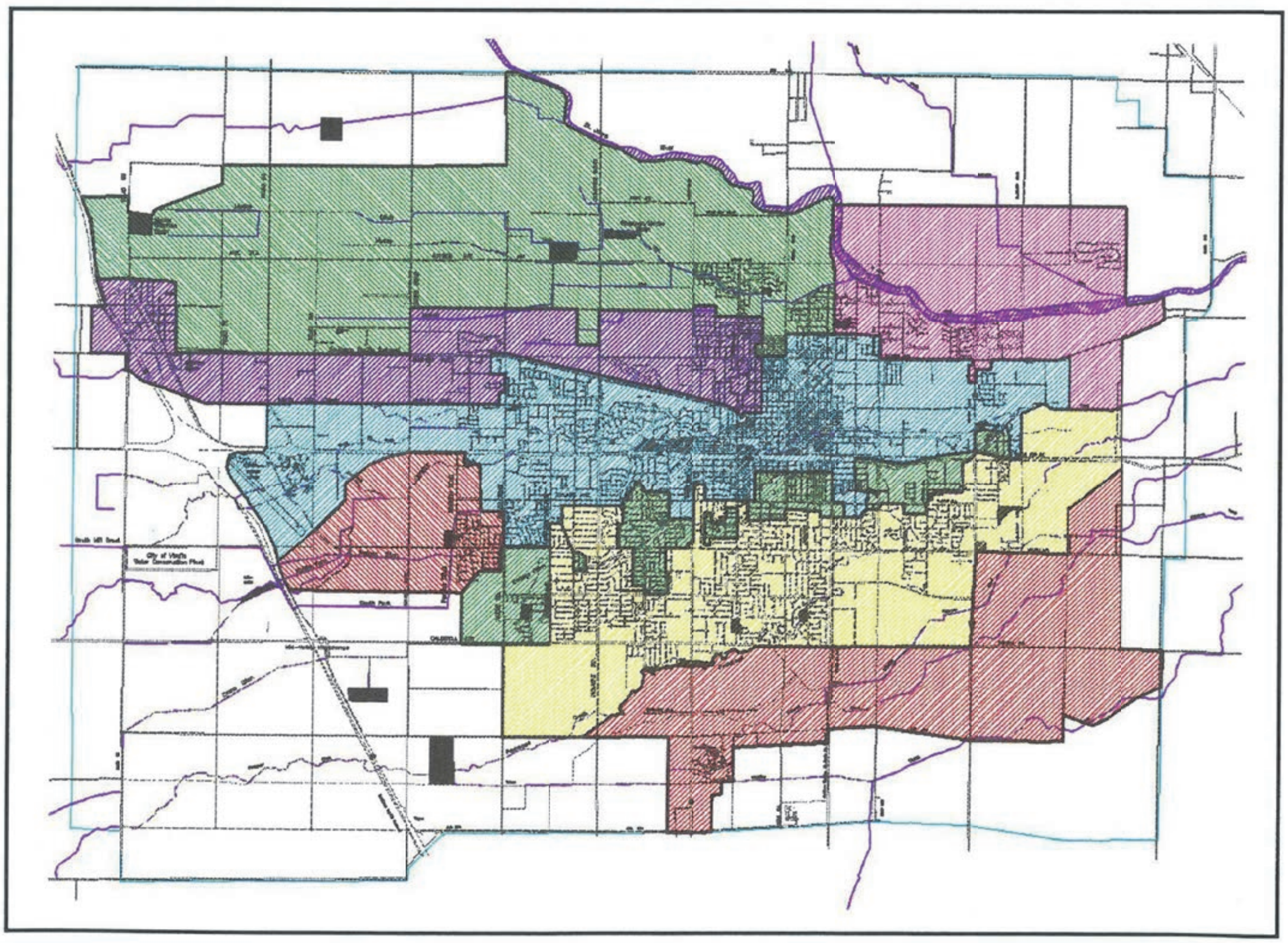
City of Visalia

Storm Water Master Plan
and Management Program

VOLUME 1
STORM WATER MASTER PLAN



Boyle Engineering Corporation

City of Visalia
Storm Water Master Plan
and
Management Program

STORM WATER MASTER PLAN

Final Report

September 1994

REGISTERED PROFESSIONAL ENGINEER
KENNETH V. LEWIS
No. C47532
Exp. 6/96
CIVIL
STATE OF CALIFORNIA

PREFACE

In July, 1991, the City of Visalia contracted with Boyle Engineering Corporation to review and update a Storm Water Master Plan developed in 1987 and develop a computerized Facility Management System for the entire City. The results of the study are presented in the following documents:

Storm Water Master Plan	Contains a discussion of the existing conditions, basis of design, alternatives, proposed improvements including cost estimates, a capital improvement plan and water quality measures.
Basin Reports	Contains all reports generated by the Storm Water Facilities Management System.
Storm Water Atlas Sheets	Provides digitized maps of existing storm water facilities.
User's Manual	Documents the use of the Storm Water Facilities Management System.

This document is the **Storm Water Master Plan.**

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1. INTRODUCTION

BACKGROUND

In September of 1991, the City of Visalia adopted an updated Land Use Element (LUE) to its General Plan. The updated LUE established development boundaries for the community (through the year 2020) and the distribution of residential, commercial, industrial, open space, and institutional uses within those boundaries. To ensure that development of the planned land uses is not restricted by infrastructure constraints, the LUE (also referred to as the 2020 Plan) contains a specific policy pertaining to the preparation of an update of the City's Storm Drainage Master Plan (as well as other master plans). Policy 5.1.1 of the LUE states "Update the Wastewater Treatment Plant Master Plan, Storm Drainage Master, Plan, and the Circulation Element and any other specific or master plans related to infrastructure development on a periodic basis."

OVERVIEW

Visalia has developed from agricultural land on an alluvial fan with ill defined drainage. Historically, runoff has been disposed of by directing it to the natural creeks/rivers and irrigation ditches that flow through the City. However, the irrigation companies responsible for the operation and maintenance of many of the channels have refused to accept additional storm runoff from the City, citing their inability to handle the flows downstream as the channels narrow and lose capacity. The policy change on the part of the irrigation companies has caused the City to reevaluate their storm water facilities and policies.

The City has recently entered into agreements with the private companies that own and operate the ditches that run through the City and the Districts that operate Packwood Creek and Mill Creek. These agreements establish the conditions under which the City can discharge storm water into the channels and define the City's maintenance responsibilities.

Visalia is growing. As land use changes from agriculture and native lands to urban, storm runoff increases. The additional runoff associated with development will further tax existing storm water facilities. Currently the City is requiring developers to build temporary drainage basins to detain their storm runoff for later disposal. It is the intent that the land utilized for the temporary basins be reclaimed and developed.

The City has experienced flooding from two sources. The first is major flooding caused by runoff on the 500 square mile watershed of the Kaweah River. This source of flooding is currently controlled by Terminus Dam up to flood events expected to occur on average once in fifty years. Consideration for additional flood protection to the City from the Kaweah River Watershed is not part of this study.

The second source of flooding, which is far less severe, occurs when local rainfall exceeds the level of protection that existing drainage facilities provide. This study addresses alternatives to mitigate flooding from local rainfall and builds on the prior master plan developed in 1987. Some elements from the prior plan have been adopted after careful review and in other cases, an alternative concept for drainage improvements has been developed in conjunction with City staff.

1987 PLAN

In 1987, the City of Visalia adopted a Storm Water Master Plan prepared by James Montgomery Engineers and Michael Knopf and Associates. The 1987 Plan encompassed approximately 17,000 acres, including 4,500 acres of undeveloped land that was designated for development within the City's Urban Improvement Boundary (prior to the 1991 update of the LUE). The "industrial park" area in northwest Visalia was not included in the 1987 Plan. The 1987 plan addressed existing and future drainage conditions and evaluated a wide range of improvement alternatives including multiple use storage basins within the City, upstream storage basins to decrease runoff entering the City and downstream improvements to fully utilize the conveyance capacity of channels through the City. The plan recommended remedial measures to correct existing inadequate conditions, conveyance facilities to accommodate runoff generated by new development and the provision of additional storage to mitigate the downstream impact of increased runoff from new development. Probable cost estimates for the proposed improvements were developed as summarized in Table 1-1.

Table 1-1 1987 Plan Improvement Cost Summary (1987 $)

	St. John's	Modoc Ditch	Mill Creek	Packwood Creek	Evans Ditch	Total
City Storage Basins	1,651,785	961,705	7,662,062	10,755,494	606,300	$21,637,346
Piping	637,160	168,900	1,176,080	1,957,550	234,080	$4,173,770
Pump Stations	65,000	15,000	85,000	137,500	39,500	$342,000
Channel Improvements			100,000			$100,000
Contingency @ 20%	470,789	229,121	1,804,628	2,570,109	175,976	$5,250,623
Total Basin	2,824,734	1,374,726	10,827,770	15,420,653	1,055,856	$31,503,739
Outside City Storage						$3,694,906
Contingency @ 20%						$738,981
Total Project Cost						$35,937,626

Of the total costs, about $6 million were required to alleviate existing deficiencies in Mill Creek Basin and the remainder to provide facilities to accommodate runoff from new development. Over 80% of construction costs (about $21.6 million) were for the construction of City storage basins, the majority of which were designated for multiple use "park-ponds". Their cost includes about $10 million for landscaping.

Implementation of the plan was based on the City's ability to assess storm water impact fees from new development. Based on a total undeveloped impervious area of 1453 acres, the impact fee for drainage costs are summarized in Table 1-2.

Table 1-2 1987 Plan Impact Fees Per Net Acre

	New Development ($/acre)	All Development ($/acre)
Total Construction Cost	$30,019,249	$35,937,626
Parks - Open Land	1,379	1,649
Schools - Developed Parks	5,509	6,595
Residential - Low Density	8,264	9,893
Residential - High Density	11,019	13,191
Commercial - Small Industrial	16,528	19,786

1992 PLAN UPDATE

In 1991 Boyle Engineering Corporation was hired to update the existing Master Plan and extend the study area to the 2020 Urban Development Boundary which encompasses approximately 35,000 acres. The plan is basically an extension of the 1987 plan. For conformity, the same report layout, design criteria and alternatives reviewed have been generally adopted. Relevant sections of the prior plan have been included in this report in order for this report to be self contained. Some design methodologies and proposed improvements have been changed to reflect current conditions. These include:

- More detailed mapping of the existing drainage system and associated drainage boundaries resulted in changes to some of the drainage basins. As part of the project, all existing storm drains were digitized and Storm Water Atlas Sheets were delivered.

- Uniform hydrologic parameters were developed to enable consistent results and to make use of Geographic Information System (GIS) modeling techniques.

- A more detailed analysis of the conveyance capacity of the major drainageways was accomplished using City surveyed cross-sections.

- The 1987 Plan divided the study area into five drainage basins: St. John's River, Modoc Ditch, Mill Creek, Evans Ditch and Packwood Creek. This plan includes additional basins: Cameron Creek, Goshen and Persian Watson.

It should be noted that the 1987 Master Plan included a frequency analysis of significant rainfall events (in Visalia) and coincident flows in the channels that receive City storm water discharges. The results of this analysis indicated that large rainfall events coincided with small flows and small rainfall events coincided with large flows. Based on these results, it was determined that the "worst case" design condition for the major drainage channels was the 50-year, 1-day rainfall event with no coincident flows. This meant that full capacity of the receiving channels would be available to accommodate City discharges during the 50-year rainfall event.

The updated plan, however did not consider the concept of "conditional probability" for rainfall in Visalia and coincident flows in the receiving channels. The updated plan separates the occurrence of City storm water runoff discharges from the occurrence of flows in the receiving channels and analyzes them as two distinct, although related, events. Nevertheless, the updated plan is consistent with the 1987 plan in terms of the hydrologic/hydraulic analysis methodology. The 1987 plan and the update plan both determined the peak City discharges to the receiving channels for a design rainfall event and compared those discharges with existing channel capacities. There are, however, concerns that coincident flows in the receiving channels could reduce the capacity that is available to accommodate City discharges. In response to these concerns, the updated plan reviewed historic channel flows and water right entitlements, and developed alternatives for managing coincident flows.

STUDY SCOPE AND LIMITATIONS

The study area, shown in **Exhibit 1**, includes the existing town and area planned for development through the year 2020. The study area has been divided into 8 major drainage basins and improvements have been planned for the **major drainage system** managing runoff for these basins. Systems to collect and convey runoff to the major drainage system are the **minor drainage system.** Minor systems have been analyzed for undeveloped areas.

This study has been conducted to provide City officials with a planning tool for future drainage improvements. The location and size of new facilities presented have been developed to enable reasonable solutions and cost estimates to be generated. The exact sizes, locations, alignments, materials, slopes, shapes and other details will need to be addressed in the engineering design of any new facilities.

REPORT ORGANIZATION

1. Introduction	Presents the study background, a summary of the 1987 Plan and the report scope and limitations.
2. Existing Conditions	Provides an overview of the City's storm water system including descriptions of each major basin.
3. Basis of Design	Describes the hydrologic and hydraulic models, available data and modeling approach.
4. Storm Water Management Alternatives	Evaluates the major alternatives considered for the City's Storm Water Master Plan.
5. Entitlement Flow Management Alternatives	Evaluates the concepts of storage and diversion of entitlement flows to provide additional capacity for storm water runoff.
6. Proposed Improvements	Provides a discussion of the proposed facilities.
7. Cost Estimates and Capital Improvement Plan	Provides a summary of the cost for proposed improvements and a capital improvement plan.
8. Financing	Discusses financing the drainage improvements.
9. Water Quality Measures	Discusses measures that can be taken to improve the quality of storm water discharge.

2. EXISTING CONDITIONS

DRAINAGE SYSTEM

Runoff from the study area drains to either St. John's River, Modoc Ditch, Mill Creek, Evans Ditch or Packwood Creek and will in the future also drain to Cameron Creek and the Persian/Watson Ditch system and Goshen Drain. These drainage ways are considered to be the major drains for Visalia and each establishes a major drainage basin for the study area as shown in **Exhibit 1.** In some cases, runoff discharges directly to the major drains and in other cases it is either pumped from storage basins or collector pipes. The 1987 Plan proposed significant use of park-ponds to store storm water runoff. Since 1987, some ponds have been constructed and others are planned.

In addition to the major drains, the City has a minor drainage system that is used to collect and convey runoff to the major drains. The minor drainage system consists primarily of catch basins and underground concrete pipes. As part of this project, all existing drains were digitized and submitted to the City on Atlas Sheets. A composite of the Atlas Sheets is provided at the back of this report as a foldout map titled "Existing Drainage System". Non graphic data associated with the digitized drains are included in reports titled "Existing Facilities" in the Basin Reports document (Volume 2).

Many drains and ditches have the joint use of conveying flood water, irrigation water and storm water. During the winter months flood control releases from Kaweah Lake make use of the major drainage ways to convey flood waters through the City. The channels and ditches are also used to convey entitled irrigation flows as shown in Table 2-1. When either irrigation or flood flows are conveyed in the drainage ways, their capacity to accept the City's storm water runoff is reduced. There are however agreements with many of the irrigation companies that allows the City to improve the conveyance capacity of the channels and ditches, or provide equivalent storage, and make use of this increased capacity for storm water conveyance.

Table 2-1 Maximum Winter Entitlement Flows

Channel	Maximum Winter (1) Entitlement (cfs)	Maximum Historic (2) Winter Flow (cfs)
Packwood Creek	265	371
Mill Creek	(3)	262
Evans Ditch	54	51
Persian/Watson	99	97
Modoc	41	79
Cameron Creek	(4)	300
St Johns River	(3)	N/A

(1) Entitlement schedule established by Kaweah and St Johns River Agreement
(2) Maximum recorded winter flow at channel headgate (since 1962)
(3) Mill Creek and St Johns River convey excess flows that are not diverted to water rights holders
(4) The Rivers Agreement does not include an entitlement flow for Cameron Creek

HISTORIC FLOODING

Analysis of flooding within and around the City of Visalia indicates floods typically occur during December, January, and February, as a result of heavy rains combined with snow melt from the foothills and the Sierra Nevada Mountains. Major floods in recent history occurred in November 1950, December 1955, December 1966, and January 1969. Prior to the construction of Terminus Dam, the major sources of flooding in Visalia have been the St. John's River and Kaweah River and its distributaries. Now the major source of flood waters in Visalia is the upstream overflows of the St. John's River and Lower Kaweah which migrate toward Visalia as overland sheet flow.

Prior to the construction of Terminus Dam, the December 1955 flood resulted in the largest peak runoff from the Kaweah River watershed. The recurrence interval of this event has been estimated to be approximately 150 years. Both the 1950 and 1955 floods caused shallow flooding in Visalia itself (less than 3 feet), but contributed to extensive damage to streets, bridges, structures, and agricultural property. The December, 1966 storms produced the largest peak flow on the Kaweah River however the flow was relatively low at McKays Point due to the control at Terminus Dam.

Terminus Dam, which has been operated for flood control by the U.S. Army Corps of Engineers since 1962 has a gross capacity of approximately 150,000 acre-feet. This dam has significantly reduced potential flood hazards of Kaweah River and its distributaries. It is currently estimated that the project provides protection against a flood which would occur on an average of about once every 50 years. Additional flood control measures have been proposed by both the U.S. Army Corps of Engineers and Tulare County Flood Control District.

CURRENT DRAINAGE PROBLEMS

The historic major flooding discussed above, relates to runoff from the Kaweah River Basin. The other source of flooding occurs when local rainfall exceeds the level of protection that existing drainage facilities provide. The lack of holding areas at many of the existing pump stations also can be a potential problem if the pumps fail to operate.

Localized street ponding, or "hot spots" are shown on **Exhibit 2**. The elimination of these problems is beyond the scope of this study. Alleviating problems from the second level of drainage problems, caused by deficient major drainage systems is the objective of this study. Typical of these problems is the Mill Creek bottleneck.

No major flooding hazards exist in Visalia from local rainfall but minor, nuisance flooding does occur. Major flooding does not occur because the City is relatively flat and although ponding occurs it does not concentrate in significant, damaging depths. There are however a number of minor or nuisance flooding areas caused by local runoff concentrations. The nuisance flooding will become more frequent as development continues and remedial measures are not taken.

DRAINAGE BASINS

With reference to **Exhibit 1**, the existing major drainage basins include:

- St. John's Basin
- Modoc Ditch Basin
- Mill Creek Basin
- Evans Ditch Basin
- Packwood Creek Basin
- Cameron Creek Basin
- Persian/Watson Basin

St. John's Drainage Basin

St. John's Drainage Basin is about 3,393 acres within the study area and is located in the northeast portion of the City. The area is partially developed and planned for further residential and commercial developments. At present about 2.3 square miles of the basin area drains to St. John's. The elevation of the river bank is higher than adjacent land elevations and runoff drains to the river via four pump stations located along the river bank.

St John's River is regulated by Kaweah and St. John's Rivers Association. The river begins at McKays Point about 12 miles east of Visalia and joins Cottonwood Creek about 3 miles west of Road 80. Cottonwood Creek continues to Tulare Lake. St. John's River has a capacity ranging from about 8,000 to 11,000 cfs (per State Reclamation Board) in the vicinity of Visalia and is currently maintained by the Kaweah Delta Water Conservation District (KDWCD).

Modoc Ditch Drainage Basin

Modoc Drainage Basin is about 8,242 acres within the study area and is located in the northern portion of the City along both sides of Modoc Ditch. The area is partially developed and runoff is pumped to the ditch via two large City pumps and three small pumps which have been installed by Tulare County. At present about 1 square mile of the developed study area drains to Modoc Ditch.

Modoc Ditch is an open channel irrigation canal that provides irrigation service to about 6,500 acres. The channel begins at the St. John's River about 1/4 mile west of Ben Maddox Way and ends west of the City at Road 68 in a terminal basin. Upstream, the flow at the headgate is controlled by Modoc Ditch Company. The channel splits several times and the capacity of the main channel decreases in capacity in the downstream direction. Current capacity ranges from 154 to 674 cfs. Downstream of Mooney Boulevard, the adjoining lands are not developed thus allowing the channel to be widened to increase its capacity.

Maximum historic flows at the headgate include 91 cfs for irrigation and 79 cfs for flood flows. The maximum winter entitlement flow is 41 cfs. The Modoc Ditch Company has maintained the channel and has refused to allow any additional runoff to the Ditch without a City operation and maintenance agreement. An agreement has recently been executed, with provisions for the City to be responsible for operation and maintenance of the ditch within the City limits.

Mill Creek Drainage Basin

Mill Creek Drainage Basin is about 6,149 acres within the study area and is nearly fully developed. This drainage area includes the downtown and other commercial, industrial and residential areas along both sides of Highway 198. Part of the runoff drains by gravity and the balance is discharged by pumping stations.

Mill Creek is a combination of lined, unlined, natural and closed conduit conveyance systems. The Creek begins at a split of the Lower Kaweah River near Road 158, flows through the City and continues to Cross Creek in Kings County. A north branch splits from the main channel near Tommy Road and also continues to Cross Creek. The channel capacity varies from 147 to 1169 cfs. The main bottleneck sections are in the City. There are significant channel expansion constraints, especially through the older established residential areas between Mooney and Akers.

Irrigation and flood flow at the headwaters are regulated by Kaweah and St. John's Rivers Association. To date, the maximum flood flow in the channel at the headworks is 262 cfs and the maximum irrigation flow is 100 cfs. While there is no direct irrigation service from the channel, it delivers water to the Evans Ditch headgate on the east side of the community and the Persian/Watson Ditch system headgate near Linwood The channel is currently maintained by KDWCD. However, upon execution of a pending agreement, the City will take over maintenance within the City limits.

Evans Ditch Drainage Basin

Evans Ditch Drainage Basin is about 1,614 acres within the study area and consists of a number of isolated areas surrounded by Packwood Creek and Mill Creek drainage areas. With only a few exceptions to the west, the basin is fully developed and drains to the Evans Ditch by pump stations.

Evans Ditch is an open irrigation canal that begins at Mill Creek near McAuliff Road and flows to Nelson Pit, then beyond to Mill Creek near the County line. The channel capacity varies from 140 to 277 cfs. There are limited expansion capabilities because most of the land along the channel is developed within the City limits.

Irrigation and flood flow at the headworks are regulated by the Evans Ditch Company. To date, the maximum flood flow at the headgate has been 60 cfs, the maximum irrigation flow 51 cfs. The maximum winter entitlement flow is also 54 cfs. Both the City and the Evans Ditch Company have a 50% share in the channel and the City maintains the channel within the City limits.

Packwood Creek Drainage Basin

Packwood Creek Drainage Basin is about 5,880 acres within the study area and drains the southern part of the City. The majority of the area is developed although areas to the east, south and west are still developing. At present about 5.3 square miles of land drains to the Creek. Areas to the east drain to Packwood Creek by gravity, and areas to the west drain by pump stations.

Packwood is an unlined and natural channel that begins at a split of the Lower Kaweah River near Road 158, flows through Tagus Basin and continues to the south-west. The channel capacity varies from 515 to over 1477 cfs. Developed areas surround the channel as it passes through the City, however the potential for channel expansion is good especially downstream of Mooney Boulevard. At the headworks, the flows are regulated by the Tulare Irrigation District, however the City maintains the channel within the City limits. Maximum historic flood flow at the headgate is 371 cfs.

Cameron Creek Drainage Basin

Cameron Creek Drainage Basin, about 4,781 acres, is located in the southern portion of the City. Nearly all the Cameron Creek watershed is presently undeveloped although significant development is planned for those portions within the 2020 UDB. No storage basins or pump stations presently exist in Cameron Creek Basin.

Cameron Creek is an open channel natural stream that historically began at Deep Creek north of Farmersville. The current origin however is at Tulare Irrigation District's main canal east of Road 156. The Creek connects back with Tulare Irrigation District's main canal on the east side of Mooney's Grove. Channel capacity varies from about 397 to 1492 cfs. Irrigation and flood flow are regulated by the Tulare Irrigation District, who also maintains the channel. At times, water is diverted from the main canal to Cameron Creek for recharge when excess water is available. The maximum historic flood flow at the origin of Cameron Creek is 300 cfs and there are no entitlement irrigation flows.

Persian/Watson Basin

The Persian Watson Basin is about 1626 acres. The channel is an open irrigation canal owned by the Persian Ditch company and the Watson Ditch Company. These companies currently maintain the channel however the City will assume the responsibility within the City limits upon execution of a pending agreement in the near future with two ditch companies. The channel starts at Mill Creek near Linwood Street. The North Fork of Persian crosses Highway 99 and terminates. The Middle and South Forks of Persian and Watson Ditch flow by Miller Basin and connect with Mill Creek or terminate. Channel capacity varies from 68 to 131 cfs. Potential for channel expansion is good as the adjacent land is mostly undeveloped. Maximum flood flow at the headgate is about 97 cfs and maximum winter entitlement flow is 99 cfs.

STORAGE BASINS

There are over 20 existing storm water storage basins in Visalia ranging in size from 2-500 acre-feet. Table 2-2 provides a summary of existing storage basin capacities. The information was obtained from the 1987 study and the City of Visalia Storm Drain System Map (April, 1989).

Table 2-2 Existing Storage Facilities

Reference No (1)	Drainage Basin	Name	Ownership	Volume (ac-ft)
S1	St John's	Ruiz Park	City	15
S2	Modoc	Fairview Village	City	14
S3	Modoc	Peltzer Basin	Modoc Ditch Co	200
S4	Modoc	Shannon/Modoc	Modoc Ditch Co	50
S23	Modoc	Terminal Basin	Modoc Ditch Co	160
S5	Goshen (2)	Doe Ave (3)	City	9
S6	Goshen (2)	Goshen (4)	City	135
S7	Mill Creek	Mill Creek Park	City	20
S8	Mill Creek	Willow Glen	City	13.5
S9	Evans	Tulare/Edison	City	43
S10	Evans	Linwood Park	City	24
S12	Evans	Nelson	KDWCD	500
S15	Evans	Pinkham Park	City	3
S14	Packwood	Riparian Pond	City	43
S16	Packwood	Blain Park	City	8
S17	Packwood	Stonebrook Park	City	50
S18	Packwood	Packwood Mooney	City	14
S19	Packwood	Costco Swale	City	2
S21	Packwood	Tagus	KDWCD	330
S11	Persian/Watson	Walnut Riparian Pond	City	39
S13	Persian/Watson	Miller	Persian/Watson Cos	N/A

(1) Refer to Existing Drainage Facilities Map
(2) Relieves Mill Creek
(3) Serves portion of industrial park
(4) Serves the community of Goshen and limited portion of City's industrial park

PUMP STATIONS

There are over 20 storm water pump stations in Visalia. Data on pump station presented in Table 2-3 was obtained from the 1987 study and the City of Visalia Storm Drain System Map (April, 1989). Maximum pumping capacity presented for each station, was determined by assuming all of the pumps could be operated at their design capacity at the same time.

Table 2-3 Existing Storm Water Pumps

Reference No (1)	Drainage Basin	Location	Pumps	Horse Power	Capacity (gpm)	Capacity (cfs)
P2	Mill	Akers	1	30	5900	13.2
P2	Mill	Akers	1	40	6800	15.2
P3	Mill	Crenshaw	1	7.5	1200	2.7
P4	Mill	Chinowth	2	20	1200	2.7
P5	Mill	Demaree	1	15	1800	4.0
P5	Mill	Demaree	1	25	2400	5.4
P5	Mill	Demaree	1	30	5900	13.2
P21	Mill	Akers & Tulare	1	24	6000	13.4
P21	Mill	Akers & Tulare	1	30	6000	13.4
P6	Modoc	N. Mooney	1	25	1800	4.0
P7	Modoc	Hwy. 63	1	25	2400	5.4
P9	St. John's	Ben Maddox	1	10	1400	3.1
P10	St. John's	Bradley	1	15	1800	4.0
P11	St. John's	Buena Vista	1	75	6400	14.3
P12	St. John's	Cedar	1	50	5400	12.0
P13	Evans	County Center	1	15	2000	4.5
P13	Evans	County Center	1	25	2400	5.4
P14	Evans	Pinkham & Tulare	1	10	1400	3.1
P15	Evans	Sowell	1	10	1400	3.1
P20	Evans	Chinowth	1	7.5	2600	5.8
P16	Packwood	Giddings	1	20	2400	5.4
P16	Packwood	Giddings	1	30	5900	13.2
P17	Packwood	Mooney	2	30	6950	15.5
P18	Packwood	Demaree & Victor	1	40	9000	20.0
P19	Packwood	Caldwell & Chinowth	1	25	2400	5.4

(1) Refer to Existing Drainage Facilities Map

EXISTING CHANNEL CAPACITY

To establish the approximate existing channel capacity, the City provided cross sectional data for typical sections. Using this data, and assuming a Manning's n of 0.030 and a slope of 0.001, the capacities were established using Manning's equation. Although it is understood that the more rigorous procedure using a backwater analysis would provide more reliable results, it is considered that for the effort performed and need for only a planning level accuracy, this procedure is adequate. At the preliminary design phase for constructed improvements, it is imperative that the full section be surveyed for a more rigorous analysis.

Appendix A provides a summary of the cross sectional data and capacity analysis. The locations of the cross sections are shown on the **Existing Drainage System** map (foldout).

3. BASIS OF DESIGN

This section presents the approaches adopted during the development of the Storm Water Master Plan and identifies general assumptions made during the course of the study.

LEVEL OF PROTECTION

A common drainage standard is to provide a system that will limit major damage from a major storm expected to occur once in 50-100 years and to limit nuisance flooding from storm events that would occur on average once in 2-10 years. Because of the relatively flat topography in Visalia, excess storm runoff tends to distribute rather than concentrate which greatly reduces the threat of major flood damage from local storms. As a result, providing a drainage system for Visalia is primarily intended to prevent the more frequent nuisance flooding that would occur with relatively frequent storms. Following a review of the prior Storm Drain Master Plan Report, conditions applicable to Visalia and discussions with City staff, it was concluded that the following level of drainage protection should be adopted.

Table 3-1 Level of Protection (1)

Item	Level of Protection
Minor (Collector) Drains	2 Year
Major Drains	10 Year
In-Town Detention Basins	10 Year - 1 Day Volume (4)
In-Town Retention Basins (2)	10 Year - 10 Day Volume
Industrial Park Retention Basin	10 Year - 10 Day Volume
Downstream Ultimate Storage Basins (3)	10 Day - 50 Year Volume

(1) See discussion in Chapter 4, Level of Protection
(2) See discussion on Storage Basins in this Chapter
(3) Located downstream of the City and serve as ultimate storage
(4) Basin volume should be determined without any pump discharge during storm event

The major drains referred to above, represent the backbone of the drainage system and generally serve areas in excess of 100 acres. These drains are defined and analyzed in this Storm Water Master Plan and are specifically designated in the Facility Management system. Minor drains convey runoff to the major drains and generally serve areas less than 100 acres.

In addition to the above, all new developments shall be designed such that the surface of ponded water during the 100-year rainfall event does not rise more than one foot above the lowest top of curb in the development.

COMPUTER PROGRAMS

The following is a list of the major computer programs used in this study:

HEC-1 Version 4.0	Hydrology model developed by the U.S. Army Corps of Engineers.
dBASE IV Version 1.5	A relational database by Borland International. The Storm Water Facilities Management System was developed in dBASE IV.
FMS/AC Version 3.0	A Geographic Information System (GIS) by FMS/AC, Inc.
AutoCAD Release 11	A Computer Aided Drafting program by Autodesk Inc..

AVAILABLE DATA

Numerous documents and data have been collected and reviewed during the development of this Plan. These include:

Table 3-2 Available Data

Precipitation	- California Department of Water Resources Bulletin 195.
Soils	- Tulare County Environmental Resource Management Element.
Land Use	- Aerial photo mosaic prepared by Hark Pugh and Associates. - Visalia General Plan 1976-1996. - Adopted City Land Use Element and LUE Map - City's Conservation, Open Space, Recreation and Parks Element (1989)
Storage	- City of Visalia Storm Drain System Map (April, 1989).
Pump Stations	- List of Pump Stations presented in the 1987 Report and map. - City of Visalia Storm Drain System Map (April, 1989).
Storm Drain	- Cross section survey provided by the City, 1992. - City of Visalia Storm Drain System Map (April, 1989).
Topographic	- The 1983 Flood Insurance Study Revision (1983). - City contour maps.
Previous studies	- Storm Drain Master Plan (Montgomery-Knopf, 1987). - Flood Plain Information (U.S. Army COE, 1972). - City of Visalia Flood Insurance Study (FEMA, 1972).

MASTER PLAN HYDROLOGIC ANALYSIS

A hydrologic model of the City of Visalia has been developed as part of this Storm Water Management Plan. The model updates and extends the hydrologic model prepared in the 1987 Study. The new hydrologic model reflects future conditions with designated future land uses and includes additional analyses for planning areas to the 2020 development boundary.

Modeling Approach

Hydrologic modeling of the City of Visalia was performed using the U.S. Army Corps of Engineers Flood Hydrograph Package (HEC-1). The SCS Curve Number approach has been adopted to estimate losses and the kinematic wave overland flow plane methodology was used to compute sub basin runoff. Channel routing used the kinematic wave option.

Basin Delineation

Major basins identified for this study include **(Exhibit 1)**:

- Cameron Creek Basin
- Evans Ditch Basin
- Goshen Drain Basin
- Mill Creek Basin
- Modoc Ditch Basin
- Packwood Creek Basin
- Persian Watson Basin
- St. John's Basin

The hydrologic model developed in 1987 was used to establish drainage basin boundaries within the previously studied areas. Some modification was made as a result of recent development and additional analyses. Areas added to the model were delineated using USGS 7.5 minute quadrangle mapping and other mapping provided by the City.

In some cases, the topographic basin boundaries differ from those areas that are drained by underground storm drain systems. Since these systems are generally sized for minor events, they were not used in the delineation of major basin boundaries.

Rainfall

Rainfall used in this study, as shown in Table 3-3, is based on previously estimated values provided in the 1987 master plan. They were developed from the Exeter station, the closest continuous recording gage to the City of Visalia. To represent Visalia, the short-duration (5 minutes to 1 day) Exeter station data was reduced by 10% and the long-duration values were developed from the daily read gage in Visalia.

Table 3-3 Precipitation Depth-Duration-Frequency (Inches)

Duration	2-Year	5-Year	10-Year	25-Year	50-Year
5 min	.14	.18	.22	.26	.29
10 min	.18	.24	.29	.34	.39
15 min	.20	.27	.32	.39	.43
30 min	.24	.34	.40	.48	.53
1 hour	.34	.47	.56	.67	.74
2 hour	.50	.68	.80	.96	1.07
3 hour	.60	.83	.98	1.18	1.31
6 hour	.78	1.08	1.28	1.53	1.71
12 hour	1.03	1.42	1.68	2.01	2.24
1 day	1.28	1.76	2.09	2.48	2.77
2 day	1.55	2.20	2.64	3.19	3.59
5 day	1.98	2.87	3.48	4.24	4.79
10 day	2.41	3.47	4.17	5.04	5.67

The 5 minute to 1 day values were developed (with a 10% reduction) from continuous recording station data in Exeter (1940-1986)
The 2, 5 and 10 day values were developed from daily read gauge data in Visalia (1899-1982)

Losses

Rainfall losses within the City of Visalia have been modeled using the SCS curve number approach. This differs from the initial and final infiltration rate methodology used in the 1987 master plan. The curve number concept provides additional flexibility in the representation of various combinations of land use, hydrologic soil groups and character of cover on pervious surfaces. For all impervious surfaces a curve number of 98 was used. For pervious surfaces a composite curve number was developed based on specific soil types, land use and ground cover within each sub basin. **Exhibit 3** is a map of the land uses and **Exhibit 4** is a map of the hydraulic soil groups.

Rainfall losses are computed using the composite curve numbers for both pervious and impervious surfaces. Percent imperviousness was estimated for each basin as a function of land use. Table 3-4 summarizes information used in the development of composite curve numbers. To derive the specific Curve Number and Percent Impervious for each drainage area, a weighted average was calculated by determining the area of each land use and soil group within each drainage area. This process was automated in the Facility Management system using spatial analysis techniques.

Table 3-4 Percent Impervious and CN Values

Group	Land Use	Code	Soil Group	Percent Impervious	CN
Residential	Rural	RA	B	20	68
			C		79
			D		84
	Low Density	LDR	B	43	77
			C		84
			D		88
	Medium Density	MDR	B	70	87
			C		91
			D		93
	High Density	HDR	B	80	91
			C		93
			D		94
Commercial/Office	Convenience Center	CC	B	95	96
			C		97
			D		97
	Neighborhood Center	CNC	B	85	92
			C		94
			D		95
	Shopping/Office Center	CSO	B	80	91
			C		93
			D		94
	Community Center	CCM	B	75	89
			C		92
			D		92
	Central Business District	CBD	B	95	96
			C		97
			D		97
	Regional Center	CR	B	90	94
			C		96
			D		96
	Highway	CH	B	95	96
			C		97
			D		97
	Service	CS	B	95	96
			C		97
			D		97
	Professional/Administration	PA	B	70	87
			C		91
			D		93
Community Facilities	Public/Institutional	PI	B	60	83
			C		88
			D		91
Industry	Light	IL	B	80*	91*
			C		93
			D		94
	Heavy	IH	B	90*	94
			C		96
			D		96
Open Space	Agriculture	OSA	B	0	75
			C		82
			D		86
	Conservation	OSC	B	0	69
			C		79
			D		84
	Parks	OSP	B	15	61
			C		74
			D		80
Urban Reserve	Urban Reserve	UR	B	15	69
			C		79
			D		84

Use 10 for percent impervious and 66 for CN when all runoff, except for streets, is stored on site.

Runoff

Runoff was computed using the HEC-1 model and, more specifically, the kinematic wave overland flow plane runoff computation option. This methodology uses overland flow planes to simulate basin response and is consistent with the methodology used in the 1987 master plan. The 1987 master plan information was utilized, to the extent possible, with updates to reflect revised land use projections or revised levels of existing development.

Two overland flow planes were utilized to represent runoff from each drainage area: a pervious surface overland flow plane and an impervious surface overland flow plane. Modeling assumed that the overland flow portion from both pervious and impervious surfaces would have a uniform slope because of the relatively constant slope within the City of Visalia.

Typical overland flow planes for both pervious and impervious surfaces were developed for six groups of land use. The specific basin representation assigned to a specific sub basin in the model was determined based on the predominant land use group within the individual sub basin. Table 3-5 summarizes the overland flow plane parameters for each land use group.

Table 3-5 Kinematic Wave Overland Flow Parameters

Group	Land Use Code	Pervious Surface Length (feet)	Pervious Surface Roughness N	Impervious Surface Length (feet)	Impervious Surface Roughness N
1	RA, OSC, OSP, UR	300	0.20	100	0.10
2	LDR, MDR	150	0.30	50	0.10
3	HDR, CC, CNC, CSO, CBD, CS, PA, IL	20	0.40	200	0.10
4	CCM, CR, CH, IH	20	0.40	500	0.10
5	P1	200	0.30	200	0.10
6	OSA	800	0.20	100	0.10

Model Structure

The structure of the HEC-1 model used to represent the City of Visalia was based on the 1987 master plan. This model was extended to include new areas to the 2020 development boundary. A separate model was prepared for each major drainage basin to simplify modeling structure and to facilitate their individual evaluation. When a storm drain system was present in the existing basin, it was evaluated to determine if its drainage boundaries were consistent with those of the surface drainage system. In most cases these were relatively consistent and no adjustment of the model structure was required. In some cases additional analyses and adjustments were required.

RATIONAL METHOD HYDROLOGIC ANALYSIS

The Rational Method may be used to determine peak flows and runoff volumes for areas less than 150 acres. The method relates rainfall intensity, a runoff coefficient and drainage area size to the direct runoff from the drainage area. The relationship is expressed by the equation:

$Q = C\,I\,A$ where:
Q = the runoff (cfs) from a given area
C = a coefficient representing the ratio of runoff to rainfall
I = the rainfall intensity in inches per hour
A = the drainage area in acres.

Runoff Coefficient C

The runoff coefficient C represents the cumulative effects of infiltration, evaporation, surface retention, flow routing, surface cover and roughness and ground slope. The range of coefficients, with respect to land use is given in Table 3-6.

Table 3-6 Rational Method Runoff Coefficients and Design Criteria for Stormwater Basins

Land Use	Runoff Coefficient (C)	Storage Volume (acre-feet/acre) Detention	Retention
Industrial and Commercial	0.85	0.148	0.295
Professional Office	0.65	0.113	0.226
Residential - High Density (15-29 units/ acre)	0.55	0.096	0.191
- Medium Density (11-14 units/ acre)	0.45	0.078	0.156
- Low Density (3-10 units/ acre)	0.35	0.061	0.122
- Rural (1-2 units/acre)	0.30	0.052	0.104
Public/Institutional	0.40	0.070	0.139
Open Space - Improved (parks)	0.25	0.044	0.087
- Unimproved	0.15	0.026	0.052

	Hydrologic Soil Group A	B	C	D
Flat (0 - 2%)	0.04	0.16	0.32	0.48
Average (2 - 6%)	0.07	0.28	0.50	0.63
Steep (Over 6%)	0.21	0.45	0.64	0.77

Notes:

1) The storage volume for detention storage is based on a 10-year, 1-day storm event with a total rainfall of 2.09 inches. The basin shall also accommodate a 10-year, 2-day event with a total rainfall of 2.64 inches with freeboard and pumping taken into account. The maximum design depth and side slopes of the basin must be approved by the City. Discharge pumps with a City approved capacity shall be installed and operated in accordance with City stormwater discharge policies.

2) The storage volume for retention storage is based on a 10-year, 10-day storm event with a total rainfall of 4.17 inches. Discharge pumps can only be installed and operated with the approval of the City.

3) The design water surface elevation in a basin shall be a minimum of one foot below the lowest catch basin in the area that is tributary to the basin.

Rainfall Intensity I

The rainfall intensity I, is the average rainfall intensity in inches per hour for a duration equal to the time of concentration of the basin. For urban areas the time of concentration (T_C) consists of the time required for runoff to flow over the ground surface to the nearest point of concentration (T_O), and the time for concentrated flow to reach the point under consideration (T_D).

$$T_C = T_O + T_D$$

Figure 3-1 can be used for estimating T_O. The maximum overland flow length used in the determination of T_O shall not exceed 500 feet.

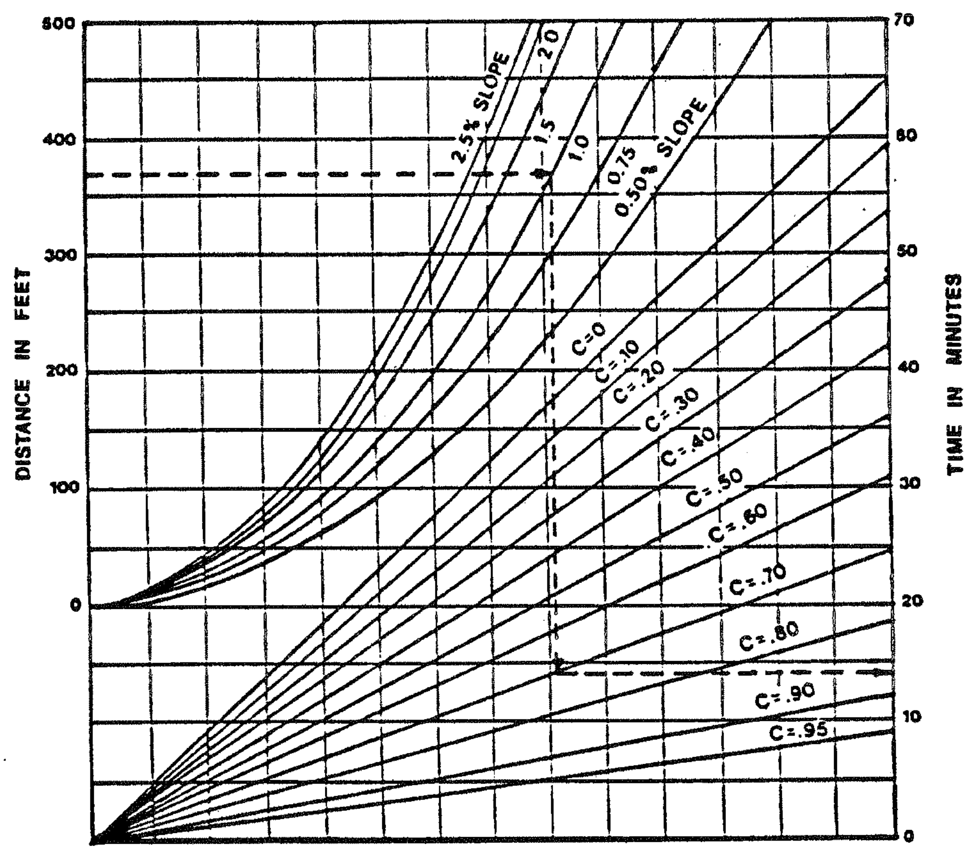


Figure 3-1 Overland Time of Flow Curves

T_D can be estimated by determining the length from the point where flows first concentrates to the point under consideration and dividing this flow length by the average velocity in the channel. The average velocity can be determined from Table 3-7.

The City's current design criteria for drainage improvements includes a "lot to street" time of 25 minutes for residential areas and a typical gutter velocity of 2 feet per second.

Table 3-7 Approximate Channel Velocities

Average Slope of Channel (Percent)	Average Velocity (feet/second)
1-2	2.0
2-4	3.0
4-6	4.0
6-10	5.0
10-15	8.0

Once the time of concentration has been determined, the rainfall intensity can be established from Figure 3-2.

TEMPORARY STORAGE BASINS

The concept to manage storm water for the City of Visalia is to direct runoff to regional retention basins as a final disposal point. However, until the regional basins are constructed, new development needs to retain some runoff onsite to mitigate the effects on downstream peaks and volumes and to contain potential pollutants from commercial and industrial sites.

One of the most common methods for controlling runoff associated with development is to detain the difference between current and historic peaks and volumes. While this method is popular, the application is impractical in small areas because low discharges result in small outlet pipes that are difficult to accurately design, construct and maintain. In addition, the system-wide benefits of such facilities are limited because the longer duration required to evacuate runoff from these basins may result in additive peak discharges.

Retention is another common method for controlling watershed runoff and is the preferred City method. The City's proposed standard requires retention of storm water volume generated by the 10-Year, 10-Day event of 4.17 inches of rainfall. Sizing of a storage facility can use the Rational Method as follows:

$$\mathbf{V = \sum CA\ \ 0.35\ acre\text{-}feet}$$

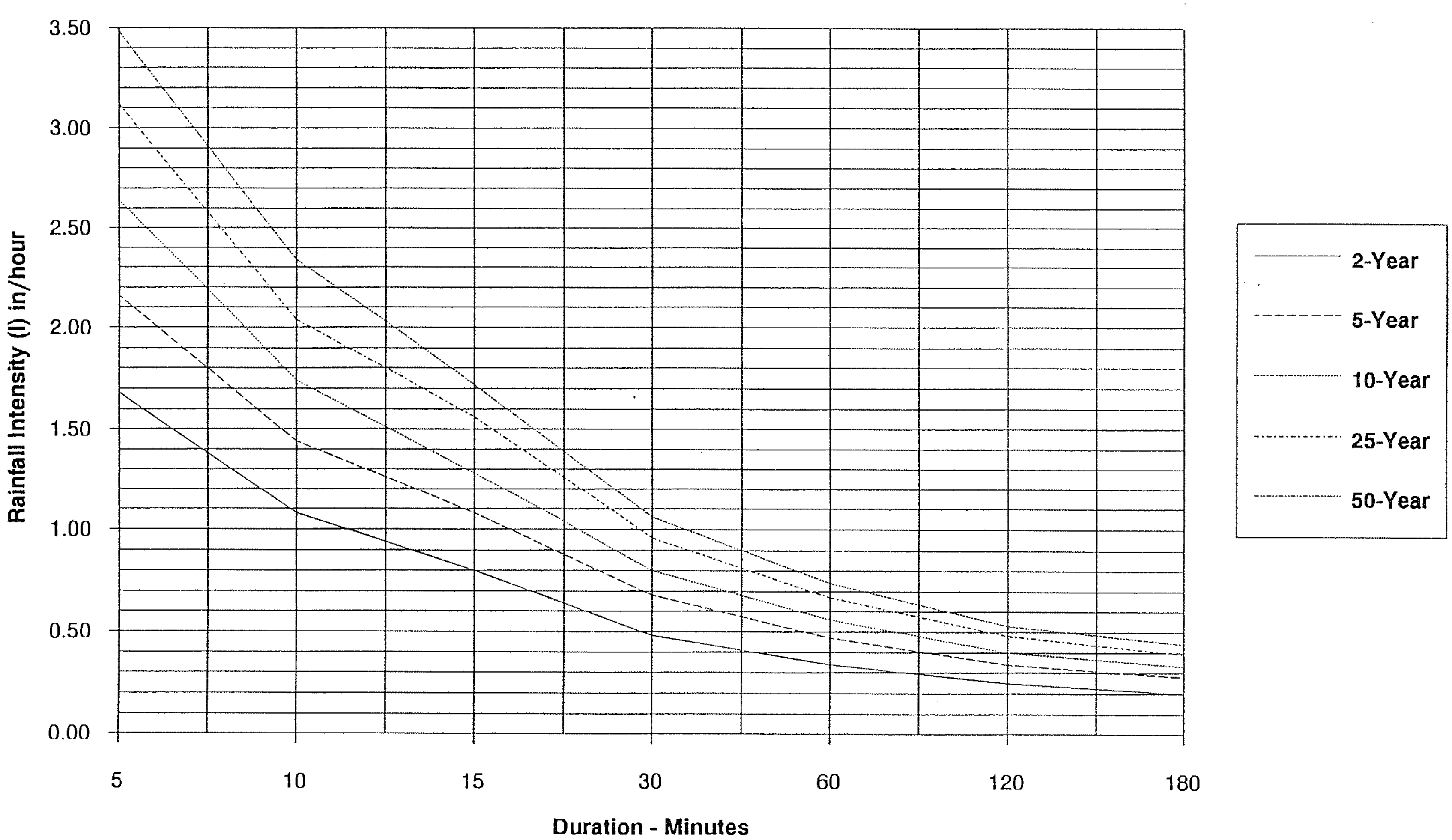
Where: $\sum CA$ = $C_1 A_1 + C_2 A_2 + C_3 A_3 + \ldots\ldots\ldots\ldots\ldots\ldots C_n A_n$

C_1 = Rational Method Runoff Coefficient from Table 3-6 for Land Use 1

A_1 = Area of Land Use 1 in acres

.35 = 10 Year - 10 day rainfall in feet

Figure 3-2 Visalia Frequency - Duration - Intensity Curves



HYDRAULIC ANALYSIS

Conduit Capacity

The hydraulic analysis of existing and proposed conveyance systems assume normal depth flow for conduits flowing full. Capacities are calculated using Manning's equation. Conveyance systems differentiated in the study include pipes, open channels and box sections. For unusual shapes, an equivalent circular section was assumed. The formulas used for the sections are as follows:

$$Q_{pipe} = (0.463/N)\ D^{8/3}\ S^{1/2}$$

$$Q_{channel,\ box} - (1.486/N)\ A\ R^{2/3}\ S^{1/2}$$

Where:

Q	=	Design Discharge in cubic feet per second (cfs)
N	=	Manning's N
D	=	Diameter of Pipe in feet
S	=	Conduit Slope
A	=	Channel or Box Area in square feet
R	=	Channel or Box Hydraulic Radius in feet

Manning's roughness values were taken from the Baxter and King's Handbook of Hydraulics (1976). For pipes a Manning's N of 0.013 was used. For open channels a Manning's N of 0.028 was used for unlined channels and .015 for concrete lined sections.

4. STORM WATER MANAGEMENT ALTERNATIVES

This section evaluates the major alternatives considered for the City's Storm Water Master Plan. They include:

- Level of Protection
- Storm Water Storage
- Storm Water Conveyance

Following a discussion of these alternatives conclusions are drawn.

LEVEL OF PROTECTION

In planning a storm water management system, consideration is given to limiting major damage from infrequent storm events of 50-100 years, minimizing nuisance flooding from the more frequent events of 2-10 years and taking measures to prevent passing drainage problems downstream. Normally the main drains and storage facilities that provide the backbone of the storm water management system are designed for the major storm event and the minor system that collects and conveys runoff to the major system is usually designed for the lower more frequent storms.

Because of the flat topography in Visalia, which results in distributed rather than concentrated ponding, major flooding does not occur from rainfall on the town itself. Therefore the level of drainage protection required relates primarily to the level of nuisance flooding that can be tolerated and the cost of the facilities to provide the protection (i.e. 2-10 years).

At present, most of the existing and currently planned drainage systems can handle about a 2 year storm. In the following sections where storm water conveyance and storage alternatives are discussed, alternative cost estimates have been developed to facilitate a recommendation for an overall policy. In planning for storage and conveyance, the level of protection should be kept the same. This is because most of the existing and planned storage basins rely on the drainage system to collect and convey runoff to the basins. Runoff from storms larger than the capacities of the drainage systems generally bypass the storage basins and gravitate in a westerly direction.

For Visalia, all runoff, with the exception of retained volumes and runoff in the St. John's Basin, ends up at the west end of the City. To prevent increasing drainage problems downstream, related primarily to runoff volumes, the difference in pre and post development runoff should be retained. For this issue, providing a level of protection to manage the difference in volumes for the 50 year-10 day event is recommended. The retention volume is established by running the HEC-1 model with hydrologic parameters for both pre and post land development to determine the pre and post development runoff volumes. The difference in these volumes is the required retention storage.

STORM WATER STORAGE

When downstream drainage ways have limited capacity and improvements are not practical due to either limited right of way, aesthetics, protecting the riparian habitat or initial cost, then storage of storm water is the most practical measure for managing runoff. Major advantages of storage include: downstream conveyance systems can be smaller, water quality can be improved, and sediment can be controlled. Disadvantages include availability of land, ongoing operation and maintenance of pumping facilities, potential unsightliness if the facilities are not combined with planned and maintained recreational facilities and unreliability if not located correctly.

If storage basins are not located to capture runoff naturally, collection systems must capture and convey all planned runoff to the basins. When storms larger than the design events occur, or if inlets are blocked due to lack of maintenance, runoff will follow the natural gradient and could bypass the planned storage facility.

Storage basins can be classified as either retention or detention basins. Retention basins have no outlet and rely on evaporation and percolation to drain the basin. Detention basins can be drained by either gravity pipes, pumps, percolation and evaporation or a combination of these methods. For in-town storage facilities, a maximum detention period, based on aesthetics and mosquito control is 5 days. The City's current policy, based in part on safety considerations is to have the detention basins drained in 2 days. For basins outside of town, draining all water in a specific time period is not a requirement.

Due to the limited capacity of the channels and ditches that form the City's drainage system, the 1987 master plan relied heavily on storage as a method of controlling runoff and used the existing channels and irrigation ditches to convey pumped flows from the storage basins to areas downstream of the City. Conveyance improvements were limited to collection systems to capture and convey runoff to the basins and the upgrading of a bottleneck on Mill Creek. Although the 1987 plan inferred a protection level of about 10 years, the system basically protects the City from nuisance flooding for about a 2 year event.

The City's recently updated Land Use Element Map designates specific areas for "conservation" uses. Many of these "conservation" areas were established where the 1987 Master Plan recommended a storm water basin. In the interest of maintaining consistency with the LUE (and the 1987 Master Plan), several of the basins that were recommended in the 1987 Plan are perpetuated in this update. The 1987 Plan basin recommendations that are perpetuated include the expansion of two existing basins along Packwood Creek near Mooney Boulevard and three new basins in southeast Visalia.

It should be noted that the capacity of the "in-town" basins was established based on the volume of the tributary runnoff that would be generated by the 10-year, 1-day storm event. However, in order to establish the size and depth of these basins, it was assumed that they would be developed as dual-use facilities that would also accommodate recreational activities. This was for the purpose of determining basin costs but not for the purpose of establishing the location od the park and conservation areas. Bases on discussions with the City staff, each of the recommended "in-town" basins was characterized as either a community park, neighborhood park, park-pond, or water storage basin facility. The configuration, landscaping requirements and unit cost for each of these basin types area presented in Table 4-1. The cost of recreational improvements, such as restrooms and playground equipment, was not included in the total cost of the basins. These basin configurations were used to establish the required land areas and landscaping needs, and their associated costs as shown in Table 4-2.

The "terminal" ponds downstream of the City, categorized as "X1" also are shown in Table 4-1. The City has adopted a procedure of having a maximum depth of 8 feet providing 50% of the required volume in these basins. The remaining required volume is achieved by constructing berms around a larger area and also incoming open channels.

Table 4-1 Alternative Storage Basin Configurations

Item	Community Park	Neighborhood Park	Park/ Pond	Water Storage Basin	Final D/S Pond (1)
Basin Type	A1	A2	B	C	X1
Percent of Basin for 15' Deep Pond Area	33%	50%	20%	95%	
Percent of Basin for 5' Deep Depressed Turf	33%	50%	80%	0%	
Deep Pond Side Slopes	2:1	2:1	2:1	2:1	2:1
Depressed Turf Ponds (2)	3-6:1	3-6:1	3-6:1	3-6:1	
Percent of Basin for Street Level Turf (%)	33	0	0	5	0
Basin Landscaping	All	All	All	15' Strip	None
Cost of Landscaping ($/acre)	45,000	40,000	50,000	35,000	
Cost of Land ($/acre)	60,000	60,000	60,000	12,500	12,500
Cost of Earthworks ($/cy)	2	2	2	2	2
Contingency (%)	20	20	20	20	20

(1) Downstream ponds have a maximum depth of 8 feet. 50% of the required volume is excavated and the remaining volume is achieved by berming the surrounding area.
(2) Side slopes for Depressed Turf Ponds vary between 3:1 for non-street frontage, areas landscaped with groundcover and 6:1 for street frontage areas landscaped with turf. For calculations an average side slope of 4:1 has been adopted.

From Table 4-2 it can be seen that the cost of storage for the same volumes and different basin configurations is significantly different. Basin type A1 (community park) provides the best multiple use facility but costs about 40% higher than type A2 (neighborhood park) for 50 acre-feet of storage. The additional costs to accommodate multiple use recreational activities with the storm water management system needs to be recognized.

Table 4-3 summarizes the storage basin volumes for this study including the 2-year and 10-year, 1-day and the 50-year, 10-day. The 50-year, 10-day includes volumes generated prior to basin development and also with ultimate proposed development. Excess storage requirements for terminal basins are also summarized. Where negative numbers are shown, it means actual volumes generated will be less due to on site storage in areas of the drainage basin. All volumes were established using the HEC-1 model.

Table 4-2 Alternative Storage Basin Costs

Basin A79-1020.xls	Storage (ac-ft)	Area (acres)	Land Cost ($)	Earthworks Cost ($)	Landscaping Cost ($)	Contingency Cost ($)	TOTAL Cost ($)
A1	5	1.9	113,070	16,133	84,803	42,801	256,808
A1	10	3.0	178,126	32,267	133,594	68,797	412,784
A1	15	4.0	238,668	48,400	179,001	93,214	559,284
A1	20	4.9	296,825	64,533	222,619	116,795	700,772
A1	25	5.9	353,442	80,667	265,081	139,838	839,028
A1	30	6.8	408,959	96,800	306,719	162,496	974,974
A1	50	10.4	624,149	161,333	468,112	250,719	1,504,313
A1	75	14.7	884,294	242,000	663,220	357,903	2,147,416
A1	100	19.0	1,138,946	322,667	854,210	463,165	2,778,987
A2	5	1.3	75,380	16,133	50,254	28,353	170,121
A2	10	2.0	118,750	32,267	79,167	46,037	276,221
A2	15	2.7	159,112	48,400	106,075	62,717	376,305
A2	20	3.3	197,883	64,533	131,922	78,868	473,207
A2	25	3.9	235,628	80,667	157,085	94,676	568,056
A2	30	4.5	272,639	96,800	181,760	110,240	661,439
A2	50	6.9	416,099	161,333	277,400	170,966	1,025,799
A2	75	9.8	589,529	242,000	393,019	244,910	1,469,458
A2	100	12.7	759,298	322,667	506,198	317,633	1,905,795
B	5	1.9	115,901	16,133	96,584	45,724	274,343
B	10	3.0	178,595	32,267	148,829	71,938	431,629
B	15	3.9	236,943	48,400	197,453	96,559	579,355
B	20	4.9	292,955	64,533	244,129	120,323	721,941
B	25	5.8	347,448	80,667	289,540	143,531	861,185
B	30	6.7	400,851	96,800	334,042	166,339	998,031
B	50	10.1	607,618	161,333	506,348	255,060	1,530,359
B	75	14.3	857,244	242,000	714,370	362,723	2,176,336
B	100	18.4	1,101,367	322,667	917,806	468,368	2,810,207
C	10	1.3	16,362	32,267	11,234	11,973	71,836
C	25	2.6	33,033	80,667	15,963	25,933	155,595
C	50	4.7	58,926	161,333	21,320	48,316	289,895
C	100	8.7	108,371	322,667	28,912	91,990	551,939
C	200	16.3	203,933	645,333	39,661	177,785	1,066,713
C	300	23.8	297,622	968,000	47,914	262,707	1,576,242
C	400	31.2	390,340	1,290,667	54,872	347,176	2,083,054
C	500	38.6	482,438	1,613,333	61,002	431,355	2,588,129

Table 4-3 Storage Basin Design Volumes

Drainage Basin	Storage Basin ID	2 Yr-1 Day (acre-feet)	10 Yr-1 Day w/o Pumping (acre-feet)	50 Yr-10 Day Post-Development (acre-feet)	50 Yr-10 Day Pre-Development (acre-feet)	50 Yr-10 Day Difference (acre-feet)	Excess Storage (acre-feet)
Cameron Creek	CC-S21	129	299	477	324	153	153
Evans Ditch	ED-EP13W	3	8	16	9	7	
	ED-EP15W	8	20	31	17	14	
	ED-S10	27	49	69	43	26	
	ED-S15	4	10	13	9	4	
	ED-S12	6	14	22	16	6	6
	ED-S9	12	24	31	18	13	
Goshen Drain	GD-S39	30	74	119	70	49	
	GD-S40	38	71	99	33	66	
	GD-S6	27	60	99	146	-47	-47
Mill Creek	MC-S32	8	19	30	15	15	
	MC-S33	17	38	58	26	32	
	MC-S34	16	38	61	27	34	
	MC-S50	200	396	585	319	266	266
	MC-S7	3	6	10	6	4	
	MC-S8	7	17	26	15	11	
Modoc Ditch	MD-S2	4	8	13	7	6	
	MD-S23	290	559	378 *	439	-61	-61
	MD-S3	53	124	197	119	78	
	MD-S31	5	12	18	9	9	
	MD-S4	15	40	66	42	24	
Packwood Creek	PC-EP16W	1	1	1	1		
	PC-EP18W	5	14	28	16	12	
	PC-EP19W	6	16	28	18	10	
	PC-S14	15	36	58	34	24	
	PC-S16	4	9	14	9	5	
	PC-S17	14	35	57	36	21	
	PC-S19	21	45	67	29	38	
	PC-S20	6	14	22	12	10	
	PC-S21	123	224	319	202	117	117
	PC-S22	3	7	11	7	4	
	PC-S41	1	6	10	9	1	
	PC-S42	6	15	24	15	9	
	PC-S43	7	18	28	17	11	
	PC-S44	8	21	34	21	13	
Persian Watson	PW-S11	7	20	33	24	9	
	PW-S17	23	69	117	97	20	20
St John's	SJ-EP10W	1	1	3	2	1	
	SJ-EP11W	1	1	2	1	1	
	SJ-EP12W	3	8	16	6	10	
	SJ-EP9W	2	6	12	7	5	
	SJ-S1	6	13	19	11	8	
	SJ-S35	8	27	49	40	9	
	SJ-S36	15	64	124	112	12	

* Post development volume is lower than pre-development volume due to proposed new upstream storage basins.

STORM WATER CONVEYANCE

When right of way is available, riparian habitat is not a major problem and aesthetics can be maintained, then open channel conveyance systems are the least expensive method of managing storm water runoff. The advantage to conveyance is that it is simple, requires no operation, generally less maintenance and is typically less expensive if right of way is available for construction of open channels.

The conveyance system discussed here includes the minor system to collect and convey runoff to either the main drains or a storage basin and also the main drains themselves. Minor drains will generally be underground concrete pipes located in street right of ways. At present they generally have a design level of protection of 2 years or less and the 2 year level of protection should be maintained.

Major drains are generally open channels and can be natural, unlined, lined or partially lined. Existing channels requiring upgrading to convey additional runoff can be widened or lined with concrete. Concrete lining a channel increases its capacity without having to necessarily increase its width. It is recommended that major drains be designed for a 10 year protection whenever possible. When there is limited right of way, riparian habitat, or resistance from adjoining property owners make it difficult to widen a channel to achieve the 10-year level of protection, the “target” level of protection may have to be reduced.

To facilitate the decision making process for sizing major drains configurations and cost estimates for alternative conveyance types were developed. Table 4-4 provides the configurations and unit rates used in the analysis and Table 4-5 the comparative cost estimates.

Table 4-4 Alternative Conveyance Configurations

Item	Unlined Open Channel	Concrete Lined Open Channel	Underground Pipe
Slope	0.001	0.001	0.001
Manning's N	0.030	0.015	0.013
Depth/Base Width	1/3	1/3	
Side Slopes	3:1	1:1	
Lining Thickness (in)		4	
Right of Way	Top Width+20'	Top Width+20'	
Earthworks Cost ($/cy)	5	5	
Land Cost ($/acre)	12,500-60,000	12,500-60,000	
Contingency (%)	20	20	
<u>Pipe Costs</u>			
36 Inch Dia RCP with manholes ($/ft)			80(1)
48 Inch Dia RCP with manholes ($/ft)			120(1)
60 Inch Dia RCP with manholes ($/ft)			189
72 Inch Dia RCP with manholes ($/ft)			245

(1) Taken from bid sheets for new street projects in the Visalia area.

Table 4-5 Alternative Conveyance Costs

Design Discharge (cfs)	Unlined Channel Cost per Foot ($60,000/acre) ($)	Lined Channel Cost per Foot ($60,000/acre) ($)	Unlined Channel Cost per Foot ($12,500/acre) ($)	Lined Channel Cost per Foot ($12,500/acre) ($)	Underground Pipes Cost per Foot ($)
25	60	72	15	37	50
50	70	84	19	46	84
75	76	91	21	51	104
100	82	100	25	58	114
125	86	107	27	63	125
150	92	112	30	67	
175	96	116	31	71	
200	100	121	33	75	
250	107	130	36	81	
300	114	138	41	88	
350	120	144	44	93	
400	**126**	150	47	98	
450	131	157	50	103	
500	136	162	53	107	
600	**146**	173	59	116	
700	155	182	64	123	
800	163	191	69	130	
900	170	199	73	137	
1,000	179	208	79	144	
1,200	193	222	88	155	
1,400	206	235	96	167	
1,600	218	247	104	177	
1,800	230	259	113	186	
2,000	241	270	120	195	
2,500	269	296	139	218	
3,000	293	319	155	237	
3,500	317	338	172	253	
4,000	337	360	187	271	

(1) Assuming these discharges are for a 2 year, then the 10 year discharges would be about 50% higher

Peak discharges for a 10 year storm are about 50% higher than for the 2 year event. Therefore it is possible to compare the cost for providing the 2 and 10 year protection from Table 4-5. For example: Assume the 2 year design discharge is 400 cfs, then the cost for an unlined open channel with right of way at $60,000 per acre is $126 per foot. The design discharge for a 10 year protection would be 600 cfs and the resulting cost for an unlined open channel with right of way at $60,000 per acre is $146 per foot.

CONCLUSIONS

The least expensive alternative to manage storm water runoff is to construct and/or improve unlined open channels. However, when open channel improvements are not feasible due to lack of right of way, then storm water storage is the most effective means. For Visalia, both alternatives are recommended.

For major drains, where right of way is available, it is recommended that unlined open channels be constructed to convey the 10 year storm. For major drains, where right of way is limited, it is recommended to convey runoff from at least the 2-year storm event. This may require partial or full lining of channels in some locations.

For the minor drainage system (collector drains and structures), it is recommended to provide conveyance capacity for the 2-year event. This is consistent with most of the drains already constructed.

For new planned in-town detention basins, it is recommended that these basins be designed to accommodate the runoff that will be generated by the 10-year, 1-day storm event (with 2.09 inches of rainfall) without any pump discharge from the basins during the 24-hour storm. As a check to evaluate the adequacy of this criteria, it should be determined if the 10-year, 1-day "no pumping" design volume can accommodate the runoff that will be generated by the 10-year, 2-day storm event (2.64 inches of rainfall) with pumps discharging during the 48-hour storm. In the event that the 10-year, 1-day design volume cannot accommodate the 10-year, 2-day event volume "with pumping", additional freeboard should be provided and/or the pump discharge should be increased (until the 2-day event can be accommodated). At a minimum, detention basin pumps should be sized to drain the basins in five days following the 10-year, 1-day storm event. Refer to table 4-3 for the 10-year, 1-day event runoff volumes.

For the downstream "terminal" basins, it is recommended that these basins accommodate the difference in the pre- and post-developement runoff volumes from the 50-year, 10-day storm event (with 5.67 inches of rainfall). Refer to Table 4-3 for the pre- and post-development runoff volumes.

Finally, for those new areas being developed for which the major drainage system has not been constructed, it is recommended that temporary retention basins should provide storage for the 10-year, 10-day event with 4.17 inches. When the major conveyance system is in place, then the areas allocated for temporary storage can be released for development.

Industrial development in the "industrial park", should retain the 10-year, 10-day event volume (4.17") on-site. The first "flush" of this volume, probably about 1 inch, is required to contain potential pollutant spills. The remainder is to provide relief for existing downstream systems.

5. ENTITLEMENT FLOW MANAGEMENT ALTERNATIVES

Storm water runoff has historically discharged into natural creeks and ditches that flow through the City. Many of these same conveyance systems are used to convey irrigation deliveries and flood control releases from Kaweah Lake. If irrigation deliveries and/or flood control releases occur at the same time as an intense storm on the town, the rate at which City runoff can be discharged into the channels may be limited, particularly to the privately owned channels. To avoid this conflict, the City is considering methods to temporarily manage the irrigation flows and flood control releases. This will provide additional capacity for the management of storm water runoff in the City.

The maximum entitled irrigation and flood flows are controlled by the Kaweah and St. John's Rivers Agreement. The entitlements and one day storage for each of the creeks and ditches passing through Visalia are summarized in Table 5-1.

Table 5-1 Entitlement Flows and Volumes

Source	Channel	Maximum Winter Entitlement (1) (cfs)	One Day Storage (acre-feet)
Lower Kaweah River	Packwood Creek	265	526
	Evans Ditch	54	107
	Mill Creek	99 (2)	196
	Sub-Total	**418**	**829**
St. Johns River	Modoc	99	196
	TOTAL	**517**	**1025**

(1) Entitlement schedule established by Kaweah and St. Johns River Agreement
(2) The Mill Creek flow consists of the maximum winter maximum entitlement for Persian/Watson Ditch.

The entitled flows represent significant flows that could be used for storm water runoff if available for that purpose. It must be emphasized however, that any modification of management of the entitlement flows will require agreements with the irrigation companies. Possible entitlement flow management alternatives include:

- Upstream Storage
- Flow Diversion

UPSTREAM STORAGE

All, or any portion, of the entitled irrigation flows for a one day period could be temporarily stored upstream of Visalia to provide additional conveyance capacity in downstream channels for storm water runoff. After the storm, the stored water would be released back to the channels. Table 5-2 presents an estimate of cost to provide upstream storage facilities. The costs assume that the basin will be 5 feet deep, made up of 2.5 feet of excavation and a 2.5 foot high embankment. An additional 1-2 foot of freeboard can be added to the embankment. Two estimates have been provided. The first for storing entitled flows for only Packwood, Mill and Evans, and the second for including Modoc Ditch entitled flow.

Table 5-2 Upstream Storage Costs

Basins Included	Quantity	Unit	Rate	Amount
Packwood, Mill and Evans (829 acre-feet)				
- Land	166	Acres	$12,500	2,075,000
- Earthworks	1,337,453	C.Y.	$2.00	2,,674,906
Total				**$4,749,906**
Packwood, Mill, Evans and Modoc (1,025 acre-feet)				
- Land	205	Acres	$12,500	2,562,500
- Earthworks	1,653,667	C. Y.	$2.00	3,307,333
Total				**$5,869,833**

KDWCD has indicated an interest in participating in the acquisition and development of a storage basin east of the City. Such a basin would be consistent with the terms of the agreements that the City has entered into for Evans Ditch, Packwood Creek, Mill Creek and the Persian/Watson Ditch system. KDWCD would probably be the party that operates such a basin, with the consent and cooperation of the effected parties. It should also be noted that the cost of land represents over 40 percent of the total construction cost, and as the location moves further to the east, land prices go down.

FLOW DIVERSION

An alternative to upstream storage to manage entitled flows, is to divert the entitled flows to an enlarged Packwood Creek at the point that the Lower Kaweah splits west of Road 158. Packwood Creek would be expanded to manage the design runoff from the Packwood Creek Basin in addition to the entitled flows for Packwood, Mill and Evans. The incremental runoff is 419 cfs. From Table 4-4 it is estimated that the incremental cost to convey the additional 419 cfs for an unlined open channel with right of way costs at $12,500 per acre is about $20 per foot of channel. Assuming about 45,000 feet of channel upgrade, then the total incremental cost is about $900,000.

6. PROPOSED IMPROVEMENTS

The Visalia Storm Water Facilities Management System contains all of the proposed collector, main drain and storage basin facilities. The system is set up so that changes in the proposed works and timing for the proposed works can be easily accomplished. The Basin Reports document of this study contains detailed reports including:

Detailed Basin Reports
- Proposed Works Cost Estimate
- Pipes and Channel Summary
- Storage Basin and Pump Summary
- Land Use Drainage Basin Summary
- Existing Facilities
- HEC1 Input Data

Summary Reports
- Unit Cost Rates
- Proposed Works Cost Estimate Summary
- Capital Improvement Plan Cost Estimate Summary
- Capital Improvement Plan Cost Estimate
- Land Use Summary
- Land Use Summary by Basin

In sizing the proposed works, the following has been adopted:

- All collector drains are assumed to be underground pipes sized for the 2 year storm.
- Main drains can be either underground pipes, unlined open channels or lined open channels. Where it is feasible a 10 year storm has been adopted. In all cases however, a section is proposed to provide at least the 2 year protection.
- In sizing pipes, a slope of 0.001 and a Manning's n of 0.013 has been adopted.
- In sizing unlined channels, three to one side slopes, a slope of 0.001 and a Manning's n of 0.030 has been adopted.
- For lined channels, one to one side slopes, a slope of 0.001 and a Manning's n of 0.015 has been adopted.
- For upgrading "in-town" storage basins, the difference between the existing capacity and the 10 year/2 day volume will be added to the existing capacity.
- For upgrading "terminal" storage basins, the difference between the 50 year/10 day post-development volume and the 50 year/10 day pre-development volumes will be added to the existing capacity.
- For future conveyance changes, Items that can be easily modified include:
  - Type of section including pipes, unlined open channels or lined open channels
  - Conveyance slope
  - Manning's n
- For future storage basin changes, items that can be easily modified include:
  - Type of basin
  - Volume
  - Pumping capacity

- For future changes in cost estimates unit rates can be changed for:
  - Earthworks for both channels and basins
  - Concrete lining of open channels
  - Landscaping for specific type basins
  - Individual pipe sizes
  - Right of way costs applied to each conveyance section or storage basin
  - Rate of contingency

The following provides brief descriptions of the proposed improvements for each of the major drainage basins. For all improvements reference is made to the Proposed Improvements Plate (fold out) attached to the back of this report. For details of the proposed improvements, refer to the "Proposed Works Cost Estimate" report for the respective major drainage basin in the Basin Reports document.

CAMERON CREEK DRAINAGE BASIN

Cameron Creek Drainage Basin is 4,780 acres and will average 34.04% impervious, resulting in 1,627 equivalent impervious acres. Cameron Creek can generally convey the 10 year design storm with the exception of a short section from 8-9 which is deficient by about 157 cfs. All improvements are required for future development and fall in the 2010 and 2020 year planning periods. They include:

- 49,707 feet of collector drains ranging in size from 24 to 60 inch diameter
- 3,479 feet of unlined open channel widening (section 8-9)
- 153 acre-feet terminal storage at S21 (additional storage from Packwood Creek)

EVANS DITCH DRAINAGE BASIN

Evans Ditch Drainage Basin is 1,614 acres and will average 48.05% impervious, resulting in 775 equivalent impervious acres. With storage basin improvements, Evans Ditch will convey the 10 year design storm. Improvements are required for future development and are proposed for the 2000 year planning period. They include:

- Additional 25 acre-feet storage and 4.9 cfs pump at S10
- Additional 8.5 acre-feet storage and 1.0 cfs pump at S15

GOSHEN DRAIN DRAINAGE BASIN

Goshen Drain Drainage Basin is 3,243 acres and will average 34.87% impervious, resulting in 1,131 equivalent impervious acres. With storage basin improvements, upgrading of newly installed conduits, Goshen Drain will convey the 2 year design storm. All improvements are required for future development and are proposed for the 2000 planning period. They include:

- A new Type C basin at S39 with 74.0 acre-feet storage and 7.4 cfs pump.
- A new Type A2 basin at S40 with 71.0 acre-feet storage and 7.1 cfs pump.
- 54,787 feet of collector pipe ranging in size from 18 to 72 inch diameter.

The City recently constructed a 48 inch diameter pipe along Goshen Avenue from Giddings to west of Demaree. This reach of the Goshen Drain will need to be upgraded with an additional 48 to 72 inch diameter pipe to convey runoff from the 2 year storm by the year 2000. The existing 48 inch diameter pipe from Plaza Drive to the "Ocean" at S6 has adequate capacity. The terminal basin at S6 does not need to be upgraded to store excess runoff from pre and post development because the post development runoff volumes are less than pre-development volumes.

It should be noted that the recommended relief line in Goshen Avenue upstream of Basin S39 can be installed on an alternative alignment providing that it serves the area east of Demaree between Goshen Avenue and Ferguson. For example, it may be less expensive and disruptive to install the relief line on the north side of the railroad line that flanks Goshen Avenue rather then with the Goshen Avenue right-of-way.

MILL CREEK DRAINAGE BASIN

Mill Creek Drainage Basin is 6,149 acres and will average 50.47% impervious, resulting in 3,104 equivalent impervious acres. With storage basin improvements, improving a number of sections on the main line, Mill Creek will convey the 2 year design storm. All main drain and basin improvements are required to upgrade existing deficiencies. About 50 percent of the collector drains proposed are for existing conditions and the remaining for future development. Work proposed falls in the 2000 and 2010 year planning periods and includes:

- A new Type A2 basin at S32 with 19.0 acre-feet storage and 1.9 cfs pump.
- A new Type A2 basin at S33 with 40.0 acre-feet storage and 4.0 cfs pump.
- A new Type A2 basin at S34 with 38.0 acre-feet storage and 3.8 cfs pump.
- A new Type X1 terminal basin at S50 with 266 acre-feet storage.
- 25,260 feet of collector pipe ranging in size from 18 to 54 inch diameter.
- 9,606 feet of open channel improvements.

It should be noted that as an alternative to the recommended plan, the City could consider serving all or a portion of the area north of S.R. 198, east of the Road 80 alignment, south of the North Branch of Mill Creek, and west of the Road 86 alignment with the North Branch of Mill Creek. This alternative potentially would allow the planned line on the Road 84 alignment to be downsized and, perhaps, terminated south of S.H. 198.

MODOC DITCH DRAINAGE BASIN

Modoc Ditch Drainage Basin is 8,242 acres and will average 25.24% impervious, resulting in 2,081 equivalent impervious acres. With storage basin improvements, improving sections of the main line, Modoc Ditch will convey the 10 year design storm. Improvements are primarily for new development and fall in the 2000, 2010 and 2020 year planning periods. Additional terminal storage at S23 is also required. Improvements include:

- A new 12.4 cfs pump at S3 and a new 4.0 cfs pump at S4.
- A new Type B basin at S31 with 12.0 acre-feet storage and 1.2 cfs pump.
- Additional 209.0 acre-feet terminal storage at S23.
- 101,511 feet of collector pipe ranging in size from 18 to 72 inch diameter.
- 17,706 feet of open channel improvements.

PACKWOOD CREEK DRAINAGE BASIN

Packwood Creek Drainage Basin is 5,880 acres and will average 44.54% impervious, resulting in 2,619 equivalent impervious acres. With storage basin improvements, Packwood Creek will convey the 10 year design storm. Improvements are required for future development and fall in the 2000 year planning period. They include:

- A new 3.6 cfs pump at S14, 1.0 cfs pump at S16 and 3.5 cfs pump at S17.
- Additional 45.0 acre-feet storage and 4.5 cfs pump at S19.
- Additional 14.0 acre-feet storage and 1.4 cfs pump at S20.
- A new Type B basin at S41 with 6.0 acre-feet and 0.6 cfs pump.
- A new Type B basin at S42 with 15.0 acre-feet storage and 1.5 cfs pump.
- A new Type C basin at S43 with 21.0 acre-feet storage and 2.1 cfs pump.
- Additional 117 acre-feet terminal storage at S21 (other storage from Cameron Creek)
- 39,775 feet of collector pipe ranging in size from 18 to 72 inch diameter.

It should be noted that because the design 10-year storm event does not utilize all of the capacity available in Packwood Creek, the service area of the channel could be expanded to include areas that currently are serviced by other drainage basins. For example, land within the 2000 UDB immediately south of Packwood Creek and east of Mooney is within the Cameron Creek Drainage Basin. As an alternative, this area could be served by Packwood Creek, which would allow it to develop without having to install pipelines that extend (through undeveloped land outside of the 2000 UDB) to Cameron Creek.

Because the design storm event does not utilize all of the capacity available in Packwood Creek, particularly downstream of Mooney Boulevard, it may be feasible to eliminate some of the recommended basins within the Packwood Drainage Basin. In the case of the recommended basin expansions near Mooney Boulevard, there may be a financial incentive to eliminate one or both of these expansions and discharge the storm water runoff (that would be tributary to the basins) directly into the channel. The recommended expansion of these basins would require the acquisition of additional land that either is designated for "Regional" commercial uses or adjacent to such designated uses. It appears that by eliminating these expansions, the land acquisition and basin construction costs of the Master Plan could be reduced without discharges exceeding the capacity of the channel. It should be noted that the recommendation to expand the two existing basins near Mooney Boulevard is based on a desire to maintain some degree of consistency with the updated Land Use Element and the 1987 Master Plan.

Before these basin expansions (or any other basins) are eliminated, the City should revise the appropriate HEC-1 model to reflect such changes and re-run the model to determine the peak flows in the receiving channel, and more accurately determine the capacity of the downstream reach of the channel. If the elimination of a recommended basin does not result in flows that exceed the capacity of the receiving channel, it is expected that such an action would be feasible. In the event that the elimination of a basin would result in flows that exceed the capacity of the receiving channel, the environmental impacts and cost of widening the channel should be examined to determine if such an alternative is feasible.

PERSIAN WATSON DRAINAGE BASIN

Persian Watson Drainage Basin is 1,626 acres and will average 17.93% impervious, resulting in 292 equivalent impervious acres. With storage basin improvements, improving a section of the main drain, the system will convey the 10 year design storm. Improvements are required for future development and fall in the 2000 year planning period. They include:

- A new 2.0 cfs pump at S11.
- 20 acre-feet terminal storage at S17
- 3,136 feet of 24 inch diameter collector pipe.
- 664 feet of unlined open channel improvement.

ST JOHN'S DRAINAGE BASIN

St John's Drainage Basin is 3,393 acres and will average 22.04% impervious, resulting in 748 equivalent impervious acres. With storage basin improvements proposed, constructing a new unlined channel main drain, the system will convey the 10 year design storm. Improvements are required for future development and fall in the 2000 and 2020 year planning periods. No provision is provided for terminal storage. Improvements include:

- A new Type A2 basin at S35 with 27.0 acre-feet storage and 2.7 cfs pump.
- A new Type C basin at S36 with 64.0 acre-feet storage and 6.4 cfs pump.
- 35,040 feet of collector pipe ranging in size from 24 to 42 inch diameter.
- 11,625 feet of new unlined open channel.

7. COST ESTIMATES AND CAPITAL IMPROVEMENT PLAN

Cost estimates have been developed for the proposed improvements based on the unit rates presented in Table 7-1. The costs have been broken down for facilities required to upgrade existing deficiencies and those required for future development. Details of the costs for each major drainage basin are provided in the Basin Reports document. A summary is provided in Table 7-2. The costs developed in this plan are suitable for developing impact fees, which will be discussed in the financing section of this report.

A capital improvement plan has been developed for each of the major development year periods: 2000, 2010 and 2020. A summary of the improvements is provided in Table 7-3 with details provided in the Basin Reports document. The Capital Improvement Plan costs are provided in current and future dollars. For future dollars, an inflation factor of 4% was used.

TABLE 7-1 UNIT COST RATES 02/23/94

Group	Cost Code	Description	Unit	Rate *
PIPE	18	18 INCH DIA RCP	LF	45.00
PIPE	24	24 INCH DIA RCP	LF	50.00
PIPE	27	27 INCH DIA RCP	LF	59.00
PIPE	30	30 INCH DIA RCP	LF	58.00
PIPE	36	36 INCH DIA RCP	LF	80.00
PIPE	42	42 INCH DIA RCP	LF	100.00
PIPE	48	48 INCH DIA RCP	LF	120.00
PIPE	54	54 INCH DIA RCP	LF	155.00
PIPE	60	60 INCH DIA RCP	LF	190.00
PIPE	66	66 INCH DIA RCP	LF	220.00
PIPE	72	72 INCH DIA RCP	LF	245.00
CHANNEL	1000	CHANNEL EARTHWORKS	CY	5.00
CHANNEL	1010	CHANNEL LINING	CY	200.00
BASIN	2000	BASIN EARTHWORKS	CY	2.00
BASIN	2010	LANDSCAPE BASIN A1	ACRE	45,000.00
BASIN	2020	LANDSCAPE BASIN A2	ACRE	40,000.00
BASIN	2030	LANDSCAPE BASIN B	ACRE	50,000.00
BASIN	2040	LANDSCAPE BASIN C	ACRE	35,000.00
PUMP	3010	0+ - 10 CFS	EA	35,000.00
PUMP	3020	10+ - 20 CFS	EA	42,000.00
PUMP	3030	20+ - 50 CFS	EA	80,000.00
PUMP	3040	50+ - 100 CFS	EA	130,000.00
PUMP	3050	100+ - 150 CFS	EA	200,000.00
CONTINGENCY	9999	CONTINGENCY	%	20.00

* Rates for pipes include manholes, trenching and pavement replacement

TABLE 7-2 PROPOSED WORKS COST ESTIMATE SUMMARY

09/14/94

SECTION ID U/S-D/S	Type	Pumps ($)	Landscaping ($)	Land ($)	Earthworks ($)	Lining ($)	Pipe ($)	Contingency ($)	Total ($)
<u>CAMERON CREEK DRAINAGE BASIN</u>									
FUTURE DEVELOPMENT				432,471	355,076		4,717,636	1,101,036	6,606,219
				432,471	355,076		4,717,636	1,101,036	6,606,219
<u>EVANS DITCH DRAINAGE BASIN</u>									
FUTURE DEVELOPMENT		70,000	227,864	106,168	108,093			102,425	614,551
		70,000	227,864	106,168	108,093			102,425	614,551
<u>GOSHEN DRAIN DRAINAGE BASIN</u>									
FUTURE DEVELOPMENT		70,000	399,130	641,030	467,867		4,567,247	1,229,055	7,374,328
		70,000	399,130	641,030	467,867		4,567,247	1,229,055	7,374,328
<u>MILL CREEK DRAINAGE BASIN</u>									
EXISTING DEFICIENCIES		105,000	577,384	1,489,514	965,692		791,809	785,880	4,715,278
FUTURE DEVELOPMENT							1,786,824	357,365	2,144,189
		105,000	577,384	1,489,514	965,692		2,578,633	1,143,244	6,859,467
<u>MODOC DITCH DRAINAGE BASIN</u>									
EXISTING DEFICIENCIES		42,000						8,400	50,400
FUTURE DEVELOPMENT		70,000	168,581	2,054,849	1,019,791		11,133,487	2,889,342	17,336,050
		112,000	168,581	2,054,849	1,019,791		11,133,487	2,897,742	17,386,450
<u>PACKWOOD CREEK DRAINAGE BASIN</u>									
FUTURE DEVELOPMENT		350,000	961,267	1,049,097	595,320		2,678,304	1,126,798	6,760,786
		350,000	961,267	1,049,097	595,320		2,678,304	1,126,798	6,760,786

TABLE 7-2 PROPOSED WORKS COST ESTIMATE SUMMARY

09/14/94

SECTION ID U/S-D/S	Type	Pumps ($)	Landscaping ($)	Land ($)	Earthworks ($)	Lining ($)	Pipe ($)	Contingency ($)	Total ($)
PERSIAN WATSON DRAINAGE BASIN									
FUTURE DEVELOPMENT		35,000		55,068	37,431		156,800	56,860	341,159
		35,000		55,068	37,431		156,800	56,860	341,159
ST. JOHN'S DRAINAGE BASIN									
FUTURE DEVELOPMENT		70,000	189,845	995,065	375,078		2,147,344	755,467	4,532,799
		70,000	189,845	995,065	375,078		2,147,344	755,467	4,532,799
TOTAL CITY IMPROVEMENTS		812,000	2,524,071	6,823,263	3,924,347		27,979,451	8,412,626	50,475,759

8. FINANCING

The previous master drainage plan identified options for the financing of drainage facilities. The basic concept presented was to utilize development fees for the construction of new facilities and alternative revenue sources to fund existing facility improvements. Quantification of the various alternatives were provided for the City to select an equitable financing plan.

The recommended financing scheme developed as part of this storm water management plan is essentially the same as that implied in the previous master plan with some refinements. In general, new development should finance the construction of new facilities necessary to prevent additional problems. When facilities must be constructed to correct existing problems the costs should be equitably distributed throughout the entire City.

New Development

The storm water management plan identifies the costs of facilities necessary to prevent additional problems as the result of new development. Future development can be assessed a fee to provide a fund which finances these facilities based on their impact. Using the same approach identified in the previous master plan, the total cost of required facilities is divided by the total impervious area proposed by new developments. The resulting costs per acre of impervious land will be assessed to all future developments. This fund will be used to generate the revenues necessary for the construction of new facilities. An appropriate inflation factor should be included to offset the escalation of anticipated construction costs. Table 8-1 presents the computation of the assessment per acre of impervious area for each major drainage basin and also provides a City wide average. The costs presented are in current dollars, therefor an inflation factor should be applied to the assessment cost annually. Table 8-2 presents the assessment per land use category.

Table 8-1 Assessment Cost per Basin

Basin	Basin Area (acres)	Vacant Area (acres)	Impervious Area (1) (acres)	Improvement Cost ($)	Assessment Cost(2) ($/Imp. acre)	Assessment Cost ($/Gross Vacant acres)
Cameron Creek	4,767	4,688	1,576	6,606,219	4,192	1,409
Evans Ditch	1,607	423	195	614,551	3,152	1,453
Goshen Drain	3,243	1,654	882	7,374,328	8,361	4,458
Mill Creek	6,149	1,306	415	2,144,189	5,167	1,642
Modoc Ditch	8,247	6,872	3,371	17,336,050	5,143	2,523
Packwood Creek	5,886	2,756	1,057	6,760,786	6,396	2,453
Persian Watson	1,626	1,345	179	341,159	1,906	254
St. John's	3,393	2,809	506	4,532,799	8,958	1,614
Total	**34,918**	**21,853**	**8,181**	**45,710,081**	**5,587**	**2,092**

(1) Impervious Area=Area x Percent Impervious (see Land Use Drainage Basin Summary Reports)

Percent Impervious values for various land use categories are shown in Table 3-4.

(2) Costs are for future development & do not include cost to upgrade existing deficiencies.

Table 8-2 Assessment Cost Per Land Use

Land Use A79-1036.XLS	Code	Vacant Area (acres)	Percent Impervious (%)	Impervious Area (acres)	Rate per Gross Vacant Acre ($/acre)
RURAL	RA	891	20	178	1,132
LOW DENSITY	LDR	7,245	43	3,115	2,433
MEDIUM DENSITY	MDR	440	70	308	3,960
HIGH DENSITY	HDR	155	80	124	4,526
TOTAL RESIDENTIAL		8,730	42.67	3,725	2,414
CONVENIENCE CENTER	CC	17	95	16	5,375
NEIGHBORHOOD CENTER	CNC	15	85	12	4,809
SHOPPING/OFFICE CENTER	CSO	113	80	91	4,526
COMMUNITY CENTER	CCM	199	75	149	4,243
REGIONAL CENTER	CR	257	90	232	5,092
HIGHWAY	CH	120	95	114	5,375
SERVICE	CS	121	95	115	5,375
PROFESSIONAL/ADMINISTRATIO	PA	577	70	404	3,960
TOTAL COMMERCIAL/OFFICE		1,418	79.81	1,132	4,515
PUBLIC/INSTITUTIONAL	PI	636	60	381	3,395
TOTAL COMMUNITY FACILITIES		636	60	381	3,395
LIGHT	IL	284	80	227	4,526
HEAVY	IH	1,968	90	1,771	5,092
TOTAL INDUSTRY		2,252	88.74	1,998	5,021
AGRICULTURE	OSA	1,778	1	18	57
CONSERVATION	OSC	933	1	9	57
PARKS	OSP	908	15	136	849
TOTAL OPEN SPACE		3,619	4.51	163	255
URBAN RESERVE	UR	5,200	15	780	849
TOTAL URBAN RESERVE		5,200	15	780	849
TOTAL STUDY AREA		21,855	37.43	8,180	2,118

Existing Development

The cost to upgrade existing drainage deficiencies is estimated to be about $4,700,000. This includes $4,650,000 to upgrade Mill Creek and $50,000 for pumps in Modoc Drainage Basin. Funds should be developed to correct those problems from the City budget. This is the approach currently being used by the City and is consistent with the concept of allocating remedial costs over the entire City. The City currently has a storm drainage utility fee of $0.75 per month for all developed properties. The revenue generated by this fee is used for the City's storm drainage operations and maintenance activities.

DRAINAGE UTILITY

A nationwide trend has evolved which generates revenues for the construction of drainage improvements and maintenance activities through the use of a drainage utility fee. With this concept, drainage fees are assessed in a manner similar to a sewer utility or a water utility. Properties are assessed based on their contribution to runoff within the City. The utility fee is a function of percent impervious of the property and the size of the parcel.

In general, single family residences are assigned a flat rate regardless of lot size or impervious area. Commercial and industrial properties are assigned a rate based on their actual impervious area. Revenues from this utility fee serve to finance maintenance and to provide a resource to make necessary capital improvements. The magnitude of the actual assessment is a function of maintenance cost and a capital improvement schedule based on the identified master plan facilities.

An option to using a utility fee to generate funds for capital improvements is to finance maintenance costs with the fee and to use the general fund for capital improvements as the need arises. This approach, while workable, does not take full advantage of the drainage utility concept and is not necessarily the most preferred plan.

As mentioned in the previous section, the City has a drainage utility fee of $0.75 per month for all developed property to cover operation and maintenance costs.

CONCLUSIONS

A development fee should be assessed to all new developments to develop an operating fund to finance the construction of facilities necessary to prevent additional problems within the City of Visalia. Upgrading the existing deficiencies, primarily in Mill Creek, can be funded through general funds. The City should continue the drainage charges for all developed property to finance operation and maintenance activities.

ADDENDUM
to
SECTIONS 7 & 8

This **Addendum to Sections 7 and 8** has been included with the Storm Water Master Plan because the City of Visalia developed alternative costs, capital improvement programs (CIPs), and scenarios for funding the recommended improvements. The City's improvement costs and CIPs supersede the material presented in Section 7.0 of the Master Plan, while the City's funding approaches supersede the financing material presented in Section 8.0. The City's CIPs, Master Plan costs, and funding scenarios are discussed below.

Capital Improvement Projects

The City developed Capital Improvement Programs (for the pipeline improvements recommended in the Master Plan) with the premise that specific improvements would be installed by the City and the remaining improvements would be installed by private developers. This distinction between "City-installed" and "developer-installed" projects was made because developers typically can install storm drain lines at a lower cost than the City, and developer projects generally do not include the acquisition of additional right-of-way or cutting and patching of existing pavement (as many City projects do).

The designated "City-installed" projects typically consist of the lines that will be needed to take care of existing deficiencies and the lines that have to be installed through developed areas to serve future development. The "developer-installed" lines are the lines that typically will be installed in undeveloped areas to serve specific development projects.

The cost of "developer-installed" sewer line projects were based on unit pipe costs that were established by staff (with input from the local development community) and unit manhole costs established by Boyle (that vary with depth and pipe diameter). The unit pipe costs that were used by the City to establish the cost of "developer-installed" projects are as follows:

"Developer-Installed" Unit Storm Drain Pipe Costs

Diameter (in)	Cost ($/ft)
18	32 (RCP)
24	42 (RCP)
27	47 (RCP)
30	37 (CIP)
36	43 (CIP)
42	50 (CIP)
48	57 (CIP)
54	64 (CIP)
60	71 (CIP)
72	85 (CIP)

RCP: Re-enforced concrete pipe (with rubber gaskets)
CIP: Cast-in-place concrete pipe

Note that the "developer-installed" unit costs include material (pipe and manhole) and installation costs. They do not include a cost for roadwork because it is assumed that "developer" projects generally will be in non-urban settings and require the construction of new roadways.

Cost estimates for identified "City-installed" projects were determined on a project-by-project basis. These project costs were based on pipe costs that included material (pipe and manholes) and installation costs, costs for cutting and patching of existing roadways, and costs for traffic control measures. The unit pipe costs that were used to establish the total cost of the "City-installed" projects are as follows:

"City-Installed" Unit Storm Drain Pipe Costs

Diameter (in)	Cost ($/ft) HWCP	Cost ($/ft) RCP	Cost ($/ft) CIP
18	25-30	40	-
24	35-40	75	
30	-	-	-
36	-	90	-
42	-	90-175	-
48	-	120	50
54	-	130-175	65
60		200	

HWCP: Heavy-walled concrete pipe
RCP: Re-enforced concrete pipe (with rubber gaskets)
CIP: Cast-in-place concrete pipe

Based on these unit pipe costs, the City developed a "Developer-Installed" Pipeline Capital Improvement Program and a "City-installed" Pipeline Capital Improvement Program. These CIPs are presented at the end of this Addendum.

It should be noted that the master planned improvements were designated as "City-installed" and "developer-installed" projects for the purpose of estimating the total cost of the improvements. However, it is recognized that some of the designated "City-installed" improvements may be installed by developers and some of the "developer-installed" improvements may be installed by the City.

Master Plan Improvement Costs

The improvements recommended in the Master Plan include water storage basins, pipelines, and channel widening. The cost of these improvements was developed for each of the drainage areas established by the Master Plan. The pipeline costs were obtained from the Capital Improvement Programs discussed above. The water storage basin costs were based on land, excavation, landscaping, and pump quantities presented in the Master Plan. The channel widening costs also were based on Master Plan excavation and right-of-way quantities. A summary of the total improvement costs for each drainage area and a summary of the costs for each water storage basin follow the CIPs presented at the end of this Addendum.

A summary of the total city-wide pipeline, basin, and channel widening costs is presented below. This summary also indicates how much of the total cost is needed to take care of existing deficiencies and how much is needed for the improvements that will serve future development.

Master Plan Cost Summary

	Existing Deficiencies	Future Development	Total
Developer Installed Pipe:	$0	$13,068,650	$13,068,650
City Installed Pipe:	$898,150	$5,682,898	$6,581,048
Storm Water Basins:	$4,306762	$10,621,492	$14,928,254
Channel Widening:	$0	$3,548,297	$3,548,297
Total:	**$5,204,912**	**$32,921,337**	**$38,126,249**

The $32.92 million total cost of improvements for future development includes $2.47 million of improvements in the northwest "Industrial Park" area and $4.63 million of improvements in areas designated as "Urban Reserve". The City determined that these costs should be separated from the total improvement cost (for the purpose of establishing impact fees).

The cost of "Industrial Park" improvements were excluded from the total cost because industrial properties are required to retain storm water runoff on-site. However, the Master Plan does recommend a system of improvements to drain the streets and frontage of industrial properties (in the Industrial Park). A CIP for the Industrial Park Master Plan improvements also is presented at the end of this Addendum.

The cost of "Urban Reserve" improvements were excluded from the total cost because the actual size of the improvements cannot be determined until the "reserve" areas are designated for a particular urban use and the costs cannot be allocated until the urban uses are established.

The net cost of the Master Plan improvements (for future development), excluding the cost of improvements for the Industrial Park and "Urban Reserve" areas, is as follows:

Total Cost of Improvements:	$32,921,000
less Cost of Industrial Park Improvements:	$2,466,000
less Cost of Urban Reserve Improvements:	$4,626,000
Net Total Cost:	**$25,829,000**

It was assumed that all of the improvements would be installed on a "pay as you go" basis and not require bonding by the City. Therefore, no debt service costs were included in the Master Plan improvement costs.

Funding Alternatives

The City considered five alternative combinations of developer impact fees and monthly utility payments to fund the $25.83 million in master plan improvements. These alternatives are as follows:

1) Fund 100% of the remaining improvement costs with developer impact fees. No increase in monthly rates.

2) Fund 75% of the remaining improvement costs ($19.37 million) with developer impact fees and fund 25% of the cost with an increase in monthly rates.

3) Fund approximately 60% of the remaining improvement costs ($15.50 million) with developer impact fees and fund 40% of the cost with an increase in monthly rates.

4) Fund 50% of the remaining improvement costs ($12.91 million) with developer impact fees and fund 50% of the cost with an increase in monthly rates.

5) Fund 100% of the remaining improvement costs with an increase in monthly rates. No impact fees.

It should be noted that the City intends to fund the improvements needed to upgrade the identified existing deficiencies with an increase of $0.54 in the monthly Storm Drain Utility rates (effective July 1, 1995). The current rate for all developed parcels in Visalia is $0.75 per month.

The developer impact fees and monthly rate increases for the identified funding alternatives are presented below (for single-family residences).

Funding Alternative Impact Fees and Monthly Rate Increases
(for single-family residences)

	Existing	100% Impact Fees	75% Impact Fees	60% Impact Fees	50% Impact Fees	0% Impact Fees
Impact Fee ($/unit)	$1,075	$628	$471	$377	$314	$0
Monthly Rate Increase[1] ($/unit/month)	$0.75[2]	$0.54	$1.21	$1.62	$1.89	$3.23

Note: The fees for a single-family residential unit are based on a density of four units per acre. To obtain the actual "per acre" fee, multiply the "per unit" fee by four.

1 The monthly rate increases include $0.54 to upgrade existing deficiencies.
2 Existing monthly rate for all developed parcels in Visalia.

A graphical representation of the residential impact fees and monthly rate increases for the identified alternatives is displayed in Figure A-1. The impact fees that would be charged for other land uses are presented for each of the funding alternatives in Table A-1. The alternative fees for non-low density residential (LDR) uses were obtained by applying the ratio of "the percent impervious value for a non-LDR use to the percent impervious value for LDR uses" to the fee for LDR uses.

Industrial Development

The total cost of the Master Plan improvements that serve the northwest industrial area is $2.47 million. New development will totally fund the installation of the Master Plan improvements with an impact fee of $819 per gross acre of undeveloped land. The monthly utility rate for industries in the Industrial Park area will not be increased to fund the installation of Master Plan improvements.

Industrial development outside of the Industrial Park will be subject to the impact fees that were established for the "100 percent Impact Fee" funding alternative (Refer to Table A-1). The monthly utility rates for these industries will not be increased to fund Master Plan improvements.

City Council Action

City staff presented these Master Plan funding alternatives to the City Council at a work session on April 18, 1994, that also was attended by representatives of the development community.

On November 21, 1994, the City Council adopted the Storm Water Master Plan with Resolution No. 94-170.

On November 21, 1994, the City Council also voted to fund 75 percent of the cost of the Master Plan improvements needed to serve future development (excluding the Industrial Park area) with developer impact fees and fund 25 percent of the cost of the improvements with a city-wide increase in the monthly utility rates. New development in the industrial park will fund the installation of the Master Plan improvements with an impact fee of the $819 per gross acre of undeveloped land. The monthly utility rate for industries in the Industrial Park area will not be increased to fund the installation of Master Plan improvements.

The new developer impact fees were adopted with Resolution No. 94-171. These fees, which are presented in Table A-2, are effective as of November 22, 1994. The proposed increase ion the monthly utility rates will become effective on July 1, 1995. At that time, it is expected that the utility rate for a single-family residential unit will be increased $1.21 per month.

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BASIN	REACH	LOCATION	LIMITS	PIPE LENGTH (ft)	PIPE DIAM. (in)	PIPE TYPE	PIPE UNIT COST ($/ft)	TOTAL PIPE COST ($)	BORE DIST (ft)	BORE UNIT COST ($/ft)	TOTAL BORE COST ($)	MISC. FACILITIES ($)	SUB-TOTAL ($)	20% CONT.	TOTAL ($)	
CAMERON CREEK	0014-0015	Caldwell	Rd 148 to McAuliff	2,566	30	CIP	37	94,942	0	0	0	0	94,942	18,988	113,930	
	0015-0004	Caldwell	McAuliff to Lovers Lane	2,758	42	CIP	50	137,900	0	0	0	0	137,900	27,580	165,480	
	0016-0017	Ave 276	Rd 148 to McAuliff	2,581	36	CIP	43	110,983	0	0	0	0	110,983	22,197	133,180	
	0017-0018	Ave 276	McAuliff to Lovers Lane	2,629	48	CIP	57	149,853	0	0	0	0	149,853	29,971	179,824	
	0018-0005	Ave 276	Lovers Lane to Cam. Cr	3,297	60	CIP	71	234,087	0	0	0	0	234,087	46,817	280,904	
	0020-0021	Ave 272	County Cntr east	1,249	24	RCP	42	52,458	0	0	0	0	52,458	10,492	62,950	
	0021-0012	1/4 mi w/o Mny	Ave 272 south	1,821	48	CIP	57	103,797	0	0	0	0	103,797	20,759	124,556	
	0101-0102	1/4 mi e/o R148	Tulare south	1,638	30	CIP	37	60,606	0	0	0	0	60,606	12,121	72,727	
	0103-0104	Walnut	e/o Rd 148	1,597	30	CIP	37	59,089	0	0	0	0	59,089	11,818	70,907	
	0105-0002	K Road	e/o Rd 148	2,830	30	CIP	37	104,710	0	0	0	0	104,710	20,942	125,652	
	0106-0003	McAuliff	Walnut to Cameron Creek	2,836	36	CIP	43	121,948	0	0	0	0	121,948	24,390	146,338	
	0107-0014	Caldwell	e/o Rd 148	1,871	30	CIP	37	69,227	0	0	0	0	69,227	13,845	83,072	
	0108-0004	Lovers Lane	n/o Caldwell	1,918	48	CIP	57	109,326	0	0	0	0	109,326	21,865	131,191	
	0109-0016	Ave 276	e/o Rd 148	1,954	30	CIP	37	72,298	0	0	0	0	72,298	14,460	86,758	
	0110-0006	Ben Maddox	n/o Cameron Creek	2,492	42	CIP	50	124,600	0	0	0	0	124,600	24,920	149,520	
	0111-0006	Ben Maddox	s/o Cameron Creek	970	48	CIP	57	55,290	0	0	0	0	55,290	11,058	66,348	
	0112-0007	Santa Fe	n/o Cameron Creek	2,381	48	CIP	57	135,717	0	0	0	0	135,717	27,143	162,860	
	0113-0007	Santa Fe	s/o Cameron Creek	1,196	30	CIP	37	44,252	0	0	0	0	44,252	8,850	53,102	
	0114-0008	West	n/o Cameron Creek	3,921	42	CIP	50	196,050	0	0	0	0	196,050	39,210	235,260	
	0115-0009	Giddings align.	n/o Cameron Creek	2,752	42	CIP	50	137,600	0	0	0	0	137,600	27,520	165,120	
			SUBTOTAL:	45,257				2,174,733			0	0	2,174,733	434,947	**2,609,680**	SUBTOTAL
EVANS DITCH	NO DEVELOPER INSTALLED FACILITIES			0				0	0	0	0	0	0	0	**0**	SUBTOTAL
GOSHEN DRAIN	0001-0002	Goshen Ave	Mooney to Cnty Cntr	2,624	48	CIP	57	149,568	0	0	0	0	149,568	29,914	179,482	
	0002-0003	Goshen Ave	Cnty Cntr to Demaree	2,726	60	CIP	71	193,546	0	0	0	0	193,546	38,709	232,255	
	0003-0004	Goshen Ave	w/o Demaree	773	72	CIP	85	65,705	0	0	0	0	65,705	13,141	78,846	
	0009-0010	Goshen Ave	Shirk to Basin S40	1,864	48	CIP	57	106,248	0	0	0	0	106,248	21,250	127,498	
	0017-0007	near Roeben	s/o Ferguson to S40	1,338	30	CIP	37	49,506	0	0	0	0	49,506	9,901	59,407	
	0101-0002	Cnty Cntr align	n/o Goshen Ave	2,624	48	CIP	57	149,568	0	0	0	0	149,568	29,914	179,482	
	0102-0003	Demaree	n/o Goshen Ave	1,986	48	CIP	57	113,202	0	0	0	0	113,202	22,640	135,842	
	0103-0005	Linwood	n/o Goshen Ave	2,874	42	CIP	50	143,700	0	0	0	0	143,700	28,740	172,440	
	0104-0006	Akers	n/o Goshen Ave	1,682	42	CIP	50	84,100	0	0	0	0	84,100	16,820	100,920	
	0105-0009	Shirk	n/o Goshen Ave	1,770	48	CIP	57	100,890	0	0	0	0	100,890	20,178	121,068	
	0107-0007	near Roeben	s/o Goshen Ave	3,003	30	CIP	37	111,111	0	0	0	0	111,111	22,222	133,333	
	0109-0009	Shirk	s/o Goshen Ave	2,763	30	CIP	37	102,231	0	0	0	0	102,231	20,446	122,677	
	0110-0010	Rd 88	s/o Goshen Ave	2,657	24	RCP	42	111,594	0	0	0	0	111,594	22,319	133,913	
	0113-0013	Rd 76	s/o Goshen Ave	2,603	24	RCP	42	109,326	0	0	0	0	109,326	21,865	131,191	
	0114-0015	Camp Dr	s/o Goshen "Ocean"	1,929	24	RCP	42	81,018	0	0	0	0	81,018	16,204	97,222	
			SUBTOTAL:	33,216				1,671,313			0	0	1,671,313	334,263	**2,005,576**	SUBTOTAL
MILL CREEK	0026-0027	w/o Lovers Ln	s/o Houston to S32	3,029	30	CIP	37	112,073	0	0	0	0	112,073	22,415	134,488	
	0028-0029	w/o Ben Mddx	Houston to S33	2,789	30	CIP	37	103,193	0	0	0	0	103,193	20,639	123,832	
	0101-0029	Goshen Ave	near Cain to S33	2,399	54	CIP	64	153,536	0	0	0	0	153,536	30,707	184,243	
			SUBTOTAL:	8,217				368,802			0	0	368,802	73,760	**442,562**	SUBTOTAL
MODOC DITCH	0026-0004	Conyer	Ferguson to S2	1,650	36	CIP	43	70,950	0	0	0	0	70,950	14,190	85,140	
	0027-0028	Riggin	Dinuba Blvd to Giddings	2,583	48	CIP	57	147,231	0	0	0	0	147,231	29,446	176,677	
	0029-0006	Riggin	Mooney to Modoc Dt	1,649	72	CIP	85	140,165	0	0	0	0	140,165	28,033	168,198	
	0030-0031	w/o Cnty Cntr	County Center to S4	683	48	CIP	57	38,931	0	0	0	0	38,931	7,786	46,717	
	0032-0033	Demaree	n/o S4	1,551	42	CIP	50	77,550	0	0	0	0	77,550	15,510	93,060	
	0034-0035	n/o Riggin	S4 to S3	2,078	24	RCP	42	87,276	0	0	0	0	87,276	17,455	104,731	
	0036-0010	Linwood	Ave 320 to S3	3,863	36	CIP	43	166,109	0	0	0	0	166,109	33,222	199,331	
	0037-0012	Akers	Ave 320 to Ave 316	2,690	30	CIP	37	99,530	0	0	0	0	99,530	19,906	119,436	
	0038-0011	Akers	Riggin to Modoc Ditch	1,737	42	CIP	50	86,850	0	0	0	0	86,850	17,370	104,220	
	0039-0013	Roeben	Riggin to Modoc Ditch	2,634	36	CIP	43	113,262	0	0	0	0	113,262	22,652	135,914	
	0040-0014	Shirk	Riggin to Modoc Ditch	2,120	48	CIP	57	120,840	0	0	0	0	120,840	24,168	145,008	
	0042-0015	Rd 88	Riggin to Modoc Ditch	2,385	24	RCP	42	100,170	0	0	0	0	100,170	20,034	120,204	
	0044-0016	Rd 84	Riggin to Modoc Ditch	2,634	24	RCP	42	110,628	0	0	0	0	110,628	22,126	132,754	
	0045-0046	Plaza	Ferguson to Riggin	2,627	18	RCP	32	84,064	0	0	0	0	84,064	16,813	100,877	
	0046-0017	Plaza	Riggin to Modoc Ditch	2,675	24	RCP	42	112,350	0	0	0	0	112,350	22,470	134,820	

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	0047-0048	Road 76	Ferguson to Riggin	2,595	18	RCP	32	83,040	0	0	0	0	83,040	16,608	99,648	
	0048-0018	Road 76	Riggin to Modoc Ditch	2,701	24	RCP	42	113,442	0	0	0	0	113,442	22,688	136,130	
	0049-0050	Road 72	Ferguson to Riggin	2,564	18	RCP	32	82,048	0	0	0	0	82,048	16,410	98,458	
	0050-0019	Road 72	Riggin to Modoc Ditch	2,710	36	CIP	43	116,530	0	0	0	0	116,530	23,306	139,836	
	0101-0027	Riggin	w/o Dinuba Blvd	1,552	48	CIP	57	88,464	0	0	0	0	88,464	17,693	106,157	
	0102-0027	Dinuba Blvd	n/o Riggin	2,028	48	CIP	57	115,596	0	0	0	0	115,596	23,119	138,715	
	0103-0028	Giddings	n/o Riggin	2,023	48	CIP	57	115,311	0	0	0	0	115,311	23,062	138,373	
	0104-0105	Mooney	n/o Pratt	1,303	48	CIP	57	74,271	0	0	0	0	74,271	14,854	89,125	
	0105-0029	Mooney	Pratt to Riggin	3,285	48	CIP	57	187,245	0	0	0	0	187,245	37,449	224,694	
	0106-0107	Cnty Center	n/o Pratt	1,302	48	CIP	57	74,214	0	0	0	0	74,214	14,843	89,057	
	0107-0030	Cnty Center	s/o Pratt	1,690	48	CIP	57	96,330	0	0	0	0	96,330	19,266	115,596	
	0108-0007	Cnty Center	s/o Riggin	1,841	42	CIP	50	92,050	0	0	0	0	92,050	18,410	110,460	
	0109-0032	Demaree	s/o Ave 320	2,213	42	CIP	50	110,650	0	0	0	0	110,650	22,130	132,780	
	0110-0008	Demaree	Ferguson to Riggin	2,046	42	CIP	50	102,300	0	0	0	0	102,300	20,460	122,760	
	0111-0112	Linwood	s/o St Johns River	1,936	36	CIP	43	83,248	0	0	0	0	83,248	16,650	99,898	
	0112-0036	Linwood	n/o and s/o Ave 320	2,036	36	CIP	43	87,548	0	0	0	0	87,548	17,510	105,058	
	0113-0010	Linwood	Fergusno to S3	3,260	48	CIP	57	185,820	0	0	0	0	185,820	37,164	222,984	
	0114-0115	Akers	s/o St Johns River	2,082	30	CIP	37	77,034	0	0	0	0	77,034	15,407	92,441	
	0115-0037	Akers	n/o Ave 320	1,543	30	CIP	37	57,091	0	0	0	0	57,091	11,418	68,509	
	0116-0038	Akers	Ferguson to Riggin	2,161	42	CIP	50	108,050	0	0	0	0	108,050	21,610	129,660	
	0117-0013	Roeben	n/o Modoc Ditch	1,294	30	CIP	37	47,878	0	0	0	0	47,878	9,576	57,454	
	0118-0039	Roeben	Ferguson to Riggin	2,079	36	CIP	43	89,397	0	0	0	0	89,397	17,879	107,276	
	0119-0014	Shirk	n/o Modoc Ditch	1,799	24	RCP	42	75,558	0	0	0	0	75,558	15,112	90,670	
	0120-0040	Shirk	Ferguson to Riggin	2,093	48	CIP	57	119,301	0	0	0	0	119,301	23,860	143,161	
	0121-0015	Rd 88	n/o Modoc Ditch	1,568	24	RCP	42	65,856	0	0	0	0	65,856	13,171	79,027	
	0123-0016	Rd 84	n/o Modoc Ditch	1,292	18	RCP	32	41,344	0	0	0	0	41,344	8,269	49,613	
	0125-0017	Plaza	n/o Modoc Ditch	1,267	18	RCP	32	40,544	0	0	0	0	40,544	8,109	48,653	
	0127-0018	Rd 76	n/o Modoc Ditch	1,218	18	RCP	32	38,976	0	0	0	0	38,976	7,795	46,771	
	0128-0047	Rd 76	s/o Ferguson	1,250	18	RCP	32	40,000	0	0	0	0	40,000	8,000	48,000	
			SUBTOTAL:	90,290				4,165,042			0	0	4,165,042	833,008	**4,998,050**	SUBTOTAL
PACKWOOD CR	0025-0026	McAuliff	SR 198 to S14	2,594	42	CIP	50	129,700	0	0	0	0	129,700	25,940	155,640	
	0027-0028	Pinkham	S43 to S42	2,283	18	RCP	32	73,056	0	0	0	0	73,056	14,611	87,667	
	0033-0020	Linwood	n/o Ave 276 to PC	3,602	42	CIP	50	180,100	0	0	0	0	180,100	36,020	216,120	
	0034-0035	Akers	Ave 276 to Ave 272	2,519	36	CIP	43	108,317	0	0	0	0	108,317	21,663	129,980	
	0035-0021	Akers	Ave 272 to PC	1,228	42	CIP	50	61,400	0	0	0	0	61,400	12,280	73,680	
	0051-0010	Santa Fe	S44 to PC	2,278	18	RCP	32	72,896	0	0	0	0	72,896	14,579	87,475	
	0101-0025	McAuliff	n/o SR 198	1,182	42	CIP	50	59,100	0	0	0	0	59,100	11,820	70,920	
	0102-0003	Tulare	Rd 148 to McAuliff (S14)	2,390	36	CIP	43	102,770	0	0	0	0	102,770	20,554	123,324	
	0103-0003	McAuliff	Walnut to Tulare (S14)	2,029	42	CIP	50	101,450	0	0	0	0	101,450	20,290	121,740	
	0104-0027	Pinkham	Caldwell to S43	1,753	42	CIP	50	87,650	0	0	0	0	87,650	17,530	105,180	
	0105-0033	Linwood	s/o Caldwell	989	42	CIP	50	49,450	0	0	0	0	49,450	9,890	59,340	
	0106-0034	Akers	s/o Caldwell to Ave 276	1,818	36	CIP	43	78,174	0	0	0	0	78,174	15,635	93,809	
			SUBTOTAL:	24,665				1,104,063			0	0	1,104,063	220,813	**1,324,876**	SUBTOTAL
PERSIAN/WATSON	0008-0004	n/o Walnut	Shirk to PWD	3,136	24	RCP	42	131,712	0	0	0	0	131,712	26,342	**158,054**	SUBTOTAL
ST JOHNS RIVER	0001-0002	Rd 148	Houston to S35	1,720	30	CIP	37	63,640	0	0	0	0	63,640	12,728	76,368	
	0101-0001	Houston	n/o Goshen to Houston	2,508	30	CIP	37	92,796	0	0	0	0	92,796	18,559	111,355	
	0102-0103	n/o Houston	e/o Rd 152	1,811	36	CIP	43	77,873	0	0	0	0	77,873	15,575	93,448	
	0103-0002	n/o Houston	e/o Rd 148 (S35)	2,406	36	CIP	43	103,458	0	0	0	0	103,458	20,692	124,150	
	0104-0002	n/o Houston	e/o McAuliff to S35	2,533	36	CIP	43	108,919	0	0	0	0	108,919	21,784	130,703	
	0105-0016	Rd 148	n/o Riggin	2,451	30	CIP	37	90,687	0	0	0	0	90,687	18,137	108,824	
	0106-0016	Rd 148	s/o Riggin	1,817	24	RCP	42	76,314	0	0	0	0	76,314	15,263	91,577	
	0107-0017	McAuliff	n/o Riggin	2,447	30	CIP	37	90,539	0	0	0	0	90,539	18,108	108,647	
	0108-0017	McAuliff	s/o Riggin	1,778	24	RCP	42	74,676	0	0	0	0	74,676	14,935	89,611	
	0109-0018	Lovers Lane	n/o Riggin	2,466	30	CIP	37	91,242	0	0	0	0	91,242	18,248	109,490	
	0110-0018	Lovers Lane	s/o Riggin	1,757	24	RCP	42	73,794	0	0	0	0	73,794	14,759	88,553	
	0111-0019	Pinkham	n/o Riggin	2,497	30	CIP	37	92,389	0	0	0	0	92,389	18,478	110,867	
	0112-0019	Pinkham	s/o Riggin	1,756	24	RCP	42	73,752	0	0	0	0	73,752	14,750	88,502	
	0113-0020	Ben Maddox	n/o Riggin	2,528	30	CIP	37	93,536	0	0	0	0	93,536	18,707	112,243	
	0114-0022	Santa Fe	s/o Ave 316 to S36	1,926	30	CIP	37	71,262	0	0	0	0	71,262	14,252	85,514	
			SUBTOTAL:	32,401				1,274,877			0		1,274,877	254,975	**1,529,852**	SUBTOTAL
				237,182				10,890,542			0	**0**	10,890,542	2,178,108	**13,068,650**	**TOTAL**

STORM WATER MASTER PLAN
CAPITAL IMPROVEMENT PROGRAM
FOR
CITY-INSTALLED PIPELINE PROJECTS
(CITY-WIDE)

BASIN	REACH	LOCATION	LIMITS	PIPE LENGTH (ft)	PIPE DIAM. (in)	PIPE TYPE	PIPE UNIT COST ($/ft)	TOTAL PIPE COST ($)	BORE DIST (ft)	BORE UNIT COST ($/ft)	TOTAL BORE COST ($)	MISC. FACILITIES ($)	SUB-TOTAL ($)	15% CONT.	TOTAL ($)	
CAMERON CREEK	0116-0011	Mooney	s/o Packwood to Cam. Cr	4,500	42	RCP	175	787,500	0	0	0	50,000	837,500	125,625	963,125	SUBTOTAL
EVANS DITCH		NO CITY INSTALLED FACILITIES		0				0	0	0	0	0	0	0	0	SUBTOTAL
GOSHEN DRAIN	0006-0007	Goshen Ave	Akers to Basin 40	3,200	48	CIP	50	160,000	0	0	0	0	160,000	24,000	184,000	
	0008-0010	Goshen Ave	Basin 40 to Rd 88	4,600	48	CIP	50	230,000	0	0	0	0	230,000	34,500	264,500	
	0010-0012	Goshen Ave	Rd 88 to Plaza	5,200	48	CIP	50	260,000	0	0	0	0	260,000	39,000	299,000	
				200	48	RCP	120	24,000	0	0	0	0	24,000	3,600	27,600	
								0			0	110,000	110,000	16,500	126,500	
													784,000	117,600	901,600	subtotal
	0011-south	Road 84	1/4 mile s/o Goshen	1,300	18	HWCP	25	32,500	0	0	0	5,000	37,500	5,625	43,125	
	0112-0012	Plaza Dr	N.B. Mill Ck to Goshen	2,600	24	RCP	75	195,000	0	0	0	20,000	215,000	32,250	247,250	
													1,036,500	155,475	1,191,975	SUBTOTAL
MILL CREEK																
Existing Deficiencies	0031-0006	Santa Fe	Mineral King to Mill Creek	1,500	36	RCP	90	135,000	0	0	0	22,500	157,500	23,625	181,125	
	0032-0007	Conyer	Murray to Mill Creek	2,000	54	RCP	130	260,000	0	0	0	32,000	292,000	43,800	335,800	
	0034-0008	Mooney	Mineral King to Mill Creek	1,600	54	RCP	150	240,000	0	0	0	17,500	257,500	38,625	296,125	
	0035-0009	County Center	S.H. 198 to Mill Creek	300	36	RCP	90	27,000	0	0	0	7,000	34,000	5,100	39,100	
	0036-0014	Parkwood	Willow Glen Basin to Mill Cr	1,000	18	HWCP	30	30,000	0	0	0	10,000	40,000	6,000	46,000	
												89,000	781,000	117,150	898,150	SUBTOTAL
Future Development	0039-0015	Cottonwood	Basin 34 to Mill Creek	1,500	24	HWCP	40	60,000	350	200	70,000	10,000	140,000	21,000	161,000	
	0037-0038	1/4 mile s/o 19[illegible]	to Basin 34	3,000	54	CIP	65	195,000			0		195,000	29,250	224,250	
				110	54	RCP	175	19,250			0		19,250	2,888	22,138	
								0			0	15,000	15,000	2,250	17,250	
													229,250	34,388	263,638	subtotal
	0102-0020	Road 84	1/4 mi n/o of 189 to Mill Cr	1,400	54	RCP	130	182,000			0		182,000	27,300	209,300	
				1,100	54	CIP	65	71,500			0		71,500	10,725	82,225	
								0	350	400	140,000	0	140,000	21,000	161,000	
								0			0	9,000	9,000	1,350	10,350	
								0			0		402,500	60,375	462,875	subtotal
	0103-0020	Road 84	Aviation Way to Mill Creek	2,900	24	HWCP	35	101,500			0	11,000	112,500	16,875	129,375	
													884,250	132,638	1,016,888	SUBTOTAL
MODOC DITCH	0028-0029	Riggen	Giddings to Mooney	2,800	60	RCP	200	560,000	100	250	25,000	30,000	615,000	92,250	707,250	
	0122-0042	Road 88	Doe Ave to Riggen	3,700	18	HWCP	30	111,000			0		111,000	16,650	127,650	
				80	18	RCP	40	3,200			0		3,200	480	3,680	
								0			0	20,000	20,000	3,000	23,000	
								0			0		134,200	20,130	154,330	subtotal
	0124-0044	Road 84	Doe Ave to Riggen	3,800	18	RCP	40	152,000			0	20,000	172,000	25,800	197,800	
	0126-0045	Plaza	Doe Ave to Ferguson	1,200	18	RCP	40	48,000			0	10,000	58,000	8,700	66,700	
													979,200	146,880	1,126,080	SUBTOTAL
PACKWOOD CREEK	0028-0006	Pinkham	Basin 42 to Packwood Cr	1,700	24	RCP	75	127,500	80	200	16,000	10,000	153,500	23,025	176,525	
	0029-0008	Ben Maddox	Basin 22 to Packwood Cr	1,000	18	HWCP	25	25,000	80	120	9,600	10,000	44,600	6,690	51,290	
	0030-0013	Giddings	Basin 17 to Packwood Cr	1,000	24	RCP	75	75,000	110	160	17,600	10,000	102,600	15,390	117,990	
	0031-0032	Caldwell	w/o Demaree	1,000	24	RCP	75	75,000			0	6,000	81,000	12,150	93,150	
	0032-0019	Demaree	Caldwell to Packwood Cr	4,000	42	RCP	120	480,000	100	350	35,000	24,000	539,000	80,850	619,850	
													920,700	138,105	1,058,805	SUBTOTAL
PERSIAN/WATSON		NO CITY INSTALLED FACILITIES		0				0	0		0	0	0	0	0	SUBTOTAL
ST JOHNS RIVER	0005-0006	Lovers Lane	Houston to S.J. Parkway	1,700	24	RCP	75	127,500	0		0	16,000	143,500	21,525	165,025	
	0006-0008	S.J. Parkway	w/o Lovers Lane	1,400	42	RCP	90	126,000	0		0	14,000	140,000	21,000	161,000	
													283,500	42,525	326,025	SUBTOTAL
												TOTAL EXISTING DEFICIENCIES:	781,000	117,150	898,150	
												TOTAL FUTURE DEVELOPMENT:	4,941,650	741,248	5,682,898	
												TOTAL CITY-INSTALLED COSTS:	5,722,650	858,398	**6,581,048**	

STORM WATER MASTER PLAN
CAPITAL IMPROVEMENT PROGRAM
FOR THE
NORTHWEST INDUSTRIAL AREA

BASIN	REACH	LOCATION	LIMITS	CITY OR DEVELOPER (C/D)	PIPE LENGTH (ft)	PIPE DIAM. (in)	PIPE TYPE	PIPE UNIT COST ($/ft)	TOTAL PIPE COST ($)	BORE DIST (ft)	BORE UNIT COST ($/ft)	TOTAL BORE COST ($)	MISC. FACILITIES ($)	SUB-TTL ($)	CONT. (%)	CONT. ($)	TOTAL ($)	PERCENT INDUSTRIAL USE (%)	TOTAL INDUSTRIAL CITY-INSTLLD ($)	TOTAL INDUSTRIAL DVLPR-INSTLLD ($)
GOSHEN DRAIN	0109-0009	Shirk Road	Ave 302 to Goshen	D	2,763	30	CIP	37	102,231	0	0	0	0	102,231	20%	20,446	122,677	50.00%	0	61,339
	0110-0010	Road 88	Ave 302 to Goshen	D	2,657	24	RCP	42	111,594	0	0	0	0	111,594	20%	22,319	133,913	50.00%	0	66,956
	0009-0012	Goshen Ave	Shirk to Plaza	C	7,920	48	CIP	50	396,000	0	0	0	51,000	447,000	15%	67,050	514,050	6.60%	33,927	0
	0011-south	Road 84	1/4 mile s/o Goshen	C	2,600	18	HWCP	25	65,000	0	0	0	5,000	70,000	15%	10,500	80,500	50.00%	40,250	0
	0112-0012	Plaza Dr	N.B. Mill Ck to Goshen	C	2,600	24	RCP	75	195,000	0	0	0	20,000	215,000	15%	32,250	247,250	100.00%	247,250	0
	0113-0013	Road 76	Ave 300 to Goshen	D	2,603	24	RCP	42	109,326	0	0	0	0	109,326	20%	21,865	131,191	100.00%	0	131,191
	0114-0015	Camp	No. Br Mill Cr to Go. Basin	D	1,929	24	RCP	42	81,018	0	0	0	0	81,018	20%	16,204	97,222	100.00%	0	97,222
			SUBTOTAL:		23,072				1,060,169			0	76,000	1,136,169		190,634	1,326,803		321,427	356,708
																		TOTAL INDUSTRIAL GOSHEN BASIN:		678,135
MODOC DITCH	0122-0042	Road 88	Doe Ave to Riggen	C	3,700	18	HWCP	30	111,000	0	0	0	20,000	131,000	15%	19,650	150,650	100.00%	150,650	0
		Road 88	Doe Ave to Riggen	C	80	18	RCP	40	3,200	0	0	0	0	3,200	15%	480	3,680	100.00%	3,680	0
	0124-0044	Road 84	Doe Ave to Riggen	C	3,800	18	RCP	40	152,000	0	0	0	20,000	172,000	15%	25,800	197,800	100.00%	197,800	0
	0126-0045	Plaza	Doe Ave to Ferguson	C	1,200	18	RCP	40	48,000	0	0	0	10,000	58,000	15%	8,700	66,700	100.00%	66,700	0
	0045-0046	Plaza	Ferguson to Riggen	D	2,627	18	RCP	32	84,064	0	0	0	0	84,064	20%	16,813	100,877	100.00%	0	100,877
	0128-0048	Road 76	Doe to Ferguson	D	3,845	18	RCP	32	123,040	0	0	0	0	123,040	20%	24,608	147,648	100.00%	0	147,648
	0049-0050	Road 72	Ferguson to Riggen	D	2,564	18	RCP	32	82,048	0	0	0	0	82,048	20%	16,410	98,458	100.00%	0	98,458
	0042-0015	Road 88	Riggen to Modoc Ditch	D	2,385	24	RCP	42	100,170	0	0	0	0	100,170	20%	20,034	120,204	100.00%	0	120,204
	0121-0015	Road 88	Ave 318 to Modoc Ditch	D	1,568	24	RCP	42	65,856	0	0	0	0	65,856	20%	13,171	79,027	100.00%	0	79,027
	0044-0016	Road 84	Riggen to Modoc Ditch	D	2,634	24	RCP	42	110,628	0	0	0	0	110,628	20%	22,126	132,754	100.00%	0	132,754
	0123-0016	Road 84	Ave 318 to Modoc Ditch	D	1,292	18	RCP	32	41,344	0	0	0	0	41,344	20%	8,269	49,613	100.00%	0	49,613
	0046-0017	Plaza	Riggen to Modoc Ditch	D	2,675	24	RCP	42	112,350	0	0	0	0	112,350	20%	22,470	134,820	100.00%	0	134,820
	0125-0017	Plaza	Ave 318 to Modoc Ditch	D	1,267	18	RCP	32	40,544	0	0	0	0	40,544	20%	8,109	48,653	100.00%	0	48,653
	0048-0018	Road 76	Riggen to Modoc Ditch	D	2,701	24	RCP	42	113,442	0	0	0	0	113,442	20%	22,688	136,130	100.00%	0	136,130
	0127-0018	Road 76	Ave 318 to Modoc Ditch	D	1,218	18	RCP	32	38,976	0	0	0	0	38,976	20%	7,795	46,771	100.00%	0	46,771
			SUBTOTAL:		33,556				1,226,662			0	50,000	1,276,662		237,122	1,513,784		418,830	1,094,954
	0014-0018	DITCH CHANNEL IMPROVEMENTS		C	14,771	earthwork+row		103	1,527,321	0	0	0	0	1,527,321	20%	305,464	1,832,786	14.00%	256,590	0
	S23	Terminal Basin		C			earthwork		106,480	0	0	0	0	106,480	20%	21,296	127,776	14.00%	17,889	0
			SUBTOTAL:						1,633,801				0	1,633,801		326,760	1,960,562		274,479	0
																	SUBTOTAL MODOC BASIN		693,309	1,094,954
																		TOTAL INDUSTRIAL MODOC BASIN:		1,788,263
																		TOTAL INDUSTRIAL:		**2,466,398**

STORM WATER MASTER PLAN
COST SUMMARY
FOR THE
MASTER PLAN DRAINAGE AREAS

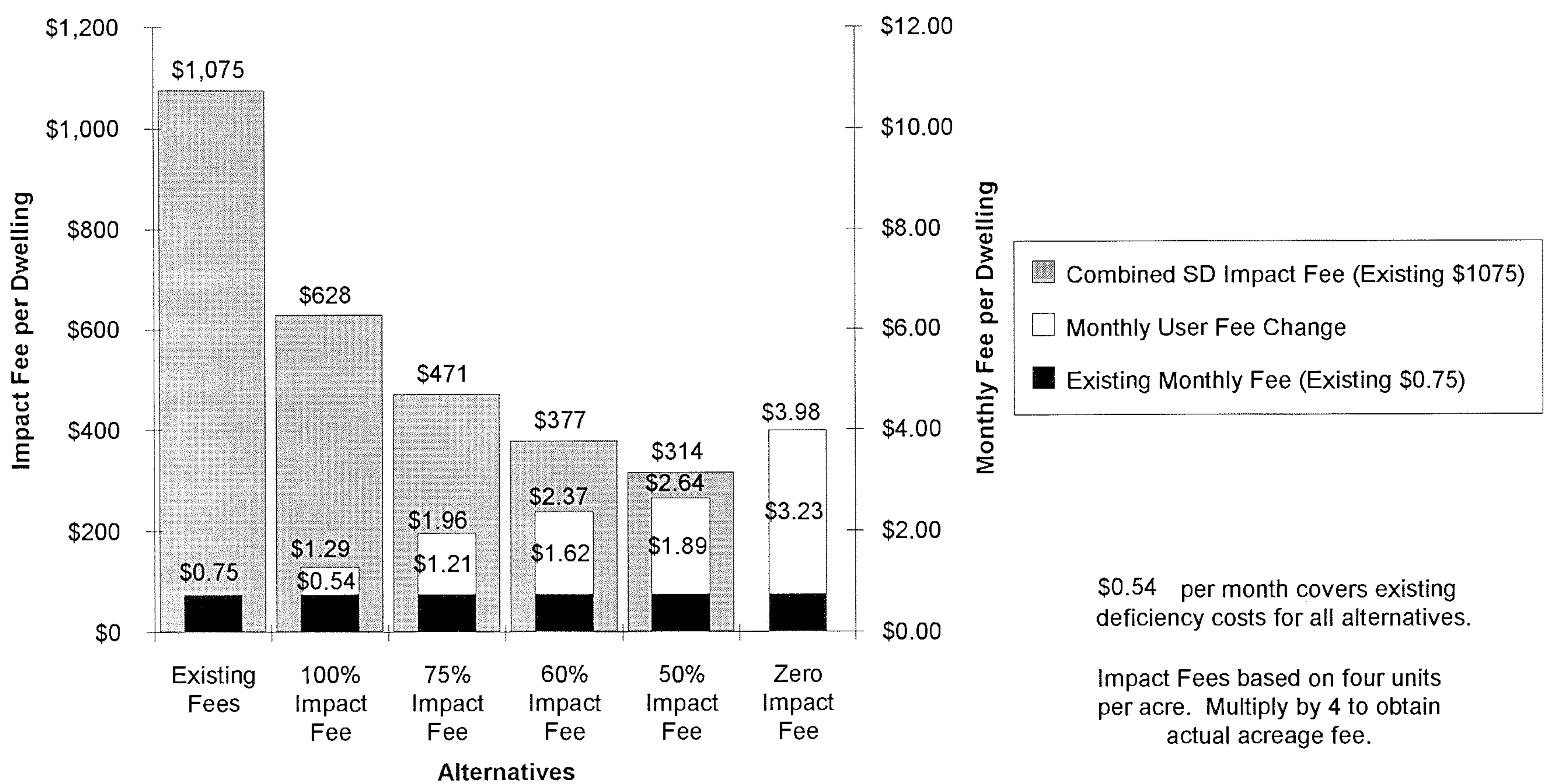
		PUMPS ($)	LAND-SCAPING ($)	LAND ($)	EARTH-WORKS ($)	BASIN SUBTOTAL ($)	20% CONT. ($)	BASIN TOTAL ($)	DEVELOPER INSTALLED PIPE ($)	20% CONT. ($)	EVELOPER INSTALLED PIPE TOTAL ($)	CITY INSTALLED PIPE&MISC FACILITIES ($)	15% CONT. ($)	CITY NSTALLED TOTAL ($)	CHANNEL WIDENING ROW ($)	CHANNEL WIDENING ERTHWRK ($)	CHANNEL WIDENING SUBTTL ($)	20% CONT. ($)	CHANNEL WIDENING TOTAL ($)	BASIN TOTAL ($)	
CAMERON CREEK	Existing Deficiencies	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Future Development	0	0	358,625	246,840	605,465	121,093	726,558	2,174,733	434,947	2,609,680	837,500	125,625	963,125	73,877	108,236	182,113	36,423	218,536	4,517,898	
	Subtotal:	0	0	358,625	246,840	605,465	121,093	726,558	2,174,733	434,947	2,609,680	837,500	125,625	963,125	73,877	108,236	182,113	36,423	218,536	4,517,898	SUB:
EVANS DITCH	Existing Deficiencies	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Future Development	105,000	328,800	257,400	153,270	844,470	168,894	1,013,364	0	0	0	0	0	0	0	0	0	0	0	1,013,364	
	Subtotal	105,000	328,800	257,400	153,270	844,470	168,894	1,013,364	0	0	0	0	0	0	0	0	0	0	0	1,013,364	SUB:
GOSHEN DRAIN	Existing Deficiencies	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Future Development	70,000	399,300	941,400	467,868	1,878,568	375,714	2,254,282	1,671,313	334,263	2,005,576	1,036,500	155,475	1,191,975	0	0	0	0	0	5,451,832	
	Subtotal	70,000	399,300	941,400	467,868	1,878,568	375,714	2,254,282	1,671,313	334,263	2,005,576	1,036,500	155,475	1,191,975	0	0	0	0	0	5,451,832	SUB:
MILL CREEK	Existing Deficiencies	105,000	455,700	1,555,000	325,894	2,441,594	488,319	2,929,913	0	0	0	781,000	117,150	898,150	0	0	0	0	0	3,828,063	
	Future Development	0	0	625,000	429,146	1,054,146	210,829	1,264,975	368,802	73,760	442,562	884,250	132,638	1,016,888	0	223,559	223,559	44,712	268,271	2,992,696	
	Subtotal	105,000	455,700	2,180,000	755,040	3,495,740	699,148	4,194,888	368,802	73,760	442,562	1,665,250	249,788	1,915,038	0	223,559	0	0	0	6,552,488	SUB:
MODOC DITCH	Existing Deficiencies	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Future Development	112,000	225,000	520,000	409,464	1,266,464	253,293	1,519,757	4,165,042	833,008	4,998,050	979,200	146,880	1,126,080	1,431,339	350,044	1,781,383	356,277	2,137,660	9,781,547	
	Subtotal	112,000	225,000	520,000	409,464	1,266,464	253,293	1,519,757	4,165,042	833,008	4,998,050	979,200	146,880	1,126,080	1,431,339	350,044	1,781,383	356,277	2,137,660	9,781,547	SUB:
PACKWOOD CREEK	Existing Deficiencies	70,000	354,800	532,200	190,374	1,147,374	229,475	1,376,849	0	0	0	0	0	0	0	0	0	0	0	1,376,849	
	Future Development	245,000	544,500	1,042,250	382,360	2,214,110	442,822	2,656,932	1,104,063	220,813	1,324,876	920,700	138,105	1,058,805	0	0	0	0	0	5,040,613	
	Subtotal	315,000	899,300	1,574,450	572,734	3,361,484	672,297	4,033,781	1,104,063	220,813	1,324,876	920,700	138,105	1,058,805	0	0	0	0	0	6,417,461	SUB:
PERSIAN/WATSON	Existing Deficiencies	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Future Development	35,000	0	46,875	32,267	114,142	22,828	136,970	131,712	26,342	158,054	0	0	0	8,193	5,164	13,357	2,671	16,028	311,053	
	Subtotal	35,000	0	46,875	32,267	114,142	22,828	136,970	131,712	26,342	158,054	0	0	0	8,193	5,164	13,357	2,671	16,028	311,053	SUB:
ST. JOHNS RIVER	Existing Deficiencies	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Future Development	70,000	189,950	320,300	293,628	873,878	174,776	1,048,654	1,274,877	254,975	1,529,852	283,500	42,525	326,025	675,051	81,451	756,502	151,300	907,802	3,812,333	
	Subtotal	70,000	189,950	320,300	293,628	873,878	174,776	1,048,654	1,274,877	254,975	1,529,852	283,500	42,525	326,025	675,051	81,451	756,502	151,300	907,802	3,812,333	SUB:
TOTAL:	Existing Deficiencies	175,000	810,500	2,087,200	516,268	3,588,968	717,794	4,306,762	0	0	0	781,000	117,150	898,150	0	0	0	0	0	5,204,912	
	Future Devleopment	637,000	1,687,550	4,111,850	2,414,843	8,851,243	1,770,249	10,621,492	10,890,542	2,178,108	13,068,650	4,941,650	741,248	5,682,898	2,188,460	768,454	2,956,914	591,383	3,548,297	32,921,336	
	Total	812,000	2,498,050	6,199,050	2,931,111	12,440,211	2,488,042	14,928,253	10,890,542	2,178,108	13,068,650	5,722,650	858,398	6,581,048	2,188,460	768,454	2,956,914	591,383	3,548,297	38,126,248	TOTAL:

NOTE: ST JOHNS RIVER CHANNEL WIDENING IS FOR A NEW OPEN CHANNEL ALONG RIGGIN AVE.

STORM WATER MASTER PLAN
COST SUMMARY
FOR
WATER STORAGE BASINS

DRAINAGE AREA	BASIN	NAME/LOCATION	EXIST. (or) PROP. (E/P)	IN-TOWN (or) TERMINAL	TYPE	EXISTING CAPACITY (ac-ft)	DESIGN VOLUME 10-Y/1-D (ac-ft)	DESIGN VOLUME 50-Y/10-D (ac-ft)	EXIST. DEFIC. (Y/N)	DEFIC. (ac-ft)	SURPLUS (ac-ft)	EXPANSION (yes/no)	NEW VOLUME (ac-ft) (Boyle)	NEW VOLUME (cy) (calcd)	NEW LAND (ac) (Boyle)	UNIT LAND COST ($/ac)	TOTAL LAND COSTS ($)	EXCAV. (cy) (Boyle)	UNIT EXCAV. COST ($/cy)	TOTAL EXCAV. COSTS ($)	LNDSCPNG (ac) (Boyle)	UNIT LNDSCPNG COST ($/ac)	TOTAL LNDSCPNG COSTS ($)	PUMP DISCHRG (cfs)	PUMP COST ($)	SUB-TTL COST ($)	20% CONT. ($)	EXIST. DEFIC. TOTAL COST ($)	FUTURE DEVLOP. TOTAL COST ($)	
Packwood Cr	PC-14	McAuliff @ Tulare	E	I	Riparian	43	36	58	N	0	7.0		0	0	0		0	0		0	0		0	3.6	35,000	35,000	7,000	0	42,000	
	PC-16	Blain Park	E	I	Park-Pond	8	9	14	N	1.0	0	YES	1.0	1,613	0		0	0		0	0		0	1.0	35,000	35,000	7,000	0	42,000	
	PC-17	Stonebrook	E	I	Park-Pond	50	35	57	N	0	15.0		0	0	0		0	0		0	0		0	3.5	35,000	35,000	7,000	0	42,000	
	PC-19	Costco Swale	E	I	Neigh. Park	1.5	45	67	Y	43.5	0	YES	43.5	70,180	6.35	60,000	381,000	72,600	2.00	145,200	6.35	40,000	254,000	4.5	35,000	815,200	163,040	978,240	0	
	PC-20	County Cntr @ PC	E	I	Neigh. Park	3.5	14	22	Y	10.5	0	YES	10.5	16,940	2.52	60,000	151,200	22,587	2.00	45,174	2.52	40,000	100,800	1.4	35,000	332,174	66,435	398,609	0	
	PC-41	n/o 198 @ Rd 148	P	I	Park-Pond	0	6	10	N	0	0		6.0	9,680	2.15	60,000	129,000	9,680	2.00	19,360	2.15	50,000	107,500	0.6	35,000	290,860	58,172	0	349,032	
	PC-42	s/o Walnut @ Pinkham	P	I	Park-Pond	0	15	24	N	0	0		15.0	24,200	3.95	60,000	237,000	24,200	2.00	48,400	3.95	50,000	197,500	1.5	35,000	517,900	103,580	0	621,480	
	PC-43	s/o K Rd @ Pinkham	P	I	Park-Pond	0	18	28	N	0	0		18.0	29,040	4.51	60,000	270,600	29,040	2.00	58,080	4.51	50,000	225,500	1.8	35,000	589,180	117,836	0	707,016	
	PC-44	n/o Caldwell e/o Santa Fe	P	I	Water Storage	0	21	34	N	0	0		21.0	33,880	2.19	60,000	131,400	33,880	2.00	67,760	0.4	35,000	14,000	2.1	35,000	248,160	49,632	0	297,792	
not modeled	PC-22	s/o Walnut w/o Ben Maddox	E	I	Water Storage	10	7	11		0	3.0		0	0			0			0	0		0			0	0	0	0	
not modeled	PC-18	w/o Mooney (Food-4-less)	E	I	Water Storage	11	0	0		0	11.0		0	0			0			0	0		0			0	0	0	0	
post-pre vol	PC-21	Tagus Basin	E	T	Terminal	330	224	319	N	0	11.0	YES	117.0	188,760	21.94	12,500	274,250	94,380	2.00	188,760	0		0	0.0		463,010	92,602	0	555,612	
																												1,376,849	2,656,932	SUB:
Mill Creek	MC-32	w/o Lovers Land n/o Mill Cr	P	I	Neigh. Park	0	19	30	Y	19.0	0		19.0	30,653	3.17	60,000	190,200	30,654	2.00	61,308	3.17	40,000	126,800	1.9	35,000	413,308	82,662	495,970	0	
	MC-33	w/o Ben Maddox n/o Mill Cr	P	I	Neigh. Park	0	40	61	Y	40.0	0		40.0	64,533	5.75	200,000	1,150,000	64,533	2.00	129,066	5.75	40,000	230,000	4.0	35,000	1,544,066	308,813	1,852,879	0	
	MC-34	w/o Akers s/o S.R. 198	P	I	Water Storage	0	38	61	Y	38.0	0		38.0	61,307	3.58	60,000	214,800	61,307	2.00	122,614	0.54	35,000	18,900	3.8	35,000	391,314	78,263	469,577	0	
	MC-7	e/o Lovers Lane n/o Mill Cr	E	I	Park-Pond	20	6	10	N	0	14.0		0	0			0			0	0		0			0	0	0	0	
	MC-8	Willow Glen School @ Akers	E	I	Park-Pond	13	17	26	Y	4.0	0	YES	4.0	6,453	0		0	6,453	2.00	12,906	2	40,000	80,000			92,906	18,581	111,487	0	
post-pre vol	MC-50	w/o WWTP	P	T	Terminal	0	396	585	N	0	0		266.0	429,147	50	12,500	625,000	214,573	2.00	429,146	0		0			1,054,146	210,829	0	1,264,975	
																												2,929,913	1,264,975	SUB:
Modoc Ditch	MD-3	Peltzer Basin on Riggin	E	I	Water Storage	200	124	197	N	0	76.0		0	0			0			0	0		0	12.4	42,000	42,000	8,400	0	50,400	
	MD-4	Shannon-Modoc Basin	E	I	Water Storage	50	40	66	N	0	10.0		0	0			0			0	0		0	4.0	35,000	35,000	7,000	0	42,000	
	MD-2	Fairview School w/o Dinuba Bl	E	I	Park-Pond	14	8	13	N	0	6.0		0	0			0			0	0		0			0	0	0	0	
in-progress	MD-31	e/o Court n/o Modoc Ditch	P	I	Park-Pond	0	12	18	N	0	0		12.0	19,360	4.5	60,000	270,000	28,879	2.00	57,758	4.5	50,000	225,000	1.8	35,000	587,758	117,552	0	705,310	
post-dev vol	MD-23	Overflow Basin on Rd 68	E	T	Terminal	160	226	378	N	218.0	0	YES	218.0	351,707	20	12,500	250,000	175,853	2.00	351,706	0		0			601,706	120,341	0	722,047	
																												0	1,519,757	SUB:
Goshen Drain	GD-39	n/o Goshen w/o Demaree	P	I	Water Storage	0	74	119	N	0	0		74.0	119,387	6.32	60,000	379,200	119,387	2.00	238,774	0.7	35,000	24,500	7.4	35,000	677,474	135,495	0	812,969	
	GD-40	n/o Goshen e/o Shirk	P	I	Neigh. Park	0	71	99	N	0	0		71.0	114,547	9.37	60,000	562,200	114,547	2.00	229,094	9.37	40,000	374,800	7.1	35,000	1,201,094	240,219	0	1,441,313	
post-pre vol	GD-6	Goshen Ocean @ Goshen&Camp	E	T	Terminal	135	60	99	N	0	36.0		0	0			0			0	0		0			0	0	0	0	
																												0	2,254,282	SUB:
Evans Ditch	ED-10	Linwood Park e/o Akers	E	I	Neigh. Park	24	49	69	N	25.0	0	YES	25.0	40,333	0		0	40,334	2.00	80,668	3.93	40,000	157,200	4.9	35,000	272,868	54,574	0	327,442	
	ED-15	Pinkham Park @ Tulare	E	I	Neigh. Park	2.5	11	13	N	8.5	0	YES	8.5	13,713	1.77	60,000	106,200	13,714	2.00	27,428	1.77	40,000	70,800	1.0	35,000	239,428	47,886	0	287,314	
	ED-9	Edison Park @ Tulare	E	I	Park-Pond	43	24	31	N	0	19.0		0	0			0			0	0		0			0	0	0	0	
in-progress	ED-38	Lisendra Hts Park s/o Whitendale	P	I	Neigh. Park	0	14	22	N	0	0		14.0	22,587	2.52	60,000	151,200	22,587	2.00	45,174	2.52	40,000	100,800	1.4	35,000	332,174	66,435	0	398,609	
omitted in MP	ED-12	Nelson Basin s/o Caldwell	E	T	Terminal	500				0	500.0		0	0			0			0	0		0			0	0	0	0	
																												0	1,013,364	SUB:
St. Johns	SJ-1	Ruiz Park w/o Burke	E	I	Park-Pond	15	13	19	N	0	2.0		0	0			0			0	0		0			0	0	0	0	
in-progress	SJ-35	n/o Houston e/o McAuliff	P	I	Neigh. Park	0	27	49	N	0	0		27.0	43,560	4.18	60,000	250,800	43,560	2.00	87,120	4.18	40,000	167,200	2.7	35,000	540,120	108,024	0	648,144	
	SJ-36	n/o SJR w/o Ben Maddox	P	I	Water Storage	0	64	124	N	0	0		64.0	103,253	5.56	12,500	69,500	103,254	2.00	206,508	0.65	35,000	22,750	6.4	35,000	333,758	66,752	0	400,510	
																												0	1,048,654	SUB:
Persian-Watson	PW-11	w/o Roeben n/o Walnut	E	I	Water Storage	39	20	33	N	0	19.0		0	0			0			0	0		0	2.0	35,000	35,000	7,000	0	42,000	
post-pre	PW-17	Miller Basin w/o S.R. 99	E	T	Terminal		69	117	N	117.0	0		20.0	32,267	3.75	12,500	46,875	16,134	2.00	32,268	0		0			79,143	15,829	0	94,972	
																												0	136,972	SUB:
Cameron	CC-21	Tagus Basin s/o Ave 272	E	T	Terminal	330	299	477	N	147.0	0		153.0	246,840	28.69	12,500	358,625	123,420	2.00	246,840	0		0			605,465	121,093	0	726,558	
																												0	726,558	SUB:
																	6,199,050			2,931,112			2,498,050		812,000		2,488,042	4,306,762	10,621,493	Total:
	NOTE: NEW VOLUME FOR TERMINAL BASINS BASED ON POST-DEVELOPMENT 50YR/10D VOL - PRE-DEVELOPMENT 50YR/10D VOL.																						EXIST. DEFIC. + FUTURE DEVELOP.:					14,928,254		

Residential Storm Drain Impact & Monthly Fees



$0.54 per month covers existing deficiency costs for all alternatives.

Impact Fees based on four units per acre. Multiply by 4 to obtain actual acreage fee.

Figure A-1
Storm Drain Master Plan
Funding Alternatives

Alternative Storm Drain Impact Fee Schedules

	Percent Impervious	Existing Rates	Units	100% Impact Fee	75% Impact Fee	60% Impact Fee	50% Impact Fee	Zero Impact Fee
Rural	20	$2,865.59	per Acre	$1,168.84	$876.74	$701.40	$584.65	$0.00
Low Density	43	$4,298.95	per Acre	$2,513.00	$1,885.00	$1,508.00	$1,257.00	$0.00
Medium Density	70	$5,731.15	per Acre	$4,090.93	$3,068.60	$2,454.88	$2,046.28	$0.00
High Density	80	$5,731.15	per Acre	$4,675.35	$3,506.98	$2,805.58	$2,338.60	$0.00
Convenience Center	95	$11,463.47	per Acre	$5,551.98	$4,164.53	$3,331.63	$2,777.09	$0.00
Neighborhood Center	85	$11,463.47	per Acre	$4,967.56	$3,726.16	$2,980.93	$2,484.77	$0.00
Shopping/Office Center	80	$11,463.47	per Acre	$4,675.35	$3,506.98	$2,805.58	$2,338.60	$0.00
Community Center	75	$11,463.47	per Acre	$4,383.14	$3,287.79	$2,630.23	$2,192.44	$0.00
Regional Center	90	$11,463.47	per Acre	$5,259.77	$3,945.35	$3,156.28	$2,630.93	$0.00
Highway	95	$11,463.47	per Acre	$5,551.98	$4,164.53	$3,331.63	$2,777.09	$0.00
Service	95	$11,463.47	per Acre	$5,551.98	$4,164.53	$3,331.63	$2,777.09	$0.00
Professional/Administration	70	$11,463.47	per Acre	$4,090.93	$3,068.60	$2,454.88	$2,046.28	$0.00
Public/Institutional	60	$11,463.47	per Acre	$3,506.51	$2,630.23	$2,104.19	$1,753.95	$0.00
Light Industrial	80	$11,463.47	per Acre	$4,675.35	n/a	n/a	n/a	n/a
Heavy Industrial	90	$11,463.47	per Acre	$5,259.77	n/a	n/a	n/a	n/a
Industrial Park (Industrial)	Separate System	$0.00	per Acre	$819.00	n/a	n/a	n/a	n/a

TABLE A-2

STORM DRAIN IMPACT FEES

(effective November 22, 1994 via City Council Resolution No. 94-171)

Land Use	Fee
Residential	
Rural	$ 876.74
Low Density	$1,885.00
Medium Density	$3,068.60
High Density	$3,506.98
Commercial	
Convenience Center	$4,164.53
Neighborhood Center	$3,726.16
Shopping/Office Center	$3,506.98
Community Center	$3,287.79
Central Business District	$4,164.53
Regional Center	$3,945.35
Highway	$4,164.53
Service	$4,164.53
Professional/Administration	$3,068.60
Public/Institutional	$2,630.23
Light Industrial	$4,675.35
Heavy Industrial	$5,259.74
Industrial Park (Industrial)	$ 819.00

9. WATER QUALITY MEASURES

NPDES PERMITS

EPA has established a permitting program for non-point source storm water discharges. The program currently regulates municipalities with populations in excess of 100,000 people and most industrial facilities. At some time in the near future, EPA is expected to announce regulations governing non-point source storm water discharges from municipalities less than 100,000 people. While the elements of this program have not yet been announced, it is likely that many of the features will be similar to those found in the regulations governing larger communities.

EPA's requirements for large and medium communities fell into two primary categories: Source Identification, and Source Control Measures. The Source Identification component requires the inventory of storm sewer systems, the identification of regulated outfalls, the mapping of watersheds and the identification of basin characteristics tributary to the outfalls.

The Source Control Measures dealt primarily with management practices and were intended to reduce the introduction of pollutants to the storm water runoff. Major elements of this program include identifying problem sources and illicit connections and establishing best management practices to control the introduction of contaminants such as suspended solids, oils and greases.

STORM DRAINAGE MANAGEMENT PLAN

The storm drainage management plan developed for the City of Visalia provides basic information which can be used to satisfy the eventual requirements imposed by EPA and the California Water Quality Control Board. In particular, the mapping, land use and system inventory information provided through Boyle's Facility Management System (BFMS) are the foundation for any permit application requirements which may be established by EPA and the State. The databases associated with BFMS are also useful in satisfying the basic source identification information and can be adapted relatively easily to meet any unanticipated requirements established by EPA.

The drainage management plan also provides valuable information by identifying runoff characteristics and quantities. This information is important in establishing relative contributions from various watersheds and in identifying hydraulic characteristics.

WATER QUALITY CONSIDERATIONS

Runoff from the City of Visalia is generated from two principle land use types; urban areas and non-urbanized agricultural areas. The relative quantity of runoff from these areas is different. This is a result of the higher level of imperviousness associated with the urbanized areas. The water quality concerns from each land use is also much different.

Urbanized Areas

The presence of homes, offices, and businesses in the urbanized areas results in substantially more human activity such as vehicular traffic. Non-point source storm water runoff from urbanized areas generally contains higher levels of greases, oils and heavy metals. These particles are generally deposited on streets and driveways and are washed into the storm drain collection system during rain storms and carried downstream. Nutrients such as animal waste and lawn fertilizers are also common in urbanized areas and are often introduced into the storm drainage system. Other common urban area pollutants are household waste products. In many cases household cleaning agents, pesticides and other contaminants are disposed by home owners into the storm drainage system. The impacts of these may be significant but are generally intermittent.

Non-Urbanized Areas

In non-urbanized agricultural area, the types and sources of pollutants are generally more easily identified. The most common pollutants are sediments from unprotected agricultural activities. Rainfall and the subsequent runoff from agricultural fields can provide a mechanism to transport large amounts of sediment to the stream. Other pollutants frequently found in non-urbanized agricultural runoff are nutrients. These are generally the by-product of agricultural fertilizing and are transported along with sediments to the stream.

MANAGEMENT PLAN IMPACTS

The initial collection of storm water runoff from the urban areas in streets, gutters and storm sewer system should have a minimal impact on water quality. Most pollutants introduced from the urban areas will be transported through the system. If water quality from these areas is an immediate concern, several simple measures may be taken to provide some benefit. The most fundamental, and perhaps most beneficial, measure is public education. In this way over fertilization, control of animal waste and the discharge of household wastes can be limited. Since those constituents are transported through the system, benefits at the source will be translated through the entire system. Other, somewhat more labor intensive measures, such as street sweeping and inlet and storm sewer maintenance are probably already part of the City's program and could be scheduled more frequently in problem areas. Once again these measures provide control at the source which is consistent with EPA's probable upcoming requirements.

Generally the local collector systems outfall into major drains which flow east to west through the City. The collection system generally discharges by gravity or by pumping. The gravity discharges should have no impact on water quality since all pollutants in the system will be discharged directly into the major drain. The pumped discharges provide a limited opportunity to enhance water quality. The holding ponds and forebays at the pumping stations provide an opportunity to settle out some suspended solids. These include nutrients and some heavy metals which may have been generated from the urban areas. There may also be an opportunity to provide oil and grease separators at the pump stations.

Once in the major drains, most flows are conveyed through open channels to the west side of town. These channels are generally earthen or grass lined. These provide some benefit to water quality as a result of their ability to provide nutrient uptake. Infiltration into the channel banks and vegetative nutrient uptake are both mechanisms which may reduce the amount of nutrients in the stream. The velocities in these channels are generally slower than those from the collection system and may result in the settlement of some of the larger grained suspended solids. Care must be taken not to have erosive velocities in unlined channel sections. Erosion provides an additional source of suspended solids. In most cases channel improvements have been designed in a manner which minimizes the probability of future erosion.

The collection and major drainage systems ultimately discharge into large ponding areas on the west side of town. These ponding areas provide significant storage and are emptied through evaporation and infiltration. All waterborne pollutants are contained at the pond site.

CONCLUSION

The facilities in the proposed plan will not adversely impact storm water quality. In fact, the use of detention basins and open channels may result in some improvement in water quality. The databases developed through BFMS can facilitate future data submittal requirements which may be imposed by EPA or the Regional Water Quality Control Boards as part of a non-point source discharge permit program.

APPENDIX A

City Surveyed Cross Sections and Channel Capacities

Appendix A City Surveyed Cross Sections and Channel Capacities

Channel	Section	Offset	Elev	Offset	Elev	Offset	Elev	Offset	Elev	Offset	Elev	Offset	Elev	Offset	Elev	Offset	Elev	Mann N	Slope	Area	WP	Q (cfs)
Modoc Ditch																						
20' e/o Court	MD-7	100	100.0	112	94.3	119	94.1	126	94.3	141	101.1							0.030	0.001	172.5	43.8	674
100' e/o Quail Drive	MD-8	100	100.0	108	96.0	114	94.7	120	94.7	124	98.5							0.030	0.001	71.3	26.6	216
600' nw/o Riggin Road	MD-9	100	100.0	110	95.0	113	94.9	117	95.1	127	100.5							0.030	0.001	88.9	29.6	290
150' e/o Akers Road	MD-10	100	100.0	108	95.4	111	95.2	114	95.3	120	99.5							0.030	0.001	57.4	22.6	167
50' e/o Dinuba Hwy	MD-11	100	100.0	107	95.7	110	95.3	114	95.6	119	99.4							0.030	0.001	53.6	21.5	154
Mill Creek																						
500' s/o Hwy 198 on Rd 86	MC-1	100	100.3	107	97.2	116	94.4	123	94.7	129	96.2	138	100.6					0.030	0.001	143.5	40.3	524
1250' s/o Hurley	MC-2	100	100.8	104	95.8	116	95.6	123	100.8									0.030	0.001	89.4	27.1	310
50' w/o westside Akers Road	MC-3	100	100.3	108	95.7	112	94.9	116	94.2	123	94.8	133	99.8					0.030	0.001	123.8	35.6	445
30' e/o eastside of Crenshaw	MC-4	100	99.2	107	95.2	110	94.6	114	94.9	121	98.4	125	99.9					0.030	0.001	71.5	27.2	213
200' w/o Linwood	MC-5	100	308.6	103	306.6	107	305.1	110	304.8	114	305.1	121	308.8					0.030	0.001	53.2	22.8	147
100' west of Bollinger	MC-6	100	308.6	104	305.2	110	304.5	115	305.4	120	307.2	125	310.1					0.030	0.001	77.6	27.5	243
100' west of Chinowth	MC-7	100	310.9	106	306.5	112	306.1	118	306.3	126	307.7	132	311.8					0.030	0.001	121.5	34.8	438
150' e/o eastside of Akers	MC-8	100	101.8	110	98.5	118	95.2	123	94.7	130	94.9	140	102.4					0.030	0.001	182.9	43.7	744
So side of Main St and Ranch	MC-9	100	98.2	109	91.7	113	91.5	118	91.8	127	96.4							0.030	0.001	101.0	30.2	354
So end of Midland 300' s/o Gr Acres	MC-10	100	98.8	112	92.4	118	91.6	123	92.3	132	97.2							0.030	0.001	124.3	34.9	454
West side Fairway Dr 150' s/o Manor	MC-11	100	98.4	108	92.1	114	92.2	123	94.7	126	97.9							0.030	0.001	107.1	29.9	393
No side Sierra 150' e/o Divisadero	MC-12	100	98.2	109	94.1	115	92.1	120	91.6	120	99.1							0.030	0.001	89.8	28.7	301
50' e/o eastside Giddings	MC-12A	100	99.6	107	94.1	112	93.4	114	92.0	124	91.6	129	98.0					0.030	0.001	141.1	34.5	565
500' w/o Conyer	MC-13	100	98.6	100	92.3	107	92.5	111	92.9	115	95.1	115	98.6					0.030	0.001	85.4	25.4	300
200' w/o Johnson	MC-14	100	99.4	109	96.0	109	91.7	116	91.5	122	91.8	126	94.3	127	97.4	136	99.4	0.030	0.001	154.3	44.1	557
100' w/o West Street	MC-15	100	98.2	101	91.9	107	92.0	112	94.2	115	96.2	116	97.9					0.030	0.001	73.9	23.4	249
150' e/o Tipton Street	MC-16	100	100.0	110	90.8	115	90.4	120	91.0	132	99.5							0.030	0.001	188.5	38.3	854
200' e/o Ben Maddox Way	MC-17	100	99.8	104	94.9	111	94.1	119	94.4	121	99.0							0.030	0.001	89.1	26.4	314
100' e/o Lovers Lane	MC-18	100	99.7	112	92.3	115	88.6	120	88.5	128	88.3	132	93.8	139	98.0			0.030	0.001	246.4	46.8	1,168
Evans Ditch																						
1400' ne/o Mineral King	ED-12	100	100.0	102	96.7	106	95.2	111	95.3	116	95.4	122	100.2					0.030	0.001	81.9	25.8	277
100' w/o Ben Maddox	ED-13	100	100.0	103	95.9	108	94.8	112	95.7	114	98.2	124	98.9					0.030	0.001	55.8	27.5	140
200' w/o Mooney Blvd	ED-14	100	100.0	109	94.0	113	93.2	116	93.6	120	97.7							0.030	0.001	55.8	27.5	140
100' e/o County Center	ED-15	100	100.0	107	95.9	109	94.4	112	94.0	115	94.1	124	99.3					0.030	0.001	80.6	27.0	262
200' se/o Whitendale	ED-16	100	100.0	103	95.8	108	95.4	113	95.5	117	100.1							0.030	0.001	60.7	21.3	191
.5 mile w/o Akers Road	ED-17	100	100.0	107	95.3	110	95.3	114	95.4	123	100.8							0.030	0.001	75.5	25.9	241

Appendix A City Surveyed Cross Sections and Channel Capacities

Channel	Section	Offset	Elev	Offset	Elev	Offset	Elev	Offset	Elev	Offset	Elev	Offset	Elev	Offset	Elev	Offset	Elev	Mann N	Slope	Area	WP	Q (cfs)
Packwood Creek																						
8000' w/o Mooney Blvd	PC-1	100	101.4	115	90.3	123	90.0	131	90.2	148	99.5							0.030	0.001	329.4	54.0	1,723
1100' d/s Caldwell Crossing	PC-2	100	100.5	110	93.1	118	92.2	124	92.5	136	100.1							0.030	0.001	191.9	40.7	846
300' e/o Pinkham Street	PC-3	100	100.7	110	93.8	119	93.1	128	93.1	140	100.6							0.030	0.001	212.4	44.3	946
Between Harvard and Princeton	PC-4	100	100.1	114	92.2	121	91.6	127	92.1	142	99.8							0.030	0.001	218.2	46.0	965
200' w/o McAuliff	PC-5	100	100.9	114	92.1	119	91.7	124	91.8	138	100.5							0.030	0.001	211.3	43.0	956
.5 mile sw/o County Center STA 0+	PC-101	100	99.8	107	96.5	114	93.2	128	92.5	144	93.3	155	98.9					0.030	0.001	269.9	57.9	1,181
STA 3+07	PC-102	100	100.4	111	94.4	117	93.1	127	92.4	135	93.0	148	99.1					0.030	0.001	236.4	51.1	1,029
STA 11+20	PC-103	100	101.8	112	93.6	120	93.3	127	93.5	138	101.1							0.030	0.001	211.0	42.9	956
STA 15+90	PC-104	100	102.7	114	93.9	125	93.7	134	94.7	144	100.8							0.030	0.001	243.7	48.3	1,123
STA 19+52	PC-105	100	101.4	112	93.6	120	93.1	130	93.1	146	101.3							0.030	0.001	259.1	50.3	1,211
STA 1+41	PC-201	100	98.9	107	95.2	113	91.3	117	91.1	121	91.4	124	95.2	135	99.7			0.030	0.001	155.0	39.8	601
STA 4+22	PC-202	100	99.4	114	91.9	122	91.4	130	91.5	138	95.6	146	98.6					0.030	0.001	224.9	49.4	968
STA 6+54	PC-203	100	98.3	123	92.7	131	92.1	140	91.7	144	93.2	145	99.7					0.030	0.001	226.0	51.6	948
STA 8+71	PC-204	100	98.7	108	96.8	116	92.9	124	92.2	134	92.6	144	99.9					0.030	0.001	201.5	47.5	827
STA 10+17	PC-205	100	97.9	119	94.3	122	92.7	130	92.2	141	93.1	147	97.4					0.030	0.001	152.9	49.2	510
STA 14+03	PC-206	100	99.7	106	96.5	111	93.2	120	92.5	127	92.2	131	96.5					0.030	0.001	118.8	34.7	423
West headwall @ Court St STA 14+78																						
East Headwall @ Sante Fe STA 0+00																						
STA 3+25	PC-301	100	97.7	112	88.6	118	88.7	123	89.0	134	94.7							0.030	0.001	166.5	38.5	693
STA 6+00	PC-302	100	97.2	112	89.2	119	89.4	125	90.0	131	93.5	139	95.5					0.030	0.001	169.5	42.6	666
STA 8+45	PC-303	100	97.5	111	89.7	115	89.0	123	89.6	130	93.8							0.030	0.001	126.2	33.7	477
STA 9+94	PC-304	100	98.1	111	90.3	120	88.9	126	89.4	130	94.0							0.030	0.001	137.2	34.7	538
STA 13+62	PC-305	100	100.3	116	90.0	122	89.8	129	90.6	138	95.6							0.030	0.001	191.0	42.4	817
STA 16+96	PC-306	100	99.2	113	90.1	119	89.7	123	90.2	133	97.3							0.030	0.001	175.1	38.2	758
STA 19+35	PC-307	100	99.2	113	90.7	121	89.7	127	89.7	133	94.4	142	98.7					0.030	0.001	240.5	47.2	1,116
STA 21+75	PC-308	100	99.6	112	90.5	116	89.7	120	89.8	126	94.6	135	97.9					0.030	0.001	176.8	40.4	741
STA 24+21	PC-309	100	99.6	112	90.5	119	90.4	123	90.9	131	95.0	141	99.1					0.030	0.001	222.9	45.9	1,002
STA 26+22	PC-310	100	100.6	112	92.1	119	90.8	124	91.0	133	97.3							0.030	0.001	167.2	37.8	706
STA 27+67	PC-311	100	101.8	114	91.6	120	90.9	127	91.5	141	101.7							0.030	0.001	279.7	47.7	1,425

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Appendix A City Surveyed Cross Sections and Channel Capacities

Channel	Section	Offset	Elev	Offset	Elev	Offset	Elev	Offset	Elev	Offset	Elev	Offset	Elev	Offset	Elev	Offset	Elev	Mann N	Slope	Area	WP	Q (cfs)
Cameron Creek																						
300' sw/o Caldwell and Lovers Lane	CC-1	100	100.0	110	93.2	117	93.1	124	93.6	136	100.7							0.030	0.001	175.3	40.1	735
1000' w/o Sante Fe	CC-2	100	100.0	110	93.9	115	93.5	120	93.5	132	100.8							0.030	0.001	141.5	35.8	555
100' sw/o Avenue 272	CC-3	100	100.0	107	94.8	115	95.2	124	95.5	133	99.6							0.030	0.001	115.5	35.6	396
1600' sw/o Avenue 272	CC-4	100	100.0	109	95.2	122	94.4	136	94.5	147	100.3							0.030	0.001	202.6	49.7	810
150' w/o Mooney Blvd	CC-5	100	100.0	110	92.8	120	92.6	131	92.0	141	99.6							0.030	0.001	227.5	45.9	1,036
	CC-6	100	100.0	115	90.9	123	90.4	132	90.8	144	99.9							0.030	0.001	281.3	49.6	1,401
Persian-Watson Ditch																						
400' w/o Akers	PW-18	100	100.0	105	96.2	111	96.3	117	96.3	122	100.9							0.030	0.001	71.1	25.1	223
50' e/o Shirk Road	PW-19	100	100.0	103	96.7	107	96.5	110	96.6	117	100.9							0.030	0.001	45.3	19.7	124
North Fork Persian Ditch																						
100'e/o RCL 86	PW-20	100	100.0	105	96.1	107	95.6	110	95.0	114	99.1							0.030	0.001	37.7	17.2	99
Middle Fork Persian Ditch																						
50' n/o Plaza Drive	PW-21	100	100.0	104	96.5	107	96.4	109	96.4	113	99.2							0.030	0.001	28.5	15.2	68
Watson Ditch																						
100' e/o Shirk Road	PW-22	100	100.0	107	95.0	108.5	95.1	110	95.3	117	99.7							0.030	0.001	47.0	19.9	131
Watson/So Branch Persian Ditch																						
100' n/o Walnut Ave	PW-23	100	100.0	106	95.8	108.5	95.6	111	94.7	117	100.1							0.030	0.001	52.2	20.5	152

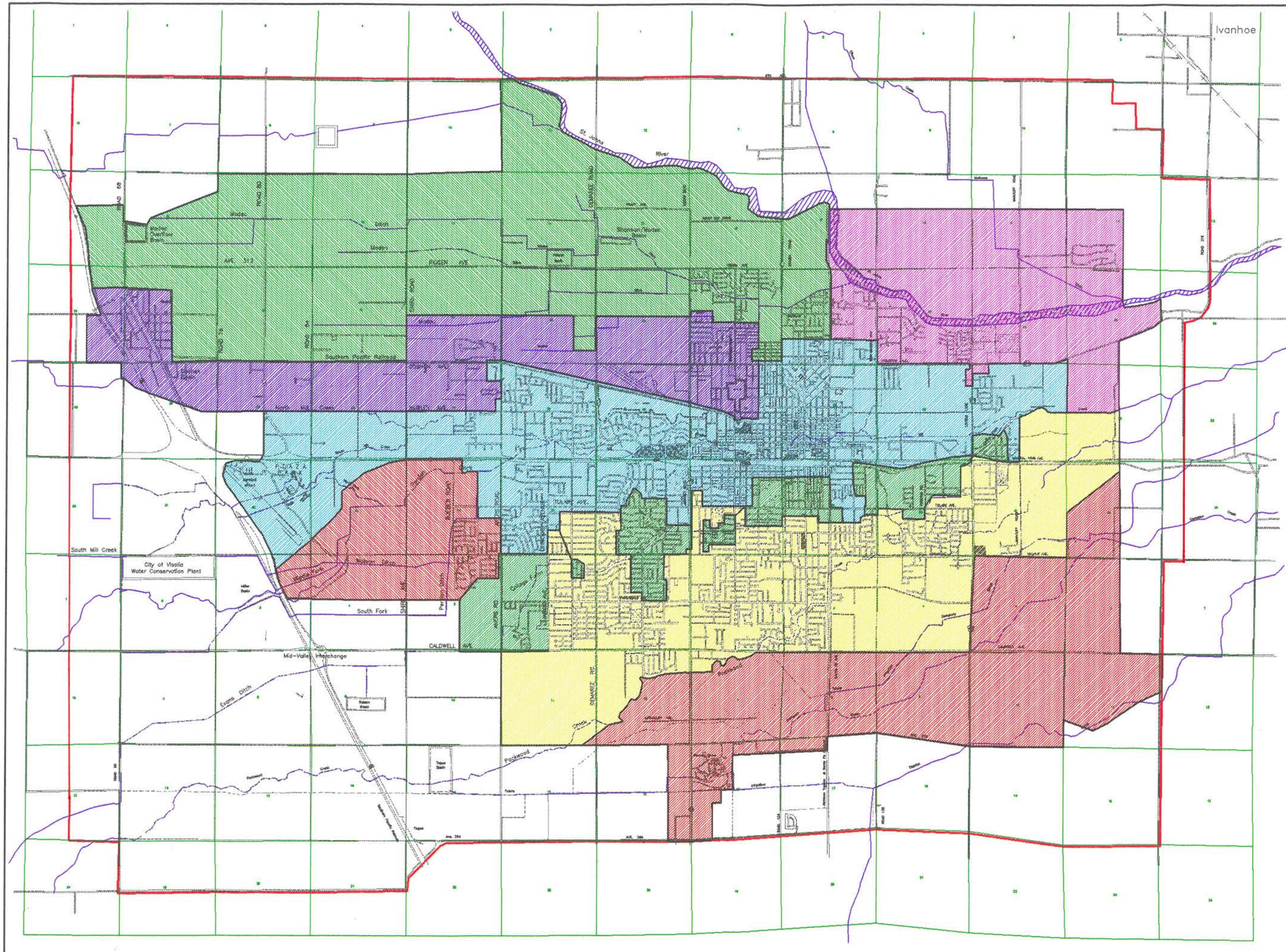

Exhibit 1

N

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Legend

- Urban Boundary
- Streams / Ditches
- Section lines
- Basin Boundary

Drainage Basins

- St Johns River
- Modoc Ditch
- Goshen Drain
- Mill Creek
- Evans Ditch
- Packwood Creek
- Cameron Creek
- Persian/Watson

City of Visalia

BOYLE ENGINEERING CORPORATION

Drainage Basin Map

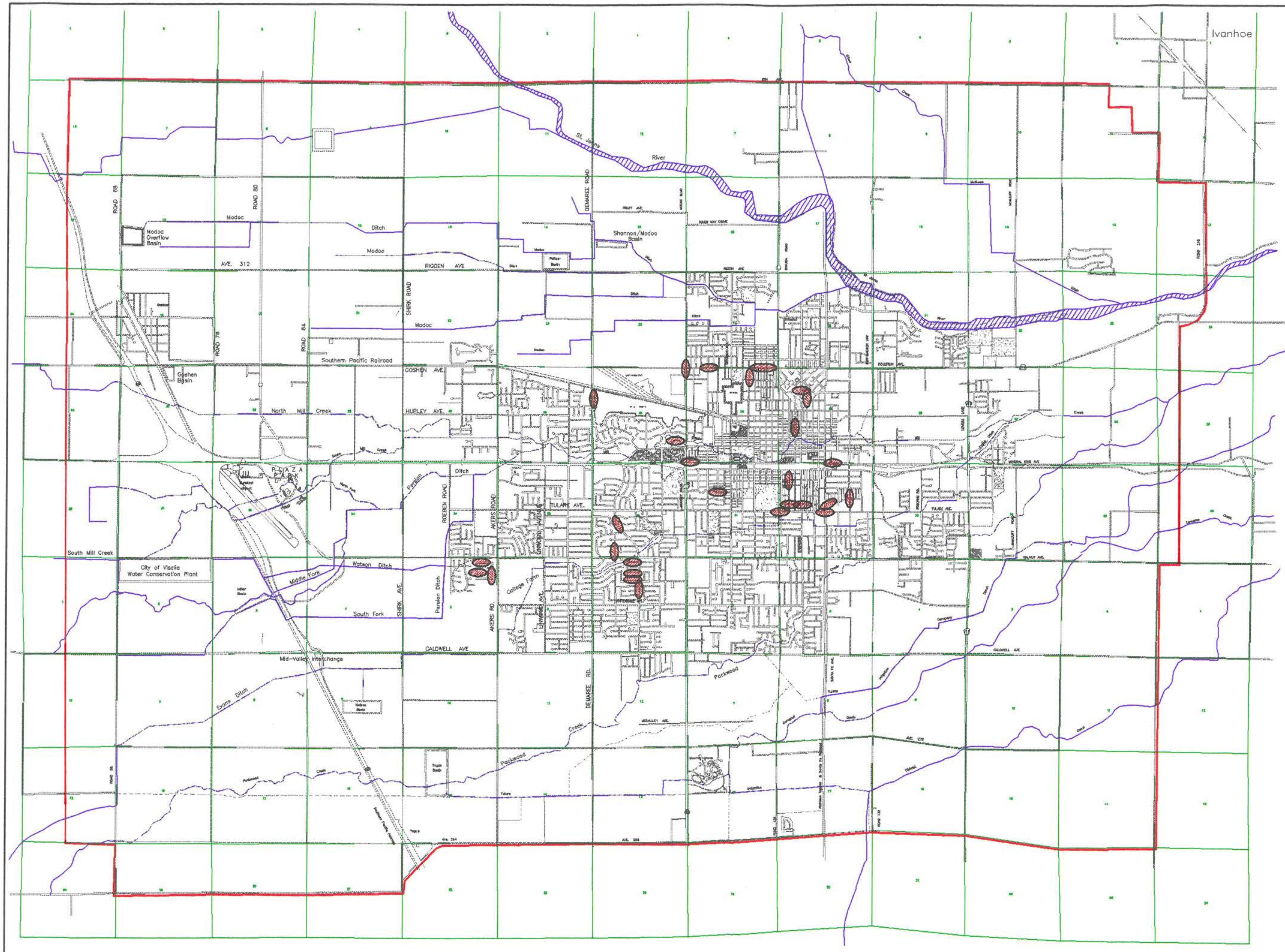

Exhibit 2

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Legend

Urban Boundary

Streams / Ditches

Section lines

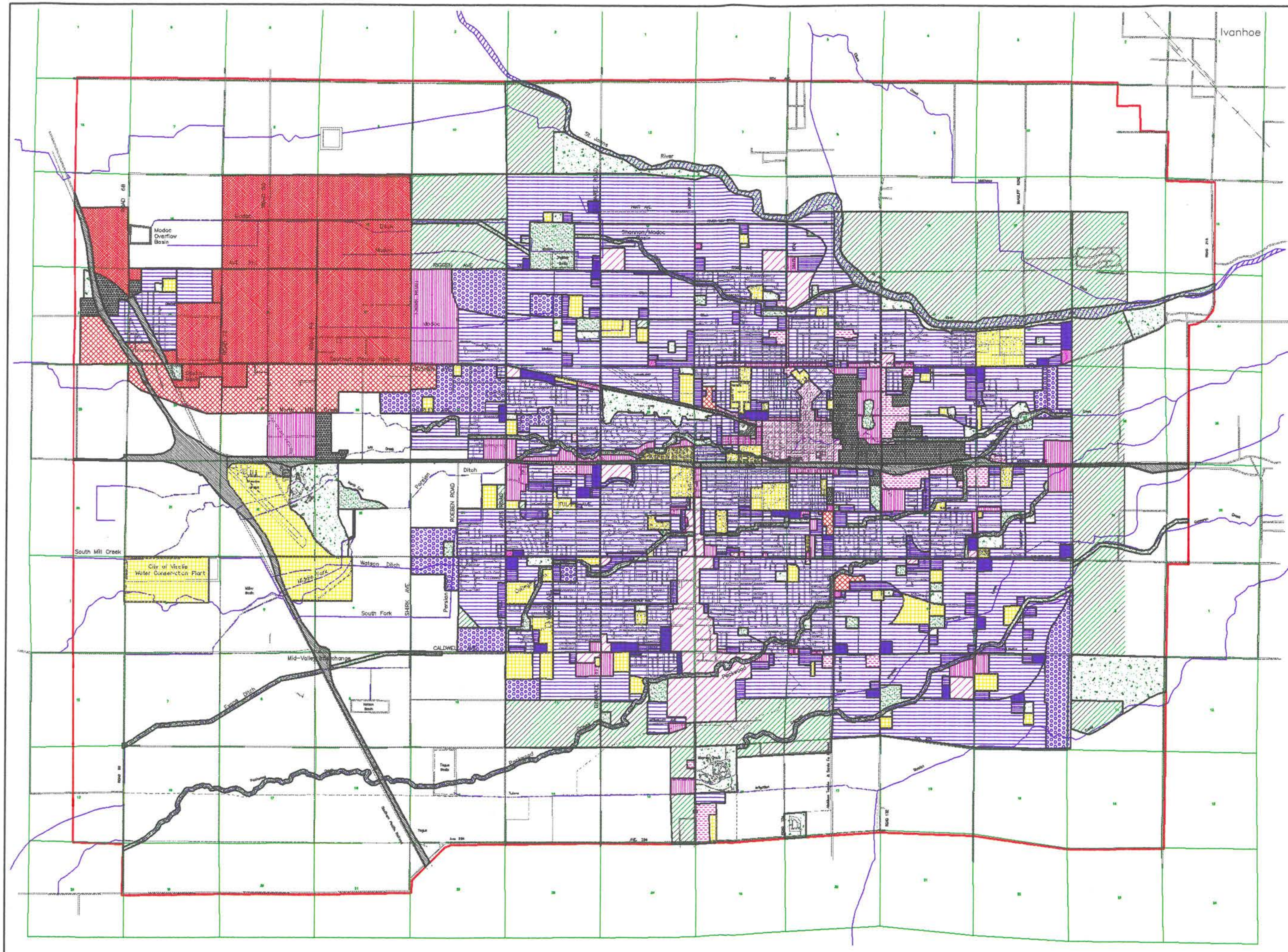
Existing Areas of Street Ponding. Information Provided by the City of Visalia Public Works Department

City of Visalia

BOYLE ENGINEERING CORPORATION

Street Ponding Map

Exhibit 3



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Legend

- Urban Boundary
- Section lines
- Landuse Boundary

Residential
- RA Rural
- LDR Low Density
- MDR Medium Density
- HDR High Density

Commercial/Office
- CC Convenience Ctr
- CNC Neighborhood Ctr
- CSO Shop/Office Ctr
- CCM Community Center
- CBD Central Busin. Ctr
- CR Regional Center
- CH Highway
- CS Service
- PA Professional/Administrative

Community Facilities
- PI Public/Institutional

Industry
- IL Light Industry
- IH Heavy Industry

Open Space
- OSA Agriculture
- OSC Conservation
- OSP Parks

- UR Urban Reserve

City of Visalia

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Land Use Map

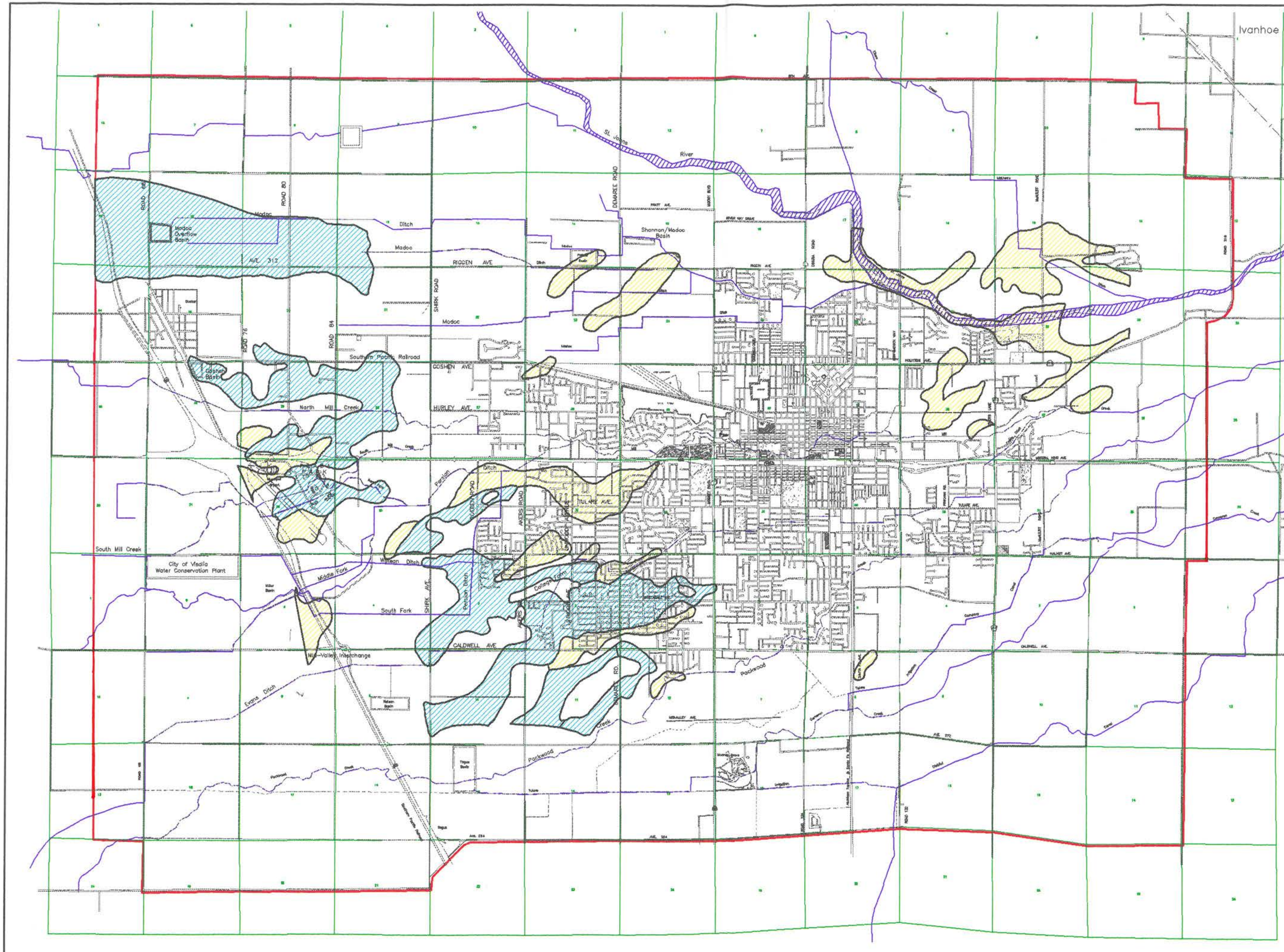

Exhibit 4

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Legend

- Urban Boundary
- Streams / Ditches
- Section lines
- Soil Boundary

Drainage Basins

- Soil Type A
- Soil Type B
- Soil Type C
- Soil Type D

City of Visalia

BOYLE ENGINEERING CORPORATION

Soil Map