CITY *of* CALABASAS

City of Calabasas

Department of Public Works

CALABASAS HIGHLANDS

MASTER PLAN OF DRAINAGE UPDATE

2013

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1.0 INTRODUCTION

1.1 GENERAL

This report presents the results of the City's recent efforts to provide an update the existing Master Plan of Drainage (hereafter "Update") study for the Calabasas Highlands community (alternately "project study area"). Described herein are the methodologies employed and results obtained in an engineering review of the drainage characteristics of the watershed study area within Calabasas Highlands.

1.2 FIELD REVIEW

A pedestrian level field review of visible elements of the existing drainage system was performed. This review focused on existing drainage structure locations, geometry, surface flow patterns and existing development patterns. The existing Master Plan of Drainage and related construction documents were reviewed to determine the level and extent of improvements recommended by the Master Plan that had subsequently been implemented. A topography map was provided by the City for use as a base map for hydrologic delineation and associated flow characterization for the various portions of the community.

It should be noted that the field review did not include a site specific topographic survey of existing surface features or storm drain improvements. No subsurface location or investigation of storm drain pipe alignment, assessment of condition or structural adequacy of system pipes and structures were completed.

1.3 SCOPE OF WORK

The Scope of Work for updating the Master Plan of Drainage includes the following:

1. Review existing available plans, reports, built improvements.
2. Perform a pedestrian level field review of existing storm drain facilities and surface topographic development patterns.
3. Prepare an inventory of existing drainage facilities.
4. Prepare a hydrology delineation and analysis of drainage areas in the community.
5. Prepare a review of the relative effectiveness of existing storm drainage facilities in the interception of tributary drainage.
6. Identify areas of deficiency based on the above review of relative effectiveness and stipulated criteria for deficiency status.
7. Prepare recommendations for future improvements based on identified areas of deficiency and stipulated prioritization criteria.

1.4 STANDARDS AND PROCEDURES

The following standards and procedures have been used to develop the Master Plan document:

1. Hydrologic Calculations - Los Angeles County Department of Public Works Hydrology Manual (December 1991).

2. Design Frequencies - Los Angeles County Department of Public Works Hydrology Manual (December 1991).

2.0 BACKGROUND

2.1 SETTING

The Calabasas Highlands project study area is located in the southwest portion of Los Angeles County and encompasses about 70 acres of single family development. The topography is dominated by hilly to mountainous terrain with slopes ranging from 5% to 80%. The slope aspect in the Calabasas Highlands is predominately north facing.

The project area is characterized by an informal roadway and drainage system which has been expanded incrementally by development of the community over the years. A comprehensive program and facilities for storm water collection, debris interception and peak flow attenuation is largely nonexistent. Rather, the placement of catch basins and associated roadway culverts has been dictated by the need to locally intercept storm water runoff and convey drainage for the protection of access roads. Traditional streets with curb and gutter and associated catch basins used to intercept and convey local surface storm water occur only rarely in the community. The result of these factors is a developed drainage condition in which cross lot drainage and high levels of surface flow are typical. Traditional methods of intercepting drainage from uphill undeveloped areas such as brow ditches and down drains occur only rarely and where required for individual lot development. Where such facilities occur, maintenance is typically provided by individual property owners. The community's history of predominantly infill development on small lots has resulted in relatively high densities of hillside development in the context of a drainage infrastructure which is rural in nature.

2.2 CLIMATE

The project area has a Mediterranean type climate characterized by long, dry summers and mild winters. Most of the precipitation occurs during the period from November through March, with little or no rainfall from May through October.

Three types of storms that produce precipitation in the area are: general winter storms, thunderstorms, and tropical cyclones. Flooding is most often caused by high intensity rainfall associated with general winter storms. Flood flow stages can rise from nearly dry stream beds to extreme flood levels in a matter of hours.

2.3 PREVIOUS STUDIES

A previous study entitled "Calabasas Highlands Master Plan of Drainage", dated November 1997, was prepared by ASL Consulting Engineering. A hydrology review was performed which delineated individual areas of drainage and associated runoff, with associated hydraulic calculations for existing tributary drainage structures. The study indentified areas of deficiency in existing drainage catchments and infrastructure based on patterns of development and associated runoff extant at the time of report preparation, and made recommendations for improvements. As of the time of preparation of this study, a portion of these recommended improvements have been completed.

2.4 Existing Improvements

Among the deficiencies identified as priority improvements by the previous Master Plan prepared by ASL included the facilities along Orchid Trail. Orchid Trail is a “paper” street (mapped but undeveloped) oriented north to south in the central portion of the community. The alignment of Orchid Trail between Summit Drive and Valley View Road is characterized by steep grades and a high potential for erosion. To mitigate this condition, ASL recommended a system of gabions be implemented as the primary energy dissipation and erosion control system. The gabions, which consist of stone filled containers of galvanized steel hexagonal wire mesh, form a trapezoidal lining for Orchid Trail. The trapezoidal channel is supplemented by drop structures in multiple locations limit high velocity flow and related erosion.

The Orchid Trail drainage is intercepted at its northerly terminus at Valley View Road by a head wall and an inlet. The inlet conveys the Orchid trail drainage to a 36’’ RCP storm drain system. The storm drain collects additional drainage from inlets located on Valley View Road, then proceeds north on Rosebud to its terminus in a series of concrete lined open channels which in turn outlet near the northerly tract boundary.

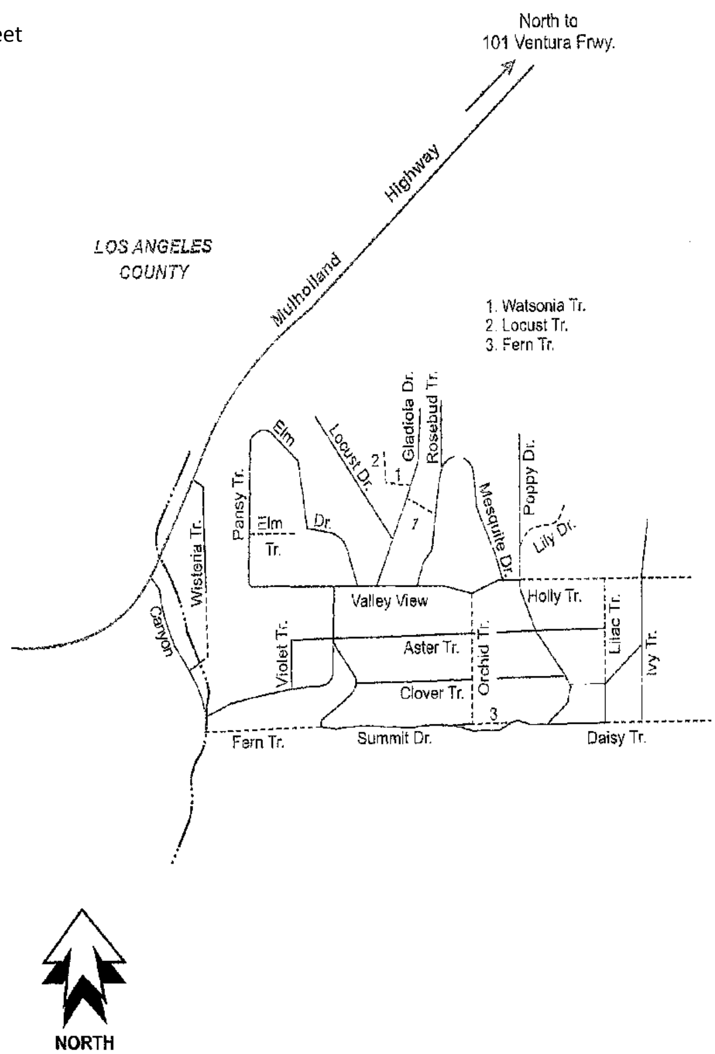
These are the major drainage improvements that had done in the Calabasas Highlands since 1997. Other recommended improvements not yet completed have been reviewed by this Update study, and have been considered in the recommendations provided herein.

CITY *of* CALABASAS

Legend

--------- Paper Street

_______ Improved Street



3.0 HYDROLOGIC ANALYSIS

3.1 Design Runoff Method

The Modified Rational Method, conforming to the 1991 Los Angeles County Department of Public Works Hydrology Manual, is used in this Hydrology Study. The Modified Rational Method, related data and criteria incorporated are consistent with accepted methods of analyzing storm water runoff in Los Angeles County.

The Modified Rational Method relates rainfall intensity, the ratio of runoff to rainfall and the drainage area size to peak runoff as expressed by the equation:

$$Q = CIA$$

Where:

Q = runoff in cubic feet per second (cfs)

C = runoff coefficient relating the ratio of runoff to rainfall

I = rainfall intensity (in inches per hour)

A = drainage area (in acres)

The following describes in detail the components of the Modified Rational Method.

3.2 Runoff Coefficient

The runoff coefficient, C, is a factor relating the quantity of storm water runoff to the quantity of rainfall striking the earth. The runoff coefficient is based on the soil's being saturated, and is a variable depending on the imperviousness, soil type, and rainfall intensity. The imperviousness for urban residential development is 0.42. The soil classification for this area is 66.

3.3 Rainfall Intensity

Rainfall intensity, I, is expressed in inches per hour and is based on the cumulative rainfall mass curve from a design storm. Rainfall intensity is a variable depending on duration of rainfall (short-duration storms are more intense), time of concentration, and rainfall frequency (less frequent storms are more intense). The Rainfall Zone for this area is L.

3.4 Time of Concentration

The time of concentration (T_c), is the time required for runoff from the most hydrologically remote point in a drainage area to reach a specified collection point. The path of flow is defined by examination of topographic and development features, and subsequent delineation of the most probable path of travel in the drainage area under consideration. This path of travel may traverse slopes and streets in a sheet flow condition, mountain channels, in ditches, pipes, open channels or combination of all of these modes of conveyance. As the behavior of storm water under flow conditions depends on the mode of flow, geometry of conveyance, roughness and slope of the channel bottom, and other watershed conditions the total flow path is segregated into each of these representative modes for consideration. The time of travel required for the quantity of drainage to traverse these portions of the flow path is determined separately, and the sum of these individual travel times is the time of concentration for the drainage area in question. The calculation is a trial and error procedure, based on flow velocities and flow path lengths using the maximum rainfall intensity for the subarea time of concentration. Since rainfall intensity tends to decrease with an increase in T_c, and conversely increases with shorter T_c's, the choice of an appropriate time of concentration is critical for the accurate characterization of storm runoff for a given rainfall event.

3.5 Design Storm

According to the Los Angeles County Department of Public Works Hydrology/Sedimentation Manual, "A Department of Public Works memorandum dated March 31, 1986, General files No. 2-15.321, established the policy of levels of flood protection. This policy describes which degree of flooding, and therefore which design storms, to use for certain conditions and structures..."

3.6 Capital Flood Protection

The Capital Flood is runoff from a 50-year frequency design storm falling on a saturated watershed. The Capital Flood level of protection applies to all facilities that are constructed in, to intercept flood waters from, natural watercourses. A natural watercourse is a path along which water flows due to natural topographic features, drains a watershed greater than 100 acres, and has flow velocities greater than five feet per second. All facilities in this area are covered under Capital Flood criteria.

The hydraulic analysis of existing facilities using the 50-year design storm reflects that some do not meet the Capital Flood Protection goals. The intent of this Update study is to identify facilities which are deficient in the interception, conveyance and/or discharge of the 50-year design event.

3.7 Debris and Sediment Production

The increase in volumetric flow rate due to the inclusion of debris and sediment is a common condition and is typically referred to as 'bulking'. This condition applies primarily to mountain areas subject to wildfires that destroy the vegetative cover protecting the soil. It also applies to watersheds in mountain areas with loose surface material that is likely to produce sediment. A detailed explanation of debris production methodology is provided in the County of Los Angeles Hydrology Manual (Sedimentation Appendix). In keeping with the County's method and related terminology, the term 'debris' is understood to include the contribution of related sediment complement from the drainage area under consideration.

To determine bulked flow rates, QB, use the equation listed below for the appropriate case:

QB = BF(A) X Q(A)

Where: QB = Bulked discharge in cfs

BF(A) = Bulking factor based on area A

Q(A) = Clear discharge, based on area A, in cfs

3.8 HYDROLOGIC ASSUMPTIONS

A topographic map was provided by the City of Calabasas to facilitate the determination of overall flow patterns within the Calabasas Highlands. On that map, the major drainage area boundaries were outlined to reflect the primary drainage areas within the community and tributary offsite areas. Master times of concentration were developed for both the community and the offsite tributary area to the southwest. Flow patterns within these areas were then analyzed to quantify drainage within the individual subareas. The assumptions made from the topographic map were then field checked and a result of our field investigations, the location of asphalt berms along the streets were noted and incorporated into the flow routing of the hydrologic analysis.

3.9 METHODOLOGY

3.9.1 TIME OF CONCENTRATION (T_C) AND RELATED RUNOFF CALCULATION

The hydrologic investigations of this report included a review of the choice of times of concentration utilized in the existing Calabasas Highlands Master Plan of Drainage study, and their effect on overall developed hydrology. In the determination of individual area drainage, the existing Master Plan specified a time of concentration for each delineated subarea in the community. As these subareas were dictated by topographic conditions and drainage device locations, the characterization of the flow path often resulted in times of concentration of less than 5 minutes. Review of drainage reports for individual developments in the community reveals a similar phenomenon in which the flow path considered for time of concentration determination is limited to the footprint of the individual development. Given the small size of typical lots in the community, the corresponding limitation on flow path length would routinely limit the calculated time of concentration to the 5 minute minimum prescribed by the County of Los Angeles Hydrology methodology. This artificial shortening of time of concentration by constraining the related flow path to small project areas or limited subareas is a misapplication of the County of Los Angeles' Hydrologic methodology and results in the overestimation of peak flow from the subarea in question.

Current hydrologic theories employed in both the County of Los Angeles and the County of Ventura postulate that times of concentration should be based on drainage areas of approximately 40 acres, with consideration of smaller areas where topography limits size. As the equations contained in the County of Los Angeles Hydrology Manual for the development of "C" and "I" are based on the theory of a larger watershed, the use of a short Tc suggests a steep watershed with large elevation changes in all portions of the prescribed flow path. Under such conditions, storm water would accumulate and run off rapidly, with little opportunity for infiltration or basin storage. The values of the undeveloped and developed runoff coefficient would begin to converge, and the drainage basin's ability to distinguish between runoff associated with an undeveloped versus fully developed conditions would diminish. While such conditions may in fact exist in some watersheds, these conditions would be by far the exception and not the rule.

The City recognized this trend in artificial shortening of times of concentration in the period of time since the implementation of the existing Calabasas Highlands Master Plan of Drainage in 1997, both in the Highlands community as well as in other portions of the City. In a community where individual single family lots and associated project areas are often less than 0.5 acre, this misapplication of methodology became problematic, as the proper delineation of drainage areas necessary to accomplish an appropriate time of concentration determination required more of a watershed analysis than a project calculation. The analysis of the larger drainage areas in the Highlands allows for the computation of a time of concentration that is both consistent with the intent of the County's hydrologic methodology and representative of the true character of runoff from the watershed. This permits the development of a 'master' time of concentration with related peak flow hydrology from a larger tributary area. Once a master time of concentration has been developed, associated values of "C" and "I" can be determined and the peak flow from the larger drainage area determined. This runoff can then be prorated to each individual subarea based on a reduction of the total runoff to a measure of cfs per acre. In this manner the intent of the County's hydrologic method can be preserved while allowing for the computation of runoff for arbitrarily small subareas within the drainage area. Similarly, proposed development within the study area can be provided with the estimates of runoff which both simplifies their calculations and ensures consistency of criteria for sizing inlets and storm drain lines.

In the current study, the Highlands community and adjacent offsite areas were reviewed in terms of larger drainage areas, based on existing topographic and development conditions. Time of concentration (Tc) calculations were developed for each these representative subareas. Starting from the most hydrologically remote portions of the Highlands, flow paths were delineated for each area, and total times of concentration developed. Based on the areas chosen, the flow path most central to the community beginning at Summit Drive, following the course of Orchid Trail to the 36" storm drain at Valley View and its outlet on the north end of the community were chosen for computational purposes.

Kinematic wave theory was applied to find Tc for the overland flow. Manning's equation was applied to compute the time in pipe for the portion of the flow path contained by the 36" RCP storm drain pipe and areas of open channel flow. Average rainfall intensity duration curves and runoff coefficient curves from the County of Los Angeles Hydrology Manual (Appendix), were used to find the peak rainfall intensity and the associated runoff coefficient, respectively. Runoff from each subarea was then calculated using the Modified Rational Method as discussed herein.

3.9.2. Sediment and Debris Production

The potential for debris and sediment production was analyzed in conjunction with this Update study. In the existing Calabasas Highlands Master Plan of Drainage, the characterization of debris and sediment potential had been based on a stipulated bulking factor of 1.25. The offsite areas tributary to the community were analyzed based on the methodology outlined in the County of Los Angeles Hydrology Manual (Sedimentation Appendix) and determined a bulking factor of 1.66.

As noted previously, the Highlands community does not contain a comprehensive system of facilities for debris and sediment diversion and attenuation. In this context there is a tendency of flows from offsite natural areas to combine with those originating from existing developed areas without clarification. While flows originating from developed areas will not contain the same level of sediment and debris as recently burned natural areas, the contribution from heavily planted and landscaped single family lots will likely contribute significantly to related runoff. Considering the prevalence of grated inlets and small diameter (under 36") culverts subject to clogging in the community, staff determined the application of the bulking factor to both developed area flows and offsite (natural area) flows a prudent and conservative measure. The calculated bulking factor is a direct multiplier of calculated runoff rates determined by the Modified Rational Method discussed herein.

3.10 Table of Discharges

The following tables provide the hydrologic results which include the discharges, from 50-year storm, in the Calabasas Highlands watershed.

ORCHID TRAIL SUB WATERSHED

Location	Area	Node	Acreage	Type of Facility	Q50 (cfs)
Summit Dr.@ Orchid Tr.	2B		2.05	18" CMP	5.33
Summit Dr. @ 150' west of Orchid Tr.	4C		3.42	24" CMP	8.89
Clover Tr. @ east of Orchid Tr.	3B		1.32	None	3.43
Clover Tr. @ west of Orchid Tr.	5C		1.90	None	4.92
Clover Tr. @ Orchid Tr.		6BC	8.23**	None	21.34*
Aster Tr. @ Orchid Tr.	7B1		1.65◊	36" RCP	4.28*
Aster Tr. @ 300' east of Summit Dr	7B2		0.82◊	18" CMP	3.37**
Aster Tr. @ Orchid Tr.		8BC	11.15**	36" RCP	28.99*
Valley View Dr. @ east of Orchid Tr.	1A		2.60	None	6.76
Valley View Dr. @ west of Orchid Tr.	8B		1.07	36" RCP, 18" RCP	2.78
Orchid Tr. @ valley View Rd.		9AB1	11.86**	36" RCP	30.84*
Orchid Tr. @ Valley View Rd.		9AB2	2.96**	18" RCP	7.69*
Valley View Dr. @ east of Rosebud Tr.	11D		0.95	18" RCP	3.77**
Rosebud Tr 200' north of Valley View	12D		1.32	24"RCP/ u/s of U-Channel	2.29*
Rosebud Tr. @ 230' north of Valley View		13AD	17.59**	u/s of U-Channel	45.73*
Rosebud Tr. @ north of 24" RCP	14A		2.10	U-Channel	5.46
Mesquite Dr. @ northerly end	15E		2.29	None	1.98*
Rosebud Tr. @ northerly end		16AE	20.82**	u/s of U-Channel	54.17*
Poppy Tr. @ northerly end	16F		0.49	None	1.27
North of Mesquite Dr.	16B		1.97	None	5.12
Tact boundary @ north of Mesquite Dr.		17AEFB	23.29**	None	60.56*

Table 3.10.1 Hydrologic Result in Orchid Tr. Sub watershed. See hydrology map for flow routing.

* The Q's at the nodes are cumulative at each subsequent node.
◊ This area is 2/3 the sub area 7B
* The Q's are prorated from larger discharges.
◊ This area is 1/3 the sub area 7B
** The Q's for the sub areas 7B2 & 11D are 2.13 cfs & 2.47 cfs, respectively.
** The acreages at the nodes are cumulative at each subsequent node.

Location	Area	Node	Acreage	Type of Facility	Q50 (cfs)
Summit Dr. @ west of Daisy Tr.	1A		2.09	None	5.43
Daisy Tr. @ west of Lilac Tr.	2B		0.99	18″ CMP	2.57
Summit Dr. @ west of Lilac Tr.	3B		0.25	18″ CMP, 12″ CMP	0.65
Summit Dr. @ east of Lilac Tr.	4C		2.87	None	7.87
North of Summit Dr. @ west of lilac t r.		5AC	2.56**	12″ CMP	6.65*
South of Summit Dr. @ west of lilac Tr.		5ABC	3.80**	18″ CMP	9.87*
Ivy Tr. @180′ north of Summit Dr.	5D		0.26	18″ CMP	0.68
Lilac Tr. @ north of Summit Dr.	6B		2.04	None	5.30
Lilac Tr. @north of Summit Dr.		7BD	8.65**	None	22.50*
North of Lilac Tr.	8E		10.97	None	28.52
Tract boundary @ north of Lilac Tr.		9BDE	19.62**	None	51.02*
Summit Dr. @ Aster Tr.	7D		2.85	None	7.41
Aster Tr. @ 150′ east of Summit Dr.	9E		0.51	18″ CMP	1.33
Aster Tr. @ 150′ east of Summit Dr.		8DE	0.99**	18″ CMP	2.57*
Valley View Rd. @ Gladiola Dr.	8D		0.70	24″ CMP	1.82
Valley View Rd. @ Gladiola Dr.	10E		0.53	None	3.95**
Valley View Rd. @ Gladiola Dr.		9DE	2.66**	24″ CMP	6.92*
Locust Dr. @ west of Gladiola Dr.	12D		0.51	18″ CMP	1.33
Locust Dr. @ west of Gladiola Dr.		11DE	3.17**	18″ CMP	8.25*
Locust Dr.	13D		0.92	None	2.39
Locust Dr. (northerly end)		14DE	4.09**	None	10.64*
North of Locust Dr.	15A		3.65	None	9.52

Table 3.10.2 Hydrologic Result in Lilac Tr. Sub watershed. See hydrology map for flow routing.

Table of Discharge – Continued

Location	Area	Node	Acreage	Type of Facility	Q50 (cfs)
Tract boundary @ north of Locust Dr.		16ADE	7.76**	None	20.18*
Gladiola Dr. @ 670' north of Valley View Rd.	14F		1.00	None	2.60
North of Gladiola Dr.	16A		0.80	None	2.08
Tract boundary @ north of Gladiola Dr.		15AF	1.80**	None	4.68*

Table 3.10.2 Hydrologic Result in Lilac Tr. Sub watershed. See hydrology map for flow routing.

* The Q's at the nodes are cumulative at each subsequent node.
** This is cumulative from sub areas (9E, 10E& 7D) . The Q for the sub area 10E is 0.53 cfs.
** The acreages at the nodes are cumulative at each subsequent node.

Location	Area	Node	Acreage	Type of Facility	Q50 (cfs)
Off Site	5A		56.25	None	274.05
Off Site	6A		20.02	None	110.58
Elsie Dr. @ Canyon Dr.	2B		4.47	72″ RCP	11.62
Fern Dr. @ south of Canyon Dr.	3C		4.19	None	10.89
72″ RCP inlet @ Canyon Dr.		4BC	84.93**	72″ RCP	407.14*
Catch Basin Canyon Dr. West of Elsie	6D		2.27	18″ CMP	7.14*
North of Canyon Dr.	8B		0.88	None	2.29
West of Aster Tr.	9E		3.58	None	11.78**
North of Canyon dr. @ West of Aster Tr.		10BE	91.66**	None	428.35*
North of Canyon Dr, East of Mulholland HWY	11B		2.10	66″ RCP	5.46
Canyon Dr. @ Mulholland Hwy	12F		2.73	24″CMP	7.10
North of Canyon Dr, East of Mulholland Hwy		13BF	96.49**	66″ RCP	440.91*
Pansy Dr. @ Elm Dr.	1A		4.60	24″ CMP	11.96

Table 3.10.3 Hydrologic Result in Canyon Dr. and Pansy Tr. Sub watershed. See hydrology map for flow routing.

* The Q's at the nodes are cumulative at each subsequent node.
* This is cumulative from sub areas (6D& 7D/6). The Q, for the sub area (6D) only, is 5.90 cfs.
** This is cumulative from sub areas (9E& 7D/3). The Q, for the sub area (9E) only, is 9.31 cfs.
** The acreages at the nodes are cumulative at each subsequent node.

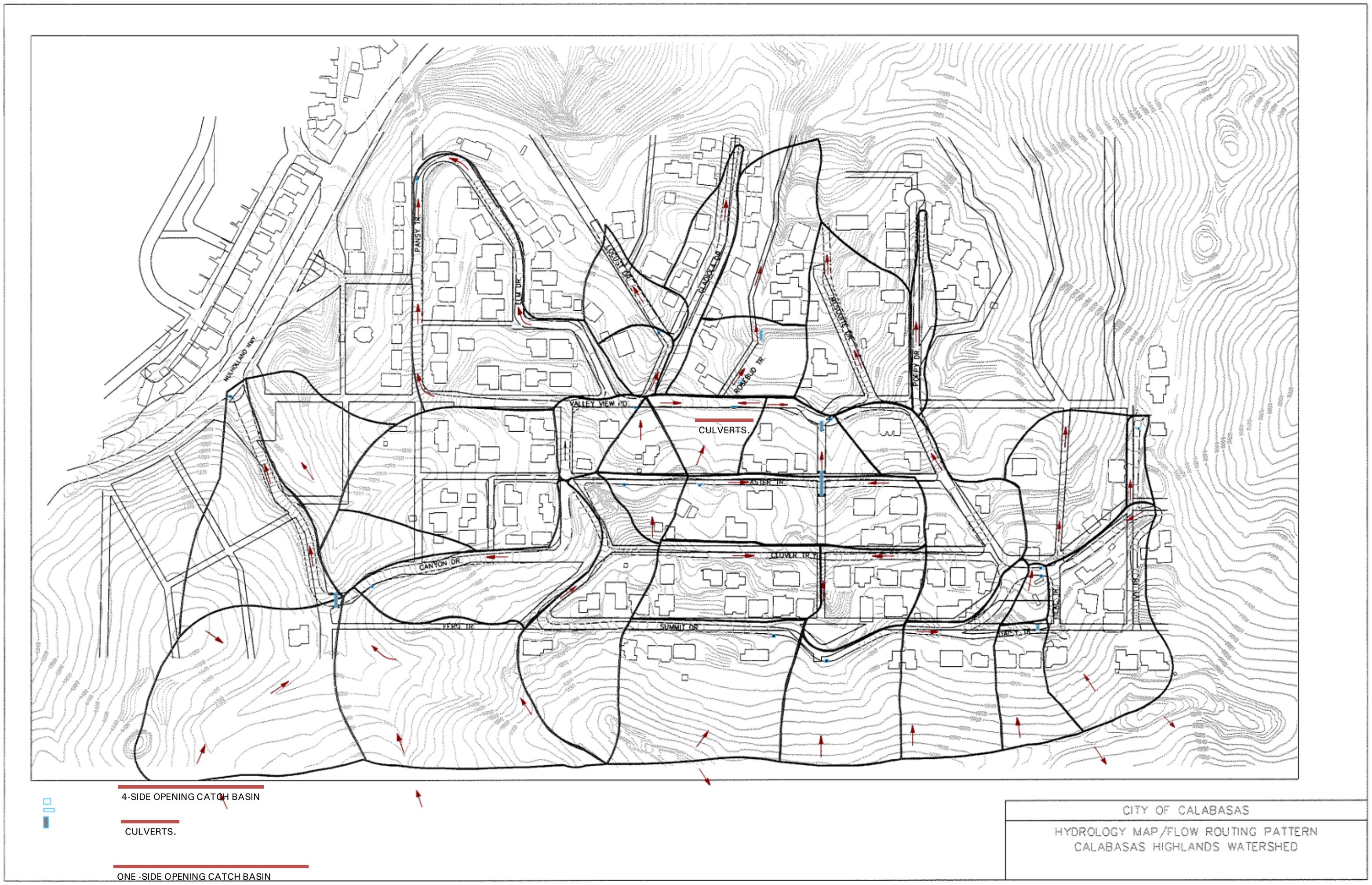
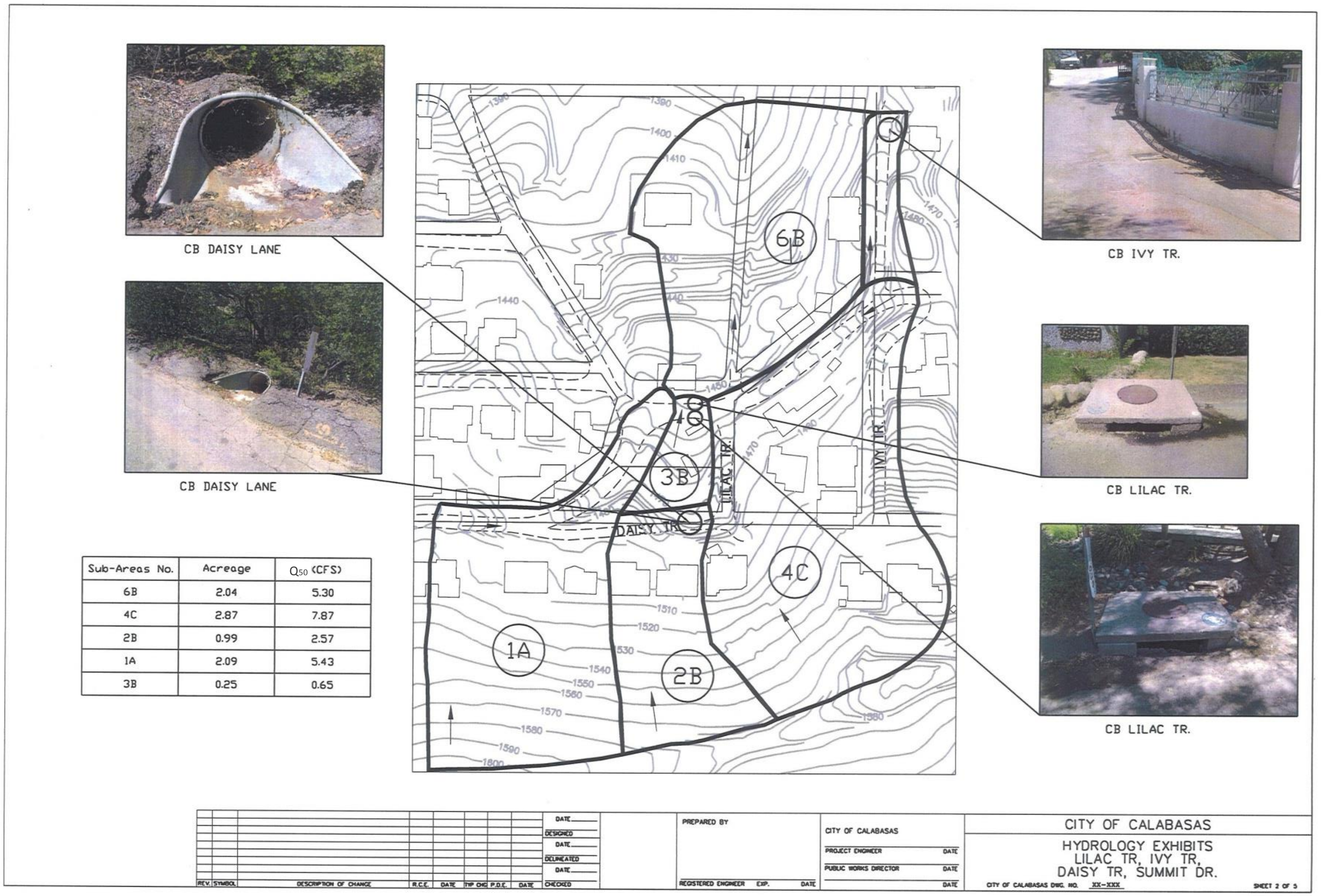
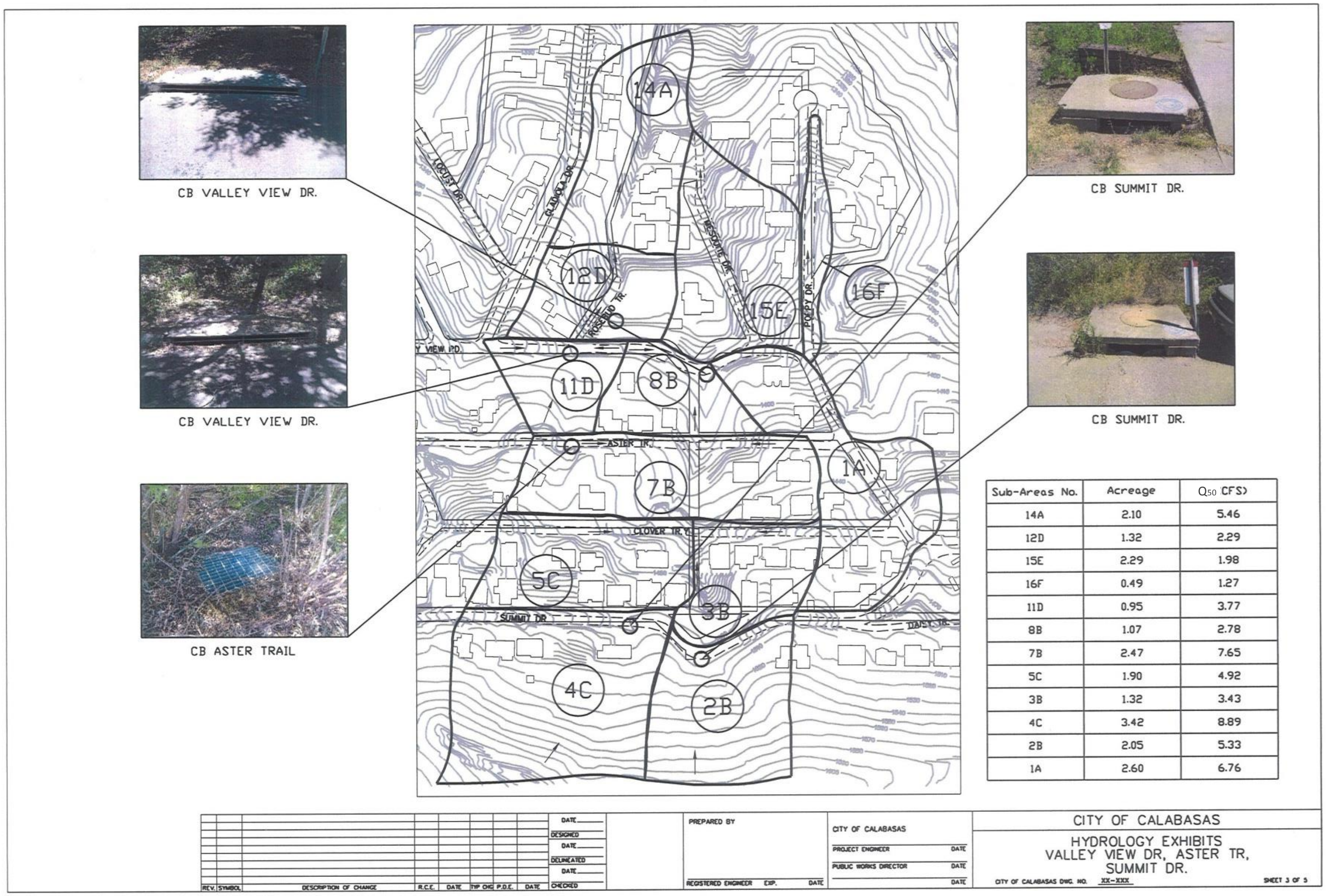


FIGURE 3.9.B. **EXISTING FLOW TRENDS IN HIGHLANDS WATERSHED.**



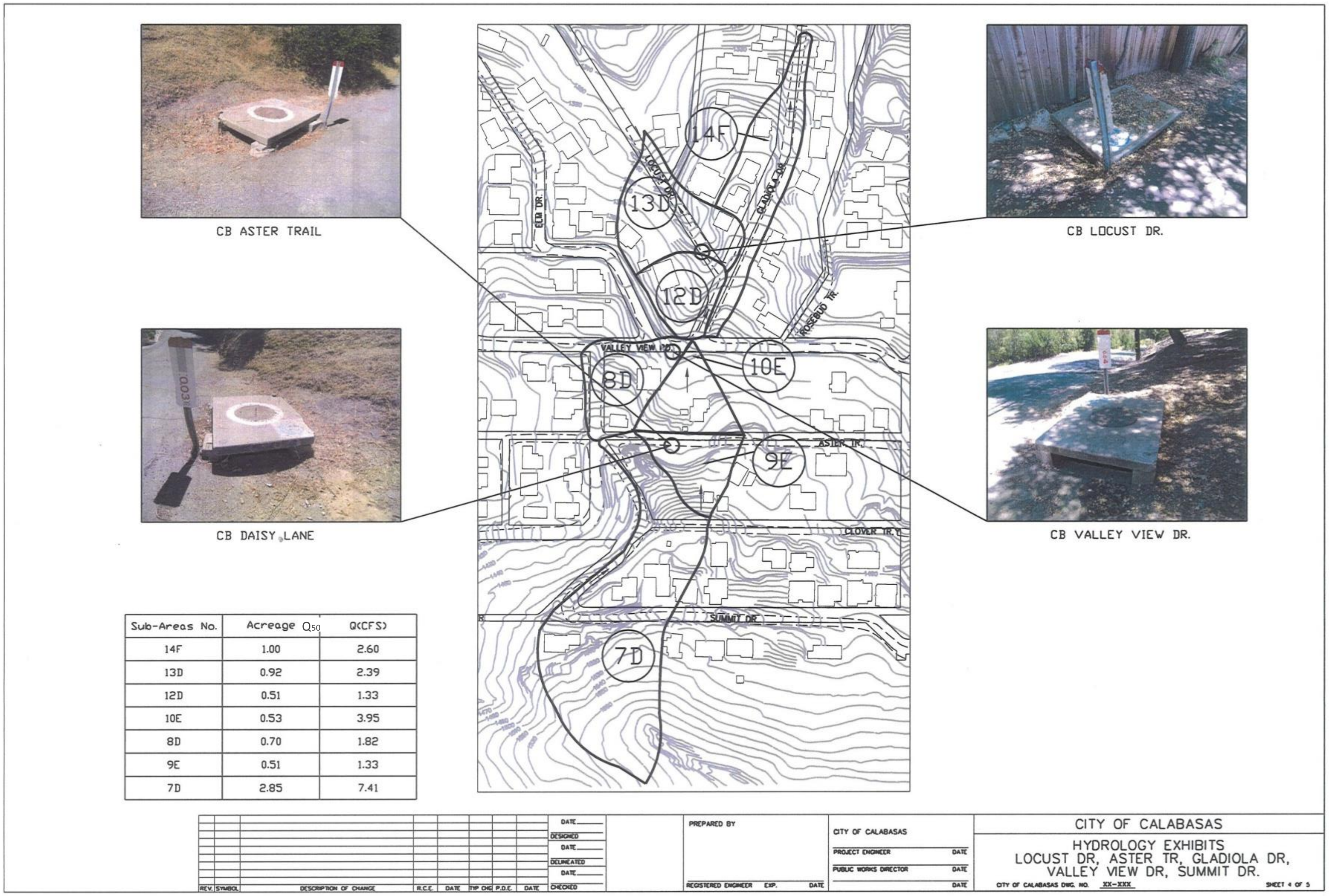
Sub-Areas No.	Acreage	Q_{50} (CFS)
6B	2.04	5.30
4C	2.87	7.87
2B	0.99	2.57
1A	2.09	5.43
3B	0.25	0.65

FIGURE 3.9.C1. **Q50 FOR LILAC TRAIL SUB WATERSHED.**



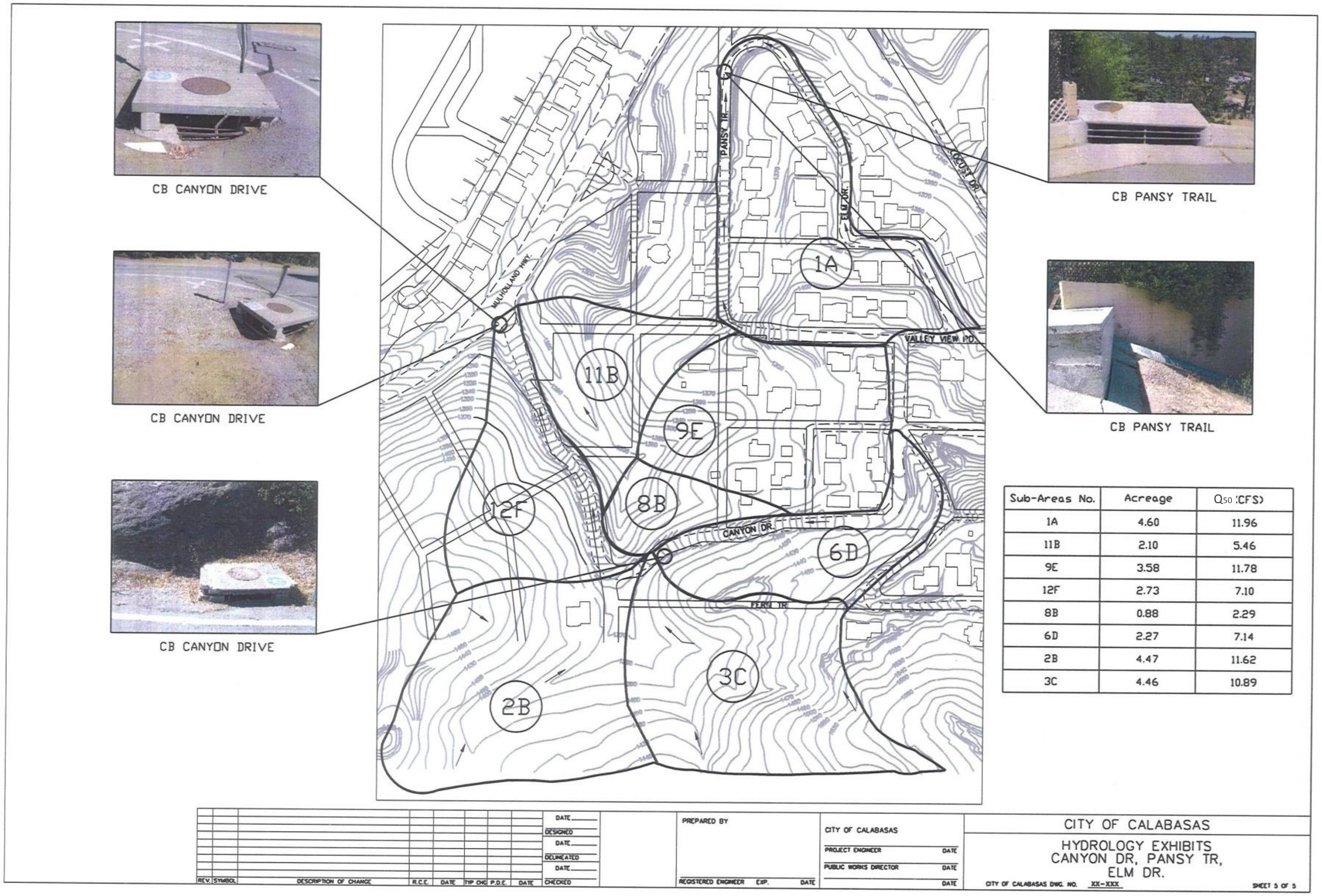
Sub-Areas No.	Acreage	Q_{50} CFS)
14A	2.10	5.46
12D	1.32	2.29
15E	2.29	1.98
16F	0.49	1.27
11D	0.95	3.77
8B	1.07	2.78
7B	2.47	7.65
5C	1.90	4.92
3B	1.32	3.43
4C	3.42	8.89
2B	2.05	5.33
1A	2.60	6.76

FIGURE 3.9.C2. **Q_{50} FOR ORCHID TRAIL SUB WATERSHED.**



Sub-Areas No.	Acreage Q_{50}	Q(CFS)
14F	1.00	2.60
13D	0.92	2.39
12D	0.51	1.33
10E	0.53	3.95
8D	0.70	1.82
9E	0.51	1.33
7D	2.85	7.41

FIGURE 3.9.C3. **Q_{50} FOR SUMMIT DRIVE SUB WATERSHED.**



Sub-Areas No.	Acreage	Q_{50} (CFS)
1A	4.60	11.96
11B	2.10	5.46
9E	3.58	11.78
12F	2.73	7.10
8B	0.88	2.29
6D	2.27	7.14
2B	4.47	11.62
3C	4.46	10.89

FIGURE 3.9.C4. **Q_{50} FOR CANYON DRIVE SUB WATERSHED.**

3.11 Detention Requirements

Detention is the attenuation of peak flows and related volumetric storage of such flows to mitigate adverse downstream impacts on storm drain systems, facilities and adjacent development. Such attenuation and related storage may be accomplished specifically by basins, pipes and other subsurface structures. Detention systems may differ in design but are related in the premise of accepting inlet flows from a specific drainage area and regulating the release of such flows to an allowable outflow by way of an outlet control mechanism. Such mechanisms include but are not limited to weirs, orifices and other diversion structures. Flows in excess of the prescribed allowable outflow are temporarily stored in the detention system. Such systems have the benefit of limiting the peak flow a specific drainage area can provide to the drainage areas and facilities downstream. The effects of the extended duration of flow that this regulatory mechanism has on downstream facilities and recombination of peak flows due to such detention is typically analyzed by larger watershed studies and is beyond the scope of this Update study.

The City of Calabasas has traditionally required that a 'no-net increase' policy be applied to specific development projects. This policy is consistent with the need to mitigate a project's drainage impacts to adjacent and downstream development that is traditionally analyzed in environmental studies. The determination of the volumetric detention requirements for a given study area is based on a comparison of the existing conditions hydrology and the proposed developed condition hydrology and ensuring that the additional flows generated by development are detained on-site and released at pre-development flow rates. Additionally, larger projects tributary to County of Los Angeles drainage systems and facilities are requested to coordinate the development of their hydrologic models with the allowable runoff rates (typically in cfs/acre) allowed for their specific drainage area by County Flood Control staff. The most conservative requirement of either City or County prevails in determining the allowable runoff from a specific drainage area, and this requirement is utilized in the determination of allowable outflow and related detention requirements.

Traditionally development within the Calabasas Highlands has not been required to provide detention, according to the existing Calabasas Highlands Master Plan of Drainage. The motivations for this exemption are related to historic uncertainties surrounding the geologic structure of the Highlands area and the difficulties inherent in the implementation and maintenance of such measures by the infill-type single family development common in the community. At the time of writing of this Update study, there is an improved understanding of the nature of the geology of the Highlands area and the related delineation subsurface conditions. To date, however, no study of the cumulative effects of Highlands development on downstream systems and facilities has been completed by either the City or County staff to quantify the potential need for a detention of peak flows in the area. Pending the completion of such a study or directive change in policy from City staff the current exemption on detention policy will be upheld.

4.0 HYDRAULIC ANALYSIS

4.1 INVENTORY

The existing drainage facilities were identified from field investigations and existing plans. At the time of the field investigations each culvert was reviewed for size, material (CMP or RCP), inlet/outlet condition and approximate location. Information gathered on the storm drain systems was analyzed to determine the location and magnitude of inlet system deficiencies. No plan and/or profiles are available for the existing culverts in the project area and a topographic survey of the culvert inlet/outlet elevations was not performed.

4.2 ANALYSIS OF EXISTING IMPROVEMENTS

The present storm drain system in the Calabasas Highlands was reviewed to determine the location and magnitude of deficiencies.

Due to the lack of plan and profiles for the existing systems within the project area, certain assumptions were made:

1. Maximum allowable headwater elevations for protruding pipe inlets were assumed to occur at the edge of the roadway. For pipes with an open faced inlet the maximum headwater elevation is assumed to occur at the roadway crown.

2. Only openings that intercept drainage were considered as effective length to calculate the capacity provided by catch basins with 4-side openings.

4.2.1 STORM DRAIN FACILITIES

Storm drain inlets are used to collect runoff and discharge it into underground storm drainage system. Inlets are typically located in gutter sections, paved medians, road sides and median ditches. Inlets used in the Highlands can be divided into the following classes:

1. Grate inlets,

2. Curb-opening inlets,

3. Culvert inlets.

Grate inlets consist of an opening in a pipe, gutter or ditch covered by a grate. Curb-opening inlets are vertical openings in the curb covered by a top slab. A culvert is a closed conduit used to convey water from one area to another.

4.2.1.1 Grate Inlets

Grate inlets, as a class, perform satisfactorily over a wide range of gutter grades. Grate inlets generally lose capacity with increase in grade, but to lesser degree than curb opening inlets. The principal advantage of grate inlets is that they are installed along the road way where the water is flowing. Their principal disadvantage is that they may be clogged by floating trash or debris.

The interception capacity* of all inlet configurations increases with increasing flow rates, and inlet efficiency generally decreases with increasing flow rates. Factors affecting gutter flow also affect inlet interception capacity. The depth of water next to the curb is the major factor in the interception capacity of both grate inlets and curb-opening inlets.

The interception capacity of a grate inlet depends on the amount of water flowing over the grate, the size and the configuration of the grate and the velocity of the flow in the gutter. The efficiency of the grate is dependent on the same factors and total flow in the gutter.

Grate inlets in sag locations operate as weirs for shallow ponding depths and as orifices at greater depths. Between weir and orifice flow depths, a transition from weir to orifice occurs; dependent on the grate size (i.e. grates of larger dimension will operate as weirs to greater depths than smaller grates or grates with less opening area). The perimeter and the clear opening area of the grate and the depth of water at the curb affect inlet capacity. The capacity at a given depth can be severely affected if debris collects on the grate and reduces the effective perimeter or clear opening area.

The efficiency of inlets in passing debris is critical in sag locations because all runoff which enter the sag must be passed through the inlet. Total or partial clogging of inlets in these locations can result in hazardous ponded conditions.

The capacity of grate inlets operating as weirs is:

$$Q_i = C_w P d^{1.5}$$

Where:

P = perimeter of the grate, in ft

C_w = weir flow coefficient, 1.66

* The interception capacity is the flow intercepted by an inlet under a given set of conditions.

d = flow depth, ft

The capacity of grate inlets operating as an orifice is:

$$Q_i = C_o A_g (2gd)^{0.5}$$

Where:

$C_o = 0.67$

$A_g =$ clear opening area of the grate, ft^2

$g = 32.3\ ft/sec^2$

Based on the formula of the capacity of grate inlets operating in weir flow, the perimeter P was reduced by 50% to allow for clogging due to debris. Similarly for flow in which the grate operates in an orifice condition, the value of the clear opening area of the grate Ag was reduced by 50% for the same reason. Figures 4.2.2.1a and 4.2.2.1b are a view of the grate inlets that were observed in the Highlands

FIGURE 4.2.2.1a Grate inlet in Ivy Tr**.**

FIGURE 4.2.2.1b Grate inlet in Aster Tr.

4.2.1.2 Curb Opening Inlets

Curb opening inlets are most effective on flatter slopes, in sags, and with flows which typically carry significant amounts of floating debris. Curb-openings are less susceptible to clogging and offer little interference to traffic operation. The interception capacity of the curb-opening inlets decreases as the gutter grades steepens. Consequently, the use of curb-opening inlets is recommended in sags and on grades less than 3%.

The interception capacity of a curb-opening inlet is largely dependent on flow depth at the curb and curb-opening length and the height of the curb-opening. Effective flow depth at the curb and consequently, curb-opening inlet interception capacity and efficiency, is increased by the use of a local gutter depression at the curb-opening or a continuously depressed gutter to increase the proportion of the total flow adjacent to the curb or by use of an increased cross slope, thus decreasing the width of spread at the inlet.

Curb-opening inlets operate as weirs in sag vertical curve locations up to the ponding depth equal to the opening height. At depths above 1.4 times the opening height, the inlet operates as an orifice and between these depths, transition between weirs and orifice flow occurs. The capacity of a curb-opening inlets operating as weirs:

$$Q_i = C_w (L + 1.8W)\, d^{1.5}$$

Where:

C_w = weir flow coefficient, 2.3

L = length of curb-opening, ft

W = lateral width of depression, ft

d = depth at the curb, ft

Figure 4.2.2.2a Curb-Opening inlet in Pansy Tr.

The equation is applicable to the height of the opening plus the depth of the depression. Based on the formula of the capacity of the curb opening inlets operating as weirs, W was assumed to be 1.5 ft typical in all locations. Since there is no curb and gutter in the most locations, d is measured in the field for each facility.

For curb inlet facility, d was the equal to the height of the curb-opening while for 4-side opening inlet, d was dependent on the geometry of the catch basin itself and the effective height of the facility opening that intercepts the water. Figures 4.2.2.2a and 4.2.2.2b are examples of curb-opening inlets in the Highlands.

Figure 4.2.2.2b 4-Side Opening Inlet in Canyon Dr.

4.2.1.3 Culverts

Cross-drainage culverts allow water that is not confined to a perennial or intermittent stream channel move from one side of the road to the other without crossing the surface. The principal disadvantage of culverts is that they are expensive to install and require frequent maintenance to keep them free of debris at all times. Otherwise, they will plug up and become ineffective. Plugged culverts could cause a backup and damage the traffic surface, too.

There are two types of culvert flow:

1. Flow with inlet control
2. Flow with outlet control

Culvert flowing with inlet control means that the discharge capacity of a culvert is controlled at the culvert entrance by the depth of the headwater (HW) and the entrance geometry, including the barrel shape and cross sectional area, and the type of inlet edge. Figures 4.2.1.3a and 4.2.1.3b are examples of the culvert inlet in the Highlands.

The culvert capacity is the amount of flow a structure can convey prior to overtopping. The overtopping frequency was identified through hydrologic and hydraulic review, study of topographic maps and field investigation.

Culvert capacity was determined from HEC 5, Appendix B, Chart 2: "Head Water Depth for RCP Culverts with Inlet Control" and Chart 5: "Head Water Depth for CMP Culverts with Inlet Control".

Figure 4.2.1.3a CMP Culvert Inlet in Daisy Trail.

Figure 4.2.1.3b RCP Culvert Inlet in Canyon Drive.

4.2.3 Hydraulic Results

The actual hydraulic capacities of the storm drain inlet facilities were determined as described previously in section 4.2.2. The hydraulic analysis and results of each storm drain inlet facility are included in the following tables:

CATCH BASIN/ INLET CAPACITY

ORCHID TRAIL SUB WATERSHED

Location	Inlet #	Opening length* (ft)	Effective Opening length* (ft)	Dim. (ft)	PRM (ft)	Sump	On Grade	Capacity Required (cfs)	Capacity Provided (cfs)	Total Capacity Provided (cfs)	Bypass (cfs)
Summit Dr.@ Orchid Tr.	CB2B	8.25	8.25			X		5.33	8.90	8.90	0.0
Summit Dr. @ 150' west of Orchid Tr.	CB4C	5.50	5.50			X		8.89	10.27	10.27	0.0
Clover Tr. @ Orchid Tr.	None	-		-	-	-	-	21.34	-	-	-
Aster Tr. @ Orchid Tr.	IN7B1			3		X		28.99	57.00	57.00	0.0
Aster Tr. @ 300' east of Summit Dr.	GR7B2				10.1		X	3.37	9.65	9.65	0.0
Valley View Rd. @ Orchid Tr.	IN9AB1			3		X		30.84	40.00	40.00	0.0
Valley View Rd. @ east of Orchid Tr.	CB9AB 2	10.00	10.00	-	-	X		7.69	18.97	18.97	0.0
Valley View Dr. @ east of Rosebud Tr.	CB11D	10.00	10.00	-	-	X		6.45*	18.97	18.97	0..0
Rosebud Tr. @ northerly end	None	-		-	-	-	-	54.17	-	-	-
Rosebud Tr. @ 200' north of Valley View	IN12D			2		-	-	2.29	23.00	2.29	0.0

Table 4.2.2.1 Hydraulic Results from Orchid Tr. Sub Watershed.

* Length of opening for side opening or perimeter for multi-side inlets.

* This value is the Q_{50} from sub area 11D (3.77 cfs) plus the bypass from the node 11DE (2.68 cfs).

Location	Inlet #	Opening length* (ft)	Effective Opening length* (ft)	Dim. (ft)	PRM (ft)	Sump	On Grade	Capacity Required (cfs)	**Capacity Provided (cfs)**	Total Capacity Provided (cfs)	Bypass (cfs)
Daisy Tr. @ west of Lilac Tr.	IN2B			1.5		X		2.57	**3.50**	3.50	0.0
South of Summit Dr. @ west of lilac Tr.	CB5ABC	8.25	8.25			X		9.87	8.90	8.90	0.97
North of Summit Dr. @ west of lilac Tr.	CB5AC	11.00	8.25			X		7.62*	**8.90**	8.90	0.0
Ivy Tr. @180' north of Summit Dr.	GR5D				9.00	X		0.68	**8.61**	8.61	0.0
Summit Dr. @ Aster Tr.	None	-		-	-	-	-	7.41	**-**	-	-
Aster Tr. @ 150' east of Summit Dr.	CB8DE	11.00	8.25			X		2.57	**8.90**	8.90	0.0
Valley View Rd. @ Gladiola Dr.	CB9DE	8.25	6.88			X		6.92	4.24	4.24	2.68
Locust Dr. @ west of Gladiola Dr.	CB11DE	8.25	5.50			X		8.25	10.27	8.25	0.0
Locust Dr. (northerly end)	None	-		-	-	-	-	10.64	-	-	-
Gladiola Dr. @ 670' north of Valley View Rd.	None	-		-	-	-	-	2.60	-	-	-

Table 4.2.2.2 Hydraulic Results from Lilac Tr. Sub Watershed.

* Length of opening for side opening or perimeter for multi-side inlets.

* This value is the Q50 from the node 5AC (6.65 cfs) plus the bypass from the node 5ABC (0.97 cfs).

CATCH BASIN/ INLET CAPACITY

ELM DRIVE /PANSY TRAIL, CANYON DRIVE

Location	Inlet #	Opening Length* (ft)	Effective Opening Length* (ft)	Dim (ft)	PRM (ft)	Sump	On Grade	**Capacity Required (cfs)**	**Capacity Provided (cfs)**	**Total Capacity Provided (cfs)**	**Bypass (cfs)**
18" CMP inlet @ Canyon Dr.	CB6D	8.25	5.50			X		7.14	1.28	1.28	5.86
72" RCP inlet @ Canyon Dr.	IN4BC			6.00		X		407.14	350.00	350.00	57.14
North of Canyon Dr, East of Mulholland HWY	IN13BF			5.00		X		498.05*	180.00	180.00	318.05
Canyon Dr. @ Mulholland HWY	CB12F	13.67	9.84			X		12.96**	15.70	15.70	0.0
Pansy Dr. @ Elm Dr.	CB1A	8.00	8.00			X		11.96	34.39	34.39	0.0

Table 4.2.2.3 Hydraulic Results from Canyon Dr. and Pansy Tr. Sub Watershed.

* Length of opening for side opening or perimeter for multi-side inlets.

* This value is the Q50 at the node 13BF (440.91 cfs) plus the bypass from the node 4BC (57.14 cfs).

** This value is the Q50 from sub area 12F (7.10 cfs) plus the bypass from sub area 6D (5.86 cfs).

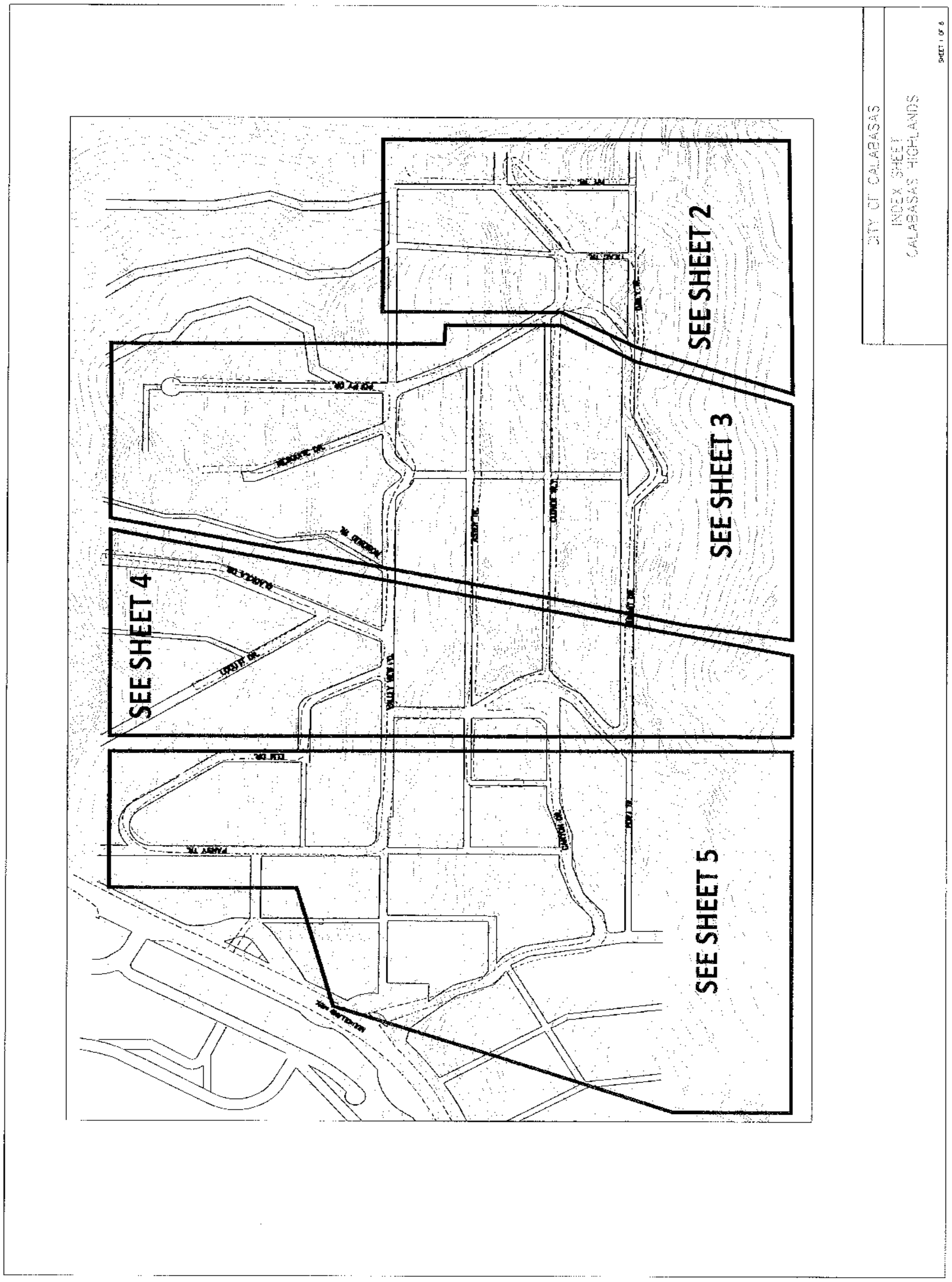


FIGURE 4.1.D1. INDEX SHEET :HIGHLANDS CATCH BASIN MAP.

SHEET 2

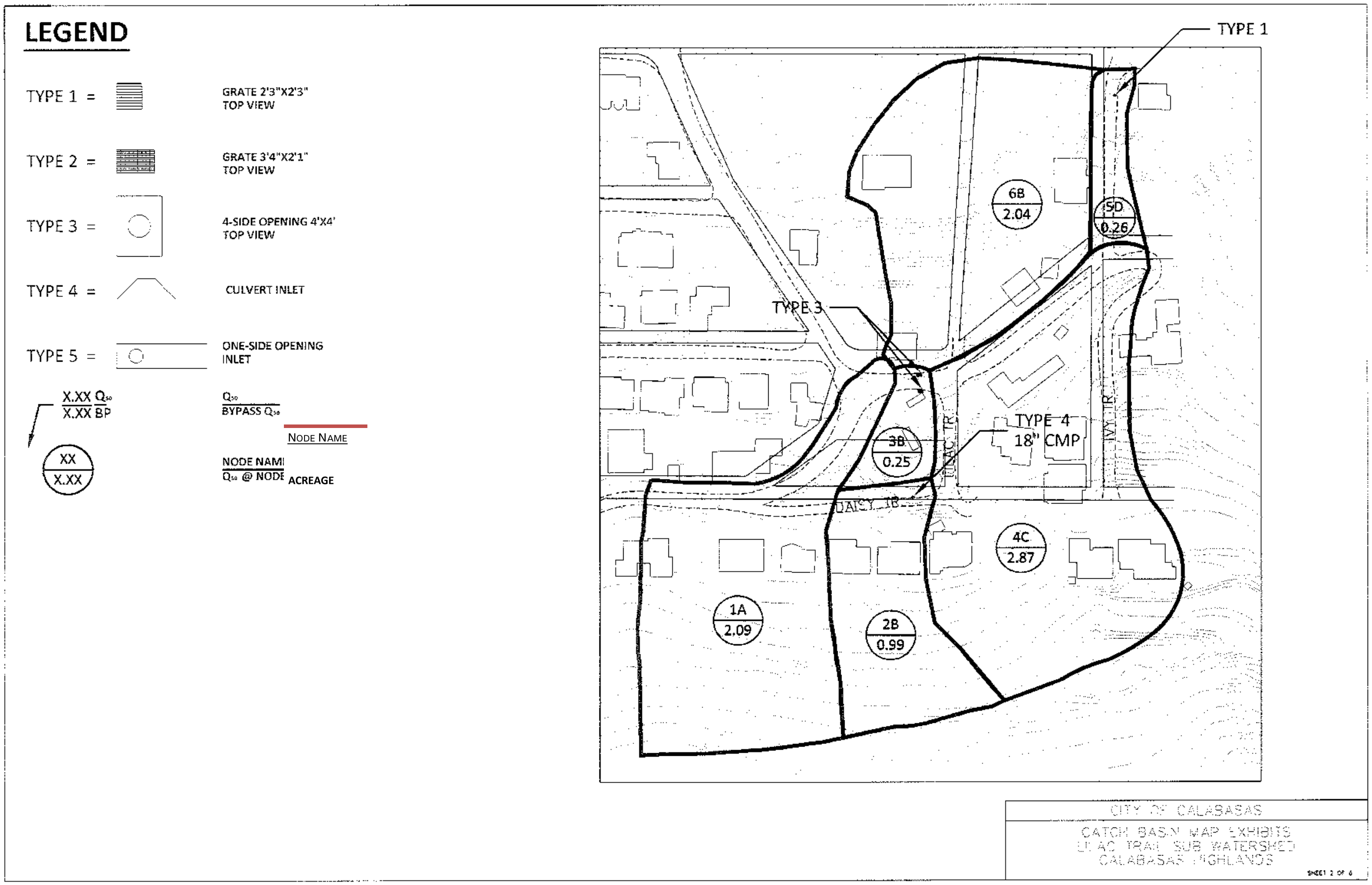


FIGURE 4.1.D2. **CATCH BASIN MAP FOR LILAC TRAIL SUB WATERSHED.**

SHEET 3

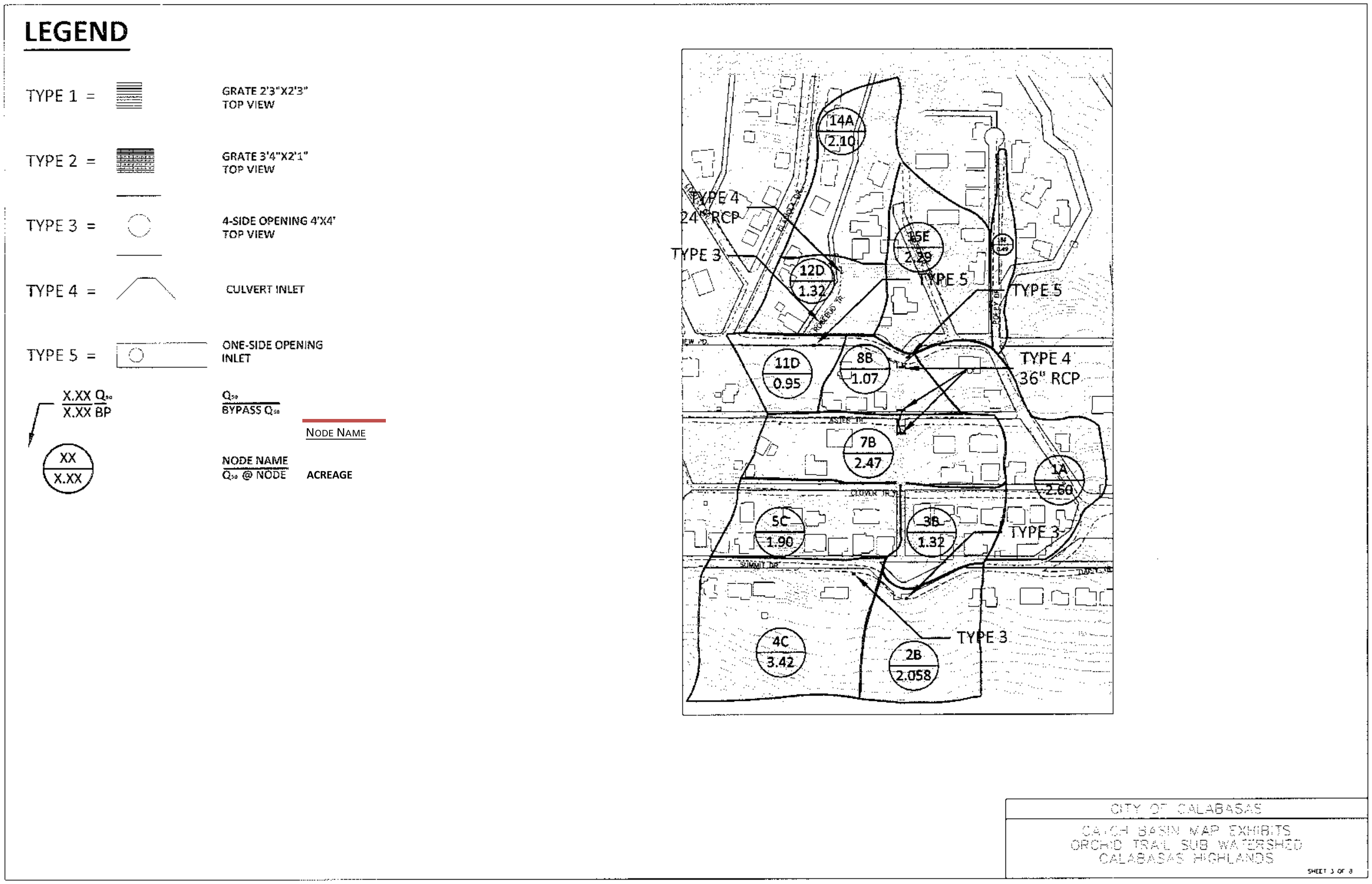


FIGURE 4.1.D3. **CATCH BASIN MAP FOR ORCHID TRAIL SUB WATERSHED.**

SHEET 4

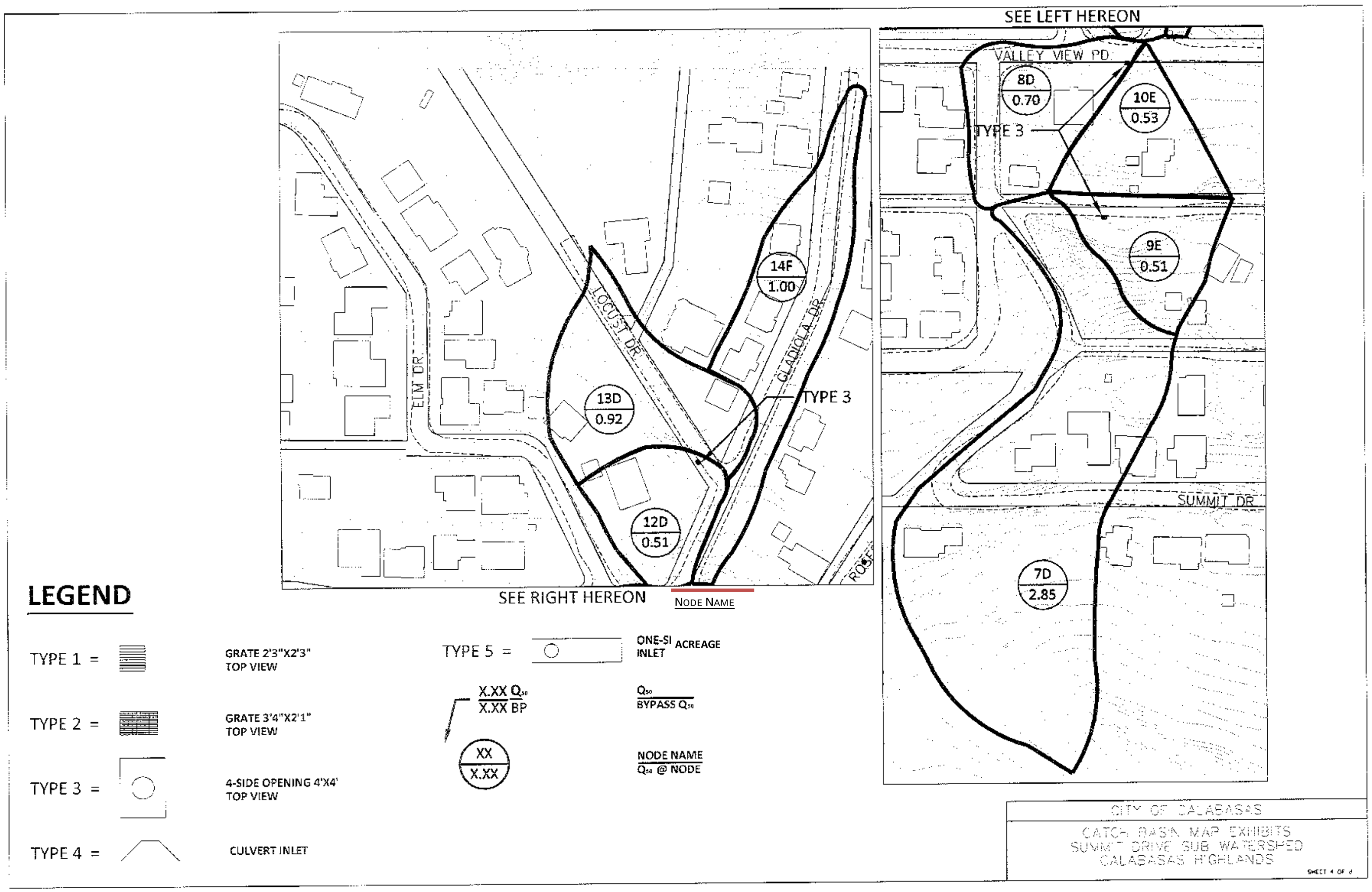


FIGURE 4.1.D4. **CATCH BASIN MAP FOR SUMMIT DRIVE SUB WATERSHED.**

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SHEET 5

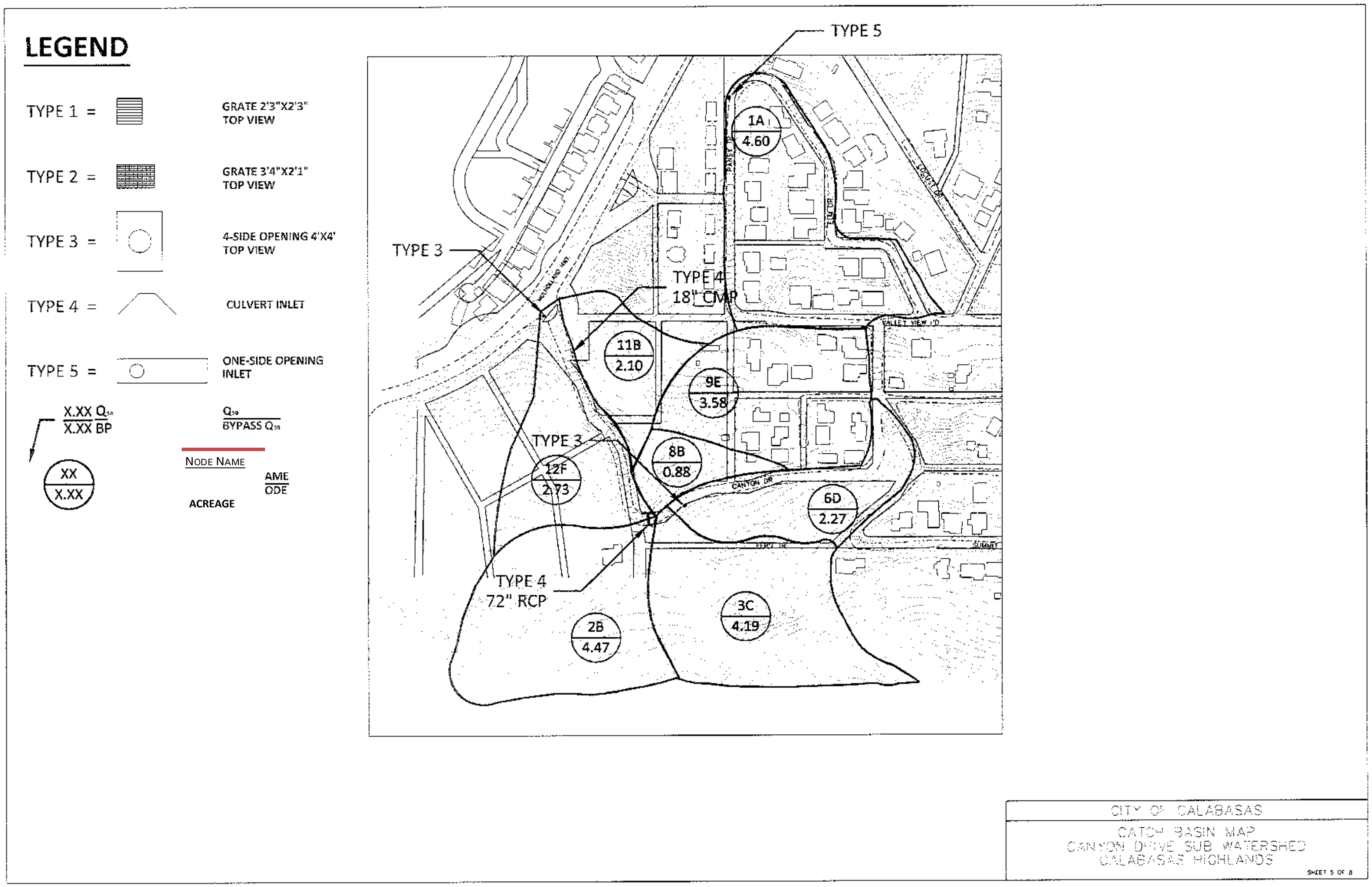


FIGURE 4.1.D5. **CATCH BASIN MAP FOR CANYON DRIVE SUB WATERSHED.**

5.0 REVIEW OF STORM DRAIN SYSTEM DEFICIENCIES

5.1 General

A deficiency review of existing storm drain facilities was completed in conjunction with the developed hydrology of drainage areas in the community, as well as the inventory of storm drain facilities and related hydraulics. The existing storm drain facilities were evaluated based on their capacity to intercept and convey drainage from tributary subareas. This evaluation included a review of existing culverts, storm drain inlets and related storm drain conveyance conduits. Additionally, the review considered outlet conditions and alignment, and their effect on adjacent property and public right of way.

5.2 Analysis of Existing Deficiencies

Determinations of deficiency were based on the facilities capacity to adequately intercept, convey tributary drainage and discharge such drainage in a manner that does not create either a nuisance or a flood hazard to adjacent property. Specifically, facilities were deemed to be deficient if one or more of the following criteria were met:

1. Culverts. Deficiency exists where calculated headwater exceeds the highest point of the adjacent roadway elevation.
2. Catch Basin (Sump). Deficiency exists where calculated water surface elevation exceeds the lowest adjacent elevation which serves to confine the flow. In the case of a grated inlet, the deficiency considers 50% clogging of the grate and related water surface required to process flow under weir or orifice conditions.
3. Catch Basin (On Grade). Deficiency exists where one or more on-grade inlets are required to intercept flow in a given delineated flow path. While bypass flow is allowable, such bypass flow must be intercepted by the next inlet or series of inlets downstream. Failure of facilities either singularly or collectively to intercept tributary drainage in weir flow deems such facilities deficient.
4. Outlet Culvert Capacity. Deficiency exists where the capacity of the outlet culvert is inadequate to convey the tributary flow intercepted by upstream drainage facilities.
5. Outlet Culvert Alignment. Deficiency exists where the alignment of the culvert outlet places the facility on private property outside of the public right of way.
6. Outlet Culvert Flow Conditions. Deficiency exists where drainage which has been previously intercepted by storm drain facilities is discharged adjacent to, or in a manner which poses a nuisance to existing development. (This determination shall not apply to development or related improvements which have been intentionally constructed in or adjacent to the flow path of storm drain facility discharge.)
7. Outlet Culvert Flow Hazard. Deficiency exists where drainage which has been previously intercepted by storm drain facilities is discharged in a manner which poses a flooding hazard to existing adjacent development.

Narratives of specific storm drain facility deficiencies are provided in the paragraphs to follow. A summary of facility deficiencies is provided in Table 5.0. This Table identifies the locations of all deficient facilities within the Highlands project area and the nature of the deficiency. The deficiencies and related conditions serve as a basis for both the determination of recommended improvements and the prioritization of such improvements.

5.2.1 INTERSECTION OF VALLEY VIEW ROAD AND GLADIOLA DRIVE

This intersection is influenced by tributary Subareas 7D, 8D, 9E and 10E. The tributary drainage is intercepted by an inlet (see Figure 5.2.1d) on the south side of Valley View Road and conveyed north across Valley View by a 24″ CMP. The 24″ CMP discharges to private property located within Subarea 12D to the north of the intersection. Drainage is conveyed across this private property in a northwesterly direction and is intercepted by an inlet on Locust Drive to the north of its intersection with Gladiola Drive (see Figure 5.2.1a). The intercepted flow is then conveyed across and down Locust Drive in a northwesterly direction by an 18″ CMP. This CMP conveys drainage along the north side of Locust and discharges at an outlet (see Figure 5.2.1b).

Figure 5.2.1a Catch Basin at Locust Dr.

Figure 5.2.1b 18″CMP Outlet Pipe at Locust Dr.

This discharge is in turn intercepted by a 24″ CMP which discharges further down Locust (see Figure 5.2.1c) from which point it proceeds as sheet flow to the northwesterly terminus of Locust Drive.

The interception by the inlet of flows from tributary Subarea 12D is complicated by the vertical geometry of Locust Drive and the local grades around the inlet. The contribution of debris by adjacent oak trees further complicates the effective capacity of the facility in intercepting the upstream discharge of the 24″ CMP on Valley View and the local drainage. The 18″ and 24″ CMP's aligned on the north side of Locust Drive form a flow path which is interrupted by a mixture of public and private street and property improvements. The flow from the outlet is only partially confined to the street due to local street geometry, but will tend to diverge from public right of way based on changes in street geometry to the northwest of this outlet and the adjacent private driveway access improvements near the terminus of Locust.

Figure 5.2.1c 24″CMP Outlet at Valley View Rd.

Figure 5.2.1d 24″CMP Catch Basin at Valley View Rd.

5.2.2 CANYON DRIVE AND ELSIE DRIVE

The existing 72″ RCP culvert which traverses Canyon Drive from south to north adjacent to Elsie Drive is influenced by local Subareas 2B and 3C, as well as the larger offsite tributary areas 5A and

6A. The upstream channel is undeveloped, and the natural channel is required to abruptly transition to the upstream end of the 72″ RCP in an inlet condition which consists of a straight headwall with a combination of concrete abutment and sacked riprap (see Figure 5.2.2a). The outlet condition consists of a similarly constructed mixture of down-sloping sacked riprap and an outlet for the 72″ RCP to the natural area below.

The combination of natural channel upstream, inefficiently shaped inlet and inadequately sized conduit contribute to deficiencies in the capacity of the culvert crossing. This deficiency will lead to the ponding of headwater upstream of the inlet to the point of overtopping Canyon Drive in a 50-year event. At this point the surface of Canyon Drive will function as a weir to the overtopping flow. The combination of a ponded condition in conjunction with high velocity approach flow in the upstream channel will potentially cause the erosion of the unprotected channel around the inlet headwall and the embankment of Canyon Drive into which the headwall (concrete and sacked riprap) are embedded. Depending on the severity and duration of the flow and related scour, this deficiency may lead to the progressive failure of a portion of Canyon Drive at the crossing.

Figure 5.2.2a 72″ RCP Culvert Inlet

Figure5.2.2b 72″ RCP Culvert Outlet

5.2.3 CATCH BASIN CANYON DRIVE EAST OF ELSIE DRIVE

This facility is located on Canyon Drive just east of Elsie Drive. The facility consist of 4-sided catch basin that intercepts down-slope flow and localized street flow. The catch basin outlet is provided by 18″ CMP that crosses under Canyon Drive and outlets to the watercourse below. The combinations of factors including velocity and quantity of approaching flows, street geometry and design of the existing catch basin limit the effectiveness the existing facility to adequately intercept the tributary flows. The inadequacy of the existing facility results in

Figure 5.2.2b Inlet on Canyon Dr.

additional sheet flow across Canyon Drive, which in turn flows over the top of the embankment on the north side of the road, which in turn encourages related erosion of the slope.

5.2.4 Intersection of Lilac Trail and Summit Drive

This intersection is influenced by tributary Subareas 1A, 2B, 3B and 4C. This tributary drainage is intercepted by catch basins at the intersection, which is in turn conveyed to the north by a CMP to a point of discharge on Lilac Trail. The drainage proceeds north along an undeveloped portion of Lilac Trail, eventually converging with a natural watercourse north of the intersection with Aster Trail.

The drainage facilities located at this intersection have a history of known issues. At some point in the past, the outlet conduit from the northerly inlet was repaired and rerouted to its current outlet on Lilac Trail. The existing CMP outlet is located on private property, and appears to be broken or severely damaged. According to inspection reports, drainage backs up in the northerly inlet, overtops the asphalt berm and floods the residential property to the north on a seasonal basis. Attempts by the homeowner to protect the residence from flooding are evidenced by the installation of sandbags around the home, north of the inlet. The portion of the intercepted drainage that passes the remains of the CMP outlet conduit form the source of severe erosion in the undeveloped portion of Lilac Trail.

5.2.5 66" RCP at the Intersection of Mulholland Hwy and Canyon Drive

This facility located near the intersection of Canyon Drive and Mulholland was deemed deficient in capacity due to tributary based on quantity of approaching flow. This Update acknowledges such deficiency, but does not include recommendations for improvements. Any recommendations for future improvement of this facility must consider the effects of increases in flow on downstream system capacity. Such research and recommendations are beyond the scope of this Update study.

Figure 5.2.5a Inlet Facility with Debris Rack

Figure 5.2.5b 66" RCP Inlet

5.2.6 Summit Drive at Orchid Trail

This location is influenced by flows from Subarea 2B. The tributary drainage is partially intercepted on the south side of Summit Drive by an existing catch basin (see Figure 5.2.6a), and conveyed to an outlet on the north side of the road by an 18" CMP culvert (see Figure 5.2.6b). The outlet lateral from the southern inlet has very limited cover, as apparent in the pavement cracking at the pipe soffit. The local grades at the southerly inlet encourage surface drainage to cross Summit from south to north and flow over the top of slope in a concentrated and erosive manner. This drainage then joins a natural channel to the north of the outlet for a short distance, and merges with surface improvements constructed in conjunction with the development of single family homes on the south side of Clover Trail on either side of the Orchid Trail right of way. While the nature of the area topography encourages drainage to flow generally north, the velocity of the drainage from Subareas 2B and 3B is significant due to the elevation change between the Summit and Clover Trail facilities. The high velocity of flow, combined with the geometry of constructed improvements creates undesirable nuisance flooding of portions of the adjacent single family property.

Figure 5.2.6a Inlet and Portion of Summit Dr. Looking East

Figure 5.2.6b 18" CMP Outlet Adjacent to Summit Dr.

5.2.7 SUMMIT DRIVE WEST OF ORCHID TRAIL

This location is influenced by flows from Subarea 4C. The tributary drainage is intercepted on the south side of Summit Drive by an existing catch basin, then conveyed north by a 24" CMP. The culvert appears to be deteriorating, and the condition creates flooding and flood related issues for residences to the north. The culvert appears to daylight north of Aster Trail, but the alignment of the line remains uncertain. The outlet culvert was not installed in either public right of way or within a drainage easement, which makes repair of the conduit problematic.

Table of Deficiencies

Location	Facility	Deficient (Bulked Q50)	Deficiency Criteria
Summit Dr.@ Orchid Tr.	18″ CMP	Y	6,7
Summit Dr. 150′ west of Orchid Tr.	24″ CMP	Y	**4,5,6**
Aster Tr. @ Orchid Tr.	36″ RCP	N	
Aster Tr. @ 300′ east of Summit Dr.	18″ CMP	N	
Valley View Rd. @ Orchid Tr.	36″ RCP	N	
Valley View Rd. @ east of Orchid Tr.	18″ RCP	N	
Valley View Dr. @ east of Rosebud Tr.	18″ RCP	N	
Rosebud Tr. @ 200′ north of Valley View	24″ RCP	N	
Daisy Tr. @ west of Lilac Tr.	18″ CMP	N	
North of Summit Dr. @ west of Lilac Tr.	12″ CMP	Y	1,2,4, 5, 7
South of Summit Dr. @ west of Lilac Tr.	18″ CMP	Y	2
Ivy Tr. @ 180′ north of Summit Tr.	18″ CMP	N	
Aster Tr. @ 150′ east of Summit Dr.	18″ CMP	N	

Table 5.0 Table of Facilities and Deficiencies

Table of Deficiencies- Continued

Location	Facility	Deficient (Bulked Q50)	Deficiency Criteria
Valley View Rd. @ Gladiola Dr.	24" CMP	Y	5,6
Locust Dr. @ west of Gladiola Dr.	18" CMP	N	
North of Canyon Dr, East of Mulholland HWY	66" RCP	Y	N/A
Elsie Dr. @ Canyon Dr.	72" RCP	Y	1
Catch Basin Canyon Dr East of Elsie	18" CMP	Y	3
Canyon Dr. @ Mulholland Hwy	24" CMP	N	
Pansy Dr. @ Elm Dr.	24" CMP	N	

Table 5.0 Table of Facilities and Deficiencies

5.3 Recommended Facility and System Improvements

The following are recommendations for improvements to remedy the facility deficiencies that have been identified in the deficiency review (see attached Figures for illustrations).

5.3.1 Intersection of Valley View Rd. and Gladiola

The recommended improvement is intended to efficiently intercept drainage at Valley View Drive and conduct such drainage to an outlet at the northerly terminus of Locust Drive. The intent is to eliminate repetitive discharge and interception of drainage, and the conveyance of drainage intercepted by public facilities on private property. Specifically the recommended improvements consist of installing a new catch basin, with a curb and gutter, on the existing 24″ CMP at the south shoulder of Valley View Drive with a new 24″ RCP (54′±) extending to a storm drain manhole (SDMH) structure in Gladiola Drive slope. A new 24″ RCP (122′±) will be extending from that SDMH; along Gladiola Drive slope, to another SDMH structure at the intersection of Gladiola Drive with Locust Drive. Then, 24″ RCP (220′±) will be installed across Lot 1 and Lot 1A in Locust Drive to a new SDMH structure. At this location, two new catch basins, with curb and gutter, will be installed on both shoulders of Locust Drive (175′±from the intersection of Gladiola Drive and Locust drive) with a new lateral of 18″ RCP (15′±) extending from each catch basin to the same SDMH structure. A final section of 24″ RCP (150′±) will be installed to the existing terminus of Locust Drive, with an outlet protected by an energy dissipation structure. This structure will allow for the reduction of velocity and the dissipation of flow to existing natural channel in the vicinity of the northerly tract boundary.

5.3.2 Canyon Drive and Elsie Drive

The current deficiency is related to both the adequacy of the existing 72″ RCP culvert and the inefficiencies of the existing inlet. The recommended improvement is to increase the hydraulic capacity of the existing 72″ RCP culvert by replacement with a 96″ RCP culvert. The existing inlet structure with associated sacked rip rap should be replaced with an improved inlet/transition structure to more efficiently conduct the upstream drainage into the culvert. The construction of the inlet structure should be accompanied by local upstream channel improvements which will provide a transition from natural channel to the concrete inlet and minimize erosion of adjacent banks and channel bottom. The outlet structure will require reconstruction in conjunction with the culvert replacement. The improvements should consider both minimizing erosion at the outlet, as well as the modification of steep grade of the adjacent road embankment. This may be accomplished by the construction of a heightened upper portion of the outlet headwall, which will serve to retain embankment grades and minimize the slope grade above to 2:1 or less. The top of slope at the edge of pavement should be protected by a metal beam guardrail for vehicle traffic on Canyon Drive, and the top of headwall provided a fence of protective barrier 42″ or greater in height.

5.3.3 Catch Basin Canyon Drive East of Elsie Drive

The recommended improvements are intended to eliminate deficiencies in the existing inlet structure and surrounding grades. The improvements consist of modification of the existing inlet to more efficiently intercept tributary drainage, accompanied by upstream drainage improvements at the base of the existing slope. These improvements may consist of the local widening of the Canyon Drive shoulder and construction of a concrete interceptor ditch to collect down-slope drainage. This improvement would require the partial excavation of the existing embankment on the south side of Canyon Drive within existing right of way, accompanied by the construction of a widened shoulder, interceptor ditch and protective barrier. The modifications of the existing inlet should provide for the connection of the proposed interceptor ditch and associated drainage. The CMP outlet condition should be reviewed, and if necessary improved to minimize erosion due to the velocity and vertical drop of drainage from the existing conduit.

5.3.4 Intersection of Lilac Trail and Summit Drive

The recommended improvements involve the construction of curb, gutter, improved catch basin and storm drain conduit to an outlet structure on Lilac Trail north of Aster Trail. The intent of the improvements is to more efficiently intercept high velocity sheet flow, abandon an existing damaged outlet conduit on private property, relieve flooding to adjacent single family dwelling and eliminate the erosion of Lilac Trail due to the existing outlet. Specifically, the recommended improvements consist of installing two new catch basins with curb and gutter on the existing 18″ CMP at both shoulders, north and south, of Summit Drive with new laterals of 18″ RCP, (13′±) SE from the north catch basin and (20′±) NE from the south catch basin, extending to a new manhole structure in the Summit Drive slope, then a new 24″ RCP (21′±) extending east of Summit Dr. will make a turn to the north, with (R=22.5′±) and (L=33′(±) to a new storm drain manhole (SDMH) structure in the Lilac Trail slope, then 24″ RCP (184′±) extending north across (Lot1, Lot2, Lot7, Block 7), and (Lot 2, Block 8) to another SDMH structure. A final section of 24″ RCP (50′±) will be installed from that SDMH to an outlet protected by an energy dissipation structure. This structure will allow for the reduction of velocity and the dissipation of flow to existing natural channel to the north of Aster Trail.

5.3.5 66" RCP at the Intersection of Mulholland Hwy and Canyon Drive

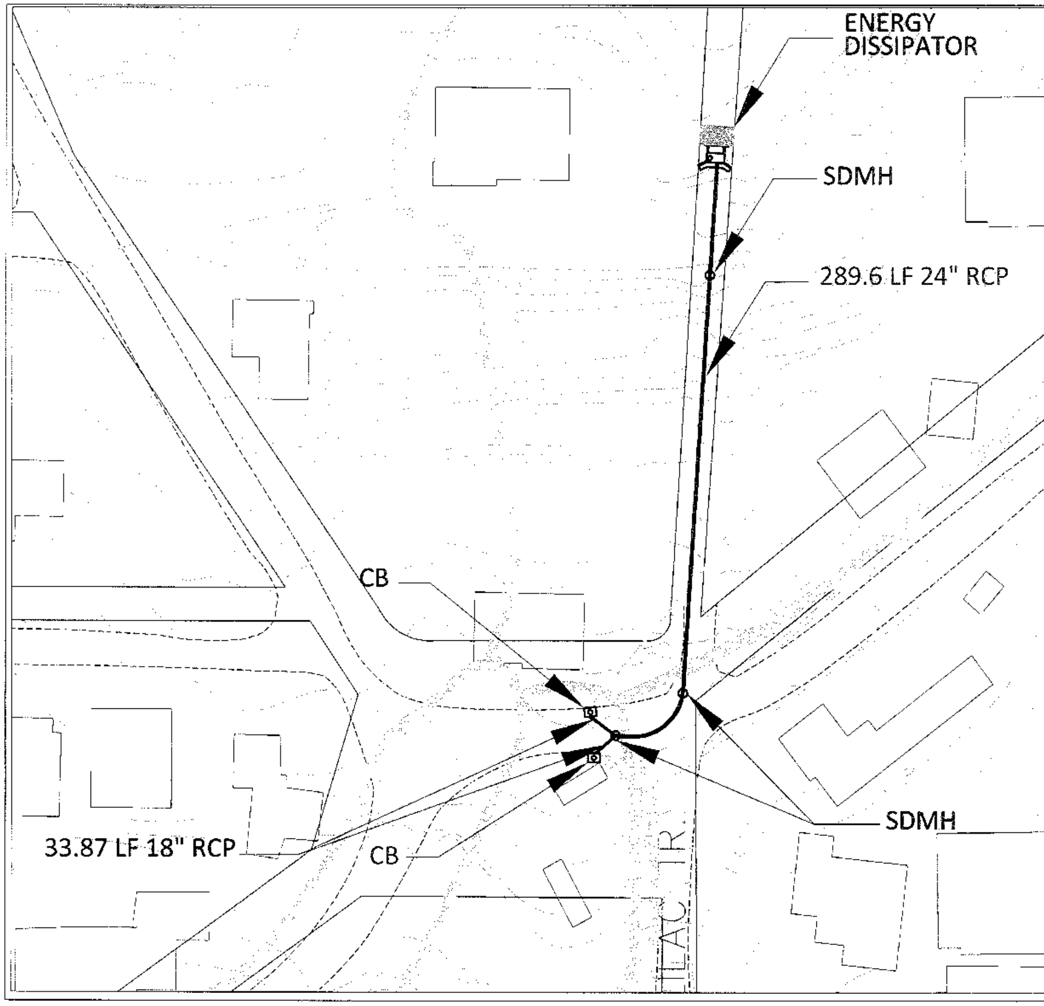
No improvements are recommended at this time.

5.3.6 Summit Drive at Orchid Trail

The recommended improvements involve the construction of drainage collection and conveyance facilities in the vicinity of the intersection. Due to the issues identified with existing overland flow patterns and hazards, the conveyance of existing surface flow to underground conduits is central to the recommended improvements. Due to the proximity of the deficiencies identified to the facilities to the west, the recommendations for Summit Drive west of Orchid Trail will be included in these recommendations. Specifically, the recommended improvements anticipate the installation of a new catch basin with related curb and gutter at the north shoulder of Summit Drive, which will in turn be connected with a new 24″ RCP outlet. The 24″ RCP will be routed in a radius to convey flow to a prolongation of the Orchid Trail right of way. To the west the existing inlet will be provided a new outlet which will be installed within existing Summit right of way. This outlet lateral is anticipated to be an 18″ RCP, which will turn through a 90 degree radius and extend to the existing Orchid Trail right of way by way of a portion of undeveloped Summit Drive right of way. This lateral will connect with the aforementioned 24″ RCP at a junction structure, from where it will be conveyed north to an outlet beyond Clover Trail in the existing gabion structure in Orchid Trail. Existing improvements within the Orchid Trail right of way will be removed and replaced as appropriate, and temporary catch basins to intercept interim undeveloped flows from adjacent lots will be constructed.

A condition to the alignment reflected in these recommendations is the conveyance to the City of a drainage easement for a portion of affected property south of the existing 'paper' Summit Drive right of way and the existing developed right of way. It is anticipated that future development may occur in the context of the existing undeveloped parcels adjacent to the Summit/Orchid right of way, and it is likely that both rights and construction may be accomplished at such time. This recommendation is a modification to a similar concept noted in the previous Highlands Master Plan of Drainage.

Intersection of Lilac Trail and Summit Drive



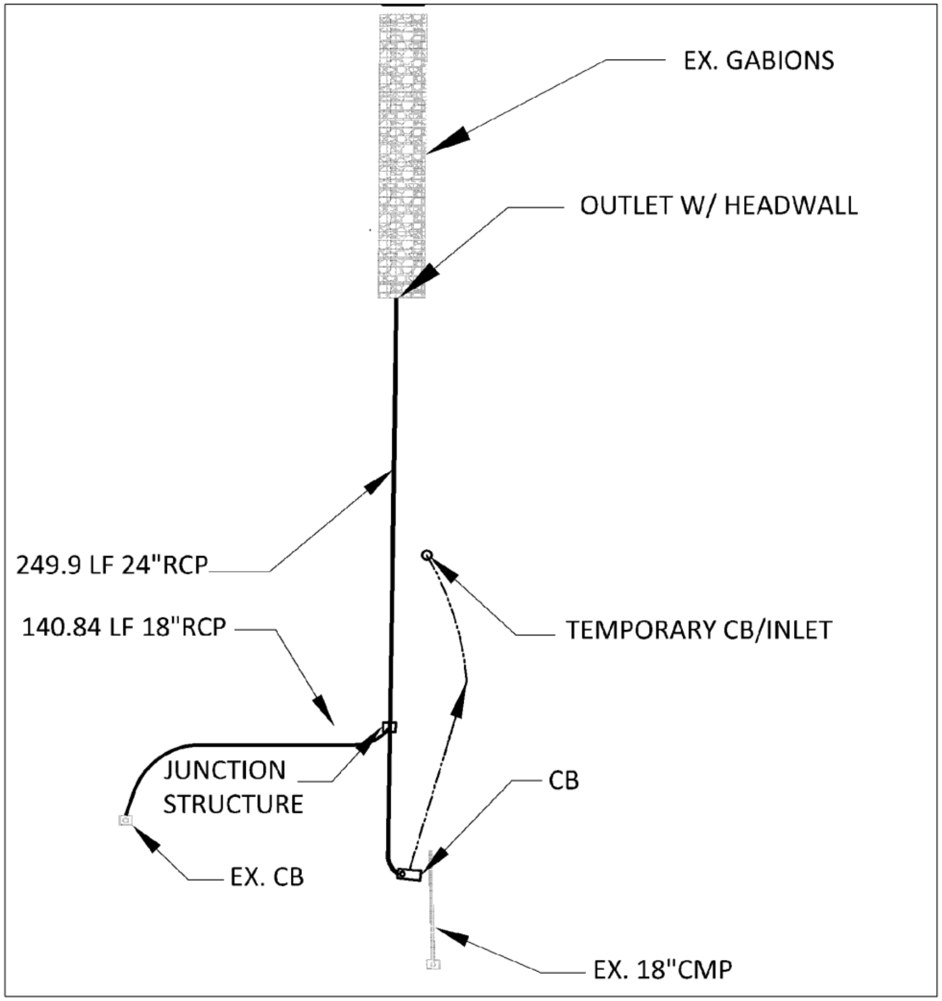
QUANTITIES

Item	Quantity	UNIT	DESCRIPTION
1	1	Each	Energy Dissipator
2	289.60	LF	24" RCP
3	33.87	LF	18" RCP
4	3	Each	SDMH
5	2	Each	Catch Basin

CITY OF CALABASAS
PROPOSED STORM DRAIN IMPROVEMENT EXHIBITS
LILAC TRAIL SUB WATERSHED
CALABASAS HIGHLANDS

FIGURE 5.3.E1. **PROPOSED STORM DRAIN FOR LILAC TRAIL SUB WATERSHED.**

Summit Drive at Orchid Trail



QUANTITIES

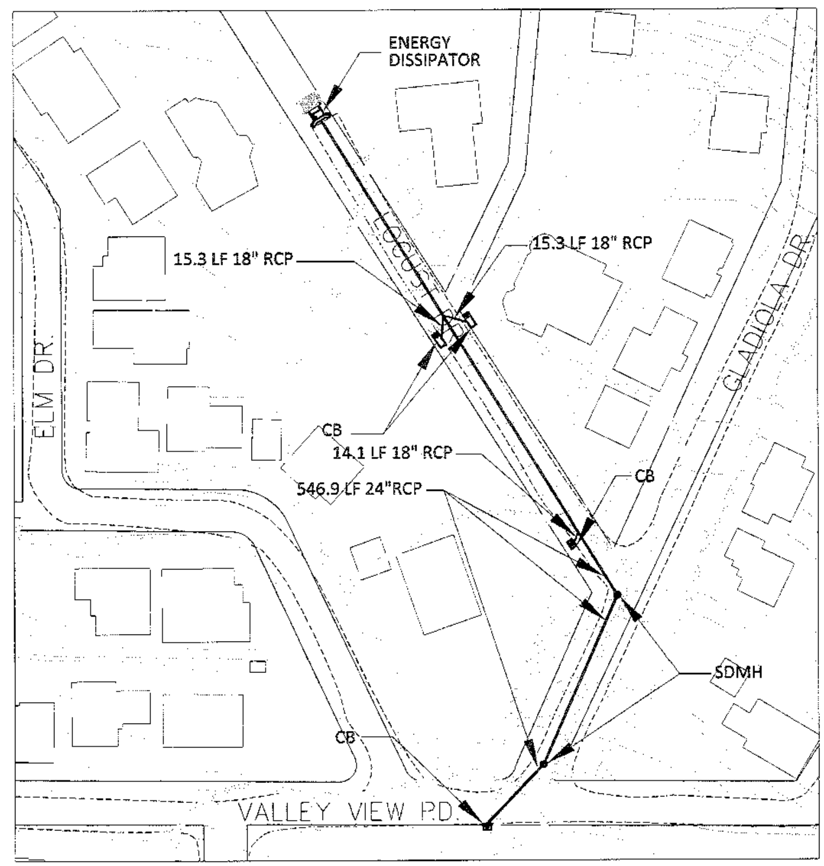
Item	Quantity	Unit	Description
1	1	Each	Junction Structure
2	250	LF	24' RCP
3	141	LF	18' RCP
4	1	Each	Catch Basin

CITY OF CALABASAS

PROPOSED STORM DRAIN IMPROVEMENT EXHIBITS
ORCHID TRAIL SUB WATERSHED
CALABASAS HIGHLANDS

FIGURE 5.3.E2. **PROPOSED STORM DRAIN FOR ORCHID TRAIL SUB WATERSHED.**

Intersection of Valley View Rd. and Gladiola

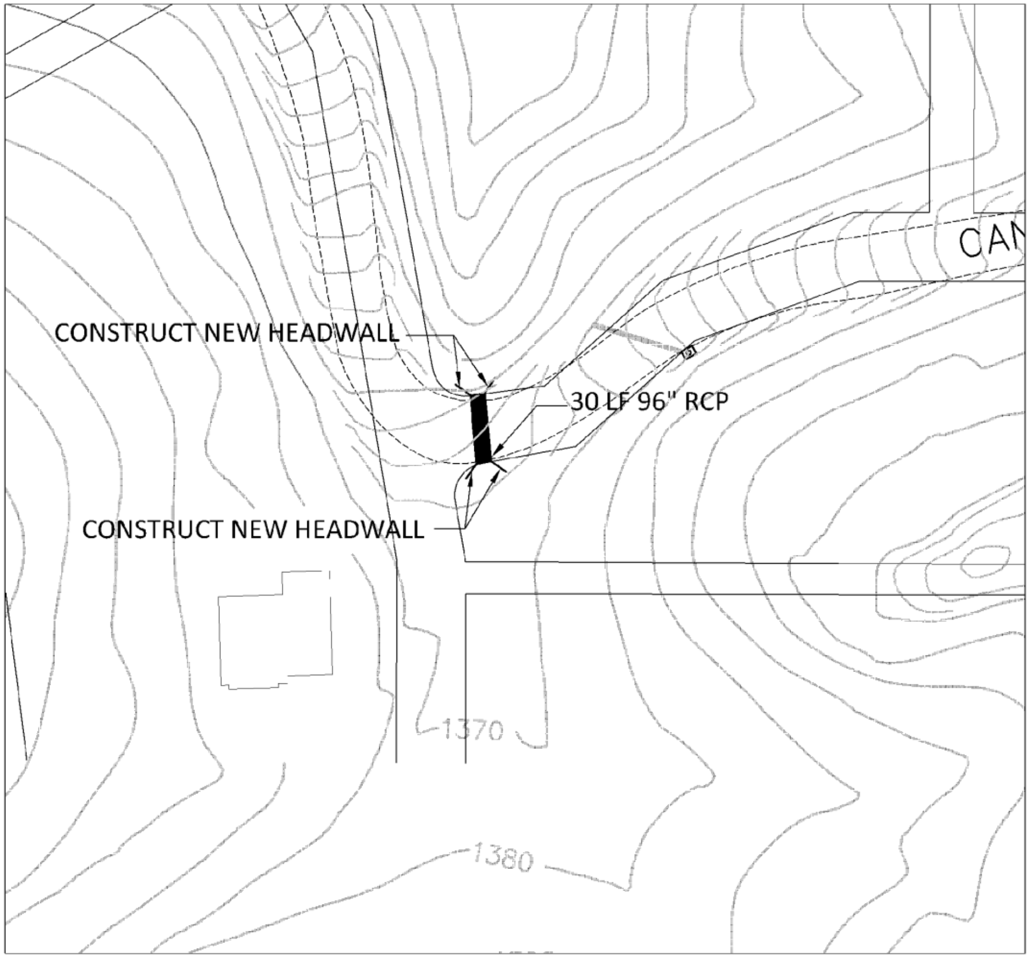


QUANTITIES			
Item	Quantity	UNIT	DESCRIPTION
1	1	Each	Energy Dissipator
2	546.9	LF	24" RCP
3	45.8	LF	18" RCP
4	23	Each	SDMH
5	4	Each	Catch Basin

CITY OF CALABASAS
PROPOSED STORM DRAIN IMPROVEMENT EXHIBITS
SUMMIT DRIVE SUB WATERSHED
CALABASAS HIGHLANDS

FIGURE 5.3.E3. **PROPOSED STORM DRAIN FOR SUMMIT DRIVE SUB WATERSHED.**

Canyon Drive and Elsie Drive



QUANTITY			
Item	Quantity	Unit	Description
1	2	EACH	Headwall
2	30	LF	96" RCP

CITY OF CALABASAS

PROPOSED STORM DRAIN IMPROVEMENT EXHIBITS
CANYON DRIVE SUB WATERSHED
CALABASAS HIGHLANDS

FIGURE 5.3.E4. **PROPOSED STORM DRAIN FOR CANYON DRIVE WATERSHED.**

5.4 Summary

5.4.1 Project Prioritization Considerations

Based on the review of facilities and definition of deficiency criteria, the facilities and related recommendations for improvements were prioritized. The establishment of priorities was based on the following considerations, in order of importance:

1. Flow Hazard to Residential Dwelling;
2. Flow Nuisance Affecting Private Property or Accessory Structure (Non-Habitable);
3. Facility Location/Alignment Deficiency;
4. General Facility Deficiency;
5. Other Factors of Necessity or Convenience as Determined by the City Engineer.

These considerations should be considered as guidelines for decision making in the prioritization of projects. Many of the facilities reviewed in this Update study contained multiple criteria that qualify the facility for recommended improvements, and also meet multiple items contained in the above considerations.

5.4.2 Prioritized Projects

Based on the above considerations, and tabulated facility deficiencies, the following projects are recommended for priority in implementation:

1. Intersection of Lilac Trail and Summit Drive
2. Summit Drive and Orchid Trail (2 Projects)
3. Valley View and Gladiola
4. Canyon Drive and Elsie Drive (Culvert Crossing)
5. Canyon Drive East of Elsie Drive

Note that actual project development and construction is based on the availability of access (through easement or right of way), availability of funding and considerations of adjacent development. Ultimate programming of recommended improvements is at the sole discretion of the City Engineer.

5.4.3 Funding

Currently the development of infrastructure repair or construction projects are based on the availability of funding. There is currently no benefit assessment district or other means of providing direct funding of projects within a specific drainage area. Funds are allocated at the discretion of the City Council, considering the recommendations of the City Engineer. As such, the timing of implementation of a specific prioritized project is based on the availability of sufficient funds from the City's budget.