THE BOARD OF SUPERVISORS OF THE COUNTY OF STANISLAUS
ACTION AGENDA SUMMARY

DEPT: Public Works **BOARD AGENDA #** *C-4

Urgent ☐ **Routine** ☒ **AGENDA DATE** September 9, 2014

CEO Concurs with Recommendation YES ☐ **NO** ☐ **(Information Attached)** **4/5 Vote Required YES** ☐ **NO** ☒

SUBJECT:

Approval to Accept the Empire Community Storm Drainage Report; Approval to Initiate a Proposition 218 Proceedings for the Annexation of Phase 1B, 2, and 3 into County Service Area No. 27 (Empire); and Approval to use Community Development Funds

STAFF RECOMMENDATIONS:

1. Accept the Empire Community Storm Drainage Report.
2. Approve the initiation of the Proposition 218 proceedings for the annexation of Phase 1B, 2, and 3 (as shown in Figure 2 in the Empire Community Storm Drainage Report) into County Service Area No. 27 (Empire) to fund a portion of needed capital and ongoing maintenance.
3. Direct the Public Works Department to prepare and file the required Engineer's Report.
4. Approve the use of Stanislaus County Community Development funds in the amount of $20,000 for costs associated with the annexation.

FISCAL IMPACT:

Upon voter approval the ongoing operation and maintenance costs of the service area will be borne by the Empire - CSA 27 through annual assessments estimated to generate a total of approximately $34,692. The funds will be used for ongoing operating and maintenance for the CSA's storm water drainage system. This will include swale maintenance, catch basin maintenance and street sweeping to prevent debris from entering the system. The annexation to the existing CSA will serve the public where businesses, employees, and customers are free from concerns over storm water runoff, flooding and property damage, and roadway hazards and restrictions. (Continued on Page 2)

BOARD ACTION AS FOLLOWS:

No. 2014-466

On motion of Supervisor Withrow, **Seconded by Supervisor** O'Brien
and approved by the following vote,
Ayes: Supervisors: O'Brien, Withrow, Monteith, and Chairman De Martini
Noes: Supervisors: None
Excused or Absent: Supervisors: Chiesa
Abstaining: Supervisor: None

1) X **Approved as recommended**
2) ___ **Denied**
3) ___ **Approved as amended**
4) ___ **Other:**
MOTION:

ATTEST: CHRISTINE FERRARO TALLMAN, Clerk

File No. CSA-27-4

FISCAL IMPACT (Continued):

There will also be a capital recovery amount collected by CSA 27 for construction of the improvements for the community of Empire. Costs associated to assure the delivery of this project is in the amount of $2,870,000, which includes $200,000 for the design phase, and $2,670,000 for the preliminarily estimated construction phase. The $2,650,000 estimated construction phase consists of $1,300,000 of Community Development Block Grant (CDBG) funds, $20,000 for the Proposition 218 ballot effort and the remaining $1,550,000 will be self -assessed financed with a loan from the United States Department of Agriculture (USDA). USDA has a program for rural communities called Community Facilities Direct and Guaranteed Loans, which would be guaranteed and paid back by the proposed self-assessment. The loan would be a 3% interest, 40-year loan.

One time costs estimated at $20,000, associated with the annexation to CSA 27 are recommended to be funded by the Community Development Fund, which includes staff project time for the ballot procedure, Engineer's Report, and public meetings. It is recommended that the Community Development Fund include the $2,000 one time start up costs for State Board of Equalization fees as part of this funding request. This is consistent with Stanislaus County's goal of providing funding for "one-time projects or programs benefiting the unincorporated area that demonstrates strong local support and commitment, and a general public benefit".

The Stanislaus County Community Development Fund was established by the Board of Supervisors at $1.5 million as part of the Fiscal Year 2007-2008 Adopted Final Budget. To date, twenty-two projects have been awarded funding from this source. Such community projects have included sidewalk, lighting, and infrastructure improvements; establishing maintenance districts in the unincorporated areas of Stanislaus County; and neighborhood cleanup activities. The current uncommitted balance in the Community Development Fund is $1,118,937. If the recommended use of Community Development Funds is approved, the uncommitted balance would be $1,098,937 not including interest earnings.

DISCUSSION:

In March 2007, the Board of Supervisors authorized the County to enter into a contract with Stantec Consulting Inc. to provide design, surveying and general engineering services to develop plans and specifications for the Empire Infrastructure Improvement Project. The design process was the first step toward the ultimate realization of storm drain infrastructure in Empire and was funded by the CDBG Program and the Stanislaus County Redevelopment Agency. On July 21, 2009, the Board adopted the plans and specifications for the Empire Improvement Project Phase 1A and related actions, including environmental exemption. The Board of Supervisors awarded the contract to Granite Construction Company on November 3, 2009, for the construction of all the improvements for Phase 1A.

Phase 1A was completed in 2010, using a combination of Redevelopment and CDBG funds. Phase IA serves 80 parcels for approximately $3,031,000. This included $2,092,000 in construction costs, plus an additional $939,000 to cover construction related items such as: construction contingency for change orders, inspection services, material testing, quality assurance, project management administration, public outreach, and budget contingency.

CSA 27 was formed to fund operations and maintenance (O&M) of the improvements at a per parcel cost of approximately $84 annually ($7 monthly). As completed, the system serves only as a self-contained French drain and not as a traditional positive storm drain collection system that would have discharged directly to the Tuolumne River, a surface body of water belonging to the United States and regulated by the Federal Environmental Protection Agency.

Prior to the elimination of the Redevelopment Agency (RDA) in 2011, the plan was to connect the town of Empire to the Modesto Irrigation District outfall near the Santa Fe Bridge that crosses the Tuolumne River. The cost of the traditional storm drainage system that was contemplated in the Stantec plans would have cost approximately $15 million.

Due to funding constraints caused by the elimination of the RDA in 2011, the Planning and Community Development Department in conjunction with the Department of Public Works has developed an alternative storm drainage project. The Empire Community Storm Drainage Report (Report) is the result of that effort. The subject Report recommends an environmentally friendly storm drainage solution, which instead of collecting stormwater and piping it to the Tuolumne River, it would slow down and recharge the water where it falls. This is beneficial for ground water recharge. The project will build roadside swales which will collect, store and percolate the water from the public right of way. Sidewalks will be built throughout the town of Empire, for two purposes; one of which will be to help keep private water on private property, separate from the street swales, and second for pedestrian safety.

The three remaining phases of the Empire project can be completed either in its entirety or in separate phases. However, it is recommended that the project be built out in one phase in order to obtain economy of scale and more favorable funding. Phase 1A in Empire consists of 80 parcels, which have storm drainage improvements in place, less sidewalks. This phase is currently the extent of CSA 27. The assessment for maintenance is $7 per month per parcel. This area will need the capital improvement of sidewalks. The capital cost plus the existing storm drainage maintenance is estimated at less than $20 per month per parcel.

Phases 1B, Phase 2, and Phase 3 consist of 333 parcels. These phases would need to be added to CSA 27, which will take a Proposition 218 election. The scope of the capital improvements for these areas includes drainage swales and sidewalks. These areas would have a lower maintenance cost compared to the conventional system, Phase 1A, yet incur more capital costs due to the lack of any system in place. The capital cost plus the proposed storm drainage maintenance is estimated at less than $20 per month per parcel.

The magnitude of the capital improvement costs associated with implementation of this Report to serve Phase 1B, Phase 2, and Phase 3 is approximately $2.87 million dollars. A combination of funding sources is anticipated to be able to complete the proposed project. It is anticipated to use $1.3 million in CDBG funds, which should be available in October of 2015.

While the CDBG funds are being accumulated over two fiscal years, staff will work on obtaining a USDA small community loan to cover the rest of the $1.57 million capital cost. The USDA loan will be paid off pending a CSA ballot initiative, which is anticipated to cost less than $20 per month per parcel, including maintenance costs. Public Works' staff, after the design is complete and the cost estimates perfected, will conduct the Proposition 218 ballot proceedings. The Proposition 218 ballot will include a capital construction repayment and an ongoing maintenance component.

POLICY ISSUES:

The recommended actions are consistent with the Board's priorities of providing A Safe Community, A Healthy Community and A Well Planned Infrastructure System by constructing a storm drainage system and providing sidewalks in the remaining portions of the town of Empire.

STAFFING IMPACT:

Public Works' staff will manage the design of the project and conduct the Proposition 218 ballot proceedings.

CONTACT PERSON:

Matt Machado, Public Works Director. Telephone: (209) 525-4130.

ATTACHMENTS:

1. Empire Community Storm Drainage Report

DL/dm

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Empire Community Storm Drainage Report
Low Impact Development & Greening Study

100% Submittal

Prepared for:

Stanislaus County Dept. of Planning & Community Development
Stanislaus County Board of Supervisors
Citizens of the Empire Community

Prepared by:

Paul Saini, Associate Civil Engineer, RCE, QSD-P, MBA
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Development Services Division
1010 10th Street, Suite 4202
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Reviewed by:
David Leamon, Deputy Director of Public Works
Lester Stachura, Senior Engineering Technician

Approved by:
Matt Machado, Director Public Works

Report Date: August 7, 2014

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1. PURPOSES AND OBJECTIVE

The purpose of this report is to develop feasible and economical methods for draining storm water from unincorporated rural and urban areas of the Empire Community.

This report provides general information and documentation necessary for the County to assess the suitability of assumptions, design criteria, and design methodology used in developing the proposed Low Impact Development (LID) system to accommodate storm water runoff in the Empire community. To accomplish the objective of this report, three major tasks were undertaken:

First, compute projected storm water runoff generated by the Project based on land uses and the basic rational formula as defined in Chapter 4 of the 2014 Standards and Specifications.

Second, determine overall proposed storm drainage system layout and sizing necessary to collect, convey, store, treat, and percolate storm water runoff using Low Impact Development, Hydro-modification, and 'green technology' design methodology.

Third, provide an Engineer's Construction Cost Estimate and recommendations for the proposed improvements.

This storm drainage Low Impact Development & Greening Project (Project) is being undertaken by the County of Stanislaus (County) to assess economical and affordable storm water design options for the community of Empire. This Project also takes into consideration the storm drainage improvements that were recently completed and installed as part of the original Phase 1A.

Major Project components that are proposed in this report include re-grading of roadway rights-of-way; installing sidewalk, constructing bio-retention swales for storm water storage; and providing storm water quality treatment through natural soil percolation.

Figure 1 and Figure 2 illustrates the Project boundary, phases, and vicinity in relation to surrounding areas.

Figure 1: Empire Community Map

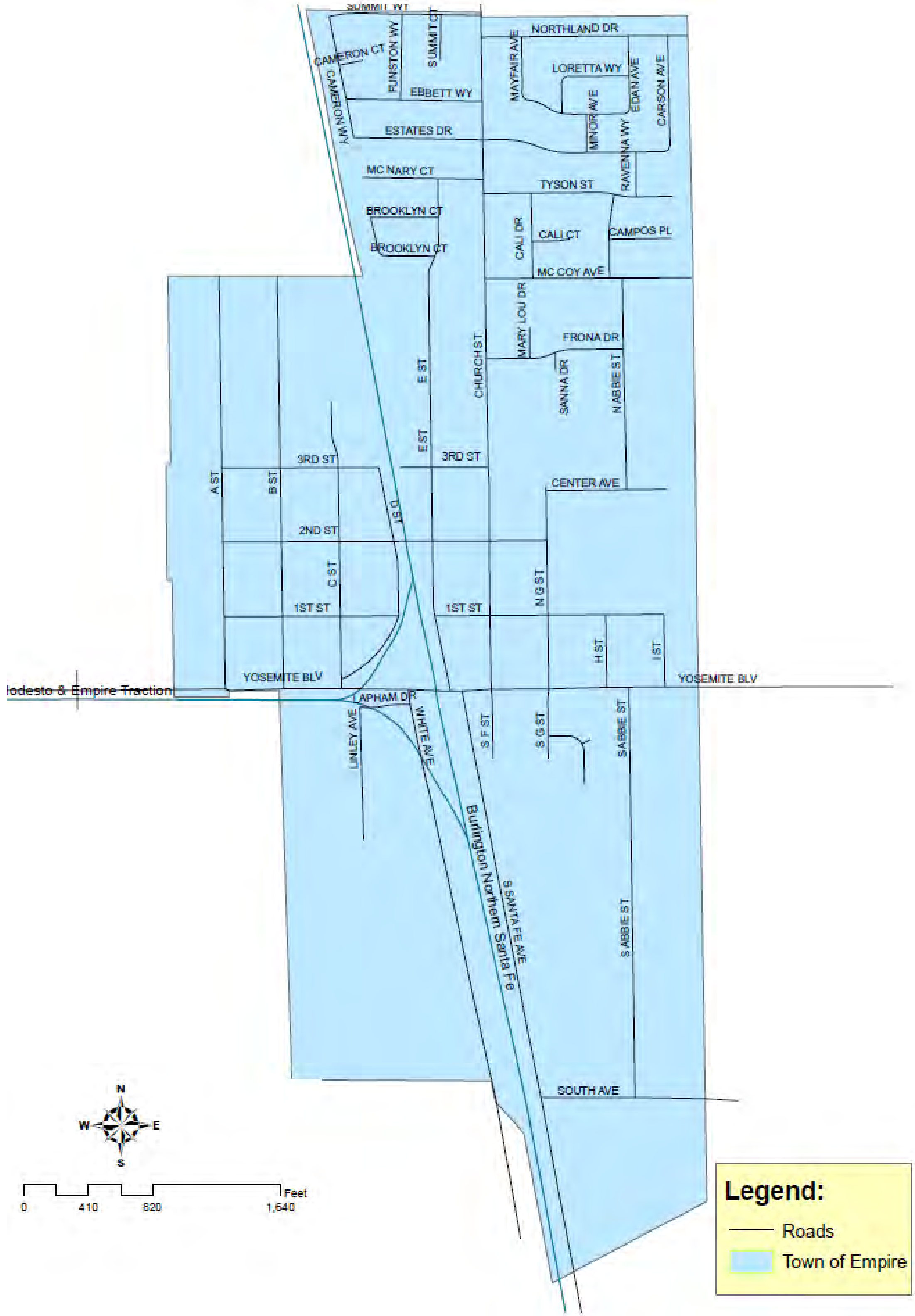
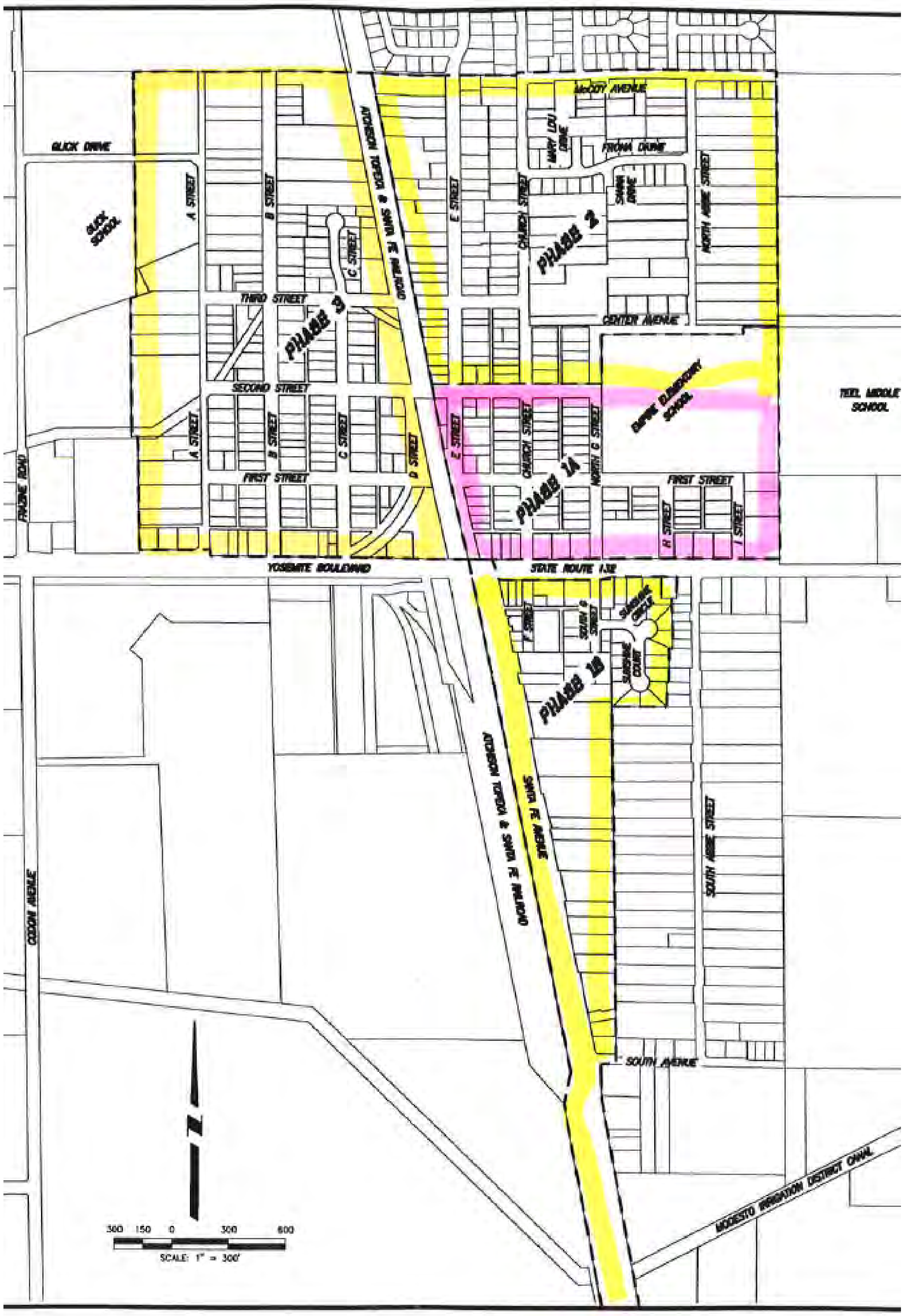


Figure 2: Existing Phasing Boundary for Phase 1A and Proposed Phases 1B, 2, and 3



The proposed LID solutions recommended in this report can enhance livability and sustainability through the effective use of best-management practices (BMP) related to storm water management. BMP's recommended in this study includes curb-less streets draining into native swales which can help capture, slow down, and provide natural water quality treatment to the peak design storm water runoff.

LID and hydro-modification design techniques can also help reduce greenhouse gas emissions, increasing urban greening, decrease air and water pollution, reduce the consumption of natural resources and energy, help recharge the local groundwater, and increase the community awareness of reusing storm water runoff. LID in turn, can help improve the overall community's health, safety, and welfare.

The specific intent of this report is to determine the storm water needs for the Empire Community and to provide a strategy for managing the storm drainage requirements using LID techniques. The recommendations in this report can be used for further engineering analysis and the development of more detailed plans, specifications & estimates (PSE) for managing the storm run-off in an efficient and cost-effective manner.

2. PHASING OF IMPROVEMENTS

Phase 1A was completed in 2010, serving 80 parcels for approximately $3 million dollars. This included $2,092,000 in construction cost plus an additional $939,000 to cover construction related items such as: construction contingency for change orders, inspection services, material testing, quality assurance, project management administration, public outreach, and budget contingency.

Phase 1A was constructed using both Community Development Block Grant (CDBG) in the amount of $1.9 million dollars and former Stanislaus County Redevelopment Agency (RDA) funds in the amount of approximately $1.1 million dollars.

Community Service Area (CSA) 27 was formed to fund operations and maintenance (O&M) of the improvements at a per parcel cost of approximately $70 annually ($6 monthly). As completed, the system serves only as a self-contained French drain and not as a traditional positive storm drain collection system that would have discharged directly to the Tuolumne River, a surface water body belonging to the United State and regulated by the Federal EPA.

Due to funding constraints caused by the elimination of the Redevelopment Agency (RDA), the Planning and Community Development Department in conjunction with the Department of Public Works has developed an initial plan for construction of only Phase 1A of the overall Storm Drain Master Plan. Phase 1A consisted of installing curb, gutter, sidewalk, handicap returns, new street sections, and a positive storm drain collection system leading to an underground French drain system. The Phase 1A plan encompasses the area generally bounded on the south by Highway 132; on the west by E Street; on the east by I Street; and, on the north by 2nd Street and Center Avenue. This area was considered due to the geographical location and its proximity to the school, the developed park, the open play area and the new pool facilities (Regional Water Safety Training Center).

To help minimize construction and engineering cost, it is assumed that the remaining phases will not utilize a storm drain trunk line connecting to an existing Modesto Irrigation District (MID) outfall structure that directly discharges to the Tuolumne River.

The three remaining phases of the Empire storm water LID project can be completed in a single or in separate phases. Phase 1B, 2, and 3 can all be constructed under one construction bid project or in individual projects spread out over a number of years if available funding and resources become an issue. The number of phases ultimately constructed will depend on funding availability. It is important to note that phasing the proposed improvements may be more costly due to the reoccurring costs for each phase (i.e. mobilization, traffic control, NPDES permitting, etc). Construction costs could be significantly lower if all improvements were constructed as one project rather than phasing the construction for the remaining Phase 1B, 2, 3 phases.

Additional phasing cost analysis can be provided, if necessary. This report reviews the Low Impact Development (LID) design options for the remaining phases 1B, 2, and 3. Greening technology using LID, post-development BMPs, and hydro-modification techniques are explored in lieu of the conventional positive storm drainage systems. The remaining phases as currently planned consist of serving the following number of parcels:

Phase 1A:	80 parcels (constructed in 2010 for about $3 million)
Phase 1B:	65 parcels
Phase 2:	134 parcels
Phase 3:	134 parcels
Total:	333 total parcels (Phase 1A, 1B, 2, and 3)

Phase 1B originally included the trunk line connecting to the MID outfall to the Tuolumne River for a total cost of $6.2 million. This trunk line has been eliminated in this study due to funding availability.

The magnitude of the capital improvement costs associated with implementation of this storm drain master plan (SDMP) to serve Phase 1B, Phase 2, and Phase 3 is approximately $2.87 million dollars (see Engineer's Construction Cost Estimate in Figure 24, Section 9 of this report).

Based on available resources, the implementation of this SDMP may need to be performed in phases, as funding sources become available. It is anticipated that build out of the study area would occur over the next 1-3 years assuming USDA or internal financing options. The CDBG financing option may require additional phasing and construction time. The additional phasing costs associated with the CDBG option is expected to be more expensive and will require phasing the improvements over a longer time period – up to 8 years or more. These three financing options are discussed in more detail in Section 11 of this report.

First priority should be given to constructing bio-retention basins in developed areas that currently do not have positive storm drainage systems and that have experienced flooding historically. These flood-prone areas have been designated as “hot zones” and are shown in Figure 17A and Figure 17B.

The second priority will be to construct concrete sidewalks in conformance to current ADA design width requirements using the latest 2014 County Construction Standard Plate Number 3-D7.

The third priority will be to rejuvenate and rehabilitate the existing vertical drywells, catch basins, and other existing storm drain facilities in the Project area to ensure optimal system performance.

3. STORM WATER QUALITY OBJECTIVES BY THE EPA

The County is required by State and Federal regulations to develop a comprehensive inventory, monitoring, and management program to reduce the amount of pollutants in storm water runoff discharged to receiving waters of the United States to the maximum extent practicable (MEP). The County is a National Pollutant Discharge Elimination System (NPDES) Phase II community and has received a NPDES Permit from the Regional Water Quality Control Board (RWQCB) in 1995, and an updated Permit in 2013. A map of the NPDES Municipal Separate Storm Sewer Systems (MS4) coverage area near the proposed project boundary is shown in Figure 3.

The NPDES Permit stipulates numerous requirements and practices that are needed to improve the quality of the County's storm water discharges. All new projects meeting certain minimum threshold requirements are subject to these regulatory provisions. As a result, the County is mandated to develop a Storm Water Management Plan (SWMP) that prescribes specific Best Management Practices (BMPs) and performance standards that needs to be scheduled and implemented. BMPs represent control mechanisms to reduce the discharge of pollutants from new or existing developments to the maximum extent practicable. Post-Development and Low Impact Development design requirements are now two integral components of the new MS4 Phase II permit.

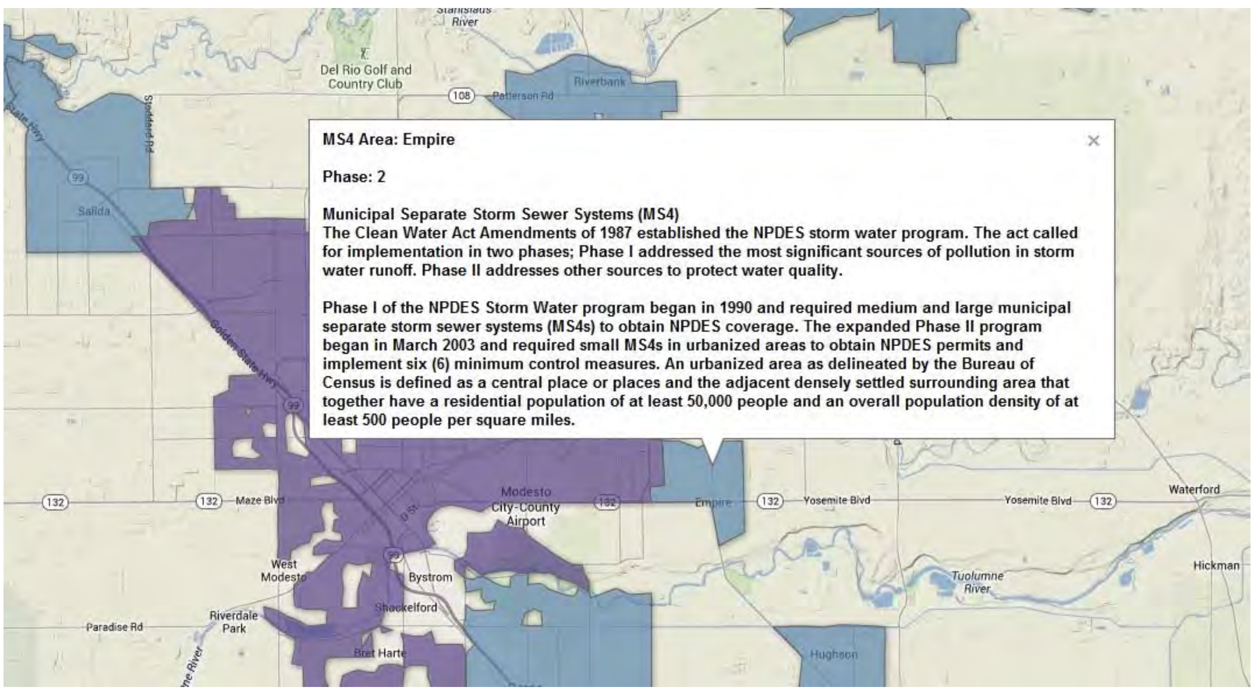
The proposed recommendations presented in this report have been developed in consideration of these environmental concerns. The recommendations will also provide opportunities for protecting our natural groundwater resources.

One of the most cost effective methods to improve the quality of storm water runoff is to utilize bio-retention swales. The swales provide attenuation storage and opportunities for pollutants to settle and be retained within the swale area without having a need to discharge the storm water into receiving waters of the State, such as the Tuolumne River and Dry Creek rivers. Allowing urban runoff to flow through grassy swales and turf areas provides a filtering mechanism that serves to improve the quality of urban runoff. Bio-retention swales can be used as an acceptable BMP to help the County meet the requirements of the County's NPDES permit. This report includes recommendations for the proposed construction of bio-retention swales that will provide flood control attenuation as well as water quality treatment opportunities to satisfy NPDES environmental requirements.

In general, a properly designed and maintained bio-retention swale that holds storm water for a prescribed period of time will help reduce the concentration of constituents discharged into receiving waters by providing for ‘volatization’, settlement, and subsequent absorption by vegetative matter and the soil. Suspended solids, heavy metals, hydrocarbons, and possibly some organic compounds are the most predominant constituents that would be expected to have reduced levels of concentrations after bio-retention storage.

The LID approach has been used to design and manage storm water runoff by utilizing bio-retention swales. The natural pre-development hydrology of the site is maintained such that the existing area within the County’s road rights-of-way can naturally infiltrate, filter, store, treat, evaporate, and detain storm water runoff ‘***close to the source’***. LID can be used in combination with traditional storm drain systems to infiltrate the smaller, more frequent storms. LID will help reduce the amount of runoff entering into a municipal MS4 Phase II system and/or into a surface water body of the United States. LID will also aid in recharging our local ground water.

Figure 3: NPDES MS4 Phase II Coverage Area



4. TOTAL MAXIMUM DAILY LOAD (TMDL) & SECTION 303(D)

Incorporating the Low Impact Development technologies and BMPs for the Empire Community may help minimize pollutants from nonpoint sources. The Federal Clean Water Act (CWA) contains two strategies for managing water quality. The first is a ‘technology-based’ approach that envisions requirements to maintain a minimum level of pollutant management using the best available technology (BAT). The second is a water ‘quality-based’ approach that relies on evaluating the condition of surface waters and setting limitations on the amount of pollution that the water can be exposed to without adversely affecting the beneficial uses of those waters. Figure 4 provides a map of the various receiving watershed risk levels. According to this map, the Empire community area is considered a “High Risk” level.

Section 303(d) of the CWA bridges these two approaches. Section 303(d) requires that the California State Regional Water Quality Control Board make a list of *surface waters of the United State* that are not attaining standards after the technology-based limits are put into place. For waters on this list (which includes the Tuolumne River that is tributary to the Empire study area) the State has established total maximum daily loads or TMDLs. A TMDL must account for all sources of the pollutants that caused the water to be listed. Federal regulations require that the TMDL, at a minimum, account for contributions from point sources (federally permitted discharges) and contributions from nonpoint sources. US EPA is required to review and approve the list of impaired waters and each TMDL. Figure 5 and Figure 6 lists the pollutants of concern, sources, and status of TMDLs for the Tuolumne and Dry Creek rivers.

TMDLs are established at the level necessary to implement the applicable water quality standards. A TMDL requires that all sources of pollution and all aspects of a watershed's drainage system be reviewed, not just the pollution coming from discrete conveyances (known as point sources), such as a discharge pipe from an commercial/industrial site or a sewage treatment plant. Point sources are defined in the Clean Water Act, Section 502.

"Nonpoint source" pollution (also called polluted runoff) is the release of pollutants from everything other than point sources. These include landscape runoff, agricultural runoff, as well as dust & air pollution that find their way into water bodies. Nonpoint source pollution is not typically associated with discrete conveyances. Nonpoint sources are not defined in statute, but are considered everything that is not covered under the point source definition.

The Clean Water Act does not expressly require the implementation of TMDLs. Section 303(d), 303(e), and their implementing regulations require that approved TMDLs be incorporated into water quality control basin plans. The U.S. Environmental Protection Agency (USEPA) has established regulations (40 CFR 122) requiring that National Pollutant Discharge Elimination System (NPDES) permits be revised to be consistent with any approved TMDL. New federal regulation is requiring that implementation plans be developed along with the TMDLs.

In California, the SWRCB has interpreted state law (Porter-Cologne Water Quality Control Act, California Water Code Section 13000 et. seq.) to require that implementation be addressed when TMDLs are incorporated into Basin Plans (water quality control plans). The Porter-Cologne Act requires each Regional Board to formulate and adopt water quality control plans for all areas within its region. It also requires that a program of implementation be developed that describes how water quality standards will be attained. When the TMDL is established as a standard, the program of implementation must be designed to implement the TMDL.

Incorporating the low impact development technologies and BMPs as recommended in this report may help minimize pollutants from nonpoint source. This will help meet the TMDL goals established by the State and the Federal EPA.

Figure 4: NPDES Receiving Watershed Risk Level

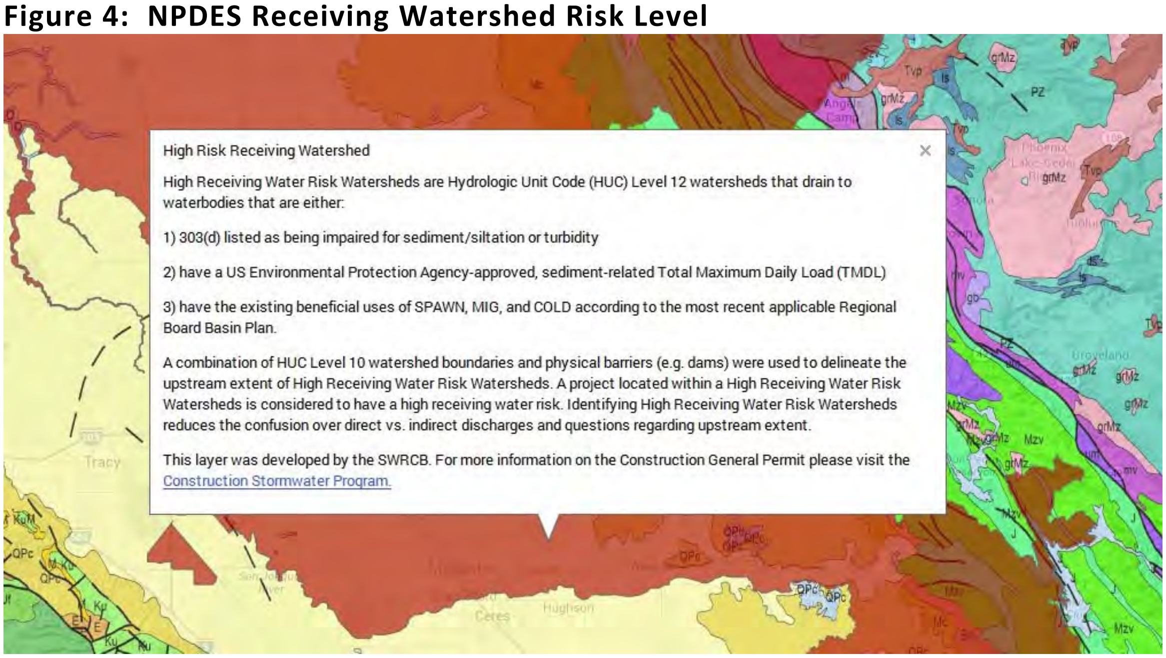


Figure 5: Tuolumne River Water Body TMDL Status

Tuolumne River, Lower

TMDLS & 303(D) LIST (2010) FOR TUOLUMNE RIVER, LOWER (DON PEDRO RESERVOIR TO SAN JOAQUIN RIVER)

Key: Pollutant on 303(d) list | Pollutant with a TMDL

Pollutant	Source	Size	Status	Comments
Chlorpyrifos	Agriculture	60 Miles	TMDL required	
Diazinon	Agriculture	60 Miles	TMDL required	
Group A Pesticides	Agriculture	60 Miles	TMDL required	
Mercury	Resource Extraction	60 Miles	TMDL required	
Temperature, water	Source Unknown	60 Miles	TMDL required	
Unknown Toxicity	Source Unknown	60 Miles	TMDL required	

Figure 6: Water Body in Project Vicinity with TMDLs

WATER BODY NAME	WATER BODY ID NO (WBID)	ESTIMATED SIZE AFFECTED	POLLUTANT	POLLUTANT CATEGORY
Dry Creek (tributary to Tuolumne River at Modesto, E Stanislaus County)	CAR5354001120080623180014	34 miles	Chlorpyrifos, Diazinon	Pesticides
			Escherichia coli (E. coli)	Pathogens
Note: Final Listing Decision: Listed on 303(d) List (TMDL required list)			Unknown Toxicity	Toxicity

WATER BODY NAME	WATER BODY ID NO (WBID)	ESTIMATED SIZE AFFECTED	POLLUTANT	POLLUTANT CATEGORY
Tuolumne River, Lower (Don Pedro Reservoir to San Joaquin River)	CAR5355000019980817143435	60 miles	Chlorpyrifos, Diazinon, Groups A Pesticides	Pesticides
			Mercury	Metals/Metalloids
			Temperature, water	Miscellaneous
			Unknown Toxicity	Toxicity

5. PHYSICAL CHARACTERISTICS OF THE STUDY AREA

The Project encompasses approximately 235 acres of unincorporated area in the town of Empire, California. The principal intersection of Yosemite Boulevard (State Highway Route 132) and Santa Fe Avenue can be considered a central and identifying location within the community and the Project area.

The original study area was identified by four distinct phases (Phase 1A which has already been completed, Phase 1B, Phase 2, and Phase 3). These phases are shown in Figure 7 and Figure 8. The total watershed area in this study is approximately 223 acres and excludes the Yosemite Boulevard right-of-way belonging to Caltrans. However, only 30.1 acres that represents the areas within the existing road rights-of-way were considered for this hydrology and drainage study.

In evaluating runoff quantities and the proposed drainage solutions for the Empire study area, several aspects of the existing physical environment were considered. These physical characteristics included: land use & zoning, climate, precipitation, topography, soil classification, soil characteristics, percolation & absorption rates, groundwater impact, and FEMA flood zone analysis. These are briefly discussed below:

a. Land Use & Zoning

Land uses and zoning designations for the study area were obtained from the County’s current General Plan. The percent of impervious area for each watershed area was based on a weighted average of the amount and type of the different land uses. Each watershed area was designated as a Drainage Management Area (DMA). This is an important input parameter in the rational formula because the mathematical equation relates the amount of impervious area to the total area of each watershed in order to estimate the amount of runoff losses attributed to pervious areas.

Approximately sixty-five (65) DMAs were identified and tabulated in this study. These DMAs are shown in Figure 8

The predominant existing land use within the Project area is low-density single-family residential; others represented to a lesser degree are high-density residential, general commercial, schools, parks and open space/ recreation areas. Figure 7 shows the existing land use map of the Empire community along with the delineated pahse boundary.

Table 1 and Table 2 shows the type of runoff coefficients used in the study based on the Surface Description of the watershed area and typical Land Uses that exist in the Empire community:

Table 1 - Summary of Land Use Designations

SURFACE DESCRIPTION	"C"
Lawns, pasture and farmland	0.30
Compacted earth without pavement	0.80
Pavement & Roofs	0.95
Detention Basin/Drainage Swales	1.00

Table 2 - Summary of Land Use Designations

LAND USE DESCRIPTION	"C"
R-1 Single family residence:	
Over 1.5 acres	0.40
0.5 to 1.5 acres	0.45
6000 sf. to 0.5 acres	0.55
Less than 6000 sf.	0.60
R-2 Medium Density Residential/Multi-family:	
Apts., condos, duplexes, & town homes	0.70
R-3 High Density Residential (cluster housing)	0.85
Commercial and industrial	0.90
Schools (to be determined by Engineer)	TBD

Figure 7: Existing Land Use in the Community of Empire, CA

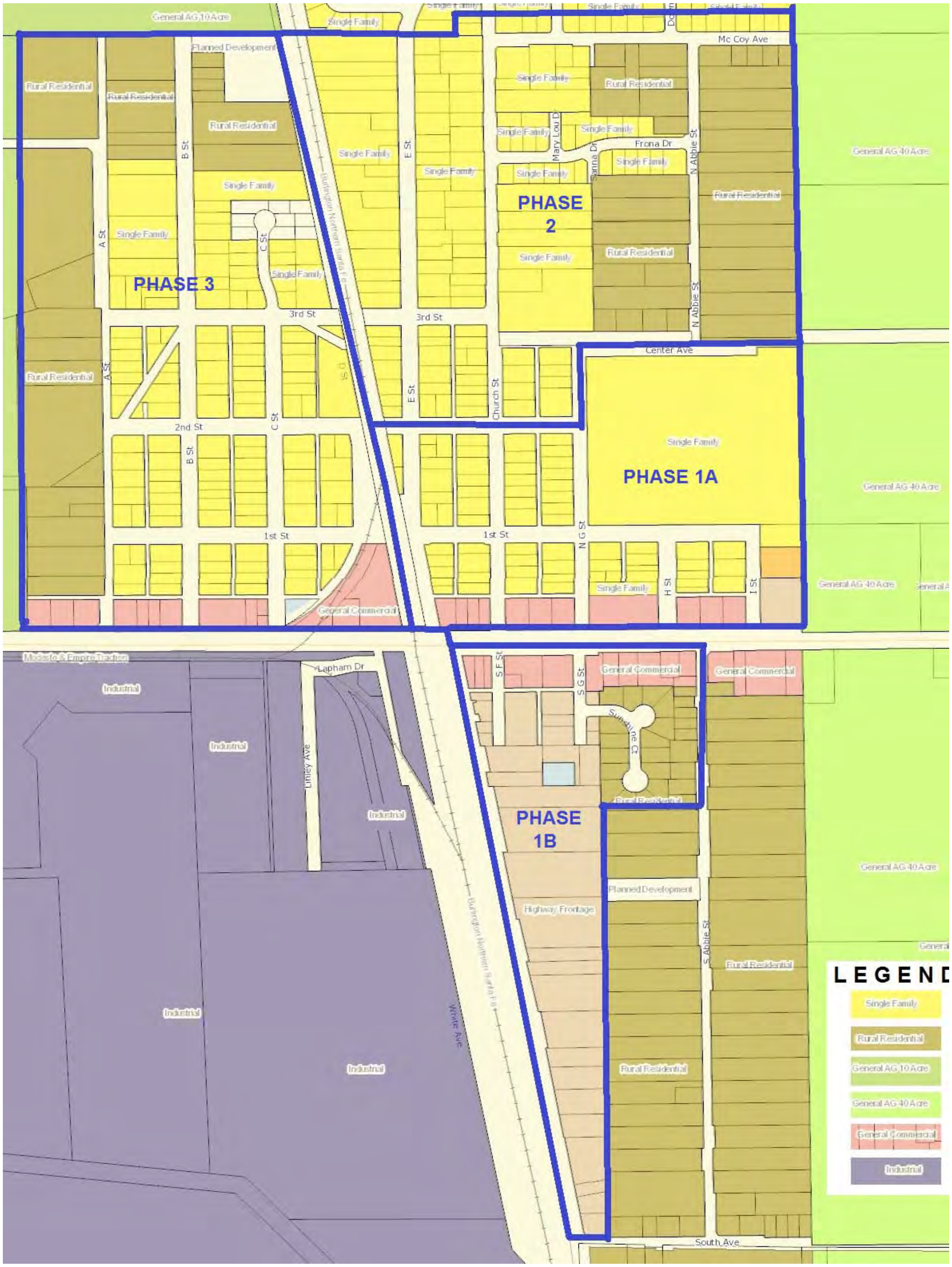
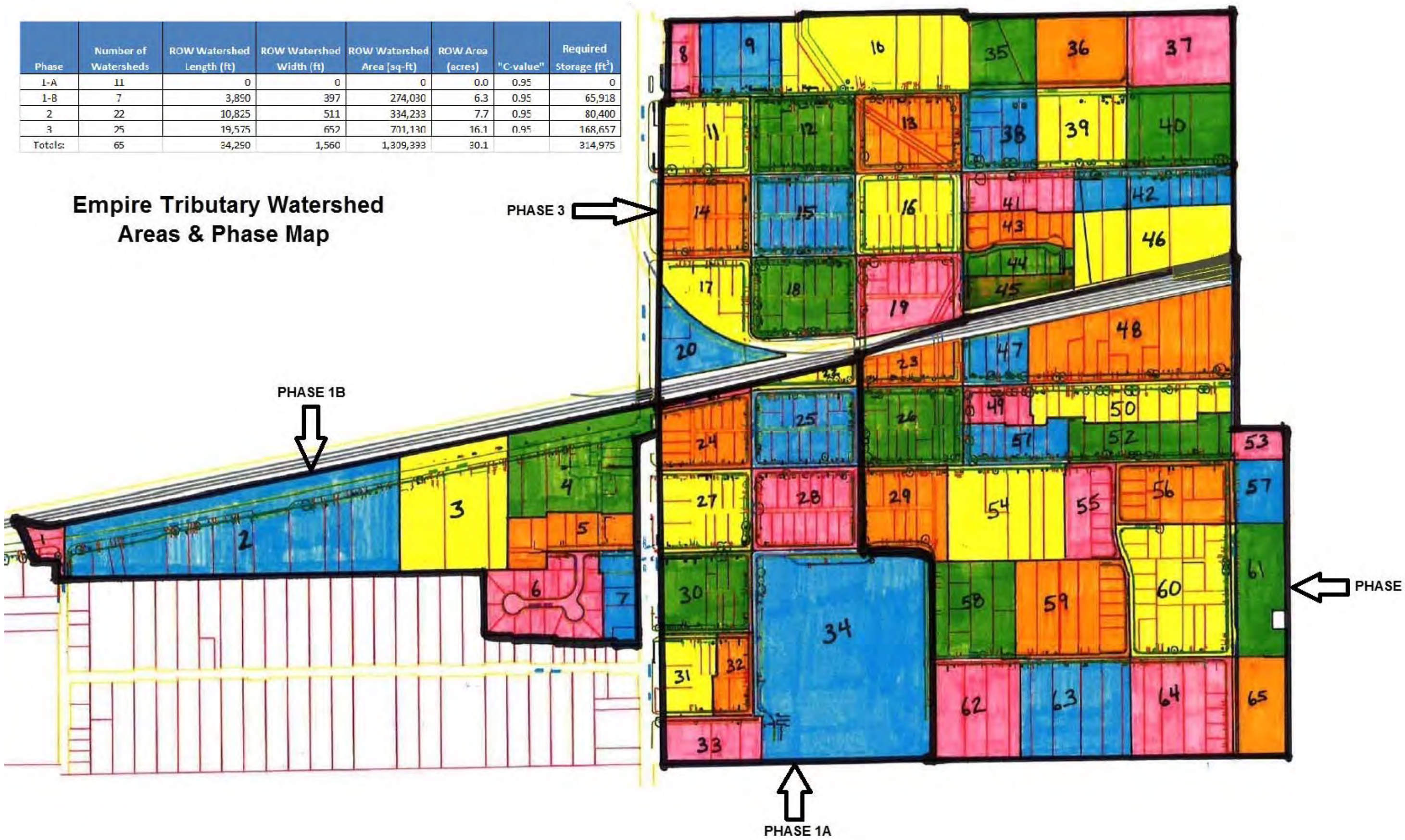


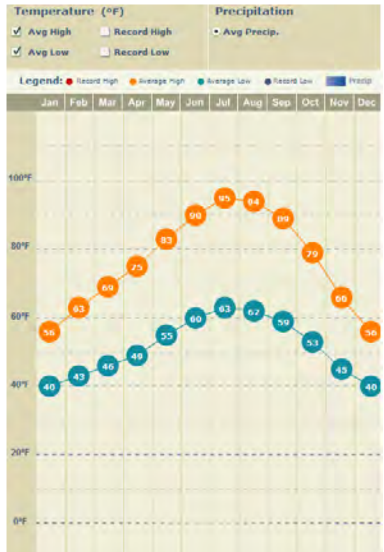
Figure 8: Watershed Drainage Management Areas (DMAs)



Phase	Number of Watersheds	ROW Watershed Length (ft)	ROW Watershed Width (ft)	ROW Watershed Area (sq-ft)	ROW Area (acres)	"C-value"	Required Storage (ft^3)
1-A	11	0	0	0	0.0	0.95	0
1-B	7	3,890	397	274,030	6.3	0.95	65,918
2	22	10,825	511	334,233	7.7	0.95	80,400
3	25	19,575	652	701,130	16.1	0.95	168,657
Totals:	65	34,290	1,560	1,309,393	30.1		314,975

b. Climate

The project study area is typical to that of San Joaquin Valley, with two distinct weather seasons; wet and cool winters along with dry and hot summers. Average high temperatures in the winter are in the 50's, and summer temperatures average in the 90's as shown in the Figure below:



c. Precipitation

Precipitation records from rain gage data monitored by MID and located in downtown Modesto indicate the amount of normal annual rainfall in the Modesto area averages about 12 inches per year.

Approximately 95 percent of this rainfall typically occurs from early fall through mid-spring, although infrequent summer showers do occur. Storm events during the rainy season consist of either individual storms or clusters of storms.

An evaluation of daily rainfall data for the Modesto area from January 1983 to August 1991 indicates that approximately 88 percent of the precipitation during this period resulted from storm events with a 2-year or less return period. Major storms of greater magnitude and duration generally occur during the rainy season; however. This includes design events such as the 50-year, 24-hour storm which typically produces approximately 3.04 inches of rainfall near the Empire community area.

Average monthly precipitation records from the downtown MID rain gage are shown below. Figure 9 below shows the average number of days per month with precipitation in the Empire community area:

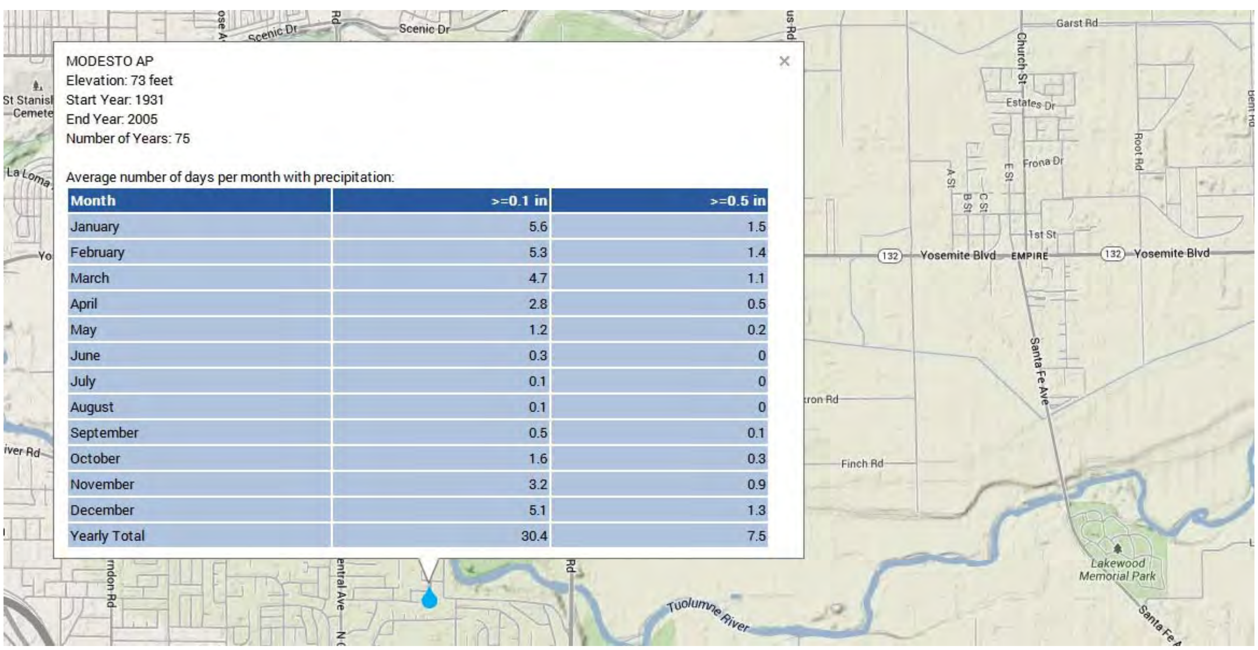
Historical Rainfall Data for Years 1888 to 2014

* Rain Season from July 1 thru June 30

Rain Records		
Lowest rainfall season total	1913	4.30"
Highest rainfall season total	1983	26.01"
Season Rainfall Average		12.19"

Average Rainfall by Month:	
January	2.34"
February	2.07"
March	1.91"
April	0.95"
May	0.5"
June	0.1"
July	0.02"
August	0.03"
September	0.21"
October	0.62"
November	1.33"
December	2.08"

Figure 9: Average number of days per month with percipitation



MODESTO AP
Elevation: 73 feet
Start Year: 1931
End Year: 2005
Number of Years: 75

Average number of days per month with precipitation:

Month	>=0.1 in	>=0.5 in
January	5.6	1.5
February	5.3	1.4
March	4.7	1.1
April	2.8	0.5
May	1.2	0.2
June	0.3	0
July	0.1	0
August	0.1	0
September	0.5	0.1
October	1.6	0.3
November	3.2	0.9
December	5.1	1.3
Yearly Total	30.4	7.5

d. Topography

The Empire study area is located within a portion of the broad valley floor of the San Joaquin Valley, and generally slopes from northeast to southwest at an average topographic gradient of approximately 0.1 percent. The ground surface elevations above mean sea level range from about 115 feet to about 120 feet within the study area.

Like most rural areas, the existing Empire community is prone to flooding during the winter and early spring, where storm water moves predominantly as sheet flow. As the community developed railroads, roadways, irrigation laterals, and other facilities, it obstructed the natural flow patterns of storm water runoff in some areas.

The existing BNSF Railway, for example, crosses the Project upon an elevated earthen fill such as to cause two separate drainage areas, one each being either wholly east of or wholly west of the dividing segment of track.

With the exception of Phase 1A boundary, most existing roadways in the Empire community currently lack curb, gutter, sidewalk, and ADA compliant handicap access ramps.

It is assumed that the storm runoff generated from Yosemite Avenue will not be included in the study. The runoff will be handled by the existing storm drain facilities that exist along Yosemite Blvd through natural percolation or positive drainage facilities maintained by California Department of Transportation (Caltrans).

The primary mode of existing storm water runoff management is achieved through the use of rock well, vertical drains, and through natural ground percolation. However, existing open space within the road rights-of-way provides the opportunity to apply above-ground detention and/or retention facilities using BMPs such as grassy swales, bioswales, bio-retention basins, and other Low Impact Development BMPs.

e. Soil Classification & Characteristics

The Natural Resource Conservation Service classifies soils into four hydrologic groups based on the soil's runoff potential:

Group A soils are sand, loamy sand, or sandy loam. These soils have low runoff potential and high infiltration rates (greater than 0.30 in/hr) even when thoroughly wetted. They consist chiefly of deep, well to excessively drained sands or gravels, and have a high rate of water transmission.

Group B soils are silt loam or loam. These soils have moderate infiltration rates (0.15-0.30 in/hr) rates when thoroughly wetted and consist primarily of moderately drained soils with moderately fine to moderately coarse textures.

Group C soils are sandy clay loam. These soils have low infiltration rates (0.05 - 0.15 in/hr) when thoroughly wetted and consist primarily of soils with a layer that impedes downward movement of water and soils with moderately fine to fine structure.

Group D soils are clay loam, silty clay loam, sandy clay, silty clay, or clay. These soils have the highest runoff potential and very low infiltration rates (0.0 - 0.05 in/hr) when thoroughly wetted. Soils in Group D consist primarily of clay soils with a high swelling potential and/or soils with a permanent high water table.

All soils identified within the Empire community generally belong to hydrologic Group B.

Figure 10 summarizes the existing soil inventory of the various soil classifications found within the Project area.

Figure 10: Soil Map Composition in the Empire Community

Symbol	Map Unit Name	Map Unit Soil Composition							Available Water Storage (0-100 cm)
		Hanford	Greenfield	Snelling	Tujunga	Grangeville	Dinuba	Foster	
HdA	Hanford Sandy Loam	85%			5%	5%	5%		13.4
HbSA	Hanford Fine Sandy	85%			5%	5%	5%		14
HbpA	Hanford Fine Sandy Loam	85%			5%	5%	5%		14.18
HdSA	Hanford Sandy Loam	85%			5%	5%	5%		13.4
GsA	Greenfield Sandy Loam	5%	85%	5%					14
TuA	Tujunga Loamy Sand	5%			85%	5%		5%	7.25

f. Soil Percolation Rates & Absorption Capacity

Copies of geotechnical report were reviewed for projects that were recently completed in the town of Empire. The purpose of reviewing these geotechnical reports were to evaluate the existing soil profiles and percolation rates.

A copy of the Scientific Investigations Report 2004-5232 prepared by the US Geological Survey for the Modesto Irrigation District was reviewed. This report titled, "Hydrogeologic Characterization of the Modest Area, San Joaquin Valley, California" was used to estimate the soil percolation rates near the Modesto area.

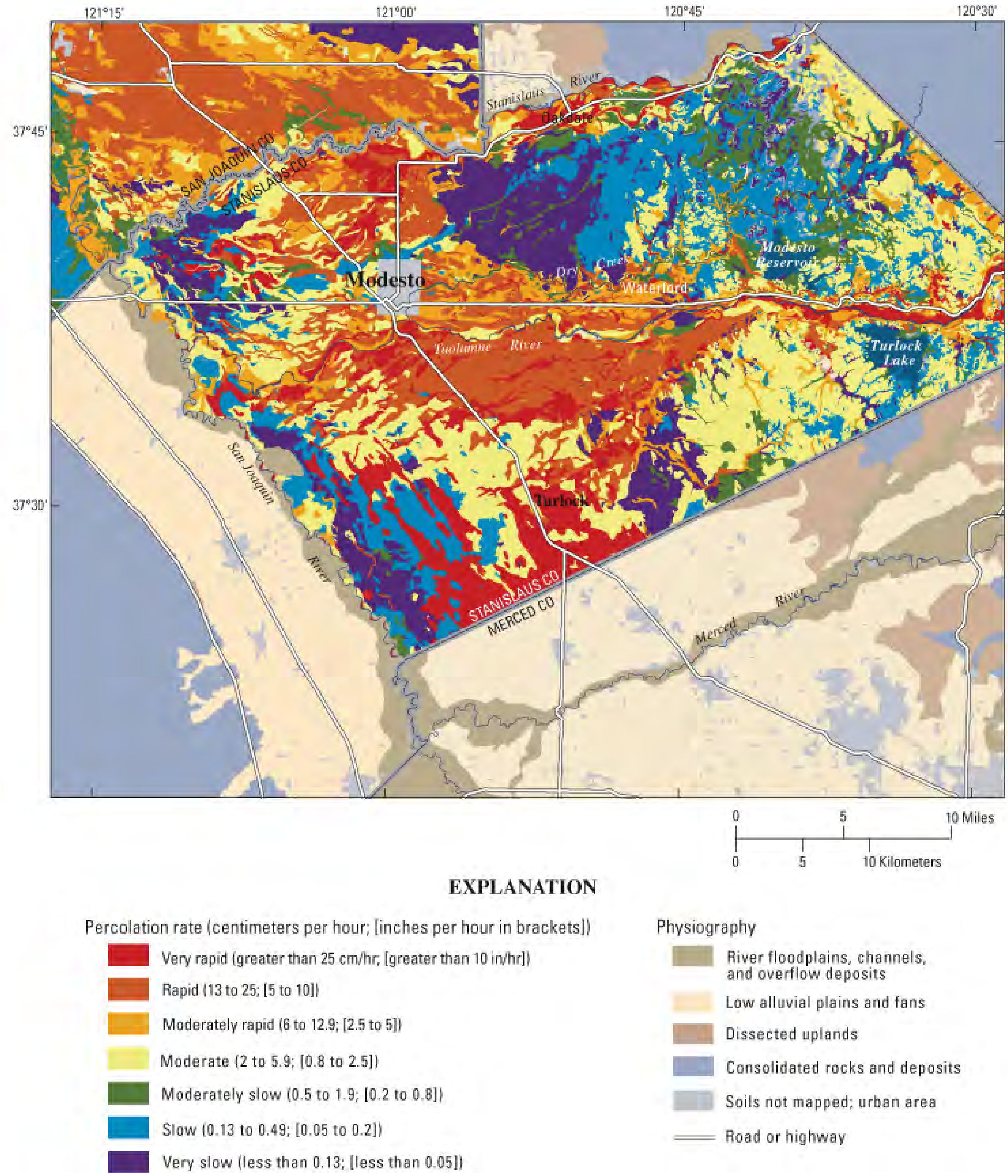
The percolation map shown in the above referenced report indicates that the soil absorption capacity for the Empire community is approximately 2.5 inches per hour to 10 inches per hour (or 37.40 gallons per square foot per day to 149.60 gallons per square foot per day, respectively). This map is shown in Figure 11.

For the purposes of this study, a percolation rate of approximately 80 gallons per square foot per day (gallons/sf/day) was assumed. Because absorption rates can vary over time as a result of soil clogging from water impurities, a minimum factor of safety (FS) of 4 was applied. The design absorption capacity used in this report was therefore reduced to only 20 gallons/sf/day.

To maintain the percolation rates and absorption capacity of the soils, it is also assumed that frequent maintenance will be provided to the installed storm drainage facilities. For example, periodic maintenance consisting of clearing the bottom of the bio-retention drainage swales of clogged soils should be expected.

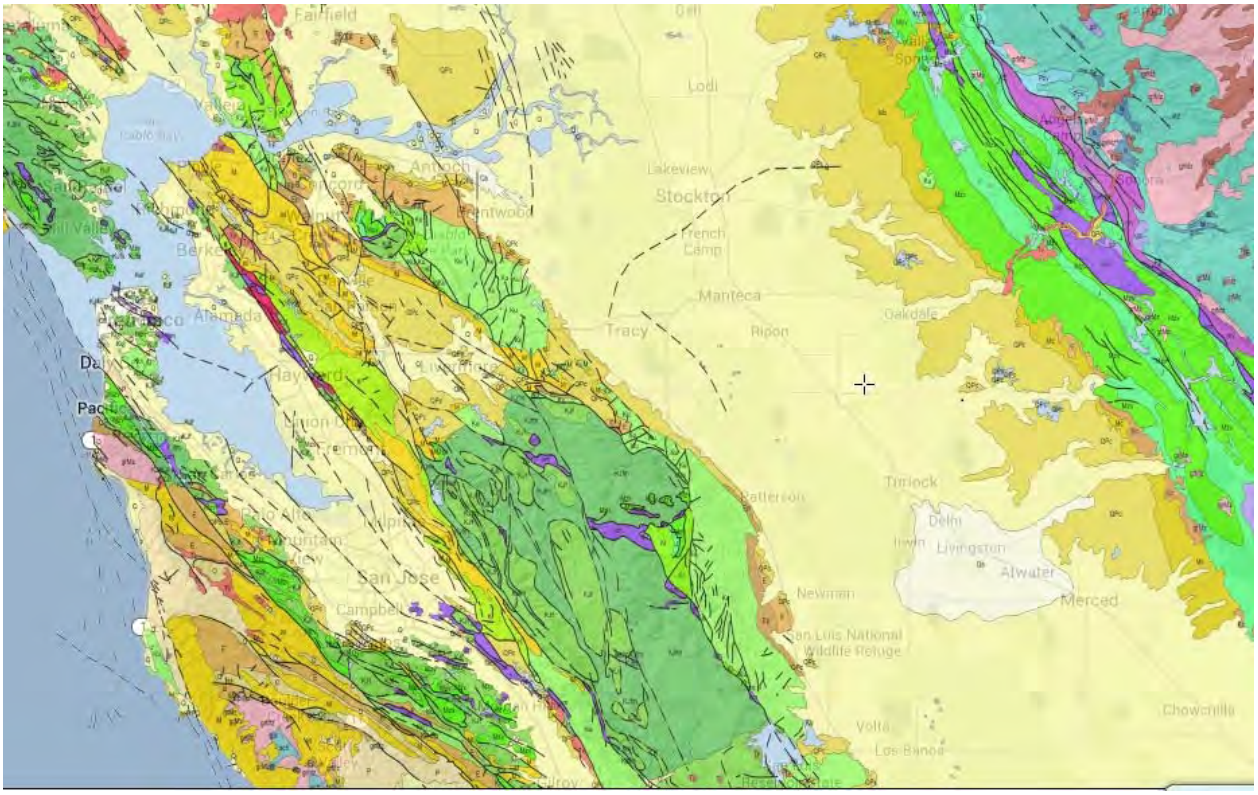
Figures 11, 12, and 13 are included in this report to provide general information on soil geological maps specific to the State of California and provide reference information for the various soil erosivity isoerodent contour levels and indexes that are applicable for the Empire community. These index values are import soil design parameters when conducting hydrology and drainage studies.

Figure 11: Soil Percolation Rates Near Modesto, CA. Soils data for Stanislaus County derived from Arkley (1964)



Source: USGS Scientific Investigation Report 2004-5232: Hydrogeologic Characterization of the Modesto Area, San Joaquin Valley, California. Prepared for the Modesto Irrigation District by the United States Geological Survey.

Figure 12: Soil Geological Map of California (GMC)



2010 GEOLOGIC MAP OF CALIFORNIA

California Geological Survey, Geologic Data Map No. 2

Compilation and Interpretation by: Charles W. Jennings (1977)

Updated version by: Carlos Gutierrez, William Bryant, George Saucedo, and Chris Wills

Graphics by: Milind Patel, Ellen Sander, Jim Thompson, Barbara Wanish and Milton Fonseca

Explanation

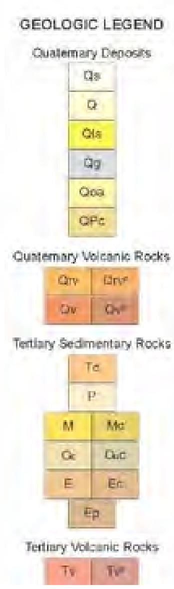


Figure 13: Soil Erosivity Isoerodent Contour Map
Empire Community Area (R-Factor = 20)

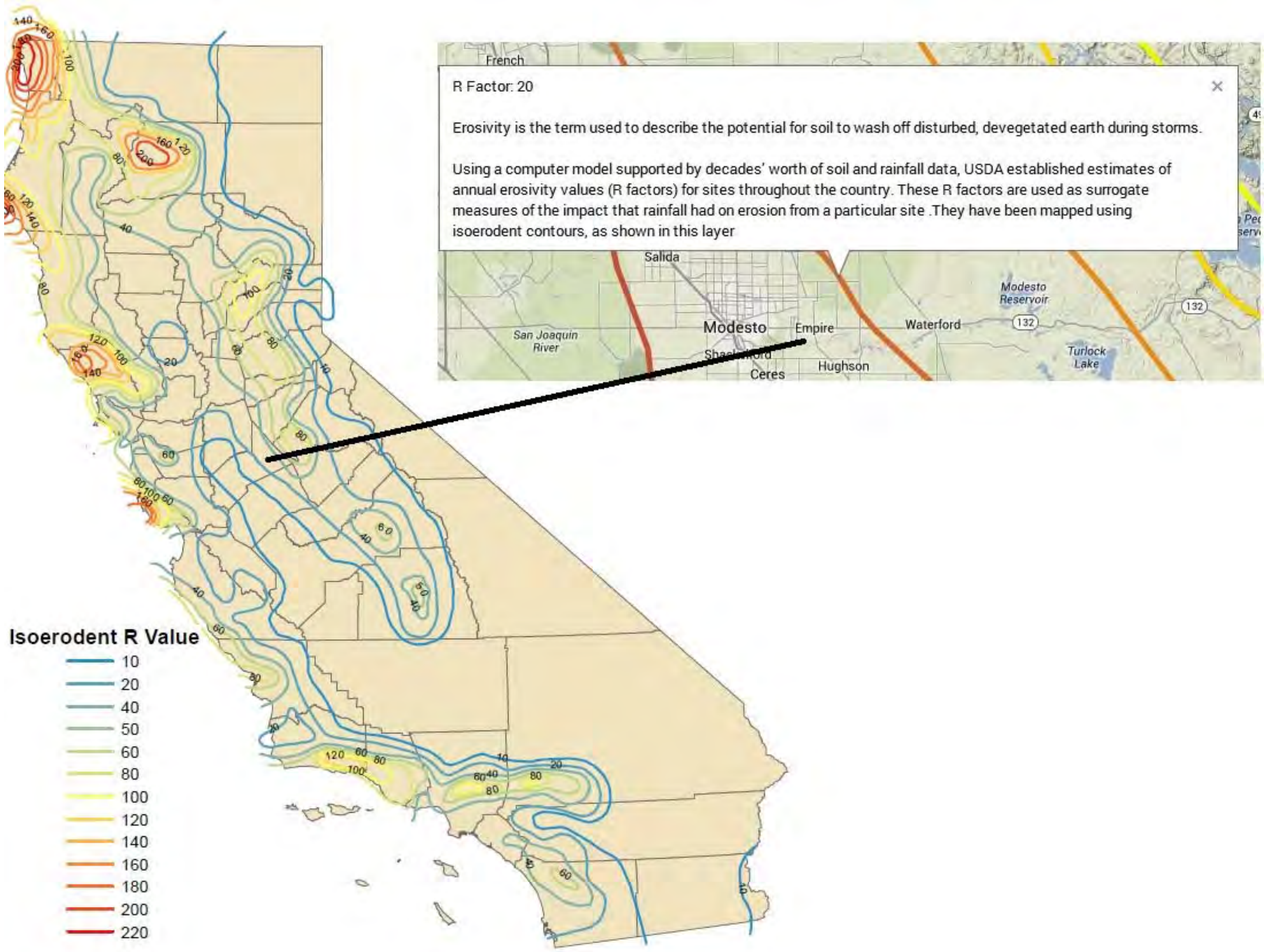


Figure 14: Erosivity Index Zone No. 23 for Empire, CA

Erosivity Index Zone: 23

Erosivity Index Table

Date	Erosivity Index Percent	Date	Erosivity Index Percent
Jan 1	0	Jul 14	49.9
Jan 16	7.9	Jul 29	50.7
Feb 15	20.9	Aug 13	51.8
Mar 1	25.7	Aug 28	54.1
Mar 16	31.1	Sep 12	57.7
Mar 31	35.7	Sep 27	62.8
Apr 15	40.2	Oct 12	65.9
May 15	46.2	Oct 27	70.1
May 30	47.7	Nov 11	77.3
Jun 14	48.8	Nov 26	86.8
Jun 29	49.4	Dec 11	93.5
		Dec 31	100

The USDA developed the Erosivity Index Table to show how the annual erosivity factor (R Factor) is distributed throughout the year in two-week increments.

g. Groundwater

The groundwater table in the Study Area is generally replenished by a combination of rainfall, unused landscape water, agricultural irrigation waters, and, under certain conditions, surface waterways from upstream tributary areas.

Groundwater levels within the study area were examined from data provided by the California Department of Water Resources. Generally, the depth to groundwater averages between 60 and 70 below ground elevation, depending on the time of year. These groundwater levels indicate that construction of depressed surface retention basins & bio-swales are suitable for the project study area.

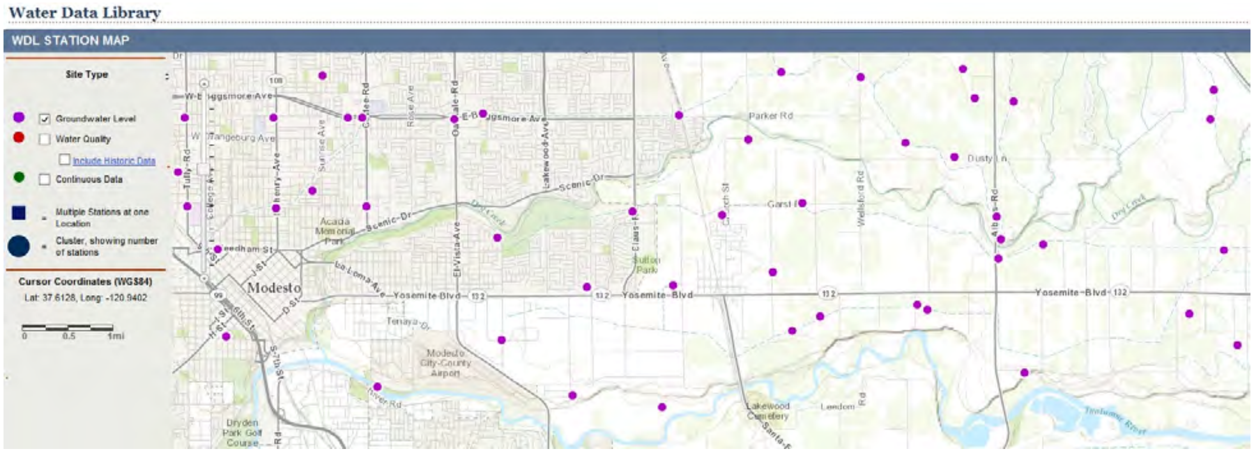
A detailed analysis on groundwater was not performed as part of this study. However, based on historical records, it is not anticipated that groundwater will rise within ten (10) feet from the bottom of any proposed drainage facilities.

Site-specific subsurface borings should be completed to confirm the depth to groundwater so that the ten foot minimum separation between the deepest part of the basin and the highest seasonal elevation of the groundwater table is maintained.

Figure 15 provides general information on groundwater level monitoring wells that is located near the north vicinity of the Empire Community.

Figure 16 provides historic groundwater levels as measured from 1968 to 1979 for the monitoring well mentioned above.

Figure 15: Groundwater Level Monitoring Stations near the Empire Community



Groundwater Levels for Station 376513N1209035W001

State Well Number: 03S10E30A001M
Local Well ID:
Site Code: 376513N1209035W001
Latitude (NAD83): 37.651300
Longitude (NAD83): -120.9035
Groundwater Basin (code): Modesto (5-22.02)

Well Use: Unknown
Well Status: Active
Well Completion Report Number:
Reference Point Elevation (NAVD88 ft): 119.42
Ground Surface Elevation (NAVD88 ft): 118.42
Total Depth (ft): Confidential
Perforated Interval Depths (ft): Confidential

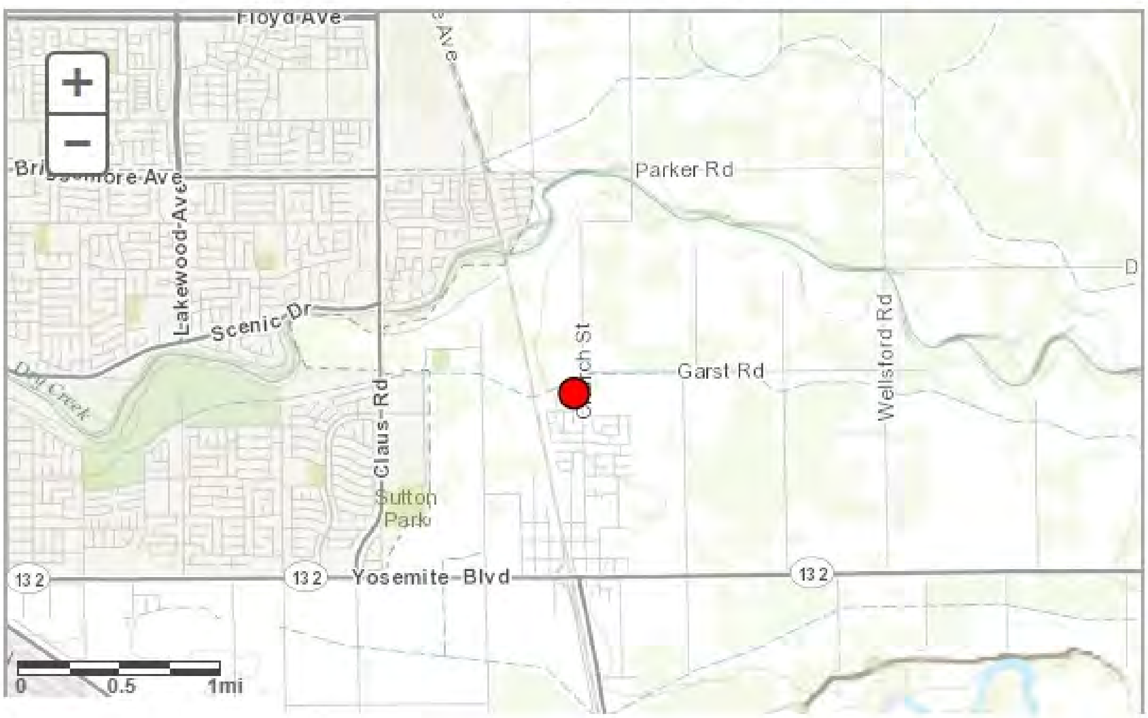
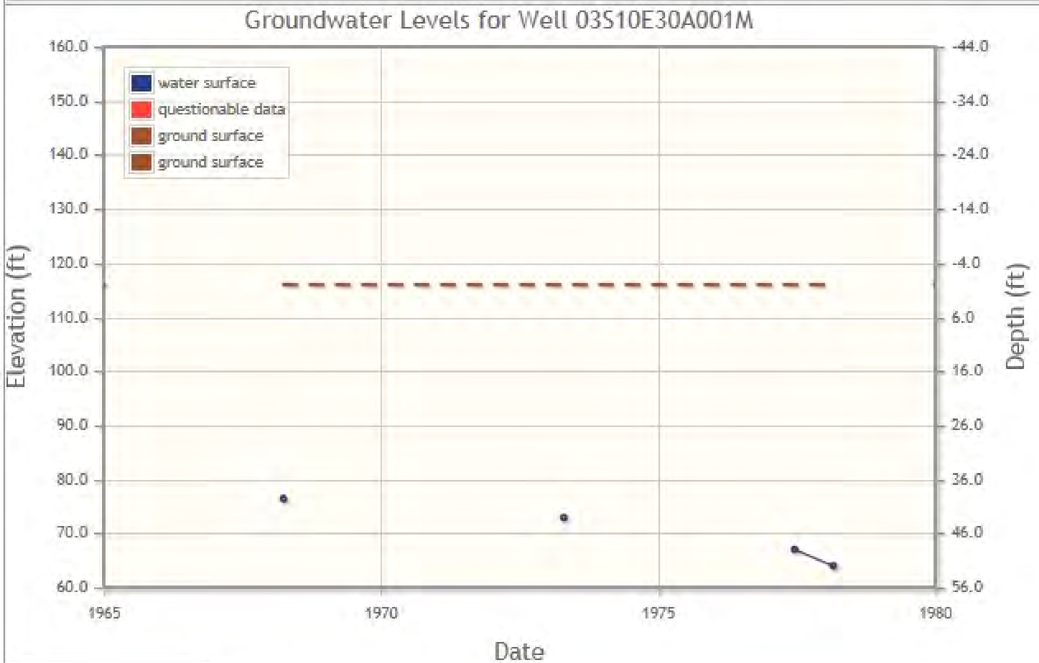


Figure 16: Historic Groundwater Levels for Empire Monitoring Station

Groundwater Levels for Station 376513N1209035W001

Station Data | Recent Groundwater Level Data | **Historical Groundwater Level Data**



Date	RPE	GSE	RPWS	WSE	GS to...	NM Code	QM Code	Agency	Comments
03/27/1968	117	116	40.6	76.4	39.6			5050	
03/24/1969	117	116				8		5050	
04/17/1973	117	116	44.1	72.9	43.1			5050	
04/09/1974	117	116				7		5050	
06/16/1977	117	116	50	67	49			5050	
02/27/1978	117	116	53	64	52			5050	
02/06/1979	117	116				3		5050	

All elevation and depth measurements are in feet. The vertical datum for historical measurements is NGVD29.

h. FEMA Flood Insurance Rate Map

Field investigations were performed by County encroachment inspectors to identify areas that do not have existing positive storm drainage system. These areas tend to experience reoccurring flooding during heavy rainstorm events and are therefore defined as 'hot zones'. These 'hot-zones' are shown in Figure 17.

The hot zones identified in this study are seen as pedestrian unfriendly. Maintenance crews are often needed to help alleviate local flooding problems by pumping storm water using vactor trucks. Eliminating ponding water often times require County Road Maintenance staff having to pump the water and haul it off to an authorized discharge point such as an existing storm drain catch basin that leads to a detention basin and/or to an approved sanitary sewer system.

To help review the potential for major flooding in the Empire community, FEMA Flood Insurance Rate Map (FIRM) for the 100-year flood plain elevations and flood categories for the study area were obtained and reviewed. Figure 18 shows the FEMA Flood Insurance Rate Map Panel 345 of 1075 (Map Number 06099C0345E), revised September 26, 2008.

Flood hazard areas identified on the Flood Insurance Rate Map are identified as a Special Flood Hazard Area (SFHA). SFHA are defined as the area that will be inundated by the flood event having a 1-percent chance of being equaled or exceeded in any given year. The 1-percent annual chance flood is also referred to as the base flood or 100-year flood. SFHAs are labeled as Zone A, Zone AO, Zone AH, Zones A1-A30, Zone AE, Zone A99, Zone AR, Zone AR/AE, Zone AR/AO, Zone AR/A1-A30, Zone AR/A, Zone V, Zone VE, and Zones V1-V30.

Moderate flood hazard areas, labeled Zone B or Zone X are also shown on the FIRM, and are the areas between the limits of the base flood and the 0.2-percent-annual-chance (or 500-year) flood. The areas of minimal flood hazard, which are the areas outside the SFHA and higher than the elevation of the 0.2-percent-annual-chance flood, are labeled Zone C or Zone X).

The Empire Project area is entirely categorized as Zone X, which is defined as "areas of minimal flooding" for the Empire community.

Figure 17A: Areas of Ponding Water after Major Rain Events (Hot Spots) Areas North of Yosemite Blvd Phase 1A, 2, 3)

Figure 17B: Areas of Ponding Water after Major Rain Events (Hot Spots) Areas South of Yosemite Blvd (Phase 1B)

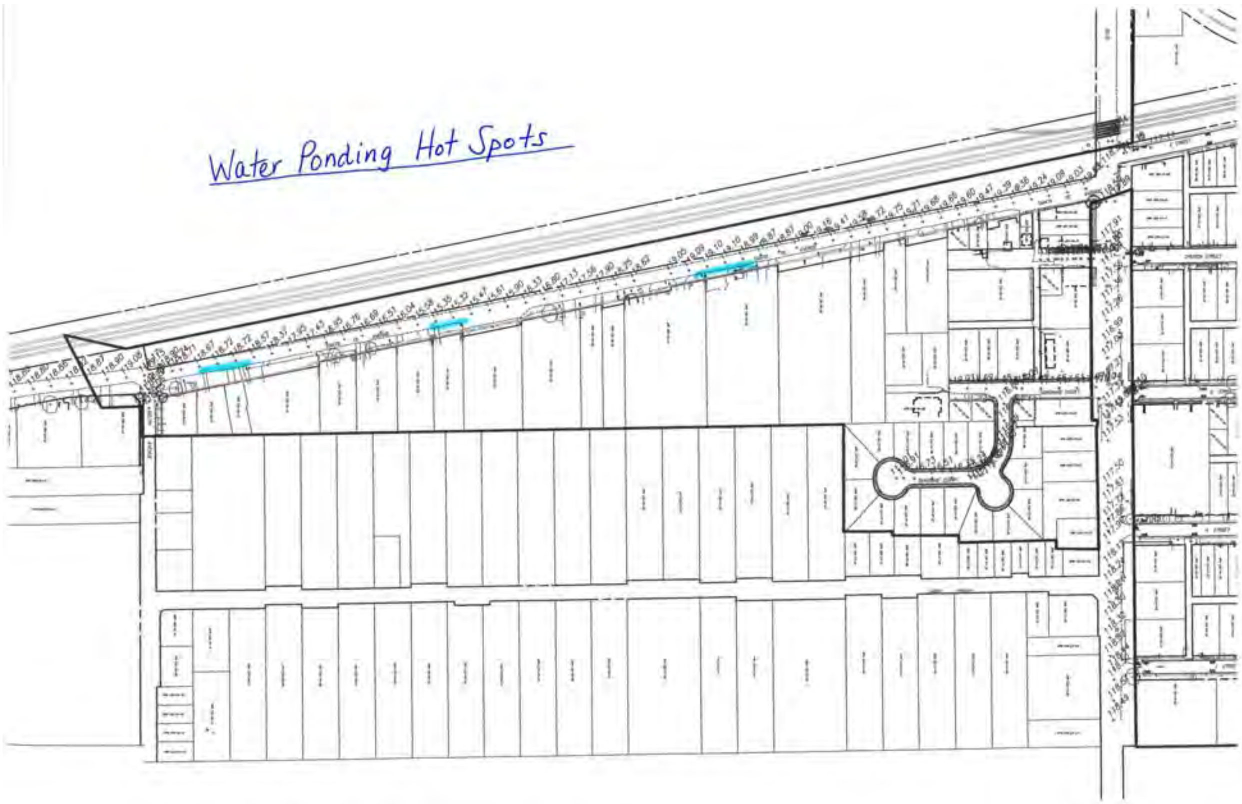
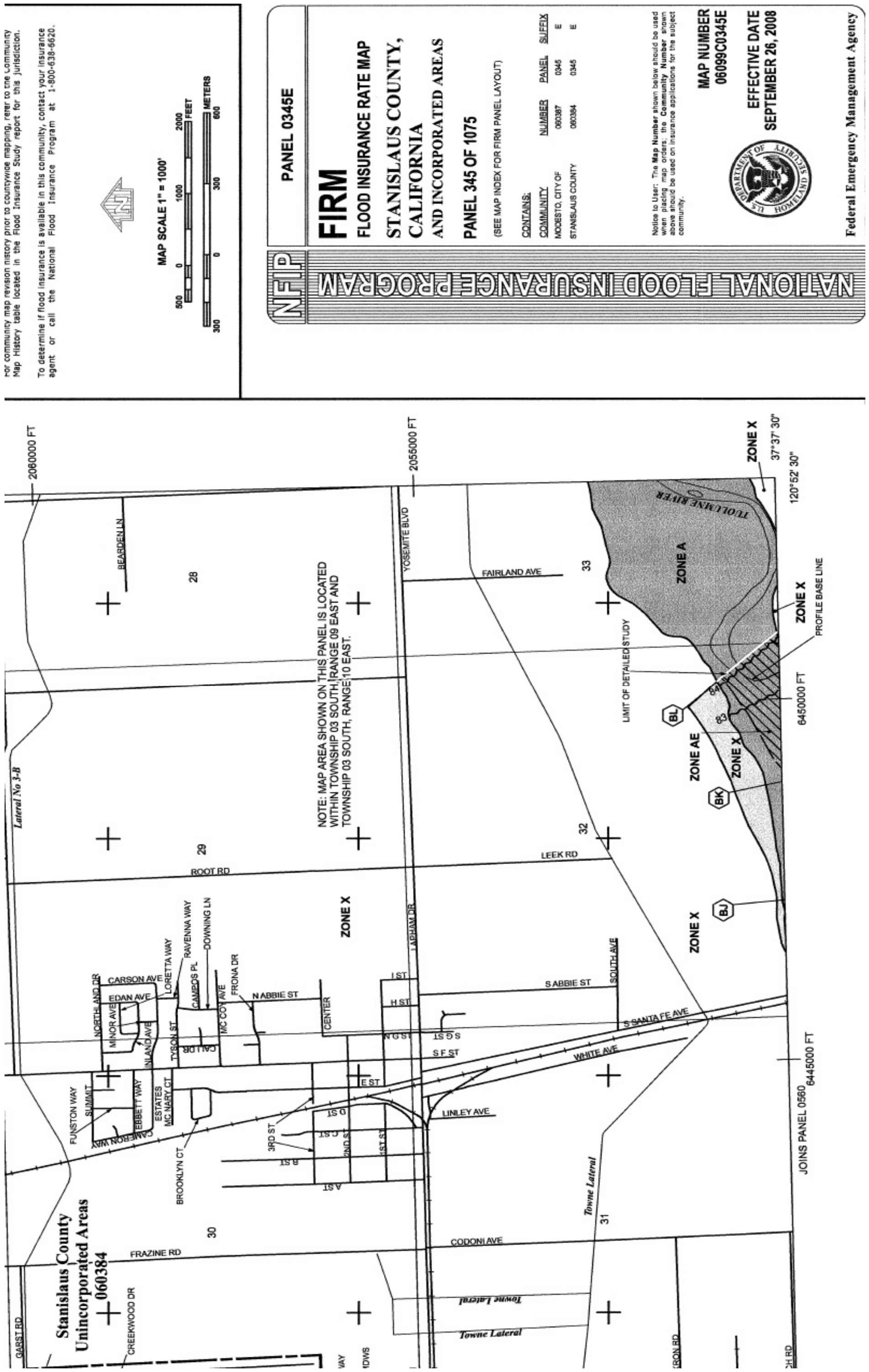


Figure 18: Flood Insurance Rate Map Panel 345 of 1075



6. STORM DRAINAGE DESIGN METHODOLOGY

The design of storm drainage system is based upon many factors. Some of the more important elements are defined here so that a uniform set of criteria can be followed for each specific Drainage Management Area (DMA). Specifically, the proposed storm drainage system identified in this study has been evaluated using the design criteria defined in the latest edition of Stanislaus County's 2014 Standards and Specifications

The County's ultimate road right-of-way areas are can be re-graded and designed to retain runoff and percolate via natural roadside swale systems. These drainage systems can be constructed between the road's edge of pavement and the ultimate road right-of-way property line. These proposed roadside bio-retention swales are shown in Figure 19.

The 50-year-frequency, 24-hour design storm event was used for analysis in this study using the basic rational formula. The proposed storm drainage systems were sized to accommodate the peak rain storm run-off generated from this design storm event.

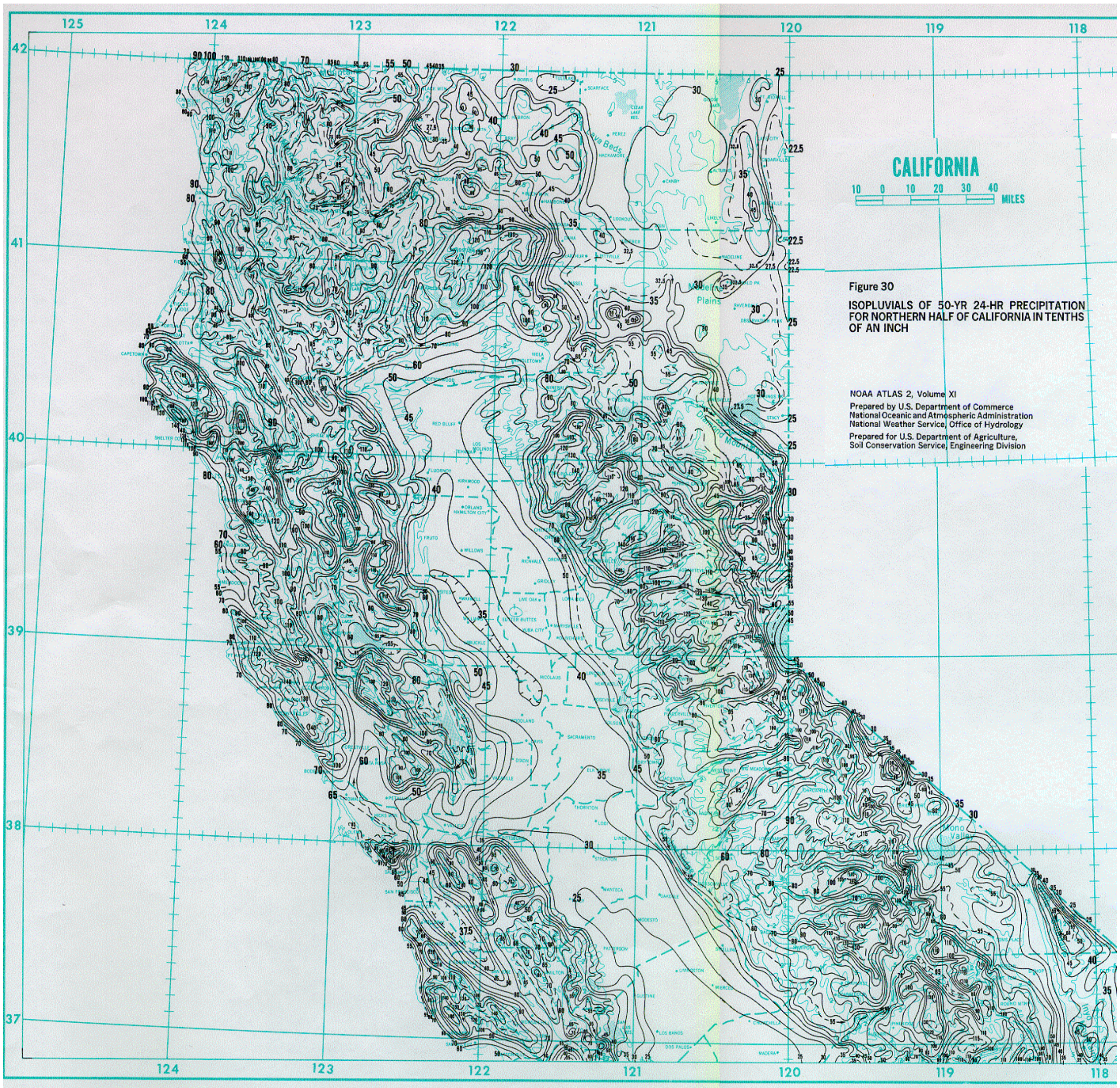
a. Rational Method versus Advanced Hydrology Analysis

The Stanislaus County Storm Drain Design Manual is primarily based on the Rational Method and is generally acceptable for small watershed boundaries, typically 200 acres or less. When considering larger watershed areas, a more sophisticated rainfall/runoff model is typically required and often better suited for analyzing runoff behavior and drainage conditions.

Storm frequencies were compared against isopluvial maps found in the National Oceanic and Atmospheric Administration (NOAA) Atlas 2, Volume XI. The 50-year, 24-hour storm event was selected as the design storm for this analysis. NOAA Atlas 2, Volume XI, was used to obtain rainfall data for the 50-year storm events for the project location and is shown in Figure 19.

NRCS has developed 4 synthetic rainfall distributions that are indicative of the rainfall intensities inherent to the geographic regions of the United States.

Figure 19: Isopluvials of 50-year, 24-hour precipitation for Northern California



The 4 standard rainfall distributions, labeled Type I, Type Ia, Type II, and Type Ill, have been developed from the NOAA/NWS Rainfall Frequency Atlases. Since most rainfall data is reported on a 24-hour basis, this study used 24 hours as the duration for these distributions. The location of the peak rainfall intensity in each storm is intended to mimic the location of the peak intensity for the particular region of the United States. The Empire Storm Water Project is located within the Type I rainfall distribution, which indicates that the peak intensities of the storms generally occur around 8 hours.

The cost to perform a more sophisticated design analysis and modeling system is not justified. Neither the NRCS Technical Release 55 Urban Hydrology for Small Watersheds (TR-55) nor the United States Army Corps of Engineers (USAGE) Hydrologic Engineering Center (HEC) Hydrologic Modeling System (HEC- HMS) is necessary to evaluate the peak discharge rates and runoff volumes. The peak discharge rates and volumes can be determined using the basic rational formula: V = CAR/12 for storage volume determination and Q = CIA for flow determination.

Table 3 summarizes the design storm events that were used in this drainage study.

TABLE 3: STORM DRAINAGE DESIGN EVENTS

Design Requirement	Design Method	Design Storm Return	Rainfall Intensity "R" (inches)
Storage Requirement	$V = CAR_{50}/12$	50-Year, 24-hours event	R_{50} = 2.88" x MAP/10.9" R_{50} = 2.88" x 11.5"10.9" R_{50} = 3.04"
Percolation Requirement	$V = CAR_{10}/12$	10-year, 24-hour event Drainage facilities shall be designed to percolate the design volume within 48 hours.	R_{10} = 1.88" x MAP/10.9" R_{10} = 1.88" x 11.5"/10.9" R_{10} = 1.98"
Pipelines Culverts Channels	Q = CIA Rational Method	10-year, 24-hours event Assuming time of concentration of 10 minutes.	I = I_M x MAP/10.9" I = 1.88 x 11.5"/10.9" I = 1.98"

b. Tasks Specific to Storm Drainage Design Study

In order to complete this report, the following tasks were conducted as part of this storm water LID and greening study:

Review Existing Records

- Collect and research existing records (as-built) that can be used to identify existing storm water facilities.

- Review existing utilities to gather information that can be used to determine potential conflicts with existing underground and above ground utilities.

- Identify any existing storm water inflow locations, and corresponding inflow rates (cfs), from adjoining land areas (such as run-on from irrigated parcels).

- Identify existing conditions and constraints related to the storm water run-off.

Map the Drainage Watershed Study Boundary

- Identify and define target area for the storm system feasibility study.

- Review existing topographical survey to gather relevant information that can be used to define the water shed area. The water shed area will be used for determining storm water system demands. This task shall produce drainage maps and identify any inflow locations from neighboring land parcels.

- Collect information on the existing and proposed land uses for the existing areas within the watershed boundary in order to estimate the run-off coefficients.

Design Method Selection & Hydrology Study

- Analyze existing conditions and determine the most practical direction for the storm water system study.

- Determine appropriate hydrological model and method to be used for the study.

- Determine appropriate flood period for the hydrology study.

- Determine an engineering approach for analyzing existing drainage conditions and develop ideas for proposed Low Impact Development storm drainage solutions that best fit the "greening" objectives for the Empire Community.

- Calculate the amount of storm water run-off volume (measured in cubic feet, ft^3) for each Drainage Management Area (DMA).

- Research and collect any reference charts that will be used for calculating run-off from a maximum storm event.

- Perform appropriate hydrology calculations using the basic Rational Formula, V=CAR/12.

Assess Low Impact Development (LID) Design Alternatives

- Assess LID options for disposing water from storm water run-off, with an emphasis on sustainability, urban greening and ground water recharge.

- Perform storm drain sizing calculations for the various LID options.

- Develop possible alternatives for storm water storage and elimination.

- Determine most practical locations for LID storm water facilities.

- Review percolation rates at the proposed LID drainage facility locations to verify assumed design percolation rates.

- Review existing soil borings at the proposed LID drainage facility locations (if available) to determine the soil profile, soil characteristics, and any potential impact to groundwater.

Calculate Engineers Construction Cost Estimate System

- Determine the Engineer's Construction Cost Estimate for the project.

- Determine possible sources for financing the project.

- Prepare an Engineer's Report that summarizes the final findings and recommendations.

c. Volume Reduction and Storm Water Quality Calculator

A Low Impact Development Volume Treatment and Reduction calculator was developed using Microsoft Excel. This spreadsheet was developed to design the various treatment control storm drainage BMPs such as bioswales, grassy swales, bio-retention basins, etc. Sample copies of the spreadsheet print outs for these volume reduction and storm water quality treatment worksheets are provided in the attached Appendix.

The Project area consists of four watershed drainage areas identified as Phase 1A, Phase 1B, Phase 2, and Phase 3. Three of these areas are north of Yosemite Boulevard and one south of Yosemite Boulevard. Drainage from the Phase 1A has been excluded from the study since this area is currently being served by the new 66-inch horizontal French drain that has been recently constructed.

The storage volume calculations assumed that percolation credit over a 48 hour period would be considered in computing the available storage. The tabulated results of each watershed Drainage Management Area (DMA) have been calculated and are summarized in the attached hydrology/hydraulic Tables.

The basic rational formula method is based on a runoff coefficient for each watershed Drainage Management Area (DMA); soil classifications, soil cover, and land use classification tables. For the purpose of this study, the highest runoff coefficient value of 0.95 was used. This coefficient is a typical representative of surface areas such as pavements, sidewalks, and runoff from rooftops that generally tend to drain into the County's road rights-of-way.

The study boundary of the Empire community was separated into sixty-five (65) specific Drainage Management Areas (DMAs). Each individual DMA has been tabulated and is shown in Table 4.

A sample example for DMA Number 38 is provided in this report to demonstrate the design and sizing of the storm drainage LID facilities. This DMA design sample worksheet is shown in Table 5A and Table 5B. In addition, a detailed and tabulated report for all the remaining sixty-four (64) DMAs within the project's study boundary is provided and is shown in Table 6.

Table 6 calculates and tabulates the following for each watershed DMA area: Bio-swale area, storage volume available in proposed bio-swale areas, 50-year, 24-hour design storm storage requirements for each DMA, and the difference between storage requirements and available storage.

Table 7 demonstrates that each DMA watershed area is capable of storage and percolating the 50-year, 24-hour design storm within 48 hours.

The following figures are used in tabulated the Bio-Swale basin areas (designated as BS-##) for each of the 65 DMA watershed areas within Phases 1A, 1B, 2, and 3. It should be noted that no DMAs are calculated for areas that fall within Phase 1A since it is assumed that these areas are already being served by the 66-inch underground French drain that was recently installed.

Figure of DMA Watershed Areas and Proposed Bio-Swale Areas for Phase 1B:

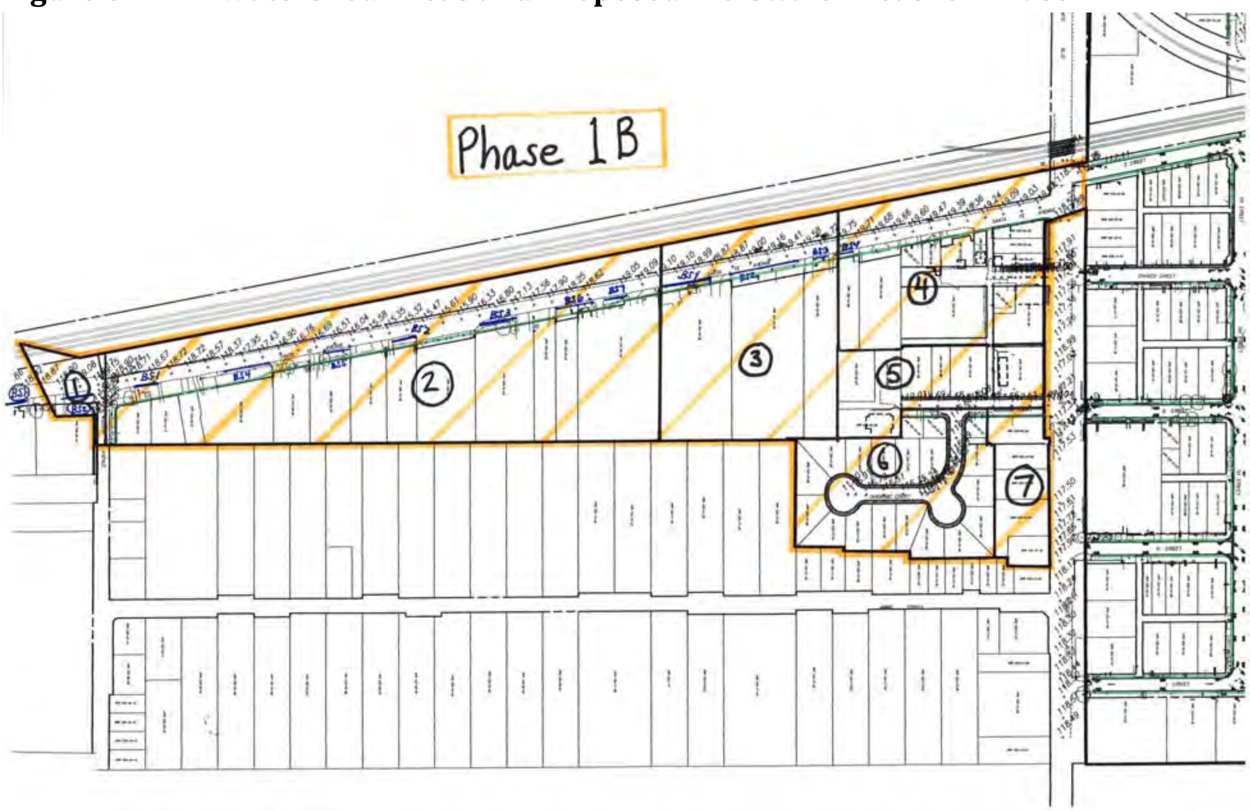
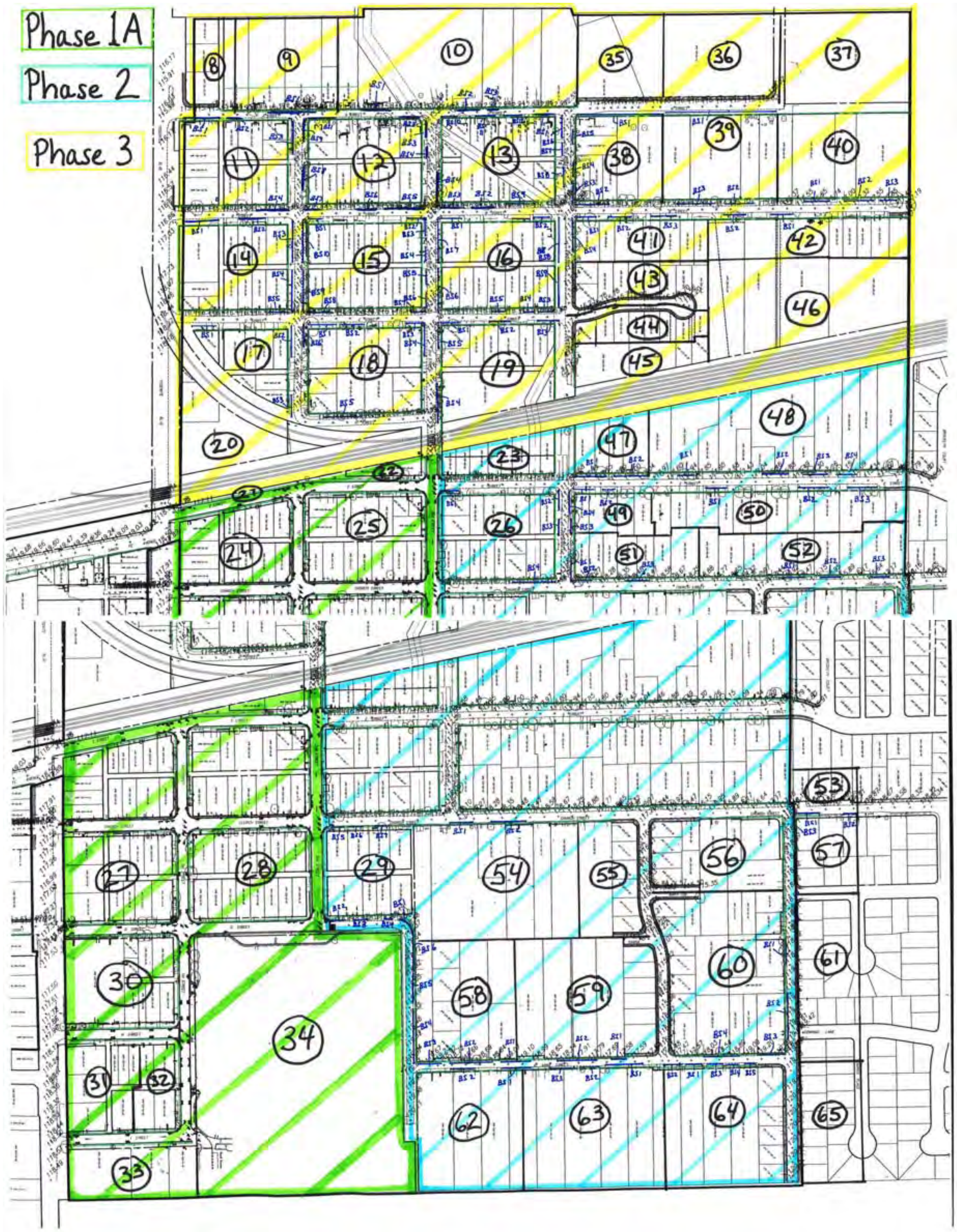


Figure of DMA Watershed Areas and Proposed Bio-Swale Areas for Phase 1A, Phase 2, and Phase 3:



7. LOW IMPACT DEVELOPMENT STRATEGIES

a. Overview

Low Impact Development (LID) is an alternative site design strategy that uses natural and engineered infiltration and storage techniques to control storm water where it is generated (managing storm water ***'at the source'***). LID combines conservation practices with storm water source controls and pollution prevention to maintain or restore natural watershed functions. The objective is to disperse Low Impact Development BMP devices uniformly across a site to minimize and treat storm water runoff.

LID reintroduces the hydrologic and environmental functions that are altered with typical conventional storm drainage systems. LID helps to maintain the water balance on a site and reduces the detrimental effects that traditional end-of-pipe systems have on waterways. LID devices provide temporary retention areas; increase infiltration; allow for nutrient/pollutant removal; and eliminates the direct discharge of storm water into adjacent waterways, such as the nearby Tuolumne River.

Some examples of LID technologies that were reviewed in this study include but were not limited to the following:

- Engineered systems that filter storm water from parking lots, streets, and other impervious surfaces. Impervious surfaces include bio-retention cells, filter strips, tree box filters, infiltration trenches, etc.
- Modifications to infrastructure to decrease the amount of impervious surfaces such as curb less streets, gutter less streets, and streets with reduced pavement width;
- Low-tech vegetated areas that filter, direct, and retain storm water such as rain gardens and bio-swales;
- Innovative materials that help break up (disconnect) impervious areas such as porous concrete and permeable pavers;
- Water collection systems such as subsurface collection facilities, cisterns, or rain barrels; and
- Native or site-appropriate vegetation.

b. Conventional Design versus Low Impact Development

Conventional storm water management techniques typically directs all of the storm water to storm drain catch basins and pipelines in order to remove it from the site as quickly as possible. End-of-pipe facilities are typically designed to store and detain runoff to reduce peak flows for storm events that are infrequent, such as the 50 year, 24-hour storm. Controls, such as detention basins with pump stations, are often not in place to reduce flows for smaller, more frequently occurring events. Controls also are not structured to address non-point source pollution problems or to recharge the groundwater. Since runoff needs to be managed on the site for traditional storm drainage systems, large ponds, or a series of ponds, are required. These controls can take up a significant portion of land.

Storm water ponds are typically constructed with fences around the periphery for health and safety reasons. The outbreak of the West Nile virus and concern about fecal droppings of migratory birds has heightened concern about the suitability and maintenance of laregeretention/detention ponds. Ponds also require annual maintenance and can require expensive long-term rehabilitation costs that often times reoccur during the facility's life-cycle.

In contrast, the requirement for storm water retention is achieved with LID through the use of distributed controls. The retention areas are designed into the existing open space or below existing infrastructure, such as parking lots, roadways, or landscape strips within the right-of-ways. These new LID techniques create opportunities for alternative design configurations that are less dependent on inlets, pipes, ponds, and pumps that discharge to surface water bodies of the United States (i.e. Tuolumne River in this particular study). Additionally, LID technologies eliminate the need for costly maintenance contracts, typically requiring only routine landscape maintenance that can mostly be done by each private home owner along their property frontage.

c. Benefits of the LID Design Strategy

There are a number of benefits of LID. Some of these include reducing infrastructural life-cycle costs for conventional storm drainage systems such as ponds, curbs, gutters, catch basins, inlets, pipes, pumps, and other control structures such as CDS treatment units.

In lieu of conventional infrastructure costs, the project cost could be greatly reduced by eliminating these conventional storm water components and replacing them with natural LID solutions.

The use of distributed LID technologies reduce or eliminate the need for large-scale, end-of-pipe systems and thus reduces the infrastructural costs of a network of pipes, gutters, catch basins, ponds, and/or treatment controls. Space traditionally set aside for detention ponds can now be designated for an alternative use, such as a public park/open area or landscaped buffer strips.

Small-scale LID technologies in this study were positioned in precise locations to accomplish specific storm water quality or water quantity objectives. The most effective location of the devices is ***'close to the source'***. For example, bio-retention cells or rain gardens can be installed within the landscaped areas between existing driveways so that they can filter and treat runoff at the source. Tree box filters could be located on streets that already contain curbs and gutters to filter and treat surface runoff before it enters the catch basins or waterways. Vegetated swales can be placed adjacent to curbless roads and can be effective at filtering and infiltrating storm water and recharging the groundwater supply. These Low Impact Development BMPs eliminate having to capture and direct the storm water using expensive underground pipes and dedicated land area for basins and ponds.

Parcel owners can be encouraged to incorporate rain barrels or cisterns to capture, harvest, and reuse rainwater from rooftops to irrigate landscaped areas. Subsurface collection can also be constructed at varying depths with and without under drains to accommodate larger storms and to filter, retain and/or store water for reuse or for slow-release infiltration.

Improved site design has a direct correlation to enhanced livability and community aesthetics. LID not only facilitates the stabilization of the hydrologic condition of a site, but it can also help mimic natural site conditions.

d. Site Appropriate Landscaping

It is recommended that native plants be used because of their performance, site enhancement, and life-cycle cost benefits.

Native plants typically cost more initially depending on local availability; however, they are more cost-effective in the long run because they require less water and fertilizer, and are more resistant to local pests and diseases than non-native ornamentals. Life-cycle costs are reduced due to reduced maintenance and replanting requirements. Native plants are also known to be very effective in managing storm water because many species have deep root systems which stabilize soil and facilitate the infiltration of storm water runoff.

When selecting plants for a landscape design, it is important to have knowledge of the site conditions. Plant materials should be selected for their form, color, and texture, as well as solar, soil, and moisture requirements. Plants that do well in various micro-climates on a site are considered "site appropriate."

The Appendix at the end of this report provides a list of recommend plants, grasses, trees, and shrubs that can be used for each Drainage Management Area (if required).

e. LID Practices and Benefits

The LID site design approach is a precise arrangement of natural and engineered technologies. These devices, or Best Management Practices (BMPs), function as a comprehensive system across the site to achieve the goals of:

- Peak flow control;
- Volume reduction;
- Water quality improvement (filter and treat pollutants); and
- Water conservation.

Table 4 illustrates several LID technologies and their associated benefit(s). A brief description of commonly used LID practices and suitable applications follows.

Table 4: LID Practices and Devices

LID PRACTICE / DEVICE	Peak Flow Control	Volume Reduction	Water Quality Treatment	Water Conservation
Bio-Retention Cell	•	•	•	
Cistern	•	•		•
Curbless Streets	•	•	•	
Downspout Disconnection	•	•	•	
Grassy Swales	•	•	•	
Green Rooftops	•		•	
Infiltration Trench	•	•	•	
Narrow Road Design	•	•	•	
Permeable Pavers & Porous Concrete	•	•	•	
Rain Barrel	•	•		•
Rain Garden	•	•	•	
Rockwells	•	•	•	
Sand Filter	•		•	
Tree Box Filter	•		•	
Tree Planting	•	•		

f. **LID Challenges & Constraints**

Bio-retention swale basins have been selected as the most suitable BMP for this drainage study. All though bio-retention swale basins have are designed to accommodate the 50-year, 24-hour design storm, it should be noted that not all basins will function in the same way because some basins may be located in areas that have underlying soils with poor soil types and thus lower percolation rates.

Some basins could be located in areas with a higher local groundwater table (i.e. those areas that are closer to the Tuolumne River or Dry Creek River for example).

While some amount of percolation is expected to occur in all bio-retention swale basin areas, the slow accumulation of fine sediments or silts conveyed with storm water runoff may slowly accumulate over the years.

If these bio-retention swale areas are not properly maintained, they may result in marsh-like conditions by allowing weed growth, stagnant water, or insect breeding. These facilities will thus require routine maintenance – either by individual home owners or through a community service district (CSA).

In areas where positive storm drainage systems do not exist and bio-retention swale basins are used, issues with the appearance and maintenance requirements of these types of linear basins may become more of a concern. While they may operate adequately in the early years of usage, their appearance and ultimately their function may make this type of storm drainage facility less favorable than more expensive treatment like porous concrete or underground French drains/rock chamber vaults.

8. PROPOSED STORM DRAIN BEST MANAGEMENT PRACTICES (BMPs)

Below are common LID Best Management Practices (BMPs) that are applicable for the Empire Storm Drain Master Plan Study. A brief overview of the storm water controls that can be integrated into each watershed's unique and specific Drainage Management Area (DMA) is described below:

a. Curbless Streets

Majority of the existing streets in the Empire Community typically have no curbs or gutters and use existing land area that exists between the street edge of pavement and road right-of-way property lines to store and infiltrate storm water. Every street segment has an existing low point that can be constructed into a LID Bio-retention swale area or rain garden.

The swales and bio-retention cells can either be 'grassy' or 'non-grassy' and are considered to be important because they handle the first flush of all rain storms. The first flush typically contains the greatest amount of pollutants. LID bio-retention swale areas allow the water to be stored and infiltrated naturally into the ground. A conventional system does not filter the storm water from the streets and sends large amounts of untreated water into nearby waterways, via underground pipes and/or pump stations.

Although most streets currently do not have curbs and gutters, most of the ultimate rights-of-way are exceptionally wide. Based on the Assessor's Map, some local streets are currently as wide as 74 feet. However, constructing wider paved roadways are no longer a recommended practice since minimizing impervious cover is one of the major LID concepts.

b. Bio-retention Swales (Rain Garden)

A bio-retention swale (also called cell, strip, trench, or rain garden) is an engineered natural treatment system consisting of a slightly recessed landscaped area constructed with a specialized soil mixture, an aggregate base, an optional under drain, and site-appropriate plant materials that tolerate both moist and dry conditions. The site is graded to intercept runoff from paved areas. The soil and plants can store and filter runoff, remove petroleum products, nutrients, metals, and sediments, and promote groundwater recharge through infiltration. Figure 20 and Figure 21 provides a typical cross section for a bio-retention swale that was considered and used in this drainage design.

A rain garden typically does not have the full spectrum of engineered features that bio-retention cells have, such as under drains and the entire soil mix. They can be designed and built by homeowners and located near a drainage area, such as a roof downspout.

Typical Uses: Parking lot islands, edges of paved areas (roads, driveways, sidewalks), areas adjacent to buildings, open space, median strips, swales, etc. They are suitable for new construction and retrofit projects.

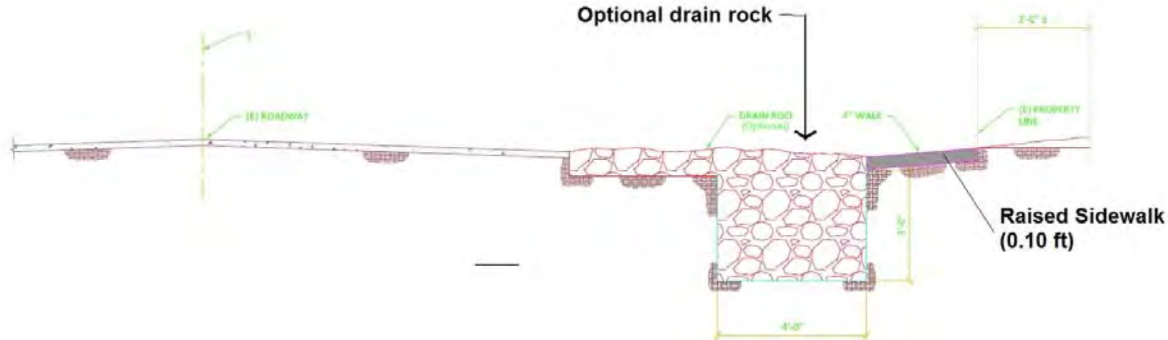
Land Use: Bio-retention cells/rain gardens are ideal for commercial, industrial, and residential land use areas. They are widely used in transportation projects like highway medians and rail projects.

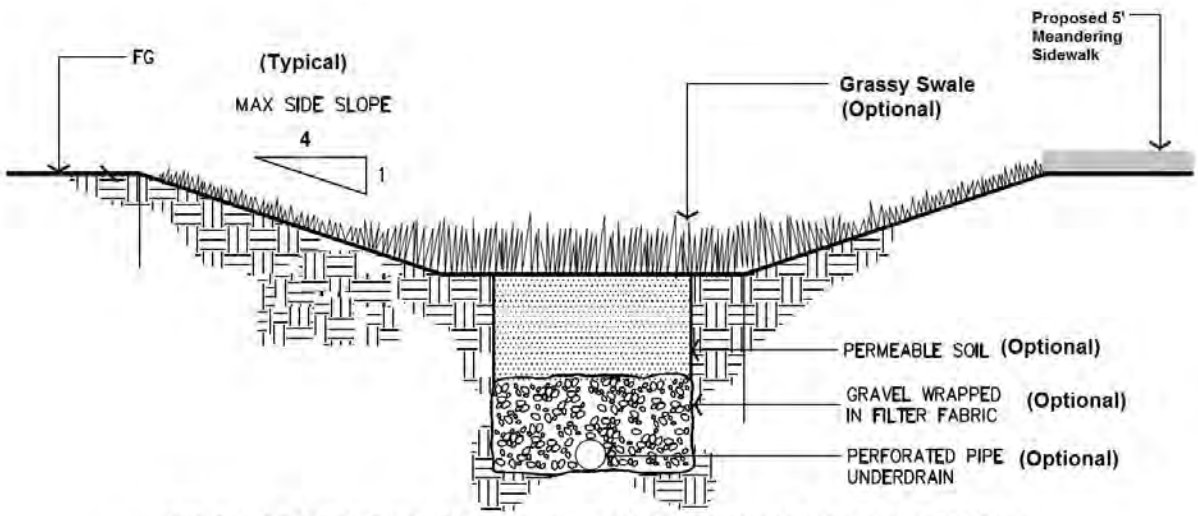
Approximate Cost: Residential costs average $3-$4 per square foot of size plus excavation and soil amendment costs. Commercial, industrial, and institutional site costs can range from $10-$40 per square foot, based on the need for control structures, curbing, storm drains, and under drains.

Maintenance: Routine maintenance is required and can be performed as part of the regular site landscaping program (i.e., biannual evaluation of trees and shrubs, regular pruning schedule). The use of native, site-appropriate vegetation reduces the need for fertilizers, pesticides, excessive water, and overall maintenance requirements.

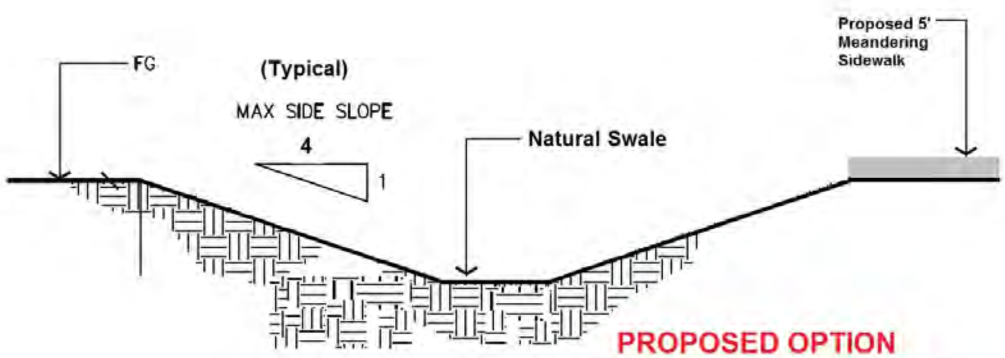
Additional Benefits: Easily customized to various projects by the size, shape, and depth and land uses; enhances aesthetic value of site; uses small parcels of land, easements, right-of-ways; easily retrofitted into existing buildings/open space.

Figure 20: Bioretention Swale Cross Section with optional landscape and under drain





TYPICAL CROSS SECTION OF BIORETENTION GRASSY SWALE WITH UNDER DRAIN



TYPICAL CROSS SECTION OF BIORETENTION SWALE WITH NO UNDER DRAIN

Figure 21: Bioretention Swale General Guidelines

BIOSWALE DESIGN GUIDANCE

1. Longitudinal slope of swales shall be between 1% and 5%. Swales of greater than 3% may be required to install check dams to reduce velocity through the swale.
2. All swales shall be required to provide an adequate underdrain system to prevent ponding.
3. Swales shall be designed to eliminate any ponding of water for more than 48 hours.
4. Side slopes shall not exceed 3:1, horizontal: vertical.
5. Erosion control practices must be implemented and maintained until such a time that the vegetation in the swale has established allowing the proper function of the drainage area as a "bioswale".
6. Swale bottom must be graded flat to improve pollutant removal. Swale bottom should ideally be at least 4–6 feet wide, with a minimum of 2 feet. Properly designed swales should resemble more of a flat–soft "U" shape rather than a sharp "V" ditch shape.
7. Velocity for water quality design storm may not exceed 2 feet per second, with a goal of 1 feet per second. Velocity for 10 year design storm should not exceed the maximum velocity for the vegetation selected (estimated at 8–10 ft/s max for most grasses with a channel slope of <5%).
8. Swales shall be designed and sized to meet the following hydraulic sizing requirement:

   "Swales shall be designed and sized accordingly to treat stormwater equivalent to the flow of runoff resulting from a rain event equal to at least 0.2 inches per hour intensity using local rainfall data".

   Generally, swales provided for water quality treatment should be sized to provide and 8–10 minute contact time for runoff from the contributing drainage area, or using the general guideline of 1200 sq. ft. of swale area for each acre of contributing drainage area.
9. For swales proposed in residential parkway strips, the minimum width allowed should be 12 feet, with 15 feet or more recommended.
10. Maintenance of swales will be the responsibility of the property owner for commerical/industrial applications, or a homeowner's association or light and landscape district for residential applications. The Public Services Department will not assume maintenance responsibilities for swales of detention basins.
11. Swales will require sufficient irrigation to establish and maintain complete turf coverage. Turf damaged due to ponding, erosion, insufficient irrigation, or other problems, it must be replaced. Turf shall be mowed as needed to maintain a 4–6 inch grass height.
12. Swales must be densely vegetated with conventional turf, approved alternatives to conventional turf, or other approved vegetation as referenced in the Bioswale Plant List shown below.
13. Areas of a site used for grass swales or other stormwater treatment will be exempt from the Water Efficient Landscaping requirements.

Figure 22: Proposed Cross Section of Retention Swale

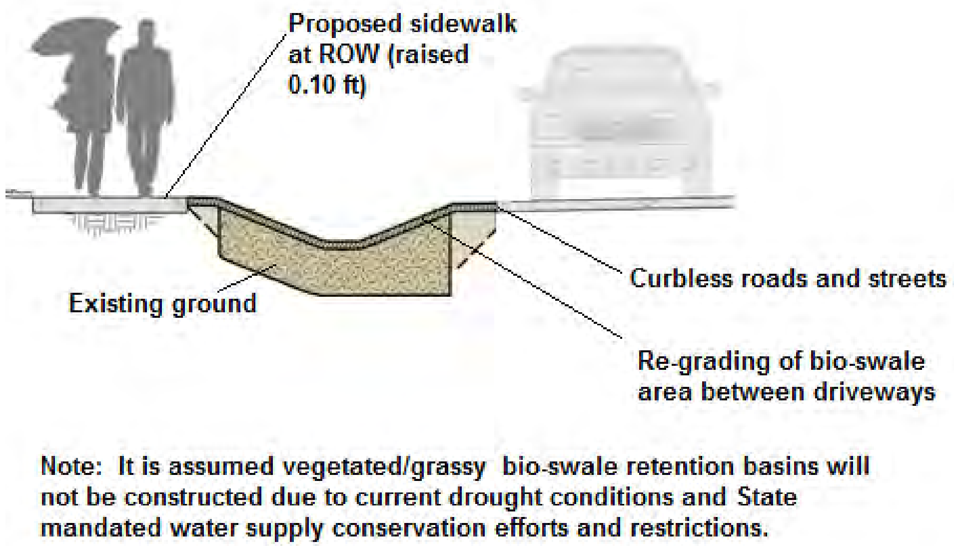


Figure 22 shows a typical cross section of a vegetated bio-retention swale basin with optional drain rock. The drain rock is optional and is only needed for areas with poor soil type (i.e. clay). Based on our preliminary soil analysis, the Empire community generally consists of Group B soils types that are silt loam or loam. These soils have moderate infiltration rates (0.15-0.30 in/hr) rates when thoroughly wetted and consist primarily of moderately drained soils. For this reason, it is assumed that underground drain rock will not be required.

Vegetation and drain rock along the bio-swale serves primarily to maintain soil porosity and prevent erosion. Although the aesthetic appeal of control measures such as vegetation and/or drain rock can help enhance the aesthetic look of the drainage system, important maintenance consideration should be taken. Drain rock can lead to maintenance headaches associated with clogging and sedimentation. For this reason, we assume that no drain rock will be used in the construction of the bio-retention swale basins.

Vegetation and grassy swales on the other hand, will require periodic mowing, maintenance, and irrigation. To help conserve irrigation water during severe drought conditions that is facing the entire State of California, this study assumes that a bio-retention swale without vegetation or grass will be installed.

The proposed native bioswales will be constructed between existing driveways to create sub-basin drainage management areas (DMAs). These multiple DMAs may help control localized flooding and minimize the amount of storm water that runs off to the street’s low points (generally at or near the vicinity of most intersections).

c. Vegetated/ Swale (Bio-swale)

A vegetated or grassy swale is an area with dense vegetation that retains and filters the first flush of runoff from impervious surfaces. It is constructed downstream of a runoff source. After the soil-plant mixture below the channel becomes saturated, the swale acts as a conveyance structure to a bio-retention cell, wetland, or infiltration area.

There is a range of design options for these systems. Some swales are designed to filter pollutants and promote infiltration and others are designed with a geo-textile layer that stores the runoff for slow release into depressed open areas or an infiltration zone.

Alternative Devices: Filter strip or vegetated buffer.

Typical Uses: Edges of paved areas (roads, driveways, sidewalks, or parking lots), parking lot islands, intermediary common spaces, open space, or adjacent to buildings.

Land Use: Commercial, industrial, residential; transportation projects (highway medians and rail projects); new construction and retrofit projects.

Approximate Cost: $0.25 per square foot for construction only; $0.50 per square foot for design and construction.

Maintenance: Routine maintenance is required. Maintenance of a dense, healthy vegetated cover; periodic mowing; weed control; reseeding of bare areas; and clearing of debris and accumulated sediment.

Additional Benefits: Easily customized to various projects (size, shape, and depth) and land uses; enhances aesthetic value of site; uses small parcels of land, easements, right-of-ways; easily retrofitted into existing buildings/open space.

d. Subsurface Retention Facilities

Subsurface retention facilities, such as underground storage vaults or porous concrete, are typically constructed below parking lots either permeable or impervious. They can be built to any depth to retain, filter, infiltrate, and alter the runoff volume and timing. This practice is well suited to dense urban areas. Subsurface facilities can provide a considerable amount of runoff storage. The porous subsurface retention bay has an infiltration gallery with 35% - 40% void space below it for storm water retention. The water is filtered through the stone aggregate and infiltrates into the ground.

Figure 22 provides a typical cross section of a non-vegetated bio-retention swale with an option rock trench section for additional storage and percolation area.

Similar techniques include gravel storage galleries, sand filters, infiltration basins, and infiltration trenches for areas with space constraints.

Typical Uses: Parking lots, sidewalks, and roads.

Land Use: Subsurface retention facilities are ideal for commercial, industrial, and residential uses; suitable for new construction and retrofit projects.

Approximate Cost: Costs are typically higher than conventional paving systems; however, they help reduce the overall storm water infrastructure costs. These costs can include land allocated for ponds, cost of pipes, inlets, curbs, gutters, pump stations, etc.

Maintenance: Varies according to manufacturer; routine street sweeping and vacuuming will retain infiltration capacity of voids.

Additional Benefits: Easily customized to various projects and land uses; enhances aesthetic value of site; easily retrofitted into existing paving configurations.

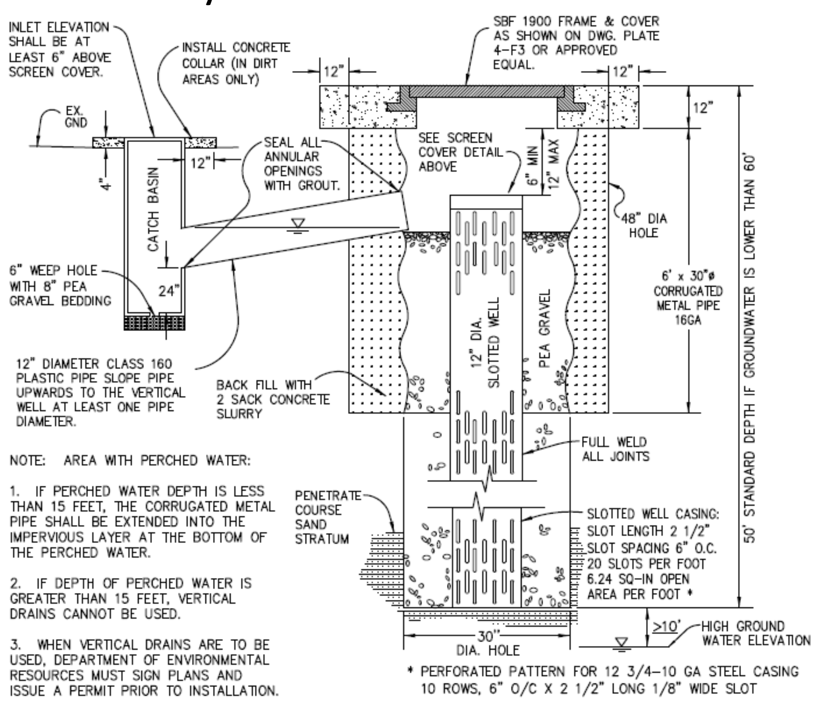
e. Rockwell Systems

Portions of the existing Empire area discharge storm water runoff into the ground via catch basins and rockwells. A rockwell is typically a 30-inch diameter vertical hole drilled in the ground to a depth of typically 50 feet and filled with graded rocks with a 20 foot-long perforated pipe down its center. These are located in depressed areas where storm water is likely to collect. The watershed area near the “B” Street and Yosemite Avenue intersection is currently served by rockwells.

Typically, rockwells are designed such that a single rockwell can drain approximately 10,000 square feet of impervious area. Most rockwells perform well for a few years. Without continuous maintenance they eventually lose their ability to function as intended due to sedimentation buildup, which results in reduced storm water infiltration.

Rockwells have been permitted as a storm drainage solution for new development in the County for many years. Under certain circumstances and with prior approval by the Department of Environmental Resources, drywells may still be constructed, although they are not really preferred in urbanized areas. Figure 23 below provides a typical cross section of a vertical rock well (per Stanislaus County Standard Plate 4-D2).

Figure 23 – Vertical Drywell



f. **Rain Harvesting**

The downspouts of most rooftops can direct rainwater into vegetated areas located at the side of homes. The residents of the Empire Community can be encouraged to utilize rain barrels to harvest and reuse the storm water. Water reuse can be used for such things as providing water for landscaping and gardening.

The groundwater supply is recharged and collected rainwater satisfies irrigation needs. Community cooperation can be positive if the residents understand their role in preserving storm water, a natural resource in the local community. Ongoing community participation and upkeep of the Rain Harvesting BMPs will need to be promoted through public education and outreach.

9. ENGINEERS COST ESTIMATES

a. Basis of Developing Opinion of Probable Costs

The basis for the opinion of probable costs comes from a number of sources, including bid results from current projects, previous studies, and industry standardized cost data. The Engineer's Cost Estimate can be tied to an index such as the Engineering News Record Construction Cost Index (ENR CCI) of 8441 for the San Francisco Average in order to adjust for future construction cost increases.

b. Opinion of Probable Cost Accuracy

The project costs prepared for this study are considered "order of magnitude" estimates and are relevant for initial budgeting and related master planning purposes. Final project cost will be dependent on a number of factors at the time of bidding, including: final detail design, actual scope of work, labor and material costs, number of competing projects, allotted construction schedule, and construction time of year, among other things. Order of magnitude estimates are appropriate for master planning level work, but it is important to note that they have been made without the benefit of detailed project specifications and design drawings.

c. Unit Cost Estimates

The unit costs presented in this Chapter represent installation costs under what would be considered "typical" site conditions and project schedules. Cost estimates for the various projects do not include right-of-way (ROW) or easement purchases for construction of the storm drainage improvements because it was assumed that only improvements in the existing public ROW would be constructed. However, land acquisition costs, or utility coordination may need to be considered in certain areas.

d. Engineer's Construction Cost Estimate & Soft Cost Mark-Ups

The actual costs for each item in the following four main categories of soft cost mark-ups will vary according to many individual project factors (i.e., complexity of the project, existing site conditions, etc.).

In general, they are supported historically as appropriate mark-up estimates for master planning purposes standardized as a percentage relative to the estimated construction cost and are included in the total Engineer's Construction Cost Estimate. These soft costs include but are not limited to the following:

<u>Construction Contingency</u> – Due to the fact that there are many unknowns related to a given project at the master planning level (i.e., site conditions, unforeseen constraints, details of design alternatives, construction schedule uncertainty, etc.), a 10 percent construction contingency is added to the construction cost estimate.

<u>Planning and Design</u> – These services typically include management of consultant agreements, preliminary site investigations, feasibility studies, preparation of final detail plans and specifications, surveying and staking, geotechnical reports, and utility coordination. The cost of this work is estimated to be 15 percent of the estimated construction cost.

<u>Construction Management</u> – This primarily covers management of the construction contract, sampling and testing of materials, and site inspections during construction. This work is estimated to be 10 percent of the estimated construction cost.

The total opinion of probable cost of the proposed storm drainage facilities to serve the 65 watershed Drainage Management Areas (DMA) is shown in Figure 24.

Figure 24: ENGINEER'S CONSTRUCTION COST ESTIMATE: Phases 1B, 2, and 3
Empire Community Storm Drainage Report
Low Impact Development & Greening Study

ITEM NO.	ITEM DESCRIPTION	ESTIMATED QUANTITY	UNIT OF MEASURE	UNIT COST	ITEM TOTAL
1	Mobilization	1	LS	$ 5,000	$ 5,000
2	NPDES Storm Water Polution Prevention Plan (SWPPP)	1	LS	$ 2,500	$ 2,500
3	Traffic Control System	1	LS	$ 15,000	$ 15,000
4	Portable Changeable Message Signs	4	EA	$ 2,500	$ 10,000
5	Clearing and Grubbing	1	LS	$ 10,000	$ 10,000
6	Grading of Bio-Swale Areas	5,000	CY	$ 75	$ 375,000
7	Minor Concrete - Sidewalk	156,000	SF	$ 6.00	$ 936,000
8	Remove Existing Trees (Cut, Grind, Haul Off, Stump Backfill)	180	EA	$ 1,000	$ 180,000
9	Relocate Existing Fence	11,000	LF	$ 35	$ 385,000
10	Rehabilitate and Clean Existing Drywells	15	EA	$ 2,500	$ 37,500
11	Rehabilitate and Clean Existing Storm Drain Catch Basins	15	EA	$ 500	$ 7,500

SUB-TOTAL:	$ 1,963,500
CONSTRUCTION CONTINGENCIES (10%±):	$ 196,350
PLANNING & FINAL DESIGN SERVICES (15%±):	$ 294,525
CONSTRUCTION MANAGEMENT (10%±):	$ 196,350
TOTAL CONSTRUCTION COSTS:	**$ 2,650,725**
UTILITY RELOCATION & CONFLICT RESOLUTION (5%±):	$ 98,175
COMMUNITY SERVICE AREA FORMATION (4%±):	$ 78,540
COMMUNITY OUTREACH & ADVERTISING (2%±):	$ 39,270
TOTAL OTHER COSTS:	**$ 215,985**
TOTAL BUDGET COSTS:	**$ 2,866,710**

10. FUNDING SOURCES

a. General

The needed funding to ensure the existing system functions properly plus constructing the proposed improvements identified in this report may not be available under the County's current financing structure. Since it is likely that construction of the recommended facilities will be spread out over a number of years as funding does become available, and since the cost estimates in this study have been developed without the benefit of detailed design plans & specifications, it is expected that the cost of implementing the recommendations may increase over the years. Therefore, it is important that the funding mechanisms established to implement the various elements in this study include provisions for any increased costs of deferred construction.

In order to generate the revenue necessary to construct the improvements identified in this report, several funding alternatives are discussed and funding may consist of one or more of these alternatives. They are presented in no particular order and will have varying applicability depending on the circumstances of the particular improvements being proposed. The funding alternatives include but is not limited to the following:

- ✓ Development Impact Fees (capacity charges)
- ✓ Assessment District (1913/15 Act)
- ✓ Special Tax Districts (Mello Roos Community Facilities District Act of 1982)
- ✓ Storm Drainage Utility Rate Assessment (subject to Proposition 218)
- ✓ State and Federal Grants
- ✓ General Fund Subsidy

b. Development Impact Fees (Capacity Charges)

New development creates a need for new and upgraded storm drainage facilities to accommodate the design storm water runoff. Any new development that utilizes these facilities should be required to pay their fair share towards funding the required storm drain improvements via development impact fees or capacity charges. Since no new development is proposed as part of this study, the development impact fees funding alternative is considered to be not applicable to this project study.

c. Assessment Districts (1913/15 Act)

The potential exists for the establishment of one or more assessment districts to fund the required storm drainage facilities and their maintenance, where a common interest is shared by a large, but clearly defined group of constituents. Assessment district financing provides a vehicle to apportion the cost of improvements to those who will benefit by typically issuing bonds. Assessment districts can be established without bonding which are then repaid with revenue generated by assessing those benefiting parties directly from the improvements.

The establishment of an assessment district such as a community service area – CSA, requires a finding of direct and special benefit to the parcels being assessed, which shall be set forth in an Engineer's Report. Two public hearings and a mailed ballot are also required to establish an assessment district. If an assessment district is selected as a preferred financing mechanism, this report may be utilized as a resource to assist in making the benefit findings required pursuant to Proposition 218 and preparing an Engineer's Report as part of formation of the district.

d. Storm Drainage Utility Rate Establishment

The County may initiate the steps that are required to establish a County-wide storm drainage utility rates for the purpose of funding items such as bio-retention swale basin maintenance, street sweeping, leaf collection, system maintenance, storm water quality monitoring, storm drainage repairs, and capital improvements to improve existing storm drainage deficiencies. Many of these services are needed to meet the requirements of the Federal Clean Water Act, and the proposed rates may include both an operating component and a capital improvement component. The process of increasing the existing utility rates would be subject to the Proposition 218 (the "Right to Vote on Taxes Act" of 1996) governed ballot measure process.

Under Proposition 218, there are two options for establishing storm drain fees, they are:

- A positive majority vote of the affected property owners (50%+1 of the returned ballots)
- A positive two-thirds majority vote of the entire electorate residing in the affected area of the proposed increase (2/3 of the returned ballots)

e. State and Federal Grants

The federal government, through the Economic Development Administration, has in the past provided grants to assist communities with the funding of public works projects that contribute to the creation or retention of private sector jobs and to the alleviation of unemployment and underemployment. Depending on circumstances, the construction of drainage improvements identified in this report may be eligible for federal funds related to the NPDES under the Clean Water Act.

f. General Fund Subsidy

With prior approval from the Board, the County's General Fund may subsidize certain storm drainage projects and studies, sometimes via loans, because of the lack of available Storm Drain Enterprise funds. However, challenged with multiple revenue shortfalls due to State funding cuts and the overall slowdown in the construction industry and the local economy, it appears that continued general fund support is unlikely.

11. FUNDING COST ALTERNATIVES

Stanislaus County is currently considered a NPDES Municipal Separate Storm Sewer Systems (MS4) Phase II community and will face challenges relating to funding the proposed improvements. Funding for Phase II communities will be difficult because Stanislaus County, like many other Phase II agencies, may have no funding source and rely on General Fund monies to implement their storm water management program. In addition, the County may have no way to increase existing revenue due to Prop 218 limitations.

A capital and maintenance cost analysis for two financing alternatives were considered. The first alternative was to assume that internal financing would be provided at an assumed 3.00% interest rate over a 10 year term. The second alterative was to assume a 3.00% USDA financing loan for a 40 year term.

OPTION ONE: 100% INTERNAL FINANCING OPTION

Loan Amount ($)	=	$2,650,000
Interest Rate (i)	=	3.00%
Period (years)	=	10 years
Monthly Payment ($)	=	$25,589/month
Number of Parcels	=	333 parcels
Capital Cost per Parcel	=	$76.84/month per parcel
Maintenance Cost per Parcel	=	$7.00/month per parcel
Total Cost per Parcel	=	$84.74/month per parcel

Attachment A on page 67 shows that the average initial capital costs for a 10 year loan at 3.00% interest rate with zero percent down will be approximately $25,589 per month. For 333 parcels, the price per month per parcel is estimated to be $76.84/month per parcel.

The average O & M costs is assumed to be $7.00 per parcel per month based on recent cost studies performed during the formation of the Community Service Area (CSA) Number 27. Therefore, the total monthly capital and O&M cost is expected to be approximately $84.74 per parcel per month.

OPTION TWO: 100% USDA FINANCING OPTION

The second option assumes a 3.00% USDA loan over a 40 year period with 0.00% down.

Figure 25 below shows that the monthly payment for option two would be approximately $9,487 per month.

Figure 25: Capital Cost Financing Options (40 year USDA loan at 3%)

Mortgage Principal	$ 2,650,000	
Term of Mortgage	40	yrs
Starting Interest Rate	3	%

Interest Rate	Monthly Payments	Total Principle	Total Interest	Total Payments
3.000 %	$9,487	$2,650,000	$1,903,562	$4,553,562

For 333 parcels, the capital cost per month per parcel is estimated to be $28.49/ month per parcel.

Assuming a $7.00 monthly operational & maintenance cost per parcel, the total capital cost plus O & M cost per parcel is expected to be approximately $35.49 per parcel per month.

ALTERNATIVE TWO: 100 % USDA FINANCING OPTION

Loan Amount ($)	=	$2,650,000
Interest Rate (i)	=	3.00%
Period (years)	=	40 years
Monthly Payment ($)	=	$9,487/month
Number of Parcels	=	333 parcels
Capital Cost per Parcel	=	$28.49/month per parcel
Maintenance Cost per Parcel	=	$7.00/month per parcel
Total Cost per Parcel	=	$35.49/month per parcel

It should be noted that the obligation amount may be reduced if the project qualifies for partial deferral and/or grant options.

Attachment A shows the monthly capital costs plus O & M cost per parcel for a 3% APR, 10 year internal financing option with an initial down payment of 0%, 25%, 50%, and 75% respectively.

Attachment A also shows the monthly capital costs plus O & M cost per parcel for a 3% APR 40 year USDA loan financing option with an initial down payment of 0%, 25%, 50%, and 75% respectively.

Additional financing options with different rates, terms, and conditions can be calculated, if necessary.

OPTION THREE: CDBG FINANCING OPTION

The third option assumes CDBG financing in the amount of $500,000 annually. The limited annual funds under this option would require additional construction time and phasing than Options One and Option Two scenarios (i.e. 1-3 years). With the additional phasing costs, the CDBG option is expected to be more expensive and will require phasing the improvements over a longer time period – up to 8 years.

ATTACHMENT A: FINANCING OPTIONS (INTERNAL vs USDA LOAN)

ALTERNATIVE ONE: INTERNAL FINANCING Principal: $ 2,650,000

3.00% APR, 10 YEAR PERIOD

Description	Amount Financed	Monthly Payment	Number of Parcels	Cost per Parcel per Month	O&M Assessment Cost per Month per Parcel	Total Cost per Month per Parcel	Total Cost per Year per Parcel
Phase 1A	Built						
CDBG Only	0	0	0	$0	$7	$7.00	$84.00
25% Financed	$ 662,500	$ 6,397	333	$19	$7	$26.21	$314.52
50% Financed	$ 1,325,000	$ 12,794	333	$38	$7	$45.42	$545.05
75% Financed	$ 1,987,500	$ 19,191	333	$58	$7	$64.63	$775.57
100% Financed	$ 2,650,000	$ 25,589	333	$77	$7	$83.84	$1,006.13

ALTERNATIVE TWO: USDA FINANCING

3.00% APR, 40 YEAR PERIOD

Description	Amount Financed	Monthly Payment	Number of Parcels	Cost per Parcel per Month	O&M Assessment Cost per Month per Parcel	Total Cost per Month per Parcel	Total Cost per Year per Parcel
Phase 1A	Built						
CDBG Only	$0	$0	0	$0	$7	$7.00	$84.00
25% Financed	$662,500	$2,372	333	$7	$7	$14.12	$169.48
50% Financed	$1,325,000	$4,743	333	$14	$7	$21.24	$254.92
75% Financed	$1,987,500	$7,115	333	$21	$7	$28.37	$340.40
100% Financed	$2,650,000	$9,487	333	$28	$7	$35.49	$425.87

12. RECOMMENDATIONS

The following recommended action items are proposed based on this Low Impact Development & Greening Study for the Empire Community:

a. Adopt this Storm Water Master Plan Report and Engineer's Construction Cost Estimate as a guide for the development of the proposed storm drainage improvements.

b. Develop a detailed Engineer's Report based on this drainage study and add this project to the County's master capital improvement project (CIP) list in order to determine the cost allocation of the proposed improvements between the existing rate payers and future users.

c. Create the formation of a new Community Assessment District (CSA) to identify the fair share portions of the costs associated with constructing the improvements in areas for those benefiting parties.

   Note: Community Service Area (CSA) 27 was formed to fund operations and maintenance (O&M) of the Phase 1A improvements at a per parcel cost of approximately $70 annually ($6 monthly).

   In lieu of creating a new CSA, the County may consider adding the parcels in Phase 1B, 2, and 3 into this existing CSA 27.

d. Evaluate current maintenance procedures and recommend future on-going maintenance requirements for the proposed storm drainage improvements.

13. LIST OF REFERENCES

a. Stantech's Empire Infrastructure Improvement Project Phase 1A for the Town of Empire.

b. Department of Public Works Stanislaus County: Standards & Specifications, 2014 Edition. Stanislaus County Public Works, 2014 http://www.stancounty.com/publicworks/pdf/2014_imp_stand.pdf

c. Department of Planning and Community Development, General Plan dated 1994 (with 2006 Circulation Element Update). http://www.stancounty.com/planning/pl/general-plan.shtm

d. USGS Scientific Investigation Report 2004-5232: Hydrogeologic Characterization of the Modesto Area, San Joaquin Valley, California. Prepared for the Modesto Irrigation District by the United States Geological Survey.

e. California Storm water Quality Association Storm water Best Management Practice Handbook: New Development and Redevelopment. California Storm water Quality Association, January 2003

f. City of Riverbank: Model Standards & Specifications for Low Impact Development Practices, AECOM, January 2013

g. Geotechnical Services Report by Kleinfelder Est, Inc. for Proposed Empire Improvement project, January 2008.

h. Geotechnical Engineers Investigation by Salem Engineering Group, Inc. for Family Dollar Retail Store, December 2012.

i. J.D. Hightower, Community Development , Director of Public Works

j. Stanislaus County Post-Development Storm water Quality Design Standards by Public Works Development Services Division, September 2011. – DRAFT –

k. City of Modesto Storm water Management Program: 2011 Guidance Manual for Development Storm water Quality Control Measures. Wastewater Division, City of Modesto, May 2011.

l. City of Modesto Department of Public Works, "Storm Drainage, A Community Wide Problem", October 1958.

m. City of Modesto, “Standard Specifications”, 1997 Edition.

n. City of Modesto, “Standard Specifications, Section 4, Storm Drainage Design”, Revised October 2002.

o. City of Modesto Storm water Management Program, “Guidance Manual for New Development Storm water Quality Control Measures”, January 2001.

p. Corps of Engineers, Hydrological Engineering Center, “HEC-HMS Hydrological Modeling System Version 2.1”, January 2001.

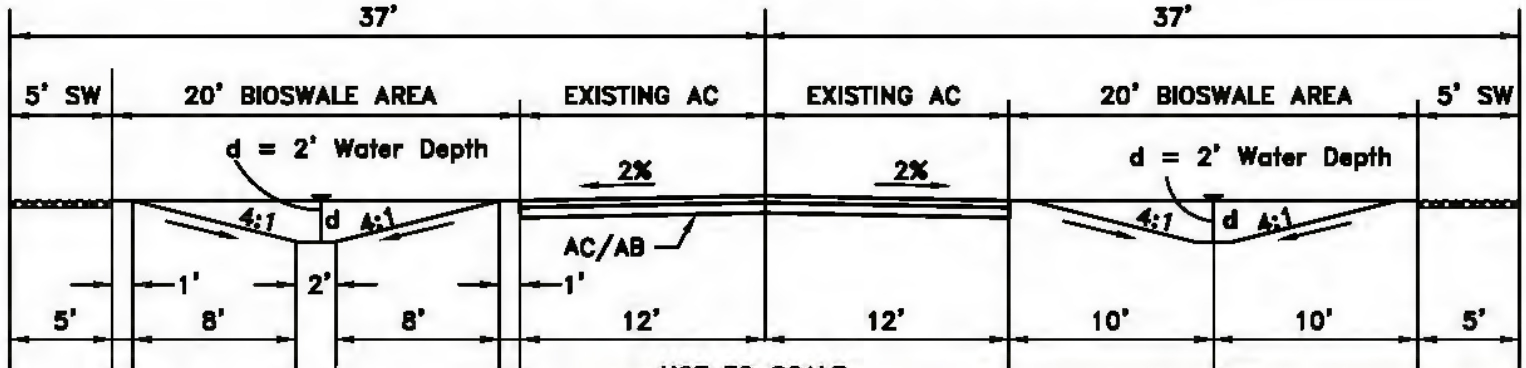
q. Federal Emergency Management Agency, “Flood Insurance Study, City of Modesto, California”, Revised August 17, 1982.

r. George S. Nolte and Associates, “County of Stanislaus Department of Public Works, Storm Drainage Study and Master Plan”, November 1976.

s. Stantec, “City of Modesto, Design Standards for Dual Use Flood Control/Recreation Facilities”, December 2000.

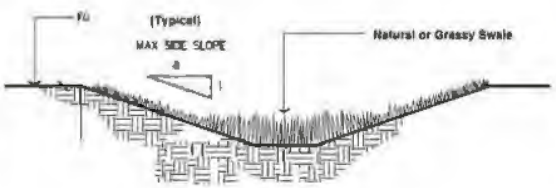
14. LIST OF APPENDIXES

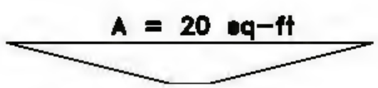
DRAINAGE MANAGEMENT AREA NO. 38



NOT TO SCALE

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft²)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft²/ft)	Available Volume in BioSwale (ft3)	50-year Storage Required (ft3)	Difference in Volume (ft³)	Time to percolate Volume Difference (hours)
38	BS-1	315	20	6,300	4	8	2	8	4	18.49	20.00	6,300	8,989	(1,358)	1.36
	BS-2	140	10	1,400	4	3	2	3	4	8.18	3.75	525			
	BS-3	70	10	700	4	3	2	3	4	8.18	3.75	263			
	BS-4	70	10	700	4	3	2	3	4	8.18	3.75	263			
	BS-5	75	10	750	4	3	2	3	4	8.18	3.75	281			
		Sub-total		9,850								7,631			





BIOSWALE SUMMARY:

d = Depth of bioswale = 2 ft
p = Wetted perimeter = 18.5 ft
A = Area of Flow = 20 sq-ft
V = Volume per foot = A x 1 ft
V = 20 cubic feet

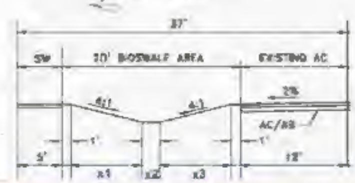
Total Volume = V per side

= V x 2 sides
= 20 cf x 2 = 40 cf per foot

Typical DMA Drainage Calculation Worksheet (for DMA Number 38)
Empire Storm Water Low Impact Master Plan Study
Storm Water Design Example for Drainage Management Area No.: DMA 38

Therefore, use following intensities and assumed perc rate for the design storms shown below.

	Intensity (inch)	P = (Intensity x MAP/ 10.9)	Notes
P_{50} =	2.88	3.04	inches for a 50-year, 24-hour design storm (storage)
Perc Rate	70	gallons/ft²-day assumed based on Phase 1A horizontal drain study	



Phase	Drainage Unit	Area (sq-ft)	Area (acres)	"C" value	Storage V^{50} = CAR/12 (ft³)
3	38	37,370	0.86	0.95	8,989

Bioswale Storage & Percolation Calculations

Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)
4.00	8.00	2.00	8.00	4.00

Wetted Perimeter: 18.49 ft (assume flowing full)
Area of Flow: 20.00 ft² (assuming no freeboard)
Volume of Bioswale per foot: 20.00 ft³ / ft (assuming no freeboard)

Linear footage of bioswale for Area 38-BS1: V50 / (Area)
V^{50} = 8,989 ft³
Area of Flow = 20.00 ft² (assuming no freeboard)
Linear footage of bioswale for Area 38-BS1: 315.00 ft
Total Volume provided in Area 38-BS1: 6,300 ft³
Similarly for Bio-swale areas BS-2, BS-3, BS-4, BS-5: 1,331 ft³ (see calculations in Table below)
Storage Available for Watershed Area 38 Bioswales: 7,631 ft³
Difference in Storage Requirements: (1,358) ft³ Attain this volume through percolation using 70 gallons/sf-day

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft²)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft²/ft)	Volume Stored in BioSwale (ft3)
38	BS-1	315	20	6,300	4	8	2	8	4	18.49	20.00	6,300
	BS-2	140	10	1,400	4	3	2	3	4	8.18	3.75	525
	BS-3	70	10	700	4	3	2	3	4	8.18	3.75	263
	BS-4	70	10	700	4	3	2	3	4	8.18	3.75	263
	BS-5	75	10	750	4	3	2	3	4	8.18	3.75	281
		Sub-total		9,850								7,631

Difference in storage needed will be handled by percolation within the swale area.

DMA Area 38 BS-1 provides the following volume of percolation within 48 hours:

Area of Bioswale Bottom = Wetted Perimeter x Linear footage of bioswale
Wetted Perimeter = 18.49 ft (assume flowing full)
Linear footage of bioswale = 315.00 ft
Area of Bioswale Bottom = 5,825.11 ft²
Assumed Perc Rate = 20.00 gallons/(ft² x day)
Volume percolated = 116,502.20 gallons/day
15,575 ft³/day
31,150 ft³ within 2 days (48 hours)
Note: This exceeds the 1,358 ft³ required for DMA 38

Conclusion:
With percolation credit, watershed DMA number 38 will be adequate with percolation credit.
See Tabulated percolation credit volumes for remaining bioswale areas BS-2, BS-3, BS-4, and BS-5.

Stanislaus County
Striving to be the Best

TYPICAL 74' ROW
2 LANE URBAN

EMPIRE STORM DRAINAGE
LID & GREENING STUDY

EXHIBIT NO: XXX

TABLE 4: SUMMARY OF SIXTY-FIVE (65) DRAINAGE MANAGEMENT AREAS (DMAs)
Empire Storm Water Low Impact Master Plan Study
Storm Water Design Storms:
Designed by: Paul Saini & Lester Stachura
Date: June 20, 2014

V = CAR / 12 R = Intensity = R_{design} x M.A.P./10.9" where M.A.P. = 11.5"

R_{50} = 2.88 " x 11.5" / 10.9 = 3.04 inches

Therefore, use following intensities for the design storms shown below:

R_{50} = 3.04 inches for a 50 year, 24 hour deign storm (for storage)

Phase	Number of Watersheds	ROW Watershed Length (ft)	ROW Watershed Width (ft)	ROW Watershed Area (sq-ft)	ROW Area (acres)	"C-value"	Required Storage (ft^3)
1-A	11	0	0	0	0.0	0.95	0
1-B	7	3,890	397	274,030	6.3	0.95	65,918
2	22	10,825	511	334,233	7.7	0.95	80,400
3	25	19,575	652	701,130	16.1	0.95	168,657
Totals:	65	34,290	1,560	1,309,393	30.1		314,975

Phase	Drainage Unit	ROW Watershed Length (ft)	ROW Watershed Width (ft)	ROW Watershed Area (sq-ft)	ROW Area (acres)	"C-value"	Required Storage (ft^3)
1-A	21	0	0	0	0.0	0.95	-
1-A	22	0	0	0	0.0	0.95	-
1-A	24	0	0	0	0.0	0.95	-
1-A	25	0	0	0	0.0	0.95	-
1-A	27	0	0	0	0.0	0.95	-
1-A	28	0	0	0	0.0	0.95	-
1-A	30	0	0	0	0.0	0.95	-
1-A	31	0	0	0	0.0	0.95	-
1-A	32	0	0	0	0.0	0.95	-
1-A	33	0	0	0	0.0	0.95	-
1-A	34	0	0	0	0.0	0.95	-
	Totals:	0	0	0	0		

Phase	Drainage Unit	ROW Watershed Length (ft)	ROW Watershed Width (ft)	ROW Watershed Area (sq-ft)	ROW Area (acres)	"C-value"	Required Storage (ft^3)
1-B	1	360	80	28,800	0.7	0.95	6,928
1-B	2	1535	80	122,800	2.8	0.95	29,540
1-B	3	495	80	39,600	0.9	0.95	9,526
1-B	4	560	80	44,800	1.0	0.95	10,777
1-B	5	390	27	10,530	0.2	0.95	2,533
1-B	6	550	50	27,500	0.6	0.95	6,615
1-B	7	0	0	0	0.0	0.95	-
	Totals:	3890	397	274,030	6.3		65,918

Phase	Drainage Unit	ROW Watershed Length (ft)	ROW Watershed Width (ft)	ROW Watershed Area (sq-ft)	ROW Area (acres)	"C-value"	Required Storage (ft^3)
2	23	0	0	0	0.0	0.95	-
2	26	1260	37	46,620	1.1	0.95	11,214
2	29	670	32	21,440	0.5	0.95	5,157
2	47	515	37	19,055	0.4	0.95	4,584
2	48	925	37	34,225	0.8	0.95	8,233
2	49	465	37	17,205	0.4	0.95	4,139
2	50	915	37	33,855	0.8	0.95	8,144
2	51	660	28.5	18,810	0.4	0.95	4,525
2	52	745	28.5	21,233	0.5	0.95	5,107
2	53	215	28.5	6,128	0.1	0.95	1,474
2	54	525	28.5	14,963	0.3	0.95	3,599
2	55	0	0	0	0.0	0.95	-
2	56	0	0	0	0.0	0.95	-
2	57	490	30	14,700	0.3	0.95	3,536
2	58	820	25	20,500	0.5	0.95	4,931
2	59	385	25	9,625	0.2	0.95	2,315
2	60	1010	25	25,250	0.6	0.95	6,074
2	61	0	0	0	0.0	0.95	-
2	62	385	25	9,625	0.2	0.95	2,315
2	63	510	25	12,750	0.3	0.95	3,067
2	64	330	25	8,250	0.2	0.95	1,985
2	65	0	0	0	0.0	0.95	-
	Totals:	10825	511	334,233	7.7		80,400

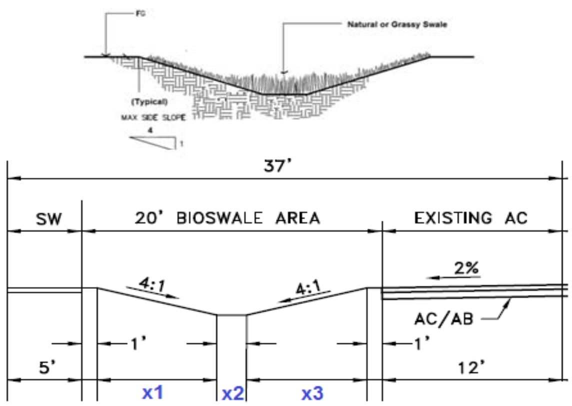
Phase	Drainage Unit	ROW Watershed Length (ft)	ROW Watershed Width (ft)	ROW Watershed Area (sq-ft)	ROW Area (acres)	"C-value"	Required Storage (ft^3)
3	8	200	30	6,000	0.1	0.95	1,443
3	9	375	18.5	6,938	0.2	0.95	1,669
3	10	860	30	25,800	0.6	0.95	6,206
3	11	1285	37	47,545	1.1	0.95	11,437
3	12	1850	37	68,450	1.6	0.95	16,466
3	13	1670	37	61,790	1.4	0.95	14,864
3	14	1295	37	47,915	1.1	0.95	11,526
3	15	1685	37	62,345	1.4	0.95	14,997
3	16	1720	37	63,640	1.5	0.95	15,309
3	17	840	37	31,080	0.7	0.95	7,476
3	18	1705	37	63,085	1.4	0.95	15,175
3	19	1285	37	47,545	1.1	0.95	11,437
3	20	0	0	0	0.0	0.95	-
3	35	0	0	0	0.0	0.95	-
3	36	0	0	0	0.0	0.95	-
3	37	475	18.5	8,788	0.2	0.95	2,114
3	38	1010	37	37,370	0.9	0.95	8,989
3	39	820	37	30,340	0.7	0.95	7,298
3	40	950	37	35,150	0.8	0.95	8,455
3	41	680	37	25,160	0.6	0.95	6,052
3	42	720	37	26,640	0.6	0.95	6,408
3	43	0	0	0	0.0	0.95	-
3	44	0	0	0	0.0	0.95	-
3	45	150	37	5,550	0.1	0.95	1,335
3	46	0	0	0	0.0	0.95	-
	Totals:	19575	652	701,130	16.1		168,657

TABLE 5A: Typical DMA Drainage Calculation Worksheet (for DMA Number 38)
Empire Storm Water Low Impact Master Plan Study
Storm Water Design Example for Drainage Management Area No: DMA 38

V = CAR / 12 R = Intensity = R_{design} x M.A.P./10.9" where M.A.P. = 11.5"

Therefore, use following intensities and assumed perc rate for the design storms shown below:

	Intensity (inch)	R = (Intensity x MAP/10.9)	Notes
R_{50} =	2.88	3.04	inches for a 50-year, 24 hour deign storm (storage)
Percolation Rate:	20		gallons/sf-day assumed based on Phase 1A horizontal drain study



Phase	Drainage Unit	Area (sq-ft)	Area (acres)	"C-value"	Storage V^{50}= CAR/12 (ft^3)
3	38	37,370	0.86	0.95	8,989

Bioswale Storage & Percolation Calculations:

Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)
4.00	8.00	2.00	8.00	4.00

Wetted Perimeter: 18.49 ft (assume flowing full)
Area of Flow: 20.00 ft^2 (assuming no freeboard)
Volume of Bioswale per foot: 20.00 ft^3 / ft (assuming no freeboard)

Linear footage of bioswale for Area 38-BS1: V50 =/ (Area)
V^{50} = 8,989 ft^3
Area of Flow = 20.00 ft^2 (assuming no freeboard)
Linear footage of bioswale for Area 38-BS1: 315.00 ft
Total Volume provided in Area 38-BS1: 6,300 ft^3
Similiarly for Bio-swale areas BS-2, BS-3, BS-4, BS-5: 1,331 ft^3 (see calculations in Table below)
Total Storage Available for Watershed Area 38 Bioswales: 7,631 ft^3
Difference in Storage Requirements: (1,358) ft^3 Attain this volume through percolation using 20 gallons/sf-day

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Volume Stored in BioSwale (ft3)
38	BS-1	315	20	6,300	4	8	2	8	4	18.49	20.00	6,300
	BS-2	140	10	1,400	4	3	2	3	4	8.18	3.75	525
	BS-3	70	10	700	4	3	2	3	4	8.18	3.75	263
	BS-4	70	10	700	4	3	2	3	4	8.18	3.75	263
	BS-5	75	10	750	4	3	2	3	4	8.18	3.75	281
			Sub-total:	9,850								7,631

Difference in storage needed will be handled by percolation within bio-swale area.

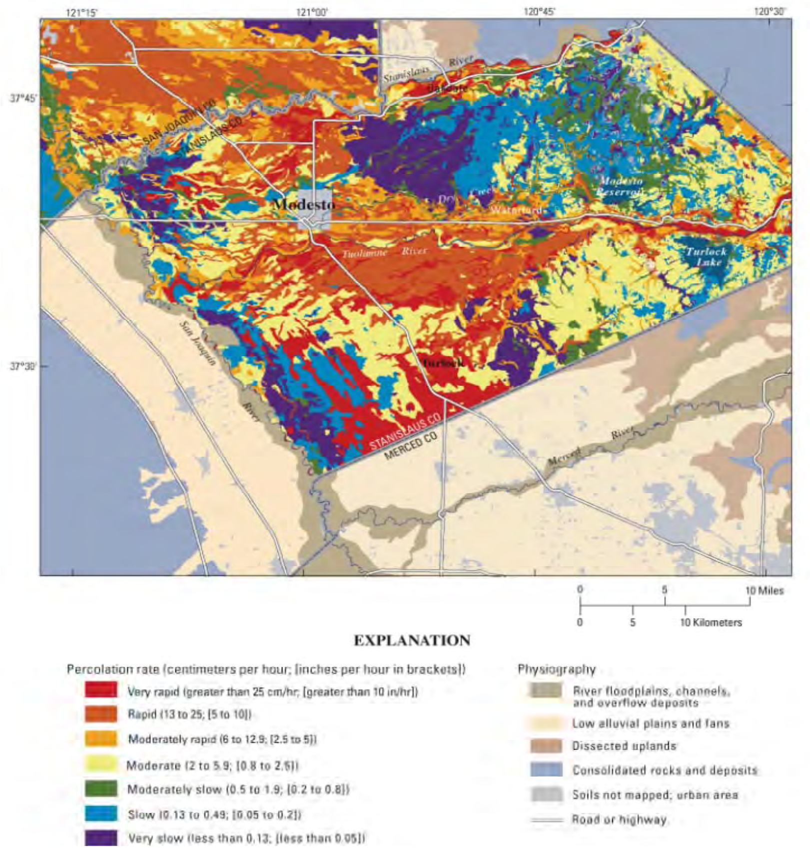
DMA Area 38 BS-1 provides the following volume of percolation within 48 hours:

Area of Bioswale Bottom = Wetted Perimeter x Linear footage of bioswale
Wetted Perimeter = 18.49 ft (assume flowing full)
Linear footage of bioswale = 315.00 ft
Area of Bioswale Bottom = 5,825.11 ft^2
Assumed Perc Rate = 20.00 gallons/(ft^2 x day)
Volume percolated = 116,502.26 gallons/day
15,575 ft^3/day
31,150 ft^3 within 2 days (48 hours)
Note: This exceeds the 1,358 ft^3 required for DMA 38

Conclusion:

With percolation credit, watershed DMA number 38 will be adequate with percolation credit.
See Tabulated percolation credit volumes for remaining bioswale areas BS-2, BS-3, BS-4, and BS-5

TABLE 5B: Typical DMA Drainage Calculation Worksheet (for DMA Number 38)
Empire Storm Water Low Impact Master Plan Study
Storm Water Design Example for Drainage Management Area No: 38



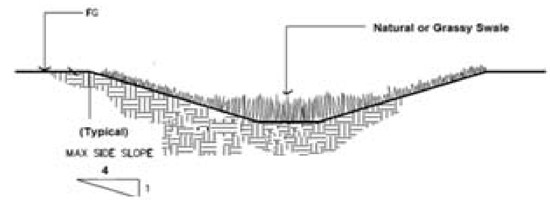
Soil Percolation Rate for Empire Community Project Area	Percolation Rate (inch/hour)	Conversion Percolation Rate (gallons/sf-day)	Factor of Safety	Percolation Rate (gallons/sf-day)
Moderate	2.5	37.40	4.00	9.35
Moderately rapid	5	74.80	4.00	18.70
Rapid	10	149.60	4.00	37.40

For the Empire Storm Drain Master Plan Study, assume a percolation rate of 80 gallons/sf-day.
With a factor of safety of 4.0, the percolation rate will be 20 gallongs/sf-day

DMA Number 38 - Storage Calculations				
Description	Area "A" (sf)	Area "A" (acres)	Runoff Coefficient "C"	C*A
Residential	0	0.00	0.55	0.00
Commercial/Industrial/Streets	37,370	0.86	0.95	0.82
Open Space/Parks	0	0.00	0.35	0.00
Totals	37,370	0.86	--	0.82
		Composite C =	0.95	
		50-Year/24-Hour Rainfall "R" =	2.88	in
		Mean Annual Precipitation =	11.50	in
		Intensity = R x MAP/10.9"	3.04	inch
		V = C*A*R/12 =	0.2064	acre-foot
		V =	8,989	cubic foot
		Volume Required to Retain 50 Year / 24 Hour Storm =	**67,240**	**gallons**

DMA Number 38 - Percolation Calculations		
50-Year/24-Hour Rainfall "R" =	2.8800	in
Mean Annual Precipitation =	11.5000	in
Intensity = R x MAP/10.9"	3.04	inch
V = C*A*R/12 =	0.2064	acre-foot
Volume Required to Percolate a 50 Year / 24 Hour Storm =	8,989	cubic foot
Volume Required =	67,240	gallons
Retention System Bottom Surface Area=	9,850	sq. ft
Assumed Percolation Rate =	80	gallons/sf-day
Safety Factor=	4	
Design Percolation Rate=	20.00	gallons/sf-day
Time to Evacuate Design Storm=	0.34	days
Time to Percolate a 50-year, 24-hour Design Storm=	**8.19**	**hours**

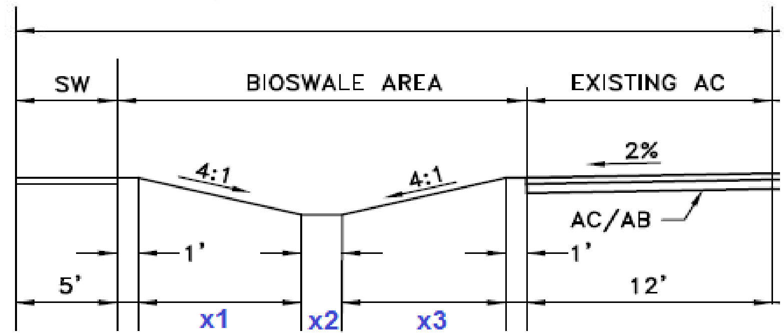
TABLE 6: STORAGE REQUIREMENTS FOR EACH DMA WATERSHED AREA
STORAGE CALCULATIONS REQUIREMENTS FOR 50-YEAR, 24-HOUR STORM
Empire Storm Water Low Impact Master Plan Study
Storm Water Design Summary for All Drainage Management Areas
Designed by: Paul Saini & Lester Stachura



$V = CAR / 12$ $\quad$ R = Intensity = R_{design} x M.A.P./10.9" where M.A.P. = 11.5"

Therefore, use following intensities and assumed perc rate for the design storms shown below:

	Intensity (inch)	R = (Intensity x MAP/10.9)	Notes
R_{50} =	2.88	3.04	inches for a 50-year, 24 hour deign storm (storage)
Perc =	20	Percolation rate in gallons/sf-day assumed based on attached reference	



Amount of water that can percolate within 2 days (48 hours) assuming 20 gallons/sq-ft/day rate:

V_{perc} = [Bioswale Surface Area x Perc Rate in gallons/sf-day x 2 days] / 7.48 gallons/ft^3
V_{perc} = [Wetted Perimeter x length x 20 gallons/sf-day x 2 days] / 7.48 gallons/ft^3
V_{perc} = Percolated volume measured in ft^3

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Volume Stored in BioSwale (ft3)	Volume percolated within 48 hours (ft3)	Total Volume Stored & Percolated (ft3)	50-year Storage Required (ft3)	Net Volume (ft^3)
1	BS-1	85	20	1,700	4	8	2	8	4	18.49	20.00	1,700	8,406	10,106	6,928	13,283
	BS-2	85	20	1,700	4	8	2	8	4	18.49	20.00	1,700	8,406	10,106		
			Sub-total:	3,400								3,400	16,811	20,211		

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Volume Stored in BioSwale (ft3)	Volume percolated within 48 hours (ft3)	Total Volume Stored & Percolated (ft3)	50-year Storage Required (ft3)	Net Volume (ft^3)
2	BS-1	110	10	1,100	4	3	2	3	4	8.18	3.75	413	4,815	5,227	29,540	19,654
	BS-2	65	10	650	4	3	2	3	4	8.18	3.75	244	2,845	3,089		
	BS-3	110	20	2,200	4	8	2	8	4	18.49	20.00	2,200	10,878	13,078		
	BS-4	135	10	1,350	4	3	2	3	4	8.18	3.75	506	5,909	6,415		
	BS-5	70	20	1,400	4	8	2	8	4	18.49	20.00	1,400	6,922	8,322		
	BS-6	100	15	1,500	4	6	2	6	4	13.34	10.31	1,031	7,133	8,164		
	BS-7	60	15	900	4	6	2	6	4	13.34	10.31	619	4,280	4,898		
			Sub-total:	9,100								6,413	42,781	49,193		

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Volume Stored in BioSwale (ft3)	Volume percolated within 48 hours (ft3)	Total Volume Stored & Percolated (ft3)	50-year Storage Required (ft3)	Net Volume (ft^3)
3	BS-1	185	10	1,850	4	3	2	3	4	8.18	3.75	694	8,097	8,791	9,526	27,840
	BS-2	190	15	2,850	4	6	2	6	4	13.34	10.31	1,959	13,553	15,512		
	BS-3	40	15	600	4	6	2	6	4	13.34	10.31	413	2,853	3,266		
	BS-4	45	15	675	4	6	2	6	4	13.34	10.31	464	3,210	3,674		
	BS-5	75	15	1,125	4	6	2	6	4	13.34	10.31	773	5,350	6,123		
			Sub-total:	1,125								4,303	33,062	37,365		

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Volume Stored in BioSwale (ft3)	Volume percolated within 48 hours (ft3)	Total Volume Stored & Percolated (ft3)	50-year Storage Required (ft3)	Net Volume (ft^3)
9	BS-1	170	10	1,700	4	3	2	3	4	8.18	3.75	638	7,441	8,078	1,669	6,409
			Sub-total:	1,700								638	7,441	8,078		

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Volume Stored in BioSwale (ft3)	Volume percolated within 48 hours (ft3)	Total Volume Stored & Percolated (ft3)	50-year Storage Required (ft3)	Net Volume (ft^3)
10	BS-1	70	10	700	4	3	2	3	4	8.18	3.75	263	3,064	3,326	6,206	5,436
	BS-2	135	10	1,350	4	3	2	3	4	8.18	3.75	506	5,909	6,415		
	BS-3	40	10	400	4	3	2	3	4	8.18	3.75	150	1,751	1,901		
			Sub-total:	2,450								919	10,723	11,642		

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Volume Stored in BioSwale (ft3)	Volume percolated within 48 hours (ft3)	Total Volume Stored & Percolated (ft3)	50-year Storage Required (ft3)	Net Volume (ft^3)
11	BS-1	155	10	1,550	4	3	2	3	4	8.18	3.75	581	6,784	7,365	11,437	24,017
	BS-2	55	10	550	4	3	2	3	4	8.18	3.75	206	2,407	2,614		
	BS-3	130	15	1,950	4	6	2	6	4	13.34	10.31	1,341	9,273	10,613		
	BS-4	125	20	2,500	4	8	2	8	4	18.49	20.00	2,500	12,361	14,861		
			Sub-total:	6,550								4,628	30,825	35,453		

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Volume Stored in BioSwale (ft3)	Volume percolated within 48 hours (ft3)	Total Volume Stored & Percolated (ft3)	50-year Storage Required (ft3)	Net Volume (ft^3)
12	BS-1	125	10	1,250	4	3	2	3	4	8.18	3.75	469	5,471	5,940	16,466	29,616
	BS-2	85	10	850	4	3	2	3	4	8.18	3.75	319	3,720	4,039		
	BS-3	80	10	800	4	3	2	3	4	8.18	3.75	300	3,501	3,801		
	BS-4	45	10	450	4	3	2	3	4	8.18	3.75	169	1,970	2,138		
	BS-5	150	10	1,500	4	3	2	3	4	8.18	3.75	563	6,565	7,128		
	BS-6	90	10	900	4	3	2	3	4	8.18	3.75	338	3,939	4,277		
	BS-7	65	10	650	4	3	2	3	4	8.18	3.75	244	2,845	3,089		
	BS-8	90	15	1,350	4	6	2	6	4	13.34	10.31	928	6,420	7,348		
	BS-9	70	20	1,400	4	8	2	8	4	18.49	20.00	1,400	6,922	8,322		
			Sub-total:	9,150								4,728	41,354	46,082		

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Volume Stored in BioSwale (ft3)	Volume percolated within 48 hours (ft3)	Total Volume Stored & Percolated (ft3)	50-year Storage Required (ft3)	Net Volume (ft^3)
13	BS-1	75	10	750	4	3	2	3	4	8.18	3.75	281	3,283	3,564	14,864	51,356
	BS-2	70	10	700	4	3	2	3	4	8.18	3.75	263	3,064	3,326		
	BS-3	120	10	1,200	4	3	2	3	4	8.18	3.75	450	5,252	5,702		
	BS-4	120	10	1,200	4	3	2	3	4	8.18	3.75	450	5,252	5,702		
	BS-5	70	10	700	4	3	2	3	4	8.18	3.75	263	3,064	3,326		
	BS-6	75	25	1,875	4	11	2	11	4	23.65	32.81	2,461	9,484	11,945		
	BS-7	50	25	1,250	4	11	2	11	4	23.65	32.81	1,641	6,323	7,963		
	BS-8	70	25	1,750	4	11	2	11	4	23.65	32.81	2,297	8,852	11,148		
	BS-9	105	10	1,050	4	3	2	3	4	8.18	3.75	394	4,596	4,989		
	BS-10	50	10	500	4	3	2	3	4	8.18	3.75	188	2,188	2,376		
	BS-11	65	10	650	4	3	2	3	4	8.18	3.75	244	2,845	3,089		
	BS-12	65	10	650	4	3	2	3	4	8.18	3.75	244	2,845	3,089		
			Sub-total:	12,275								9,173	57,046	66,220		

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Volume Stored in BioSwale (ft3)	Volume percolated within 48 hours (ft3)	Total Volume Stored & Percolated (ft3)	50-year Storage Required (ft3)	Net Volume (ft^3)
14	BS-1	150	15	2,250	4	6	2	6	4	13.34	10.31	1,547	10,699	12,246	11,526	50,509
	BS-2	90	15	1,350	4	6	2	6	4	13.34	10.31	928	6,420	7,348		
	BS-3	170	20	3,400	4	8	2	8	4	18.49	20.00	3,400	16,811	20,211		
	BS-4	155	20	3,100	4	8	2	8	4	18.49	20.00	3,100	15,328	18,428		
	BS-5	80	10	800	4	3	2	3	4	8.18	3.75	300	3,501	3,801		
			Sub-total:	10,900								9,275	52,760	62,035		

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Volume Stored in BioSwale (ft3)	Volume percolated within 48 hours (ft3)	Total Volume Stored & Percolated (ft3)	50-year Storage Required (ft3)	Net Volume (ft^3)
15	BS-1	70	15	1,050	4	6	2	6	4	13.34	10.31	722	4,993	5,715	14,997	42,863
	BS-2	70	15	1,050	4	6	2	6	4	13.34	10.31	722	4,993	5,715		
	BS-3	60	10	600	4	3	2	3	4	8.18	3.75	225	2,626	2,851		
	BS-4	65	10	650	4	3	2	3	4	8.18	3.75	244	2,845	3,089		
	BS-5	60	10	600	4	3	2	3	4	8.18	3.75	225	2,626	2,851		
	BS-6	70	10	700	4	3	2	3	4	8.18	3.75	263	3,064	3,326		
	BS-7	75	15	1,125	4	6	2	6	4	13.34	10.31	773	5,350	6,123		
	BS-8	95	10	950	4	3	2	3	4	8.18	3.75	356	4,158	4,514		
	BS-9	150	15	2,250	4	6	2	6	4	13.34	10.31	1,547	10,699	12,246		
	BS-10	140	15	2,100	4	6	2	6	4	13.34	10.31	1,444	9,986	11,430		
			Sub-total:	11,075								6,520	51,340	57,860		

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Volume Stored in BioSwale (ft3)	Volume percolated within 48 hours (ft3)	Total Volume Stored & Percolated (ft3)	50-year Storage Required (ft3)	Net Volume (ft^3)
16	BS-1	140	10	1,400	4	3	2	3	4	8.18	3.75	525	6,128	6,653	15,309	80,140
	BS-2	80	10	800	4	3	2	3	4	8.18	3.75	300	3,501	3,801		
	BS-3	65	15	975	4	6	2	6	4	13.34	10.31	670	4,636	5,307		
	BS-4	40	15	600	4	6	2	6	4	13.34	10.31	413	2,853	3,266		
	BS-5	55	15	825	4	6	2	6	4	13.34	10.31	567	3,923	4,490		
	BS-6	165	10	1,650	4	3	2	3	4	8.18	3.75	619	7,222	7,841		
	BS-7	90	10	900	4	3	2	3	4	8.18	3.75	338	3,939	4,277		
	BS-8	150	30	4,500	4	13	2	13	4	28.80	48.75	7,313	23,102	30,414		
	BS-9	145	30	4,350	4	13	2	13	4	28.80	48.75	7,069	22,332	29,400		
			Sub-total:	16,000								17,813	77,636	95,449		

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Volume Stored in BioSwale (ft3)	Volume percolated within 48 hours (ft3)	Total Volume Stored & Percolated (ft3)	50-year Storage Required (ft3)	Net Volume (ft^3)
17	BS-1	85	20	1,700	4	8	2	8	4	18.49	20.00	1,700	8,406	10,106	7,476	16,100
	BS-2	115	15	1,725	4	6	2	6	4	13.34	10.31	1,186	8,203	9,389		
	BS-3	50	15	750	4	6	2	6	4	13.34	10.31	516	3,566	4,082		
			Sub-total:	4,175								3,402	20,175	23,577		

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Volume Stored in BioSwale (ft3)	Volume percolated within 48 hours (ft3)	Total Volume Stored & Percolated (ft3)	50-year Storage Required (ft3)	Net Volume (ft^3)
18	BS-1	115	15	1,725	4	6	2	6	4	13.34	10.31	1,186	8,203	9,389	15,175	36,259
	BS-2	85	15	1,275	4	6	2	6	4	13.34	10.31	877	6,063	6,940		
	BS-3	75	15	1,125	4	6	2	6	4	13.34	10.31	773	5,350	6,123		
	BS-4	120	15	1,800	4	6	2	6	4	13.34	10.31	1,238	8,559	9,797		
	BS-5	135	15	2,025	4	6	2	6	4	13.34	10.31	1,392	9,629	11,022		
	BS-6	100	15	1,500	4	6	2	6	4	13.34	10.31	1,031	7,133	8,164		
			Sub-total:	9,450								6,497	44,937	51,434		

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Volume Stored in BioSwale (ft3)	Volume percolated within 48 hours (ft3)	Total Volume Stored & Percolated (ft3)	50-year Storage Required (ft3)	Net Volume (ft^3)
19	BS-1	85	10	850	4	3	2	3	4	8.18	3.75	319	3,720	4,039	11,437	13,748
	BS-2	125	10	1,250	4	3	2	3	4	8.18	3.75	469	5,471	5,940		
	BS-3	65	10	650	4	3	2	3	4	8.18	3.75	244	2,845	3,089		
	BS-4	155	10	1,550	4	3	2	3	4	8.18	3.75	581	6,784	7,365		
	BS-5	100	10	1,000	4	3	2	3	4	8.18	3.75	375	4,377	4,752		
			Sub-total:	5,300								1,988	23,197	25,185		

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Volume Stored in BioSwale (ft3)	Volume percolated within 48 hours (ft3)	Total Volume Stored & Percolated (ft3)	50-year Storage Required (ft3)	Net Volume (ft^3)
26	BS-1	50	15	750	4	6	2	6	4	13.34	10.31	516	3,566	4,082	11,214	10,475
	BS-2	80	10	800	4	3	2	3	4	8.18	3.75	300	3,501	3,801		
	BS-3	50	10	500	4	3	2	3	4	8.18	3.75	188	2,188	2,376		
	BS-4	140	15	2,100	4	6	2	6	4	13.34	10.31	1,444	9,986	11,430		
			Sub-total:	4,150								2,447	19,242	21,689		

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Volume Stored in BioSwale (ft3)	Volume percolated within 48 hours (ft3)	Total Volume Stored & Percolated (ft3)	50-year Storage Required (ft3)	Net Volume (ft^3)
29	BS-1	50	10	500	4	3	2	3	4	8.18	3.75	188	2,188	2,376	5,157	70
	BS-2	60	10	600	4	3	2	3	4	8.18	3.75	225	2,626	2,851		
			Sub-total:	1,100								413	4,815	5,227		

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Volume Stored in BioSwale (ft3)	Volume percolated within 48 hours (ft3)	Total Volume Stored & Percolated (ft3)	50-year Storage Required (ft3)	Net Volume (ft^3)
38	BS-1	315	20	6,300	4	8	2	8	4	18.49	20.00	6,300	31,150	37,450	8,989	45,330
	BS-2	140	10	1,400	4	3	2	3	4	8.18	3.75	525	6,128	6,653		
	BS-3	70	10	700	4	3	2	3	4	8.18	3.75	263	3,064	3,326		
	BS-4	70	10	700	4	3	2	3	4	8.18	3.75	263	3,064	3,326		
	BS-5	75	10	750	4	3	2	3	4	8.18	3.75	281	3,283	3,564		
			Sub-total:	9,850								7,631	46,688	54,319		

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Volume Stored in BioSwale (ft3)	Volume percolated within 48 hours (ft3)	Total Volume Stored & Percolated (ft3)	50-year Storage Required (ft3)	Net Volume (ft^3)
29	BS-1	400	15	6,000	4	6	2	6	4	13.34	10.31	4,125	28,532	32,657	5,157	47,714
	BS-2	105	15	1,575	4	6	2	6	4	13.34	10.31	1,083	7,490	8,572		
	BS-3	55	10	550	4	3	2	3	4	8.18	3.75	206	2,407	2,614		
	BS-4	30	10	300	4	3	2	3	4	8.18	3.75	113	1,313	1,426		
	BS-5	50	10	500	4	3	2	3	4	8.18	3.75	188	2,188	2,376		
	BS-6	50	10	500	4	3	2	3	4	8.18	3.75	188	2,188	2,376		
	BS-7	60	10	600	4	3	2	3	4	8.18	3.75	225	2,626	2,851		
			Sub-total:	10,025								6,127	46,744	52,871		

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Volume Stored in BioSwale (ft3)	Volume percolated within 48 hours (ft3)	Total Volume Stored & Percolated (ft3)	50-year Storage Required (ft3)	Net Volume (ft^3)
38	BS-1	315	20	6,300	4	8	2	8	4	18.49	20.00	6,300	31,150	37,450	8,989	45,330
	BS-2	140	10	1,400	4	3	2	3	4	8.18	3.75	525	6,128	6,653		
	BS-3	70	10	700	4	3	2	3	4	8.18	3.75	263	3,064	3,326		
	BS-4	70	10	700	4	3	2	3	4	8.18	3.75	263	3,064	3,326		
	BS-5	75	10	750	4	3	2	3	4	8.18	3.75	281	3,283	3,564		
			Sub-total:	9,850								7,631	46,688	54,319		

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Volume Stored in BioSwale (ft3)	Volume percolated within 48 hours (ft3)	Total Volume Stored & Percolated (ft3)	50-year Storage Required (ft3)	Additional Storage Needed (ft^3)
39	BS-1	400	15	6,000	4	6	2	6	4	13.34	10.31	4,125	28,532	32,657	7,298	44,544
	BS-2	105	15	1,575	4	6	2	6	4	13.34	10.31	1,083	7,490	8,572		
	BS-3	130	15	1,950	4	6	2	6	4	13.34	10.31	1,341	9,273	10,613		
			Sub-total:	9,525								6,548	45,294	51,842		

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Volume Stored in BioSwale (ft3)	Volume percolated within 48 hours (ft3)	Total Volume Stored & Percolated (ft3)	50-year Storage Required (ft3)	Net Volume (ft^3)
40	BS-1	95	15	1,425	4	6	2	6	4	13.34	10.31	980	6,776	7,756	8,455	11,955
	BS-2	90	15	1,350	4	6	2	6	4	13.34	10.31	928	6,420	7,348		
	BS-3	65	15	975	4	6	2	6	4	13.34	10.31	670	4,636	5,307		
			Sub-total:	3,750								2,578	17,832	20,410		

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Volume Stored in BioSwale (ft3)	Volume percolated within 48 hours (ft3)	Total Volume Stored & Percolated (ft3)	50-year Storage Required (ft3)	Net Volume (ft^3)
41	BS-1	85	10	850	4	3	2	3	4	8.18	3.75	319	3,720	4,039	6,052	9,629
	BS-2	85	10	850	4	3	2	3	4	8.18	3.75	319	3,720	4,039		
	BS-3	70	10	700	4	3	2	3	4	8.18	3.75	263	3,064	3,326		
	BS-4	90	10	900	4	3	2	3	4	8.18	3.75	338	3,939	4,277		
			Sub-total:	3,300								1,238	14,444	15,681		

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Volume Stored in BioSwale (ft3)	Volume percolated within 48 hours (ft3)	Total Volume Stored & Percolated (ft3)	50-year Storage Required (ft3)	Net Volume (ft^3)
42	BS-1	80	15	1,200	4	6	2	6	4	13.34	10.31	825	5,706	6,531	6,408	5,838
	BS-2	70	15	1,050	4	6	2	6	4	13.34	10.31	722	4,993	5,715		
			Sub-total:	2,250								1,547	10,699	12,246		

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Volume Stored in BioSwale (ft3)	Volume percolated within 48 hours (ft3)	Total Volume Stored & Percolated (ft3)	50-year Storage Required (ft3)	Net Volume (ft^3)
47	BS-1	140	15	2,100	4	6	2	6	4	13.34	10.31	1,444	9,986	11,430	4,584	17,460
	BS-2	130	15	1,950	4	6	2	6	4	13.34	10.31	1,341	9,273	10,613		
			Sub-total:	4,050								2,784	19,259	22,043		

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Volume Stored in BioSwale (ft3)	Volume percolated within 48 hours (ft3)	Total Volume Stored & Percolated (ft3)	50-year Storage Required (ft3)	Net Volume (ft^3)
48	BS-1	55	15	825	4	6	2	6	4	13.34	10.31	567	3,923	4,490	8,233	15,443
	BS-2	95	15	1,425	4	6	2	6	4	13.34	10.31	980	6,776	7,756		
	BS-3	85	15	1,275	4	6	2	6	4	13.34	10.31	877	6,063	6,940		
	BS-4	55	15	825	4	6	2	6	4	13.34	10.31	567	3,923	4,490		
			Sub-total:	4,350								2,991	20,685	23,676		

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Volume Stored in BioSwale (ft3)	Volume percolated within 48 hours (ft3)	Total Volume Stored & Percolated (ft3)	50-year Storage Required (ft3)	Net Volume (ft^3)
49	BS-1	50	15	750	4	6	2	6	4	13.34	10.31	516	3,566	4,082	4,139	13,700
	BS-2	55	15	825	4	6	2	6	4	13.34	10.31	567	3,923	4,490		
	BS-3	115	10	1,150	4	3	2	3	4	8.18	3.75	431	5,033	5,465		
	BS-4	80	10	800	4	3	2	3	4	8.18	3.75	300	3,501	3,801		
			Sub-total:	3,525								1,814	16,024	17,838		

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Volume Stored in BioSwale (ft3)	Volume percolated within 48 hours (ft3)	Total Volume Stored & Percolated (ft3)	50-year Storage Required (ft3)	Net Volume (ft^3)
50	BS-1	75	15	1,125	4	6	2	6	4	13.34	10.31	773	5,350	6,123	8,144	14,716
	BS-2	95	15	1,425	4	6	2	6	4	13.34	10.31	980	6,776	7,756		
	BS-3	110	15	1,650	4	6	2	6	4	13.34	10.31	1,134	7,846	8,981		
			Sub-total:	4,200								2,888	19,972	22,860		

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Volume Stored in BioSwale (ft3)	Volume percolated within 48 hours (ft3)	Total Volume Stored & Percolated (ft3)	50-year Storage Required (ft3)	Net Volume (ft^3)
52	BS-1	95	10	950	4	3	2	3	4	8.18	3.75	356	4,158	4,514	5,107	6,297
	BS-2	75	10	750	4	3	2	3	4	8.18	3.75	281	3,283	3,564		
	BS-3	70	10	700	4	3	2	3	4	8.18	3.75	263	3,064	3,326		
			Sub-total:	2,400								900	10,504	11,404		

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Volume Stored in BioSwale (ft3)	Volume percolated within 48 hours (ft3)	Total Volume Stored & Percolated (ft3)	50-year Storage Required (ft3)	Net Volume (ft^3)
54	BS-1	105	10	1,050	4	3	2	3	4	8.18	3.75	394	4,596	4,989	3,599	7,805
	BS-2	135	10	1,350	4	3	2	3	4	8.18	3.75	506	5,909	6,415		
			Sub-total:	2,400							Sub-total:	900	10,504	11,404		

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Volume Stored in BioSwale (ft3)	Volume percolated within 48 hours (ft3)	Total Volume Stored & Percolated (ft3)	50-year Storage Required (ft3)	Net Volume (ft^3)
57	BS-1	80	10	800	4	3	2	3	4	8.18	3.75	300	3,501	3,801	3,536	7,393
	BS-2	80	10	800	4	3	2	3	4	8.18	3.75	300	3,501	3,801		
	BS-3	70	10	700	4	3	2	3	4	8.18	3.75	263	3,064	3,326		
			Sub-total:	2,300								863	10,067	10,929		

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Volume Stored in BioSwale (ft3)	Volume percolated within 48 hours (ft3)	Total Volume Stored & Percolated (ft3)	50-year Storage Required (ft3)	Net Volume (ft^3)
58	BS-1	120	5	600	4	1	2	1	4	3.03	0.31	38	1,945	1,982	4,931	18,525
	BS-2	160	5	800	4	1	2	1	4	3.03	0.31	50	2,593	2,643		
	BS-3	90	5	450	4	1	2	1	4	3.03	0.31	28	1,459	1,487		
	BS-4	175	10	1,750	4	3	2	3	4	8.18	3.75	656	7,659	8,316		
	BS-5	100	10	1,000	4	3	2	3	4	8.18	3.75	375	4,377	4,752		
	BS-6	90	10	900	4	3	2	3	4	8.18	3.75	338	3,939	4,277		
			Sub-total:	5,500								1,484	21,972	23,457		

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Volume Stored in BioSwale (ft3)	Volume percolated within 48 hours (ft3)	Total Volume Stored & Percolated (ft3)	50-year Storage Required (ft3)	Net Volume (ft^3)
59	BS-1	50	5	250	4	1	2	1	4	3.03	0.31	16	810	826	2,315	906
	BS-2	145	5	725	4	1	2	1	4	3.03	0.31	45	2,350	2,395		
			Sub-total:	975								61	3,160	3,221		

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Volume Stored in BioSwale (ft3)	Volume percolated within 48 hours (ft3)	Total Volume Stored & Percolated (ft3)	50-year Storage Required (ft3)	Net Volume (ft^3)
60	BS-1	75	10	750	4	3	2	3	4	8.18	3.75	281	3,283	3,564	6,074	8,892
	BS-2	160	10	1,600	4	3	2	3	4	8.18	3.75	600	7,003	7,603		
	BS-3	100	5	500	4	1	2	1	4	3.03	0.31	31	1,621	1,652		
	BS-4	130	5	650	4	1	2	1	4	3.03	0.31	41	2,107	2,148		
			Sub-total:	3,500								953	14,013	14,966		

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Volume Stored in BioSwale (ft3)	Volume percolated within 48 hours (ft3)	Total Volume Stored & Percolated (ft3)	50-year Storage Required (ft3)	Net Volume (ft^3)
62	BS-1	110	10	1,100	4	3	2	3	4	8.18	3.75	413	4,815	5,227	2,315	6,951
	BS-2	85	10	850	4	3	2	3	4	8.18	3.75	319	3,720	4,039		
			Sub-total:	1,950								731	8,535	9,266		

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Volume Stored in BioSwale (ft3)	Volume percolated within 48 hours (ft3)	Total Volume Stored & Percolated (ft3)	50-year Storage Required (ft3)	Net Volume (ft^3)
63	BS-1	135	10	1,350	4	3	2	3	4	8.18	3.75	506	5,909	6,415	3,067	11,426
	BS-2	70	10	700	4	3	2	3	4	8.18	3.75	263	3,064	3,326		
	BS-3	100	10	1,000	4	3	2	3	4	8.18	3.75	375	4,377	4,752		
			Sub-total:	3,050								1,144	13,349	14,493		

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Volume Stored in BioSwale (ft3)	Volume percolated within 48 hours (ft3)	Total Volume Stored & Percolated (ft3)	50-year Storage Required (ft3)	Net Volume (ft^3)
64	BS-1	65	10	650	4	3	2	3	4	8.18	3.75	244	2,845	3,089	1,985	11,083
	BS-2	60	10	600	4	3	2	3	4	8.18	3.75	225	2,626	2,851		
	BS-3	55	10	550	4	3	2	3	4	8.18	3.75	206	2,407	2,614		
	BS-4	50	10	500	4	3	2	3	4	8.18	3.75	188	2,188	2,376		
	BS-5	45	10	450	4	3	2	3	4	8.18	3.75	169	1,970	2,138		
			Sub-total:	450								1,031	12,036	13,068		
			Grand Total:	195,100 ft^2 =							Grand Totals (ft^3):	134,398	942,618	1,077,016	298,306	778,710

Average depth of Bio-Swale = Total BioSwale Volume / Total BioSwale Area

Average depth of Bio-Swale = 134398 ft^3 / ft^2 195100 = 0.69 feet

Proposed Bio-Swale Quantity in cubic feet = 134398 ft^3 / 27 ft^3 per cy = 4,978 cy

Say Bio-Swale Quantity in cubic yard = 5,000 cy

TABLE 7: STORAGE AND PERCOLATION CALCS FOR EACH DMA

TIME TO PERCOLATE AND STORE A 50-YEAR, 24-HOUR DESIGN STORM

Empire Storm Water Low Impact Master Plan Study

Storm Water Design Summary for All Drainage Management Areas

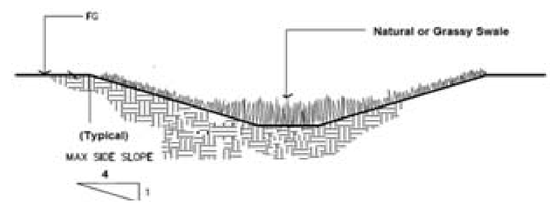
Designed by: Paul Saini & Lester Stachura

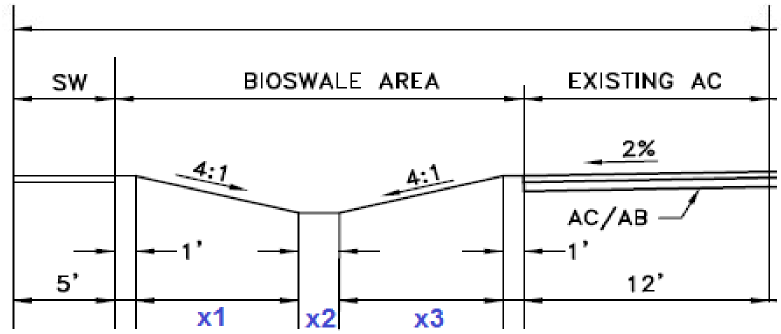
R = Intensity = R_{design} x M.A.P./10.9" where M.A.P. = 11.5"

V = CAR / 12

Therefore, use following intensities and assumed perc rate for the design storms shown below:

	Intensity (inch)	R = (Intensity x MAP/10.9)	Notes
R_{50} =	2.88	3.04	inches for a 50-year, 24 hour deign storm (storage)
Perc =	20	Percolation rate in gallons/sf-day assumed based on attached reference	
		179.52	-8.976





Amount of water that can percolate within 2 days (48 hours) assuming 20 gallons/sq-ft/day rate:

V_{perc} = [Bioswale Surface Area x Perc Rate in gallons/sf-day x 2 days] / 7.48 gallons/ft^3

V_{perc} = [Wetted Perimeter x length x 20 gallons/sf-day x 2 days] / 7.48 gallons/ft^3

V_{perc} = Percolated volume measured in ft^3

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Available Volume in BioSwale (ft3)	50-year Storage Required (ft3)	Difference in Volume (ft^3)	Time to percolate Volume Difference (hours)
1	BS-1	85	20	1,700	4	8	2	8	4	18.49	20.00	1,700	6,928	(3,528)	9.31
	BS-2	85	20	1,700	4	8	2	8	4	18.49	20.00	1,700			
			Sub-total:	3,400								3,400			

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Available Volume in BioSwale (ft3)	50-year Storage Required (ft3)	Difference in Volume (ft^3)	Time to percolate Volume Difference (hours)
2	BS-1	110	10	1,100	4	3	2	3	4	8.18	3.75	413	29,540	(23,127)	22.81
	BS-2	65	10	650	4	3	2	3	4	8.18	3.75	244			
	BS-3	110	20	2,200	4	8	2	8	4	18.49	20.00	2,200			
	BS-4	135	10	1,350	4	3	2	3	4	8.18	3.75	506			
	BS-5	70	20	1,400	4	8	2	8	4	18.49	20.00	1,400			
	BS-6	100	15	1,500	4	6	2	6	4	13.34	10.31	1,031			
	BS-7	60	15	900	4	6	2	6	4	13.34	10.31	619			
			Sub-total:	9,100								6,413			

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Available Volume in BioSwale (ft3)	50-year Storage Required (ft3)	Difference in Volume (ft^3)	Time to percolate Volume Difference (hours)
3	BS-1	185	10	1,850	4	3	2	3	4	8.18	3.75	694	9,526	(5,223)	41.67
	BS-2	190	15	2,850	4	6	2	6	4	13.34	10.31	1,959			
	BS-3	40	15	600	4	6	2	6	4	13.34	10.31	413			
	BS-4	45	15	675	4	6	2	6	4	13.34	10.31	464			
	BS-5	75	15	1,125	4	6	2	6	4	13.34	10.31	773			
			Sub-total:	1,125								4,303			

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Available Volume in BioSwale (ft3)	50-year Storage Required (ft3)	Difference in Volume (ft^3)	Time to percolate Volume Difference (hours)
9	BS-1	170	10	1,700	4	3	2	3	4	8.18	3.75	638	1,669	(1,031)	5.45
			Sub-total:	1,700								638			

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Available Volume in BioSwale (ft3)	50-year Storage Required (ft3)	Difference in Volume (ft^3)	Time to percolate Volume Difference (hours)
10	BS-1	70	10	700	4	3	2	3	4	8.18	3.75	263	6,206	(5,287)	19.37
	BS-2	135	10	1,350	4	3	2	3	4	8.18	3.75	506			
	BS-3	40	10	400	4	3	2	3	4	8.18	3.75	150			
			Sub-total:	2,450								919			

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Available Volume in BioSwale (ft3)	50-year Storage Required (ft3)	Difference in Volume (ft^3)	Time to percolate Volume Difference (hours)
11	BS-1	155	10	1,550	4	3	2	3	4	8.18	3.75	581	11,437	(6,809)	9.33
	BS-2	55	10	550	4	3	2	3	4	8.18	3.75	206			
	BS-3	130	15	1,950	4	6	2	6	4	13.34	10.31	1,341			
	BS-4	125	20	2,500	4	8	2	8	4	18.49	20.00	2,500			
			Sub-total:	6,550								4,628			

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Available Volume in BioSwale (ft3)	50-year Storage Required (ft3)	Difference in Volume (ft^3)	Time to percolate Volume Difference (hours)
12	BS-1	125	10	1,250	4	3	2	3	4	8.18	3.75	469	16,466	(11,738)	11.51
	BS-2	85	10	850	4	3	2	3	4	8.18	3.75	319			
	BS-3	80	10	800	4	3	2	3	4	8.18	3.75	300			
	BS-4	45	10	450	4	3	2	3	4	8.18	3.75	169			
	BS-5	150	10	1,500	4	3	2	3	4	8.18	3.75	563			
	BS-6	90	10	900	4	3	2	3	4	8.18	3.75	338			
	BS-7	65	10	650	4	3	2	3	4	8.18	3.75	244			
	BS-8	90	15	1,350	4	6	2	6	4	13.34	10.31	928			
	BS-9	70	20	1,400	4	8	2	8	4	18.49	20.00	1,400			
			Sub-total:	9,150								4,728			

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Available Volume in BioSwale (ft3)	50-year Storage Required (ft3)	Difference in Volume (ft^3)	Time to percolate Volume Difference (hours)
13	BS-1	75	10	750	4	3	2	3	4	8.18	3.75	281	14,864	(5,690)	4.16
	BS-2	70	10	700	4	3	2	3	4	8.18	3.75	263			
	BS-3	120	10	1,200	4	3	2	3	4	8.18	3.75	450			
	BS-4	120	10	1,200	4	3	2	3	4	8.18	3.75	450			
	BS-5	70	10	700	4	3	2	3	4	8.18	3.75	263			
	BS-6	75	25	1,875	4	11	2	11	4	23.65	32.81	2,461			
	BS-7	50	25	1,250	4	11	2	11	4	23.65	32.81	1,641			
	BS-8	70	25	1,750	4	11	2	11	4	23.65	32.81	2,297			
	BS-9	105	10	1,050	4	3	2	3	4	8.18	3.75	394			
	BS-10	50	10	500	4	3	2	3	4	8.18	3.75	188			
	BS-11	65	10	650	4	3	2	3	4	8.18	3.75	244			
	BS-12	65	10	650	4	3	2	3	4	8.18	3.75	244			
			Sub-total:	12,275								9,173			

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Available Volume in BioSwale (ft3)	50-year Storage Required (ft3)	Difference in Volume (ft^3)	Time to percolate Volume Difference (hours)
14	BS-1	150	15	2,250	4	6	2	6	4	13.34	10.31	1,547	11,526	(2,251)	1.85
	BS-2	90	15	1,350	4	6	2	6	4	13.34	10.31	928			
	BS-3	170	20	3,400	4	8	2	8	4	18.49	20.00	3,400			
	BS-4	155	20	3,100	4	8	2	8	4	18.49	20.00	3,100			
	BS-5	80	10	800	4	3	2	3	4	8.18	3.75	300			
			Sub-total:	10,900								9,275			

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Available Volume in BioSwale (ft3)	50-year Storage Required (ft3)	Difference in Volume (ft^3)	Time to percolate Volume Difference (hours)
15	BS-1	70	15	1,050	4	6	2	6	4	13.34	10.31	722	14,997	(8,477)	6.87
	BS-2	70	15	1,050	4	6	2	6	4	13.34	10.31	722			
	BS-3	60	10	600	4	3	2	3	4	8.18	3.75	225			
	BS-4	65	10	650	4	3	2	3	4	8.18	3.75	244			
	BS-5	60	10	600	4	3	2	3	4	8.18	3.75	225			
	BS-6	70	10	700	4	3	2	3	4	8.18	3.75	263			
	BS-7	75	15	1,125	4	6	2	6	4	13.34	10.31	773			
	BS-8	95	10	950	4	3	2	3	4	8.18	3.75	356			
	BS-9	150	15	2,250	4	6	2	6	4	13.34	10.31	1,547			
	BS-10	140	15	2,100	4	6	2	6	4	13.34	10.31	1,444			
			Sub-total:	11,075								6,520			

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Available Volume in BioSwale (ft3)	50-year Storage Required (ft3)	Difference in Volume (ft^3)	Time to percolate Volume Difference (hours)
16	BS-1	140	10	1,400	4	3	2	3	4	8.18	3.75	525	15,309	2,504	(1.40)
	BS-2	80	10	800	4	3	2	3	4	8.18	3.75	300			
	BS-3	65	15	975	4	6	2	6	4	13.34	10.31	670			
	BS-4	40	15	600	4	6	2	6	4	13.34	10.31	413			
	BS-5	55	15	825	4	6	2	6	4	13.34	10.31	567			
	BS-6	165	10	1,650	4	3	2	3	4	8.18	3.75	619			
	BS-7	90	10	900	4	3	2	3	4	8.18	3.75	338			
	BS-8	150	30	4,500	4	13	2	13	4	28.80	48.75	7,313			
	BS-9	145	30	4,350	4	13	2	13	4	28.80	48.75	7,069			
			Sub-total:	16,000								17,813			

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Available Volume in BioSwale (ft3)	50-year Storage Required (ft3)	Difference in Volume (ft^3)	Time to percolate Volume Difference (hours)
17	BS-1	85	20	1,700	4	8	2	8	4	18.49	20.00	1,700	7,476	(4,075)	8.24
	BS-2	115	15	1,725	4	6	2	6	4	13.34	10.31	1,186			
	BS-3	50	15	750	4	6	2	6	4	13.34	10.31	516			
			Sub-total:	4,175								3,402			

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Available Volume in BioSwale (ft3)	50-year Storage Required (ft3)	Difference in Volume (ft^3)	Time to percolate Volume Difference (hours)
18	BS-1	115	15	1,725	4	6	2	6	4	13.34	10.31	1,186	15,175	(8,678)	8.24
	BS-2	85	15	1,275	4	6	2	6	4	13.34	10.31	877			
	BS-3	75	15	1,125	4	6	2	6	4	13.34	10.31	773			
	BS-4	120	15	1,800	4	6	2	6	4	13.34	10.31	1,238			
	BS-5	135	15	2,025	4	6	2	6	4	13.34	10.31	1,392			
	BS-6	100	15	1,500	4	6	2	6	4	13.34	10.31	1,031			
			Sub-total:	9,450								6,497			

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Available Volume in BioSwale (ft3)	50-year Storage Required (ft3)	Difference in Volume (ft^3)	Time to percolate Volume Difference (hours)
19	BS-1	85	10	850	4	3	2	3	4	8.18	3.75	319	11,437	(9,449)	16.00
	BS-2	125	10	1,250	4	3	2	3	4	8.18	3.75	469			
	BS-3	65	10	650	4	3	2	3	4	8.18	3.75	244			
	BS-4	155	10	1,550	4	3	2	3	4	8.18	3.75	581			
	BS-5	100	10	1,000	4	3	2	3	4	8.18	3.75	375			
			Sub-total:	5,300								1,988			

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Available Volume in BioSwale (ft3)	50-year Storage Required (ft3)	Difference in Volume (ft^3)	Time to percolate Volume Difference (hours)
26	BS-1	50	15	750	4	6	2	6	4	13.34	10.31	516	11,214	(8,768)	18.96
	BS-2	80	10	800	4	3	2	3	4	8.18	3.75	300			
	BS-3	50	10	500	4	3	2	3	4	8.18	3.75	188			
	BS-4	140	15	2,100	4	6	2	6	4	13.34	10.31	1,444			
			Sub-total:	4,150								2,447			

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Available Volume in BioSwale (ft3)	50-year Storage Required (ft3)	Difference in Volume (ft^3)	Time to percolate Volume Difference (hours)
29	BS-1	50	10	500	4	3	2	3	4	8.18	3.75	188	5,157	(4,745)	38.72
	BS-2	60	10	600	4	3	2	3	4	8.18	3.75	225			
			Sub-total:	1,100								413			

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Available Volume in BioSwale (ft3)	50-year Storage Required (ft3)	Difference in Volume (ft^3)	Time to percolate Volume Difference (hours)
38	BS-1	315	20	6,300	4	8	2	8	4	18.49	20.00	6,300	8,989	(1,358)	1.24
	BS-2	140	10	1,400	4	3	2	3	4	8.18	3.75	525			
	BS-3	70	10	700	4	3	2	3	4	8.18	3.75	263			
	BS-4	70	10	700	4	3	2	3	4	8.18	3.75	263			
	BS-5	75	10	750	4	3	2	3	4	8.18	3.75	281			
			Sub-total:	9,850								7,631			

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Available Volume in BioSwale (ft3)	50-year Storage Required (ft3)	Difference in Volume (ft^3)	Time to percolate Volume Difference (hours)
29	BS-1	400	15	6,000	4	6	2	6	4	13.34	10.31	4,125	5,157	969	(0.87)
	BS-2	105	15	1,575	4	6	2	6	4	13.34	10.31	1,083			
	BS-3	55	10	550	4	3	2	3	4	8.18	3.75	206			
	BS-4	30	10	300	4	3	2	3	4	8.18	3.75	113			
	BS-5	50	10	500	4	3	2	3	4	8.18	3.75	188			
	BS-6	50	10	500	4	3	2	3	4	8.18	3.75	188			
	BS-7	60	10	600	4	3	2	3	4	8.18	3.75	225			
			Sub-total:	10,025								6,127			

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Available Volume in BioSwale (ft3)	50-year Storage Required (ft3)	Difference in Volume (ft^3)	Time to percolate Volume Difference (hours)
38	BS-1	315	20	6,300	4	8	2	8	4	18.49	20.00	6,300	8,989	(1,358)	1.24
	BS-2	140	10	1,400	4	3	2	3	4	8.18	3.75	525			
	BS-3	70	10	700	4	3	2	3	4	8.18	3.75	263			
	BS-4	70	10	700	4	3	2	3	4	8.18	3.75	263			
	BS-5	75	10	750	4	3	2	3	4	8.18	3.75	281			
			Sub-total:	9,850								7,631			

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Available Volume in BioSwale (ft3)	50-year Storage Required (ft3)	Difference in Volume (ft^3)	Time to percolate Volume Difference (hours)
39	BS-1	400	15	6,000	4	6	2	6	4	13.34	10.31	4,125	7,298	(750)	0.71
	BS-2	105	15	1,575	4	6	2	6	4	13.34	10.31	1,083			
	BS-3	130	15	1,950	4	6	2	6	4	13.34	10.31	1,341			
			Sub-total:	9,525								6,548			

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Available Volume in BioSwale (ft3)	50-year Storage Required (ft3)	Difference in Volume (ft^3)	Time to percolate Volume Difference (hours)
40	BS-1	95	15	1,425	4	6	2	6	4	13.34	10.31	980	8,455	(5,877)	14.07
	BS-2	90	15	1,350	4	6	2	6	4	13.34	10.31	928			
	BS-3	65	15	975	4	6	2	6	4	13.34	10.31	670			
			Sub-total:	3,750								2,578			

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Available Volume in BioSwale (ft3)	50-year Storage Required (ft3)	Difference in Volume (ft^3)	Time to percolate Volume Difference (hours)
41	BS-1	85	10	850	4	3	2	3	4	8.18	3.75	319	6,052	(4,815)	13.10
	BS-2	85	10	850	4	3	2	3	4	8.18	3.75	319			
	BS-3	70	10	700	4	3	2	3	4	8.18	3.75	263			
	BS-4	90	10	900	4	3	2	3	4	8.18	3.75	338			
			Sub-total:	3,300								1,238			

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Available Volume in BioSwale (ft3)	50-year Storage Required (ft3)	Difference in Volume (ft^3)	Time to percolate Volume Difference (hours)
42	BS-1	80	15	1,200	4	6	2	6	4	13.34	10.31	825	6,408	(4,861)	19.39
	BS-2	70	15	1,050	4	6	2	6	4	13.34	10.31	722			
			Sub-total:	2,250								1,547			

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Available Volume in BioSwale (ft3)	50-year Storage Required (ft3)	Difference in Volume (ft^3)	Time to percolate Volume Difference (hours)
47	BS-1	140	15	2,100	4	6	2	6	4	13.34	10.31	1,444	4,584	(1,799)	3.99
	BS-2	130	15	1,950	4	6	2	6	4	13.34	10.31	1,341			
			Sub-total:	4,050								2,784			

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Available Volume in BioSwale (ft3)	50-year Storage Required (ft3)	Difference in Volume (ft^3)	Time to percolate Volume Difference (hours)
48	BS-1	55	15	825	4	6	2	6	4	13.34	10.31	567	8,233	(5,242)	10.82
	BS-2	95	15	1,425	4	6	2	6	4	13.34	10.31	980			
	BS-3	85	15	1,275	4	6	2	6	4	13.34	10.31	877			
	BS-4	55	15	825	4	6	2	6	4	13.34	10.31	567			
			Sub-total:	4,350								2,991			

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Available Volume in BioSwale (ft3)	50-year Storage Required (ft3)	Difference in Volume (ft^3)	Time to percolate Volume Difference (hours)
49	BS-1	50	15	750	4	6	2	6	4	13.34	10.31	516	4,139	(2,325)	5.92
	BS-2	55	15	825	4	6	2	6	4	13.34	10.31	567			
	BS-3	115	10	1,150	4	3	2	3	4	8.18	3.75	431			
	BS-4	80	10	800	4	3	2	3	4	8.18	3.75	300			
			Sub-total:	3,525								1,814			

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Available Volume in BioSwale (ft3)	50-year Storage Required (ft3)	Difference in Volume (ft^3)	Time to percolate Volume Difference (hours)
50	BS-1	75	15	1,125	4	6	2	6	4	13.34	10.31	773	8,144	(5,256)	11.23
	BS-2	95	15	1,425	4	6	2	6	4	13.34	10.31	980			
	BS-3	110	15	1,650	4	6	2	6	4	13.34	10.31	1,134			
			Sub-total:	4,200								2,888			

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Available Volume in BioSwale (ft3)	50-year Storage Required (ft3)	Difference in Volume (ft^3)	Time to percolate Volume Difference (hours)
52	BS-1	95	10	950	4	3	2	3	4	8.18	3.75	356	5,107	(4,207)	15.74
	BS-2	75	10	750	4	3	2	3	4	8.18	3.75	281			
	BS-3	70	10	700	4	3	2	3	4	8.18	3.75	263			
			Sub-total:	2,400								900			

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Available Volume in BioSwale (ft3)	50-year Storage Required (ft3)	Difference in Volume (ft^3)	Time to percolate Volume Difference (hours)
54	BS-1	105	10	1,050	4	3	2	3	4	8.18	3.75	394	3,599	(2,699)	10.10
	BS-2	135	10	1,350	4	3	2	3	4	8.18	3.75	506			
			Sub-total:	2,400							Sub-total:	900			

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Available Volume in BioSwale (ft3)	50-year Storage Required (ft3)	Difference in Volume (ft^3)	Time to percolate Volume Difference (hours)
57	BS-1	80	10	800	4	3	2	3	4	8.18	3.75	300	3,536	(2,674)	10.43
	BS-2	80	10	800	4	3	2	3	4	8.18	3.75	300			
	BS-3	70	10	700	4	3	2	3	4	8.18	3.75	263			
			Sub-total:	2,300								863			

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Available Volume in BioSwale (ft3)	50-year Storage Required (ft3)	Difference in Volume (ft^3)	Time to percolate Volume Difference (hours)
58	BS-1	120	5	600	4	1	2	1	4	3.03	0.31	38	4,931	(3,447)	5.63
	BS-2	160	5	800	4	1	2	1	4	3.03	0.31	50			
	BS-3	90	5	450	4	1	2	1	4	3.03	0.31	28			
	BS-4	175	10	1,750	4	3	2	3	4	8.18	3.75	656			
	BS-5	100	10	1,000	4	3	2	3	4	8.18	3.75	375			
	BS-6	90	10	900	4	3	2	3	4	8.18	3.75	338			
			Sub-total:	5,500								1,484			

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^2/ft)	Available Volume in BioSwale (ft3)	50-year Storage Required (ft3)	Difference in Volume (ft^3)	Time to percolate Volume Difference (hours)
59	BS-1	50	5	250	4	1	2	1	4	3.03	0.31	16	2,315	(2,254)	20.75
	BS-2	145	5	725	4	1	2	1	4	3.03	0.31	45			
			Sub-total:	975								61			

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^{2}/ft)	Available Volume in BioSwale (ft3)	50-year Storage Required (ft3)	Difference in Volume (ft^3)	Time to percolate Volume Difference (hours)
60	BS-1	75	10	750	4	3	2	3	4	8.18	3.75	281	6,074	(5,121)	13.13
	BS-2	160	10	1,600	4	3	2	3	4	8.18	3.75	600			
	BS-3	100	5	500	4	1	2	1	4	3.03	0.31	31			
	BS-4	130	5	650	4	1	2	1	4	3.03	0.31	41			
			Sub-total:	3,500								953			

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^{2}/ft)	Available Volume in BioSwale (ft3)	50-year Storage Required (ft3)	Difference in Volume (ft^3)	Time to percolate Volume Difference (hours)
62	BS-1	110	10	1,100	4	3	2	3	4	8.18	3.75	413	2,315	(1,584)	7.29
	BS-2	85	10	850	4	3	2	3	4	8.18	3.75	319			
			Sub-total:	1,950								731			

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^{2}/ft)	Available Volume in BioSwale (ft3)	50-year Storage Required (ft3)	Difference in Volume (ft^3)	Time to percolate Volume Difference (hours)
63	BS-1	135	10	1,350	4	3	2	3	4	8.18	3.75	506	3,067	(1,923)	5.66
	BS-2	70	10	700	4	3	2	3	4	8.18	3.75	263			
	BS-3	100	10	1,000	4	3	2	3	4	8.18	3.75	375			
			Sub-total:	3,050								1,144			

Watershed Number	Bio-Swale No.	Bio-Swale Length (ft)	Bio-Swale Width (ft)	Bio-Swale Area (ft^2)	Slope (L)	x1 (ft)	x2 (ft)	x3 (ft)	Slope (R)	Wetted Perimeter	Area of Flow per foot (ft^{2}/ft)	Available Volume in BioSwale (ft3)	50-year Storage Required (ft3)	Difference in Volume (ft^3)	Time to percolate Volume Difference (hours)
64	BS-1	65	10	650	4	3	2	3	4	8.18	3.75	244	1,985	(953)	19.01
	BS-2	60	10	600	4	3	2	3	4	8.18	3.75	225			
	BS-3	55	10	550	4	3	2	3	4	8.18	3.75	206			
	BS-4	50	10	500	4	3	2	3	4	8.18	3.75	188			
	BS-5	45	10	450	4	3	2	3	4	8.18	3.75	169			
			Sub-total:	450								1,031			

Grand Total: 195,100 ft^2 =

Grand Totals (ft^3): 134,398 298,306 (163,908)

Average depth of Bio-Swale = Total BioSwale Volume / Total BioSwale Area

Average depth of Bio-Swale = 134398 ft^3 / ft^2 195100 = 0.69 feet

Proposed Bio-Swale Quantity in cubic feet = 134398 ft^3 / 27 ft^3 per cy = 4,978 cy

Say Bio-Swale Quantity in cubic yard = 5,000 cy

EMPIRE STORM DRAIN WATERSHED INFORMATION

CALWATER WATERSHED

Hydrologic Unit	SAN JOAQUIN VALLEY FLOOR
Hydrologic Area	Riverbank
Latitude, Longitude	37.6414, -120.8923
Project Area (acres)	195 acres
Planning Area	Hickman, California

WATERSHED BOUNDARY DATASET

Watershed	Peaslee Creek-Tuolumne River	**Subwatershed**	Salter Gulch-Tuolumne River	**Hydrologic Unit Code**	180400091402
Average Annual Precipitation (inches)	12.74 inches				

Water Quality Objectives

The following waterbodies are in or near the Hickman, California project site.

Waterbody Name	Beneficial Uses	Sediment-Sensitive Waterbody
Stanislaus River - Goodwin Dam to San Joaquin River	AGR, COLD, IND, MIGR, MUN, POW, PROC, REC1, REC2, SPWN, WARM, WILD	Yes
Tuolumne River - New Don Pedro Dam to San Joaquin River	AGR, COLD, MIGR, MUN, POW, REC2, SPWN, WARM, WILD	Yes

TMDLS: Listing a water body as impaired in California is governed by the Water Quality Control Policy for developing California's Clean Water Act Section 303(d) Listing Policy. The State and Regional Water Boards assess water quality data for California's waters every two years to determine if they contain pollutants at levels that exceed protective water quality criteria and standards. This biennial assessment is required under Section 303(d) of the Federal Clean Water Act.

TMDLs & 303(d) Listed Water Bodies (2010 List)

Key: Water body on 303(d) list | Water body with a TMDL

Name	Pollutant	Size	Status
Dry Creek (tributary to Tuolumne River at Modesto, E Stanislaus County)	Chlorpyrifos	34 Miles	TMDL required
Dry Creek (tributary to Tuolumne River at Modesto, E Stanislaus County)	Diazinon	34 Miles	TMDL required
Dry Creek (tributary to Tuolumne River at Modesto, E Stanislaus County)	Escherichia coli (E. coli)	34 Miles	TMDL required
Dry Creek (tributary to Tuolumne River at Modesto, E Stanislaus County)	Unknown Toxicity	34 Miles	TMDL required
San Joaquin River (Tuolumne River to Stanislaus River)	Electrical Conductivity	8.4 Miles	TMDL required
San Joaquin River (Tuolumne River to Stanislaus River)	Group A Pesticides	8.4 Miles	TMDL required
San Joaquin River (Tuolumne River to Stanislaus River)	Mercury	8.4 Miles	TMDL required
San Joaquin River (Tuolumne River to Stanislaus River)	Temperature, water	8.4 Miles	TMDL required
San Joaquin River (Tuolumne River to Stanislaus River)	Unknown Toxicity	8.4 Miles	TMDL required
Stanislaus River, Lower	Chlorpyrifos	59.02 Miles	TMDL required
Stanislaus River, Lower	Diazinon	59.02 Miles	TMDL required
Stanislaus River, Lower	Group A Pesticides	59.02 Miles	TMDL required
Stanislaus River, Lower	Mercury	59.02 Miles	TMDL required
Stanislaus River, Lower	Temperature, water	59.02 Miles	TMDL required
Stanislaus River, Lower	Unknown Toxicity	59.02 Miles	TMDL required
Tuolumne River, Lower (Don Pedro Reservoir to San Joaquin River)	Chlorpyrifos	60 Miles	TMDL required
Tuolumne River, Lower (Don Pedro Reservoir to San Joaquin River)	Diazinon	60 Miles	TMDL required
Tuolumne River, Lower (Don Pedro Reservoir to San Joaquin River)	Group A Pesticides	60 Miles	TMDL required
Tuolumne River, Lower (Don Pedro Reservoir to San Joaquin River)	Mercury	60 Miles	TMDL required
Tuolumne River, Lower (Don Pedro Reservoir to San Joaquin River)	Temperature, water	60 Miles	TMDL required
Tuolumne River, Lower (Don Pedro Reservoir to San Joaquin River)	Unknown Toxicity	60 Miles	TMDL required

*

Summary of Primary LID Volume Reduction Controls

Control	Function		Disconnection Application	
	Volume Reduction	Treatment	Rooftop	Pavement
Volume Reduction Measures (Section 5)				
Rain Garden (V-1)	Primary	Secondary	X	X
Rain Barrel/Cistern (V-2)	Primary	Secondary	X	
Vegetated Roof (V-3)	Primary	Secondary	X	
Interception Trees (V-4)	Primary	Secondary		X
Grassy Channel (V-5)	Primary	Secondary	X	X
Vegetated Buffer Strip (V-6)*	Primary	Secondary	X	X

*Disconnected rooftops (rooftops allowed to drain to lawn as opposed to impervious area) should utilize the Vegetated Buffer Strip (V-6) in order to receive credit towards Volume Reduction Requirement.

Summary of Primary LID Storm Water Treatment Controls

Control	Function		Disconnection Application	
	Volume Reduction	Treatment	Rooftop	Pavement
LID Treatment Controls (Section 6)				
Bioretention (L-1)	Secondary	Primary	X	X
Storm Water Planter (L-2)	Secondary	Primary	X	X
Tree-well Filter (L-3)	Secondary	Primary		X
Infiltration Basin (L-4)	Secondary	Primary	X	X
Infiltration Trench/Dry Well (L-5)	Secondary	Primary	X	X
Porous Pavement Filter (L-6)	Secondary	Primary		X
Vegetated (Dry) Swale (L-7)	Secondary	Primary	X	X
Grassy Swale (L-8)	Secondary	Primary	X	X
Grassy Filter Strip (L-9)	Secondary	Primary	X	X
Infiltration Vertical Drain / Vertical Drywell (L-10)	Secondary		X	X
Rooftop Storage Chamber (L-11)	Primary	Secondary	X	X

Note: Conventional Treatment Controls such as extended detention basins, wet ponds, and proprietary control measures are generally considered ***not*** to provide volume reduction or treatment benefits.

Legend: Highlighted BMPs in green shown above were considered in this study. All other BMPs were considered not applicable or recommended for this study.

*

BMP Pollutant Removal Efficiency

Different pollutants tend to be present in runoff depending on the land use. The table below provides general guidance as to which pollutants may be expected in higher concentrations, as well as the typical ability for different BMPs to remove the pollutants.

		Target Pollutant				
		Sediment	Nutrients	Metals	Bacteria	Oil & Grease
Land Use	Agriculture	*	*		*	
	Commercial	*		*		*
	Residential	*				
	Industrial	*		*		*
	Parks	*				
	Vacant/Open Areas	*	*			
	Roads & Parking Lots	*		*		*

		Pollutant Removal Efficiency				
		Sediment	Nutrients	Metals	Bacteria	Oil & Grease
Best Management Practice	Underground Infiltration[1]	M	H	H	H	H
	Bioretention Area[2]	H	M	M	H	H
	Vegetated Swale	M	L	M	L	M
	Filter Strip	H	L	H	L	M
	Vegetated Basin	M	L	M	M	M
	Constructed Wetland	H	M	H	H	H
	Permeable Pavement [1]	H	H	M	M	M
	Rainwater Harvesting [3]	H	H	H	H	H
	Green Roof [4]	H	H	H	H	H

Key to Symbols: H High M Medium L Low

1 If underground infiltration and permeable pavement are unable to drain by infiltration, removal efficiency for all constituents is low.

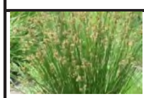
2 Assumes that bioretention area is drained by underdrains. If able to discharge via infiltration, efficiency will be increased.

3 Rainwater harvesting effectively removes all pollutants from runoff since the water quality volume is never released downstream.

4 Green roofs receive runoff which has not yet encountered pollutants, and eliminate the addition of pollutants typically found on roofs.

Recommended Plant List

The species listed below are intended to serve as a general guide for identifying plants within Central California climate zones that are most likely to be suitable for use in each specific Drainage Management Area (DMA). This list has been compiled of largely California native species and augmented with California friendly species to promote species diversity while avoiding monoculture. The list has been organized and reduced to group classification consisting of the form shrub, grass, and perennial. These plant forms require Low, Very Low, or Medium Irrigation needs that likely to be compatible with the hydrozones found within each Drainage Management Areas (DMA).

Photo	Common Name	Latin Name	Form	Light Level	Irrigation Need	Height/ Spread
	California Encelia [(1)]	*Encelia californica*	Shrub	Sunny	Very Low	3'-5' / 3'-5'
	Blue Eyed Grass[(2)]	*Sisyrichium bellum*	Grass	Sunny	Very Low	6"-18"
	Fourwing Saltbush[(2)]	*Atriplex canescens*	Shrub	Sunny	Very Low	4'-5'
	Pacific Reed Grass[(3)]	*Calamagrostis*	Grass	Sunny	Low	2' / 2'-3'
	Cardinal Flower[(3)]	*Lobelia cardinalis*	Perennial	Sunny	Medium	1'-6' / 1'-3'
	Scarlet Monkey[(3)]	*Mimulus cardinalis*	Perennial	Sunny	Medium	3' / 2'
	Soft Rush[(3)]	*Juncus effuses*	Grass	Sunny	Medium	2'-3' / 2'-3'
	Grape Soda Lupine	*Lupinus excubitus*	Shrub	Sunny	Very Low	3' / 4'
	Lyme Grass	*Leymus arenarius*	Grass	Sunny	Very low	4'-5' / clumping
	Wild Rye	*Leymus condensatus*	Grass	Sunny	Very Low	2'-3' / 2'-3'

NOTES:

[(1)] Prefer upland / suitable for slope stability
[(2)] Suitable for short periods of inundation (24-48 hours)
[(3)] Suitable for long periods of inundation or permanent shallow water (Certain plants which prefer very wet environments will generally be suitable for use in locations which experience only short periods of inundation. Of the plants listed above, this would include Cardinal Flower, Pacific Reed Grass, and Scarlet Monkey Flower).

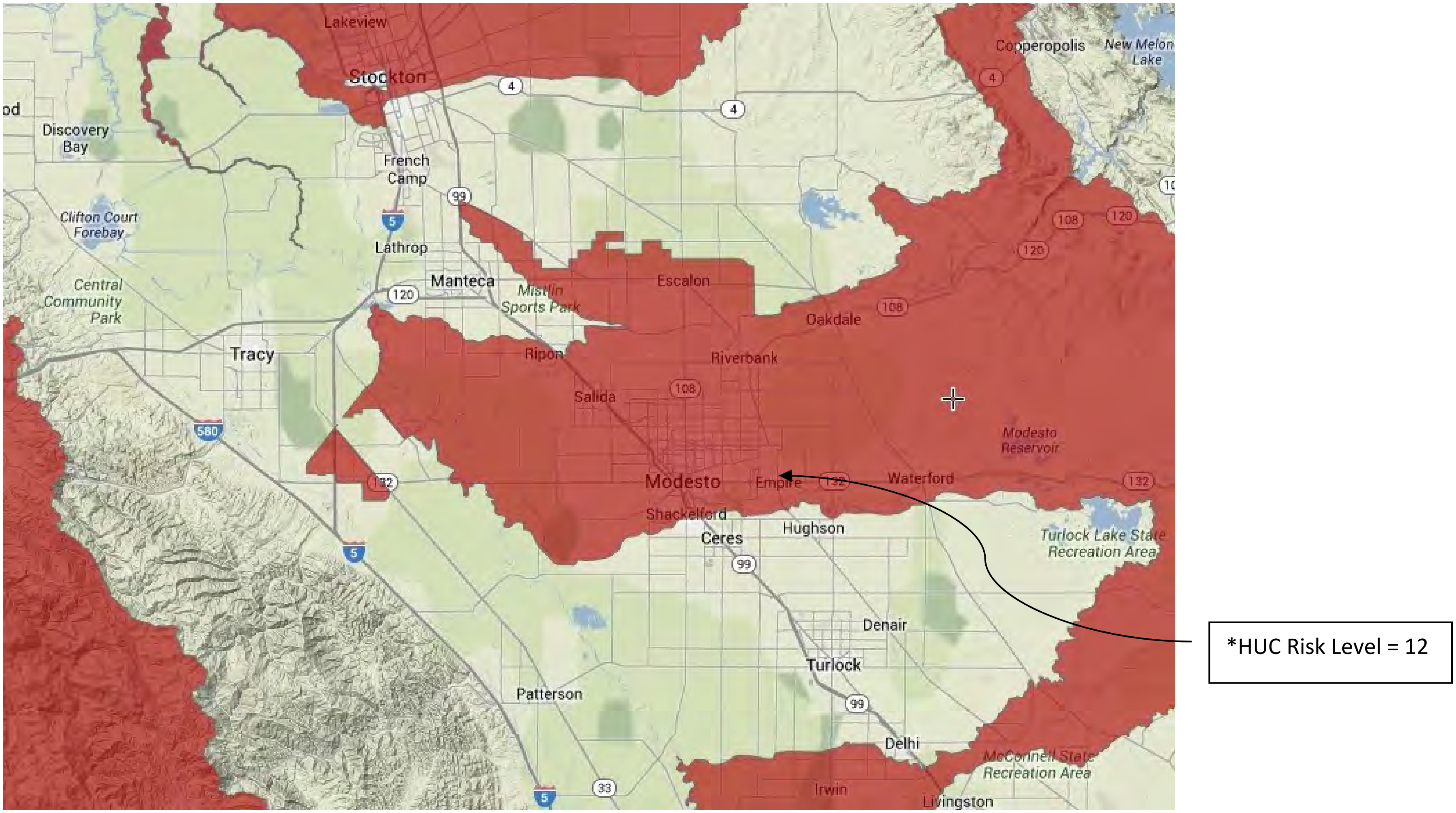
Erosivity Index Zone: 23

Erosivity Index Table

Date	Erosivity Index Percent	Date	Erosivity Index Percent
Jan 1	0	Jul 14	49.9
Jan 16	7.9	Jul 29	50.7
Feb 15	20.9	Aug 13	51.8
Mar 1	25.7	Aug 28	54.1
Mar 16	31.1	Sep 12	57.7
Mar 31	35.7	Sep 27	62.8
Apr 15	40.2	Oct 12	65.9
May 15	46.2	Oct 27	70.1
May 30	47.7	Nov 11	77.3
Jun 14	48.8	Nov 26	86.8
Jun 29	49.4	Dec 11	93.5
		Dec 31	100

The USDA developed the Erosivity Index Table to show how the annual erosivity factor (R Factor) is distributed throughout the year in two-week increments.

Erosivity Index Map

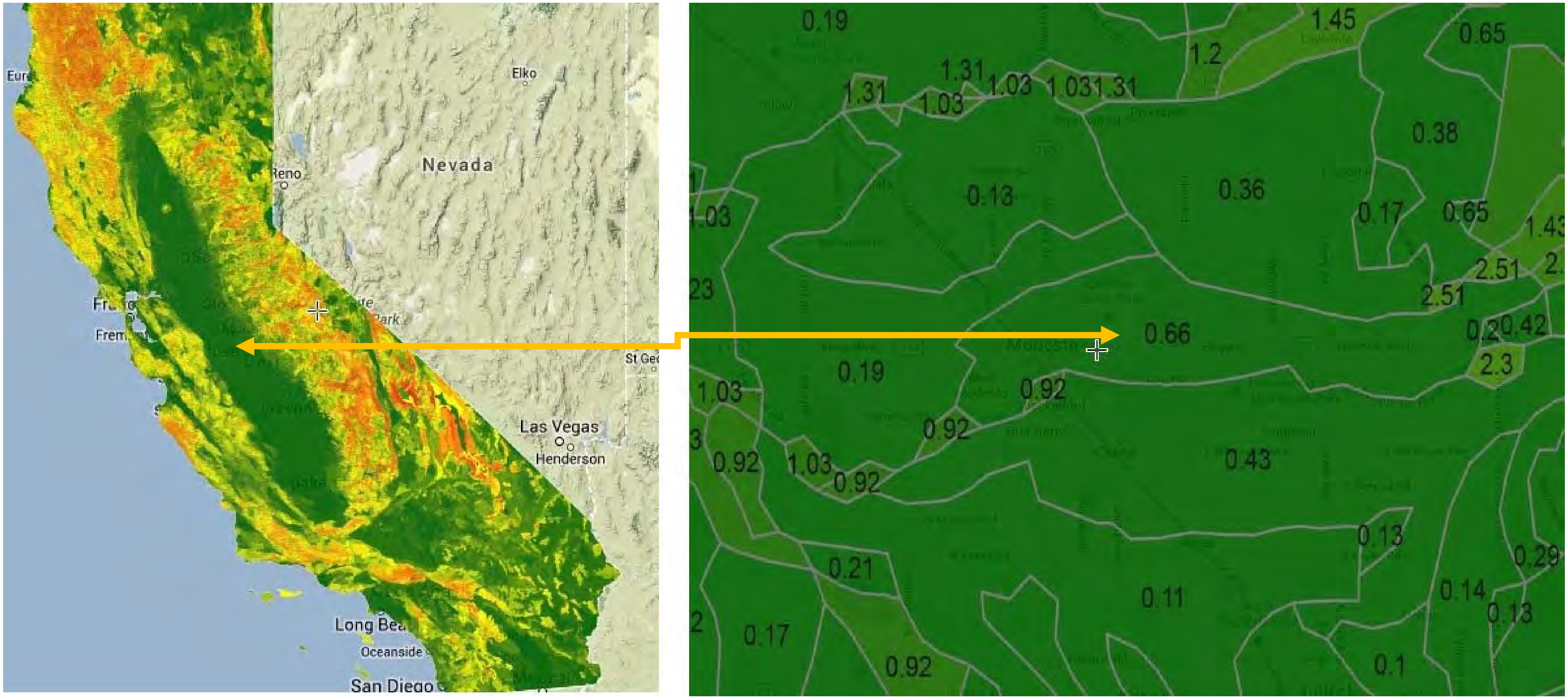


<u>*Note:</u>

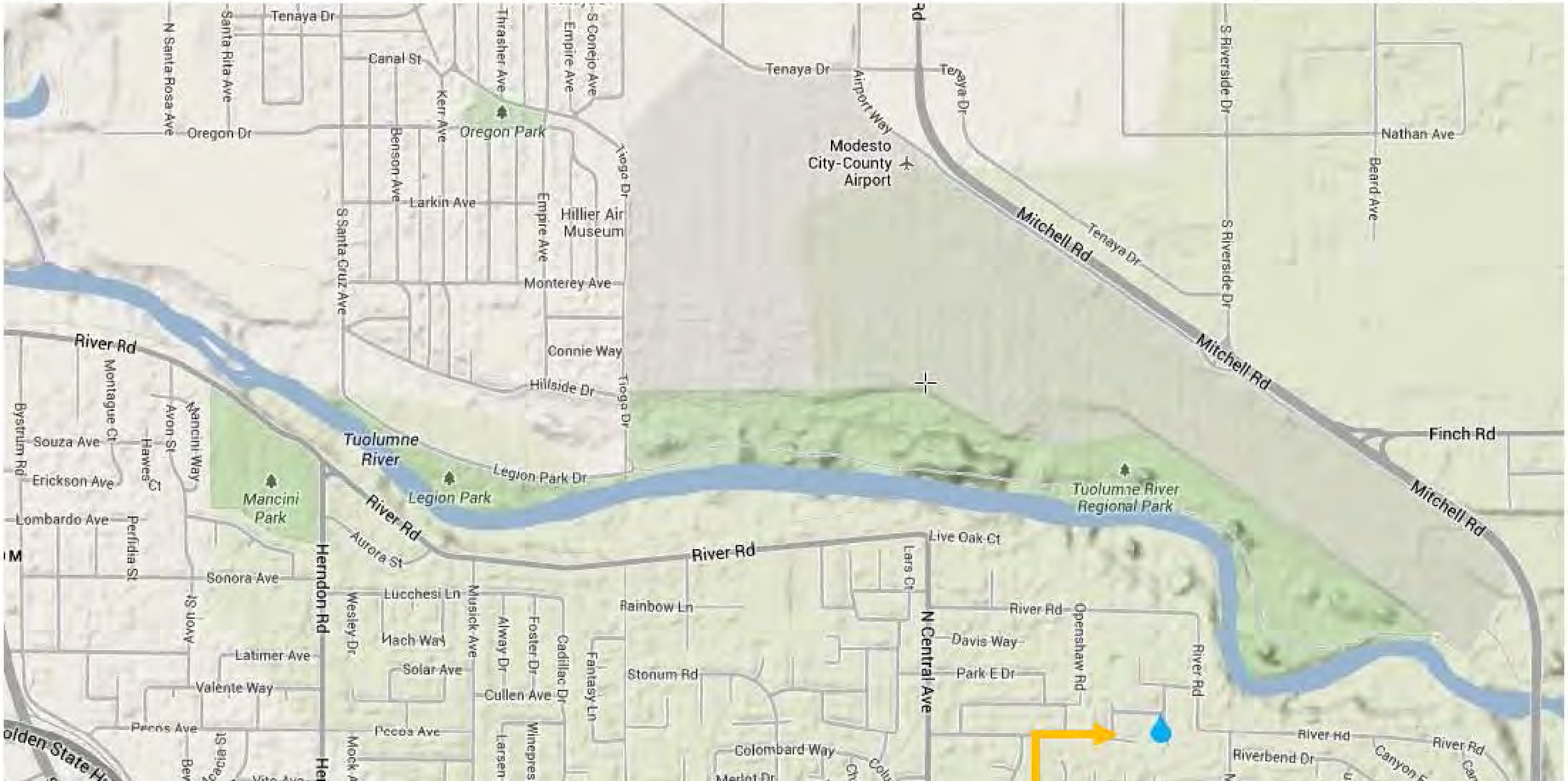
High Risk Receiving Water Risk Watersheds are Hydrologic Unit Code (HUC) Level 12 watersheds that drain to waterbodies that are either 1) 3039d) listed as impaired for sediment/siltation or turbidity; 2) have a US Environmental Protection Agency-approved, sediment-felated Total Maximum Daily Lad (TMDL); 3) have the existing beneficial uses of SPAWN, Migratory, and COLD according to the most recent applicable Regional Board Basin Plan.

A combination of HUC Level 10 watershed boundaries and physical barriers (e.g. dams) were used to delinate the upstream extent of High Receiving Water risk Watersheds. This project is located within a High Receiving Water Risk Watershed and is considered to have a high receiving water risk. Identifying High Receiving Water Risk Watersheds reduces the confusion over direct versus indirect discharges and questions regarding upstream extent.

Source: This layer was developed by the SWRCB. For more information on the Construction General Permit, please visit the construction stormwater program website.



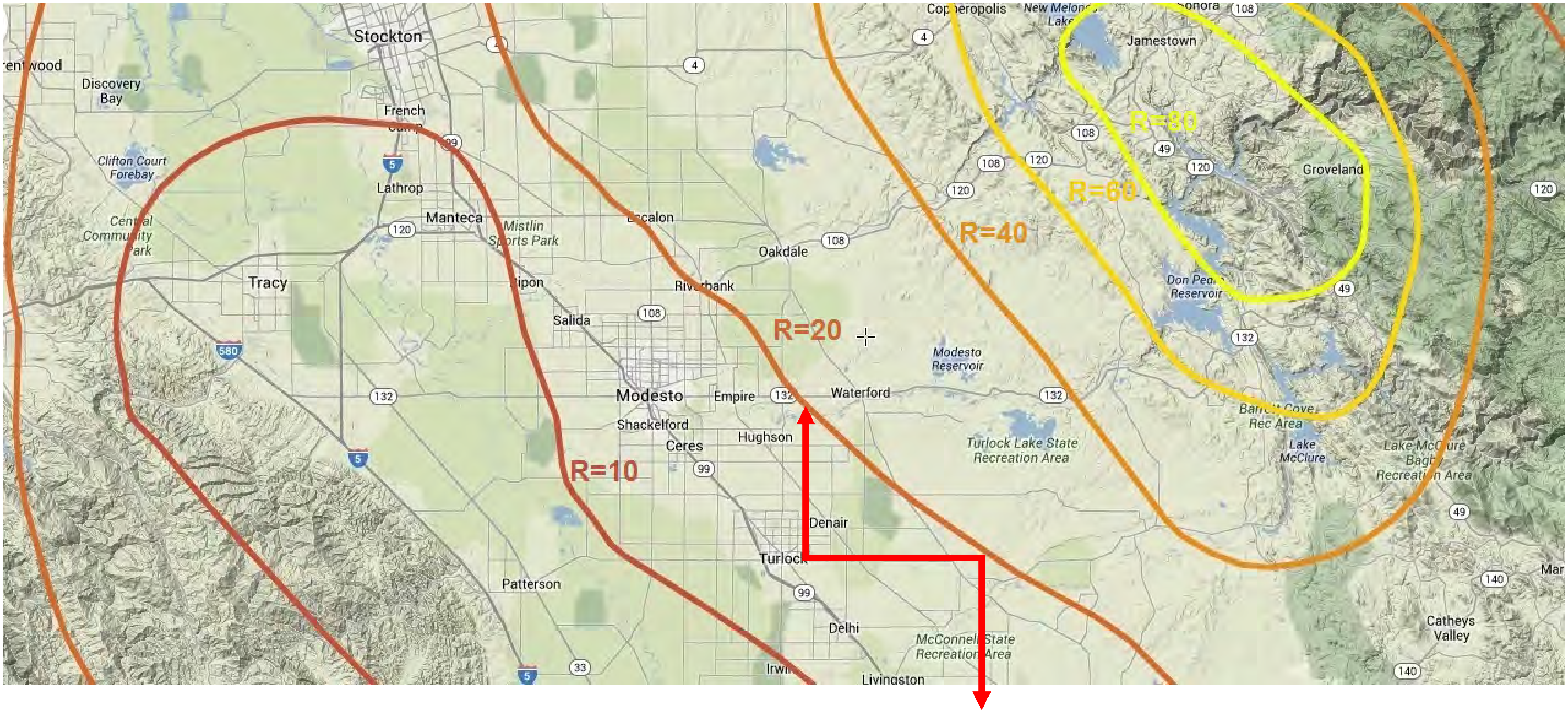
LS Factor Map



Average number of days per month with precipitation:

MODESTO AP
Elevation: 73 feet
Start Year: 1931
End Year: 2005
Number of Years: 75

Month	>=0.1 in	>=0.5 in
January	5.6	1.5
February	5.3	1.4
March	4.7	1.1
April	2.8	0.5
May	1.2	0.2
June	0.3	0
July	0.1	0
August	0.1	0
September	0.5	0.1
October	1.6	0.3
November	3.2	0.9
December	5.1	1.3
Yearly Total	30.4	7.5



Approximate R Factor = (10 + 20) / 2 = 15

Erosivity is the term used to describe the potential for soil to wash off disturbed, de-vegetated earth during rain storms. The Erosivity value for the Empire Community Project Area is approximately 15.

Using a computer model supported by decades' worth of soil and rainfall data, the United States Department of Agriculture (USDA) established estimates of annual erosivity values (R factors) for sites throughout the country. These R factors are used as surrogate measures of the impact that rainfall had on erosion from a particular site. They have been mapped using isoerodent contours, as shown in the above figure.

Figure B-2 Approximate geographic boundaries for NRCS (SCS) rainfall distributions

Rainfall data sources

This section lists the most current 24-hour rainfall data published by the National Weather Service (NWS) for various parts of the country. Because NWS Technical Paper 40 (TP-40) is out of print, the 24-hour rainfall maps for areas east of the 105th meridian are included here as figures B-3 through B-8. For the area generally west of the 105th meridian, TP-40 has been superseded by NOAA Atlas 2, the Precipitation-Frequency Atlas of the Western United States, published by the National Ocean and Atmospheric Administration.

East of 105th meridian

Hershfield, D.M. 1961. Rainfall frequency atlas of the United States for durations from 30 minutes to 24 hours and return periods from 1 to 100 years. U.S. Dept. Commerce, Weather Bur. Tech. Pap. No. 40. Washington, DC. 155 p.

West of 105th meridian

Miller, J.F., R.H. Frederick, and R.J. Tracey. 1973. Precipitation-frequency atlas of the Western United States. Vol. I Montana; Vol. II, Wyoming; Vol III, Colorado; Vol. IV, New Mexico; Vol V, Idaho; Vol. VI, Utah; Vol. VII, Nevada; Vol. VIII, Arizona; Vol. IX, Washington; Vol. X, Oregon; Vol. XI, California. U.S. Dept. of Commerce, National Weather Service, NOAA Atlas 2. Silver Spring, MD.

Alaska

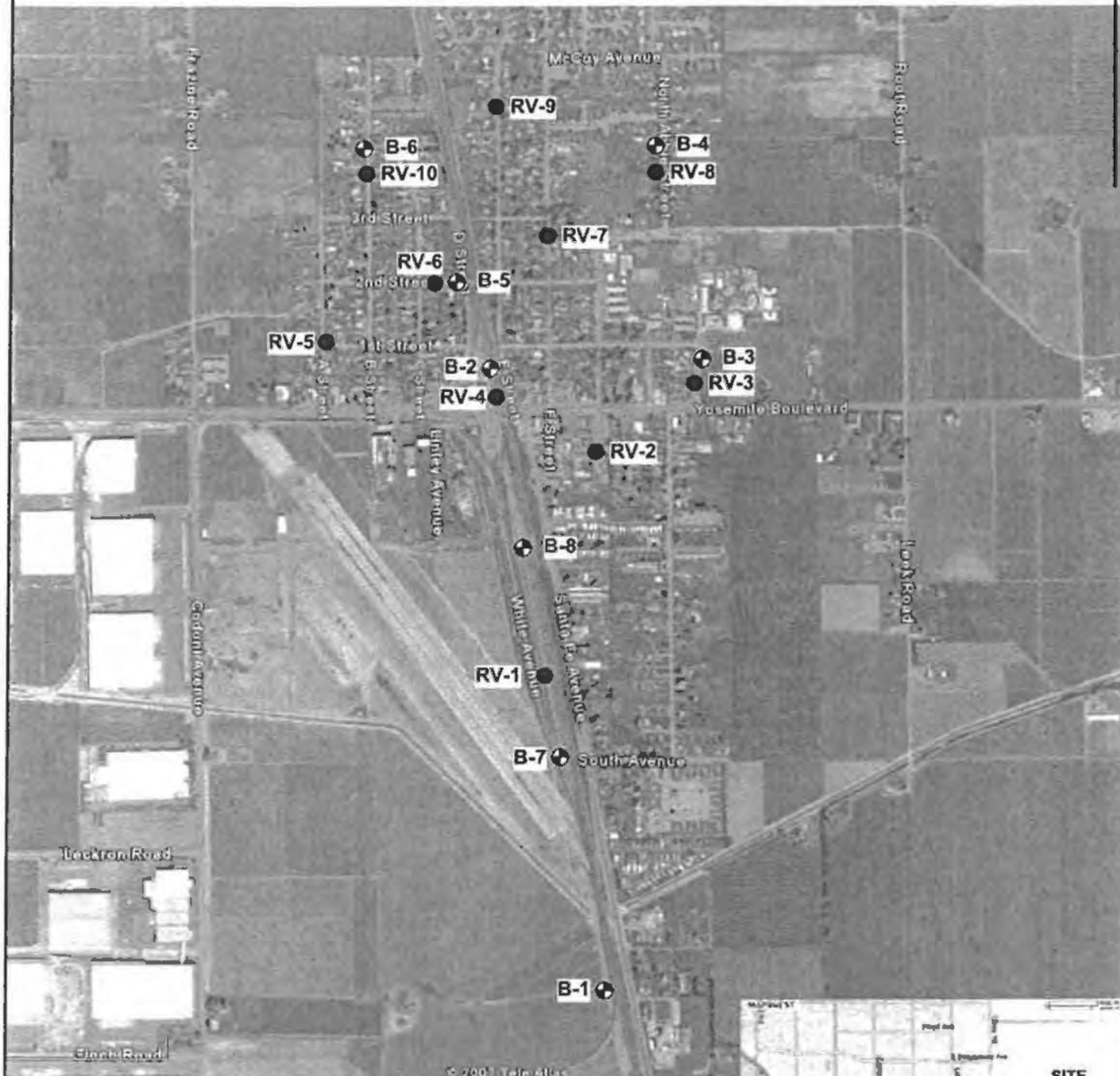
Miller, John F. 1963. Probable maximum precipitation and rainfall-frequency data for Alaska for areas to 400 square miles, durations to 24 hours and return periods from 1 to 100 years. U.S. Dept. of Commerce, Weather Bur. Tech. Pap. No. 47. Washington, DC. 69 p.

Hawaii

Weather Bureau. 1962. Rainfall-frequency atlas of the Hawaiian Islands for areas to 200 square miles, durations to 24 hours and return periods from 1 to 100 years. U.S. Dept. Commerce, Weather Bur. Tech. Pap. No. 43. Washington, DC. 60 p.

Puerto Rico and Virgin Islands

Weather Bureau. 1961. Generalized estimates of probable maximum precipitation and rainfall-frequency data for Puerto Rico and Virgin Islands for areas to 400 square miles, durations to 24 hours, and return periods from 1 to 100 years. U.S. Dept. Commerce, Weather Bur. Tech. Pap. No. 42. Washington, DC. 94 P.



O B-1 DENOTES NUMBERS AND APPROXIMATE LOCATIONS OF BORINGS DRILLED FOR THIS INVESTIGATION

RV-1 DENOTES NUMBERS AND APPROXIMATE LOCATIONS OF RESISTANCE VALUE SAMPLES OBTAINED FOR THIS INVESTIGATION

N

1 TO SCAL

KLEINFELDER

SITE PLAN AND VICINITY MAP
PROPOSED EMPIRE IMPROVEMENTS PROJECT
STANISLAS COUNTY, CALIFORNIA

1

DATE PRODUCED:121512007	DATE REVISED.
PROJ. NO.: 89759.G01	FILENAME.ST07D062.FH11

Unified Soil Classification System

Major Divisions			Letter	Symbol	Description
Coarse-grained Soils More than ½ retained on the No. 200 Sieve	Gravels More than ½ coarse fraction retained on the No. 4 sieve	Clean Gravels	GW		Well-graded gravels and gravel-sand mixtures, little or no fines.
			GP		Poorly-graded gravels and gravel-sand mixtures, little or no fines.
		Gravels With Fines	GM		Silty gravels, gravel-sand-silt mixtures.
			GC		Clayey gravels, gravel-sand-clay mixtures.
	Sands More than ½ passing through the No. 200 sieve	Clean Sands	SW		Well-graded sands and gravelly sands, little or no fines.
			SP		Poorly-graded sands and gravelly sands, little or no fines.
		Sands With Fines	SM		Silty sands, sand-silt mixtures
			SC		Clayey sands, sandy-clay mixtures.
Coarse-grained Soils More than ½ passing through the No. 200 Sieve	Silts and Clays Liquid Limit less than 50%		ML		Inorganic silts, very fine sands, rock flour, silty or clayey fine sands.
			CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
			OL		Organic clays of medium to high plasticity.
	Silts and Clays Liquid Limit greater than 50%		MH		Inorganic silts, micaceous or diatomaceous fines sands or silts, elastic silts.
			CH		Inorganic clays of high plasticity, fat clays.
			OH		Organic clays of medium to high plasticity.
Highly Organic Soils			PT		Peat, muck, and other highly organic soils.

Consistency Classification

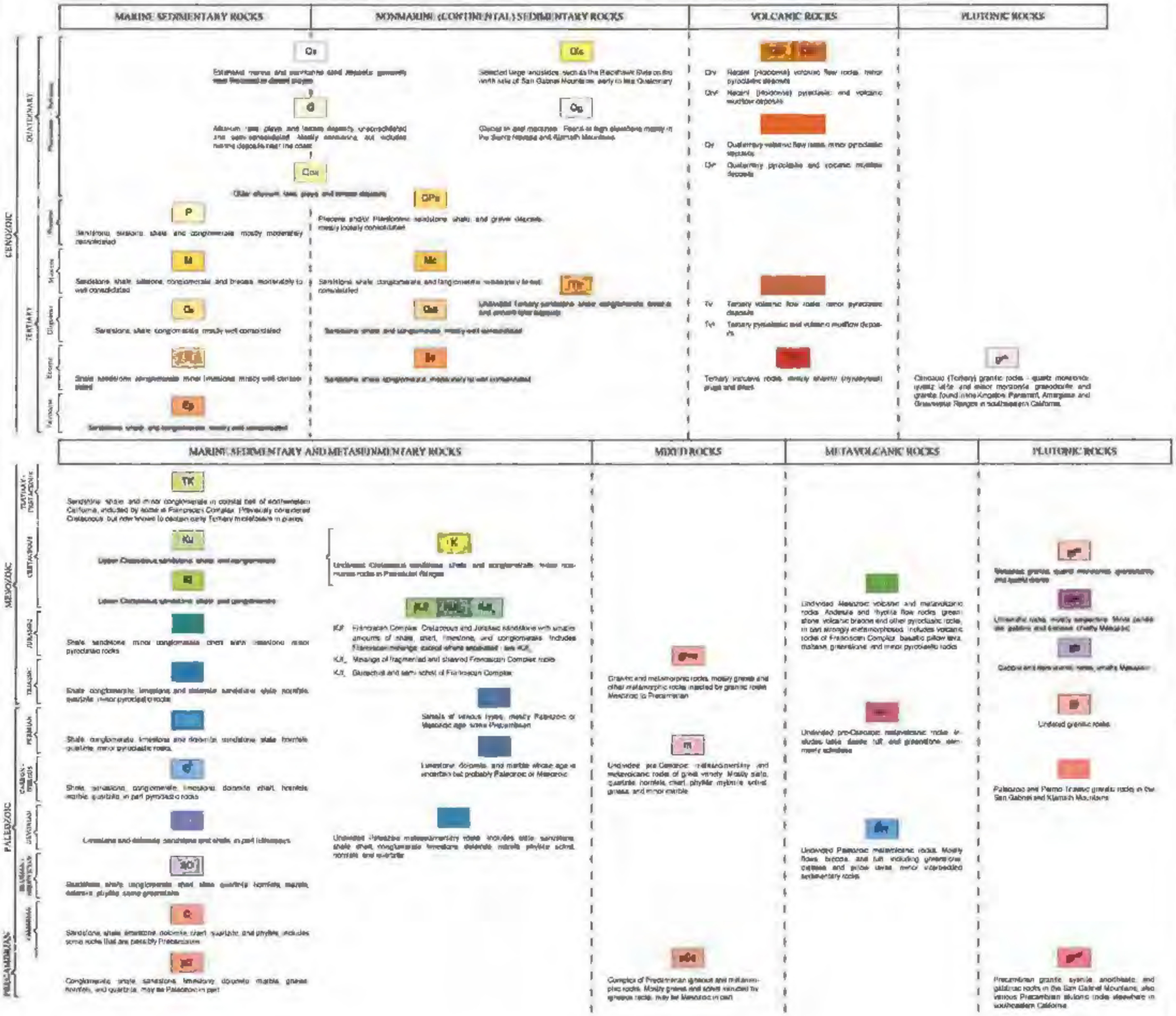
Granular Soils			Cohesive Soils		
Description - Blows Per Foot (Corrected)			Description - Blows Per Foot (Corrected)		
	MCS	SPT		MCS	SPT
Very loose	<5	<4	Very soft	<3	<2
Loose	5 - 15	4 - 10	Soft	3 - 5	2 - 4
Medium dense	16 - 40	11 - 30	Firm	6 - 10	5 - 8
Dense	41 - 65	31 - 50	Stiff	11 - 20	9 - 15
Very dense	>65	>50	Very Stiff	21 - 40	16 - 30
			Hard	>40	>30

MCS = Modified California Sample

SPT = Standard Penetration Test Sampler

GEOLOGIC LEGEND

(GENERALIZED DESCRIPTION OF ROCK TYPES)



SYMBOLS

Geologic boundary

Fault traces, solid where well located, dashed where approximately located or inferred, and dotted where concealed by younger rocks or by lakes or bays. Fault traces are queried where continuation or existence is uncertain. Many concealed faults in the Great Valley are based on maps of selected subsurface horizons, so locations shown are approximate and may indicate structural trends only. For faults color-coded according to recency of movement, see FAULT ACTIVITY MAP OF CALIFORNIA, GEOLOGIC DATA MAP SERIES, MAP NO. 6 (2010)

Ball and bar on downthrown side (relative or apparent)

Arrows indicate direction of lateral movement (relative or apparent)

Thrust fault (barbs on upper plate), solid where well located, dashed where approximately located or inferred; and dotted where concealed by younger rocks or by lakes or bays. Fault surface generally dips less than 45 degrees, but locally may have been subsequently steepened

Regional strike and dip of stratified rocks

Regional strike and dip of stratified rocks (overturned)

Anticlinal fold
Synclinal fold
— Dotted offshore and where concealed under alluvium in the Great Valley and elsewhere. Arrow indicates direction of plunge. Concealed folds may be confined to certain units, and their location may be approximate.

Monoclinal fold

Structural discontinuity in the offshore region

Volcano or cinder cone