PRE-FINAL REPORT for the

KIHEI DRAINAGE MASTER PLAN
WAIAKOA GULCH TO KILOHANA DRIVE

NOVEMBER 2016

Prepared For:

County of Maui
Department of Public Works & Environmental Management
Engineering Division
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EXECUTIVE SUMMARY

Purpose and Methodology

Development in the Kihei District has increased rapidly with the population growth on Maui in the past two decades. As development continues in the Kihei District today, a comprehensive drainage master plan is needed for the public, land developers, and government agencies in order to mitigate the flood risk. The purpose of this study is to formulate and update the existing drainage master plans. The scope of work includes:

- Prepare updated drainage maps based on the County's Light Detection and Ranging (LIDAR) data
- Evaluate existing conditions by conducting hydrologic analysis for the mauka and makai drainage basins
- Assess the existing infrastructure capacity and incorporate future development in the analysis
- Recommend possible flood mitigation improvements and estimate the associated costs.

The study area has been divided into eight drainage districts corresponding to drainage paths and major gulches. Within each drainage district, the boundaries of the drainage basins which had been delineated in the previous drainage studies were updated on the drainage maps prepared for this study. Piilani Highway is the boundary between the mauka and makai drainage basins.
The drainage districts are:

- Waiakoa District
- Kulanihakoi District
- Waipuilani District
- Keokea District
- Charlie Young District
- Kamaole District
- Liilioholo District
- Kilohana Drive District

For areas mauka of Piilani Highway, recommendations of the proposed improvements are to 1) limit the runoff to the predevelopment values (existing condition) with detention basins, 2) divert flow to major drainageways, and 3) mitigate the flood impacts to the downstream areas.

For areas makai of Piilani Highway, the proposed improvements are based on evaluation of the existing outlet condition. The intent is to provide improvements to mitigate flooding utilizing the existing outlet. Construction of new outlets to provide solutions to the regional and local flooding has been considered, but will require further study to assess the feasibility. In addition, the maintenance of the existing outlets to be free of debris and sand dune accumulation shall be one of the priorities to increase outlet capacity.

Each future development, both mauka and makai of Piilani Highway, is assumed to control its onsite increased runoff (detention facilities) so as to not to cause adverse impact to the downstream areas. The proposed detention facilities shown in the figures were analyzed for the regional runoff (100-year, 24-hour storm in the proposed condition) instead of the 50-year, 1-hour storm for the local system. For the existing structures (channel, culverts, and bridges) if determined to have inadequate capacities, options are discussed to provide flood mitigation improvements (see Section 4).

Hydrology

For drainage areas greater than 100 acres and for all streams, the Maui County Drainage Standards require the use of the Natural Resources Conservation Service (NRCS, formerly Soil Conservation Service, SCS) method with a design storm of recurrence interval of 100 years and duration of 24 hours. Most of the drainage basins makai of Piilani Highway were determined to be less than 100 acres in size. However, the accumulated drainage areas of mauka and makai drainage basins at South Kihei Road are greater than 100 acres. For the sake of consistency in the hydrologic model, all drainage basins were analyzed with the 100-year, 24-hour design storm.

For cases where the local flows are routed out of one drainage basin to another drainage basin through a subdivision drainage system, it was assumed that the local flows collected through the subdivision drainage system were relatively small compared to the 100-year peak discharge and will not cause significant impact to the surface flows during the design storm event. The method used in the hydrologic model for this drainage master plan only considers the runoff conveyed by the surface drainage systems.

Hydraulics

Culvert analyses were used to determine the existing culvert capacities with the use of HY-8, Hydraflow (AutoCAD extension), and nomographs. For culverts with as-built plans available, the capacity was re-evaluated based on the inverts and roadway elevation. The maximum allowable headwater elevation was set to be one foot below the edge of the roadway (LiDAR) in order to evaluate the existing culvert capacities. For culverts without as-built plans, the capacity was adopted from the previous drainage reports where available or is assumed to be able to convey the flow. Capacities of the existing sub-surface drainage systems were not evaluated because of the uncertainty of the drainage system catchment areas.

Recommendations

The existing storm drainage system on South Kihei Road is not meant to convey large runoff. Conceptual recommendations provided for flood mitigation from Waikoloa District to Kilohana Drive District are based on the available information. To address the flooding problems at South Kihei Road, it will involve several factors such as land acquisition, roadway and private driveways reconstruction, utility relocation, and community involvement.

The major recommendations are briefly summarized below for each drainage district. For detailed descriptions, refer to Section 4 of this report. In addition, maintenance of the outlet shall be performed regularly to be free of debris and sand dune accumulation.

Waiakoa District

- Construct a channel (Waiakoa Gulch Improvements) from Piilani Highway to the existing outlet to convey design flow. Similar channel could also be considered at mauka side of Piilani Highway up to the location where the split flow occurs.

- Ultimately, consider construction of a new bridge at the South Kihei Road crossing as a long-term goal in conjunction with the proposed channel.

- Restore and improve the existing ditch mauka of the existing Ohukai Subdivision, and construct a new diversion ditch with the same dimensions as the aforementioned ditch to convey runoff to a proposed detention basin.

- Construct a potential storm drainage system on Ohukai Road from Kaiola Place to the ocean.

Kulanihakoi District

- Construct a diversion channel to direct the flow from Upper Waipuilani Gulch to Kulanihakoi Gulch mauka of Piilani Highway.

- Improve the existing channel from makai of Piilani Highway to the ocean to convey the design flow.

- Ultimately, consider construction of a new bridge at the South Kihei Road crossing as a long-term goal in conjunction with the improved channel.

- Construct detention basins mauka of Piilani Highway for the purposes of both flood and erosion control.

Waipuilani District

- Construct a diversion channel to direct the flow from Upper Waipuilani Gulch to Kulanihakoi Gulch mauka of Piilani Highway as mentioned in Kulanihakoi District

- Improve Waipuilani Gulch from Liloa Drive to the ocean and replace the existing culvert at the South Kihei Road crossing.

Keokea District

- Provide a roadway drainage system, drywells along Uluniu Road or construct a new outlet.

- Construct detention basins mauka of Piilani Highway for the purposes of both flood and erosion control.

Charlie Young District

- Construct detention basins mauka of Piilani Highway for the purposes of both flood and erosion control.

- Provide and improve existing drainage systems to convey runoff to the ocean for Waimahahaihai Gulch, Kihei Gulch 1, and Kaluaihakoko Stream.

Kamaole District

- Construct a detention basin mauka of Piilani Highway for the purposes of both flood and erosion control.

- Improve Kamaole Gulch from downstream of Kuli Puu Street to the ocean and replace the existing culverts at Maui Coast Hotel and the South Kihei Road crossing.

- Provide and improve existing drainage systems at Kihei Kai Nani.

Liilioholo District

- Replace the existing culvert at the South Kihei Road crossing.

- Construct culverts at the existing Kanakanui Road concrete ford crossing and North-South Collector concrete ford crossing.

Kilohana Drive District

- Consider replacement of the existing culvert at the Piilani Highway Road crossing to convey the 100-year flow. However, per HDOT drainage design standards, the culvert is only required to pass the 50-year peak flow.

- Construction of a channel in Wailea SF-58 development could be considered to claim more useable lands.

Proposed Phasing

Refer to Figures 3.1 and 3.2 for the proposed drainage basin map and phasing plan.

Phase 1

The initial phase of work involves the projects that are currently in design phase and will be constructed for the interim condition. These improvements are not intended to alleviate the existing flooding condition completely (Time Frame: 5 years).

- Proposed South Kihei Road Bridge (Interim 2-10'x3; RCBs, Waiakoa District)
- Proposed South Kihei Road Bridge (Interim 6-6'x4' RCBs, Kulanihakoi District)

Phase 2

This phase involves the improvements currently in planning stage, the detention basins providing protection with greater benefits to the areas makai of Piilani Highway, and Uluniu Road drainage system and study (Time Frame: 5 to 10 years).

- Proposed Detention Basin at Piilani Basin 9 (Kihei High School, Kulanihakoi District)
- Proposed Liloa Drive Culverts (Liloa Drive Extension, Waipuilani District)
- Uluniu Road Drainage System and Study (The improvements will not alleviate the existing flooding condition completely due to the nature of the existing terrain, Keokea District)
- Proposed Detention Basin at Piilani Basin 19 (Charlie Young District)
- Proposed Detention Basin at Piilani Basin 20 (Charlie Young District)
- Proposed Detention Basin at Piilani Basin 23 (Kamaole District)

Phase 3

This phase involves the remaining improvements mauka of Piilani Highway (excluding Waipuilani Gulch Diversion) and the South Kihei Road Culvert Improvements at Liilioholo Gulch (Time Frame: 10 to 20 years).

- Restoration and Improvements of Existing Ditch Mauka of Ohukai Subdivision (Waiakoa District)
- Proposed Ditch to Proposed Detention Basin at Piilani Basin 6U (Kulanihakoi District)
- Proposed Detention Basin at Piilani Basin 6U (Kulanihakoi District)
- Proposed Detention Basin at Piilani Basin 6D (Kulanihakoi District)
- Proposed Detention Basin at Piilani Basin 7, mauka of future Kaonoulu Affordable Apts (Kulanihakoi District)
- Proposed Detention Basin at Piilani Basin 7, mauka of Piilani Highway (Kulanihakoi District)
- Proposed Detention Basin at Piilani Basin 13U (Keokea District)
- Proposed Detention Basin at Piilani Basin 14U (Keokea District)
- Proposed Detention Basin at Piilani Basin 16U (Keokea District)
- Proposed Detention Basin at Piilani Basin 17A (Charlie Young District)
- Proposed Detention Basin at Piilani Basin 19A1 (Charlie Young District)
- Proposed Detention Basin at Piilani Basin 19A2 (Charlie Young District)

- Proposed South Kihei Road Culvert Improvements (Liilioholo District)

Phase 4

This phase involves the improvements makai of Piilani Highway. These improvements are long-term targets as majority of the improvements requires coordination among Maui County, other government agencies, and the private owners. In addition, roadway reconstruction, utility relocation, and land acquisition are anticipated. Depending on the progress of the individual project, the improvements could be considered at an earlier phase (Time Frame: 20 years and beyond).

- Waiakoa Gulch Improvements (Waiakoa District)
- Proposed South Kihei Road Bridge (Ultimate, Waiakoa District)
- Proposed Ohukai Road Drainage System (Waiakoa District)
- Kulanihakoi Gulch Improvements (Kulanihakoi District)
- Kula 2_1 Channel Improvements (Kulanihakoi District)
- Kula 2_1 Culvert Improvements (Kulanihakoi District)
- Proposed South Kihei Road Bridge (Ultimate, Kulanihakoi District)
- Waipuilani Gulch Improvements (Waipuilani District)
- Proposed South Kihei Road Culvert Improvements (Waipuilani District)
- Waipuilani Gulch Diversion (Waipuilani District)
- Proposed Piilani Highway Culvert Improvements at Piilani Basin 14D (Keokea District)
- Waimahaihai Gulch Drainage Improvements (Charlie Young District)
- Restoration and Improvements of Existing Waimahaihai Gulch (Charlie Young District)
- Kihei Gulch 1 Improvements (Charlie Young District)
- Kihei Gulch 1 Drainage System Improvements (Charlie Young District)
- Kalama Beach Park Channel Improvements (Charlie Young District)
- Proposed Auhana Road Culvert Improvements (Charlie Young District)
- Proposed Kanoe Street Culvert Improvements (Charlie Young District)
- Kaluaihakoko Gulch Improvements (Charlie Young District)
- Proposed Piilani Highway Culvert Improvements at Piilani Basin 21 (Kamaole District)
- Proposed Maui Coast Hotel Culvert Improvements (Kamaole District)
- Proposed South Kihei Road Culvert Improvements (Kamaole District)
- Kamaole Gulch Improvements (Kamaole District)
- Kihei Kai Nani Drainage Improvements (Kamaole District)
- Proposed Kanakanui Road Culverts to Replace Existing Conc. Ford (Liilioholo District)
- Proposed North-South Collector Road Culverts to Replace Existing Conc. Ford (Liilioholo District)
- Proposed Piilani Highway Culvert Improvements at Piilani Basin 29 (Kilohana Drive District)
- Waile SF-58 Channel Improvements (Kilohana Drive District)

Cost Estimate Summary

The conceptual cost estimate is summarized in the following table. Refer to Appendix C for detailed cost estimate.

	District	Improvements Total Cost
1	Waiakoa	$16,479,000
2	Kulanihakoi	$57,080,000
3	Waipuilani	$16,876,000
4	Keokea	$10,793,000
5	Charlie Young	$20,193,000
6	Kamaole	$8,739,000
7	Liilioholo	$1,031,000
8	Kilohana Drive	$2,058,000

SECTION 1 – INTRODUCTION

1.1 Background

Development in the Kihei District has increased rapidly with the population growth on Maui in the past two decades. The lowland areas between Piilani Highway and South Kihei Road have been transformed into residential and commercial communities.

Several well-defined gulches exist within the study area that carries large quantities of storm water runoff across Piilani Highway and South Kihei Road to the ocean. Rare, but intense, storms cause flash floods in the lowland areas. As development continues in the Kihei District today, a comprehensive drainage master plan is needed for the public, land developers, and government agencies in order to mitigate the flood risk.

1.2 Purpose and Scope

The purpose of this study is to formulate and update the existing drainage master plans. The scope of work includes:

- Prepare updated drainage maps based on the County's Light Detection and Ranging (LIDAR) data
- Evaluate existing conditions by conducting hydrologic analysis for the mauka and makai drainage basins
- Assess the existing infrastructure capacity and incorporate future development in the analysis
- Recommend possible flood mitigation improvements and estimate the associated costs

1.3 Related Studies

Two past drainage master plans are used as references in preparing this study.

- "Hydrology Report for Piilani Highway, Island of Maui," Trans-Meridian Engineers & Surveyors, Inc., January 1978, referred as 1978 Report

The 1978 Report provided analyses of storm runoff within the South Kihei District east of Piilani Highway. The peak discharges calculations were based on 50-year storm frequency and was used in the design of drainage crossings along Piilani Highway.

- “Drainage Master Plan for Kihei, Maui, Hawaii,” Norman Saito Engineering Consultants, Inc., August 1997, referred as 1997 DMP

  The 1997 DMP assessed the existing drainage to define flooding and drainage problems within the South Kihei District from Waiakoa Gulch to the Kilohana Drive vicinity. The runoff calculations provided both the 50-year and 100-year peak discharges. Recommend improvements were presented as possible flood mitigation.

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SECTION 2 – SITE DESCRIPTION

2.1 Location

The Kihei District is located along the leeward coast of East Maui and western slope of Haleakala (Figure 2.1). It is about 12 miles southeast of Wailuku. Piilani Highway and South Kihei Road are the two major roadways through the Kihei District.

2.2 Topography

The topography in the Kihei District varies greatly. The flat coastal areas are heavily developed and consist of urbanized, residential, and commercial landscapes. Between South Kihei Road and Piilani Highway, the elevation starts to rise up to 200 feet mean sea level (msl) at the south part of the Kihei District. Mauka of Piilani Highway, the slope becomes steeper as it approaches the leeward side of Haleakala and well-defined gulches mark the landscapes. The elevation within the study area ranges from 0 to 9,600 feet msl.

2.3 Climate

The general climate on the island of Maui is greatly influenced by geographic location, and can be characterized as the wet winter season (October to April) and the dry summer season (May to September). At the windward side of the Haleakala mountain range, the predominant northeasterly trade winds generate heavy rainfall whereas the leeward side of the Haleakala mountain range remains relatively dry. Kihei has a mean annual rainfall of approximately 10 inches (Reference 3).

Orographic rainfall and cyclonic storms also contribute to precipitation on the island. The orographic rainfall pattern is restricted to elevations exceeding 2,000 feet where clouds are formed. Moisture in the air from the ocean is uplifted and cooled at upper elevation of the mountain where the highest rainfall is observed. Rainfall decreases gradually toward the coastal areas, as the elevations descend. Cyclonic storms usually produce distributed rainfall several times a year.

Temperature in Kihei District is generally warm and pleasant and varies with elevation. The average annual temperature is 72°F in the coastal areas and may drop to freezing during winter at the summit of Haleakala (Reference 3).

2.4 Drainage Districts

The study area has been divided into eight drainage districts corresponding to drainage paths and major gulches. Within each drainage district, the boundaries of the drainage basins which had

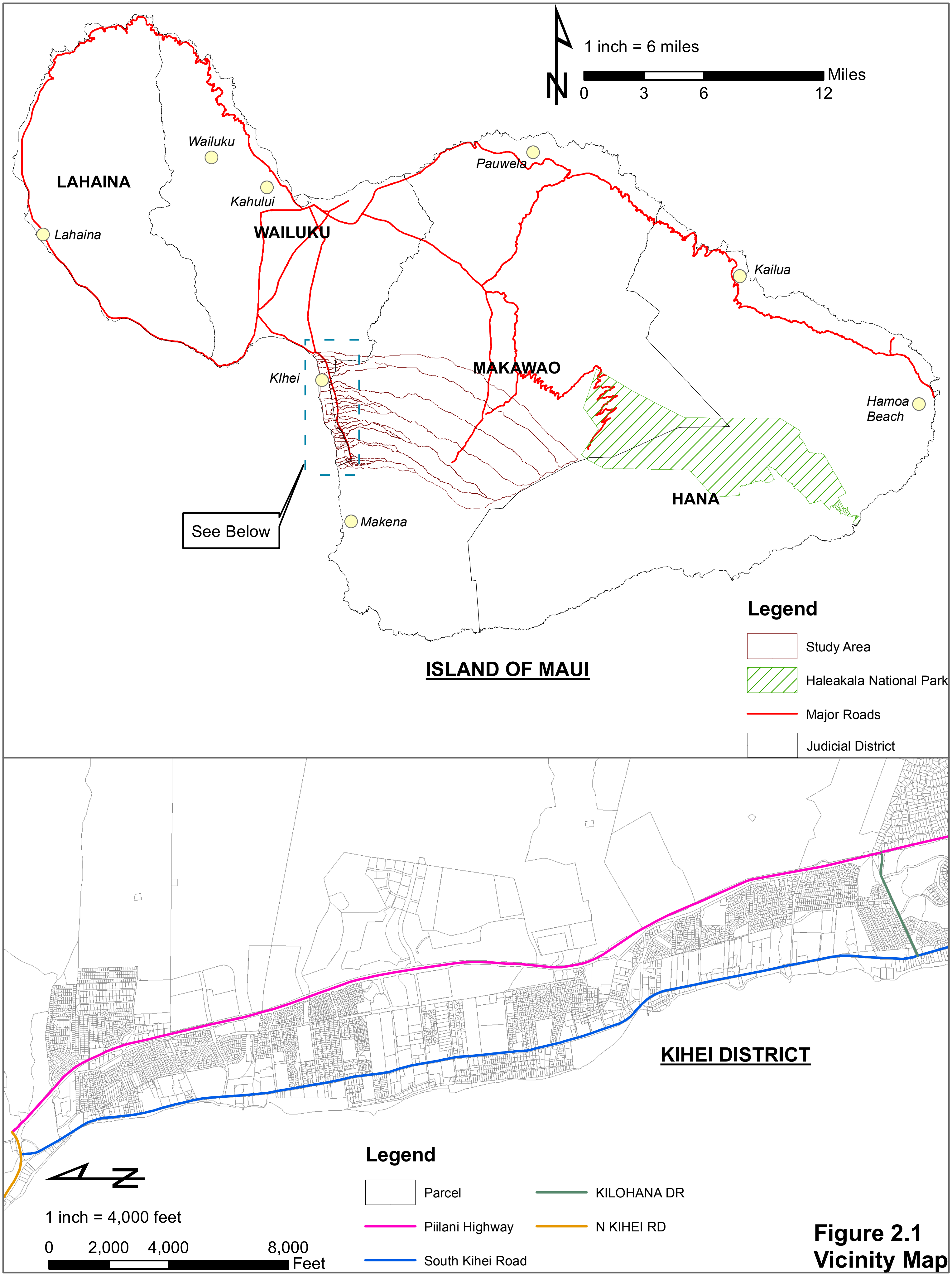


Figure 2.1
Vicinity Map

been delineated in the previous drainage studies were updated on the drainage maps prepared for this study. Piilani Highway is the boundary between the mauka and makai drainage basins. The drainage districts are:

- Waiakoa District
- Kulanihakoi District
- Waipuilani District
- Keokea District
- Charlie Young District
- Kamaole District
- Liilioholo District
- Kilohana Drive District

SECTION 3 – METHODOLOGY

3.1 General

The methodology used to update the drainage master plan generally follows the guidelines in the Maui County Drainage Standards (Reference 4) and is outlined as follows:

For the existing condition:

- The base maps were prepared based on the detailed LiDAR topography and the United States Geological Survey (USGS) quadrangle maps. The drainage basins mauka and makai of Piilani Highway were re-evaluated.

- The base maps were assessed to identify the existing outlets to the ocean where drainage crossings are under South Kihei Road. As-built plans and previous reports were also checked to confirm locations.

- Drainage structures along Piilani Highway were identified and the capacities were determined using information obtained from as-built plans. This was to determine the impact of the Mauka flows to the makai areas.

- The existing drainage conditions for areas makai of Piilani Highway were evaluated based on the available as-built plans. This was to determine how the flows are routed to the existing outlets through the heavily populated lowland areas.

For the proposed condition:

- The base maps were prepared based on the existing condition and the future development projects obtained from Maui County website (Reference 12). The drainage basins mauka of Piilani Highway were re-delineated and the drainage basins makai of Piilani Highway remained unchanged.

- For areas mauka of Piilani Highway, recommendations of the proposed improvements are to 1) limit the runoff to the predevelopment values (existing condition) with detention basins, 2) divert flow to major drainageways, and 3) mitigate the flood impacts to the downstream areas.

- For areas makai of Piilani Highway, the proposed improvements are based on evaluation of the existing outlet condition. The intent is to provide improvements to mitigate flooding utilizing the existing outlet. Construction of new outlets to provide solutions to the regional and local flooding has been considered, but will require further study to assess the feasibility. In addition, the maintenance of the existing outlets to be free of debris and sand dune accumulation shall be one of the priorities to increase outlet capacity.

- Each future development, both mauka and makai of Piilani Highway, is assumed to control its onsite increased runoff (detention facilities) so as to not to cause adverse impact to the downstream areas. The proposed detention facilities shown in the figures were analyzed for the regional runoff (100-year, 24-hour storm in the proposed condition) instead of the 50-year, 1-hour storm for the local system.

- For the existing structures (channel, culverts, and bridges) if determined to have inadequate capacities, options are discussed to provide flood mitigation improvements (see Section 4).

The storm drainage system on South Kihei Road is not meant to convey large runoff. Conceptual recommendations for flood mitigation from Waikoloa District to Kilohana Drive District are provided and discussed in Section 4 of this report. To address the flooding problems at South Kihei Road, it will involve several factors such as land acquisition, roadway and private driveways reconstruction, and community involvement.

3.2 Base Maps

LiDAR data was used as the primary source to delineate drainage basins. Two LiDAR sets were used in this study. The LiDAR data from the 2008 Hawaii Hurricane Study (Reference 5) provided contours from 0 up to 80 feet inland (topographic data collected in 2006). The 2005 Maui Flood Insurance Study (Reference 6) provided topography beyond elevation 80 feet (topographic data collected in 2004). For areas outside of LiDAR coverage, the USGS quadrangle maps were used to continue delineation. The Interferometric Synthetic Aperture Radar (IFSAR) data set provided by the County of Maui was also used as a supplement. The updated existing drainage basin map is shown on Figure 3.1. The LiDAR topography shows South Kihei Road is almost level for majority of its segment. As a result, flooding is observed throughout South Kihei Road during heavy rainfall. The flooding is noticeably severe for the northern portion of South Kihei Road between Kulanihakoi District and Charlie Young District.

3.3 Hydrology

For drainage areas greater than 100 acres and for all streams, the Maui County Drainage Standards require the use of the Natural Resources Conservation Service (NRCS, formerly Soil Conservation Service, SCS) method with a design storm of recurrence interval of 100 years and duration of 24 hours. The Hydrologic Engineering Center–Hydrologic Modeling System (HEC-HMS, Reference 7) from the United States Army Corps of Engineers (USACE) was utilized to determine the 100-year peak flow rates and runoff volumes. The HEC-HMS software incorporates the NRCS method as one of its tools.

Most of the drainage basins makai of Piilani Highway were determined to be less than 100 acres in size. However, the accumulated drainage areas of mauka and makai drainage basins at South Kihei Road are greater than 100 acres. For the sake of consistency in the HEC-HMS model, all drainage basins were analyzed with the 100-year, 24-hour design storm. The drainage basins were delineated based on the topography for the surface flows. For cases where the local flows are routed out of one drainage basin to another drainage basin through a subdivision drainage

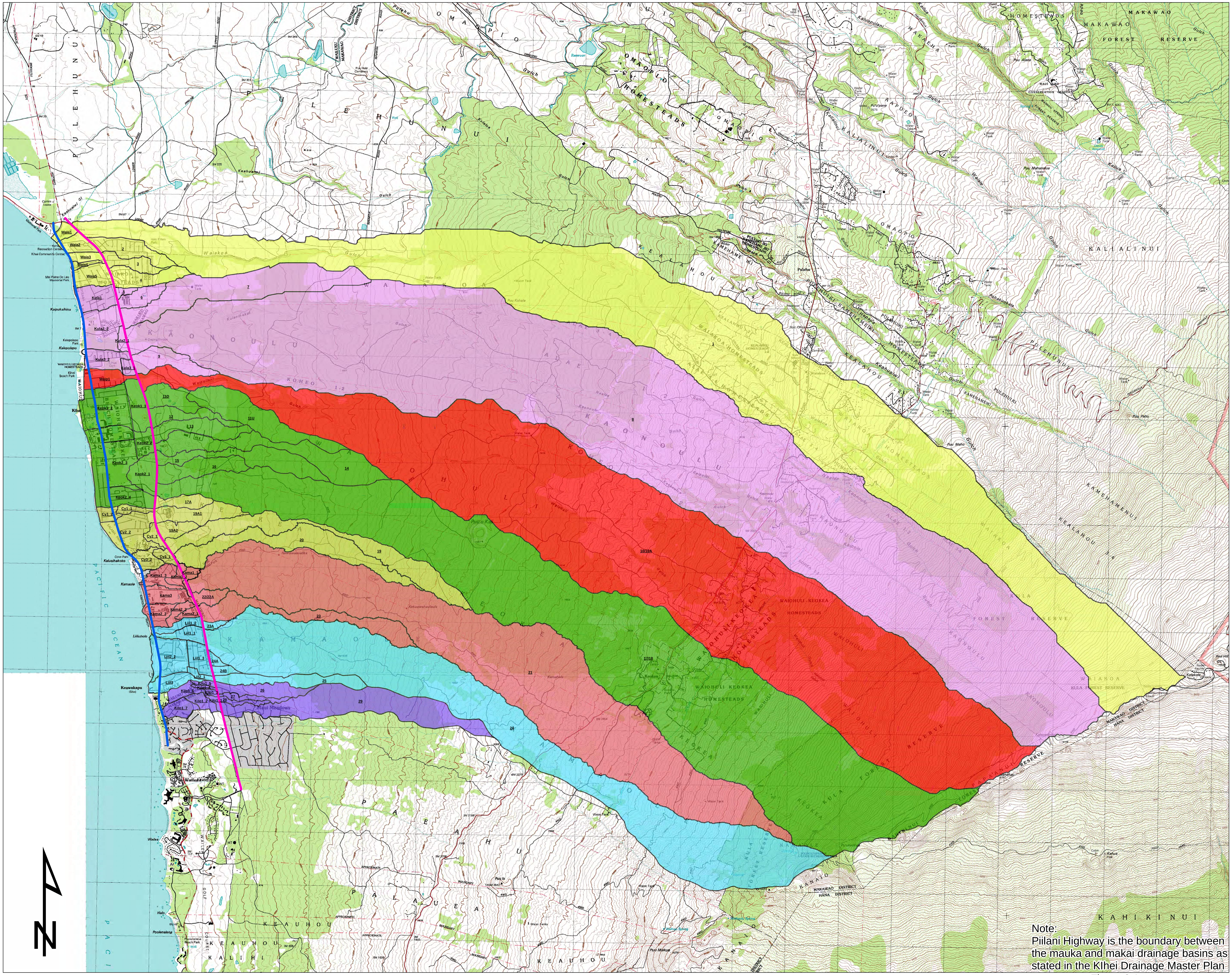


Figure 3.1
Existing Drainage Basin Map

1 inch = 2,000 feet
0 2,000 4,000 6,000
Feet

Legend

- Charlie Young
- Kamaole
- Keokea
- Kilohana
- Kulanihakoi
- Lilioholo
- Waiakoa
- Waipuilani
- Piilani Highway
- South Kihei Road

system, it was assumed that the local flows collected through the subdivision drainage system were relatively small compared to the 100-year peak discharge and will not cause significant impact to the surface flows during the design storm event. The HEC-HMS program is a generalized modeling system capable of representing the watershed runoff. The method used in the HEC-HMS model for this drainage master plan only considers the runoff conveyed by the surface drainage systems.

The HEC-HMS model used in this study is a precipitation-runoff process model, which is built on several parameters. The SCS runoff curve number (CN) was selected as the loss method and the SCS unit hydrograph was selected as the transform method to develop peak discharges and relevant hydrographs in this study. The hydrographs were added to form composite hydrographs where two or more drainage basins contribute to the same point of interest. The resultant peak discharges may not be the summation of all the peak discharges since the time to the peak of each hydrograph varies, and therefore the peaks may not coincide.

A composite runoff curve number for each drainage basin was calculated based on the soil types and land cover. The soil types for the island of Maui were obtained from NRCS website (Soil Survey Geographic Database, SSURGO, Reference 8) and the hydrologic soil group (HSG) classification (A, B, C, and D) was determined. Existing land covers/land uses (LCLU) were obtained from the National Oceanic and Atmospheric Administration (NOAA) Coastal Change Analysis Program (C-CAP) website (imagery collected on 2010, published on 2013, Reference 11). Future LCLU conditions were based on "South Maui Development Projects, Maalaea to Makena" by the Long Range Planning Division at Department of Planning, Maui County (Reference 12). The proposed drainage basin map and future developments are shown in Figures 3.2 and 3.3 with phasing plans included.

The time of concentration (Tc) and lag time are the other parameters required for the model. The Tc is computed based on Technical Release-55 (TR-55, Reference 13) methodology by summing the Tc values of three flow regions: sheet flow, shallow concentrated flow, and channel flow (if applicable). Studies by SCS found that the lag time can be approximated by taking 60% of the time of concentration. The Tc was recalculated for the proposed condition for basins where there were changes to the drainage areas.

Reach routing was only applied to the major gulches in the HEC-HMS model where open channel flow was observed. The lag routing method was selected to represent the time required to travel from makai of Piilani Highway to South Kihei Road. The attenuation is small since the stream segment is relatively short and the velocity is assumed to be consistent throughout the reach. Manning's Equation is used to determine travel velocity for open channel. Reservoir routing was not considered for makai drainage basins since they are designed for local drainage systems during smaller storm events unless the mauka flows are routed to these basins. It is also assumed that the runoff from the future developments will be controlled to assure not to create adverse effects to adjacent or downstream properties.

The meteorologic model is one of the main components in the HEC-HMS model, which specifies boundary conditions and precipitation amounts. The SCS unit hydrograph was adopted in the model. Typically, the SCS Type I storm is used for the Hawaiian Islands. The cumulative

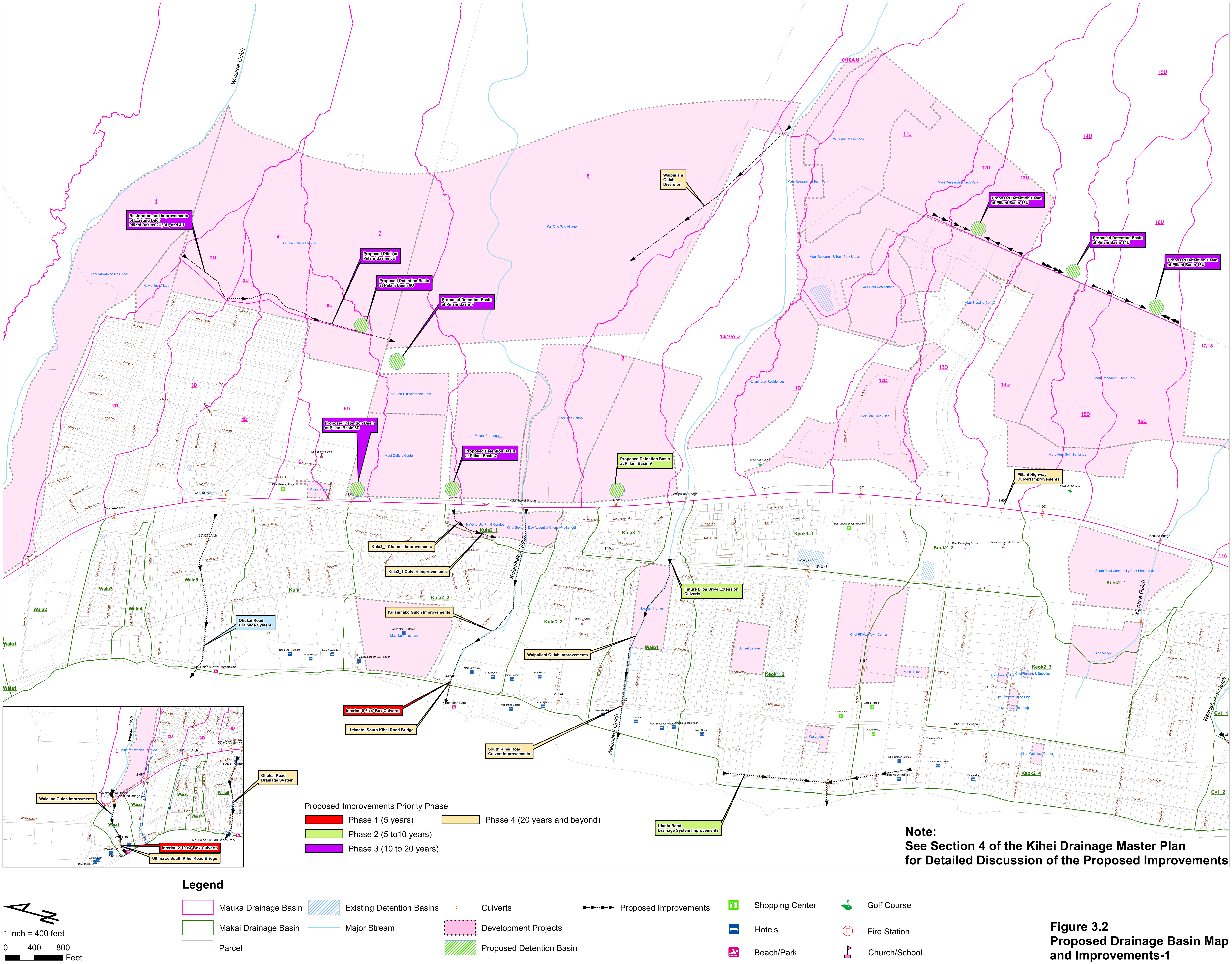
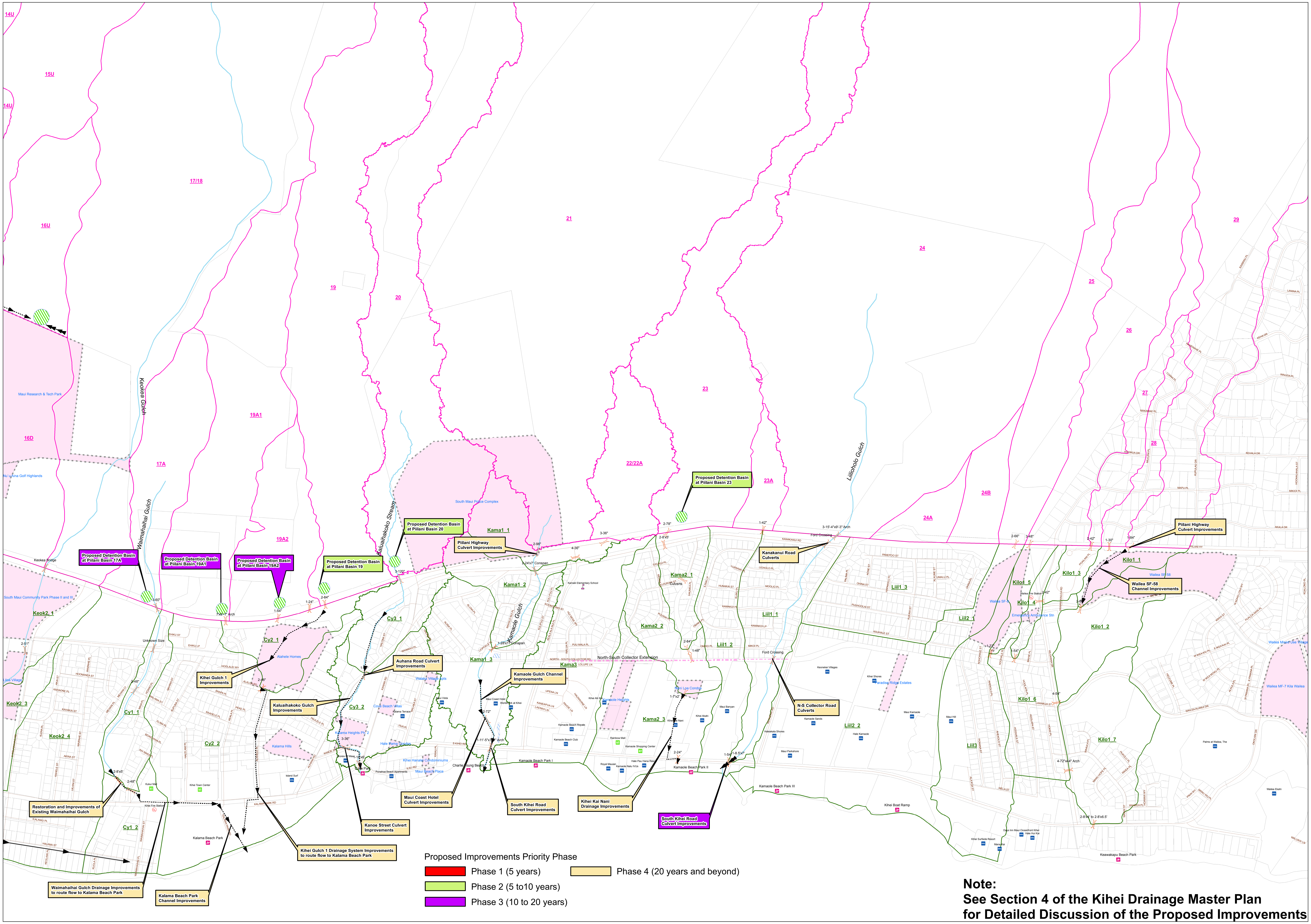


Figure 3.2
Proposed Drainage Basin Map and Improvements-1



Note:
See Section 4 of the Kihei Drainage Master Plan for Detailed Discussion of the Proposed Improvements

Legend

- Mauka Drainage Basin
- Makai Drainage Basin
- Parcel
- Detention Basins
- Major Stream
- Culverts
- Development Projects
- Proposed Detention Basin
- Proposed Improvements
- Shopping Center
- Hotels
- Beach/Park
- Golf Course
- Fire Station
- Church/School

1 inch = 400 feet

0 400 800 Feet

Figure 3.3
Proposed Drainage Basin Map and Improvements-2

precipitation of the SCS Type I unit hydrograph for the duration of 24-hour was input as a time-series table (Reference 14). The total 24-hour rainfall depths of various recurrence intervals were obtained from the NOAA website, Precipitation Frequency Data Server (NOAA Atlas 14 for the Hawaiian Island, Reference 15).

3.4 Hydraulics

Culvert analyses were used to determine the existing culvert capacities with the use of HY-8 (Federal Highway Administration, Reference 16), Hydraflow (AutoCAD extension), and nomographs (Reference 17). For culverts with as-built plans available, the capacity was re-evaluated based on the inverts and roadway elevation. The maximum allowable headwater elevation was set to be one foot below the edge of the roadway (LiDAR) in order to evaluate the existing culvert capacities. For culverts without as-built plans, the capacity was adopted from the previous drainage reports where available or is assumed to be able to convey the flow. Capacities of the existing sub-surface drainage systems were not evaluated because of the uncertainty of the drainage system catchment areas.

Piilani Highway is within the Hawaii Department of Transportation (HDOT) jurisdiction. For the culverts located at Piilani Highway crossings, the recurrence interval, according to the HDOT drainage design standards, is based on the 50-year storm event unless the site is covered under the Flood Insurance Rate Map (FIRM), in which case the 100-year recurrence interval shall be applied. In addition, it’s assumed the detention facilities will be constructed for the future developments mauka of Piilani Highway to limit the peak discharges less or equal to the pre-development condition. The proposed improvements to the drainage structures located on Piilani Highway in this report are subject to HDOT’s approval.

3.5 Consultation With County

The R. M. Towill Corporation has worked closely with Maui County personnel to obtain guidance and information. Mr. Raynard Oshiro from the Department of Public Works (DPW) provided valuable information regarding existing flooding problems in Kihei. As-built plans were obtained with the assistance of Mr. Joe Krueger and Mr. Ty Takeno from DPW. Comments received from the Maui County DPW personnel, Mr. David Goode, Mr. Ty Takeno, and Ms. Kristi Ono are greatly appreciated.

3.6 Community Presentations

The results of this study will be presented to the community to solicit input and answer questions from the community.

SECTION 4 – ASSESSMENT OF DRAINAGE DISTRICTS

4.1 Waiakoa District

The Waiakoa District consists of Piilani Basins 1, 2, 3, and 4 mauka of Piilani Highway. Makai of Piilani Highway, the district is divided into five drainage basins from Waia1 to Waia5. Waiakoa Gulch is the major drainageway in the district. The basins in the Waiakoa District and the existing conditions runoff for the 100-year storm (Q_{100}) are listed in Table 4.1.1. The Waiakoa District Existing Conditions map is shown in Figure 4.1.a and the Waiakoa Existing Conditions HEC-HMS diagram is shown in Figure 4.1.b.

Table 4.1.1 Waiakoa District, Existing Conditions

Mauka of Piilani Highway			Makai of Piilani Highway		
Piilani Basin	Area (acres)	Q_{100} (cfs)	Makai Basin	Area (acres)	Q_{100} (cfs)
1	6,339	6,518	Waia1	26	56
2	107	295	Waia2	46	127
3	59	181	Waia3	28	90
			Waia4	13	48
4	103	315	Waia5	69	243

For the proposed conditions, an existing diversion ditch located mauka of Ohukai Subdivision will be utilized and expanded to accommodate the flows from future developments. The diversion ditch divides Piilani Basins 2, 3, 4, and 6 into 2U and 2D, 3U and 3D, 4U and 4D, 6U, and 6D respectively, and conveys the runoff to a proposed detention basin before discharging to Piilani Basin 7 (Figure 4.1.f). The basins in the Waiakoa District and the proposed conditions runoff for the 100-year storm (Q_{100}) are listed in Table 4.1.2. The Waiakoa District Proposed Conditions map is shown in Figure 4.1.c and the Waiakoa Proposed Conditions HEC-HMS diagram is shown in Figure 4.1.d. Discussions of the recommendations are presented in the following subsections.

Table 4.1.2 Waiakoa District, Proposed Conditions

Mauka of Piilani Highway			Makai of Piilani Highway		
Piilani Basin	Area (acres)	Q_{100} (cfs)	Makai Basin	Area (acres)	Q_{100} (cfs)
1	6,339	6,588	Waia1	26	56
2U	16	63	Waia2	46	127
2D	91	291			
3U	4	16	Waia3	28	90
3D	55	180			
			Waia4	13	48
4U	35	125	Waia5	69	243
4D	68	258			

The runoff quantities along Piilani Highway and South Kihei Road in the Waiakoa District are listed in Tables 4.1.3 and 4.1.4. The Waiakoa Bridge and Waiakoa Uka Bridge capacity, water surface elevation, and freeboard were estimated from the as-built plans using the linear relationship and are summarized in Tables 4.1.5 and 4.1.6.

Table 4.1.3 Waiakoa District, Runoff Quantities along Piilani Highway

Cross-Drain Description	Capacity (cfs)	Existing			Proposed		
		Piilani Basin	Area (acres)	Q_{100} (cfs)	Piilani Basin	Area (acres)	Q_{100} (cfs)
1-48”	94	1	6,339	6,518	1	6,339	6,588
Waiakoa Bridge Waiakoa Uka Bridge	7,070 37,600						
2-48”	244	2	107	295	2D	91	291
1-60” (sub-surface)	N/A						
2-72”x44” arch	343	3	59	181	3D	55	180
1-65”x40” arch	110	4	103	315	4D	68	258
1-72”	335						

Table 4.1.4 Waiakoa District, Runoff Quantities along South Kihei Road

Cross-Drain Description	Capacity (cfs)	Existing			Proposed		
		Makai Basin	Area (acres)	Q_{100} (cfs)	Makai Basin	Area (acres)	Q_{100} (cfs)
1-24” and 1-48”	N/A	Waia1[1]	6,365	6,528	Waia1[1]	6,365	6,598
1-8’x3’(sub-surface) and sheet flow	N/A	Waia2[2e]	153	409	Waia2[2p]	137	415
Sheet flow	N/A	Waia3[3e]	87	266	Waia3[3p]	83	268
Sheet flow	N/A	Waia4	13	48	Waia4	13	48
1-18” and 1-27”x18” arch (sub-surface) and sheet flow	N/A	Waia5[4e]	172	535	Waia5[4p]	137	500

[1] including Piilani Basin 1 and Waia1,
[2e] including Piilani Basin 2 and Waia2, [2p] including Piilani Basin 2D and Waia2
[3e] including Piilani Basin 3 and Waia3, [3p] including Piilani Basin 3D and Waia3
[4e] including Piilani Basin 4 and Waia5, [4p] including Piilani Basin 4D and Waia5

Table 4.1.5 Waiakoa Bridge Capacity

	Flow (cfs)	Water Surface Elevation (ft)	* Freeboard (ft)	Remark
Bridge Capacity	7,070	19.6	0.0	Estimated
As-Built Plan Q_{100}	7,070	19.6	0.0	As-Built Plan Data
(P) Kihei DMP Q_{100}	6,558	19.5	0.1	Estimated
(Ex) Kihei DMP Q_{100}	6,518	19.5	0.1	Estimated
As-Built Plan Q_{50}	4,310	19.2	0.4	As-Built Plan Data

* based on the bridge low chord elevation of 19.6 feet (as-built plan data)

Table 4.1.6 Waiakoa Uka Bridge Capacity

	Flow (cfs)	Water Surface Elevation (ft)	* Freeboard (ft)	Remark
Bridge Capacity	37,600	26.6	2.0	Estimated
As-Built Plan Q_{100}	7,070	16.6	12.0	As-Built Plan Data
(P) Kihei DMP Q_{100}	6,558	16.5	12.1	Estimated
(Ex) Kihei DMP Q_{100}	6,518	16.4	12.2	Estimated
As-Built Plan Q_{50}	4,310	15.7	12.9	As-Built Plan Data

* based on the bridge low chord elevation of 28.6 feet (as-built plan data)

4.1.1 Waia1 and Piilani Basin 1

Existing Conditions

Waiakoa Gulch is the major drainageway in Piilani Basin 1 and has been studied by Federal Emergency Management Agency (FEMA). According to the latest Flood Insurance Study (FIS, Reference 3), Q_{100} at Piilani Highway is 6,800 cfs.

Waiakoa Gulch crosses the recently widened Piilani Highway at the new Waiakoa Uka Bridge (mauka) and the existing Waiakoa Bridge (makai) with Q_{100} = 6,518 cfs calculated in this report. The highway widening project was to accommodate the increasing traffic volume in Kihei. A new 48” culvert, located a short distance north of Waiakoa Uka Bridge, connects to the existing 48” culvert. It has a capacity of 94 cfs, which is insignificant during intense storms. After crossing the bridges, water flows overland through a flat and shallow earth channel towards South Kihei Road. Flooding problems at both Waiakoa Uka Bridge and Waiakoa Bridge are caused by the Waiakoa Gulch flow and the split flow from Waiakoa Gulch to Keahaiwai Gulch to the northwest as shown on the Flood Insurance Rate Map (FIRM), dated September 19, 2012. Waiakoa Bridge is the physical constraint of the two bridges according to Tables 4.1.4 and 4.1.5 and barely passes the 100-year flow.

The ground cover between Piilani Highway and South Kihei Road consists of dense vegetation of Keawe trees and brush. Sand deposits and debris accumulate along the gulch. One 48” and one 24” culverts are located at the South Kihei Road crossing and do not have sufficient capacities to handle large flows. As a result, South Kihei Road is overtopped during large storm events (Q_{100} is 6,528 cfs). The channel outlet makai of South Kihei Road at the Kihei Beach is normally blocked by sand dunes. There are condominium and apartment buildings along both banks makai of South Kihei Road, which further limit channel conveyance. All of these factors contribute to the flooding problems at the South Kihei Road crossing.

Future Conditions

Two future developments are proposed within Piilani Basin 1: Kihei Kaiwahine Residence A&B and Kaiwahine Village. The runoff mauka of Piilani Highway will be collected by local drainage systems and detention basins before it discharges to Waiakoa Gulch to ensure minimum impact at Waiakoa Bridge.

The lands makai of Piilani Highway remain unchanged. The future developments increase the Q_{100} from 6,528 cfs to 6,598 cfs at South Kihei Road. The flooding problems at South Kihei Road are mainly caused by the large width of the Waiakoa Gulch floodplain. As discussed in section 4.1.1, the Waiakoa Gulch outlet is restricted by the existing developments at both banks. Currently, the County of Maui is in the design phase to replace the existing culverts at the South Kihei Road crossing with 2-10'x3' box culverts. The improvement is not intended to alleviate the existing flooding condition completely.

Recommendations

The recommendations listed below are based on the technical data analyzed in this report and are conceptual. Further study will be needed to assess the feasibility of the solutions.

- Construct a rectangular concrete-lined channel (Waiakoa Gulch Improvements, 40-feet bottom width, 10-feet height) from Piilani Highway to the existing outlet to convey 6,598 cfs. This is to contain the designed peak flow within the proposed channel. Similar channel could also be considered at mauka side of Piilani Highway up to the location where the split flow occurs.

  A second alternative is to construct a grassed trapezoidal channel with 40-feet bottom width, 11-feet height, and a 2:1 side slope. However, consideration shall be taken into account for the 84-feet top width of the grassed channel transitioning to the proposed 40-feet span bridge at the South Kihei Road crossing mentioned below and the downstream restrictions.

- Ultimately construction of a new bridge (40-feet span) at the South Kihei Road crossing could be considered as a long-term goal in conjunction with the proposed channel. However, due to the flat terrain at the crossing, this option may require reconstruction of South Kihei Road and the private driveways in the vicinity. This is to raise the bridge and the approaches to provide sufficient opening to pass the design flow. In addition, it may require utility relocation and land acquisition to accommodate the width of the proposed channel and bridge.

- Provide erosion control measures (channel revetment or reinforcement matting) at the vicinity of the discharge points to Waiakoa Gulch from the future developments. This is to minimize the impacts to the downstream area. Constructing a regional detention basin at mauka of Piilani Highway as a mean for flood and erosion control for Waiakoa Gulch will not be feasible because of the large sheer volume of the peak flow and runoff volume generated from the mauka drainage area.

- Perform maintenance of the outlet regularly to be free of debris and sand dune accumulation.

The proposed channel and bridge will provide sufficient capacity for the future condition and mitigate flooding at South Kihei Road.

4.1.2 Waia2 and Piilani Basin 2

Existing Conditions

Piilani Basin 2 covers portions of Hale Piilani Subdivision and Ohukai Subdivision and for the basin Q_{100} = 295 cfs. An existing ditch running north to south though Piilani Basins 2, 3, and 4 is located mauka of Ohukai Subdivision (Figure 4.1.e). The ditch connects to the Ohukai Road drainage system after it crosses the existing dirt road with an outlet to an open ditch south of Hale Kai Street, and the flow is eventually discharged to a gulch in Piilani Basin 7. Aerial photos and LiDAR contours show the existing ditch is not well maintained. Therefore, the existing ditch does not provide sufficient capacity during the design storm and majority of the runoff still flows toward Piilani Highway.

Storm runoff from Hale Piilani Subdivision and parts of Ohukai Subdivision are collected by the local drainage system and directed to an underground 60” pipe at the Piilani Highway crossing. The underground pipe changes to a 72”x44” arch pipe after it crosses Piilani Highway and runs parallel to Uwapo Road. It then connects to a 6’x3’ concrete box culvert and increases to an 8’x3’ concrete box culvert at the South Kihei Road crossing. The culvert eventually outlets to Kihei Beach. It is assumed that the drainage system also receives the storm runoff from the existing Kihei Villages Development located south of Uwapo Road and mauka of Kenolio Road. Runoff from other open areas in Waia2 is assumed to sheet flow towards the ocean.

Two 48” culverts with combined capacity of 244 cfs are located a short distance north of the 60” underground pipe. It is assumed that the 2-48” culverts receive the remaining Piilani Basin 2 runoff that is not captured by the local drainage system. The flow discharges to open spaces past Piilani Highway and sheet flows to the ocean seeking natural outlets.

Future Conditions

The major future developments mauka of Piilani Highway are Kaiwahine Village and Ohukai Village, located mauka of the existing Ohukai Subdivision. Portions of Kihei Kaiwahine Residence A&B also contribute the flow to Piilani Basin 2. No development is anticipated in Waia2.

The existing diversion ditch located mauka of Ohukai Subdivision will be utilized and expanded to accommodate the flows from future developments; the intent is to route the runoff following the existing flow pattern to Piilani Basin 7 and minimize the impacts to the downstream establishments. A detention basin is proposed at the end of the expanded diversion ditch to serve as both the erosion and flood control measure (Figure 4.1.f). For the runoff generated from future developments bordering the existing subdivision, it is assumed the runoff will be conveyed through local drainage systems to Waiakoa Gulch or to the expanded diversion ditch.

The Q_{100} at Piilani Highway is reduced from 295 cfs to 291 cfs due to the proposed diversion ditch mauka of Ohukai Subdivision. The increase of 6 cfs at South Kihei Road is due to shorter time of concentration at Piilani Basin 2D and have coincidence peak with Waia 2. It will have minimum effect to the drainage as the runoff sheet flows through the vast area.

Recommendations

- Restore and improve the existing ditch mauka of the existing Ohukai Subdivision to convey Q_{100} (242 cfs) from Piilani Basins 2U, 3U, 4U, and 6U (Figure 4.1.f). The trapezoidal, grassed ditch will have 10-feet bottom width, 5-feet height, and a 2:1 side slope. The alignment of the ditch could be altered to accommodate the future development layout and shall be coordinated between the developer and the government agencies.

- Construct a new diversion ditch with the same dimensions to convey runoff (242 cfs) to a proposed detention basin (15 ac-ft) at Piilani Basin 6U before discharging to Piilani Basin 7 (Figure 4.1.f). The outflow from the detention basin will be reduced to 74 cfs.

The proposed ditch improvements, diversion ditch mauka of Ohukai Subdivision, and a detention basin will provide sufficient capacity for the future condition and mitigate the impacts to the downstream areas.

4.1.3 Waia3 and Piilani Basin 3

Existing Conditions

The Q_{100} from Piilani Basin 3 is 181 cfs and crosses Piilani Highway though 2-72"x44" arch pipes with capacity of 343 cfs. After it crosses Piilani Highway, the runoff flows overland to Kaiola Place mauka of Honualahele Subdivision, where an existing small drainage swale is located. The swale diverts portions of the flows to the subdivision grassed detention ponds. The remaining runoff is assumed to sheet flow across the subdivision towards the ocean. There is no report of observed flooding problems at South Kihei Road.

Future Conditions

See Section 4.1.2 for future developments mauka of Piilani Highway. No development is anticipated in Waia3. The Q_{100} at Piilani Highway is reduced from 181 cfs to 180 cfs due to the proposed diversion ditch mauka of Ohukai Subdivision. The increase of 3 cfs at South Kihei Road is due to shorter time of concentration at Piilani Basin 3D and have coincidence peak with Waia 3. It will have minimum effect to the drainage as the runoff sheet flows through the vast area.

Recommendations

As discussed in section 4.1.2, the proposed ditch improvements, diversion ditch mauka of Ohukai Subdivision, and a detention basin will provide sufficient capacity for the future condition and minimize the impacts to the downstream areas. No drainage improvements are proposed because no flooding has been observed at South Kihei Road and there is no development anticipated.

4.1.4 Waia4

Existing Conditions

Waia4 is an isolated makai drainage basin and does not receive any mauka runoff. It covers Arilani Subdivision and for the basin Q_{100} = 48 cfs. An existing retention basin is located mauka of Kenolio Road and south of Aliiilani Place. It is assumed that the majority of the flow from Arilani Subdivision is contained in the retention basin. Runoff generated from areas makai of Kenolio Road sheet flows across South Kihei Road towards the ocean.

Future Conditions

No development is anticipated in Waia4.

Recommendations

No drainage improvements are proposed because no flooding has been observed at South Kihei Road and there is no development anticipated.

4.1.5 Waia5 and Piilani Basin 4

Existing Conditions

Storm runoff from Piilani Basin 4 crosses Piilani Highway at two locations: 1-65"x40" arch pipes at a detention basin outlet and 1-72" culvert north of Ohukai Road. The detention basin located mauka of Piilani Highway and north of Ohukai Road is intended to control the local drainage for Waiakoa Kai Estates Subdivision and reduce peak flow. The total runoff generated in Piilani Basin 4 is 315 cfs (Q_{100}) irrespective of flow attenuation due to the detention basin.

After crossing Piilani Highway, the two flows combine and flow overland toward Ohukai Road. Small amounts of the flows are captured by a 36"x27" arch pipe with a capacity of 45 cfs at the Pakalana Place crossing and outlets to Ohukai Road. Ohukai Road functions as a flood channel and carries majority of the flows towards the ocean. The roadway drainage system located at the intersection of Ohukai Road and South Kihei Road consists of an 18" pipe and a 29"x18" arch pipe and outlets to the beach. The LiDAR topography shows the segment of South Kihei Road in the vicinity of Ohukai Road intersection has level slope. Sand dunes and vegetation makai of South Kihei Road is higher than the road forming a natural barrier and block the water reaching to the ocean. Flow will pond along South Kihei Road until it overtops or breaks the sand dunes causing flooding problems around the Ohukai Road intersection during heavy rainfall.

Future Conditions

See Section 4.1.2 for future developments mauka of Piilani Highway. No development is anticipated in Waia5. The Q_{100} at Piilani Highway is reduced from 315 cfs to 258 cfs and the Q_{100} at South Kihei Road is reduced from 535 cfs to 500 cfs due to the proposed diversion ditch mauka of Ohukai Subdivision. The reduction in flow will help to mitigate the observed local flooding.

Recommendations

- Due to lack of data and no natural outlet, further study will be needed to assess the South Kihei Road and Ohukai intersection and determine if it's feasible to remove the sand dunes for the floodwater to flow out to the ocean.

- Another possible alternative is to construct a storm drainage system on Ohukai Road from Kaiola Place to the ocean. This is to convey the concentrated mauka runoff (258 cfs) from Piilani Basin 4D and minimize the surface runoff on Ohukai Road. This option may require reconstruction of the existing drainage system along South Kihei Road to prevent flooding to the adjacent private properties.

Implementation of a new outlet and/or a storm drainage system to convey the mauka runoff on Ohukai Road will reduce the flooding at South Kihei Road.

4.1.6 Waiakoa District Cost Estimate

The conceptual cost estimate for Waiakoa District improvements is summarized in the following table. Refer to Appendix C for detailed cost estimate.

Table 4.1.7 Waiakoa District Cost Estimate Summary

	Improvements	Cost
1	Waiakoa Gulch Improvements	$5,554,000
2	Proposed South Kihei Road Bridge, Waiakoa Gulch	$7,714,000
3	Restoration and Improvements of Existing Ditch Mauka of Ohukai Subdivision	$312,000
4	Proposed Ditch to Proposed Detention Basin at Piilani Basin 6U	$127,000
5	Proposed Ohukai Road Drainage System	$2,772,000
	Total	$16,479,000

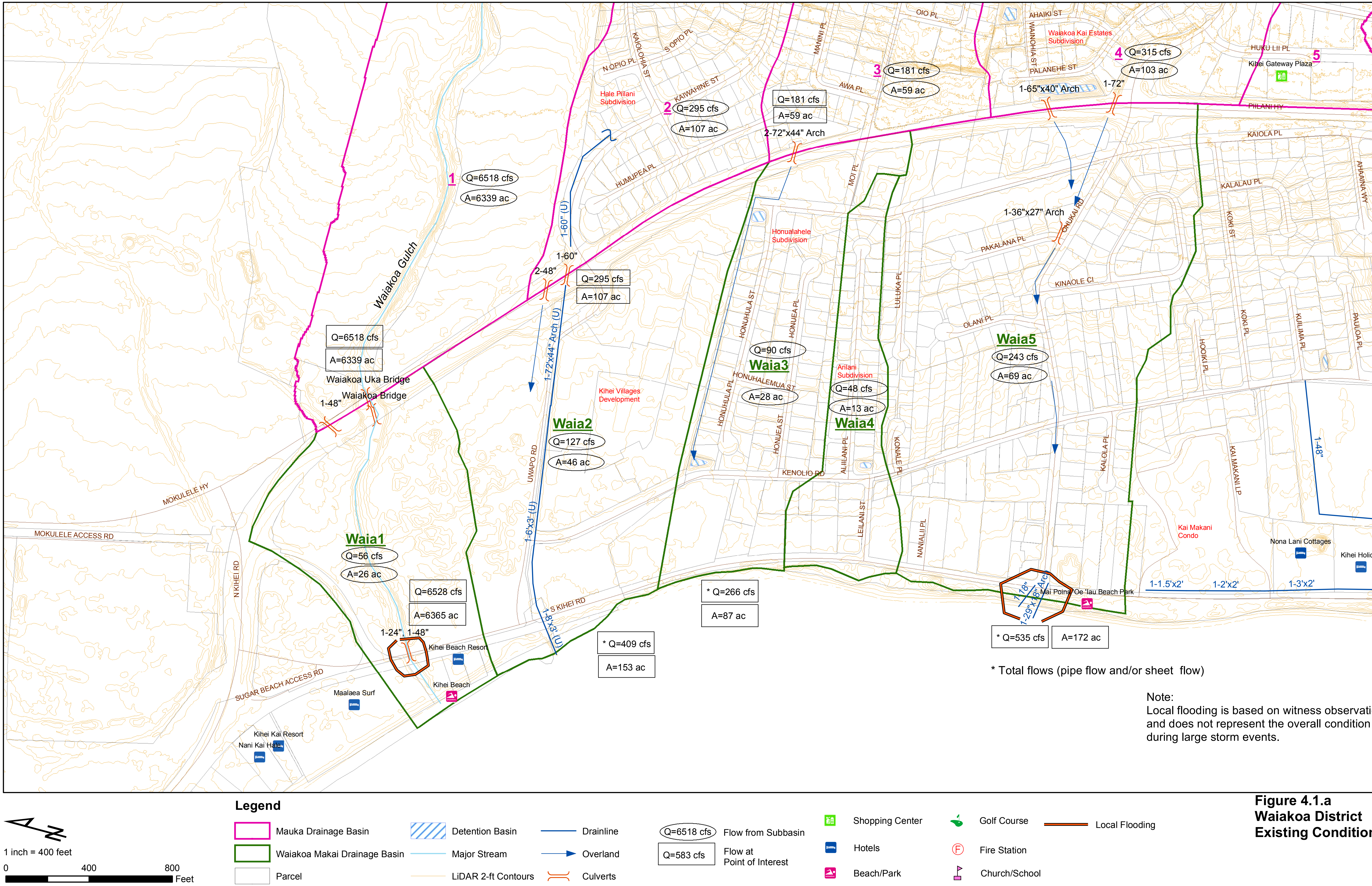
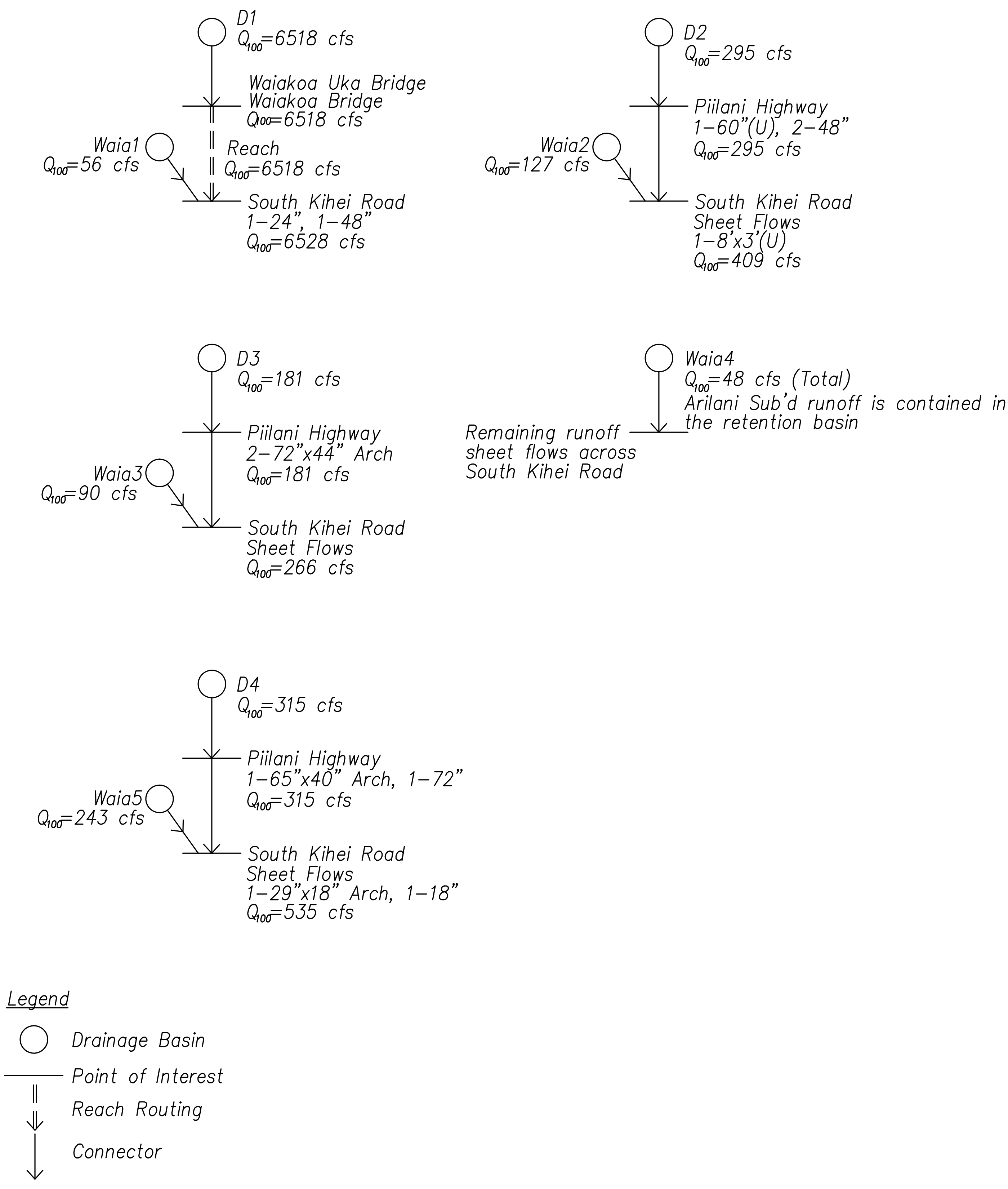


Figure 4.1.a
Waiakoa District
Existing Conditions



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Waiakoa District
Existing Conditions
HEC-HMS Diagram

Figure
4.1.b

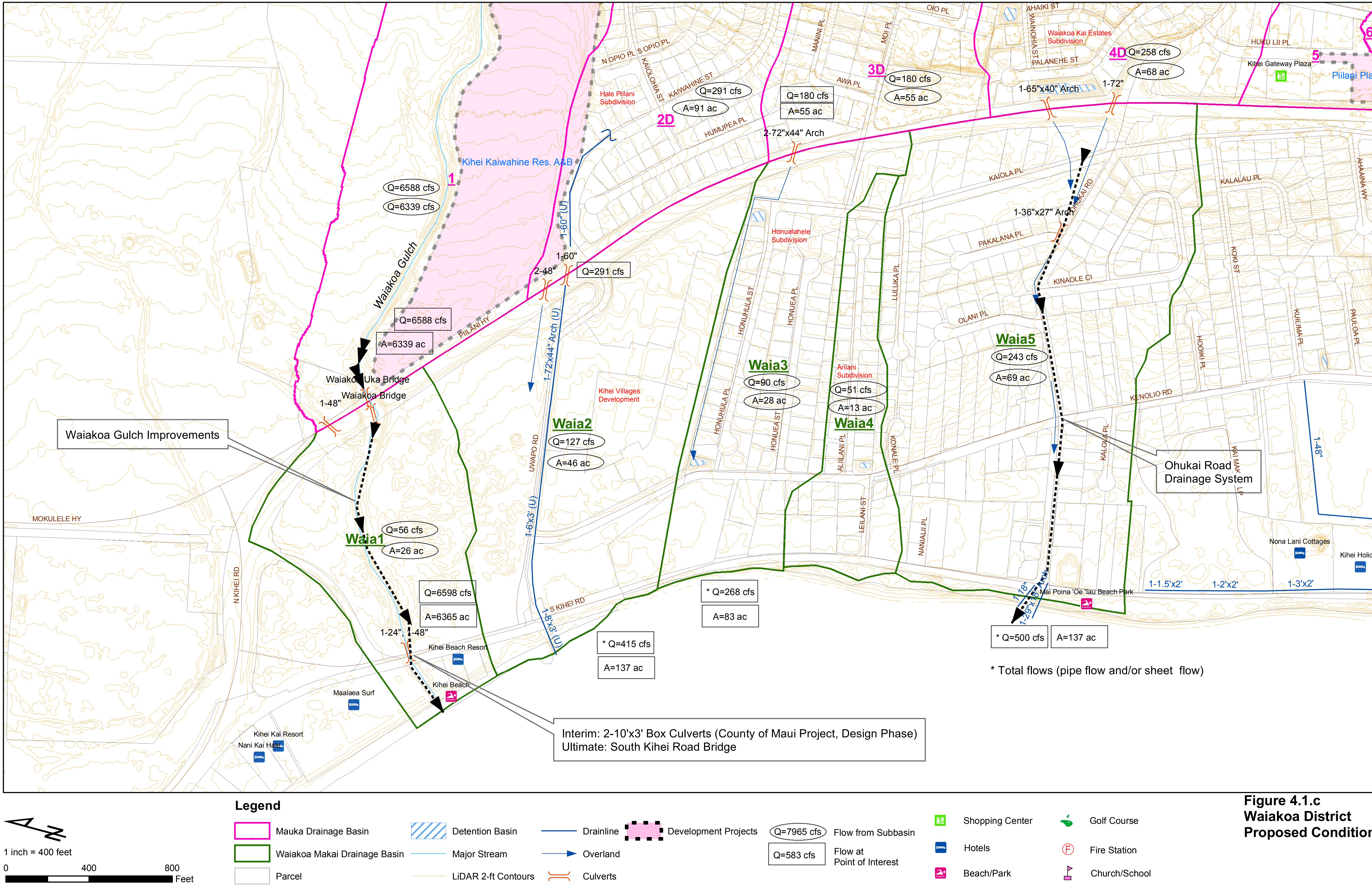
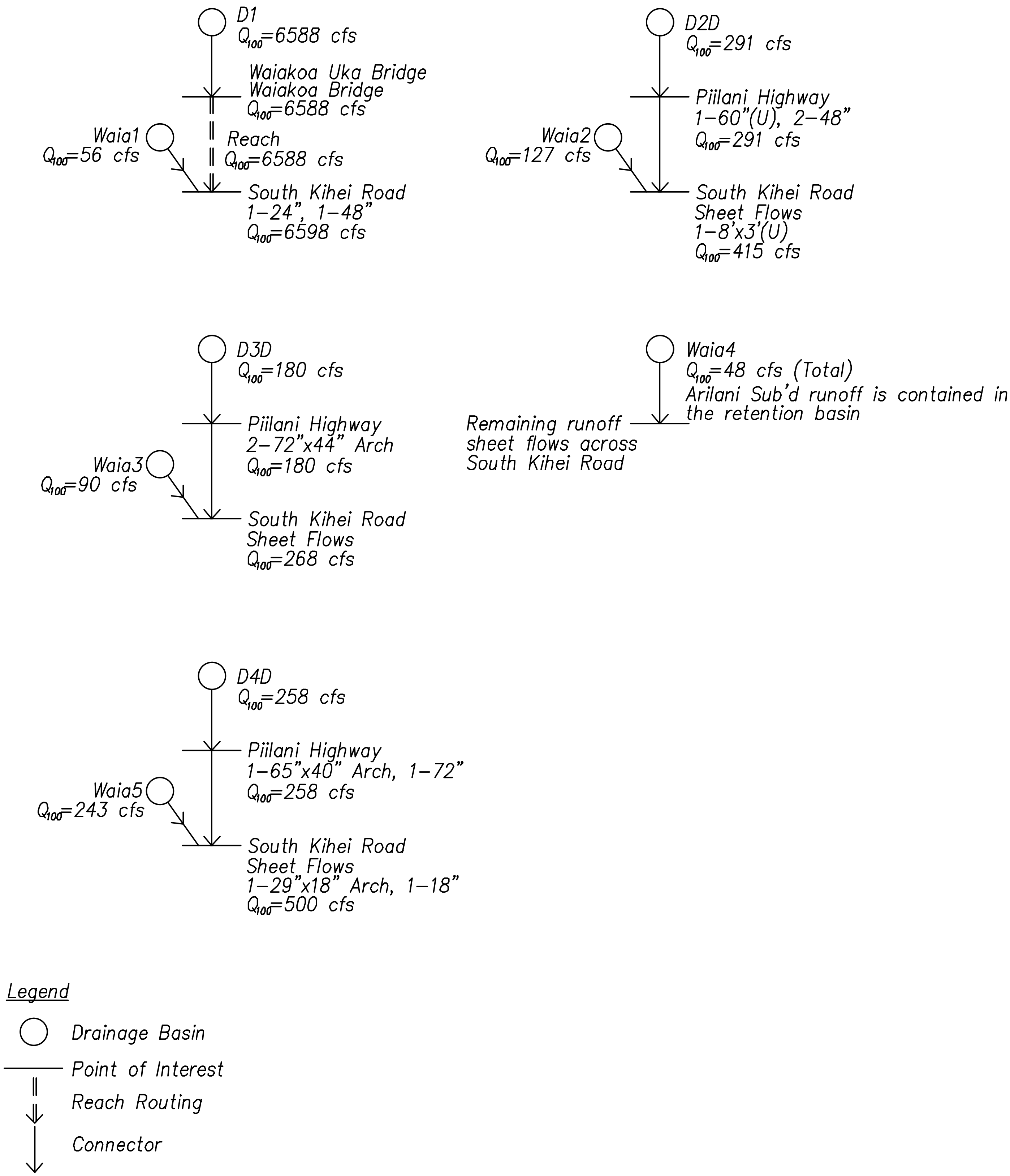


Figure 4.1.c
Waiakoa District
Proposed Conditions



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Waiakoa District
Proposed Conditions
HEC-HMS Diagram

Figure
4.1.d

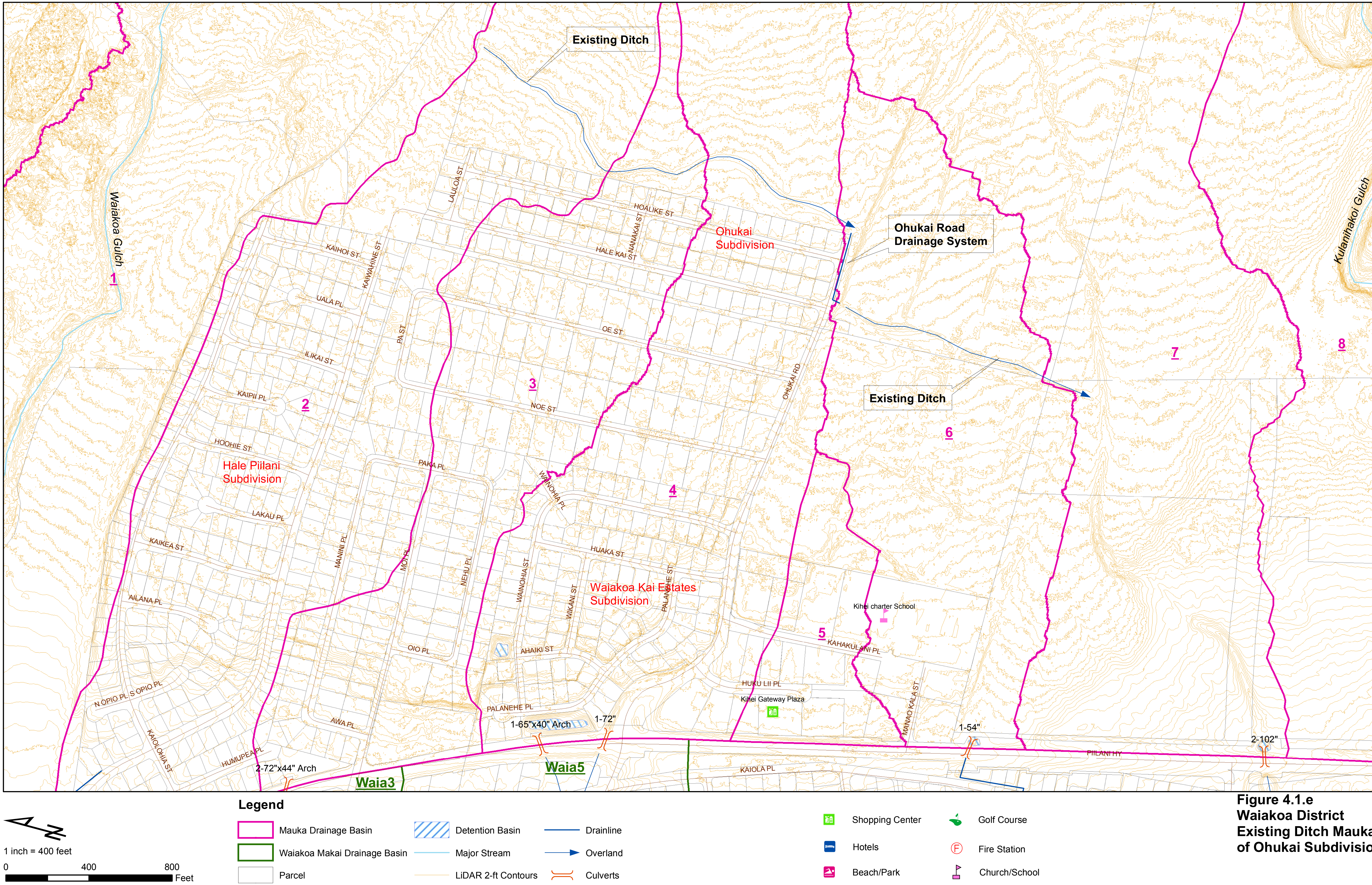


Figure 4.1.e
Waiakoa District
Existing Ditch Mauka
of Ohukai Subdivision

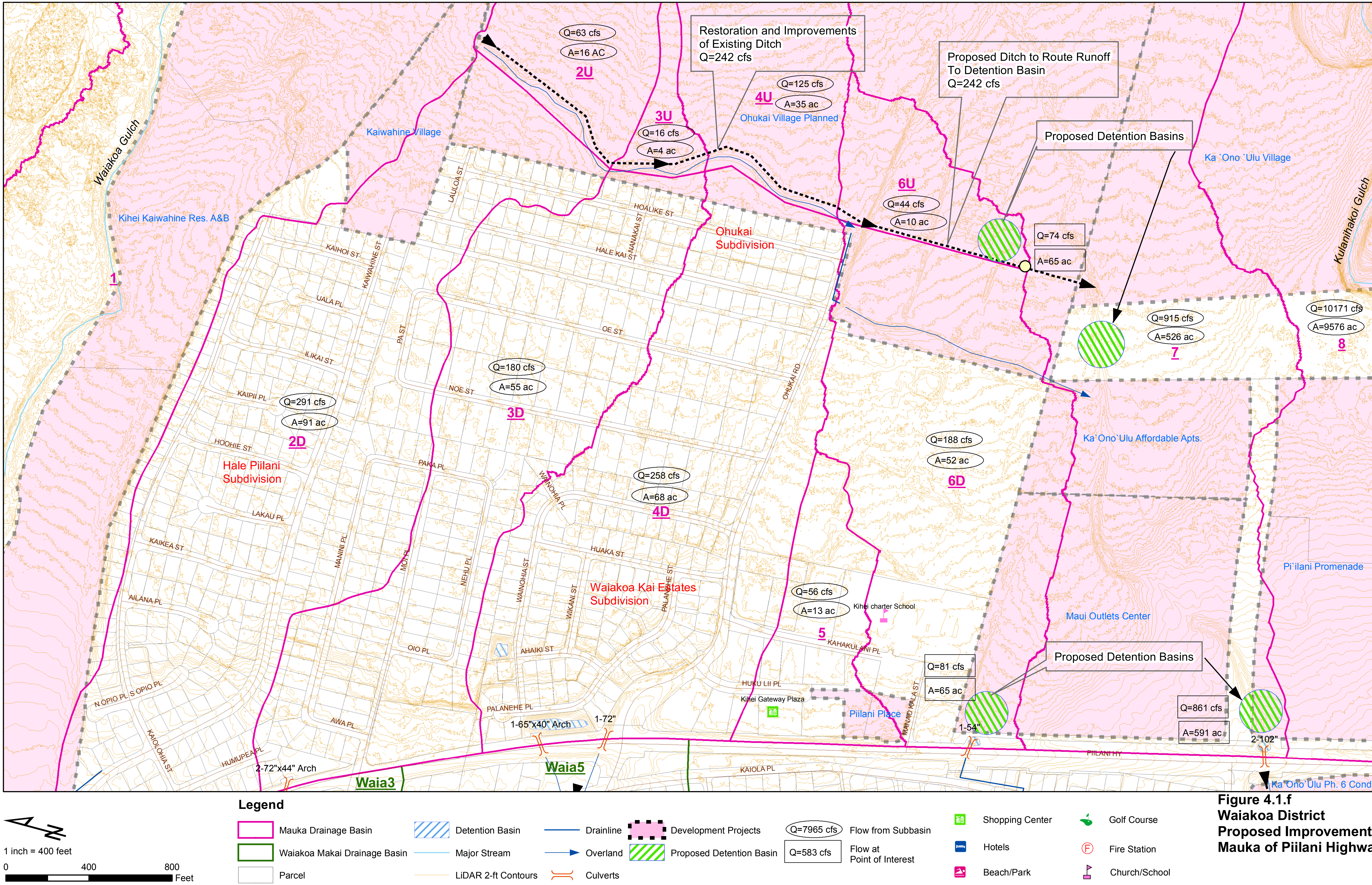


Figure 4.1.f
Waiakoa District
Proposed Improvements
Mauka of Piilani Highway

4.2 Kulanihakoi District

The Kulanihakoi District consists of Piilani Basins 5, 6, 7, 8, and 9 mauka of Piilani Highway. Makai of Piilani Highway, the district is divided into five drainage basins from Kula1 to Kula3_2. Kulanihakoi Gulch is the major drainageway in the district. The basins in the Kulanihakoi District and the existing conditions runoff for the 100-year storm (Q_{100}) are listed in Table 4.2.1. The Kulanihakoi District Existing Conditions map is shown in Figure 4.2.a and the Kulanihakoi Existing Conditions HEC-HMS diagram is shown in Figure 4.2.b.

Table 4.2.1 Kulanihakoi District, Existing Conditions

Mauka of Piilani Highway			Makai of Piilani Highway		
Piilani Basin	Area (acres)	Q_{100} (cfs)	Makai Basin	Area (acres)	Q_{100} (cfs)
			Kula1	82	252
5	13	55	Kula2_1	18	51
6	62	187	Kula2_2	129	321
7	526	876			
8	9,576	10,086			
9	121	258	Kula3_1	18	46
			Kula3_2	69	169

For the proposed conditions, Piilani Basin 6 is divided into 6D and 6U by a proposed diversion ditch (see section 4.1.2). A Waipuilani Gulch diversion channel (Figure 4.2.e) is proposed to divert the majority of Waipuilani Gulch flow (Piilani Basin 10/10A U) to Kulanihakoi Gulch mauka of Piilani Highway. The basins in the Kulanihakoi District and the proposed conditions runoff for the 100-year storm (Q_{100}) are listed in Table 4.2.2. The Kulanihakoi District Proposed Conditions map is shown in Figure 4.2.c and the Kulanihakoi Proposed Conditions HEC-HMS diagram is shown in Figure 4.2.d. Discussions of the recommendations are presented in the following subsections.

Table 4.2.2 Kulanihakoi District, Proposed Conditions

Mauka of Piilani Highway			Makai of Piilani Highway		
Piilani Basin	Area (acres)	Q_{100} (cfs)	Makai Basin	Area (acres)	Q_{100} (cfs)
			Kula1	82	252
5	13	56	Kula2_1	18	69
6U	10	44	Kula2_2	129	367
6D	52	188			
7	526	915			
8	9,576	10,171			
10/10A U	7,080	8,719			
9	119	275	Kula3_1	18	46
			Kula3_2	69	170

The runoff quantities along Piilani Highway and South Kihei Road in the Kulanihakoi District are listed in Tables 4.2.3 and 4.2.4. The Kulanihakoi Bridge capacity, water surface elevation, and freeboard were estimated from the as-built plans using the linear relationship and are summarized in Table 4.2.5.

Table 4.2.3 Kulanihakoi District, Runoff Quantities along Piilani Highway

Cross-Drain Description	Capacity (cfs)	Existing			Proposed		
		Piilani Basin	Area (acres)	Q_{100} (cfs)	Piilani Basin	Area (acres)	Q_{100} (cfs)
1-54”	121	5,6	75	234	5,6D	65	81
2-102”	1,265	7	526	876	7[1]	591	861
Kulanihakoi Bridge	20,200	8	9,576	10,086	8[2]	16,656	18,683[2]
1-72”	307	9	121	258	9	119	193

[1] including Piilani Basin 2U, 3U, 4U, 6U, and 7

[2] including Piilani Basin 8 and 10/10A U (Waipuilani Gulch Diversion)

Table 4.2.4 Kulanihakoi District, Runoff Quantities along South Kihei Road

Cross-Drain Description	Capacity (cfs)	Existing			Proposed		
		Makai Basin	Area (acres)	Q_{100} (cfs)	Makai Basin	Area (acres)	Q_{100} (cfs)
1-6’x4’ (sub-surface) and sheet flow	N/A	Kula1	82	252	Kula1	82	252
4-6’x4’ and sheet flow	672 (culvert)	Kula2_2[1e]	10,324	10,733	Kula2_2[1p]	17,458	19,642
1-36” and 3-7’x3’ (sub-surface) and sheet flow	N/A	Kula3_2[2]	208	435	Kula3_2[2]	206	281

[1e] including Piilani Basin 5, 6, 7, 8, Kula2_1, and Kula2_2

[1p] including Piilani Basin 2U, 3U, 4U, 5, 6U, 6D, 7, 8, 10/10A U, Kula2_1, and Kula2_2

[2] including Piilani Basin 9, Kula3_1, and Kula3_2

Table 4.2.5 Kulanihakoi Bridge Capacity

	Flow (cfs)	Water Surface Elevation (ft)	* Freeboard (ft)	Remark
Bridge Capacity	20,200	26.1	2.0	Estimated
(P) Kihei DMP Q_{100}	18,683	25.6	2.4	Estimated
As-Built Plan Q_{100}	13,100	24.0	4.1	As-Built Plan Data
(Ex) Kihei DMP Q_{100}	10,086	23.1	5.0	Estimated
As-Built Plan Q_{50}	9,685	23.0	5.1	As-Built Plan Data

* based on the bridge low chord elevation of 28.1 feet (as-built plan data)

4.2.1 Kula1

Existing Conditions

Kula1 is situated makai of Piilani Highway and does not receive any mauka flows. Runoff sheet flows across Kenolio Road or is collected by street catch basins at Kenolio Road. The street drainage system is connected to the Southpointe condominium drainlines at two locations on Kenolio Road: a 48" culvert at Kuilima Place and a 57"x38" arch pipe at Lanakila Place. Both drainlines pass through Southpointe condominium and eventually combine at the makai side of the subdivision connecting to a 6'x4' box culvert. The 6'x4' box culvert continues through the Maui Beach Resort and passes under South Kihei Road to the ocean outlet. The 6'x4' culvert also receives portions of storm runoff from the Kai Makani condominium and South Kihei Road. No flooding has been observed at South Kihei Road.

Future Conditions

No development is anticipated in Kula1.

Recommendations

No drainage improvements are proposed because no flooding has been observed at South Kihei Road and there is no development anticipated.

4.2.2 Kula2_1, Kula2_2 and Piilani Basins 5, 6, 7, 8

Existing Conditions

Storm runoff from Piilani Basin 5 is routed to Piilani Basin 6 by a roadside ditch and underground pipes. The combined flow of Piilani Basins 5 and 6 is 234 cfs (Q_{100}) and crosses Piilani Highway through a 54" culvert. The 54" culvert connects to the Kaonoulu Estates Phase I drainage system and the flow is routed to Kulanihakoi Gulch at the makai side of the Kaonoulu Estates Phase III.

For Piilani Basin 7, Q_{100} is 876 cfs at the Piilani Highway crossing, where 2-102" culverts are located. After passing under Piilani Highway, the runoff follows a shallow earth channel mauka of Kenolio Road and enters a 16'x6'-6" box culvert. After existing the box culvert, Piilani Basin 7 flow combines with flows from Piilani Basin 8 and Kula2_1 approximately 600 feet makai of Kulanihakoi Bridge. The combined flow at this location is 10,625 cfs (Q_{100}).

Kulanihakoi Gulch is the major drainageway in Piilani Basin 8 and has the largest drainage area in the Kihei District. It has been studied by FEMA and the Q_{100} at the stream mouth is 10,061 cfs according to the latest FIS (Reference 3). The FIRM shows the area from approximately 1,300 feet mauka of South Kihei Road to the ocean is inundated by both the Kulanihakoi Gulch and Waipuilani Gulch floodplain.

Storm runoff from Piilani Basin 8 crosses Piilani Highway through Kulanihakoi Bridge and for the basin Q_{100} = 10,086 cfs. The flow continues to a natural earth channel between Piilani Highway and Kenolio Road and enters a trapezoidal channel with boulder-lined side slopes and geotextile bottom until it passes Kaonoulu Estates Phase IV. The combined flow from Piilani Basins 5, 6, 7, and 8 at the makai side of the subdivision is 10,669 cfs (Q_{100}). The gulch starts to flatten out as it approaches South Kihei Road. Four 6'x4' box culverts with capacity of 672 cfs are located under South Kihei Road, where Q_{100} is 10,733 cfs. The runoff from other open areas in Kula 2_2 either sheet flows to the ocean or is collected at the local depression.

Sand dunes accumulating at the gulch mouth intensify the flooding problems and cause backwater effects. During heavy rainfall, the runoff will overtop South Kihei Road and overflow to the nearby lots. Flooding was observed along a segment of South Kihei Road from Kaonoulu Street (Kulanihakoi District) to Hoonani Street (Waipuilani District). The backwater effects also cause upstream flooding problems in Kaonoulu Estates Phase IV as observed during intense storms. The impacted areas, as reported, are near the intersection of Malimali Street and Hoopili Akau Street.

Future Conditions

There are several future developments mauka of Piilani Highway: Piilani Place, Ohukai Village, Kaonoulu Village, Piilani Promenade, Kaonoulu Affordable Apartments, Maui Oulets Center, and Kihei High School. The future developments makai of Piilani Highway consist of Kaonoulu Phase 6 Condominium, Kihei 7th Day Adventist Church PreSchool, and the renovated Maui Lu Timeshare. The proposed developments are expected to increase impervious surface areas, which will result in additional surface runoff. The Kulanihakoi Gulch outlet is located near Kalepolepo Park, which offers flexibility to construct a new structure at the South Kihei Road crossing to accommodate the design flows.

Currently the County of Maui is in the design phase to replace the existing four 6'x4' box culverts with six 6'x4' box culverts (Reference 19). The improvement is not intended to alleviate the existing flooding condition completely. In addition, the County of Maui is in the planning stage of the future Liloa Drive extension from Kaonoulu Street to Namauu Place, which will involve improvements to Kulanihakoi Gulch and Waipuilani Gulch.

The flooding problems along South Kihei Road are caused by the overflow from both Kulanihakoi Gulch and Waipuilani Gulch. To mitigate the regional flooding problems, a Waipuilani Gulch diversion channel, approximately 5,100 feet mauka of Piilani Highway, is proposed to divert the majority of Waipuilani Gulch flow (8,719 cfs, Piilani Basin 10/10A U) to Kulanihakoi Gulch mauka of Piilani Highway. The reasons are because 1) The Kulanihakoi Gulch outlet has greater flexibility to accommodate larger flow; 2) The Waipuilani outlet is restricted by the existing developments. This will increase the Piilani Basin 8 flow from 10,086 cfs to 18,683 cfs at Piilani Highway. Based on Table 4.2.5, Kulanihakoi Bridge is able to pass 18,683 cfs. Detention basins are proposed at three locations mauka of Piilani Highway as flood control measures. The recommended improvements are provided below to mitigate the flooding.

Recommendations

- Construct a diversion channel to direct the flow (8,719 cfs) from Upper Waipuilani Gulch (Piilani Basin 10/10A U) to Kulanihakoi Gulch (Piilani Basin 8) mauka of Piilani Highway (see Section 4.3 for details). The trapezoidal CRM-lined channel will have 50-feet bottom width, 10-feet height, and a 2:1 side slope. The Q_{100} will be reduced from 8,089 cfs to 392 cfs (Piilani Basin 10/10A D) at the Piilani Highway crossing (Waipuilani Bridge).

  In lieu of the CRM-lined channel, a grassed trapezoidal channel with 50-feet bottom width, 11-feet height, and a 2:1 side slope could be considered. Maintenance and erosion shall also be factored into the consideration of this alternative.

- Improve the existing channel from makai of Piilani Highway to the ocean to convey 19,642 cfs to the ocean. The trapezoidal concrete-lined channel will have 80-feet bottom width, 12-feet height, and a 2:1 side slope (Kulanihakoi Gulch Improvements). A grassed channel is not considered as it will encroach into the existing private properties on both sides of the stream banks.

- Ultimately construction of a new bridge (130-ft span) at the South Kihei Road crossing could be considered as a long-term goal to pass the design flow (19,642 cfs) to the ocean. However, due to the flat terrain at the crossing, this option may require reconstruction of South Kihei Road from the Kaonoulu Street intersection to Kihei Bay Vista and the private driveways in the vicinity. This is to raise the bridge and the approaches to provide sufficient opening to pass the design flow. In addition, it may require relocation of the existing utilities.

- Construct a detention basin mauka of Piilani Highway at Piilani Basin 6D (16 acre-ft). The outflow from the detention basin reaching the 1-54" culvert will be 81 cfs.

- Construct two detention basins mauka of Piilani Highway at Piilani Basin 7 with similar sizes of approximately 43 acre-ft. One detention basin will be located mauka of the future Kaonoulu Affordable Apartments (Figure 4.1.f). The second detention basin will be located mauka of the Piilani Highway crossing. The resulting outflow from the two detention basins reaching the 2-102" culverts will be 861 cfs.

- Improve the channel from downstream of the 2-102" culverts (Kula 2_1 Channel Improvements) to the confluence with Kulanihakoi Gulch and replace the existing 1-16'x6.5' culvert with 2-12'x6' concrete box culverts (Kula 2_1 Culvert Improvements). The trapezoidal CRM-lined channel will have 20-feet bottom width, 5-feet height, and a 2:1 side slope.

  In lieu of the CRM-lined channel, a grassed trapezoidal channel with 20-feet bottom width, 6-feet height, and a 2:1 side slope could be considered. Maintenance and erosion shall also be factored into the consideration of this alternative.

- Provide erosion control measures (channel revetment or reinforcement matting) at the vicinity of the discharge points to Kulanihakoi Gulch from the future developments. This is to minimize the impacts to the downstream area. Constructing a regional detention basin at mauka of Piilani Highway as a mean for flood and erosion control for Kulanihakoi Gulch will not be feasible because of the large sheer volume of the peak flow and runoff volume generated from the mauka drainage area.

- Perform maintenance of the outlet regularly to be free of debris and sand dune accumulation.

The proposed drainage improvements will provide sufficient capacity for the future condition and mitigate overflow from both Kulanihakoi Gulch and Waipuilani Gulch.

4.2.3 Kula3_1, Kula3_2 and Piilani Basin 9

Existing Conditions

Storm runoff from Piilani Basin 9 crosses Piilani Highway though a 72" culvert and for the basin Q_{100} = 258 cfs. After passing under Piilani Highway, the culvert connects to the local drainage system and the flow is discharged to an open channel though a 10'x4' culvert (Kenolio Road crossing). The combined flow from Piilani Basins 9 and Kula3_1 at the culvert outlet is 281 cfs (Q_{100}).

A riprap open channel runs along the south side of Alii Village Subdivision and Trinity Church routing flows to the drainage system along Oluea Street. The Oluea Street drainage system consists of 1-50", 1-55", and 1-60" culverts running north to Kulanihakoi Street and then parallel to Kulanihakoi Street towards the ocean. The drainage system becomes 3-7'x3' culverts at the intersection of Kulanihakoi Street and South Kihei Road and outlets to the ocean. A separate 36" pipe captures flows along Kulanihakoi Street and also receives runoff from Koa Resort to the same outlet. The natural flow path is usually blocked by sand dunes at the mouth of the outlet causing flooding at the intersection and the nearby lots and flows to overtop South Kihei Road. In addition, the LiDAR topography shows the intersection of Kulanihakoi Street and South Kihei Road is the low spot of South Kihei Road. Surface runoff will accumulate at the intersection and flow out to the outlet.

Future Conditions

The future developments mauka of Piilani Highway are portions of Kaonoulu Village, Kihei High School, and an unnamed project. No development is anticipated makai of Piilani Highway. The roadway drainage system on South Kihei Road is not meant to convey the regional flow. With the proposed improvements on both Kulanihakoi Gulch and Waipuilani Gulch, the flooding will be reduced at South Kihei Road. The increase in runoff must be retained onsite at each individual development.

Recommendations

- Construct a detention basin mauka of Piilani Highway at Piilani Basin 9 (18 acre-ft). The outflow from the detention basin reaching the 1-72" culvert will be reduced to 193 cfs. The 100-year peak flow at the Kenolio Road crossing will be reduced to 204 cfs.

- Perform maintenance of the outlet regularly to be free of debris and sand dune accumulation.

As discussed in section 4.2.2, the proposed drainage improvements will provide sufficient capacity for the future condition and mitigate overflow from both Kulanihakoi Gulch and Waipuilani Gulch.

4.2.4 Kulanihakoi District Cost Estimate

The conceptual cost estimate for Kulanihakoi District improvements is summarized in the following table. Refer to Appendix C for detailed cost estimate.

Table 4.2.6 Kulanihakoi District Cost Estimate Summary

	Improvements	Cost
1	Proposed Detention Basin at Piilani Basin 6U	$1,266,000
2	Proposed Detention Basin at Piilani Basin 6D	$1,342,000
3	Proposed Detention Basin at Piilani Basin 7, mauka of future Kaonoulu Affordable Apts	$3,111,000
4	Proposed Detention Basin at Piilani Basin 7, mauka of Piilani Highway	$3,111,000
5	Proposed Detention Basin at Piilani Basin 9	$1,583,000
6	Kulanihakoi Gulch Improvements	$20,490,000
7	Kula 2_1 Channel Improvements	$1,281,000
8	Kula 2_1 Culvert Improvements	$999,000
9	Proposed South Kihei Road Bridge, Kulanihakoi Gulch	$23,897,000
	Total	$57,080,000

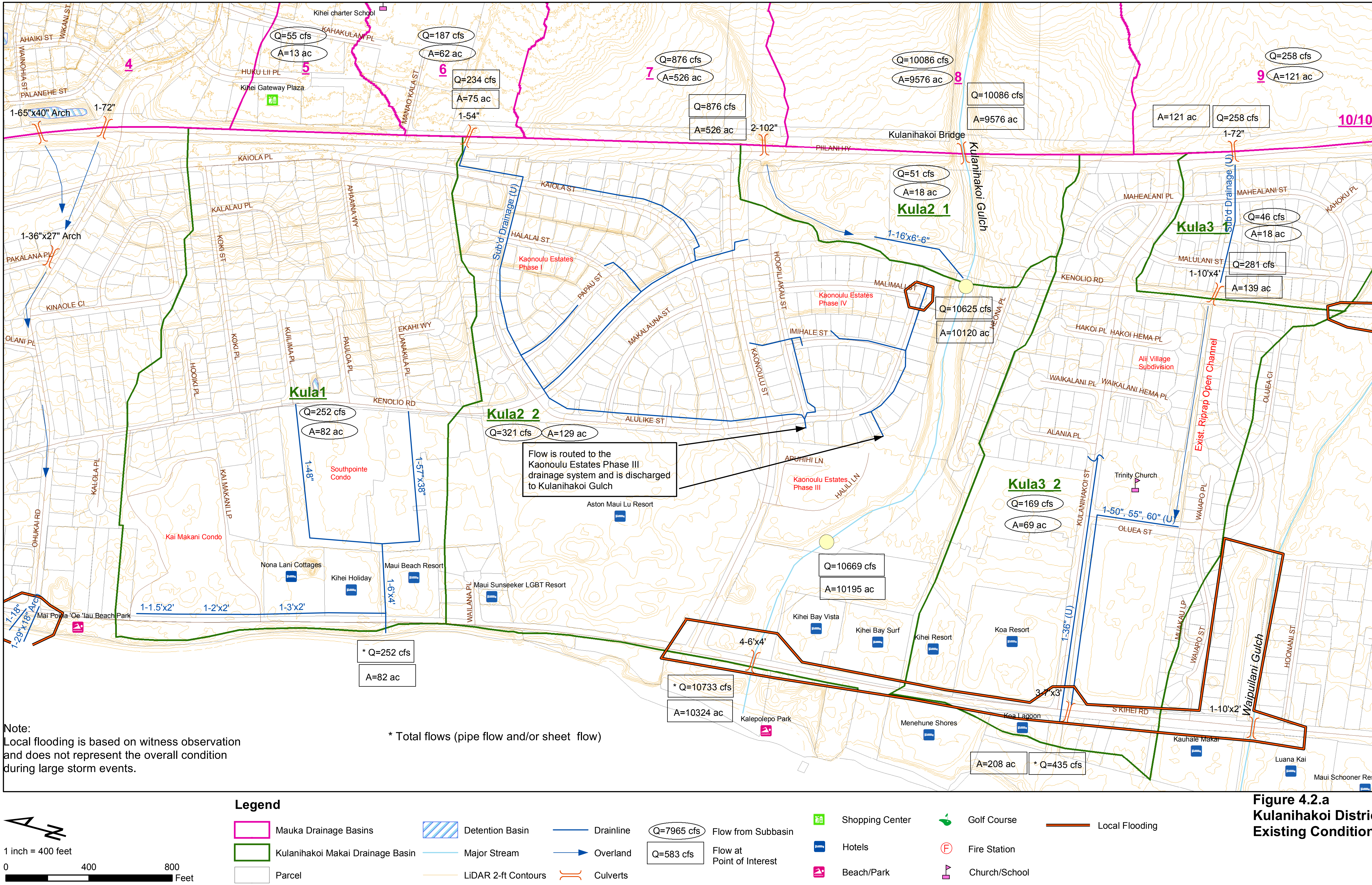
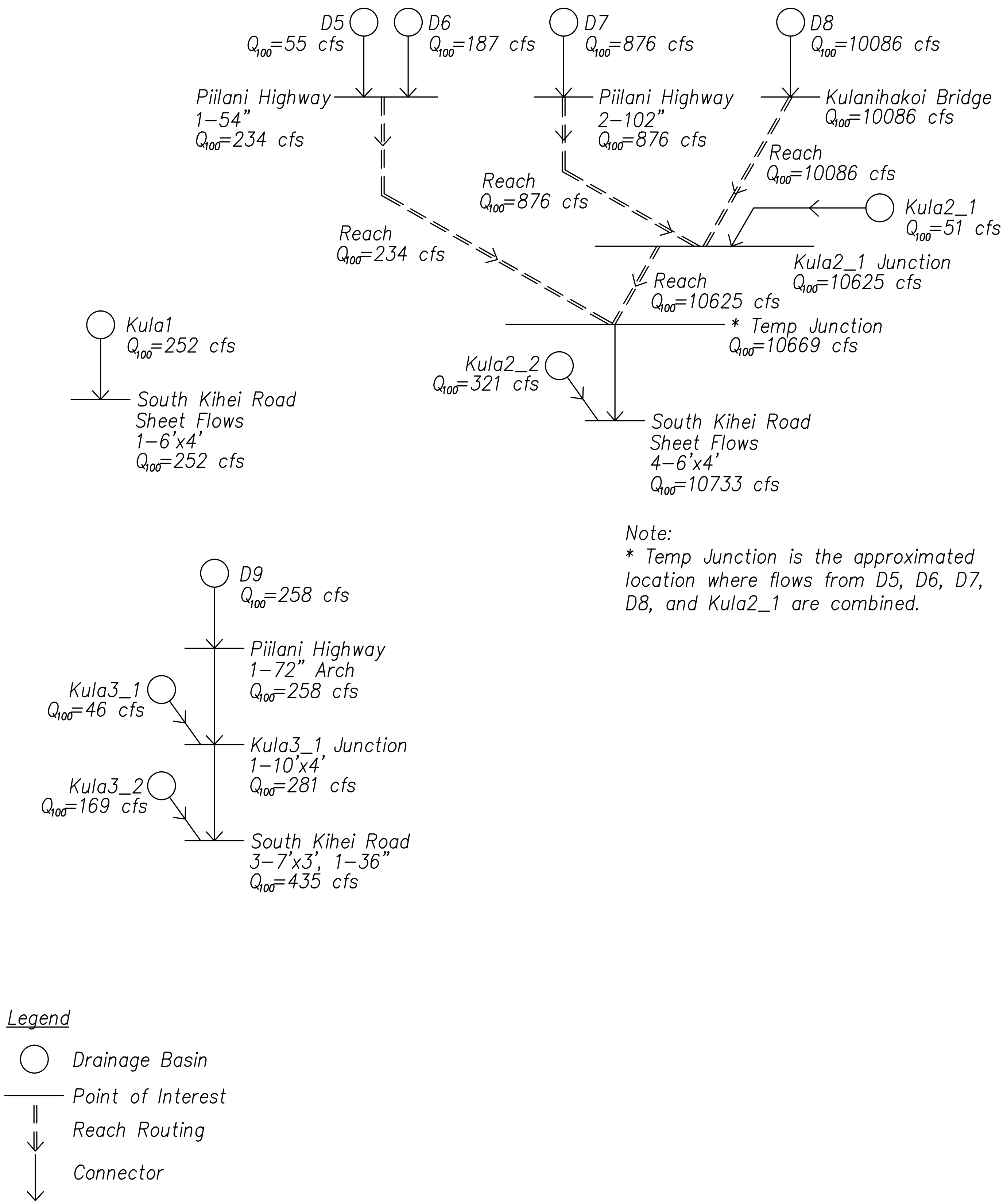


Figure 4.2.a
Kulanihakoi District
Existing Conditions



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Kulanihakoi District
Existing Conditions
HEC-HMS Diagram

Figure 4.2.b

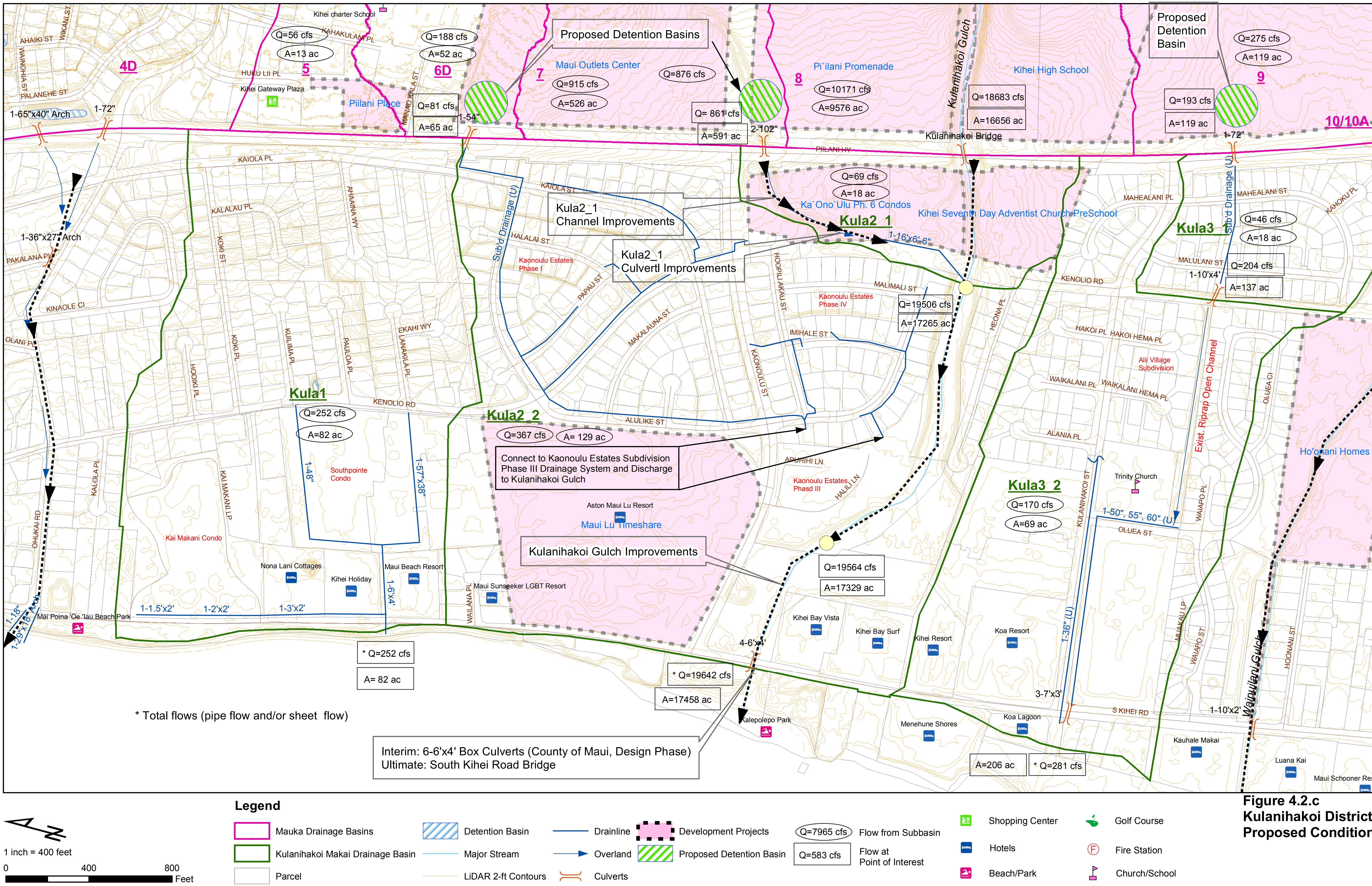
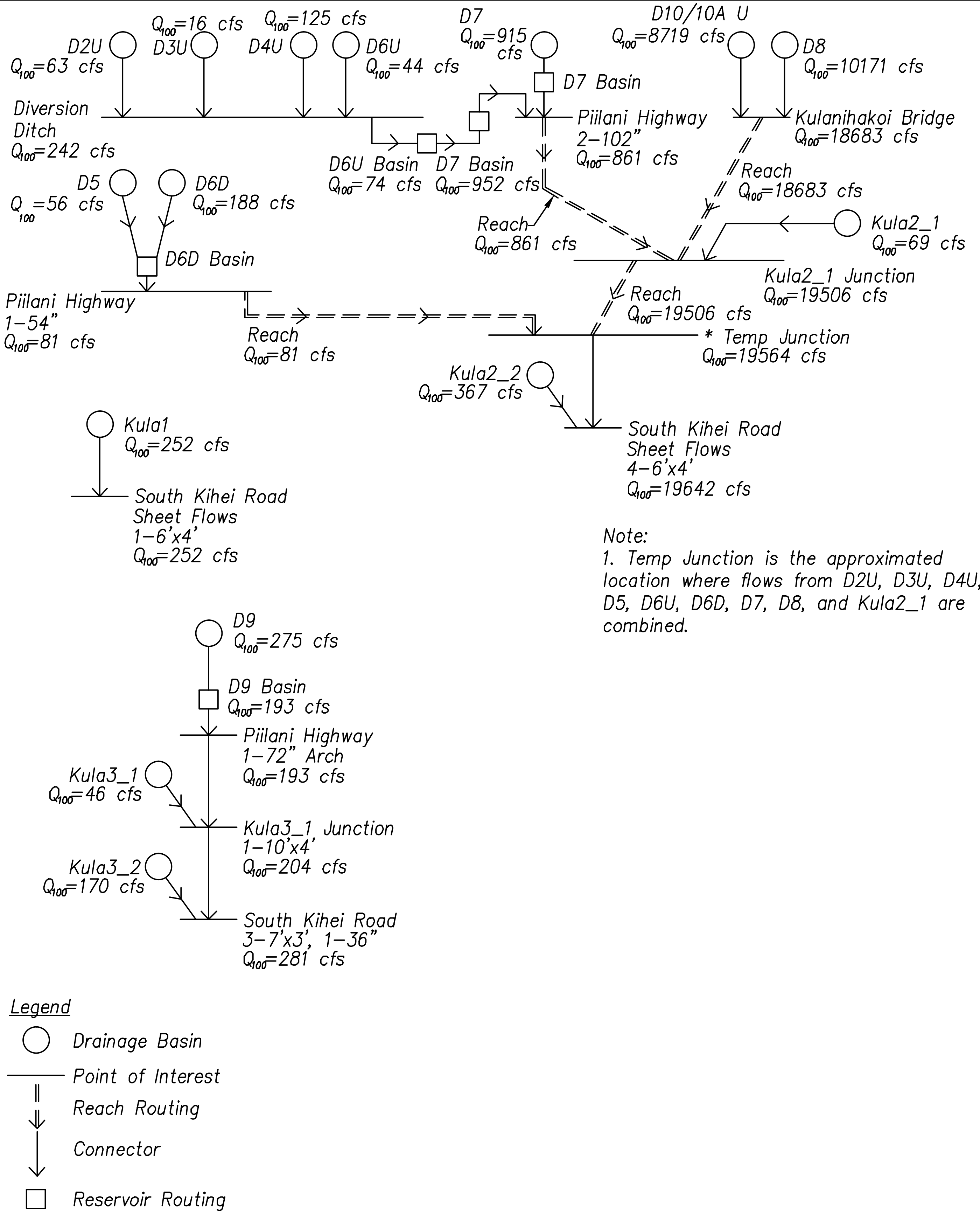


Figure 4.2.c
Kulanihakoi District
Proposed Conditions



Note:
1. Temp Junction is the approximated location where flows from D2U, D3U, D4U, D5, D6U, D6D, D7, D8, and Kula2_1 are combined.

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Kulanihakoi District
Proposed Conditions
HEC-HMS Diagram

Figure
4.2.d

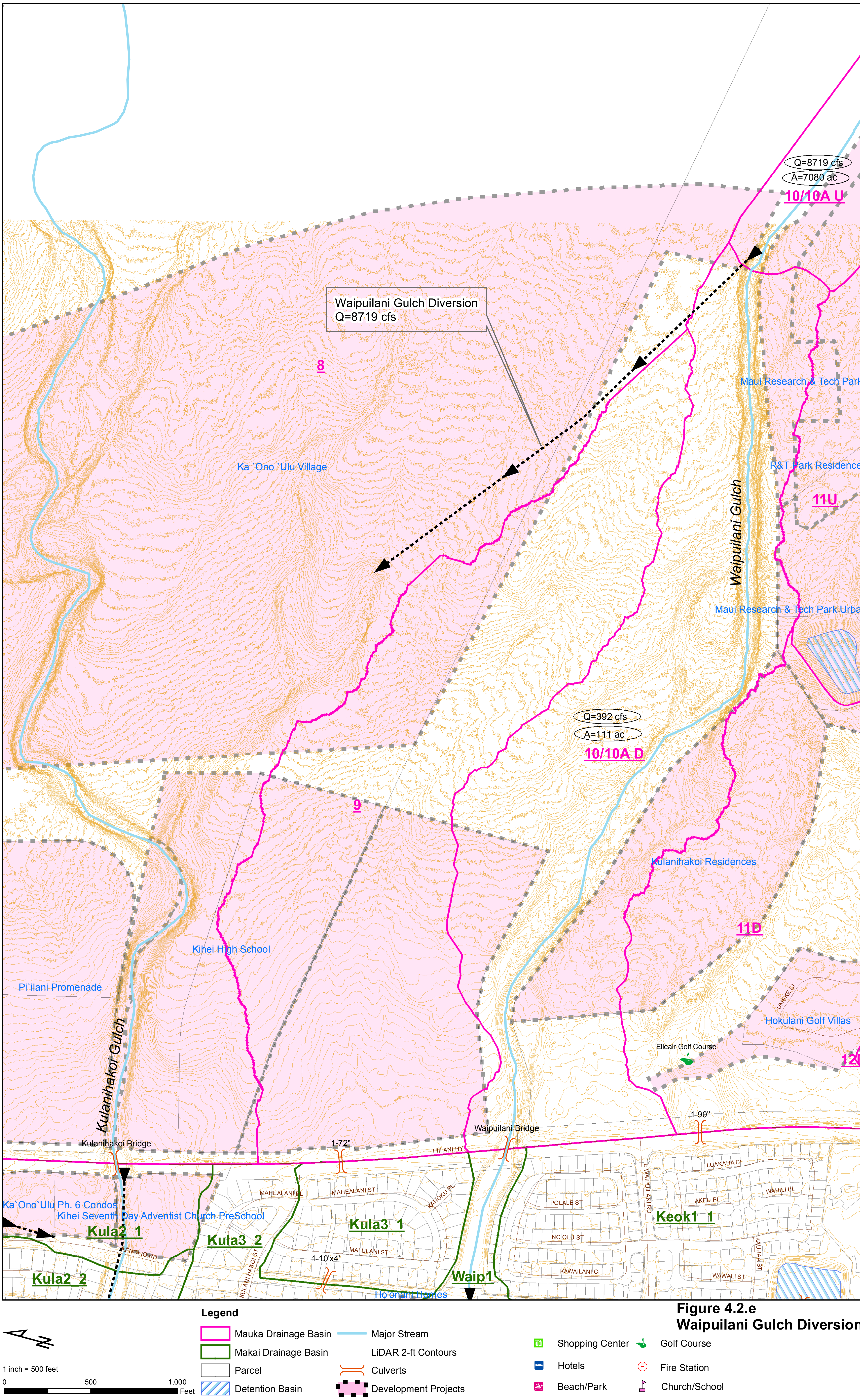

Figure 4.2.e
Waipuilani Gulch Diversion

4.3 Waipuilani District

The Waipuilani District consists of the Piilani Basin 10/10A mauka of Piilani Highway. Makai of Piilani Highway, the district only contains one drainage basin, Waip1. Waipuilani Gulch is the major drainageway in the district. The basins in the Waipuilani District and the existing conditions runoff for the 100-year storm (Q_{100}) are listed in Table 4.3.1. The Waipuilani District Existing Conditions map is shown in Figure 4.3.a and the Waipuilani Existing Conditions HEC-HMS diagram is shown in Figure 4.3.b.

Table 4.3.1 Waipuilani District, Existing Conditions

Mauka of Piilani Highway			Makai of Piilani Highway		
Piilani Basin	Area (acres)	Q_{100} (cfs)	Makai Basin	Area (acres)	Q_{100} (cfs)
10/10A	7,191	8,089	Waip1	68	111

For the proposed conditions, Piilani Basin 10/10A is divided into 10/10A D and 10/10A U by a proposed Waipuilani Gulch diversion channel (Figure 4.2.e) that routes the upper Waipuilani Gulch runoff to Kulanihakoi Gulch mauka of Piilani Highway. The basins in the Waipuilani District and the proposed conditions runoff for the 100-year storm (Q_{100}) are listed in Table 4.3.2. The Waipuilani District Proposed Conditions map is shown in Figure 4.3.c and the Waipuilani Proposed Conditions HEC-HMS diagram is shown in Figure 4.3.d. Discussions of the recommendations are presented in the following subsection.

Table 4.3.2 Waipuilani District, Proposed Conditions

Mauka of Piilani Highway			Makai of Piilani Highway		
Piilani Basin	Area (acres)	Q_{100} (cfs)	Makai Basin	Area (acres)	Q_{100} (cfs)
10/10A U	7,080	8,719			
10/10A D	111	392	Waip1	68	130

The runoff quantities along Piilani Highway and South Kihei Road in the Waipuilani District are listed in Tables 4.3.3 and 4.2.4. The Waipuilani Bridge capacity, water surface elevation, and freeboard were estimated from the as-built plans using the linear relationship and are summarized in Table 4.3.5.

Table 4.3.3 Waipuilani District, Runoff Quantities along Piilani Highway

Cross-Drain Description	Capacity (cfs)	Existing			Proposed		
		Piilani Basin	Area (acres)	Q_{100} (cfs)	Piilani Basin	Area (acres)	Q_{100} (cfs)
Waipuilani Bridge	11,200	10/10A	7,191	8,089	10/10A D	111	392

Table 4.3.4 Waipuilani District, Runoff Quantities along South Kihei Road

Cross-Drain Description	Capacity (cfs)	Existing			Proposed		
		Makai Basin	Area (acres)	Q_{100} (cfs)	Makai Basin	Area (acres)	Q_{100} (cfs)
1-10'x2' and sheet flow	N/A	Waip1[1e]	7,259	8,120	Waip1[1p]	179	515

[1e] including Piilani Basin 10/10A and Waip1
[1p] including Piilani Basin 10/10A D and Waip1

Table 4.3.5 Waipuilani Bridge Capacity

	Flow (cfs)	Water Surface Elevation (ft)	* Freeboard (ft)	Remark
Bridge Capacity	11,200	39.0	2.0	Estimated
As-Built Plan Q_{100}	9,995	38.6	2.4	As-Built Plan Data
(Ex) Kihei DMP Q_{100}	8,089	38.0	3.0	Estimated
As-Built Plan Q_{50}	7,880	37.9	3.1	As-Built Plan Data
(P) Kihei DMP Q_{100}	392	< 37.9	> 3.1	Estimated

* based on the bridge low chord elevation of 41.0 feet (as-built plan data)

4.3.1 Waip1 and Piilani Basin 10/10A

Existing Conditions

Waipuilani Gulch is the major drainageway in Piilani Basin 10/10A and has been studied by FEMA. According to the latest FIS (Reference 3), Q_{100} at stream mouth is 9,275 cfs. As discussed in section 4.2.2, the overflow from both Kulanihakoi Gulch and Waipuilani Gulch are the major flooding sources at South Kihei Road.

Waipuilani Gulch crosses Piilani Highway at Waipuilani Bridge with Q_{100} = 8,089 cfs. After crossing Piilani Highway, the runoff continues through a natural earth channel towards the ocean and the terrain starts to flatten out as the gulch approaches South Kihei Road. The channel is further restricted before it approaches South Kihei Road because of debris and trash accumulation in the channel bed. Buildings occupy both banks mauka of South Kihei Road and only one 10'x2' culvert was installed at the South Kihei Road crossing. The Q_{100} at South Kihei Road calculated in this report is 8,120 cfs. The channel makai of South Kihei Road is also constrained by condominiums. Sand berms located along the shoreline at the mouth further aggravate flooding problems, which were observed along South Kihei Road and within the Kamalii Alayna Subdivision south of Waiapo Street. Insufficient channel/culvert capacity forces the storm water to overflow into the nearby lots and causes flooding at South Kihei Road. Backwater effects are observed at a dirt road (future Kenolio Road extension) between Piilani Highway and South Kihei Road.

Future Conditions

The major future developments mauka of Piilani Highway at the upper Waipuilani District (10/10A U) are Keokea Homestead DHHL (early conceptual stage) and Keokea/Waiohuli Subdivision DHHL. Both developments are located at the upper mountainous areas across several drainage districts and are accounted for in this drainage master plan.

Portions of the future developments mauka of Piilani Highway at the lower Waipuilani District (10/10A D) are Maui Research & Tech Park, Kulanihakoi Residences, and R&T Park Residences, all of which will contribute runoff to Waipuilani Gulch. Waipuilani Bridge at the Piilani Highway crossing will receive 392 cfs due to the proposed Waipuilani Gulch diversion channel. Makai of Piilani Highway, the only future development is Hoonani Homes (single-family), which is bisected by Waipuilani Gulch.

A proposed Waipuilani Gulch diversion channel mauka of Piilani Highway will reduce the flow discharging to the outlet and allow a reasonable channel design makai of Piilani Highway. The existing earth channel between Piilani Highway and the future Liloa Drive extension has capacity to convey 392 cfs.

Recommendations

- Construct a diversion channel to divert the flow (8,719 cfs) from Upper Waipuilani Gulch (Piilani Basin 10/10A U) to Kulanihakoi Gulch (Piilani Basin 8) mauka of Piilani Highway (same recommendations mentioned in Section 4.2.2). The trapezoidal CRM-lined channel will have 50-feet bottom width, 10-feet height, and a 2:1 side slope. This is because the Waipuilani Gulch outlet is restricted by the existing developments at both banks from approximately 700 feet mauka of South Kihei Road to the ocean. This option will reduce the 100-year peak flow to 392 cfs at the Piilani Highway crossing. Further study will be needed to determine if it's feasible to improve Waipuilani Gulch outlet with the no-diversion scenario as it will impact the Hoonani Homes development.

- Construct 2-11'x3'box culverts to convey 392 cfs at the future Liloa Drive extension during the Hoonani Homes development assuming the future Liloa Drive extension will be the access road to the Hoonani Homes development. This will eliminate the flooding problem at the existing dirt road.

- Improve Waipuilani Gulch within the Hoonani Homes development to convey the design flow (392 to 515 cfs). The improved channel will be a grassed trapezoidal channel with 25-feet bottom width, 5 feet height, and 2:1 side slope. The channel will transition to a concrete-lined rectangular channel with 15-feet bottom width and 5 feet height approximately 800 feet mauka of South Kihei Road where the existing buildings are located at both banks.

- Replace the existing 1-10'x2' box culvert with 2-11'x4' box culverts at the South Kihei Road crossing to pass the design flow and improve the downstream channel (concrete-lined rectangular channel with 15-feet bottom width and 5 feet height).

- Provide erosion control measures (channel revetment or reinforcement matting) at the vicinity of the discharge points to Waipuilani Gulch from the future developments. This is to minimize the impacts to the downstream area. With the mauka diversion channel constructed, erosion of Waipuilani Gulch makai of Piilani Highway is expected to reduce significantly

- Perform maintenance of the outlet regularly to be free of debris and sand dune accumulation.

In conjunction with the Kulanihakoi Gulch drainage improvements, the proposed Waipuilani Gulch drainage improvements will provide sufficient capacity for the future condition and mitigate overflow from both Kulanihakoi Gulch and Waipuilani Gulch.

4.3.2 Waipuilani District Cost Estimate

The conceptual cost estimate for Waipuilani District improvements is summarized in the following table. Refer to Appendix C for detailed cost estimate.

Table 4.3.6 Waipuilani District Cost Estimate Summary

	Improvements	Cost
1	Proposed Liloa Drive Culverts	$177,000
2	Waipuilani Gulch Improvements - 1 (future Hoonali Homes development)	$374,000
3	Waipuilani Gulch Improvements - 2 (approx. 800' mauka of S. Kihei Rd to stream mouth)	$1,822,000
4	Proposed South Kihei Road Culvert Improvements	$144,000
5	Waipuilani Gulch Diversion	$14,359,000
	Total	$16,876,000

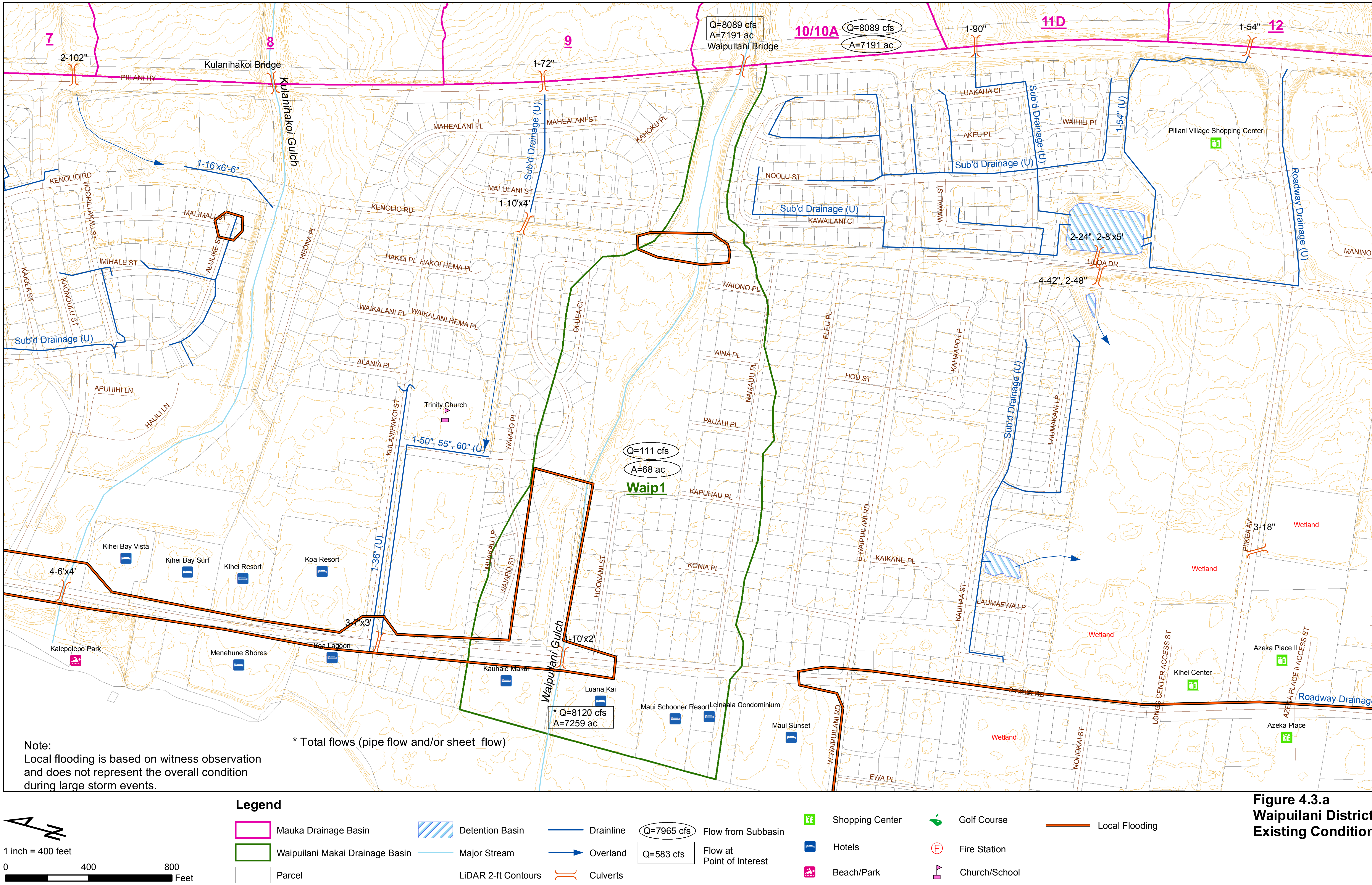

Figure 4.3.a
Waipuilani District
Existing Conditions

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Waipuilani District
Existing Conditions
HEC-HMS Diagram

Figure 4.3.b

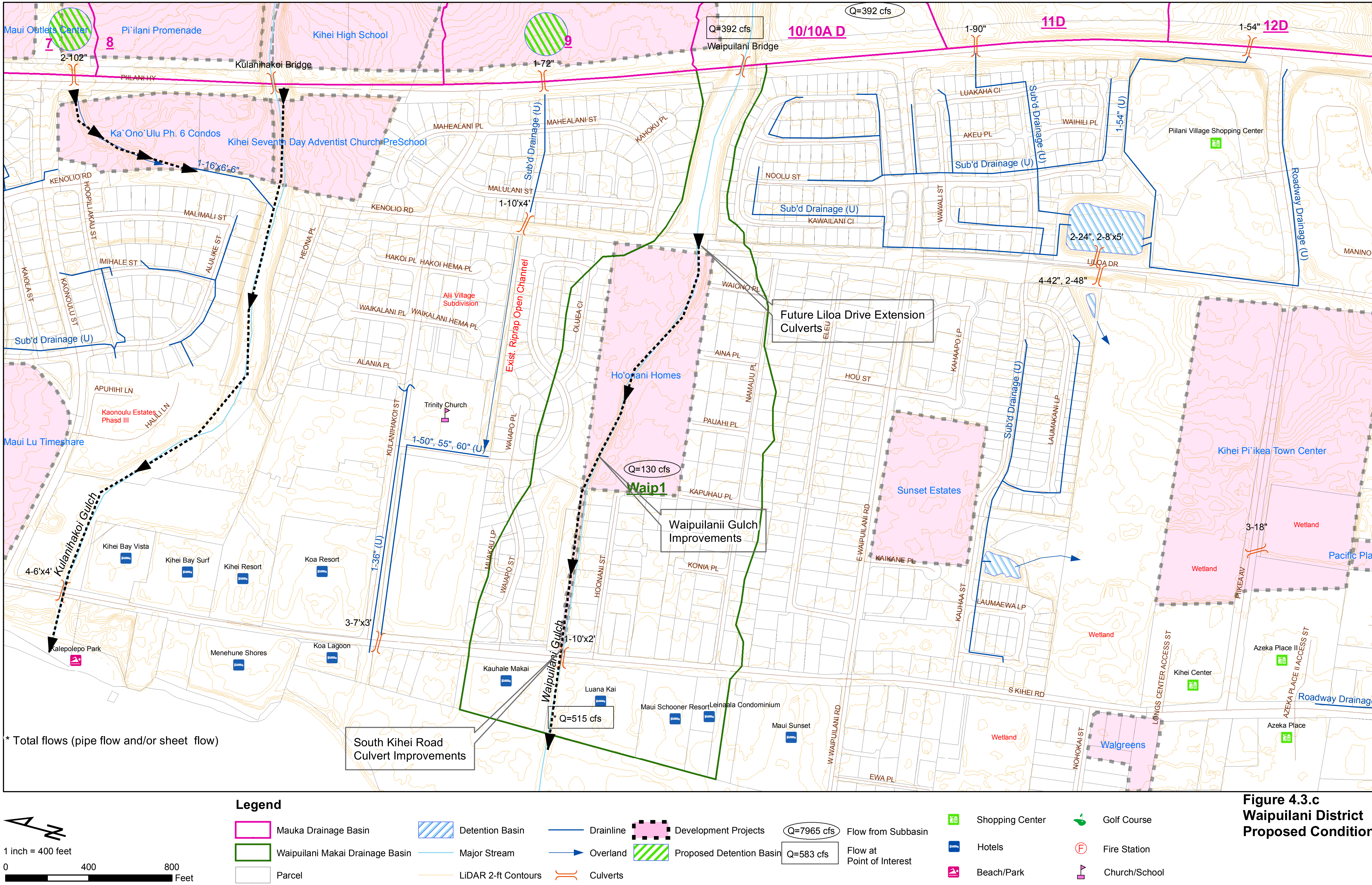
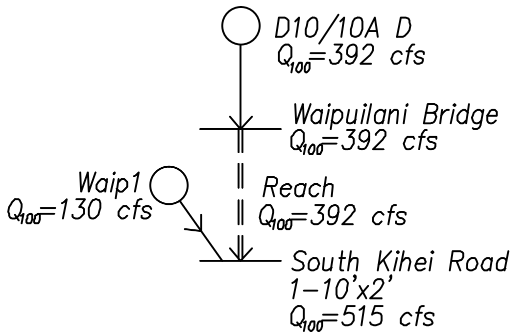


Figure 4.3.c
Waipuilani District
Proposed Conditions



Legend

Drainage Basin

Point of Interest

Reach Routing

Connector

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Waipuilani District
Proposed Conditions
HEC-HMS Diagram

Figure
4.3.d

4.4 Keokea District

The Keokea District consists of Piilani Basins 11U, 11D, 12, 13, 14, 15, 16, and 17/18 mauka of Piilani Highway. Makai of Piilani Highway, the district is divided into six drainage basins from Keok1_1 to Keok2_4. Keokea Gulch is the major drainageway in the district. The basins in the Keokea District and the existing conditions runoff for the 100-year storm (Q_{100}) are listed in Table 4.4.1. The Keokea District Existing Conditions map is shown in Figures 4.4.a and 4.4.b, and the Keokea Existing Conditions HEC-HMS diagram is shown in Figure 4.4.c.

Table 4.4.1 Keokea District, Existing Conditions

Mauka of Piilani Highway			Makai of Piilani Highway		
Piilani Basin	Area (acres)	Q_{100} (cfs)	Makai Basin	Area (acres)	Q_{100} (cfs)
11U	274	454	Keok1_1	78	259
11D	91	257	Keok1_2	170	272
12	81	202			
13	120	275	Keok2_1	78	302
14	358	508	Keok2_2	42	170
15	200	319	Keok2_3	110	259
16	130	315	Keok2_4	210	434
17/18	5,461	5,664			

For the proposed conditions, the drainage basins are divided at the boundary between Maui Research & Tech Park and Maui Research & Tech Park Urban. The basins in the Keokea District and the proposed conditions runoff for the 100-year storm (Q_{100}) are listed in Table 4.4.2. The Keokea District Proposed Conditions maps are shown in Figures 4.4.d and 4.4.e, and the Keokea Proposed Conditions HEC-HMS diagram is shown in Figure 4.4.f. Discussions of the recommendations are presented in the following subsections.

Table 4.4.2 Keokea District, Proposed Conditions

Mauka of Piilani Highway			Makai of Piilani Highway		
Piilani Basin	Area (acres)	Q_{100} (cfs)	Makai Basin	Area (acres)	Q_{100} (cfs)
11U	274	520	Keok1_1	78	259
11D	91	276	Keok1_2	170	311
12D	66	203			
12U	15	59	Keok2_1	78	308
13U	44	154	Keok2_2	42	170
13D	76	240	Keok2_3	110	267
14U	275	401	Keok2_4	210	447
14D	83	309			
15U	157	287			
15D	43	154			
16U	53	175			
16D	77	272			
17/18	5,461	6,087			

The runoff quantities along Piilani Highway and Coast in the Keokea District are listed in Tables 4.4.3 and 4.4.3. The Keokea Bridge capacity, water surface elevation, and freeboard were estimated from the as-built plans using the linear relationship and are summarized in Table 4.4.5.

Table 4.4.3 Keokea District, Runoff Quantities along Piilani Highway

Cross-Drain Description	Capacity (cfs)	Existing			Proposed		
		Piilani Basin	Area (acres)	Q_{100} (cfs)	Piilani Basin	Area (acres)	Q_{100} (cfs)
1-90"	568	11U,11D	365	260	11U,11D	365	279
1-54"	213	12	81	202	12D	66	203
2-66'	440	13	120	275	13D[1]	135	254
1-60"	204	14	358	508	14U,14D	358	394
1-60"	218	15	200	319	15D	43	154
Keokea Bridge	11,800	16/17/18	5,591	5,753	17/18[2]	5,748	6,234

[1] including Piilani Basin 12U, 13U, and 13D
[2] including Piilani Basin 15U, 16U, 16D, and 17/18

Table 4.4.4 Keokea District, Runoff Quantities along Coast

Cross-Drain Description	Capacity (cfs)	Existing			Proposed		
		Makai Basin	Area (acres)	Q_{100} (cfs)	Makai Basin	Area (acres)	Q_{100} (cfs)
1-18" (sub-surface) and sheet flow	N/A	Keok1_2[1e]	694	859	Keok1_2[1p]	679	921
5x'2' (sub-surface) and sheet flow	213	Keok2_4[2e]	6,709	6,689	Keok2_4[2p]	6,724	6,820

[1e] including Piilani Basin 11U, 11D, 12, Keok1_1, and Keok1_2

[1p] including Piilani Basin 11U, 11D, 12D, Keok1_1, and Keok1_2

[2e] including Piilani Basin 13, 14, 15, 16, 17/18, Keok2_1, Keok2_2, Keok2_3, and Keok2_4

[2p] including Piilani Basin 12U, 13U, 13D, 14U, 14D, 15U, 15D, 16U, 16D, 17/18, Keok2_1, Keok2_2, Keok2_3, and Keok2_4

Table 4.4.5 Keokea Bridge Capacity

	Flow (cfs)	Water Surface Elevation (ft)	* Freeboard (ft)	Remark
Bridge Capacity	11,800	78.8	2.0	Estimated
As-Built Plan Q_{100}	9,065	76.4	4.4	As-Built Plan Data
(P) Kihei DMP Q_{100}	6,234	73.9	6.9	Estimated
As-Built Plan Q_{50}	6,100	73.8	7.0	As-Built Plan Data
(Ex) Kihei DMP Q_{100}	5,753	73.5	7.3	Estimated

* based on the bridge low chord elevation of 80.8 feet (as-built plan data)

4.4.1 Keok1_1, Keo1_2 and Piilani Basins 11U, 11D, 12

Existing Conditions

An existing mauka offsite detention basin divides Piilani Basin 11 into two sub-basins, 11U and 11D (Figure 4.4.b). The mauka offsite detention basin attenuates the peak flow from Piilani Basin 11U before the flow is discharged to the downstream area. The overflow from the mauka offsite detention basin combines with Piilani Basin 11D flow at a 90" culvert located at the Piilani Highway crossing. The Q_{100} for Piilani Basin 11U is 454 cfs, and after routing through the mauka offsite detention basin, the Q_{100} is decreased to 173 cfs. Combining with the Q_{100} from Piilani Basin 11D (Q_{100}=257 cfs), the total Q_{100} at the Piilani Highway crossing (1-90" culvert) is 260 cfs.

For Piilani Basin 12, Q_{100} is 202 cfs and crosses Piilani Highway through a 54" culvert. Both the 90" culvert (Piilani Basins 11U and 11D) and the 54" culvert (Piilani Basin 12) connect to the Piilani Village Subdivision drainage system and route the mauka flows to a makai detention basin within the subdivision. The makai detention basin discharges flows through 2-24" and 2-8'x5' culverts, which transition to 4-42" and 2-48" culverts under Liloa Drive, to a second makai detention basin located mauka of Meadowlands Subdivision Phase II. The overflow from the second makai detention basin is eventually discharged to the wetland area between Liloa Drive and South Kihei Road. Three 18" pipes connect the two wetland areas located at both sides of

Piikea Avenue. Combined with the flow from Keok1_1, the total Q_{100} is 588 cfs after routing through the two makai detention basins. There are no drainage structures crossing under South Kihei Road from the wet land area. Runoff overflows to South Kihei Road and eventually spreads to the makai of the road. The total Q_{100} sheet flow to the ocean, when combining the Q_{100} from Keok1_2 (272 cfs), is 859 cfs.

The intersection of East Waipuilani Road and South Kihei Road is the low spot of South Kihei Road. Water is unable to drain efficiently during heavy rainfall because the local drainage system is not designed to cope with large runoff. Pumping is required to take out the water. The segment of South Kihei Road from West Waipuilani Road to West Lipoa Street has almost a level slope and is flooded during heavy rainfall.

The area bounded by South Kihei Road, West Lipoa Street, Uluniu Road, and West Waipuilani Road lacks a drainage system. The existing terrain within this enclosed area generally is in a sump condition making it a challenge to drain. The storm water is not collected and flows overland seeking natural outlets to the ocean. Whenever there are depressions in the terrain, ponding will occur. A 12" pipe running along Uluniu Road is the only drainline identified in this area and outlets to the beach via an 18" pipe. The latest FIRM shows the area within Keok 1_2, approximately from 480 feet mauka of South Kihei Road to the ocean, is subject to Zone AO (shallow flooding due to sheet flow on sloping terrain) and Zone AH (shallowing flooding due to ponding).

Future Conditions

Maui Research & Tech Park Urban, Maui Research & Tech Park, Kulanihakoi Residences, R&T Park Residences, and Hokulani Golf Villas are the five major future developments mauka of Piilani Highway. Sunset Estates and Kihei Piikea Town Center are the two major development makai of Piilani Highway. In addition to the two major developments, a proposed Walgreens Kihei development located at the intersection of Nohokai Street and South Kihei Road is in the preliminary engineering stage. A retention basin is proposed to capture onsite runoff from the development.

Recommendations

- There is no defined natural outlet for this region and runoff sheet flows across South Kihei Road. The future developments, both mauka and makai of Piilani Highway, must retain the increased runoff onsite.

- Provide a roadway drainage system (1-24") along Uluniu Road and upsize the existing 18" outlet pipe to address local flooding. However, due to the nature of the existing terrain, this option will not alleviate the flooding problem.

- Another alternative to mitigate flooding problem is to install drywells with grated drain inlets along Uluniu Road at the locations where the most severe local flooding was observed.

- Third possible alternative is to construct a new outlet from the existing wetland area (TMK 3-9-07: 07) to the parcel (TMK: 3-9-07: 05) makai of Uluniu Road with a new culvert under Uluniu Road. A new drainage system would connect the two wetland areas (TMK: 39-46: 17 and 3-9-07: 07) and allow runoff to cross under South Kihei Road. A feasibility study is required.

The proposed Uluniu roadway drainage system will reduce the local flooding on Uluniu Road. Implementation of a new outlet will help to mitigate the flooding problems at South Kihei Road. However, due to lack of data, permitting issues, and environmental assessment, further study is required to assess the feasibility of the new outlet alternative (third alternative).

4.4.2 Keok2_1, Keo2_2, Keok2_3, Keok2_4 and Piilani Basins 13, 14, 15, 16, 17/18

Existing Conditions

Storm runoff from Piilani Basin 13 crosses Piilani Highway through 2-66" culverts and for the basin Q_{100} = 275 cfs. The flow enters a small ponding area immediately downstream of the culverts, and is then conveyed by the East Lipoa Street drainage system (1-72" to 1-8'x4' box). The 8'x4' box turns south at the intersection of East Lipoa Street and Liloa Drive and increases in size to a 10'x4' culvert at the Liloa Drive crossing.

Storm runoff from Piilani Basin 14 crosses Piilani Highway through a 60" culvert and for the basin Q_{100} = 508 cfs. After crossing Piilani Highway, the runoff flows to an earth channel though Kihei Elementary School and Lokelani Intermediate School and crosses Liloa Drive at a 10'x4' culvert. The combined flows from Piilani Basins 13, 14, and Keok2_2 at this location are 761 cfs (Q_{100}). The resultant flow continues through a 10'x4' box to the wetland areas mauka of South Kihei Road.

Storm runoff from Piilani Basin 15 crosses Piilani Highway through a 60" culvert and for the basin Q_{100} = 319 cfs. After crossing Piilani Highway, the runoff is captured by a 66" underground pipe that routes through the South Maui Community Park Phase 1A site and converges with the flows from Piilani Basins 16 and 17/18.

Storm runoff from Piilani Basins 16 and 17/18 (Keokea Gulch) combine at Keokea Bridge crossing Piilani Highway with Q_{100} = 5,753 cfs. The runoff travels overland through a natural channel and combines with Piilani Basin 15 and Keok2_1 flows at location approximately 1,200 feet mauka of South Kihei Road. The combined flow is 5,963 cfs (Q_{100}) and continues towards the wetlands mauka of South Kihei Road. There are 10-11'x7' arches located at Halekuai Street that connect the wetlands at both sides of the street (Keok2_3). The flow eventually ends at the Keokea Gulch Outlet (Q_{100} = 6,689 cfs).

Keokea Gulch has been studied by FEMA and the latest FIS (Reference 3) identifies the Q_{100} is 8,066 cfs at the stream mouth, and Keok2_3 is subject to the inundation from Keokea Gulch floodplain and Zone AH (shallowing flooding due to ponding). Based on Table 4.4.5, Keokea Bridge is able to pass the 100-year peak flow. As indicated in the Keokea Gulch FIRM, the flow is contained within the channel bank downstream of the bridge until the terrain flattens out at Liloa Drive before it approaches the wetland area.

The Keokea Gulch Outlet is Maui County's existing regulation reservoir located south of St. Theresa's Church, and is the primary outlet for the Keokea District. There are existing wetlands mauka of South Kihei Road that act as natural detention basins. A series of existing underground pipes along South Kihei Road convey storm water from mauka lands to the natural reservoir. Storm water not captured by the South Kihei Road drainage system seeks its natural path and ends up in the reservoir or sheet flows to the ocean. Flooding problems are observed at South Kihei Road mauka of the regulation reservoir.

Another outlet identified in the Keokea District is the drainage system along South Kihei Road between Waimahaihai Street and West Welakahao Road. The drainage system runs along South Kihei Road, turns west at West Welakahao Street towards the ocean and outlets through a 5'x2' box culvert at the beach.

Future Conditions

The future developments mauka of Piilani Highway consist of Maui Research & Tech Park Urban, Maui Research & Tech Park, R&T Park Residences, Hokulani Golf Villas, Maui Brewing Company, and Nuu Aina Golf Highlands. Various projects are proposed makai of Piilani Highway; Kihei Piikea Town Center, Liloa Village, South Maui Community Park Phase II and III, and Liloa Drive Extension (North-South Collector Extension) are the major developments. Detention basins are proposed mauka of Piilani Highway to reduce the runoff and minimize the impacts to the downstream areas (Figure 4.4.e).

Recommendations

- Construct a detention basin (26 acre-ft) located at Piilani Basin 13U to reduce runoff from both Piilani Basins 12U and 13U. The outflow from the detention basin will be 19 cfs. Overflow from the detention basin will combine with flow from Piilani Basin 13D and pass Piilani Highway through the existing 2-66" culverts (254 cfs).

- Construct a detention basin (26 acre-ft) located at Piilani Basin 14U to reduce runoff. The outflow from the detention basin will be 172 cfs. The overflow from the detention basin will combine with flow from Piilani Basin 14D and pass Piilani Highway through the existing 1-60" culvert (394 cfs). Additional onsite detention facilities at Piilani Basin 14D within the future developments shall be considered to limit the discharge equal or less than the culvert capacity.

- Another alternative is to replace the existing 1-60" culvert with an 8'x5' box culvert. However, the site is not covered under FEMA's flood maps. Per HDOT drainage design standards, the culvert is only required to pass the 50-year peak flow (325 cfs), which a 7'x5' box culvert will be sufficient. This option will require the approval from HDOT.

- Construct a detention basin (34 acre-ft) located at Piilani Basin 16U to reduce runoff from both Piilani Basins 15U and 16U. The outflow from the detention basin will be 103 cfs. Overflow from the detention basin will combine flow from Piilani Basins 16D and 17/18 and pass Piilani Highway through Keokea Bridge (6,234 cfs).

- The future developments, both mauka and makai of Piilani Highway, must retain the increased runoff onsite.

- Provide erosion control measures (channel revetment or reinforcement matting) at the vicinity of the discharge points to Keokea Gulch from the future developments. This is to minimize the impacts to the downstream area. Constructing a regional detention basin at mauka of Piilani Highway as a mean for flood and erosion control for Keokea Gulch will not be feasible because of the large sheer volume of the peak flow and runoff volume generated from the mauka drainage area.

- Perform maintenance of the outlet regularly to be free of debris and sand dune accumulation.

The proposed drainage improvements will reduce the mauka runoff. The reduction in flow will help to mitigate the observed local flooding. Further studies such as environmental assessment, coastal study, and permitting issues are needed to determine the feasibility of expanding the existing regulation reservoir to accommodate Keokea Gulch flow.

4.4.3 Keokea District Cost Estimate

The conceptual cost estimate for Keokea District improvements is summarized in the following table. Refer to Appendix C for detailed cost estimate.

Table 4.4.6 Keokea District Cost Estimate Summary

	Improvements	Cost
1	Proposed Detention Basin at Piilani Basin 13U	$2,261,000
2	Proposed Detention Basin at Piilani Basin 14U	$2,068,000
3	Proposed Detention Basin at Piilani Basin 16U	$2,595,000
4	Uluniu Road Drainage System - Alternative 1	$2,103,000
5	Uluniu Road Drainage System - Alternative 2	$790,000
6	Uluniu RoadNew Outlet (Feasibility Study) - Alternative 3	$600,000
7	Proposed Piilani Highway Culvert Improvements at Piilani Basin 14D	$376,000
	Total	$10,793,000

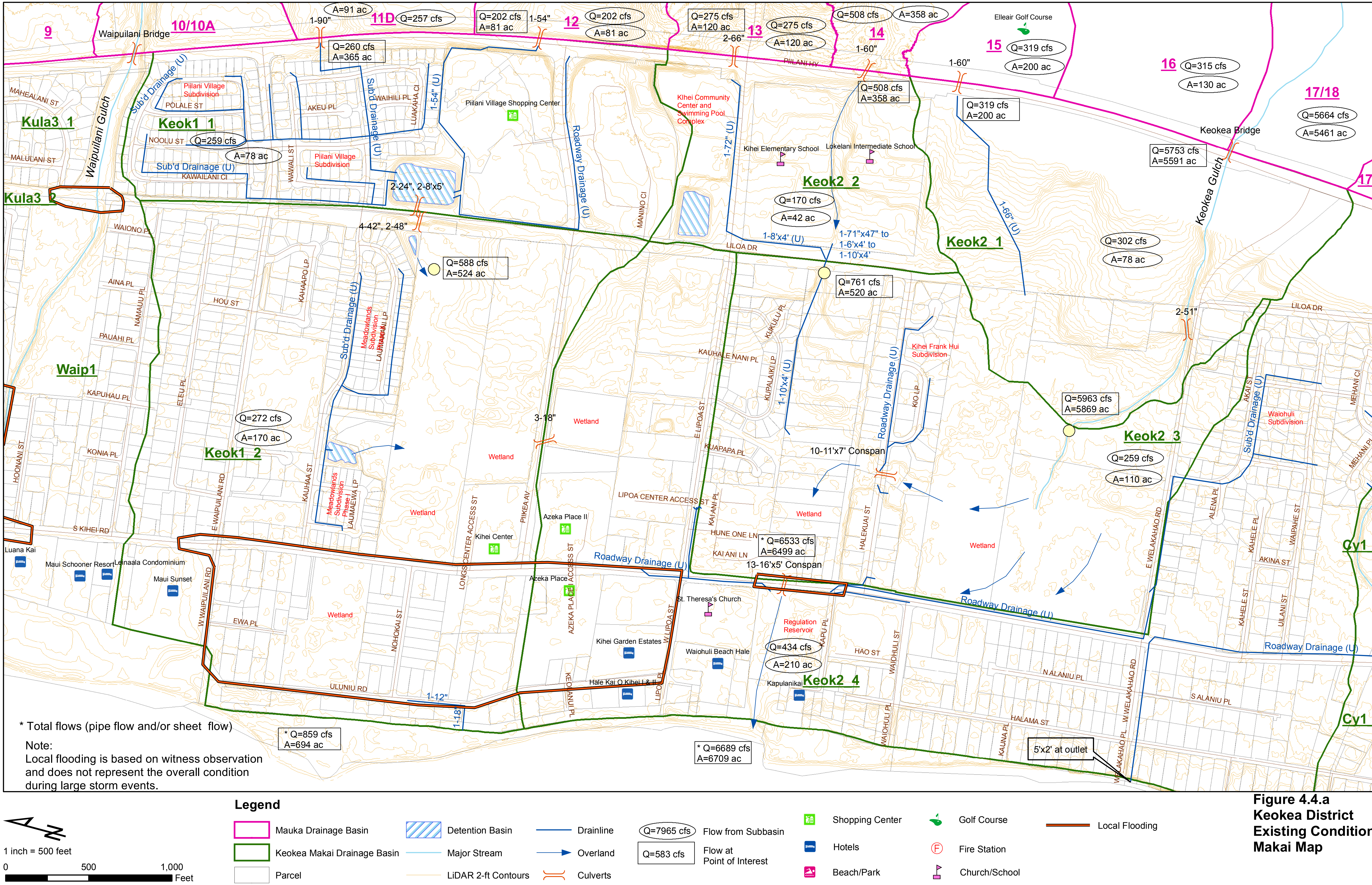
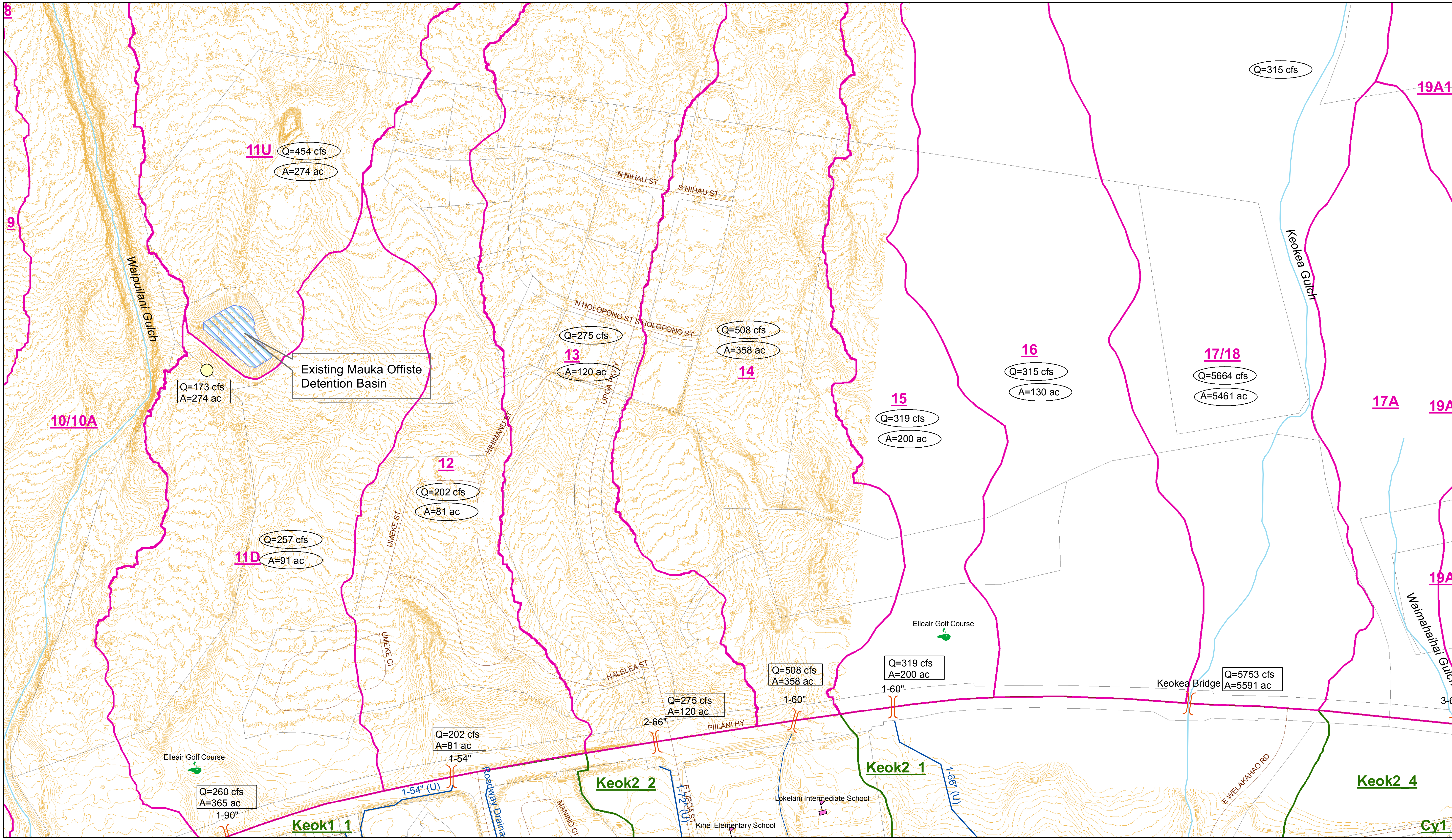


Figure 4.4.a
Keokea District
Existing Conditions
Makai Map



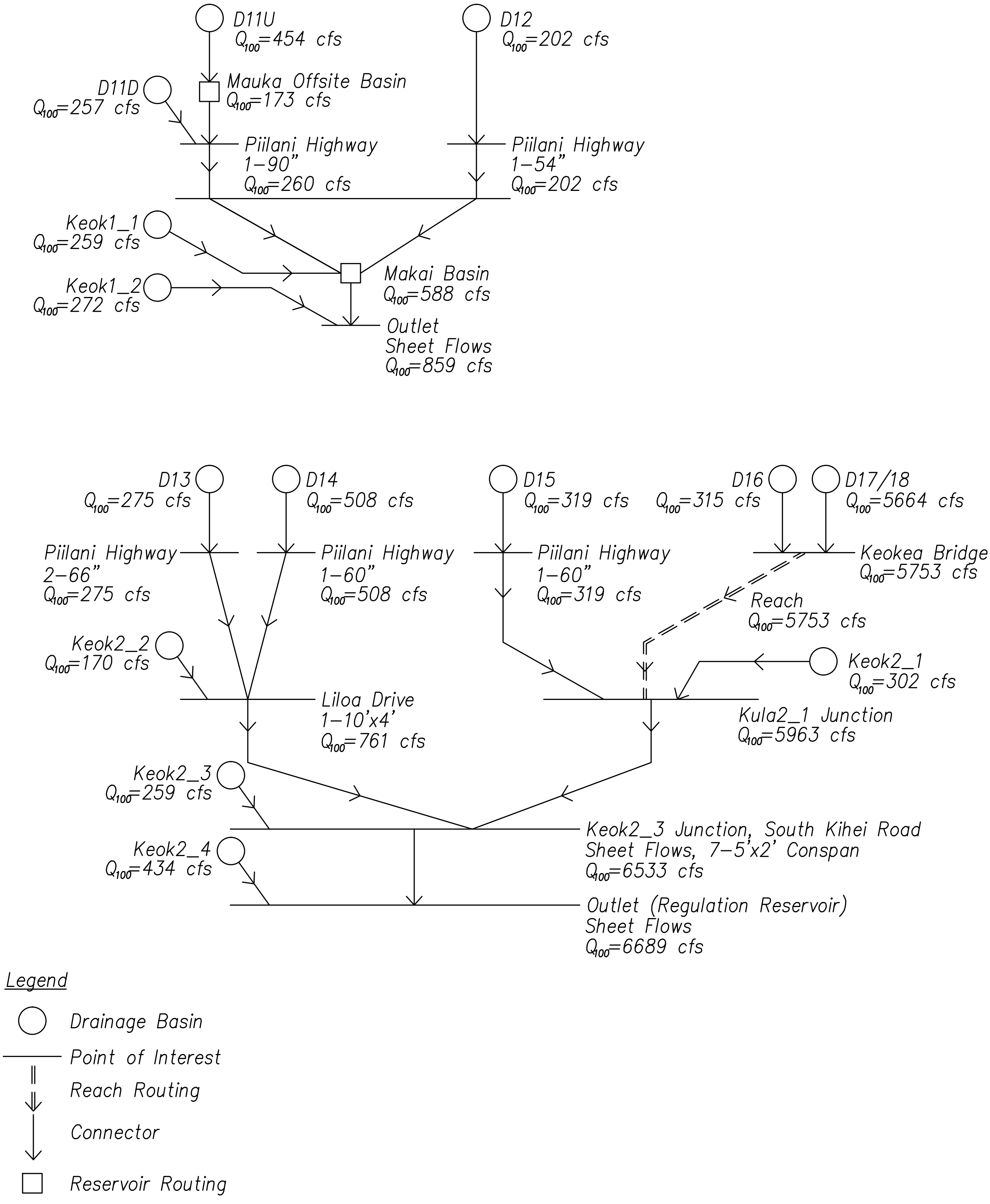
1 inch = 500 feet

0 500 1,000 Feet

Legend

Mauka Drainage Basin
Keokea Makai Drainage Basin
Parcel
Detention Basin
Major Stream
LiDAR 2-ft Contours
Drainline
Overland
Culverts
Q=7965 cfs — Flow from Subbasin
Q=583 cfs — Flow at Point of Interest
Shopping Center
Hotels
Beach/Park
Golf Course
Fire Station
Church/School

Figure 4.4.b
Keokea District
Existing Conditions
Mauka Map



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Keokea District
Existing Conditions
HEC-HMS Diagram

Figure
4.4.c

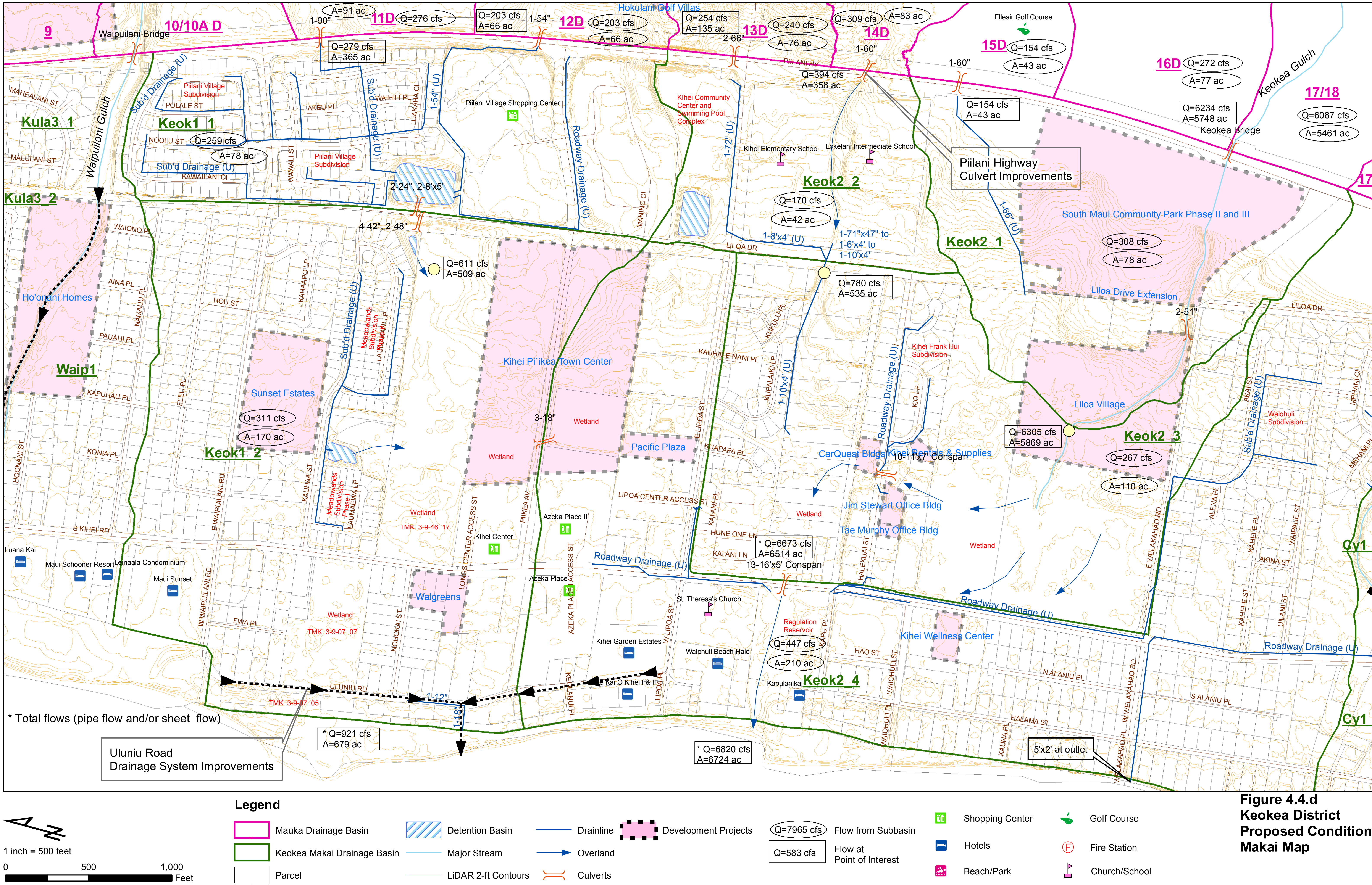


Figure 4.4.d
Keokea District
Proposed Conditions
Makai Map

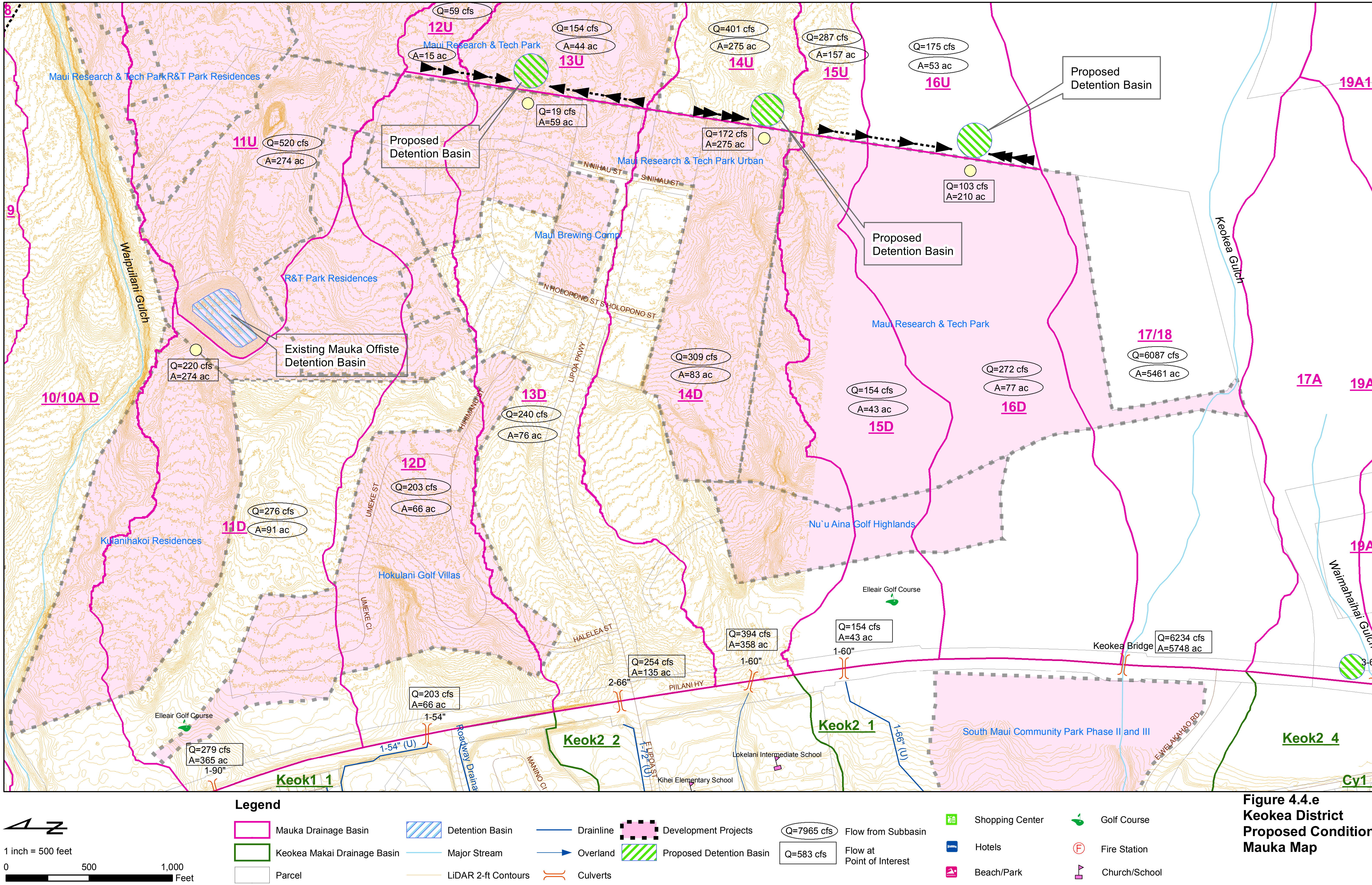
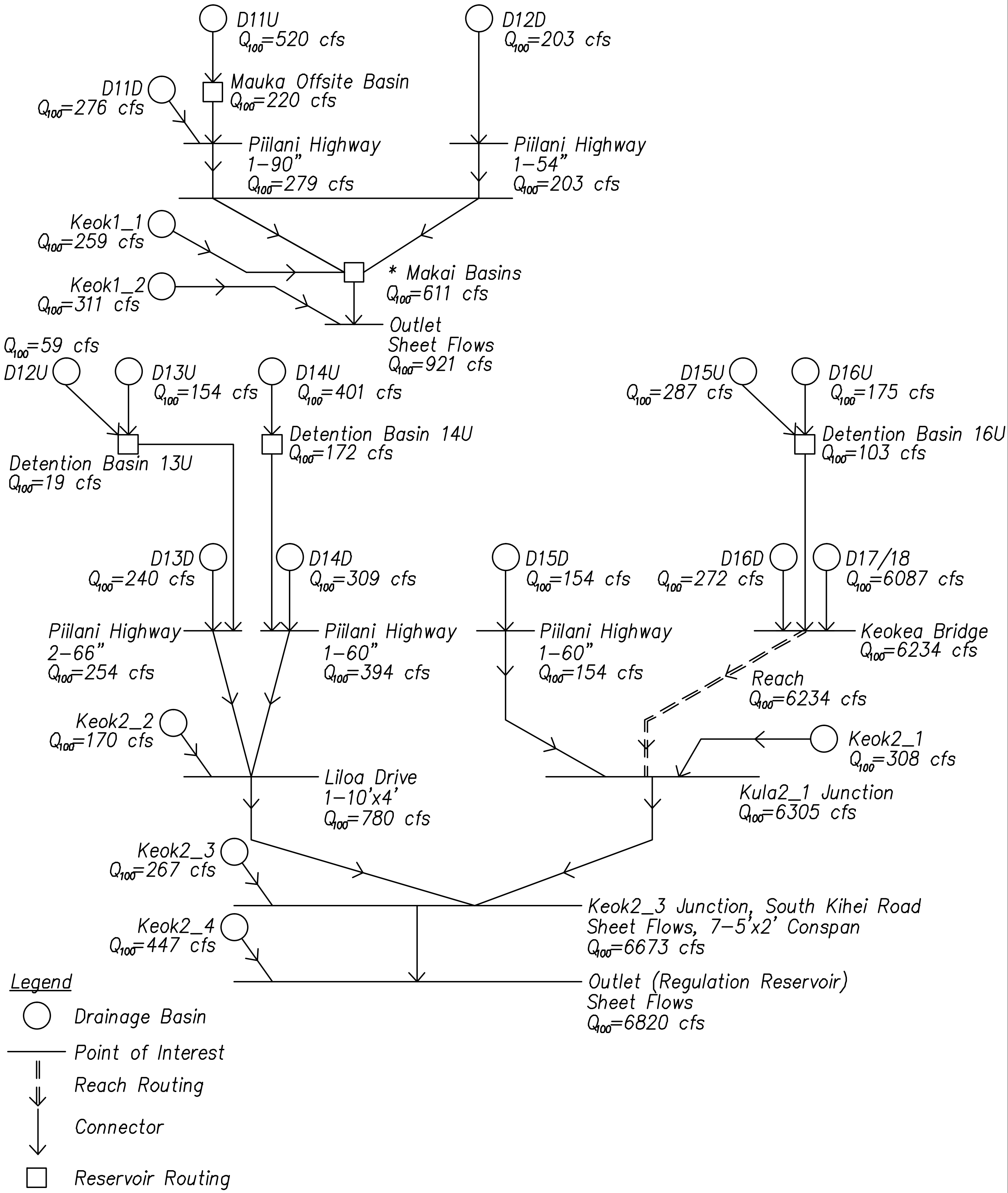


Figure 4.4.e
Keokea District
Proposed Conditions
Mauka Map



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Keokea District
Proposed Conditions
HEC-HMS Diagram

Figure
4.4.f

4.5 Charlie Young District

The Charlie Young District consists of Piilani Basins 17A, 19A1, 19A2, 19, and 20 mauka of Piilani Highway. Makai of Piilani Highway, the district is divided into six drainage basins from Cy1_1 to Cy3_1. The basins in the Charlie Young District and the existing conditions runoff for the 100-year storm (Q_{100}) are listed in Table 4.5.1. The Charlie Young District Existing Conditions map is shown in Figure 4.5.a and the Charlie Young Existing Conditions HEC-HMS diagram is shown in Figure 4.5.b.

Table 4.5.1 Charlie Young District, Existing Conditions

Mauka of Piilani Highway			Makai of Piilani Highway		
Piilani Basin	Area (acres)	Q_{100} (cfs)	Makai Basin	Area (acres)	Q_{100} (cfs)
17A	54	180	Cy1_1	20	72
			Cy1_2	25	60
19A1	116	291	Cy2_1	24	89
19A2	47	153	Cy2_2	136	398
19	406	538			
20	358	507	Cy3_1	23	96
			Cy3_2	40	175

The proposed conditions runoff for the 100-year storm (Q_{100}) is listed in Table 4.5.2. The Charlie Young District Proposed Conditions map is shown in Figure 4.5.c and the Charlie Young Proposed Conditions HEC-HMS diagram is shown in Figure 4.5.d. Discussions of the recommendations are presented in the following subsections.

Table 4.5.2 Charlie Young District, Proposed Conditions

Mauka of Piilani Highway			Makai of Piilani Highway		
Piilani Basin	Area (acres)	Q_{100} (cfs)	Makai Basin	Area (acres)	Q_{100} (cfs)
17A	54	180	Cy1_1	20	72
			Cy1_2	25	60
19A1	116	291	Cy2_1	24	97
19A2	47	153	Cy2_2	136	403
19	406	559			
20	358	525	Cy3_1	23	96
			Cy3_2	40	178

The runoff quantities along Piilani Highway and coast in the Charlie Young District are listed in Tables 4.5.3 and 4.5.4.

Table 4.5.3 Charlie Young District, Runoff Quantities along Piilani Highway

Cross-Drain Description	Capacity (cfs)	Existing			Proposed		
		Piilani Basin	Area (acres)	Q_{100} (cfs)	Piilani Basin	Area (acres)	Q_{100} (cfs)
3-60”	561	17A	54	180	17A	54	96
1-7’x5’-1” arch	206	19A1	116	291	19A1	116	107
1-54”,	222	19A2	47	153	19A2	47	55
1-24” (drop inlet)	N/A	-		-	-	-	-
2-84”	959	19	406	538	19	406	396
3-120”	2,452	20	358	507	20	358	436

Table 4.5.4 Charlie Young District, Runoff Quantities along Coast

Cross-Drain Description	Capacity (cfs)	Existing			Proposed		
		Makai Basin	Area (acres)	Q_{100} (cfs)	Makai Basin	Area (acres)	Q_{100} (cfs)
Sheet flow	N/A	Cy1_2[1e]	99	298	Cy1_2[1p]	25	60
Kalama Beach Park Channel and sheet flow	N/A	Cy2_2[2e]	729	1,059	Cy2_2[2e]	803	728
1-10’x6’	530	Cy3_2[3]	421	549	Cy3_2[3]	421	471

[1e] including Piilani Basin 17A, Cy1_1 and Cy1_2, [1p] only Cy1_2
[2e] including Piilani Basin 19A1, 19A2, 19, Cy2_1, and Cy2_2
[2p] including Piilani Basin 17A, 19A1, 19A2, 19, Cy1_1, Cy2_1, and Cy2_2
[3] including Piilani Basin 20, Cy3_1, and Cy3_2

4.5.1 Cy1_1, Cy1_2 and Piilani Basin 17A

Existing Conditions

For Piilani Basin 17A, Q_{100} is 180 cfs and the runoff crosses Piilani Highway through 3-60” culverts (Waimahaihai Gulch). The runoff flows in an earth channel after crossing Piilani Highway and enters the Kalama View Subdivision. The channel continues downstream crossing Malama Street (2-48” culverts, estimated capacity = 234 cfs), a private road (2-8’x5’ box culverts), and eventually Kupuna Street (2-48”). The drainageway loses definition approximately 360 feet (LIDAR topo) upstream of the 2-48” culverts at Kupuna Street crossing. There is evidence (site visit) showing the runoff overtops Kupuna Street and sheet flows toward the lawn areas located north of Kukui Mall. The peak flow at this location is 239 cfs (Q_{100}). Portion of the overflow is captured by a 2’x1.5’ drainline located at the intersection of Kupuna Street and South Kihei Road. The remaining runoff either is captured by the other drainline (between Kukui Mall and Keala Place) or sheets flow to Kalama Beach Park. There is observed flooding in the Kalama Beach Park and the surrounding low-lying areas.

Waimahaihai Gulch has been analyzed by approximate methods (no detailed hydraulic analyses and no Base Flood Elevations) in the latest FIS and is shown as Zone A subject to 1% annual chance flood from makai of Piilani Highway to South Kihei Road.

Two existing 20” sewer force mains (as-built plans) are identified running along Kapuna Street and turn south at South Kihei Road. The sewer force mains continue on South Kihei Road until past Waimahaihai Street where the sewer force mains are located makai of South Kihei Road.

Future Conditions

There are no future developments planned in this region.

Recommendations

- Construct a detention basin mauka of Piilani Highway at Piilani Basin 17A (8 acre-ft). The outflow from the detention basin reaching the 3-60’ culverts will be reduced to 96 cfs at the Piilani Highway crossing and to 124 cfs at the Kupuna Street crossing.

- Restore and improve the existing Waimahaihai Gulch from 360 feet upstream of the Kapuna Street crossing to Kapuna Street. The trapezoidal, grassed channel will have 12-feet bottom width, 4-feet height, and a 2:1 side slope.

- Replace the existing 2-48” culverts at Kapuna Street crossing with an underground drainage system (Waimahaihai Gulch Drainage Improvements, 1-8’x3’ box to 1-11’x3’ box) and route the flow to the Kalama Beach Park channel. The proposed drainage system will require a drainage easement through the Kukui Mall parking lot and will replace the existing drainline running between Kukui Mall and Keala Place. Utility relocation is expected to accommodate the width of the proposed drainage system

  The alternative for the underground drainage system running along Kupuna Street and South Kihei Road may encounter potential conflict with the existing 2-20” sewer force mains. Thus, this makes the alternative less desirable due to the potential higher utility relocation costs.

  The alternative for the connection to the existing draining system running along South Kihei Road to the Welakahao Road outlet (north of Kupuna Street intersection) will not be cost effective as it will still involve replacing the existing drainage system and utility relocation with greater length.

- Another possible alternative is to divert Piilani Basin 17A flow to Keokea Gulch. A drainage system is still required to route the remaining flow from Kupuna Street to Kalama Beach Park.

The proposed drainage improvements will route the flow to the Kalama Beach Park outlet and mitigate the flooding at South Kihei Road.

4.5.2 Cy2_1, Cy2_2 and Piilani Basins 19A1, 19A2, 19

Existing Conditions

Storm runoff from Piilani Basin 19A1 crosses Piilani Highway through a 7'x5'-1" arch and for the basin Q_{100} = 291 cfs. Immediately downstream of the 7'x5'-1" arch, the flow is routed along the mauka boundary of the Keala Hills Subdivision via a 72" pipe to the open areas within Cy2_1. The 72" pipe increases in size to 1-8'x5' culvert at the outlet.

Storm runoff from Piilani Basin 19A2 crosses Piilani Highway through a 54" culvert and for the basin Q_{100} = 153 cfs. A 24" culvert (drop inlet) also carries a small amount of the total flow, but the flow through the 24" culvert is assumed to be insignificant compared to the flow through the 54" culvert.

Storm runoff from Piilani Basin 19 (Kihei Gulch 1) crosses Piilani Highway through 2-84" culverts and for the basin Q_{100} = 538 cfs. Flows from Basins 19 and 19A2 continue overland in the natural terrain and combine with flows from Piilani Basin 19A1 and Cy2_1 at the Alaloa Road crossing. The combined flow is 734 cfs (Q_{100}). Double 48" culverts convey flow across Alaloa Road to the downstream Kalama Subdivision. The natural channel fades out midway through the Kalama Subdivision and it is assumed that the runoff sheet flows across South Kihei Road to Kalama Beach Park.

Kihei Gulch 1 has been studied by FEMA and the latest FIS shows Q_{100} is 1,007 cfs at the Kalama Beach Park outlet, 712 cfs at Alaloa Road, and 518 cfs at Piilani Highway (Piilani Basin 19). The area from makai of Piilani Highway to South Kihei Road is inundated by Kihei Gulch 1.

A drainline running along South Kihei Road from Kukui Mall to Keala Place captures runoff though drain inlets and discharges to an open channel in Kalama Park though a 7'x4' culvert. The 7'x4' culvert also receives storm water from the Keala Place drainage system. Another drainage system from Alahele Place also outlets to the same channel via a 5'x3' culvert. The open channel is normally blocked with sand dunes at the mouth and there is normally standing water in the channel. A 7'x3' underground pipe crosses the intersection of Auhana Road and South Kihei Road and outlets to the ocean. It is assumed this drainline is the outlet for the nearby lots and roadways. There has been flooding observed in Kalama Beach Park and the surrounding low-lying areas due to the existing flat terrain.

Future Conditions

The major future development mauka of Piilani Highway at the upper Charlie Young District (Piilani Basins 19 and 20) is Keokea Homestead DHHL (early conceptual stage). Two future projects are proposed makai of Piilani Highway: Alahele Homes and Kalama Hills. To reduce the flood damage from Kihei Gulch 1, detention basins and drainage system are proposed to convey the flow to the Kalama Park makai of Piilani Highway. It will reduce Q_{100} from 734 cfs to 523 cfs at the Alaloa Road crossing and from 1,059 cfs to 728 cfs at Kalama Beach Park. A proposed drainage system mentioned in section 4.5.1 will route the Waimahaihai Gulch runoff to the Kalama Beach Park channel.

Recommendations

- Construct detention basins mauka of Piilani Highway at Piilani Basin 19A1 (21 acre-ft), Piilani Basin A2 (12 acre-ft), and Piilani Basin 19 (50 acre-ft).

- Improve the existing channel between makai of Piilani Highway and Alaloa Road (Kihei Gulch 1 Improvements). The improved channel (Q_{100} = 523 cfs) is estimated to be a trapezoidal CRM-line channel with 15-feet bottom width, 5-feet height, and a 2:1 side slope.

  In lieu of the CRM-lined channel, a grassed trapezoidal channel with the same dimensions could be considered. Maintenance and erosion shall also be factored into the consideration of this alternative.

- Construct an underground drainage system to route the flow from Alaloa Road to the Kalama Beach Park outlet. The proposed drainage system (Kihei Gulch 1 Drainage System Improvements, 1-9'x4' box to 1-17'x4' box) will run along Alahele Place to South Kihei Road replacing the existing drainline (5'x3' box) at South Kihei Road, and discharge to the Kalama Beach Park channel. This option may also require utility relocation.

- Improve the existing Kalama Beach Park channel (Kalama Beach Park Channel Improvements). The improved channel will be a trapezoidal CRM-line channel with 25-feet bottom width, 5.5-feet height, and a 2:1 side slope.

- The future developments, both mauka and makai of Piilani Highway, must retain the increased runoff onsite.

- Perform maintenance of the Kalama Beach Park channel regularly to be free of debris and sand dune accumulation.

As discussed under the existing condition, the existing channel (Kihei Gulch 1) fades out and runoff sheets flow to South Kihei Road. There are existing parking lots and buildings between the end of the channel and South Kihei Road. With the upstream improvements and the proposed drainage system, it will help to reduce the flooding at South Kihei Road.

The proposed drainage improvements will reduce the mauka runoff to minimize the impacts to the downstream areas while providing sufficient capacity for the future condition.

4.5.3 Cy3_1, Cy3_2 and Piilani Basin 20

Existing Conditions

The drainage area boundaries for Piilani Basin 20 and the makai basins (Cy3_1 and Cy3_2) were taken from the 2005 Maui Flood Insurance Study (FIS, Reference 6) for Kaluaihakoko Stream. The FIS study utilized LiDAR data and regression equations to perform a hydrologic analysis. A review of the drainage basins delineated in the FIS showed a major difference in drainage areas for Piilani Basins 20 and 21. The previous drainage master plans (References 1 and 2) reported that majority of runoff flowed to Piilani Basin 20 (Kaluaihakoko Stream) instead of Piilani Basin 21 (Kamaole Gulch); however, the FIS results showed otherwise. Since the topography in the FIS was collected by the LiDAR technology compared to the use of USGS quadrangle maps in the previous master plan, the detailed LiDAR topography should provide more accurate delineation results.

The drainage areas from the 2005 Maui FIS were adopted in this study with flow values re-calculated by the HEC-HMS model using the NRCS method. Kaluaihakoko Stream crosses Piilani Highway through 3-120" culverts with the NRCS Q_{100} = 507 cfs whereas the FIS regression Q_{100} is 400 cfs. At the stream mouth, the NRCS Q_{100} is 549 cfs whereas the FIS regression Q_{100} is 461 cfs.

After passing Piilani Highway, the terrain flattens out at Kanakanui Road and immediately the stream passes through residential houses. The houses were built on the natural flow path and the neighborhood is in floodplain zones. Flooding has been observed during intense storm events on residential areas between Halona Street and Piilani Highway. Storm water flows overland and crosses Auhana Road (Q_{100} =522 cfs) through an inadequate 60" culvert. Runoff then flows through a natural earth channel to Kanoe Street, where the 3-42" culverts are often blocked by debris. The runoff overtops the Kanoe Street and Kanani Road intersection and continues downstream through a concrete-lined channel makai of Kanoe Street. At the South Kihei Road crossing, a 10'x6' box culvert conveys flow to the ocean.

Future Conditions

The major future development mauka of Piilani Highway at the upper Charlie Young District (Piilani Basins 19 and 20) is Keokea Homestead DHHL (early conceptual stage). Various projects are proposed makai of Piilani Highway. Kalama Heights Phase 2 is the most notable site that is within the Kaluaihakoko Stream floodplain. As discussed in the existing condition, the Kaluaihakoko Stream path is blocked by the existing residential area. To construct a channel through the private properties is not likely to be feasible without significant impacts to existing structures. Instead, a detention basin is proposed mauka of Piilani Highway to reduce the runoff. The resulting Q_{100} is 436 cfs at the Piilani Highway crossing and 471 cfs at the South Kihei Road crossing. The existing 1-10'x6' box culvert at South Kihei is able to convey 471 cfs to the ocean.

Recommendations

- Construct a detention basin (17 acre-ft) in Piilani Basin 20 mauka of Piilani Highway to reduce Q_{100}. There are existing buildings and a roadway in the vicinity of the proposed detention basin site. Further study is needed determine the size of the basin without impacting the existing infrastructures and drainage pattern. With the upstream improvements, it will help to reduce the flooding at South Kihei Road.

- Replace the existing 1-60” culvert at Auhana Road with 2-7’x5’ box culverts.

- Improve the existing drainageway (Kaluaihakoko Gulch Improvements) from approximately 900 feet mauka of Auhana Road to South Kihei Road. The rectangular concrete-lined channel will have 15-feet bottom width and 5-feet height. Due to the existing restrictions at the both stream banks, a grassed channel is not considered because it may encroach into the private properties to accommodate a wider channel.

- Replace the existing 3-36” culverts at Kanoe Street with 3-6’x4’ box culverts.

- The future developments, both mauka and makai of Piilani Highway, must retain the increased runoff onsite.

- Perform maintenance of the outlet regularly to be free of debris and sand dune accumulation.

The proposed drainage improvements will provide sufficient capacity for the future condition and help to reduce the flooding at South Kihei Road. However, to address the flooding problems ultimately, it is required to acquire private properties downstream of the 3-120” culverts in order to construct a drainage channel to convey the floodwater downstream (Kaluaihakoko Stream). The solutions will have to be coordinated and negotiated between the landowners and the government agencies.

4.5.4 Charlie Young District Cost Estimate

The conceptual cost estimate for Charlie Young District improvements is summarized in the following table. Refer to Appendix C for detailed cost estimate.

Table 4.5.5 Charlie Young District Cost Estimate Summary

	Improvements	Cost
1	Proposed Detention Basin at Piilani Basin 17A	$682,000
2	Proposed Detention Basin at Piilani Basin 19A1	$1,622,000
3	Proposed Detention Basin at Piilani Basin 19A2	$985,000
4	Proposed Detention Basin at Piilani Basin 19	$3,500,000
5	Proposed Detention Basin at Piilani Basin 20	$1,366,000
6	Waimahaihai Gulch Drainage Improvements	$2,233,000
7	Restoration and Improvements of Existing Waimahaihai Gulch	$52,000
8	Kihei Gulch 1 Drainage System Improvements	$3,363,000
9	Kihei Gulch 1 Improvements	$1,931,000
10	Kalama Beach Park Channel Improvements	$1,196,000
11	Proposed Auhana Road Culvert Improvements	$87,000
12	Proposed Kanoe Street Culvert Improvements	$156,000
13	Kaluaihakoko Gulch Improvements	$3,020,000
	Total	$20,193,000

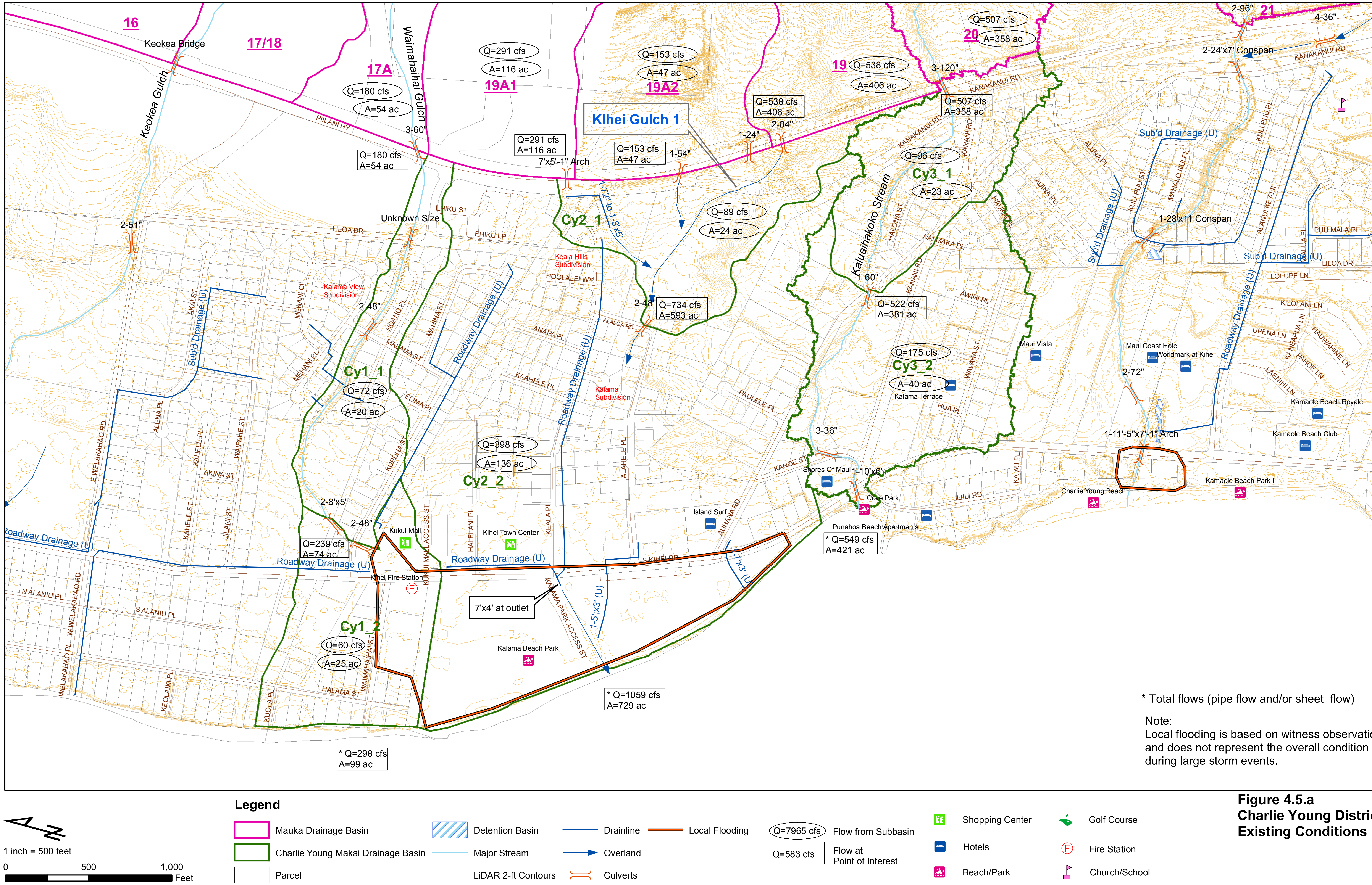
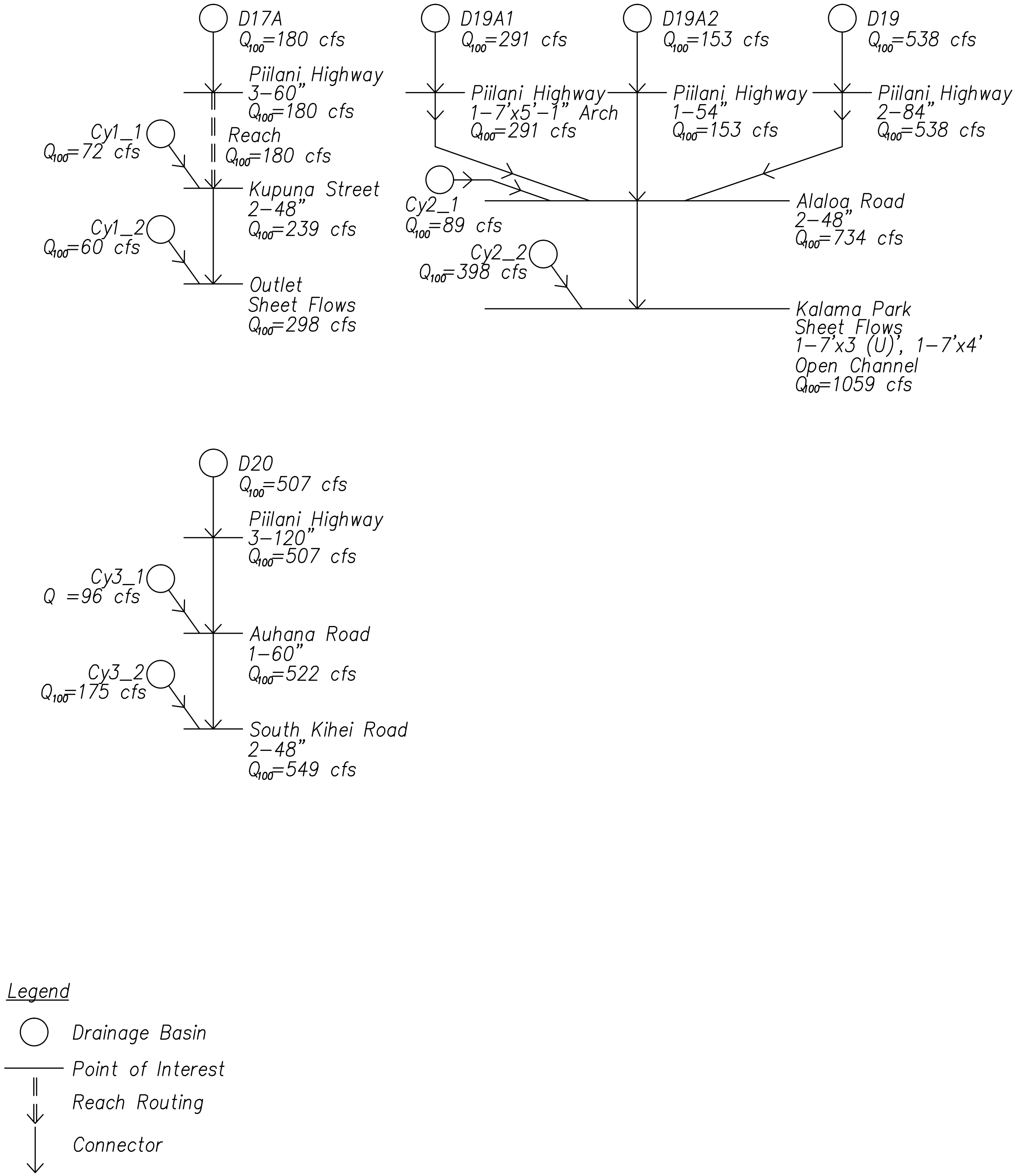


Figure 4.5.a
Charlie Young District
Existing Conditions



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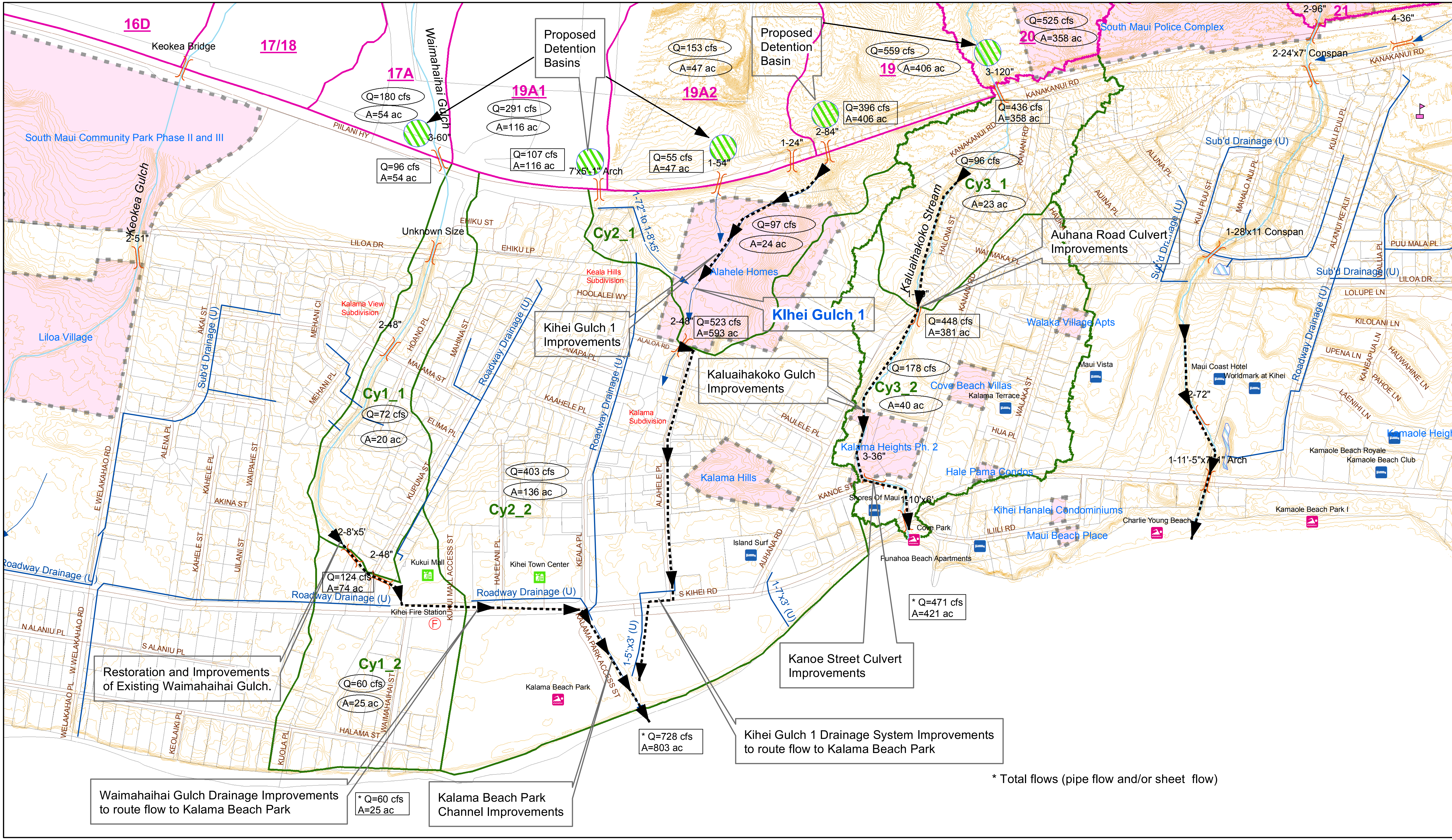
Charlie Young District
Existing Conditions
HEC-HMS Diagram

Figure
4.5.b



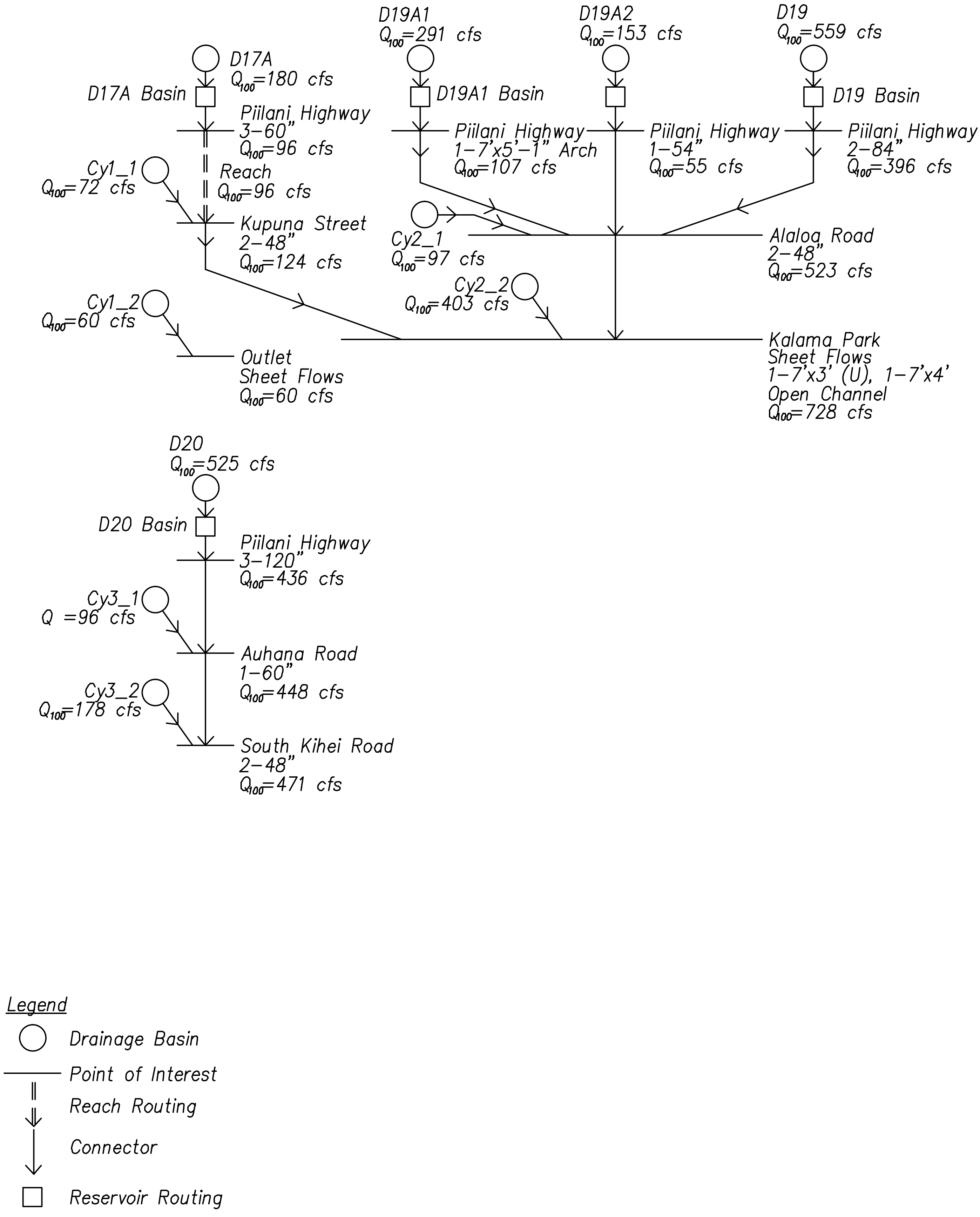
Legend

Mauka Drainage Basin	Detention Basin	Drainline
Charlie Young Makai Drainage Basin	Major Stream	Overland
Parcel	LiDAR 2-ft Contours	Culverts
Development Projects	Q=7965 cfs — Flow from Subbasin	Shopping Center
Proposed Detention Basin	Q=583 cfs — Flow at Point of Interest	Hotels
Beach/Park	Golf Course	Fire Station
Church/School		

1 inch = 500 feet

0 500 1,000 Feet

Figure 4.5.c
Charlie Young District
Proposed Conditions



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Charlie Young District
Proposed Conditions
HEC-HMS Diagram

Figure
4.5.d

4.6 Kamaole District

The Kamaole District consists of Piilani Basins 21, 22/22A, 23, and portions of Kama1_1 mauka of Piilani Highway. Makai of Piilani Highway, the district is divided into seven drainage basins from Kama1_1 to Kama3. Kamaole Gulch is the major drainageway in the district. The basins in the Kamaole District and the existing conditions runoff for the 100-year storm (Q_{100}) are listed in Table 4.6.1. The Kamaole District Existing Conditions map is shown in Figure 4.6.a and the Kamaole Existing Conditions HEC-HMS diagram is shown in Figure 4.6.b.

Table 4.6.1 Kamaole District, Existing Conditions

Mauka of Piilani Highway			Makai of Piilani Highway		
Piilani Basin	Area (acres)	Q_{100} (cfs)	Makai Basin	Area (acres)	Q_{100} (cfs)
21	3,202	2,806	Kama1_1	21	80
22/22A	38	113	Kama1_2	22	97
			Kama1_3	50	210
23	256	394	Kama2_1	17	70
			Kama2_2	24	80
			Kama2_3	49	162
			Kama3	66	206

The proposed conditions runoff for the 100-year storm (Q_{100}) is listed in Table 4.6.2. The Kamaole District Proposed Conditions map is shown in Figure 4.6.c and the Kamaole Proposed Conditions HEC-HMS diagram is shown in Figure 4.6.d. Discussions of the recommendations are presented in the following subsections.

Table 4.6.2 Kamaole District, Proposed Conditions

Mauka of Piilani Highway			Makai of Piilani Highway		
Piilani Basin	Area (acres)	Q_{100} (cfs)	Makai Basin	Area (acres)	Q_{100} (cfs)
21	3,202	2,986	Kama1_1	21	83
22/22A	38	113	Kama1_2	22	97
			Kama1_3	50	210
23	256	394	Kama2_1	17	70
			Kama2_2	24	84
			Kama2_3	49	168
			Kama3	66	206

The runoff quantities along Piilani Highway and South Kihei Road in the Kamaole District are listed in Tables 4.6.3 and 4.6.4.

Table 4.6.3 Kamaole District, Runoff Quantities along Piilani Highway

Cross-Drain Description	Capacity (cfs)	Existing			Proposed		
		Piilani Basin	Area (acres)	Q_{100} (cfs)	Piilani Basin	Area (acres)	Q_{100} (cfs)
2-96”	979	21	3,202	2,806	21	3,202	2,986
3-36”	120	22/22A	38	113	22/22A	38	113
2-78”	587	23	256	394	23	256	222

Table 4.6.4 Kamaole District, Runoff Quantities along South Kihei Road

Cross-Drain Description	Capacity (cfs)	Existing			Proposed		
		Makai Basin	Area (acres)	Q_{100} (cfs)	Makai Basin	Area (acres)	Q_{100} (cfs)
1-11’-5”x7’-1” arch pipe	550	Kama1_3[1]	3,333	2,871	Kama1_3[1]	3,333	3,051
Sheet flow	N/A	Kama2_3[2]	346	496	Kama2_3[2]	346	330
Sheet flow	N/A	Kama3	66	206	Kama3	66	206

[1] including Piilani Basin 21, 22/22A, Kama1_1, Kama1_2, and Kama1_3

[2] including Piilani Basin 23, Kama2_1, Kama2_2, and Kama2_3

4.6.1 Kama1_1, Kama1_2, Kama1_3 and Piilani Basins 21, 22/22A

Existing Conditions

The drainage areas of Piilani Basins 21 and 22/22A were adopted from the 2005 Maui FIS. Kamaole Gulch is a well-defined gulch that runs through Piilani Basins 21 and is studied by FEMA. The Q_{100} is 3,630 cfs at the Piilani Highway crossing and 3,765 cfs at the stream mouth according to the latest FIS and the FEMA hydraulic model.

Kamaole Gulch crosses Piilani Highway through 2-96” culverts with a calculated Q_{100} = 2,806 cfs in this report. The runoff travels approximately 200 feet downstream to the Kanakanui Road crossing and enters the Ke Alii Subdivision via 2-24’x7’ Conspan culverts. This is where the Piilani Basin 21 flow combines with Piilani Basin 22/22A and Kama1_1 flows, and the resultant flow is 2,834 cfs (Q_{100}). Runoff flows in a well-defined natural channel within Ke Alii Subdivision and crosses Kuli Puu Street through a 28’x11’ Conspan. The total Q_{100} including Kama1_2 at this location is 2,845 cfs. The FEMA hydraulic model shows the existing channel within Ke Alii Subdivision, the culvert at Kanakanui Road, and the culvert at Kuli Puu Street are able to convey 3,765 cfs. After passing Kuli Puu Street, the earth channel fades out approximately 400 feet downstream of Kuli Puu Street. The widespread runoff sheet flows to the 2-72” culverts located by the Maui Coast Hotel and under its parking lot. The channel continues downstream to South Kihei Road, where 1-11’-5”x7’-1” arch pipe is located. Existing residential developments occupy both banks downstream of South Kihei Road. The total Q_{100} including Kama1_3 at the South Kihei Road crossing is 2,871 cfs. During past storm events, floodwater from Kamaole Gulch has overtopped South Kihei Road and the lawn of nearby Kamaole Beach Park was completely washed away.

Storm runoff from Piilani Basin 22/22A crosses Piilani Highway through 3-36" culverts and for the basin Q_{100} = 113 cfs. The flow continues in an earth channel that runs parallel to Kanakanui Road. Four 36" culverts under the Ke Alii Alanui Place crossing convey the flow. The flow eventually merges with Kamaole Gulch flow at the Kanakanui Road crossing.

Kama1_1 consists of a portion of areas mauka of Piilani Highway and areas between Piilani Highway and Kanakanui Road. The flow from Kama1_1 sheet flows to the 2-24'x7' Conspan at the Kanakanui Road crossing with Q_{100} = 80 cfs.

Future Conditions

The two major future developments mauka of Piilani Highway are Keokea Homestead DHHL (early conceptual stage) at the upper Kamaole District (Piilani Basin 21) and South Maui Police Complex. There are no future developments makai of Piilani Highway. Channel and culvert improvements are proposed to address Kamaole Gulch flooding. The Q_{100} from the FIS is used as a conservative approach because of its much higher peak flow compared to the values calculated in this report.

Recommendations

- Replace the existing 2-96" culverts with 2-24'x7' box culverts at the Piilani Highway crossing to convey 3,630 cfs. This option will require the approval from HDOT.

- Improve the existing channel from approximately 400 feet downstream of Kuli Puu Street to the outlet. The rectangular concrete-lined channel will have 25-feet bottom width and 9-feet height. However, further study is needed to assess the feasibility due to the restrictions at Maui Coast Hotel and the outlet (private properties on both banks).

- Replace the existing 2-72" culverts at Maui Coast Hotel and 1-11'-5"x7'-1" arch pipe at the South Kihei Road crossing with 2-22'x8' box culverts. The solution will have to be coordinated and negotiated between the private property owners and the government agencies.

- Provide erosion control measures (channel revetment or reinforcement matting) at the vicinity of the discharge point (Kamaole Gulch) from the future developments. This is to minimize the impacts to the downstream area. Constructing a regional detention basin at mauka of Piilani Highway as a mean for flood and erosion control for Kamaole Gulch will not be feasible because of the large sheer volume of the peak flow and runoff volume generated from the mauka drainage area.

- Perform maintenance of the outlet regularly to be free of debris and sand dune accumulation.

The proposed drainage improvements will provide sufficient capacity for the future condition and mitigate overflow from Kamaole Gulch.

4.6.2 Kama2_1, Kama2_2, Kama2_3 and Piilani Basin 23

Existing Conditions

Storm runoff from Piilani Basin 23 passes Piilani Highway though 2-78" culverts and for the basin Q_{100} = 394 cfs. Two 8'x5' box culverts are located at the Kanakanui Road crossing immediately downstream of the 2-78" culverts. After crossing Kanakanui Road, the runoff enters a subdivision continuing in a natural channel and crosses Laukahi Street (2-8'x5' box culverts) until it reaches a drainage system located west of Omiko Place within the Keonekai Heights IV Subdivision. The Q_{100} is 409 cfs at this location, where 2-84" culverts were installed and have a capacity of 1,000 cfs (previous report). Downstream of the 2-84" culverts, the runoff will pass the recently constructed North-South Collector Extension (Walua Place to Keonekai Road) through a 1-48" culvert. The road is designed to form a sag curve (concrete ford) at this location to allow the large runoff to overflow at the crossing. According to the as-built plans, the 100-year water-surface elevation at the crossing is approximately 1.6 feet above the road.

The runoff continues in an earth channel to the mauka boundary of the Kihei Kai Nani, where a 7'x2' box culvert is located. Immediately downstream of the culvert is a private parking lot driveway that acts as a flow channel, and the overflow funnels towards South Kihei Road through Kihei Kai Nani property, causing flood damages to the private property. The segment of South Kihei Road between Kihei Kai Nani and Maui Banyan is a low point of South Kihei Road. There is no natural outlet along this segment of South Kihei Road, and it is assumed the majority of flow overtops South Kihei Road towards Kamaole Beach Park II during intense storms. Approximately 100 feet south of the intersection of the Kihei Kai Nani driveway and South Kihei Road, there are 2-24" culverts under South Kihei Road that outlet to Kamaole Beach Park II.

Future Conditions

There are no future developments planned mauka of Piilani Highway. Kamaole Heights and Nani Loa Condominiums are the two future developments makai of Piilani Highway.

Recommendations

- Construct a detention basin mauka of Piilani Highway at Piilani Basin 23 (33 acre-ft). The outflow from the detention basin reaching the 2-78" culverts will be reduced to 222 cfs.

- Replace the existing 7’x2’ box culvert at the mauka boundary of Kihei Kai Nani with an underground drainage system (1-8’x3’) under the existing Kihei Kai Nani parking lot driveway in order to route the flow (245 cfs) to Kamaole Beach Park II. The upstream side of the drainage system will have to be regraded to ensure the runoff can properly flow to the inlet. This option may also require utility relocation and will have to be coordinated and negotiated between the private property owners and the government agencies.

- The future developments makai of Piilani Highway must retain the increased runoff onsite.

- Perform maintenance of the outlet regularly to be free of debris and sand dune accumulation.

4.6.3 Kama3

Existing Conditions

Makai basin Kama3 does not receive flow from areas mauka of Piilani Highway. The Q_{100} for Kama3 is 206 cfs. Kama3 consists of Kamaole Beach Royale Resort, Kamalii Elementary School, Ke Alii Villas, and Kamaole Heights Subdivision. The main drainage system is the roadway drainage along Alanui Ke Alii Place. The roadway system captures surface flow from the roadway and also receives flow from Ke Alii Villas and Kamaole Heights Subdivision through an underground drainage system. The Ke Alii Alanui roadway drainage system turns north approximately 200 feet mauka of South Kihei Road and routes the flow to a temporary detention basin. The overflow from the detention basin is discharged to Kamaole Gulch. Surface runoff in Kama3 not captured by the local drainage system is assumed to sheet flow across South Kihei Road to the ocean. Flooding is observed in the vicinity of Kamaole Gulch outlet due to the Kamaole Gulch overflow.

Future Conditions

There are no future developments planned in Kama3.

Recommendations

No drainage improvements are proposed because no development is anticipated. However, with the proposed Kamaole Gulch drainage improvements, the flooding at South Kihei Road will be reduced.

4.6.4 Kamaole District Cost Estimate

The conceptual cost estimate for Kamaole District improvements is summarized in the following table. Refer to Appendix C for detailed cost estimate.

Table 4.6.5 Kamaole District Cost Estimate Summary

	Improvements	Cost
1	Proposed Detention Basin at Piilani Basin 23	$2,550,000
2	Proposed Piilani Highway Culvert Improvements at Piilani Basin 21	$690,000
3	Proposed Maui Coast Hotel Culvert Improvements	$1,162,000
4	Proposed South Kihei Road Culvert Improvements	$567,000
5	Kamaole Gulch Improvements	$2,242,000
6	Kihei Kai Nani Drainage Improvements	$1,528,000
	Total	$8,739,000

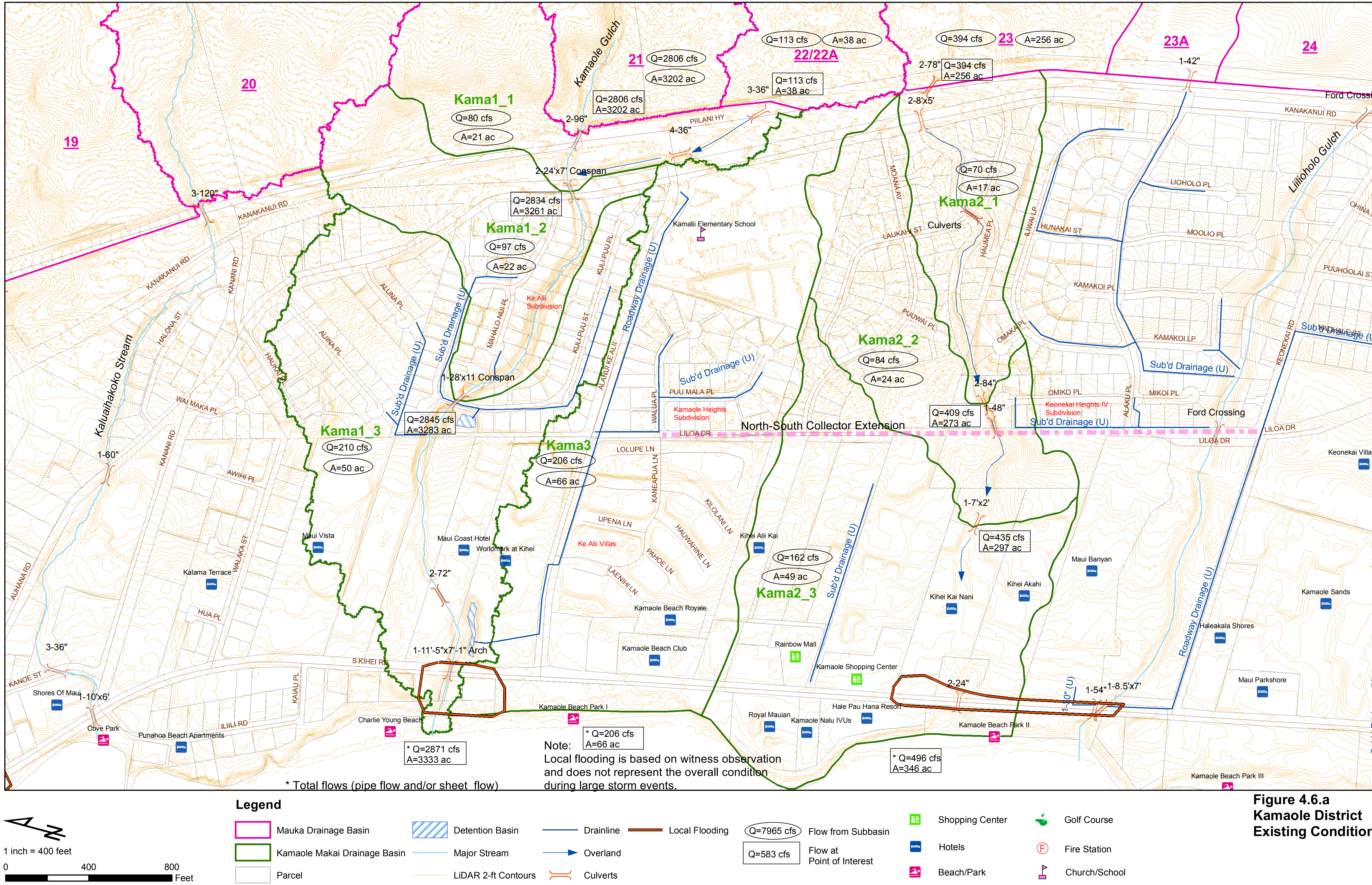
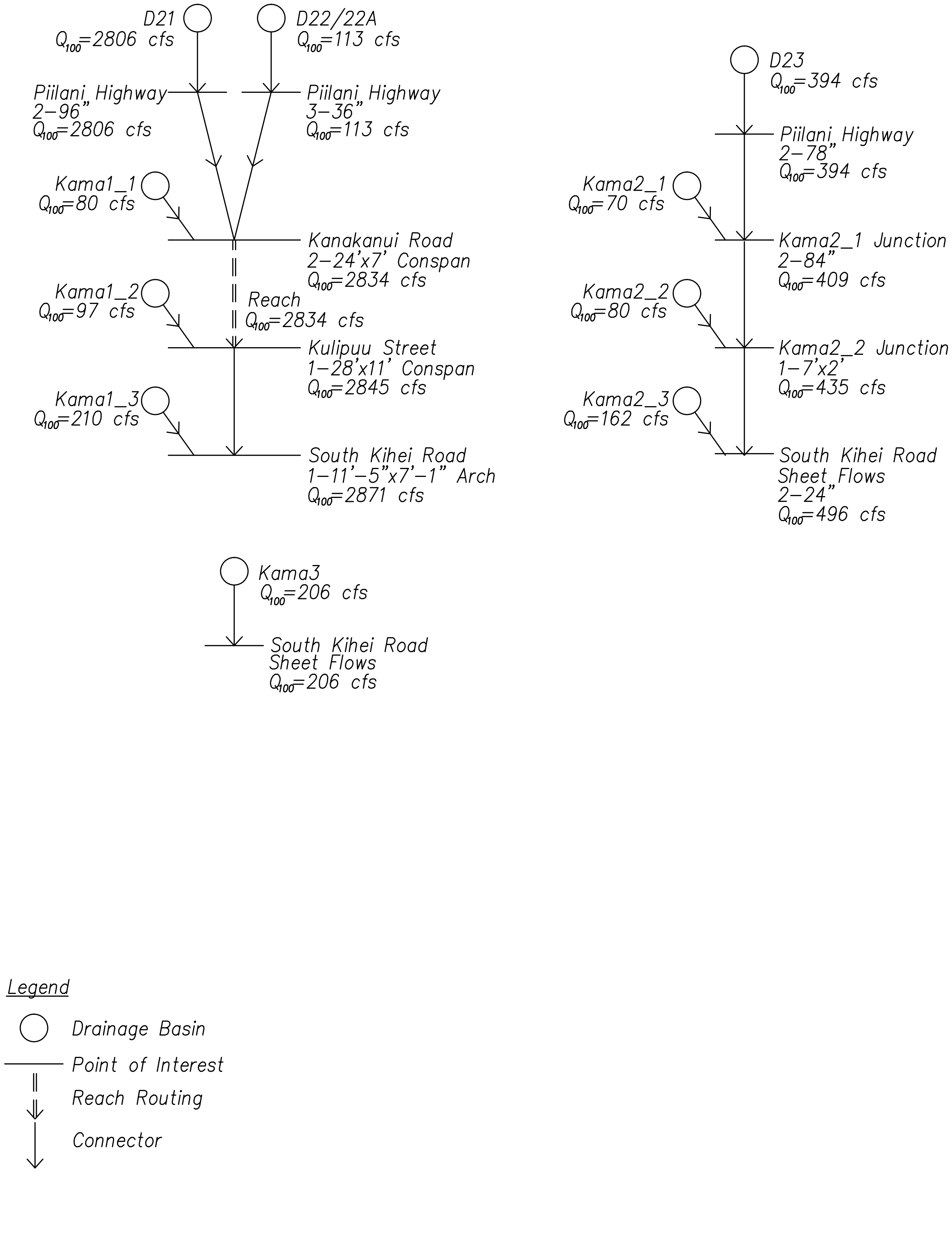


Figure 4.6.a
Kamaole District
Existing Conditions



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Kamaole District
Existing Conditions
HEC-HMS Diagram

Figure
4.6.b

4.7 Liilioholo District

The Liilioholo District consists of Piilani Basins 23A, 24/24A/24B, and 25 mauka of Piilani Highway. Makai of Piilani Highway, the district is divided into five drainage basins from Liil1_1 to Liil3. Liilioholo Gulch is the major drainageway in the district. The basins in the Liilioholo District and the existing conditions runoff for the 100-year storm (Q_{100}) are listed in Table 4.7.1. The Liilioholo District Existing Conditions map is shown in Figure 4.7.a and the Liilioholo Existing Conditions HEC-HMS diagram is shown in Figure 4.7.b.

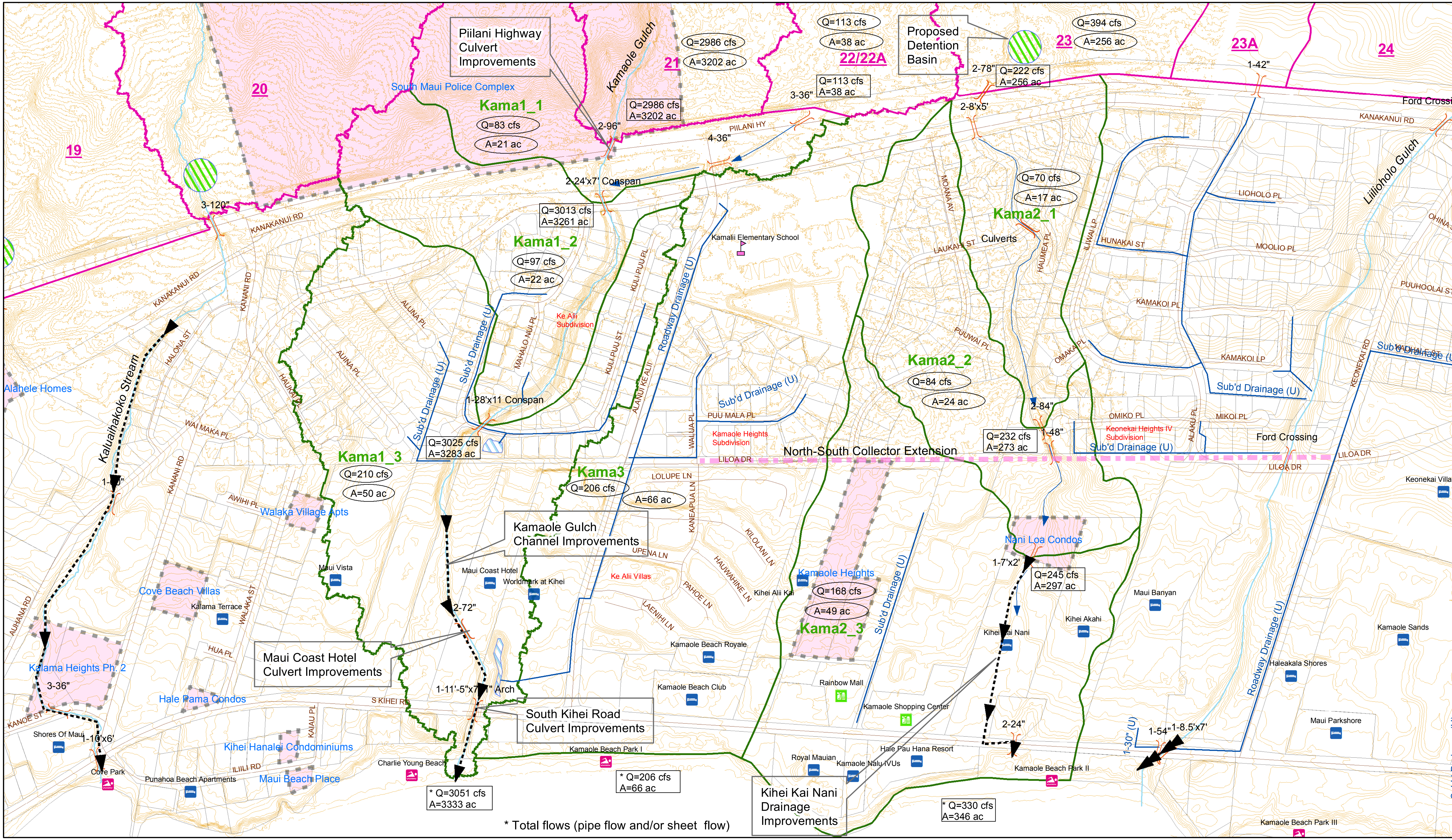
Table 4.7.1 Liilioholo District, Existing Conditions

Mauka of Piilani Highway			Makai of Piilani Highway		
Piilani Basin	Area (acres)	Q_{100} (cfs)	Makai Basin	Area (acres)	Q_{100} (cfs)
23A	14	42	Liil1_1	45	163
24/24A/24B	2,656	2,990	Liil1_2	37	116
25	130	237	Liil2_1	14	43
			Liil2_2	116	340
			Liil1_3	56	226
			Liil3	55	121

The proposed conditions runoff for the 100-year storm (Q_{100}) is listed in Table 4.7.2. The Liilioholo District Proposed Conditions map is shown in Figure 4.7.c and the Liilioholo Proposed Conditions HEC-HMS diagram is shown in Figure 4.7.d. Discussions of the recommendations are presented in the following subsections.

Table 4.7.2 Liilioholo District, Proposed Conditions

Mauka of Piilani Highway			Makai of Piilani Highway		
Piilani Basin	Area (acres)	Q_{100} (cfs)	Makai Basin	Area (acres)	Q_{100} (cfs)
23A	14	42	Liil1_1	45	163
24/24A/24B	2,656	2,990	Liil1_2	37	116
25	130	237	Liil2_1	14	49
			Liil2_2	116	344
			Liil1_3	56	226
			Liil3	55	125



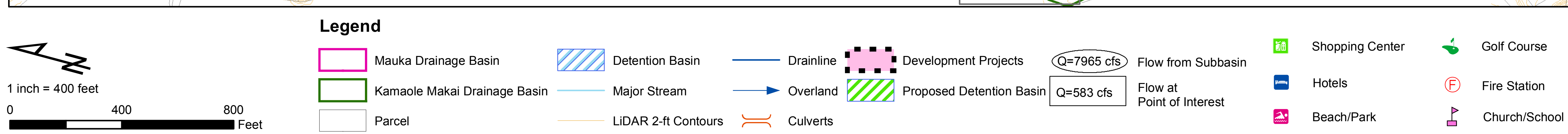
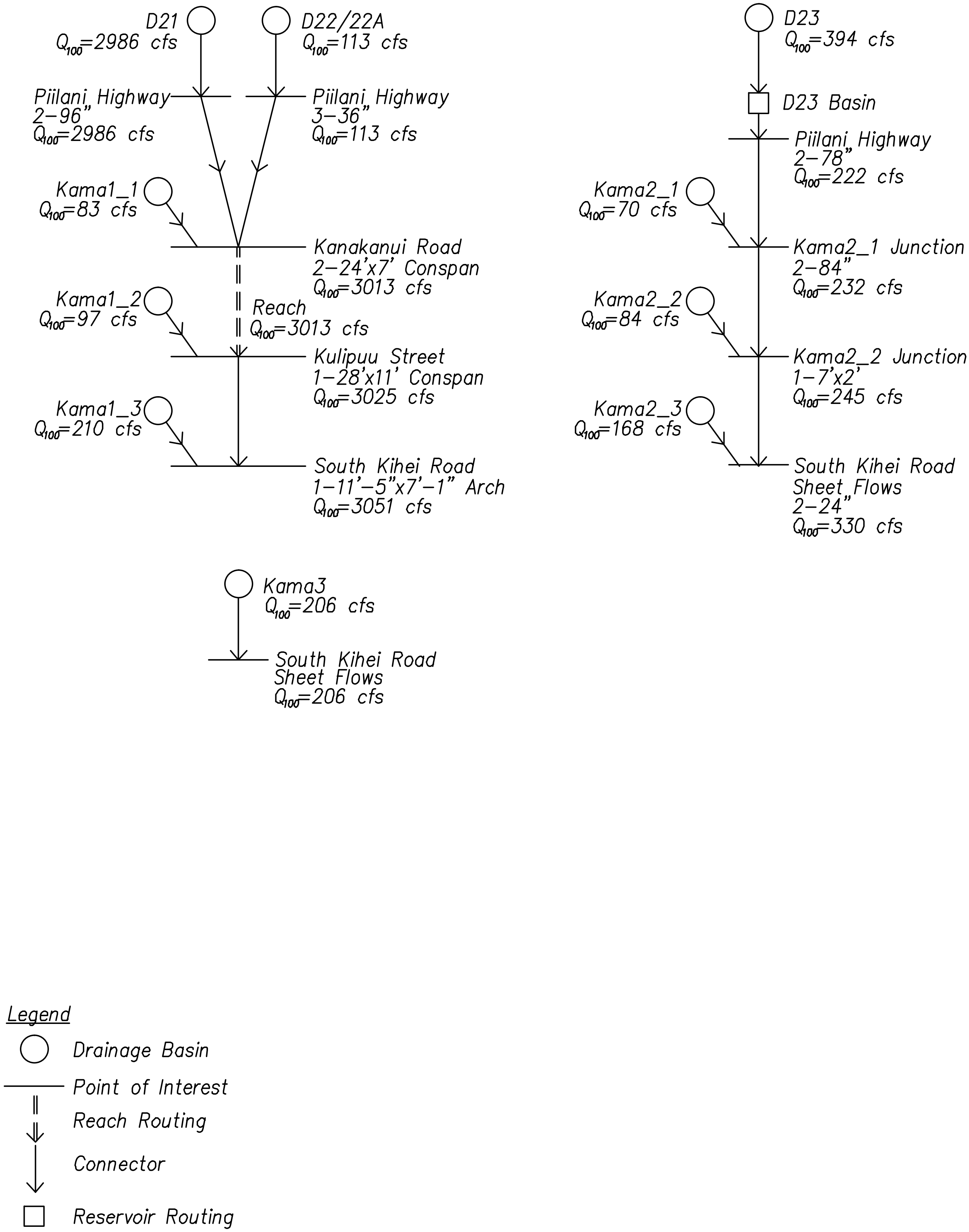


Figure 4.6.c
Kamaole District
Proposed Conditions



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Kamaole District
Proposed Conditions
HEC-HMS Diagram

Figure 4.6.d

The runoff quantities along Piilani Highway and coast in the Liilioholo District are listed in Tables 4.7.3 and 4.7.4.

Table 4.7.3 Liilioholo District, Runoff Quantities along Piilani Highway

Cross-Drain Description	Capacity (cfs)	Existing			Proposed		
		Piilani Basin	Area (acres)	Q_{100} (cfs)	Piilani Basin	Area (acres)	Q_{100} (cfs)
1-42”	59	23A	14	42	23A	14	42
3-15’-4”x9’-3”	3,900	24/24A/ 24B	2,656	2,990	24/24A/ 24B	2,656	2,990
2-66”	351	25	130	237	25	130	237

Table 4.7.4 Liilioholo District, Runoff Quantities along Coast

Cross-Drain Description	Capacity (cfs)	Existing			Proposed		
		Makai Basin	Area (acres)	Q_{100} (cfs)	Makai Basin	Area (acres)	Q_{100} (cfs)
1-54”, 1-8.5’x7, and sheet flow’	N/A	Liil1_2[1]	2,752	3,045	Liil1_2[1]	2,752	3,045
Sheet flow	N/A	Liil2_2[2]	316	772	Liil2_2[2]	316	782
Sheet flow”	N/A	Liil3	55	121	Liil3	55	125

[1] including Piilani Basin 23A, 24, 24A, 24B, Lii1_1, and Lii1_2

[2] including Piilani Basin 25, Liil1_3, Liil2_1, and Liil2_2

4.7.1 Liil1_1, Liil1_2 and Piilani Basins 23A, 24/24A/24B

Existing Conditions

Storm runoff from Piilani Basin 23A crosses Piilani Highway through a 42” culvert and for the basin Q_{100} = 42 cfs. After passing Piilani Highway, the flow enters the underground roadway drainage system along Alaku Place. The roadway drainage system turns south at the boundary between the Keonekai Estate Subdivision and the Keonekai Heights Subdivision III (approximately 150 feet mauka of Mikoi Place) and routes the flow to Liilioholo Gulch.

Liilioholo Gulch is the main drainageway in Piilani Basin 24 and has been studied by FEMA from the stream outlet to approximately 1,700 feet mauka of South Kihei Road at Liloa Drive. The latest FIS shows Q_{100} is 3,000 cfs at the stream mouth. The Liilioholo Gulch floodplain is contained within the natural channel within the FEMA study area except at South Kihei Road crossing where insufficient culvert capacity causes flow to overtop South Kihei Road. Based on the preliminary assessment, Liilioholo Gulch floodplain is contained within the channel bank between Piilani Highway and North-South Collector Extension (Liloa Drive).

Storm runoff from Piilani Basins 24A and 24B is diverted to Piilani Basin 24 through ditches along the mauka side of Piilani Highway. Liilioholo Gulch crosses Piilani Highway though 3-15’-4”x9’-3” arches with Q_{100} = 2,990 cfs. A short distance makai of the culverts, the gulch crosses Kanakanui Road at a concrete ford (more than 12 feet deep per as-built plans) and enters the Keonekai Heights Subdivision. Liilioholo Gulch is a well-defined earth channel throughout the existing subdivision(Liloa Drive). Based on the preliminary assessment, the 100-year water-surface elevation at the concrete ford is approximately 5.5 feet above the road Q_{100} = 2,997 cfs). The gulch meanders through the undeveloped land to South Kihei Road, where an 8.5'x7' box culvert is located and outlets to the Kamaole Beach Park II. A 54" corrugated aluminum pipe running side by side with the 8.5'x7' box culvert receives local flows from Maui Banyan Condo and discharges to the same outlet. The Q_{100} is 3,045 cfs at the South Kihei Road crossing.

Both Liil1_1 and 1_2 have local drainage systems (Keonekai Heights Subdivision) that routes portions of the surface flows to Liilioholo Gulch. However, it is assumed that the majority of the flows that are not captured by the local drainage systems still sheet flow towards South Kihei Road during intense storms.

Future Conditions

There are no future developments planned mauka or makai of Piilani Highway.

Recommendations

- Construction of 2-22'x9' box culverts at the existing Kanakanui Road concrete ford crossing could be considered as a long-term goal to pass the design flow of 2,990 cfs. This will involve the reconstruction of Kanakanui Road and further study is needed to assess the feasibility.

- Construct 2-22'x9' box culverts at the existing North-South Collector concrete ford crossing. This will require 1) re-grading the existing channel upstream and downstream of the ford crossing to provide a positive flow direction, or 2) raising the road elevation, or 3) combination of the aforementioned two items.

- Replace the existing 8.5'x7' box culvert at the South Kihei Road crossing with 2-22'x9' box culverts.

- Perform maintenance of the outlet regularly to be free of debris and sand dune accumulation.

The proposed drainage improvements will provide sufficient capacity for the future condition and prevent overflow from Liilioholo Gulch.

4.7.2 Liil2_1, Liil2_2, Liil1_3 and Piilani Basin 25

Existing Conditions

Liil1_3 does not receive any mauka flows because of the roadside ditches mauka of Piilani Highway described in section 4.7.1. The terrain in Liil1_3 slopes from southeast (Ohina Place) to northwest (intersection of Kauhale Street and Keonekai Road) in general. Local drainage systems from Kauhale Kai Subdivision and Kihei Village Subdivision drain portions of surface runoff to the Keonekai Road roadway drainage system and eventually into the Liilioholo Gulch at the South Kihei Road crossing (1-8.5'x7' culvert). It is assumed that the remaining surface flows will follow natural terrain and sheet flow across Liil2_2 towards the ocean.

Storm runoff from Piilani Basin 25 crosses Piilani Highway through 2-66" culverts and for the basin Q_{100} = 237 cfs. The runoff flows overland after passing Piilani Highway and enters the Hale Kilohana Subdivision through 3-48" culverts. The culverts connect to a ditch running north and the flow crosses Kauhale Street through 2-66" culverts entering Maui Kamaole properties. It is assumed that the runoff is carried by the Maui Kamaole drainage system or sheet flows to South Kihei Road, where 1-72" culvert is located and outlets to the ocean.No flooding problems have been observed at South Kihei Road.

Makai drainage basin Liil2_2 is fully developed and consists primarily of time-share hotels and condominiums. Local drainage systems capture flows and drain to the South Kihei Road drainage system. The remaining surface runoff sheet flows towards South Kihei Road seeking natural outlets. The terrain is relatively steep compared to other makai drainage basins at the northern parts of Kihei and no flooding problems have been observed at South Kihei Road in Liil2_2.

Future Conditions

There are no future developments planned mauka of Piilani Highway. Makai of Piilani Highway, Wailea SF-8 and Paradise Ridge Estates are the two future developments.

Recommendations

- The future developments makai of Piilani Highway must retain the increased runoff onsite.

There is no defined outlet for this region and runoff sheet flows across South Kihei Road. No drainage improvements are proposed because no flooding has been observed at South Kihei Road.

4.7.3 Liil3

Existing Conditions

The Liil3 drainage basin is situated makai of Piilani Highway and the Q_{100} is 121 cfs. The basin consists of Hale Kilohana Subdivision and its mauka open area, Aston Maui Hill Resort, portions of the Kilohana Mauka Subdivision, and the Keawakapu View Subdivision. A roadway drainage system in Ponana Street within the Keawakapu View Subdivision conveys a portion of surface flow to Wela Street and then turns north to Ala Koa Street. The roadway drainage system is connected to the South Kihei Roadway drainage system that runs south towards Kilohana Drive, and eventually discharges to the ocean through 2-8'x4' box culverts under South Kihei Road (see Kilohana Drive District). The Kilohana Mauka Subdivision drainage system running along Ahekolo Street, however, routes the flow through Kilo1_6 and ends up at the same outlet system (2-8'x4' box culverts) as the Keawakapu View Subdivision drainage. Similar to the flow conditions in Liil2_2, most of the runoff is assumed to sheet flow across South Kihei Road and through the private properties towards the ocean. No flooding problems have been observed at South Kihei Road in Liil3.

Future Conditions

A portion of the Wailea SF-8 development is within Liil3.

Recommendations

- The future developments makai of Piilani Highway must retain the increased runoff onsite.

There is no defined outlet for this region and runoff sheet flows across South Kihei Road. No drainage improvements are proposed because no flooding has been observed at South Kihei Road.

4.7.3 Liilioholo District Cost Estimate

The conceptual cost estimate for Liilioholo District improvements is summarized in the following table. Refer to Appendix C for detailed cost estimate.

Table 4.7.5 Liilioholo District Cost Estimate Summary

	Improvements	Cost
1	Proposed Kanakanui Road Culverts to Replace Existing Conc. Ford	$407,000
2	Proposed North-South Collector Road Culverts to Replace Existing Conc. Ford	$357,000
3	Proposed South Kihei Road Culvert Improvements	$267,000
	Total	$1,031,000

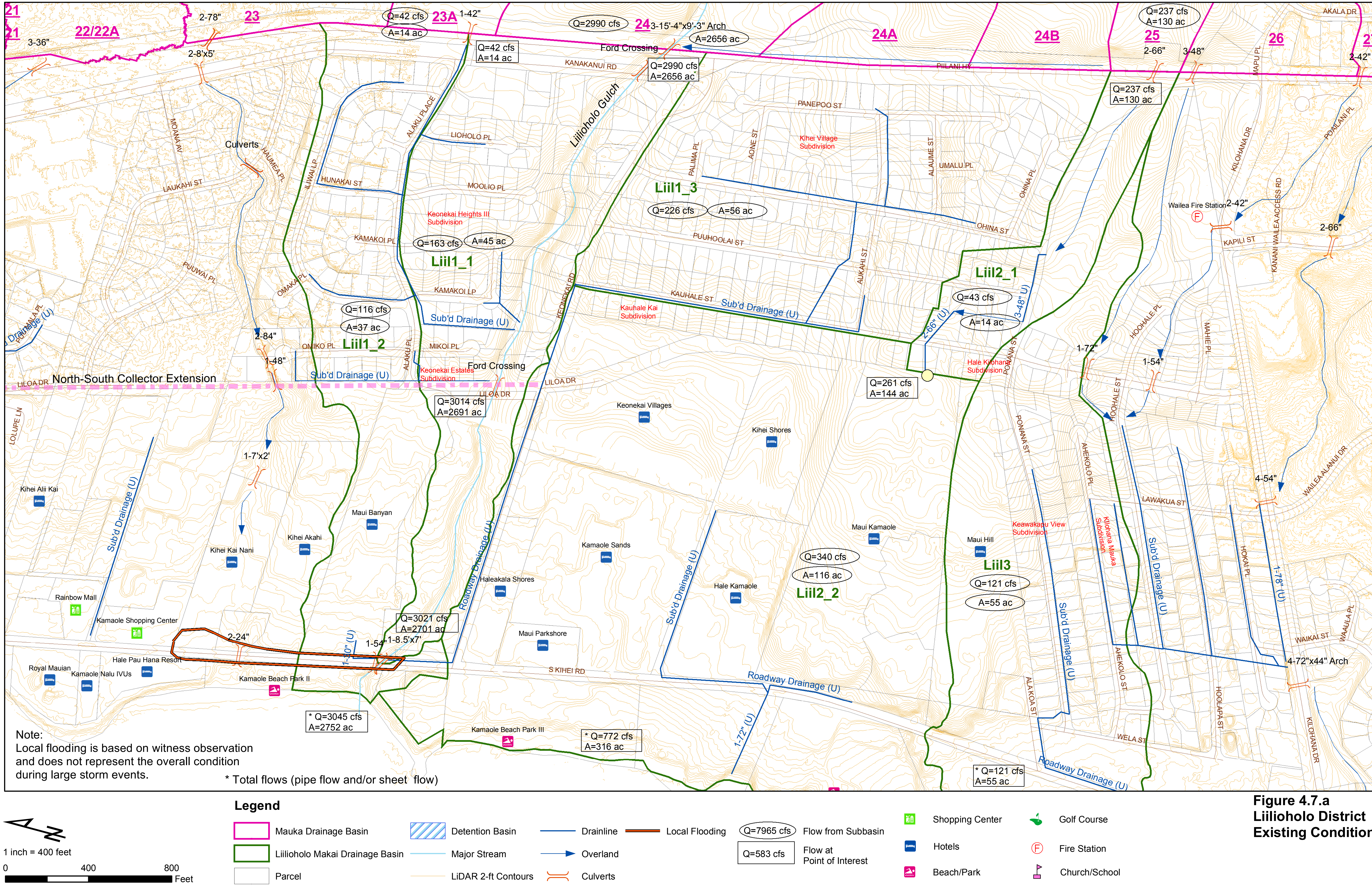
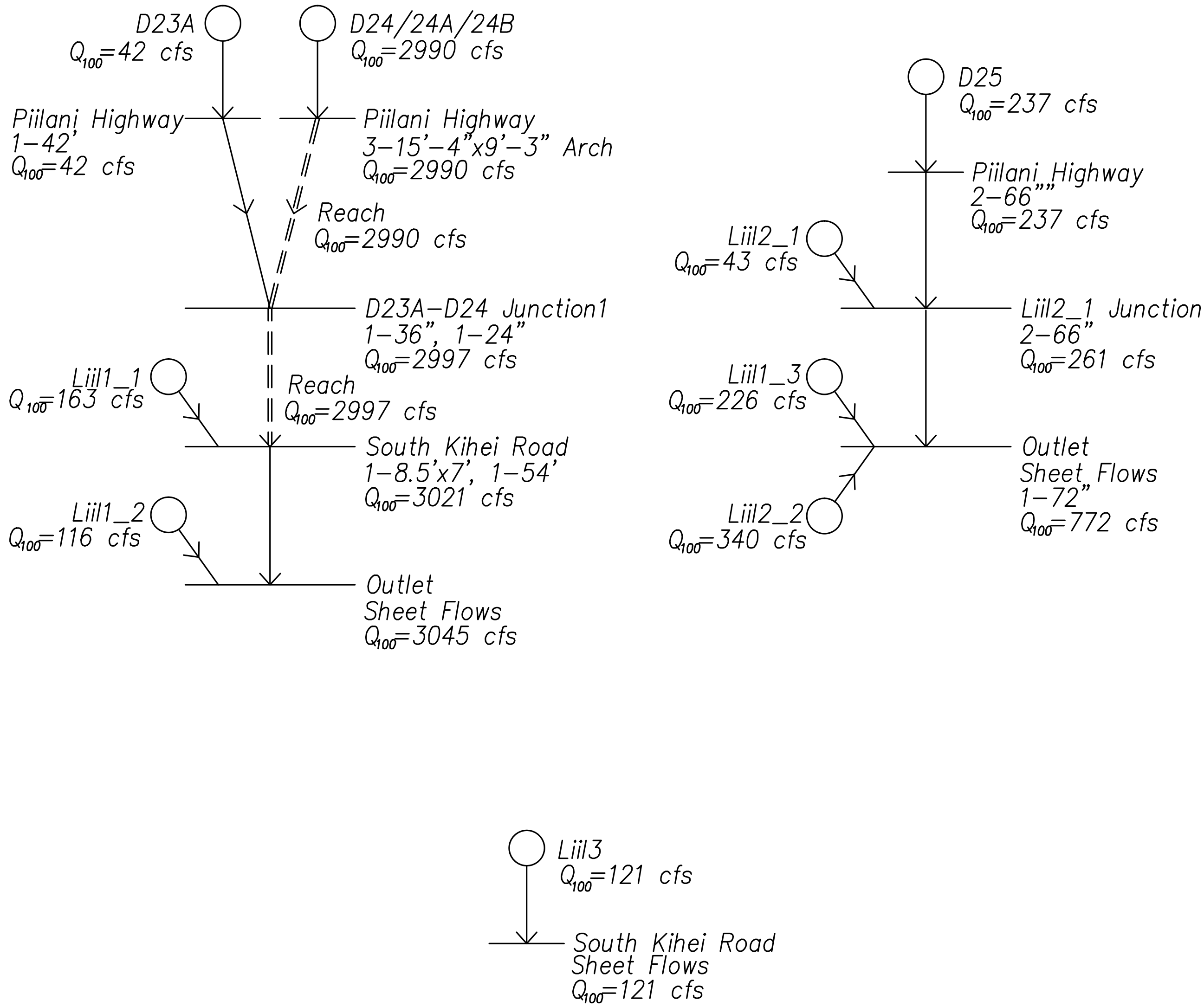


Figure 4.7.a
Liiilioholo District
Existing Conditions



Legend

Drainage Basin

Point of Interest

Reach Routing

Connector

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Liilioholo District
Existing Conditions
HEC-HMS Diagram

Figure
4.7.b

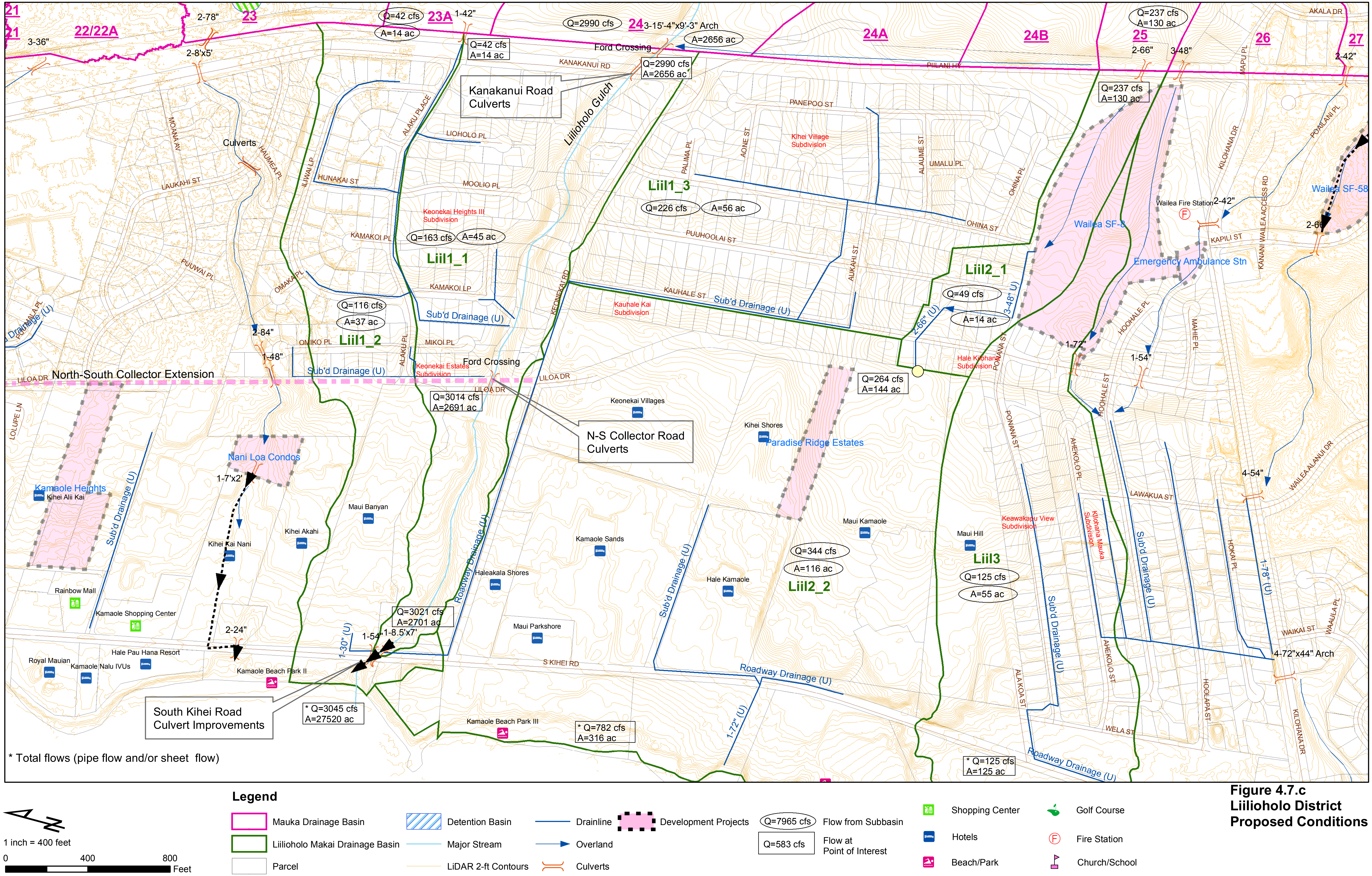
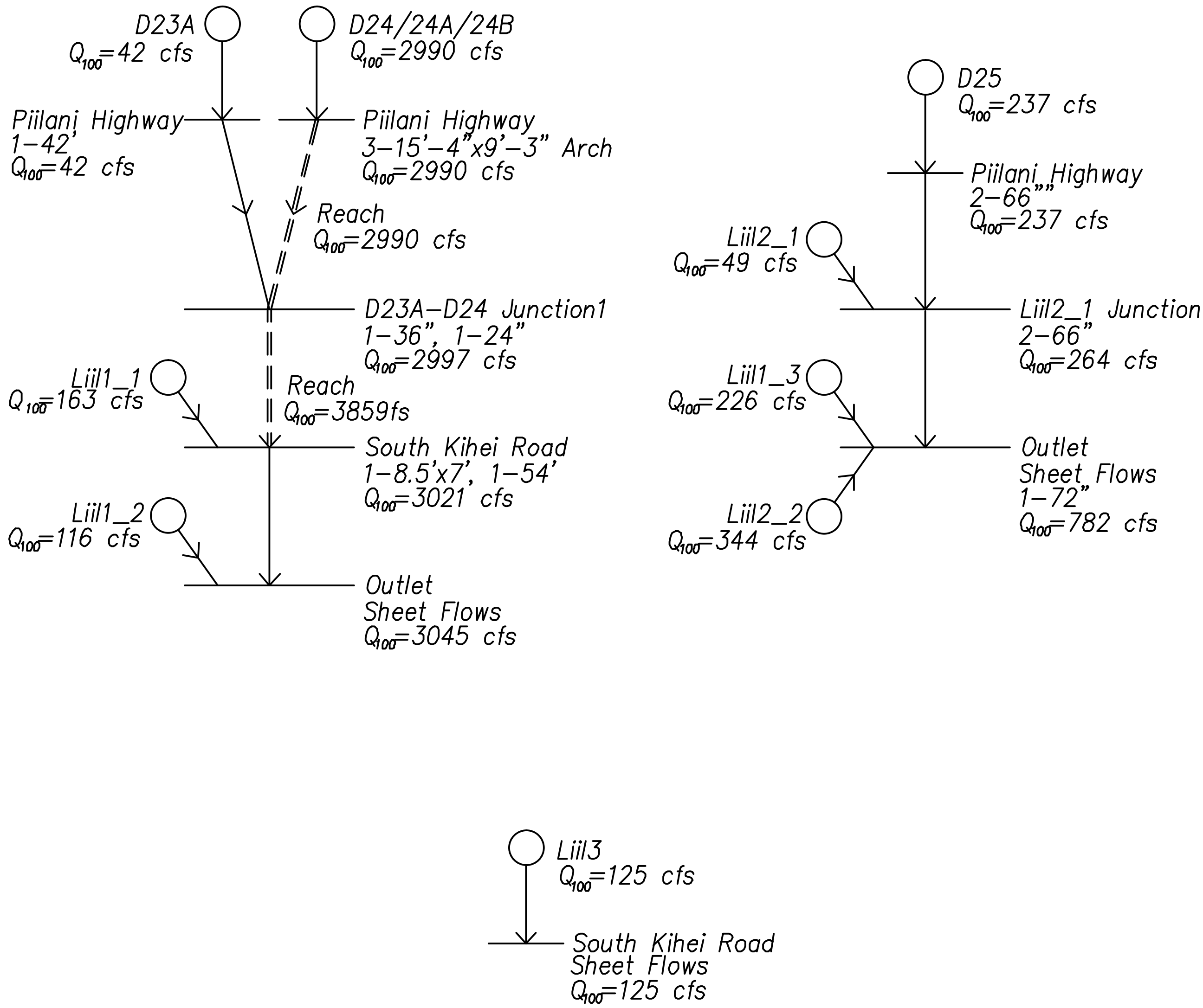


Figure 4.7.c
Liilioholo District
Proposed Conditions



Legend

Drainage Basin

Point of Interest

Reach Routing

Connector

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Liilioholo District
Proposed Conditions
HEC-HMS Diagram

Figure
4.7.d

4.8 Kilohana Drive District

Mauka of Piilani Highway, the Kilohana Drive District consists of Piilani Basins 26 to 29 and covers most of the Maui Meadows Subdivision. Makai of Piilani Highway, the district is divided into seven drainage basins from Kilo1_1 to Kilo1_7. The basins in the Kilohana Drive District and the existing conditions runoff for the 100-year storm (Q_{100}) are listed in Table 4.8.1. The Kilohana Drive District Existing Conditions map is shown in Figure 4.8.a and the Kilohana Drive Existing Conditions HEC-HMS diagram is shown in Figure 4.8.b.

Table 4.8.1 Kilohana Drive District, Existing Conditions

Mauka of Piilani Highway			Makai of Piilani Highway		
Piilani Basin	Area (acres)	Q_{100} (cfs)	Makai Basin	Area (acres)	Q_{100} (cfs)
26	93	175	Kilo1_1	10	28
27	28	76	Kilo1_2	29	71
28	20	73	Kilo1_3	7	32
29	483	718	Kilo1_4	6	22
			Kilo1_5	9	26
			Kilo1_6	34	134
			Kilo1_7	44	122

The proposed conditions runoff for the 100-year storm (Q_{100}) is listed in Table 4.8.2. The Kilohana Drive District Proposed Conditions map is shown in Figure 4.8.c and the Kilohana Drive Proposed Conditions HEC-HMS diagram is shown in Figure 4.8.d. Discussions of the recommendations are presented in the following subsection.

Table 4.8.2 Kilohana Drive District, Proposed Conditions

Mauka of Piilani Highway			Makai of Piilani Highway		
Piilani Basin	Area (acres)	Q_{100} (cfs)	Makai Basin	Area (acres)	Q_{100} (cfs)
26	93	175	Kilo1_1	10	35
27	28	76	Kilo1_2	29	77
28	20	73	Kilo1_3	7	32
29	483	718	Kilo1_4	6	24
			Kilo1_5	9	32
			Kilo1_6	34	134
			Kilo1_7	44	122

The runoff quantities along Piilani Highway and South Kihei Road in the Kilohana Drive District are as listed in Tables 4.8.3 and 4.8.4.

Table 4.8.3 Kilohana Drive District, Runoff Quantities along Piilani Highway

Cross-Drain Description	Capacity (cfs)	Existing			Proposed		
		Piilani Basin	Area (acres)	Q_{100} (cfs)	Piilani Basin	Area (acres)	Q_{100} (cfs)
3-48”	333	26	93	175	26	93	175
2-42”	107	27	28	76	27	28	76
1-30”	57	28	20	73	28	20	73
1-84”	571	29	483	718	29	483	718

Table 4.8.4 Kilohana Drive District, Runoff Quantities along South Kihei Road

Cross-Drain Description	Capacity (cfs)	Existing			Proposed		
		Piilani Basin	Area (acres)	Q_{100} (cfs)	Piilani Basin	Area (acres)	Q_{100} (cfs)
2-8’x6.5’	N/A	Kilo1_7[1]	763	1,009	Kilo1_7[1]	763	1,026

[1] including Piilani Basin 26 to 29 and Kilo1_1 to 1_7

Existing Conditions

Storm runoff from Piilani Basin 26 crosses Piilani Highway through 3-48” culverts and for the basin Q_{100} = 175 cfs. Once the runoff passes the culverts, it flows overland in an earth channel to the Hale Kilohana Subdivision and crosses Kauhale Street through a 72” culvert with Q_{100} = 188 cfs. Approximately 200 feet downstream of the 72” culvert, the flow enters a 66” culvert through an inlet structure that is part of the Kilohana Mauka Subdivision underground drainage system and combines with flows from Piilani Basin 27, Kilo1_3, and Kilo1_4.

Storm runoff from Piilani Basin 27 crosses Piilani Highway through 2-42” culverts and for the basin Q_{100} = 76 cfs. The runoff flows through Kanani Wailea Subdivision within Kilo1_3 to the Kilohana Drive crossing, where 2-42” culverts are located and the combined flow value is 115 cfs (Q_{100}). The runoff continues in an earth channel within Kilo1_4 to the Hale Kilohana Subdivision. The channel crosses Kauhale Street through a 54” culvert with Q_{100} = 119 cfs. Approximately 200 feet downstream of the 54” culvert, the runoff is conveyed to the Kilohana Mauka Subdivision underground drainage system through a 36” culvert with an inlet structure and combines with flows from Piilani Basin 26 and Kilo1_5. The combined flow is 287 cfs (Q_{100}).

Storm runoff from Piilani Basins 28 and 29 cross Piilani Highway through a 30” culvert and an 84” culvert, respectively. The Q_{100} flow values at each location are 73 cfs and 718 cfs, respectively. The runoff from the two Piilani Basins combines approximately 150 feet downstream of the 30” culvert and continues flowing in the natural terrain within Kilo1_1. At the Kapili Street crossing, 2-66” culverts convey the flow of 740 cfs (Q_{100}). After passing the double 66” culverts, the runoff flows overland within Kilo1_2 to the intersection of Kilohana Drive and Wailea Alanui Drive, where 4-54” culverts are located and enters the Kilohana Hema

Subdivision. The combined flow at the 4-54” culverts is 760 cfs (Q_{100}). The 4-54” culverts connect to a 78” underground drainline running along Kilohana Drive to a concrete open channel, where all the mauka flows converge.

Kilo1_6 is a developed area consisting mainly of the Kilohana Hema Subdivision, Kilohana Waena Subdivision, and Kilohana Mauka Subdivision. This makai drainage basin includes the backbone drainage system that transports mauka flows via underground pipes. The Hoohale Street drainage system within Kilohana Mauka Subdivision receives flows from Piilani Basins 25, 26, Kilo1_3, Kilo1_4, and Kilo1_5. The drainline runs along Hoohale Street and turns south about 750 feet makai of Lawakua Street and enters the Kilohana Waena Subdivision via a 78” pipe. The 78” pipe carries the flows through the Kilohana Waena Subdivision to the Kilohana Hema Subdivision and outlets to a concrete open channel. The concrete open channel connects to 4-72”x44” arches conveying flow of 946 cfs (Q_{100}) under Kilohana Drive. The local drainage system consists of sub-surface drain and pipes and is assumed to able to collect most of the 134 cfs (Q_{100}) generated within Kilo1_6.

After passing the 4-72”x44” arches, the runoff enters a grassed channel south of Kilohana Drive in Kilo1_7 and leads to double 8’x4’ concrete box culverts at the South Kihei Road crossing. The culverts size transitions from 2-8’x4’ to 2-8’x6.5’ midway through the culverts. No observed flooding is reported here. The channel banks makai of South Kihei Road are occupied by the existing residential developments. The channel outlet at the Keawakapu Beach Park is usually blocked by sand dunes. The Q_{100} at the South Kihei Road crossing is 1,009 cfs. As-built plans shows underground perforated drainage systems were provided within the existing subdivisions. As a result, the Q_{100} reaching the South Kihei Road crossing is expected to be less than the values calculated in this report for both the existing and future conditions.

Future Conditions

There are no future developments planned mauka of Piilani Highway. Makai of Piilani Highway, Wailea SF-8, Emergency Ambulance Station, and Wailea SF-58 are the three future developments.

Recommendations

- The existing 1-84” culvert (Piilani Basin 29) is not able to pass the 100-year peak flow (718 cfs). However, the site is not covered under FEMA’s flood maps. Per HDOT drainage design standards, the culvert is only required to pass the 50-year peak flow (565 cfs). In this case, the existing 1-84” culvert has sufficient capacity. Replacing the existing 1-84” culvert with 2-66” culverts to pass the 100-year peak flow will require the approval from HDOT.

- Construction of a CRM-lined channel in Kilo1_1 to convey flow from Piilani Highway to Kapili Street could be considered to claim more useable lands during the Wailea SF-58 development. The trapezoidal channel will have 15-feet bottom width, 5-feet height, and a 2:1 side slope.

- The mauka runoff is routed through various subdivision drainage systems and underground retention. The future developments makai of Piilani Highway must retain the increased runoff onsite to not have adverse impacts to the downstream subdivisions.

- Perform maintenance of the outlet regularly to be free of debris and sand dune accumulation.

The proposed drainage improvements are to convey the runoff from Piilani Highway through the Wailea SF-58 development. No drainage improvements at South Kihei Road are proposed because no flooding has been observed at South Kihei Road.

4.8.1 Kilohana Drive District Cost Estimate

The conceptual cost estimate for Kilohana Drive District improvements is summarized in the following table. Refer to Appendix C for detailed cost estimate.

Table 4.8.5 Kilohana Drive District Cost Estimate Summary

	Improvements	Cost
1	Proposed Piilani Highway Culvert Improvemrents at Piilani Basin 29	$528,000
2	Waile SF-58 Channel Improvements	$1,530,000
	Total	$2,058,000

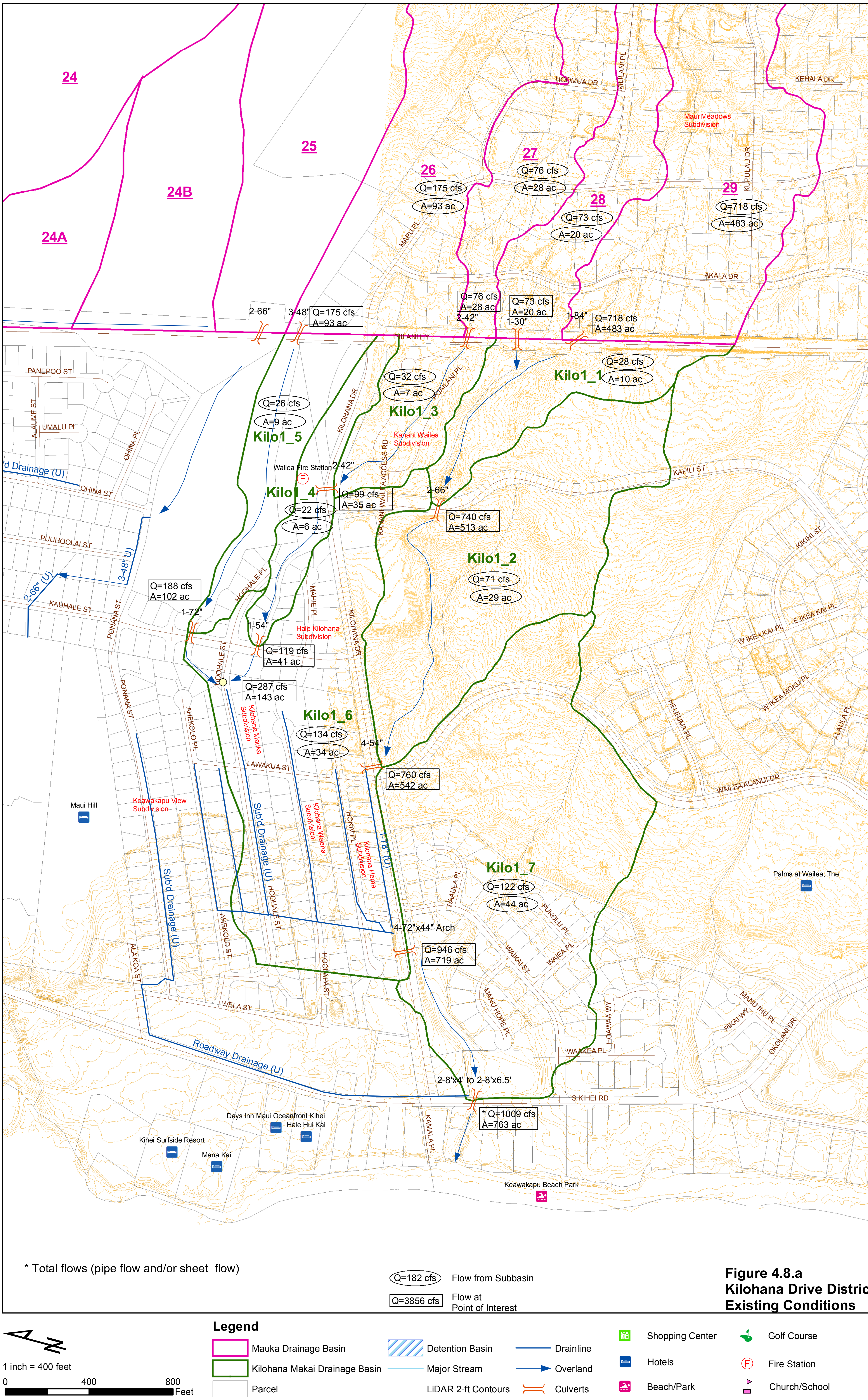
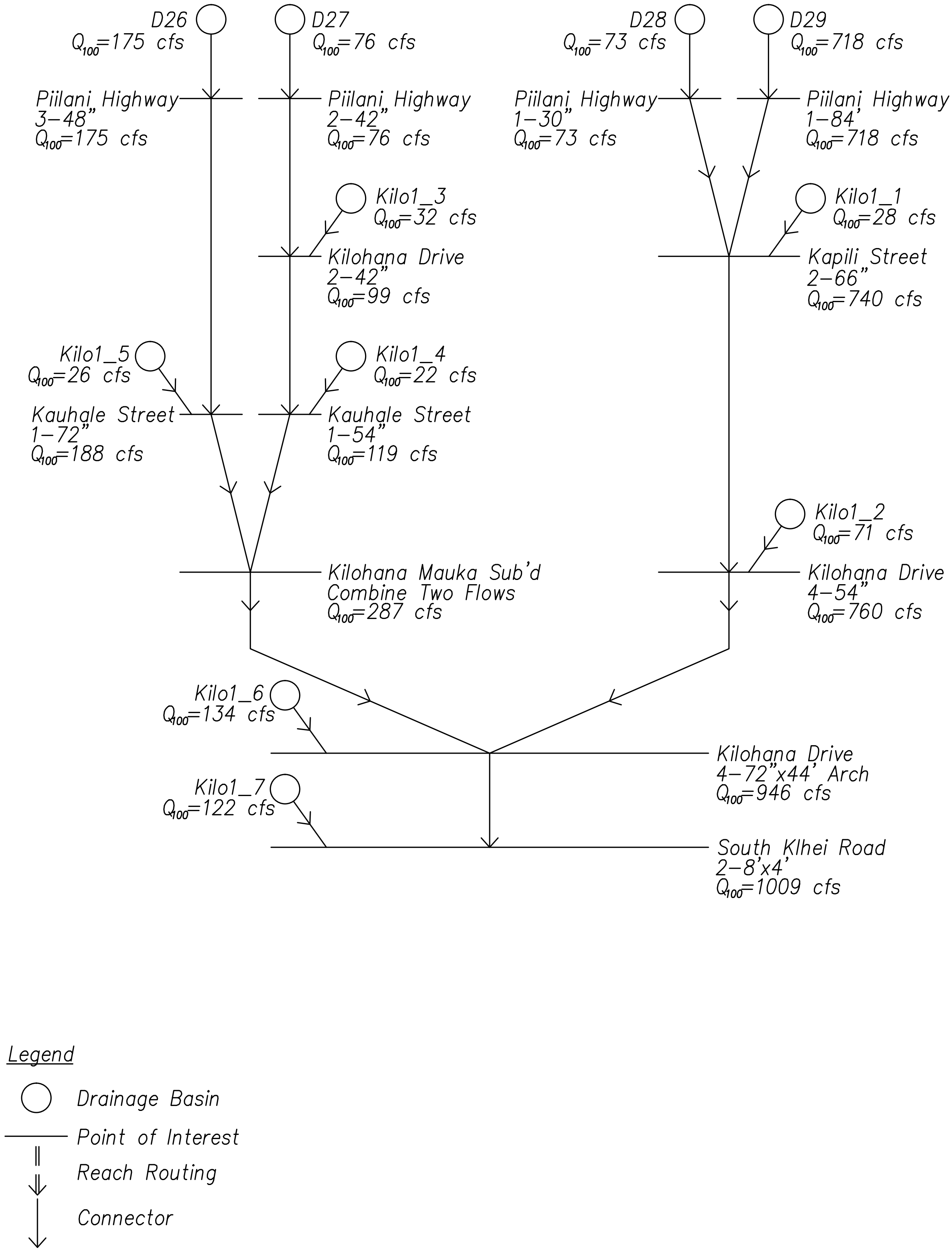


Figure 4.8.a
Kilohana Drive District
Existing Conditions



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Kilohana District Existing Conditions HEC-HMS Diagram

Figure 4.8.b

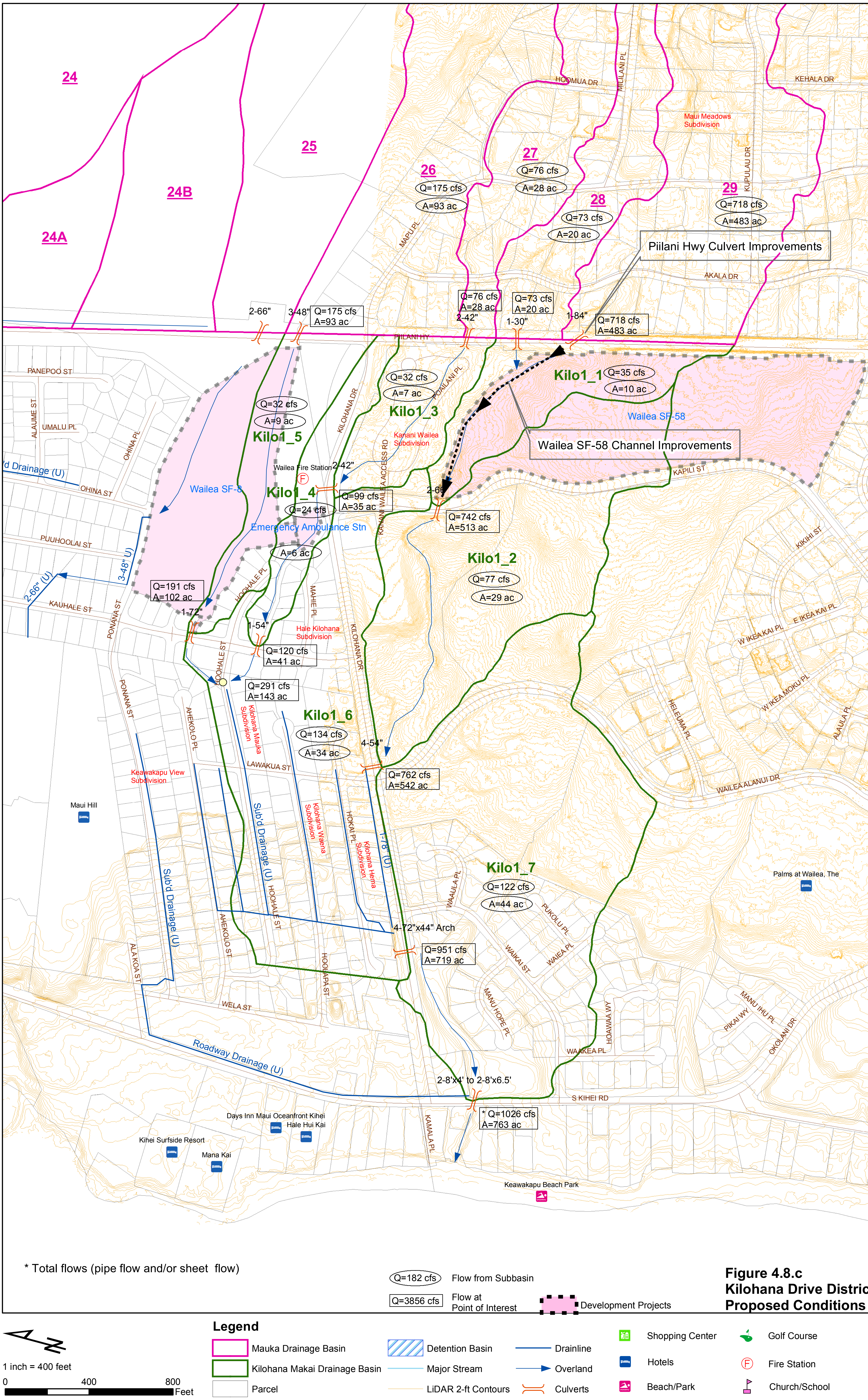
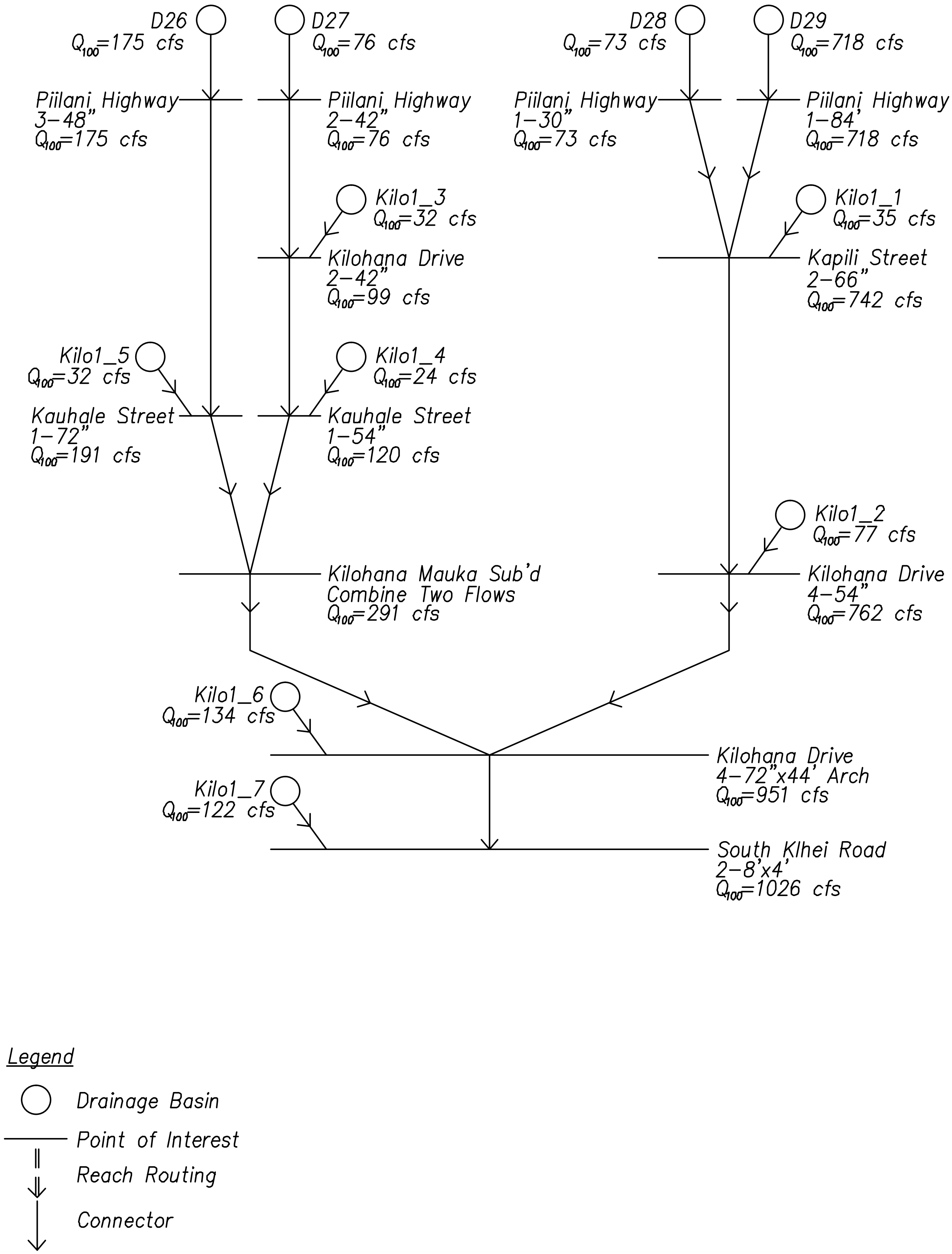


Figure 4.8.c
Kilohana Drive District
Proposed Conditions



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Kilohana District
Proposed Conditions
HEC-HMS Diagram

Figure 4.8.d

SECTION 5 – IMPLEMENTATION

5.1 Construction Cost Estimates (To Be Included In Next Submittal)

5.2 Permits and Approvals

The following permits are anticipated to be required for the proposed channels:

- Conservation District Use Permit (CDUP), State Department of Land and Natural Resources (DLNR) – Required only if work extends beyond the certified shoreline into the ocean
- Clean Water Act, Section 404, COE; and Section 10, Rivers and Harbors Appropriation Act, COE
    - Section 7, Endangered Species Act Consultation with U.S. Fish and Wildlife Service (USFWS)
    - Consultation with National Marine Fisheries Service (NMFS) – Required only if work extends beyond the certified shoreline into the ocean
    - Section 106, National Historic Preservation Act Consultation with Native Hawaiian Organizations (NHOs) and State Historic Preservation Office (SHPO)
- Clean Water Act, Section 401, Clean Water Certification, State Department of Health (DOH)
- Coastal Zone Management (CZM) Certification, State Office of Planning
- Special Management Area (SMA) Use Permit, City Department of Planning and Permitting (DPP)
- Shoreline Setback Variance (SSV), DPP (requires certified shoreline from DLNR)
- Construction Right of Entry, DLNR – Required only if work extends beyond the certified shoreline into the ocean
- Submarine Easement, DLNR – Required only if work extends beyond the certified shoreline into the ocean
- Stream Channel Alteration Permit (SCAP), DLNR
- National Pollutant Discharge Elimination System (NPDES) Permits (Construction Stormwater and Dewatering), DOH
- Environmental Assessment (EA) or Environmental Impact Statement (EIS), State Office of Environmental Quality Control
- Noise Variance, DOH

The following permits are anticipated to be required for the proposed bridge replacement, culverts and storage basins:

- Clean Water Act, Section 404, COE; and Section 10, Rivers and Harbors Appropriation Act, COE
    - Section 7, Endangered Species Act Consultation with U.S. Fish and Wildlife

Service (USFWS)
    - Consultation with National Marine Fisheries Service (NMFS) – Required only if work extends beyond the certified shoreline into the ocean
    - Section 106, National Historic Preservation Act Consultation with Native Hawaiian Organizations (NHOs) and State Historic Preservation Office (SHPO)
- Clean Water Act, Section 401, Clean Water Certification, State Department of Health (DOH)
- Coastal Zone Management (CZM) Certification, State Office of Planning
- Special Management Area (SMA) Use Permit, City Department of Planning and Permitting (DPP)
- Stream Channel Alteration Permit (SCAP), DLNR
- National Pollutant Discharge Elimination System (NPDES) Permits (Construction Stormwater and Dewatering), DOH
- Environmental Assessment (EA) or Environmental Impact Statement (EIS), State Office of Environmental Quality Control
- Noise Variance, DOH

LIST OF REFERENCES

1. "Hydrology Report for Piilani Highway, Island of Maui," Trans-Meridian Engineers & Surveyors, Inc., January 1978

2. "Drainage Master Plan for Kihei, Maui, Hawaii," Norman Saito Engineering Consultants, Inc., August 1997

3. "Flood Insurance Study, Maui County, Hawaii," Federal Emergency Management Agency, November 4, 2015

4. "Rules for the Design of Storm Drainage Facilities in the County of Maui," Department of Public Works and Waste Management, County of Maui, November 1995

5. "Coastal Technical Support Data Notebook for Maui County, Hawaii Hurricane Study," R. M. Towill Corporation/Dewberry and Davis, LLC., March 2008

6. "Technical Support Data Notebook for Riverine Flood Insurance Studies/Restudies Throughout Region IX, EMF-2003-CO-0046, Task Order 002," R. M. Towill Corporation/URS Corporation, March/2005

7. "Hydrologic Engineering Center-Hydrologic Modeling System (HEC-HMS), version 3.5," United States Army Corps of Engineers, August 2010

8. "Natural Resources Conservation Service, Soil Survey Geographic Database website, http://www.soils.usda.gov/survey/geography/ssurgo/," Natural Resources Conservation Service, United States Department of Agriculture, December 2006

9. "Soil Survey of Islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii," Soil Conservation Service, United States Department of Agriculture, August 1972

10. "Erosion and Sediment Control Guide for Hawaii," Soil Conservation Service, United States Department of Agriculture, March 1981

11. "hi_maui_2010_ccap_hr_land_cover_20150213.img," Coastal Change Analysis Program (C-CAP), National Oceanic and Atmospheric Administration, July 2013

12. "Development Projects Mapping website, http://www.co.maui.hi.us/1061/Development-Projects-Mapping," Long Range Planning Division, Department of Planning, County of Maui, May 2016

13. "Urban Hydrology for Small Watersheds TR-55," Natural Resources Conservation Service, United States Department of Agriculture, June 1986

14. "TR-20 Computer Program for Project Formulation Hydrology," Soil Conservation Service, United States Department of Agriculture, February 1992

15. "NOAA Atlas 14 Volume 4 Version 3", Precipitation Frequency Data Server website, http://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_hi.html

16. "HY-8 Version 8.7.30," Federal Highway Administration, January 2013

17. "Hydraulic Design Series Number 5 – Hydraulic Design of Highway Culverts," Federal Highway Administration, United States Department of Transportation, May 2005

18. "Piilani Highway Vicinity of Mokulele Highway to Vicinity of Kilohana Street, F.A. Project No. TQF-RF-031-1(6)," State of Hawaii Department of Transportation, September 1978

19. "Drainage Report for Kulanihakoi Bridge Replacement," Wilson Okamoto Corporation, March 2013

APPENDIX A

HYDROLOGIC CALCULATION

HEC-HMS Output

Existing Conditions

Existing Condition: D1, Waia1

HEC-HMS 3.5 [K:\study\20258 Kihei Drainage MP\Hydrology\HMS\Ex3\Waiakoa1\Waiakoa1.hms]

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
D1	9.904	6518.2	01Nov2008, 11:37	2927.84
Waiakoa Bridge	9.904	6518.2	01Nov2008, 11:37	2927.84
Waia1	0.040	56.2	01Nov2008, 10:09	9.56
South Kihei Road	9.944	6528.4	01Nov2008, 11:40	2933.86
Waikoa Bridge to Sou...	9.904	6518.2	01Nov2008, 11:40	2924.29

Existing Condition: D2, Waia2

HEC-HMS 3.5 [K:\study\20258 Kihei Drainage MP\Hydrology\HMS\Ex3\Waiakoa2\Waiakoa2.hms]

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
D2	0.167	295.1	01Nov2008, 10:18	61.0
Piilani Hwy Culvert	0.167	295.1	01Nov2008, 10:18	61.0
South Kihei Raod	0.239	408.8	01Nov2008, 10:15	82.5
Waiakoa2	0.072	127.2	01Nov2008, 10:10	21.5

Existing Condition: D3, Waia3

HEC-HMS 3.5 [K:\study\20258 Kihei Drainage MP\Hydrology\HMS\Ex3\Waiakoa3\Waiakoa3.hms]

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
D3	0.093	180.5	01Nov2008, 10:14	34.59
Piilani Hwy 2-72"x44"	0.093	180.5	01Nov2008, 10:14	34.59
Waiakoa3	0.044	89.8	01Nov2008, 10:09	14.92
South Kihei Road	0.137	266.1	01Nov2008, 10:12	49.50

Existing Condition: Waia4

HEC-HMS 3.5 [K:\study\20258 Kihei Drainage MP\Hydrology\HMS\Ex3\Waiakoa4\Waiakoa4.hms]

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
Waiakoa4	0.020	48.1	01Nov2008, 10:04	6.69
South Kihei Road	0.020	48.1	01Nov2008, 10:04	6.69

Existing Condition: D4, Waia5

HEC-HMS 3.5 [K:\study\20258 Kihei Drainage MP\Hydrology\HMS\Ex3\Waiakoa5\Waiakoa5.hms]

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
D4	0.160	314.9	01Nov2008, 10:12	56.55
Piilani Hwy	0.160	314.9	01Nov2008, 10:12	56.55
Waiakoa5	0.108	242.8	01Nov2008, 10:05	35.44
South Kihei Road	0.268	535.3	01Nov2008, 10:08	91.99

Existing Condition: Kula1

HEC-HMS 3.5 [K:\study\20258 Kihei Drainage MP\Hydrology\HMS\Ex3\Kulanihakoi1\Kulanihakoi...

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
Kula1	0.128	251.8	01Nov2008, 10:10	42.90
South Kihei Road	0.128	251.8	01Nov2008, 10:10	42.90

Existing Condition: D5, D6, D7, D8, Kula2_1, Kula2_2

HEC-HMS 3.5 [K:\study\20258 Kihei Drainage MP\Hydrology\HMS\Ex3\Kulanihakoi2\Kulanihakoi...

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
Kula2_2	0.202	320.6	01Nov2008, 10:12	57.84
South Kihei Road	16.133	10733.3	01Nov2008, 11:27	4609.49
D5	0.021	55.2	01Nov2008, 10:05	8.01
D6	0.097	187.4	01Nov2008, 10:12	33.16
D7	0.822	875.9	01Nov2008, 10:41	254.95
D8	14.963	10085.7	01Nov2008, 11:25	4256.08
Piilani Hwy 1-54"	0.118	234.1	01Nov2008, 10:10	41.17
Piilani Hwy 2-102"	0.822	875.9	01Nov2008, 10:41	254.95
Kulanihakoi Bridge	14.963	10085.7	01Nov2008, 11:25	4256.08
Kula2_1 Junction	15.813	10624.8	01Nov2008, 11:24	4515.79
Reach D8 to Kula2_1	14.963	10085.7	01Nov2008, 11:26	4254.41
Reach D7 to Kula2_1	0.822	875.9	01Nov2008, 10:44	254.73
Kula2_1	0.028	51.2	01Nov2008, 10:01	6.66
Reach D6 pipe	0.118	234.1	01Nov2008, 10:15	41.15
Temp Junction	15.931	10668.7	01Nov2008, 11:27	4551.64
Reach to Temp Junction	15.813	10624.8	01Nov2008, 11:27	4510.49

Existing Condition: D9, Kula3_1, Kula3_2

HEC-HMS 3.5 [K:\study\20258 Kihei Drainage MP\Hydrology\HMS\Ex3\Kulanihakoi3\Kulanihakoi...

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
D9	0.189	258.4	01Nov2008, 10:21	56.47
Piilani Hwy 1-72"	0.189	258.4	01Nov2008, 10:21	56.47
Kula3_1	0.028	45.6	01Nov2008, 10:05	6.72
Kula3_2	0.107	169.1	01Nov2008, 10:10	29.28
South Kihei Road	0.324	434.7	01Nov2008, 10:14	92.47
Kula3_1 Junction	0.217	280.7	01Nov2008, 10:19	63.18

Existing Condition: D10/10A, Waip1

HEC-HMS 3.5 [K:\study\20258 Kihei Drainage MP\Hydrology\HMS\Ex3\Waipuilani1\Waipuilani1....

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
D10/10A	11.236	8089.3	01Nov2008, 11:14	3208.43
Waipuilani Bridge	11.236	8089.3	01Nov2008, 11:14	3208.43
Waip1	0.106	110.7	01Nov2008, 10:17	23.23
South Kihei Road	11.342	8120.0	01Nov2008, 11:21	3222.82
Waipuilani Bridge to SKR	11.236	8089.3	01Nov2008, 11:21	3199.58

Existing Condition: D11U, D11D, D12, Keok1_1, Keok1_2

HEC-HMS 3.5 [K:\study\20258 Kihei Drainage MP\Hydrology\HMS\Ex3\Keokea1\Keokea1.hms]

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
D11U	0.427	453.7	01Nov2008, 10:33	120.04
Mauka Offsite Basin	0.427	173.0	01Nov2008, 11:39	82.50
D11D	0.142	257.3	01Nov2008, 10:11	44.60
Piilani Hwy 1-90"	0.569	259.5	01Nov2008, 10:11	127.11
D12	0.126	201.5	01Nov2008, 10:20	42.76
Piilani Hwy 1-54"	0.126	201.5	01Nov2008, 10:20	42.76
Keok1_1	0.122	259.3	01Nov2008, 10:10	43.96
Makai Basin1	0.817	587.6	01Nov2008, 10:22	213.75
Makai Basin2	0.817	587.6	01Nov2008, 10:22	213.13
Keok1_2	0.266	271.7	01Nov2008, 10:22	62.17
Outlet	1.083	859.4	01Nov2008, 10:22	275.30

Existing Condition: D13, D14, D15, D16, D17/18, Keok2_1, Keok2_2, Keok2_3, Keok2_4
HEC-HMS 3.5 [K:\study\20258 Kihei Drainage MP\Hydrology\HMS\Ex3\Keokea2\Keokea2.hms]

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
D13	0.188	275.0	01Nov2008, 10:21	60.32
D14	0.560	508.2	01Nov2008, 10:43	152.09
D17/D18	8.533	5664.0	01Nov2008, 11:12	2239.45
D16	0.203	314.6	01Nov2008, 10:16	62.51
Keokea Bridge	8.736	5753.1	01Nov2008, 11:11	2301.96
Keokea Bridge to Keo...	8.736	5753.1	01Nov2008, 11:13	2300.13
D15	0.312	319.3	01Nov2008, 10:31	82.41
Piilani Hwy 1-60" D15	0.312	319.3	01Nov2008, 10:31	82.41
Keok2_1	0.122	301.8	01Nov2008, 10:04	42.39
Keok2_1 Junction	9.170	5962.7	01Nov2008, 11:12	2424.93
Piilani Hwy 2-66"	0.188	275.0	01Nov2008, 10:21	60.32
Piilani Hwy 1-60" D14	0.560	508.2	01Nov2008, 10:43	152.09
Keok2_2	0.065	169.6	01Nov2008, 10:02	21.82
Liloa Dr 1-10'x4'	0.813	760.8	01Nov2008, 10:31	234.23
Keok2_3 Junction	10.155	6533.0	01Nov2008, 11:08	2705.42
Keok2_3	0.172	259.1	01Nov2008, 10:11	46.25
Outlet	10.483	6689.1	01Nov2008, 11:07	2798.24
Keok2_4	0.328	434.2	01Nov2008, 10:20	92.82

Existing Condition: D17A, Cy1_1, Cy1_2

HEC-HMS 3.5 [K:\study\20258 Kihei Drainage MP\Hydrology\HMS\Ex3\Charlie_Young1\Charlie...

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
D17A	0.085	180.2	01Nov2008, 10:07	27.46
Cy1_1	0.032	72.4	01Nov2008, 10:06	10.75
Cy1_2	0.040	59.5	01Nov2008, 10:09	10.03
Kupuna St 2-48"	0.117	239.4	01Nov2008, 10:12	38.20
Piilani Hwy 3-60"	0.085	180.2	01Nov2008, 10:07	27.46
D17A to Cy1_1 Junction	0.085	180.2	01Nov2008, 10:14	27.45
Outlet	0.157	297.8	01Nov2008, 10:11	48.23

Existing Condition: D19A1, D19A2, D19, Cy2_1, Cy2_2

HEC-HMS 3.5 [K:\study\20258 Kihei Drainage MP\Hydrology\HMS\Ex3\Charlie_Young2\Charlie...

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
D19A1	0.181	290.5	01Nov2008, 10:20	62.05
D19A2	0.074	153.3	01Nov2008, 10:09	25.44
D19	0.634	538.0	01Nov2008, 11:03	192.43
Cy2_1	0.037	88.9	01Nov2008, 10:02	11.39
Cy2_2	0.213	397.8	01Nov2008, 10:08	63.06
Piilani Hwy 1-7'x5'-1"	0.181	290.5	01Nov2008, 10:20	62.05
Piilani Hwy 1-54"	0.074	153.3	01Nov2008, 10:09	25.44
Piilani Hwy 1-84"	0.634	538.0	01Nov2008, 11:03	192.43
Alaloa Rd 2-48"	0.926	733.6	01Nov2008, 10:31	291.31
Kalama Park	1.139	1059.0	01Nov2008, 10:11	354.37

Existing Condition: D20, Cy3_1, Cy3_2

HEC-HMS 3.5 [K:\study\20258 Kihei Drainage MP\Hydrology\HMS\Ex3\Charlie_Young3\Charlie...

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
D20	0.559	507.1	01Nov2008, 10:51	164.64
Cy3_1	0.035	95.6	01Nov2008, 10:01	12.11
Cy3_2	0.062	175.2	01Nov2008, 10:01	22.69
Piilani Hwy 3-120"	0.559	507.1	01Nov2008, 10:51	164.64
Auhana Rd 1-60"	0.594	521.8	01Nov2008, 10:51	176.75
South Kihei Road	0.656	549.0	01Nov2008, 10:50	199.43

Existing Condition: D21, D22/22A, Kama1_1, Kama1_2, Kama1_3

HEC-HMS 3.5 [K:\study\20258 Kihei Drainage MP\Hydrology\HMS\Ex3\Kamaole1\Kamaole1.hms]

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
D21	5.003	2806.2	01Nov2008, 11:19	1182.96
D22/22A	0.060	112.5	01Nov2008, 10:03	15.11
Kama1_1	0.033	80.3	01Nov2008, 10:02	10.60
Kama1_2	0.035	97.1	01Nov2008, 10:00	11.97
Kama1_3	0.078	209.6	01Nov2008, 10:01	26.29
Piilani Hwy 2-96"	5.003	2806.2	01Nov2008, 11:19	1182.96
Piilani Hwy 3-36"	0.060	112.5	01Nov2008, 10:03	15.11
Kanakanui Rd 2-24'x7'	5.096	2833.6	01Nov2008, 11:19	1208.67
Kulipuu St 1-28'x11'	5.131	2845.2	01Nov2008, 11:20	1220.14
Reach-Ke Alii Sub	5.096	2833.6	01Nov2008, 11:20	1208.16
South Kihei Road	5.209	2871.1	01Nov2008, 11:20	1246.43

Existing Condition: D23, Kama2_1, Kama2_2, Kama2_3

HEC-HMS 3.5 [K:\study\20258 Kihei Drainage MP\Hydrology\HMS\Ex3\Kamaole2\Kamaole2.hms]

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
D23	0.400	393.6	01Nov2008, 10:31	103.37
Kama2_1	0.026	70.1	01Nov2008, 10:01	8.85
Kama2_2	0.038	80.4	01Nov2008, 10:04	11.36
Kama2_3	0.077	161.6	01Nov2008, 10:03	22.11
Piilani Hwy 2-78"	0.400	393.6	01Nov2008, 10:31	103.37
Kama2_1 Junction 2-84"	0.426	409.2	01Nov2008, 10:31	112.22
Kama2_2 Junction 1-...	0.464	434.7	01Nov2008, 10:29	123.58
Outlet	0.541	495.6	01Nov2008, 10:06	145.69

Existing Condition: Kama3

HEC-HMS 3.5 [K:\study\20258 Kihei Drainage MP\Hydrology\HMS\Ex3\Kamaole3\Kamaole3.hms]

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
Kama3	0.103	205.6	01Nov2008, 10:10	35.16
Outlet	0.103	205.6	01Nov2008, 10:10	35.16

Existing Condition: D23A, D24/24A/24B, Liil1_1, Liil1_2

HEC-HMS3.5[K:\study\20258KiheiDrainageMP\Hydrology\HMS\Ex3\Liilioholo1\Liilioholo1.hms]

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
D24/D24A/D24B	4.150	2990.0	01Nov2008, 10:54	1039.54
Piilani Hwy 3 culverts	4.150	2990.0	01Nov2008, 10:54	1039.54
D24 to Junction1	4.150	2990.0	01Nov2008, 10:56	1038.75
D23A	0.022	41.7	01Nov2008, 10:01	5.34
Piilani Hwy 1-42"	0.022	41.7	01Nov2008, 10:01	5.34
D23A-D24 Junction1	4.172	2996.8	01Nov2008, 10:56	1044.09
Junction 1 to SKR	4.172	2996.8	01Nov2008, 10:57	1043.68
Liil1_1	0.070	163.4	01Nov2008, 10:00	20.30
South Kihei Road	4.242	3021.3	01Nov2008, 10:57	1063.99
Liil1_2	0.058	116.3	01Nov2008, 10:07	17.64
Outlet	4.300	3044.7	01Nov2008, 10:57	1081.63

Existing Condition: D25, Liil1_3, Liil_2_1, Liil2_2

HEC-HMS3.5[K:\study\20258KiheiDrainageMP\Hydrology\HMS\Ex3\Liilioholo2\Liilioholo2.hms]

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
D25	0.204	236.5	01Nov2008, 10:16	48.45
Liil2_1	0.022	42.6	01Nov2008, 10:04	5.94
Liil2_2	0.181	339.6	01Nov2008, 10:04	46.93
Liil1_3	0.087	226.1	01Nov2008, 10:03	30.12
Piilani Hwy 2-66"	0.204	236.5	01Nov2008, 10:16	48.45
Liil2_1 Junction 2-66"	0.226	261.1	01Nov2008, 10:14	54.40
Outlet	0.494	771.8	01Nov2008, 10:04	131.45

Existing Condition: Liil3

HEC-HMS3.5[K:\study\20258KiheiDrainageMP\Hydrology\HMS\Ex3\Liilioholo3\Liilioholo3.hms]

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
Liil3	0.086	121.4	01Nov2008, 10:09	20.48
Outlet	0.086	121.4	01Nov2008, 10:09	20.48

Existing Condition: D26, D27, D28, D29, Kilo1_1 to Kilo1_7

HEC-HMS 3.5 [K:\study\20258 Kihei Drainage MP\Hydrology\HMS\Ex3\Kilohana1\Kilohana1.hms]

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
D26	0.145	175.2	01Nov2008, 10:14	33.92
D27	0.044	76.4	01Nov2008, 10:07	12.01
D28	0.031	73.0	01Nov2008, 10:03	9.79
D29	0.754	717.6	01Nov2008, 10:37	202.89
Kilo1_1	0.015	27.9	01Nov2008, 10:02	3.72
Kilo1_2	0.045	70.5	01Nov2008, 10:05	10.28
Kilo1_3	0.011	32.1	01Nov2008, 09:58	3.76
Kilo1_4	0.009	22.2	01Nov2008, 09:59	2.67
Kilo1_5	0.014	26.4	01Nov2008, 10:02	3.45
Kilo1_6	0.054	133.5	01Nov2008, 10:01	16.98
Kilo1_7	0.069	122.1	01Nov2008, 10:04	17.32
Piilani Hwy 1-84"	0.754	717.6	01Nov2008, 10:37	202.89
Piilani Hwy 1-30"	0.031	73.0	01Nov2008, 10:03	9.79
Piilani Hwy 2-42"	0.044	76.4	01Nov2008, 10:07	12.01
Piilani Hwy 3-48"	0.145	175.2	01Nov2008, 10:14	33.92
Kapili St 2-66"	0.800	740.4	01Nov2008, 10:36	216.40
Kilohana Dr 4-54"	0.845	759.8	01Nov2008, 10:36	226.68
Kilohana Dr 2-42"	0.055	98.6	01Nov2008, 10:04	15.77
Kauhale St 1-54"	0.064	118.5	01Nov2008, 10:03	18.44
KauhaleSt 1-72"	0.159	188.3	01Nov2008, 10:12	37.37
Kilohana Dr 4-72"x44"	1.122	946.3	01Nov2008, 10:28	299.48
South Kihei Road	1.191	1009.2	01Nov2008, 10:07	316.80

Existing Curve Number

Existing Condition

	A	B	C	D
Impervious	95	95	95	95
Open Space Developed	39	61	74	80
Cultivated Land	62	71	78	81
Pasture/Hay	39	61	74	80
Grassland	39	61	74	80
Evergreen	25	55	70	77
Bare Land	77	86	91	94
Scrub Shrub	45	66	77	83
Open Water/Shore	100	100	100	100
Palustrine Emergent Wetland	36	60	73	79
Palustrine Forested Wetland	25	55	70	77
Palustrine Scrub Shrub Wetland	45	66	77	83

Kihei Drainage Master Plan
Existing Condition - Weighted CN

REF: 1-20258-0E
PREPARED BY: TL
DATE: 8/14/15

Subbasin 1

HSG	Class_name	Area_AC	CN	AreaxCN
A	Bare Land	86.28247438340	77	6643.7505
A	Cultivated Land	14.41986561430	62	894.03167
A	Evergreen	1.95498085496	25	48.874521
A	Grassland	1.39771357157	39	54.510829
A	Impervious Surface	3.25761906155	95	309.47381
A	Open Space Developed	0.58027689847	39	22.630799
A	Scrub Shrub	0.38818449405	45	17.468302
B	Bare Land	20.04439270110	86	1723.8178
B	Cultivated Land	220.22838800300	71	15636.216
B	Evergreen	1098.21527092000	55	60401.84
B	Grassland	569.27508719200	61	34725.78
B	Impervious Surface	194.70791597800	95	18497.252
B	Open Space Developed	378.43307707100	61	23084.418
B	Open Water	0.23599708635	100	23.599709
B	Pasture/Hay	64.15430589650	61	3913.4127
B	Scrub Shrub	1597.47818937000	66	105433.56
C	Bare Land	388.80645207100	91	35381.387
C	Cultivated Land	349.52085748600	78	27262.627
C	Evergreen	40.73776329890	70	2851.6434
C	Grassland	179.72476789400	74	13299.633
C	Impervious Surface	12.67651363940	95	1204.2688
C	Open Space Developed	3.22604803189	74	238.72755
C	Scrub Shrub	933.86049036300	77	71907.258
D	Bare Land	0.42867228722	94	40.295195
D	Cultivated Land	3.58235052922	81	290.17039
D	Evergreen	84.03614678210	77	6470.7833
D	Grassland	21.49105650870	80	1719.2845
D	Impervious Surface	4.77458701802	95	453.58577
D	Open Space Developed	8.59561545275	80	687.64924
D	Scrub Shrub	56.33087330230	83	4675.4625
Sum		6338.84593376075		437913.41

Weighted CN **69.1**

Subbasin 2

HSG	Class_name	Area_AC	CN	AreaxCN
A	Impervious Surface	0.16726518592	95	15.890193
A	Open Space Developed	0.05499109838	39	2.1446528
C	Evergreen	3.26538643136	70	228.57705
C	Grassland	3.07633222440	74	227.64858
C	Impervious Surface	51.20203975640	95	4864.1938
C	Open Space Developed	25.92692341990	74	1918.5923

C	Scrub Shrub	23.17438060630	77	1784.4273
Sum		106.86731872266		9041.4739

Weighted CN **84.6**

Subbasin 3

HSG	Class_name	Area_AC	CN	AreaxCN
C	Evergreen	4.26803379387	70	298.76237
C	Grassland	0.01436079513	74	1.0626988
C	Impervious Surface	32.84897366180	95	3120.6525
C	Open Space Developed	16.13626205740	74	1194.0834
C	Scrub Shrub	6.05470446345	77	466.21224
Sum		59.32233477165		5080.7732

Weighted CN **85.6**

Subbasin 4

HSG	Class_name	Area_AC	CN	AreaxCN
C	Cultivated Land	0.18084035123	78	14.105547
C	Evergreen	2.89497970278	70	202.64858
C	Grassland	1.31409874035	74	97.243307
C	Impervious Surface	37.73864255970	95	3585.171
C	Open Space Developed	20.65182471580	74	1528.235
C	Scrub Shrub	39.93216198140	77	3074.7765
Sum		102.71254805126		8502.18

Weighted CN **82.8**

Subbasin 5

HSG	Class_name	Area_AC	CN	AreaxCN
C	Cultivated Land	0.20186233004	78	15.745262
C	Grassland	1.42948918462	74	105.7822
C	Impervious Surface	8.14181271639	95	773.47221
C	Open Space Developed	2.13551032222	74	158.02776
C	Scrub Shrub	1.58989757419	77	122.42211
Sum		13.49857212746		1175.4495

Weighted CN **87.1**

Subbasin 6

HSG	Class_name	Area_AC	CN	AreaxCN
C	Bare Land	4.43606658457	91	403.68206
C	Cultivated Land	16.47395601780	78	1284.9686
C	Grassland	2.67882877505	74	198.23333
C	Impervious Surface	9.77672778613	95	928.78914
C	Open Space Developed	1.20326872634	74	89.041886
C	Open Water	0.23034764098	100	23.034764
C	Scrub Shrub	27.57523979040	77	2123.2935
Sum		62.37443532127		5051.0432

Weighted CN **81.0**

Subbasin 7

HSG	Class_name	Area_AC	CN	AreaxCN
B	Grassland	0.00886853702	61	0.5409808
B	Scrub Shrub	3.53455613308	66	233.2807
C	Bare Land	10.64735334430	91	968.90915
C	Cultivated Land	18.98505262930	78	1480.8341
C	Evergreen	1.22281208113	70	85.596846
C	Grassland	57.98636312920	74	4290.9909
C	Impervious Surface	2.33725347837	95	222.03908
C	Open Space Developed	1.36998972324	74	101.37924
C	Scrub Shrub	430.28764579000	77	33132.149
Sum		526.37989484564		40515.72

Weighted CN **77.0**

Subbasin 8

HSG	Class_name	Area_AC	CN	AreaxCN
A	Bare Land	98.08383410880	77	7552.4552
A	Evergreen	0.24606301977	25	6.1515755
A	Grassland	0.70447117162	39	27.474376
A	Impervious Surface	0.70502657927	95	66.977525
A	Scrub Shrub	59.24638185670	45	2666.0872
B	Bare Land	16.34501980950	86	1405.6717
B	Cultivated Land	95.12111442630	71	6753.5991
B	Evergreen	2058.29017492000	55	113205.96
B	Grassland	1200.25348919000	61	73215.463
B	Impervious Surface	82.49716611130	95	7837.2308
B	Open Space Developed	91.91479390700	61	5606.8024
B	Open Water	0.26443522548	100	26.443523
B	Pasture/Hay	304.31631857900	61	18563.295
B	Scrub Shrub	1323.39490198000	66	87344.064
C	Bare Land	94.82079298850	91	8628.6922
C	Evergreen	113.53305648400	70	7947.314
C	Grassland	150.96042589800	74	11171.072
C	Impervious Surface	23.33300943920	95	2216.6359
C	Open Space Developed	0.25493680561	74	18.865324
C	Scrub Shrub	3862.14164252000	77	297384.91
Sum		9576.42705502005		651645.16

Weighted CN **68.0**

Subbasin 9

HSG	Class_name	Area_AC	CN	AreaxCN
A	Evergreen	0.64108227719	25	16.027057
A	Grassland	1.00180347503	39	39.070336
A	Impervious Surface	0.03029791785	95	2.8783022
A	Open Space Developed	0.04954181139	39	1.9321306

A	Scrub Shrub	0.13841297262	45	6.2285838
C	Evergreen	0.82774320385	70	57.942024
C	Grassland	63.15008731270	74	4673.1065
C	Impervious Surface	1.32621320167	95	125.99025
C	Open Space Developed	0.05748045884	74	4.253554
C	Scrub Shrub	53.48923554500	77	4118.6711
Sum		120.71189817613		9046.0998

Weighted CN **74.9**

Subbasin 10/10A

HSG	Class_name	Area_AC	CN	AreaxCN
A	Bare Land	40.85884465310	77	3146.131
A	Evergreen	1.11713463820	25	27.928366
A	Grassland	20.53758190130	39	800.96569
A	Impervious Surface	1.47985692637	95	140.58641
A	Open Space Developed	0.36741503497	39	14.329186
A	Scrub Shrub	243.63384445600	45	10963.523
B	Bare Land	42.60694862740	86	3664.1976
B	Cultivated Land	39.87153433840	71	2830.8789
B	Evergreen	2130.84622635000	55	117196.54
B	Grassland	476.49609483500	61	29066.262
B	Impervious Surface	173.69853008500	95	16501.36
B	Open Space Developed	289.29120888000	61	17646.764
B	Open Water	0.35400186016	100	35.400186
B	Pasture/Hay	50.74826575690	61	3095.6442
B	Scrub Shrub	1788.69339402000	66	118053.76
C	Bare Land	30.49213395040	91	2774.7842
C	Evergreen	113.41661771500	70	7939.1632
C	Grassland	79.49465594540	74	5882.6045
C	Impervious Surface	7.17782059899	95	681.89296
C	Open Space Developed	3.89837978930	74	288.4801
C	Scrub Shrub	1655.66560842000	77	127486.25
Sum		7190.74609878188		468237.45

Weighted CN **65.1**

Subbasin 11D

HSG	Class_name	Area_AC	CN	AreaxCN
A	Evergreen	0.15592999957	25	3.89825
A	Impervious Surface	0.00010951576	95	0.010404
A	Open Space Developed	0.23682113998	39	9.2360245
A	Scrub Shrub	0.09823618100	45	4.4206281
C	Bare Land	9.46327580156	91	861.1581
C	Evergreen	6.06227833225	70	424.35948
C	Grassland	3.87493364720	74	286.74509
C	Impervious Surface	1.72778915247	95	164.13997
C	Open Space Developed	22.07736079600	74	1633.7247

C	Open Water	0.57870916088	100	57.870916
C	Scrub Shrub	46.82516676560	77	3605.5378
Sum		91.10061049228		7051.1014
Weighted CN				**77.4**

Subbasin 11U

HSG	Class_name	Area_AC	CN	AreaxCN
B	Impervious Surface	0.22856042831	95	21.713241
B	Scrub Shrub	94.37455083130	66	6228.7204
C	Bare Land	0.06571962721	91	5.9804861
C	Grassland	25.03842604450	74	1852.8435
C	Impervious Surface	1.51884974861	95	144.29073
C	Scrub Shrub	152.30837701200	77	11727.745
Sum		273.53448369193		19981.293
Weighted CN				**73.0**

Subbasin 12

HSG	Class_name	Area_AC	CN	AreaxCN
C	Bare Land	19.65112816960	91	1788.2527
C	Evergreen	2.43477260875	70	170.43408
C	Grassland	2.35131170592	74	173.99707
C	Impervious Surface	8.49823025831	95	807.33187
C	Open Space Developed	15.33045248330	74	1134.4535
C	Open Water	0.11943909777	100	11.94391
C	Scrub Shrub	32.19146371970	77	2478.7427
Sum		80.57679804335		6565.1558
Weighted CN				**81.5**

Subbasin 13

HSG	Class_name	Area_AC	CN	AreaxCN
C	Bare Land	5.12426604171	91	466.30821
C	Evergreen	10.25369811230	70	717.75887
C	Grassland	7.36869669089	74	545.28356
C	Impervious Surface	16.01452933810	95	1521.3803
C	Open Space Developed	17.49306876440	74	1294.4871
C	Scrub Shrub	64.21578068390	77	4944.6151
Sum		120.47003963130		9489.8331
Weighted CN				**78.8**

Subbasin 14

HSG	Class_name	Area_AC	CN	AreaxCN
B	Evergreen	0.31816600000	55	17.49913
B	Impervious Surface	0.87595500000	95	83.215725
B	Scrub Shrub	213.89800000000	66	14117.268
C	Bare Land	6.19784000000	91	564.00344
C	Evergreen	7.13384000000	70	499.3688

C	Grassland	3.98127000000	74	294.61398
C	Impervious Surface	15.88670000000	95	1509.2365
C	Open Space Developed	11.06700000000	74	818.958
C	Open Water	0.29928600000	100	29.9286
C	Pasture/Hay	0.01137510000	74	0.8417574
C	Scrub Shrub	98.69190000000	77	7599.2763
Sum		358.36133210000		25534.21

Weighted CN **71.3**

Subbasin 15

HSG	Class_name	Area_AC	CN	AreaxCN
B	Impervious Surface	0.14447534336	95	13.725158
B	Scrub Shrub	128.51752676300	66	8482.1568
C	Bare Land	2.14187830996	91	194.91093
C	Evergreen	2.03124311124	70	142.18702
C	Impervious Surface	3.72655956263	95	354.02316
C	Open Space Developed	6.97607969229	74	516.2299
C	Open Water	0.08035986831	100	8.0359868
C	Scrub Shrub	56.37451343730	77	4340.8375
Sum		199.99263608809		14052.106

Weighted CN **70.3**

Subbasin 16

HSG	Class_name	Area_AC	CN	AreaxCN
B	Scrub Shrub	4.26094736182	66	281.22253
C	Bare Land	5.47279885292	91	498.0247
C	Evergreen	8.90040700498	70	623.02849
C	Grassland	0.69295940406	74	51.278996
C	Impervious Surface	2.29977160696	95	218.4783
C	Open Space Developed	12.84438175310	74	950.48425
C	Scrub Shrub	95.54745446210	77	7357.154
Sum		130.01872044594		9979.6713

Weighted CN **76.8**

Subbasin 17A

HSG	Class_name	Area_AC	CN	AreaxCN
C	Bare Land	7.73081699438	91	703.50435
C	Cultivated Land	0.06629661861	78	5.1711363
C	Evergreen	2.36175822599	70	165.32308
C	Grassland	8.81302550211	74	652.16389
C	Impervious Surface	3.07754084470	95	292.36638
C	Open Space Developed	3.68960674121	74	273.0309
C	Scrub Shrub	28.44006581770	77	2189.8851
Sum		54.17911074470		4281.4448

Weighted CN **79.0**

Subbasin 17/18

HSG	Class_name	Area_AC	CN	AreaxCN
A	Bare Land	4.89588104594	77	376.98284
A	Evergreen	74.96052157870	25	1874.013
A	Grassland	121.43387455000	39	4735.9211
A	Impervious Surface	7.74372226423	95	735.65362
A	Scrub Shrub	241.50835841800	45	10867.876
B	Bare Land	6.35589289118	86	546.60679
B	Cultivated Land	3.12673708643	71	221.99833
B	Evergreen	1671.48336603000	55	91931.585
B	Grassland	896.33646018600	61	54676.524
B	Impervious Surface	70.55417257460	95	6702.6464
B	Open Space Developed	87.69382461250	61	5349.3233
B	Open Water	0.12369040224	100	12.36904
B	Pasture/Hay	103.78655311300	61	6330.9797
B	Scrub Shrub	1527.04602080000	66	100785.04
C	Bare Land	32.54186696330	91	2961.3099
C	Cultivated Land	11.76184154280	78	917.42364
C	Evergreen	228.36289597800	70	15985.403
C	Grassland	19.83779922420	74	1467.9971
C	Impervious Surface	8.24477834539	95	783.25394
C	Open Space Developed	15.37965581800	74	1138.0945
C	Open Water	0.49339620291	100	49.33962
C	Pasture/Hay	0.93052284139	74	68.85869
C	Scrub Shrub	326.76235189900	77	25160.701
Sum		5461.36418436781		333679.9
Weighted CN				**61.1**

Subbasin 19

HSG	Class_name	Area_AC	CN	AreaxCN
B	Cultivated Land	2.93875556993	71	208.65165
B	Evergreen	2.65008510576	55	145.75468
B	Grassland	0.45994235675	61	28.056484
B	Impervious Surface	0.08938046102	95	8.4911438
B	Scrub Shrub	93.50353567170	66	6171.2334
C	Bare Land	13.52277514650	91	1230.5725
C	Cultivated Land	79.64946661250	78	6212.6584
C	Evergreen	38.44462552980	70	2691.1238
C	Grassland	18.54681198060	74	1372.4641
C	Impervious Surface	7.39978219084	95	702.97931
C	Open Space Developed	0.33601964002	74	24.865453
C	Scrub Shrub	148.04759043500	77	11399.664
Sum		405.58877070042		30196.515
Weighted CN				**74.5**

Subbasin 19A1

HSG	Class_name	Area_AC	CN	AreaxCN
C	Bare Land	21.59282037390	91	1964.9467
C	Cultivated Land	19.41029449490	78	1514.003
C	Evergreen	0.78762042231	70	55.13343
C	Grassland	5.74323392392	74	424.99931
C	Impervious Surface	17.11588085060	95	1626.0087
C	Open Space Developed	2.83322004970	74	209.65828
C	Scrub Shrub	48.39354670060	77	3726.3031
Sum		115.87661681593		9521.0524

Weighted CN **82.2**

Subbasin 19A2

HSG	Class_name	Area_AC	CN	AreaxCN
C	Bare Land	12.78512706090	91	1163.4466
C	Cultivated Land	1.23948097730	78	96.679516
C	Evergreen	0.93218140473	70	65.252698
C	Grassland	8.48856438216	74	628.15376
C	Impervious Surface	5.64870143522	95	536.62664
C	Scrub Shrub	18.30592674980	77	1409.5564
Sum		47.39998201011		3899.7155

Weighted CN **82.3**

Subbasin 20

HSG	Class_name	Area_AC	CN	AreaxCN
B	Bare Land	0.50214459711	86	43.184435
B	Evergreen	1.37042398658	55	75.373319
B	Impervious Surface	0.25420231725	95	24.14922
B	Scrub Shrub	76.42864717030	66	5044.2907
C	Bare Land	27.38812920430	91	2492.3198
C	Cultivated Land	14.63072645900	78	1141.1967
C	Evergreen	82.27302171140	70	5759.1115
C	Grassland	2.36914283687	74	175.31657
C	Impervious Surface	5.35149987734	95	508.39249
C	Open Space Developed	1.18113148954	74	87.40373
C	Scrub Shrub	146.01550832700	77	11243.194
Sum		357.76457797669		26593.933

Weighted CN **74.3**

Subbasin 21

HSG	Class_name	Area_AC	CN	AreaxCN
A	Evergreen	96.82759314420	25	2420.6898
A	Grassland	426.11366507100	39	16618.433
A	Impervious Surface	9.11320959828	95	865.75491
A	Open Space Developed	0.70148240340	39	27.357814
A	Pasture/Hay	172.65148235700	39	6733.4078

A	Scrub Shrub	122.36529575900	45	5506.4383
B	Bare Land	2.08321552965	86	179.15654
B	Evergreen	160.72473222300	55	8839.8603
B	Grassland	197.69410211200	61	12059.34
B	Impervious Surface	12.78904308090	95	1214.9591
B	Open Space Developed	1.20114467334	61	73.269825
B	Pasture/Hay	543.80434195600	61	33172.065
B	Scrub Shrub	938.76935055600	66	61958.777
C	Bare Land	21.25404690580	91	1934.1183
C	Evergreen	124.00799034900	70	8680.5593
C	Grassland	28.16831678350	74	2084.4554
C	Impervious Surface	2.72344662254	95	258.72743
C	Scrub Shrub	341.15170849400	77	26268.682
Sum		3202.14416761861		188896.05

Weighted CN **59.0**

Subbasin 22/22A

HSG	Class_name	Area_AC	CN	AreaxCN
B	Bare Land	1.24428219909	86	107.00827
B	Grassland	0.10768022311	61	6.5684936
B	Impervious Surface	0.36179360334	95	34.370392
B	Scrub Shrub	34.61937301880	66	2284.8786
C	Bare Land	0.96464282794	91	87.782497
C	Grassland	0.60375610733	74	44.677952
C	Impervious Surface	0.30530227083	95	29.003716
C	Scrub Shrub	0.15007222833	77	11.555562
Sum		38.35690247877		2605.8455

Weighted CN **67.9**

Subbasin 23

HSG	Class_name	Area_AC	CN	AreaxCN
B	Bare Land	0.46657563010	86	40.125504
B	Evergreen	0.01725017090	55	0.9487594
B	Grassland	2.30494509357	61	140.60165
B	Impervious Surface	1.64397533462	95	156.17766
B	Scrub Shrub	230.93653926300	66	15241.812
C	Bare Land	0.01517049550	91	1.3805151
C	Evergreen	1.79789029366	70	125.85232
C	Grassland	0.01433399571	74	1.0607157
C	Impervious Surface	0.26295101482	95	24.980346
C	Scrub Shrub	18.30668516080	77	1409.6148
Sum		255.76631645267		17142.554

Weighted CN **67.0**

Subbasin 23A

HSG	Class_name	Area_AC	CN	AreaxCN
B	Grassland	1.59886095467	61	97.530518
B	Impervious Surface	0.38669022340	95	36.735571
B	Scrub Shrub	12.00972434760	66	792.64181
Sum		13.99527552567		926.9079
Weighted CN				**66.2**

Subbasin 24

HSG	Class_name	Area_AC	CN	AreaxCN
A	Bare Land	0.20473226443	77	15.764384
A	Evergreen	219.05502098400	25	5476.3755
A	Grassland	43.92164240080	39	1712.9441
A	Impervious Surface	5.88138380953	95	558.73146
A	Open Space Developed	5.22838720560	39	203.9071
A	Pasture/Hay	99.27770100230	39	3871.8303
A	Scrub Shrub	157.32288966000	45	7079.53
B	Bare Land	3.91794812312	86	336.94354
B	Cultivated Land	0.78622779516	71	55.822173
B	Evergreen	238.52507101200	55	13118.879
B	Grassland	219.80460650000	61	13408.081
B	Impervious Surface	25.07024259320	95	2381.673
B	Open Space Developed	13.78746686020	61	841.03548
B	Pasture/Hay	433.49898946500	61	26443.438
B	Scrub Shrub	1026.39799847000	66	67742.268
C	Bare Land	0.43222765588	91	39.332717
C	Evergreen	9.15222647691	70	640.65585
C	Grassland	0.75063765149	74	55.547186
C	Impervious Surface	0.15317111421	95	14.551256
C	Scrub Shrub	88.10811658260	77	6784.325
D	Grassland	0.11974177297	80	9.5793418
D	Impervious Surface	0.23377455533	95	22.208583
D	Pasture/Hay	30.93910369470	80	2475.1283
D	Scrub Shrub	1.60979779735	83	133.61322
Sum		2624.17910544678		153422.16
Weighted CN				**58.5**

Subbasin 24A

HSG	Class_name	Area_AC	CN	AreaxCN
B	Grassland	9.84232137833	61	600.3816
B	Impervious Surface	0.21483828763	95	20.409637
B	Scrub Shrub	3.06397256873	66	202.22219
Sum		13.12113223469		823.01343
Weighted CN				**62.7**

Subbasin 24B

HSG	Class_name	Area_AC	CN	AreaxCN
B	Grassland	16.55666295410	61	1009.9564
B	Impervious Surface	0.25299172935	95	24.034214
B	Scrub Shrub	1.67285710640	66	110.40857
Sum		18.48251178985		1144.3992

Weighted CN **61.9**

Subbasin 25

HSG	Class_name	Area_AC	CN	AreaxCN
B	Grassland	64.98274405760	61	3963.9474
B	Impervious Surface	0.52880237525	95	50.236226
B	Scrub Shrub	64.97433707900	66	4288.3062
Sum		130.48588351185		8302.4899

Weighted CN **63.6**

Subbasin 26

HSG	Class_name	Area_AC	CN	AreaxCN
B	Evergreen	5.30793732668	55	291.93655
B	Grassland	74.32965754890	61	4534.1091
B	Impervious Surface	7.38697924720	95	701.76303
B	Open Space Developed	3.66912824828	61	223.81682
B	Scrub Shrub	2.26525449473	66	149.5068
Sum		92.95895686579		5901.1323

Weighted CN **63.5**

Subbasin 27

HSG	Class_name	Area_AC	CN	AreaxCN
B	Evergreen	4.10851724587	55	225.96845
B	Grassland	9.65306162300	61	588.83676
B	Impervious Surface	7.97784772775	95	757.89553
B	Open Space Developed	4.74487161667	61	289.43717
B	Scrub Shrub	1.61129124076	66	106.34522
Sum		28.09558945405		1968.4831

Weighted CN **70.1**

Subbasin 28

HSG	Class_name	Area_AC	CN	AreaxCN
B	Evergreen	4.60977762328	55	253.53777
B	Grassland	0.14846597050	61	9.0564242
B	Impervious Surface	9.89859988671	95	940.36699
B	Open Space Developed	4.73304289440	61	288.71562
B	Scrub Shrub	0.45194247580	66	29.828203
Sum		19.84182885069		1521.505

Weighted CN **76.7**

Subbasin 29

HSG	Class_name	Area_AC	CN	AreaxCN
B	Bare Land	0.47916473809	86	41.208167
B	Evergreen	20.89817633400	55	1149.3997
B	Grassland	86.56094305510	61	5280.2175
B	Impervious Surface	24.71621314620	95	2348.0402
B	Open Space Developed	21.80921891390	61	1330.3624
B	Scrub Shrub	328.15141992900	66	21657.994
Sum		482.61513611629		31807.222

Weighted CN **65.9**

Subbasin Cy1

HSG	Class_name	Area_AC	CN	AreaxCN
A	Evergreen	0.01779790111	25	0.4449475
A	Impervious Surface	0.21097619136	95	20.042738
A	Open Space Developed	0.27719631009	39	10.810656
C	Bare Land	0.04725438461	91	4.300149
C	Evergreen	5.51375375032	70	385.96276
C	Grassland	2.90382177045	74	214.88281
C	Impervious Surface	7.94509015009	95	754.78356
C	Open Space Developed	3.15797124874	74	233.68987
C	Scrub Shrub	0.36572956267	77	28.161176
Sum		20.43959126944		1653.0787

Weighted CN **80.9**

Subbasin Cy1_2

HSG	Class_name	Area_AC	CN	AreaxCN
A	Evergreen	4.69265682782	25	117.31642
A	Impervious Surface	13.21646684930	95	1255.5644
A	Open Space Developed	4.82861523299	39	188.31599
A	Open Water	0.00098261256	100	0.0982613
A	Scrub Shrub	1.71704905599	45	77.267208
C	Evergreen	0.17033216865	70	11.923252
C	Impervious Surface	0.50582616188	95	48.053485
C	Open Space Developed	0.17224920362	74	12.746441
Sum		25.30417811280		1711.2854

Weighted CN **67.6**

Subbasin Cy2_1

HSG	Class_name	Area_AC	CN	AreaxCN
C	Evergreen	3.28361006616	70	229.8527
C	Grassland	15.73067394440	74	1164.0699
C	Impervious Surface	3.61395671012	95	343.32589
C	Open Space Developed	0.52022799035	74	38.496871
C	Scrub Shrub	0.39732861222	77	30.594303
Sum		23.54579732325		1806.3396

Weighted CN **76.7**

Subbasin Cy2_2

HSG	Class_name	Area_AC	CN	AreaxCN
A	Bare Land	1.94719697160	77	149.93417
A	Evergreen	8.00604612523	25	200.15115
A	Grassland	1.34456197943	39	52.437917
A	Impervious Surface	36.25720786660	95	3444.4347
A	Open Space Developed	21.33778933130	39	832.17378
A	Open Water	0.29181267273	100	29.181267
A	Scrub Shrub	3.93684598092	45	177.15807
C	Bare Land	0.06256343441	91	5.6932725
C	Evergreen	8.02314732101	70	561.62031
C	Grassland	9.40485716772	74	695.95943
C	Impervious Surface	31.21040910630	95	2964.9889
C	Open Space Developed	11.31875068440	74	837.58755
C	Scrub Shrub	3.14361078728	77	242.05803
Sum		136.28479942894		10193.379

Weighted CN **74.8**

Subbasin Cy3_1

HSG	Class_name	Area_AC	CN	AreaxCN
C	Evergreen	1.83778166861	70	128.64472
C	Grassland	3.52762076935	74	261.04394
C	Impervious Surface	9.60662366795	95	912.62925
C	Open Space Developed	7.26689039562	74	537.74989
C	Scrub Shrub	0.35477609761	77	27.31776
Sum		22.59369259914		1867.3856

Weighted CN **82.7**

Subbasin 3_2

HSG	Class_name	Area_AC	CN	AreaxCN
	Evergreen	0.00000102304	25	2.558E-05
	Impervious Surface	0.00000385508	95	0.0003662
	Unconsolidated Shore	0.00012404634	100	0.0124046
A	Evergreen	0.07928644904	25	1.9821612
A	Impervious Surface	1.43196207000	95	136.0364
A	Open Space Developed	0.41939845366	39	16.35654
A	Unconsolidated Shore	0.00070061335	100	0.0700613
C	Bare Land	0.94698338352	91	86.175488
C	Evergreen	4.03371754704	70	282.36023
C	Grassland	2.41107583636	74	178.41961
C	Impervious Surface	21.78229475850	95	2069.318
C	Open Space Developed	8.55666328097	74	633.19308
C	Scrub Shrub	0.08397211704	77	6.465853
Sum		39.74618343394		3410.3902

Weighted CN **85.8**

Subbasin Kama1_1

HSG	Class_name	Area_AC	CN	AreaxCN
B	Scrub Shrub	0.00194687347	66	0.1284936
C	Bare Land	0.09200048027	91	8.3720437
C	Evergreen	0.13223512345	70	9.2564586
C	Grassland	3.57586039043	74	264.61367
C	Impervious Surface	2.56490105285	95	243.6656
C	Open Space Developed	0.00006630322	74	0.0049064
C	Scrub Shrub	14.80696680140	77	1140.1364
Sum		21.17397702509		1666.1776
Weighted CN				**78.7**

Subbasin Kama1_2

HSG	Class_name	Area_AC	CN	AreaxCN
C	Grassland	2.98973913150	74	221.2407
C	Impervious Surface	8.06686861784	95	766.35252
C	Open Space Developed	7.54078785200	74	558.0183
C	Scrub Shrub	3.83494653999	77	295.29088
Sum		22.43234214133		1840.9024
Weighted CN				**82.1**

Subbasin Kama1_3

HSG	Class_name	Area_AC	CN	AreaxCN
A	Bare Land	0.17145478893	77	13.202019
A	Evergreen	1.00386383825	25	25.096596
A	Grassland	1.31072207822	39	51.118161
A	Impervious Surface	3.69000204660	95	350.55019
A	Open Space Developed	1.45378897770	39	56.69777
A	Scrub Shrub	0.40172323347	45	18.077546
A	Unconsolidated Shore	0.07877756676	100	7.8777567
C	Bare Land	0.67397568249	91	61.331787
C	Evergreen	4.32665609412	70	302.86593
C	Grassland	4.50925922984	74	333.68518
C	Impervious Surface	20.69285457500	95	1965.8212
C	Open Space Developed	6.68288485032	74	494.53348
C	Scrub Shrub	4.69026420209	77	361.15034
Sum		49.68622716379		4042.0079
Weighted CN				**81.4**

Subbasin Kama2_1

HSG	Class_name	Area_AC	CN	AreaxCN
B	Bare Land	0.00036527325	86	0.0314135
B	Impervious Surface	0.88421155088	95	84.000097
B	Open Space Developed	0.12106955458	61	7.3852428
B	Scrub Shrub	0.48752785428	66	32.176838
C	Bare Land	0.00046293321	91	0.0421269
C	Evergreen	1.23176490547	70	86.223543
C	Grassland	0.03309778269	74	2.4492359

C	Impervious Surface	5.58306859086	95	530.39152
C	Open Space Developed	7.32826482693	74	542.2916
C	Scrub Shrub	1.07238563027	77	82.573694
Sum		16.74221890241		1367.5653

Weighted CN **81.7**

Subbasin Kama2_2

HSG	Class_name	Area_AC	CN	AreaxCN
A	Evergreen	0.82517246601	25	20.629312
A	Grassland	2.43127000248	39	94.81953
A	Impervious Surface	0.53737799599	95	51.05091
A	Scrub Shrub	0.62874620752	45	28.293579
C	Evergreen	0.90566526993	70	63.396569
C	Grassland	0.94473019076	74	69.910034
C	Impervious Surface	7.88459496366	95	749.03652
C	Open Space Developed	8.89366760553	74	658.1314
C	Scrub Shrub	1.28480419829	77	98.929923
Sum		24.33602890018		1834.1978

Weighted CN **75.4**

Subbasin Kama2_3

HSG	Class_name	Area_AC	CN	AreaxCN
A	Bare Land	0.39295221383	77	30.25732
A	Evergreen	6.95379103464	25	173.84478
A	Grassland	3.24297710018	39	126.47611
A	Impervious Surface	17.25002615240	95	1638.7525
A	Open Space Developed	1.31944917301	39	51.458518
A	Open Water	0.11047245846	100	11.047246
A	Scrub Shrub	0.49758707267	45	22.391418
C	Evergreen	1.48942408580	70	104.25969
C	Grassland	8.64367223781	74	639.63175
C	Impervious Surface	6.57076590576	95	624.22276
C	Open Space Developed	2.52150792296	74	186.59159
C	Scrub Shrub	0.12609256863	77	9.7091278
Sum		49.11871792614		3618.6428

Weighted CN **73.7**

Subbasin Kama3

HSG	Class_name	Area_AC	CN	AreaxCN
A	Bare Land	0.96146809282	77	74.033043
A	Evergreen	2.95970435815	25	73.992609
A	Impervious Surface	11.76469267020	95	1117.6458
A	Open Space Developed	2.73849803033	39	106.80142
A	Scrub Shrub	0.90269094850	45	40.621093
C	Bare Land	0.63623727071	91	57.897592
C	Evergreen	1.74750257837	70	122.32518
C	Grassland	0.56491369418	74	41.803613

C	Impervious Surface	25.56750159250	95	2428.9127
C	Open Space Developed	14.28842789880	74	1057.3437
C	Scrub Shrub	3.88774583402	77	299.35643
Sum		66.01938296857		5420.7331
Weighted CN				**82.1**

Subbasin Keok1_1

HSG	Class_name	Area_AC	CN	AreaxCN
A	Grassland	0.00012459748	39	0.0048593
A	Impervious Surface	11.64980883400	95	1106.7318
A	Open Space Developed	3.91476875973	39	152.67598
A	Scrub Shrub	0.01473707067	45	0.6631682
B	Evergreen	1.49604356205	55	82.282396
B	Impervious Surface	27.47762173620	95	2610.3741
B	Open Space Developed	11.26889745570	61	687.40274
C	Evergreen	1.49243960000	70	104.47077
C	Grassland	0.00602938010	74	0.4461741
C	Impervious Surface	14.38213075210	95	1366.3024
C	Open Space Developed	5.76598711306	74	426.68305
C	Scrub Shrub	0.37592345935	77	28.946106
Sum		77.84451232044		6566.9836
Weighted CN				**84.4**

Subbasin Keok1_2

HSG	Class_name	Area_AC	CN	AreaxCN
A	Bare Land	0.99220598794	77	76.399861
A	Evergreen	28.04091314190	25	701.02283
A	Grassland	0.89476544689	39	34.895852
A	Impervious Surface	54.12744147910	95	5142.1069
A	Open Space Developed	20.81606100380	39	811.82638
A	Open Water	2.21684042300	100	221.68404
A	Palustrine Emergent Wetland	2.85050219063	36	102.61808
A	Scrub Shrub	8.12449749704	45	365.60239
B	Bare Land	0.05545421075	86	4.7690621
B	Evergreen	15.06086202590	55	828.34741
B	Grassland	11.76277173840	61	717.52908
B	Impervious Surface	12.01910081520	95	1141.8146
B	Open Space Developed	4.96757683788	61	303.02219
B	Open Water	0.84879771877	100	84.879772
B	Palustrine Emergent Wetland	1.85317900236	60	111.19074
B	Scrub Shrub	5.48137862691	66	361.77099
C	Grassland	0.06441837337	74	4.7669596
Sum		170.17676651984		11014.247
Weighted CN				**64.7**

Subbasin Keok2_1

HSG	Class_name	Area_AC	CN	AreaxCN
C	Bare Land	28.65075562970	91	2607.2188
C	Evergreen	4.51859780693	70	316.30185
C	Grassland	27.69266075600	74	2049.2569
C	Impervious Surface	9.92278047300	95	942.66414
C	Open Space Developed	5.41878110985	74	400.9898
C	Scrub Shrub	1.85938126061	77	143.17236
Sum		78.06295703609		6459.6038
Weighted CN				**82.7**

Subbasin Keok2_2

HSG	Class_name	Area_AC	CN	AreaxCN
B	Evergreen	3.44352429520	55	189.39384
B	Grassland	0.00710950302	61	0.4336797
B	Impervious Surface	7.38140888251	95	701.23384
B	Open Space Developed	5.82998447314	61	355.62905
B	Scrub Shrub	0.30138065237	66	19.891123
C	Bare Land	1.26627083635	91	115.23065
C	Evergreen	3.05841285907	70	214.0889
C	Grassland	0.39872988524	74	29.506012
C	Impervious Surface	12.22840851600	95	1161.6988
C	Open Space Developed	6.20748456442	74	459.35386
C	Scrub Shrub	1.44256870775	77	111.07779
Sum		41.56528317508		3357.5376
Weighted CN				**80.8**

Subbasin Keok2_3

HSG	Class_name	Area_AC	CN	AreaxCN
A	Bare Land	2.90410786678	77	223.61631
A	Evergreen	8.09712511348	25	202.42813
A	Grassland	1.79499556354	39	70.004827
A	Impervious Surface	11.44196663460	95	1086.9868
A	Open Space Developed	1.13699439496	39	44.342781
A	Scrub Shrub	14.78518671550	45	665.3334
B	Bare Land	0.71095107120	86	61.141792
B	Evergreen	0.36135853784	55	19.87472
B	Impervious Surface	5.49874679307	95	522.38095
B	Open Space Developed	4.27447431474	61	260.74293
B	Scrub Shrub	0.01806895957	66	1.1925513
C	Bare Land	0.14462619623	91	13.160984
C	Evergreen	24.60958641280	70	1722.671
C	Grassland	7.93999873464	74	587.55991
C	Impervious Surface	13.85337077780	95	1316.0702
C	Open Space Developed	5.76850775331	74	426.86957
C	Scrub Shrub	6.58374592234	77	506.94844
Sum		109.92381176241		7731.3254
Weighted CN				**70.3**

Subbasin Keok2_4

HSG	Class_name	Area_AC	CN	AreaxCN
A	Bare Land	1.69923943577	77	130.84144
A	Evergreen	27.05500091940	25	676.37502
A	Grassland	5.70284499959	39	222.41095
A	Impervious Surface	76.75347236960	95	7291.5799
A	Open Space Developed	19.03080293010	39	742.20131
A	Open Water	1.84474278949	100	184.47428
A	Palustrine Emergent Wetland	1.22995370499	36	44.278333
A	Scrub Shrub	9.21037085627	45	414.46669
B	Evergreen	3.07068004908	55	168.8874
B	Grassland	2.38263238030	61	145.34058
B	Impervious Surface	3.68979674571	95	350.53069
B	Open Space Developed	0.19734010732	61	12.037747
B	Open Water	0.92732506904	100	92.732507
B	Scrub Shrub	0.36539987604	66	24.116392
C	Bare Land	1.54384828915	91	140.49019
C	Evergreen	10.06412802950	70	704.48896
C	Grassland	6.65646370048	74	492.57831
C	Impervious Surface	27.65942032990	95	2627.6449
C	Open Space Developed	10.01417846990	74	741.04921
C	Open Water	0.71551174167	100	71.551174
C	Scrub Shrub	0.01610386700	77	1.2399978
Sum		209.82925666029		15279.316
Weighted CN				**72.8**

Subbasin Kilo1_1

HSG	Class_name	Area_AC	CN	AreaxCN
B	Bare Land	0.38675006587	86	33.260506
B	Grassland	7.13497209770	61	435.2333
B	Impervious Surface	1.35185349710	95	128.42608
B	Open Space Developed	0.90809705245	61	55.39392
Sum		9.78167271312		652.31381
Weighted CN				**66.7**

Subbasin Kilo1_2

HSG	Class_name	Area_AC	CN	AreaxCN
B	Bare Land	0.00273647364	86	0.2353367
B	Evergreen	4.16193862876	55	228.90662
B	Grassland	6.57996205813	61	401.37769
B	Impervious Surface	0.94886604507	95	90.142274
B	Open Space Developed	1.01812508180	61	62.10563
B	Scrub Shrub	16.36301690490	66	1079.9591
Sum		29.07464519231		1862.7267
Weighted CN				**64.1**

Subbasin Kilo1_3

HSG	Class_name	Area_AC	CN	AreaxCN
B	Impervious Surface	4.42298065735	95	420.18316
B	Open Space Developed	2.65091088838	61	161.70556
B	Scrub Shrub	0.18768850260	66	12.387441
Sum		7.26158004833		594.27617
Weighted CN				**81.8**

Subbasin Kilo1_4

HSG	Class_name	Area_AC	CN	AreaxCN
B	Evergreen	1.05617551250	55	58.089653
B	Grassland	1.16758670505	61	71.222789
B	Impervious Surface	2.44409108299	95	232.18865
B	Open Space Developed	0.28601376175	61	17.446839
B	Scrub Shrub	1.00345938274	66	66.228319
Sum		5.95732644503		445.17625
Weighted CN				**74.7**

Subbasin Kilo1_5

HSG	Class_name	Area_AC	CN	AreaxCN
B	Evergreen	1.13375478387	55	62.356513
B	Grassland	5.26143970921	61	320.94782
B	Impervious Surface	1.66191124799	95	157.88157
B	Open Space Developed	0.15829257354	61	9.655847
B	Scrub Shrub	0.93606870273	66	61.780534
Sum		9.15146701734		612.62229
Weighted CN				**66.9**

Subbasin Kilo1_6

HSG	Class_name	Area_AC	CN	AreaxCN
A	Bare Land	3.63922437208	77	280.22028
A	Grassland	0.13934509783	39	5.4344588
A	Impervious Surface	4.91163771967	95	466.60558
A	Open Space Developed	2.90321136972	39	113.22524
A	Scrub Shrub	0.00071830457	45	0.0323237
B	Bare Land	1.35069003822	86	116.15934
B	Evergreen	2.45422964176	55	134.98263
B	Grassland	0.10513097083	61	6.4129892
B	Impervious Surface	11.72207161770	95	1113.5968
B	Open Space Developed	6.84106464249	61	417.30494
B	Scrub Shrub	0.22796309724	66	15.045564
Sum		34.29528687211		2669.0202
Weighted CN				**77.8**

Subbasin Kilo1_7

HSG	Class_name	Area_AC	CN	AreaxCN
A	Evergreen	5.26481684027	25	131.62042
A	Impervious Surface	7.08076538287	95	672.67271
A	Open Space Developed	5.42234412833	39	211.47142
A	Scrub Shrub	1.21214777958	45	54.54665

B	Evergreen	1.15510665628	55	63.530866
B	Grassland	0.38267049514	61	23.3429
B	Impervious Surface	10.77377637630	95	1023.5088
B	Open Space Developed	6.45326098035	61	393.64892
B	Scrub Shrub	6.35473207048	66	419.41232
Sum		44.09962070960		2993.755
Weighted CN				**67.9**

Subbasin Kula1

HSG	Class_name	Area_AC	CN	AreaxCN
A	Bare Land	0.01145170739	77	0.8817815
A	Evergreen	3.11940124203	25	77.985031
A	Grassland	0.17247812827	39	6.726647
A	Impervious Surface	13.03981429940	95	1238.7824
A	Open Space Developed	7.82881684860	39	305.32386
A	Scrub Shrub	1.35967372310	45	61.185318
C	Evergreen	6.44400084364	70	451.08006
C	Grassland	0.00710958653	74	0.5261094
C	Impervious Surface	33.25778992080	95	3159.49
C	Open Space Developed	15.35857136200	74	1136.5343
C	Scrub Shrub	1.10006286413	77	84.704841
Sum		81.69917052590		6523.2203
Weighted CN				**79.8**

Subbasin Kula2_1

HSG	Class_name	Area_AC	CN	AreaxCN
A	Bare Land	0.27551429182	77	21.2146
A	Grassland	5.84787799963	39	228.06724
A	Impervious Surface	1.27331415708	95	120.96484
A	Open Space Developed	0.07693734395	39	3.0005564
A	Scrub Shrub	0.87816835555	45	39.517576
C	Bare Land	0.20699923011	91	18.83693
C	Grassland	6.58998916253	74	487.6592
C	Impervious Surface	2.02231147446	95	192.11959
C	Open Space Developed	0.53838993281	74	39.840855
C	Scrub Shrub	0.04867363533	77	3.7478699
Sum		17.75817558328		1154.9693
Weighted CN				**65.0**

Subbasin Kula2_2

HSG	Class_name	Area_AC	CN	AreaxCN
A	Bare Land	0.16577128157	77	12.764389
A	Evergreen	9.69988807433	25	242.4972
A	Grassland	6.81674630794	39	265.85311
A	Impervious Surface	25.37928157690	95	2411.0317
A	Open Space Developed	13.69574066080	39	534.13389
A	Open Water	0.12248781598	100	12.248782
A	Scrub Shrub	7.34840491807	45	330.67822
C	Bare Land	0.18753086115	91	17.065308
C	Evergreen	7.92943337695	70	555.06034

C	Grassland	2.07012943817	74	153.18958
C	Impervious Surface	30.08045169970	95	2857.6429
C	Open Space Developed	20.78670186400	74	1538.2159
C	Open Water	0.01401625788	100	1.4016258
C	Scrub Shrub	1.30590899588	77	100.55499
D	Bare Land	0.00107957795	94	0.1014803
D	Evergreen	0.22529464231	77	17.347687
D	Impervious Surface	2.78080768556	95	264.17673
D	Open Space Developed	0.63833570267	80	51.066856
D	Scrub Shrub	0.08305250113	83	6.8933576
Sum		129.33106323894		9371.9241
Weighted CN				**72.5**

Subbasin Kula3_1

HSG	Class_name	Area_AC	CN	AreaxCN
A	Bare Land	0.01706285376	77	1.3138397
A	Evergreen	5.52369720907	25	138.09243
A	Grassland	0.12652727413	39	4.9345637
A	Impervious Surface	6.00298473850	95	570.28355
A	Open Space Developed	1.21620272194	39	47.431906
A	Scrub Shrub	0.00798172158	45	0.3591775
C	Evergreen	1.49406273169	70	104.58439
C	Grassland	0.03631993898	74	2.6876755
C	Impervious Surface	2.32677766694	95	221.04388
C	Open Space Developed	0.86877177987	74	64.289112
C	Scrub Shrub	0.03752887469	77	2.8897234
Sum		17.65791751116		1157.9102
Weighted CN				**65.6**

Subbasin Kuls3_2

HSG	Class_name	Area_AC	CN	AreaxCN
A	Bare Land	0.18323263031	77	14.108913
A	Evergreen	7.71952027160	25	192.98801
A	Grassland	0.22359632109	39	8.7202565
A	Impervious Surface	32.41192120800	95	3079.1325
A	Open Space Developed	17.66299777960	39	688.85691
A	Open Water	0.00023026979	100	0.023027
A	Scrub Shrub	0.60417757492	45	27.187991
C	Evergreen	1.78505013685	70	124.95351
C	Grassland	0.34959926687	74	25.870346
C	Impervious Surface	3.06357552202	95	291.03967
C	Open Space Developed	0.98693892389	74	73.03348
C	Scrub Shrub	0.07633964669	77	5.8781528
D	Evergreen	0.87858442716	77	67.651001
D	Impervious Surface	2.06223225082	95	195.91206
D	Open Space Developed	0.57974179947	80	46.379344
D	Open Water	0.04827317159	100	4.8273172
D	Scrub Shrub	0.01112281677	83	0.9231938
Sum		68.64713401745		4847.4857
Weighted CN				**70.6**

Subbasin Liil1_1

HSG	Class_name	Area_AC	CN	AreaxCN
A	Evergreen	2.55074456506	25	63.768614
A	Grassland	3.88131280831	39	151.3712
A	Impervious Surface	0.18607856159	95	17.677463
A	Open Space Developed	0.00770425016	39	0.3004658
A	Scrub Shrub	2.29402299116	45	103.23103
B	Evergreen	0.41394634849	55	22.767049
B	Grassland	0.00181537321	61	0.1107378
B	Impervious Surface	2.84000365484	95	269.80035
B	Open Space Developed	1.47147512199	61	89.759982
B	Scrub Shrub	0.00908472093	66	0.5995916
C	Evergreen	5.14668226387	70	360.26776
C	Grassland	0.33698133967	74	24.936619
C	Impervious Surface	14.60276412890	95	1387.2626
C	Open Space Developed	9.85799059286	74	729.4913
C	Scrub Shrub	1.27275434181	77	98.002084
Sum		44.87336106285		3319.3468

Weighted CN **74.0**

Subbasin Liil1_2

HSG	Class_name	Area_AC	CN	AreaxCN
A	Bare Land	0.42314485673	77	32.582154
A	Evergreen	3.79618750725	25	94.904688
A	Grassland	1.47478413567	39	57.516581
A	Impervious Surface	5.96367967222	95	566.54957
A	Open Space Developed	1.08762209112	39	42.417262
A	Scrub Shrub	0.76563597691	45	34.453619
B	Grassland	0.07755549223	61	4.730885
B	Impervious Surface	1.71525855364	95	162.94956
B	Open Space Developed	0.40904841433	61	24.951953
B	Scrub Shrub	0.60616628218	66	40.006975
C	Evergreen	1.57267971377	70	110.08758
C	Grassland	1.01150801372	74	74.851593
C	Impervious Surface	10.89738538150	95	1035.2516
C	Open Space Developed	6.00692094674	74	444.51215
C	Scrub Shrub	1.34560333216	77	103.61146
Sum		37.15318037017		2829.3776

Weighted CN **76.2**

Subbasin Liil1_3

HSG	Class_name	Area_AC	CN	AreaxCN
B	Bare Land	0.02466155791	86	2.120894
B	Evergreen	2.85851963487	55	157.21858
B	Grassland	1.00128527109	61	61.078402
B	Impervious Surface	17.11403415580	95	1625.8332
B	Open Space Developed	8.62912233673	61	526.37646
B	Scrub Shrub	0.10279464390	66	6.7844465
C	Evergreen	2.25588707969	70	157.9121
C	Impervious Surface	14.31477207660	95	1359.9033
C	Open Space Developed	9.26359235999	74	685.50583
C	Scrub Shrub	0.11085936603	77	8.5361712
Sum		55.67552848262		4591.2695
Weighted CN				**82.5**

Subbasin Liil2_1

HSG	Class_name	Area_AC	CN	AreaxCN
B	Bare Land	0.69576863905	86	59.836103
B	Evergreen	0.59538541147	55	32.746198
B	Grassland	6.26140401281	61	381.94564
B	Impervious Surface	3.46469080319	95	329.14563
B	Open Space Developed	2.65973010654	61	162.24354
B	Scrub Shrub	0.16969418030	66	11.199816
Sum		13.84667315336		977.11692
Weighted CN				**70.6**

Subbasin Liil2_2

HSG	Class_name	Area_AC	CN	AreaxCN
A	Bare Land	2.15249488404	77	165.74211
A	Evergreen	15.07575336520	25	376.89383
A	Grassland	1.28058168566	39	49.942686
A	Impervious Surface	33.53329452180	95	3185.663
A	Open Space Developed	13.66477990420	39	532.92642
A	Open Water	0.23113098707	100	23.113099
A	Scrub Shrub	8.64475416905	45	389.01394
A	Unconsolidated Shore	0.65958784018	100	65.958784
B	Bare Land	0.06575300197	86	5.6547582
B	Evergreen	4.47192842730	55	245.95606
B	Grassland	2.10018266137	61	128.11114
B	Impervious Surface	11.40668937000	95	1083.6355
B	Open Space Developed	5.17868085399	61	315.89953
C	Bare Land	0.33095279056	91	30.116704
C	Evergreen	3.63327984995	70	254.32959
C	Grassland	0.54657919795	74	40.446861
C	Impervious Surface	8.13641435434	95	772.95936
C	Open Space Developed	4.90457571690	74	362.9386
C	Scrub Shrub	0.08513660436	77	6.5555185
Sum		116.10255018589		8035.8575
Weighted CN				**69.2**

Subbasin Liil3

HSG	Class_name	Area_AC	CN	AreaxCN
A	Bare Land	0.14241698354	77	10.966108
A	Evergreen	4.75632412766	25	118.9081
A	Grassland	5.49335140461	39	214.2407
A	Impervious Surface	14.87339948640	95	1412.973
A	Open Space Developed	9.75765264488	39	380.54845
A	Scrub Shrub	1.27786726964	45	57.504027
B	Bare Land	0.14306017462	86	12.303175
B	Evergreen	0.25340994359	55	13.937547
B	Grassland	3.47756047417	61	212.13119
B	Impervious Surface	8.42000825321	95	799.90078
B	Open Space Developed	6.27786533290	61	382.94979
Sum		54.87291609522		3616.3628
Weighted CN				65.9

Subbasin Waia1

HSG	Class_name	Area_AC	CN	AreaxCN
A	Bare Land	0.33988206177	77	26.170919
A	Evergreen	0.03051358698	25	0.7628397
A	Impervious Surface	0.00889612017	90	0.8006508
A	Open Space Developed	0.02008781622	39	0.7834248
A	Open Water	0.06813327436	100	6.8133274
A	Unconsolidated Shore	0.36650628259	100	36.650628
B	Bare Land	0.32263991908	86	27.747033
B	Evergreen	12.57057929980	55	691.38186
B	Grassland	4.21761797039	61	257.2747
B	Impervious Surface	3.89691874125	95	370.20728
B	Open Space Developed	2.55254467176	61	155.70522
B	Open Water	0.12797354207	100	12.797354
B	Scrub Shrub	1.04598888986	66	69.035267
Sum		25.56828217627		1656.1305
Weighted CN				64.8

Subbasin Waia2

HSG	Class_name	Area_AC	CN	AreaxCN
A	Bare Land	0.36044925728	77	27.754593
A	Evergreen	0.80344469621	25	20.086117
A	Grassland	0.18181220931	39	7.0906762
A	Impervious Surface	2.71804388907	95	258.21417
A	Open Space Developed	1.70356188297	39	66.438913
A	Open Water	0.03732174151	100	3.7321742
A	Palustrine Emergent Wetland	0.26660562641	36	9.5978026
A	Scrub Shrub	0.14611433192	45	6.5751449
A	Unconsolidated Shore	0.65730145331	100	65.730145
B	Bare Land	0.21974264062	86	18.897867
B	Evergreen	5.38547760145	55	296.20127
B	Grassland	2.72137304488	61	166.00376
B	Impervious Surface	13.80877886830	95	1311.834

B	Open Space Developed	8.96874851534	61	547.09366
B	Palustrine Emergent Wetland	3.04789117475	60	182.87347
B	Scrub Shrub	0.51319360496	66	33.870778
C	Evergreen	0.45441449737	70	31.809015
C	Grassland	0.02184243120	74	1.6163399
C	Impervious Surface	2.91928875569	95	277.33243
C	Open Space Developed	0.91185613817	74	67.477354
C	Scrub Shrub	0.41610881812	77	32.040379
Sum		46.26337117884		3432.27
Weighted CN				74.2

Subbasin Waia3

HSG	Class_name	Area_AC	CN	AreaxCN
A	Bare Land	0.09002205795	77	6.9316985
A	Evergreen	0.26283398914	25	6.5708497
A	Grassland	0.19464295972	39	7.5910754
A	Impervious Surface	1.03888481536	95	98.694057
A	Open Space Developed	0.51996311607	39	20.278562
A	Scrub Shrub	0.91633781224	45	41.235202
B	Evergreen	0.78509389780	55	43.180164
B	Impervious Surface	6.93090343882	95	658.43583
B	Open Space Developed	4.00354420597	61	244.2162
B	Scrub Shrub	0.79757382924	66	52.639873
C	Evergreen	0.54051176468	70	37.835824
C	Grassland	1.26925549169	74	93.924906
C	Impervious Surface	7.27483179782	95	691.10902
C	Open Space Developed	3.47938080599	74	257.47418
C	Scrub Shrub	0.16777871613	77	12.918961
Sum		28.27155869863		2273.0364
Weighted CN				80.4

Subbasin Waia4

HSG	Class_name	Area_AC	CN	AreaxCN
A	Bare Land	0.02140232645	77	1.6479791
A	Evergreen	0.94429947762	25	23.607487
A	Grassland	0.03788721922	39	1.4776015
A	Impervious Surface	2.20558851878	95	209.53091
A	Open Space Developed	0.30630302652	39	11.945818
A	Scrub Shrub	0.82369942804	45	37.066474
B	Evergreen	0.05552881258	55	3.0540847
B	Impervious Surface	0.41581998780	95	39.502899
B	Open Space Developed	0.12375966175	61	7.5493394
B	Scrub Shrub	0.29453042516	66	19.439008
C	Evergreen	0.11789340935	70	8.2525387
C	Grassland	0.14283905181	74	10.57009
C	Impervious Surface	4.99701592516	95	474.71651
C	Open Space Developed	2.16494967744	74	160.20628

C	Scrub Shrub	0.26515077538	77	20.41661
Sum		12.91666772304		1028.9836

Weighted CN **79.7**

Subbasin Waia5

HSG	Class_name	Area_AC	CN	AreaxCN
A	Bare Land	0.10373014206	77	7.9872209
A	Evergreen	2.82549412828	25	70.637353
A	Grassland	1.29353476666	39	50.447856
A	Impervious Surface	3.95486141033	95	375.71183
A	Open Space Developed	3.17685343223	39	123.89728
A	Scrub Shrub	1.05099040321	45	47.294568
C	Evergreen	3.12062992089	70	218.44409
C	Grassland	0.76044135110	74	56.27266
C	Impervious Surface	27.16015278760	95	2580.2145
C	Open Space Developed	23.73328589880	74	1756.2632
C	Scrub Shrub	1.81559844231	77	139.80108
Sum		68.99557268348		5426.9716

Weighted CN **78.7**

Subbasin Waip1

HSG	Class_name	Area_AC	CN	AreaxCN
A	Bare Land	0.58033398403	77	44.685717
A	Evergreen	8.82524196763	25	220.63105
A	Grassland	10.38683280900	39	405.08648
A	Impervious Surface	29.48497116140	95	2801.0723
A	Open Space Developed	14.21089809860	35	497.38143
A	Scrub Shrub	2.52555415413	45	113.64994
C	Evergreen	0.02428053320	70	1.6996373
C	Grassland	0.62766929047	74	46.447527
C	Impervious Surface	0.45336994690	95	43.070145
C	Open Space Developed	0.44750864614	74	33.11564
Sum		67.56666059151		4206.8398

Weighted CN **62.3**

Existing Time of Concentration

KIHEI DRAINAGE MASTER PLAN

ITEM: EXISTING Tc

LOCATION: KIHEI, MAUI, HAWAII — REF: 1-20258-0E
PREPARED BY: TL — CHECKED BY:
DATE: 8/14/15 — DATE:

1. INTRODUCTION
   This is to find the times of concentration (Tc) for subwatersheds mauka of Piilani Highway. The method described in SCS TR-55, Section 3 is used.

2. REFERENCES
   - 2.1 "Urban Hydrology for Small Watersheds, TR-55, 2nd Edition", Soil Conservation Service, U. S. Dept. of Agriculture, June 1986.
   - 2.2 LiDAR 2-ft contour (Hurricane Study 2006, Maui FIS 2005)
     USGS Map
   - 2.3 Erosion and Sediment Control Guide for Hawaii," Soil and Water Conservation Service, U. S. Dept. of Agriculture, March 1981 w/ Addendum July 1983.
   - 2.4 NOAA Atlas 14 for Hawaian Islands

3. COMPUTATIONS
   Travel time computation for sheet flow from TR-55 kinematic equation.
   Velocity computation for shallow concentrated flow (based on TR-55, Figure 3-1).

   SF = Sheetflow
   SCF = Shallow Concentrated Flow
   OCF = Open channel flow, where blue line is shown on USGS quadrangle map

Subarea	Reach Description	Hyd. Length (ft)	Elev1 (ft)	Elev2 (ft)	Approx. Slope (ft/ft)	Est. Vel. (fps)	Kinematic Eqn. P2-24 (in)	n	Travel Time (hr)
1	SF	100	9920	9860	0.600		4.6	0.8	0.133
	SCF, unpaved	14000	9860	6000	0.276	8.5			0.459
	SCF, unpaved	11100	6000	3550	0.221	7.6			0.407
	OCF, natural	5750	3550	2800	0.130	10.7			0.149
	OCF, natural	18500	2800	1200	0.086	11.5			0.447
	OCF, natural	20100	1200	360	0.042	9.2			0.607
	OCF, natural	12900	360	14	0.027	8.3			0.432
	Total	82450							2.634
8	SF	100	9280	9260	0.200		3.9	0.8	0.225
	SCF, unpaved	8650	9260	6700	0.296	8.8			0.274
	OCF, natural	12750	6700	3560	0.246	11.1			0.319
	OCF, natural	6250	3560	2800	0.122	9.3			0.187
	OCF, natural	15750	2800	1300	0.095	9.2			0.476
	OCF, natural	9300	1300	780	0.056	10.1			0.256
	OCF, natural	10200	780	350	0.042	10.4			0.272
	OCF, natural	11200	350	16	0.030	9.4			0.331
	Total	74200							2.339

Subarea	Reach Description	Hyd. Length (ft)	Elev1 (ft)	Elev2 (ft)	Approx. Slope (ft/ft)	Est. Vel. (fps)	Kinematic P2-24 (in)	Eqn. n	Travel Time (hr)
10/10A	SF	100	8720	8660	0.600		3.72	0.8	0.148
	SCF, unpaved	4450	8660	7200	0.328	9.2			0.134
	SCF, unpaved	9000	7200	5000	0.244	8.0			0.313
	OCF, natural	9800	5000	2950	0.209	10.5			0.259
	OCF, natural	13200	2950	1480	0.111	9.2			0.399
	OCF, natural	10750	1480	780	0.065	10.0			0.299
	OCF, natural	8150	780	340	0.054	10.6			0.214
	OCF, natural	10400	340	31	0.030	8.8			0.328
	Total	65850							2.094
21	SF	100	6134	6118	0.160		3.63	0.8	0.255
	SCF, unpaved	5650	6118	4600	0.269	8.4			0.188
	SCF, unpaved	5050	4600	3400	0.238	7.9			0.178
	SCF, unpaved	11950	3400	1920	0.124	5.7			0.585
	OCF, natural	7200	1920	1300	0.086	8.1			0.247
	OCF, natural	14050	1300	400	0.064	8.2			0.476
	OCF, natural	6100	400	103.6	0.049	8.4			0.202
	Total	50100							2.130
17/18	SF	100	8640	8590	0.500		3.84	0.8	0.157
	SCF, unpaved	13050	8590	5120	0.266	8.3			0.436
	SCF, unpaved	13300	5120	2330	0.210	7.4			0.500
	OCF, natural	10800	2330	1320	0.094	10.9			0.275
	OCF, natural	15900	1320	360	0.060	10.7			0.413
	OCF, natural	6800	360	68	0.043	9.6			0.197
	Total	59950							1.977
16	SF	100	369	365	0.040		2.88	0.13	0.116
	SCF, unpaved	2600	365	210	0.060	3.9			0.183
	SCF, unpaved	1900	210	144	0.035	3.0			0.176
	SCF, unpaved	2000	144	68	0.038	3.1			0.177
	Total	6600							0.652
20	SF	100	1160	1156	0.040		3.04	0.4	0.278
	SCF, unpaved	5300	1156	800	0.067	4.2			0.352
	SCF, unpaved	5800	800	446	0.061	4.0			0.404
	OCF, natural	2400	446	350	0.040	4.0			0.167
	OCF, natural	5450	350	104.5	0.045	4.5			0.336
	Total	19050							1.538
24	SF	100	7040	6996	0.440		3.79	0.8	0.166
	SCF, unpaved	2250	6996	6200	0.354	9.6			0.065
	SCF, unpaved	5700	6200	4700	0.263	8.3			0.191
	SCF, unpaved	4850	4700	3520	0.243	8.0			0.169
	OCF, natural	11450	3520	2000	0.133	9.8			0.325
	OCF, natural	11800	2000	800	0.102	9.8			0.334
	OCF, natural	5700	800	360	0.077	8.8			0.180
	OCF, natural	3500	360	138.5	0.063	9.2			0.106
	Total	45350							1.537

Subarea	Reach Description	Hyd. Length (ft)	Elev1 (ft)	Elev2 (ft)	Approx. Slope (ft/ft)	Est. Vel. (fps)	Kinematic Eqn. P2-24 (in)	n	Travel Time (hr)
7	SF	100	640	635	0.050		2.88	0.13	0.106
	SCF, unpaved	7200	635	340	0.041	3.3			0.612
	OCF, natural	4400	340	200	0.032	4.6			0.266
	OCF, natural	5600	200	30.22	0.030	5.1			0.305
	Total	17300							1.290
29	SF	100	2070	2055	0.150		3.34	0.4	0.156
	SCF, unpaved	12800	2055	686	0.107	5.3			0.674
	SCF, unpaved	1950	686	522	0.084	4.7			0.116
	OCF, natural	4250	522	239.88	0.066	5.8			0.204
	Total	19100							1.150
2	SF	100	212	210	0.020		2.83	0.13	0.155
	SCF, unpaved	3600	210	106	0.029	2.7			0.365
	SCF, paved	2350	106	36	0.030	3.5			0.186
	Total	6050							0.706
3	SF	100	202	200	0.020		2.83	0.13	0.155
	SCF, unpaved	2900	200	106	0.032	2.9			0.277
	SCF, paved	1950	106	62	0.023	3.1			0.177
	Total	4950							0.610
4	SF	100	238	234	0.040		2.85	0.13	0.117
	SCF, unpaved	2350	234	160	0.031	2.9			0.228
	SCF, paved	2700	160	65	0.035	3.8			0.197
	Total	5150							0.542
5	SF	100	124	117	0.070		2.84	0.13	0.094
	SCF, unpaved	1350	117	88	0.021	2.4			0.159
	SCF, paved	400	88	86	0.005	1.4			0.077
	Total	1850							0.330
6	SF	100	180	178.5	0.015		2.84	0.13	0.173
	SCF, unpaved	1500	178.5	130	0.032	2.9			0.144
	SCF, unpaved	2050	130	71.45	0.029	2.7			0.209
	Total	3650							0.526
9	SF	100	214	213	0.010		2.86	0.13	0.203
	SCF, unpaved	4150	213	86	0.031	2.8			0.408
	SCF, unpaved	1700	86	28.41	0.034	3.0			0.159
	Total	5950							0.771
12	SF	100	298	296	0.020		2.86	0.13	0.154
	SCF, unpaved	4000	296	170	0.032	2.9			0.388
	SCF, unpaved	2550	170	49.06	0.047	3.5			0.202
	Total	6650							0.744

Subarea	Reach Description	Hyd. Length (ft)	Elev1 (ft)	Elev2 (ft)	Approx. Slope (ft/ft)	Est. Vel. (fps)	Kinematic Eqn. P2-24 (in)	n	Travel Time (hr)
13	SF	100	318	316	0.020		2.87	0.13	0.154
	SCF, unpaved	1950	316	236	0.041	3.3			0.166
	SCF, unpaved	2550	236	174	0.024	2.5			0.282
	SCF, unpaved	2350	174	63	0.047	3.5			0.186
	Total	6950							0.787
14	SF	100	815	812	0.030		3.03	0.13	0.127
	SCF, unpaved	10150	812	288	0.052	3.7			0.769
	SCF, unpaved	1500	288	248	0.027	2.6			0.158
	OCF, natural	4500	248	72.5	0.039	4.9			0.255
	Total	16250							1.310
15	SF	100	603	599	0.040		2.91	0.13	0.116
	SCF, unpaved	4250	599	428	0.040	3.2			0.365
	SCF, unpaved	2100	428	284	0.069	4.2			0.138
	OCF, natural	5800	284	78.1	0.036	4.0			0.403
	Total	12250							1.021
17A	SF	100	257	248	0.090		2.87	0.13	0.084
	SCF, unpaved	2000	248	140	0.054	3.7			0.148
	SCF, unpaved	1650	140	79.7	0.037	3.1			0.149
	Total	3750							0.381
19A1	SF	100	351	348	0.030		2.9	0.24	0.212
	SCF, unpaved	2200	348	250	0.045	3.4			0.179
	SCF, unpaved	2750	250	128	0.044	3.4			0.225
	SCF, unpaved	1600	128	63	0.041	3.3			0.137
	Total	6650							0.753
19A2	SF	100	215	213	0.020		2.88	0.24	0.251
	SCF, unpaved	2900	213	49.5	0.056	3.8			0.210
	Total	3000							0.461
19	SF	100	1464	1460	0.040		3.19	0.4	0.272
	SCF, unpaved	5550	1460	1000	0.083	4.6			0.332
	SCF, unpaved	8650	1000	450	0.064	4.1			0.591
	SCF, unpaved	8000	450	64.4	0.048	3.5			0.627
	Total	22300							1.821
28	SF	100	492	486	0.060		3.03	0.13	0.096
	SCF, unpaved	950	486	398	0.093	4.9			0.054
	SCF, paved	1280	398	298	0.078	5.7			0.063
	SCF, unpaved	900	298	235.48	0.069	4.3			0.059
	Total	3230							0.272
27	SF	100	614	609	0.050		3.03	0.13	0.104
	SCF, unpaved	1300	609	486	0.095	5.0			0.073
	SCF, unpaved	1400	486	378	0.077	4.5			0.087
	SCF, unpaved	2000	378	232.26	0.073	4.4			0.128
	Total	4800							0.391

Subarea	Reach Description	Hyd. Length (ft)	Elev1 (ft)	Elev2 (ft)	Approx. Slope (ft/ft)	Est. Vel. (fps)	Kinematic P2-24 (in)	Eqn. n	Travel Time (hr)
26	SF	100	753	748	0.050		3.09	0.13	0.103
	SCF, unpaved	1150	748	672	0.066	4.1			0.077
	SCF, unpaved	3400	672	384	0.085	4.7			0.201
	SCF, unpaved	650	384	356	0.043	3.3			0.054
	SCF, unpaved	600	356	290	0.110	5.4			0.031
	SCF, unpaved	1250	290	220	0.056	3.8			0.091
	Total	7150						41	0.557
25	SF	100	1028	1022	0.060		3.14	0.13	0.095
	SCF, unpaved	4300	1022	630	0.091	4.9			0.245
	OCF, natural	2300	630	448	0.079	5.1			0.125
	OCF, natural	3100	448	220	0.074	5.5			0.157
	Total	9800							0.622
23	SF	100	1294	1286	0.080		3.15	0.4	0.207
	SCF, unpaved	2350	1286	1060	0.096	5.0			0.130
	OCF, natural	5900	1060	600	0.078	5.3			0.309
	OCF, natural	5200	600	230	0.071	6.1			0.237
	OCF, natural	2350	230	127.3	0.044	5.1			0.128
	Total	15900							1.012
23A	SF	100	298	290	0.080		2.96	0.13	0.087
	SCF, unpaved	500	290	210	0.160	6.5			0.022
	SCF, unpaved	1250	210	148.5	0.049	3.6			0.097
	Total	1850							0.206
22/22A	SF	100	280	270	0.100		2.92	0.13	0.080
	SCF, unpaved	800	270	194	0.095	5.0			0.045
	SCF, unpaved	1600	194	117.4	0.048	3.5			0.126
	Total	2500							0.251
11U	SF	100	626	620	0.060		2.9	0.13	0.099
	SCF, unpaved	2750	622	510	0.041	3.3			0.235
	SCF, unpaved	3300	510	344	0.050	3.6			0.253
	SCF, unpaved	2800	344	242	0.036	3.1			0.253
	SCF, unpaved	2600	242	144	0.038	3.1			0.231
	Total	11550							1.070
11D	SF	100	210	208	0.020		2.86	0.13	0.154
	SCF, unpaved	1700	208	110	0.058	3.9			0.122
	SCF, unpaved	2300	110	39.5	0.031	2.8			0.226
	Total	4100							0.502

KIHEI DRAINAGE MASTER PLAN

ITEM: EXISTING Tc

LOCATION: KIHEI, MAUI, HAWAII — REF: 1-20258-0E
PREPARED BY: TL — CHECKED BY:
DATE: 8/14/15 — DATE:

1. INTRODUCTION
   This is to find the times of concentration (Tc) for subwatersheds makai of Piilani Highway. The method described in SCS TR-55, Section 3 is used.

2. REFERENCES
   - 2.1 "Urban Hydrology for Small Watersheds, TR-55, 2nd Edition", Soil Conservation Service, U. S. Dept. of Agriculture, June 1986.
   - 2.2 LiDAR 2-ft contour (Hurricane Study 2006, Maui FIS 2005)
     USGS Map
   - 2.3 Erosion and Sediment Control Guide for Hawaii," Soil and Water Conservation Service, U. S. Dept. of Agriculture, March 1981 w/ Addendum July 1983.
   - 2.4 NOAA Atlas 14 for Hawaiian Islands

3. COMPUTATIONS
   Travel time computation for sheet flow from TR-55 kinematic equation.
   Velocity computation for shallow concentrated flow (based on TR-55, Figure 3-1).

   SF = Sheetflow
   SCF = Shallow Concentrated Flow
   OCF = Open channel flow, where blue line is shown on USGS quadrangle map

Subarea	Reach Description	Hyd. Length (ft)	Elev1 (ft)	Elev2 (ft)	Approx. Slope (ft/ft)	Est. Vel. (fps)	Kinematic P2-24 (in)	Eqn. n	Travel Time (hr)
Waia1	SF	100	26	20	0.060		2.83	0.4	0.245
	SCF, unpaved	1200	20	6	0.012	1.7			0.191
	Total	1300							0.437
Waia2	SF	100	36	31	0.050		2.83	0.4	0.264
	SCF, unpaved	1500	31	8	0.015	2.0			0.209
	Total	1600							0.472
Waia3	SF	100	64	63.5	0.005		2.83	0.13	0.270
	SCF, unpaved	1950	63.5	4	0.031	2.8			0.192
	Total	2050							0.462
Waia4	SF	100	66	64	0.020		2.83	0.13	0.155
	SCF, unpaved	200	64	56	0.040	3.2			0.017
	SCF, paved	1650	56	8	0.029	3.5			0.132
	Total	1950							0.304
Waia5	SF	100	76	72.5	0.035		2.83	0.13	0.124
	SCF, paved	2550	72.5	8	0.025	3.2			0.219
	Total	2650							0.343

Subarea	Reach Description	Hyd. Length (ft)	Elev1 (ft)	Elev2 (ft)	Approx. Slope (ft/ft)	Est. Vel. (fps)	Kinematic Eqn. P2-24 (in)	n	Travel Time (hr)
Kula1	SF	100	72	70	0.020		2.83	0.13	0.155
	SCF, unpaved	1350	70	14	0.041	3.3			0.114
	SCF, paved	1150	14	8	0.005	1.5			0.218
	Total	2600							0.487
Kula2_1	SF	100	48	32	0.160		2.84	0.13	0.067
	SCF, unpaved	1200	32	8	0.020	2.3			0.146
	Total	1300							0.213
Kula2_2	SF	100	76	72	0.040		2.84	0.13	0.117
	SCF, paved	1300	72	22	0.038	4.0			0.091
	SCF, unpaved	1850	22	4	0.010	1.6			0.323
	Total	3250							0.531
Kula3_1	SF	100	40	37	0.030		2.84	0.13	0.131
	SCF, unpaved	1250	37	20	0.014	1.9			0.185
	Total	1350							0.316
Kula3_2	SF	100	42	37	0.050		2.84	0.13	0.107
	SCF, unpaved	600	37	24	0.022	2.4			0.070
	SCF, paved	2150	24	4	0.009	2.0			0.305
	Total	2850							0.482
Waip1	SF	100	46	31	0.150		2.84	0.13	0.069
	SCF, unpaved	3000	31	6	0.008	1.5			0.566
	Total	3100							0.635
Keok1_1	SF	100	46	44	0.020		2.85	0.13	0.154
	SCF, paved	1400	44	30	0.010	2.0			0.191
	SCF, unpaved	950	30	16	0.015	2.0			0.135
	Total	2450							0.480
Keok1_2	SF	100	30	27	0.030		2.84	0.13	0.131
	SCF, unpaved	2400	27	8	0.008	1.4			0.464
	SCF, unpaved	730	8	4	0.005	1.2			0.170
	Total	3230							0.766
Keok2_1	SF	100	80	74	0.060		2.86	0.13	0.099
	SCF, unpaved	400	74	62	0.030	2.8			0.040
	SCF, unpaved	1700	62	12	0.029	2.8			0.171
	Total	2200							0.310
Keok2_2	SF	100	84	81	0.030		2.86	0.13	0.131
	SCF, unpaved	150	81	62	0.127	5.7			0.007
	SCF, unpaved	1000	62	32	0.030	2.8			0.099
	Total	1250							0.238

Subarea	Reach Description	Hyd. Length (ft)	Elev1 (ft)	Elev2 (ft)	Approx. Slope (ft/ft)	Est. Vel. (fps)	Kinematic Eqn. P2-24 (in)	n	Travel Time (hr)
Keok2_3	SF	100	56	50	0.060		2.85	0.13	0.099
	SCF, unpaved	1150	50	12	0.033	2.9			0.109
	SCF, unpaved	1350	12	4	0.006	1.2			0.302
	Total	2600							0.510
Keok2_4	SF	100	42	31	0.110		2.85	0.13	0.078
	SCF, paved	800	31	8	0.029	3.4			0.064
	SCF, paved	1950	8	4	0.002	0.9			0.588
	Total	2850							0.731
Cy1_1	SF	100	86	82	0.040		2.85	0.13	0.117
	SCF, unpaved	350	82	72	0.029	2.7			0.036
	SCF, unpaved	2050	72	12	0.029	2.8			0.206
	Total	2500							0.359
Cy1_2	SF	100	25	23	0.020		2.85	0.13	0.154
	SCF, unpaved	200	23	12	0.055	3.8			0.015
	SCF, unpaved	1150	12	6	0.005	1.2			0.274
	Total	1450							0.443
Cy2_1	SF	100	110	91	0.190		2.87	0.13	0.062
	SCF, unpaved	600	91	50	0.068	4.2			0.040
	SCF, unpaved	1200	50	20	0.025	2.6			0.131
	Total	1900							0.233
Cy2_2	SF	100	86	82	0.040		2.85	0.13	0.117
	SCF, unpaved	500	82	64	0.036	3.1			0.045
	SCF, paved	1300	64	14	0.038	4.0			0.091
	SCF, paved	1100	14	4	0.009	1.9			0.158
	Total	3000							0.411
Cy3_1	SF	100	140	130	0.100		2.87	0.13	0.081
	SCF, unpaved	750	130	98	0.043	3.3			0.063
	SCF, unpaved	1000	98	52	0.046	3.5			0.080
	Total	1850							0.224
Cy3_2	SF	100	108	99	0.090		2.87	0.13	0.084
	SCF, unpaved	850	99	58	0.048	3.5			0.067
	SCF, paved	1200	58	14	0.037	3.9			0.086
	Total	2150							0.237
Kama1_1	SF	100	210	206	0.040		2.91	0.13	0.116
	SCF, unpaved	400	206	194	0.030	2.8			0.040
	SCF, unpaved	1500	194	100	0.063	4.0			0.103
	Total	2000							0.259

Subarea	Reach Description	Hyd. Length (ft)	Elev1 (ft)	Elev2 (ft)	Approx. Slope (ft/ft)	Est. Vel. (fps)	Kinematic Eqn. P2-24 (in)	n	Travel Time (hr)
Kama1_2	SF	100	178	158	0.200		2.89	0.13	0.061
	SCF, unpaved	450	158	114	0.098	5.0			0.025
	SCF, unpaved	610	114	100	0.023	2.4			0.069
	SCF, unpaved	500	100	80	0.040	3.2			0.043
	SCF, unpaved	100	80	60	0.200	7.2			0.004
	Total	2500							0.202
Kama1_3	SF	100	138	132	0.060		2.87	0.13	0.099
	SCF, unpaved	210	132	126	0.029	2.7			0.021
	SCF, paved	370	126	88	0.103	6.5			0.016
	SCF, unpaved	560	88	62	0.046	3.5			0.045
	SCF, unpaved	60	62	38	0.400	10.2			0.002
	OCF	1270	38	8	0.024	10.2			0.035
	Total	2570							0.217
Kama3	SF	100	132	128	0.040		2.87	0.13	0.117
	SCF, unpaved	1150	128	108	0.017	2.1			0.150
	SCF, unpaved	500	108	90	0.036	3.1			0.045
	SCF, paved	800	90	76	0.018	2.7			0.083
	SCF, unpaved	1250	76	13	0.050	3.6			0.096
	Total	3800							0.491
Kama2_1	SF	100	148	143	0.050		2.92	0.13	0.106
	SCF, unpaved	600	143	106	0.062	4.0			0.042
	SCF, unpaved	1000	106	54	0.052	3.7			0.075
	Total	1700							0.223
Kama2_2	SF	100	130	124	0.060		2.89	0.13	0.099
	SCF, unpaved	1470	124	64	0.041	3.3			0.125
	SCF, unpaved	200	64	62	0.010	1.6			0.034
	SCF, unpaved	30	62	52	0.333	9.3			0.001
	SCF, unpaved	550	52	34	0.033	2.9			0.052
	Total	2350							0.312
Kama2_3	SF	100	104	93	0.110		2.87	0.13	0.078
	SCF, unpaved	850	93	60	0.039	3.2			0.074
	SCF, paved	450	60	36	0.053	4.7			0.027
	SCF, unpaved	950	36	12	0.025	2.6			0.103
	Total	2350							0.282
Kilo1_1	SF	100	290	287	0.030		2.98	0.13	0.128
	SCF, unpaved	580	287	250	0.064	4.1			0.040
	SCF, unpaved	1050	250	188	0.059	3.9			0.074
	Total	1730							0.242
Kilo1_2	SF	100	285	282	0.030		2.94	0.13	0.129
	SCF, unpaved	520	282	256	0.050	3.6			0.040
	SCF, paved	870	256	198	0.067	5.2			0.046
	SCF, unpaved	1430	198	76	0.085	4.7			0.084
	Total	2920							0.300

Subarea	Reach Description	Hyd. Length (ft)	Elev1 (ft)	Elev2 (ft)	Approx. Slope (ft/ft)	Est. Vel. (fps)	Kinematic Eqn. P2-24 (in)	n	Travel Time (hr)
Kilo1_3	SF	100	242	233	0.090		2.94	0.13	0.083
	SCF, unpaved	370	233	212	0.057	3.8			0.027
	SCF, unpaved	580	212	190	0.038	3.1			0.051
	Total	1050							0.161
Kilo1_4	SF	100	238	224	0.140		2.94	0.13	0.070
	SCF, unpaved	1520	224	135	0.059	3.9			0.108
	Total	1620							0.178
Kilo1_5	SF	100	222	218	0.040		2.93	0.13	0.115
	SCF, unpaved	1550	219	125	0.061	4.0			0.108
	Total	1650							0.224
Kilo1_6	SF	100	216	204	0.120		2.90	0.13	0.075
	SCF, unpaved	25	204	200	0.160	6.5			0.001
	SCF, paved	1970	200	56	0.073	5.5			0.100
	SCF, unpaved	680	56	22	0.050	3.6			0.052
	Total	2775							0.228
Kilo1_7	SF	100	216	208	0.080		2.90	0.13	0.088
	SCF, unpaved	420	208	144	0.152	6.3			0.019
	SCF, paved	860	144	76	0.079	5.7			0.042
	SCF, paved	870	76	20	0.064	5.2			0.047
	SCF, unpaved	740	20	8	0.016	2.1			0.100
	Total	2990							0.295
Liil3	SF	100	210	206	0.040		2.90	0.13	0.116
	SCF, unpaved	1370	206	140	0.048	3.5			0.107
	SCF, paved	1600	140	34	0.066	5.2			0.085
	SCF, unpaved	1080	34	10	0.022	2.4			0.125
	Total	4150							0.433
Liil2_1	SF	100	210	206	0.040		2.93	0.13	0.115
	SCF, unpaved	2020	206	128	0.039	3.2			0.177
	Total	2120							0.292
Liil2_2	SF	100	128	124	0.040		2.93	0.13	0.115
	SCF, unpaved	1530	124	46	0.051	3.6			0.117
	SCF, unpaved	670	46	4	0.063	4.0			0.046
	Total	2300							0.278
Liil1_3	SF	100	220	212	0.080		2.93	0.13	0.087
	SCF, paved	1900	212	140	0.038	4.0			0.133
	SCF, unpaved	650	140	100	0.062	4.0			0.045
	Total	2650							0.266

Subarea	Reach Description	Hyd. Length (ft)	Elev1 (ft)	Elev2 (ft)	Approx. Slope (ft/ft)	Est. Vel. (fps)	Kinematic Eqn. P2-24 (in)	n	Travel Time (hr)
Liil1_2	SF	100	152	144	0.080		2.89	0.13	0.088
	SCF, paved	480	144	138	0.013	2.3			0.059
	SCF, paved	1140	138	102	0.032	3.6			0.087
	SCF, unpaved	1800	102	12	0.050	3.6			0.139
	Total	3520							0.373
Liil1_1	SF	100	140	134	0.060		2.89	0.13	0.099
	SCF, unpaved	580	134	94	0.069	4.2			0.038
	OCF	1350	94	62	0.024	9.7			0.039
	OCF	1210	62	10	0.043	12.1			0.028
	Total	3240							0.203

HEC-HMS Output

Proposed Conditions

Proposed Condition: D1, Waia1

HEC-HMS 3.5 [K:\study\20258 Kihei Drainage MP\Hydrology\HMS\Pro3\Waiakoa1\Waiakoa1.h...

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
D1	9.904	6588.2	01Nov2008, 11:37	2954.58
Waiakoa Bridge	9.904	6588.2	01Nov2008, 11:37	2954.58
Waia1	0.040	56.2	01Nov2008, 10:09	9.56
South Kihei Road	9.944	6598.3	01Nov2008, 11:40	2960.58
Waikoa Bridge to Sou...	9.904	6588.2	01Nov2008, 11:40	2951.02

Proposed Condition: D2D, Waia2

HEC-HMS 3.5 [K:\study\20258 Kihei Drainage MP\Hydrology\HMS\Pro3\Waiakoa2\Waiakoa2.h...

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
D2D	0.143	290.8	01Nov2008, 10:13	54.39
Piilani Hwy Culvert	0.143	290.8	01Nov2008, 10:13	54.39
South Kihei Raod	0.215	415.3	01Nov2008, 10:12	75.91
Waiakoa2	0.072	127.2	01Nov2008, 10:10	21.52

Proposed Condition: D3D, Waia3

HEC-HMS 3.5 [K:\study\20258 Kihei Drainage MP\Hydrology\HMS\Pro3\Waiakoa3\Waiakoa3.h...

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
D3D	0.087	180.0	01Nov2008, 10:12	32.82
Piilani Hwy 2-72"x44"	0.087	180.0	01Nov2008, 10:12	32.82
Waiakoa3	0.044	89.8	01Nov2008, 10:09	14.92
South Kihei Road	0.131	268.3	01Nov2008, 10:11	47.74

Proposed Condition: Waia4

HEC-HMS 3.5 [K:\study\20258 Kihei Drainage MP\Hydrology\HMS\Pro3\Waiakoa4\Waiakoa4.h...

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
Waiakoa4	0.020	48.1	01Nov2008, 10:04	6.69
South Kihei Road	0.020	48.1	01Nov2008, 10:04	6.69

Proposed Condition: D4D, Waia5

HEC-HMS 3.5 [K:\study\20258 Kihei Drainage MP\Hydrology\HMS\Pro3\Waiakoa5\Waiakoa5.h...

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
D4D	0.106	257.5	01Nov2008, 10:07	39.62
Piilani Hwy	0.106	257.5	01Nov2008, 10:07	39.62
Waiakoa5	0.108	242.8	01Nov2008, 10:05	35.44
South Kihei Road	0.214	500.0	01Nov2008, 10:06	75.06

Proposed Condition: Kula1

HEC-HMS 3.5 [K:\study\20258 Kihei Drainage MP\Hydrology\HMS\Pro3\Kulanihakoi1\Kulanihak...

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
Kula1	0.128	251.8	01Nov2008, 10:10	42.90
South Kihei Road	0.128	251.8	01Nov2008, 10:10	42.90

Proposed Condition: D2U, D3U, D4U, D5, D6U, D6D, D7, D8, D10/10A U, Kula2_1, Kula2_2

HEC-HMS 3.5 [K:\study\20258 Kihei Drainage MP\Hydrology\HMS\Pro3\Kulanihakoi2\Kulanihak...

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
D8	14.963	10171.1	01Nov2008, 11:25	4286.2
D10/10A U	11.062	8718.7	01Nov2008, 11:08	3287.5
Reach D10/10A U	11.062	8718.7	01Nov2008, 11:10	3285.1
Kulanihakoi Bridge	26.025	18682.5	01Nov2008, 11:17	7571.3
Reach D8 to Kula2_1	26.025	18682.5	01Nov2008, 11:17	7571.3
D7	0.822	915.4	01Nov2008, 10:41	265.5
D2U	0.024	63.1	01Nov2008, 10:03	8.6
D3U	0.006	16.4	01Nov2008, 10:02	2.1
D4U	0.054	124.8	01Nov2008, 10:07	19.1
D6U	0.016	44.0	01Nov2008, 10:02	5.7
Diversion Ditch	0.100	242.1	01Nov2008, 10:04	35.5
D6U Basin	0.100	73.8	01Nov2008, 10:32	29.6
D7 Basin Upper	0.922	951.6	01Nov2008, 10:49	268.6
D7 Basin	0.922	861.2	01Nov2008, 11:05	241.9
Piilani Hwy 2-102"	0.922	861.2	01Nov2008, 11:05	241.9
Reach D7 to Kula2_1	0.922	861.2	01Nov2008, 11:06	241.8
Kula2_1	0.028	68.8	01Nov2008, 10:01	8.6
Kula2_1 Junction	26.975	19506.1	01Nov2008, 11:16	7821.7
Reach to Temp Junction	26.975	19506.1	01Nov2008, 11:16	7821.7
D6D	0.082	187.5	01Nov2008, 10:08	29.8
D5	0.021	56.2	01Nov2008, 10:05	8.2
P6D Basin	0.103	80.7	01Nov2008, 10:35	31.3
Piilani Hwy 1-54"	0.103	80.7	01Nov2008, 10:35	31.3
Reach D6 pipe	0.103	80.7	01Nov2008, 10:40	31.2
Temp Junction	27.078	19563.8	01Nov2008, 11:16	7852.9
Kula2_2	0.202	366.7	01Nov2008, 10:12	65.3
South Kihei Road	27.280	19641.5	01Nov2008, 11:16	7918.2
2-102" Basin	0.000	0.0	01Nov2008, 00:00	0.0
1-54" Basin	0.000	0.0	01Nov2008, 00:00	0.0

Proposed Condition: D9, Kula3_1, Kula3_2

HEC-HMS 3.5 [K:\study\20258 Kihei Drainage MP\Hydrology\HMS\Pro3\Kulanihakoi3\Kulanihak...

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
D9	0.185	275.2	01Nov2008, 10:21	59.7
D9 Basin	0.185	192.7	01Nov2008, 10:40	51.2
Piilani Hwy 1-72"	0.185	192.7	01Nov2008, 10:40	51.2
Kula3_1	0.028	45.6	01Nov2008, 10:05	6.7
Kula3_1 Junction	0.213	204.4	01Nov2008, 10:40	57.9
Kula3_2	0.107	169.5	01Nov2008, 10:10	29.4
South Kihei Road	0.320	280.5	01Nov2008, 10:31	87.2

Proposed Condition: D10/10A D, Waip1

HEC-HMS 3.5 [K:\study\20258 Kihei Drainage MP\Hydrology\HMS\Pro3\Waipuilani1\Waipuilani1...

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
D10/10A D	0.174	392.1	01Nov2008, 10:04	53.77
Waipuilani Bridge	0.174	392.1	01Nov2008, 10:04	53.77
Waip1	0.106	130.3	01Nov2008, 10:16	26.49
South Kihei Road	0.280	514.6	01Nov2008, 10:11	80.26
Waipuilani Bridge to SKR	0.174	392.1	01Nov2008, 10:11	53.77

Proposed Condition: D11U, D11D, D12D, Keok1_1, Keok1_2

HEC-HMS 3.5 [K:\study\20258 Kihei Drainage MP\Hydrology\HMS\Pro3\Keokea1\Keokea1.hms]

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
D11U	0.427	520.2	01Nov2008, 10:32	135.62
Mauka Offsite Basin	0.427	219.5	01Nov2008, 11:28	98.05
D11D	0.142	276.0	01Nov2008, 10:11	47.72
Piilani Hwy 1-90"	0.569	279.0	01Nov2008, 10:11	145.77
Keok1_1	0.122	259.3	01Nov2008, 10:10	43.96
D12D	0.103	203.0	01Nov2008, 10:11	35.87
Piilani Hwy 1-54"	0.103	203.0	01Nov2008, 10:11	35.87
Makai Basin1	0.794	610.8	01Nov2008, 10:20	225.52
Makai Basin2	0.794	610.9	01Nov2008, 10:20	224.90
Keok1_2	0.266	310.8	01Nov2008, 10:19	66.99
Outlet	1.060	921.4	01Nov2008, 10:20	291.89

Proposed Condition: D12U to D16U, D12D to D16D, D17/18, Keok2_1 to Keok2_4

HEC-HMS 3.5 [K:\study\20258 Kihei Drainage MP\Hydrology\HMS\Pro3\Keokea2\Keokea2.hms]

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
D17/D18	8.533	6087.4	01Nov2008, 11:11	2377.14
D16D	0.121	272.1	01Nov2008, 10:08	43.22
D15U	0.245	286.5	01Nov2008, 10:21	63.55
D16U	0.083	174.9	01Nov2008, 10:06	25.62
D16U Basin	0.328	102.5	01Nov2008, 11:40	83.99
Keokea Bridge	8.982	6234.0	01Nov2008, 11:11	2504.35
Keokea Bridge to Keo...	8.982	6234.0	01Nov2008, 11:13	2502.39
Keok2_1	0.122	308.4	01Nov2008, 10:05	43.26
D15D	0.067	153.6	01Nov2008, 10:08	24.74
Piilani Hwy 1-60" D15D	0.067	153.6	01Nov2008, 10:08	24.74
Keok2_1 Junction	9.171	6305.0	01Nov2008, 11:14	2570.39
D14U	0.430	401.1	01Nov2008, 10:34	110.41
D14U Basin	0.430	171.8	01Nov2008, 11:37	108.74
D14D	0.130	308.7	01Nov2008, 10:07	47.26
Piilani Hwy 1-60" D14D	0.560	394.1	01Nov2008, 10:08	156.00
D13D	0.119	240.1	01Nov2008, 10:10	41.32
D12U	0.023	58.5	01Nov2008, 10:06	8.61
D13U	0.069	153.6	01Nov2008, 10:08	24.89
D13U Basin	0.092	19.1	01Nov2008, 13:50	22.65
Piilani Hwy 2-66"	0.211	253.8	01Nov2008, 10:11	63.97
Keok2_2	0.065	170.1	01Nov2008, 10:02	21.83
Liloa Dr 1-10'x4'	0.836	779.8	01Nov2008, 10:06	241.80
Keok2_3 Junction	10.179	6672.7	01Nov2008, 11:14	2859.56
Keok2_3	0.172	266.8	01Nov2008, 10:11	47.37
Outlet	10.507	6820.6	01Nov2008, 11:13	2954.74
Keok2_4	0.328	447.3	01Nov2008, 10:19	95.18

Proposed Condition: Cy1_2

HEC-HMS 3.5 [K:\study\20258 Kihei Drainage MP\Hydrology\HMS\Pro3\Charlie_Young1\Charlie...

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
Cy1_2	0.040	59.5	01Nov2008, 10:09	10.0
Outlet	0.040	59.5	01Nov2008, 10:09	10.0

Proposed Condition: D17A, D19A1, D19A2, D19, Cy1_1, Cy2_1, Cy2_2

HEC-HMS 3.5 [K:\study\20258 Kihei Drainage MP\Hydrology\HMS\Pro3\Charlie_Young2\Charlie...

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
D19	0.634	558.8	01Nov2008, 11:02	199.0
P19 Basin	0.634	396.3	01Nov2008, 11:46	190.8
Piilani Hwy 1-84"	0.634	396.3	01Nov2008, 11:46	190.8
D19A1	0.181	290.5	01Nov2008, 10:20	62.1
P19A1 Basin	0.181	106.8	01Nov2008, 11:05	59.9
Piilani Hwy 1-7'x5'-1"	0.181	106.8	01Nov2008, 11:05	59.9
D19A2	0.074	153.3	01Nov2008, 10:09	25.4
P19A2 Basin	0.074	54.9	01Nov2008, 10:39	24.2
Piilani Hwy 1-54"	0.074	54.9	01Nov2008, 10:39	24.2
Cy2_1	0.037	96.5	01Nov2008, 10:01	12.3
Alaloa Rd 2-48"	0.926	529.6	01Nov2008, 11:45	287.3
Cy2_2	0.213	402.6	01Nov2008, 10:08	63.7
D17A	0.085	180.2	01Nov2008, 10:07	27.5
P17A Basin	0.085	95.9	01Nov2008, 10:22	26.9
Piilani Hwy 3-60"	0.085	95.9	01Nov2008, 10:22	26.9
D17A to Cy1_1 Junction	0.085	95.9	01Nov2008, 10:29	26.8
Cy1_1	0.032	72.4	01Nov2008, 10:06	10.7
Kupuna St 2-48"	0.117	123.6	01Nov2008, 10:27	37.5
Kalama Park	1.256	727.8	01Nov2008, 10:07	388.6

Proposed Condition: D20, Cy3_1, Cy3_2

HEC-HMS 3.5 [K:\study\20258 Kihei Drainage MP\Hydrology\HMS\Pro3\Charlie_Young3\Charlie...

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
D20	0.559	524.7	01Nov2008, 10:51	169.68
P20 Basin	0.559	436.4	01Nov2008, 11:17	168.25
Piilani Hwy 3-120"	0.559	436.4	01Nov2008, 11:17	168.25
Cy3_1	0.035	95.5	01Nov2008, 10:01	12.09
Auhana Rd 1-60"	0.594	448.4	01Nov2008, 11:16	180.34
Cy3_2	0.062	177.8	01Nov2008, 10:01	23.08
South Kihei Road	0.656	470.6	01Nov2008, 11:15	203.42

Proposed Condition: D21, D22/22A, Kama1_1, Kama1_2, Kama1_3

HEC-HMS 3.5 [K:\study\20258 Kihei Drainage MP\Hydrology\HMS\Pro3\Kamaole1\Kamaole1.hms]

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
D21	5.003	2985.6	01Nov2008, 11:19	1241.66
D22/22A	0.060	112.5	01Nov2008, 10:03	15.11
Kama1_1	0.033	83.0	01Nov2008, 10:02	10.96
Kama1_2	0.035	97.3	01Nov2008, 10:00	12.00
Kama1_3	0.078	209.6	01Nov2008, 10:01	26.29
Piilani Hwy 2-96"	5.003	2985.6	01Nov2008, 11:19	1241.66
Piilani Hwy 3-36"	0.060	112.5	01Nov2008, 10:03	15.11
Kanakanui Rd 2-24'x7'	5.096	3013.3	01Nov2008, 11:18	1267.74
Kulipuu St 1-28'x11'	5.131	3025.0	01Nov2008, 11:19	1279.22
Reach-Ke Alii Sub	5.096	3013.3	01Nov2008, 11:19	1267.22
South Kihei Road	5.209	3051.0	01Nov2008, 11:19	1305.51

Proposed Condition: D23, Kama2_1, Kama2_2, Kama2_3

HEC-HMS 3.5 [K:\study\20258 Kihei Drainage MP\Hydrology\HMS\Pro3\Kamaole2\Kamaole2.hms]

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
D23	0.400	393.6	01Nov2008, 10:31	103.4
D23 Basin	0.400	222.3	01Nov2008, 11:09	81.8
Piilani Hwy 2-78"	0.400	222.3	01Nov2008, 11:09	81.8
Kama2_1	0.026	70.1	01Nov2008, 10:01	8.9
Kama2_1 Junction 2-84"	0.426	231.5	01Nov2008, 11:09	90.6
Kama2_2	0.038	84.1	01Nov2008, 10:04	11.9
Kama2_2 Junction 1-...	0.464	244.8	01Nov2008, 11:08	102.5
Kama2_3	0.077	168.4	01Nov2008, 10:03	22.9
Outlet	0.541	330.0	01Nov2008, 10:03	125.4

Proposed Condition: Kama3

HEC-HMS3.5[K:\study\20258 Kihei Drainage MP\Hydrology\HMS\Pro3\Kamaole3\Kamaole3.hms]

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
Kama3	0.103	205.6	01Nov2008, 10:10	35.16
Outlet	0.103	205.6	01Nov2008, 10:10	35.16

Proposed Condition: D23A, D24/24A/24B, Liil1_1, Liil1_2

HEC-HMS3.5[K:\study\20258KiheiDrainageMP\Hydrology\HMS\Pro3\Liilioholo1\Liilioholo1.hms]

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
D23A	0.022	41.7	01Nov2008, 10:01	5.34
D24/24A/24B	4.150	2990.0	01Nov2008, 10:54	1039.54
Liil1_1	0.070	163.4	01Nov2008, 10:00	20.30
Liil1_2	0.058	116.3	01Nov2008, 10:07	17.64
Piilani Hwy 1-42"	0.022	41.7	01Nov2008, 10:01	5.34
Piilani Hwy 3 culverts	4.150	2990.0	01Nov2008, 10:54	1039.54
D23A-D24 Junction1	4.172	2996.8	01Nov2008, 10:56	1044.09
South Kihei Road	4.242	3021.3	01Nov2008, 10:57	1063.99
Outlet	4.300	3044.7	01Nov2008, 10:57	1081.63
D24 to Junction1	4.150	2990.0	01Nov2008, 10:56	1038.75
Junction 1 to SKR	4.172	2996.8	01Nov2008, 10:57	1043.68

Proposed Condition: D25, Liil1_3, Liil2_2, Liil2_2

HEC-HMS3.5[K:\study\20258KiheiDrainageMP\Hydrology\HMS\Pro3\Liilioholo2\Liilioholo2.hms]

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
D25	0.204	236.5	01Nov2008, 10:16	48.45
Liil2_1	0.022	48.5	01Nov2008, 10:04	6.68
Liil2_2	0.181	343.5	01Nov2008, 10:03	47.40
Liil1_3	0.087	226.1	01Nov2008, 10:03	30.12
Piilani Hwy 2-66"	0.204	236.5	01Nov2008, 10:16	48.45
Liil2_1 Junction 2-66"	0.226	264.4	01Nov2008, 10:14	55.13
Outlet	0.494	781.6	01Nov2008, 10:04	132.65

Proposed Condition: Liil3

HEC-HMS3.5[K:\study\20258KiheiDrainageMP\Hydrology\HMS\Pro3\Liilioholo3\Liilioholo3.hms]

Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
0.086	125.0	01Nov2008, 10:09	20.97
0.086	125.0	01Nov2008, 10:09	20.97

Proposed Condition: D26, D27, D28, D29, Kilo1_1 to Kilo1_7

HEC-HMS 3.5 [K:\study\20258 Kihei Drainage MP\Hydrology\HMS\Pro3\Kilohana1\Kilohana1.hms]

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
D26	0.145	175.2	01Nov2008, 10:14	33.92
D27	0.044	76.4	01Nov2008, 10:07	12.01
D28	0.031	73.0	01Nov2008, 10:03	9.79
D29	0.754	717.6	01Nov2008, 10:37	202.89
Kilo1_1	0.015	35.2	01Nov2008, 10:02	4.56
Kilo1_2	0.045	77.1	01Nov2008, 10:04	11.06
Kilo1_3	0.011	32.1	01Nov2008, 09:58	3.76
Kilo1_4	0.009	23.6	01Nov2008, 09:59	2.83
Kilo1_5	0.014	31.7	01Nov2008, 10:01	4.04
Kilo1_6	0.054	133.5	01Nov2008, 10:01	16.98
Kilo1_7	0.069	122.1	01Nov2008, 10:04	17.32
Piilani Hwy 1-84"	0.754	717.6	01Nov2008, 10:37	202.89
Piilani Hwy 1-30"	0.031	73.0	01Nov2008, 10:03	9.79
Piilani Hwy 2-42"	0.044	76.4	01Nov2008, 10:07	12.01
Piilani Hwy 3-48"	0.145	175.2	01Nov2008, 10:14	33.92
Kapili St 2-66"	0.800	741.6	01Nov2008, 10:36	217.24
Kilohana Dr 4-54"	0.845	762.3	01Nov2008, 10:36	228.30
Kilohana Dr 2-42"	0.055	98.6	01Nov2008, 10:04	15.77
Kauhale St 1-54"	0.064	119.7	01Nov2008, 10:03	18.60
KauhaleSt 1-72"	0.159	190.8	01Nov2008, 10:12	37.97
Kilohana Dr 4-72"x44"	1.122	950.9	01Nov2008, 10:28	301.85
South Kihei Road	1.191	1026.3	01Nov2008, 10:06	319.17
Kilohana Mauka Subd	0.223	290.9	01Nov2008, 10:07	56.57

Proposed Curve Number

Proposed Condiiton

CombinedNa	Class Name
Hokulani Golf Villas	Res 1/3 ac
Ka`Ono`Ulu Affordable Apts.	Res 1/8 ac
Cove Beach Villas	Res 1/8 ac
Hale Pama Condos	Res 1/8 ac
Ho'onani Homes	Res 1/3 ac
Maui Lu Timeshare	Res 1/8 ac
Paradise Ridge Estates	Res 1/8 ac
Honua`ula	Res 1/8 ac
Nu`u Aina Golf Highlands	Res 1/4 ac
Andaz Maui Hotel	Res 1/8 ac
Erehwon Ranch Center	park f
Kula Lodge Project District 1	Res 1/4 ac
Kihei Hanalei Condominiums	Res 1/8 ac
Liloa Village	Res 1/4 ac
Kalama Heights Ph. 2	Res 1/8 ac
Pacific Plaza	Res 1/8 ac
CarQuest Bldgs	Commercial
Ka `Ono `Ulu Village	Res 1/4 ac
Kulanihakoi Residences	Res 1/4 ac
Kihei Kaiwahine Res. A&B	Res 1/4 ac
Keokea/Waiohuli Subdivision DHHL	Res 1 ac
Kihei Seventh Day Adventist Church PreSchool	Res 1 ac-open f
Kamaole Heights	Res 1/8 ac
Ohukai Village Planned	Res 1/4 ac
Kalama Hills	Res 1/4 ac
Kula Senior Housing	Res 1/8 ac
Kula Ridge Affordable Homes	Res 1/2 ac
Maui Beach Place	Commercial
Tae Murphy Office Bldg	Commercial
Jim Stewart Office Bldg	Commercial
South Maui Police Complex	Res 1 ac
Emergency Ambulance Stn	Commercial
Walaka Village Apts	Res 1/8 ac
Maui Research & Tech Park Urban	Res 1/8 ac
Maui Research & Tech Park	Industrial
Kaiwahine Village	Res 1/8 ac
Kihei Rentals & Supplies	Commercial
Alahele Homes	Res 1/4 ac
Ka`Ono`Ulu Ph. 6 Condos	Res 1/8 ac
Nani Loa Condos	Res 1/8 ac
Keokea Homestead DHHL	Res 1 ac-open f
Piilani Place	Res 1/8 ac
Wailea SF-8	Res 1/4 ac
Sunset Estates	Res 1/4 ac

CombinedNa	Class Name
Kihei High School	Res 1 ac-open f
Wailea MF-7 Kila Wailea	Res 1/4 ac
Maui Outlets Center	Commercial
Pi`ilani Promenade	Commercial
	Commercial
	Commercial
Wailea SF-58	Res 1/3 ac
Wailea Mixed Use Village	Res 1/2 ac
Kihei Pi`ikea Town Center	Res 1/8 ac
Andaz Residences	Res 1/3 ac
R&T Park Residences	Res 1/8 ac
Maui Brewing Comp.	Commercial
Kihei Wellness Center	Commercial

Proposed Condiiton

Class Name	A	B	C	D
1/8	77	85	90	92
1/4	61	75	83	87
1/3	57	72	81	86
1/2	54	70	80	85
1	51	68	79	84
Business	89	92	94	95
Commercial	89	92	94	95
Industrial	81	88	91	93
Open f	49	69	79	84
1/open f	50	69	79	84
Park f	49	69	79	84

Kihei Drainage Master Plan
Propsosed Condition - Weighted CN

REF: 1-20258-0E
PREPARED BY: TL
DATE: 8/31/15

Subbasin 1

Class_name	HSG	Area_AC	CN	AreaxCN
Open Space Developed	C	8.73096E-06	74	0.0006461
Bare Land	A	86.28247438	77	6643.7505
Bare Land	B	19.79220258	86	1702.1294
Bare Land	C	388.8064521	91	35381.387
Bare Land	D	0.428672287	94	40.295195
Cultivated Land	A	11.98832649	62	743.27624
Cultivated Land	B	209.9673605	71	14907.683
Cultivated Land	C	293.3456061	78	22880.957
Cultivated Land	D	3.582350529	81	290.17039
Erehwon Ranch Center	B	1.413780684	69	97.550867
Evergreen	A	1.865427473	25	46.635687
Evergreen	B	1096.397261	55	60301.849
Evergreen	C	35.18306866	70	2462.8148
Evergreen	D	84.03614678	77	6470.7833
Grassland	A	1.397713571	39	54.510829
Grassland	B	568.1541118	61	34657.401
Grassland	C	175.6298478	74	12996.609
Grassland	D	21.49105651	80	1719.2845
Impervious Surface	A	2.727823759	95	259.14326
Impervious Surface	B	194.5354297	95	18480.866
Impervious Surface	C	9.947508729	95	945.01333
Impervious Surface	D	4.774587024	95	453.58577
Kaiwahine Village	C	5.328540963	90	479.56869
Kihei Kaiwahine Res. A&B	A	3.413487315	61	208.22273
Kihei Kaiwahine Res. A&B	B	11.41948781	75	856.46159
Kihei Kaiwahine Res. A&B	C	85.263873	83	7076.9015
Kula Senior Housing	B	0.954752169	85	81.153934
Ohukai Village Planned	C	25.50398054	83	2116.8304
Open Space Developed	A	0.21767738	39	8.4894178
Open Space Developed	B	378.32141	61	23077.606
Open Space Developed	C	2.347441067	74	173.71064
Open Space Developed	D	8.595615456	80	687.64924
Open Water	B	0.235997086	100	23.599709
Pasture/Hay	B	64.1543059	61	3913.4127
Scrub Shrub	A	0.388184494	45	17.468302
Scrub Shrub	B	1597.426525	66	105430.15
Scrub Shrub	C	887.2044182	77	68314.74
Scrub Shrub	D	56.3308733	83	4675.4625
Sum		6338.85378678708		438677.12
Weighted CN				**69.2**

Subbasin 2D

Class_name	HSG	Area_AC	CN	AreaxCN
Scrub Shrub	C	0.000103804	77	0.0079929
Evergreen	C	3.264348957	70	228.50443
Grassland	C	0.252751406	74	18.703604
Impervious Surface	A	0.14984648	95	14.235416
Impervious Surface	C	50.6260607	95	4809.4758
Kaiwahine Village	C	4.515866088	90	406.42795
Kihei Kaiwahine Res. A&B	A	0.022046252	61	1.3448213
Kihei Kaiwahine Res. A&B	C	1.581298959	83	131.24781
Ohukai Village Planned	C	4.649133956	83	385.87812
Open Space Developed	A	0.050363551	39	1.9641785
Open Space Developed	C	24.86860869	74	1840.277
Scrub Shrub	C	1.459185628	77	112.35729
Sum		91.43961447		7950.4244
Weighted CN				**86.9**

Subbasin 2U				
Class_name	HSG	Area_AC	CN	AreaxCN
Kaiwahine Village	C	0.022316262	90	2.0084636
Ohukai Village Planned	C	15.39696365	83	1277.948
Scrub Shrub	C	0.008424341	77	0.6486742
Sum		15.42770425		1280.6051
Weighted CN				**83.0**

Subbasin 3D				
Class_name	HSG	Area_AC	CN	AreaxCN
Evergreen	C	4.268033794	70	298.76237
Impervious Surface	C	32.84897366	95	3120.6525
Ohukai Village Planned	C	0.841380168	83	69.834554
Open Space Developed	C	15.7291608	74	1163.9579
Scrub Shrub	C	1.818740801	77	140.04304
Sum		55.50628922		4793.2504
Weighted CN				**86.4**

Subbasin 3U

Class_name	HSG	Area_AC	CN	AreaxCN
Ohukai Village Planned	C	3.816045547	**83**	

Subbasin 4D

Class_name	HSG	Area_AC	CN	AreaxCN
Cultivated Land	C	0.180840351	78	14.105547
Evergreen	C	2.894979703	70	202.64858
Grassland	C	1.31409874	74	97.243307
Impervious Surface	C	37.73839995	95	3585.148
Ohukai Village Planned	C	1.798990277	83	149.31619
Open Space Developed	C	20.10357953	74	1487.6649
Scrub Shrub	C	3.84772777	77	296.27504
Sum		67.87861632		5832.4015
Weighted CN				**85.9**

Subbasin 4D

Class_name	HSG	Area_AC	CN	AreaxCN
Ohukai Village Planned	C	34.55870956	83	2868.3729
Scrub Shrub	C	0.275222175	77	21.192107
Sum		34.83393173		2889.565
Weighted CN				**83.0**

Subbasin 5

Class_name	HSG	Area_AC	CN	AreaxCN
Open Space Developed	C	5.14401E-06	74	0.0003807
Cultivated Land	C	0.20186233	78	15.745262
Grassland	C	1.429489185	74	105.7822
Impervious Surface	C	8.099005383	95	769.40551
Open Space Developed	C	0.894459277	74	66.189987
Piilani Place	C	1.283840177	90	115.54562
Piilani Placen Space Developed	C	1.30576E-05	90	0.0011752
Scrub Shrub	C	1.589897574	77	122.42211
Sum		13.49857213		1195.0922
Weighted CN				**88.5**

Subbasin 6D

Class_name	HSG	Area_AC	CN	AreaxCN
Cultivated Land	C	10.7217991	78	836.30033
Grassland	C	0.868248549	74	64.250393
Impervious Surface	C	8.403074707	95	798.2921
Ka`Ono`Ulu Affordable Apts.	C	2.197867617	90	197.80809
Maui Outlets Center	C	7.401721888	94	695.76186
Ohukai Village Planned	C	11.0737534	83	919.12153
Open Space Developed	C	0.786758078	74	58.220098
Open Water	C	0.230347641	100	23.034764
Piilani Place	C	0.375953307	90	33.835798
Scrub Shrub	C	10.12439763	77	779.57862
Sum		52.18392192		4406.2036
Weighted CN				**84.4**

Subbasin 6U

Class_name	HSG	Area_AC	CN	AreaxCN
Ohukai Village Planned	C	10.19792908	**83**	

Subbasin 7

Class_name	HSG	Area_AC	CN	AreaxCN
Bare Land	C	2.010590576	91	182.96374
Cultivated Land	C	0.400431239	78	31.233637
Evergreen	C	0.568741635	70	39.811914
Grassland	B	0.008868536	61	0.5409807
Grassland	C	47.10323067	74	3485.6391
Impervious Surface	C	1.709283148	95	162.3819
Ka `Ono `Ulu Village	C	29.83312717	83	2476.1496
Ka`Ono`Ulu Affordable Apts.	C	11.1986153	90	1007.8754

Maui Outlets Center	C	24.16796687	94	2271.7889
Ohukai Village Planned	C	67.85655415	83	5632.094
Open Space Developed	C	1.369989723	74	101.37924

Pi`ilani Promenade	C	2.086347102	94	196.11663
Scrub Shrub	B	3.534556131	66	233.2807
Scrub Shrub	C	334.5701606	77	25761.902
Sum		526.4184629		41583.158

Weighted CN **79.0**

Subbasin 8

Class_name	HSG	Area_AC	CN	AreaxCN
Evergreen	A	0.161056532	25	4.0264133
Scrub Shrub	C	4.658514968	77	358.70565
Bare Land	A	98.08383411	77	7552.4552
Bare Land	B	16.34501981	86	1405.6717
Bare Land	C	94.69204746	91	8616.9763
Cultivated Land	B	95.12111443	78	7419.4469
Evergreen	B	2058.290175	55	113205.96
Evergreen	C	102.5915825	70	7181.4108
Grassland	A	0.441415253	39	17.215195
Grassland	B	1200.253489	61	73215.463
Grassland	C	137.0583413	74	10142.317
Impervious Surface	A	0.705026579	95	66.977525
Impervious Surface	B	82.49716611	95	7837.2308
Impervious Surface	C	20.70041567	95	1966.5395
Ka `Ono `Ulu Village	C	225.593953	83	18724.298
Ka`Ono`Ulu Affordable Apts.	C	0.002669163	90	0.2402247
Keokea Homestead DHHL	C	30.50774482	79	2410.1118
Kihei High School	A	0.310745986	49	15.226553
Kihei High School	C	28.91989001	79	2284.6713
Ohukai Village Planned	C	0.039493659	83	3.2779737
Open Space Developed	B	91.91479391	61	5606.8024
Open Space Developed	C	0.254936806	74	18.865324
Open Water	B	0.264435225	100	26.443523
Pasture/Hay	B	304.3163186	61	18563.295
Pi`ilani Promenade	A	0.104407217	89	9.2922424
Pi`ilani Promenade	C	36.65309659	94	3445.3911
Scrub Shrub	A	59.17937011	45	2663.0717
Scrub Shrub	B	1323.394902	66	87344.064
Scrub Shrub	C	3565.540168	77	274546.59
Sum		9578.596124		654652.04

Weighted CN **68.3**

Subbasin 9

Class_name	HSG	Area_AC	CN	AreaxCN
Evergreen	A	0.990961621	25	24.774041
Development	C	38.60772888	83	3204.4415
Development	A	0.020982654	61	1.2799419
Evergreen	C	0.113445959	70	7.9412171

Grassland	A	0.772312819	39	30.1202
Grassland	C	31.4413722	74	2326.6615
Impervious Surface	A	0.030297918	95	2.8783022
Impervious Surface	C	0.231644712	95	22.006248
Ka `Ono `Ulu Village	C	15.39147006	83	1277.492
Kihei High School	C	18.54012163	79	1464.6696
Open Space Developed	A	0.046584265	39	1.8167863
Open Space Developed	C	0.057480459	74	4.253554
Scrub Shrub	C	12.31836418	77	948.51404
Sum		118.5627674		9316.849
Weighted CN				**78.6**

Subbasin 10/10A D

Class_name	HSG	Area_AC	CN	AreaxCN
Evergreen	A	0.104999151	25	2.6249788
Grassland	C	7.794889625	74	576.82183
Evergreen	A	0.292340116	25	7.3085029
Evergreen	C	9.892614657	70	692.48303
Grassland	A	0.034881034	39	1.3603603
Grassland	C	39.87380441	74	2950.6615
Impervious Surface	A	0.00929823	95	0.8833319
Impervious Surface	C	0.262962905	95	24.981476
Ka `Ono `Ulu Village	C	0.287629518	83	23.87325
Kulanihakoi Residences	C	14.66709356	83	1217.3688
Maui Research & Tech Park	C	5.49935562	91	500.44136
Maui Research & Tech Park Urban	C	1.087157408	90	97.844167
Open Space Developed	A	0.360758738	39	14.069591
Open Space Developed	C	3.889419151	74	287.81702
R&T Park Residences	C	1.581081612	90	142.29735
Scrub Shrub	A	0.002268889	45	0.1021
Scrub Shrub	C	25.46146779	77	1960.533
Sum		111.1020224		8501.4717
Weighted CN				**76.5**

Subbasin 10/10A U

Class_name	HSG	Area_AC	CN	AreaxCN
Grassland	B	6.69755E-05	61	0.0040855
Scrub Shrub	C	1.11841E-05	77	0.0008612
Bare Land	A	40.85884465	77	3146.131
Bare Land	B	40.91468521	86	3518.6629
Bare Land	C	18.08320395	91	1645.5716
Cultivated Land	B	39.87153434	71	2830.8789
Evergreen	A	0.726451663	25	18.161292
Evergreen	B	2027.004461	55	111485.25
Evergreen	C	20.8109562	70	1456.7669
Grassland	A	20.50270087	39	799.60533
Grassland	B	333.9158009	61	20368.864
Grassland	C	18.52879516	74	1371.1308

Impervious Surface	A	1.470558696	95	139.70308
Impervious Surface	B	163.4687574	95	15529.532
Impervious Surface	C	2.274546684	95	216.08193
Ka `Ono `Ulu Village	C	1.44879696	83	120.25015
Keokea Homestead DHHL	B	974.5857974	69	67246.42
Keokea Homestead DHHL	C	1119.13809	79	88411.909
Keokea/Waiohuli Subdivision DHHL	B	51.94571958	68	3532.3089
Maui Research & Tech Park	C	4.980287056	91	453.20612
Open Space Developed	B	289.2912089	61	17646.764
Open Water	B	0.35400186	100	35.400186
Pasture/Hay	B	50.74826576	61	3095.6442
R&T Park Residences	C	6.806511015	90	612.58599
Scrub Shrub	A	243.6315756	45	10963.421
Scrub Shrub	B	1020.505905	66	67353.39
Scrub Shrub	C	587.7829927	77	45259.29
Sum		7079.650527		467256.93
Weighted CN				**66.0**

Subbasin 11D

Class_name	HSG	Area_AC	CN	AreaxCN
Bare Land	C	1.887568212	91	171.76871
Evergreen	A	0.15593	25	3.89825
Evergreen	C	5.802032202	70	406.14225
Grassland	C	0.594831139	74	44.017504
Hokulani Golf Villas	C	10.17854488	81	824.46214
Impervious Surface	A	0.000109516	95	0.010404
Impervious Surface	C	1.082095097	95	102.79903
Kulanihakoi Residences	C	25.09041652	83	2082.5046
Maui Research & Tech Park Urban	C	3.888308439	90	349.94776
Open Space Developed	A	0.23682114	39	9.2360245
Open Space Developed	C	21.56293605	74	1595.6573
Open Water	C	0.578709161	100	57.870916
R&T Park Residences	C	12.94254954	90	1164.8295
Scrub Shrub	A	0.098236181	45	4.4206281
Scrub Shrub	C	7.020584569	77	540.58501
Sum		91.11967265		7358.1499
Weighted CN				**80.8**

Subbasin 11U

Class_name	HSG	Area_AC	CN	AreaxCN
Scrub Shrub	C	0.000450356	77	0.0346774
Grassland	C	0.068112681	74	5.0403384
Impervious Surface	B	0.228560428	95	21.713241
Impervious Surface	C	0.412771924	95	39.213333
Maui Research & Tech Park	C	32.66290887	91	2972.3247
Maui Research & Tech Park Urban	C	28.60595617	90	2574.5361

R&T Park Residences	C	50.46110162	90	4541.4991
Scrub Shrub	B	94.37455083	66	6228.7204
Scrub Shrub	C	66.72198113	77	5137.5925
Sum		273.536394		21520.674

Weighted CN **78.7**

Subbasin 12D

Class_name	HSG	Area_AC	CN	AreaxCN
Bare Land	C	0.000171527	91	0.0156089
Bare Land	C	2.86149093	91	260.39567
Evergreen	C	2.270911323	70	158.96379
Grassland	C	0.515475498	74	38.145187
Hokulani Golf Villas	C	27.79791702	81	2251.6313
Impervious Surface	C	0.867289991	95	82.392549
Maui Research & Tech Park	C	0.191980587	91	17.470233
Maui Research & Tech Park Urban	C	12.07845487	90	1087.0609
Open Space Developed	C	9.76912232	74	722.91505
R&T Park Residences	C	7.094492894	90	638.50436
Scrub Shrub	C	2.337610066	77	179.99598
Sum		65.78491702		5437.4906

Weighted CN **82.7**

Subbasin 12U

Class_name	HSG	Area_AC	CN	AreaxCN
Impervious Surface	C	0.124598087	95	11.836818
Maui Research & Tech Park	C	10.47694265	91	953.40178
Scrub Shrub	C	4.190340279	77	322.6562
Sum		14.79188102		1287.8948

Weighted CN **87.1**

Subbasin 13D

Class_name	HSG	Area_AC	CN	AreaxCN
Bare Land	C	5.46121E-06	91	0.000497
Bare Land	C	0.995740268	91	90.612364
Evergreen	C	10.19774309	70	713.84202
Grassland	C	2.214991364	74	163.90936
Hokulani Golf Villas	C	4.165540817	81	337.40881
Impervious Surface	C	12.78825382	95	1214.8841
Maui Brewing Comp.	C	5.175046192	94	486.45434
Maui Research & Tech Park	C	0.12985776	91	11.817056
Maui Research & Tech Park Urban	C	15.12566417	90	1361.3098
Open Space Developed	C	15.54951978	74	1150.6645
R&T Park Residences	C	0.022342336	90	2.0108102
Scrub Shrub	C	9.723215116	77	748.68756
Sum		76.08792018		6281.6012

Weighted CN **82.6**

Subbasin 13U

Class_name	HSG	Area_AC	CN	AreaxCN
Bare Land	C	0.502002503	91	45.682228
Impervious Surface	C	0.319808144	95	30.381774
Maui Research & Tech Park	C	24.51809044	91	2231.1462
Scrub Shrub	C	19.04221836	77	1466.2508
Sum		44.38211945		3773.461
Weighted CN				**85.0**

Subbasin 14D

Class_name	HSG	Area_AC	CN	AreaxCN
Bare Land	C	1.495827375	91	136.12029
Evergreen	C	5.152579899	70	360.68059
Grassland	C	0.008852801	74	0.6551073
Impervious Surface	C	7.219211942	95	685.82513
Maui Research & Tech Park	C	10.08780345	91	917.99011
Maui Research & Tech Park Urban	C	30.86845165	90	2778.1606
Nu`u Aina Golf Highlands	C	8.647120444	83	717.711
Open Space Developed	C	10.65687287	74	788.60859
Open Water	C	0.299285624	100	29.928562
Scrub Shrub	C	8.487643615	77	653.54856
Sum		82.92364966		7069.2286
Weighted CN				**85.2**

Subbasin 14U

Class_name	HSG	Area_AC	CN	AreaxCN
Bare Land	C	3.186472369	91	289.96899
Impervious Surface	B	0.875954855	95	83.215711
Impervious Surface	C	2.57210408	95	244.34989
Keokea Homestead DHHL	B	31.93396209	69	2203.4434
Keokea Homestead DHHL	C	4.590108906	79	362.6186
Maui Research & Tech Park	C	0.10633767	91	9.676728
Scrub Shrub	B	182.2824278	66	12030.64
Scrub Shrub	C	49.89053569	77	3841.5712
Sum		275.4379035		19065.485
Weighted CN				**69.2**

Subbasin 15D

Class_name	HSG	Area_AC	CN	AreaxCN
Bare Land	C	0.141890397	91	12.912026
Evergreen	C	2.031243111	70	142.18702
Impervious Surface	C	0.310252662	95	29.474003
Maui Research & Tech Park	C	28.43814479	91	2587.8712
Maui Research & Tech Park Urban	C	0.028885727	90	2.5997154
Nu`u Aina Golf Highlands	C	3.230829856	83	268.15888

Open Space Developed	C	6.976079692	74	516.2299
Open Water	C	0.080359868	100	8.0359868
Scrub Shrub	C	1.901109826	77	146.38546
Sum		43.13879593		3713.8542
Weighted CN				**86.1**

Subbasin 15U

Class_name	HSG	Area_AC	CN	AreaxCN
Bare Land	C	0.376167948	91	34.231283
Impervious Surface	B	0.144475343	95	13.725158
Impervious Surface	C	3.068091508	95	291.46869
Scrub Shrub	B	128.5175268	66	8482.1568
Scrub Shrub	C	24.7475786	77	1905.5636
Sum		156.8538402		10727.145
Weighted CN				**68.4**

Subbasin 16D

Class_name	HSG	Area_AC	CN	AreaxCN
Impervious Surface	C	9.89851E-06	95	0.0009404
Bare Land	C	0.362132574	91	32.954064
Evergreen	C	8.858635705	70	620.1045
Grassland	C	0.136505786	74	10.101428
Impervious Surface	C	0.909827935	95	86.433654
Maui Research & Tech Park	C	44.07271242	91	4010.6168
Nu`u Aina Golf Highlands	C	4.855248677	83	402.98564
Open Space Developed	C	12.84438175	74	950.48425
Scrub Shrub	C	5.091909136	77	392.077
Sum		77.13136389		6505.7583
Weighted CN				**84.3**

Subbasin 16U

Class_name	HSG	Area_AC	CN	AreaxCN
Bare Land	C	2.166733247	91	197.17273
Impervious Surface	C	0.673168276	95	63.950986
Scrub Shrub	B	4.260947362	66	281.22253
Scrub Shrub	C	45.78650765	77	3525.5611
Sum		52.88735653		4067.9073
Weighted CN				**76.9**

Subbasin 17A

Class_name	HSG	Area_AC	CN	AreaxCN
Bare Land	C	7.730816994	91	703.50435
Cultivated Land	C	0.066296619	78	5.1711363
Evergreen	C	2.361758226	70	165.32308
Grassland	C	8.813025502	74	652.16389
Impervious Surface	C	3.077540845	95	292.36638

Maui Research & Tech Park	C	0.017492855	91	1.5918498
Open Space Developed	C	3.689606741	74	273.0309
Scrub Shrub	C	28.42257296	77	2188.5381
Sum		54.17911074		4281.6897
Weighted CN				**79.0**

Subbasin 17/18

Class_name	HSG	Area_AC	CN	AreaxCN
Grassland	A	0.000278893	39	0.0108768
Open Space Developed	B	0.000216519	61	0.0132077
Bare Land	A	4.693280868	77	361.38263
Bare Land	C	4.938769867	91	449.42806
Cultivated Land	B	3.126737086	71	221.99833
Cultivated Land	C	11.76184154	78	917.42364
Evergreen	A	39.28089394	25	982.02235
Evergreen	B	1386.478495	55	76256.317
Evergreen	C	24.05142505	70	1683.5998
Grassland	A	44.34036586	39	1729.2743
Grassland	B	522.8542048	61	31894.106
Grassland	C	9.360613049	74	692.68537
Impervious Surface	A	6.38259498	95	606.34652
Impervious Surface	B	48.12376901	95	4571.7581
Impervious Surface	C	7.261909679	95	689.88142
Keokea Homestead DHHL	A	96.02044132	50	4801.0221
Keokea Homestead DHHL	B	1378.275783	69	95101.029
Keokea Homestead DHHL	C	430.8926019	79	34040.516
Keokea/Waiohuli Subdivision DHHL	A	24.72545337	51	1260.9981
Keokea/Waiohuli Subdivision DHHL	B	206.6451673	68	14051.871
Maui Research & Tech Park	C	8.244081332	91	750.2114
Open Space Developed	B	85.66773714	61	5225.732
Open Space Developed	C	15.37965582	74	1138.0945
Open Water	B	0.123690402	100	12.36904
Open Water	C	0.493396203	100	49.33962
Pasture/Hay	B	92.71056634	61	5655.3445
Pasture/Hay	C	0.930522841	74	68.85869
Scrub Shrub	A	235.0990487	45	10579.457
Scrub Shrub	B	642.5099511	66	42405.657
Scrub Shrub	C	131.0002916	77	10087.022
Sum		5461.373784		346283.77
Weighted CN				**63.4**

Subbasin 19

Class_name	HSG	Area_AC	CN	AreaxCN
Bare Land	C	6.639210221	91	604.16813
Cultivated Land	B	2.93875557	71	208.65165
Cultivated Land	C	79.64946661	78	6212.6584
Evergreen	C	0.25816686	70	18.07168
Grassland	B	0.459942357	61	28.056484
Grassland	C	18.54681198	74	1372.4641
Impervious Surface	B	0.089380461	95	8.4911438
Impervious Surface	C	7.399782191	95	702.97931
Keokea Homestead DHHL	B	52.17020811	69	3599.7444
Keokea Homestead DHHL	C	157.511551	79	12443.413
Open Space Developed	C	0.33601964	74	24.865453
Scrub Shrub	B	43.98341267	66	2902.9052
Scrub Shrub	C	35.60606295	77	2741.6668
Sum		405.5887706		30868.135
Weighted CN				**76.1**

Subbasin 19A1

Class_name	HSG	Area_AC	CN	AreaxCN
Bare Land	C	21.59282037	91	1964.9467
Cultivated Land	C	19.41029449	78	1514.003
Evergreen	C	0.787620422	70	55.13343
Grassland	C	5.743233924	74	424.99931
Impervious Surface	C	17.11588085	95	1626.0087
Open Space Developed	C	2.83322005	74	209.65828
Scrub Shrub	C	48.3935467	77	3726.3031
Sum		115.8766168		9521.0524
Weighted CN				**82.2**

Subbasin 19A2

Class_name	HSG	Area_AC	CN	AreaxCN
Bare Land	C	12.78512706	91	1163.4466
Cultivated Land	C	1.239480977	78	96.679516
Evergreen	C	0.932181405	70	65.252698
Grassland	C	8.488564382	74	628.15376
Impervious Surface	C	5.648701435	95	536.62664
Scrub Shrub	C	18.30592675	77	1409.5564
Sum		47.39998201		3899.7155
Weighted CN				**82.3**

Subbasin 20

Class_name	HSG	Area_AC	CN	AreaxCN
Bare Land	B	0.502144597	86	43.184435
Bare Land	C	11.31616498	91	1029.771
Cultivated Land	C	14.63072646	78	1141.1967
Evergreen	B	1.09364724	55	60.150598
Evergreen	C	26.56489164	70	1859.5424
Grassland	C	2.369142837	74	175.31657
Impervious Surface	B	0.254202317	95	24.14922

Impervious Surface	C	4.847637255	95	460.52554
Keokea Homestead DHHL	B	5.322740702	69	367.26911
Keokea Homestead DHHL	C	107.469781	79	8490.1127
Open Space Developed	C	1.18113149	74	87.40373
Scrub Shrub	B	71.38268322	66	4711.2571
Scrub Shrub	C	77.73370155	77	5985.495
South Maui Police Complex	C	33.09598287	80	2647.6786
Sum		357.7645781		27083.053
Weighted CN				**75.7**

Subbasin 21

Class_name	HSG	Area_AC	CN	AreaxCN
Grassland	A	9.36197E-05	39	0.0036512
Scrub Shrub	C	1.25142E-05	77	0.0009636
Bare Land	B	0.990015815	86	85.14136
Bare Land	C	3.710628666	91	337.66721
Evergreen	A	79.1769617	25	1979.424
Evergreen	B	142.7127323	55	7849.2003
Evergreen	C	41.80808048	70	2926.5656
Grassland	A	232.4715588	39	9066.3908
Grassland	B	49.06710229	61	2993.0932
Grassland	C	16.350163	74	1209.9121
Impervious Surface	A	7.613474612	95	723.28009
Impervious Surface	B	12.36854003	95	1175.0113
Impervious Surface	C	2.309531076	95	219.40545
Keokea Homestead DHHL	A	171.1959373	50	8559.7969
Keokea Homestead DHHL	B	279.4722139	69	19283.583
Keokea Homestead DHHL	C	302.6234283	79	23907.251
Keokea/Waiohuli Subdivision DHHL	A	43.50140921	51	2218.5719
Open Space Developed	A	0.701482403	39	27.357814
Open Space Developed	B	1.201144673	61	73.269825
Pasture/Hay	A	172.6514824	39	6733.4078
Pasture/Hay	B	543.804342	61	33172.065
Scrub Shrub	A	120.4603283	45	5420.7148
Scrub Shrub	B	818.9148137	66	54048.378
Scrub Shrub	C	139.8880291	77	10771.378
South Maui Police Complex	B	8.535025347	70	597.45177
South Maui Police Complex	C	10.61563648	80	849.25092
Sum		3202.144168		194227.57
Weighted CN				**60.7**

Subbasin 22/22A				
Class_name	HSG	Area_AC	CN	AreaxCN
Bare Land	B	1.244282199	86	107.00827
Bare Land	C	0.964642828	91	87.782497
Grassland	B	0.107680223	61	6.5684936
Grassland	C	0.603756107	74	44.677952
Impervious Surface	B	0.361793603	95	34.370392
Impervious Surface	C	0.305302271	95	29.003716
Scrub Shrub	B	34.61937302	66	2284.8786
Scrub Shrub	C	0.150072228	77	11.555562
Sum		38.35690248		2605.8455
Weighted CN				**67.9**

Subbasin 23

Class_name	HSG	Area_AC	CN	AreaxCN
Bare Land	B	0.46657563	86	40.125504
Bare Land	C	0.015170495	91	1.3805151
Evergreen	B	0.017250171	55	0.9487594
Evergreen	C	1.797890294	70	125.85232
Grassland	B	2.304945094	61	140.60165
Grassland	C	0.014333996	74	1.0607157
Impervious Surface	B	1.643975335	95	156.17766
Impervious Surface	C	0.262951015	95	24.980346
Scrub Shrub	B	230.9365393	66	15241.812
Scrub Shrub	C	18.30668516	77	1409.6148
Sum		255.7663165		17142.554
Weighted CN				**67.0**

Subbasin 23A

Class_name	HSG	Area_AC	CN	AreaxCN
Grassland	B	1.598860955	61	97.530518
Impervious Surface	B	0.386690223	95	36.735571
Scrub Shrub	B	12.00972435	66	792.64181
Sum		13.99527553		926.9079
Weighted CN				**66.2**

Subbasin 24

Class_name	HSG	Area_AC	CN	AreaxCN
Bare Land	A	0.204732264	77	15.764384
Bare Land	B	3.917948123	86	336.94354
Bare Land	C	0.432227656	91	39.332717
Cultivated Land	B	0.786227795	71	55.822173
Evergreen	A	219.055021	25	5476.3755
Evergreen	B	238.525071	55	13118.879
Evergreen	C	9.152226477	70	640.65585
Grassland	A	43.9216424	39	1712.9441
Grassland	B	219.8046065	61	13408.081
Grassland	C	0.750637651	74	55.547186
Grassland	D	0.119741773	80	9.5793418
Impervious Surface	A	5.88138381	95	558.73146

Impervious Surface	B	25.07024259	95	2381.673
Impervious Surface	C	0.153171114	95	14.551256
Impervious Surface	D	0.233774555	95	22.208583
Open Space Developed	A	5.228387206	39	203.9071
Open Space Developed	B	13.78746686	61	841.03548
Pasture/Hay	A	99.277701	39	3871.8303
Pasture/Hay	B	433.4989895	61	26443.438
Pasture/Hay	D	30.93910369	80	2475.1283
Scrub Shrub	A	157.3228897	45	7079.53
Scrub Shrub	B	1026.397998	66	67742.268
Scrub Shrub	C	88.10811658	77	6784.325
Scrub Shrub	D	1.609797797	83	133.61322
Sum		2624.179105		153422.16

Weighted CN **58.5**

Subbasin 24A

Class_name	HSG	Area_AC	CN	AreaxCN
Grassland	B	9.842321378	61	600.3816
Impervious Surface	B	0.214838288	95	20.409637
Scrub Shrub	B	3.063972569	66	202.22219
Sum		13.12113223		823.01343

Weighted CN **62.7**

Subbasin 24B

Class_name	HSG	Area_AC	CN	AreaxCN
Grassland	B	16.55666295	61	1009.9564
Impervious Surface	B	0.252991729	95	24.034214
Scrub Shrub	B	1.672857106	66	110.40857
Sum		18.48251179		1144.3992

Weighted CN **61.9**

Subbasin 25

Class_name	HSG	Area_AC	CN	AreaxCN
Grassland	B	64.98274406	61	3963.9474
Impervious Surface	B	0.528802375	95	50.236226
Scrub Shrub	B	64.97433708	66	4288.3062
Sum		130.4858835		8302.4899

Weighted CN **63.6**

Subbasin 26

Class_name	HSG	Area_AC	CN	AreaxCN
Evergreen	B	5.307937327	55	291.93655
Grassland	B	74.32965755	61	4534.1091
Impervious Surface	B	7.386979247	95	701.76303
Open Space Developed	B	3.669128248	61	223.81682
Scrub Shrub	B	2.265254495	66	149.5068
Sum		92.95895687		5901.1323

Weighted CN **63.5**

Subbasin 27

Class_name	HSG	Area_AC	CN	AreaxCN
Evergreen	B	4.108517246	55	225.96845
Grassland	B	9.653061623	61	588.83676
Impervious Surface	B	7.977847728	95	757.89553
Open Space Developed	B	4.744871617	61	289.43717
Scrub Shrub	B	1.611291241	66	106.34522
Sum		28.09558945		1968.4831
Weighted CN				**70.1**

Subbasin 28

Class_name	HSG	Area_AC	CN	AreaxCN
Evergreen	B	4.609777623	55	253.53777
Grassland	B	0.14846597	61	9.0564242
Impervious Surface	B	9.898599887	95	940.36699
Open Space Developed	B	4.733042894	61	288.71562
Scrub Shrub	B	0.451942476	66	29.828203
Sum		19.84182885		1521.505
Weighted CN				**76.7**

Subbasin 29

Class_name	HSG	Area_AC	CN	AreaxCN
Bare Land	B	0.479164738	86	41.208167
Evergreen	B	20.89817633	55	1149.3997
Grassland	B	86.56094305	61	5280.2175
Impervious Surface	B	24.71621315	95	2348.0402
Open Space Developed	B	21.80921891	61	1330.3624
Scrub Shrub	B	328.1514199	66	21657.994
Sum		482.6151361		31807.222
Weighted CN				**65.9**

Subbasin Cy1_1

Class_name	HSG	Area_AC	CN	AreaxCN
Bare Land	C	0.047254385	91	4.300149
Evergreen	A	0.017797901	25	0.4449475
Evergreen	C	5.51375375	70	385.96276
Grassland	C	2.90382177	74	214.88281
Impervious Surface	A	0.210976191	95	20.042738
Impervious Surface	C	7.94509015	95	754.78356
Open Space Developed	A	0.27719631	39	10.810656
Open Space Developed	C	3.157971249	74	233.68987
Scrub Shrub	C	0.365729563	77	28.161176
Sum		20.43959127		1653.0787
Weighted CN				**80.9**

Subbasin Cy1_2

Class_name	HSG	Area_AC	CN	AreaxCN
Evergreen	A	4.692656828	25	117.31642
Evergreen	C	0.170332169	70	11.923252
Impervious Surface	A	13.21646685	95	1255.5644
Impervious Surface	C	0.505826162	95	48.053485
Open Space Developed	A	4.828615233	39	188.31599
Open Space Developed	C	0.172249204	74	12.746441
Open Water	A	0.000982613	100	0.0982613
Scrub Shrub	A	1.717049056	45	77.267208
Sum		25.30417811		1711.2854
Weighted CN				**67.6**

Subbasin Cy2_1

Class_name	HSG	Area_AC	CN	AreaxCN
Alahele Homes	C	11.74087081	83	974.49228
Evergreen	C	0.976697507	70	68.368825
Grassland	C	7.573375609	74	560.4298
Impervious Surface	C	2.706989839	95	257.16403
Open Space Developed	C	0.52022799	74	38.496871
Scrub Shrub	C	0.027635566	77	2.1279386
Sum		23.54579732		1901.0797
Weighted CN				**80.7**

Subbasin Cy2_2

Class_name	HSG	Area_AC	CN	AreaxCN
Alahele Homes	A	0.019805248	61	1.2081201
Alahele Homes	C	2.76051847	83	229.12303
Bare Land	A	1.947196972	77	149.93417
Bare Land	C	0.062563434	91	5.6932725
Evergreen	A	7.986240875	25	199.65602
Evergreen	C	4.695942913	70	328.716
Grassland	A	1.344561979	39	52.437917
Grassland	C	7.384585732	74	546.45934
Impervious Surface	A	36.25720787	95	3444.4347
Impervious Surface	C	30.99455783	95	2944.483
Kalama Heights Ph. 2	C	0.074549852	90	6.7094867
Kalama Hills	C	3.158453554	83	262.15164
Open Space Developed	A	21.33778933	39	832.17378
Open Space Developed	C	10.88855593	74	805.75314
Open Water	A	0.291812673	100	29.181267
Scrub Shrub	A	3.936845981	45	177.15807
Scrub Shrub	C	3.143610787	77	242.05803
Sum		136.2847994		10257.331
Weighted CN				**75.3**

Subbasin Cy3_1

Class_name	HSG	Area_AC	CN	AreaxCN
Evergreen	C	1.837781669	70	128.64472
Grassland	C	3.527620769	74	261.04394
Impervious Surface	C	9.505928792	95	903.06324
Open Space Developed	C	7.266890396	74	537.74989
Scrub Shrub	C	0.158970027	77	12.240692
South Maui Police Complex	C	0.296500947	80	23.720076
Sum		22.5936926		1866.4625
Weighted CN				**82.6**

Subbasin Cy3_2				
Class_name	HSG	Area_AC	CN	AreaxCN
Bare Land	C	0.076604782	91	6.9710352
Cove Beach Villas	C	1.012425185	90	91.118267
Evergreen	A	1.02304E-06	25	2.558E-05
Evergreen	A	0.079286449	25	1.9821612
Evergreen	C	3.945556144	70	276.18893
Grassland	C	0.450353259	74	33.326141
Hale Pama Condos	A	0.232365308	77	17.892129
Impervious Surface	A	3.85508E-06	95	0.0003662
Impervious Surface	A	1.395253369	95	132.54907
Impervious Surface	C	20.912952	95	1986.7304
Kalama Heights Ph. 2	C	2.721568394	90	244.94116
Open Space Developed	A	0.223741846	39	8.725932
Open Space Developed	C	8.148580831	74	602.99498
Scrub Shrub	C	0.083972117	77	6.465853
Unconsolidated Shore	A	0.000124046	100	0.0124046
Unconsolidated Shore	A	0.000700613	100	0.0700613
Walaka Village Apts	C	0.462694211	90	41.642479
Sum		39.74618343		3451.6114
Weighted CN				**86.8**

Subbasin Kama1_1

Class_name	HSG	Area_AC	CN	AreaxCN
Bare Land	C	0.09200048	91	8.3720437
Evergreen	C	0.132235123	70	9.2564586
Grassland	C	3.534201068	74	261.53088
Impervious Surface	C	2.08032015	95	197.63041
Open Space Developed	C	6.63032E-05	74	0.0049064
Scrub Shrub	C	0.381200455	77	29.352435
South Maui Police Complex	B	0.001946873	70	0.1362811
South Maui Police Complex	C	14.95200657	80	1196.1605
Sum		21.17397703		1702.4439
Weighted CN				**80.4**

Subbasin Kama1_2

Class_name	HSG	Area_AC	CN	AreaxCN
Grassland	C	2.989585976	74	221.22936
Impervious Surface	C	7.521530532	95	714.5454
Open Space Developed	C	7.540787852	74	558.0183
Scrub Shrub	C	0.163583911	77	12.595961
South Maui Police Complex	C	4.216853871	80	337.34831
Sum		22.43234214		1843.7373
Weighted CN				**82.2**

Subbasin Kama1_3

Class_name	HSG	Area_AC	CN	AreaxCN
Bare Land	A	0.171454789	77	13.202019
Bare Land	C	0.673975682	91	61.331787
Evergreen	A	1.003863838	25	25.096596
Evergreen	C	4.326656094	70	302.86593
Grassland	A	1.310722078	39	51.118161
Grassland	C	4.50925923	74	333.68518
Impervious Surface	A	3.690002047	95	350.55019
Impervious Surface	C	20.69284413	95	1965.8202
Open Space Developed	A	1.453788978	39	56.69777
Open Space Developed	C	6.682895299	74	494.53425
Scrub Shrub	A	0.401723233	45	18.077546
Scrub Shrub	C	4.690264202	77	361.15034
Unconsolidated Shore	A	0.078777567	100	7.8777567
Sum		49.68622716		4042.0077
Weighted CN				**81.4**

Subbasin Kama2_1

Class_name	HSG	Area_AC	CN	AreaxCN
Bare Land	B	0.000365273	86	0.0314135
Bare Land	C	0.000462933	91	0.0421269
Evergreen	C	1.231764906	70	86.223543
Grassland	C	0.033097783	74	2.4492359
Impervious Surface	B	0.884211551	95	84.000097
Impervious Surface	C	5.583068591	95	530.39152
Open Space Developed	B	0.121069555	61	7.3852428
Open Space Developed	C	7.328264827	74	542.2916
Scrub Shrub	B	0.487527854	66	32.176838
Scrub Shrub	C	1.07238563	77	82.573694
Sum		16.7422189		1367.5653
Weighted CN				**81.7**

Subbasin Kama2_2

Class_name	HSG	Area_AC	CN	AreaxCN
Evergreen	A	0.418834254	25	10.470856
Evergreen	C	0.891376087	70	62.396326
Grassland	A	1.696185521	39	66.151235
Grassland	C	0.944730188	74	69.910034
Impervious Surface	A	0.537177259	95	51.03184

Impervious Surface	C	7.884594964	95	749.03652
Nani Loa Condos	A	1.14162352	77	87.905011
Nani Loa Condos	C	0.014289186	90	1.2860267
Open Space Developed	C	8.893667605	74	658.1314
Scrub Shrub	A	0.628746208	45	28.293579
Scrub Shrub	C	1.284804198	77	98.929923
Sum		24.33602899		1883.5428
Weighted CN				**77.4**

Subbasin Kama2_3

Class_name	HSG	Area_AC	CN	AreaxCN
Bare Land	A	0.392952214	77	30.25732
Evergreen	A	6.592960665	25	164.82402
Evergreen	C	0.535489158	70	37.484241
Grassland	A	3.112971533	39	121.40589
Grassland	C	5.95887018	74	440.95639
Impervious Surface	A	17.10296552	95	1624.7817
Impervious Surface	C	6.38720595	95	606.78457
Kamaole Heights	A	0.415380536	77	31.984301
Kamaole Heights	C	3.947304399	90	355.2574
Nani Loa Condos	A	0.224511893	77	17.287416
Nani Loa Condos	C	0.06387216	90	5.7484944
Open Space Developed	A	1.317453218	39	51.380675
Open Space Developed	C	2.332628311	74	172.61449
Open Water	A	0.110472458	100	11.047246
Scrub Shrub	A	0.497587073	45	22.391418
Scrub Shrub	C	0.126092569	77	9.7091278
Sum		49.11871784		3703.9147
Weighted CN				**75.4**

Subbasin Kama3

Class_name	HSG	Area_AC	CN	AreaxCN
Bare Land	A	0.961468093	77	74.033043
Bare Land	C	0.636237271	91	57.897592
Evergreen	A	2.959704358	25	73.992609
Evergreen	C	1.747502578	70	122.32518
Grassland	C	0.564913694	74	41.803613
Impervious Surface	A	11.76469267	95	1117.6458
Impervious Surface	C	25.56750159	95	2428.9127
Open Space Developed	A	2.73849803	39	106.80142
Open Space Developed	C	14.2884279	74	1057.3437
Scrub Shrub	A	0.902690948	45	40.621093
Scrub Shrub	C	3.887745834	77	299.35643
Sum		66.01938297		5420.7331
Weighted CN				**82.1**

Subbasin Keok1_1

Class_name	HSG	Area_AC	CN	AreaxCN
Evergreen	B	1.496043562	55	82.282396
Evergreen	C	1.4924396	70	104.47077
Grassland	A	0.000124597	61	0.0076004
Grassland	C	0.00602938	74	0.4461741
Impervious Surface	A	11.64980883	95	1106.7318
Impervious Surface	B	27.47762174	95	2610.3741
Impervious Surface	C	14.38213075	95	1366.3024
Open Space Developed	A	3.91476876	39	152.67598
Open Space Developed	B	11.26889746	61	687.40274
Open Space Developed	C	5.765987113	74	426.68305
Scrub Shrub	A	0.014737071	45	0.6631682
Scrub Shrub	C	0.375923459	77	28.946106
Sum		77.84451232		6566.9863
Weighted CN				**84.4**

Subbasin Keok1_2

Class_name	HSG	Area_AC	CN	AreaxCN
Impervious Surface	A	1.05488E-05	95	0.0010021
Bare Land	A	0.992205988	77	76.399861
Bare Land	B	0.055454211	86	4.7690621
Evergreen	A	22.71005751	25	567.75144
Evergreen	B	10.62986509	55	584.64258
Grassland	A	0.894765447	39	34.895852
Grassland	B	4.833035156	61	294.81514
Impervious Surface	A	53.76541481	95	5107.7144
Impervious Surface	B	10.97373339	95	1042.5047
Kihei Pi`ikea Town Center	A	2.456915605	77	189.1825
Kihei Pi`ikea Town Center	B	14.54712981	85	1236.506
Kihei Pi`ikea Town Center	C	0.064418373	90	5.7976536
Open Space Developed	A	20.75381247	39	809.39869
Open Space Developed	B	4.961021235	61	302.6223
Open Water	A	0.272185968	100	27.218597
Open Water	B	0.312592733	100	31.259273
Palustrine Emergent Wetland	A	2.850502191	36	102.61808
Palustrine Emergent Wetland	B	1.852473562	60	111.14841
Scrub Shrub	A	7.722488154	45	347.51197
Scrub Shrub	B	2.204183668	66	145.47612
Sunset Estates	A	5.64486847	61	344.33698
Sunset Estates	B	1.679632132	75	125.97241
Sum		170.1767665		11492.543
Weighted CN				**67.5**

Subbasin Keok2_1

Class_name	HSG	Area_AC	CN	AreaxCN
Bare Land	C	28.44263799	91	2588.2801
Evergreen	C	1.359009119	70	95.130638
Grassland	C	23.36120433	74	1728.7291
Impervious Surface	C	9.663205269	95	918.0045
Liloa Village	C	9.178934828	83	761.85159
Open Space Developed	C	5.41878111	74	400.9898
Scrub Shrub	C	0.639184385	77	49.217198
Sum		78.06295704		6542.2029
Weighted CN				**83.8**

Subbasin Keok2_2

Class_name	HSG	Area_AC	CN	AreaxCN
Bare Land	C	1.266270836	91	115.23065
Evergreen	B	3.443524295	55	189.39384
Evergreen	C	3.058412859	70	214.0889
Grassland	B	0.007109503	61	0.4336797
Grassland	C	0.398729885	74	29.506012
Impervious Surface	B	7.381408883	95	701.23384
Impervious Surface	C	12.22840852	95	1161.6988
Open Space Developed	B	5.829984473	61	355.62905
Open Space Developed	C	6.207484565	74	459.35386
Scrub Shrub	B	0.301380652	66	19.891123
Scrub Shrub	C	1.442568708	77	111.07779
Sum		41.56528318		3357.5376
Weighted CN				**80.8**

Subbasin Keok2_3

Class_name	HSG	Area_AC	CN	AreaxCN
Grassland	A	3.60185E-05	39	0.0014047
Scrub Shrub	C	5.29704E-05	77	0.0040787
Bare Land	A	2.687736254	77	206.95569
Bare Land	B	0.710951071	86	61.141792
Bare Land	C	0.144626196	91	13.160984
CarQuest Bldgs	A	0.208108032	89	18.521615
CarQuest Bldgs	C	0.391237614	94	36.776336
Evergreen	A	8.07754681	25	201.93867
Evergreen	B	0.361358538	55	19.87472
Evergreen	C	20.75478923	70	1452.8352
Grassland	A	1.250888316	39	48.784644
Grassland	C	6.607468233	74	488.95265
Impervious Surface	A	11.16918396	95	1061.0725
Impervious Surface	B	5.498746793	95	522.38095
Impervious Surface	C	13.30691405	95	1264.1568
Jim Stewart Office Bldg	A	0.678508397	89	60.387247
Kihei Rentals & Supplies	C	0.307506113	94	28.905575
Liloa Village	C	7.169050584	83	595.0312
Open Space Developed	A	1.128946522	39	44.028914
Open Space Developed	B	4.274474315	61	260.74293

Open Space Developed	C	5.768501577	74	426.86912
Scrub Shrub	A	14.73006429	45	662.85289
Scrub Shrub	B	0.01806896	66	1.1925513
Scrub Shrub	C	4.449689222	77	342.62607
Tae Murphy Office Bldg	A	0.229357692	89	20.412835
Sum		109.9238118		7839.6074
Weighted CN				**71.3**

Subbasin Keok2_4

Class_name	HSG	Area_AC	CN	AreaxCN
Scrub Shrub	A	4.47552E-05	45	0.002014
Bare Land	A	1.078503111	77	83.04474
Bare Land	C	1.543848289	91	140.49019
Evergreen	A	27.05500092	25	676.37502
Evergreen	B	1.545474394	55	85.001092
Evergreen	C	7.574603443	70	530.22224
Grassland	A	3.127774066	39	121.98319
Grassland	B	0.360912018	61	22.015633
Grassland	C	5.62257365	74	416.07045
Impervious Surface	A	76.59649599	95	7276.6671
Impervious Surface	B	3.645232535	95	346.29709
Impervious Surface	C	27.65528292	95	2627.2519
Kihei Pi`ikea Town Center	A	3.15087581	77	242.61744
Kihei Pi`ikea Town Center	B	4.518815306	85	384.0993
Kihei Pi`ikea Town Center	C	4.243627062	90	381.92644
Kihei Wellness Center	A	1.006529851	89	89.581157
Open Space Developed	A	18.99011273	39	740.6144
Open Space Developed	B	0.197340107	61	12.037747
Open Space Developed	C	10.01229982	74	740.91019
Open Water	A	0.247441109	100	24.744111
Open Water	C	0.001315377	100	0.1315377
Pacific Plaza	A	1.40003962	77	107.80305
Palustrine Emergent Wetland	A	1.192469302	36	42.928895
Scrub Shrub	A	8.681140733	45	390.65133
Scrub Shrub	B	0.365399876	66	24.116392
Scrub Shrub	C	0.016103867	77	1.2399978
Sum		209.8292567		15508.823
Weighted CN				**73.9**

Subbasin Kilo1_1

Class_name	HSG	Area_AC	CN	AreaxCN
Grassland	B	0.905525155	61	55.237034
Impervious Surface	B	1.351853497	95	128.42608
Open Space Developed	B	0.763117618	61	46.550175
Wailea SF-58	B	6.761176443	75	507.08823
Sum		9.781672713		737.30152
Weighted CN				**75.4**

Subbasin Kilo1_2

Class_name	HSG	Area_AC	CN	AreaxCN
Bare Land	B	0.002736474	86	0.2353367
Evergreen	B	4.161938629	55	228.90662
Grassland	B	1.695945619	61	103.45268
Impervious Surface	B	0.947391506	95	90.002193
Open Space Developed	B	1.018125082	61	62.10563
Scrub Shrub	B	15.00911556	66	990.60163
Wailea SF-58	B	6.239392325	75	467.95442
Sum		29.07464519		1943.2585
Weighted CN				**66.8**

Subbasin Kilo1_3

Class_name	HSG	Area_AC	CN	AreaxCN
Impervious Surface	B	4.422980657	95	420.18316
Open Space Developed	B	2.650910888	61	161.70556
Scrub Shrub	B	0.187688503	66	12.387441
Sum		7.261580048		594.27617
Weighted CN				**81.8**

Subbasin Kilo1_4

Class_name	HSG	Area_AC	CN	AreaxCN
Impervious Surface	B	9.12166E-06	95	0.0008666
Emergency Ambulance Stn	B	0.425569742	92	39.152416
Evergreen	B	0.967599666	55	53.217982
Grassland	B	0.738503038	61	45.048685
Impervious Surface	B	2.438035021	95	231.61333
Open Space Developed	B	0.201508949	61	12.292046
Scrub Shrub	B	0.976886628	66	64.474517
Wailea SF-8	B	0.20921428	75	15.691071
Sum		5.957326445		461.49091
Weighted CN				**77.5**

Subbasin Kilo1_5

Class_name	HSG	Area_AC	CN	AreaxCN
Evergreen	B	0.60243596	55	33.133978
Grassland	B	1.795415312	61	109.52033
Impervious Surface	B	1.655259082	95	157.24961
Open Space Developed	B	0.158292574	61	9.655847
Scrub Shrub	B	0.845058055	66	55.773832
Wailea SF-8	B	4.095006035	75	307.12545
Sum		9.151467017		672.45906
Weighted CN				**73.5**

Subbasin Kilo1_6

Class_name	HSG	Area_AC	CN	AreaxCN
Bare Land	A	3.639224372	77	280.22028
Bare Land	B	1.350690038	86	116.15934
Evergreen	B	2.454229642	55	134.98263
Grassland	A	0.139345098	39	5.4344588
Grassland	B	0.105130971	61	6.4129892
Impervious Surface	A	4.91163772	95	466.60558
Impervious Surface	B	11.72207162	95	1113.5968
Open Space Developed	A	2.90321137	39	113.22524
Open Space Developed	B	6.841064642	61	417.30494
Scrub Shrub	A	0.000718305	45	0.0323237
Scrub Shrub	B	0.227963097	66	15.045564
Sum		34.29528687		2669.0202
Weighted CN				**77.8**

Subbasin Kilo1_7

Class_name	HSG	Area_AC	CN	AreaxCN
Evergreen	A	5.26481684	25	131.62042
Evergreen	B	1.155106656	55	63.530866
Grassland	B	0.382670495	61	23.3429
Impervious Surface	A	7.080765383	95	672.67271
Impervious Surface	B	10.77377638	95	1023.5088
Open Space Developed	A	5.422344128	39	211.47142
Open Space Developed	B	6.45326098	61	393.64892
Scrub Shrub	A	1.21214778	45	54.54665
Scrub Shrub	B	6.35473207	66	419.41232
Sum		44.09962071		2993.755
Weighted CN				**67.9**

Subbasin Kula1

Class_name	HSG	Area_AC	CN	AreaxCN
Bare Land	A	0.011451707	77	0.8817815
Evergreen	A	3.119401242	25	77.985031
Evergreen	C	6.444000844	70	451.08006
Grassland	A	0.172478128	39	6.726647
Grassland	C	0.007109587	74	0.5261094
Impervious Surface	A	13.0398143	95	1238.7824
Impervious Surface	C	33.25778992	95	3159.49
Open Space Developed	A	7.828816849	39	305.32386
Open Space Developed	C	15.35857136	74	1136.5343
Scrub Shrub	A	1.359673723	45	61.185318
Scrub Shrub	C	1.100062864	77	84.704841
Sum		81.69917053		6523.2203
Weighted CN				**79.8**

Subbasin Kula2_1

Class_name	HSG	Area_AC	CN	AreaxCN
Grassland	A	4.15499E-06	39	0.000162
Bare Land	A	0.045221831	77	3.482081
Grassland	A	1.163217582	39	45.365486
Grassland	C	0.44139914	74	32.663536
Impervious Surface	A	0.790508504	95	75.098308
Impervious Surface	C	1.732748609	95	164.61112
Ka`Ono`Ulu Ph. 6 Condos	A	3.629326001	77	279.4581
Ka`Ono`Ulu Ph. 6 Condos	C	3.903613627	90	351.32523
Kihei Seventh Day Adventist Church Pr	A	2.170811447	50	108.54057
Kihei Seventh Day Adventist Church Pr	C	2.880818282	79	227.58464
Open Space Developed	A	0.066441306	39	2.591211
Open Space Developed	C	0.399110125	74	29.534149
Scrub Shrub	A	0.486281339	45	21.88266
Scrub Shrub	C	0.048673635	77	3.7478699
Sum		17.75817558		1345.8851
Weighted CN				**75.8**

Subbasin Kula2_2

Class_name	HSG	Area_AC	CN	AreaxCN
Bare Land	A	0.013626184	77	1.0492162
Bare Land	C	0.187530861	91	17.065308
Bare Land	D	0.001079578	94	0.1014803
Evergreen	A	4.290739026	58	248.86286
Evergreen	C	2.968879877	70	207.82159
Evergreen	D	0.225294642	77	17.347687
Grassland	A	6.808498289	39	265.53143
Grassland	C	1.482334015	74	109.69272
Impervious Surface	A	21.7763865	95	2068.7567
Impervious Surface	C	28.95368371	95	2750.6
Impervious Surface	D	2.780807686	95	264.17673
Ka`Ono`Ulu Ph. 6 Condos	C	0.78540334	90	70.686301
Kihei Seventh Day Adventist Church Pr	C	0.08936309	79	7.0596841
Maui Lu Timeshare	A	14.74026591	77	1135.0005
Maui Lu Timeshare	C	10.95670581	90	986.10352
Open Space Developed	A	9.395334278	39	366.41804
Open Space Developed	C	16.22306211	74	1200.5066
Open Space Developed	D	0.638335703	80	51.066856
Open Water	A	0.122487816	100	12.248782
Open Water	C	0.014016258	100	1.4016258
Scrub Shrub	A	6.080982566	45	273.64422
Scrub Shrub	C	0.713193493	77	54.915899
Scrub Shrub	D	0.083052501	83	6.8933576
Sum		129.3310632		10116.951
Weighted CN				**78.2**

Subbasin Kula3_1

Class_name	HSG	Area_AC	CN	AreaxCN
Bare Land	A	0.017062854	77	1.3138397
Evergreen	A	5.523697209	25	138.09243
Evergreen	C	1.494062732	70	104.58439
Grassland	A	0.126527274	39	4.9345637
Grassland	C	0.036319939	74	2.6876755
Impervious Surface	A	6.002984738	95	570.28355
Impervious Surface	C	2.326777667	95	221.04388
Open Space Developed	A	1.216202722	39	47.431906
Open Space Developed	C	0.86877178	74	64.289112
Scrub Shrub	A	0.007981722	45	0.3591775
Scrub Shrub	C	0.037528875	77	2.8897234
Sum		17.65791751		1157.9102
Weighted CN				**65.6**

Subbasin Kula3_2

Class_name	HSG	Area_AC	CN	AreaxCN
Bare Land	A	0.18323263	77	14.108913
Evergreen	A	7.719520271	25	192.98801
Evergreen	C	1.70600848	70	119.42059
Evergreen	D	0.878584427	77	67.651001
Grassland	A	0.12080435	39	4.7113696
Grassland	C	0.157729197	74	11.671961
Ho'onani Homes	A	0.115717909	57	6.5959208
Impervious Surface	A	32.41107525	95	3079.0521
Impervious Surface	C	3.060320473	95	290.73044
Impervious Surface	D	2.062232251	95	195.91206
Kihei Seventh Day Adventist Church Pr	C	0.33001579	79	26.071247
Open Space Developed	A	17.66299778	39	688.85691
Open Space Developed	C	0.931089909	74	68.900653
Open Space Developed	D	0.579741799	80	46.379344
Open Water	A	0.00023027	100	0.023027
Open Water	D	0.048273172	100	4.8273172
Scrub Shrub	A	0.592097595	45	26.644392
Scrub Shrub	C	0.076339647	77	5.8781528
Scrub Shrub	D	0.011122817	83	0.9231938
Sum		68.64713402		4851.3467
Weighted CN				**70.7**

Subbasin Liil1_1

Class_name	HSG	Area_AC	CN	AreaxCN
Evergreen	A	2.550744565	25	63.768614
Evergreen	B	0.413946349	55	22.767049
Evergreen	C	5.146682264	70	360.26776
Grassland	A	3.881312808	39	151.3712
Grassland	B	0.001815373	61	0.1107378
Grassland	C	0.33698134	74	24.936619
Impervious Surface	A	0.186078562	95	17.677463
Impervious Surface	B	2.840003655	95	269.80035
Impervious Surface	C	14.60276413	95	1387.2626
Open Space Developed	A	0.00770425	39	0.3004658
Open Space Developed	B	1.471475122	61	89.759982
Open Space Developed	C	9.857990593	74	729.4913
Scrub Shrub	A	2.294022991	45	103.23103
Scrub Shrub	B	0.009084721	66	0.5995916
Scrub Shrub	C	1.272754342	77	98.002084
Sum		44.87336106		3319.3468
Weighted CN				**74.0**

Subbasin Liil1_2

Class_name	HSG	Area_AC	CN	AreaxCN
Bare Land	A	0.423144857	77	32.582154
Evergreen	A	3.796187507	25	94.904688
Evergreen	C	1.572679714	70	110.08758
Grassland	A	1.474784136	39	57.516581
Grassland	B	0.077555492	61	4.730885
Grassland	C	1.011508014	74	74.851593
Impervious Surface	A	5.963679672	95	566.54957
Impervious Surface	B	1.715258554	95	162.94956
Impervious Surface	C	10.89738538	95	1035.2516
Open Space Developed	A	1.087622091	39	42.417262
Open Space Developed	B	0.409048414	61	24.951953
Open Space Developed	C	6.006920947	74	444.51215
Scrub Shrub	A	0.765635977	45	34.453619
Scrub Shrub	B	0.606166282	66	40.006975
Scrub Shrub	C	1.345603332	77	103.61146
Sum		37.15318037		2829.3776
Weighted CN				**76.2**

Subbasin Liil1_3

Class_name	HSG	Area_AC	CN	AreaxCN
Bare Land	B	0.024661558	86	2.120894
Evergreen	B	2.858519635	55	157.21858
Evergreen	C	2.25588708	70	157.9121
Grassland	B	1.001285271	61	61.078402
Impervious Surface	B	17.11403416	95	1625.8332
Impervious Surface	C	14.31477208	95	1359.9033
Open Space Developed	B	8.629122337	61	526.37646
Open Space Developed	C	9.26359236	74	685.50583
Scrub Shrub	B	0.102794644	66	6.7844465
Scrub Shrub	C	0.110859366	77	8.5361712
Sum		55.67552848		4591.2695
Weighted CN				**82.5**

Subbasin Liil2_1

Class_name	HSG	Area_AC	CN	AreaxCN
Bare Land	B	0.420235491	86	36.140252
Evergreen	B	0.595385411	55	32.746198
Grassland	B	1.012063539	61	61.735876
Impervious Surface	B	3.464690803	95	329.14563
Open Space Developed	B	2.58054845	61	157.41346
Scrub Shrub	B	0.089968907	66	5.9379478
Wailea SF-8	B	5.683780552	75	426.28354
Sum		13.84667315		1049.4029
Weighted CN				**75.8**

Subbasin Liil2_2

Class_name	HSG	Area_AC	CN	AreaxCN
Bare Land	A	0.013626184	77	1.0492162
Bare Land	C	0.187530861	91	17.065308
Bare Land	D	0.001079578	94	0.1014803
Evergreen	A	4.290739026	58	248.86286
Evergreen	C	2.968879877	70	207.82159
Evergreen	D	0.225294642	77	17.347687
Grassland	A	6.808498289	39	265.53143
Grassland	C	1.482334015	74	109.69272
Impervious Surface	A	21.7763865	95	2068.7567
Impervious Surface	C	28.95368371	95	2750.6
Impervious Surface	D	2.780807686	95	264.17673
Ka`Ono`Ulu Ph. 6 Condos	C	0.78540334	90	70.686301
Kihei Seventh Day Adventist Church Pr	C	0.08936309	79	7.0596841
Maui Lu Timeshare	A	14.74026591	77	1135.0005
Maui Lu Timeshare	C	10.95670581	90	986.10352
Open Space Developed	A	9.395334278	39	366.41804
Open Space Developed	C	16.22306211	74	1200.5066
Open Space Developed	D	0.638335703	80	51.066856
Open Water	A	0.122487816	100	12.248782
Open Water	C	0.014016258	100	1.4016258
Scrub Shrub	A	6.080982566	45	273.64422

Scrub Shrub	C	0.713193493	77	54.915899
Scrub Shrub	D	0.083052501	83	6.8933576
Sum		129.3310632		10116.951
Weighted CN				**78.2**

Subbasin Liil3

Class_name	HSG	Area_AC	CN	AreaxCN
Bare Land	A	0.142416984	77	10.966108
Bare Land	B	0.142792052	86	12.280116
Evergreen	A	4.756324128	25	118.9081
Evergreen	B	0.225622349	55	12.409229
Grassland	A	5.493351405	39	214.2407
Grassland	B	0.001855134	61	0.1131632
Impervious Surface	A	14.87339949	95	1412.973
Impervious Surface	B	8.420008253	95	799.90078
Open Space Developed	A	9.757652645	39	380.54845
Open Space Developed	B	6.190898548	61	377.64481
Scrub Shrub	A	1.27786727	45	57.504027
Wailea SF-8	B	3.590727842	75	269.30459
Sum		54.8729161		3666.793
Weighted CN				**66.8**

Subbasin Waia1

Class_name	HSG	Area_AC	CN	AreaxCN
Bare Land	A	0.339882062	77	26.170919
Bare Land	B	0.322639919	86	27.747033
Evergreen	A	0.030513587	25	0.7628397
Evergreen	B	12.5705793	55	691.38186
Grassland	B	4.21761797	61	257.2747
Impervious Surface	A	0.00889612	95	0.8451314
Impervious Surface	B	3.896918741	95	370.20728
Open Space Developed	A	0.020087816	39	0.7834248
Open Space Developed	B	2.552544672	61	155.70522
Open Water	A	0.068133274	100	6.8133274
Open Water	B	0.127973542	100	12.797354
Scrub Shrub	B	1.04598889	66	69.035267
Unconsolidated Shore	A	0.366506283	100	36.650628
Sum		25.56828218		1656.175
Weighted CN				**64.8**

Subbasin Waia2

Class_name	HSG	Area_AC	CN	AreaxCN
Bare Land	A	0.360449257	77	27.754593
Bare Land	B	0.219742641	86	18.897867
Evergreen	A	0.803444696	25	20.086117
Evergreen	B	5.385477601	55	296.20127
Evergreen	C	0.454414497	70	31.809015
Grassland	A	0.181812209	39	7.0906762
Grassland	B	2.721373045	61	166.00376
Grassland	C	0.021842431	74	1.6163399
Impervious Surface	A	2.718043889	95	258.21417
Impervious Surface	B	13.80877887	95	1311.834
Impervious Surface	C	2.919288756	95	277.33243
Open Space Developed	A	1.703561883	39	66.438913
Open Space Developed	B	8.968748515	61	547.09366
Open Space Developed	C	0.911856138	74	67.477354
Open Water	A	0.037321742	100	3.7321742
Palustrine Emergent Wetland	A	0.266605626	36	9.5978026
Palustrine Emergent Wetland	B	3.047891175	60	182.87347
Scrub Shrub	A	0.146114332	45	6.5751449
Scrub Shrub	B	0.513193605	66	33.870778
Scrub Shrub	C	0.416108818	77	32.040379
Unconsolidated Shore	A	0.657301453	100	65.730145
Sum		46.26337118		3432.27
Weighted CN				**74.2**

Subbasin Waia3

Class_name	HSG	Area_AC	CN	AreaxCN
Bare Land	A	0.090022058	77	6.9316985
Evergreen	A	0.262833989	25	6.5708497
Evergreen	B	0.785093898	55	43.180164
Evergreen	C	0.540511765	70	37.835824
Grassland	A	0.19464296	39	7.5910754
Grassland	C	1.269255492	74	93.924906
Impervious Surface	A	1.038884815	95	98.694057
Impervious Surface	B	6.930903439	95	658.43583
Impervious Surface	C	7.274831798	95	691.10902
Open Space Developed	A	0.519963116	39	20.278562
Open Space Developed	B	4.003544206	61	244.2162
Open Space Developed	C	3.479380806	74	257.47418
Scrub Shrub	A	0.916337812	45	41.235202
Scrub Shrub	B	0.797573829	66	52.639873
Scrub Shrub	C	0.167778716	77	12.918961
Sum		28.2715587		2273.0364
Weighted CN				**80.4**

Subbasin Waia4

Class_name	HSG	Area_AC	CN	AreaxCN
Bare Land	A	0.021402326	77	1.6479791
Evergreen	A	0.944299478	25	23.607487
Evergreen	B	0.055528813	55	3.0540847
Evergreen	C	0.117893409	70	8.2525387
Grassland	A	0.037887219	39	1.4776015
Grassland	C	0.142839052	74	10.57009
Impervious Surface	A	2.205588519	95	209.53091
Impervious Surface	B	0.415819988	95	39.502899
Impervious Surface	C	4.997015925	95	474.71651
Open Space Developed	A	0.306303027	39	11.945818
Open Space Developed	B	0.123759662	61	7.5493394
Open Space Developed	C	2.164949677	74	160.20628
Scrub Shrub	A	0.823699428	45	37.066474
Scrub Shrub	B	0.294530425	66	19.439008
Scrub Shrub	C	0.265150775	77	20.41661
Sum		12.91666772		1028.9836
Weighted CN				**79.7**

Subbasin Waia5

Class_name	HSG	Area_AC	CN	AreaxCN
Bare Land	A	0.103730142	77	7.9872209
Evergreen	A	2.825494128	25	70.637353
Evergreen	C	3.120629921	70	218.44409
Grassland	A	1.293534767	39	50.447856
Grassland	C	0.760441351	74	56.27266
Impervious Surface	A	3.95486141	95	375.71183
Impervious Surface	C	27.16015279	95	2580.2145
Open Space Developed	A	3.176853432	39	123.89728
Open Space Developed	C	23.7332859	74	1756.2632
Scrub Shrub	A	1.050990403	45	47.294568
Scrub Shrub	C	1.815598442	77	139.80108
Sum		68.99557268		5426.9716
Weighted CN				**78.7**

Subbasin Waip1

Class_name	HSG	Area_AC	CN	AreaxCN
Open Space Developed	A	4.14701E-07	39	1.617E-05
Bare Land	A	0.580333984	77	44.685717
Evergreen	A	4.774880679	25	119.37202
Evergreen	C	0.024280533	70	1.6996373
Grassland	A	3.101473218	39	120.95746
Grassland	C	0.62766929	74	46.447527
Ho'onani Homes	A	12.95711687	57	738.55566
Impervious Surface	A	29.20038036	95	2774.0361
Impervious Surface	C	0.453369947	95	43.070145
Open Space Developed	A	13.53084871	39	527.7031
Open Space Developed	C	0.447508646	74	33.11564
Scrub Shrub	A	1.868797877	45	84.095904
Sum		67.56666053		4533.739
Weighted CN				**67.1**

Proposed Time of Concentration

KIHEI DRAINAGE STUDY

ITEM: PROPOSED Tc

LOCATION: KIHEI, MAUI, HAWAII
PREPARED BY: TL
DATE: 8/31/15

REF: 1-20253-0E
CHECKED BY:
DATE:

1. INTRODUCTION
   This is to find the times of concentration (Tc) for subwatersheds makai of Piilani Highway. The method described in SCS TR-55, Section 3 is used.

2. REFERENCES
   2.1 "Urban Hydrology for Small Watersheds, TR-55, 2nd Edition", Soil Conservation Service, U. S. Dept. of Agriculture, June 1986.
   2.2 LiDAR 2-ft contour (Hurricane Study 2006, Maui FIS 2005)
   USGS Map
   2.3 Erosion and Sediment Control Guide for Hawaii," Soil and Water Conservation Service, U. S. Dept. of Agriculture, March 1981 w/ Addendum July 1983.

3. COMPUTATIONS
   Travel time computation for sheet flow from TR-55 kinematic equation.
   Velocity computation for shallow concentrated flow (based on TR-55, Figure 3-1).

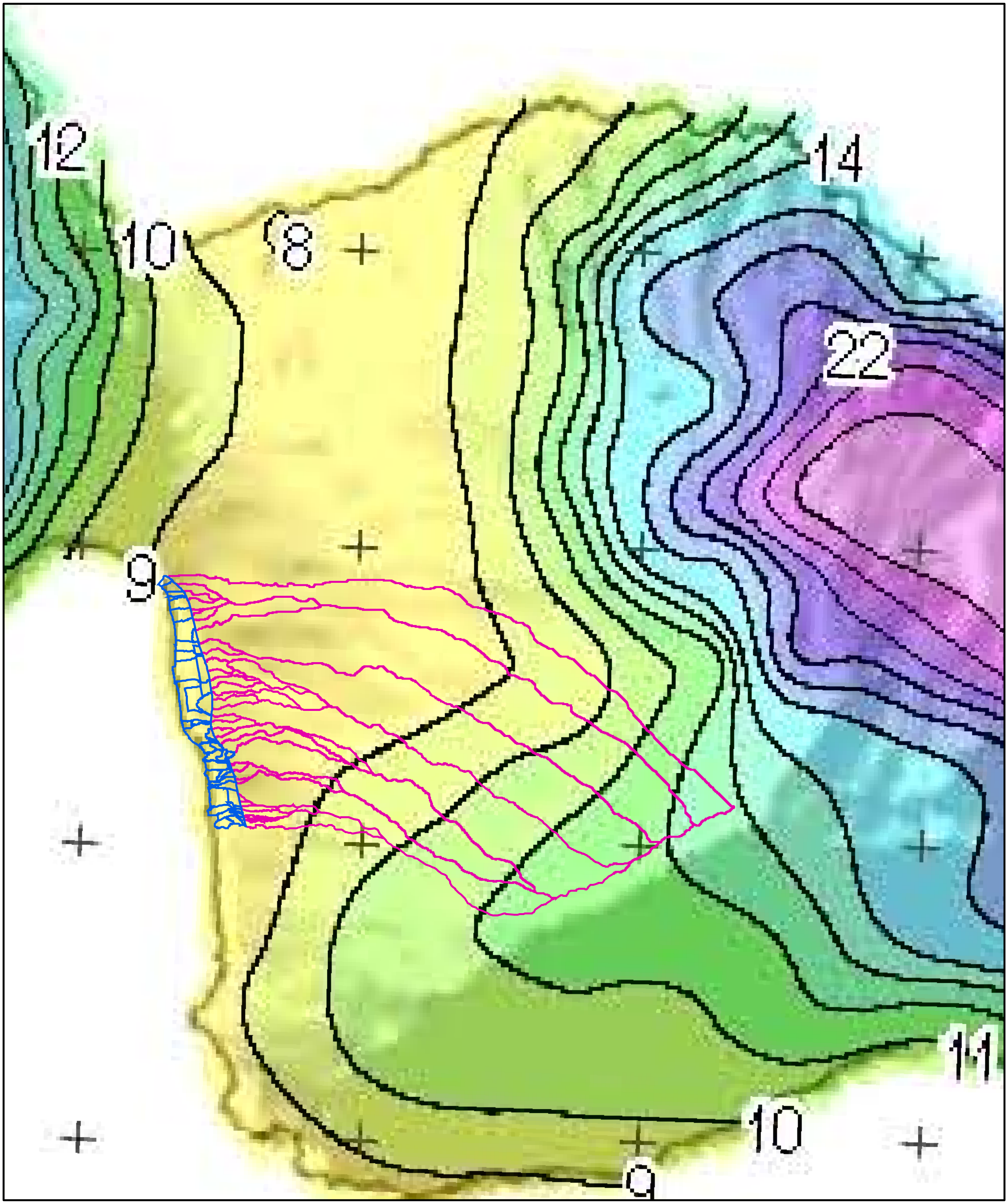
   SF = Sheetflow
   SCF = Shallow Concentrated Flow
   OCF = Open channel flow, where blue line is shown on USGSquadrangle map

Subarea	Reach Description	Hyd. Length (ft)	Elev1 (ft)	Elev2 (ft)	Approx. Slope (ft/ft)	Est. Vel. (fps)	Kinematic Eqn. P2-24 (in)	Kinematic Eqn. n	Travel Time (hr)
10/10A D	SF	100	238	230	0.080		2.86	0.13	0.088
	SCF, unpaved	150	230	216	0.093	4.9			0.008
	SCF, unpaved	200	216	206	0.050	3.6			0.015
	SCF, unpaved	100	206	174	0.320	9.1			0.003
	OCF, natural	5500	174	31	0.026	8.8			0.174
	Total	6050							0.289
10/10A U	SF	100	8720	8660	0.600		3.76	0.8	0.147
	SCF, unpaved	4450	8660	7200	0.328	9.2			0.134
	SCF, unpaved	9000	7200	5000	0.244	8.0			0.313
	OCF, natural	9800	5000	2950	0.209	10.5			0.259
	OCF, natural	13200	2950	1480	0.111	9.2			0.399
	OCF, natural	10750	1480	780	0.065	10.0			0.299
	OCF, natural	8150	780	340	0.054	10.6			0.214
	OCF, natural	4750	340	180	0.034	8.8			0.150
	Total	60200							1.915

Subarea	Reach Description	Hyd. Length (ft)	Elev1 (ft)	Elev2 (ft)	Approx. Slope (ft/ft)	Est. Vel. (fps)	Kinematic P2-24 (in)	Eqn. n	Travel Time (hr)
16D	SF	100	222	218	0.040		2.87	0.13	0.117
	SCF, unpaved	1000	218	152	0.066	4.1			0.067
	SCF, unpaved	450	152	144	0.018	2.2			0.058
	SCF, unpaved	2000	144	68	0.038	3.1			0.177
	Total	3550							0.418
16U	SF	100	369	365	0.040		2.89	0.13	0.116
	SCF, unpaved	2600	365	210	0.060	3.9			0.183
	SCF, unpaved	400	210	202	0.020	2.3			0.049
	Total	3100							0.348
2D	SF	100	172	168.5	0.035		2.83	0.15	0.139
	SCF, unpaved	450	168	150	0.040	3.2			0.039
	SCF, unpaved	1900	150	106	0.023	2.5			0.215
	SCF, paved	2350	106	36	0.030	3.5			0.186
	Total	4800							0.579
2U	SF	100	212	210	0.020		2.84	0.13	0.155
	SCF, unpaved	1300	210	170	0.031	2.8			0.128
	Total	1400							0.282
3D	SF	100	168	165.5	0.025		2.83	0.15	0.159
	SCF, unpaved	1200	165	130	0.029	2.8			0.121
	SCF, unpaved	900	130	106	0.027	2.6			0.095
	SCF, paved	1950	106	62	0.023	3.1			0.177
	Total	4150							0.552
3U	SF	100	202	200	0.020		2.85	0.13	0.154
	SCF, unpaved	950	200	168	0.034	3.0			0.089
	Total	1050							0.243
4D	SF	100	168	164	0.040		2.84	0.15	0.131
	SCF, unpaved	1400	164	118	0.033	2.9			0.133
	SCF, paved	1600	118	65	0.033	3.7			0.120
	Total	3100							0.384
4U	SF	100	238	234	0.040		2.85	0.13	0.117
	SCF, unpaved	2550	234	166	0.027	2.6			0.269
	Total	2650							0.386
6D	SF	100	164	160	0.040		2.84	0.15	0.131
	SCF, unpaved	80	160	148	0.150	6.2			0.004
	SCF, unpaved	400	148	137	0.028	2.7			0.042
	SCF, unpaved	2350	137	71.45	0.028	2.7			0.242
	Total	2930							0.419

Subarea	Reach Description	Hyd. Length (ft)	Elev1 (ft)	Elev2 (ft)	Approx. Slope (ft/ft)	Est. Vel. (fps)	Kinematic P2-24 (in)	Eqn. n	Travel Time (hr)
6U	SF	100	180	178.5	0.015		2.85	0.13	0.173
	SCF, unpaved	650	178.5	160	0.028	2.7			0.066
	Total	750							0.239
12D	SF	100	226	222	0.040		2.86	0.13	0.117
	SCF, unpaved	1050	222	196	0.025	2.5			0.115
	SCF, unpaved	900	196	170	0.029	2.7			0.091
	SCF, unpaved	2550	170	49.06	0.047	3.5			0.202
	Total	4600							0.524
12U	SF	100	298	296	0.020		2.88	0.13	0.154
	SCF, unpaved	2100	296	220	0.036	3.1			0.190
	Total	2200							0.344
13D	SF	100	226	223	0.030		2.86	0.13	0.131
	SCF, unpaved	1300	223	188	0.027	2.6			0.136
	SCF, unpaved	450	188	174	0.031	2.8			0.044
	SCF, unpaved	2350	174	63	0.047	3.5			0.186
	Total	4200							0.497
13U	SF	100	318	316	0.020		2.88	0.13	0.154
	SCF, unpaved	1950	316	236	0.041	3.3			0.166
	SCF, unpaved	950	236	217	0.020	2.3			0.116
	SCF, unpaved								
	Total	3000							0.435
14D	SF	100	230	222	0.080		2.87	0.13	0.088
	SCF, unpaved	750	222	208	0.019	2.2			0.095
	SCF, unpaved	1300	208	144	0.049	3.6			0.101
	OCF, natural	1750	144	72.5	0.041	4.9			0.099
	Total	3900							0.383
14U	SF	100	815	812	0.030		2.98	0.13	0.128
	SCF, unpaved	10150	812	288	0.052	3.7			0.769
	SCF, unpaved	1500	288	248	0.027	2.6			0.158
	OCF, natural	950	248	204	0.046	4.9			0.054
	Total	12700							1.109
15D	SF	100	208	206	0.020		2.87	0.13	0.154
	SCF, unpaved	500	206	190	0.032	2.9			0.048
	OCF, natural	3250	190	78.1	0.034	4.0			0.226
	Total	3850							0.428
15U	SF	100	603	599	0.040		2.93	0.13	0.115
	SCF, unpaved	4250	599	428	0.040	3.2			0.365
	SCF, unpaved	2100	428	284	0.069	4.2			0.138
	OCF, natural	2050	284	208	0.037	4.0			0.142
	Total	8500							0.761

Rainfall Maps



100-YEAR, 24-HOUR RAINFALL DEPTH

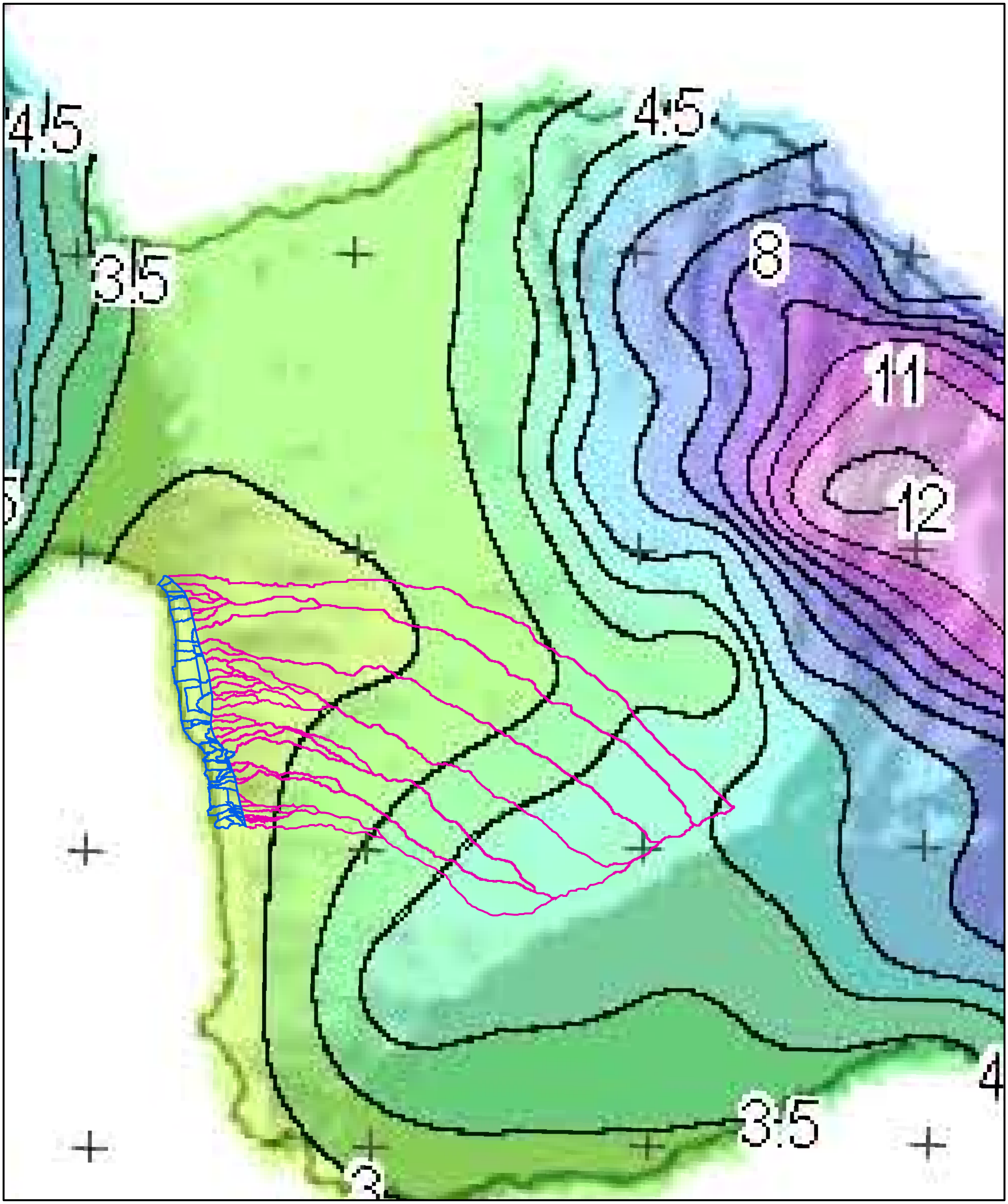
Legend

Makai Drainage Basin

Mauka Drainage Basin

0 1.5 3 6 Miles

1 inch = 3 miles



2-YEAR, 24-HOUR RAINFALL DEPTH

Legend

Makai Drainage Basin

Mauka Drainage Basin

0 1.5 3 6 Miles

1 inch = 3 miles

KIHEI DRAINAGE STUDY

ITEM: 100-YEAR, 24-HOUR RAINFALL

LOCATION: KIHEI, MAUI, HAWAII — REF: 1-20258-0E
PREPARED BY: TL — CHECKED BY:
DATE: 9/1/15 — DATE:

1. INTRODUCTION
   Find the 100-year/2-year, 24-hour rainfall for subwatersheds

2. REFERENCES
   2.1 "NOAA Atlas 14 Volume 4 Version3", Precipitation Frequency Data Server, http://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_hi.html

3. COMPUTATIONS

Existing Condition: Mauka of Piilani Hwy

	P100-24	P2-24	Centroid_X	Centroid_Y
	(in)	(in)	HI SP Zone 2, US Feet, NAD 83	
1	8.77	3.17	1745198.68	159623.54
2	8.72	2.83	1714443.61	162385.94
3	8.72	2.83	1714464.26	161578.79
4	8.71	2.85	1715290.19	160748.87
5	8.71	2.84	1714012.60	159829.33
6	8.71	2.84	1715097.05	159514.28
29	9.31	3.34	1728667.08	134107.24
28	8.74	3.03	1721323.82	134461.22
27	8.74	3.03	1721940.37	134696.73
26	8.83	3.09	1722655.61	135182.45
25	8.90	3.14	1724439.35	135789.43
24	10.00	3.79	1737864.78	131981.74
24B	8.66	2.98	1720171.17	136390.15
24A	8.66	2.98	1719655.34	137026.51
23A	8.63	2.96	1719540.94	139218.77
23	8.90	3.15	1725222.78	139670.68
22/22A	8.59	2.92	1719309.72	140954.48
21	9.75	3.63	1737102.38	136278.96
20	8.71	3.04	1724446.70	143919.14
19	8.90	3.19	1730786.19	143250.61
17/18	10.00	3.84	1744788.41	137157.87
19A2	8.58	2.88	1717159.28	145155.03
19A1	8.59	2.90	1718582.35	146106.48
17A	8.59	2.87	1717726.88	146828.33
10/10A	9.90	3.72	1747464.68	142561.04
16	8.58	2.88	1718679.36	148903.43
15	8.56	2.91	1722059.61	149384.08
14	8.61	3.03	1726898.49	148894.48
13	8.59	2.87	1718650.66	151320.11
12	8.61	2.86	1717799.35	152133.26
8	9.14	3.33	1746910.87	149348.75
9	8.65	2.86	1716717.93	155460.23
7	8.65	2.88	1721297.67	160029.54
11D	8.62	2.86	1716834.06	153240.63
11U	8.56	2.90	1722078.37	152080.62

Existing Condition: Makai of Piilani Hwy

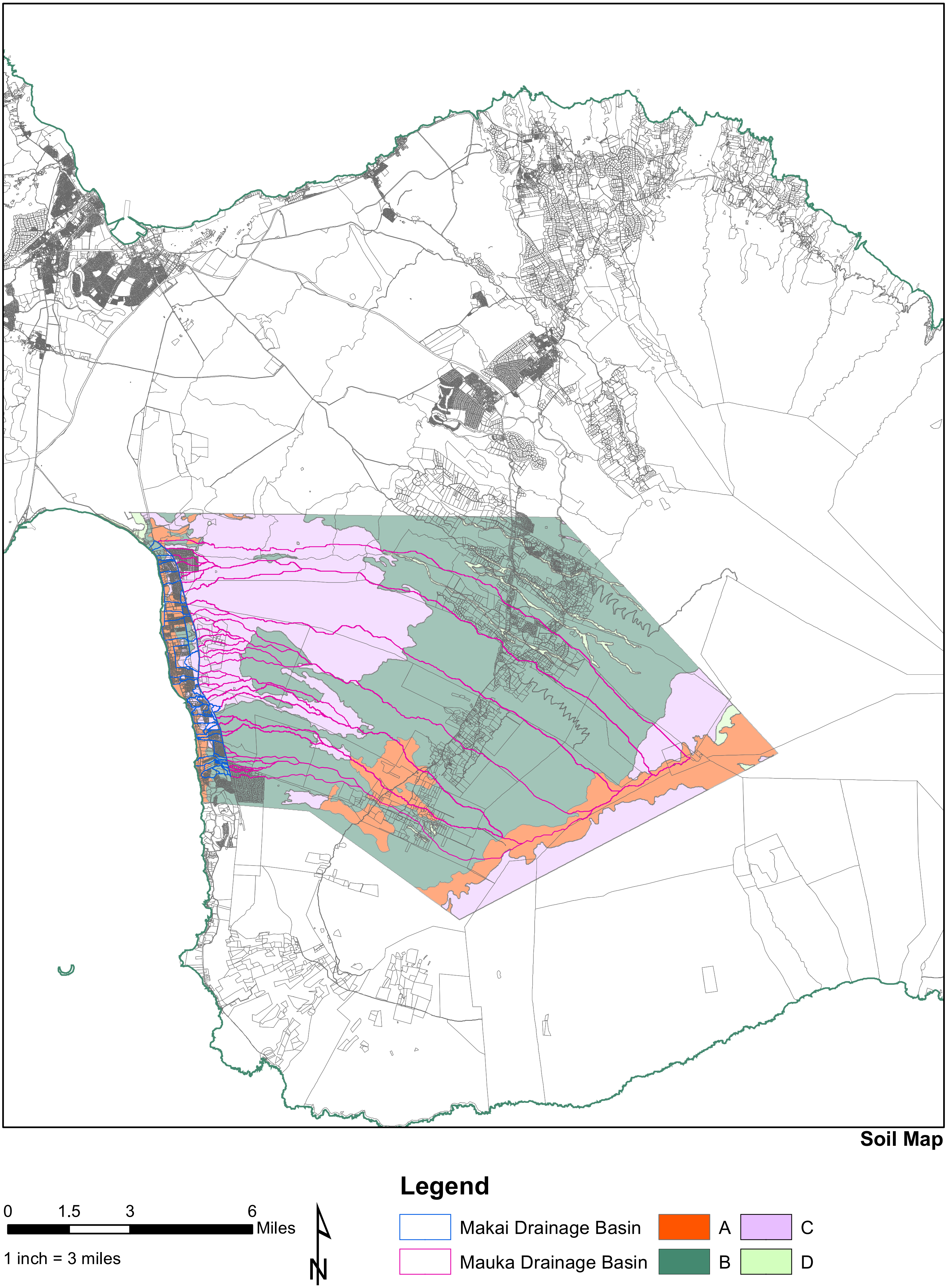
Liil2_2	8.57	2.90	1716756.64	137251.65
Cy2_2	8.59	2.85	1714446.67	144964.02
Kama2_3	8.55	2.87	1716131.48	139904.96
Kilo1_7	8.57	2.90	1717442.36	134023.46
Kilo1_6	8.57	2.90	1717698.06	135070.24
Liil2_1	8.61	2.93	1718670.26	136135.85
Liil3	8.57	2.90	1716913.05	135664.06
Kilo1_5	8.61	2.93	1719030.49	135598.67
Kilo1_4	8.61	2.94	1718937.46	135377.70
Kilo1_2	8.61	2.94	1718844.24	134448.17
Kilo1_3	8.61	2.94	1719408.83	135044.71
Liil1_3	8.60	2.93	1718651.45	137163.50
Liil1_2	8.57	2.89	1717341.53	139148.58
Kama1_1	8.59	2.91	1718096.03	142107.31
Kama2_2	8.57	2.89	1717369.31	139992.76
Liil1_1	8.57	2.89	1717897.14	138607.86
Kilo1_1	8.67	2.98	1719668.09	134425.64
Kama2_1	8.59	2.92	1718054.05	139913.02
Kama3	8.56	2.87	1716562.00	141044.73
Cy3_2	8.57	2.87	1715470.57	143259.31
Cy3_1	8.57	2.87	1716581.98	143440.79
Cy2_1	8.58	2.87	1715918.89	144698.96
Cy1_2	8.61	2.85	1713018.52	146065.78
Cy1_1	8.60	2.85	1714501.23	146343.25
Waip1	8.67	2.84	1712778.05	154455.24
Kula3_1	8.65	2.84	1714249.74	155132.88
Kula3_2	8.69	2.84	1712828.41	155637.43
Kula2_1	8.69	2.84	1713909.53	156804.91
Kula2_2	8.70	2.84	1712668.59	157536.58
Waia5	8.73	2.83	1712050.63	160794.10
Kula1	8.73	2.83	1712264.89	159452.47
Waia3	8.73	2.83	1711626.41	161968.98
Waia2	8.73	2.83	1711107.47	162742.82
Waia1	8.75	2.83	1710315.02	163510.68
Waia4	8.73	2.83	1711441.47	161508.59
Keok1_2	8.66	2.84	1712881.31	152629.02
Keok1_1	8.64	2.85	1714866.35	152759.98
Keok2_2	8.61	2.86	1715264.14	150472.91
Keok2_1	8.60	2.86	1715286.78	148562.49
Keok2_4	8.60	2.85	1713755.71	147205.46
Kama1_3	8.56	2.87	1716329.58	142181.13
Keok2_3	8.63	2.85	1713785.70	149255.20
Kama1_2	8.57	2.89	1717335.18	142200.68

Proposed Condition: Mauka of Piilani Hwy

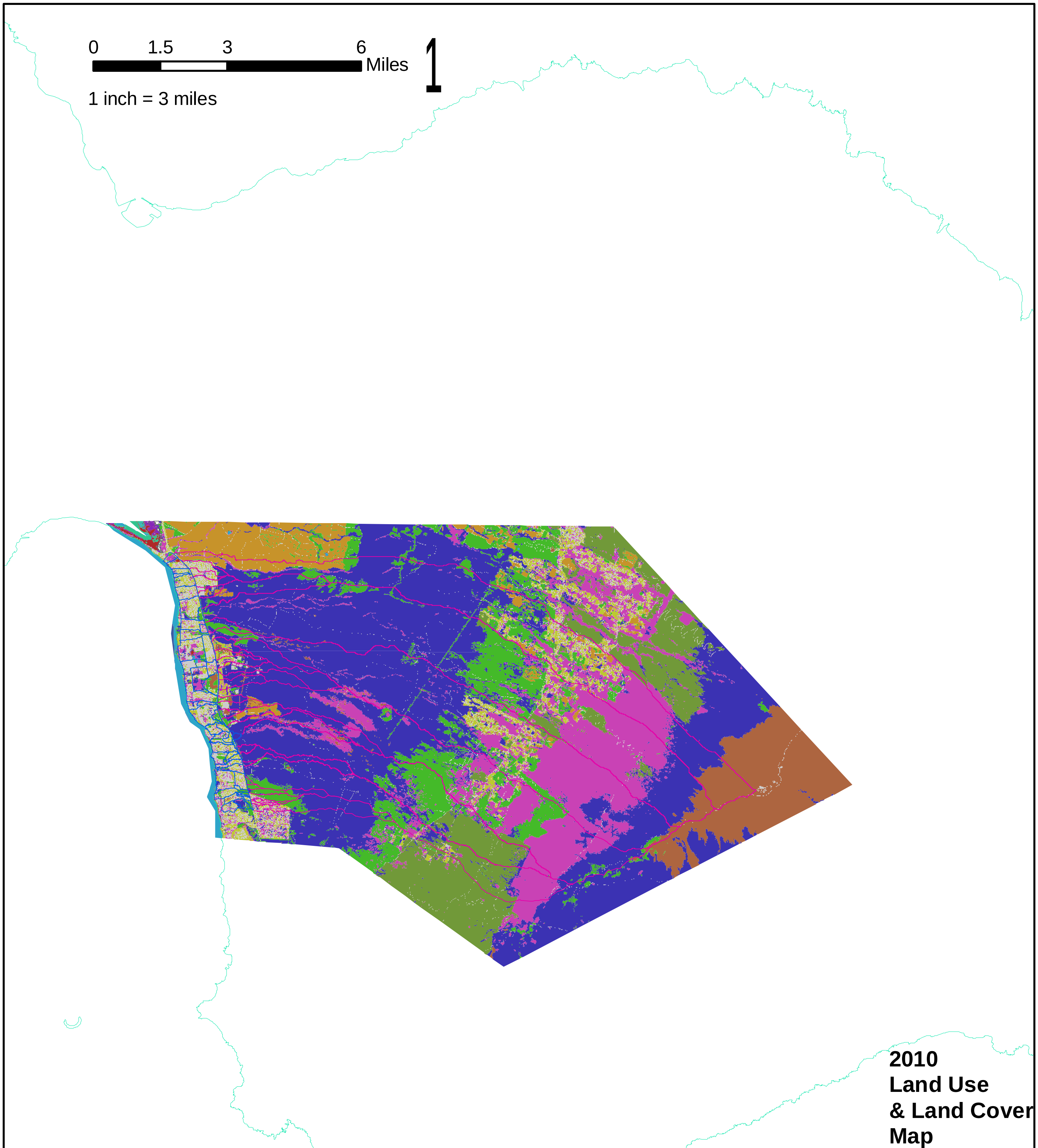
	P100-24	P2-24	Centroid_X	Centroid_Y
	(in)	(in)	HI SP Zone 2, US Feet, NAD 83	
1	8.77	3.17	1745198.68	159623.54
2U	8.75	2.84	1716521.57	161643.77
2D	8.72	2.83	1714093.02	162511.16
3U	8.71	2.85	1716245.75	161199.25
3D	8.72	2.83	1714341.78	161604.89
4U	8.70	2.85	1716957.66	160888.69
4D	8.71	2.84	1714434.48	160677.11
5	8.71	2.84	1714012.60	159829.33
6U	8.71	2.85	1716222.12	159940.76
6D	8.71	2.84	1714877.16	159430.93
29	9.31	3.34	1728667.08	134107.24
28	8.74	3.03	1721323.82	134461.22
27	8.74	3.03	1721940.37	134696.73
26	8.83	3.09	1722655.61	135182.45
25	8.90	3.14	1724439.35	135789.43
24	10.10	3.79	1737864.78	131981.74
24B	8.66	2.98	1720171.17	136390.15
24A	8.66	2.98	1719655.34	137026.51
23A	8.63	2.96	1719540.94	139218.77
23	8.90	3.15	1725222.78	139670.68
22/22A	8.59	2.92	1719309.72	140954.48
21	9.75	3.63	1737102.38	136278.96
20	8.71	3.04	1724446.70	143919.14
19	8.90	3.19	1730786.19	143250.61
17/18	10.00	3.84	1744788.41	137157.87
19A2	8.58	2.88	1717159.28	145155.03
19A1	8.59	2.90	1718582.35	146106.48
17A	8.59	2.87	1717726.88	146828.33
10/10A U	8.65	3.76	1747937.41	142375.04
10/10A D	8.63	2.86	1717339.33	154413.43
16U	8.57	2.89	1720317.52	149129.58
16D	8.59	2.87	1717556.10	148748.37
15U	8.56	2.93	1723330.91	149330.09
15D	8.60	2.87	1717437.12	149580.37
14U	8.56	2.98	1725711.19	149489.32
14D	8.60	2.87	1717629.77	150453.03
13U	8.57	2.88	1720400.33	151198.16
13D	8.61	2.86	1717630.07	151391.24
12U	8.57	2.88	1720387.29	151793.25
12D	8.62	2.86	1717217.45	152209.71
8	9.14	3.33	1746904.72	149350.00
9	8.65	2.86	1716667.46	155469.48
7	8.65	2.88	1721297.67	160029.54
11D	8.62	2.86	1716834.06	153240.63
11U	8.56	2.90	1722078.37	152080.62

Proposed Condition: Makai of Piilani Hwy
There are no changes to the makai areas.
Therefore, the existing rainfall values were applied.

Soil Maps


Soil Map
Legend
Makai Drainage Basin
Mauka Drainage Basin
A
B
C
D
0
1.5
3
6
Miles
1 inch = 3 miles
N

Existing Land Use/Land Cover Map



Legend

- Makai Drainage Basin
- Mauka Drainage Basin
- Bare Land
- Cultivated Land
- Evergreen
- Grassland
- Impervious Surface
- Open Space Developed
- Open Water
- Palustrine Emergent Wetland
- Palustrine Forested Wetland
- Palustrine Scrub Shrub Wetland
- Pasture/Hay
- Scrub Shrub
- Unclassified
- Unconsolidated Shore

APPENDIX B

HYDRAULIC CALCULATION

Piilani Hwy Culverts

HY-8 Culvert Analysis Report

Site Data - Basin 1, 1-48 CMP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 13.80 ft

Outlet Station: 110.00 ft

Outlet Elevation: 12.70 ft

Number of Barrels: 1

Culvert Data Summary - Basin 1, 1-48 CMP

Barrel Shape: Circular

Barrel Diameter: 4.00 ft

Barrel Material: Corrugated Aluminum

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: NONE

Table 1 - Culvert Summary Table: Basin 1, 1-48 CMP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
94.00	94.00	18.96	4.869	5.158	7-M2c	4.000	2.936	2.936	0.000	9.510	0.000
94.00	94.00	18.96	4.869	5.158	7-M2c	4.000	2.936	2.936	0.000	9.510	0.000

****

Straight Culvert

Inlet Elevation (invert): 13.80 ft, Outlet Elevation (invert): 12.70 ft

Culvert Length: 110.01 ft, Culvert Slope: 0.0100

****

Table 2 - Downstream Channel Rating Curve (Crossing: Basin 1)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
94.00	12.70	0.00
94.00	12.70	0.00

Tailwater Channel Data - Basin 1

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 12.70 ft

Site Data - Basin 2, 2-48" CMP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 27.50 ft

Outlet Station: 130.00 ft

Outlet Elevation: 25.94 ft

Number of Barrels: 2

Culvert Data Summary - Basin 2, 2-48" CMP

Barrel Shape: Circular

Barrel Diameter: 4.00 ft

Barrel Material: Corrugated Aluminum

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: NONE

Table 3 - Culvert Summary Table: Basin 2, 2-48" CMP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
244.00	244.00	34.96	6.320	7.456	7-M2c	4.000	3.319	3.319	0.000	10.944	0.000
244.00	244.00	34.96	6.320	7.456	7-M2c	4.000	3.319	3.319	0.000	10.944	0.000

****

Straight Culvert

Inlet Elevation (invert): 27.50 ft, Outlet Elevation (invert): 25.94 ft

Culvert Length: 130.01 ft, Culvert Slope: 0.0120

****

Table 4 - Downstream Channel Rating Curve (Crossing: Basin 2)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
244.00	25.94	0.00
244.00	25.94	0.00

Tailwater Channel Data - Basin 2

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 25.94 ft

Site Data - Basin 3, 2-72x44 Arch

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 55.90 ft

Outlet Station: 116.00 ft

Outlet Elevation: 54.74 ft

Number of Barrels: 2

Culvert Data Summary - Basin 3, 2-72x44 Arch

Barrel Shape: Pipe Arch

Barrel Span: 72.20 in

Barrel Rise: 44.40 in

Barrel Material: Steel or Aluminum

Embedment: 0.00 in

Barrel Manning's n: 0.0250

Culvert Type: Straight

Inlet Configuration: Headwall

Inlet Depression: NONE

Table 5 - Culvert Summary Table: Basin 3, 2-72x44 Arch

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
343.00	343.00	62.98	6.132	7.076	7-M2c	3.700	2.934	2.934	0.000	11.128	0.000
343.00	343.00	62.98	6.132	7.076	7-M2c	3.700	2.934	2.934	0.000	11.128	0.000

****

Straight Culvert

Inlet Elevation (invert): 55.90 ft, Outlet Elevation (invert): 54.74 ft

Culvert Length: 116.01 ft, Culvert Slope: 0.0100

****

Table 6 - Downstream Channel Rating Curve (Crossing: Basin 3)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
343.00	54.74	0.00
343.00	54.74	0.00

Tailwater Channel Data - Basin 3

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 54.74 ft

Site Data - Basin 4, 1-65x40 Arch

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 67.46 ft

Outlet Station: 96.00 ft

Outlet Elevation: 65.54 ft

Number of Barrels: 1

Culvert Data Summary - Basin 4, 1-65x40 Arch

Barrel Shape: Pipe Arch

Barrel Span: 65.00 in

Barrel Rise: 40.00 in

Barrel Material: Steel or Aluminum

Embedment: 0.00 in

Barrel Manning's n: 0.0250

Culvert Type: Straight

Inlet Configuration: Headwall

Inlet Depression: NONE

Table 7 - Culvert Summary Table: Basin 4, 1-65x40 Arch

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
110.00	110.00	71.97	4.493	4.505	7-M2c	2.402	2.395	2.395	0.000	9.524	0.000
110.00	110.00	71.97	4.493	4.505	7-M2c	2.402	2.395	2.395	0.000	9.524	0.000

****

Straight Culvert

Inlet Elevation (invert): 67.46 ft, Outlet Elevation (invert): 65.54 ft

Culvert Length: 96.02 ft, Culvert Slope: 0.0200

****

Table 8 - Downstream Channel Rating Curve (Crossing: Basin 4)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
110.00	65.54	0.00
110.00	65.54	0.00

Tailwater Channel Data - Basin 4

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 65.54 ft

Site Data - Basin 4, 1-72 CMP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 65.00 ft

Outlet Station: 113.00 ft

Outlet Elevation: 63.87 ft

Number of Barrels: 1

Culvert Data Summary - Basin 4, 1-72 CMP

Barrel Shape: Circular

Barrel Diameter: 6.00 ft

Barrel Material: Corrugated Aluminum

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: NONE

Table 9 - Culvert Summary Table: Basin 4, 1-72 CMP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
335.00	335.00	75.00	9.448	9.999	7-M2c	6.000	4.974	4.974	0.000	13.368	0.000
335.00	335.00	75.00	9.448	9.999	7-M2c	6.000	4.974	4.974	0.000	13.368	0.000

****

Straight Culvert

Inlet Elevation (invert): 65.00 ft, Outlet Elevation (invert): 63.87 ft

Culvert Length: 113.01 ft, Culvert Slope: 0.0100

****

Table 10 - Downstream Channel Rating Curve (Crossing: Basin 4)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
335.00	63.87	0.00
335.00	63.87	0.00

Tailwater Channel Data - Basin 4

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 63.87 ft

Site Data - Basin 6, 1-54 CMP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 71.45 ft

Outlet Station: 105.00 ft

Outlet Elevation: 70.40 ft

Number of Barrels: 1

Culvert Data Summary - Basin 6, 1-54 CMP

Barrel Shape: Circular

Barrel Diameter: 4.50 ft

Barrel Material: Corrugated Aluminum

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: NONE

Table 11 - Culvert Summary Table: Basin 6, 1-54 CMP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
121.00	121.00	76.98	5.280	5.527	7-M2c	4.500	3.234	3.234	0.000	9.889	0.000
121.00	121.00	76.98	5.280	5.527	7-M2c	4.500	3.234	3.234	0.000	9.889	0.000

****

Straight Culvert

Inlet Elevation (invert): 71.45 ft, Outlet Elevation (invert): 70.40 ft

Culvert Length: 105.01 ft, Culvert Slope: 0.0100

****

Site Data - Basin 7, 2-102 CMP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 30.22 ft

Outlet Station: 122.00 ft

Outlet Elevation: 29.00 ft

Number of Barrels: 2

Culvert Data Summary - Basin 7, 2-102 CMP

Barrel Shape: Circular

Barrel Diameter: 8.50 ft

Barrel Material: Corrugated Aluminum

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: NONE

Table 13 - Culvert Summary Table: Basin 7, 2-102 CMP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
1265.00	1265.00	40.98	10.553	10.756	7-M2c	8.500	6.311	6.311	0.000	14.000	0.000
1265.00	1265.00	40.98	10.553	10.756	7-M2c	8.500	6.311	6.311	0.000	14.000	0.000

****

Straight Culvert

Inlet Elevation (invert): 30.22 ft, Outlet Elevation (invert): 29.00 ft

Culvert Length: 122.01 ft, Culvert Slope: 0.0100

****

Table 14 - Downstream Channel Rating Curve (Crossing: Basin 7)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
1265.00	29.00	0.00
1265.00	29.00	0.00

Tailwater Channel Data - Basin 7

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 29.00 ft

Site Data - Basin 9, 1-72 CMP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 28.41 ft

Outlet Station: 108.00 ft

Outlet Elevation: 26.90 ft

Number of Barrels: 1

Culvert Data Summary - Basin 9, 1-72 CMP

Barrel Shape: Circular

Barrel Diameter: 6.00 ft

Barrel Material: Corrugated Aluminum

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: NONE

Table 15 - Culvert Summary Table: Basin 9, 1-72 CMP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
307.00	307.00	37.00	8.587	8.497	7-M2c	6.000	4.782	4.782	0.000	12.705	0.000
307.00	307.00	37.00	8.587	8.497	7-M2c	6.000	4.782	4.782	0.000	12.705	0.000

****

Straight Culvert

Inlet Elevation (invert): 28.41 ft, Outlet Elevation (invert): 26.90 ft

Culvert Length: 108.01 ft, Culvert Slope: 0.0140

****

Table 16 - Downstream Channel Rating Curve (Crossing: Basin 9)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
307.00	26.90	0.00
307.00	26.90	0.00

Tailwater Channel Data - Basin 9

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 26.90 ft

Site Data - Basin 11D, 1-90 CMP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 39.50 ft

Outlet Station: 117.00 ft

Outlet Elevation: 38.21 ft

Number of Barrels: 1

Culvert Data Summary - Basin 11D, 1-90 CMP

Barrel Shape: Circular

Barrel Diameter: 7.50 ft

Barrel Material: Corrugated Aluminum

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: NONE

Table 17 - Culvert Summary Table: Basin 11D, 1-90 CMP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
568.00	568.00	50.96	11.422	11.458	7-M2c	7.500	6.136	6.136	0.000	14.681	0.000
568.00	568.00	50.96	11.422	11.458	7-M2c	7.500	6.136	6.136	0.000	14.681	0.000

****

Straight Culvert

Inlet Elevation (invert): 39.50 ft, Outlet Elevation (invert): 38.21 ft

Culvert Length: 117.01 ft, Culvert Slope: 0.0110

****

Table 18 - Downstream Channel Rating Curve (Crossing: Basin 11D)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
568.00	38.21	0.00
568.00	38.21	0.00

Tailwater Channel Data - Basin 11D

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 38.21 ft

Site Data - Basin 12, 1-54 CMP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 49.06 ft

Outlet Station: 90.00 ft

Outlet Elevation: 46.90 ft

Number of Barrels: 1

Culvert Data Summary - Basin 12, 1-54 CMP

Barrel Shape: Circular

Barrel Diameter: 4.50 ft

Barrel Material: Corrugated Aluminum

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: NONE

Table 19 - Culvert Summary Table: Basin 12, 1-54 CMP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
213.00	213.00	58.97	9.877	9.912	7-M2c	4.500	4.116	4.116	0.000	13.968	0.000
213.00	213.00	58.97	9.877	9.912	7-M2c	4.500	4.116	4.116	0.000	13.968	0.000

****

Straight Culvert

Inlet Elevation (invert): 49.06 ft, Outlet Elevation (invert): 46.90 ft

Culvert Length: 90.03 ft, Culvert Slope: 0.0240

****

Table 20 - Downstream Channel Rating Curve (Crossing: Basin 12)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
213.00	46.90	0.00
213.00	46.90	0.00

Tailwater Channel Data - Basin 12

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 46.90 ft

Site Data - Basin 13, 2-66 CMP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 63.00 ft

Outlet Station: 118.00 ft

Outlet Elevation: 60.20 ft

Number of Barrels: 2

Culvert Data Summary - Basin 13, 2-66 CMP

Barrel Shape: Circular

Barrel Diameter: 5.50 ft

Barrel Material: Corrugated Aluminum

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: NONE

Table 21 - Culvert Summary Table: Basin 13, 2-66 CMP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
440.00	440.00	70.00	6.997	0.0*	5-S2n	3.666	4.149	3.695	0.000	12.958	0.000
440.00	440.00	70.00	6.997	0.0*	5-S2n	3.666	4.149	3.695	0.000	12.958	0.000

* Full Flow Headwater elevation is below inlet invert.

****

Straight Culvert

Inlet Elevation (invert): 63.00 ft, Outlet Elevation (invert): 60.20 ft

Culvert Length: 118.03 ft, Culvert Slope: 0.0237

****

Table 22 - Downstream Channel Rating Curve (Crossing: Basin 13)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
440.00	60.20	0.00
440.00	60.20	0.00

Tailwater Channel Data - Basin 13

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 60.20 ft

Site Data - Basin 14, 1-60 CMP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 72.50 ft

Outlet Station: 119.00 ft

Outlet Elevation: 67.98 ft

Number of Barrels: 1

Culvert Data Summary - Basin 14, 1-60 CMP

Barrel Shape: Circular

Barrel Diameter: 5.00 ft

Barrel Material: Corrugated Aluminum

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: NONE

Table 23 - Culvert Summary Table: Basin 14, 1-60 CMP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
204.00	204.00	79.96	7.462	5.006	5-S2n	3.205	4.072	3.236	0.000	15.185	0.000
204.00	204.00	79.96	7.462	5.006	5-S2n	3.205	4.072	3.236	0.000	15.185	0.000

****

Straight Culvert

Inlet Elevation (invert): 72.50 ft, Outlet Elevation (invert): 67.98 ft

Culvert Length: 119.09 ft, Culvert Slope: 0.0380

****

Table 24 - Downstream Channel Rating Curve (Crossing: Basin 14)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
204.00	67.98	0.00
204.00	67.98	0.00

Tailwater Channel Data - Basin 14

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 67.98 ft

Site Data - Basin 15, 1-60 CMP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 78.10 ft

Outlet Station: 102.00 ft

Outlet Elevation: 77.08 ft

Number of Barrels: 1

Culvert Data Summary - Basin 15, 1-60 CMP

Barrel Shape: Circular

Barrel Diameter: 5.00 ft

Barrel Material: Corrugated Aluminum

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: NONE

Table 25 - Culvert Summary Table: Basin 15, 1-60 CMP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
218.00	218.00	86.98	8.111	8.876	7-M2c	5.000	4.190	4.190	0.000	12.408	0.000
218.00	218.00	86.98	8.111	8.876	7-M2c	5.000	4.190	4.190	0.000	12.408	0.000

****

Straight Culvert

Inlet Elevation (invert): 78.10 ft, Outlet Elevation (invert): 77.08 ft

Culvert Length: 102.01 ft, Culvert Slope: 0.0100

****

Table 26 - Downstream Channel Rating Curve (Crossing: Basin 15)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
218.00	77.08	0.00
218.00	77.08	0.00

Tailwater Channel Data - Basin 15

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 77.08 ft

Site Data - Basin 17A, 3-60 CMP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 79.70 ft

Outlet Station: 110.00 ft

Outlet Elevation: 78.60 ft

Number of Barrels: 3

Culvert Data Summary - Basin 17A, 3-60 CMP

Barrel Shape: Circular

Barrel Diameter: 5.00 ft

Barrel Material: Corrugated Aluminum

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: NONE

Table 27 - Culvert Summary Table: Basin 17A, 3-60 CMP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
561.00	561.00	86.99	6.880	7.292	7-M2c	5.000	3.911	3.911	0.000	11.347	0.000
561.00	561.00	86.99	6.880	7.292	7-M2c	5.000	3.911	3.911	0.000	11.347	0.000

****

Straight Culvert

Inlet Elevation (invert): 79.70 ft, Outlet Elevation (invert): 78.60 ft

Culvert Length: 110.01 ft, Culvert Slope: 0.0100

****

Table 28 - Downstream Channel Rating Curve (Crossing: Basin 17A)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
561.00	78.60	0.00
561.00	78.60	0.00

Tailwater Channel Data - Basin 17A

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 78.60 ft

Site Data - Basin 19A1, 1-84x61 Pipe Arch

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 63.00 ft

Outlet Station: 93.00 ft

Outlet Elevation: 62.10 ft

Number of Barrels: 1

Culvert Data Summary - Basin 19A1, 1-84x61 Pipe Arch

Barrel Shape: Pipe Arch

Barrel Span: 84.20 in

Barrel Rise: 61.10 in

Barrel Material: Steel Structural Plate

Embedment: 0.00 in

Barrel Manning's n: 0.0350

Culvert Type: Straight

Inlet Configuration: Headwall

Inlet Depression: NONE

Table 29 - Culvert Summary Table: Basin 19A1, 1-84x61 Pipe Arch

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
206.00	206.00	68.98	5.413	5.980	7-M2c	5.092	3.226	3.226	0.000	10.235	0.000
206.00	206.00	68.98	5.413	5.980	7-M2c	5.092	3.226	3.226	0.000	10.235	0.000

****

Straight Culvert

Inlet Elevation (invert): 63.00 ft, Outlet Elevation (invert): 62.10 ft

Culvert Length: 93.00 ft, Culvert Slope: 0.0097

****

Table 30 - Downstream Channel Rating Curve (Crossing: Basin 19A1)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
206.00	62.10	0.00
206.00	62.10	0.00

Tailwater Channel Data - Basin 19A1

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 62.10 ft

Site Data - Basin 19A2, 1-54 CMP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 49.50 ft

Outlet Station: 132.00 ft

Outlet Elevation: 44.62 ft

Number of Barrels: 1

Culvert Data Summary - Basin 19A2, 1-54 CMP

Barrel Shape: Circular

Barrel Diameter: 4.50 ft

Barrel Material: Corrugated Aluminum

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: NONE

Table 31 - Culvert Summary Table: Basin 19A2, 1-54 CMP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
222.00	222.00	59.94	10.444	9.351	7-M2c	4.500	4.161	4.161	0.000	14.455	0.000
222.00	222.00	59.94	10.444	9.351	7-M2c	4.500	4.161	4.161	0.000	14.455	0.000

****

Straight Culvert

Inlet Elevation (invert): 49.50 ft,   Outlet Elevation (invert): 44.62 ft

Culvert Length: 132.09 ft,   Culvert Slope: 0.0370

****

Table 32 - Downstream Channel Rating Curve (Crossing: Basin 19A2)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
222.00	44.62	0.00
222.00	44.62	0.00

Tailwater Channel Data - Basin 19A2

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 44.62 ft

Site Data - Basin 19, 2-84 CMP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 64.40 ft

Outlet Station: 131.00 ft

Outlet Elevation: 59.16 ft

Number of Barrels: 2

Culvert Data Summary - Basin 19, 2-84 CMP

Barrel Shape: Circular

Barrel Diameter: 7.00 ft

Barrel Material: Corrugated Aluminum

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: NONE

Table 33 - Culvert Summary Table: Basin 19, 2-84 CMP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
959.00	959.00	75.00	10.596	7.247	5-S2n	4.285	5.735	4.396	0.000	18.871	0.000
959.00	959.00	75.00	10.596	7.247	5-S2n	4.285	5.735	4.396	0.000	18.871	0.000

****

Straight Culvert

Inlet Elevation (invert): 64.40 ft, Outlet Elevation (invert): 59.16 ft

Culvert Length: 131.10 ft, Culvert Slope: 0.0400

****

Table 34 - Downstream Channel Rating Curve (Crossing: Basin 19)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
959.00	59.16	0.00
959.00	59.16	0.00

Tailwater Channel Data - Basin 19

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 59.16 ft

Site Data - Basin 20, 3-120 RCP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 104.50 ft

Outlet Station: 100.00 ft

Outlet Elevation: 103.50 ft

Number of Barrels: 3

Culvert Data Summary - Basin 20, 3-120 RCP

Barrel Shape: Circular

Barrel Diameter: 10.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0300

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: NONE

Table 35 - Culvert Summary Table: Basin 20, 3-120 RCP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
2452.00	2452.00	116.00	11.019	11.500	7-M2c	10.000	6.887	6.887	0.000	14.171	0.000
2452.00	2452.00	116.00	11.019	11.500	7-M2c	10.000	6.887	6.887	0.000	14.171	0.000

****

Straight Culvert

Inlet Elevation (invert): 104.50 ft, Outlet Elevation (invert): 103.50 ft

Culvert Length: 100.00 ft, Culvert Slope: 0.0100

****

Table 36 - Downstream Channel Rating Curve (Crossing: Basin 20)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
2452.00	103.50	0.00
2452.00	103.50	0.00

Tailwater Channel Data - Basin 20

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 103.50 ft

Site Data - Basin 21, 2-96 CMP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 103.60 ft

Outlet Station: 113.00 ft

Outlet Elevation: 102.47 ft

Number of Barrels: 2

Culvert Data Summary - Basin 21, 2-96 CMP

Barrel Shape: Circular

Barrel Diameter: 8.00 ft

Barrel Material: Corrugated Aluminum

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: NONE

Table 37 - Culvert Summary Table: Basin 21, 2-96 CMP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
979.00	979.00	113.00	9.069	9.399	7-M2c	6.538	5.637	5.637	0.000	12.931	0.000
979.00	979.00	113.00	9.069	9.399	7-M2c	6.538	5.637	5.637	0.000	12.931	0.000

****

Straight Culvert

Inlet Elevation (invert): 103.60 ft, Outlet Elevation (invert): 102.47 ft

Culvert Length: 113.01 ft, Culvert Slope: 0.0100

****

Table 38 - Downstream Channel Rating Curve (Crossing: Basin 21)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
979.00	102.47	0.00
979.00	102.47	0.00

Tailwater Channel Data - Basin 21

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 102.47 ft

Site Data - Basin 22, 3-36 CMP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 117.40 ft

Outlet Station: 260.00 ft

Outlet Elevation: 114.80 ft

Number of Barrels: 3

Culvert Data Summary - Basin 22, 3-36 CMP

Barrel Shape: Circular

Barrel Diameter: 3.00 ft

Barrel Material: Corrugated Aluminum

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: NONE

Table 39 - Culvert Summary Table: Basin 22, 3-36 CMP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
120.00	120.00	120.99	3.259	3.591	7-M2c	3.000	2.057	2.057	0.000	7.743	0.000
120.00	120.00	120.99	3.259	3.591	7-M2c	3.000	2.057	2.057	0.000	7.743	0.000

****

Straight Culvert

Inlet Elevation (invert): 117.40 ft, Outlet Elevation (invert): 114.80 ft

Culvert Length: 260.01 ft, Culvert Slope: 0.0100

****

Table 40 - Downstream Channel Rating Curve (Crossing: Basin 22)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
120.00	114.80	0.00
120.00	114.80	0.00

Tailwater Channel Data - Basin 22

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 114.80 ft

Site Data - Basin 23, 2-78 CMP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 127.30 ft

Outlet Station: 132.00 ft

Outlet Elevation: 125.98 ft

Number of Barrels: 2

Culvert Data Summary - Basin 23, 2-78 CMP

Barrel Shape: Circular

Barrel Diameter: 6.50 ft

Barrel Material: Corrugated Aluminum

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: NONE

Table 41 - Culvert Summary Table: Basin 23, 2-78 CMP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
587.00	587.00	135.00	7.415	7.699	7-M2c	5.592	4.594	4.594	0.000	11.705	0.000
587.00	587.00	135.00	7.415	7.699	7-M2c	5.592	4.594	4.594	0.000	11.705	0.000

****

Straight Culvert

Inlet Elevation (invert): 127.30 ft, Outlet Elevation (invert): 125.98 ft

Culvert Length: 132.01 ft, Culvert Slope: 0.0100

****

Table 42 - Downstream Channel Rating Curve (Crossing: Basin 23)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
587.00	125.98	0.00
587.00	125.98	0.00

Tailwater Channel Data - Basin 23

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 125.98 ft

Site Data - Basin 23A, 1-42 CMP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 148.50 ft

Outlet Station: 162.00 ft

Outlet Elevation: 146.07 ft

Number of Barrels: 1

Culvert Data Summary - Basin 23A, 1-42 CMP

Barrel Shape: Circular

Barrel Diameter: 3.50 ft

Barrel Material: Corrugated Aluminum

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: NONE

Table 43 - Culvert Summary Table: Basin 23A, 1-42 CMP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
59.00	59.00	152.49	3.803	3.986	7-M2c	2.564	2.404	2.404	0.000	8.375	0.000
59.00	59.00	152.49	3.803	3.986	7-M2c	2.564	2.404	2.404	0.000	8.375	0.000

****

Straight Culvert

Inlet Elevation (invert): 148.50 ft, Outlet Elevation (invert): 146.07 ft

Culvert Length: 162.02 ft, Culvert Slope: 0.0150

****

Table 44 - Downstream Channel Rating Curve (Crossing: Basin 23A)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
59.00	146.07	0.00
59.00	146.07	0.00

Tailwater Channel Data - Basin 23A

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 146.07 ft

Site Data - Basin 25, 2-66 CMP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 196.52 ft

Outlet Station: 166.00 ft

Outlet Elevation: 195.69 ft

Number of Barrels: 2

Culvert Data Summary - Basin 25, 2-66 CMP

Barrel Shape: Circular

Barrel Diameter: 5.50 ft

Barrel Material: Corrugated Aluminum

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: NONE

Table 45 - Culvert Summary Table: Basin 25, 2-66 CMP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
351.00	351.00	202.99	5.818	6.474	7-M2c	5.500	3.702	3.702	0.000	10.319	0.000
351.00	351.00	202.99	5.818	6.474	7-M2c	5.500	3.702	3.702	0.000	10.319	0.000

****

Straight Culvert

Inlet Elevation (invert): 196.52 ft, Outlet Elevation (invert): 195.69 ft

Culvert Length: 166.00 ft, Culvert Slope: 0.0050

****

Table 46 - Downstream Channel Rating Curve (Crossing: Basin 25)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
351.00	195.69	0.00
351.00	195.69	0.00

Tailwater Channel Data - Basin 25

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 195.69 ft

Site Data - Basin 26, 3-48 CMP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 206.77 ft

Outlet Station: 85.00 ft

Outlet Elevation: 205.50 ft

Number of Barrels: 3

Culvert Data Summary - Basin 26, 3-48 CMP

Barrel Shape: Circular

Barrel Diameter: 4.00 ft

Barrel Material: Corrugated Aluminum

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: NONE

Table 48 - Downstream Channel Rating Curve (Crossing: Basin 26)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
333.00	205.50	0.00
333.00	205.50	0.00

Tailwater Channel Data - Basin 26

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 205.50 ft

Site Data - Basin 27, 2-42 CMP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 232.26 ft

Outlet Station: 82.14 ft

Outlet Elevation: 231.24 ft

Number of Barrels: 2

Culvert Data Summary - Basin 27, 2-42 CMP

Barrel Shape: Circular

Barrel Diameter: 3.50 ft

Barrel Material: Corrugated Aluminum

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: NONE

Site Data - Basin 28, 1-30 CMP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 235.48 ft

Outlet Station: 102.07 ft

Outlet Elevation: 232.69 ft

Number of Barrels: 1

Culvert Data Summary - Basin 28, 1-30 CMP

Barrel Shape: Circular

Barrel Diameter: 2.50 ft

Barrel Material: Corrugated Aluminum

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: NONE

Site Data - Basin 29, 1-84 CMP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 239.88 ft

Outlet Station: 184.23 ft

Outlet Elevation: 235.11 ft

Number of Barrels: 1

Culvert Data Summary - Basin 29, 1-84 CMP

Barrel Shape: Circular

Barrel Diameter: 7.00 ft

Barrel Material: Corrugated Aluminum

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: NONE

Table 53 - Culvert Summary Table: Basin 29, 1-84 CMP

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
571.00	571.00	252.98	13.104	0.0*	5-S2n	5.965	6.158	5.965	0.000	16.400	0.000
571.00	571.00	252.98	13.104	0.0*	5-S2n	5.965	6.158	5.965	0.000	16.400	0.000

* Full Flow Headwater elevation is below inlet invert.

****

Straight Culvert

Inlet Elevation (invert): 239.88 ft, Outlet Elevation (invert): 235.11 ft

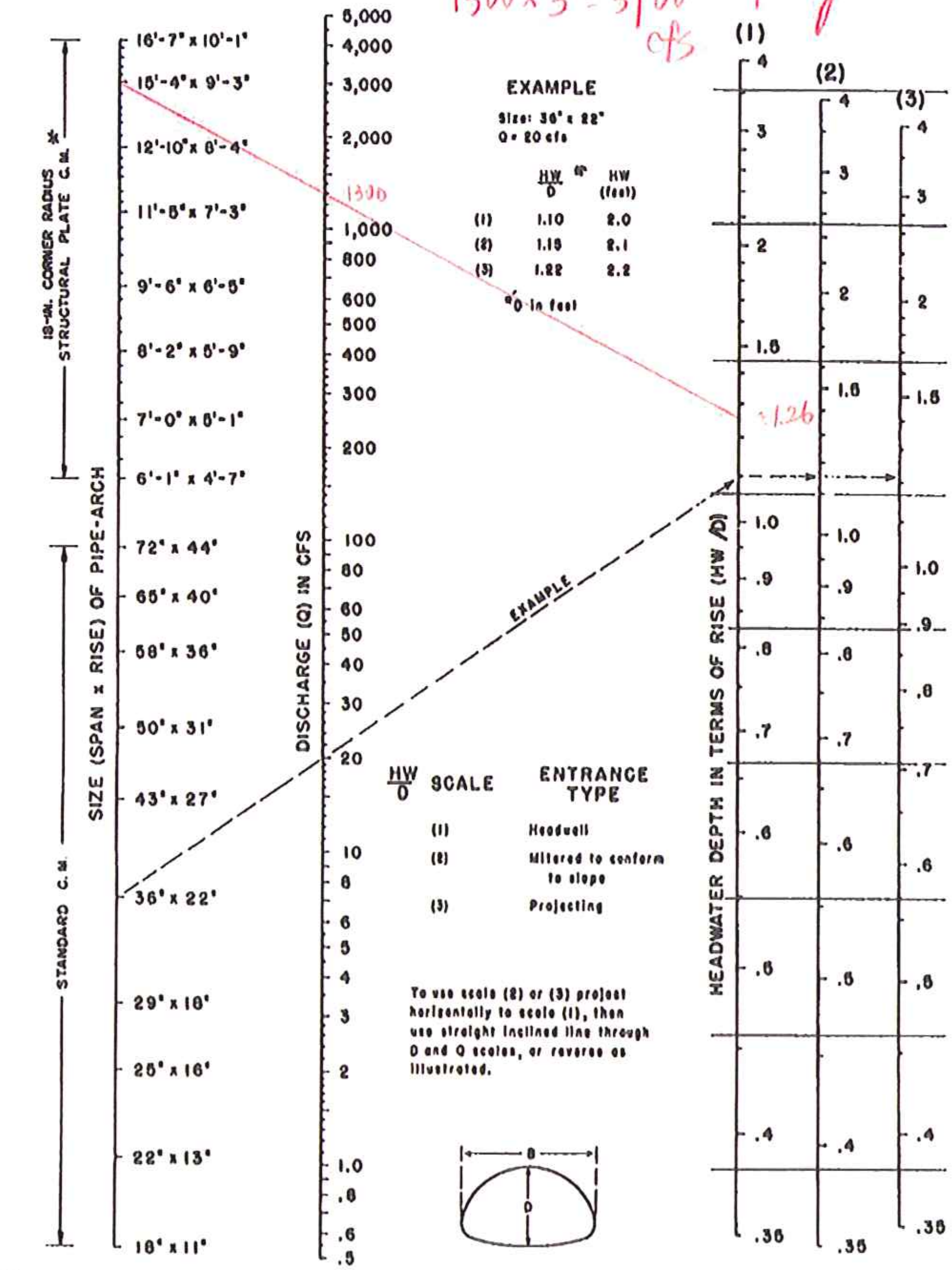
Culvert Length: 184.29 ft, Culvert Slope: 0.0259

****

BASIN 24/24A/24B
Q_{100} = 3869 cfs. EXISTING
3-15'-4"x9'-3"

CHART 34B

1300 x 3 = 3900 cfs Capacity



*ADDITIONAL SIZES NOT DIMENSIONED ARE LISTED IN FABRICATOR'S CATALOG

BUREAU OF PUBLIC ROADS JAN. 1963

HEADWATER DEPTH FOR C. M. PIPE-ARCH CULVERTS WITH INLET CONTROL

Charlie Young District, CY1-1
$Q_{100} = 239$ cfs
2 culverts $239/2 = 119.5$, use 120

NOMOGRAPH FOR BOX CULVERTS WITH ENTRANCE CONTROL

PLATE 20

6×4 $\frac{Q}{b} = \frac{120}{6} = 20$
$b = 6$ $H/a = 0.87$
$a = 4$
$H = 3.5$

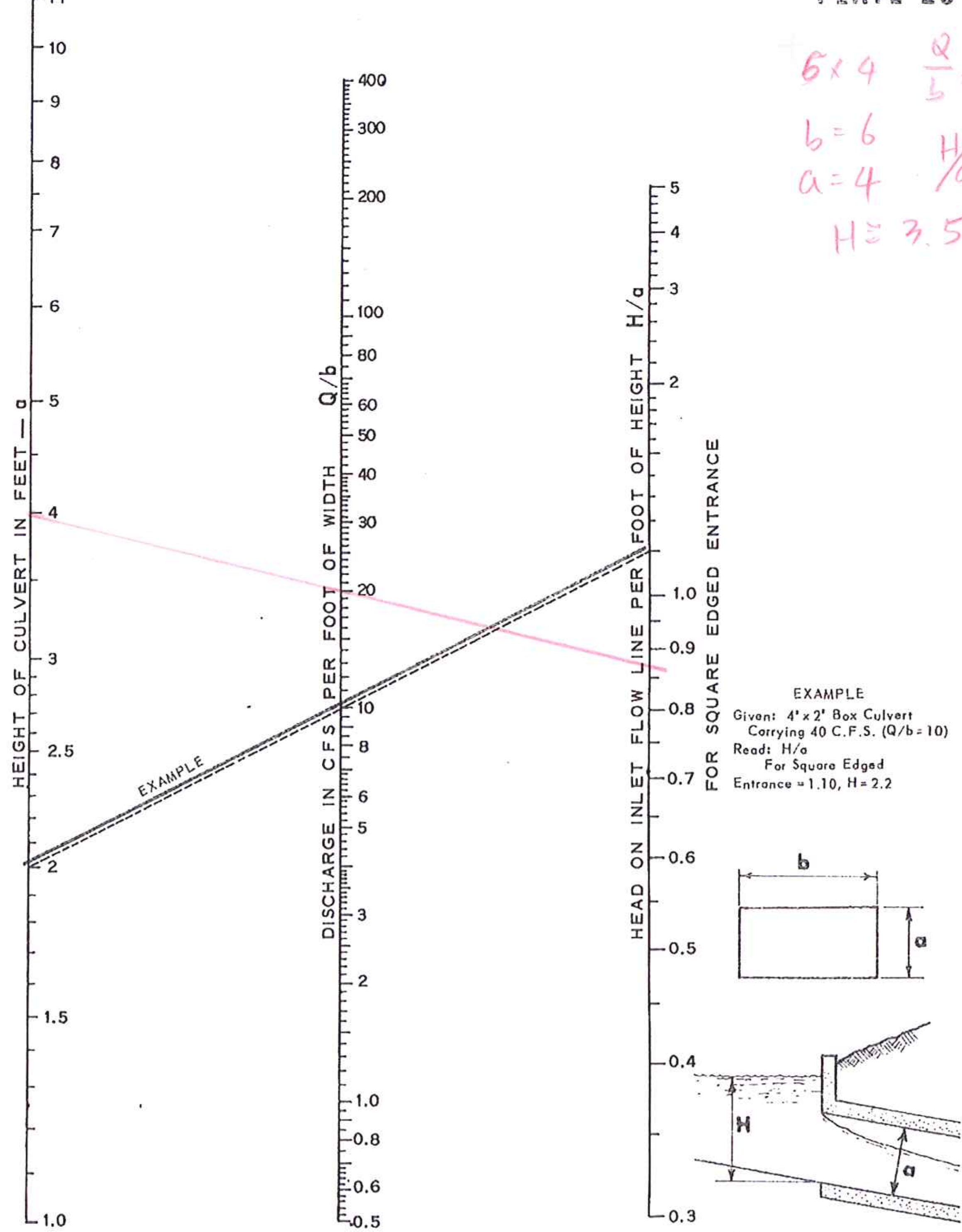


Table 54 - Downstream Channel Rating Curve (Crossing: Basin 29)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
571.00	235.11	0.00
571.00	235.11	0.00

Tailwater Channel Data - Basin 29

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 235.11 ft

Other Culverts and Channels

Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Thursday, Oct 29 2015

Auhana Road Culvert

Invert Elev Dn (ft)	=	49.50
Pipe Length (ft)	=	35.00
Slope (%)	=	0.57
Invert Elev Up (ft)	=	49.70
Rise (in)	=	60.0
Shape	=	Box
Span (in)	=	84.0
No. Barrels	=	2
n-Value	=	0.013
Culvert Type	=	Flared Wingwalls
Culvert Entrance	=	30D to 75D wingwall flares
Coeff. K,M,c,Y,k	=	0.026, 1, 0.0347, 0.81, 0.4

Embankment

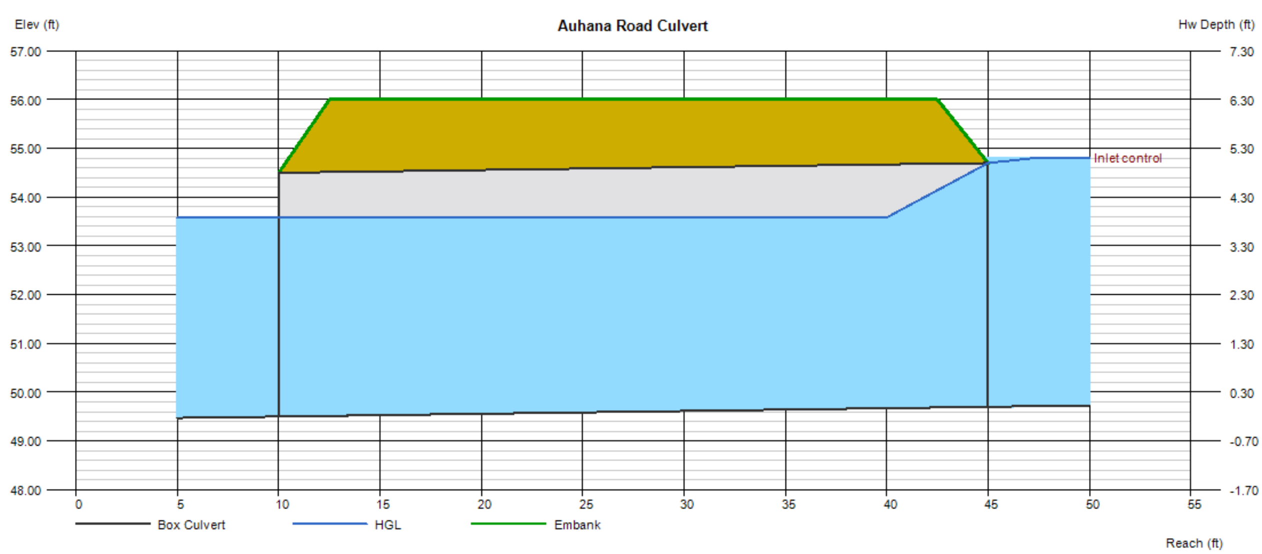
Top Elevation (ft)	=	56.00
Top Width (ft)	=	30.00
Crest Width (ft)	=	20.00

Calculations

Qmin (cfs)	=	448.00
Qmax (cfs)	=	448.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	448.00
Qpipe (cfs)	=	448.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	7.84
Veloc Up (ft/s)	=	8.24
HGL Dn (ft)	=	53.58
HGL Up (ft)	=	53.58
Hw Elev (ft)	=	54.81
Hw/D (ft)	=	1.02
Flow Regime	=	Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. | Monday, Nov 2 2015

Auhana Road Culvert

Invert Elev Dn (ft)	=	49.50
Pipe Length (ft)	=	35.00
Slope (%)	=	0.57
Invert Elev Up (ft)	=	49.70
Rise (in)	=	60.0
Shape	=	Box
Span (in)	=	84.0
No. Barrels	=	2
n-Value	=	0.013
Culvert Type	=	Flared Wingwalls
Culvert Entrance	=	30D to 75D wingwall flares
Coeff. K,M,c,Y,k	=	0.026, 1, 0.0347, 0.81, 0.4

Embankment

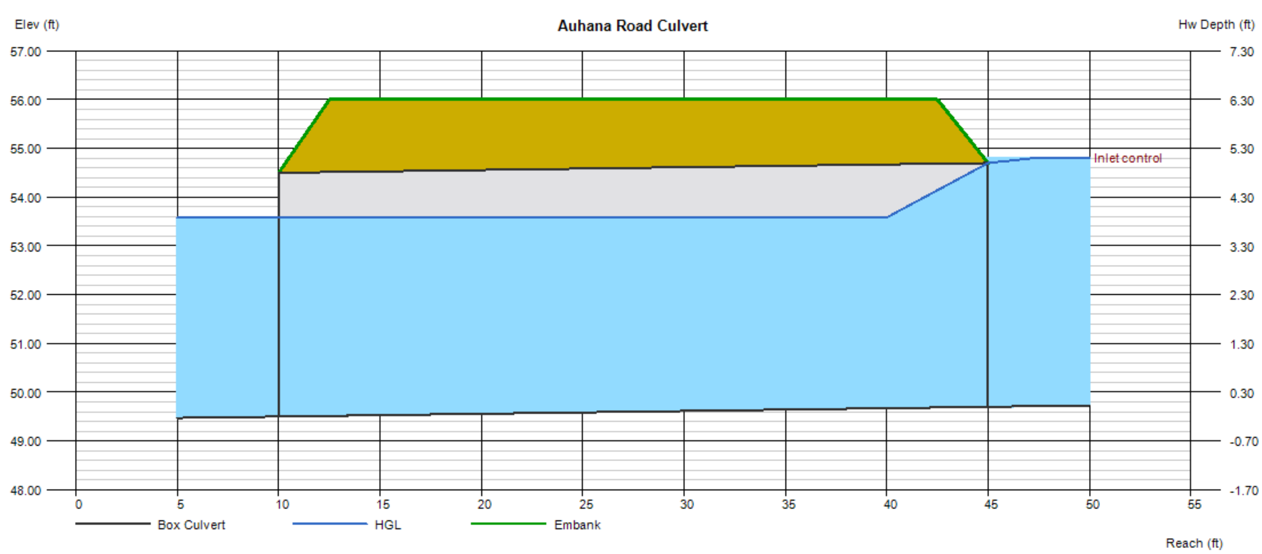
Top Elevation (ft)	=	56.00
Top Width (ft)	=	30.00
Crest Width (ft)	=	20.00

Calculations

Qmin (cfs)	=	448.00
Qmax (cfs)	=	448.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

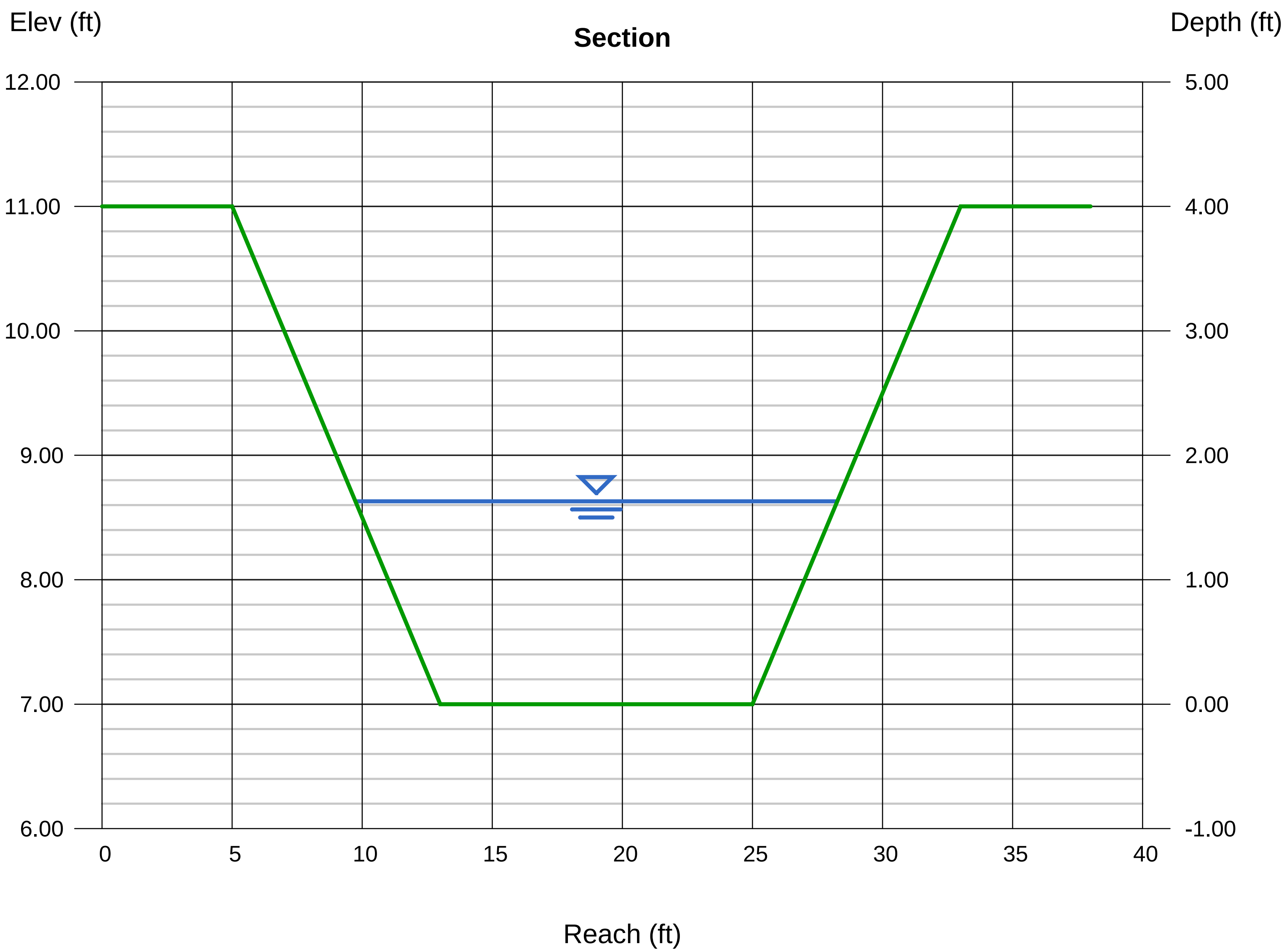
Qtotal (cfs)	=	448.00
Qpipe (cfs)	=	448.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	7.84
Veloc Up (ft/s)	=	8.24
HGL Dn (ft)	=	53.58
HGL Up (ft)	=	53.58
Hw Elev (ft)	=	54.81
Hw/D (ft)	=	1.02
Flow Regime	=	Inlet Control



Channel Report

Cy1_1 Channel

Trapezoidal		**Highlighted**	
Bottom Width (ft)	= 12.00	Depth (ft)	= 1.63
Side Slopes (z:1)	= 2.00, 2.00	Q (cfs)	= 124.00
Total Depth (ft)	= 4.00	Area (sqft)	= 24.87
Invert Elev (ft)	= 7.00	Velocity (ft/s)	= 4.99
Slope (%)	= 1.00	Wetted Perim (ft)	= 19.29
N-Value	= 0.035	Crit Depth, Yc (ft)	= 1.38
		Top Width (ft)	= 18.52
Calculations		EGL (ft)	= 2.02
Compute by:	Known Q		
Known Q (cfs)	= 124.00		



Channel Report

Cy 2_1 Channel

Trapezoidal

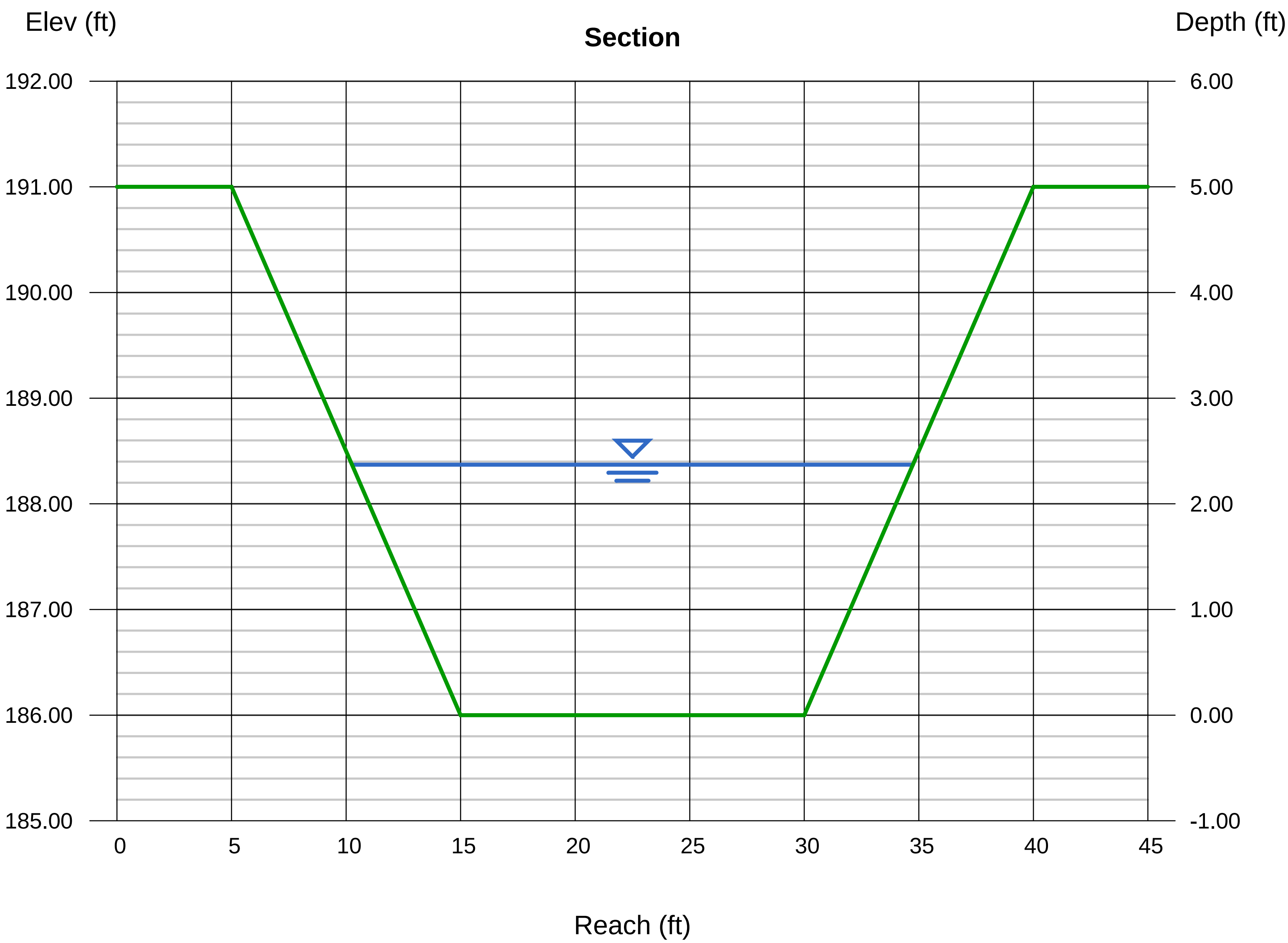
Bottom Width (ft)	= 15.00
Side Slopes (z:1)	= 2.00, 2.00
Total Depth (ft)	= 5.00
Invert Elev (ft)	= 186.00
Slope (%)	= 2.50
N-Value	= 0.025

Calculations

Compute by:	Known Q
Known Q (cfs)	= 656.00

Highlighted

Depth (ft)	= 2.37
Q (cfs)	= 656.00
Area (sqft)	= 46.78
Velocity (ft/s)	= 14.02
Wetted Perim (ft)	= 25.60
Crit Depth, Yc (ft)	= 3.34
Top Width (ft)	= 24.48
EGL (ft)	= 5.43

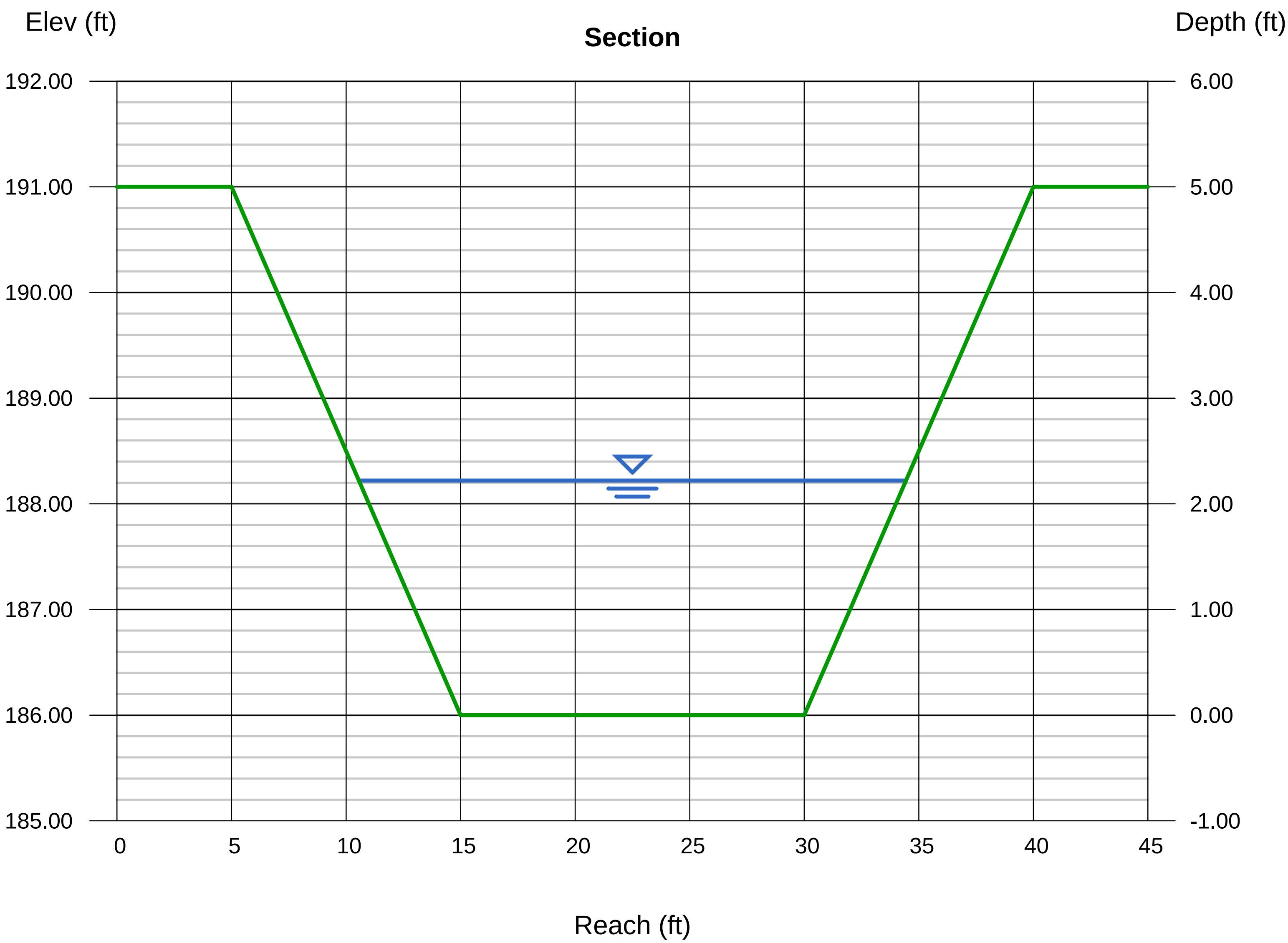


Channel Report

Cy 2_1 Channel

Trapezoidal	
Bottom Width (ft)	= 15.00
Side Slopes (z:1)	= 2.00, 2.00
Total Depth (ft)	= 5.00
Invert Elev (ft)	= 186.00
Slope (%)	= 2.00
N-Value	= 0.025
Calculations	
Compute by:	Known Q
Known Q (cfs)	= 523.00

Highlighted	
Depth (ft)	= 2.22
Q (cfs)	= 523.00
Area (sqft)	= 43.16
Velocity (ft/s)	= 12.12
Wetted Perim (ft)	= 24.93
Crit Depth, Yc (ft)	= 2.93
Top Width (ft)	= 23.88
EGL (ft)	= 4.50

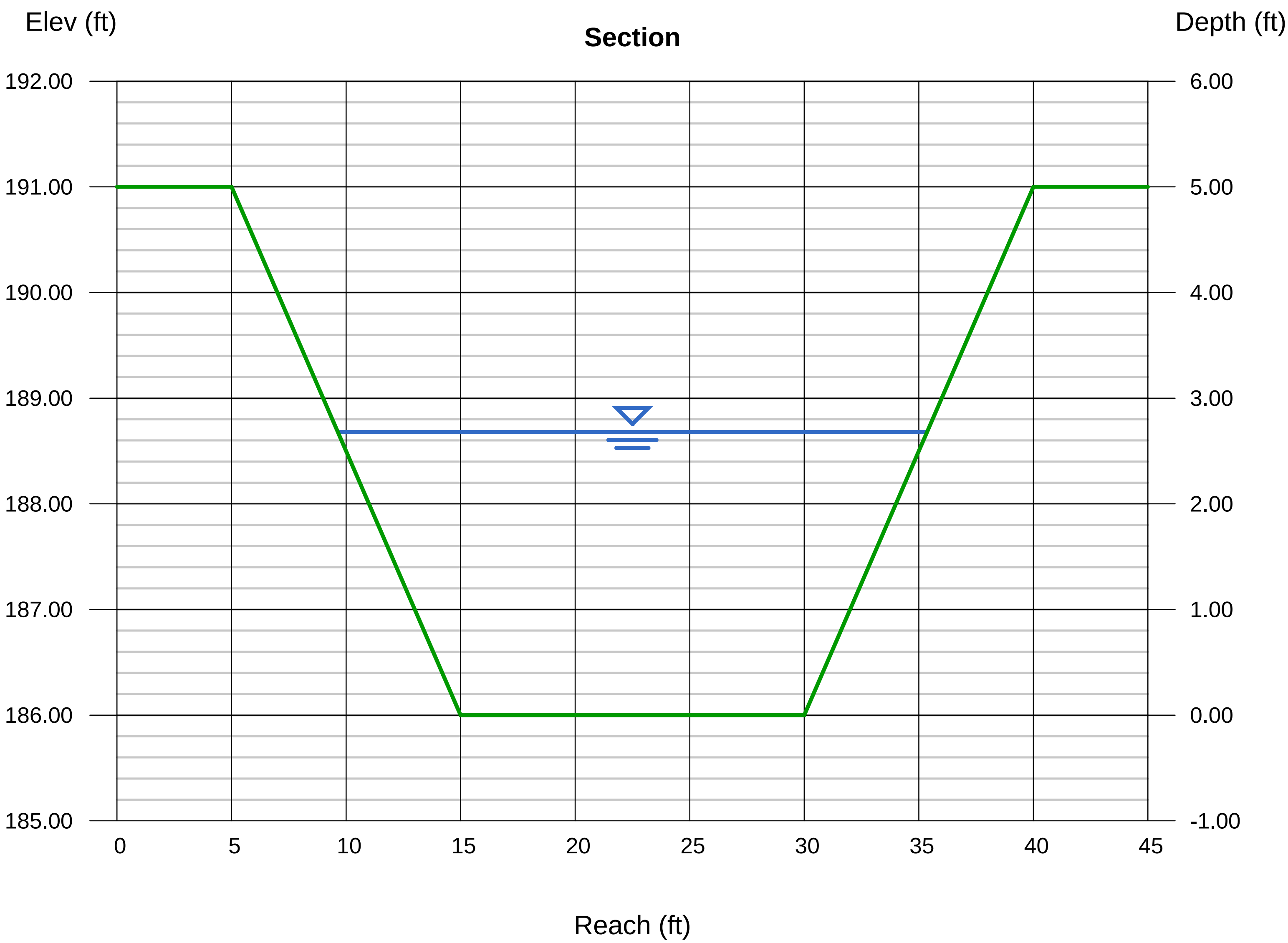


Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Wednesday, Sep 28 2016

Cy 2_1 Channel_Grassed

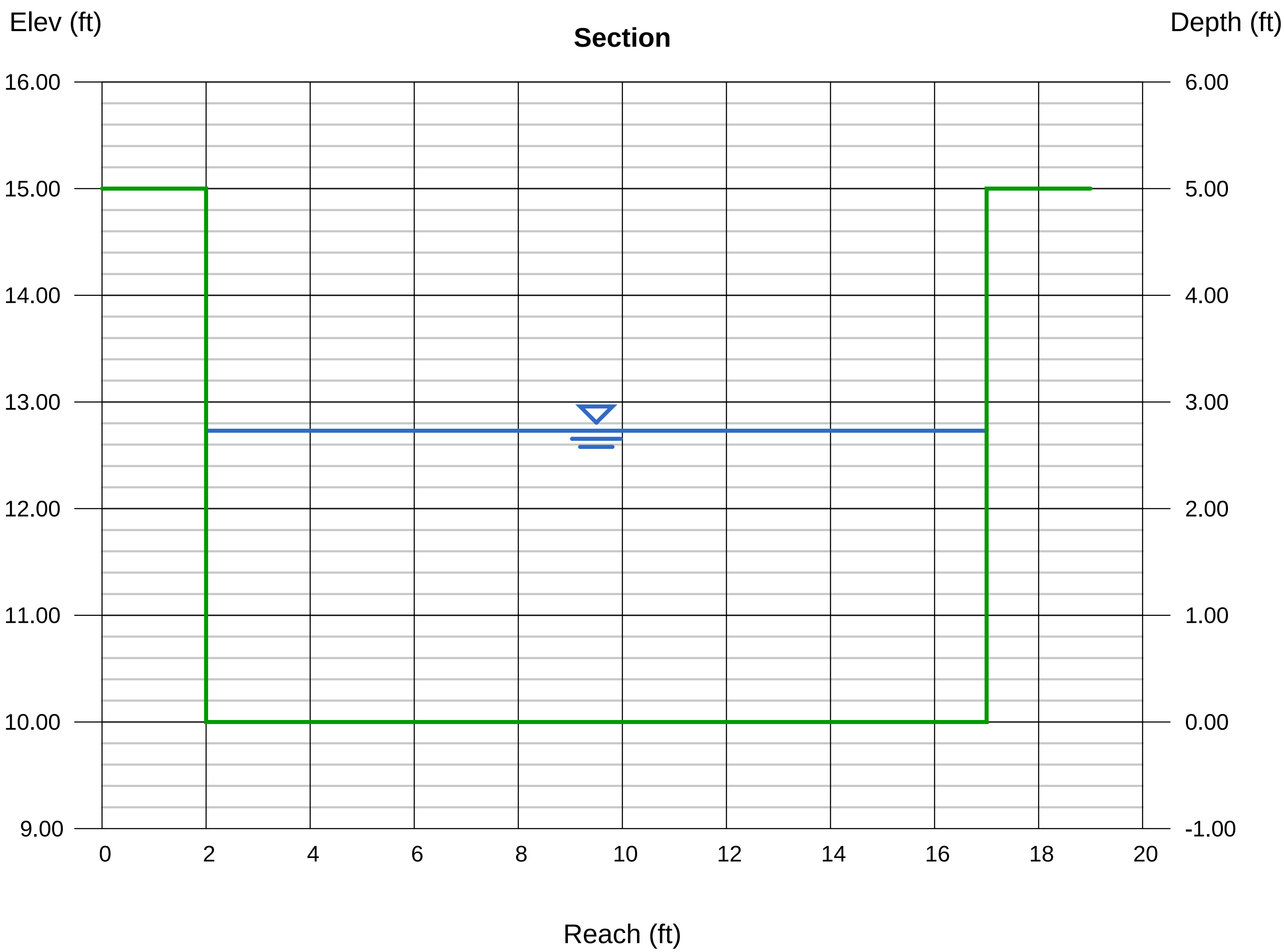
Trapezoidal		**Highlighted**	
Bottom Width (ft)	= 15.00	Depth (ft)	= 2.68
Side Slopes (z:1)	= 2.00, 2.00	Q (cfs)	= 523.00
Total Depth (ft)	= 5.00	Area (sqft)	= 54.56
Invert Elev (ft)	= 186.00	Velocity (ft/s)	= 9.58
Slope (%)	= 2.00	Wetted Perim (ft)	= 26.99
N-Value	= 0.035	Crit Depth, Yc (ft)	= 2.93
		Top Width (ft)	= 25.72
Calculations		EGL (ft)	= 4.11
Compute by:	Known Q		
Known Q (cfs)	= 523.00		



Channel Report

Cy2_2 Channel

Rectangular			**Highlighted**	
Bottom Width (ft)	= 15.00		Depth (ft)	= 2.73
Total Depth (ft)	= 5.00		Q (cfs)	= 523.00
			Area (sqft)	= 40.95
Invert Elev (ft)	= 10.00		Velocity (ft/s)	= 12.77
Slope (%)	= 0.50		Wetted Perim (ft)	= 20.46
N-Value	= 0.013		Crit Depth, Yc (ft)	= 3.36
			Top Width (ft)	= 15.00
Calculations			EGL (ft)	= 5.27
Compute by:	Known Q			
Known Q (cfs)	= 523.00			

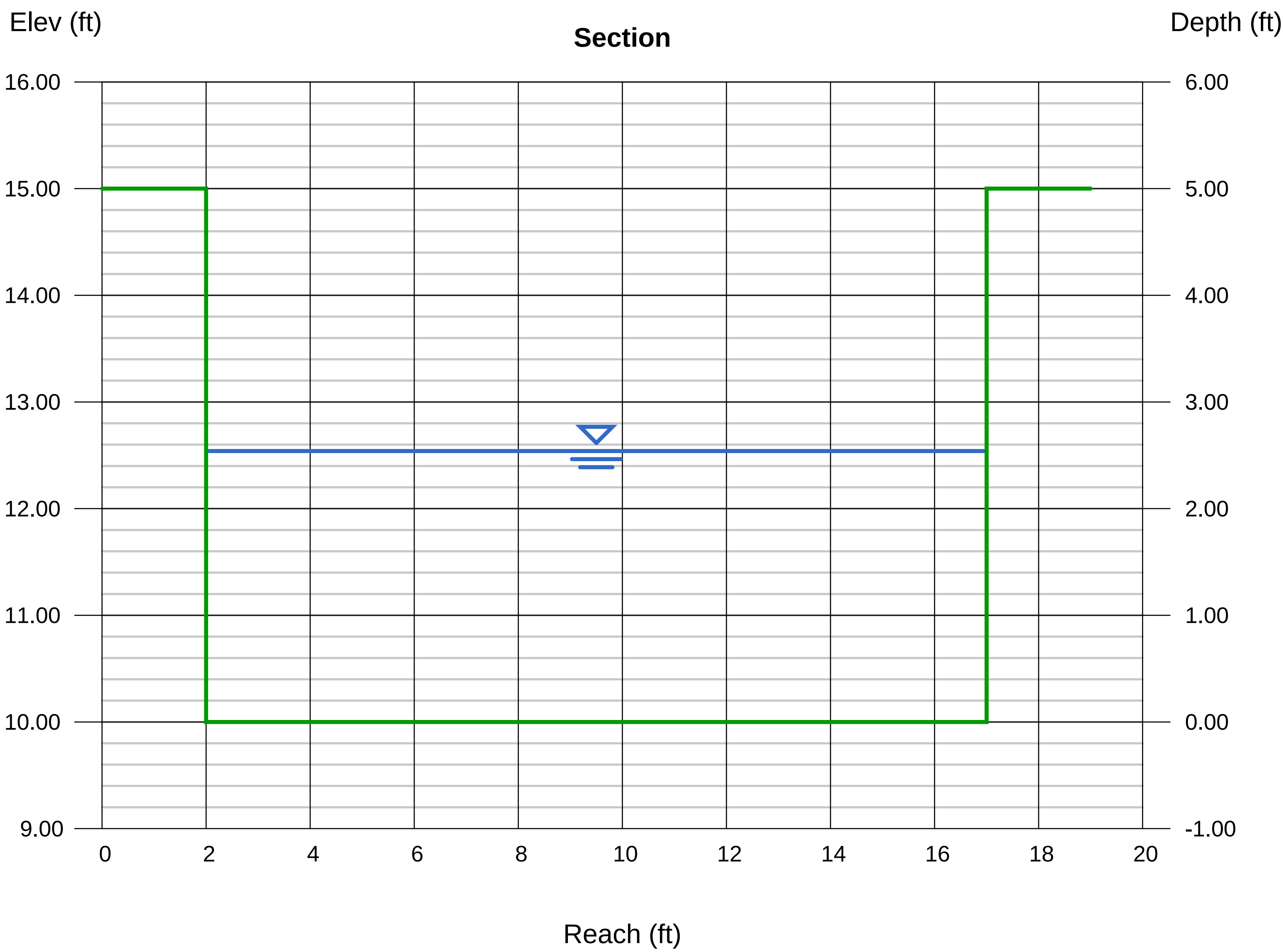


Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Thursday, Oct 29 2015

Cy3_2 Channel

Rectangular		**Highlighted**	
Bottom Width (ft)	= 15.00	Depth (ft)	= 2.54
Total Depth (ft)	= 5.00	Q (cfs)	= 471.00
		Area (sqft)	= 38.10
Invert Elev (ft)	= 10.00	Velocity (ft/s)	= 12.36
Slope (%)	= 0.50	Wetted Perim (ft)	= 20.08
N-Value	= 0.013	Crit Depth, Yc (ft)	= 3.13
		Top Width (ft)	= 15.00
Calculations		EGL (ft)	= 4.92
Compute by:	Known Q		
Known Q (cfs)	= 471.00		



Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Thursday, Oct 29 2015

Cy3_2 South Kihei Road Culvert

Invert Elev Dn (ft)	=	6.80
Pipe Length (ft)	=	60.00
Slope (%)	=	1.50
Invert Elev Up (ft)	=	7.70
Rise (in)	=	48.0
Shape	=	Box
Span (in)	=	72.0
No. Barrels	=	3
n-Value	=	0.013
Culvert Type	=	Flared Wingwalls
Culvert Entrance	=	30D to 75D wingwall flares
Coeff. K,M,c,Y,k	=	0.026, 1, 0.0347, 0.81, 0.4

Embankment

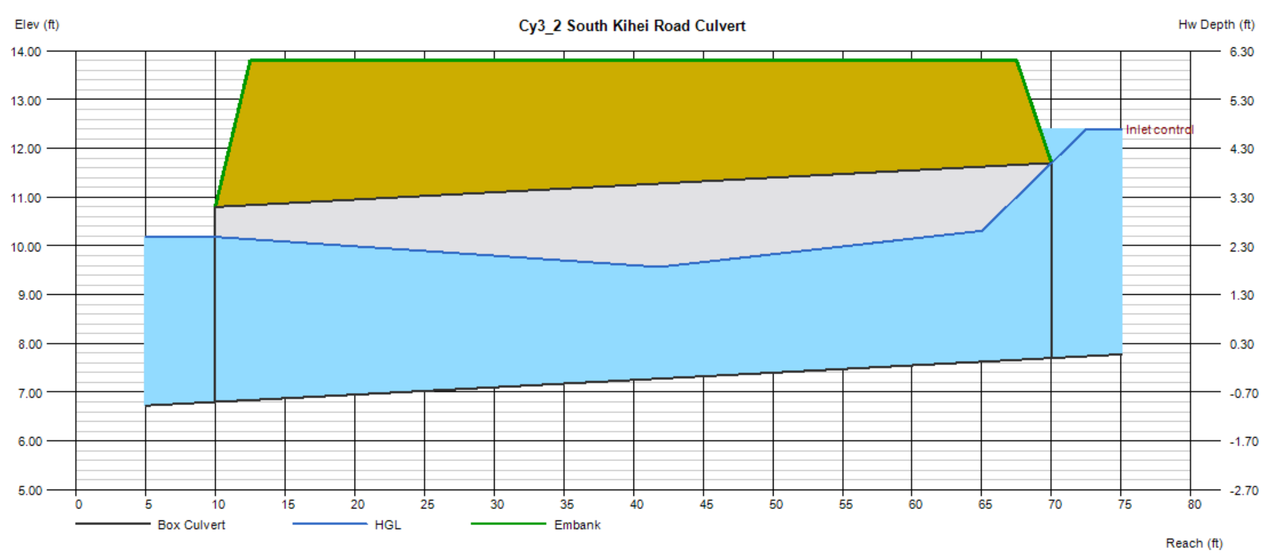
Top Elevation (ft)	=	13.80
Top Width (ft)	=	55.00
Crest Width (ft)	=	20.00

Calculations

Qmin (cfs)	=	471.00
Qmax (cfs)	=	471.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	471.00
Qpipe (cfs)	=	471.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	7.73
Veloc Up (ft/s)	=	9.45
HGL Dn (ft)	=	10.18
HGL Up (ft)	=	10.47
Hw Elev (ft)	=	12.39
Hw/D (ft)	=	1.17
Flow Regime	=	Inlet Control

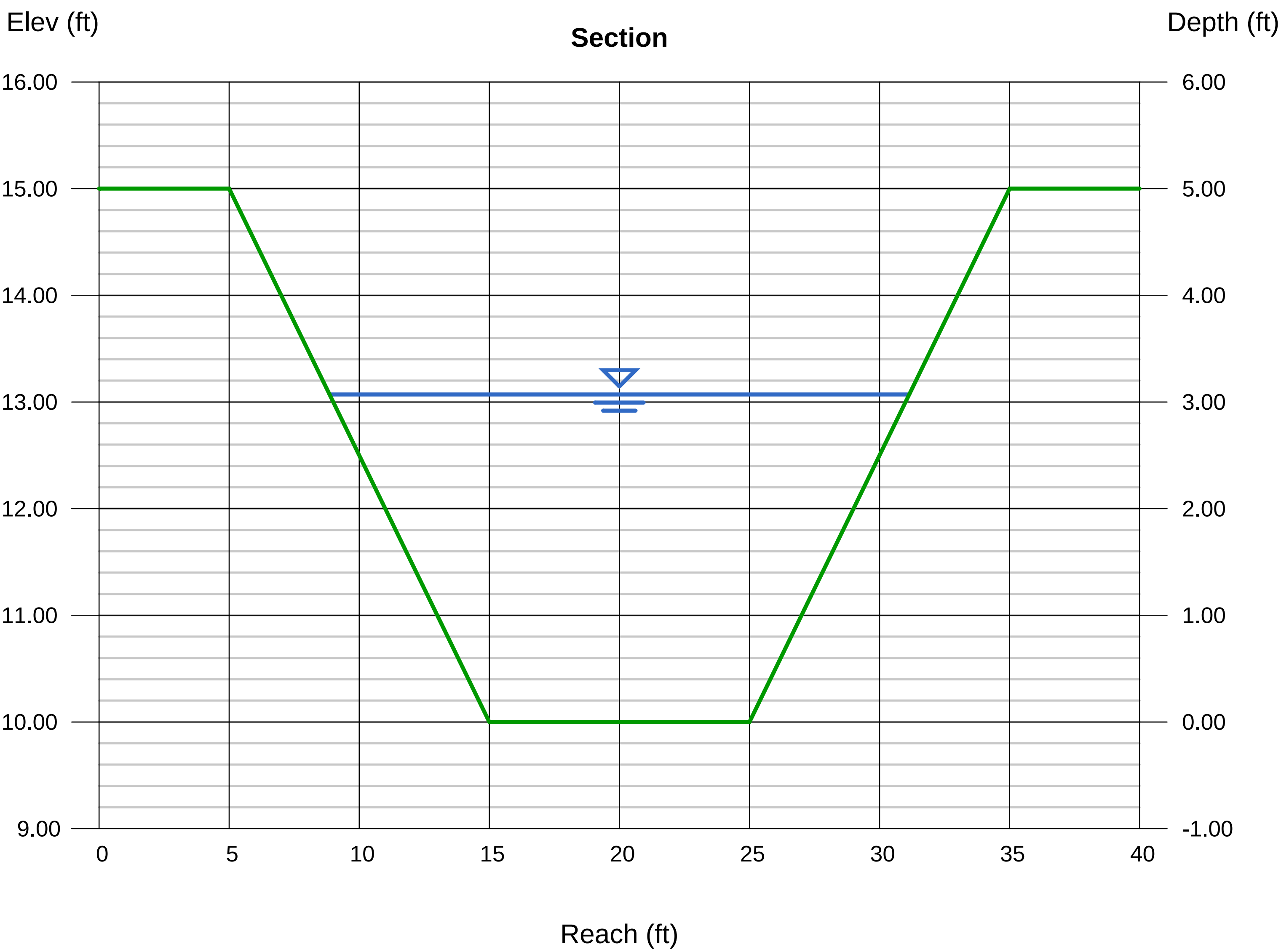


Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Tuesday, Oct 27 2015

Diversion Ditch 2U to 6U

Trapezoidal		**Highlighted**	
Bottom Width (ft)	= 10.00	Depth (ft)	= 3.07
Side Slopes (z:1)	= 2.00, 2.00	Q (cfs)	= 242.00
Total Depth (ft)	= 5.00	Area (sqft)	= 49.55
Invert Elev (ft)	= 10.00	Velocity (ft/s)	= 4.88
Slope (%)	= 0.50	Wetted Perim (ft)	= 23.73
N-Value	= 0.035	Crit Depth, Yc (ft)	= 2.25
		Top Width (ft)	= 22.28
Calculations		EGL (ft)	= 3.44
Compute by:	Known Q		
Known Q (cfs)	= 242.00		



Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Wednesday, Jul 27 2016

Ex 2-48 Kupuna St.

Invert Elev Dn (ft)	=	2.86
Pipe Length (ft)	=	76.00
Slope (%)	=	1.50
Invert Elev Up (ft)	=	4.00
Rise (in)	=	48.0
Shape	=	Circular
Span (in)	=	48.0
No. Barrels	=	2
n-Value	=	0.024
Culvert Type	=	Circular Corrugate Metal Pipe
Culvert Entrance	=	Headwall
Coeff. K,M,c,Y,k	=	0.0078, 2, 0.0379, 0.69, 0.5

Embankment

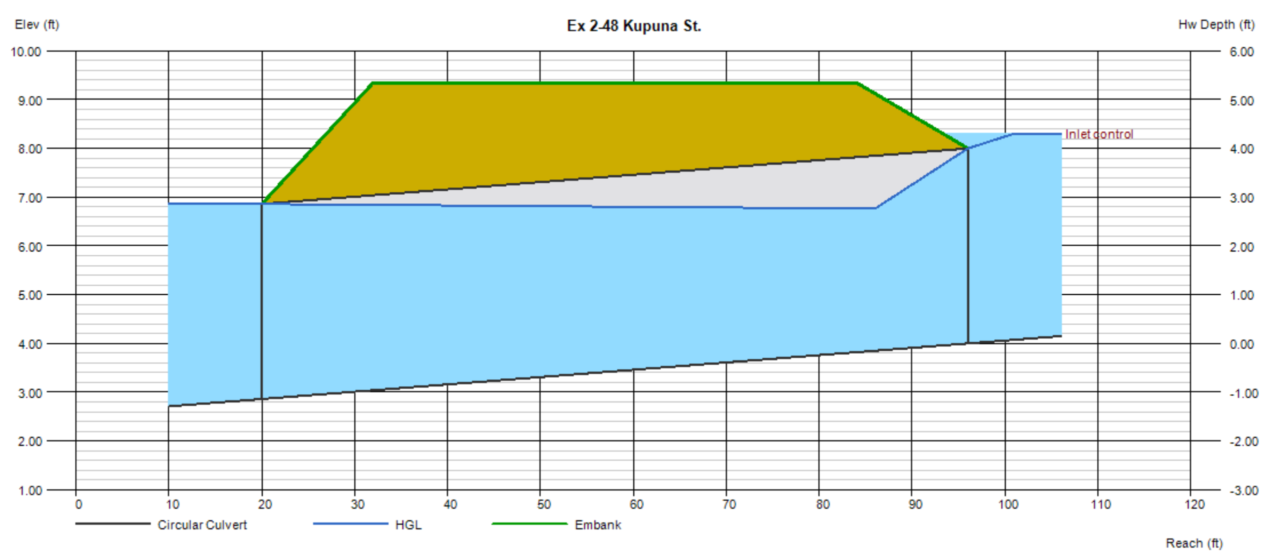
Top Elevation (ft)	=	9.35
Top Width (ft)	=	52.00
Crest Width (ft)	=	10.00

Calculations

Qmin (cfs)	=	165.00
Qmax (cfs)	=	165.00
Tailwater Elev (ft)	=	Crown

Highlighted

Qtotal (cfs)	=	165.00
Qpipe (cfs)	=	165.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	6.57
Veloc Up (ft/s)	=	8.96
HGL Dn (ft)	=	6.86
HGL Up (ft)	=	6.75
Hw Elev (ft)	=	8.30
Hw/D (ft)	=	1.08
Flow Regime	=	Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Wednesday, Jul 27 2016

Ex 2-48 Malama St.

Invert Elev Dn (ft)	=	33.42
Pipe Length (ft)	=	78.00
Slope (%)	=	2.03
Invert Elev Up (ft)	=	35.00
Rise (in)	=	48.0
Shape	=	Circular
Span (in)	=	48.0
No. Barrels	=	2
n-Value	=	0.024
Culvert Type	=	Circular Corrugate Metal Pipe
Culvert Entrance	=	Headwall
Coeff. K,M,c,Y,k	=	0.0078, 2, 0.0379, 0.69, 0.5

Embankment

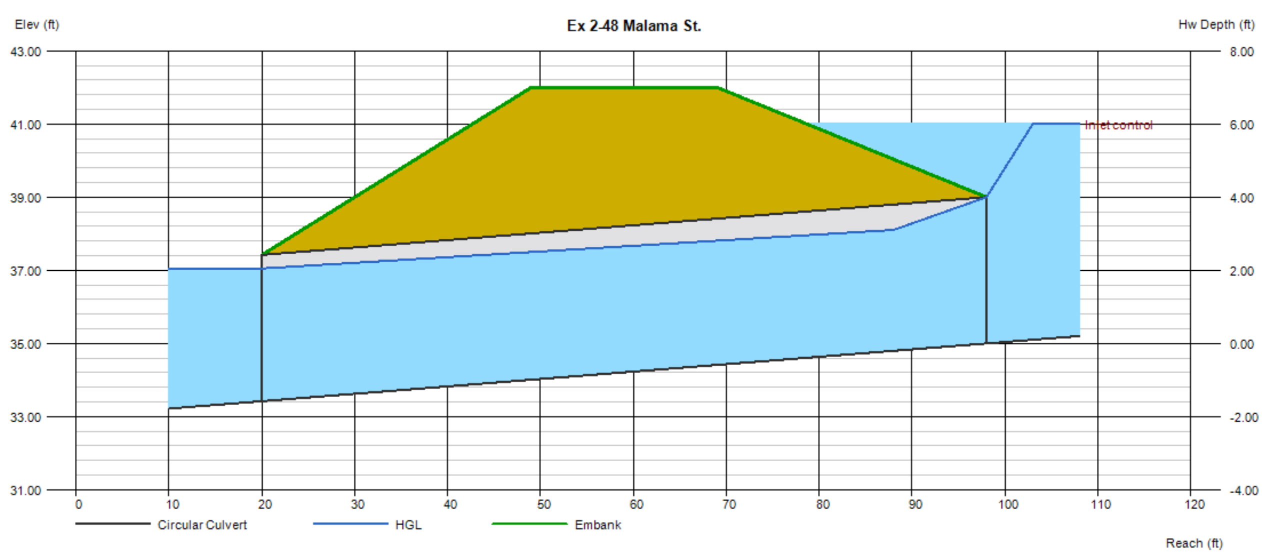
Top Elevation (ft)	=	42.00
Top Width (ft)	=	20.00
Crest Width (ft)	=	10.00

Calculations

Qmin (cfs)	=	234.00
Qmax (cfs)	=	239.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

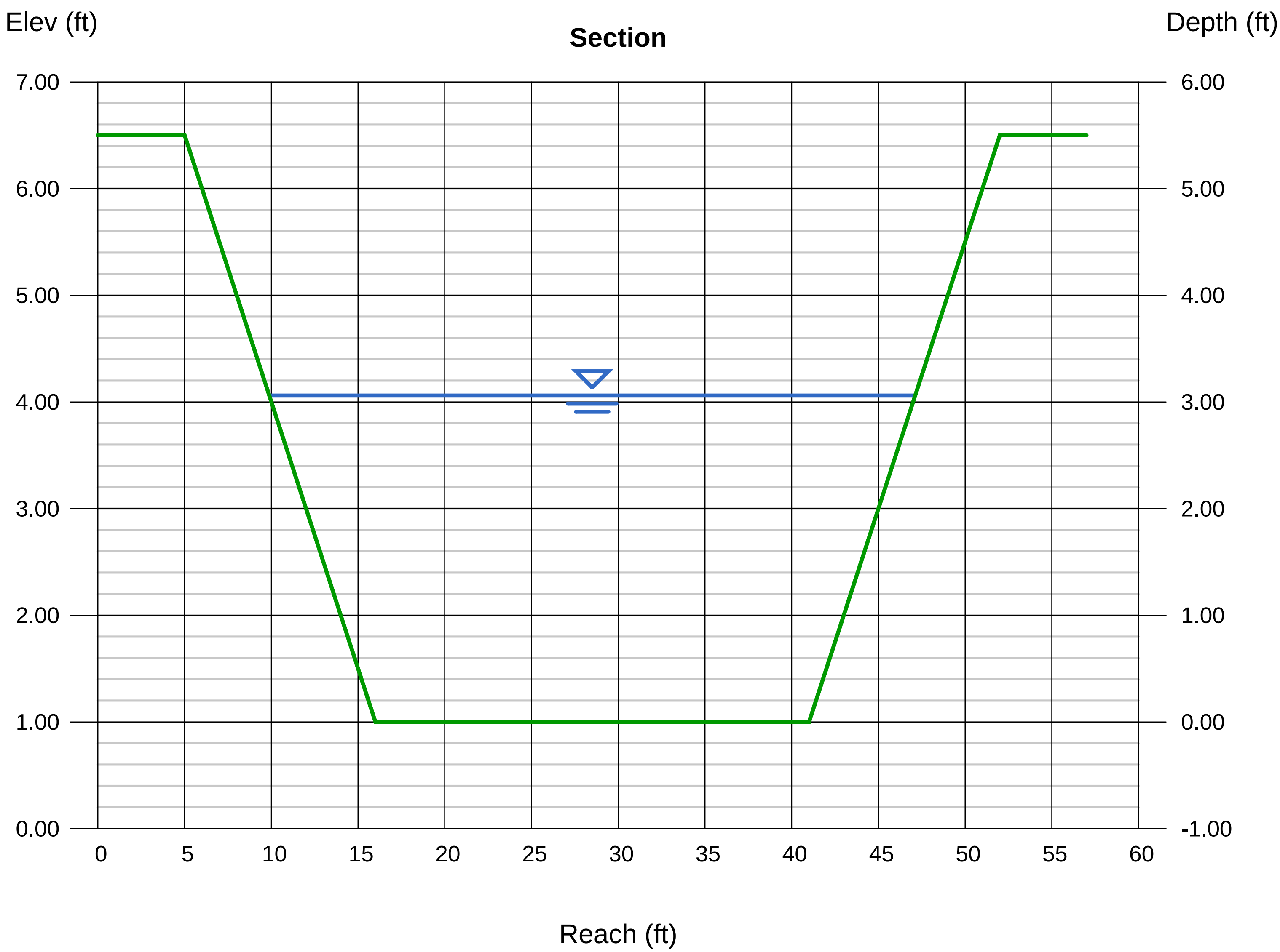
Qtotal (cfs)	=	234.00
Qpipe (cfs)	=	234.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	9.77
Veloc Up (ft/s)	=	10.67
HGL Dn (ft)	=	37.05
HGL Up (ft)	=	38.26
Hw Elev (ft)	=	41.00
Hw/D (ft)	=	1.50
Flow Regime	=	Inlet Control



Channel Report

Kalama Beach Park Channel

Trapezoidal		**Highlighted**	
Bottom Width (ft)	= 25.00	Depth (ft)	= 3.06
Side Slopes (z:1)	= 2.00, 2.00	Q (cfs)	= 728.00
Total Depth (ft)	= 5.50	Area (sqft)	= 95.23
Invert Elev (ft)	= 1.00	Velocity (ft/s)	= 7.64
Slope (%)	= 0.50	Wetted Perim (ft)	= 38.68
N-Value	= 0.025	Crit Depth, Yc (ft)	= 2.76
		Top Width (ft)	= 37.24
Calculations		EGL (ft)	= 3.97
Compute by:	Known Q		
Known Q (cfs)	= 728.00		



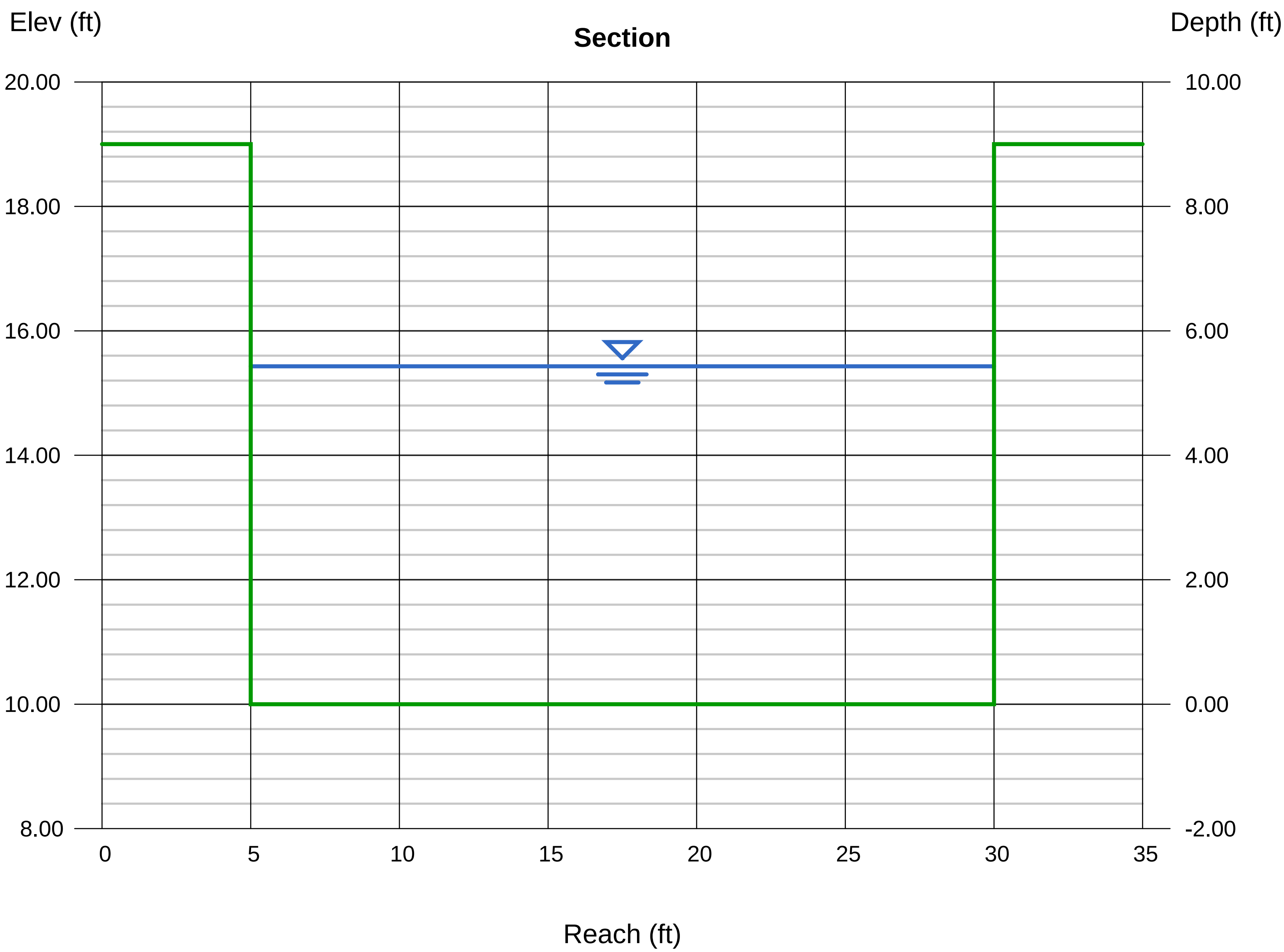
Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. — Friday, Oct 30 2015

Kamaole Gulch-Channel

Rectangular	
Bottom Width (ft)	= 25.00
Total Depth (ft)	= 9.00
Invert Elev (ft)	= 10.00
Slope (%)	= 1.00
N-Value	= 0.013
Calculations	
Compute by:	Known Q
Known Q (cfs)	= 3765.00

Highlighted	
Depth (ft)	= 5.43
Q (cfs)	= 3,765
Area (sqft)	= 135.75
Velocity (ft/s)	= 27.73
Wetted Perim (ft)	= 35.86
Crit Depth, Yc (ft)	= 8.91
Top Width (ft)	= 25.00
EGL (ft)	= 17.39



Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. — Friday, Oct 30 2015

Kamaole Gulch - Piilani Hwy Culvert, FEMA Q

Invert Elev Dn (ft)	=	102.47
Pipe Length (ft)	=	113.00
Slope (%)	=	1.00
Invert Elev Up (ft)	=	103.60
Rise (in)	=	84.0
Shape	=	Box
Span (in)	=	288.0
No. Barrels	=	2
n-Value	=	0.013
Culvert Type	=	Flared Wingwalls
Culvert Entrance	=	30D to 75D wingwall flares
Coeff. K,M,c,Y,k	=	0.026, 1, 0.0347, 0.81, 0.4

Embankment

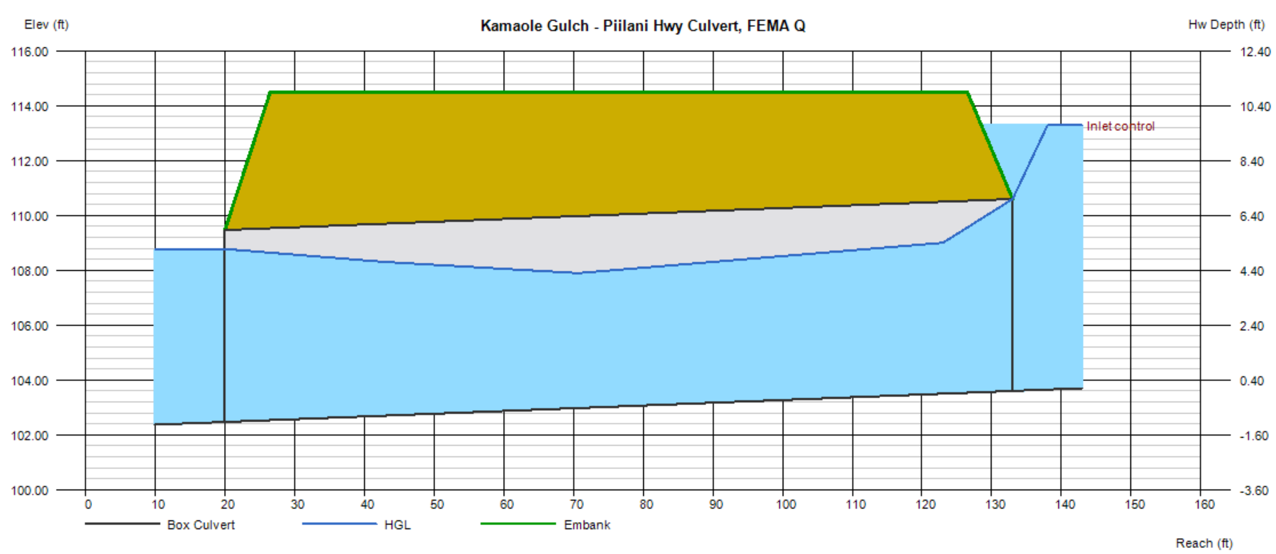
Top Elevation (ft)	=	114.50
Top Width (ft)	=	100.00
Crest Width (ft)	=	10.00

Calculations

Qmin (cfs)	=	3630.00
Qmax (cfs)	=	3630.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	3630.00
Qpipe (cfs)	=	3630.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	11.99
Veloc Up (ft/s)	=	13.47
HGL Dn (ft)	=	108.78
HGL Up (ft)	=	109.21
Hw Elev (ft)	=	113.29
Hw/D (ft)	=	1.38
Flow Regime	=	Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Monday, Nov 2 2015

Kamaole Gulch - South Kihei Road Culvert, FEMA Q

Invert Elev Dn (ft)	=	6.00
Pipe Length (ft)	=	51.50
Slope (%)	=	0.97
Invert Elev Up (ft)	=	6.50
Rise (in)	=	96.0
Shape	=	Box
Span (in)	=	264.0
No. Barrels	=	2
n-Value	=	0.013
Culvert Type	=	Flared Wingwalls
Culvert Entrance	=	30D to 75D wingwall flares
Coeff. K,M,c,Y,k	=	0.026, 1, 0.0347, 0.81, 0.4

Embankment

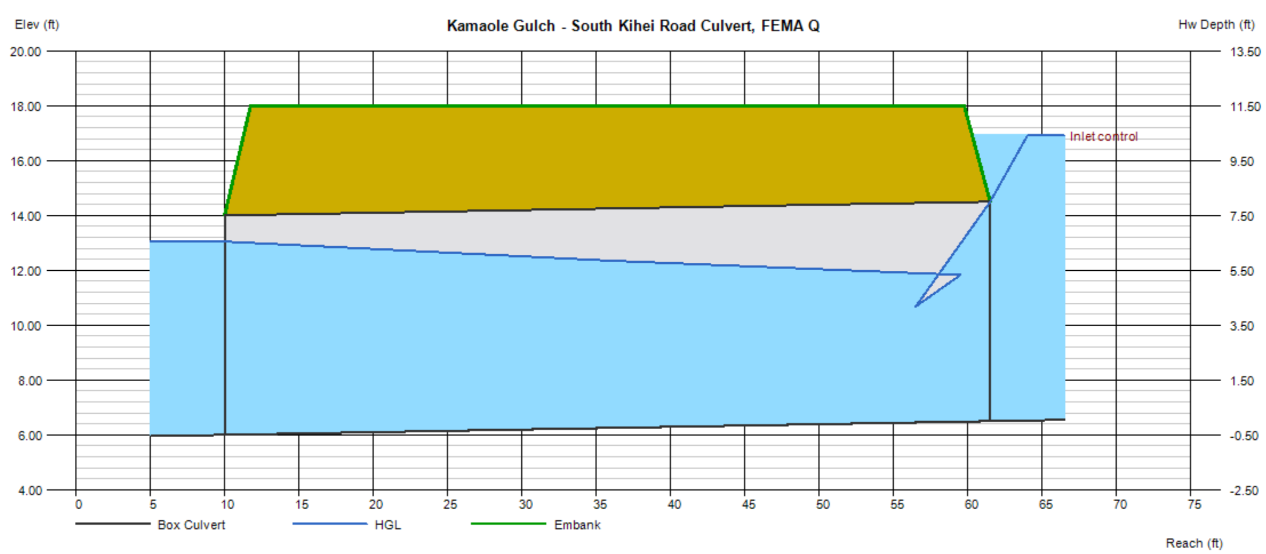
Top Elevation (ft)	=	18.00
Top Width (ft)	=	48.00
Crest Width (ft)	=	10.00

Calculations

Qmin (cfs)	=	3765.00
Qmax (cfs)	=	3765.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	3765.00
Qpipe (cfs)	=	3765.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	12.14
Veloc Up (ft/s)	=	14.04
HGL Dn (ft)	=	13.05
HGL Up (ft)	=	12.60
Hw Elev (ft)	=	16.91
Hw/D (ft)	=	1.30
Flow Regime	=	Inlet Control

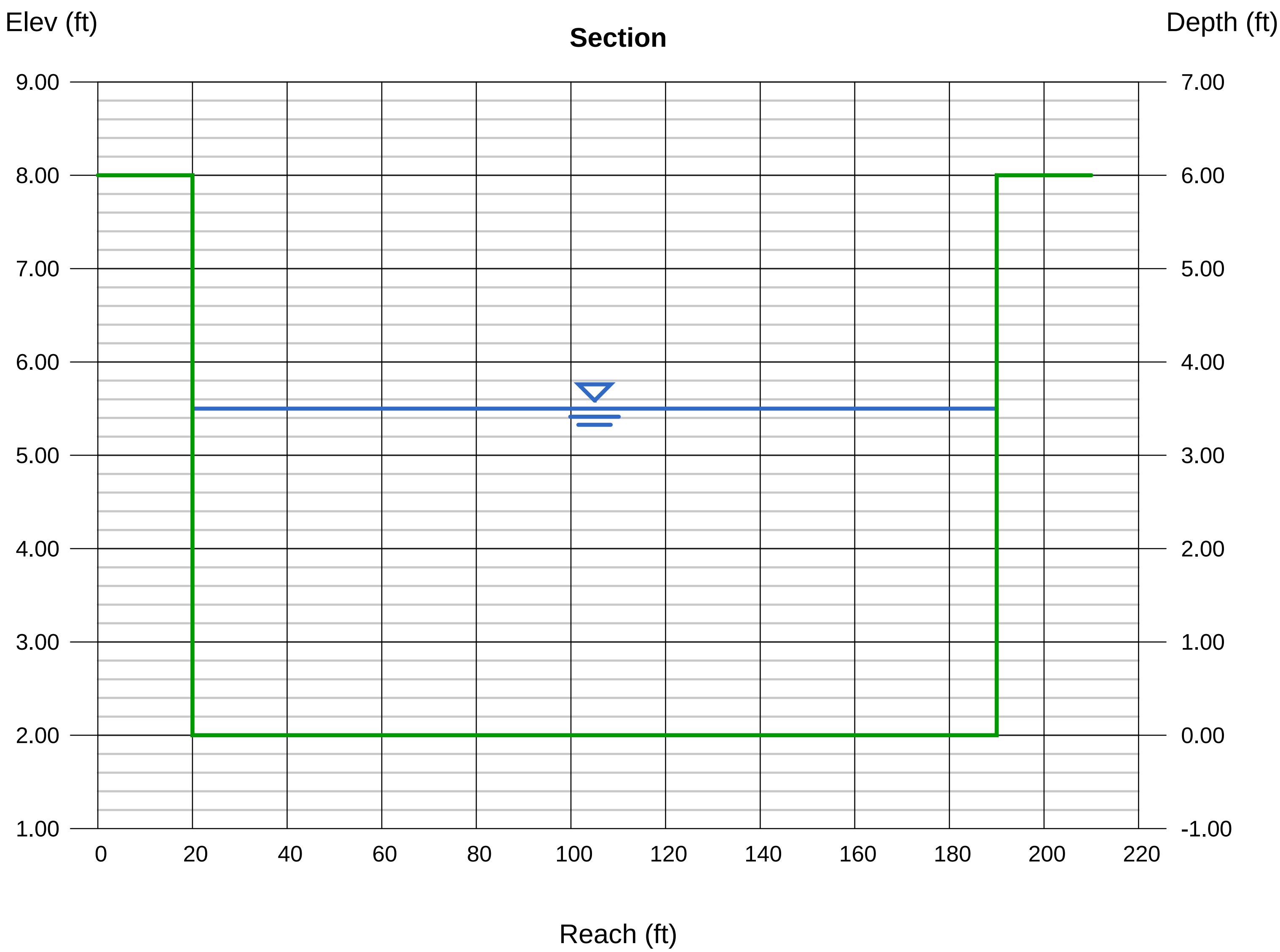


Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Wednesday, Oct 28 2015

Keokea Outlet

Rectangular		**Highlighted**	
Bottom Width (ft)	= 170.00	Depth (ft)	= 3.50
Total Depth (ft)	= 6.00	Q (cfs)	= 6,820
		Area (sqft)	= 595.00
Invert Elev (ft)	= 2.00	Velocity (ft/s)	= 11.46
Slope (%)	= 0.20	Wetted Perim (ft)	= 177.00
N-Value	= 0.013	Crit Depth, Yc (ft)	= 3.69
		Top Width (ft)	= 170.00
Calculations		EGL (ft)	= 5.54
Compute by:	Known Q		
Known Q (cfs)	= 6820.00		



Channel Report

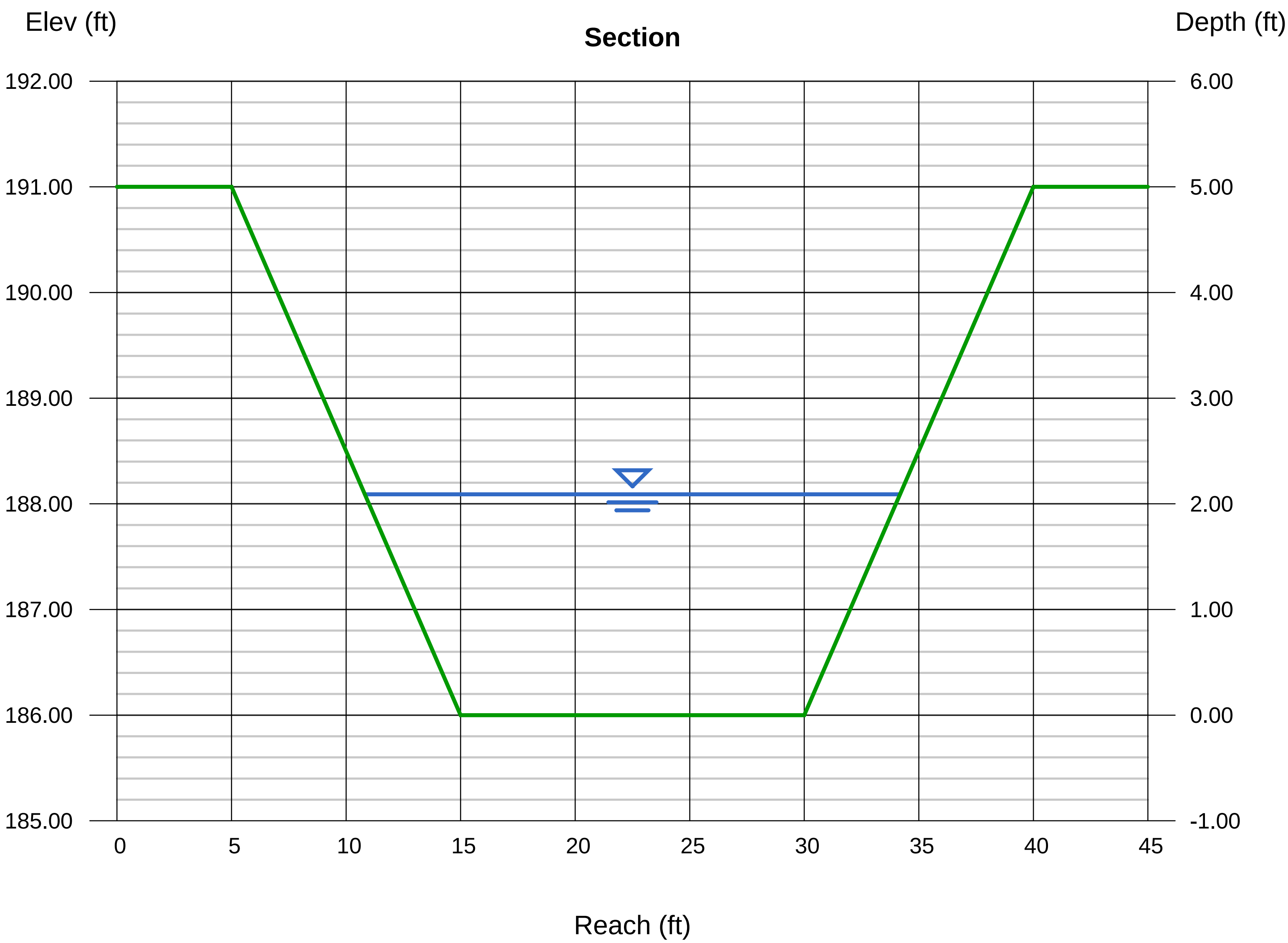
Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Friday, Oct 30 2015

Kilo1_1 Channel

Trapezoidal
Bottom Width (ft) = 15.00
Side Slopes (z:1) = 2.00, 2.00
Total Depth (ft) = 5.00
Invert Elev (ft) = 186.00
Slope (%) = 5.00
N-Value = 0.025

Calculations
Compute by: Known Q
Known Q (cfs) = 742.00

Highlighted
Depth (ft) = 2.09
Q (cfs) = 742.00
Area (sqft) = 40.09
Velocity (ft/s) = 18.51
Wetted Perim (ft) = 24.35
Crit Depth, Yc (ft) = 3.59
Top Width (ft) = 23.36
EGL (ft) = 7.42

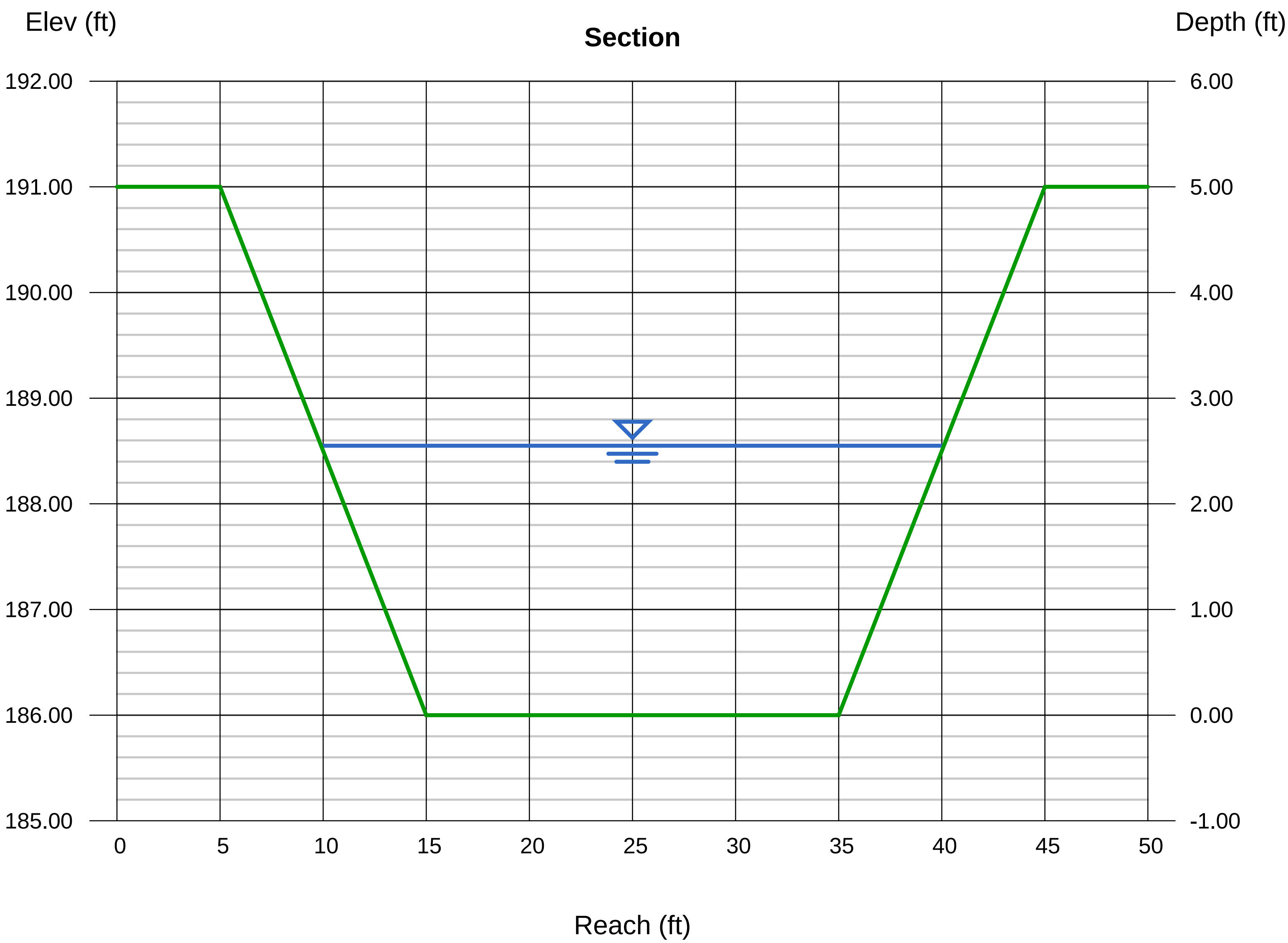


Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. | Sunday, Sep 25 2016

Kula 2_1 Channel

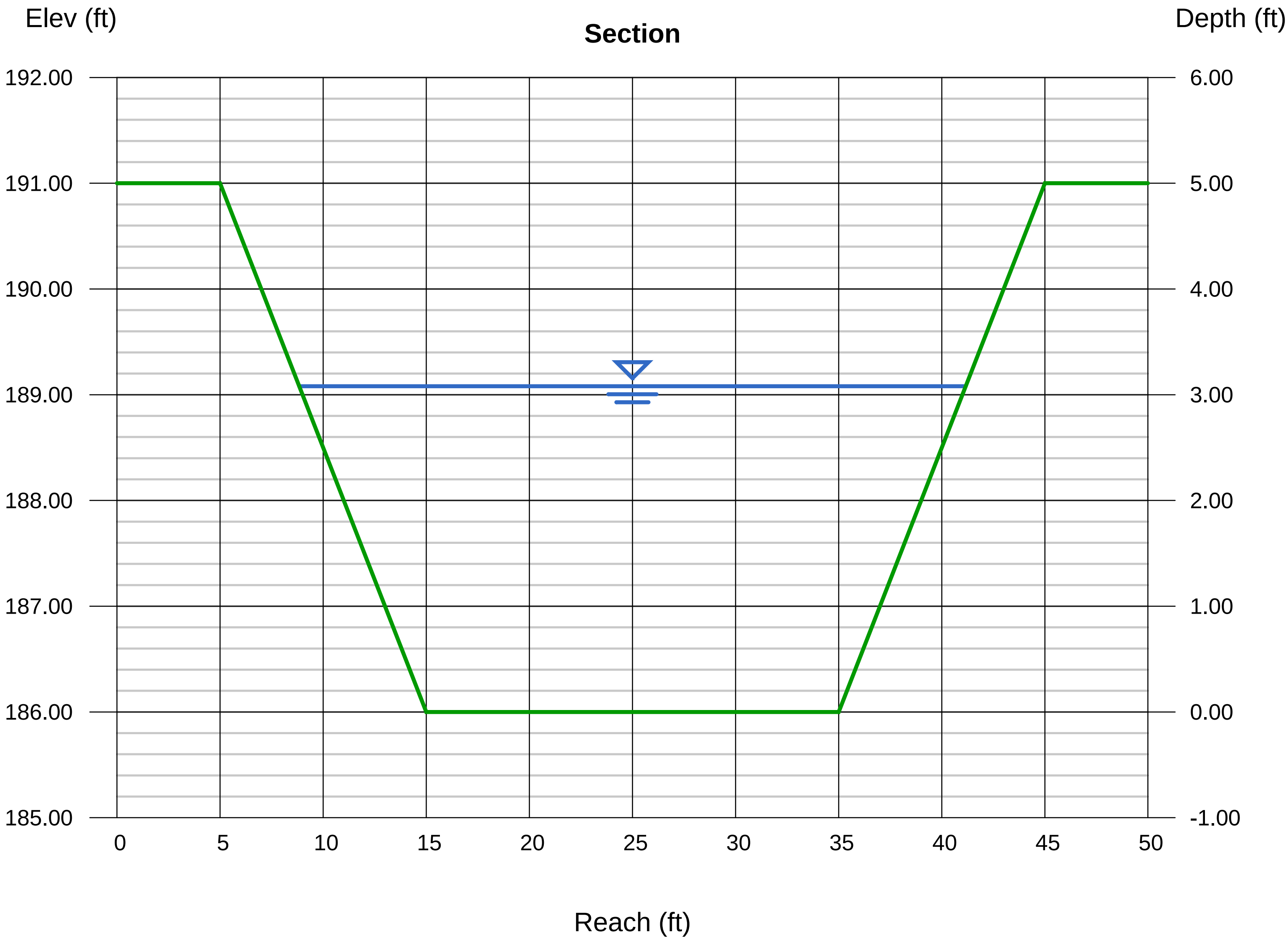
Trapezoidal			**Highlighted**	
Bottom Width (ft)	= 20.00		Depth (ft)	= 2.55
Side Slopes (z:1)	= 2.00, 2.00		Q (cfs)	= 861.00
Total Depth (ft)	= 5.00		Area (sqft)	= 64.00
Invert Elev (ft)	= 186.00		Velocity (ft/s)	= 13.45
Slope (%)	= 2.00		Wetted Perim (ft)	= 31.40
N-Value	= 0.025		Crit Depth, Yc (ft)	= 3.43
			Top Width (ft)	= 30.20
Calculations			EGL (ft)	= 5.36
Compute by:	Known Q			
Known Q (cfs)	= 861.00			



Channel Report

Kula 2_1 Channel_Grassed

Trapezoidal		**Highlighted**	
Bottom Width (ft)	= 20.00	Depth (ft)	= 3.08
Side Slopes (z:1)	= 2.00, 2.00	Q (cfs)	= 861.00
Total Depth (ft)	= 5.00	Area (sqft)	= 80.57
Invert Elev (ft)	= 186.00	Velocity (ft/s)	= 10.69
Slope (%)	= 2.00	Wetted Perim (ft)	= 33.77
N-Value	= 0.035	Crit Depth, Yc (ft)	= 3.43
		Top Width (ft)	= 32.32
Calculations		EGL (ft)	= 4.86
Compute by:	Known Q		
Known Q (cfs)	= 861.00		



Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Sunday, Sep 25 2016

Kula 2_1 Culvert

Invert Elev Dn (ft)	=	10.00
Pipe Length (ft)	=	500.00
Slope (%)	=	1.80
Invert Elev Up (ft)	=	19.00
Rise (in)	=	72.0
Shape	=	Box
Span (in)	=	144.0
No. Barrels	=	2
n-Value	=	0.013
Culvert Type	=	Flared Wingwalls
Culvert Entrance	=	30D to 75D wingwall flares
Coeff. K,M,c,Y,k	=	0.026, 1, 0.0347, 0.81, 0.4

Embankment

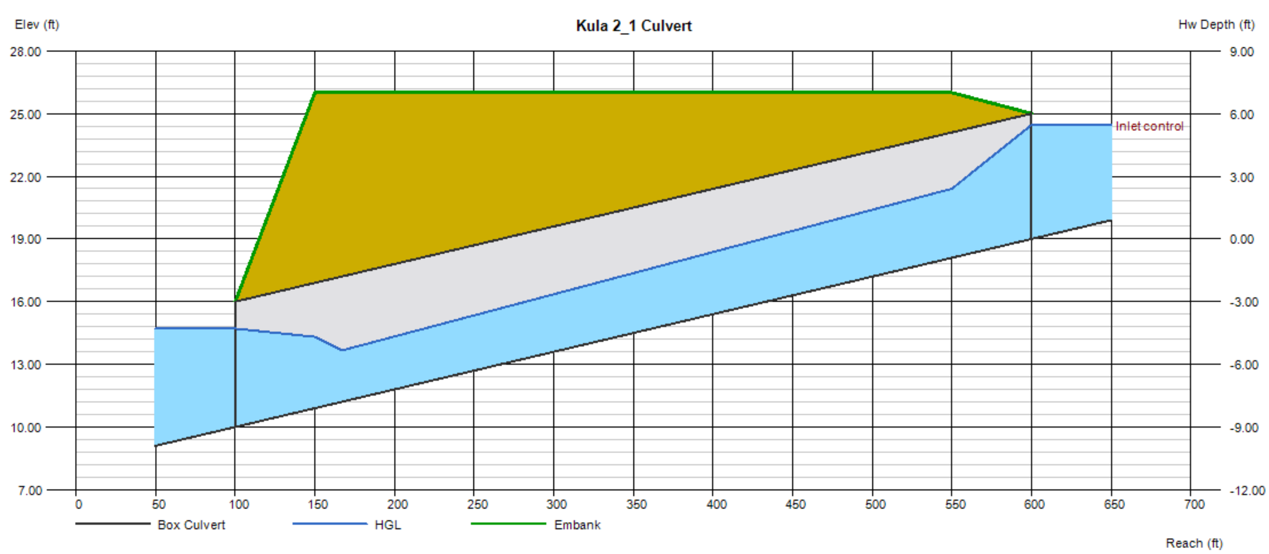
Top Elevation (ft)	=	26.00
Top Width (ft)	=	400.00
Crest Width (ft)	=	10.00

Calculations

Qmin (cfs)	=	861.00
Qmax (cfs)	=	861.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	861.00
Qpipe (cfs)	=	861.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	7.62
Veloc Up (ft/s)	=	10.50
HGL Dn (ft)	=	14.71
HGL Up (ft)	=	22.42
Hw Elev (ft)	=	24.46
Hw/D (ft)	=	0.91
Flow Regime	=	Inlet Control

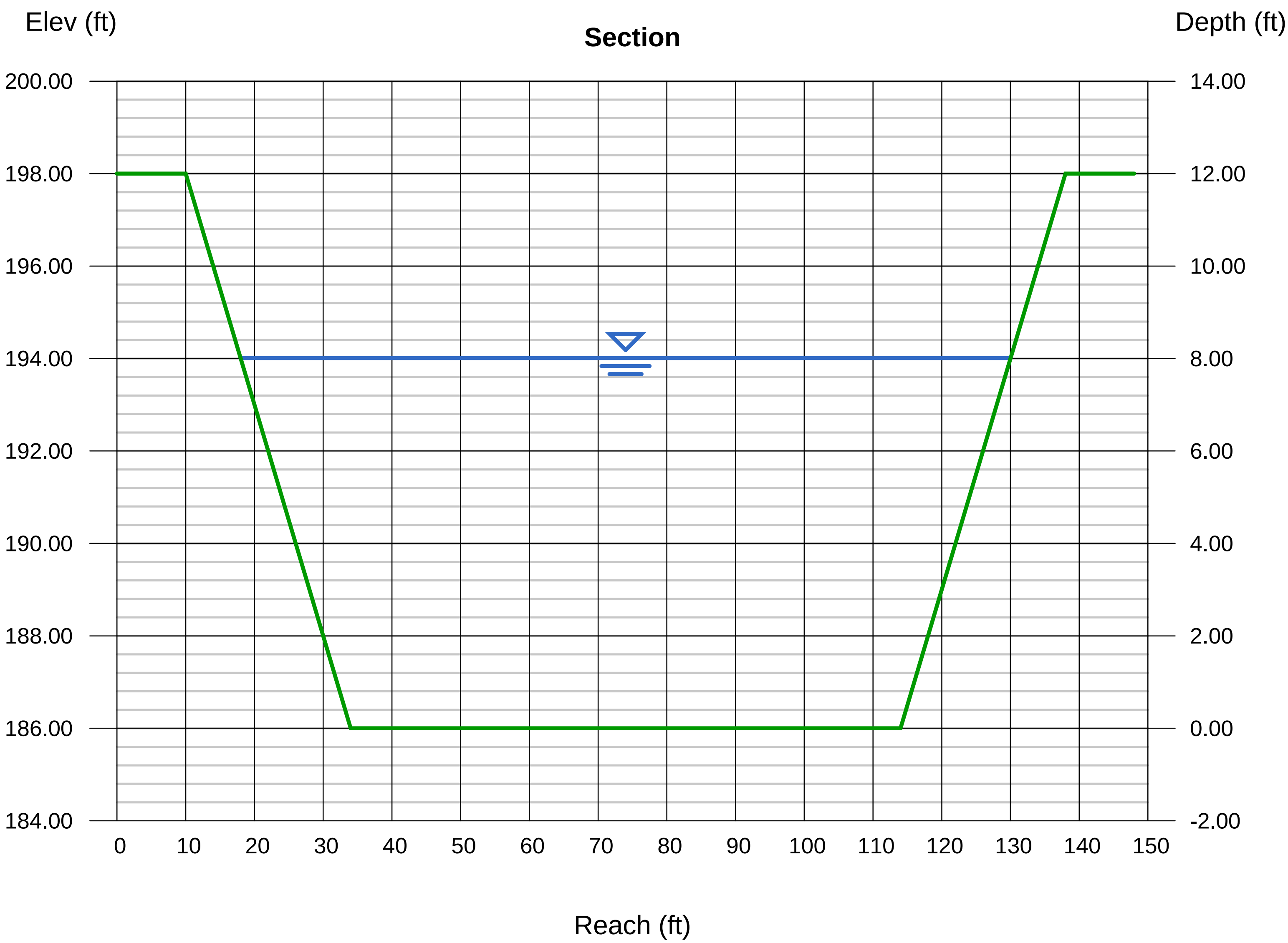


Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Sunday, Sep 25 2016

Kulanihakoi Channel

Trapezoidal		**Highlighted**	
Bottom Width (ft)	= 80.00	Depth (ft)	= 8.01
Side Slopes (z:1)	= 2.00, 2.00	Q (cfs)	= 19,642
Total Depth (ft)	= 12.00	Area (sqft)	= 769.13
Invert Elev (ft)	= 186.00	Velocity (ft/s)	= 25.54
Slope (%)	= 0.40	Wetted Perim (ft)	= 115.82
N-Value	= 0.013	Crit Depth, Yc (ft)	= 11.18
		Top Width (ft)	= 112.04
Calculations		EGL (ft)	= 18.15
Compute by:	Known Q		
Known Q (cfs)	= 19642.00		



Culvert Report

P29 New Culvert

Invert Elev Dn (ft)	=	235.11
Pipe Length (ft)	=	184.23
Slope (%)	=	2.59
Invert Elev Up (ft)	=	239.88
Rise (in)	=	66.0
Shape	=	Circular
Span (in)	=	66.0
No. Barrels	=	2
n-Value	=	0.013
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Square edge w/headwall (C)
Coeff. K,M,c,Y,k	=	0.0098, 2, 0.0398, 0.67, 0.5

Embankment

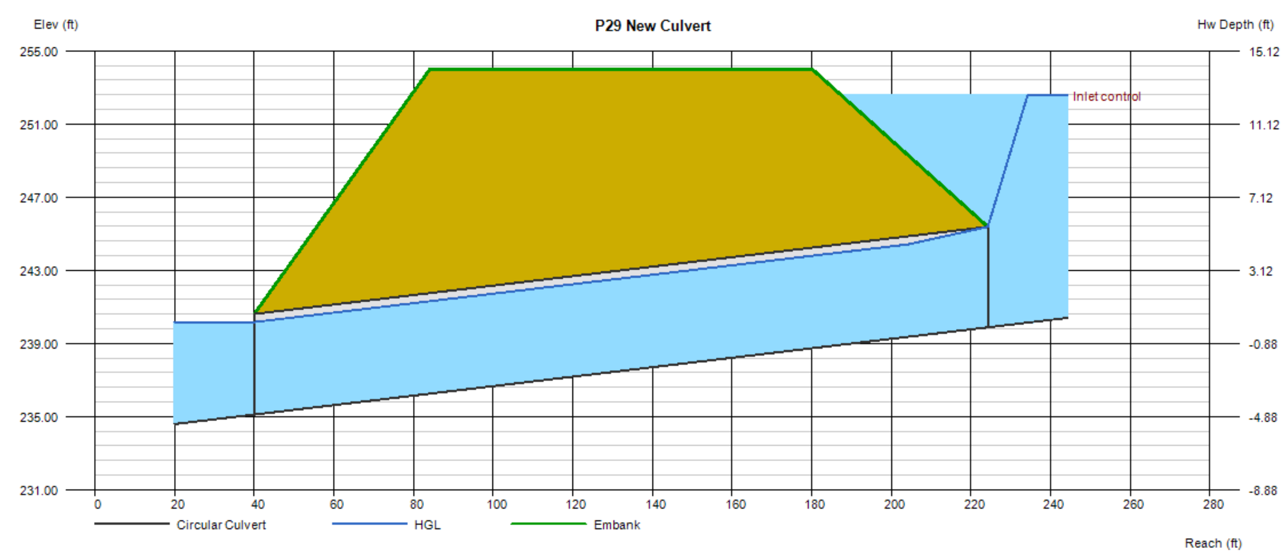
Top Elevation (ft)	=	254.00
Top Width (ft)	=	96.00
Crest Width (ft)	=	10.00

Calculations

Qmin (cfs)	=	718.00
Qmax (cfs)	=	718.00
Tailwater Elev (ft)	=	0.00

Highlighted

Qtotal (cfs)	=	718.00
Qpipe (cfs)	=	718.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	15.71
Veloc Up (ft/s)	=	15.71
HGL Dn (ft)	=	240.17
HGL Up (ft)	=	244.94
Hw Elev (ft)	=	252.58
Hw/D (ft)	=	2.31
Flow Regime	=	Inlet Control



Culvert Report

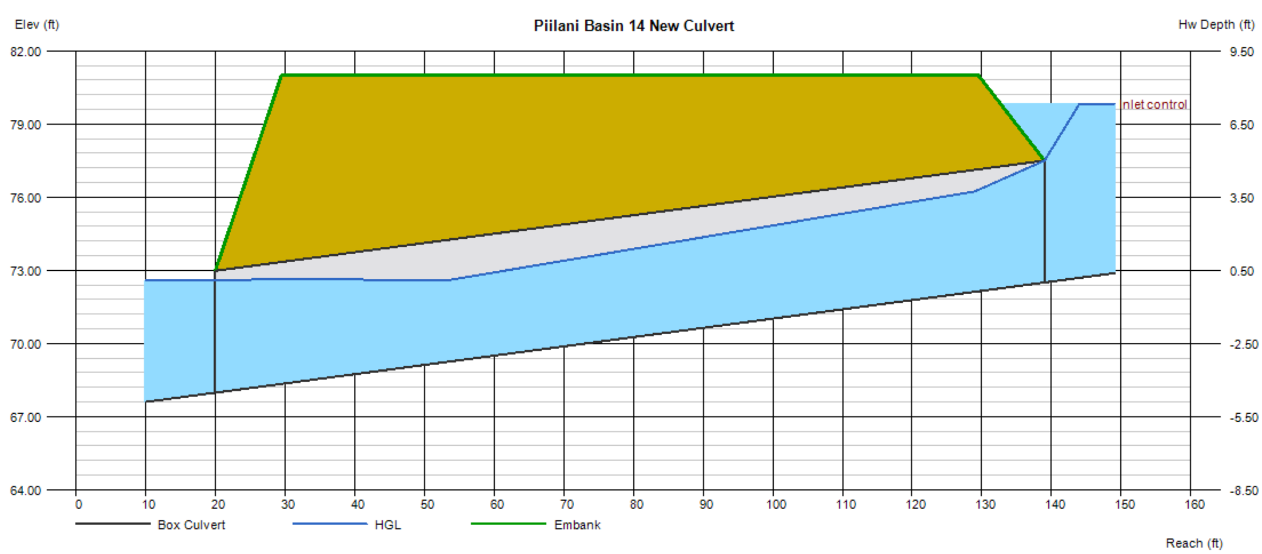
Piilani Basin 14 New Culvert

Invert Elev Dn (ft) = 67.98
Pipe Length (ft) = 119.00
Slope (%) = 3.80
Invert Elev Up (ft) = 72.50
Rise (in) = 60.0
Shape = Box
Span (in) = 96.0
No. Barrels = 1
n-Value = 0.013
Culvert Type = Flared Wingwalls
Culvert Entrance = 30D to 75D wingwall flares
Coeff. K,M,c,Y,k = 0.026, 1, 0.0347, 0.81, 0.4

Embankment
Top Elevation (ft) = 81.00
Top Width (ft) = 100.00
Crest Width (ft) = 10.00

Calculations
Qmin (cfs) = 394.00
Qmax (cfs) = 394.00
Tailwater Elev (ft) = (dc+D)/2

Highlighted
Qtotal (cfs) = 394.00
Qpipe (cfs) = 394.00
Qovertop (cfs) = 0.00
Veloc Dn (ft/s) = 10.68
Veloc Up (ft/s) = 11.67
HGL Dn (ft) = 72.59
HGL Up (ft) = 76.72
Hw Elev (ft) = 79.82
Hw/D (ft) = 1.46
Flow Regime = Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Tuesday, Aug 2 2016

Piilani Basin 14 New Culvert Q50

Invert Elev Dn (ft)	=	67.98
Pipe Length (ft)	=	119.00
Slope (%)	=	3.80
Invert Elev Up (ft)	=	72.50
Rise (in)	=	60.0
Shape	=	Box
Span (in)	=	84.0
No. Barrels	=	1
n-Value	=	0.013
Culvert Type	=	Flared Wingwalls
Culvert Entrance	=	30D to 75D wingwall flares
Coeff. K,M,c,Y,k	=	0.026, 1, 0.0347, 0.81, 0.4

Embankment

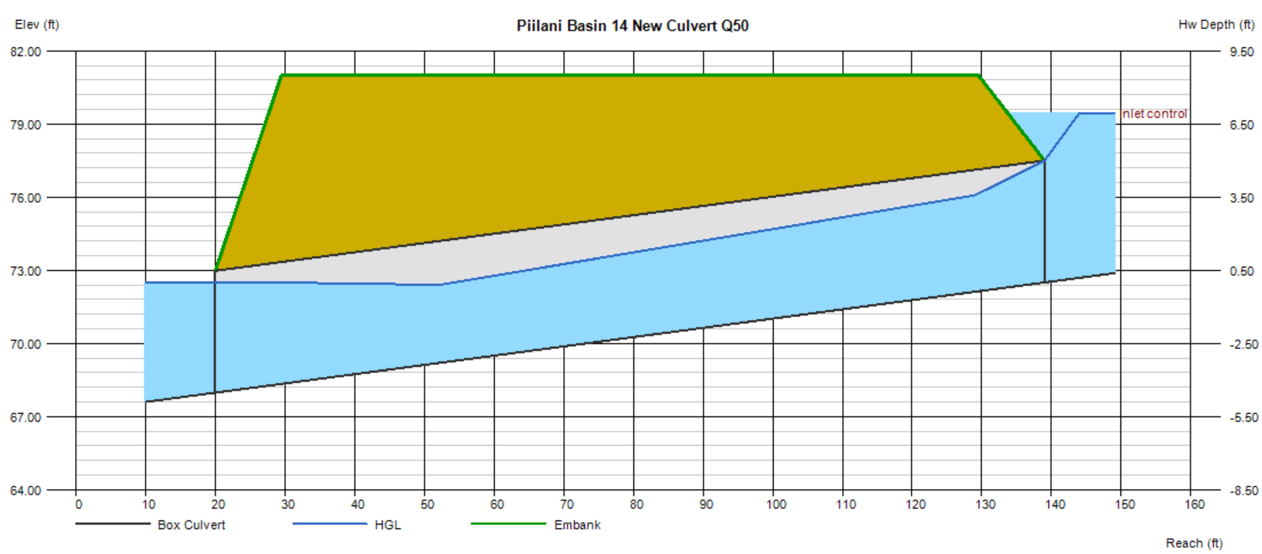
Top Elevation (ft)	=	81.00
Top Width (ft)	=	100.00
Crest Width (ft)	=	10.00

Calculations

Qmin (cfs)	=	325.00
Qmax (cfs)	=	325.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	325.00
Qpipe (cfs)	=	325.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	10.25
Veloc Up (ft/s)	=	11.45
HGL Dn (ft)	=	72.51
HGL Up (ft)	=	76.56
Hw Elev (ft)	=	79.45
Hw/D (ft)	=	1.39
Flow Regime	=	Inlet Control



Channel Report

Waiakoa Gulch - Channel

Rectangular

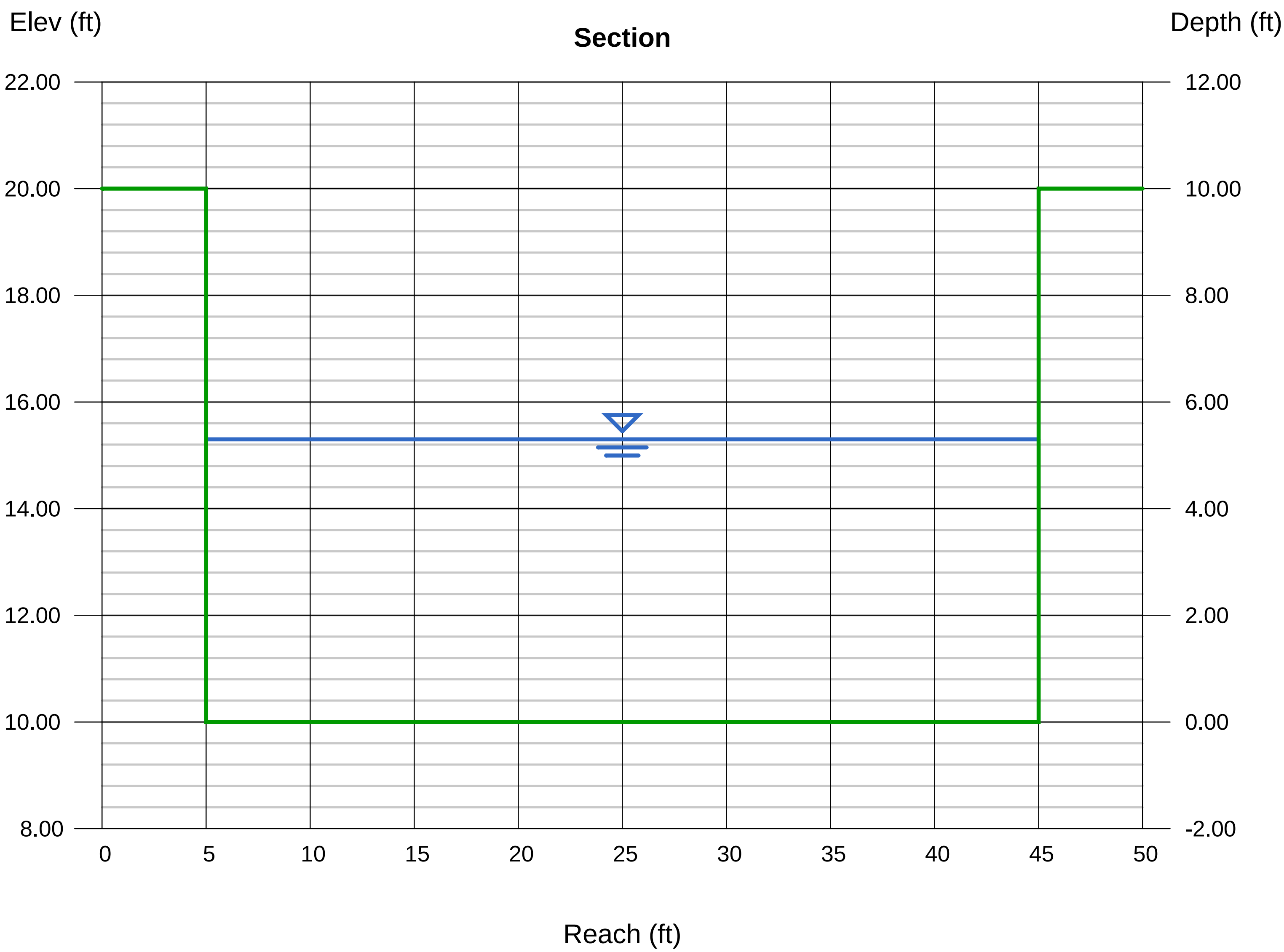
Bottom Width (ft)	=	40.00
Total Depth (ft)	=	10.00
Invert Elev (ft)	=	10.00
Slope (%)	=	1.10
N-Value	=	0.013

Calculations

Compute by:		Known Q
Known Q (cfs)	=	6598.00

Highlighted

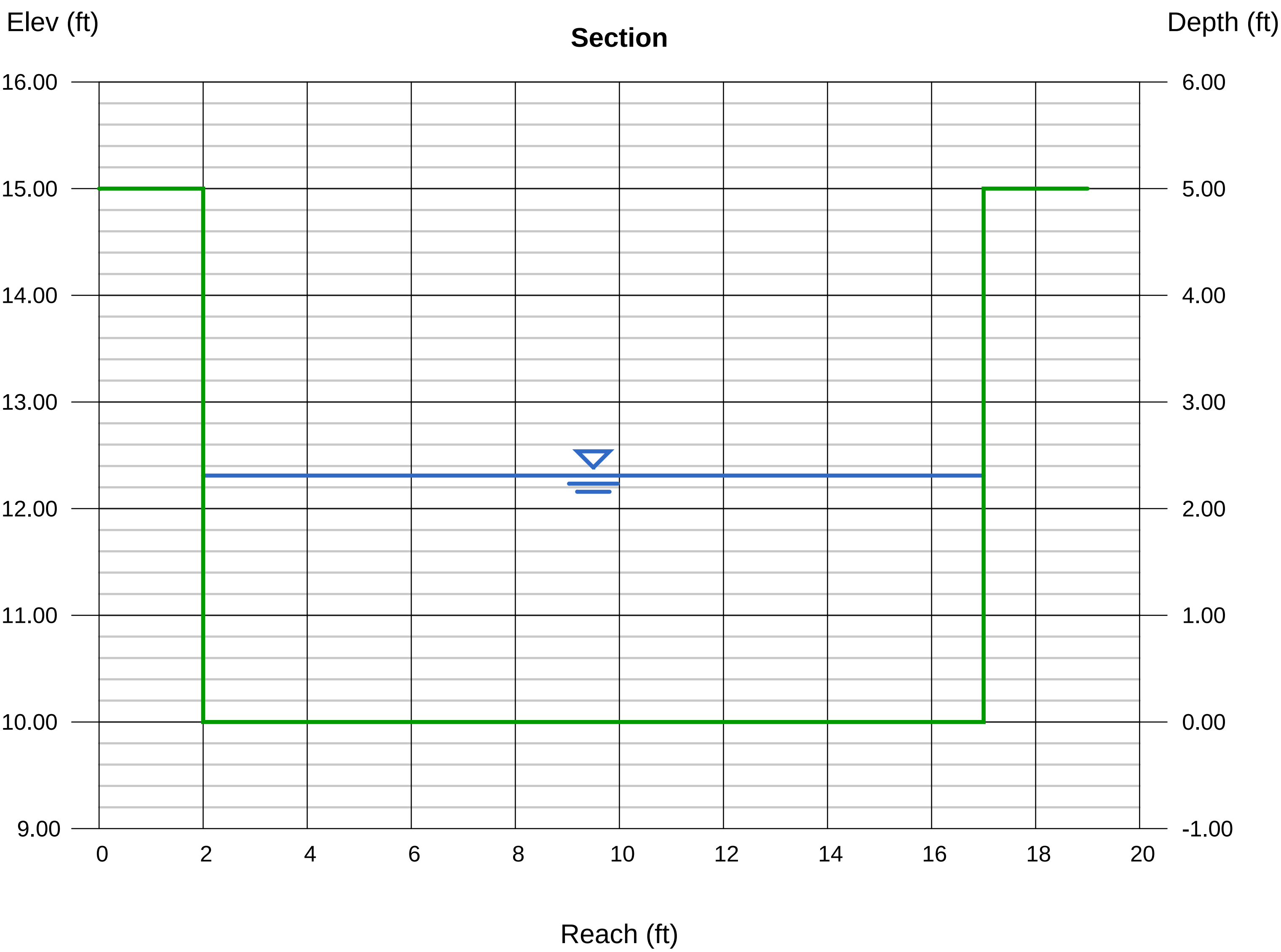
Depth (ft)	=	5.30
Q (cfs)	=	6,598
Area (sqft)	=	212.00
Velocity (ft/s)	=	31.12
Wetted Perim (ft)	=	50.60
Crit Depth, Yc (ft)	=	9.46
Top Width (ft)	=	40.00
EGL (ft)	=	20.36



Channel Report

Waip1 Channel-Conc

Rectangular		**Highlighted**	
Bottom Width (ft)	= 15.00	Depth (ft)	= 2.31
Total Depth (ft)	= 5.00	Q (cfs)	= 515.00
		Area (sqft)	= 34.65
Invert Elev (ft)	= 10.00	Velocity (ft/s)	= 14.86
Slope (%)	= 0.80	Wetted Perim (ft)	= 19.62
N-Value	= 0.013	Crit Depth, Yc (ft)	= 3.33
		Top Width (ft)	= 15.00
Calculations		EGL (ft)	= 5.74
Compute by:	Known Q		
Known Q (cfs)	= 515.00		



Channel Report

Waip1 Channel-Grass

Trapezoidal

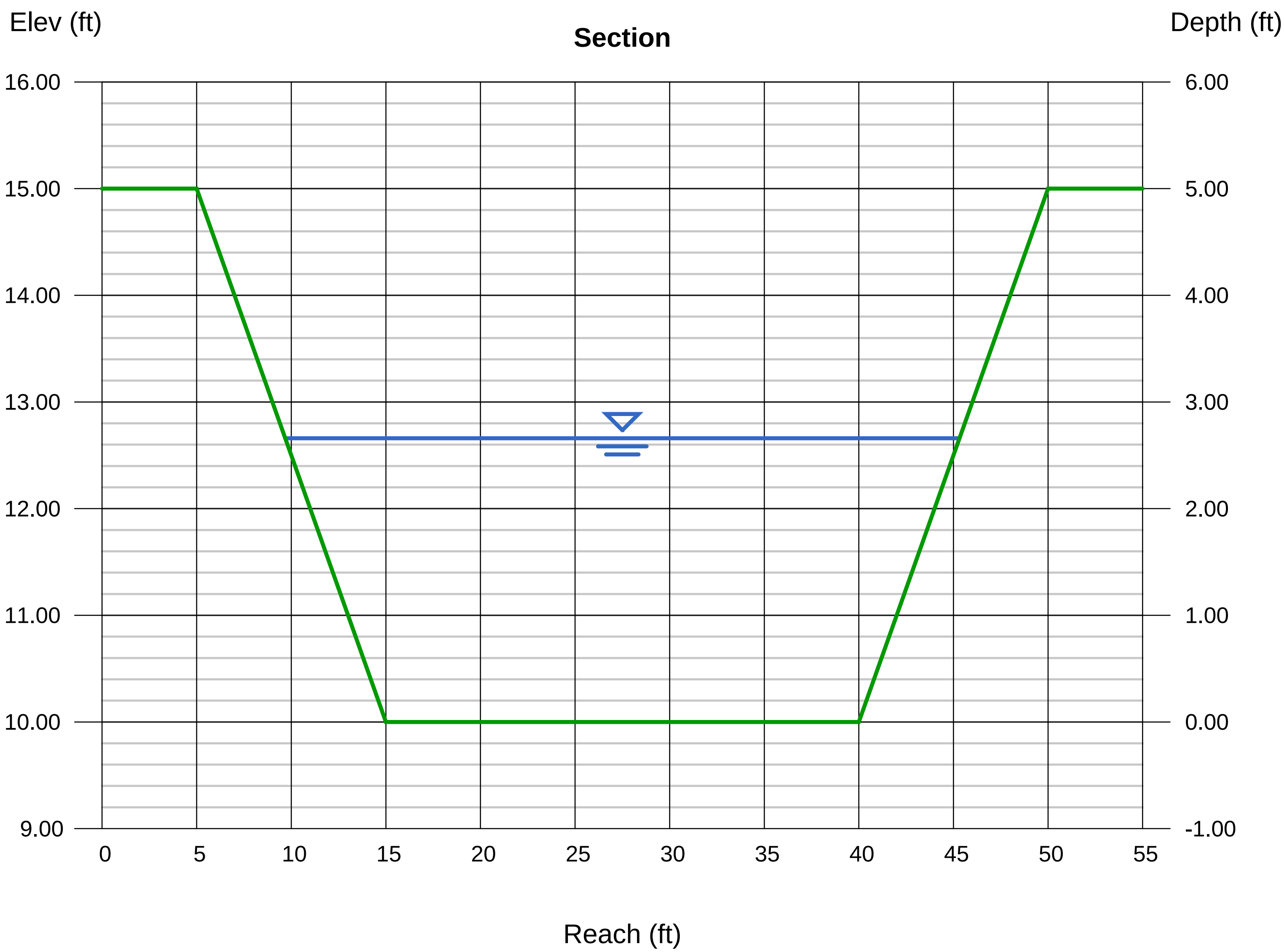
Bottom Width (ft)	= 25.00
Side Slopes (z:1)	= 2.00, 2.00
Total Depth (ft)	= 5.00
Invert Elev (ft)	= 10.00
Slope (%)	= 0.80
N-Value	= 0.035

Calculations

Compute by:	Known Q
Known Q (cfs)	= 515.00

Highlighted

Depth (ft)	= 2.66
Q (cfs)	= 515.00
Area (sqft)	= 80.65
Velocity (ft/s)	= 6.39
Wetted Perim (ft)	= 36.90
Crit Depth, Yc (ft)	= 2.23
Top Width (ft)	= 35.64
EGL (ft)	= 3.29



Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. Wednesday, Oct 28 2015

Waip1 Culvert-Kenolio Road Extension

Invert Elev Dn (ft)	=	26.00
Pipe Length (ft)	=	80.00
Slope (%)	=	0.63
Invert Elev Up (ft)	=	26.50
Rise (in)	=	36.0
Shape	=	Box
Span (in)	=	132.0
No. Barrels	=	2
n-Value	=	0.013
Culvert Type	=	Flared Wingwalls
Culvert Entrance	=	30D to 75D wingwall flares
Coeff. K,M,c,Y,k	=	0.026, 1, 0.0347, 0.81, 0.4

Embankment

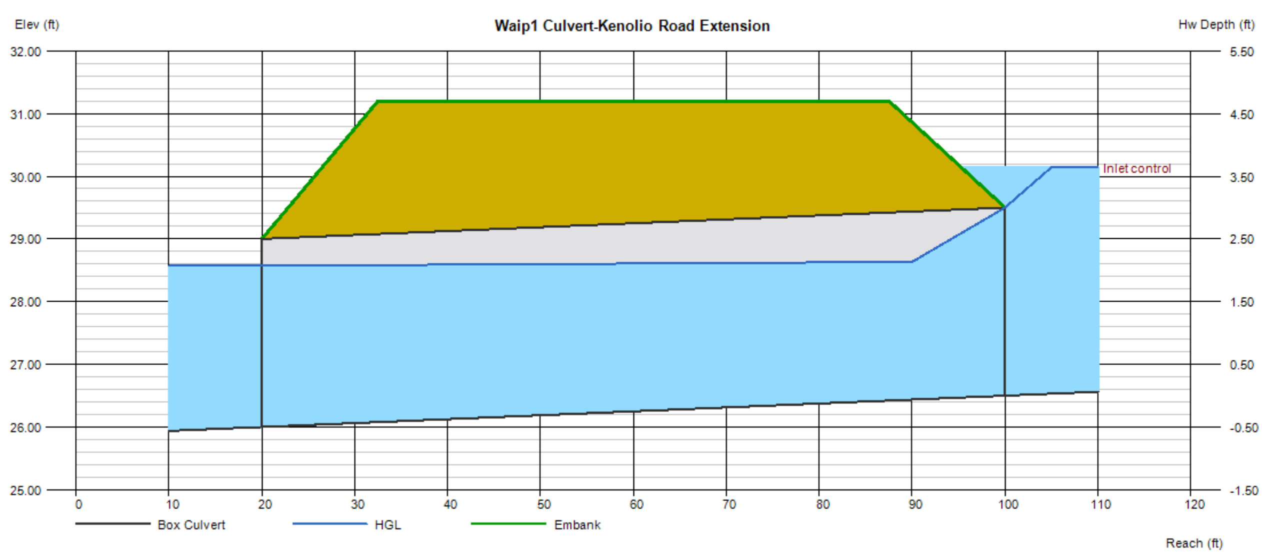
Top Elevation (ft)	=	31.20
Top Width (ft)	=	55.00
Crest Width (ft)	=	10.00

Calculations

Qmin (cfs)	=	392.00
Qmax (cfs)	=	392.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	392.00
Qpipe (cfs)	=	392.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	6.93
Veloc Up (ft/s)	=	8.31
HGL Dn (ft)	=	28.57
HGL Up (ft)	=	28.64
Hw Elev (ft)	=	30.14
Hw/D (ft)	=	1.21
Flow Regime	=	Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. — Wednesday, Oct 28 2015

Waip1 Culvert-South Kihei Road

Invert Elev Dn (ft)	=	3.00
Pipe Length (ft)	=	60.00
Slope (%)	=	0.50
Invert Elev Up (ft)	=	3.30
Rise (in)	=	48.0
Shape	=	Box
Span (in)	=	132.0
No. Barrels	=	2
n-Value	=	0.013
Culvert Type	=	Flared Wingwalls
Culvert Entrance	=	30D to 75D wingwall flares
Coeff. K,M,c,Y,k	=	0.026, 1, 0.0347, 0.81, 0.4

Embankment

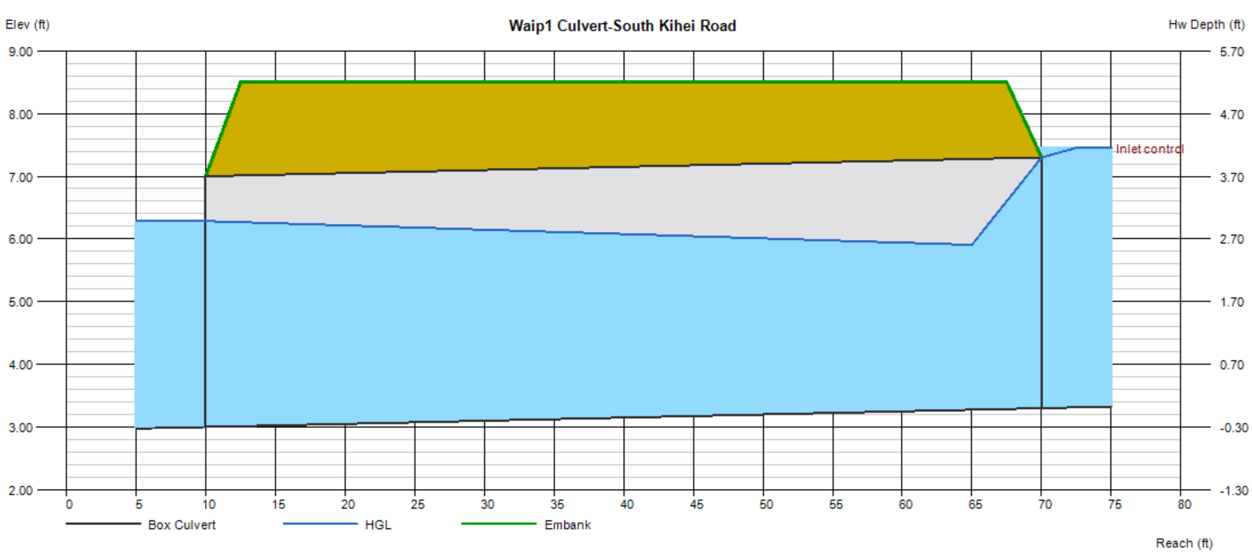
Top Elevation (ft)	=	8.50
Top Width (ft)	=	55.00
Crest Width (ft)	=	10.00

Calculations

Qmin (cfs)	=	515.00
Qmax (cfs)	=	515.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	515.00
Qpipe (cfs)	=	515.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	7.13
Veloc Up (ft/s)	=	9.11
HGL Dn (ft)	=	6.29
HGL Up (ft)	=	5.87
Hw Elev (ft)	=	7.45
Hw/D (ft)	=	1.04
Flow Regime	=	Inlet Control

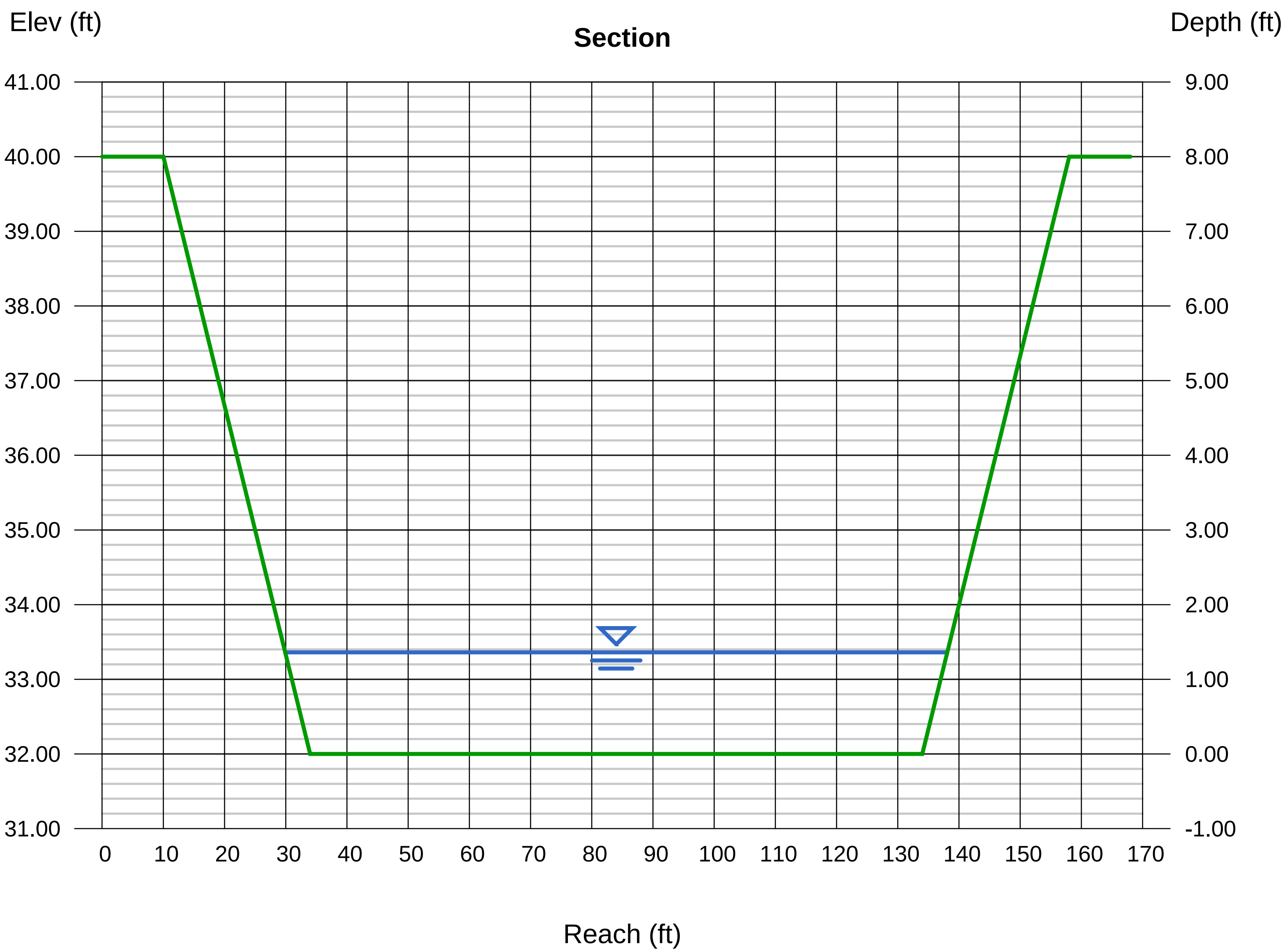


Channel Report

Waip1 Exist. Earth Channel

Trapezoidal	
Bottom Width (ft)	= 100.00
Side Slopes (z:1)	= 3.00, 3.00
Total Depth (ft)	= 8.00
Invert Elev (ft)	= 32.00
Slope (%)	= 0.30
N-Value	= 0.035
Calculations	
Compute by:	Known Q
Known Q (cfs)	= 392.00

Highlighted	
Depth (ft)	= 1.36
Q (cfs)	= 392.00
Area (sqft)	= 141.55
Velocity (ft/s)	= 2.77
Wetted Perim (ft)	= 108.60
Crit Depth, Yc (ft)	= 0.78
Top Width (ft)	= 108.16
EGL (ft)	= 1.48

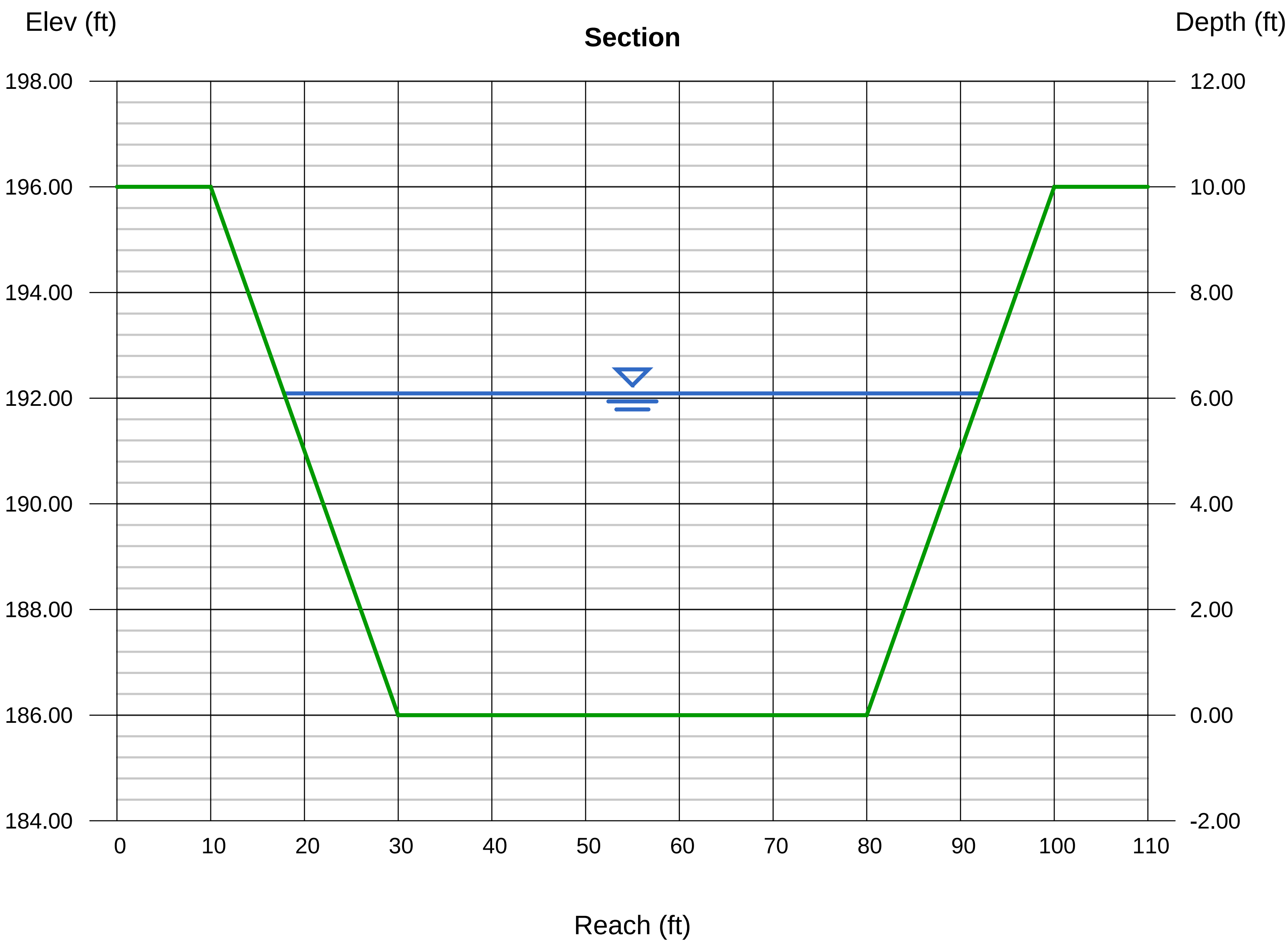


Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc. — Wednesday, Jul 27 2016

Waipuilani Diversion Channel

Trapezoidal		**Highlighted**	
Bottom Width (ft)	= 50.00	Depth (ft)	= 6.09
Side Slopes (z:1)	= 2.00, 2.00	Q (cfs)	= 8,719
Total Depth (ft)	= 10.00	Area (sqft)	= 378.68
Invert Elev (ft)	= 186.00	Velocity (ft/s)	= 23.02
Slope (%)	= 1.80	Wetted Perim (ft)	= 77.24
N-Value	= 0.025	Crit Depth, Yc (ft)	= 8.69
		Top Width (ft)	= 74.36
Calculations		EGL (ft)	= 14.33
Compute by:	Known Q		
Known Q (cfs)	= 8719.00		



APPENDIX C

CONCEPTUAL COST ESTIMATE

Overall Summary

	District	Improvements Total Cost
1	Waiakoa	$16,479,000
2	Kulanihakoi	$57,080,000
3	Waipuilani	$16,876,000
4	Keokea	$10,793,000
5	Charlie Young	$20,193,000
6	Kamaole	$8,739,000
7	Liiioholo	$1,031,000
8	Kilohana Drive	$2,058,000

Waiakoa District Summary

	Improvements	Cost
1	Waiakoa Gulch Improvements	$5,554,000
2	Proposed South Kihei Road Bridge, Waiakoa Gulch	$7,714,000
3	Restoration and Improvements of Existing Ditch Mauka of Ohukai Subdivision	$312,000
4	Proposed Ditch to Proposed Detention Basin at Piilani Basin 6U	$127,000
5	Proposed Ohukai Road Drainage System	$2,772,000
	Total	$16,479,000

Kulanihakoi District Summary

	Improvements	Cost
1	Proposed Detention Basin at Piilani Basin 6U	$1,266,000
2	Proposed Detention Basin at Piilani Basin 6D	$1,342,000
3	Proposed Detention Basin at Piilani Basin 7, mauka of future Kaonoulu Affordable Apts	$3,111,000
4	Proposed Detention Basin at Piilani Basin 7, mauka of Piilani Highway	$3,111,000
5	Proposed Detention Basin at Piilani Basin 9	$1,583,000
6	Kulanihakoi Gulch Improvements	$20,490,000
7	Kula 2_1 Channel Improvements	$1,281,000
8	Kula 2_1 Culvert Improvements	$999,000
9	Proposed South Kihei Road Bridge, Kulanihakoi Gulch	$23,897,000
	Total	$57,080,000

Waipuilani District Summary

	Improvements	Cost
1	Proposed Liloa Drive Culverts	$177,000
2	Waipuilani Gulch Improvements - 1 (future Hoonali Homes development)	$374,000
3	Waipuilani Gulch Improvements - 2 (approx. 800' mauka of S. Kihei Rd to stream mouth)	$1,822,000
4	Proposed South Kihei Road Culvert Improvements	$144,000
5	Waipuilani Gulch Diversion	$14,359,000
	Total	$16,876,000

Keokea District Summary

	Improvements	Cost
1	Proposed Detention Basin at Piilani Basin 13U	$2,261,000
2	Proposed Detention Basin at Piilani Basin 14U	$2,068,000
3	Proposed Detention Basin at Piilani Basin 16U	$2,595,000
4	Uluniu Road Drainage System - Alternative 1	$2,103,000
5	Uluniu Road Drainage System - Alternative 2	$790,000
6	Uluniu RoadNew Outlet (Feasibility Study) - Alternative 3	$600,000
7	Proposed Piilani Highway Culvert Improvements at Piilani Basin 14D	$376,000
	Total	$10,793,000

Charlie Young District Summary

	Improvements	Cost
1	Proposed Detention Basin at Piilani Basin 17A	$682,000
2	Proposed Detention Basin at Piilani Basin 19A1	$1,622,000
3	Proposed Detention Basin at Piilani Basin 19A2	$985,000
4	Proposed Detention Basin at Piilani Basin 19	$3,500,000
5	Proposed Detention Basin at Piilani Basin 20	$1,366,000
6	Waimahaihai Gulch Drainage Improvements	$2,233,000
7	Restoration and Improvements of Existing Waimahaihai Gulch	$52,000
8	Kihei Gulch 1 Drainage System Improvements	$3,363,000
9	Kihei Gulch 1 Improvements	$1,931,000
10	Kalama Beach Park Channel Improvements	$1,196,000
11	Proposed Auhana Road Culvert Improvements	$87,000
12	Proposed Kanoe Street Culvert Improvements	$156,000
13	Kaluaihakoko Gulch Improvements	$3,020,000
	Total	$20,193,000

Kamaole District Summary

	Improvements	Cost
1	Proposed Detention Basin at Piilani Basin 23	$2,550,000
2	Proposed Piilani Highway Culvert Improvements at Piilani Basin 21	$690,000
3	Proposed Maui Coast Hotel Culvert Improvements	$1,162,000
4	Proposed South Kihei Road Culvert Improvements	$567,000
5	Kamaole Gulch Improvements	$2,242,000
6	Kihei Kai Nani Drainage Improvements	$1,528,000
	Total	$8,739,000

Liilioholo District Summary

	Improvements	Cost
1	Proposed Kanakanui Road Culverts to Replace Existing Conc. Ford	$407,000
2	Proposed North-South Collector Road Culverts to Replace Existing Conc. Ford	$357,000
3	Proposed South Kihei Road Culvert Improvements	$267,000
	Total	$1,031,000

Kilohana Drive District Summary

	Improvements	Cost
1	Proposed Piilani Highway Culvert Improvemrents at Piilani Basin 29	$528,000
2	Waile SF-58 Channel Improvements	$1,530,000
	Total	$2,058,000

1 Waiakoa Gulch Improvements

Channel Characteristics:
Rectangular/Concrete

Bottom Width	40	feet
Height	10	feet
Length	2,000	feet
Assumed Excavated Depth	5	feet
Assumed Lining Thickness	1	feet

	Quantity	Unit	Unit Price	Total
Excavation for Channel	14,820	CY	$30	$444,600
Concrete Channel Lining	4,450	CY	$940	$4,183,000
Subtotal				$4,627,600
Contingency (20%)				$925,520
Total				$5,553,120
Say				**$5,554,000**

2 Proposed South Kihei Road Bridge, Waiakoa Gulch

	Quantity	Unit	Unit Price	Total
Proposed Bridge (40 feet span)	LS	LS	LS	$5,920,000
Demolition of Exist. Culverts	LS	LS	LS	$20,000
Reconstruction of S. Kihei Rd.	LS	LS	LS	$168,000
Reconstruction of Private Dwy	LS	LS	LS	$20,000
Utility Relocation	LS	LS	LS	$300,000
Subtotal				$6,428,000
Contingency (20%)				$1,285,600
Total				$7,713,600
Say				**$7,714,000**

3 Restoration and Improvements of Existing Ditch Mauka of Ohukai Subdivision

Ditch Characteristics:
Grassed/Trapezoidal

Bottom Width	10	feet
Height	5	feet
Length	2,200	feet
Side Slope	2H: 1 V	
Assumed Excavated Depth	3	feet

	Quantity	Unit	Unit Price	Total
Excavation for Channel	3,920	CY	$30	$117,600
Hydromulch for Grassed Channel	71,200	SF	$2	$142,400
Subtotal				$260,000
Contingency (20%)				$52,000
Total				$312,000
Say				**$312,000**

4 Proposed Ditch to Proposed Detention Basin at Piilani Basin 6U

Ditch Characteristics:
Grassed/Trapezoidal

Bottom Width	10	feet
Height	5	feet
Length	600	feet
Side Slope	2H: 1 V	
Assumed Excavated Depth	5	feet

	Quantity	Unit	Unit Price	Total
Excavation for Channel	2,230	CY	$30	$66,900
Hydromulch for Grassed Channel	19,420	SF	$2	$38,840
Subtotal				$105,740
Contingency (20%)				$21,148
Total				$126,888
Say				**$127,000**

5 Proposed Ohukai Road Drainage System

	Quantity	Unit	Unit Price	Total
1-11'x3' Box	2,100	LF	$640	$1,344,000
Demolition of Exist. Pipes	LS	LS	LS	$210,000
Excavation for Drainage System	9,340	CY	$30	$280,200
Inlet/Outlet Conc. Headwall	2	EA	$16,050	$32,100
Restoration of Roadway	3,500	SY	$41	$143,500
Utility Relocation	LS	LS	LS	$300,000
Subtotal				$2,309,800
Contingency (20%)				$461,960
Total				$2,771,760
Say				**$2,772,000**

Waiakoa District Improvements Total Cost	**$16,479,000**

1 Proposed Detention Basin at Piilani Basin 6U

	Quantity	Unit	Unit Price	Total
Excavation for Detention Basin	24,200	CY	$30	$726,000
Hydromulch for Detention Basin	89,400	SF	$2	$178,800
GRP Slope Protection at Spillway	60	CY	$540	$32,400
Inlet/Outlet Conc. Headwall	2	EA	$16,050	$32,100
Perimeter 6' High Chain Link Fence	1200	LF	$60	$72,000
1-18" RCP	50	LF	$260	$13,000
Subtotal				$1,054,300
Contingency (20%)				$210,860
Total				$1,265,160
Say				**$1,266,000**

2 Proposed Detention Basin at Piilani Basin 6D

	Quantity	Unit	Unit Price	Total
Excavation for Detention Basin	25,820	CY	$30	$774,600
Hydromulch for Detention Basin	95,800	SF	$2	$191,600
GRP Slope Protection at Spillway	60	CY	$540	$32,400
Inlet/Outlet Conc. Headwall	2	EA	$16,050	$32,100
Perimeter 6' High Chain Link Fence	1240	LF	$60	$74,400
1-18" RCP	50	LF	$260	$13,000
Subtotal				$1,118,100
Contingency (20%)				$223,620
Total				$1,341,720
Say				**$1,342,000**

3 Proposed Detention Basin at Piilani Basin 7, mauka of future Kaonoulu Affordable Apts

	Quantity	Unit	Unit Price	Total
Excavation for Detention Basin	69,380	CY	$30	$2,081,400
Hydromulch for Detention Basin	152,200	SF	$2	$304,400
GRP Slope Protection at Spillway	100	CY	$540	$54,000
Inlet/Outlet Conc. Headwall	2	EA	$16,050	$32,100
Perimeter 6' High Chain Link Fence	1570	LF	$60	$94,200
2-18" RCP	50	LF	$520	$26,000
Subtotal				$2,592,100
Contingency (20%)				$518,420
Total				$3,110,520
Say				**$3,111,000**

4 Proposed Detention Basin at Piilani Basin 7, mauka of Piilani Highway

	Quantity	Unit	Unit Price	Total
Excavation for Detention Basin	69,380	CY	$30	$2,081,400
Hydromulch for Detention Basin	152,200	SF	$2	$304,400
GRP Slope Protection at Spillway	100	CY	$540	$54,000
Inlet/Outlet Conc. Headwall	2	EA	$16,050	$32,100
Perimeter 6' High Chain Link Fence	1570	LF	$60	$94,200
2-18" RCP	50	LF	$520	$26,000
Subtotal				$2,592,100
Contingency (20%)				$518,420
Total				$3,110,520
Say				**$3,111,000**

5 Proposed Detention Basin at Piilani Basin 9

	Quantity	Unit	Unit Price	Total
Excavation for Detention Basin	29,040	CY	$30	$871,200
Hydromulch for Detention Basin	140,100	SF	$2	$280,200
GRP Slope Protection at Spillway	60	CY	$540	$32,400
Inlet/Outlet Conc. Headwall	2	EA	$16,050	$32,100
Perimeter 6' High Chain Link Fence	1500	LF	$60	$90,000
1-18" RCP	50	LF	$260	$13,000
Subtotal				$1,318,900
Contingency (20%)				$263,780
Total				$1,582,680
Say				**$1,583,000**

6 Kulanihakoi Gulch Improvements

Channel Characteristics:
Concrete/Trapezoidal

Bottom Width	80	feet
Height	12	feet
Length	3,100	feet
Side Slope	2H: 1 V	
Assumed Excavated Depth	8	feet
Assumed Lining Thickness	1	feet

	Quantity	Unit	Unit Price	Total
Excavation for Channel	88,180	CY	$30	$2,645,400
Concrete Channel Lining	15,350	CY	$940	$14,429,000
Subtotal				$17,074,400
Contingency (20%)				$3,414,880
Total				$20,489,280
Say				**$20,490,000**

7 Kula 2_1 Channel Improvements

Channel Characteristics:
CRM/Trapezoidal

Bottom Width	20	feet
Height	5	feet
Length	700	feet
Side Slope	2H: 1 V	
Assumed Excavated Depth	3	feet
Assumed Lining Thickness	1.5	feet

	Quantity	Unit	Unit Price	Total
Excavation for Channel	2,030	CY	$30	$60,900
CRM Channel Lining	1,650	CY	$610	$1,006,500
Subtotal				$1,067,400
Contingency (20%)				$213,480
Total				$1,280,880
Say				**$1,281,000**

8 Kula 2_1 Culvert Improvements

	Quantity	Unit	Unit Price	Total
2-12'x6' Box	500	LF	$1,400	$700,000
Demolition of Exist. Culverts	LS	LS	LS	$100,000
Inlet/Outlet Conc. Headwall	2	EA	$16,050	$32,100
Subtotal				$832,100
Contingency (20%)				$166,420
Total				$998,520
Say				**$999,000**

9 Proposed South Kihei Road Bridge, Kulanihakoi Gulch

	Quantity	Unit	Unit Price	Total
Proposed Bridge (130 feet span)	LS	LS	LS	$19,240,000
Demolition of Exist. Culverts	LS	LS	LS	$60,000
Reconstruction of S. Kihei Rd.	LS	LS	LS	$294,000
Reconstruction of Private Dwy	LS	LS	LS	$20,000
Utility Relocation	LS	LS	LS	$300,000
Subtotal				$19,914,000
Contingency (20%)				$3,982,800
Total				$23,896,800
Say				**$23,897,000**

Kulanihakoi District Improvements Total Cost **$57,080,000**

1 Proposed Liloa Drive Culverts

	Quantity	Unit	Unit Price	Total
2-11'x3' Box	80	LF	$1,200	$96,000
Excavation for Culvert	620	CY	$30	$18,600
Inlet/Outlet Conc. Headwall	2	EA	$16,050	$32,100
Subtotal				$146,700
Contingency (20%)				$29,340
Total				$176,040
Say				**$177,000**

2 Waipuilani Gulch Improvements - 1 (future Hoonali Homes development)

Ditch Characteristics:
Grassed/Trapezoidal

Bottom Width	25	feet
Height	5	feet
Length	1,290	feet
Side Slope	2H: 1 V	
Assumed Excavated Depth	4	feet

	Quantity	Unit	Unit Price	Total
Excavation for Channel	6,310	CY	$30	$189,300
Hydromulch for Grassed Channel	61,100	SF	$2	$122,200
Subtotal				$311,500
Contingency (20%)				$62,300
Total				$373,800
Say				**$374,000**

3 Waipuilani Gulch Improvements - 2 (approx. 800' mauka of S. Kihei Rd to stream mouth)

Channel Characteristics:
Rectangular/Concrete

Bottom Width	15	feet
Height	5	feet
Length	1,620	feet
Assumed Excavated Depth	4	feet
Assumed Lining Thickness	1	feet

	Quantity	Unit	Unit Price	Total
Excavation for Channel	3,600	CY	$30	$108,000
Concrete Channel Lining	1,500	CY	$940	$1,410,000
Subtotal				$1,518,000
Contingency (20%)				$303,600
Total				$1,821,600
Say				**$1,822,000**

4 Proposed South Kihei Road Culvert Improvements

	Quantity	Unit	Unit Price	Total
2-11'x4' Box	60	LF	$1,240	$74,400
Demolition of Exist. Culverts	LS	LS	LS	$6,000
Inlet/Outlet Conc. Headwall	2	EA	$16,050	$32,100
Restoration of Roadway	180	SY	$41	$7,380
Subtotal				$119,880
Contingency (20%)				$23,976
Total				$143,856
Say				**$144,000**

5 Waipuilani Gulch Diversion

Channel Characteristics:
CRM/Trapezoidal

Bottom Width	50	feet
Height	10	feet
Length	3,000	feet
Side Slope	2H: 1 V	
Assumed Excavated Depth	10	feet
Assumed Lining Thickness	1.5	feet

	Quantity	Unit	Unit Price	Total
Excavation for Channel	77,780	CY	$30	$2,333,400
CRM Channel Lining	15,790	CY	$610	$9,631,900
Subtotal				$11,965,300
Contingency (20%)				$2,393,060
Total				$14,358,360
Say				**$14,359,000**
Waipuilani District Improvements Total Cost				**$16,876,000**

1 Proposed Detention Basin at Piilani Basin 13U

	Quantity	Unit	Unit Price	Total
Excavation for Detention Basin	41,950	CY	$30	$1,258,500
Hydromulch for Detention Basin	217,800	SF	$2	$435,600
GRP Slope Protection at Spillway	60	CY	$540	$32,400
Inlet/Outlet Conc. Headwall	2	EA	$16,050	$32,100
Perimeter 6' High Chain Link Fence	1870	LF	$60	$112,200
1-18" RCP	50	LF	$260	$13,000
Subtotal				$1,883,800
Contingency (20%)				$376,760
Total				$2,260,560
Say				**$2,261,000**

2 Proposed Detention Basin at Piilani Basin 14U

	Quantity	Unit	Unit Price	Total
Excavation for Detention Basin	41,950	CY	$30	$1,258,500
Hydromulch for Detention Basin	147,200	SF	$2	$294,400
GRP Slope Protection at Spillway	60	CY	$540	$32,400
Inlet/Outlet Conc. Headwall	2	EA	$16,050	$32,100
Perimeter 6' High Chain Link Fence	1540	LF	$60	$92,400
1-18" RCP	50	LF	$260	$13,000
Subtotal				$1,722,800
Contingency (20%)				$344,560
Total				$2,067,360
Say				**$2,068,000**

3 Proposed Detention Basin at Piilani Basin 16U

	Quantity	Unit	Unit Price	Total
Excavation for Detention Basin	54,860	CY	$30	$1,645,800
Hydromulch for Detention Basin	169,900	SF	$2	$339,800
GRP Slope Protection at Spillway	60	CY	$540	$32,400
Inlet/Outlet Conc. Headwall	2	EA	$16,050	$32,100
Perimeter 6' High Chain Link Fence	1650	LF	$60	$99,000
1-18" RCP	50	LF	$260	$13,000
Subtotal				$2,162,100
Contingency (20%)				$432,420
Total				$2,594,520
Say				**$2,595,000**

4 Uluniu Road Drainage System - Alternative 1

	Quantity	Unit	Unit Price	Total
1-24"	3,000	LF	$270	$810,000
Demolition of Exist. Pipes	LS	LS	LS	$65,000
Excavation for Drainage System	4,670	CY	$30	$140,100
Grated Drain Inlet	11	EA	$30,800	$338,800
Outlet Conc. Headwall	1	EA	$16,050	$16,050
Restoration of Roadway	2,000	SY	$41	$82,000
Utility Relocation	LS	LS	LS	$300,000
Subtotal				$1,751,950
Contingency (20%)				$350,390
Total				$2,102,340
Say				**$2,103,000**

5 Uluniu Road Drainage System - Alternative 2

	Quantity	Unit	Unit Price	Total
Drywell w/ Grated Drain Inlet	11	EA	$59,800	$657,800
Subtotal				$657,800
Contingency (20%)				$131,560
Total				$789,360
Say				**$790,000**

6 Uluniu RoadNew Outlet (Feasibility Study) - Alternative 3

	Quantity	Unit	Unit Price	Total
New ocean outlet feasibility study (drainage system, excavation, environmental assessment, permitting, land acquisition, coastal study..Etc)	LS	LS	LS	$500,000
Subtotal				$500,000
Contingency (20%)				$100,000
Total				$600,000
Say				**$600,000**

Note: This is the estimated cost to conduct a feasibility study. Actual construction cost coud be determined at that time.

7 Proposed Piilani Highway Culvert Improvements at Piilani Basin 14D

	Quantity	Unit	Unit Price	Total
1-7'x5' Box	120	LF	$520	$62,400
Demolition of Exist. Culvert	LS	LS	LS	$12,000
Inlet/Outlet Conc. Headwall	2	EA	$16,050	$32,100
Restoration of Roadway	150	SY	$41	$6,150
Piilani Highway Bypass	LS	LS	LS	$200,000
Subtotal				$312,650
Contingency (20%)				$62,530
Total				$375,180
Say				**$376,000**

Keokea District Improvements Total Cost **$10,793,000**

1 Proposed Detention Basin at Piilani Basin 17A

	Quantity	Unit	Unit Price	Total
Excavation for Detention Basin	12,910	CY	$30	$387,300
Hydromulch for Detention Basin	36,400	SF	$2	$72,800
GRP Slope Protection at Spillway	30	CY	$540	$16,200
Inlet/Outlet Conc. Headwall	2	EA	$16,050	$32,100
Perimeter 6' High Chain Link Fence	770	LF	$60	$46,200
1-18" RCP	50	LF	$260	$13,000
Subtotal				$567,600
Contingency (20%)				$113,520
Total				$681,120
Say				**$682,000**

2 Proposed Detention Basin at Piilani Basin 19A1

	Quantity	Unit	Unit Price	Total
Excavation for Detention Basin	33,880	CY	$30	$1,016,400
Hydromulch for Detention Basin	92,700	SF	$2	$185,400
GRP Slope Protection at Spillway	50	CY	$540	$27,000
Inlet/Outlet Conc. Headwall	2	EA	$16,050	$32,100
Perimeter 6' High Chain Link Fence	1220	LF	$60	$73,200
1-36" RCP	50	LF	$340	$17,000
Subtotal				$1,351,100
Contingency (20%)				$270,220
Total				$1,621,320
Say				**$1,622,000**

3 Proposed Detention Basin at Piilani Basin 19A2

	Quantity	Unit	Unit Price	Total
Excavation for Detention Basin	19,360	CY	$30	$580,800
Hydromulch for Detention Basin	55,400	SF	$2	$110,800
GRP Slope Protection at Spillway	50	CY	$540	$27,000
Inlet/Outlet Conc. Headwall	2	EA	$16,050	$32,100
Perimeter 6' High Chain Link Fence	950	LF	$60	$57,000
1-18" RCP	50	LF	$260	$13,000
Subtotal				$820,700
Contingency (20%)				$164,140
Total				$984,840
Say				**$985,000**

4 Proposed Detention Basin at Piilani Basin 19

	Quantity	Unit	Unit Price	Total
Excavation for Detention Basin	80,670	CY	$30	$2,420,100
Hydromulch for Detention Basin	158,200	SF	$2	$316,400
GRP Slope Protection at Spillway	60	CY	$540	$32,400
Inlet/Outlet Conc. Headwall	2	EA	$16,050	$32,100
Perimeter 6' High Chain Link Fence	1600	LF	$60	$96,000
1-48" RCP	50	LF	$390	$19,500
Subtotal				$2,916,500
Contingency (20%)				$583,300
Total				$3,499,800
Say				**$3,500,000**

5 Proposed Detention Basin at Piilani Basin 20

	Quantity	Unit	Unit Price	Total
Excavation for Detention Basin	27,430	CY	$30	$822,900
Hydromulch for Detention Basin	67,000	SF	$2	$134,000
GRP Slope Protection at Spillway	60	CY	$540	$32,400
Inlet/Outlet Conc. Headwall	2	EA	$16,050	$32,100
Perimeter 6' High Chain Link Fence	1040	LF	$60	$62,400
3-42" RCP	50	LF	$1,080	$54,000
Subtotal				$1,137,800
Contingency (20%)				$227,560
Total				$1,365,360
Say				**$1,366,000**

6 Waimahaihai Gulch Drainage Improvements

	Quantity	Unit	Unit Price	Total
1-8'x3' Box	260	LF	$520	$135,200
1-11'x3' Box	1,060	LF	$640	$678,400
1-30"	180	LF	$330	$59,400
Demolition of Exist. Pipes	LS	LS	LS	$84,000
Excavation for Drainage System	5,980	CY	$30	$179,400
Inlet/Outlet Conc. Headwall	2	EA	$16,050	$32,100
Restoration of Roadway	2,250	SY	$41	$92,250
Utility Relocation	LS	LS	LS	$300,000
Land Acquisition (Easement)	LS	LS	LS	$300,000
Subtotal				$1,860,750
Contingency (20%)				$372,150
Total				$2,232,900
Say				**$2,233,000**

7 Restoration and Improvements of Existing Waimahaihai Gulch

Ditch Characteristics:
Grassed/Trapezoidal

Bottom Width	12	feet
Height	4	feet
Length	360	feet
Side Slope	2H: 1 V	
Assumed Excavated Depth	3	feet

	Quantity	Unit	Unit Price	Total
Excavation for Channel	720	CY	$30	$21,600
Hydromulch for Grassed Channel	10,760	SF	$2	$21,520
Subtotal				$43,120
Contingency (20%)				$8,624
Total				$51,744
Say				**$52,000**

8 Kihei Gulch 1 Drainage System Improvements

	Quantity	Unit	Unit Price	Total
1-9'x4' Box	645	LF	$580	$374,100
1-17'x4' Box	1,570	LF	$900	$1,413,000
Demolition of Exist. Pipes	LS	LS	LS	$80,000
Excavation for Drainage System	13,790	CY	$30	$413,700
Inlet/Outlet Conc. Headwall	2	EA	$16,050	$32,100
Restoration of Roadway	4,610	SY	$41	$189,010
Utility Relocation	LS	LS	LS	$300,000
Subtotal				$2,801,910
Contingency (20%)				$560,382
Total				$3,362,292
Say				**$3,363,000**

9 Kihei Gulch 1 Improvements

Channel Characteristics:
CRM/Trapezoidal

Bottom Width	15	feet
Height	5	feet
Length	1,200	feet
Side Slope	2H: 1 V	
Assumed Excavated Depth	3	feet
Assumed Lining Thickness	1.5	feet

	Quantity	Unit	Unit Price	Total
Excavation for Channel	2,800	CY	$30	$84,000
CRM Channel Lining	2,500	CY	$610	$1,525,000
Subtotal				$1,609,000
Contingency (20%)				$321,800
Total				$1,930,800
Say				**$1,931,000**

10 Kalama Beach Park Channel Improvements

Channel Characteristics:
CRM/Trapezoidal

Bottom Width	25	feet
Height	5.5	feet
Length	550	feet
Side Slope	2H: 1 V	
Assumed Excavated Depth	3.5	feet
Assumed Lining Thickness	1.5	feet

	Quantity	Unit	Unit Price	Total
Excavation for Channel	2,290	CY	$30	$68,700
CRM Channel Lining	1,520	CY	$610	$927,200
Subtotal				$995,900
Contingency (20%)				$199,180
Total				$1,195,080
Say				**$1,196,000**

11 Proposed Auhana Road Culvert Improvements

	Quantity	Unit	Unit Price	Total
2-7'x5' Box	35	LF	$960	$33,600
Demolition of Exist. Culvert	LS	LS	LS	$3,500
Inlet/Outlet Conc. Headwall	2	EA	$16,050	$32,100
Restoration of Roadway	70	SY	$41	$2,870
Subtotal				$72,070
Contingency (20%)				$14,414
Total				$86,484
Say				**$87,000**

12 Proposed Kanoe Street Culvert Improvements

	Quantity	Unit	Unit Price	Total
3-6'x4' Box	60	LF	$1,220	$73,200
Demolition of Exist. Culvert	LS	LS	LS	$18,000
Inlet/Outlet Conc. Headwall	2	EA	$16,050	$32,100
Restoration of Roadway	150	SY	$41	$6,150
Subtotal				$129,450
Contingency (20%)				$25,890
Total				$155,340
Say				**$156,000**

13 Kaluaihakoko Gulch Improvements

Channel Characteristics:
Rectangular/Concrete

Bottom Width	15	feet
Height	5	feet
Length	2,400	feet
Assumed Excavated Depth	3	feet
Assumed Lining Thickness	1	feet

	Quantity	Unit	Unit Price	Total
Excavation for Channel	4,000	CY	$30	$120,000
Concrete Channel Lining	2,230	CY	$940	$2,096,200
Land Acquisition	LS	LS	LS	$300,000
Subtotal				$2,516,200
Contingency (20%)				$503,240
Total				$3,019,440
Say				**$3,020,000**

Charlie Young District Improvements Total Cost **$20,193,000**

1 Proposed Detention Basin at Piilani Basin 23

	Quantity	Unit	Unit Price	Total
Excavation for Detention Basin	53,240	CY	$30	$1,597,200
Hydromulch for Detention Basin	172,300	SF	$2	$344,600
GRP Slope Protection at Spillway	70	CY	$540	$37,800
Inlet/Outlet Conc. Headwall	2	EA	$16,050	$32,100
Perimeter 6' High Chain Link Fence	1670	LF	$60	$100,200
1-18" RCP	50	LF	$260	$13,000
Subtotal				$2,124,900
Contingency (20%)				$424,980
Total				$2,549,880
Say				**$2,550,000**

2 Proposed Piilani Highway Culvert Improvements at Piilani Basin 21

	Quantity	Unit	Unit Price	Total
2-24'x7' Box	113	LF	$2,390	$270,070
Demolition of Exist. Culvert	LS	LS	LS	$45,200
Inlet/Outlet Conc. Headwall	2	EA	$16,050	$32,100
Restoration of Roadway	660	SY	$41	$27,060
Piilani Highway Bypass	LS	LS	LS	$200,000
Subtotal				$574,430
Contingency (20%)				$114,886
Total				$689,316
Say				**$690,000**

3 Proposed Maui Coast Hotel Culvert Improvements

	Quantity	Unit	Unit Price	Total
2-22'x8' Box	220	LF	$2,270	$499,400
Demolition of Exist. Culvert	LS	LS	LS	$88,000
Inlet/Outlet Conc. Headwall	2	EA	$16,050	$32,100
Restoration of Parking Lot	1,180	SY	$41	$48,380
Utility Relocation	LS	LS	LS	$300,000
Subtotal				$967,880
Contingency (20%)				$193,576
Total				$1,161,456
Say				**$1,162,000**

4 Proposed South Kihei Road Culvert Improvements

	Quantity	Unit	Unit Price	Total
2-22'x8' Box	52	LF	$2,270	$118,040
Demolition of Exist. Culvert	LS	LS	LS	$10,400
Inlet/Outlet Conc. Headwall	2	EA	$16,050	$32,100
Restoration of Roadway	280	SY	$41	$11,480
Utility Relocation	LS	LS	LS	$300,000
Land Acquisition	LS	LS	LS	$300,000
Subtotal				$472,020
Contingency (20%)				$94,404
Total				$566,424
Say				**$567,000**

5 Kamaole Gulch Improvements

Channel Characteristics:
Rectangular/Concrete

Bottom Width	25	feet
Height	9	feet
Length	1,100	feet
Assumed Excavated Depth	7	feet
Assumed Lining Thickness	1	feet

	Quantity	Unit	Unit Price	Total
Excavation for Channel	7,130	CY	$30	$213,900
Concrete Channel Lining	1,760	CY	$940	$1,654,400
Subtotal				$1,868,300
Contingency (20%)				$373,660
Total				$2,241,960
Say				**$2,242,000**

6 Kihei Kai Nani Drainage Improvements

	Quantity	Unit	Unit Price	Total
1-8'x3' Box	1,220	LF	$520	$634,400
Demolition of Exist. Culvert	LS	LS	LS	$9,000
Excavation for Drainage System	4,340	CY	$30	$130,200
Inlet/Outlet Conc. Headwall	2	EA	$16,050	$32,100
Restoration of Roadway	1,630	SY	$41	$66,830
Reconstruction of Parking Lot	LS	LS	LS	$100,000
Utility Relocation	LS	LS	LS	$300,000
Subtotal				$1,272,530
Contingency (20%)				$254,506
Total				$1,527,036
Say				**$1,528,000**

Kamaole District Improvements Total Cost	**$8,739,000**

1 Proposed Kanakanui Road Culverts to Replace Existing Conc. Ford

	Quantity	Unit	Unit Price	Total
2-22'x9' Box	60	LF	$2,310	$138,600
Reconstruction of Kanakanui Road	LS	LS	LS	$168,000
Inlet/Outlet Conc. Headwall	2	EA	$16,050	$32,100
Subtotal				$338,700
Contingency (20%)				$67,740
Total				$406,440
Say				**$407,000**

2 Proposed North-South Collector Road Culverts to Replace Existing Conc. Ford

	Quantity	Unit	Unit Price	Total
2-22'x9' Box	60	LF	$2,310	$138,600
Reconstruction of N-S Collector Road	LS	LS	LS	$126,000
Inlet/Outlet Conc. Headwall	2	EA	$16,050	$32,100
Subtotal				$296,700
Contingency (20%)				$59,340
Total				$356,040
Say				**$357,000**

3 Proposed South Kihei Road Culvert Improvements

	Quantity	Unit	Unit Price	Total
2-22'x9' Box	70	LF	$2,310	$161,700
Demolition of Exist. Culvert	LS	LS	LS	$28,000
Inlet/Outlet Conc. Headwall	2	EA	$16,050	$32,100
Restoration of Roadway	380	SY	$41	$15,580
Subtotal				$221,800
Contingency (20%)				$44,360
Total				$266,160
Say				**$267,000**

Liilioholo District Improvements Total Cost **$1,031,000**

1 Proposed Piilani Highway Culvert Improvemrents at Piilani Basin 29

	Quantity	Unit	Unit Price	Total
2-66"	184	LF	$860	$158,240
Demolition of Exist. Culvert	LS	LS	LS	$36,800
Inlet/Outlet Conc. Headwall	2	EA	$16,050	$32,100
Restoration of Roadway	310	SY	$41	$12,710
Piilani Highway Bypass	LS	LS	LS	$200,000
Subtotal				$439,850
Contingency (20%)				$87,970
Total				$527,820
Say				**$528,000**

2 Waile SF-58 Channel Improvements

Channel Characteristics:
CRM/Trapezoidal

Bottom Width	15	feet
Height	5	feet
Length	950	feet
Side Slope	2H: 1 V	
Assumed Excavated Depth	3	feet
Assumed Lining Thickness	1.5	feet

	Quantity	Unit	Unit Price	Total
Excavation for Channel	2,220	CY	$30	$66,600
CRM Channel Lining	1,980	CY	$610	$1,207,800
Subtotal				$1,274,400
Contingency (20%)				$254,880
Total				$1,529,280
Say				**$1,530,000**

Kilohana Drive District Improvements Total Cost	**$2,058,000**