provided by P.A.C.E.
Runoff Total P is reported mean concentration from LA County Monitoring Data for High Density Residential Land Use
Runoff Total N is sum of Nitrate-N, Nitrite-N, and TKN reported by LA County for High Density Residential Land Use

Condition 2: Lake Mixing

2a: Lake at Normal Level prior to each event

Storm	Lake Volume (AF)	Lake Total P (mg/l)*	Lake Total N (mg/l)*	Diluted Total P (mg/l)	Diluted Total N (mg/l)
85th %ile	250	1	5.0	0.98	4.96
10 yr	250	1	5.0	0.91	4.84
50 yr	250	1	5.0	0.88	4.78
100-yr	250	1	5.0	0.87	4.76

* Notes:
Typical Lake concentrations of Total P and Total N
Lake concentrations of Total N include only NO_3. Total N data are not available.

Condition 3: Lake Treatment

Storm	Diluted Total P (mg/l)	Diluted Total N (mg/l)	P Removal Efficiency (%)*	N Removal Efficienc y (%)*	Treated Total P (mg/l)	Treated Total N (mg/l)
85th %ile	0.98	4.96	50%	30%	0.49	3.47
10 yr	0.91	4.84	50%	30%	0.45	3.39
50 yr	0.88	4.78	50%	30%	0.44	3.35
100-yr	0.87	4.76	50%	30%	0.43	3.33

* Notes
Removal efficiencies based on average efficiencies for wet ponds and wetlands based on data compiled by the multi-state Chesapeake Bay Program

Condition 4: Lake Discharge

Storm	Lake Storage Capacity (AF)	Volume of Water Discharged (AF)	Total P Disharge d (mg/l)	In-lake P TMDL Goal (mg/l)*	Total N Discharged (mg/l)*	In-lake N TMDL Goal (mg/l)	Total P Disharge d (Lbs)	Total N Discharge d (Lbs)
85th %ile	12.5	0.0	0.49	0.1	3.47	0.75	0.0	0.0
10 yr	12.5	31.2	0.45	0.1	3.39	0.75	38.5	287.1
50 yr	12.5	48.3	0.44	0.1	3.35	0.75	57.9	440.1
100-yr	12.5	55.8	0.43	0.1	3.33	0.75	65.9	505.9

* Notes
In-lake TMDL Goals refer to pollutant concentrations within Canyon Lake and Lake Elsinore. These goals are not necessarily the same as stormwater discharge goals for Aquabella Lakes.

Condition 1: Onsite Runoff

Storm	Runoff Depth (in)*	Runoff Volume (AF)	Runoff Total P* (mg/l)	Runoff Total N* (mg/l)	Runoff Total P (lbs)	Runoff Total N (lbs)
85th %ile	0.4	10.1	0.39	3.9	11	107
10 yr	1.9	47.6	0.39	3.9	51	505
50 yr	2.6	66.3	0.39	3.9	70	703
100-yr	3.0	74.4	0.39	3.9	79	790

* Notes:
Runoff depths provided by P.A.C.E.
Runoff Total P is reported mean concentration from LA County Monitoring Data for High Density Residential Land Use
Runoff Total N is sum of Nitrate-N, Nitrite-N, and TKN reported by LA County for High Density Residential Land Use

Condition 2: Lake Mixing
no lake mixing

Condition 3: Lake Treatment
no treatment

Condition 4: Site Discharge

Storm	Lake Storage Capacity (AF)	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	In-lake P TMDL Goal (mg/l)*	Total N Discharged (mg/l)*	In-lake N TMDL Goal (mg/l)	Total P Disharged (Lbs)	Total N Discharged (Lbs)
85th %ile	0	10.1	0.39	0.1	3.90	0.75	10.7	107.1
10 yr	0	47.6	0.39	0.1	3.90	0.75	50.5	505.2
50 yr	0	66.3	0.39	0.1	3.90	0.75	70.3	703.4
100-yr	0	74.4	0.39	0.1	3.90	0.75	79.0	789.8

* Notes
In-lake TMDL Goals refer to pollutant concentrations within Canyon Lake and Lake Elsinore. These goals are not necessarily the same as stormwater discharge goals for Aquabella Lakes.

Condition 1: Onsite Runoff

Storm	Runoff Depth (in)*	Runoff Volume (AF)	Runoff Total P* (mg/l)	Runoff Total N* (mg/l)	Runoff Total P (lbs)	Runoff Total N (lbs)
85th %ile	0.4	9.3	0.39	3.9	10	98
10 yr	1.9	43.7	0.39	3.9	46	463
50 yr	2.6	60.8	0.39	3.9	65	645
100-yr	3.0	68.3	0.39	3.9	72	724

* Notes:
Runoff depths provided by P.A.C.E.
Runoff Total P is reported mean concentration from LA County Monitoring Data for High Density Residential Land Use
Runoff Total N is sum of Nitrate-N, Nitrite-N, and TKN reported by LA County for High Density Residential Land Use

Condition 2: Lake Mixing

no lake mixing

Condition 3: BMP Treatment

Storm	Diluted Total P (mg/l)	Diluted Total N (mg/l)	P Removal Efficiency (%)*	N Removal Efficiency (%)*	Treated Total P (mg/l)	Treated Total N (mg/l)
85th %ile	0.39	3.9	20%	30%	0.31	2.73
10 yr	0.39	3.9	20%	30%	0.31	2.73
50 yr	0.39	3.9	20%	30%	0.31	2.73
100-yr	0.39	3.9	20%	30%	0.31	2.73

* Notes
Removal efficiencies based on average efficiencies for dry extended detention basins based on data compiled by the multi-state Chesapeake Bay Program

Condition 4: Discharge

Storm	Lake Storage Capacity (AF)	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	In-lake P TMDL Goal (mg/l)*	Total N Discharged (mg/l)*	In-lake N TMDL Goal (mg/l)	Total P Disharged (Lbs)	Total N Discharged (Lbs)
85th %ile	0	9.3	0.31	0.1	2.73	0.75	7.9	68.8
10 yr	0	43.7	0.31	0.1	2.73	0.75	37.1	324.3
50 yr	0	60.8	0.31	0.1	2.73	0.75	51.6	451.6
100-yr	0	68.3	0.31	0.1	2.73	0.75	57.9	507.0

* Notes
In-lake TMDL Goals refer to pollutant concentrations within Canyon Lake and Lake Elsinore. These goals are not necessarily the same as stormwater discharge goals for Aquabella Lakes.

Runoff Calculations for Water Quality Analysis			
PROPOSED CONDITIONS			
Rainfall event	Rainfall depth (inches)	Runoff coefficient	Runoff depth (inches)
85th %ile Storm	0.67	0.60	0.40
10-year, 24-hour storm	3.16	0.60	1.90
50-year, 24-hour storm	4.4	0.60	2.64
100-year, 24-hour storm	4.94	0.60	2.96
EXISTING CONDITIONS			
Rainfall event	Rainfall depth (inches)	Runoff coefficient	Runoff depth (inches)
85th %ile Storm	0.67	0.15	0.10
10-year, 24-hour storm	3.16	0.15	0.47
50-year, 24-hour storm	4.4	0.15	0.66
100-year, 24-hour storm	4.94	0.15	0.74

Runoff coefficients are from the Riverside County Stormwater Quality Best Management Practices Design Manual, Figure 1, based on a proposed conditions impervious cover of 80%, and existing conditions impervious cover of 15%.

Riverside County LID BMP Design Handbook
85th%, 24-hr Rainfall Depth= 0.67 inches
(from Isohyetal Map Appdx. E)

3/31/23, 2:06 PM Precipitation Frequency Data Server

NOAA Atlas 14, Volume 6, Version 2
Location name: Moreno Valley, California, USA*
Latitude: 33.905°, Longitude: -117.1988°
Elevation: m/ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

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

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.091 (0.076-0.110)	0.124 (0.104-0.151)	0.169 (0.140-0.205)	0.205 (0.169-0.252)	0.256 (0.204-0.325)	0.295 (0.230-0.383)	0.336 (0.255-0.446)	0.378 (0.279-0.517)	0.436 (0.308-0.623)	0.482 (0.329-0.714)
10-min	0.130 (0.109-0.158)	0.178 (0.149-0.216)	0.242 (0.201-0.294)	0.294 (0.243-0.361)	0.367 (0.292-0.465)	0.423 (0.330-0.549)	0.481 (0.365-0.640)	0.542 (0.400-0.742)	0.625 (0.442-0.894)	0.691 (0.471-1.02)
15-min	0.158 (0.132-0.191)	0.216 (0.180-0.261)	0.293 (0.243-0.356)	0.356 (0.293-0.436)	0.443 (0.353-0.563)	0.512 (0.399-0.663)	0.582 (0.442-0.774)	0.655 (0.483-0.897)	0.756 (0.534-1.08)	0.835 (0.570-1.24)
30-min	0.252 (0.210-0.305)	0.345 (0.287-0.418)	0.468 (0.389-0.568)	0.569 (0.469-0.697)	0.709 (0.564-0.899)	0.817 (0.637-1.06)	0.930 (0.706-1.24)	1.05 (0.772-1.43)	1.21 (0.853-1.73)	1.34 (0.910-1.98)
60-min	0.350 (0.292-0.424)	0.479 (0.399-0.580)	0.650 (0.540-0.789)	0.790 (0.651-0.969)	0.984 (0.784-1.25)	1.14 (0.885-1.47)	1.29 (0.981-1.72)	1.45 (1.07-1.99)	1.68 (1.19-2.40)	1.86 (1.26-2.75)
2-hr	0.522 (0.436-0.632)	0.687 (0.573-0.833)	0.905 (0.752-1.10)	1.08 (0.893-1.33)	1.33 (1.06-1.68)	1.52 (1.18-1.97)	1.71 (1.30-2.27)	1.91 (1.41-2.61)	2.18 (1.54-3.12)	2.39 (1.63-3.55)
3-hr	0.649 (0.542-0.785)	0.844 (0.703-1.02)	1.10 (0.914-1.34)	1.31 (1.08-1.60)	1.59 (1.27-2.02)	1.81 (1.41-2.35)	2.04 (1.55-2.71)	2.27 (1.67-3.11)	2.58 (1.82-3.69)	2.83 (1.93-4.19)
6-hr	0.910 (0.760-1.10)	1.17 (0.979-1.42)	1.52 (1.26-1.85)	1.80 (1.48-2.21)	2.18 (1.74-2.77)	2.47 (1.93-3.21)	2.77 (2.10-3.68)	3.07 (2.27-4.20)	3.48 (2.46-4.98)	3.80 (2.59-5.63)
12-hr	1.17 (0.974-1.41)	1.53 (1.27-1.85)	2.00 (1.66-2.42)	2.37 (1.96-2.91)	2.89 (2.30-3.66)	3.27 (2.55-4.25)	3.67 (2.78-4.88)	4.07 (3.00-5.57)	4.61 (3.25-6.58)	5.02 (3.42-7.44)
24-hr	1.48 (1.31-1.70)	1.98 (1.75-2.29)	2.63 (2.32-3.05)	3.16 (2.76-3.69)	3.86 (3.27-4.66)	4.40 (3.65-5.41)	4.94 (4.00-6.22)	5.49 (4.33-7.10)	6.22 (4.71-8.39)	6.79 (4.97-9.46)

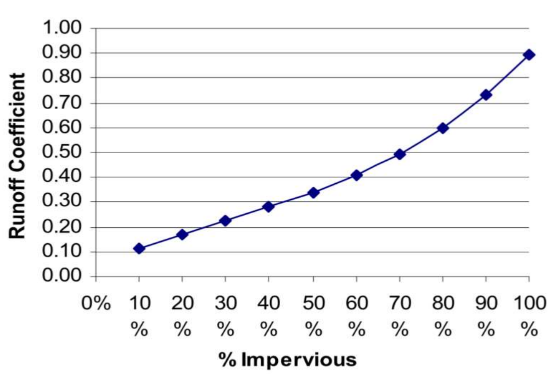


Figure 1. Impervious – Coefficient Curve (WEF/ASCE Method[1])

Aquabella Lakes, Moreno Valley, CA

A simple model for estimating the discharge of Total Phosphorous (Total P) and Total Nitrogen (Total N) from the project site during storm events

85th Percentile, 24-hour Storm Event

Site Condition	Discharge Parameters Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Existing (Agricultural Land)	0.9	0.16	1.89	0.4	4.7
Proposed w/o BMPs	3.7	0.39	3.90	3.9	38.9
Proposed w/ Std. BMPs	3.5	0.31	2.73	3.0	26.0
Proposed w/ Std. Lake	1.0	0.47	3.42	1.3	9.3
Proposed w/ Advanced Treatment Lake	1.0	0.02	0.89	0.0	2.4

10-year, 24-hour Storm Event

Site Condition	Discharge Parameters Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Existing (Agricultural Land)	4.3	0.16	1.89	1.9	22.2
Proposed w/o BMPs	17.3	0.39	3.90	18.3	183.4
Proposed w/ Std. BMPs	16.5	0.31	2.73	14.0	122.5
Proposed w/ Std. Lake	14.0	0.39	3.23	14.9	122.8
Proposed w/ Advanced Treatment Lake	14.0	0.03	1.18	1.0	45.0

50-year, 24-hour Storm Event

Site Condition	Discharge Parameters Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Existing (Agricultural Land)	6.0	0.16	1.89	2.6	30.9
Proposed w/o BMPs	24.1	0.39	3.90	25.5	255.3
Proposed w/ Std. BMPs	23.0	0.31	2.73	19.5	170.6
Proposed w/ Std. Lake	20.5	0.37	3.17	20.5	176.3
Proposed w/ Advanced Treatment Lake	20.5	0.03	1.28	1.6	71.1

100-year, 24-hour Storm Event

Site Condition	Discharge Parameters Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Existing (Agricultural Land)	6.8	0.16	1.89	2.9	34.7
Proposed w/o BMPs	27.0	0.39	3.90	28.7	286.7
Proposed w/ Std. BMPs	25.8	0.31	2.73	21.9	191.5
Proposed w/ Std. Lake	23.3	0.36	3.14	22.7	199.2
Proposed w/ Advanced Treatment Lake	23.3	0.03	1.31	1.9	83.0

Aquabella Lakes, Moreno Valley, CA

A simple model for estimating the discharge of Total Phosphorous (Total P) and Total Nitrogen (Total N) from the lake during storm events

Condition 1: Onsite Runoff

Storm	Runoff Depth (in)*	Runoff Volume (AF)	Runoff Total P* (mg/l)	Runoff Total N* (mg/l)	Runoff Total P (lbs)	Runoff Total N (lbs)
85th %ile	0.4	3.5	0.39	3.9	4	37
10 yr	1.9	16.5	0.39	3.9	17	175
50 yr	2.6	23.0	0.39	3.9	24	244
100-yr	3.0	25.8	0.39	3.9	27	274

* Notes:
Runoff depths provided by P.A.C.E.
Runoff Total P is reported mean concentration from LA County Monitoring Data for High Density Residential Land Use
Runoff Total N is sum of Nitrate-N, Nitrite-N, and TKN reported by LA County for High Density Residential Land Use

Condition 2: Lake Mixing

2a: Lake at Normal Level prior to each event

Storm	Lake Volume (AF)	Lake Total P (mg/l)*	Lake Total N (mg/l)*	Diluted Total P (mg/l)	Diluted Total N (mg/l)
85th %ile	30	0.1	1.5	0.13	1.77
10 yr	30	0.1	1.5	0.20	2.37
50 yr	30	0.1	1.5	0.23	2.55
100-yr	30	0.1	1.5	0.23	2.62

* Notes:
Lake concentrations of Total P and Total N based on Monitoring data for Bridgeport Lake, 2002-2005
Lake concentrations of Total N include only NO_3. Total N data are not available.

Condition 3: Lake Treatment

Storm	Diluted Total P (mg/l)	Diluted Total N (mg/l)	P Removal Efficiency (%)*	N Removal Efficiency (%)*	Treated Total P (mg/l)	Treated Total N (mg/l)
85th %ile	0.13	1.77	87%	50%	0.02	0.89
10 yr	0.20	2.37	87%	50%	0.03	1.18
50 yr	0.23	2.55	87%	50%	0.03	1.28
100-yr	0.23	2.62	87%	50%	0.03	1.31

* Notes
Removal efficiencies based on average efficiencies for wet ponds and wetlands based on data compiled by the multi-state Chesapeake Bay Program

Condition 4: Lake Discharge

Storm	Lake Storage Capacity (AF)	Volume of Water Discharged (AF)	Total P Discharged (mg/l)	In-lake P TMDL Goal (mg/l)*	Total N Discharged (mg/l)*	In-lake N TMDL Goal (mg/l)	Total P Disharged (Lbs)	Total N Discharged (Lbs)
85th %ile	2.5	1.0	0.02	0.1	0.89	0.75	0.0	2.4
10 yr	2.5	14.0	0.03	0.1	1.18	0.75	1.0	45.0
50 yr	2.5	20.5	0.03	0.1	1.28	0.75	1.6	71.1
100-yr	2.5	23.3	0.03	0.1	1.31	0.75	1.9	83.0

* Notes
In-lake TMDL Goals refer to pollutant concentrations within Canyon Lake and Lake Elsinore. These goals are not necessarily the same as stormwater discharge goals for Aquabella Lakes.

Condition 1: Onsite Runoff (columns in bold print represent agricultural land)

Storm	Runoff Depth (in)*	Runoff Volume (AF)	Runoff Total P* (mg/l)	Runoff Total N* (mg/l)	Runoff Total P (lbs)	Runoff Total N (lbs)	**Runoff Total P* (mg/l)**	**Runoff Total N* (mg/l)**	**Runoff Total P (lbs)**	**Runoff Total N (lbs)**
85th %ile	0.10	0.9	0.16	1.89	0	5	**3.30**	**24.20**	**8.2**	**60.3**
10 yr	0.47	4.3	0.16	1.89	2	22	**3.30**	**24.20**	**38.8**	**284.5**
50 yr	0.66	6.0	0.16	1.89	3	31	**3.30**	**24.20**	**54.0**	**396.1**
100-yr	0.74	6.8	0.16	1.89	3	35	**3.30**	**24.20**	**60.6**	**444.7**

* Notes:
Runoff depths provided by P.A.C.E.
Runoff Total P is mean concentration reported by LA County for vacant Land
Runoff Total P (in bold) is mean concentration reported by Ventura County for agricultural land
Runoff Total N is sum of Nitrate-N, Nitrite-N, and TKN reported by LA County for vacant land
Runoff Total N (IN bold) is sum of Nitrate-N, Nitrite-N, and TKN reported by Ventura County for agricultural land
Columns in bold print represent data for agricultural land

Condition 2: Lake Mixing

none

Condition 3: Lake Treatment

none

Condition 4: Site Discharge

Storm	Lake Storage Capacity (AF)	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	In-lake P TMDL Goal (mg/l)*	Total N Discharged (mg/l)*	In-lake N TMDL Goal (mg/l)	Total P Disharged (Lbs)	Total N Discharged (Lbs)	**Total P Disharged (mg/l)**	**Total N Discharged (mg/l)***	**Total P Disharged (Lbs)**	**Total N Discharged (Lbs)**
85th %ile	0	0.9	0.16	0.1	1.89	0.75	0.4	4.7	**3.30**	**24.20**	**8.22**	**60.31**
10 yr	0	4.3	0.16	0.1	1.89	0.75	1.9	22.2	**3.30**	**24.20**	**38.79**	**284.46**
50 yr	0	6.0	0.16	0.1	1.89	0.75	2.6	30.9	**3.30**	**24.20**	**54.01**	**396.09**
100-yr	0	6.8	0.16	0.1	1.89	0.75	2.9	34.7	**3.30**	**24.20**	**60.64**	**444.70**

* Notes
In-lake TMDL Goals refer to pollutant concentrations within Canyon Lake and Lake Elsinore. These goals are not necessarily the same as stormwater
Columns in bold print represent data for agricultural land

Condition 1: Onsite Runoff

Storm	Runoff Depth (in)*	Runoff Volume (AF)	Runoff Total P* (mg/l)	Runoff Total N* (mg/l)	Runoff Total P (lbs)	Runoff Total N (lbs)
85th %ile	0.4	3.5	0.39	3.9	4	37
10 yr	1.9	16.5	0.39	3.9	17	175
50 yr	2.6	23.0	0.39	3.9	24	244
100-yr	3.0	25.8	0.39	3.9	27	274

* Notes:
Runoff depths provided by P.A.C.E.
Runoff Total P is reported mean concentration from LA County Monitoring Data for High Density Residential Land Use
Runoff Total N is sum of Nitrate-N, Nitrite-N, and TKN reported by LA County for High Density Residential Land Use

Condition 2: Lake Mixing

2a: Lake at Normal Level prior to each event

Storm	Lake Volume (AF)	Lake Total P (mg/l)*	Lake Total N (mg/l)*	Diluted Total P (mg/l)	Diluted Total N (mg/l)
85th %ile	30	1	5.0	0.94	4.89
10 yr	30	1	5.0	0.78	4.61
50 yr	30	1	5.0	0.74	4.52
100-yr	30	1	5.0	0.72	4.49

* Notes:
Typical Lake concentrations of Total P and Total N
Lake concentrations of Total N include only NO_3. Total N data are not available.

Condition 3: Lake Treatment

Storm	Diluted Total P (mg/l)	Diluted Total N (mg/l)	P Removal Efficiency (%)*	N Removal Efficiency (%)*	Treated Total P (mg/l)	Treated Total N (mg/l)
85th %ile	0.94	4.89	50%	30%	0.47	3.42
10 yr	0.78	4.61	50%	30%	0.39	3.23
50 yr	0.74	4.52	50%	30%	0.37	3.17
100-yr	0.72	4.49	50%	30%	0.36	3.14

* Notes
Removal efficiencies based on average efficiencies for wet ponds and wetlands based on data compiled by the multi-state Chesapeake Bay Program

Condition 4: Lake Discharge

Storm	Lake Storage Capacity (AF)	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	In-lake P TMDL Goal (mg/l)*	Total N Discharged (mg/l)*	In-lake N TMDL Goal (mg/l)	Total P Disharged (Lbs)	Total N Discharged (Lbs)
85th %ile	2.5	1.0	0.47	0.1	3.42	0.75	1.3	9.3
10 yr	2.5	14.0	0.39	0.1	3.23	0.75	14.9	122.8
50 yr	2.5	20.5	0.37	0.1	3.17	0.75	20.5	176.3
100-yr	2.5	23.3	0.36	0.1	3.14	0.75	22.7	199.2

* Notes
In-lake TMDL Goals refer to pollutant concentrations within Canyon Lake and Lake Elsinore. These goals are not necessarily the same as stormwater discharge goals for Aquabella Lakes.

Condition 1: Onsite Runoff

Storm	Runoff Depth (in)*	Runoff Volume (AF)	Runoff Total P* (mg/l)	Runoff Total N* (mg/l)	Runoff Total P (lbs)	Runoff Total N (lbs)
85th %ile	0.4	3.7	0.39	3.9	4	39
10 yr	1.9	17.3	0.39	3.9	18	183
50 yr	2.6	24.1	0.39	3.9	26	255
100-yr	3.0	27.0	0.39	3.9	29	287

* Notes:
Runoff depths provided by P.A.C.E.
Runoff Total P is reported mean concentration from LA County Monitoring Data for High Density Residential Land Use
Runoff Total N is sum of Nitrate-N, Nitrite-N, and TKN reported by LA County for High Density Residential Land Use

Condition 2: Lake Mixing

no lake mixing

Condition 3: Lake Treatment

no treatment

Condition 4: Site Discharge

Storm	Lake Storage Capacity (AF)	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	In-lake P TMDL Goal (mg/l)*	Total N Discharged (mg/l)*	In-lake N TMDL Goal (mg/l)	Total P Disharged (Lbs)	Total N Discharged (Lbs)
85th %ile	0	3.7	0.39	0.1	3.90	0.75	3.9	38.9
10 yr	0	17.3	0.39	0.1	3.90	0.75	18.3	183.4
50 yr	0	24.1	0.39	0.1	3.90	0.75	25.5	255.3
100-yr	0	27.0	0.39	0.1	3.90	0.75	28.7	286.7

* Notes
In-lake TMDL Goals refer to pollutant concentrations within Canyon Lake and Lake Elsinore. These goals are not necessarily the same as stormwater discharge goals for Aquabella Lakes.

Condition 1: Onsite Runoff

Storm	Runoff Depth (in)*	Runoff Volume (AF)	Runoff Total P* (mg/l)	Runoff Total N* (mg/l)	Runoff Total P (lbs)	Runoff Total N (lbs)
85th %ile	0.4	3.5	0.39	3.9	4	37
10 yr	1.9	16.5	0.39	3.9	17	175
50 yr	2.6	23.0	0.39	3.9	24	244
100-yr	3.0	25.8	0.39	3.9	27	274

* Notes:
Runoff depths provided by P.A.C.E.
Runoff Total P is reported mean concentration from LA County Monitoring Data for High Density Residential Land Use
Runoff Total N is sum of Nitrate-N, Nitrite-N, and TKN reported by LA County for High Density Residential Land Use

Condition 2: Lake Mixing
no lake mixing

Condition 3: BMP Treatment

Storm	Diluted Total P (mg/l)	Diluted Total N (mg/l)	P Removal Efficiency (%)*	N Removal Efficiency (%)*	Treated Total P (mg/l)	Treated Total N (mg/l)
85th %ile	0.39	3.9	20%	30%	0.31	2.73
10 yr	0.39	3.9	20%	30%	0.31	2.73
50 yr	0.39	3.9	20%	30%	0.31	2.73
100-yr	0.39	3.9	20%	30%	0.31	2.73

* Notes
Removal efficiencies based on average efficiencies for dry extended detention basins based on data compiled by the multi-state Chesapeake Bay Program

Condition 4: Discharge

Storm	Lake Storage Capacity (AF)	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	In-lake P TMDL Goal (mg/l)*	Total N Discharged (mg/l)*	In-lake N TMDL Goal (mg/l)	Total P Disharged (Lbs)	Total N Discharged (Lbs)
85th %ile	0	3.5	0.31	0.1	2.73	0.75	3.0	26.0
10 yr	0	16.5	0.31	0.1	2.73	0.75	14.0	122.5
50 yr	0	23.0	0.31	0.1	2.73	0.75	19.5	170.6
100-yr	0	25.8	0.31	0.1	2.73	0.75	21.9	191.5

* Notes
In-lake TMDL Goals refer to pollutant concentrations within Canyon Lake and Lake Elsinore. These goals are not necessarily the same as stormwater discharge goals for Aquabella Lakes.

Runoff Calculations for Water Quality Analysis			
PROPOSED CONDITIONS			
Rainfall event	Rainfall depth (inches)	Runoff coefficient	Runoff depth (inches)
85th %ile Storm	0.67	0.60	0.40
10-year, 24-hour storm	3.16	0.60	1.90
50-year, 24-hour storm	4.4	0.60	2.64
100-year, 24-hour storm	4.94	0.60	2.96
EXISTING CONDITIONS			
Rainfall event	Rainfall depth (inches)	Runoff coefficient	Runoff depth (inches)
85th %ile Storm	0.67	0.15	0.10
10-year, 24-hour storm	3.16	0.15	0.47
50-year, 24-hour storm	4.4	0.15	0.66
100-year, 24-hour storm	4.94	0.15	0.74

Runoff coefficients are from the Riverside County Stormwater Quality Best Management Practices Design Manual, Figure 1, based on a proposed conditions impervious cover of 80%, and existing conditions impervious cover of 15%.

Riverside County LID BMP Design Handbook
85th%, 24-hr Rainfall Depth= 0.67 inches
(from Isohyetal Map Appdx. E)

3/31/23, 2:06 PM Precipitation Frequency Data Server

NOAA Atlas 14, Volume 6, Version 2
Location name: Moreno Valley, California, USA*
Latitude: 33.905°, Longitude: -117.1988°
Elevation: m/ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.091** (0.076-0.110)	**0.124** (0.104-0.151)	**0.169** (0.140-0.205)	**0.205** (0.169-0.252)	**0.256** (0.204-0.325)	**0.295** (0.230-0.383)	**0.336** (0.255-0.446)	**0.378** (0.279-0.517)	**0.436** (0.308-0.623)	**0.482** (0.329-0.714)
10-min	**0.130** (0.109-0.158)	**0.178** (0.149-0.216)	**0.242** (0.201-0.294)	**0.294** (0.243-0.361)	**0.367** (0.292-0.465)	**0.423** (0.330-0.549)	**0.481** (0.365-0.640)	**0.542** (0.400-0.742)	**0.625** (0.442-0.894)	**0.691** (0.471-1.02)
15-min	**0.158** (0.132-0.191)	**0.216** (0.180-0.261)	**0.293** (0.243-0.356)	**0.356** (0.293-0.436)	**0.443** (0.353-0.563)	**0.512** (0.399-0.663)	**0.582** (0.442-0.774)	**0.655** (0.483-0.897)	**0.756** (0.534-1.08)	**0.835** (0.570-1.24)
30-min	**0.252** (0.210-0.305)	**0.345** (0.287-0.418)	**0.468** (0.389-0.568)	**0.569** (0.469-0.697)	**0.709** (0.564-0.899)	**0.817** (0.637-1.06)	**0.930** (0.706-1.24)	**1.05** (0.772-1.43)	**1.21** (0.853-1.73)	**1.34** (0.910-1.98)
60-min	**0.350** (0.292-0.424)	**0.479** (0.399-0.580)	**0.650** (0.540-0.789)	**0.790** (0.651-0.969)	**0.984** (0.784-1.25)	**1.14** (0.885-1.47)	**1.29** (0.981-1.72)	**1.45** (1.07-1.99)	**1.68** (1.19-2.40)	**1.86** (1.26-2.75)
2-hr	**0.522** (0.436-0.632)	**0.687** (0.573-0.833)	**0.905** (0.752-1.10)	**1.08** (0.893-1.33)	**1.33** (1.06-1.68)	**1.52** (1.18-1.97)	**1.71** (1.30-2.27)	**1.91** (1.41-2.61)	**2.18** (1.54-3.12)	**2.39** (1.63-3.55)
3-hr	**0.649** (0.542-0.785)	**0.844** (0.703-1.02)	**1.10** (0.914-1.34)	**1.31** (1.08-1.60)	**1.59** (1.27-2.02)	**1.81** (1.41-2.35)	**2.04** (1.55-2.71)	**2.27** (1.67-3.11)	**2.58** (1.82-3.69)	**2.83** (1.93-4.19)
6-hr	**0.910** (0.760-1.10)	**1.17** (0.979-1.42)	**1.52** (1.26-1.85)	**1.80** (1.48-2.21)	**2.18** (1.74-2.77)	**2.47** (1.93-3.21)	**2.77** (2.10-3.68)	**3.07** (2.27-4.20)	**3.48** (2.46-4.98)	**3.80** (2.59-5.63)
12-hr	**1.17** (0.974-1.41)	**1.53** (1.27-1.85)	**2.00** (1.66-2.42)	**2.37** (1.96-2.91)	**2.89** (2.30-3.66)	**3.27** (2.55-4.25)	**3.67** (2.78-4.88)	**4.07** (3.00-5.57)	**4.61** (3.25-6.58)	**5.02** (3.42-7.44)
24-hr	**1.48** (1.31-1.70)	**1.98** (1.75-2.29)	**2.63** (2.32-3.05)	**3.16** (2.76-3.69)	**3.86** (3.27-4.66)	**4.40** (3.65-5.41)	**4.94** (4.00-6.22)	**5.49** (4.33-7.10)	**6.22** (4.71-8.39)	**6.79** (4.97-9.46)

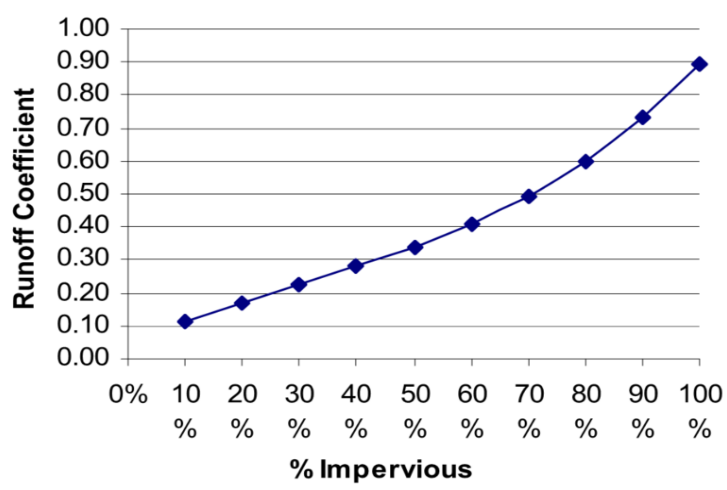


Figure 1. Impervious – Coefficient Curve (WEF/ASCE Method[1])

Aquabella Lakes, Moreno Valley, CA

A simple model for estimating the discharge of Total Phosphorous (Total P) and Total Nitrogen (Total N) from the project site during storm events

85th Percentile, 24-hour Storm Event

Site Condition	Discharge Parameters Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Existing (Agricultural Land)	0.3	0.16	1.89	0.1	1.6
Proposed w/o BMPs	1.2	0.39	3.90	1.3	12.9
Proposed w/ Std. BMPs	1.1	0.31	2.73	1.0	8.4
Proposed w/ Std. Lake	0.0	0.48	3.45	0.0	0.0
Proposed w/ Advanced Treatment Lake	0.0	0.02	0.84	0.0	0.0

10-year, 24-hour Storm Event

Site Condition	Discharge Parameters Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Existing (Agricultural Land)	1.4	0.16	1.89	0.6	7.4
Proposed w/o BMPs	5.7	0.39	3.90	6.1	60.8
Proposed w/ Std. BMPs	5.3	0.31	2.73	4.5	39.7
Proposed w/ Std. Lake	4.1	0.42	3.30	4.7	36.7
Proposed w/ Advanced Treatment Lake	4.1	0.02	1.07	0.3	11.9

50-year, 24-hour Storm Event

Site Condition	Discharge Parameters Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Existing (Agricultural Land)	2.0	0.16	1.89	0.9	10.3
Proposed w/o BMPs	8.0	0.39	3.90	8.5	84.7
Proposed w/ Std. BMPs	7.4	0.31	2.73	6.3	55.2
Proposed w/ Std. Lake	6.2	0.40	3.24	6.7	54.6
Proposed w/ Advanced Treatment Lake	6.2	0.03	1.16	0.4	19.4

100-year, 24-hour Storm Event

Site Condition	Discharge Parameters Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Existing (Agricultural Land)	2.2	0.16	1.89	1.0	11.5
Proposed w/o BMPs	9.0	0.39	3.90	9.5	95.1
Proposed w/ Std. BMPs	8.3	0.31	2.73	7.1	62.0
Proposed w/ Std. Lake	7.1	0.39	3.22	7.5	62.3
Proposed w/ Advanced Treatment Lake	7.1	0.03	1.19	0.5	22.9

Aquabella Lakes, Moreno Valley, CA

A simple model for estimating the discharge of Total Phosphorous (Total P) and Total Nitrogen (Total N) from the lake during storm events

Condition 1: Onsite Runoff

Storm	Runoff Depth (in)*	Runoff Volume (AF)	Runoff Total P* (mg/l)	Runoff Total N* (mg/l)	Runoff Total P (lbs)	Runoff Total N (lbs)
85th %ile	0.4	1.1	0.39	3.9	1	12
10 yr	1.9	5.3	0.39	3.9	6	57
50 yr	2.6	7.4	0.39	3.9	8	79
100-yr	3.0	8.3	0.39	3.9	9	89

* Notes:
Runoff depths provided by P.A.C.E.
Runoff Total P is reported mean concentration from LA County Monitoring Data for High Density Residential Land Use
Runoff Total N is sum of Nitrate-N, Nitrite-N, and TKN reported by LA County for High Density Residential Land Use

Condition 2: Lake Mixing

2a: Lake at Normal Level prior to each event

Storm	Lake Volume (AF)	Lake Total P (mg/l)*	Lake Total N (mg/l)*	Diluted Total P (mg/l)	Diluted Total N (mg/l)
85th %ile	15	0.1	1.5	0.12	1.69
10 yr	15	0.1	1.5	0.18	2.15
50 yr	15	0.1	1.5	0.20	2.31
100-yr	15	0.1	1.5	0.20	2.37

* Notes:
Lake concentrations of Total P and Total N based on Monitoring data for Bridgeport Lake, 2002-2005
Lake concentrations of Total N include only NO_3. Total N data are not available.

Condition 3: Lake Treatment

Storm	Diluted Total P (mg/l)	Diluted Total N (mg/l)	P Removal Efficiency (%)*	N Removal Efficiency (%)*	Treated Total P (mg/l)	Treated Total N (mg/l)
85th %ile	0.12	1.69	87%	50%	0.02	0.84
10 yr	0.18	2.15	87%	50%	0.02	1.07
50 yr	0.20	2.31	87%	50%	0.03	1.16
100-yr	0.20	2.37	87%	50%	0.03	1.19

* Notes
Removal efficiencies based on average efficiencies for wet ponds and wetlands based on data compiled by the multi-state Chesapeake Bay Program

Condition 4: Lake Discharge

Storm	Lake Storage Capacity (AF)	Volume of Water Discharged (AF)	Total P Discharged (mg/l)	In-lake P TMDL Goal (mg/l)*	Total N Discharged (mg/l)*	In-lake N TMDL Goal (mg/l)	Total P Disharged (Lbs)	Total N Discharged (Lbs)
85th %ile	1.25	0.0	0.02	0.1	0.84	0.75	0.0	0.0
10 yr	1.25	4.1	0.02	0.1	1.07	0.75	0.3	11.9
50 yr	1.25	6.2	0.03	0.1	1.16	0.75	0.4	19.4
100-yr	1.25	7.1	0.03	0.1	1.19	0.75	0.5	22.9

* Notes
In-lake TMDL Goals refer to pollutant concentrations within Canyon Lake and Lake Elsinore. These goals are not necessarily the same as stormwater discharge goals for Aquabella Lakes.

Condition 1: Onsite Runoff (columns in bold print represent agricultural land)

Storm	Runoff Depth (in)*	Runoff Volume (AF)	Runoff Total P* (mg/l)	Runoff Total N* (mg/l)	Runoff Total P (lbs)	Runoff Total N (lbs)	**Runoff Total P* (mg/l)**	**Runoff Total N* (mg/l)**	**Runoff Total P (lbs)**	**Runoff Total N (lbs)**
85th %ile	0.10	0.3	0.16	1.89	0	2	**3.30**	**24.20**	**2.7**	**20.0**
10 yr	0.47	1.4	0.16	1.89	1	7	**3.30**	**24.20**	**12.9**	**94.4**
50 yr	0.66	2.0	0.16	1.89	1	10	**3.30**	**24.20**	**17.9**	**131.4**
100-yr	0.74	2.2	0.16	1.89	1	12	**3.30**	**24.20**	**20.1**	**147.6**

* Notes:
Runoff depths provided by P.A.C.E.
Runoff Total P is mean concentration reported by LA County for vacant Land
Runoff Total P (in bold) is mean concentration reported by Ventura County for agricultural land
Runoff Total N is sum of Nitrate-N, Nitrite-N, and TKN reported by LA County for vacant land
Runoff Total N (IN bold) is sum of Nitrate-N, Nitrite-N, and TKN reported by Ventura County for agricultural land
Columns in bold print represent data for agricultural land

Condition 2: Lake Mixing

none

Condition 3: Lake Treatment

none

Condition 4: Site Discharge

Storm	Lake Storage Capacity (AF)	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	In-lake P TMDL Goal (mg/l)*	Total N Discharged (mg/l)*	In-lake N TMDL Goal (mg/l)	Total P Disharged (Lbs)	Total N Discharged (Lbs)	**Total P Disharged (mg/l)**	**Total N Discharged (mg/l)***	**Total P Disharged (Lbs)**	**Total N Discharged (Lbs)**
85th %ile	0	0.3	0.16	0.1	1.89	0.75	0.1	1.6	**3.30**	**24.20**	**2.73**	**20.01**
10 yr	0	1.4	0.16	0.1	1.89	0.75	0.6	7.4	**3.30**	**24.20**	**12.87**	**94.39**
50 yr	0	2.0	0.16	0.1	1.89	0.75	0.9	10.3	**3.30**	**24.20**	**17.92**	**131.43**
100-yr	0	2.2	0.16	0.1	1.89	0.75	1.0	11.5	**3.30**	**24.20**	**20.12**	**147.56**

* Notes
In-lake TMDL Goals refer to pollutant concentrations within Canyon Lake and Lake Elsinore. These goals are not necessarily the same as stormwater
Columns in bold print represent data for agricultural land

Condition 1: Onsite Runoff

Storm	Runoff Depth (in)*	Runoff Volume (AF)	Runoff Total P* (mg/l)	Runoff Total N* (mg/l)	Runoff Total P (lbs)	Runoff Total N (lbs)
85th %ile	0.4	1.1	0.39	3.9	1	12
10 yr	1.9	5.3	0.39	3.9	6	57
50 yr	2.6	7.4	0.39	3.9	8	79
100-yr	3.0	8.3	0.39	3.9	9	89

* Notes:
Runoff depths provided by P.A.C.E.
Runoff Total P is reported mean concentration from LA County Monitoring Data for High Density Residential Land Use
Runoff Total N is sum of Nitrate-N, Nitrite-N, and TKN reported by LA County for High Density Residential Land Use

Condition 2: Lake Mixing

2a: Lake at Normal Level prior to each event

Storm	Lake Volume (AF)	Lake Total P (mg/l)*	Lake Total N (mg/l)*	Diluted Total P (mg/l)	Diluted Total N (mg/l)
85th %ile	15	1	5.0	0.96	4.92
10 yr	15	1	5.0	0.84	4.71
50 yr	15	1	5.0	0.80	4.64
100-yr	15	1	5.0	0.78	4.61

* Notes:
Typical Lake concentrations of Total P and Total N
Lake concentrations of Total N include only NO_3. Total N data are not available.

Condition 3: Lake Treatment

Storm	Diluted Total P (mg/l)	Diluted Total N (mg/l)	P Removal Efficiency (%)*	N Removal Efficiency (%)*	Treated Total P (mg/l)	Treated Total N (mg/l)
85th %ile	0.96	4.92	50%	30%	0.48	3.45
10 yr	0.84	4.71	50%	30%	0.42	3.30
50 yr	0.80	4.64	50%	30%	0.40	3.24
100-yr	0.78	4.61	50%	30%	0.39	3.22

* Notes
Removal efficiencies based on average efficiencies for wet ponds and wetlands based on data compiled by the multi-state Chesapeake Bay Program

Condition 4: Lake Discharge

Storm	Lake Storage Capacity (AF)	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	In-lake P TMDL Goal (mg/l)*	Total N Discharged (mg/l)*	In-lake N TMDL Goal (mg/l)	Total P Disharged (Lbs)	Total N Discharged (Lbs)
85th %ile	1.25	0.0	0.48	0.1	3.45	0.75	0.0	0.0
10 yr	1.25	4.1	0.42	0.1	3.30	0.75	4.7	36.7
50 yr	1.25	6.2	0.40	0.1	3.24	0.75	6.7	54.6
100-yr	1.25	7.1	0.39	0.1	3.22	0.75	7.5	62.3

* Notes
In-lake TMDL Goals refer to pollutant concentrations within Canyon Lake and Lake Elsinore. These goals are not necessarily the same as stormwater discharge goals for Aquabella Lakes.

Condition 1: Onsite Runoff

Storm	Runoff Depth (in)*	Runoff Volume (AF)	Runoff Total P* (mg/l)	Runoff Total N* (mg/l)	Runoff Total P (lbs)	Runoff Total N (lbs)
85th %ile	0.4	1.2	0.39	3.9	1	13
10 yr	1.9	5.7	0.39	3.9	6	61
50 yr	2.6	8.0	0.39	3.9	8	85
100-yr	3.0	9.0	0.39	3.9	10	95

* Notes:
Runoff depths provided by P.A.C.E.
Runoff Total P is reported mean concentration from LA County Monitoring Data for High Density Residential Land Use
Runoff Total N is sum of Nitrate-N, Nitrite-N, and TKN reported by LA County for High Density Residential Land Use

Condition 2: Lake Mixing
no lake mixing

Condition 3: Lake Treatment
no treatment

Condition 4: Site Discharge

Storm	Lake Storage Capacity (AF)	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	In-lake P TMDL Goal (mg/l)*	Total N Discharged (mg/l)*	In-lake N TMDL Goal (mg/l)	Total P Disharged (Lbs)	Total N Discharged (Lbs)
85th %ile	0	1.2	0.39	0.1	3.90	0.75	1.3	12.9
10 yr	0	5.7	0.39	0.1	3.90	0.75	6.1	60.8
50 yr	0	8.0	0.39	0.1	3.90	0.75	8.5	84.7
100-yr	0	9.0	0.39	0.1	3.90	0.75	9.5	95.1

* Notes
In-lake TMDL Goals refer to pollutant concentrations within Canyon Lake and Lake Elsinore. These goals are not necessarily the same as stormwater discharge goals for Aquabella Lakes.

Condition 1: Onsite Runoff

Storm	Runoff Depth (in)*	Runoff Volume (AF)	Runoff Total P* (mg/l)	Runoff Total N* (mg/l)	Runoff Total P (lbs)	Runoff Total N (lbs)
85th %ile	0.4	1.1	0.39	3.9	1	12
10 yr	1.9	5.3	0.39	3.9	6	57
50 yr	2.6	7.4	0.39	3.9	8	79
100-yr	3.0	8.3	0.39	3.9	9	89

* Notes:
Runoff depths provided by P.A.C.E.
Runoff Total P is reported mean concentration from LA County Monitoring Data for High Density Residential Land Use
Runoff Total N is sum of Nitrate-N, Nitrite-N, and TKN reported by LA County for High Density Residential Land Use

Condition 2: Lake Mixing

no lake mixing

Condition 3: BMP Treatment

Storm	Diluted Total P (mg/l)	Diluted Total N (mg/l)	P Removal Efficiency (%)*	N Removal Efficiency (%)*	Treated Total P (mg/l)	Treated Total N (mg/l)
85th %ile	0.39	3.9	20%	30%	0.31	2.73
10 yr	0.39	3.9	20%	30%	0.31	2.73
50 yr	0.39	3.9	20%	30%	0.31	2.73
100-yr	0.39	3.9	20%	30%	0.31	2.73

* Notes
Removal efficiencies based on average efficiencies for dry extended detention basins based on data compiled by the multi-state Chesapeake Bay Program

Condition 4: Discharge

Storm	Lake Storage Capacity (AF)	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	In-lake P TMDL Goal (mg/l)*	Total N Discharged (mg/l)*	In-lake N TMDL Goal (mg/l)	Total P Disharged (Lbs)	Total N Discharged (Lbs)
85th %ile	0	1.1	0.31	0.1	2.73	0.75	1.0	8.4
10 yr	0	5.3	0.31	0.1	2.73	0.75	4.5	39.7
50 yr	0	7.4	0.31	0.1	2.73	0.75	6.3	55.2
100-yr	0	8.3	0.31	0.1	2.73	0.75	7.1	62.0

* Notes
In-lake TMDL Goals refer to pollutant concentrations within Canyon Lake and Lake Elsinore. These goals are not necessarily the same as stormwater discharge goals for Aquabella Lakes.

Runoff Calculations for Water Quality Analysis			
PROPOSED CONDITIONS			
Rainfall event	Rainfall depth (inches)	Runoff coefficient	Runoff depth (inches)
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Runoff coefficients are from the Riverside County Stormwater Quality Best Management Practices Design Manual, Figure 1, based on a proposed conditions impervious cover of 80%, and existing conditions impervious cover of 15%.

Riverside County LID BMP Design Handbook
85th%, 24-hr Rainfall Depth= 0.67 inches
(from Isohyetal Map Appdx. E)

3/31/23, 2:06 PM Precipitation Frequency Data Server

NOAA Atlas 14, Volume 6, Version 2
Location name: Moreno Valley, California, USA*
Latitude: 33.905°, Longitude: -117.1988°
Elevation: m/ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

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

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.091 (0.076-0.110)	0.124 (0.104-0.151)	0.169 (0.140-0.205)	0.205 (0.169-0.252)	0.256 (0.204-0.325)	0.295 (0.230-0.383)	0.336 (0.255-0.446)	0.378 (0.279-0.517)	0.436 (0.308-0.623)	0.482 (0.329-0.714)
10-min	0.130 (0.109-0.158)	0.178 (0.149-0.216)	0.242 (0.201-0.294)	0.294 (0.243-0.361)	0.367 (0.292-0.465)	0.423 (0.330-0.549)	0.481 (0.365-0.640)	0.542 (0.400-0.742)	0.625 (0.442-0.894)	0.691 (0.471-1.02)
15-min	0.158 (0.132-0.191)	0.216 (0.180-0.261)	0.293 (0.243-0.356)	0.356 (0.293-0.436)	0.443 (0.353-0.563)	0.512 (0.399-0.663)	0.582 (0.442-0.774)	0.655 (0.483-0.897)	0.756 (0.534-1.08)	0.835 (0.570-1.24)
30-min	0.252 (0.210-0.305)	0.345 (0.287-0.418)	0.468 (0.389-0.568)	0.569 (0.469-0.697)	0.709 (0.564-0.899)	0.817 (0.637-1.06)	0.930 (0.706-1.24)	1.05 (0.772-1.43)	1.21 (0.853-1.73)	1.34 (0.910-1.98)
60-min	0.350 (0.292-0.424)	0.479 (0.399-0.580)	0.650 (0.540-0.789)	0.790 (0.651-0.969)	0.984 (0.784-1.25)	1.14 (0.885-1.47)	1.29 (0.981-1.72)	1.45 (1.07-1.99)	1.68 (1.19-2.40)	1.86 (1.26-2.75)
2-hr	0.522 (0.436-0.632)	0.687 (0.573-0.833)	0.905 (0.752-1.10)	1.08 (0.893-1.33)	1.33 (1.06-1.68)	1.52 (1.18-1.97)	1.71 (1.30-2.27)	1.91 (1.41-2.61)	2.18 (1.54-3.12)	2.39 (1.63-3.55)
3-hr	0.649 (0.542-0.785)	0.844 (0.703-1.02)	1.10 (0.914-1.34)	1.31 (1.08-1.60)	1.59 (1.27-2.02)	1.81 (1.41-2.35)	2.04 (1.55-2.71)	2.27 (1.67-3.11)	2.58 (1.82-3.69)	2.83 (1.93-4.19)
6-hr	0.910 (0.760-1.10)	1.17 (0.979-1.42)	1.52 (1.26-1.85)	1.80 (1.48-2.21)	2.18 (1.74-2.77)	2.47 (1.93-3.21)	2.77 (2.10-3.68)	3.07 (2.27-4.20)	3.48 (2.46-4.98)	3.80 (2.59-5.63)
12-hr	1.17 (0.974-1.41)	1.53 (1.27-1.85)	2.00 (1.66-2.42)	2.37 (1.96-2.91)	2.89 (2.30-3.66)	3.27 (2.55-4.25)	3.67 (2.78-4.88)	4.07 (3.00-5.57)	4.61 (3.25-6.58)	5.02 (3.42-7.44)
24-hr	1.48 (1.31-1.70)	1.98 (1.75-2.29)	2.63 (2.32-3.05)	3.16 (2.76-3.69)	3.86 (3.27-4.66)	4.40 (3.65-5.41)	4.94 (4.00-6.22)	5.49 (4.33-7.10)	6.22 (4.71-8.39)	6.79 (4.97-9.46)

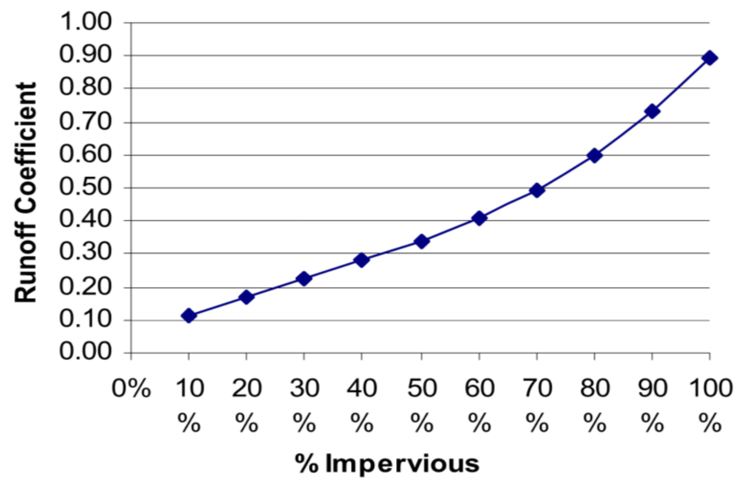

Figure 1. Impervious – Coefficient Curve (WEF/ASCE Method[1])

Aquabella Lakes, Moreno Valley, CA

A simple model for estimating the discharge of Total Phosphorous (Total P) and Total Nitrogen (Total N) from the project site during storm events

85th Percentile, 24-hour Storm Event

	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Existing (Agricultural Land)	0.3	0.16	1.89	0.1	1.4
Proposed w/o BMPs	1.1	0.39	3.90	1.2	11.7
Proposed w/ Std. BMPs	1.0	0.31	2.73	0.9	7.5
Proposed w/ Std. Lake	0.0	0.48	3.45	0.0	0.0
Proposed w/ Advanced Treatment Lake	0.0	0.02	0.84	0.0	0.0

10-year, 24-hour Storm Event

	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Existing (Agricultural Land)	1.3	0.16	1.89	0.6	6.7
Proposed w/o BMPs	5.2	0.39	3.90	5.5	55.0
Proposed w/ Std. BMPs	4.8	0.31	2.73	4.1	35.6
Proposed w/ Std. Lake	3.5	0.43	3.31	4.1	31.9
Proposed w/ Advanced Treatment Lake	3.5	0.02	1.05	0.2	10.1

50-year, 24-hour Storm Event

	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Existing (Agricultural Land)	1.8	0.16	1.89	0.8	9.3
Proposed w/o BMPs	7.2	0.39	3.90	7.7	76.6
Proposed w/ Std. BMPs	6.7	0.31	2.73	5.7	49.5
Proposed w/ Std. Lake	5.4	0.41	3.26	6.0	48.1
Proposed w/ Advanced Treatment Lake	5.4	0.02	1.13	0.4	16.6

100-year, 24-hour Storm Event

	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Existing (Agricultural Land)	2.0	0.16	1.89	0.9	10.4
Proposed w/o BMPs	8.1	0.39	3.90	8.6	85.9
Proposed w/ Std. BMPs	7.5	0.31	2.73	6.4	55.6
Proposed w/ Std. Lake	6.2	0.40	3.24	6.8	55.0
Proposed w/ Advanced Treatment Lake	6.2	0.03	1.16	0.4	19.6

Aquabella Lakes, Moreno Valley, CA

A simple model for estimating the discharge of Total Phosphorous (Total P) and Total Nitrogen (Total N) from the lake during storm events

Condition 1: Onsite Runoff

Storm	Runoff Depth (in)*	Runoff Volume (AF)	Runoff Total P* (mg/l)	Runoff Total N* (mg/l)	Runoff Total P (lbs)	Runoff Total N (lbs)
85th %ile	0.4	1.0	0.39	3.9	1	11
10 yr	1.9	4.8	0.39	3.9	5	51
50 yr	2.6	6.7	0.39	3.9	7	71
100-yr	3.0	7.5	0.39	3.9	8	79

* Notes:
Runoff depths provided by P.A.C.E.
Runoff Total P is reported mean concentration from LA County Monitoring Data for High Density Residential Land Use
Runoff Total N is sum of Nitrate-N, Nitrite-N, and TKN reported by LA County for High Density Residential Land Use

Condition 2: Lake Mixing

2a: Lake at Normal Level prior to each event

Storm	Lake Volume (AF)	Lake Total P (mg/l)*	Lake Total N (mg/l)*	Diluted Total P (mg/l)	Diluted Total N (mg/l)
85th %ile	15	0.1	1.5	0.12	1.67
10 yr	15	0.1	1.5	0.17	2.10
50 yr	15	0.1	1.5	0.19	2.25
100-yr	15	0.1	1.5	0.20	2.31

* Notes:
Lake concentrations of Total P and Total N based on Monitoring data for Bridgeport Lake, 2002-2005
Lake concentrations of Total N include only NO_3. Total N data are not available.

Condition 3: Lake Treatment

Storm	Diluted Total P (mg/l)	Diluted Total N (mg/l)	P Removal Efficiency (%)*	N Removal Efficiency (%)*	Treated Total P (mg/l)	Treated Total N (mg/l)
85th %ile	0.12	1.67	87%	50%	0.02	0.84
10 yr	0.17	2.10	87%	50%	0.02	1.05
50 yr	0.19	2.25	87%	50%	0.02	1.13
100-yr	0.20	2.31	87%	50%	0.03	1.16

* Notes
Removal efficiencies based on average efficiencies for wet ponds and wetlands based on data compiled by the multi-state Chesapeake Bay Program

Condition 4: Lake Discharge

Storm	Lake Storage Capacity (AF)	Volume of Water Discharged (AF)	Total P Discharged (mg/l)	In-lake P TMDL Goal (mg/l)*	Total N Discharged (mg/l)*	In-lake N TMDL Goal (mg/l)	Total P Disharged (Lbs)	Total N Discharged (Lbs)
85th %ile	1.25	0.0	0.02	0.1	0.84	0.75	0.0	0.0
10 yr	1.25	3.5	0.02	0.1	1.05	0.75	0.2	10.1
50 yr	1.25	5.4	0.02	0.1	1.13	0.75	0.4	16.6
100-yr	1.25	6.2	0.03	0.1	1.16	0.75	0.4	19.6

* Notes
In-lake TMDL Goals refer to pollutant concentrations within Canyon Lake and Lake Elsinore. These goals are not necessarily the same as stormwater discharge goals for Aquabella Lakes.

Condition 1: Onsite Runoff (columns in bold print represent agricultural land)

Storm	Runoff Depth (in)*	Runoff Volume (AF)	Runoff Total P* (mg/l)	Runoff Total N* (mg/l)	Runoff Total P (lbs)	Runoff Total N (lbs)	**Runoff Total P* (mg/l)**	**Runoff Total N* (mg/l)**	**Runoff Total P (lbs)**	**Runoff Total N (lbs)**
85th %ile	0.10	0.3	0.16	1.89	0	1	**3.30**	**24.20**	**2.5**	**18.1**
10 yr	0.47	1.3	0.16	1.89	1	7	**3.30**	**24.20**	**11.6**	**85.3**
50 yr	0.66	1.8	0.16	1.89	1	9	**3.30**	**24.20**	**16.2**	**118.8**
100-yr	0.74	2.0	0.16	1.89	1	10	**3.30**	**24.20**	**18.2**	**133.3**

* Notes:
Runoff depths provided by P.A.C.E.
Runoff Total P is mean concentration reported by LA County for vacant Land
Runoff Total P (in bold) is mean concentration reported by Ventura County for agricultural land
Runoff Total N is sum of Nitrate-N, Nitrite-N, and TKN reported by LA County for vacant land
Runoff Total N (IN bold) is sum of Nitrate-N, Nitrite-N, and TKN reported by Ventura County for agricultural land
Columns in bold print represent data for agricultural land

Condition 2: Lake Mixing

none

Condition 3: Lake Treatment

none

Condition 4: Site Discharge

Storm	Lake Storage Capacity (AF)	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	In-lake P TMDL Goal (mg/l)*	Total N Discharged (mg/l)*	In-lake N TMDL Goal (mg/l)	Total P Disharged (Lbs)	Total N Discharged (Lbs)	**Total P Disharged (mg/l)**	**Total N Discharged (mg/l)***	**Total P Disharged (Lbs)**	**Total N Discharged (Lbs)**
85th %ile	0	0.3	0.16	0.1	1.89	0.75	0.1	1.4	**3.30**	**24.20**	**2.47**	**18.08**
10 yr	0	1.3	0.16	0.1	1.89	0.75	0.6	6.7	**3.30**	**24.20**	**11.63**	**85.29**
50 yr	0	1.8	0.16	0.1	1.89	0.75	0.8	9.3	**3.30**	**24.20**	**16.19**	**118.75**
100-yr	0	2.0	0.16	0.1	1.89	0.75	0.9	10.4	**3.30**	**24.20**	**18.18**	**133.33**

* Notes
In-lake TMDL Goals refer to pollutant concentrations within Canyon Lake and Lake Elsinore. These goals are not necessarily the same as stormwater
Columns in bold print represent data for agricultural land

Condition 1: Onsite Runoff

Storm	Runoff Depth (in)*	Runoff Volume (AF)	Runoff Total P* (mg/l)	Runoff Total N* (mg/l)	Runoff Total P (lbs)	Runoff Total N (lbs)
85th %ile	0.4	1.0	0.39	3.9	1	11
10 yr	1.9	4.8	0.39	3.9	5	51
50 yr	2.6	6.7	0.39	3.9	7	71
100-yr	3.0	7.5	0.39	3.9	8	79

* Notes:
Runoff depths provided by P.A.C.E.
Runoff Total P is reported mean concentration from LA County Monitoring Data for High Density Residential Land Use
Runoff Total N is sum of Nitrate-N, Nitrite-N, and TKN reported by LA County for High Density Residential Land Use

Condition 2: Lake Mixing

2a: Lake at Normal Level prior to each event

Storm	Lake Volume (AF)	Lake Total P (mg/l)*	Lake Total N (mg/l)*	Diluted Total P (mg/l)	Diluted Total N (mg/l)
85th %ile	15	1	5.0	0.96	4.93
10 yr	15	1	5.0	0.85	4.73
50 yr	15	1	5.0	0.81	4.66
100-yr	15	1	5.0	0.80	4.63

* Notes:
Typical Lake concentrations of Total P and Total N
Lake concentrations of Total N include only NO_3. Total N data are not available.

Condition 3: Lake Treatment

Storm	Diluted Total P (mg/l)	Diluted Total N (mg/l)	P Removal Efficiency (%)*	N Removal Efficiency (%)*	Treated Total P (mg/l)	Treated Total N (mg/l)
85th %ile	0.96	4.93	50%	30%	0.48	3.45
10 yr	0.85	4.73	50%	30%	0.43	3.31
50 yr	0.81	4.66	50%	30%	0.41	3.26
100-yr	0.80	4.63	50%	30%	0.40	3.24

* Notes
Removal efficiencies based on average efficiencies for wet ponds and wetlands based on data compiled by the multi-state Chesapeake Bay Program

Condition 4: Lake Discharge

Storm	Lake Storage Capacity (AF)	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	In-lake P TMDL Goal (mg/l)*	Total N Discharged (mg/l)*	In-lake N TMDL Goal (mg/l)	Total P Disharged (Lbs)	Total N Discharged (Lbs)
85th %ile	1.25	0.0	0.48	0.1	3.45	0.75	0.0	0.0
10 yr	1.25	3.5	0.43	0.1	3.31	0.75	4.1	31.9
50 yr	1.25	5.4	0.41	0.1	3.26	0.75	6.0	48.1
100-yr	1.25	6.2	0.40	0.1	3.24	0.75	6.8	55.0

* Notes
In-lake TMDL Goals refer to pollutant concentrations within Canyon Lake and Lake Elsinore. These goals are not necessarily the same as stormwater discharge goals for Aquabella Lakes.

Condition 1: Onsite Runoff

Storm	Runoff Depth (in)*	Runoff Volume (AF)	Runoff Total P* (mg/l)	Runoff Total N* (mg/l)	Runoff Total P (lbs)	Runoff Total N (lbs)
85th %ile	0.4	1.1	0.39	3.9	1	12
10 yr	1.9	5.2	0.39	3.9	5	55
50 yr	2.6	7.2	0.39	3.9	8	77
100-yr	3.0	8.1	0.39	3.9	9	86

* Notes:
Runoff depths provided by P.A.C.E.
Runoff Total P is reported mean concentration from LA County Monitoring Data for High Density Residential Land Use
Runoff Total N is sum of Nitrate-N, Nitrite-N, and TKN reported by LA County for High Density Residential Land Use

Condition 2: Lake Mixing

no lake mixing

Condition 3: Lake Treatment

no treatment

Condition 4: Site Discharge

Storm	Lake Storage Capacity (AF)	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	In-lake P TMDL Goal (mg/l)*	Total N Discharged (mg/l)*	In-lake N TMDL Goal (mg/l)	Total P Disharged (Lbs)	Total N Discharged (Lbs)
85th %ile	0	1.1	0.39	0.1	3.90	0.75	1.2	11.7
10 yr	0	5.2	0.39	0.1	3.90	0.75	5.5	55.0
50 yr	0	7.2	0.39	0.1	3.90	0.75	7.7	76.6
100-yr	0	8.1	0.39	0.1	3.90	0.75	8.6	85.9

* Notes
In-lake TMDL Goals refer to pollutant concentrations within Canyon Lake and Lake Elsinore. These goals are not necessarily the same as stormwater discharge goals for Aquabella Lakes.

Condition 1: Onsite Runoff

Storm	Runoff Depth (in)*	Runoff Volume (AF)	Runoff Total P* (mg/l)	Runoff Total N* (mg/l)	Runoff Total P (lbs)	Runoff Total N (lbs)
85th %ile	0.4	1.0	0.39	3.9	1	11
10 yr	1.9	4.8	0.39	3.9	5	51
50 yr	2.6	6.7	0.39	3.9	7	71
100-yr	3.0	7.5	0.39	3.9	8	79

* Notes:
Runoff depths provided by P.A.C.E.
Runoff Total P is reported mean concentration from LA County Monitoring Data for High Density Residential Land Use
Runoff Total N is sum of Nitrate-N, Nitrite-N, and TKN reported by LA County for High Density Residential Land Use

Condition 2: Lake Mixing
no lake mixing

Condition 3: BMP Treatment

Storm	Diluted Total P (mg/l)	Diluted Total N (mg/l)	P Removal Efficiency (%)*	N Removal Efficiency (%)*	Treated Total P (mg/l)	Treated Total N (mg/l)
85th %ile	0.39	3.9	20%	30%	0.31	2.73
10 yr	0.39	3.9	20%	30%	0.31	2.73
50 yr	0.39	3.9	20%	30%	0.31	2.73
100-yr	0.39	3.9	20%	30%	0.31	2.73

* Notes
Removal efficiencies based on average efficiencies for dry extended detention basins based on data compiled by the multi-state Chesapeake Bay Program

Condition 4: Discharge

Storm	Lake Storage Capacity (AF)	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	In-lake P TMDL Goal (mg/l)*	Total N Discharged (mg/l)*	In-lake N TMDL Goal (mg/l)	Total P Disharged (Lbs)	Total N Discharged (Lbs)
85th %ile	0	1.0	0.31	0.1	2.73	0.75	0.9	7.5
10 yr	0	4.8	0.31	0.1	2.73	0.75	4.1	35.6
50 yr	0	6.7	0.31	0.1	2.73	0.75	5.7	49.5
100-yr	0	7.5	0.31	0.1	2.73	0.75	6.4	55.6

* Notes
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Runoff Calculations for Water Quality Analysis			
PROPOSED CONDITIONS			
Rainfall event	Rainfall depth (inches)	Runoff coefficient	Runoff depth (inches)
85th %ile Storm	0.67	0.60	0.40
10-year, 24-hour storm	3.16	0.60	1.90
50-year, 24-hour storm	4.4	0.60	2.64
100-year, 24-hour storm	4.94	0.60	2.96
EXISTING CONDITIONS			
Rainfall event	Rainfall depth (inches)	Runoff coefficient	Runoff depth (inches)
85th %ile Storm	0.67	0.15	0.10
10-year, 24-hour storm	3.16	0.15	0.47
50-year, 24-hour storm	4.4	0.15	0.66
100-year, 24-hour storm	4.94	0.15	0.74

Runoff coefficients are from the Riverside County Stormwater Quality Best Management Practices Design Manual, Figure 1, based on a proposed conditions impervious cover of 80%, and existing conditions impervious cover of 15%.

Riverside County LID BMP Design Handbook
85th%, 24-hr Rainfall Depth= 0.67 inches
(from Isohyetal Map Appdx. E)

3/31/23, 2:06 PM Precipitation Frequency Data Server

NOAA Atlas 14, Volume 6, Version 2
Location name: Moreno Valley, California, USA*
Latitude: 33.905°, Longitude: -117.1988°
Elevation: m/ft**
* source: ESRI Maps
** source: USGS

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10-min	0.130 (0.109-0.158)	0.178 (0.149-0.216)	0.242 (0.201-0.294)	0.294 (0.243-0.361)	0.367 (0.292-0.465)	0.423 (0.330-0.549)	0.481 (0.365-0.640)	0.542 (0.400-0.742)	0.625 (0.442-0.894)	0.691 (0.471-1.02)
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30-min	0.252 (0.210-0.305)	0.345 (0.287-0.418)	0.468 (0.389-0.568)	0.569 (0.469-0.697)	0.709 (0.564-0.899)	0.817 (0.637-1.06)	0.930 (0.706-1.24)	1.05 (0.772-1.43)	1.21 (0.853-1.73)	1.34 (0.910-1.98)
60-min	0.350 (0.292-0.424)	0.479 (0.399-0.580)	0.650 (0.540-0.789)	0.790 (0.651-0.969)	0.984 (0.784-1.25)	1.14 (0.885-1.47)	1.29 (0.981-1.72)	1.45 (1.07-1.99)	1.68 (1.19-2.40)	1.86 (1.26-2.75)
2-hr	0.522 (0.436-0.632)	0.687 (0.573-0.833)	0.905 (0.752-1.10)	1.08 (0.893-1.33)	1.33 (1.06-1.68)	1.52 (1.18-1.97)	1.71 (1.30-2.27)	1.91 (1.41-2.61)	2.18 (1.54-3.12)	2.39 (1.63-3.55)
3-hr	0.649 (0.542-0.785)	0.844 (0.703-1.02)	1.10 (0.914-1.34)	1.31 (1.08-1.60)	1.59 (1.27-2.02)	1.81 (1.41-2.35)	2.04 (1.55-2.71)	2.27 (1.67-3.11)	2.58 (1.82-3.69)	2.83 (1.93-4.19)
6-hr	0.910 (0.760-1.10)	1.17 (0.979-1.42)	1.52 (1.26-1.85)	1.80 (1.48-2.21)	2.18 (1.74-2.77)	2.47 (1.93-3.21)	2.77 (2.10-3.68)	3.07 (2.27-4.20)	3.48 (2.46-4.98)	3.80 (2.59-5.63)
12-hr	1.17 (0.974-1.41)	1.53 (1.27-1.85)	2.00 (1.66-2.42)	2.37 (1.96-2.91)	2.89 (2.30-3.66)	3.27 (2.55-4.25)	3.67 (2.78-4.88)	4.07 (3.00-5.57)	4.61 (3.25-6.58)	5.02 (3.42-7.44)
24-hr	1.48 (1.31-1.70)	1.98 (1.75-2.29)	2.63 (2.32-3.05)	3.16 (2.76-3.69)	3.86 (3.27-4.66)	4.40 (3.65-5.41)	4.94 (4.00-6.22)	5.49 (4.33-7.10)	6.22 (4.71-8.39)	6.79 (4.97-9.46)

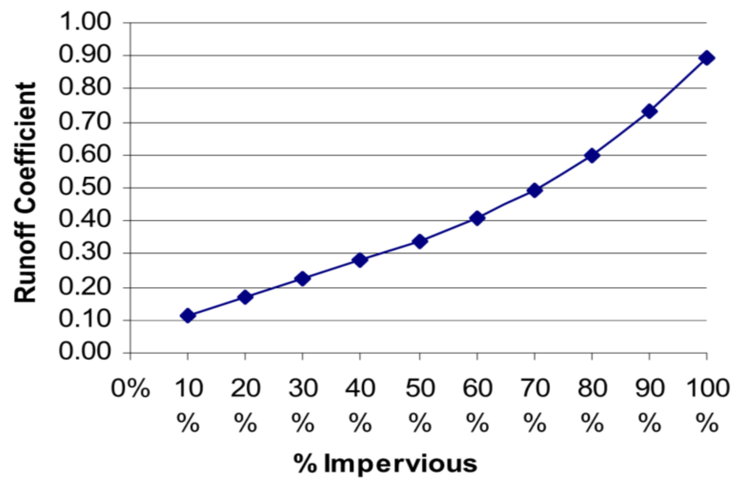

Figure 1. Impervious – Coefficient Curve (WEF/ASCE Method[1])

Aquabella Lakes, Moreno Valley, CA

A simple model for estimating the discharge of Total Phosphorous (Total P) and Total Nitrogen (Total N) from the project site during storm events

85th Percentile, 24-hour Storm Event

Site Condition	Discharge Parameters Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Existing (Agricultural Land)	0.6	0.16	1.89	0.3	3.0
Proposed w/o BMPs	2.4	0.39	3.90	2.5	24.9
Proposed w/ Std. BMPs	2.2	0.31	2.73	1.9	16.2
Proposed w/ Std. Lake	0.0	0.48	3.45	0.0	0.0
Proposed w/ Advanced Treatment Lake	0.0	0.02	0.84	0.0	0.0

10-year, 24-hour Storm Event

Site Condition	Discharge Parameters Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Existing (Agricultural Land)	2.8	0.16	1.89	1.2	14.3
Proposed w/o BMPs	11.1	0.39	3.90	11.8	117.7
Proposed w/ Std. BMPs	10.3	0.31	2.73	8.7	76.5
Proposed w/ Std. Lake	7.8	0.42	3.30	9.0	70.1
Proposed w/ Advanced Treatment Lake	7.8	0.02	1.06	0.5	22.6

50-year, 24-hour Storm Event

Site Condition	Discharge Parameters Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Existing (Agricultural Land)	3.9	0.16	1.89	1.7	19.8
Proposed w/o BMPs	15.4	0.39	3.90	16.4	163.8
Proposed w/ Std. BMPs	14.3	0.31	2.73	12.2	106.5
Proposed w/ Std. Lake	11.8	0.40	3.25	12.9	104.7
Proposed w/ Advanced Treatment Lake	11.8	0.03	1.15	0.8	36.9

100-year, 24-hour Storm Event

Site Condition	Discharge Parameters Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Existing (Agricultural Land)	4.3	0.16	1.89	1.9	22.3
Proposed w/o BMPs	17.3	0.39	3.90	18.4	183.9
Proposed w/ Std. BMPs	16.1	0.31	2.73	13.7	119.6
Proposed w/ Std. Lake	13.6	0.39	3.23	14.6	119.6
Proposed w/ Advanced Treatment Lake	13.6	0.03	1.18	1.0	43.5

Aquabella Lakes, Moreno Valley, CA

A simple model for estimating the discharge of Total Phosphorous (Total P) and Total Nitrogen (Total N) from the lake during storm events

85th Percentile, 24-hour Storm Event

Storm	Runoff Depth (in)*	Runoff Volume (AF)	Runoff Total P* (mg/l)	Runoff Total N* (mg/l)	Runoff Total P (lbs)	Runoff Total N (lbs)
85th %ile	0.4	2.2	0.39	3.9	2	23
10 yr	1.9	10.3	0.39	3.9	11	109
50 yr	2.6	14.3	0.39	3.9	15	152
100-yr	3.0	16.1	0.39	3.9	17	171

* Notes:
Runoff depths provided by P.A.C.E.
Runoff Total P is reported mean concentration from LA County Monitoring Data for High Density Residential Land Use
Runoff Total N is sum of Nitrate-N, Nitrite-N, and TKN reported by LA County for High Density Residential Land Use

Condition 2: Lake Mixing

2a: Lake at Normal Level prior to each event

Storm	Lake Volume (AF)	Lake Total P (mg/l)*	Lake Total N (mg/l)*	Diluted Total P (mg/l)	Diluted Total N (mg/l)
85th %ile	30	0.1	1.5	0.12	1.68
10 yr	30	0.1	1.5	0.17	2.13
50 yr	30	0.1	1.5	0.19	2.29
100-yr	30	0.1	1.5	0.20	2.35

* Notes:
Lake concentrations of Total P and Total N based on Monitoring data for Bridgeport Lake, 2002-2005
Lake concentrations of Total N include only NO_3. Total N data are not available.

Condition 3: Lake Treatment

Storm	Diluted Total P (mg/l)	Diluted Total N (mg/l)	P Removal Efficiency (%)*	N Removal Efficiency (%)*	Treated Total P (mg/l)	Treated Total N (mg/l)
85th %ile	0.12	1.68	87%	50%	0.02	0.84
10 yr	0.17	2.13	87%	50%	0.02	1.06
50 yr	0.19	2.29	87%	50%	0.03	1.15
100-yr	0.20	2.35	87%	50%	0.03	1.18

* Notes
Removal efficiencies based on average efficiencies for wet ponds and wetlands based on data compiled by the multi-state Chesapeake Bay Program

Condition 4: Lake Discharge

Storm	Lake Storage Capacity (AF)	Volume of Water Discharged (AF)	Total P Discharged (mg/l)	In-lake P TMDL Goal (mg/l)*	Total N Discharged (mg/l)*	In-lake N TMDL Goal (mg/l)	Total P Disharged (Lbs)	Total N Discharged (Lbs)
85th %ile	2.5	0.0	0.02	0.1	0.84	0.75	0.0	0.0
10 yr	2.5	7.8	0.02	0.1	1.06	0.75	0.5	22.6
50 yr	2.5	11.8	0.03	0.1	1.15	0.75	0.8	36.9
100-yr	2.5	13.6	0.03	0.1	1.18	0.75	1.0	43.5

* Notes
In-lake TMDL Goals refer to pollutant concentrations within Canyon Lake and Lake Elsinore. These goals are not necessarily the same as stormwater discharge goals for Aquabella Lakes.

Condition 1: Onsite Runoff (columns in bold print represent agricultural land)

85th Percentile, 24-hour Storm Event

Storm	Runoff Depth (in)*	Runoff Volume (AF)	Runoff Total P* (mg/l)	Runoff Total N* (mg/l)	Runoff Total P (lbs)	Runoff Total N (lbs)	**Runoff Total P* (mg/l)**	**Runoff Total N* (mg/l)**	**Runoff Total P (lbs)**	**Runoff Total N (lbs)**
85th %ile	0.10	0.6	0.16	1.89	0	3	**3.30**	**24.20**	**5.3**	**38.7**
10 yr	0.47	2.8	0.16	1.89	1	14	**3.30**	**24.20**	**24.9**	**182.5**
50 yr	0.66	3.9	0.16	1.89	2	20	**3.30**	**24.20**	**34.7**	**254.2**
100-yr	0.74	4.3	0.16	1.89	2	22	**3.30**	**24.20**	**38.9**	**285.4**

* Notes:
Runoff depths provided by P.A.C.E.
Runoff Total P is mean concentration reported by LA County for vacant Land
Runoff Total P (in bold) is mean concentration reported by Ventura County for agricultural land
Runoff Total N is sum of Nitrate-N, Nitrite-N, and TKN reported by LA County for vacant land
Runoff Total N (IN bold) is sum of Nitrate-N, Nitrite-N, and TKN reported by Ventura County for agricultural land
Columns in bold print represent data for agricultural land

Condition 2: Lake Mixing
none

Condition 3: Lake Treatment
none

Condition 4: Site Discharge

Storm	Lake Storage Capacity (AF)	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	In-lake P TMDL Goal (mg/l)*	Total N Discharged (mg/l)*	In-lake N TMDL Goal (mg/l)	Total P Disharged (Lbs)	Total N Discharged (Lbs)	**Total P Disharged (mg/l)**	**Total N Discharged (mg/l)***	**Total P Disharged (Lbs)**	**Total N Discharged (Lbs)**
85th %ile	0	0.6	0.16	0.1	1.89	0.75	0.3	3.0	**3.30**	**24.20**	**5.28**	**38.70**
10 yr	0	2.8	0.16	0.1	1.89	0.75	1.2	14.3	**3.30**	**24.20**	**24.89**	**182.54**
50 yr	0	3.9	0.16	0.1	1.89	0.75	1.7	19.8	**3.30**	**24.20**	**34.66**	**254.16**
100-yr	0	4.3	0.16	0.1	1.89	0.75	1.9	22.3	**3.30**	**24.20**	**38.91**	**285.36**

* Notes
In-lake TMDL Goals refer to pollutant concentrations within Canyon Lake and Lake Elsinore. These goals are not necessarily the same as stormwater
Columns in bold print represent data for agricultural land

Condition 1: Onsite Runoff

Storm	Runoff Depth (in)*	Runoff Volume (AF)	Runoff Total P* (mg/l)	Runoff Total N* (mg/l)	Runoff Total P (lbs)	Runoff Total N (lbs)
85th Perce	0.4	2.2	0.39	3.9	2	23
10 yr	1.9	10.3	0.39	3.9	11	109
50 yr	2.6	14.3	0.39	3.9	15	152
100-yr	3.0	16.1	0.39	3.9	17	171

* Notes:
Runoff depths provided by P.A.C.E.
Runoff Total P is reported mean concentration from LA County Monitoring Data for High Density Residential Land Use
Runoff Total N is sum of Nitrate-N, Nitrite-N, and TKN reported by LA County for High Density Residential Land Use

Condition 2: Lake Mixing

2a: Lake at Normal Level prior to each event

Storm	Lake Volume (AF)	Lake Total P (mg/l)*	Lake Total N (mg/l)*	Diluted Total P (mg/l)	Diluted Total N (mg/l)
85th %ile	30	1	5.0	0.96	4.93
10 yr	30	1	5.0	0.84	4.72
50 yr	30	1	5.0	0.80	4.64
100-yr	30	1	5.0	0.79	4.62

* Notes:
Typical Lake concentrations of Total P and Total N
Lake concentrations of Total N include only NO_3. Total N data are not available.

Condition 3: Lake Treatment

Storm	Diluted Total P (mg/l)	Diluted Total N (mg/l)	P Removal Efficiency (%)*	N Removal Efficiency (%)*	Treated Total P (mg/l)	Treated Total N (mg/l)
85th %ile	0.96	4.93	50%	30%	0.48	3.45
10 yr	0.84	4.72	50%	30%	0.42	3.30
50 yr	0.80	4.64	50%	30%	0.40	3.25
100-yr	0.79	4.62	50%	30%	0.39	3.23

* Notes
Removal efficiencies based on average efficiencies for wet ponds and wetlands based on data compiled by the multi-state Chesapeake Bay Program

Condition 4: Lake Discharge

Storm	Lake Storage Capacity (AF)	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	In-lake P TMDL Goal (mg/l)*	Total N Discharged (mg/l)*	In-lake N TMDL Goal (mg/l)	Total P Disharged (Lbs)	Total N Discharged (Lbs)
85th %ile	2.5	0.0	0.48	0.1	3.45	0.75	0.0	0.0
10 yr	2.5	7.8	0.42	0.1	3.30	0.75	9.0	70.1
50 yr	2.5	11.8	0.40	0.1	3.25	0.75	12.9	104.7
100-yr	2.5	13.6	0.39	0.1	3.23	0.75	14.6	119.6

* Notes
In-lake TMDL Goals refer to pollutant concentrations within Canyon Lake and Lake Elsinore. These goals are not necessarily the same as stormwater discharge goals for Aquabella Lakes.

Condition 1: Onsite Runoff

Storm	Runoff Depth (in)*	Runoff Volume (AF)	Runoff Total P* (mg/l)	Runoff Total N* (mg/l)	Runoff Total P (lbs)	Runoff Total N (lbs)
85th Perce	0.4	2.4	0.39	3.9	2	25
10 yr	1.9	11.1	0.39	3.9	12	118
50 yr	2.6	15.4	0.39	3.9	16	164
100-yr	3.0	17.3	0.39	3.9	18	184

* Notes:
Runoff depths provided by P.A.C.E.
Runoff Total P is reported mean concentration from LA County Monitoring Data for High Density Residential Land Use
Runoff Total N is sum of Nitrate-N, Nitrite-N, and TKN reported by LA County for High Density Residential Land Use

Condition 2: Lake Mixing
no lake mixing

Condition 3: Lake Treatment
no treatment

Condition 4: Site Discharge

Storm	Lake Storage Capacity (AF)	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	In-lake P TMDL Goal (mg/l)*	Total N Discharged (mg/l)*	In-lake N TMDL Goal (mg/l)	Total P Disharged (Lbs)	Total N Discharged (Lbs)
85th %ile	0	2.4	0.39	0.1	3.90	0.75	2.5	24.9
10 yr	0	11.1	0.39	0.1	3.90	0.75	11.8	117.7
50 yr	0	15.4	0.39	0.1	3.90	0.75	16.4	163.8
100-yr	0	17.3	0.39	0.1	3.90	0.75	18.4	183.9

* Notes
In-lake TMDL Goals refer to pollutant concentrations within Canyon Lake and Lake Elsinore. These goals are not necessarily the same as stormwater discharge goals for Aquabella Lakes.

Condition 1: Onsite Runoff

Storm	Runoff Depth (in)*	Runoff Volume (AF)	Runoff Total P* (mg/l)	Runoff Total N* (mg/l)	Runoff Total P (lbs)	Runoff Total N (lbs)
85th Perce	0.4	2.2	0.39	3.9	2	23
10 yr	1.9	10.3	0.39	3.9	11	109
50 yr	2.6	14.3	0.39	3.9	15	152
100-yr	3.0	16.1	0.39	3.9	17	171

* Notes:
Runoff depths provided by P.A.C.E.
Runoff Total P is reported mean concentration from LA County Monitoring Data for High Density Residential Land Use
Runoff Total N is sum of Nitrate-N, Nitrite-N, and TKN reported by LA County for High Density Residential Land Use

Condition 2: Lake Mixing
no lake mixing

Condition 3: BMP Treatment

Storm	Diluted Total P (mg/l)	Diluted Total N (mg/l)	P Removal Efficiency (%)*	N Removal Efficiency (%)*	Treated Total P (mg/l)	Treated Total N (mg/l)
85th %ile	0.39	3.9	20%	30%	0.31	2.73
10 yr	0.39	3.9	20%	30%	0.31	2.73
50 yr	0.39	3.9	20%	30%	0.31	2.73
100-yr	0.39	3.9	20%	30%	0.31	2.73

* Notes
Removal efficiencies based on average efficiencies for dry extended detention basins based on data compiled by the multi-state Chesapeake Bay Program

Condition 4: Discharge

Storm	Lake Storage Capacity (AF)	Volume of Water Discharge d (AF)	Total P Disharge d (mg/l)	In-lake P TMDL Goal (mg/l)*	Total N Discharged (mg/l)*	In-lake N TMDL Goal (mg/l)	Total P Disharged (Lbs)	Total N Discharged (Lbs)
85th %ile	0	2.2	0.31	0.1	2.73	0.75	1.9	16.2
10 yr	0	10.3	0.31	0.1	2.73	0.75	8.7	76.5
50 yr	0	14.3	0.31	0.1	2.73	0.75	12.2	106.5
100-yr	0	16.1	0.31	0.1	2.73	0.75	13.7	119.6

* Notes
In-lake TMDL Goals refer to pollutant concentrations within Canyon Lake and Lake Elsinore. These goals are not necessarily the same as stormwater discharge goals for Aquabella Lakes.

Runoff Calculations for Water Quality Analysis			
85th Percentile, 24-hour Storm Event			
PROPOSED CONDITIONS			
Rainfall event	Rainfall depth (inches)	Runoff coefficient	Runoff depth (inches)
85th %ile Storm	0.67	0.60	0.40
10-year, 24-hour storm	3.16	0.60	1.90
50-year, 24-hour storm	4.4	0.60	2.64
100-year, 24-hour storm	4.94	0.60	2.96
EXISTING CONDITIONS			
Rainfall event	Rainfall depth (inches)	Runoff coefficient	Runoff depth (inches)
85th %ile Storm	0.67	0.15	0.10
10-year, 24-hour storm	3.16	0.15	0.47
50-year, 24-hour storm	4.4	0.15	0.66
100-year, 24-hour storm	4.94	0.15	0.74

Runoff coefficients are from the Riverside County Stormwater Quality Best Management Practices Design Manual, Figure 1, based on a proposed conditions impervious cover of 80%, and existing conditions impervious cover of 15%.

Riverside County LID BMP Design Handbook
85th%, 24-hr Rainfall Depth= 0.67 inches
(from Isohyetal Map Appdx. E)

3/31/23, 2:06 PM Precipitation Frequency Data Server

NOAA Atlas 14, Volume 6, Version 2
Location name: Moreno Valley, California, USA*
Latitude: 33.905°, Longitude: -117.1988°
Elevation: m/ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

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

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.091 (0.076-0.110)	0.124 (0.104-0.151)	0.169 (0.140-0.205)	0.205 (0.169-0.252)	0.256 (0.204-0.325)	0.295 (0.230-0.383)	0.336 (0.255-0.446)	0.378 (0.279-0.517)	0.436 (0.308-0.623)	0.482 (0.329-0.714)
10-min	0.130 (0.109-0.158)	0.178 (0.149-0.216)	0.242 (0.201-0.294)	0.294 (0.243-0.361)	0.367 (0.292-0.465)	0.423 (0.330-0.549)	0.481 (0.365-0.640)	0.542 (0.400-0.742)	0.625 (0.442-0.894)	0.691 (0.471-1.02)
15-min	0.158 (0.132-0.191)	0.216 (0.180-0.261)	0.293 (0.243-0.356)	0.356 (0.293-0.436)	0.443 (0.353-0.563)	0.512 (0.399-0.663)	0.582 (0.442-0.774)	0.655 (0.483-0.897)	0.756 (0.534-1.08)	0.835 (0.570-1.24)
30-min	0.252 (0.210-0.305)	0.345 (0.287-0.418)	0.468 (0.389-0.568)	0.569 (0.469-0.697)	0.709 (0.564-0.899)	0.817 (0.637-1.06)	0.930 (0.706-1.24)	1.05 (0.772-1.43)	1.21 (0.853-1.73)	1.34 (0.910-1.98)
60-min	0.350 (0.292-0.424)	0.479 (0.399-0.580)	0.650 (0.540-0.789)	0.790 (0.651-0.969)	0.984 (0.784-1.25)	1.14 (0.885-1.47)	1.29 (0.981-1.72)	1.45 (1.07-1.99)	1.68 (1.19-2.40)	1.86 (1.26-2.75)
2-hr	0.522 (0.436-0.632)	0.687 (0.573-0.833)	0.905 (0.752-1.10)	1.08 (0.893-1.33)	1.33 (1.06-1.68)	1.52 (1.18-1.97)	1.71 (1.30-2.27)	1.91 (1.41-2.61)	2.18 (1.54-3.12)	2.39 (1.63-3.55)
3-hr	0.649 (0.542-0.785)	0.844 (0.703-1.02)	1.10 (0.914-1.34)	1.31 (1.08-1.60)	1.59 (1.27-2.02)	1.81 (1.41-2.35)	2.04 (1.55-2.71)	2.27 (1.67-3.11)	2.58 (1.82-3.69)	2.83 (1.93-4.19)
6-hr	0.910 (0.760-1.10)	1.17 (0.979-1.42)	1.52 (1.26-1.85)	1.80 (1.48-2.21)	2.18 (1.74-2.77)	2.47 (1.93-3.21)	2.77 (2.10-3.68)	3.07 (2.27-4.20)	3.48 (2.46-4.98)	3.80 (2.59-5.63)
12-hr	1.17 (0.974-1.41)	1.53 (1.27-1.85)	2.00 (1.66-2.42)	2.37 (1.96-2.91)	2.89 (2.30-3.66)	3.27 (2.55-4.25)	3.67 (2.78-4.88)	4.07 (3.00-5.57)	4.61 (3.25-6.58)	5.02 (3.42-7.44)
24-hr	1.48 (1.31-1.70)	1.98 (1.75-2.29)	2.63 (2.32-3.05)	3.16 (2.76-3.69)	3.86 (3.27-4.66)	4.40 (3.65-5.41)	4.94 (4.00-6.22)	5.49 (4.33-7.10)	6.22 (4.71-8.39)	6.79 (4.97-9.46)

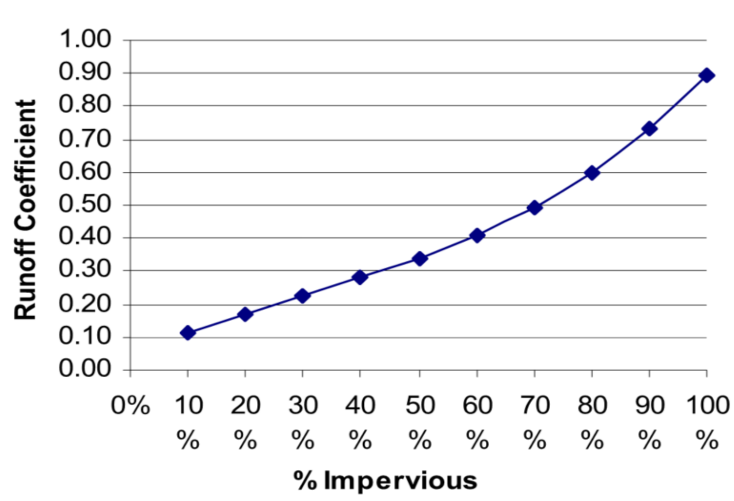

Figure 1. Impervious – Coefficient Curve (WEF/ASCE Method[1])

Aquabella Lakes, Moreno Valley, CA

A simple model for estimating the discharge of Total Phosphorous (Total P) and Total Nitrogen (Total N) from the project site during storm events

85th Percentile, 24-hour Storm Event

John F. Kennedy Dr

	Discharge Parameters Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Existing Street	0.04	0.39	3.90	0.04	0.38

85th Percentile, 24-hour Storm Event

Lasselle St

	Discharge Parameters Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Existing Street	0.15	0.39	3.90	0.16	1.60

85th Percentile, 24-hour Storm Event

Cactus Ave

	Discharge Parameters Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Existing Street	0.27	0.39	3.90	0.29	2.91

85th Percentile, 24-hour Storm Event

Nason St

	Discharge Parameters Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Existing Street	0.63	0.39	3.90	0.67	6.72

85th Percentile, 24-hour Storm Event

Delphinium Ave

	Discharge Parameters Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)

Site Condition					
Existing Street	0.10	0.39	3.90	0.10	1.01

85th Percentile, 24-hour Storm Event

Evergreen St	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Existing Street	0.03	0.39	3.90	0.04	0.35

Aquabella Lakes, Moreno Valley, CA
A simple model for estimating the discharge of Total Phosphorous (Total P) and Total Nitrogen (Total N) from the project site during storm events

85th Percentile, 24-hour Storm Event

	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Proposed w/o BMPs	0.04	0.39	3.90	0.04	0.38

10-year, 24-hour Storm Event

	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Proposed w/o BMPs	0.2	0.39	3.90	0.2	1.8

50-year, 24-hour Storm Event

	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Proposed w/o BMPs	0.2	0.39	3.90	0.2	2.5

100-year, 24-hour Storm Event

	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Proposed w/o BMPs	0.3	0.39	3.90	0.3	2.8

Condition 1: Onsite Runoff

Storm	Runoff Depth (in)*	Runoff Volume (AF)	Runoff Total P* (mg/l)	Runoff Total N* (mg/l)	Runoff Total P (lbs)	Runoff Total N (lbs)
85th %ile	0.60	0.04	0.39	3.9	0	0
10 yr	2.84	0.17	0.39	3.9	0	2
50 yr	3.96	0.23	0.39	3.9	0	2
100-yr	4.45	0.26	0.39	3.9	0	3

* Notes:
Runoff depths provided by P.A.C.E.
Runoff Total P is reported mean concentration from LA County Monitoring Data for High Density Single Family Residential Land Use
Runoff Total N is sum of Nitrate-N, Nitrite-N, and TKN reported by LA County for High-density Single Family Residential Land Use

Condition 2: Lake Dilution
no lake dilution

Condition 3: Lake Treatment
no treatment

Condition 4: Site Discharge

Storm	Lake Storage Capacity (AF)	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	In-lake P TMDL Goal (mg/l)*	Total N Discharged (mg/l)*	In-lake N TMDL Goal (mg/l)	Total P Disharged (Lbs)	Total N Discharged (Lbs)
85th %ile	0	0.04	0.39	0.1	3.90	0.75	0.04	0.38
10 yr	0	0.2	0.39	0.1	3.90	0.75	0.2	1.8
50 yr	0	0.2	0.39	0.1	3.90	0.75	0.2	2.5
100-yr	0	0.3	0.39	0.1	3.90	0.75	0.3	2.8

* Notes
In-lake TMDL Goals refer to pollutant concentrations within Canyon Lake and Lake Elsinore. These goals are not necessarily the same as stormwater discharge goals for Aquabella Lakes.

Runoff Calculations for Water Quality Analysis			
PROPOSED CONDITIONS			
Rainfall event	Rainfall depth (inches)	Runoff coefficient	Runoff depth (inches)
85th %ile Storm	0.67	0.9	0.60
10-year, 24-hour storm	3.16	0.9	2.84
50-year, 24-hour storm	4.4	0.9	3.96
100-year, 24-hour storm	4.94	0.9	4.45
EXISTING CONDITIONS			
Rainfall event	Rainfall depth (inches)	Runoff coefficient	Runoff depth (inches)
85th %ile Storm	0.67	0.9	0.60
10-year, 24-hour storm	3.16	0.9	2.84
50-year, 24-hour storm	4.4	0.9	3.96
100-year, 24-hour storm	4.94	0.9	4.45

Runoff coefficients are from the Riverside County Stormwater Quality Best Management Practices Design Manual, Figure 1, based on a proposed conditions impervious cover of 65%, and existing conditions impervious cover of 15%.

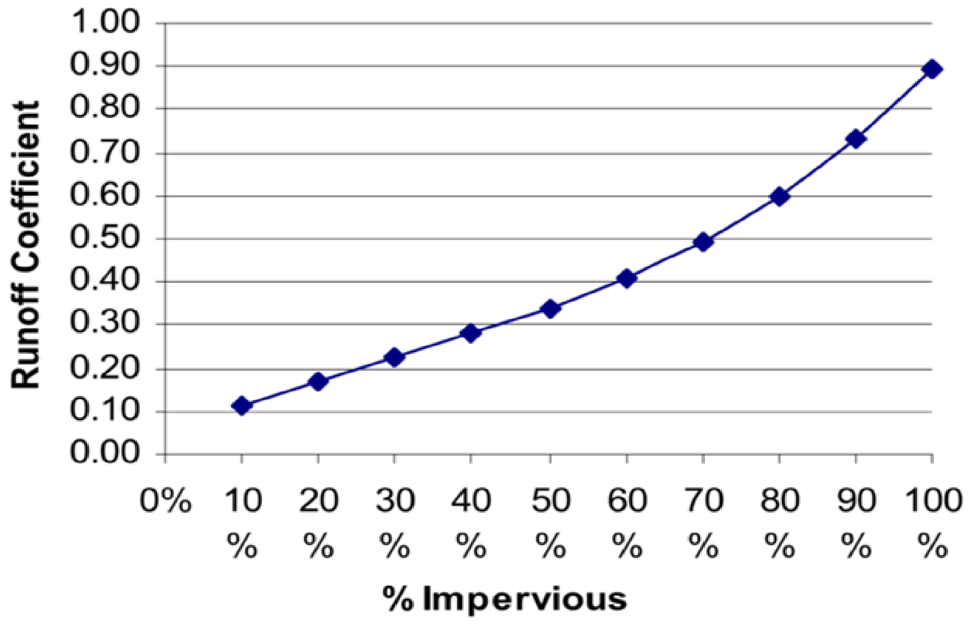

Figure 1. Impervious – Coefficient Curve (WEF/ASCE Method[1])

Aquabella Lakes, Moreno Valley, CA

A simple model for estimating the discharge of Total Phosphorous (Total P) and Total Nitrogen (Total N) from the project site during storm events

85th Percentile, 24-hour Storm Event

	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Proposed w/o BMPs	0.15	0.39	3.90	0.16	1.60

10-year, 24-hour Storm Event

	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Proposed w/o BMPs	0.7	0.39	3.90	0.8	7.5

50-year, 24-hour Storm Event

	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Proposed w/o BMPs	1.0	0.39	3.90	1.1	10.5

100-year, 24-hour Storm Event

	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Proposed w/o BMPs	1.1	0.39	3.90	1.2	11.8

Condition 1: Onsite Runoff

Storm	Runoff Depth (in)*	Runoff Volume (AF)	Runoff Total P* (mg/l)	Runoff Total N* (mg/l)	Runoff Total P (lbs)	Runoff Total N (lbs)
85th %ile	0.60	0.15	0.39	3.9	0	2
10 yr	2.84	0.71	0.39	3.9	1	8
50 yr	3.96	0.99	0.39	3.9	1	11
100-yr	4.45	1.11	0.39	3.9	1	12

* Notes:
Runoff depths provided by P.A.C.E.
Runoff Total P is reported mean concentration from LA County Monitoring Data for High Density Single Family Residential Land Use
Runoff Total N is sum of Nitrate-N, Nitrite-N, and TKN reported by LA County for High-density Single Family Residential Land Use

Condition 2: Lake Dilution
no lake dilution

Condition 3: Lake Treatment
no treatment

Condition 4: Site Discharge

Storm	Lake Storage Capacity (AF)	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	In-lake P TMDL Goal (mg/l)*	Total N Discharged (mg/l)*	In-lake N TMDL Goal (mg/l)	Total P Disharged (Lbs)	Total N Discharged (Lbs)
85th %ile	0	0.15	0.39	0.1	3.90	0.75	0.16	1.60
10 yr	0	0.7	0.39	0.1	3.90	0.75	0.8	7.5
50 yr	0	1.0	0.39	0.1	3.90	0.75	1.1	10.5
100-yr	0	1.1	0.39	0.1	3.90	0.75	1.2	11.8

* Notes
In-lake TMDL Goals refer to pollutant concentrations within Canyon Lake and Lake Elsinore. These goals are not necessarily the same as stormwater discharge goals for Aquabella Lakes.

Runoff Calculations for Water Quality Analysis			
PROPOSED CONDITIONS			
Rainfall event	Rainfall depth (inches)	Runoff coefficient	Runoff depth (inches)
85th %ile Storm	0.67	0.9	0.60
10-year, 24-hour storm	3.16	0.9	2.84
50-year, 24-hour storm	4.4	0.9	3.96
100-year, 24-hour storm	4.94	0.9	4.45
EXISTING CONDITIONS			
Rainfall event	Rainfall depth (inches)	Runoff coefficient	Runoff depth (inches)
85th %ile Storm	0.67	0.9	0.60
10-year, 24-hour storm	3.16	0.9	2.84
50-year, 24-hour storm	4.4	0.9	3.96
100-year, 24-hour storm	4.94	0.9	4.45

Runoff coefficients are from the Riverside County Stormwater Quality Best Management Practices Design Manual, Figure 1, based on a proposed conditions impervious cover of 65%, and existing conditions impervious cover of 15%.

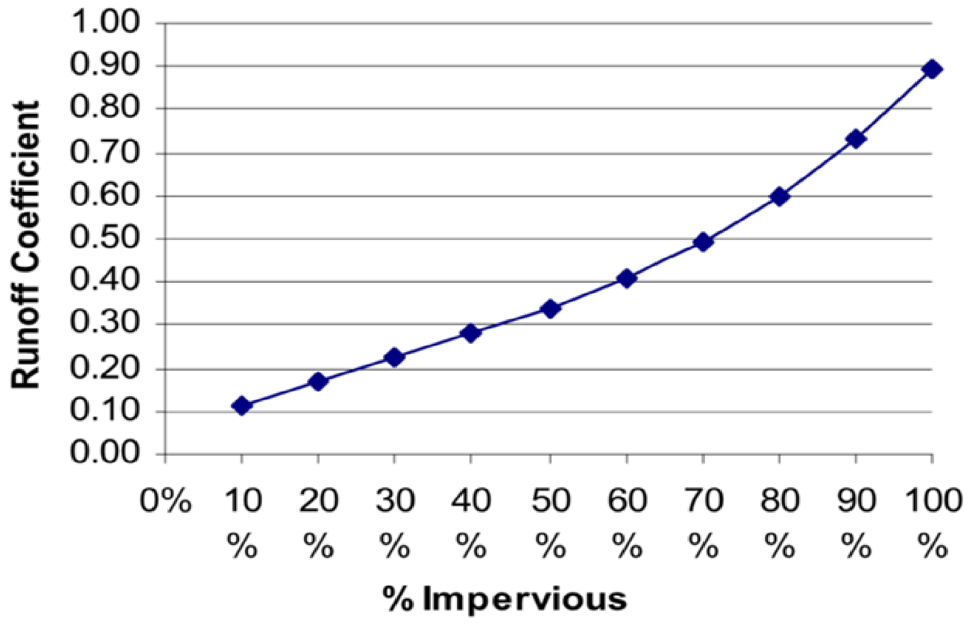

Figure 1. Impervious – Coefficient Curve (WEF/ASCE Method[1])

Aquabella Lakes, Moreno Valley, CA
A simple model for estimating the discharge of Total Phosphorous (Total P) and Total Nitrogen (Total N) from the project site during storm events

85th Percentile, 24-hour Storm Event

	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Proposed w/o BMPs	0.27	0.39	3.90	0.29	2.91

10-year, 24-hour Storm Event

	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Proposed w/o BMPs	1.3	0.39	3.90	1.4	13.7

50-year, 24-hour Storm Event

	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Proposed w/o BMPs	1.8	0.39	3.90	1.9	19.1

100-year, 24-hour Storm Event

	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Proposed w/o BMPs	2.0	0.39	3.90	2.1	21.4

Condition 1: Onsite Runoff

Storm	Runoff Depth (in)*	Runoff Volume (AF)	Runoff Total P* (mg/l)	Runoff Total N* (mg/l)	Runoff Total P (lbs)	Runoff Total N (lbs)
85th %ile	0.60	0.27	0.39	3.9	0	3
10 yr	2.84	1.29	0.39	3.9	1	14
50 yr	3.96	1.80	0.39	3.9	2	19
100-yr	4.45	2.02	0.39	3.9	2	21

* Notes:
Runoff depths provided by P.A.C.E.
Runoff Total P is reported mean concentration from LA County Monitoring Data for High Density Single Family Residential Land Use
Runoff Total N is sum of Nitrate-N, Nitrite-N, and TKN reported by LA County for High-density Single Family Residential Land Use

Condition 2: Lake Dilution
no lake dilution

Condition 3: Lake Treatment
no treatment

Condition 4: Site Discharge

Storm	Lake Storage Capacity (AF)	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	In-lake P TMDL Goal (mg/l)*	Total N Discharged (mg/l)*	In-lake N TMDL Goal (mg/l)	Total P Disharged (Lbs)	Total N Discharged (Lbs)
85th %ile	0	0.27	0.39	0.1	3.90	0.75	0.29	2.91
10 yr	0	1.3	0.39	0.1	3.90	0.75	1.4	13.7
50 yr	0	1.8	0.39	0.1	3.90	0.75	1.9	19.1
100-yr	0	2.0	0.39	0.1	3.90	0.75	2.1	21.4

* Notes
In-lake TMDL Goals refer to pollutant concentrations within Canyon Lake and Lake Elsinore. These goals are not necessarily the same as stormwater discharge goals for Aquabella Lakes.

Runoff Calculations for Water Quality Analysis			
PROPOSED CONDITIONS			
Rainfall event	Rainfall depth (inches)	Runoff coefficient	Runoff depth (inches)
85th %ile Storm	0.67	0.9	0.60
10-year, 24-hour storm	3.16	0.9	2.84
50-year, 24-hour storm	4.4	0.9	3.96
100-year, 24-hour storm	4.94	0.9	4.45
EXISTING CONDITIONS			
Rainfall event	Rainfall depth (inches)	Runoff coefficient	Runoff depth (inches)
85th %ile Storm	0.67	0.9	0.60
10-year, 24-hour storm	3.16	0.9	2.84
50-year, 24-hour storm	4.4	0.9	3.96
100-year, 24-hour storm	4.94	0.9	4.45

Runoff coefficients are from the Riverside County Stormwater Quality Best Management Practices Design Manual, Figure 1, based on a proposed conditions impervious cover of 65%, and existing conditions impervious cover of 15%.

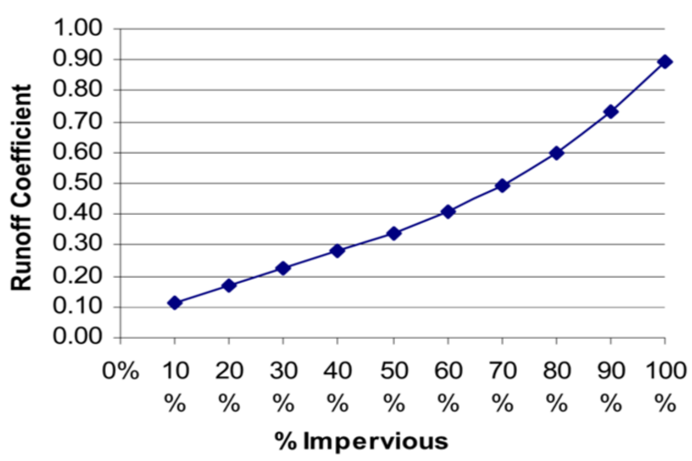

Figure 1. Impervious – Coefficient Curve (WEF/ASCE Method[1])

Aquabella Lakes, Moreno Valley, CA
A simple model for estimating the discharge of Total Phosphorous (Total P) and Total Nitrogen (Total N) from the project site during storm events

85th Percentile, 24-hour Storm Event

	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Proposed w/o BMPs	0.63	0.39	3.90	0.67	6.72

10-year, 24-hour Storm Event

	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Proposed w/o BMPs	3.0	0.39	3.90	3.2	31.7

50-year, 24-hour Storm Event

	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Proposed w/o BMPs	4.2	0.39	3.90	4.4	44.1

100-year, 24-hour Storm Event

	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Proposed w/o BMPs	4.7	0.39	3.90	5.0	49.6

Condition 1: Onsite Runoff

Storm	Runoff Depth (in)*	Runoff Volume (AF)	Runoff Total P* (mg/l)	Runoff Total N* (mg/l)	Runoff Total P (lbs)	Runoff Total N (lbs)
85th %ile	0.60	0.63	0.39	3.9	1	7
10 yr	2.84	2.99	0.39	3.9	3	32
50 yr	3.96	4.16	0.39	3.9	4	44
100-yr	4.45	4.67	0.39	3.9	5	50

* Notes:
Runoff depths provided by P.A.C.E.
Runoff Total P is reported mean concentration from LA County Monitoring Data for High Density Single Family Residential Land Use
Runoff Total N is sum of Nitrate-N, Nitrite-N, and TKN reported by LA County for High-density Single Family Residential Land Use

Condition 2: Lake Dilution
no lake dilution

Condition 3: Lake Treatment
no treatment

Condition 4: Site Discharge

Storm	Lake Storage Capacity (AF)	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	In-lake P TMDL Goal (mg/l)*	Total N Discharged (mg/l)*	In-lake N TMDL Goal (mg/l)	Total P Disharged (Lbs)	Total N Discharged (Lbs)
85th %ile	0	0.63	0.39	0.1	3.90	0.75	0.67	6.72
10 yr	0	3.0	0.39	0.1	3.90	0.75	3.2	31.7
50 yr	0	4.2	0.39	0.1	3.90	0.75	4.4	44.1
100-yr	0	4.7	0.39	0.1	3.90	0.75	5.0	49.6

* Notes
In-lake TMDL Goals refer to pollutant concentrations within Canyon Lake and Lake Elsinore. These goals are not necessarily the same as stormwater discharge goals for Aquabella Lakes.

Runoff Calculations for Water Quality Analysis			
PROPOSED CONDITIONS			
Rainfall event	Rainfall depth (inches)	Runoff coefficient	Runoff depth (inches)
85th %ile Storm	0.67	0.9	0.60
10-year, 24-hour storm	3.16	0.9	2.84
50-year, 24-hour storm	4.4	0.9	3.96
100-year, 24-hour storm	4.94	0.9	4.45
EXISTING CONDITIONS			
Rainfall event	Rainfall depth (inches)	Runoff coefficient	Runoff depth (inches)
85th %ile Storm	0.67	0.9	0.60
10-year, 24-hour storm	3.16	0.9	2.84
50-year, 24-hour storm	4.4	0.9	3.96
100-year, 24-hour storm	4.94	0.9	4.45

Runoff coefficients are from the Riverside County Stormwater Quality Best Management Practices Design Manual, Figure 1, based on a proposed conditions impervious cover of 65%, and existing conditions impervious cover of 15%.

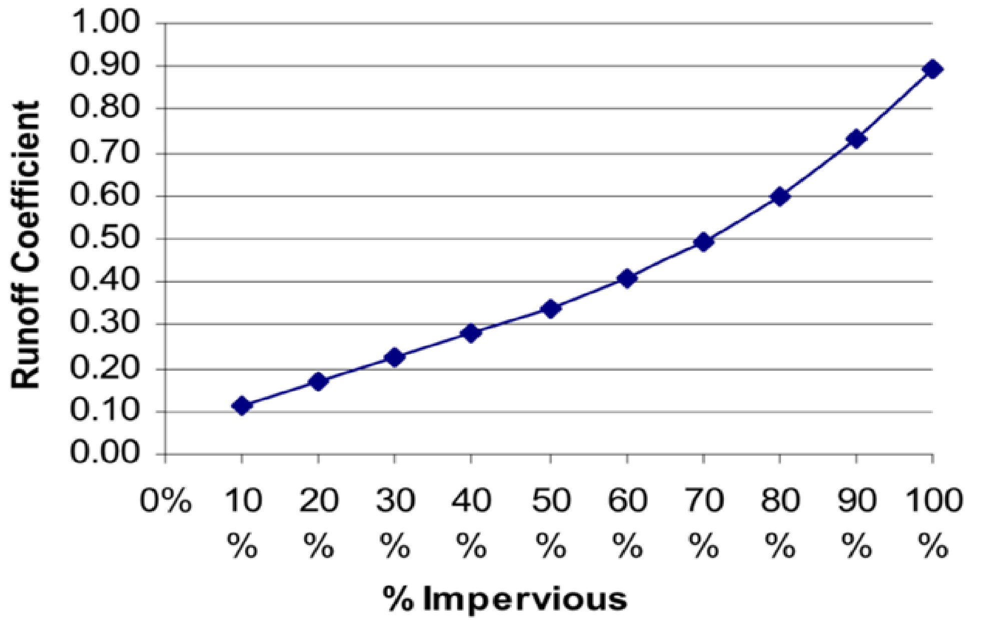

Figure 1. Impervious – Coefficient Curve (WEF/ASCE Method[1])

Aquabella Lakes, Moreno Valley, CA
A simple model for estimating the discharge of Total Phosphorous (Total P) and Total Nitrogen (Total N) from the project site during storm events

85th Percentile, 24-hour Storm Event

	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Proposed w/o BMPs	0.10	0.39	3.90	0.10	1.01

10-year, 24-hour Storm Event

	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Proposed w/o BMPs	0.5	0.39	3.90	0.5	4.8

50-year, 24-hour Storm Event

	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Proposed w/o BMPs	0.6	0.39	3.90	0.7	6.7

100-year, 24-hour Storm Event

	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Proposed w/o BMPs	0.7	0.39	3.90	0.7	7.5

Condition 1: Onsite Runoff

Storm	Runoff Depth (in)*	Runoff Volume (AF)	Runoff Total P* (mg/l)	Runoff Total N* (mg/l)	Runoff Total P (lbs)	Runoff Total N (lbs)
85th %ile	0.60	0.10	0.39	3.9	0	1
10 yr	2.84	0.45	0.39	3.9	0	5
50 yr	3.96	0.63	0.39	3.9	1	7
100-yr	4.45	0.70	0.39	3.9	1	7

* Notes:
Runoff depths provided by P.A.C.E.
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Condition 2: Lake Dilution
no lake dilution

Condition 3: Lake Treatment
no treatment

Condition 4: Site Discharge

Storm	Lake Storage Capacity (AF)	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	In-lake P TMDL Goal (mg/l)*	Total N Discharged (mg/l)*	In-lake N TMDL Goal (mg/l)	Total P Disharged (Lbs)	Total N Discharged (Lbs)
85th %ile	0	0.10	0.39	0.1	3.90	0.75	0.10	1.01
10 yr	0	0.5	0.39	0.1	3.90	0.75	0.5	4.8
50 yr	0	0.6	0.39	0.1	3.90	0.75	0.7	6.7
100-yr	0	0.7	0.39	0.1	3.90	0.75	0.7	7.5

* Notes
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Runoff Calculations for Water Quality Analysis			
PROPOSED CONDITIONS			
Rainfall event	Rainfall depth (inches)	Runoff coefficient	Runoff depth (inches)
85th %ile Storm	0.67	0.9	0.60
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100-year, 24-hour storm	4.94	0.9	4.45
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Rainfall event	Rainfall depth (inches)	Runoff coefficient	Runoff depth (inches)
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50-year, 24-hour storm	4.4	0.9	3.96
100-year, 24-hour storm	4.94	0.9	4.45

Runoff coefficients are from the Riverside County Stormwater Quality Best Management Practices Design Manual, Figure 1, based on a proposed conditions impervious cover of 65%, and existing conditions impervious cover of 15%.

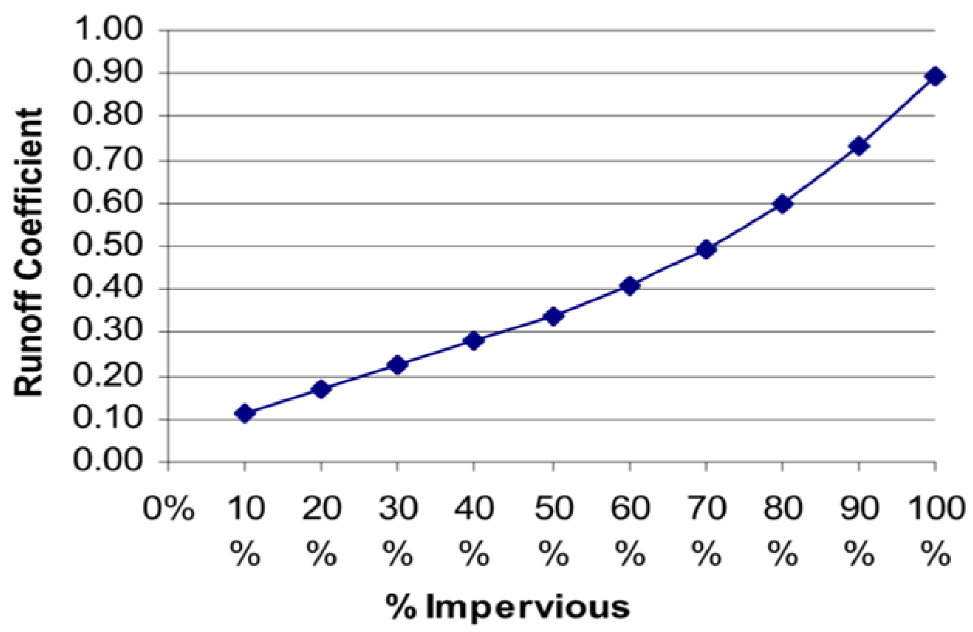

Figure 1. Impervious – Coefficient Curve (WEF/ASCE Method[1])

Aquabella Lakes, Moreno Valley, CA
A simple model for estimating the discharge of Total Phosphorous (Total P) and Total Nitrogen (Total N) from the project site during storm events

85th Percentile, 24-hour Storm Event

	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Proposed w/o BMPs	0.03	0.39	3.90	0.04	0.35

10-year, 24-hour Storm Event

	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Proposed w/o BMPs	0.2	0.39	3.90	0.2	1.7

50-year, 24-hour Storm Event

	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Proposed w/o BMPs	0.2	0.39	3.90	0.2	2.3

100-year, 24-hour Storm Event

	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Proposed w/o BMPs	0.2	0.39	3.90	0.3	2.6

Condition 1: Onsite Runoff

Storm	Runoff Depth (in)*	Runoff Volume (AF)	Runoff Total P* (mg/l)	Runoff Total N* (mg/l)	Runoff Total P (lbs)	Runoff Total N (lbs)
85th %ile	0.60	0.03	0.39	3.9	0	0
10 yr	2.84	0.16	0.39	3.9	0	2
50 yr	3.96	0.22	0.39	3.9	0	2
100-yr	4.45	0.24	0.39	3.9	0	3

* Notes:
Runoff depths provided by P.A.C.E.
Runoff Total P is reported mean concentration from LA County Monitoring Data for High Density Single Family Residential Land Use
Runoff Total N is sum of Nitrate-N, Nitrite-N, and TKN reported by LA County for High-density Single Family Residential Land Use

Condition 2: Lake Dilution
no lake dilution

Condition 3: Lake Treatment
no treatment

Condition 4: Site Discharge

Storm	Lake Storage Capacity (AF)	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	In-lake P TMDL Goal (mg/l)*	Total N Discharged (mg/l)*	In-lake N TMDL Goal (mg/l)	Total P Disharged (Lbs)	Total N Discharged (Lbs)
85th %ile	0	0.03	0.39	0.1	3.90	0.75	0.04	0.35
10 yr	0	0.2	0.39	0.1	3.90	0.75	0.2	1.7
50 yr	0	0.2	0.39	0.1	3.90	0.75	0.2	2.3
100-yr	0	0.2	0.39	0.1	3.90	0.75	0.3	2.6

* Notes
In-lake TMDL Goals refer to pollutant concentrations within Canyon Lake and Lake Elsinore. These goals are not necessarily the same as stormwater discharge goals for Aquabella Lakes.

Runoff Calculations for Water Quality Analysis			
PROPOSED CONDITIONS			
Rainfall event	Rainfall depth (inches)	Runoff coefficient	Runoff depth (inches)
85th %ile Storm	0.67	0.9	0.60
10-year, 24-hour storm	3.16	0.9	2.84
50-year, 24-hour storm	4.4	0.9	3.96
100-year, 24-hour storm	4.94	0.9	4.45
EXISTING CONDITIONS			
Rainfall event	Rainfall depth (inches)	Runoff coefficient	Runoff depth (inches)
85th %ile Storm	0.67	0.9	0.60
10-year, 24-hour storm	3.16	0.9	2.84
50-year, 24-hour storm	4.4	0.9	3.96
100-year, 24-hour storm	4.94	0.9	4.45

Runoff coefficients are from the Riverside County Stormwater Quality Best Management Practices Design Manual, Figure 1, based on a proposed conditions impervious cover of 65%, and existing conditions impervious cover of 15%.

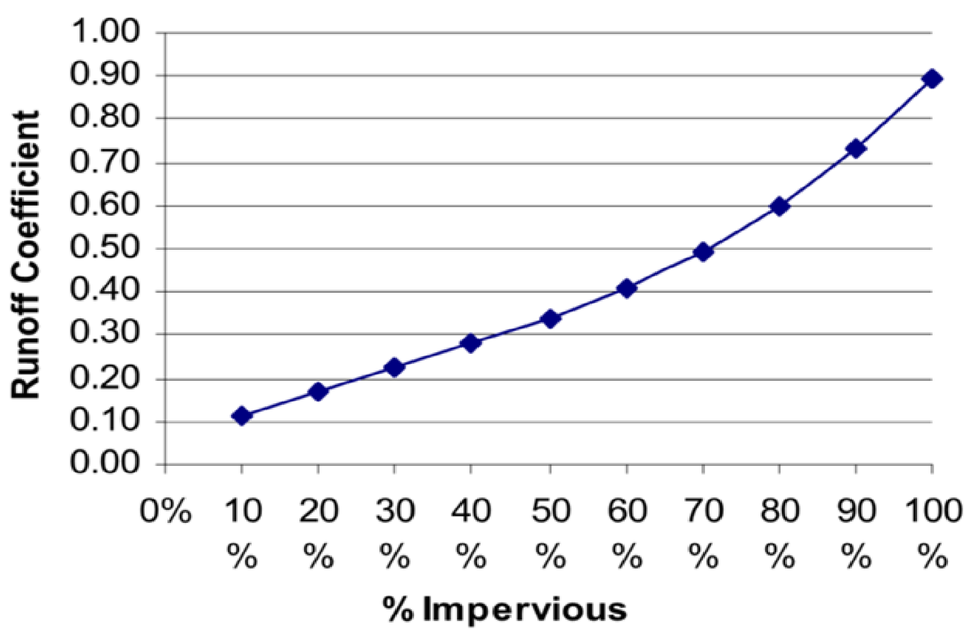

Figure 1. Impervious – Coefficient Curve (WEF/ASCE Method[1])

Aquabella Lakes, Moreno Valley, CA

A simple model for estimating the discharge of Total Phosphorous (Total P) and Total Nitrogen (Total N) from the project site during storm events

PA2 BMP

85th Percentile, 24-hour Storm Event	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Proposed w/ Std. BMPs	0.4	0.31	2.73	0.3	2.7

5/19/2023

Aquabella Lakes, Moreno Valley, CA

A simple model for estimating the discharge of Total Phosphorous (Total P) and Total Nitrogen (Total N) from the project site during storm events

85th Percentile, 24-hour Storm Event

	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Proposed w/ Std. BMPs	0.4	0.31	2.73	0.3	2.7

10-year, 24-hour Storm Event

	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Proposed w/ Std. BMPs	10.4	0.31	2.73	8.9	77.4

50-year, 24-hour Storm Event

	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Proposed w/ Std. BMPs	14.5	0.31	2.73	12.3	107.8

100-year, 24-hour Storm Event

	Discharge Parameters				
	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	Total N Discharged (mg/l)*	Total P Disharged (Lbs)	Total N Discharged (Lbs)
Site Condition					
Proposed w/ Std. BMPs	16.3	0.31	2.73	13.8	121.1

PA2 BMP

Condition 1: Onsite Runoff

Storm	Runoff Depth (in)*	Runoff Volume (AF)	Runoff Total P* (mg/l)	Runoff Total N* (mg/l)	Runoff Total P (lbs)	Runoff Total N (lbs)
85th %ile	0.4	0.4	0.39	3.9	0	4
10 yr	1.9	10.4	0.39	3.9	11	111
50 yr	2.6	14.5	0.39	3.9	15	154
100-yr	3.0	16.3	0.39	3.9	17	173

* Notes:
Runoff depths provided by P.A.C.E.
Runoff Total P is reported mean concentration from LA County Monitoring Data for High Density Residential Land Use
Runoff Total N is sum of Nitrate-N, Nitrite-N, and TKN reported by LA County for High Density Residential Land Use

Condition 2: Lake Mixing
no lake mixing

Condition 3: BMP Treatment

Storm	Diluted Total P (mg/l)	Diluted Total N (mg/l)	P Removal Efficiency (%)*	N Removal Efficiency (%)*	Treated Total P (mg/l)	Treated Total N (mg/l)
85th %ile	0.39	3.9	20%	30%	0.31	2.73
10 yr	0.39	3.9	20%	30%	0.31	2.73
50 yr	0.39	3.9	20%	30%	0.31	2.73
100-yr	0.39	3.9	20%	30%	0.31	2.73

* Notes
Removal efficiencies based on average efficiencies for dry extended detention basins based on data compiled by the multi-state Chesapeake Bay Program

Condition 4: Discharge

Storm	Lake Storage Capacity (AF)	Volume of Water Discharged (AF)	Total P Disharged (mg/l)	In-lake P TMDL Goal (mg/l)*	Total N Discharged (mg/l)*	In-lake N TMDL Goal (mg/l)	Total P Disharged (Lbs)	Total N Discharged (Lbs)
85th %ile	0	0.4	0.31	0.1	2.73	0.75	0.3	2.7
10 yr	0	10.4	0.31	0.1	2.73	0.75	8.9	77.4
50 yr	0	14.5	0.31	0.1	2.73	0.75	12.3	107.8
100-yr	0	16.3	0.31	0.1	2.73	0.75	13.8	121.1

* Notes
In-lake TMDL Goals refer to pollutant concentrations within Canyon Lake and Lake Elsinore. These goals are not necessarily the same as stormwater discharge goals for Aquabella Lakes.

PA2 BMP

Runoff Calculations for Water Quality Analysis			
PROPOSED CONDITIONS			
Rainfall event	Rainfall depth (inches)	Runoff coefficient	Runoff depth (inches)
85th %ile Storm	0.67	0.60	0.40
10-year, 24-hour storm	3.16	0.60	1.90
50-year, 24-hour storm	4.4	0.60	2.64
100-year, 24-hour storm	4.94	0.60	2.96
EXISTING CONDITIONS			
Rainfall event	Rainfall depth (inches)	Runoff coefficient	Runoff depth (inches)
85th %ile Storm	0.67	0.15	0.10
10-year, 24-hour storm	3.16	0.15	0.47
50-year, 24-hour storm	4.4	0.15	0.66
100-year, 24-hour storm	4.94	0.15	0.74
Runoff coefficients are from the Riverside County Stormwater Quality Best Management Practices Design Manual, Figure 1, based on a proposed conditions impervious cover of 80%, and existing conditions impervious cover of 15%.			

Riverside County LID BMP Design Handbook
85th%, 24-hr Rainfall Depth= 0.67 inches
(from Isohyetal Map Appdx. E)

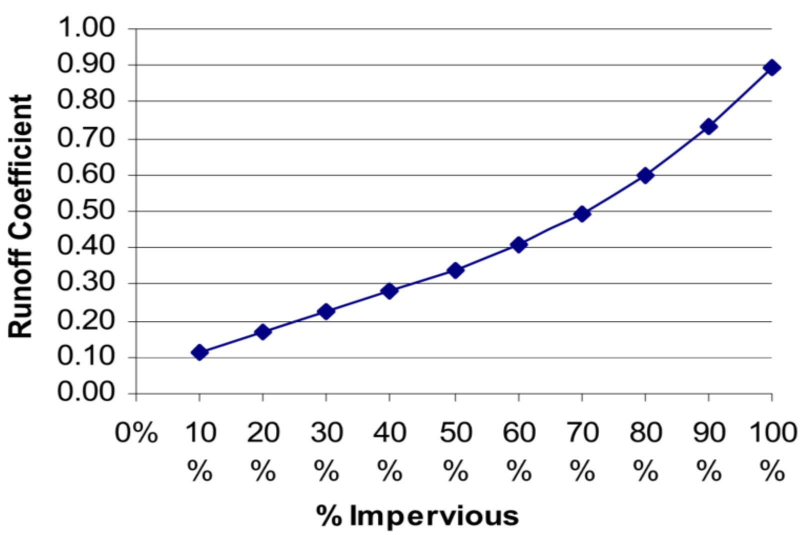

Figure 1. Impervious – Coefficient Curve (WEF/ASCE Method[1])

NOAA Atlas 14, Volume 6, Version 2
Location name: Moreno Valley, California, USA*
Latitude: 33.905°, Longitude: -117.1988°
Elevation: m/ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.091** (0.076-0.110)	**0.124** (0.104-0.151)	**0.169** (0.140-0.205)	**0.205** (0.169-0.252)	**0.256** (0.204-0.325)	**0.295** (0.230-0.383)	**0.336** (0.255-0.446)	**0.378** (0.279-0.517)	**0.436** (0.308-0.623)	**0.482** (0.329-0.714)
10-min	**0.130** (0.109-0.158)	**0.178** (0.149-0.216)	**0.242** (0.201-0.294)	**0.294** (0.243-0.361)	**0.367** (0.292-0.465)	**0.423** (0.330-0.549)	**0.481** (0.365-0.640)	**0.542** (0.400-0.742)	**0.625** (0.442-0.894)	**0.691** (0.471-1.02)
15-min	**0.158** (0.132-0.191)	**0.216** (0.180-0.261)	**0.293** (0.243-0.356)	**0.356** (0.293-0.436)	**0.443** (0.353-0.563)	**0.512** (0.399-0.663)	**0.582** (0.442-0.774)	**0.655** (0.483-0.897)	**0.756** (0.534-1.08)	**0.835** (0.570-1.24)
30-min	**0.252** (0.210-0.305)	**0.345** (0.287-0.418)	**0.468** (0.389-0.568)	**0.569** (0.469-0.697)	**0.709** (0.564-0.899)	**0.817** (0.637-1.06)	**0.930** (0.706-1.24)	**1.05** (0.772-1.43)	**1.21** (0.853-1.73)	**1.34** (0.910-1.98)
60-min	**0.350** (0.292-0.424)	**0.479** (0.399-0.580)	**0.650** (0.540-0.789)	**0.790** (0.651-0.969)	**0.984** (0.784-1.25)	**1.14** (0.885-1.47)	**1.29** (0.981-1.72)	**1.45** (1.07-1.99)	**1.68** (1.19-2.40)	**1.86** (1.26-2.75)
2-hr	**0.522** (0.436-0.632)	**0.687** (0.573-0.833)	**0.905** (0.752-1.10)	**1.08** (0.893-1.33)	**1.33** (1.06-1.68)	**1.52** (1.18-1.97)	**1.71** (1.30-2.27)	**1.91** (1.41-2.61)	**2.18** (1.54-3.12)	**2.39** (1.63-3.55)
3-hr	**0.649** (0.542-0.785)	**0.844** (0.703-1.02)	**1.10** (0.914-1.34)	**1.31** (1.08-1.60)	**1.59** (1.27-2.02)	**1.81** (1.41-2.35)	**2.04** (1.55-2.71)	**2.27** (1.67-3.11)	**2.58** (1.82-3.69)	**2.83** (1.93-4.19)
6-hr	**0.910** (0.760-1.10)	**1.17** (0.979-1.42)	**1.52** (1.26-1.85)	**1.80** (1.48-2.21)	**2.18** (1.74-2.77)	**2.47** (1.93-3.21)	**2.77** (2.10-3.68)	**3.07** (2.27-4.20)	**3.48** (2.46-4.98)	**3.80** (2.59-5.63)
12-hr	**1.17** (0.974-1.41)	**1.53** (1.27-1.85)	**2.00** (1.66-2.42)	**2.37** (1.96-2.91)	**2.89** (2.30-3.66)	**3.27** (2.55-4.25)	**3.67** (2.78-4.88)	**4.07** (3.00-5.57)	**4.61** (3.25-6.58)	**5.02** (3.42-7.44)
24-hr	**1.48** (1.31-1.70)	**1.98** (1.75-2.29)	**2.63** (2.32-3.05)	**3.16** (2.76-3.69)	**3.86** (3.27-4.66)	**4.40** (3.65-5.41)	**4.94** (4.00-6.22)	**5.49** (4.33-7.10)	**6.22** (4.71-8.39)	**6.79** (4.97-9.46)