Appendix K

Kīhei High School
Preliminary Civil Engineering Report

Gray, Hong, Nojima & Associates, Inc. – October 2011

KIHEI HIGH SCHOOL

PRELIMINARY CIVIL ENGINEERING REPORT

TMK: (2) 2-2-002: 81 and 83
Kihei, Maui, Hawaii

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Chapter 1 – INTRODUCTION

1.1 OVERVIEW

The population of Kihei, Maui is significantly increasing and without a high school in the area, students commute to Kahului and Wailuku. To relieve overcrowding in Central Maui schools and to reduce the commute time for students, the State of Hawaii Department of Education (DOE) proposes to develop the new Kihei High School on 77 acres of undeveloped land along Piilani Highway adjacent to the Elleair Golf Course (refer to Figure 1). Facilities would include construction of approximately 215,000 square feet of educational buildings to support an enrollment capacity of 1,650 students. Also proposed for the full build out are a library, auditorium, cafeteria, an administration building, a football/track stadium, gym, tennis courts, grassed playfields, a swimming pool, a softball field, and a baseball field (refer to Figure 2).

The purpose of this report is to describe the existing and proposed civil infrastructure and utilities that will serve the proposed Kihei High School site. In addition, the report will provide a preliminary basis of design for roadways, water, wastewater, and drainage infrastructure that will be further detailed in the project's request for proposal (RFP) documents for the design-build delivery of the school. The project's design-build team will be involved in the design of site improvements, as well as preparation of actual site plan and utility layouts, grading, and roadway/utility profiles during the design phase of the project; however, a conceptual construction costs based on a conceptual campus plan is provided in Appendix A.

1.2 SITE SELECTION AND LOCATION

A site selection study for the proposed Kihei High School was undertaken by the DOE and Munekiyo and Haraga in 2008. The study started with a general evaluative review of eleven different sites based on social, land use, infrastructure, topography and environmental design considerations. Through a series or progression of further analysis, three finalist site locations were identified. Upon consultation with the local community and landowners, a single preferred site was recommended. Ultimately, the DOE selected the current site for the proposed Kihei High School.

The proposed Kihei High School campus site encompasses approximately 77 acres of undeveloped land on the make side of Piilani Highway across from the Piilani Village residential subdivision in Kihei. It is bordered on the south by Waipuilani Gulch and Elleair Golf Course. Further south are the Maui Research and Technology Park, Piilani Shopping Center, and the Kihei Wastewater Reclamation Facility. To the east are undeveloped lands owned by Kaonoulu Ranch Company and Haleakala Ranch LLP. Kulanihakoi Gulch and undeveloped Kaonoulu Ranch land form the northern boundary. The site is currently owned by the two ranches (TMK 2-2-002:81 and 2-2-002:83 respectively, refer to Figure 3). Both ranches have subdivided a portion of their properties (Maui County Subdivision file Nos. 2.3124 and 2.3129) that will be acquired by the State as the school site. The two subdivided parcels will be consolidated into the proposed Kihei High School site at a future date.

Chapter 2 – ROADWAYS

2.1 EXISTING INFRASTRUCTURE

The proposed Kihei High School site is fronted by Piilani Highway. This highway is under the jurisdiction of the State of Hawaii Department of Transportation (HDOT). Piilani Highway runs in the north-south direction with two lanes heading south to Makena and two lanes heading north to Kahului. The posted speed limit is 30 miles per hour in both directions. Fronting the proposed Kihei High School site, Piilani Highway intersects Kulanihakoi Street at an un-signalized T-intersection without cross walks.

Existing access from Piilani Highway to the proposed project site are two dirt roads, one north of Kulanihakoi Gulch near a bridge. The other is south of Kulanihakoi Gulch before another bridge. According to Maui County subdivision maps there are access restrictions from the existing dirt roads to Piilani Highway. The only area along Piilani Highway without access restrictions is a 80-foot wide strip across Kulanihakoi Street created for an access and utility easement (refer to Section 2.2.2 – On-Site Roadways).

2.2 PROPOSED INFRASTRUCTURE

2.2.1 HIGHWAY IMPROVEMENTS

A traffic impact report and traffic signal warrant study was prepared in 2011 by Wilson Okamoto Corporation (WOC) to analyze the traffic impacts resulting from the proposed Kihei High School. The reports update traffic counts, forecast future traffic, and propose measures to relieve traffic impacts. WOC (2011) determined that traffic in the area at the opening of the proposed High School will remain similar to existing conditions due to improvements on Piilani Highway and a traffic signal at the intersection of Piilani Highway and Kulanihakoi Street. When the proposed High School meets full enrollment of 1,650 students, the traffic level of service is expected to worsen. Recommended improvements to Piilani Highway include the following (Wilson Okamoto Corporation, 2011):

- Provide an exclusive right-turn lane and shared left-turn and through lane on the access road approach from the high school at the intersection with Piilani Highway.
- Provide a channelized northbound deceleration lane along Piilani Highway at the intersection with the access road for the high school.
- Provide a channelized northbound acceleration lane along Piilani Highway at the intersection with the access road for the high school.
- Provide an exclusive southbound left-turn lane along Piilani Highway at the intersection with the access road for the high school.
- Provide two eastbound departure lanes along the access road for the high school from the intersection with Piilani Highway.
- Modify the eastbound approach of Kulanihakoi Street at the intersection with Piilani Highway and the access road for the high school to provide an exclusive right-turn lane and a shared left-turn and through lane.
- Install a traffic signal system at the intersection of Piilani Highway with Kulanihakoi Street and the access road for the high school.
- Prepare a Traffic Management Plan for the high school to minimize the impact of school related vehicles on the surrounding roadways. This plan should address daily school and special event traffic.

- Consider preparing Traffic Assessment Reports periodically (every 5 years at a minimum) once the high school is opened to verify projected traffic conditions in the vicinity and assess the effectiveness of traffic management strategies implemented by the high school.

Layout and dimensions of lanes, approaches, and intersection improvements will be determined by the design-build team during the design phase of the project. In addition, phasing and timing of the traffic signalization system will be established during the design phase.

2.2.2 ON-SITE ROADWAYS

According to subdivision maps prepared by the Kaonoulu Ranch Company and Haleakala Ranch, an 80-foot wide access and utility easement was created on the proposed Kihei High School site (Subdivision File 2.3129 approved on January 13, 2011). This easement has no access restriction from Piilani Highway and will serve as the right of way for an extension of Kulanihakoi Street. This Kulanihakoi Street Extension will remain private for the present and serve as the primary access to the proposed Kihei High School.

Both ranches are also planning for future upcountry developments mauka of the school site, although construction schedules are uncertain and unavailable at this time. Preliminary recommendations from the County's Department of Public Works are to design the Kulanihakoi Street Extension as a 4-lane major collector with bicycle lanes and no parking; however, this should be confirmed by the design-build team. The proposed extension must also be designed in accordance with County and HDOT standards and allow for access from Piilani Highway to the school. Since the mauka development of ranch lands will not occur before the school is constructed, the DOE could construct the full 4-lane collector up to the first intersection which could then narrow down to a 2-lane minor street in the remaining right-of-way up to the school's mauka corner. The developer(s) would then be responsible for undertaking a traffic study to assess the development's impact on surrounding roadways and determine necessary improvements and widening of the Kulanihakoi Street Extension.

Design considerations for the school's on-site driveways are as follows:

- Minimum width of 20 feet.
- Looped through the school site to allow for fire vehicle access.
- Compliance with the guidelines set forth in the DOE's Education Specifications for High Schools (EDSPECS) Chapter 10, Traffic, Bus, and Parking Design Criteria.
- School parking lots situated and designed such that there are no vehicle backups onto Piilani Highway.
- Pavement design of 2-inch asphalt concrete over 6-inch base course with a minimum California Bearing Ratio of 85, as recommended by Hirata and Associates (2009).

In addition, on-site roadways should incorporate recommendations from the project's traffic impact report (WOC, 2011):

- Maintain sufficient sight distance for motorists to safely enter and exit all project roadways.
- Provide adequate on-site loading and off-loading service areas and prohibit off-site loading operations.

- Provide adequate turn-around area for service, delivery and refuse collection vehicles to maneuver on the project site to avoid vehicle-reversing maneuvers onto public roadways.
- Provide sufficient turning radii at all project driveways to avoid or minimize vehicle encroachment to oncoming traffic lanes.

Chapter 3 – WATER

3.1 EXISTING INFRASTRUCTURE

Water Resource Associates studied the existing hydrogeological conditions of the Kihei area and concluded "…there are no potable water resources, either surface or groundwater, available within a two-mile radius of the project site that could be economically or feasibly developed for the proposed high school" (2011). Therefore, potable water will need to be provided by the Department of Water Supply (DWS) Central Maui Water System. According to available information, the Central Maui Water System does not extend to Piilani Highway or the project site. The nearest water facility to the project site is the 8-inch water line at the intersection of Kulanihakoi and Mahealani Street in the Piilani Village Subdivision. Further down Kulanihakoi Street at the intersection with Liloa Drive is a 36-inch concrete pipe transmission main and 18-inch ductile iron distribution main. The 18-inch distribution main is connected to both reservoirs in the area, but is primarily served by the Hale Kihei Reservoir at elevation 220 feet mean sea level (MSL). According to DWS staff the water pressure at fire hydrant 763 located on Mahealani Street near to the intersection of Kulanihakoi Street in the Piilani Village subdivision is 82 pounds per square inch (PSI) at elevation 33 feet MSL.

As described in Section 1.3, Department of Education (DOE) will eventually consolidate and subdivide the properties owned by Haleakala Ranch and Kaonoulu Ranch into the proposed Kihei High School site. In the past the water availability policy (a verification of long term-reliable water source for developments) per Title 14 of the Maui County Code would be a condition for subdivision approval. The recent passing of Ordinance 3818, effective April 5, 2011, amends the Maui County Code exempting public developments within the Central Maui Water System from the water availability policy. The proposed school development should qualify for exemption; however, written confirmation should be obtained from the DWS.

3.2 WATER DEMAND ESTIMATE

Conceptual site plans for the proposed school were developed through a design charrette process with input from a variety of local stakeholders. Based on the charrette discussions and the DOE's anticipated growth in enrollment for the proposed school, preliminary water demands have been projected as shown in Table 3.1. In recognition of Maui's water shortage, dual water systems are being planned for the proposed Kihei High School. It is anticipated that potable water will be supplied by the County's Central Maui Water System and brackish water wells to be located at the school site would serve as the nonpotable source of irrigation water.

Potable consumption rates used in the water demand projections were developed on the basis of incorporating low-flow and other water conservation fixtures throughout the various buildings. A sustainable design approach will take into account the Water Efficiency criteria in accordance with the Leadership in Environmental and Energy Design (LEED) rating system. In working with the DOE, the project team estimated an average potable demand of 20 gallons per capita day (GPCD) for students and staff. A corresponding 10 GPCD average demand for visitors was used. At full build-out, the average daily potable demand is projected at 37,450 GPD. In addition, due to the hot arid climate of Kihei, the nonpotable irrigation demand, estimated to be 185,000 GPD, is significantly higher than typical high school campuses. Thus, the total projected potable and nonpotable demand of 222,450 GPD exceeds the following DWS requirements:

- 60 GPCD x 1,650 students = 99,000 GPD or
- 1,700 GPD/acre x 77 acres = 130,900 GPD

Therefore, the anticipated domestic demand of 37,450 GPD is much lower than the DWS requirements since the irrigation demand will be handled by a nonpotable supply.

Table 3.1 – Projected Water Demand

Year	No. of Students & Staff	GPCD	No. of Visitors	GPCD	Potable (GPD) Avg Day	Max Day	Peak Hr	Non-Potable (GPD)
2015	240	20	10	10	4,900	7,350	14,700	185,000
2016	440	20	20	10	9,000	13,500	27,000	185,000
2017	700	20	30	10	14,300	21,450	42,900	185,000
2018	920	20	40	10	18,800	28,200	56,400	185,000
2025	1,830	20	85	10	37,450	56,175	112,350	185,000

3.3 PROPOSED INFRASTRUCTURE

There are no on-site public or private water systems serving the property. The domestic water and fire supply would be supplied through the Central Maui Water System by connecting to the existing 18-inch water main on Liloa Drive and upgrading the existing 8-inch water main in the Piilani Village Subdivision (refer to Figure 4). Irrigation water will be supplied via on-site brackish wells. The domestic, fire, and irrigation lines will consist of separate looped distribution systems following the main roadways and sidewalks throughout the campus. Any required system improvements and storage requirements will be determined during the subdivision process.

3.3.1 POTABLE SUPPLY

The proposed on- and off-site domestic water facilities must comply with DWS Water System Standards and be supplied through the Central Maui Water System. Preliminary indications by the DWS are that the proposed Kihei High School Campus would be served off an existing 18-inch ductile iron water main on Liloa Drive makai of the Piilani Village subdivision. Although there is an existing 8-inch main in Kulanihakoi Street connected to the 18-inch main, DWS will require that the DOE install a larger diameter water main in Kulanihakoi Street to service the proposed school. In addition, because Kulanihakoi Street is narrow and shares the right-of-way with other utilities, DWS requests that DOE connect any existing services to the proposed larger diameter water main and abandon the existing 8-inch main. The proposed larger diameter main will cross Piilani Highway and connect to water meters near the project site. The new water main will be situated in both County and State right-of-ways and will be dedicated to the County.

DWS will also require separate meters and on-site water mains for domestic and fire purposes, of which the fire meter should be a double-check detector assembly per Water System Standards Detail M-23 for the fire line. The fire main will be sized for fire flow (2,000 gallon per minute) with a residual pressure of 20 PSI at the critical fire hydrant. Hale Kihei Reservoir is at elevation 220 feet while the highest elevation at the site is approximately 110 feet, giving an elevation head of 110 feet or 48 PSI static pressure. Since a minimum residual pressure of 20 PSI is needed with the fire flow, the maximum loss in the fire line will be limited to 28 PSI until a booster system is required. It should be noted that per Ordinance 3819 effective April 5, 2011, the requirements for adequate fire protection for building permit applications for all non-residential units or structures will be transferred from DWS and administered by the Maui Department of Fire and Public Safety.

The domestic water supply will be served by a compound meter. The size of the compound meter would be dependent on the domestic demand. Once the potable demand is established by the design-build team, the domestic line will be sized per the Uniform Plumbing Code, which stipulates a minimum 15 PSI pressure per plumbing fixture. Assuming the critical fixture is in a multi-story building at elevation 150 feet MSL, the static head from the Hale Kihei Reservoir is approximately 70 feet or 30 PSI. Since 15 PSI is needed for domestic flow, the line can only have a maximum loss of 15 PSI until a booster system is required.

Water pressure calculations should be submitted to the DWS by the Design-build team to ensure adequate pressures can be attained in both fire and domestic lines. If adequate pressure is unavailable, DWS will require installation of a tank and pump, with an air gap off each meter. The air gap will separate the proposed Kihei High School water and fire mains from the Central Maui Water System. The tank and pump must be designed to have sufficient capacity and pressure to provide the proposed Kihei High School the required domestic and fire flow. Per the County of Maui Code §14-04-50, the DOE "shall agree to; and shall execute a written release in favor of the department for all claims on account of any inadequacy in the department's system or inadequacy of water supply to the premise."

DWS will also require fire hydrants on Piilani Highway fronting the school. The fire hydrants would feed off the proposed County water main system upstream of the proposed meters. The fire hydrant and corresponding water main would be transferred to the County.

Refer to Figure 4 for a conceptual water system plan and Appendix A for conceptual construction costs.

3.3.2 NONPOTABLE – BRACKISH GROUNDWATER

Irrigation water will be provided by on-site brackish (fresh/salt mixture) wells drilled into the groundwater lens below the site. Brackish water would be pumped from the "lens" between the salt water and the fresh water. The lens is a transition zone of brackish water that separates the fresh water from the salt water. The lens forms because the weight of the rain water that percolates into the ground depresses the salt water beneath it. Due to the high salinity of the brackish water, the project landscaping should consist of salt tolerant species.

The proposed nonpotable water system for irrigation of the school site will include two brackish wells, pressurized transmission and distribution lines, control valves, and other appurtenances, but will not include a storage tank. A primary well would be located at the northeast corner of the site at an elevation of approximately 90 feet MSL (Water Resources Associates, 2011). The second well would serve as a supplemental/standby well located at the southeast corner of the property at roughly the same elevation as the first well (refer to Figure 4).

According to the project's Groundwater and Resources Report prepared by Water Resources Associates (2011), it is projected that each well will have a capacity in the range of 250 to 350 GPM while producing suitable brackish water in the salinity range of 400 to 500 mg/L chlorides. Actual pumping capacities will be determined during well tests when the wells are drilled. Therefore, pending the test results, the system may run under alternating or simultaneous operation of the wells in order to meet the estimated demand of 185,000 GPD within an 9 to 13 hour irrigation period. According to Water Resources Associates (2011), the wells are not expected to have any adverse impact on the existing water supply (fresh and brackish) and nearby wells.

Chapter 4 – WASTEWATER

4.1 EXISTING INFRASTRUCTURE

According to available information, there are no existing wastewater facilities on-site or sewer connections on Piilani Highway. The nearest wastewater connection is a drop manhole at the intersection of Kulanihakoi Street and Mahealani Street in the Piilani Village Subdivision. Wastewater is conveyed through a collection system and pump stations to the Kihei Wastewater Reclamation Facility (WWRF).

4.2 PROPOSED INFRASTRUCTURE

Proposed on- and off-site sewer lines will comply with the County of Maui standards. The existing collection system (including Kihei Wastewater Pump Station Nos. 3, 4, 5 and 6) should have adequate capacity for flows generated by the proposed Kihei High School such that upgrades are not necessary (Munikiyo and Haraga, 2008). The County will formally determine if any upgrades are required after the Plan Review Application form is submitted. If upgrades are necessary to support the proposed Kihei High School, the DOE will be required to fund any mandatory off-site improvements to collection system.

It is anticipated that sewer service will be provided by the extension of the County System from an existing drop manhole in the intersection of Kulanihakoi Street and Mahealani Street in the Piilani Village subdivision approximately 300 feet from the proposed Kihei High School. The proposed sewer line would extend across Piilani Highway to an on-site property sewer service manhole. The DOE would be responsible for any required costs to connect to the County System. The on-site system will consist of gravity sewer mains to be located within roadways and sidewalks. The DOE will be responsible for maintenance of the on-site sewers, since the County will not accept sewer easements that traverse private property.

The wastewater flow projections for the project are based on land use areas, unit counts, and estimated enrollment using demand rates from the State HAR Chapter 11-62, Appendix F and the County of Maui, Wastewater Reclamation Division, *Wastewater Flow Standards*. The flow rate estimates in the table below factor in both wet and dry inflow and infiltration and peak flow factors, including a maximum peak flow factor of 5.

Table 4.1 – Wastewater Flow Projections

Year	Population (Students, Staff, and Visitors)	GPCD	Wastewater Flows (MGD)		
			Avg Flow	Max Flow	Design Peak
2015	250	25	0.01	0.03	0.13
2016	460	25	0.01	0.06	0.16
2017	730	25	0.02	0.09	0.19
2018	960	25	0.02	0.12	0.21
2025	1,915	25	0.05	0.21	0.32

Refer to Figure 5 for a conceptual sewer system plan and Appendix A for conceptual construction costs.

Chapter 5 – DRAINAGE

5.1 TOPOGRAPHY AND EXISTING DRAINAGE PATTERNS

The Kihei High School project site is currently undeveloped and consists of dry rolling foothills on west-facing lowland slopes of Haleakala in the Kihei area of Maui. Vegetation on the site is primarily grassland currently utilized for grazing, with scattered shrubs and trees. The project site ranges in elevation from about 30 feet mean sea level (MSL) at Piilani Highway, to an elevation of about 110 feet at the eastern boundary with slopes ranging from 2 to 8 percent.

Because the property is vacant there is no existing drainage system serving the site except for drainage infrastructure in Piilani Highway, which is owned and maintained by the Hawaii State Department of Transportation (HDOT). The majority of the existing runoff at the site drains towards a 72-inch diameter culvert under Piilani Highway. The remainder of the runoff drains into either Kulanihakoi Gulch or Waipuilani Gulch. Both gulches cross Piilani Highway under bridges spanning the gulches. These gulches are generally dry except after significant rainfall events.

5.2 SOILS

The U.S. Soil Conservation Service (SCS) Soil Survey (1972) has designated several different soil types at the project site (refer to Figure 6), including Alae sandy loam (AaB) and Waiakoa extremely stony silty clay loam (WID2).

The SCS describes the Alae series as moderately deep, well-drained soils that formed in material weathered from basic igneous rock. The slopes vary from nearly level to gently sloping with elevations ranging from 50 to 600 feet. The annual rainfall amounts to 12 to 20 inches. The mean annual soil temperature is 74°F. This sub-series are used for sugarcane and pasture with some small acreage used for truck crops. Permeability is rapid, runoff is slow, and the erosion hazard is no more than slight.

The SCS describes the Waiakoa series as of moderately deep, well-drained soils that formed in material weathered from basic igneous rock. The slopes vary from gently sloping to moderately steep with elevations ranging from 100 to 1,000 feet. The annual rainfall amounts to 12 to 20 inches; most of it occurs in winter. The mean annual soil temperature is 74°F. This sub-series are used for sugarcane, pasture, homes, and wildlife habitat. Permeability is moderate, runoff is medium, and the erosion hazard is severe. In most areas about 50 percent of the surface layer has been removed by erosion.

5.3 FLOOD HAZARDS

Based on the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (Map Number 1500030586E dated September 25, 2009), the project site is located Flood Zone X (refer to Figure 7). Flood Zone X refers to areas determined to be outside the 0.2% annual chance floodplain.

5.4 EXISTING HYDROLOGY

The Kihei coast is known to be sunny, warm, and dry throughout the year. Annual temperatures for the Kihei region average in the mid to high 70s (degrees F). Average rainfall distribution in the region varies from under 10 inches per year along the coastline to more than 20 inches per year at higher elevations. Rainfall in Kihei is highly seasonal with most precipitation occurring

during the winter months. The neighboring Kulanihakoi and Waipuilani Gulches are normally dry except during heavy rainfall events. Northeast trade winds prevail in Kihei most of the year. Trade winds out of the northeast average 10 to 15 miles per hour prevail during the afternoon with lighter winds during the morning and evening. Occasionally southerly winds from Kona occur during the months of October and April.

According to the Trans-Meridian Engineers Hydrology report (no date) for the HDOT's Piilani Highway, the site extends over three drainage basins labeled as 8, 9 and 10 (refer to Figure 8). Basins 8 and 10, which contain Kulanihakoi and Waipuilani Gulches, respectively, extend from bridges crossing Piilani Highway up to Haleakala South West Rift Zone. Basin 9 encompasses a small area between the gulches which empties into the existing 72-inch culvert under Piilani Highway. Since the report was completed in the 1970s, the current Maui Drainage Standards (refer to section 3.1 below) were applied to the basin parameters to obtain updated existing peak flows (refer to Table 5.1 below and Appendix A).

Table 5.1 – Preliminary Analysis of Existing Basins (NRCS Hydrograph Method based on 24-hour Storm)

Basin No.	Area (Acres)	CN	Tc (Min)	Q(50) (cfs)	Q(100) (cfs)	Outlet
8	9,649	73	99	9,762	12,330	Kulanihakoi Bridge
9	142	79	26	367	450	72-inch Culvert
10	7,314	73	96	7,547	9,532	Waipuilani Bridge

5.5 DESIGN CRITERIA

The proposed drainage systems hydrologic criteria should be in accordance with County Standards with the exception of applying National Oceanic and Atmospheric Administration (NOAA) Atlas 14 Volume 4 Version 2.1 (2009) in lieu of Plates 2, 4 and 7 (Intensity Duration Curves and Rainfall Intensity Maps). Plates 2, 4 and 7 of the County Drainage Standards are based on the U.S. Department of Commence Technical Paper 43, Rainfall Frequency Atlas of the Hawaiian Islands (TP-43) published in 1962. The intensity-duration-frequency (IDF) curves and isopluvial (rainfall intensity) maps in NOAA Atlas 14 Volume 4 Version 2.1 was the result of interpolation of frequency estimates of a larger sample of rain stations with longer years of record than TP-43. Hence, NOAA Atlas 14 Volume 4 Version 2.1 portrays a more accurate representation of the rainfall intensity than the current County of Maui Drainage Standards.

The on-site drainage system should be designed for runoff determined by the rational method for 1-hour rainfall with return periods of 10 years or 50 years per the County of Maui Drainage Standards. The rational method is based on the drainage area, runoff coefficient (ground cover conditions), and the rainfall intensity for duration equal to the time of concentration. Since the project site is less than 100 acres and contain potential sumps, the 50-year return period should be used to calculate the on-site runoff.

During the design phase, the Design-Build Entity should review of the effects of the proposed school development on neighboring gulches, bridges and downstream properties (Basins 8 and 10 as described in Section 5.4). It should be noted that the offsite basins drainage area exceeds 100 acres, therefore, the National Resource Conservation Service (NRCS, formerly SCS) hydrograph method for 100-year return period based on 24-hour rainfall should be considered during the design phase. The NRCS hydrograph method uses watershed characteristics (drainage area, time of concentration, rainfall, SCS curve number of the landuse

or soil group, and a SCS design storm based on geographic locale) to develop a runoff hydrograph.

Since the existing undeveloped site will be replaced with impervious surfaces, an on-site basin is necessary to regulate the increase in runoff into the existing 72-inch culvert under Piilani Highway. The basin should be designed in accordance with County Drainage Standards which stipulate that the storage volume of the basin shall be equal to at least the total additional runoff volume for a 50-year return period based on a 1-hour storm. Additionally, the Design-Build Entity could incorporate the current requirements of the United States Green Building Council (USGBC) in the basin design which may allow for possible Leadership in Excellence and Environmental Design (LEED) Site Sustainability credits.

In addition, the Maui County Public Works Engineering Division and R.M. Towill Corporation are preparing a drainage master plan for Kihei with a draft scheduled for release in 2012. During design, the design-build team should prepare a drainage report that that describes the project's overall drainage concept and incorporates the storm water management strategies in accordance with any recommendations of the forthcoming Kihei drainage master plan. The drainage report should include: analysis of existing conditions, storm water system sizing criteria, detention/retention analysis, flood analysis, drainage system plans, and hydraulic calculations. As part of the approval process for this project, the drainage report should be submitted to both the County of Maui and HDOT and include any additional criteria per the respective drainage standards.

5.6 PROPOSED CONCEPTUAL DRAINAGE PLAN

The proposed drainage system will consist of the following improvements:

- The off-site drainage improvements are intended to divert runoff generated above the proposed Kihei High School into the neighboring Waipuilani Gulch.
- The on-site drainage system should be designed to safely convey on-site runoff into the basin and prevent runoff entering Piilani Highway.
- The on-site basin should be designed to reduce post-development flow rates and quantity to below pre-development levels.
- The 7.7-acre parcel formed by the extension of Kulanihakoi Street will remain vacant; there will not be any drainage improvements constructed within the parcel at this time.

5.6.1 OFF-SITE DRAINAGE CONCEPT

The proposed school site occupies portions of Basins 8, 9, and 10 as described above. The majority of the school site is situated within the lower portion of Basin 9. The runoff from the remainder Basin 9 and portions of Basin 10 will be intercepted by a proposed ditch constructed along the Kihei High School upper boundary and diverted into Waipuilani Gulch (refer to Figures 9 and 10). The proposed ditch should be designed in accordance with County Drainage Standards with appropriate freeboard and velocity dissipation. Based on the conceptual site plan, it is anticipated that the ditch will be a 5-foot wide reinforced concrete channel with an approximate wall height of 8 feet. Final design and dimensions will be determined by the design-build team.

Before the ditch is designed, it is likely that the DOE will need to obtain permission and easements from Haleakala Ranch to grade and construct the ditch in their property. If DOE cannot obtain permission, the runoff from the upper portion of Basin 9 must be conveyed through the proposed Kihei High School site. The result would increase construction cost due to larger and more extensive on-site drainage infrastructure.

The effects of the additional flow into Waipuilani Gulch are quantified in Table 5.2 and Appendix B using Hydroflow Hydrographs Extension by Autodesk. In summary, the increase in off-site runoff will be less than 1% after the school is constructed:

Increase in area = 7,379 – 7,314 Acres
= 65 Acres (< 1%)

Increase in Q_{50} = 7,571 – 7,547 CFS
= 24 CFS (< 1%)

Increase in Q_{100} = 9,561 – 9,532 CFS
= 29 CFS (< 1%)

Table 5.2 – Preliminary Analysis of Waipuilani Gulch
(NRCS Hydrograph Method based on 24-hour Storm)

Basin Description	Area (Acres)	CN	Tc (min)	Q_{50} (CFS)	Q_{100} (CFS)
1. Post-Development Flows Above School Site	85	79	19	256	314
2. Post-Development Flows Entering Waipuilani Gulch	7,294	73	96	7,527	9,506
3. Post-Development Flows Entering Waipuilani Bridge	7,379	N/A	N/A	7,571	9,561
4. Pre-Development Flows Entering Waipuilani Bridge	7,314	73	96	7,547	9,532

5.6.2 ON-SITE DRAINAGE CONCEPT

On-site storm water runoff will sheet flow or be directed by grassed swales/gutters into drain inlets and pipes. Due to on-site sumps, the underground drainage system should be sized to convey the 50-year runoff quantities with a 1-foot freeboard allowance. The underground drainage system should drain into a detention basin before entering the existing 72-inch culvert under Piilani Highway (refer to Figure 10 for a conceptual drainage plan and Appendix A for preliminary cost estimates). On-site grading of the proposed Kihei High School site near Piilani Highway should direct runoff into on-site inlets and/or the detention basin. It is likely that the HDOT will not allow any additional runoff on to Piilani Highway.

5.6.3 ON-STE BASIN CONCEPT

Based on the conceptual campus site plan, a possible location for the basin is the lower end of the property adjacent to Piilani Highway (refer to Figures 2 and 10). The final basin location, geometry, and dimensions will be determined by the design-build team. It should be noted that the on-site basin will be designed to meet County Standards. Discharge into existing 72-inch diameter culvert must be regulated and controlled and the basin must be sized to handle the total additional runoff volume or more. As mentioned in Section 5.5 – Design Criteria, the basin could be designed to satisfy LEED Site Sustainability Credit requirements. The conceptual basin geometry and sizing are as follows:

- 90 feet wide/480 feet long
- Overall depth of 10 feet
- Side slopes at 3H:1V
- Minimum 10-foot overflow weir crest length

- Weir crest above 100-year water surface elevation
- 12-foot wide access road

A preliminary hydrologic and hydraulic analysis of the basin based on the above dimensions may be found in Appendix D. A summary of the results are shown in Table 5.3 below; approximate water surface and invert elevations are depicted in Figure 11.

Table 5.3 – Preliminary Basin Analysis
(NRCS Hydrograph Method based on 24-hour Storm)

School Site Condition	CN	Tc (min)	Q_1 (CFS)	$Volume_1$ (CF)	Q_2 (CFS)	$Volume_2$ (CF)	Q_{50} (CFS)
Existing Condition	79	13.5	20	150,428	47	294,327	248
Developed Condition	86	23	35	252,362	64	436,632	251
Flow Leaving Basin	N/A	N/A	3	107,021	10	291,292	129

The preliminary analysis demonstrates that LEED Site Sustainability Credit can be satisfied, since the post-development flows will not exceed existing flows, and that the additional runoff volume generated by the 2-year storm can be adequately retained in the bottom 3 feet of the basin.

5.7 BEST MANAGEMENT PRACTICES (BMPs)

The inland waters near the property are designated as Class 2 by the State of Hawaii Department of Health (DOH) and are not listed in the Clean Water Act §303(d) list (impaired waters bodies that do not meet State Water Quality Standards). According to DOH Water Quality Standards, "The objective of Class 2 waters is to protect their use for recreational purposes, the support and propagation of aquatic life, agricultural and industrial water supplies, shipping, and navigation" (HAR §11-54-03(b)(2)). Discharges into Class 2 inland waters qualifies for coverage under National Pollutant Discharge Elimination System (NPDES) General Permit which calls for the application of permanent and construction Best Management Practices (BMPs).

Best Management Practices (BMPs) are pollution control measures, applied to nonpoint sources, on-site or off-site, to control erosion and the transport of sediments and other pollutants which have an adverse impact on waters of the state. Construction BMPs are temporary measures installed before construction commences and removed once the site has been stabilized and permanent BMPs are in place. Potential construction BMPs include, but are not limited to gravel entrance, dust screen, silt fence, retention basins, diversion berm/ditches, and grading procedures that conform to Maui County Code Chapter 20.08 – Soil Erosion and Sediment Control.

Unlike construction BMPs, permanent BMPs are designed to remain part of the project features after the site grading operation is completed. The permanent BMPs are intended to reduce storm water pollution typically associated with the increased impervious surfaces. Examples of permanent BMPs include gravity separators before each outlet, grass swales, infiltration trenches, vegetative filter strips, maximize open space, and the use of on-site soil general or yard fill. Permanent BMPs may also qualify for LEED credit if they meet the criteria in Site Sustainability Credit 6.2 – Storm water Design – Quality Control.

In addition, DWS recommends the following BMPs to protect underlying the Kamole Aquifer (Munekiyo and Haraga, 2008):

- Prevent cement products, oil, fuel and other toxic substances from falling or leaching into the water.
- Properly and promptly dispose of all loosened and excavated soil and debris material from drainage structure work.
- Retain ground cover until the last possible date.
- Stabilize denuded areas by sodding or planting as soon as possible. Replanting should include soil amendments and temporary irrigation. Use high seeding rates to ensure rapid stand establishment.
- Avoid fertilizers and biocides, or apply only during periods of low rainfall to minimize chemical runoff.
- Keep run-off on-site.
- Use brackish or reclaimed water for irrigation and dust control during construction where available.

Increase in runoff rates resulting from the development will be mitigated by the proposed retention/detention basin and the implementation of Best Management Practices. As a result, the proposed project should not an adversely impact nearshore waters.

Chapter 6 – POTENTIAL APPROVALS AND PERMITS

6.1 OVERVIEW

This section outlines potential approvals and permits that may be applicable to the civil work on the conceptual site plan. This section does not include approvals and permits required by other disciplines (electrical, environmental review process, historic preservation, land use, etc.) as they will be addressed by others. It should be noted that additional approvals and permits maybe required depending on the final layout by the design-build team.

6.2 FEDERAL

- Department of the Army
  - Section 404 of the Clean Water Act Permit for the discharge of dredged or fill material in the waters of the United States associated with work within Waipuilani Gulch.

6.3 STATE OF HAWAII

- State Department of Health
  - Air pollution Control permit.
  - Community Noise Permit for Construction Activities.
  - Disability and Communication Access Board review for compliance with Hawaii Revised Statutes §103-50.
  - National Pollutant Discharge Elimination System (NPDES) General Permit Coverage for discharges of storm water associated with construction activities into State Waters.
  - NPDES General Permit Coverage for discharge of water system hydrotesting into State Waters.
  - Section 401 of the Clean Water Act to certify that discharges authorized by the Section 404 permit will not violate the state's water quality standards.

- State Department of Land and Natural Resources Commission on Water Resource Management
  - Stream Channel Alteration Permit for the construction of a ditch and outlet within Waipuilani Gulch.
  - Pump Installation Permit for the installation of brackish well pumps.
  - Well Construction Permit for the installation of brackish wells for landscaping.

- State Department of Transportation Highways Division
  - Construction Plan Review for conformance with the State Highway standards.
  - Permit to perform work within a State Right-of Way.
  - Discharge Permit for work that will generate construction runoff into the State Highway drainage system.
  - Drainage report review to address the impacts to changes in flow patterns and quantity to the State Highways system.
  - Permit for Connection to the State Highways Drainage System.
  - Permit to Transport of Oversize and Overweight Vehicle on State Highways.

6.4 COUNTY OF MAUI

- Department of Environmental Management
  - Construction Plan Review for conformance with County wastewater standards.
  - Wastewater Permit for connection to the County wastewater system.

- Department of Fire and Public Safety
  - Construction Plan Review for conformance with County fire standards.
  - Fire Protection Permit for water mains for fire protection and fire hydrants.

- Department of Public Works
  - Building Permit for site work.
  - Construction Plan Review for conformance with County standards.
  - Drainage report review to address the impacts to changes in flow patterns and quantity to downstream/neighboring properties and any County drainage system.
  - Grading Permit for excavation, embankment, and temporary storage of soil.
  - Grubbing Permit for the removal of vegetation.
  - Moving Permit for the transport of oversized and or overweight vehicles on County roads.
  - Permit to Perform Work on a County highway for trenching and utility installation on County owned roads.

- Department of Water Supply
  - Approval to connect to the County water system.
  - Construction Plan Review for conformance with the County water system standards.

6.5 OTHER PERMITS AND APPROVALS

- Kaonoulu Ranch LLP and Haleakala Ranch Company
  - Right-of-entry.
  - Permission to grade within ranch property.
  - Permission to construct improvements within ranch property.

- Utility Company approvals.

- Various easements.

Chapter 7 – REFERENCES

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Flood Hazard Assessment Tool
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Soil Data Mart
http://soildatamart.nrcs.usda.gov/

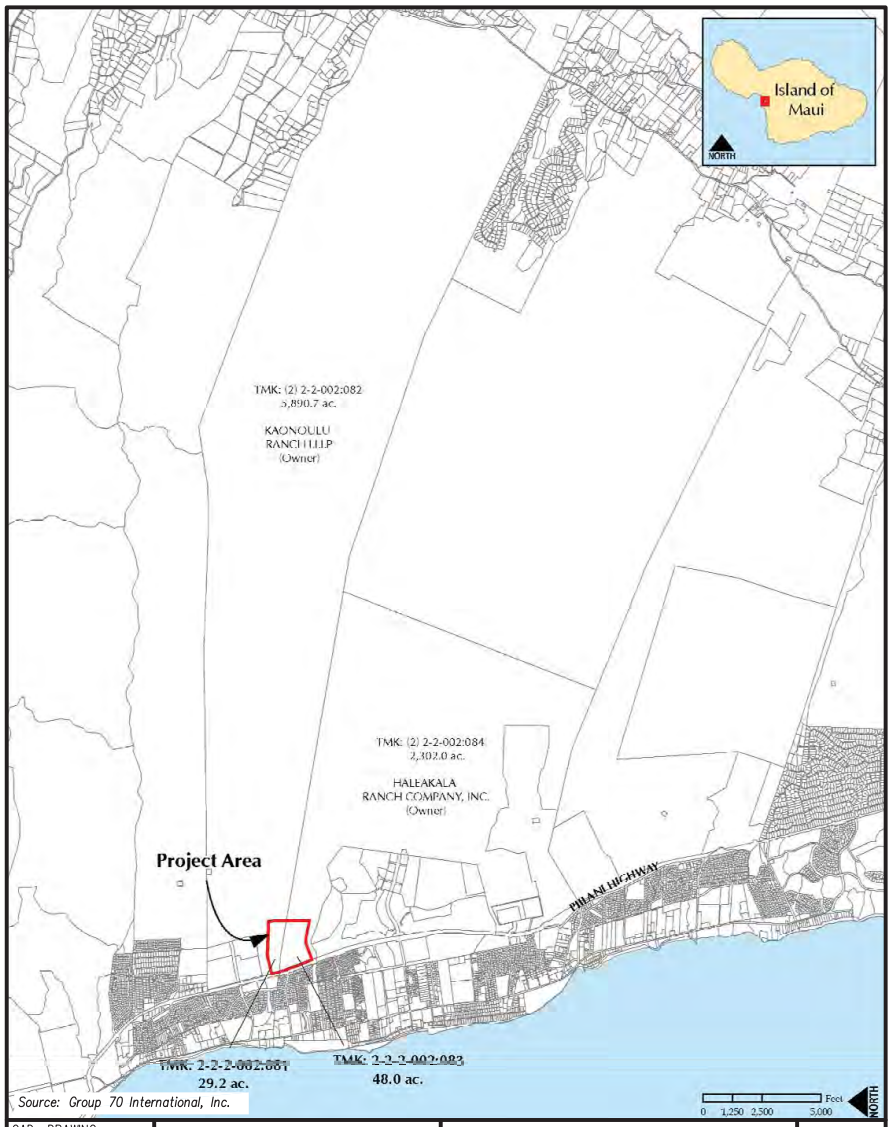
U.S. Federal Emergency Management Agency
FEMA Map Service Center
http://msc.fema.gov/

U.S. National Oceanic and Atmospheric Administration, National Weather Service
HDSC Precipitation Frequency Data Server
http://hdsc.nws.noaa.gov/hdsc/pfds/hi/hi_pfds.html

LIST OF FIGURES

CAD DRAWING: 2995-00 FIG 1-LOC DATE: AUGUST 31, 2011 SCALE: AS SHOWN PROJECT #: 2995-00	LOCATION MAP	Gray, Hong, Nojima & Associates, Inc. CONSULTING ENGINEERS 201 Merchant Street, Suite 1900 Honolulu, Hawaii 96813 Fax: (808) 531-8018 Telephone: (808) 521-0306	FIGURE 1

CAD DRAWING: 2995-00 FIG 2-SITE DATE: AUGUST 18, 2011 SCALE: AS SHOWN PROJECT #: 2995-00	PROPOSED CAMPUS SITE PLAN	Gray, Hong, Nojima & Associates, Inc. CONSULTING ENGINEERS 201 Merchant Street, Suite 1900 Honolulu, Hawaii 96813 Fax: (808) 531-8018 Telephone: (808) 521-0306	FIGURE 2



CAD DRAWING: 2995-00 FIG 3-TMK DATE: SEPT 9, 2011 SCALE: AS SHOWN PROJECT #: 2995-00	TAX MAP KEY	Gray, Hong, Nojima & Associates, Inc. CONSULTING ENGINEERS 201 Merchant Street, Suite 1900 Honolulu, Hawaii 96813 Fax: (808) 531-8018 Telephone: (808) 521-0306	FIGURE 3

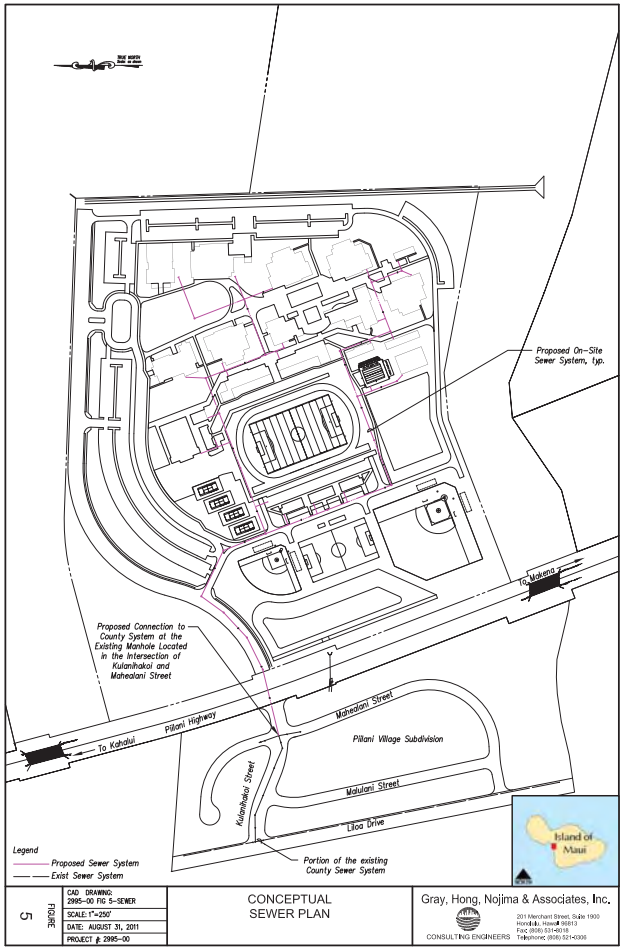


FIGURE 5			
	CAD DRAWING: 2995-00 FIG 5-SEWER	CONCEPTUAL SEWER PLAN	Gray, Hong, Nojima & Associates, Inc.
	SCALE: 1"=250'		201 Merchant Street, Suite 1900 Honolulu, Hawaii 96813 Fax: (808) 531-4616 CONSULTING ENGINEERS Telephone: (808) 521-4306
	DATE: AUGUST 31, 2011		
	PROJECT # 2995-00		

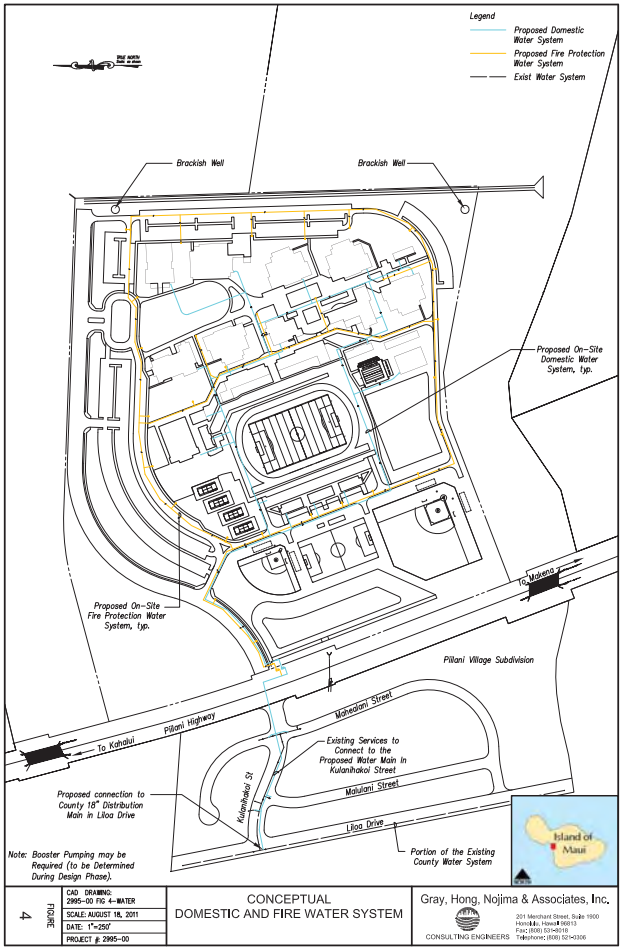
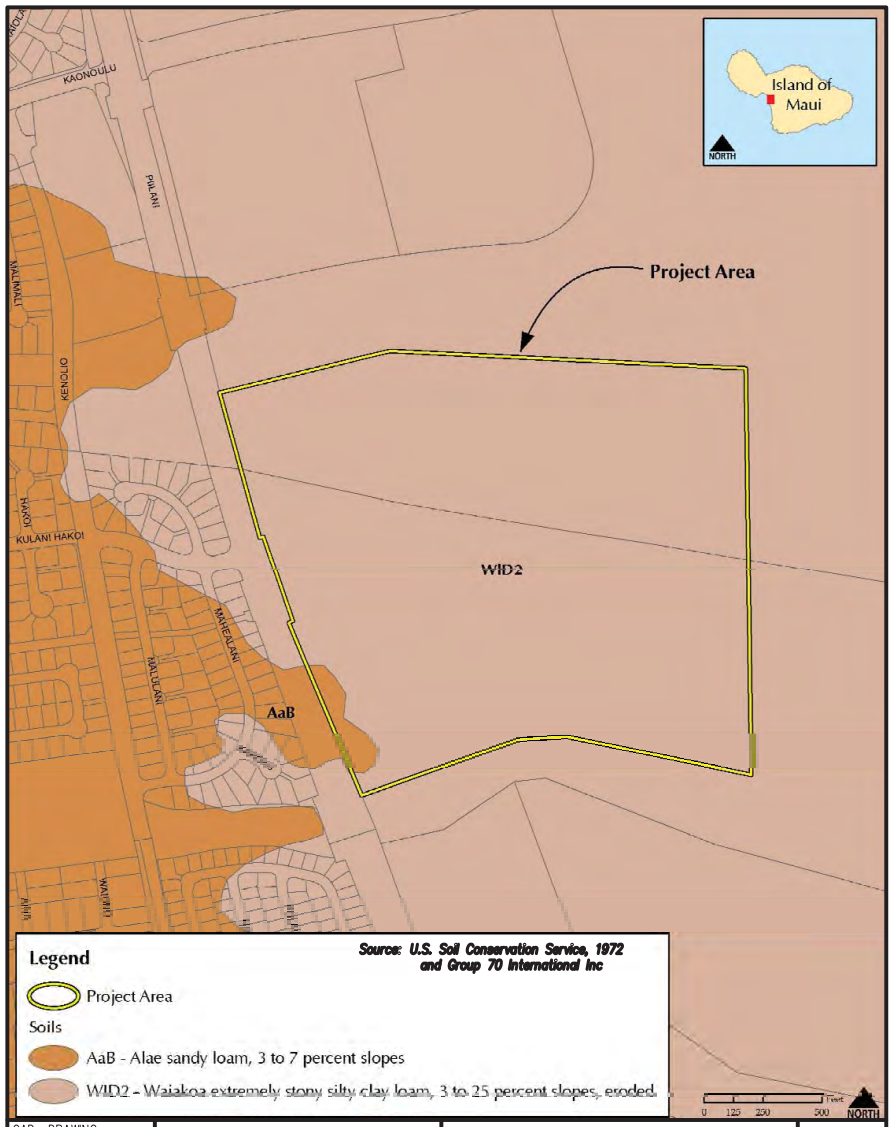
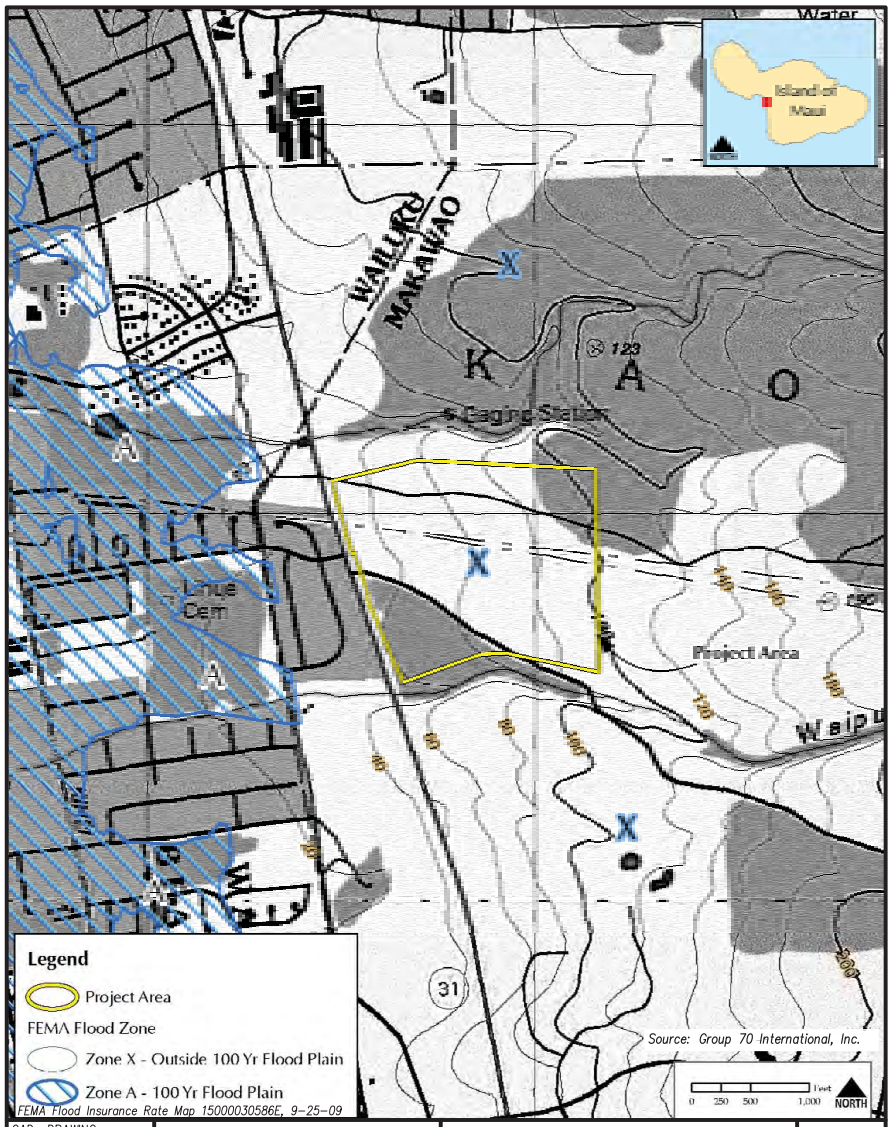


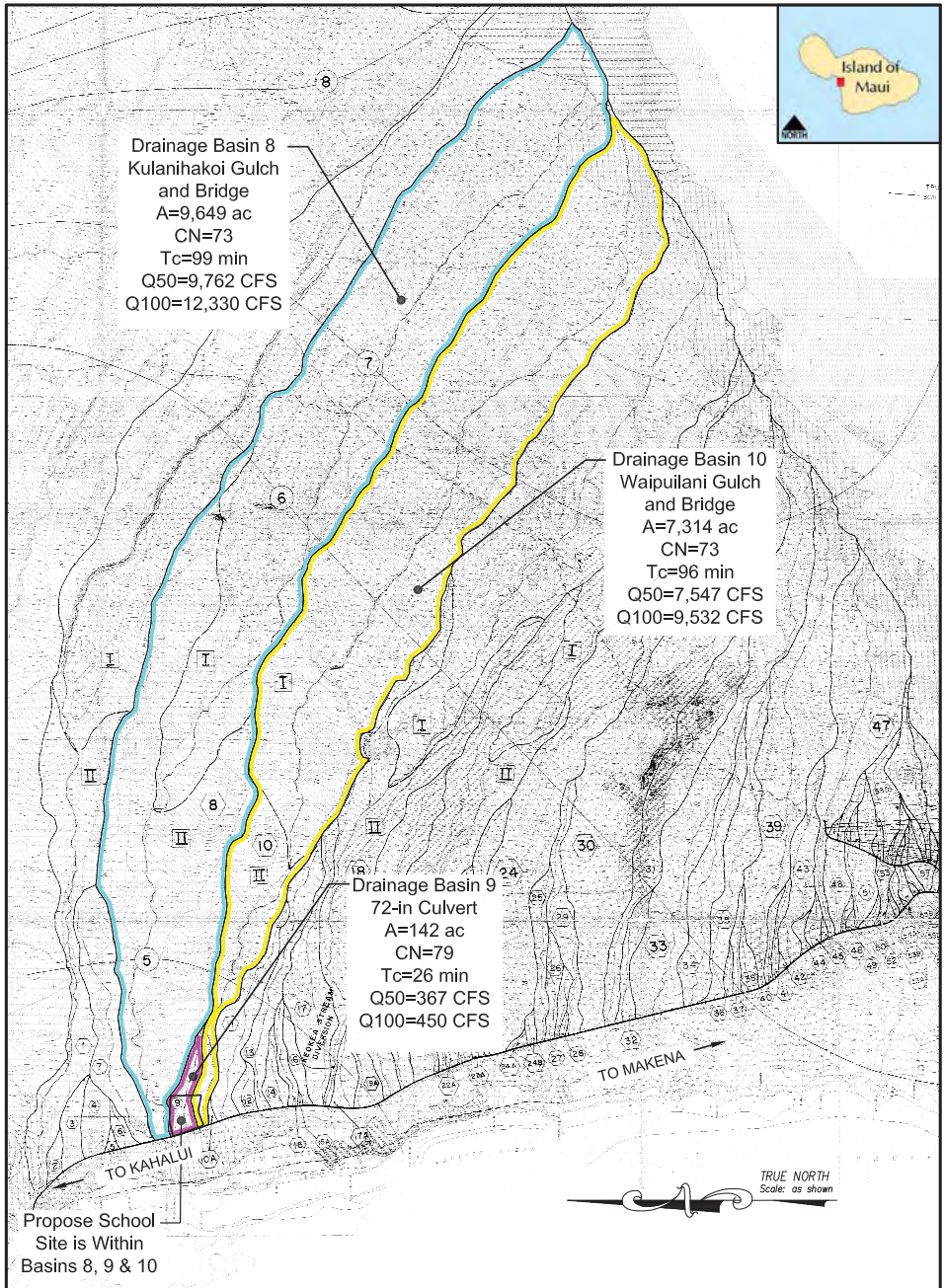
FIGURE 4			
	CAD DRAWING: 2995-00 FIG 4-WATER	CONCEPTUAL DOMESTIC AND FIRE WATER SYSTEM	Gray, Hong, Nojima & Associates, Inc.
	SCALE: AUGUST 16, 2011		201 Merchant Street, Suite 1900 Honolulu, Hawaii 96813 Fax: (808) 531-4616 CONSULTING ENGINEERS Telephone: (808) 521-4306
	DATE: 1"=250'		
	PROJECT # 2995-00		



CAD DRAWING: 2995-00 FIG 6-SOIL DATE: AUGUST 31, 2011 SCALE: AS SHOWN PROJECT #: 2995-00	SOILS MAP	Gray, Hong, Nojima & Associates, Inc. CONSULTING ENGINEERS 201 Merchant Street, Suite 1900 Honolulu, Hawaii 96813 Fax: (808) 531-8018 Telephone: (808) 521-0306	FIGURE 6



CAD DRAWING: 2995-00 FIG 7-FLOOD DATE: AUGUST 31, 2011 SCALE: AS SHOWN PROJECT #: 2995-00	FLOOD MAP	Gray, Hong, Nojima & Associates, Inc. CONSULTING ENGINEERS 201 Merchant Street, Suite 1900 Honolulu, Hawaii 96813 Fax: (808) 531-8018 Telephone: (808) 521-0306	FIGURE 7



Source: Trans-Meridian Engineers and Surveyors, Inc.

FIGURE 8	CAD DRAWING: 2995-00 FIG 8-EXIST RUNOFF SCALE: AUGUST 31, 2011 DATE: 1"=250' PROJECT #: 2995-00	EXISTING (PRE-DEVELOPMENT) RUNOFF MAP	Gray, Hong, Nojima & Associates, Inc. CONSULTING ENGINEERS Honolulu, Hawaii 96813 201 Merchant Street, Suite 1900 Fax: (808) 531-8016 Telephone: (808) 521-0306

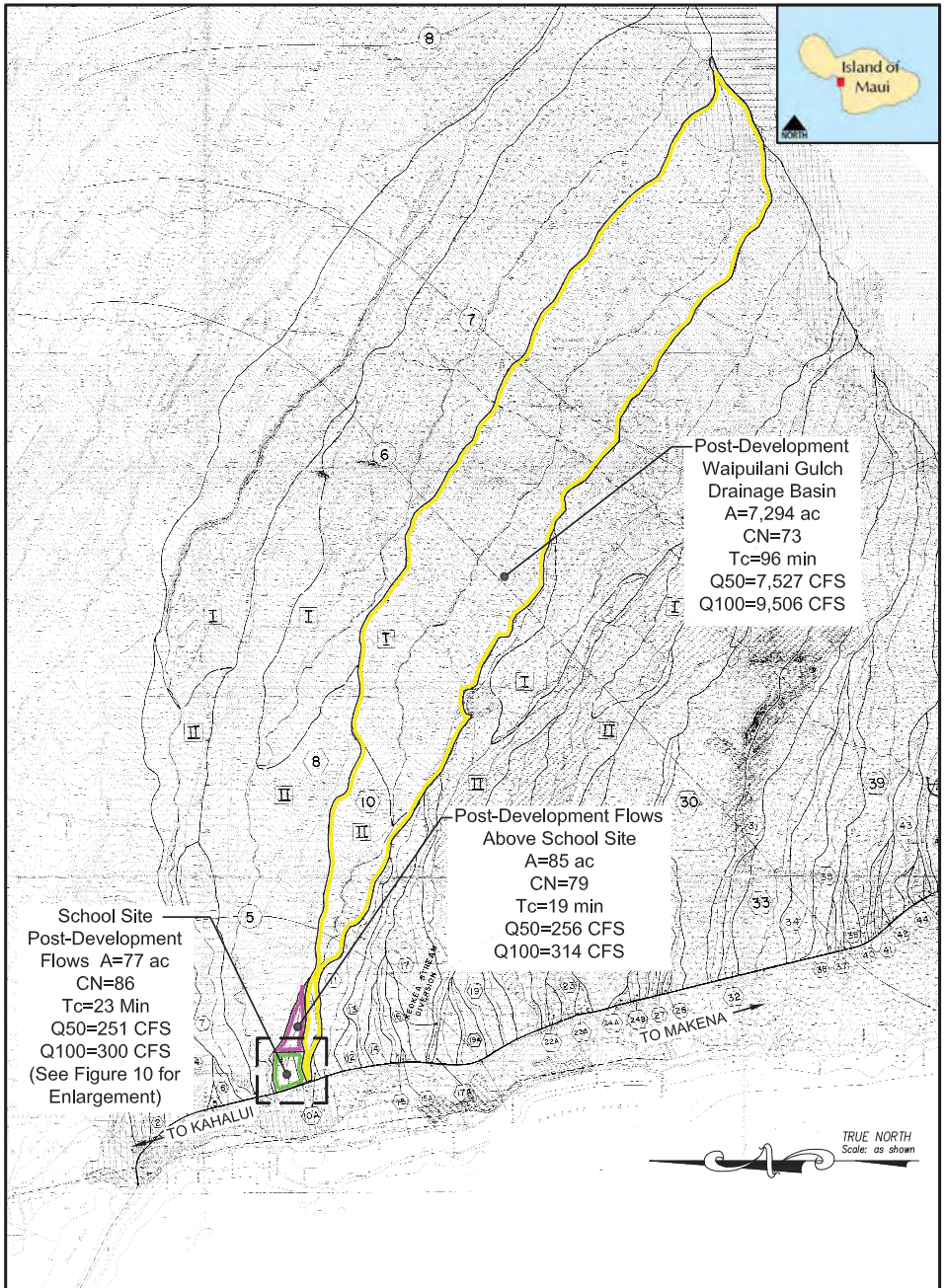
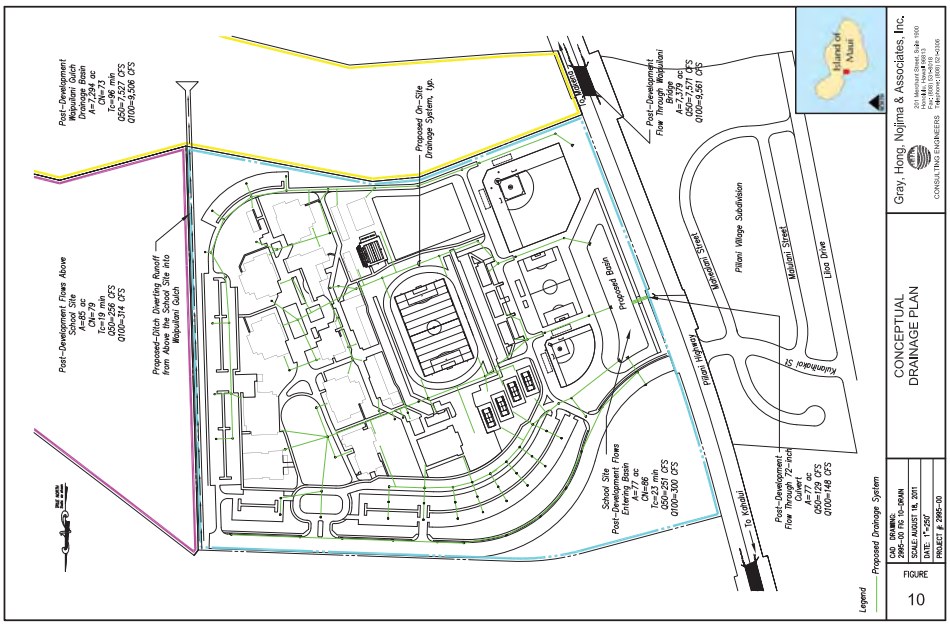
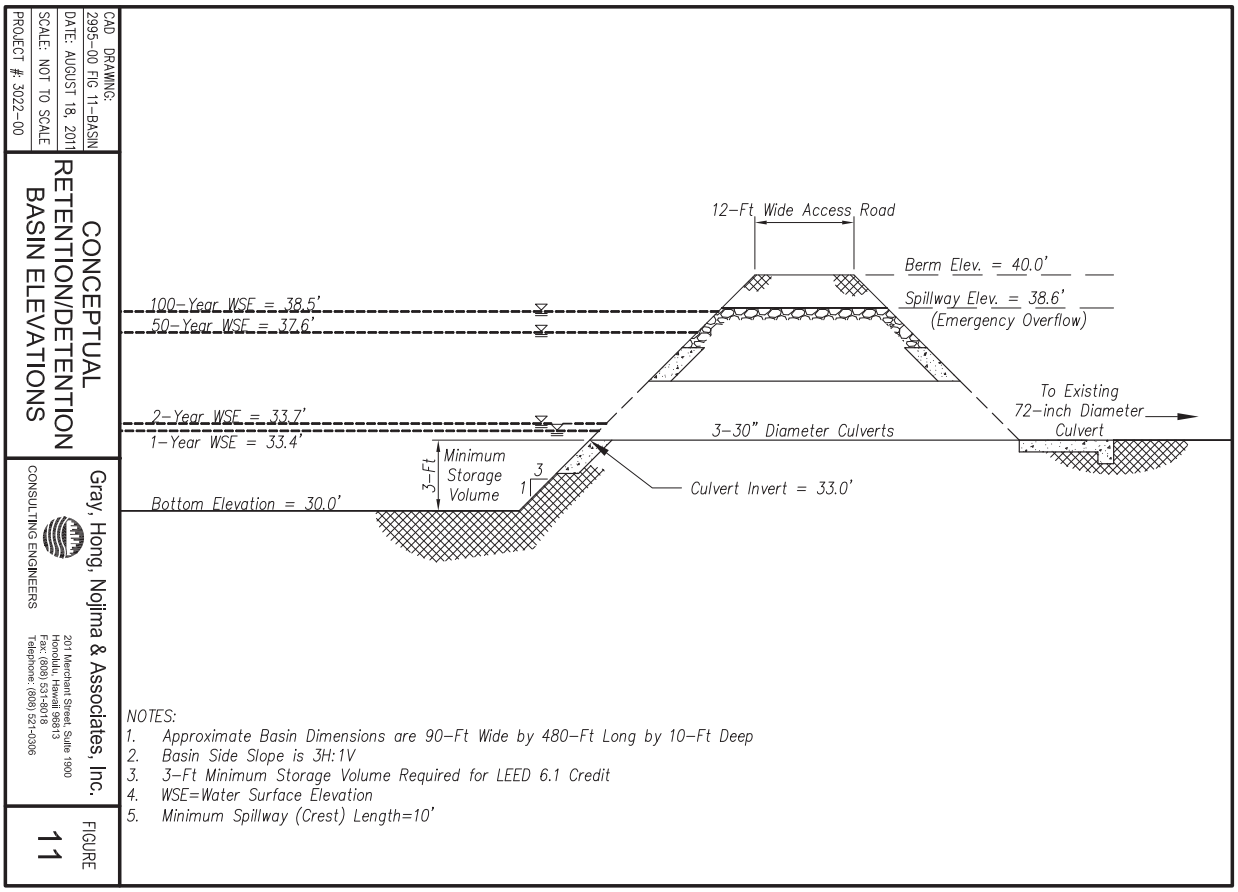


FIGURE 9	CAD DRAWING: 2995-00 FIG 9-DEV RUNOFF SCALE: AUGUST 18, 2011 DATE: 1"=250' PROJECT #: 2995-00	POST-DEVELOPMENT RUNOFF AREA	Gray, Hong, Nojima & Associates, Inc. CONSULTING ENGINEERS Honolulu, Hawaii 96813 201 Merchant Street, Suite 1900 Fax: (808) 531-8016 Telephone: (808) 521-0306


Post-Development Waipuilani Gulch Drainage Basin A=22.2 ac Tc=96 min Q50=127 CFS Q100=9,506 CFS
Post-Development Flows Above School Site A=85 ac Tc=9 min Q50=256 CFS Q100=314 CFS
Proposed Ditch Diverting Runoff from Above the School Site into Waipuilani Gulch
Proposed On-Site Drainage System, Typ.
Proposed Basin
School Site Post-Development Flows Entering Basin A=7 ac Tc=23 min Q50=200 CFS Q100=300 CFS
Post-Development Flow Through Waipuilani Bridge A=2,729 ac Q50=7,571 CFS Q100=9,561 CFS
Post-Development Flow Through 72-inch Culvert A=1 ac Q50=129 CFS Q100=148 CFS
Waipuilani Gulch
Waiohuli Stream
Pilani Village Subdivision
Waiohuli Street
Lipoa Drive
Kulanihakoi St
To Kihahli
Island of Maui
Legend
Proposed Drainage System
Gray, Hong, Nojima & Associates, Inc.
201 Merchant Street, Suite 1900
Honolulu, Hawaii 96813
Telephone: (808) 521-0306
CONSULTING ENGINEERS
CONCEPTUAL DRAINAGE PLAN
CAD DRAWING: 2995-00 FIG 10-DRAIN
SCALE: AUGUST 18, 2011
DATE: 1"=250'
PROJECT # 2995-00
FIGURE
10


CONCEPTUAL RETENTION/DETENTION BASIN ELEVATIONS
CAD DRAWING: 2995-00 FIG 11-BASIN
DATE: AUGUST 18, 2011
SCALE: NOT TO SCALE
PROJECT #: 3022-00
Gray, Hong, Nojima & Associates, Inc.
CONSULTING ENGINEERS
201 Merchant Street, Suite 1900
Honolulu, Hawaii 96813
Fax: (808) 531-8018
Telephone: (808) 521-0306
FIGURE
11
12-Ft Wide Access Road
Berm Elev. = 40.0'
Spillway Elev. = 38.6'
(Emergency Overflow)
100-Year WSE = 38.5'
50-Year WSE = 37.6'
2-Year WSE = 33.7'
1-Year WSE = 33.4'
Bottom Elevation = 30.0'
3-Ft
Minimum Storage Volume
3
1
3-30" Diameter Culverts
Culvert Invert = 33.0'
To Existing 72-inch Diameter Culvert
NOTES:
1. Approximate Basin Dimensions are 90-Ft Wide by 480-Ft Long by 10-Ft Deep
2. Basin Side Slope is 3H:1V
3. 3-Ft Minimum Storage Volume Required for LEED 6.1 Credit
4. WSE=Water Surface Elevation
5. Minimum Spillway (Crest) Length=10'

APPENDICES

APPENDIX A

Conceptual Construction Costs

APPENDIX B

Preliminary Analysis of Existing Basins

KIHEI HIGH SCHOOL **10/31/11**
Kihei, Maui, Hawaii

CONCEPTUAL CONSTRUCTION COSTS

Item	Description	Quantity	Unit	Unit Price	Total
	ON-SITE				
1	Clearing	**71**	ACS	$11,000	**$781,000**
2	Erosion and Dust Control	**71**	ACS	$27,500	**$1,952,500**
3	Excavation	**250,000**	CY	$15	**$3,750,000**
4	Embankment	**330,000**	CY	$15	**$4,950,000**
5	Concrete Walkways	**399,100**	SF	$12	**$4,789,200**
6	AC Pavement	**61,200**	SY	$50	**$3,060,000**
7	Curb/Gutter	**4,700**	LF	$30	**$141,000**
8	On-site Driveway Curb	**20,900**	LF	$15	**$313,500**
	Sewer System				
9	Sewer Main	**4,200**	LF	$110	**$462,000**
10	Sewer Lateral	**1,520**	LF	$110	**$167,200**
11	Manhole	**20**	EA	$7,700	**$154,000**
12	Cleanouts	**22**	EA	$800	**$17,600**
	Drainage System				
13	Drainlines	**12,700**	LF	$160	**$2,032,000**
14	Drain Laterals	**3,800**	LF	$80	**$304,000**
15	Catch Basins	**13**	EA	$12,100	**$157,300**
16	Drain Inlets	**120**	EA	$6,600	**$792,000**
17	Area Drains	**9**	EA	$820	**$7,380**
18	Detention Pond Outlets	**6**	EA	$24,200	**$145,200**
19	Detention Pond Culvert	**240**	LF	$380	**$91,200**
20	Detention Pond Weir/Spillway	**1**	LS	$33,000	**$33,000**
	Water System				
21	Domestic Water Main	**4,500**	LF	$100	**$450,000**
22	Domestic Water Lateral	**1,800**	LF	$100	**$180,000**
23	Domestic Water Meter Box	**1**	EA	$11,000	**$15,000**
24	Domestic Water Backflow Preventer	**1**	EA	$11,000	**$15,000**
25	Fire Protection Water Main	**9,000**	LF	$120	**$1,080,000**
26	Fire Hydrant	**34**	EA	$4,400	**$149,600**
27	Fire Protection Double Check Detector	**1**	EA	$33,000	**$33,000**
28	Fire Protection System Pumps & Controls	**2**	EA	$120,000	**$240,000**
29	Fire Protection Storage Tank	**1**	EA	$400,000	**$400,000**
30	Domestic Water System Pump & Controls	**2**	EA	$50,000	**$100,000**
31	Domestic Water Storage Tank	**1**	EA	$250,000	**$250,000**
	Non-Potable Well Development				
32	Drilling and Testing	**2**	EA	$160,000	**$320,000**
33	Pump and Controls	**2**	EA	$160,000	**$320,000**
				Subtotal	**$27,652,680**
	OFF-SITE				
34	Concrete Channel and Outlet	**2,000**	LF	$660	**$1,320,000**
35	Domestic Water Main	**3,000**	LF	$100	**$300,000**
36	Sewer Main	**300**	LF	$110	**$33,000**
37	Underground Electrical	**300**	LF	$330	**$99,000**
38	Highway Improvements	**1**	LF	$2,090,000	**$2,090,000**
39	Additional offsite development	**1**	LS	$27,500	**$27,500**
				Subtotal	**$3,869,500**
				Total	**$31,522,180**
					$32 M

Assumptions/Exclusions

1 - The scope of work for the off-site improvements items 34-39 is unknown at this time, therefore, unit cost and quantities to be determined during design-build process.

2 - Potable water system improvements for source, storage and transmission are not required. Off-site improvements limited to installation of waterline as shown on item 35.

3 - Nonpotable brackish water system improvements are limited to well development/installation. Irrigation distribution system not included.

4 - Construction cost estimates for off-site drainage improvements are limited to concrete channel and outlet.

5 - Construction cost estimates for the proposed heat rejection system including source, storage and distribution are not included.

6 - The scope of work for improvements to the 7.7 acre overflow lot (parcel) is unknown, therefore, construction cost estimates have not been included.

7 - On-site improvements for security requirements (e.g. fencing) are not included.

8 - Costs for site electrical/communications are not included.

9 - Costs for landscaping and irrigation are not included.

10 - Kulanihakoi Street/Piilani Highway Intersection improvements limited to curb, gutter and sidewalk on one side. Traffic signalization and Piilani Highway Improvements are not included.

11 - Onsite roadways assumed to have curb (no gutter).

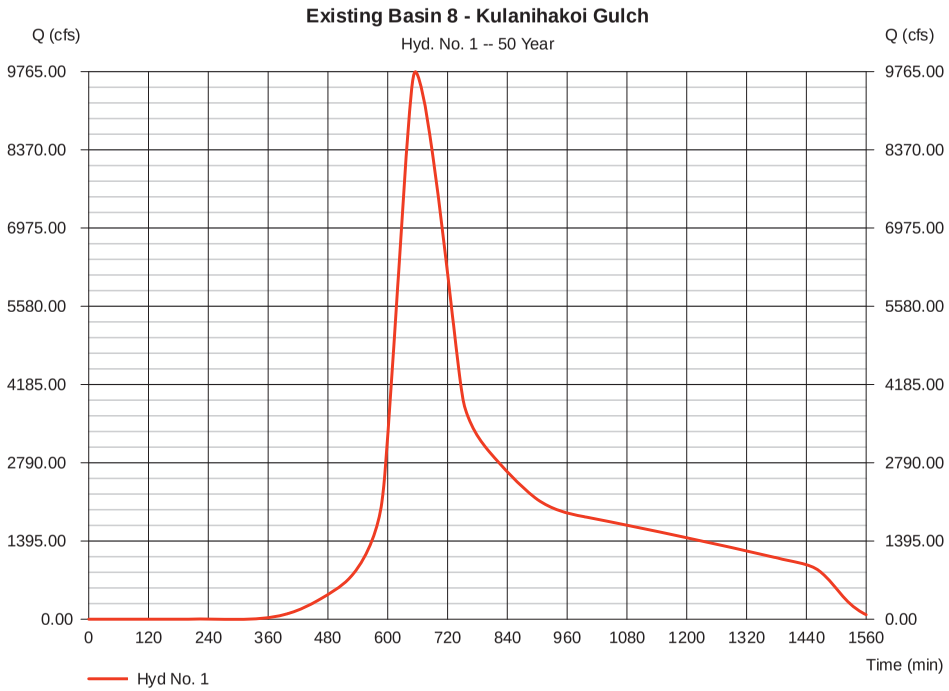
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066 — Friday, Aug 12, 2011

Hyd. No. 1

Existing Basin 8 - Kulanihakoi Gulch

Hydrograph type	= SCS Runoff	Peak discharge	= 9762.05 cfs
Storm frequency	= 50 yrs	Time to peak	= 656 min
Time interval	= 2 min	Hyd. volume	= 151,827,000 cuft
Drainage area	= 9649.180 ac	Curve number	= 73
Basin Slope	= 12.5 %	Hydraulic length	= 75200 ft
Tc method	= KIRPICH	Time of conc. (Tc)	= 98.74 min
Total precip.	= 7.46 in	Distribution	= Type I
Storm duration	= 24 hrs	Shape factor	= 484



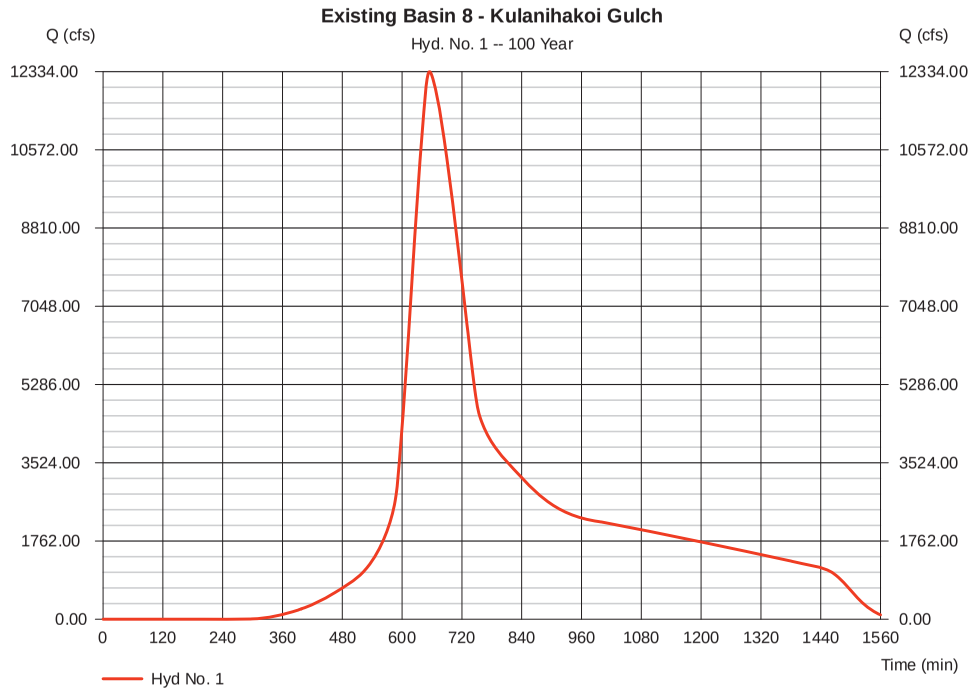
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066 — Friday, Aug 12, 2011

Hyd. No. 1

Existing Basin 8 - Kulanihakoi Gulch

Hydrograph type	= SCS Runoff	Peak discharge	= 12329.83 cfs
Storm frequency	= 100 yrs	Time to peak	= 656 min
Time interval	= 2 min	Hyd. volume	= 189,109,100 cuft
Drainage area	= 9649.180 ac	Curve number	= 73
Basin Slope	= 12.5 %	Hydraulic length	= 75200 ft
Tc method	= KIRPICH	Time of conc. (Tc)	= 98.74 min
Total precip.	= 8.66 in	Distribution	= Type I
Storm duration	= 24 hrs	Shape factor	= 484



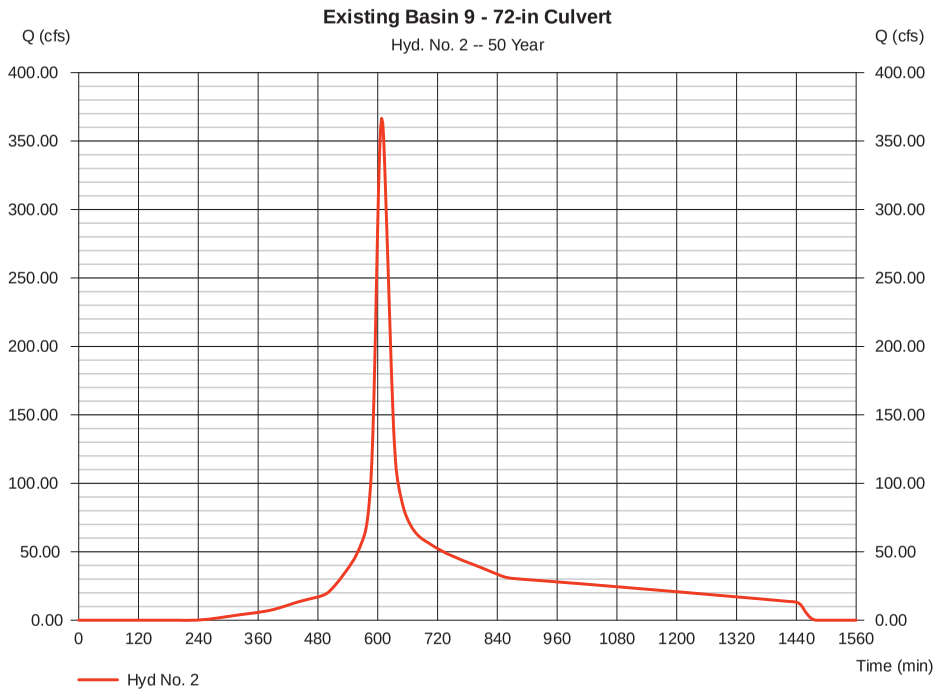
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066 — Friday, Aug 12, 2011

Hyd. No. 2

Existing Basin 9 - 72-in Culvert

Hydrograph type	= SCS Runoff	Peak discharge	= 366.58 cfs
Storm frequency	= 50 yrs	Time to peak	= 608 min
Time interval	= 2 min	Hyd. volume	= 2,546,595 cuft
Drainage area	= 142.330 ac	Curve number	= 79
Basin Slope	= 3.0 %	Hydraulic length	= 6460 ft
Tc method	= KIRPICH	Time of conc. (Tc)	= 25.84 min
Total precip.	= 7.46 in	Distribution	= Type I
Storm duration	= 24 hrs	Shape factor	= 484



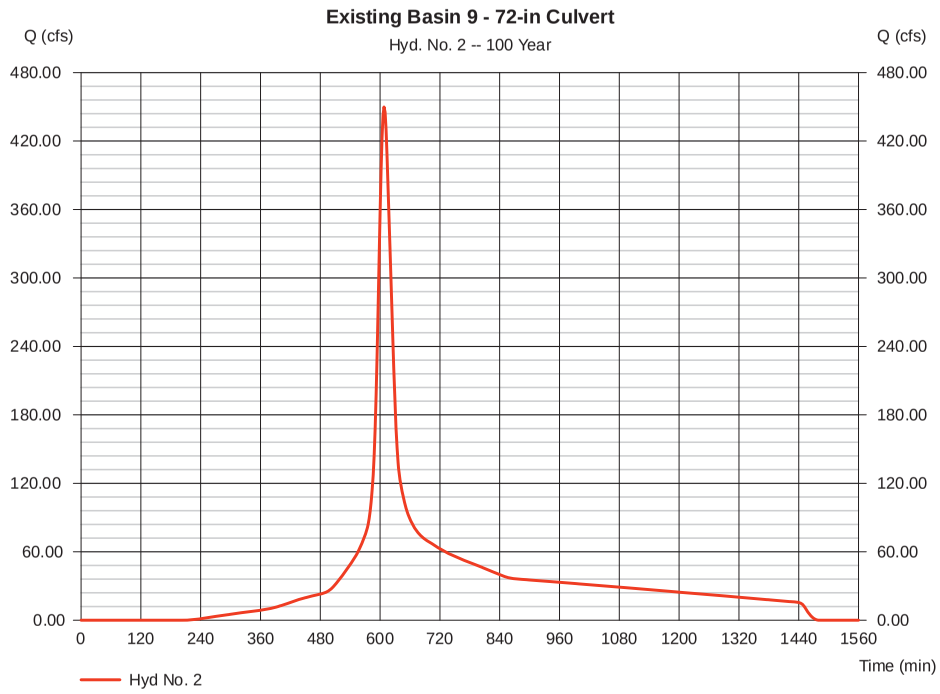
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066 — Friday, Aug 12, 2011

Hyd. No. 2

Existing Basin 9 - 72-in Culvert

Hydrograph type	= SCS Runoff	Peak discharge	= 449.92 cfs
Storm frequency	= 100 yrs	Time to peak	= 608 min
Time interval	= 2 min	Hyd. volume	= 3,115,191 cuft
Drainage area	= 142.330 ac	Curve number	= 79
Basin Slope	= 3.0 %	Hydraulic length	= 6460 ft
Tc method	= KIRPICH	Time of conc. (Tc)	= 25.84 min
Total precip.	= 8.66 in	Distribution	= Type I
Storm duration	= 24 hrs	Shape factor	= 484



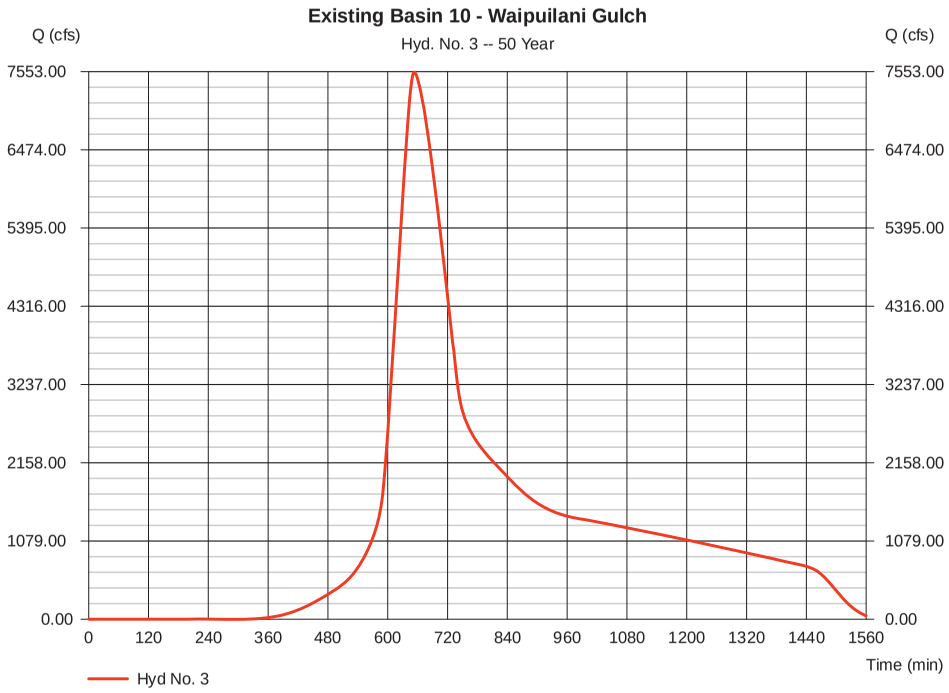
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066 — Friday, Aug 12, 2011

Hyd. No. 3

Existing Basin 10 - Waipuilani Gulch

Hydrograph type	= SCS Runoff	Peak discharge	= 7547.02 cfs
Storm frequency	= 50 yrs	Time to peak	= 654 min
Time interval	= 2 min	Hyd. volume	= 114,587,800 cuft
Drainage area	= 7314.020 ac	Curve number	= 73
Basin Slope	= 12.0 %	Hydraulic length	= 71380 ft
Tc method	= KIRPICH	Time of conc. (Tc)	= 96.35 min
Total precip.	= 7.46 in	Distribution	= Type I
Storm duration	= 24 hrs	Shape factor	= 484



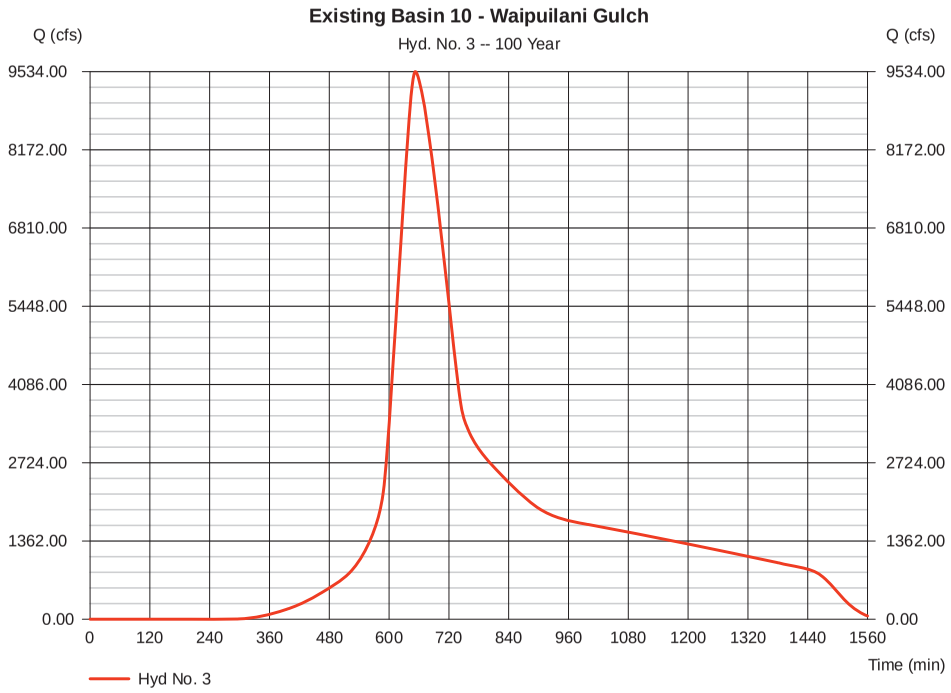
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066 — Friday, Aug 12, 2011

Hyd. No. 3

Existing Basin 10 - Waipuilani Gulch

Hydrograph type	= SCS Runoff	Peak discharge	= 9531.74 cfs
Storm frequency	= 100 yrs	Time to peak	= 652 min
Time interval	= 2 min	Hyd. volume	= 142,725,600 cuft
Drainage area	= 7314.020 ac	Curve number	= 73
Basin Slope	= 12.0 %	Hydraulic length	= 71380 ft
Tc method	= KIRPICH	Time of conc. (Tc)	= 96.35 min
Total precip.	= 8.66 in	Distribution	= Type I
Storm duration	= 24 hrs	Shape factor	= 484



APPENDIX C

Preliminary Analysis of Waipuilani Gulch

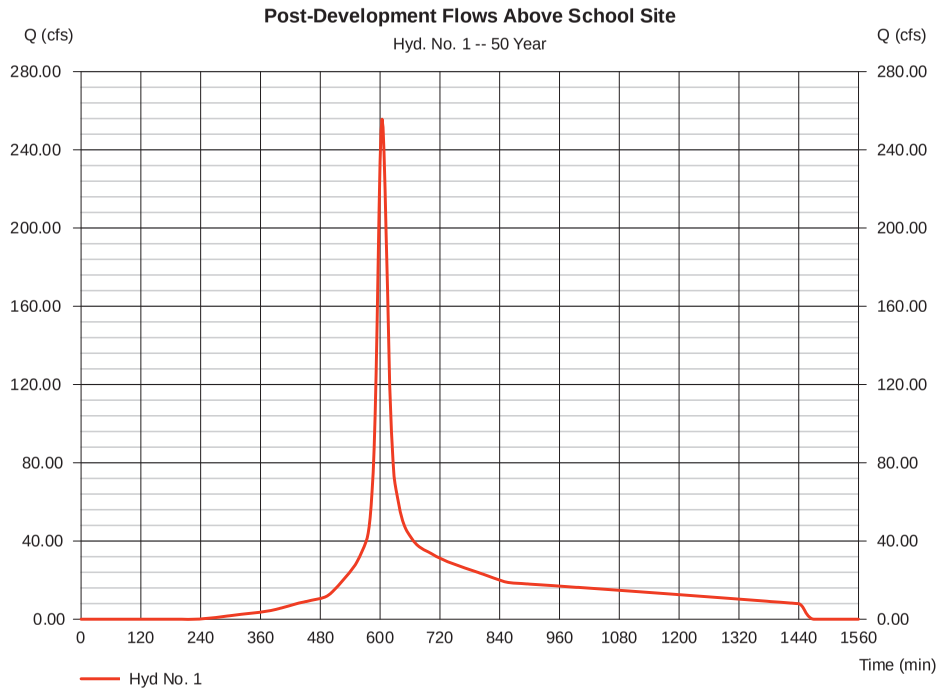
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066 Tuesday, Aug 16, 2011

Hyd. No. 1

Post-Development Flows Above School Site

Hydrograph type	= SCS Runoff	Peak discharge	= 255.71 cfs
Storm frequency	= 50 yrs	Time to peak	= 604 min
Time interval	= 2 min	Hyd. volume	= 1,548,249 cuft
Drainage area	= 85.180 ac	Curve number	= 79
Basin Slope	= 3.0 %	Hydraulic length	= 4200 ft
Tc method	= KIRPICH	Time of conc. (Tc)	= 18.55 min
Total precip.	= 7.46 in	Distribution	= Type I
Storm duration	= 24 hrs	Shape factor	= 484

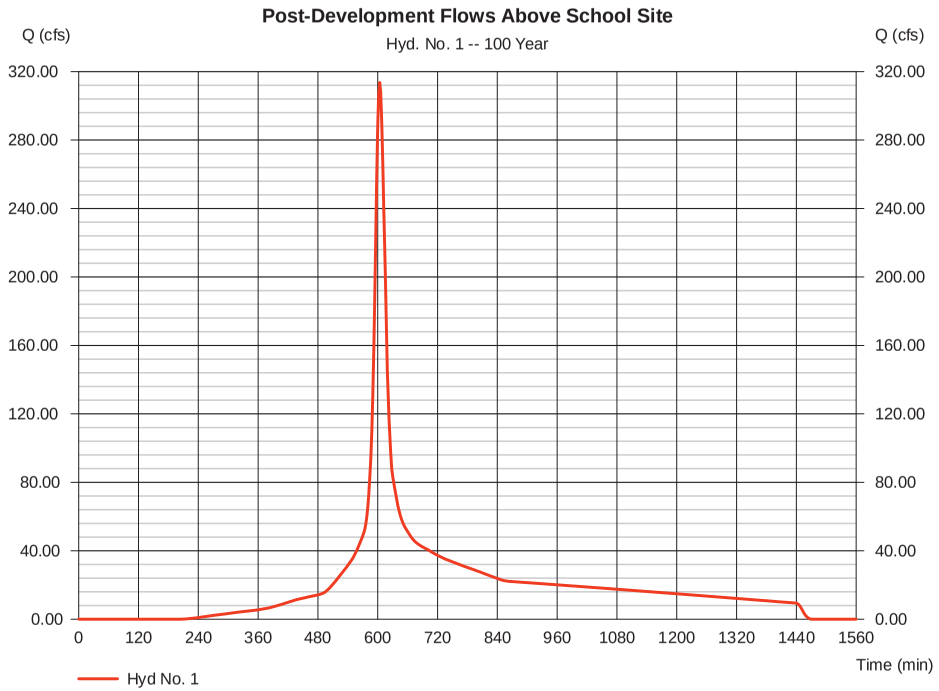


Hydrograph Report

Hyd. No. 1

Post-Development Flows Above School Site

Hydrograph type	= SCS Runoff	Peak discharge	= 313.66 cfs
Storm frequency	= 100 yrs	Time to peak	= 604 min
Time interval	= 2 min	Hyd. volume	= 1,893,937 cuft
Drainage area	= 85.180 ac	Curve number	= 79
Basin Slope	= 3.0 %	Hydraulic length	= 4200 ft
Tc method	= KIRPICH	Time of conc. (Tc)	= 18.55 min
Total precip.	= 8.66 in	Distribution	= Type I
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066 Tuesday, Aug 16, 2011

Hyd. No. 2

Post-Development Flows Entering Waipuilani Gulch

Hydrograph type	= SCS Runoff	Peak discharge	= 7526.54 cfs
Storm frequency	= 50 yrs	Time to peak	= 654 min
Time interval	= 2 min	Hyd. volume	= 114,276,800 cuft
Drainage area	= 7294.170 ac	Curve number	= 73
Basin Slope	= 12.0 %	Hydraulic length	= 71380 ft
Tc method	= KIRPICH	Time of conc. (Tc)	= 96.35 min
Total precip.	= 7.46 in	Distribution	= Type I
Storm duration	= 24 hrs	Shape factor	= 484

Hydrograph Report

Hyd. No. 2

Post-Development Flows Entering Waipuilani Gulch

Hydrograph type	= SCS Runoff	Peak discharge	= 9505.88 cfs
Storm frequency	= 100 yrs	Time to peak	= 652 min
Time interval	= 2 min	Hyd. volume	= 142,338,100 cuft
Drainage area	= 7294.170 ac	Curve number	= 73
Basin Slope	= 12.0 %	Hydraulic length	= 71380 ft
Tc method	= KIRPICH	Time of conc. (Tc)	= 96.35 min
Total precip.	= 8.66 in	Distribution	= Type I
Storm duration	= 24 hrs	Shape factor	= 484

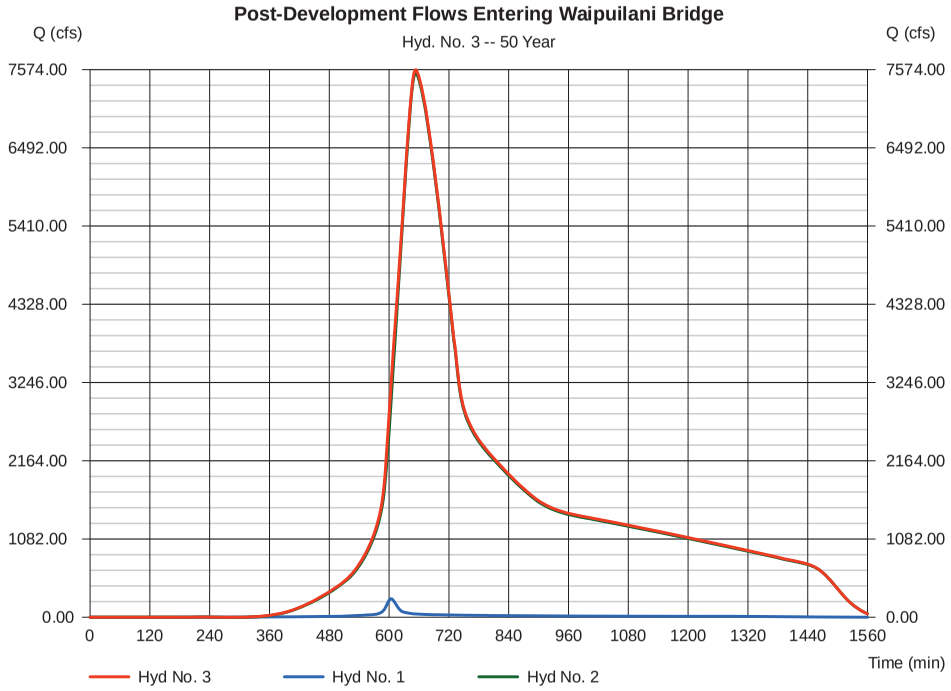
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066 Tuesday, Aug 16, 2011

Hyd. No. 3

Post-Development Flows Entering Waipuilani Bridge

Hydrograph type	= Combine	Peak discharge	= 7571.48 cfs
Storm frequency	= 50 yrs	Time to peak	= 654 min
Time interval	= 2 min	Hyd. volume	= 115,825,100 cuft
Inflow hyds.	= 1, 2	Contrib. drain. area	= 7379.350 ac

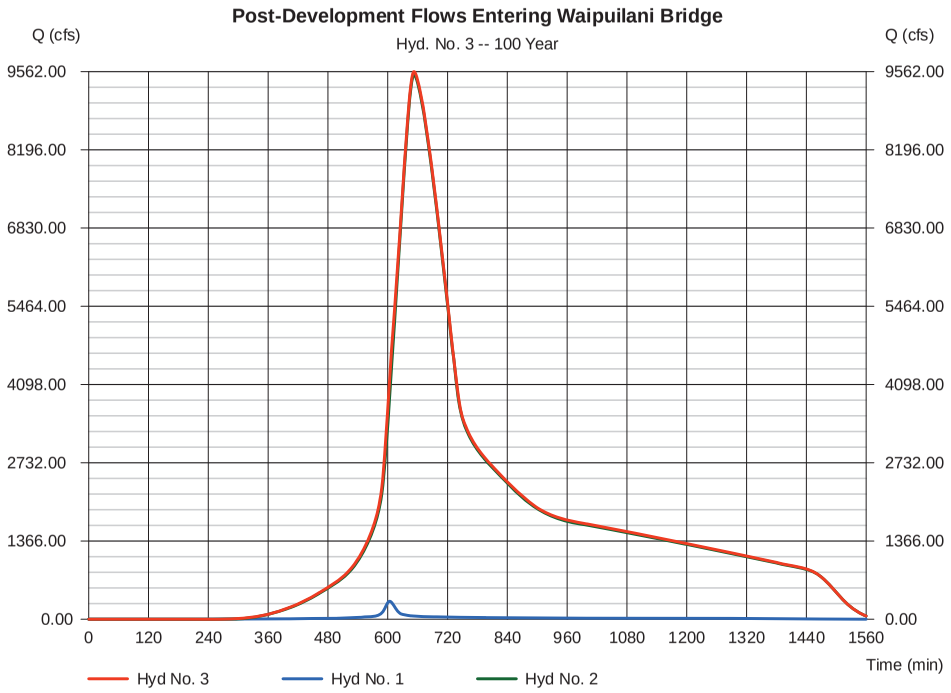


Hydrograph Report

Hyd. No. 3

Post-Development Flows Entering Waipuilani Bridge

Hydrograph type	= Combine	Peak discharge	= 9561.13 cfs
Storm frequency	= 100 yrs	Time to peak	= 652 min
Time interval	= 2 min	Hyd. volume	= 144,232,200 cuft
Inflow hyds.	= 1, 2	Contrib. drain. area	= 7379.350 ac

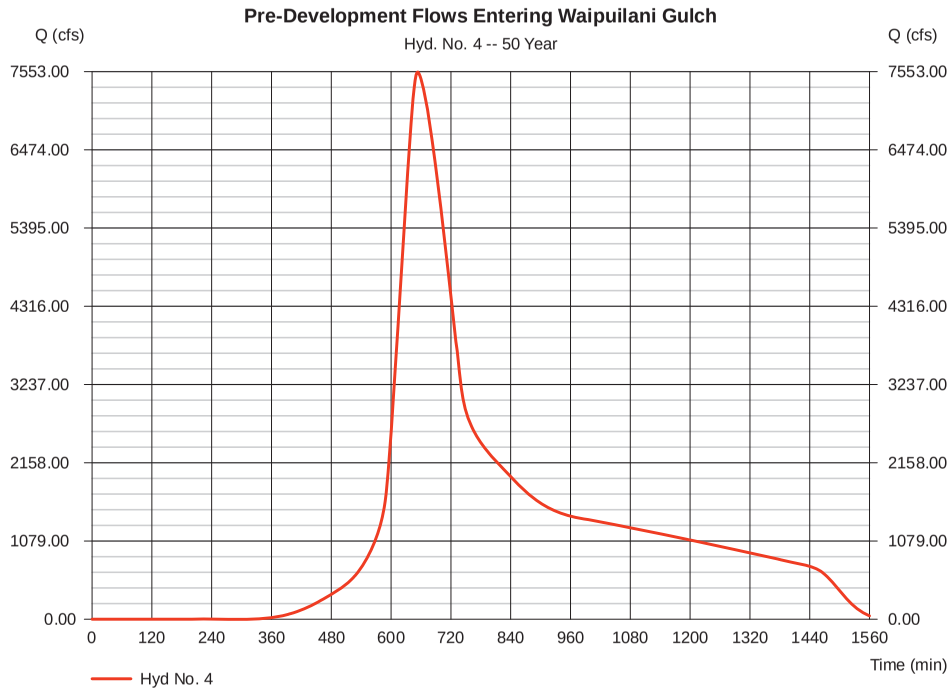


Hydrograph Report

Hyd. No. 4

Pre-Development Flows Entering Waipuilani Gulch

Hydrograph type	= SCS Runoff	Peak discharge	= 7547.02 cfs
Storm frequency	= 50 yrs	Time to peak	= 654 min
Time interval	= 2 min	Hyd. volume	= 114,587,800 cuft
Drainage area	= 7314.020 ac	Curve number	= 73
Basin Slope	= 12.0 %	Hydraulic length	= 71380 ft
Tc method	= KIRPICH	Time of conc. (Tc)	= 96.35 min
Total precip.	= 7.46 in	Distribution	= Type I
Storm duration	= 24 hrs	Shape factor	= 484



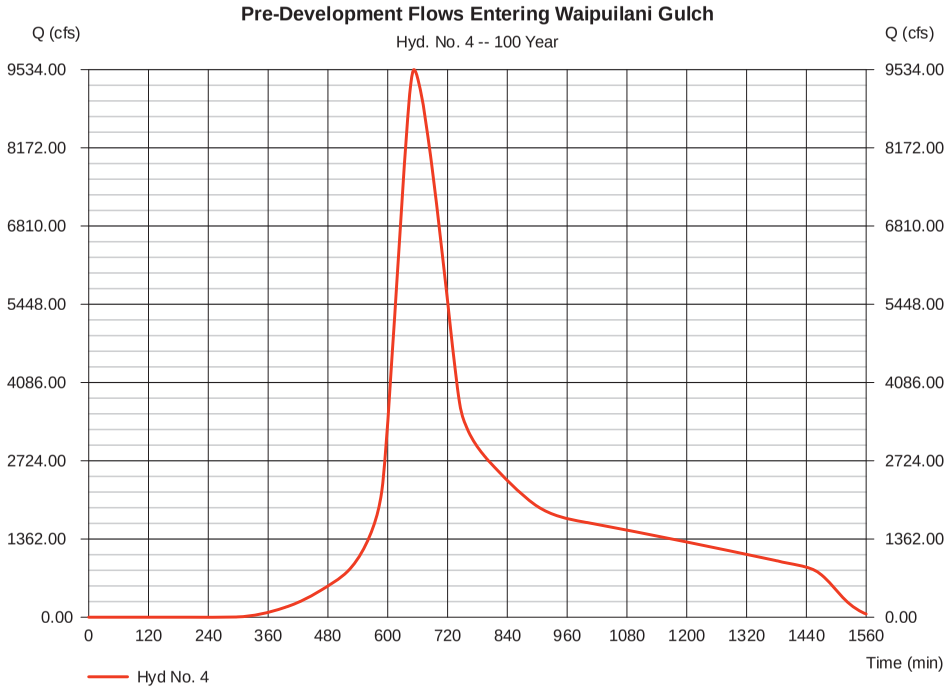
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066 — Tuesday, Aug 16, 2011

Hyd. No. 4

Pre-Development Flows Entering Waipuilani Gulch

Hydrograph type	= SCS Runoff	Peak discharge	= 9531.74 cfs
Storm frequency	= 100 yrs	Time to peak	= 652 min
Time interval	= 2 min	Hyd. volume	= 142,725,600 cuft
Drainage area	= 7314.020 ac	Curve number	= 73
Basin Slope	= 12.0 %	Hydraulic length	= 71380 ft
Tc method	= KIRPICH	Time of conc. (Tc)	= 96.35 min
Total precip.	= 8.66 in	Distribution	= Type I
Storm duration	= 24 hrs	Shape factor	= 484



APPENDIX D

Preliminary Basin Analysis

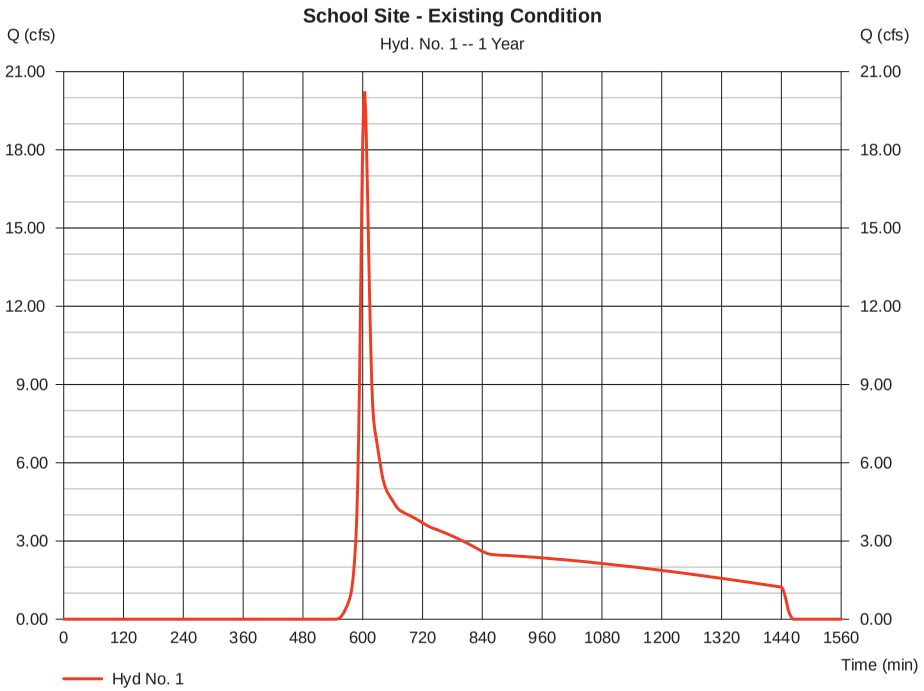
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066 Tuesday, Aug 16, 2011

Hyd. No. 1

School Site - Existing Condition

Hydrograph type	= SCS Runoff	Peak discharge	= 20.20 cfs
Storm frequency	= 1 yrs	Time to peak	= 604 min
Time interval	= 2 min	Hyd. volume	= 150,428 cuft
Drainage area	= 77.000 ac	Curve number	= 79
Basin Slope	= 2.0 %	Hydraulic length	= 2260 ft
Tc method	= KIRPICH	Time of conc. (Tc)	= 13.45 min
Total precip.	= 2.05 in	Distribution	= Type I
Storm duration	= 24 hrs	Shape factor	= 484



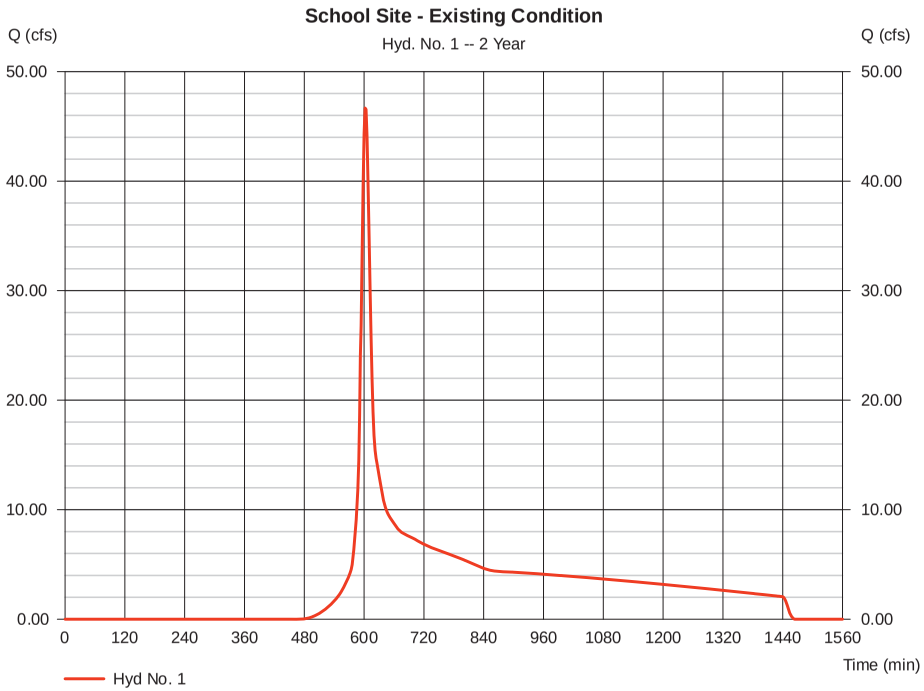
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066 Tuesday, Aug 16, 2011

Hyd. No. 1

School Site - Existing Condition

Hydrograph type	= SCS Runoff	Peak discharge	= 46.68 cfs
Storm frequency	= 2 yrs	Time to peak	= 602 min
Time interval	= 2 min	Hyd. volume	= 294,327 cuft
Drainage area	= 77.000 ac	Curve number	= 79
Basin Slope	= 2.0 %	Hydraulic length	= 2260 ft
Tc method	= KIRPICH	Time of conc. (Tc)	= 13.45 min
Total precip.	= 2.85 in	Distribution	= Type I
Storm duration	= 24 hrs	Shape factor	= 484



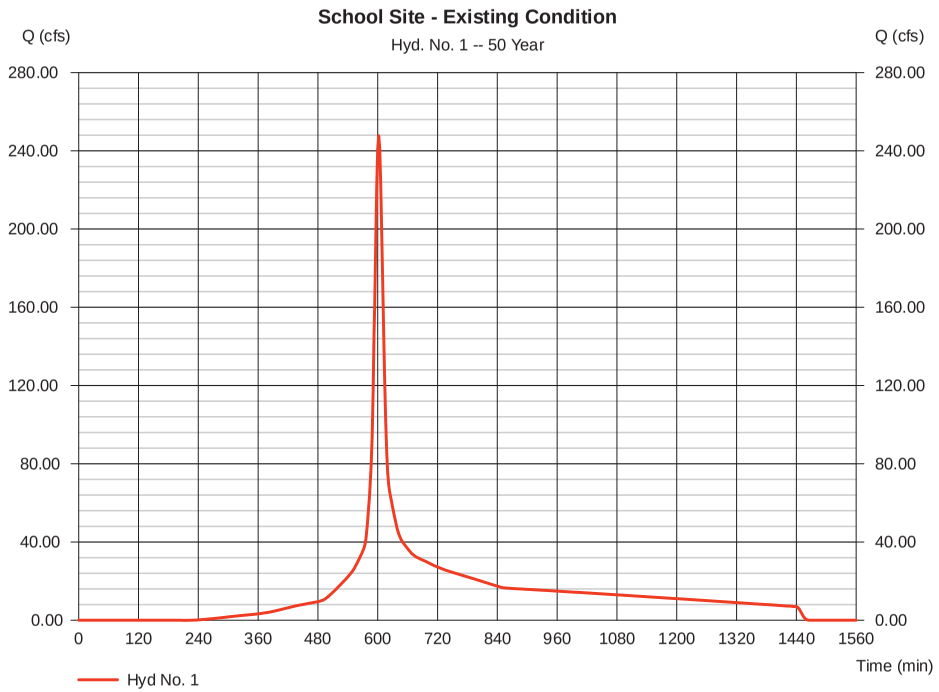
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066 Tuesday, Aug 16, 2011

Hyd. No. 1

School Site - Existing Condition

Hydrograph type	= SCS Runoff	Peak discharge	= 247.71 cfs
Storm frequency	= 50 yrs	Time to peak	= 602 min
Time interval	= 2 min	Hyd. volume	= 1,364,579 cuft
Drainage area	= 77.000 ac	Curve number	= 79
Basin Slope	= 2.0 %	Hydraulic length	= 2260 ft
Tc method	= KIRPICH	Time of conc. (Tc)	= 13.45 min
Total precip.	= 7.46 in	Distribution	= Type I
Storm duration	= 24 hrs	Shape factor	= 484



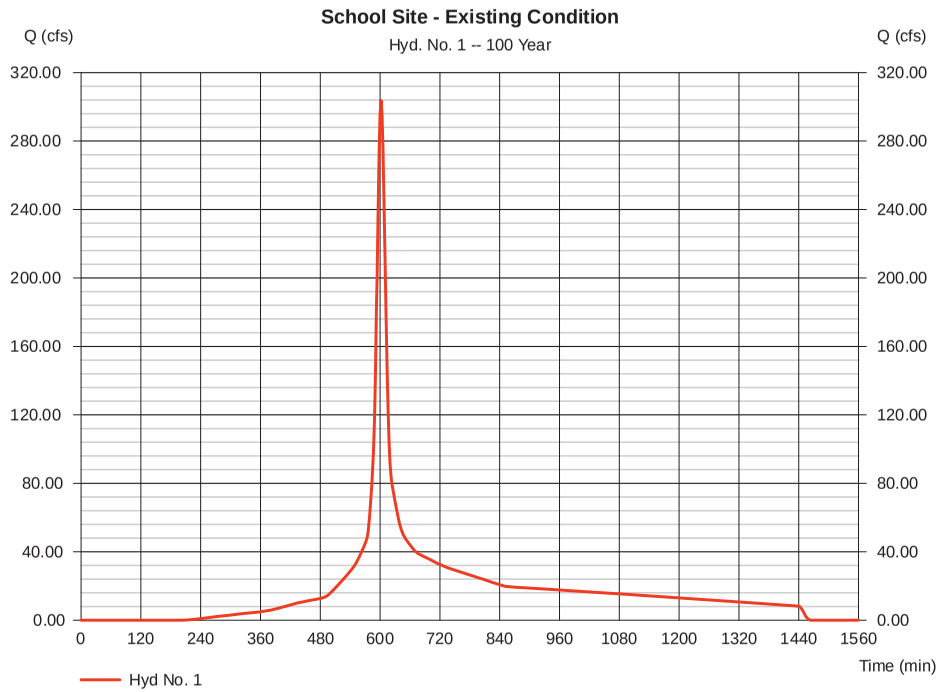
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066 Tuesday, Aug 16, 2011

Hyd. No. 1

School Site - Existing Condition

Hydrograph type	= SCS Runoff	Peak discharge	= 303.65 cfs
Storm frequency	= 100 yrs	Time to peak	= 602 min
Time interval	= 2 min	Hyd. volume	= 1,669,256 cuft
Drainage area	= 77.000 ac	Curve number	= 79
Basin Slope	= 2.0 %	Hydraulic length	= 2260 ft
Tc method	= KIRPICH	Time of conc. (Tc)	= 13.45 min
Total precip.	= 8.66 in	Distribution	= Type I
Storm duration	= 24 hrs	Shape factor	= 484



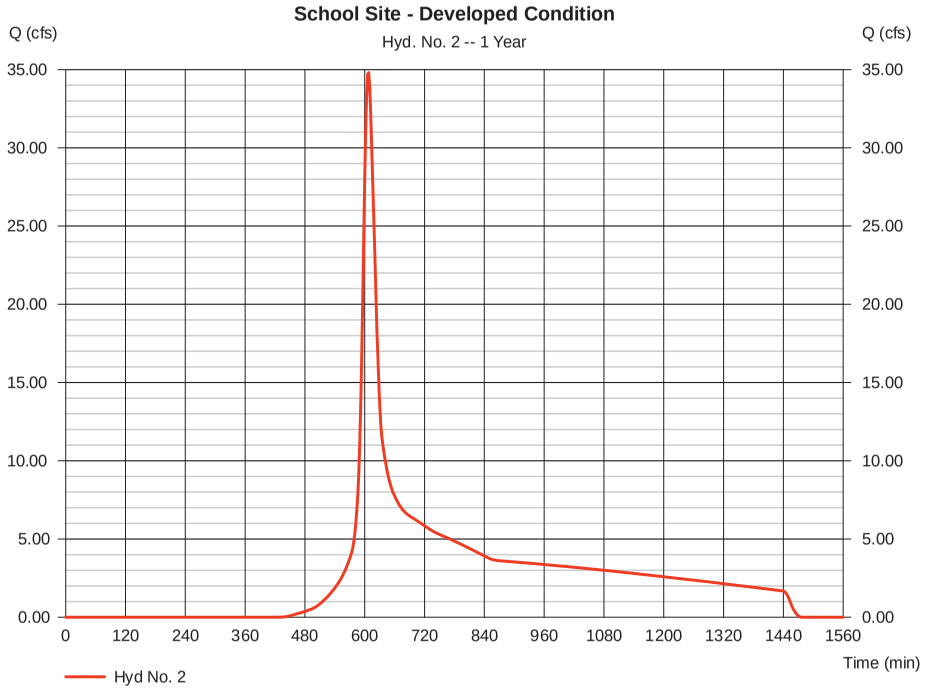
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066 Tuesday, Aug 16, 2011

Hyd. No. 2

School Site - Developed Condition

Hydrograph type	= SCS Runoff	Peak discharge	= 34.81 cfs
Storm frequency	= 1 yrs	Time to peak	= 608 min
Time interval	= 2 min	Hyd. volume	= 252,362 cuft
Drainage area	= 77.000 ac	Curve number	= 86
Basin Slope	= 1.0 %	Hydraulic length	= 300 ft
Tc method	= USER	Time of conc. (Tc)	= 23.00 min
Total precip.	= 2.05 in	Distribution	= Type I
Storm duration	= 24 hrs	Shape factor	= 484



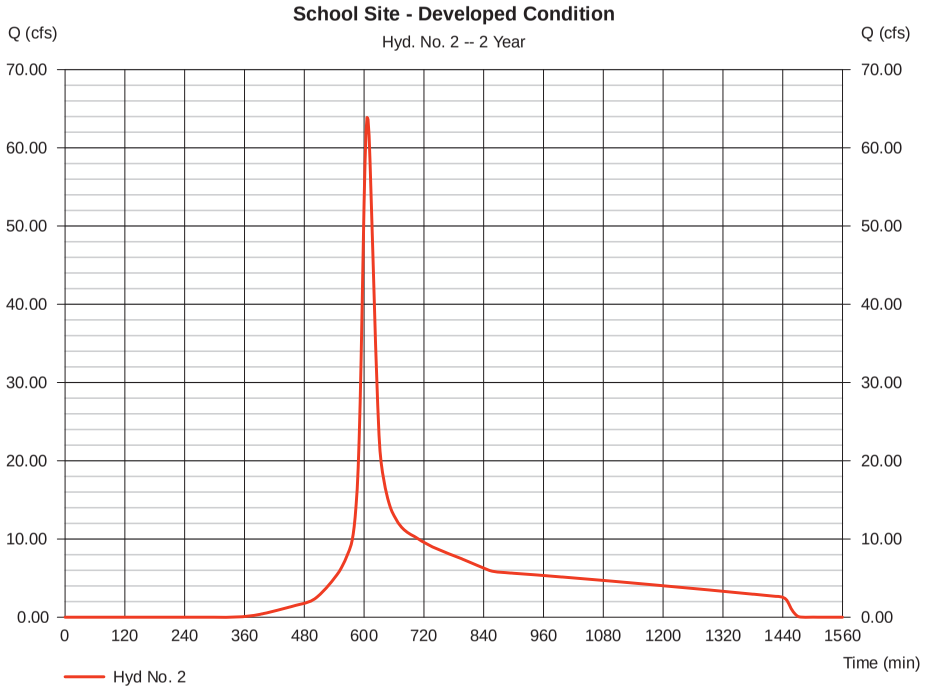
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066 Tuesday, Aug 16, 2011

Hyd. No. 2

School Site - Developed Condition

Hydrograph type	= SCS Runoff	Peak discharge	= 63.89 cfs
Storm frequency	= 2 yrs	Time to peak	= 606 min
Time interval	= 2 min	Hyd. volume	= 436,632 cuft
Drainage area	= 77.000 ac	Curve number	= 86
Basin Slope	= 1.0 %	Hydraulic length	= 300 ft
Tc method	= USER	Time of conc. (Tc)	= 23.00 min
Total precip.	= 2.85 in	Distribution	= Type I
Storm duration	= 24 hrs	Shape factor	= 484



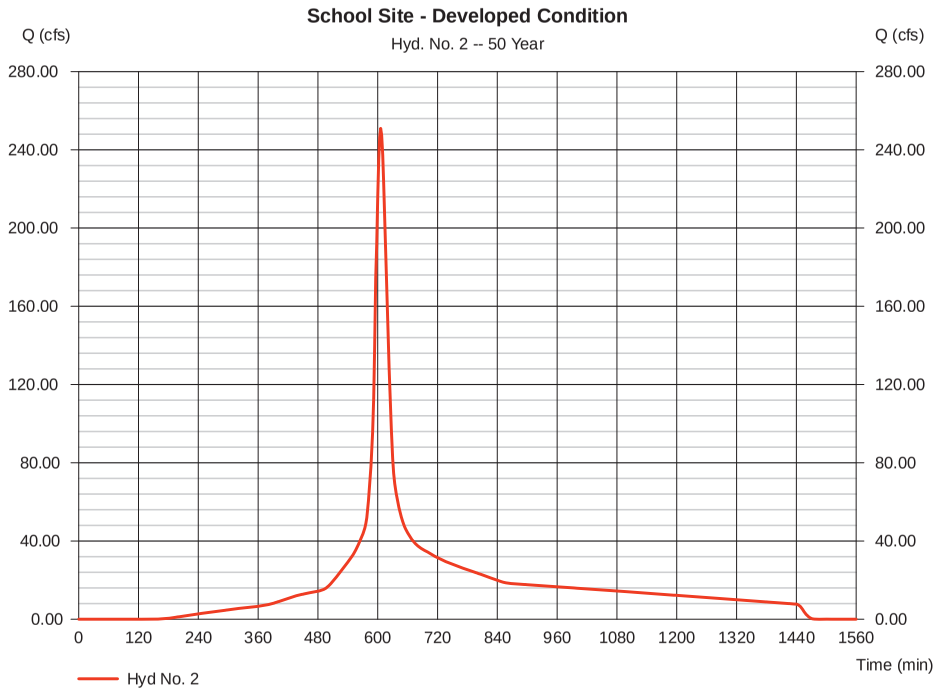
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066 Tuesday, Aug 16, 2011

Hyd. No. 2

School Site - Developed Condition

Hydrograph type	= SCS Runoff	Peak discharge	= 250.94 cfs
Storm frequency	= 50 yrs	Time to peak	= 606 min
Time interval	= 2 min	Hyd. volume	= 1,652,656 cuft
Drainage area	= 77.000 ac	Curve number	= 86
Basin Slope	= 1.0 %	Hydraulic length	= 300 ft
Tc method	= USER	Time of conc. (Tc)	= 23.00 min
Total precip.	= 7.46 in	Distribution	= Type I
Storm duration	= 24 hrs	Shape factor	= 484



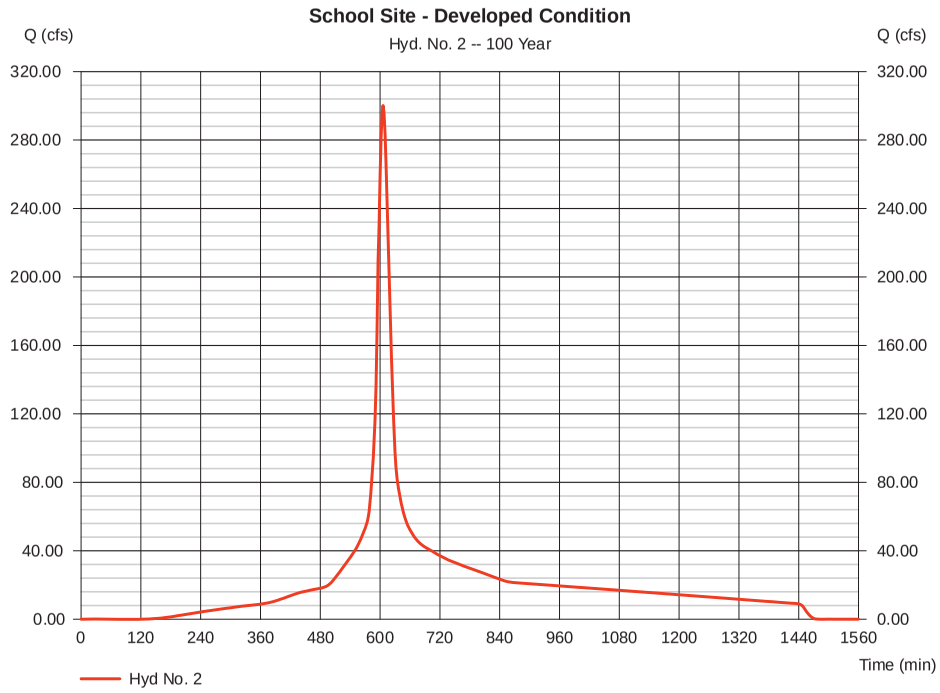
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066 Tuesday, Aug 16, 2011

Hyd. No. 2

School Site - Developed Condition

Hydrograph type	= SCS Runoff	Peak discharge	= 300.12 cfs
Storm frequency	= 100 yrs	Time to peak	= 606 min
Time interval	= 2 min	Hyd. volume	= 1,983,689 cuft
Drainage area	= 77.000 ac	Curve number	= 86
Basin Slope	= 1.0 %	Hydraulic length	= 300 ft
Tc method	= USER	Time of conc. (Tc)	= 23.00 min
Total precip.	= 8.66 in	Distribution	= Type I
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

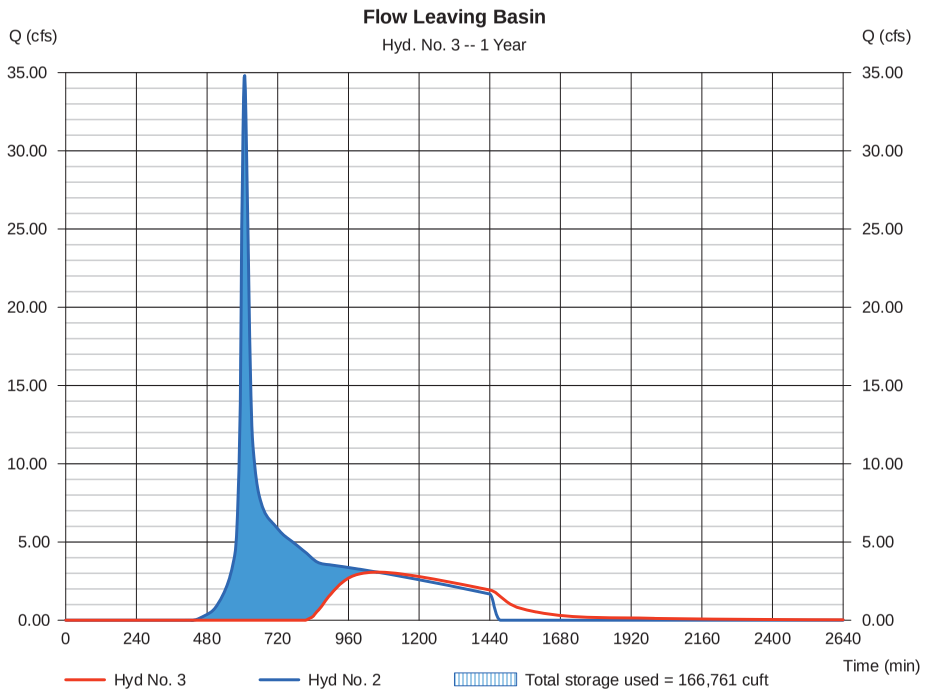
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066 Tuesday, Aug 16, 2011

Hyd. No. 3

Flow Leaving Basin

Hydrograph type	=	Reservoir	Peak discharge	=	3.074 cfs
Storm frequency	=	1 yrs	Time to peak	=	1058 min
Time interval	=	2 min	Hyd. volume	=	107,021 cuft
Inflow hyd. No.	=	2 - School Site - Developed Condition	Max. Elevation	=	33.39 ft
Reservoir name	=	Retention/Detention Basin	Max. Storage	=	166,761 cuft

Storage Indication method used.



Hydrograph Report

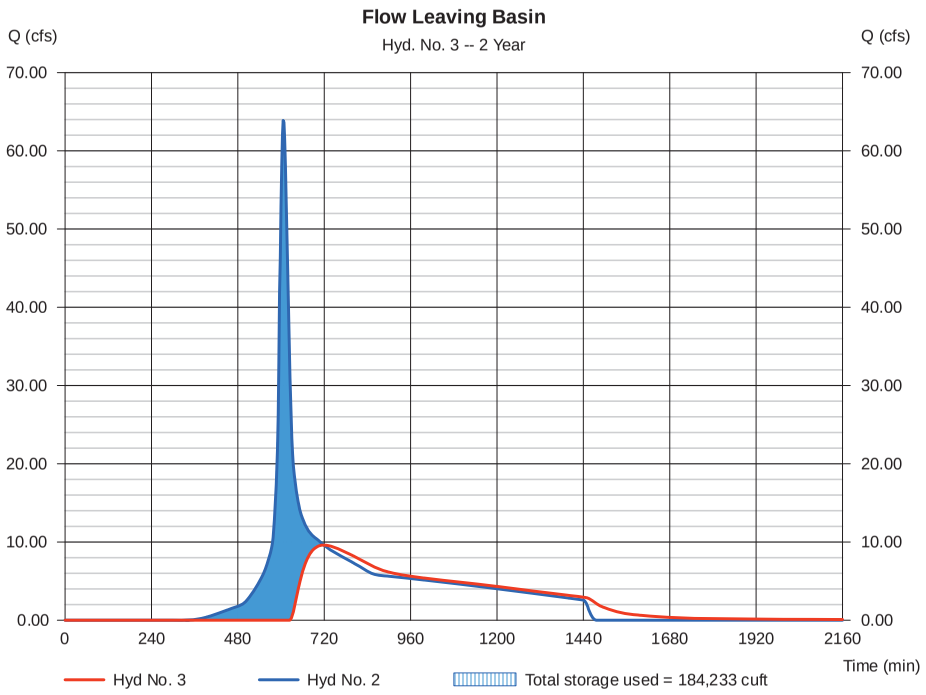
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066 Tuesday, Aug 16, 2011

Hyd. No. 3

Flow Leaving Basin

Hydrograph type	=	Reservoir	Peak discharge	=	9.612 cfs
Storm frequency	=	2 yrs	Time to peak	=	720 min
Time interval	=	2 min	Hyd. volume	=	291,292 cuft
Inflow hyd. No.	=	2 - School Site - Developed Condition	Max. Elevation	=	33.70 ft
Reservoir name	=	Retention/Detention Basin	Max. Storage	=	184,233 cuft

Storage Indication method used.



Hydrograph Report

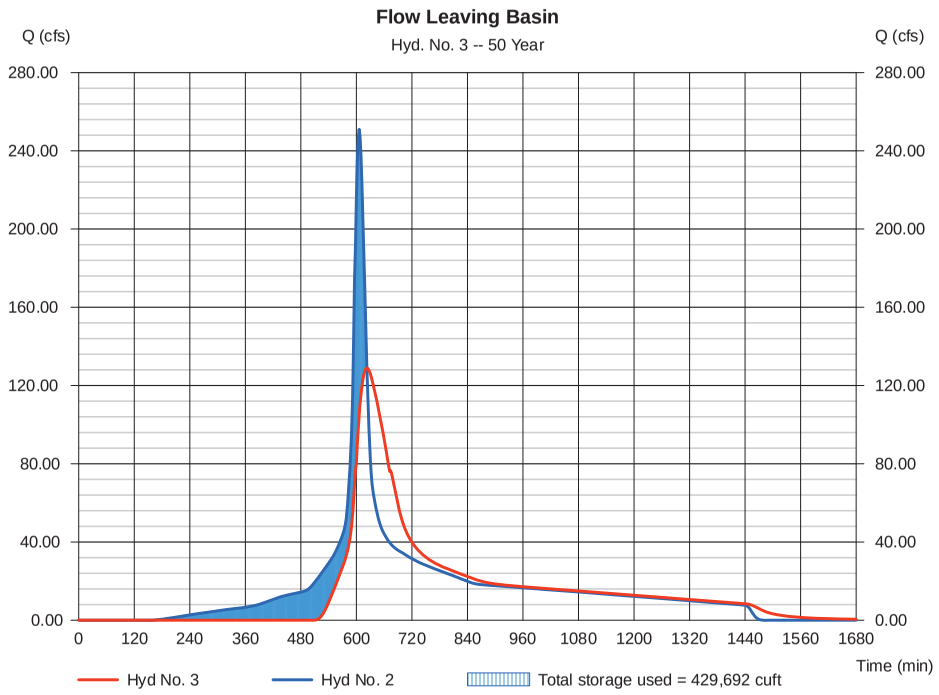
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066 Tuesday, Aug 16, 2011

Hyd. No. 3

Flow Leaving Basin

Hydrograph type	=	Reservoir	Peak discharge	=	128.90 cfs
Storm frequency	=	50 yrs	Time to peak	=	622 min
Time interval	=	2 min	Hyd. volume	=	1,507,314 cuft
Inflow hyd. No.	=	2 - School Site - Developed Condition	Max. Elevation	=	37.56 ft
Reservoir name	=	Retention/Detention Basin	Max. Storage	=	429,692 cuft

Storage Indication method used.



Hydrograph Report

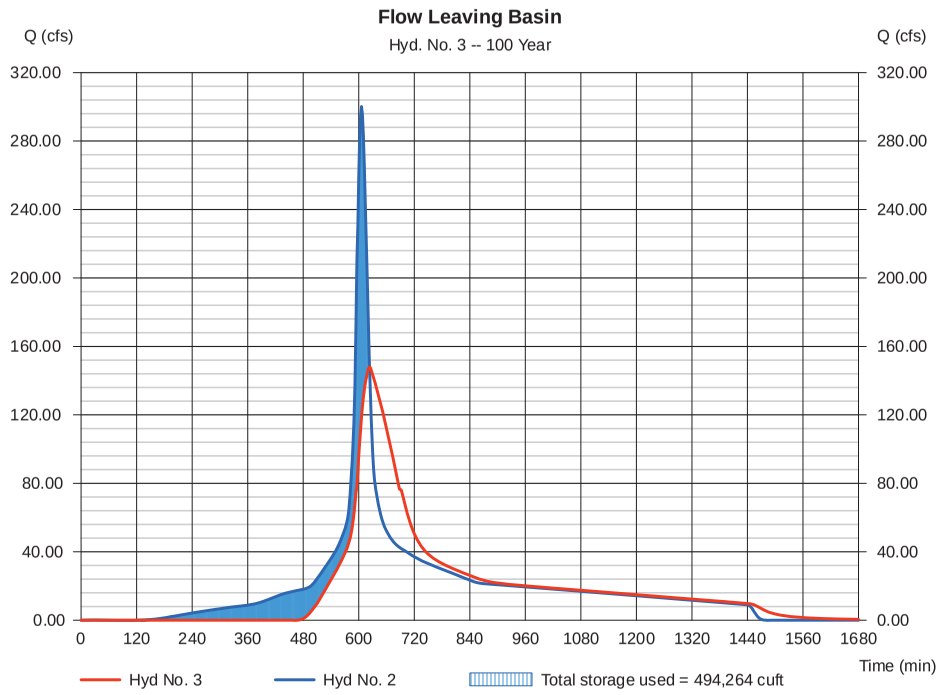
Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066 Tuesday, Aug 16, 2011

Hyd. No. 3

Flow Leaving Basin

Hydrograph type	=	Reservoir	Peak discharge	=	148.02 cfs
Storm frequency	=	100 yrs	Time to peak	=	624 min
Time interval	=	2 min	Hyd. volume	=	1,838,350 cuft
Inflow hyd. No.	=	2 - School Site - Developed Condition	Max. Elevation	=	38.45 ft
Reservoir name	=	Retention/Detention Basin	Max. Storage	=	494,264 cuft

Storage Indication method used.



Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066 — Tuesday, Aug 16, 2011

Pond No. 1 - Retention/Detention Basin

Pond Data

Trapezoid - Bottom L x W = 480.0 x 90.0 ft, Side slope = 3.00:1, Bottom elev. = 30.00 ft, Depth = 10.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	30.00	43,200	0	0
1.00	31.00	46,656	44,922	44,922
2.00	32.00	50,184	48,414	93,336
3.00	33.00	53,784	51,978	145,314
4.00	34.00	57,456	55,614	200,928
5.00	35.00	61,200	59,322	260,250
6.00	36.00	65,016	63,102	323,352
7.00	37.00	68,904	66,954	390,306
8.00	38.00	72,864	70,878	461,184
9.00	39.00	76,896	74,874	536,058
10.00	40.00	81,000	78,942	615,000

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 30.00	0.00	0.00	0.00
Span (in)	= 30.00	0.00	0.00	0.00
No. Barrels	= 3	1	1	0
Invert El. (ft)	= 33.00	0.00	0.00	0.00
Length (ft)	= 100.00	0.00	0.00	0.00
Slope (%)	= 1.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 10.00	0.00	0.00	0.00
Crest El. (ft)	= 38.25	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= Ciplti	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 0.000 (by Contour)

TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	30.00	0.00	---	---	---	0.00	---	---	---	---	---	0.000
1.00	44,922	31.00	0.00	---	---	---	0.00	---	---	---	---	---	0.000
2.00	93,336	32.00	0.00	---	---	---	0.00	---	---	---	---	---	0.000
3.00	145,314	33.00	0.00	---	---	---	0.00	---	---	---	---	---	0.000
4.00	200,928	34.00	18.74 ic	---	---	---	0.00	---	---	---	---	---	18.74
5.00	260,250	35.00	60.83 ic	---	---	---	0.00	---	---	---	---	---	60.83
6.00	323,352	36.00	93.11 oc	---	---	---	0.00	---	---	---	---	---	93.11
7.00	390,306	37.00	117.57 ic	---	---	---	0.00	---	---	---	---	---	117.57
8.00	461,184	38.00	137.29 ic	---	---	---	0.00	---	---	---	---	---	137.29
9.00	536,058	39.00	154.52 ic	---	---	---	21.63	---	---	---	---	---	176.15
10.00	615,000	40.00	170.01 ic	---	---	---	77.09	---	---	---	---	---	247.10