HDR

ZONE 7 WATER AGENCY

Development Impact Fee for Flood Protection and Storm Water Drainage

Report

March 2009

Contents

Figures

Tables

Appendices

Executive Summary

Introduction

HDR Engineering, Inc. (HDR) was retained by the Alameda County Flood Control and Water Conservation District, Zone 7 (Zone 7) to prepare a development impact fee study to identify the fair proportion of the Stream Management Master Plan (SMMP) costs attributable to new development. The SMMP requires several funding options in order for it to be implemented. A development impact fee is one of the proposed components.

The objective of this study was to calculate an updated fee for new developments in Zone 7's service area that accounts for their fair proportion of the estimated costs of the SMMP projects. By establishing a cost-based[1] development impact fee, Zone 7 will assure that "growth pays for growth", and existing developments will, for the most part, be sheltered from the financial impacts of growth. Development impact fees bring equity between existing and new customers to the system.

Zone 7 currently has a drainage fee in place under Ordinance 0-2002-24 to support the Special Drainage Area 7-1 (SDA 7-1) Program, which is the funding program for the 1960 Flood Control Master Plan. The SDA 7-1 drainage fee is currently Zone 7's only source of revenue for development-related flood protection and storm water drainage capital improvements to the creeks, arroyos, and streams within Zone 7's service area, as well as property acquisition. Since the implementation of the drainage fee, it has been Zone 7's practice, as provided by the Ordinance, to review and revise the fee with respect to the change in construction costs as reported by the Engineering News Record (ENR). The last major fee revision was performed in 2001 after undergoing an extensive review of the existing SDA 7-1 Program costs. Following the 2001 fee revision, Zone 7 focused its efforts on revising the existing Flood Control Master Plan. As a result of these efforts, Zone 7 approved the SMMP in August 2006. The SMMP proposes a regional storage strategy to provide flood protection and storm water drainage for the 100-year rainfall event within Zone 7's service area at build out of adopted general plans at the time the SMMP was completed. The SMMP did not include an implementation strategy or an evaluation of existing funding mechanisms. Since the SMMP presents a significant departure from the 1960 Flood Control Master Plan of storm water conveyance structures, Zone 7 has undertaken this study to update the development impact fee.

Summary and Conclusions

The fee is calculated using an incremental methodology which assigns to new development the incremental cost of system expansion needed to serve new development. The fee is consistent with regulatory requirements and is based on Zone 7's planning and design criteria.

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[1] Cost-based implies the fee is based on a suite of projects (e.g., the SMMP) whose capital costs have been estimated and which serve as the basis for the fee.

Four steps were employed to establish Zone 7's development impact fee, each are described below.

- **Step 1, Determination of system planning criteria.** Impervious surfaces created by new developments cause an increase in storm water runoff and drainage because storm water is unable to infiltrate into the soil naturally. The greater the amount of impervious surface, the more storm water runoff and drainage is created. Therefore, similar to Zone 7's existing SDA 7-1 fee, it was determined that square feet of impervious surface area would be the criteria used in calculating the development impact fee. Thus, the fee will be expressed as dollars per square foot of impervious area.

- **Step 2, Determination of impervious surface area.** An estimate of the number of new square feet of impervious area between 2007 and build out was prepared based upon the adopted general plans of Alameda County and the cities of Dublin, Pleasanton and Livermore. The estimated total impervious area at build out was estimated to be approximately 889,484,737 square feet, with an estimated 148,013,317 being added after 2007. This represents an increase of approximately 17% between 2007 and build out conditions.

- **Step 3, Calculation of system component costs.** The entire flood protection and storm water drainage cost portion of the SMMP projects are eligible for inclusion in the development impact fee, as each project contributes to an overall system improvement which will provide flood protection and storm water drainage during a 100-year rainfall event at build out conditions.

  The SMMP contains two fundamental types of flood protection and storm water drainage projects, namely conveyance and storage. For conveyance projects, 17% of the project costs are allocated to future development based upon the ratio of impervious surface area created by future development to the total impervious surface area at build out conditions. For storage-related projects, 57% of the project costs are allocated to future development. This percentage is based upon the volume of storage in the Chain of Lakes (COL) required to offset the additional volume of storm water runoff and drainage during a 100-year rainfall event, near the Valley's outlet at build out conditions. In other words, 57% of the storage in the Chain of Lakes is required to offset the additional volume of storm water runoff and drainage created by the impervious surfaces of future development.

  In total, approximately $226 million is attributable to future growth. This amount was then adjusted to reflect the existing balance in the SDA 7-1 fund, resulting in approximately $214 million which is eligible for inclusion in the development impact fee. This cost was then divided by the projected increase in impervious area created by new development to develop a cost per square foot of impervious area.

- **Step 4, Determination of any credits.** Typically debt service credits are applied to the development impact fee to assure that customers are not paying twice – once through development impact fees and again through debt service included in their taxes or rates. However, Zone 7's Flood Protection and Storm Water Drainage section currently has no debt obligations, thus no debt service credit for existing debt was calculated.

Table ES-1 illustrates the results of the development impact fee study and the recommended development impact fee.

Table ES-1

Calculated Development Impact Fee (1)

Conveyance Project Costs	**$36,167,301**
Storage Project Costs	**+ 186,366,637**
Total Flood Protection and Storm Water Drainage Project Costs	**222,533,939**
Cost Adjustments for Existing SDA 7-1 Funds	**- 11,981,769**
Total Adjusted Flood Protection and Storm Water Drainage Project Costs	**210,552,169**
Future Impervious Area (Square Feet)	**÷ 148,013,317**
Impact Fee for Flood Protection and Storm Water Drainage Projects	**$1.423**
Debt Service Credit	**- 0.000**
Total Fee Per Square Foot of Impervious Area	**$1.42**

(1) Refer to Chapter 5 for further details regarding the origin of these numbers. All costs are shown in 2009 dollars.

Chapter 1 -
Introduction and Overview of the Study

Introduction

HDR Engineering, Inc. was retained by the Alameda County Flood Control and Water Conservation District, Zone 7 (Zone 7) to prepare a development impact fee study for flood protection and storm water management. The fee study was developed pursuant to Section 12.1 of the Alameda County Flood Control and Water Conservation District Act which authorizes the imposition of development impact fees. Section 12.1 of the District Act does not provide specific directives as to how such fees are imposed or implemented, thus for the purpose of setting and implementing this fee, Zone 7 will utilize the Mitigation Fee Act as a guideline. The objective of this report is to properly place in context the purpose of development impact fees, and to determine an updated development impact fee for Zone 7's flood protection and storm water drainage system that is consistent with California law and accounts for project costs estimated in the SMMP.

The objective of this report is to properly place in context the purpose of development impact fees, and to determine a development impact fee for Zone 7's flood protection and storm water drainage system that is consistent with California law and accounts for project costs estimated in the SMMP .

A development impact fee is a one-time charge paid by new development to compensate for the cost of infrastructure required to provide service to the new development. Development impact fees provide the means of balancing the cost requirements for new infrastructure between existing residents and new residents. The portion of future capital improvements that will provide service (capacity) to new residents is included in the development impact fee. In contrast to this, Zone 7 also has costs that are related to maintenance of existing facilities in service. These costs are typically paid by the property taxes charged to Zone 7's customers, and are not included within the development impact fee. By establishing an updated development impact fee that only accounts for the new project costs estimated in the SMMP, Zone 7 will assure that "growth pays for growth" and existing residents and property owners will be sheltered from the financial impacts of growth.

Overview of the Study

Chapter 2 provides a review of "generally accepted" industry practices related to development impact fees. It also discusses the financial objectives of development impact fees and the practices of other utilities and flood protection and storm water drainage agencies in relation to this fee. Chapter 3 provides an overview of the criteria and methodologies used in the development of cost-based development impact fees, and Chapter 4 provides a summary of the legal requirements for the enactment of development impact fees under California law. The cost based development impact fee calculation for Zone 7's flood protection and storm water drainage system is provided in Chapter 5.

Chapter 2 -
Overview of Development Impact Fees and "Generally Accepted" Industry Practices

Introduction

An understanding of the purpose and concept of development impact fees and the financial objective of those fees is an important starting point in discussing Zone 7's continued implementation of development impact fees. This section of the report will discuss the concept of development impact fees and the "generally accepted" practices of the industry.

Defining Development Impact Fees

One must first define a "development impact fee" before beginning an assessment and review of the fees. Development impact fees are also often called system development charges (SDC's), capacity charges, buy-in fees, facility expansion charges, plant investment fees, etc. Regardless of the name applied to the fee, the concept is still the same. Simply stated, development impact fees are capital recovery fees that are generally established as one-time charges assessed against new development as a way to recover a part of or all of the cost of system capacity constructed or to be constructed for their use. Their application has generally occurred in areas that are experiencing extensive new residential and/or commercial development.[2] The main objective of a development impact fee is to assess against the benefiting parties their proportionate share of the cost of infrastructure required to provide them service. Stated another way, development impact fees imply that new development creates new or additional costs on the system, and the development impact fee assesses that cost in an equitable manner to those residents creating the additional cost.

> ***"Development impact fees are capital recovery fees that are generally established as one-time charges assessed against new developers as a way to recover a part or all of the cost of system capacity constructed or to be constructed for their use."***

Development Impact Fees and "Generally Accepted" Practices

Development impact fees are one input into the rate setting process. Therefore, it is important to understand how, within the context of "generally accepted" utility industry practices, development impact fees may be used. In conducting a comprehensive rate study, three interrelated analyses are typically conducted. They are a revenue requirement analysis, cost of service analysis and rate design analysis. Figure 2-1 provides an overview of each of these analyses.

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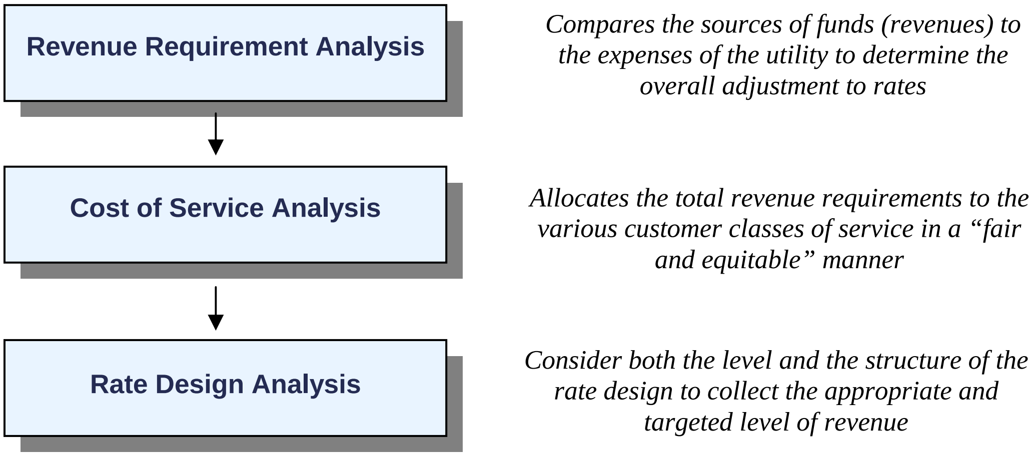
[2] George A. Raftelis, 2nd Edition, Comprehensive Guide to Water and Wastewater Finance and Pricing (Boca Raton: Lewis Publishers, 1993), p. 73.

Figure 2-1
Overview of the Three-Interrelated Analyses to Review Rates

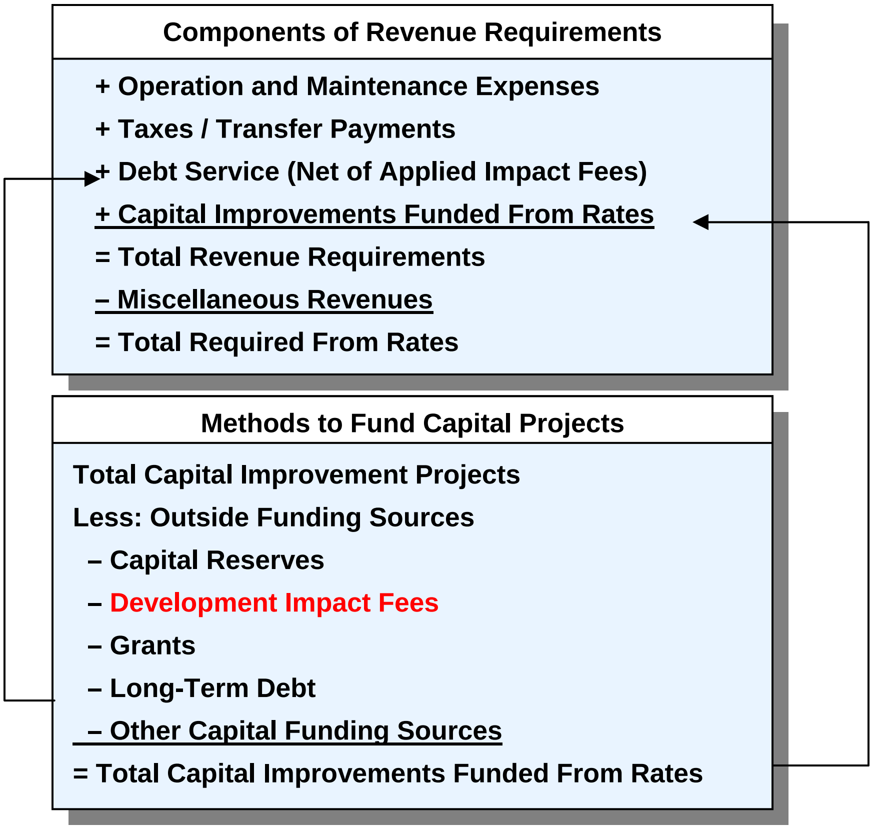

Revenue Requirement Analysis
Compares the sources of funds (revenues) to the expenses of the utility to determine the overall adjustment to rates

Cost of Service Analysis
Allocates the total revenue requirements to the various customer classes of service in a "fair and equitable" manner

Rate Design Analysis
Consider both the level and the structure of the rate design to collect the appropriate and targeted level of revenue

Development impact fees are factored into the revenue requirement analysis. The revenue requirement analysis for most municipal utilities is referred to as the "cash basis" approach. Figure 2-2, shown below, provides an overview of the key components of the "cash basis" approach to developing revenue requirements.

Figure 2-2
Overview of the "Cash-Basis" Approach to Establishing Revenue Requirements


Components of Revenue Requirements

+ Operation and Maintenance Expenses
+ Taxes / Transfer Payments
+ Debt Service (Net of Applied Impact Fees)
+ Capital Improvements Funded From Rates
= Total Revenue Requirements
– Miscellaneous Revenues
= Total Required From Rates

Methods to Fund Capital Projects

Total Capital Improvement Projects
Less: Outside Funding Sources
– Capital Reserves
– Development Impact Fees
– Grants
– Long-Term Debt
– Other Capital Funding Sources
= Total Capital Improvements Funded From Rates

As can be seen in Figure 2-2, there are two elements to establishing the "cash basis" revenue requirements. The top blue box shows the four basic cost components that are included within the "cash basis" revenue requirements. In contrast, the bottom box illustrates the various methods used to fund capital infrastructure projects.

It should be noted in Figure 2-2 that development impact fees might be used (applied) in two different ways, each of which has a different impact on the utility's revenue requirements and rates. The first possible use of development impact fees is shown in the bottom box. In that particular case, the development impact fees are applied directly against growth or expansion related capital projects. Using the funds in this manner helps to minimize long-term borrowing. One less dollar of long-term borrowing is required for each dollar of development impact fees applied in this manner.

Typically, total capital improvements funded from rates are established and fixed in the financial planning process. Therefore, applying development impact fees to capital projects typically will not have a significant impact on the amount of capital improvements funded from rates/taxes.

The other potential use of development impact fees is to apply the fees against growth-related debt service. As shown in Figure 2-2, debt service is shown as net of any development impact fees. Instead of applying development impact fees directly against the capital project, the fees are applied against debt related to facilities for growth. Every dollar applied in this manner causes a corresponding dollar decrease in revenue requirements and the resulting rates or tax-based funding requirements. This is a very effective method to help minimize rates/taxes, but even better at matching the cost of growth to the way in which resident growth occurs. In other words, a utility or agency may build or expand a facility with sufficient capacity to handle growth over the next ten to twenty years. That growth doesn't occur in the first year, but rather, trickles in over a number of years. Therefore, applying the development impact fees against the debt service associated with the project creates a better matching of the cost incurrence (debt payments) to the actual resident growth.

Financial Objectives of Development Impact Fees

A development impact fee is a regulation and not a user fee or revenue raising device. Understanding that new development creates the need for new or expanded facilities rationalizes this perspective. As a result, without payment of development impact fees, the utility or agency would have insufficient revenues to provide the facilities and, therefore the community would be unable to accommodate new development. With this said, development impact fees do have certain financial objectives associated with them. While on the surface it may appear as simply a means to extract revenue from new development, the reality is far more complicated. Development impact fees help utilities achieve a number of

> ***"A development impact fee is a regulation and not a user fee or revenue raising device. Understanding that new development creates the need for new or expanded facilities rationalizes this perspective"***

different financial objectives. These objectives tend to lean more towards financial equity between residents, as opposed to simply producing revenue.

Equity is one key financial/rate objective achieved from development impact fees. Equity is achieved in two different ways. First, a development impact fee establishes equity between existing (old) residents and new residents. For example, assume that a storm water detention basin is constructed to accommodate growth and the facility is financed over a 20-year period. Without a development impact fee, new residents connect to the system and pay for the debt service on the facility via their rates. The resident that connects to the system in year one will contribute to the cost of that facility for 20 years. In contrast, the person who connects in year 10 will only pay for debt service on the facility for ten years, even though the "value" of the capacity was the same for the person connecting in year 1 or year 10. Development impact fees create equity within the system by addressing the issue of timing and the "value" of the assets and the "value" of the capacity.

> ***"Development impact fees are most commonly adopted in high growth areas where infrastructure expansion has strained existing financial resources. Philosophically, many utilities desire to have a policy of 'growth paying for growth.'"***

Not all communities have development impact fees despite the advantages presented in the above discussion. Development impact fees are most commonly adopted in high growth areas where infrastructure expansion has strained existing financial resources. Philosophically, many utilities desire to have a policy of "growth paying for growth." Development impact fees comport with that philosophy, and it is achieved by applying the development impact fees either directly against the capital cost of the expansion facilities or against the debt service associated with it.

Relationship of Development Impact Fees and New Construction Activity

There are a number of myths surrounding development impact fees. In a very broad sense, some may argue that development impact fees (also referred to as impact fees, system development charges, or SDCs within the following text) are bad for economic development. These arguments center around two issues:

- Development will occur on those parcels with lower or non-existent development impact fees.
- Development impact fees raise the cost of doing business and hinder development.

The opposite has been found in research conducted on these topics. A brief explanation of the rebuttal of each assumption is provided below.

Developers look at many factors before a parcel is developed. One myth concerns the selection of parcels for development and whether development impact fees are applied to the land.

"The argument goes that if a developer is choosing between two parcels of land on which to build—where the first parcel is inside a city where SDC's (System Development Charge –

development impact fees) are charged and the second is just outside where lower or no SDC's (development impact fees) are charged—the developer will choose the second parcel.

The trouble is this means that the owner of the first parcel does not make a sale. The landowner must lower the land price to offset the fee in order to make a sale. However, if the landowner does not lower the price, this indicates that the value of future development may be higher on that parcel. Thus, be wary of developers who claim they will choose the second parcel. Chances are they would not have chosen the first parcel anyway. In the meantime, the land market will be holding the first parcel available for higher value development. In effect what might look like a loss in the short term may be a much higher level of development in the long-term."[4]

It is also a myth that development impact fees are bad for economic development. The argument against this position is as follows:

"The argument goes that because SDC's (development impact fees) raise the price of doing business, they frustrate economic development. However, just the opposite is really true. First, remember that SDC's (development impact fees) will be offset by reduced land prices and by enabling the community to more easily expand the supply of buildable land relative to demand.

Now, consider what economic development really looks for: skilled labor, access to markets, and land with adequate infrastructure. Competitiveness for economic development will be stimulated by the new or expanded infrastructure paid in part by SDC's (development impact fees). Besides, local governments retain the option to waive SDC's (development impact fees) for specific kinds of economic development, such as development locating in enterprise zones. In the competition for certain kinds of development, it (local government) will be able to show developers the dollar value of SDC's (development impact fees) waived as a solid demonstration of the local government's commitment to such development."[5]

Development impact fees may help to spur growth instead of hindering it, according to Nelson's opinion. It must be remembered that an important concept associated with development impact fees is that the fees are required to develop infrastructure in advance of the actual development.

"Development impact fees may help to spur growth instead of hindering it, according to Nelson's opinion."

From the developer's perspective, absent development impact fees (i.e. a moratorium on new connections) no new development can occur. Therefore, developers are generally supportive of cost-based development impact fees, particularly when it provides available capacity and opportunities for development.

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[4] Nelson. "System Development Charges for Water, Wastewater and Stormwater Facilities" P. 55.
[5] Nelson, "System Development Charges for Water, Wastewater and Stormwater Facilities" P. 56.

Summary

Development impact fees are capital recovery fees that are generally established as a one-time charge assessed against new development as a way to recover a part of, or all of, the cost of system capacity constructed, or to be constructed, for their use. The main objective of a development impact fee is to assess against the benefiting parties their proportionate share of the cost of infrastructure required to provide them service. In addition to presenting the definition and objective of development impact fees, this section of the report has introduced the historical perspective associated with them and an overview of the financial objectives associated with impact fees and some of the issues surrounding them. This section has provided a basic understanding of the fees such that, when Zone 7 has policy discussions concerning the implementation of development impact fees, the fees can be placed in proper perspective.

Chapter 3 -
Overview of Development Impact Fee Methodologies

Introduction

Having a basic understanding of the purpose of development impact fees along with the criteria and general methodology that is used to establish cost-based development impact fees is an important starting point in establishing these charges. This section of the report presents an overview of development impact fee criteria and general methodologies that are used to develop cost-based fees.

Development Impact Fee Criteria

A number of different criteria are often utilized in the determination and establishment of development impact fees. The criteria often used by utilities to establish development impact fees include:

- Customer understanding
- System planning criteria
- Financing criteria, and
- State/local laws

The component of customer understanding implies that the charge is easy to understand. This criterion has implications on the way that the fee is implemented, administered and assessed to the customer. Flood protection and storm water drainage development impact fees are usually assessed on the basis of square feet of impervious surface area created by the development. This calculation also ensures that the methodology is clear and concise in its calculation of the amount of infrastructure necessary to provide service to any new development.

> ***"The use of system planning criteria is one of the more important aspects in the determination of the impact fees. System planning criteria provides the "rational nexus" between the amount of infrastructure necessary to provide service and the charge to the customer."***

The use of system planning criteria is one of the more important aspects in the determination of development impact fees. System planning criteria provides the "rational nexus" between the amount of infrastructure necessary to provide service and the charge to the customer. The rational nexus test requires that there be a connection (nexus) established between new development and the existing or expanded facilities required to accommodate new development, and appropriate apportionment of the cost to the new development in relation to benefits reasonably received. Determining the amount of impervious square feet which can be attributed to future growth is an example of developing system planning criteria. The development impact fee methodology then charges the customer for every square foot of impervious area created by new development at the cost per square foot.

One of the driving forces behind establishing cost-based development impact fees is that “growth pays for growth.” Therefore, development impact fees are typically established as a means of having new customers pay an equitable share of the cost of their required capacity (infrastructure). The financing criteria for establishing development impact fees relates to the method used to finance infrastructure of the system and assures that customers are not paying twice for infrastructure – once through development impact fees and again through rates. The double payment can occur through the imposition of development impact fees and then the requirement to pay debt service within a customer’s rates or tax-based charge for operating budget costs.

Many states and local communities have enacted laws which govern the calculation and imposition of development impact fees. These laws must be followed in the determination of the development impact fees. Most statutes require a “reasonable relationship” between the fee charged and the cost associated with providing service (capacity) to the customer. The charges do not need to be mathematically exact, but must bear a reasonable relationship to the cost burden imposed. As discussed above, the utilization of the planning criteria and the actual costs and the planned costs of construction provide the nexus for the reasonable relationship requirement.

Overview of the Development Impact Fee Methodology

There are essentially two “generally-accepted” methodologies that are used to establish development impact fees, the equity method and the incremental method. Either method may be appropriate depending on the utility’s particular situation. In some circumstances, a combination of the two methods may be most appropriate; this is often referred to as the hybrid method. All three methods are discussed below.

Equity Method

The equity method is based on the principle of achieving capital equity between new and existing customers. Often referred to as the *buy-in method*, this method assumes that existing customers have provided equity in the existing system and that built-up equity should accrue to benefit existing customers. The methodology is most appropriate where current system facilities adequately serve existing and future customers, where no new significant system investment is anticipated, and where existing facilities are not scheduled for replacement in the near future.

Incremental Method

The incremental method is based on the concept of new development paying for the incremental cost of system capacity needed to serve new development. This method aims to mitigate the cost impact of new growth on existing customers’ user rates. The goal is to charge a fee for new customers sufficient to allow customer user rates to be revenue-neutral with respect to growth of the system. This method is considered most appropriate when a significant portion of the capacity required to serve new customers must be provided by the construction of new facilities.

Hybrid Method

The hybrid methodology is a combination of the equity and incremental methods. It may be used in instances where there are some existing facilities which can adequately serve existing and future customers, but where some additional facilities will be required to serve new customers.

Implementation Steps

Within each of the "generally accepted" development impact fee methodologies, there are a number of different steps undertaken. These steps are as follows:

- Determination of system planning criteria
- Determination of impervious surface area
- Calculation of system component costs
- Determination of any credits

The first step in establishing development impact fees is the determination of the system planning criteria. For example, for flood protection and storm water drainage, this implies calculating the amount of impervious area created by a single-family residential customer. Generally, for a flood protection and storm water drainage system, the planning criterion is the amount of impervious area.

Once the system planning criteria is determined, the total quantity of impervious area can be determined. This very important calculation provides the linkage between the amounts of infrastructure necessary to provide service to a set number of customers. This implies that if the system is designed to provide service up to the build out year, then the infrastructure costs are divided by the total amount of impervious area (in square feet) at build out to determine the cost per square foot of impervious area.

Once the amount of impervious surface area has been determined, a component by component analysis is undertaken to determine the component development impact fee in dollars per square foot. The calculation of the component development impact fee can include planned future assets, existing assets, and general assets. Planned future assets are those identified in a capital improvement program or similar program. General assets are those capital assets without which the agency could not function administratively or operationally, such as maintenance vehicles and administration buildings. Existing assets can be valued in a number of different ways, including original cost plus interest, replacement cost and depreciated replacement costs. The calculation of the component development impact fee includes only the share of the asset costs which is attributed to future growth, ensuring that new development pays for its equitable share of the costs.

Using this method, the cost of the capital infrastructure to serve growth is divided by the appropriate number of square feet of impervious surface area the infrastructure will serve in order to determine the cost per square foot of impervious surface area.

The "gross development impact fee" is determined by summing the cost per square foot of impervious surface area for each of the individual components.

The determination of any debt service credits is the last step in the calculation of the development impact fee. This is generally a calculation used to assure that customers are not paying twice − once through development impact fees and again through debt service included in their taxes or rates for flood protection and storm water drainage services. If any debt is issued in the future for the SMMP projects, that debt service total would be compared with the total development impact fee revenue projected for each year. Whenever the debt service payments exceed the annual development impact fee revenue, a credit is calculated. This credit is divided by the total impervious area for that year to determine a credit per square foot of impervious area. The credit is then deducted from the development impact fee for new development; no credits are issued for developments that have already paid the fee. Refer to Chapter 5, Figure 5-6, for an example debt service credit calculation.

The final development impact fee is determined by taking the "gross development impact fee" and subtracting any debt service credits. This results in a "net development impact fee" stated in dollars per square foot of impervious surface area. The general basis of this calculation for any flood protection or storm water collection system is the assumption that one square foot of impervious surface area is equivalent to a certain level of service. For example, the level of service provided by Zone 7 under the SMMP will be flood protection and storm water drainage at build out conditions during a 100-year rainfall event. Therefore, developments with a greater impact on the system (i.e., developments which add more impervious square footage) pay a larger fee.

Summary

There are essentially two methods used to calculate development impact fees, the equity method and the incremental method. The equity method is typically used when existing facilities can provide adequate service to both existing and future development, when no new significant system investment is anticipated. In contrast, the incremental method is typically used when a significant portion of the capacity required to serve new customers must be provided by the construction of new facilities. In either method, the following four steps are used to calculate the fee:

- Determination of system planning criteria
- Determination of impervious surface area
- Calculation of system component costs
- Determination of any credits

Chapter 4 -
Legal Considerations in Establishing Flood Protection and Storm Water Drainage Development Impact Fees for Zone 7

Introduction

Legal requirements at the state or local level are important considerations in establishing development impact fees. The legal requirements often establish the methodology around which the development impact fees must be calculated. It is, therefore, important for Zone 7 to understand these legal requirements. This section of the report provides an overview of the legal requirements for establishing development impact fees under California law.

The discussion within this section of the report is intended to be a summary of our understanding of the relevant California law as it relates to establishing a development impact fee. It in no way constitutes a legal interpretation of California law by HDR Engineering, Inc.

Requirements Under California Law

In establishing development impact fees, an important requirement is that they be developed and implemented in conformance with local laws. In particular, many states have established specific laws regarding the establishment, calculation and implementation of development impact fees. The main objective of most state laws is to assure that these charges are established in such a manner that they are fair, equitable and cost-based. In other cases, state legislation may have been needed to provide the legislative powers to the utility to establish the charges.

Section 12.1 of the Alameda County Flood Control and Water Conservation District Act authorizes Zone 7 to adopt a flood control and storm drainage development fee: “The board also may prescribe, revise, and collect fees or charges for facilities furnished or to be furnished to any area, new building, improvement or structure that will benefit from any flood control, storm drainage, water conservation or supply or sewerage system constructed or to be constructed in a zone of the district. Revenues derived under this section shall be used for the acquisition, construction, engineering, reconstruction, maintenance, and operation of the flood control, storm drainage, water, or sewerage facilities of the said zone, or to reduce the principal or interest of any bonded indebtedness thereof.”

California’s Mitigation Fee Act (Government Code sections 66000 et seq.) also regulates development fees; however, it applies to fees charged by a local agency in connection with the approval of a development project. Zone 7 does not have land use authority and does not approve development projects. Nevertheless, the Mitigation Fee Act provides useful guidelines for formulating new and revised development impact fees, which can be followed by Zone 7. The Mitigation Fee Act requires that a reasonable relationship, or rational nexus, be established between the fee and the purpose for which it is imposed, as described in the following Government Code section 66001, subsections (a) and (b):

> 66001. (a) In any action establishing, increasing, or imposing a fee as a condition of approval of a development project by a local agency, the local agency shall do all of the following:
>
> (1) Identify the purpose of the fee.
>
> (2) Identify the use to which the fee is to be put. If the use is financing public facilities, the facilities shall be identified. That identification may, but need not, be made by reference to a capital improvement plan as specified in Section 65403 or 66002, may be made in applicable general or specific plan requirements, or may be made in other public documents that identify the public facilities for which the fee is charged.
>
> (3) Determine how there is a reasonable relationship between the fee's use and the type of development project on which the fee is imposed.
>
> (4) Determine how there is a reasonable relationship between the need for the public facility and the type of development project on which the fee is imposed.
>
> (b) In any action imposing a fee as a condition of approval of a development project by a local agency, the local agency shall determine how there is a reasonable relationship between the amount of the fee and the cost of the public facility or portion of the public facility attributable to the development on which the fee is imposed.

In addition to the specific element for the determination of the reasonable relationship, the Mitigation Fee Act also provides for the following:

- Funds be maintained in a separate account,
- Annual accounting requirements on fee collections and expenditures,
- Requirement for public input to adopt or modify the fee, and
- Requirements for protest of the fees.

The basic principal that needs to be followed is that the charge be based on a proportionate share of the costs of the system required to provide service and that appropriate processes for fee adoption and accounting be in place.

Zone 7 will adopt a new ordinance to facilitate the implementation of the development impact fee.

Proposition 218 and Connection Fees

In 1996, the voters of California approved Proposition 218, which required that the imposition of certain fees and assessments by municipal governments require a vote of the people to change or increase the fee or assessment. Of interest in this particular study is the applicability of Proposition 218 to the establishment of development impact fees (connection fees) for Zone 7.

California Constitution Art.13D, Section 1(b) provides that Proposition 218 does not affect laws regulating development fees. Furthermore, in Richmond v. Shasta Community Services Dist., (2004) 32 Cal.4th 409, the California Supreme Court held that water connection fees are development fees and not subject to the procedural or substantive requirements of Proposition 218 and that the fee can be enacted by either ordinance or resolution. Therefore, Zone 7's development impact fee is not subject to Proposition 218 requirements.

Summary

Zone 7 is authorized to establish development impact fees under Section 12.1 of the Alameda County Flood Control and Water Conservation District Act. The District Act does not provide direction regarding the development and implementation of development impact fees. Therefore, the Mitigation Fee Act provides a useful guideline for formulating new and revised development impacts fees and their implementation. The Mitigation Fee Act has been used by Zone 7 as a guideline in determining the development impact fee. To facilitate the implementation of a new development impact fee, Zone 7 will adopt a new ordinance. Finally, it has been determined that Zone 7's development impact fee is not subject to Proposition 218 requirements.

Chapter 5 -
Determination of the Development Impact Fee

Introduction

This chapter of the report presents the details and key facts and bases used to calculate Zone 7's updated development impact fee. The calculation of Zone 7's development impact fee is based on agency-specific accounting and planning information. The development impact fee is specifically based on the Stream Management Master Plan (SMMP), planning data from a memorandum prepared by Northwest Hydraulic Consultants, dated August 3, 2007 (herein after referred to as the 2007 NHC Memorandum), and a technical memorandum, *Existing and Ultimate Runoff Conditions During a 100-Year Rainfall Event In Arroyo de la Laguna at Bernal Avenue*, prepared by Northwest Hydraulic Consultants, dated October 23, 2008 (herein after referred to as the 2008 NHC Memorandum and included in Appendix B).

Zone 7 currently manages and operates an existing storm drainage and flood protection system. Existing and new developments in the watershed contribute substantial storm water runoff and drainage into Zone 7's flood protection and storm water drainage system. Zone 7 is responsible for managing the storm water that flows into the watershed for flood protection, erosion and sediment control purposes. New development and the additional impervious surfaces that come with it will contribute additional storm water to Zone 7's storm water drainage and flood protection system, which requires Zone 7 to expand its facilities to meet the needs and impacts of future development. It is therefore appropriate that new development should pay its fair and equitable share of expanding that system. The development impact fee recommended by this report uses the incremental methodology to calculate a fee to cover new development's fair and equitable share of the costs of the new facilities described in the SMMP.

There is an existing Zone 7 storm water drainage development fee. However, that fee is out of date and does not reflect the current Zone 7 needs as reflected in this report and the SMMP. This report, therefore, provides the basis and support for Zone 7 to update its development impact fee in order to reflect changed plans and circumstances.

The development impact fee presented in this chapter of the report should be updated from time to time to reflect changes in the cost and timing of future capital improvements.

Overview of Zone 7's Existing Flood Protection and Storm Water Drainage System

Zone 7 manages the storm water flow in the Livermore-Amador Valley (Valley) area within the major arroyos and tributaries of the Valley. Zone 7 currently owns and maintains approximately 37 miles of both improved and unimproved channels, ranging from trapezoidal-shaped, concrete-lined channels to natural creeks, and related flood protection and storm water drainage facilities. The Valley's flood-protection system begins at city- and county-owned storm drains on local streets and roads. Storm water flows from developed properties into streets and local storm drainage systems and through other water courses that eventually flow into the Zone 7 managed flood protection and storm water drainage facilities; this flow eventually enters the local arroyos and tributaries, managed by Zone 7, and then exits the Valley through the Arroyo de la Laguna, which is a tributary to Alameda Creek.

Determination of Service Area

Zone 7's service area includes portions of two distinct watersheds, namely the Alameda Creek watershed and the San Joaquin watershed. The purpose of this section is to define the area (Service Area) in which the development impact fee will be imposed.

The general drainage pattern of the Alameda Creek watershed is east to west and north to south, through major arroyos and adjoining tributaries, before making its final exit of the Valley through the Arroyo de la Laguna.

The eastern-most portion of Zone 7's service area drains eastward toward San Joaquin County, thus contributing storm water flows to the San Joaquin watershed.

The existing and new Zone 7 flood protection and storm water drainage facilities, with the exception of two planned SMMP projects, are located in the Alameda Creek watershed in order to manage, control and facilitate the storm water flows through the Valley. Thus, these flood protection and storm water drainage facilities provide service to all development (both existing and future) within the Alameda Creek watershed within Zone 7's service area.

For the purposes of establishing a new development impact fee, it was determined that the portion of Zone 7's service area contributing storm water to the San Joaquin watershed, would not be included at this time.

In developing a rational nexus for a flood protection and storm water drainage development impact fee, it is necessary to understand how development contributes storm water to the flood protection and storm water drainage facilities. Through the creation of impervious areas, developments cause the quantity and timing of storm water runoff to be altered. The creation of impervious areas results in less natural infiltration opportunities, thereby increasing the amount of storm water runoff and reducing the amount of water that would have infiltrated naturally into the ground, as well as increasing the rate that runoff reaches the flood protection and storm water drainage facilities.

The increased quantity of storm water flows caused by the creation of impervious surfaces by new developments contributes to, and could worsen, downstream flooding, erosion and sedimentation impacts. The flood protection and storm drainage facilities presented in the SMMP will regionally manage these impacts within the Alameda Creek watershed. Developments within the Alameda Creek Watershed within Zone 7's service area should therefore contribute to the portion of project costs needed to serve development.

Based on these factors, it was determined that for the purpose of calculating and imposing the development impact fee, the Service Area would encompass the Alameda Creek watershed area within Zone 7's service boundary. Except where otherwise noted, the remaining sections in this chapter refer to the facilities and impervious surface area within the Alameda Creek watershed within Zone 7's service boundary.

Calculation of Zone 7's Development Impact Fee

The calculation of the development impact fees uses a four-step process. These steps are:

- Determination of system planning criteria
- Determination of impervious area
- Calculation of the development impact fee
- Determination of any development impact fee credits

Each of these steps is discussed in more detail below.

System Planning Criteria

In developing a rational nexus for the flood protection and storm water drainage development impact fee, system planning criteria must be defined. This criterion forms the link between future development and the capital infrastructure which Zone 7 must construct to mitigate the impacts associated with future development (e.g., increased flood flows). When calculating the development impact fee, the total cost of the SMMP projects attributed to future development will be divided by the system criteria, such that the development impact fee will be presented as a unit cost. In this way, a development creating more units will pay a higher development impact fee than a development creating fewer units.

The creation of new impervious surfaces by future development can be used to account for the impacts to the existing flood protection and storm water system (Existing System) caused by future development because the creation of new impervious areas alters the quantity and timing of storm water runoff.

As future development creates more impervious surface, natural infiltration opportunities are reduced. This increases the flow of storm water runoff into the Existing System. Moreover, due to the new impervious surfaces and man-made drainage facilities (e.g., gutters and storm drains), the time it takes for the storm water to flow overland and reach the Existing System can be accelerated.

To accommodate increased flow rates and accelerated overland flow, either the velocity of the storm water or the cross-sectional area of a channel must increase. In the latter case, this can be accommodated by channel widening or excavation, or construction of flood walls and levees. An increase in velocity can result in bed and bank erosion. To mitigate these velocity impacts, bed and bank stabilization is required. As an alternative, or in addition, to using conveyance system improvements to mitigate the impacts of increased flow rates and accelerated overland flow, these impacts can be managed through storage projects that detain additional volumes of storm water, thus reducing downstream flow rates.

Consequently, the Existing System must be modified so that it can properly manage the additional storm water generated by the creation of new impervious surfaces by future development. More specifically, the Existing System will need larger or more robust channels to properly convey larger storm water flows, additional storage to detain larger storm water volumes, or both.

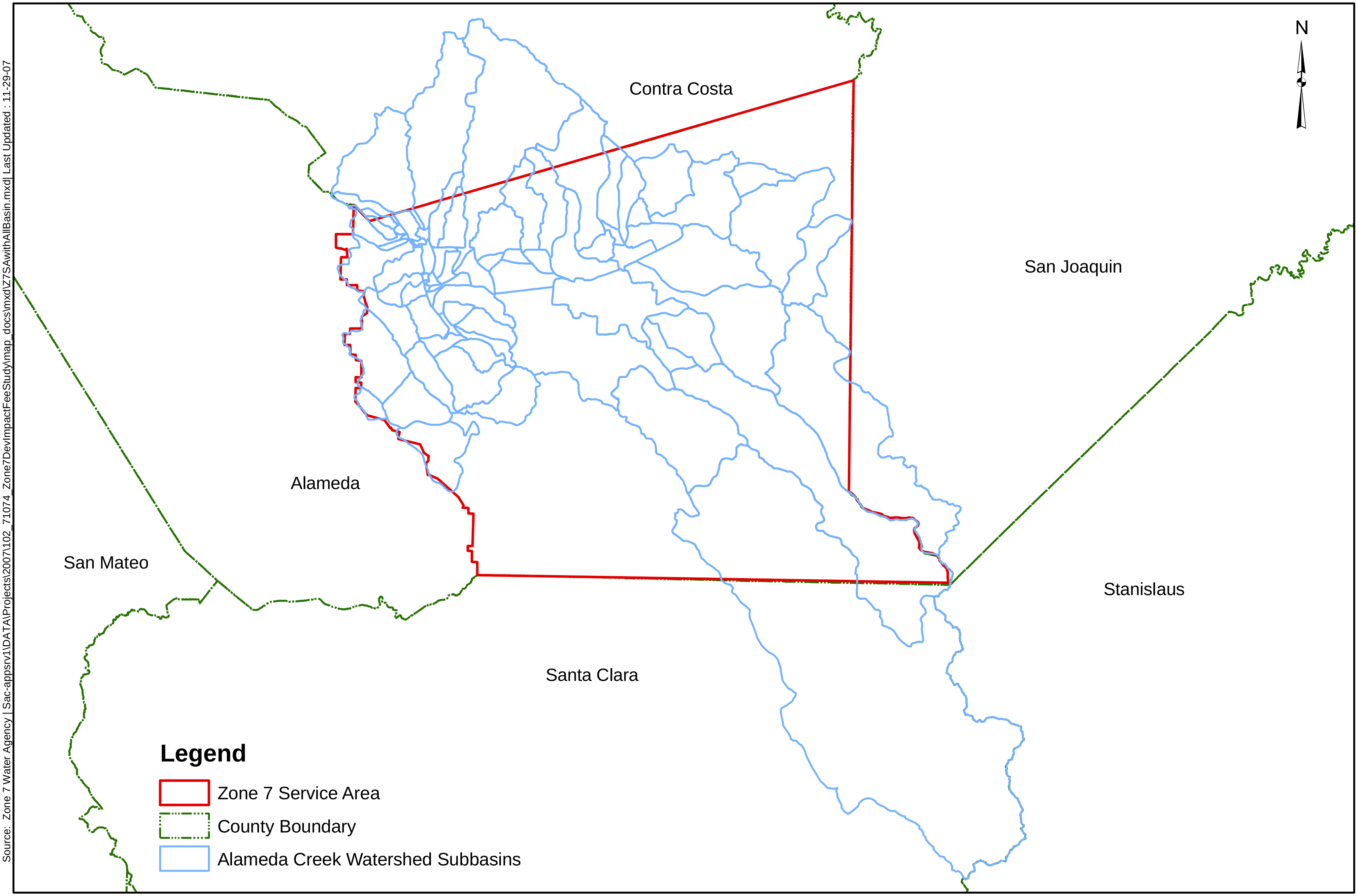
Therefore, similar to Zone 7's existing SDA 7-1 fee, it was determined that square feet of impervious surface area would be the system planning criteria used in calculating the development impact fee; this criteria can be used to account for both conveyance and storage impacts to the Existing System. The total projected new impervious surface area created between now and build out conditions will be used to determine the cost per square foot of impervious area.

Calculation of Impervious Area

The planning horizon of this study is 2007 to build out. It is expected that build out in the Valley will occur between 2024 and 2034, and is based upon the general plans developed by Alameda County and the Cities of Livermore, Pleasanton and Dublin.

A projection of the number of new/additional square feet of impervious area per year was determined as a part of this study, along with the total square feet of impervious area at build out. The 2007 NHC Memorandum and supporting geographic information system (GIS) data provided the existing quantities of impervious surface area and the percent change in impervious surface area between 2007 and build out conditions. However, as shown in Figure 5-1 the Zone 7 service area does not fully include all the subbasins of the Alameda Creek watershed modeled by NHC. Portions of several subbasins cross into Contra Costa County, San Joaquin County and Santa Clara County. Since it was determined that the Service Area used for calculating the development impact fee would include all of, and only, the Alameda Creek watershed within Zone 7's service area, the amount of impervious area included in the NHC GIS model was adjusted to include only the area of the Alameda Creek watershed which falls within the Zone 7 service boundary.

The adjustment of the subbasins such that all impervious area considered falls within Zone 7's service area was made in direct proportion to the total area (impervious and non-impervious) of a subbasin falling within the Zone 7 service area. For example, a 100 acre subbasin with 20 acres of impervious area which is 50 percent inside Zone 7's service area and 50 percent outside Zone 7's service area, would be "adjusted" to a 50 acre subbasin (all within Zone 7's service area) with 10 acres of impervious area. Similarly, the percentage increase in impervious area projected between 2007 and the build out condition for the entire (unadjusted) subbasin was also used to project the amount of impervious area for the adjusted (inside Zone 7) subbasin at build out.

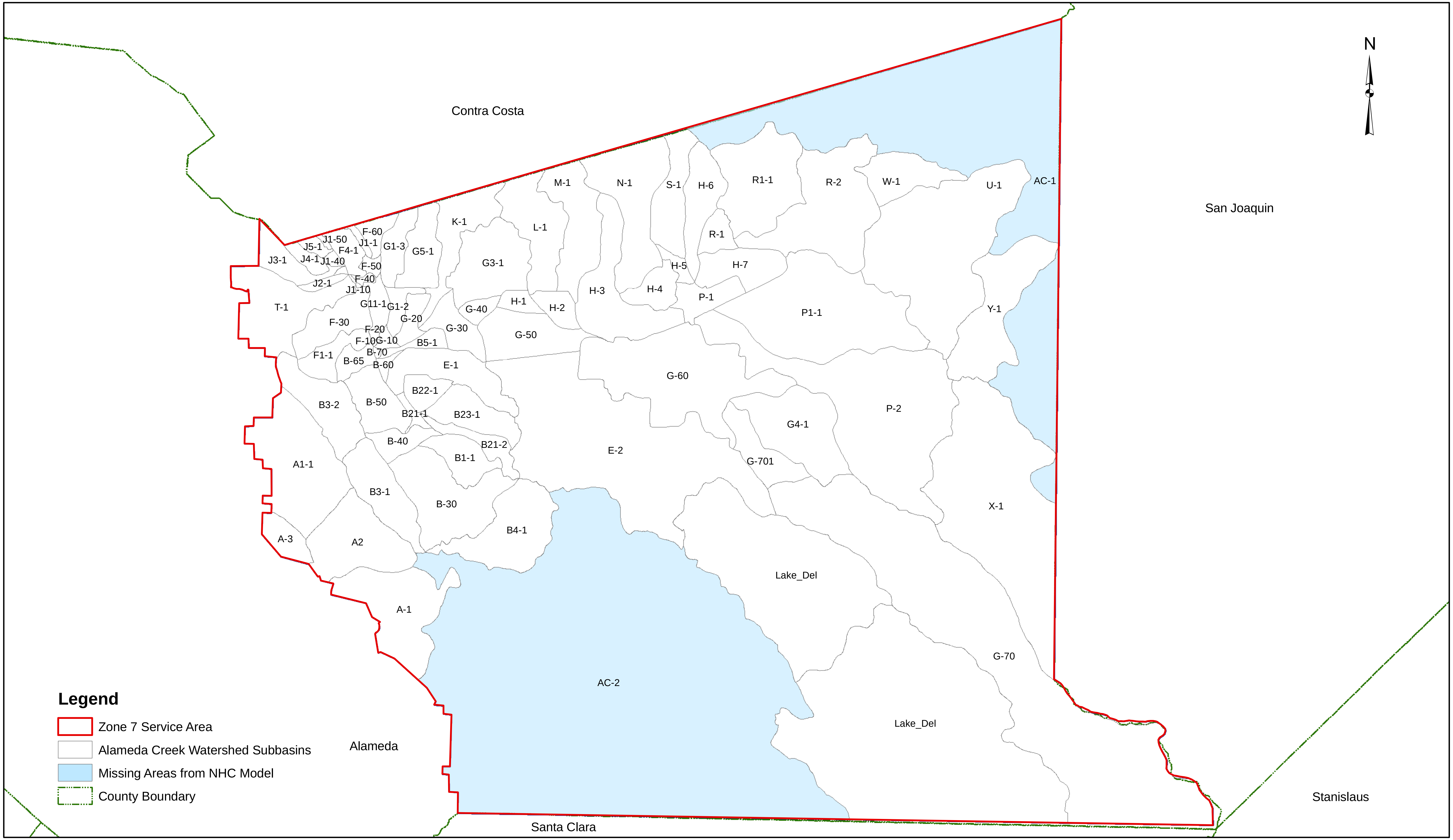


Source: Zone 7 Water Agency | Sac-appsrv1\DATA\Projects\2007\102_71074_Zone7DevImpactFeeStudy\map_docs\mxd\Z7SAwithAllBasin.mxd| Last Updated : 11-29-07

Figure 5-1 Zone 7 Service Area

* Zone 7 Service Area Boundary Supplied by Zone 7 Water Agency

Zone 7 Dev.Impact Fee Study| Zone 7 Water Agency | Service Area



Legend

🟥 Zone 7 Service Area

☐ Alameda Creek Watershed Subbasins

▨ Missing Areas from NHC Model

☐ County Boundary

Source: Zone 7 Water Agency | Sac-Appsrv1\DATA\Projects\2007\102_71074_Zone7DevImpactFeeStudy\map_docs\mxd\Z7ServiceArea.mxd| Last Updated : 11-29-07

Figure 5-2 Determination of Impervious Surface Area

* Zone 7 Service Area Boundary Supplied by Zone 7 Water Agency

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In addition to these adjustments, four basins included in the 2007 NHC Memorandum drain eastward toward San Joaquin County. These basins, shown in Figure 5-1, include W-1, U-1, X-1 and Y-1. Since these basins are not part of the Alameda Creek watershed, they are not in the defined Service Area, and thus, they were not included in the determination of the total existing and future impervious surface area for the purposes of calculating the development impact fee.

Finally, there are areas within Zone 7's service boundary which are not included in the NHC model, as shown in Figure 5-2. While storm water created in area AC-2 does drain into the Alameda Creek watershed, storm water runoff from area AC-1 does not drain into the Alameda Creek watershed, but rather it drains eastward toward San Joaquin County. Therefore, the existing and future impervious surface area in area AC-1 was not included in the determination of the development impact fee.

Area AC-2 is composed largely of open space; therefore, it was assumed that there was little or no impervious area within Basin AC-2. Thus, no impervious area in AC-2 was included in the determination of the total existing and future impervious surface area for the purposes of calculating the development impact fee.

A summary of the total impervious surface area in the Service Area for 2007 and build out is presented in Table 5-1. Details of the determination of the impervious surface area are provided in Appendix A, Exhibit 1.

Table 5-1

Impervious Surface Area

Description	Square Feet of Impervious Surface Area
Impervious Area – 2007	741,471,420
Impervious Area – Build out	889,484,737
New Impervious Area – Difference	148,484,737

The calculation indicates that the square footage of impervious area will increase by approximately 17% over the next twenty to twenty-five years.

Calculation of the Development Impact Fee

The SMMP is a collection of 45 multidisciplinary projects, of which 33 are classified as flood protection and storm water drainage projects. The remaining projects include water quality, water supply, recreation, and habitat and environment related projects that were not included in the calculation of the development impact fee.

The 33 projects address both conveyance and storage improvements required in the Existing System to manage the storm water runoff and drainage from both existing and future development. The projects are designed to provide regional flood protection and storm water drainage, and are designed to help meet the 100-year flood protection objective within the Zone 7 service boundary at build out conditions.

As noted above, the flood protection and storm water drainage projects are made up of both conveyance- and storage-related projects. The methodology used to determine what portion of these projects is equitably attributed to future development is described in the following subsections.

Conveyance Projects

Of the 33 projects classified as flood protection and storm water drainage projects, 30 were identified as conveyance-related projects. Only the conveyance-related projects which are located in the Alameda Creek watershed have been included, thus, 2 conveyance-related projects (i.e., R.12-1 and R.12-2) were not included in the determination of the development impact fee.

The conveyance-related projects in the Alameda Creek watershed facilitate the conveyance of storm water flows through the Valley by enhancing channel capacity and stability through levee construction, sediment management, bank and bed channel stabilization, and channel excavation. A list of the conveyance-related projects and their respective costs is provided in Appendix A, Exhibit 2.

Flood protection and storm water drainage channels must be designed to convey a particular flow rate, or volume of water per time interval (e.g., cubic feet per second). To accommodate increased flow rates, the conveyance projects either increase the cross-sectional area of a channel or provide bed and bank stabilization to mitigate erosion due to increased flow velocity in the channels. Just as erosion is a result of increased velocity, sedimentation occurs when flood waters slow and previously eroded particles settle. If significant sedimentation occurs, a channel’s capacity can be reduced. Thus, sediment management projects are also required to facilitate conveyance in the Existing System.

For Zone 7, the storm water runoff from both existing and new developments will flow downstream until it converges with Zone 7’s Existing System. The channels that make up the Existing System will then convey the storm water either directly out of the Valley through the Arroyo de la Laguna or to storage basins in the Chain of Lakes. Thus, both existing and future development in the Service Area will benefit from the conveyance improvements planned for Zone 7’s flood protection and storm water drainage channels.

Since the regional system of flood control and storm drainage channels provides benefit to both existing and future development, the costs of the conveyance-related projects should be shared proportionally among existing and future development. Furthermore, the proportionality should be based on impervious area since impervious area increases storm water runoff.

As previously described, the amount of impervious area in the Service Area will increase by 17% between existing and build out conditions. Thus, 17% of the conveyance-related project costs were allocated to future development. This results in an allocation of approximately $36 million to future development, as shown in Table 5-2 on page 5-13. Details of the calculation are provided in Appendix A, Exhibit 3.

Storage Projects

The three storage-related projects, which are collectively referred to as the Chain of Lakes project, detain storm water by diverting flow from the conveyance channels into the Chain of Lakes. Diverting storm water from the conveyance channels will reduce peak flows downstream; thereby, reducing both the potential for downstream flooding and the capacity for which downstream conveyance facilities must be designed.

From a storm drainage management and hydrology perspective, storage facilities are different than conveyance facilities. In determining the portion of the storage projects which is attributable to future development, it is necessary to consider the volume of water which must be accommodated.

During a rainfall event, storm water begins to flow downhill and downstream. As the storm water begins to concentrate in a channel or river, the flow rate and stage (i.e., surface elevation) increase. The peak flood wave is denoted by the maximum flow rate and stage elevation achieved before the flood wave begins to attenuate or crest.

Depending on the rainfall event (e.g. 5 year-, 20 year-, 100 year-rainfall event, etc.) the magnitude of the peak flood wave changes. With more rainfall, the magnitude of the peak flood wave will increase. As the peak flood wave increases, the potential for damage also increases.

As previously described, the creation of additional impervious surfaces increases the flow rate and thus also increases the peak flood wave. The increase in the peak flood wave over a period of time can be measured as a volume (e.g., cubic feet per second over an hour, see Figure 5-5). To offset the additional volume attributed to the additional impervious surfaces, an equivalent volume of storm water can be stored in a detention basin upstream.

In order to determine the portion of the storage-related projects that should be equitably allocated to future development, the volume of storage required to offset the peak flood wave in Arroyo de la Laguna at Bernal Avenue was used. Figure 5-3 illustrates the existing peak flood waves for Arroyo de la Laguna at Bernal Avenue. Note there are two peaks; the interpretation of these peaks and the related impact on the development impact fee follows.

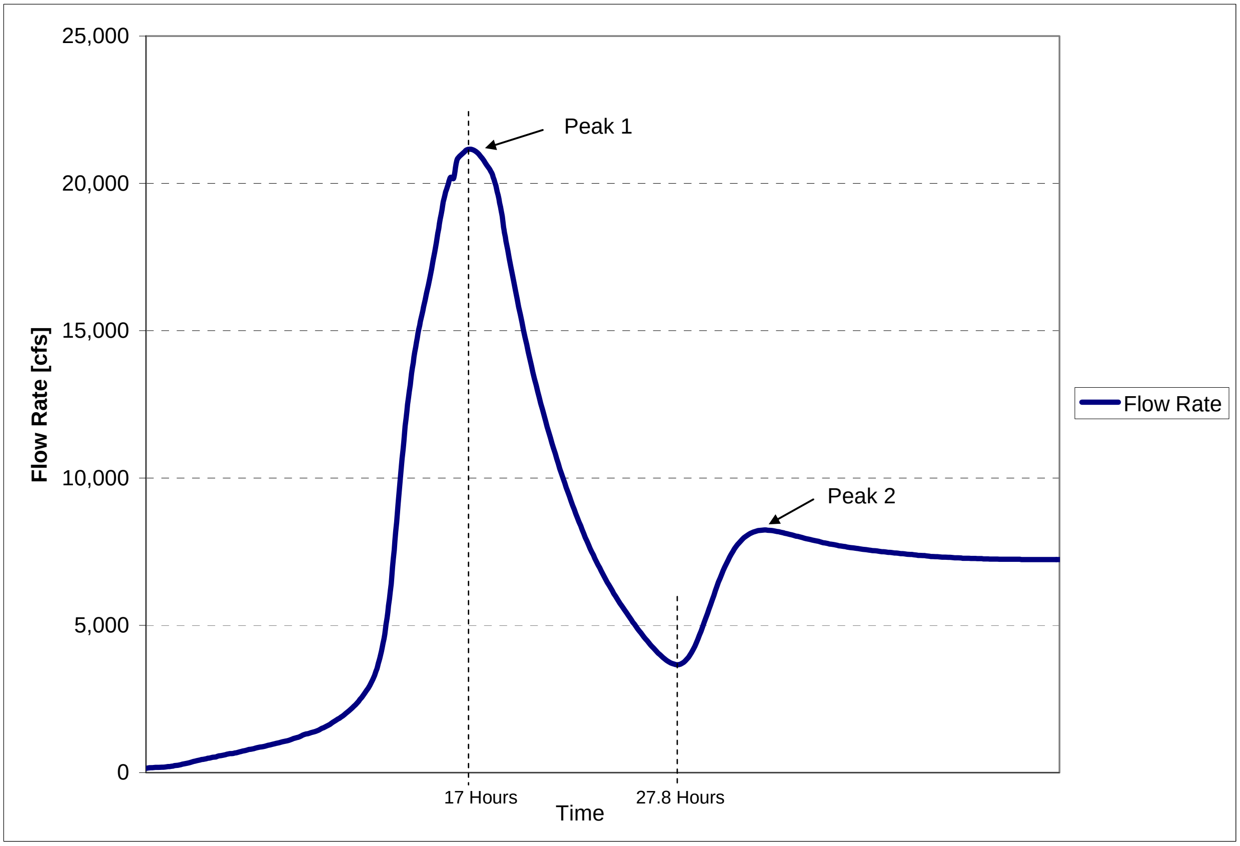

Figure 5-3. Existing Peak Flood Waves for 100-year Rainfall Event for Arroyo de la Laguna at Bernal Avenue (2008 NHC Memorandum).

Arroyo de la Laguna at Bernal Avenue is at the downstream end of the Service Area; thus, all storm water collected and leaving the Service Area through its flood protection and storm drainage channels passes through this point. Therefore, the regional increase in storm water caused by new development can be generally quantified at this point by comparing existing storm water flows with future storm water flows.

The 2008 NHC Memorandum, included in Appendix B, documents the analysis of existing and ultimate (future) runoff conditions for the 100-year 24-hour storm for existing channel and floodplain topography (i.e., without considering off-stream storage in the Chain of Lakes). Analysis of rainfall events requires two components, frequency and duration. Frequency indicates how often a particular storm event is likely to occur. For example, a 100-year storm event is likely to occur once in 100 years, or stated differently, it is a rainfall event that has only a one percent chance of occurring in any year. Duration indicates the time period over which the storm event would occur. Thus, a 24-hour storm would last 24 hours. It is typical industry practice to analyze a 24-hour duration storm, particularly for less frequent storm events (i.e., 100-year).

The specific objective of the analysis presented in the 2008 NHC Memorandum was to assess the changes in flood flows, stages, and volumes in Arroyo de la Laguna at Bernal Avenue.

As illustrated in Figure 5-3, the 2008 NHC Memorandum delineates two peaks in the flood wave at Bernal Avenue. The first peak, at 17 hours, is due to the flood inflow from the major streams in the Valley, while the second, smaller peak, beginning at 27.8 hours, is due to the delayed release of flood waters from Del Valle Reservoir. This reservoir is controlled and operated by the Department of Water Resources (DWR); consequently, the magnitude and timing of the second peak is a reflection of DWR's operation of the reservoir and not storm water runoff in the Valley. Therefore, only the flow rate up to 27.8 hours was considered.

Figure 5-4 illustrates both the existing and future flood waves at Bernal Avenue. The 2008 NHC memorandum reported that the increase in runoff stage, flow and volume for the first peak is due solely to the anticipated increase in future storm water runoff from new development.

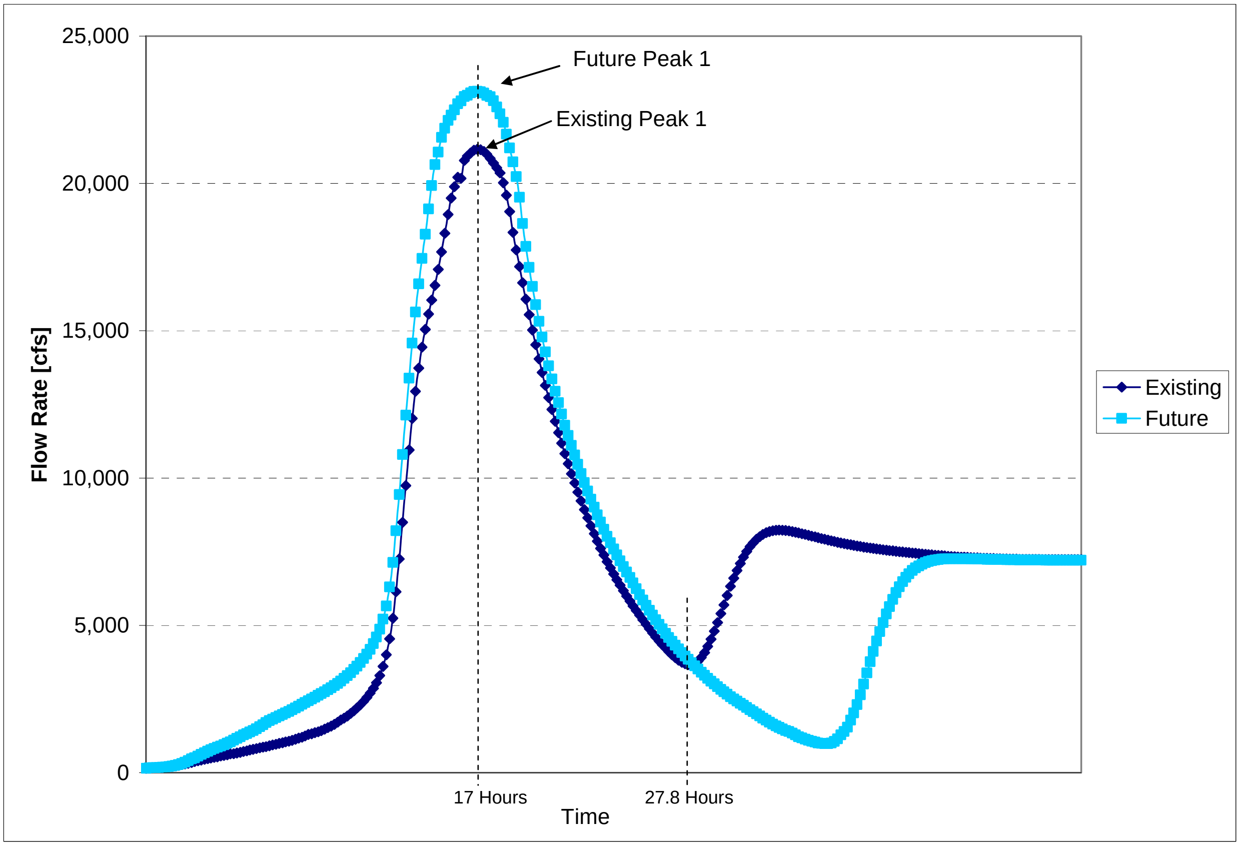

Figure 5-4. Existing and Future Peak Flood Waves for 100-year Rainfall Event for Arroyo de la Laguna at Bernal Avenue (2008 NHC Memorandum)

To determine the portion of storage in the Chain of Lakes required to offset the increase in the first peak flood wave in Arroyo de la Laguna, the increase in volume between the existing and future peaks was determined. The increase in volume is illustrated in Figure 5-5.

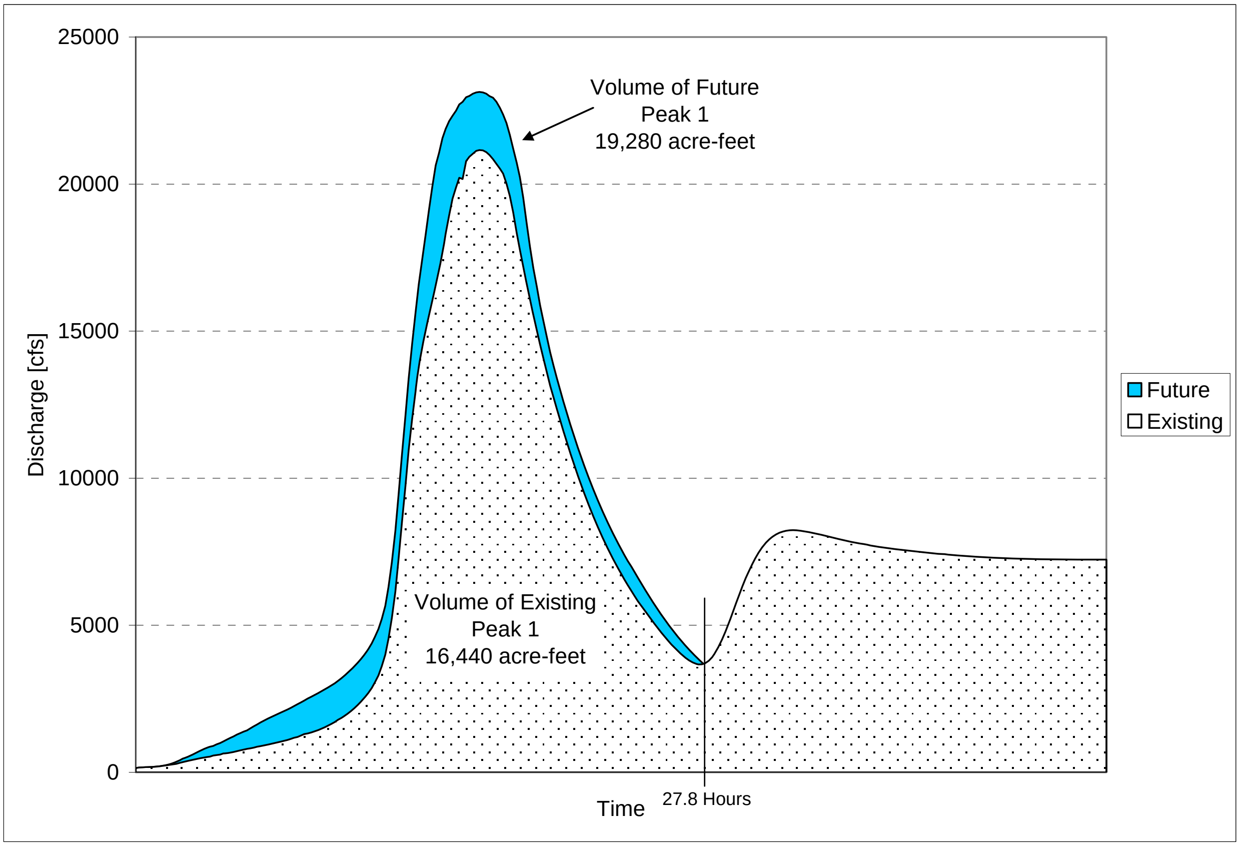

Figure 5-5. Existing and Future Storm Water Volume for First Peak Flood Wave for 100-year Rainfall Event for Arroyo de la Laguna at Bernal Avenue (2008 NHC Memorandum)

As the 2008 NHC Memorandum describes, the increase in volume between existing and future conditions, for the first peak only, is approximately 2,840 acre-feet, and is attributed solely to the increase in future runoff due to the creation of impervious surfaces created by future development. The Chain of Lakes elements of the SMMP have a storage capacity of 5,000 acre-feet. The additional volume of storm water therefore is 57% (2,840 divided by 5,000), of the total 5,000 acre-feet of storage capacity in the Chain of Lakes. In other words, approximately 57% of the storage volume in the Chain of Lakes is necessary to accommodate the increased storm water flow during a 100-year rainfall event, caused by increased impervious area created by future development. Therefore, 57%, or approximately $186 million, of the storage-related project costs were allocated to future development.

Cost Adjustment

As previously described, Zone 7 currently has a drainage fee in place under Ordinance 0-2002-24 to support the Special Drainage Area 7-1 (SDA 7-1) Program, which is the funding program for the 1960 Flood Control Master Plan. The SDA 7-1 Program currently has a positive balance of approximately $29 million. Although the SMMP has introduced a new suite of flood control and storm water drainage projects, the intended purpose of these projects remains the same as those under the 1960 Flood Control Master Plan, which is to manage storm water from new development and prevent flooding. Therefore, the payments collected for the SDA 7-1

Drainage Fee can be used to fund the SMMP projects. Consequently, the project cost allocations described in the previous two subsections were adjusted to account for the $29 million balance in the SDA 7-1 Program fund.

Specifically, the SDA 7-1 balance was split among existing and future development based upon their proportional share of the total costs for the flood protection and storm drainage projects. As a result, approximately 41% of the SDA 7-1 balance was allocated to future development, and was thus deducted from the total eligible project costs used to calculate the development impact fee.

Calculation of the Development Impact Fee

Using the methodologies described in the previous subsections, the total project cost eligible for inclusion in the development impact fee was determined to be $210,552,169[6]. This number was then divided by the impervious area expected to be created by new developments between 2007 and build out to determine the development impact fee. This resulted in a fee of $1.42 per square foot of impervious surface area (see Table 5-2). Details of the calculation of the development impact fee for flood protection and storm drainage projects are provided in Appendix A, Exhibit 3.

Table 5-2

Calculated Gross Development Impact Fee (1)

Conveyance Project Costs	**$36,167,301**
Storage Project Costs (2)	**+ 186,366,637**
Total Flood Protection and Storm Water Drainage Project Costs	**222,533,939**
Less Cost Adjustment for Existing SDA 7-1 Funds	**- 11,981,769**
Total Adjusted Flood Protection and Storm Water Drainage Costs	**210,552,169**
Future Impervious Area (Square Feet)	**÷ 148,013,317**
Development Impact Fee Per Square Foot of Impervious Area (3)	**$1.423**

(1) For further details, see Appendix A. All costs are presented in 2009 dollars.

(2) Table 5-3 of the Final SMMP lists the Flood Protection cost component of project R.5-2 as $20,290,000. However, inspection of Appendix G of the SMMP revealed that $5,760,000 of that amount was actually attributed to the Water Quality cost component. Therefore, it was determined, in collaboration with Zone 7 staff, that the Flood Protection cost component of R.5-2 should be reduced to $14,530,000, this value was then escalated to January 2009.

(3) The development impact fee is calculated as the total flood protection and storm water drainage project cost divided by the square feet of future impervious area.

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[6] All costs are referenced to January 2009 ENR Construction Cost Index for San Francisco, 9769.42.

Debt Service Credits

The final step in calculating Zone 7's development impact fee was to determine if a credit for payment on debt service is applicable for any future planned bonds or loans. Zone 7's Flood Protection and Storm Water Drainage section currently has no debt obligations, thus no debt service credit for existing debt was calculated. Additionally, since specific implementation of the SMMP, including sequencing and scheduling of the proposed projects, has not been finalized, it is difficult to estimate when and how much new debt will be required to finance the proposed projects. Therefore, no debt service credit has been calculated at this time. However, a sensitivity analysis was conducted to determine the trigger point where a debt service credit would begin to occur. Up to 25 percent of the total flood protection and storm water drainage related SMMP project cost (i.e., $138 million) can be debt financed without incurring a debt service credit, assuming a 5.5 percent interest rate over 20 years.

To illustrate how the debt service credit works, the example in Figure 5-6 has been developed, and is described below.

> *Since Zone 7's Flood Protection and Storm Water Drainage section currently has no existing debt, this example assumes bonds are sold in 2009 for 35 percent of the total SMMP costs at 5.5 percent interest and 20 years. When the debt is annualized over 20 years, the new annual debt is approximately $16 million per year. As Figure 5-6 illustrates, in years when the new debt is less than the estimated revenues collected for the development impact fee (in the example, 2023-2029), the net debt service is $0.00. However, in years when the new debt is greater than the estimated revenues from development impact fees (in the example, 2009-2022), the net debt service is the difference of the two values. The net debt service value is then divided by the total impervious area in that year to find a debt service credit per impervious square foot. Finally, the present worth of the credit for each year is calculated and summed to determine the total present value of the debt service credit. In the example shown, the debt service credit would be $0.04. Therefore, $0.04 would be subtracted from the "gross" development impact fee (as described further in the next section).*

Year	Annual Service Debt	DIF Revenue	Net Debt Service	Impervious Area (Sq Ft)	Debt / Sq Ft Impervious Area	Debt / Sq Ft Impervious Area ($2009)
2008	$0	$0	$0	755,643,757	$0.00	$0.0000
2009	16,204,478	10,675,413	5,529,065	762,694,423	0.01	0.0070
…	…	…	…	…	…	…
2021	15,220,587	983,892	847,302,413	0.00	0.0008	0.0006
2022	15,677,204	527,274	854,353,079	0.00	0.0004	0.0002
2023	16,147,520	56,958	861,403,745	0.00	0.0000	0.0000
…	…	…	…	…	…	…
2028	16,204,478	18,719,402	0	896,657,074	0.00	0.0000
2029	16,204,478	19,280,984	0	903,707,740	0.00	0.0000
Total Debt Service Credit ($ per sq ft)						**($0.0480)**

Figure 5-6 Example Calculation of a Debt Service Credit

In the example shown, it has been assumed that an equal number of impervious square feet are added each year to calculate the projected impervious square feet times the fee (which is inflated for an assumed inflation rate of 3 percent per year) to determine the projected "DIF Revenue". This method totals to the 148 million square feet of new impervious area, as shown in Table 5-1.

As financing information becomes clearer, Zone 7 should adjust the development impact fee to include a debt service credit to ensure that developers are not paying twice for the future improvements, once through the one-time development impact fee and again via on-going service taxes or rates.

Net Allowable Development Impact Fee

The net allowable development impact fee can be determined based on the sum of the costs calculated and described above. "Net" refers to the "gross" development impact fee less any debt service credits. "Allowable" refers to the concept that the calculated development impact fee shown in Table 5-3 is Zone 7's cost-based development impact fee. Zone 7, as a matter of policy, may charge any amount up to the allowable development impact fee, but not over that amount. Charging an amount greater than the allowable development impact fee would not meet the nexus test of a cost-based development impact fee. Likewise, charging amounts lower than the calculated fee moves away from the equity balance between existing and new developments. A summary of the calculated net allowable development impact fees for Zone 7 is provided in Table 5-3.

Table 5-3

Calculated Net Allowable Development Impact Fee (1)

Future Flood Protection and Storm Water Drainage Facilities	$1.423
Debt Service Credit	(0.000)
Total Fee Per Square Foot of Impervious Area	$1.423

(1) All costs are presented in 2009 dollars.

The fee is rounded for ease in implementation and customer understanding. The recommended fee for a single square foot of impervious area is $1.42.

All developments will clearly introduce more than one square foot of impervious surface area. For example, a typical residential home may have approximately 2,400 square feet of impervious area associated with it. An example of the total development impact fees for various quantities of impervious areas is shown in Table 5-4 to illustrate the magnitude of the fee for different development sizes.

Table 5-4

Example of Implementation of Development Impact Fee Per Impervious Area of New Development

Square Feet of Impervious Area	Development Impact fee
2,400	$3,408
10,000	14,200
20,000	28,400
50,000	71,000
100,000	142,000

Key Assumptions

In developing the development impact fees for Zone 7's flood protection and storm water drainage system, a number of key assumptions were utilized. These are as follows:

- The project costs in the SMMP were used to calculate the development impact fee.
- Zone 7's 2007 NHC Memorandum was used to determine estimates of future new development impervious area.
- Zone 7's 2008 NHC Memorandum was used to determine the portion of storage in the Chain of Lakes which is attributed to future development.
- All system costs were calculated to 2009 dollars (based upon the ENR Construction Cost Index for San Francisco, January 2009, 9769.42).

Implementation of the Development Impact Fees

The methodology used to calculate the development impact fees takes into account the cost of money, interest, and inflation. The calculated fees are in January 2009 dollars. HDR therefore recommends that Zone 7 adjust the development impact fees each year by an escalation factor to reflect the cost of interest and inflation. The most frequently used source to escalate development impact fees is the Engineering News-Record (ENR) Construction Cost Index, which tracks changes in construction costs for municipal utility projects. This practice is consistent with the existing fee increases Zone 7 has implemented in recent years.

Development Impact Fee Special Circumstances

In recent years, Zone 7 has been approached regarding waivers for, or exclusions from, the existing development impact fee because it is argued that storm water from certain developments does not drain to Zone 7's flood protection and storm water drainage facilities due either to topography or detention in an on-site basin.

Due to the topography within Zone 7's service boundary, there are regions within the service boundary which do not drain to Zone 7's flood protection and storm water drainage facilities. The Service Area used as the basis for calculating and imposing the development impact fee encompasses the Alameda Creek watershed area within Zone 7's service boundary. Thus, regions within Zone 7's service boundary which do not drain to the Alameda Creek watershed would not be subject to the fee.

In addition to topography considerations, many new developments are built with storm water detention basins and have requested exemptions from the development impact fee. However, the SMMP is designed to provide regional flood protection and storm water drainage during a 100-year storm event. Detention basins built at new developments are typically intended to collect storm water to design standards for the local land use development requirements, or for irrigation purposes, or other similar uses. These facilities still eventually contribute flow to the Zone 7 system because they are not built to provide 100-year flood protection, nor are they built to operate in a regionally beneficial manner to Zone 7's system.

It is unlikely that a developer would install a storm water detention basin large enough to accommodate the runoff from a 100-year event, and then detain that water for a period that provides the equivalent benefit provided by the Chain of Lakes. Therefore, the excess water from a smaller basin would eventually flow to Zone 7's flood protection and storm water drainage facilities before the system is ready to receive it; thereby, reducing Zone 7's ability to coordinate runoff during a 100-year rainfall event. A storm water detention system sized to accommodate a 100-year event would likely not be cost effective, despite the savings from water reusage and potential developer fee exclusions. Nonetheless, should a developer choose to install such a 100-year system, Zone 7 should offset the development impact fees by an amount proportional to the capacity of the proposed 100-year detention system, based on the savings to the District per the planned facilities within the SMMP that would now be unnecessary. In these cases, it is recommended that Zone 7 request the system design from the developer, including drawings, specifications, and/or cut sheets for a pre-fabricated system. The developer should also be expected to produce hydrology and hydraulic analyses from an engineer licensed in the State of California establishing that the development's storm water would not contribute to Zone 7's flood protection and storm water drainage system. A geotechnical analysis from a civil engineer licensed in the State of California may also be necessary to determine whether the area is hydrologically capable of drainage or percolation claims. Finally, the proposed facilities must be operated and maintained in perpetuity such that they continue to provide the proposed level of service (i.e., storage for a 100-year rainfall event for a detention time equal to that provided by the Chain of Lakes project).

In adopting and implementing the new development impact fee, Zone 7 should provide a mechanism for a landowner/developer to apply for a fee waiver or exemption if it can demonstrate (through the engineering analyses described above) that its project provides the same regional benefit as the SMMP project, will not contribute storm water to the existing and new Zone 7 facilities, will not otherwise benefit from the facilities, or if there is no nexus between the fee and the project. In those special circumstances, Zone 7 may evaluate particular projects on a case-by-case basis.

Consultant Recommendations

Based on our review and analysis of Zone 7's development impact fees, HDR recommends the following:

- Zone 7 should establish development impact fees for the system that are no greater than the fees as set forth in this report.
- Zone 7 should update the actual calculations for the development impact fees based on the methodology approved by the resolution or ordinance setting forth the methodology for development impact fees at such time when a new capital improvement plan, SMMP implementation plan or a comparable plan is updated or approved by Zone 7.
- In adopting and implementing the new development impact fees, Zone 7 should provide a mechanism for a landowner/developer to apply for a fee waiver if it can demonstrate that its project will not contribute storm water to the existing and new Zone 7 facilities or will not otherwise benefit from the facilities, or if there is no nexus between the fee and the project. In those special circumstances, Zone 7 may evaluate particular projects on a case-by-case basis.

Summary

The development impact fee presented in this chapter of the report is based on the engineering design criteria of Zone 7's flood protection and storm water drainage system, the cost of future capital improvements benefiting new development and "generally accepted" ratemaking principles. Specifically, the amount of future impervious surface created in the service area has been used as the basis for development of the development impact fee because impervious surfaces contribute to surface runoff which increases the storm water flow and can contribute to erosion and sedimentation impacts, which Zone 7's flood protection and storm water drainage facilities must accommodate.

In addition to the future capital improvements, debt service credit is typically calculated and deducted from the development impact fee. However, at this time, no debt service credit has been included because there is no plan yet in place for funding the SMMP costs. Once this information becomes available, the development impact fee should be revisited and updated to include debt service credit as appropriate. The net allowable development impact fee is $1.42 per square foot of impervious area.

As Zone 7 adopts and implements the updated development impact fee by ordinance, a mechanism should be included under which a landowner/developer could apply for a fee waiver or exemption if the landowner/developer can demonstrate that its project will not contribute storm water to the existing and new Zone 7 facilities or will not otherwise benefit from the facilities, or if there is no nexus between the fee and the project. In those special circumstances, Zone 7 may evaluate particular projects on a case-by-case basis to determine whether or not a fee waiver or exemption is appropriate.

APPENDIX A
Development Impact Fee Calculations

Development Impact Fee Calculations
Exhibit 1
Development of Impervious Area

Basin	Total Land (Sq Ft) [1]	Existing Impervious Surface Area (Sq Ft) [1]	Additional Impervious Surface Area (Sq Ft) [1]	Impervious Surface Area at Buildout (Sq Ft) [1]
A	525,607,939	0	0	0
B	789,524,281	67,689,293	26,166,362	93,855,655
E	664,898,191	98,625,448	16,211,885	114,837,333
F	160,538,214	54,236,199	5,607,177	59,843,377
G	1,793,051,799	234,537,347	49,806,291	284,343,638
H	365,800,347	113,794,419	21,924,267	135,718,686
J	88,612,323	30,549,002	380,574	30,929,576
K	84,286,133	2,191,439	758,575	2,950,015
L	109,047,899	2,617,150	1,090,479	3,707,629
M	110,454,543	8,284,091	1,656,818	9,940,909
N	158,309,616	0	0	0
P	795,206,186	94,548,738	19,701,650	114,250,388
R	407,259,891	11,656,459	1,786,299	13,442,757
S	77,740,416	155,481	0	155,481
T	132,860,905	22,586,354	2,922,940	25,509,294
U [2]	392,764,826	0	0	0
W [2]	70,017,213	0	0	0
X [2]	490,820,674	0	0	0
Y [2]	164,117,917	0	0	0
AC-1 [3]	939,841,070	0	0	0
AC-2 [3]	2,112,365,659	0	0	0
	10,433,126,042	741,471,420	148,013,317	889,484,737

Estimated Increase in Impervious Surface Due to Future Development **17%**

Notes:

[1] Based on data compiled from Memorandum prepared by Northwest Hydraulic Consultants, August 3, 2007. The hydrologic basins presented in the August 2007 Memorandum do not match the Zone 7 service area. Therefore, the total area considered by Northwest Hydraulic Consultants was changed such that the total area being considered matches the total area of the Zone 7 service area. The area lying outside of the Zone 7 service area was not included in the calculation of impervious surface. Zone 7 does not have authority to assess fees outside its service area boundary. Also, the area lying within the Zone 7 service area but outside the area included by Northwest Hydraulic Consultants have been denoted as areas AC-1 and AC-2, respectively.

[2] Although Basins U, W, X and Y are located within Zone 7's service area, these Basins drain eastward toward San Joaquin County. Thus, they do not contribute stormwater to the Alameda Creek watershed. Therefore, the existing and future impervious surface area in Basins U, W, X and Y was not included in the calculation of the development impact fee.

Development Impact Fee Calculations
Exhibit 2
Summary of SMMP Projects

Project	Name	Original SMMP Project Costs [1]	Costs Allocated to Flood Control [2]	Updated Flood Protection Cost [3]
R.1-1	Altamont Creek Improvements	$3,739,313	$1,020,000	$1,177,595
R.1-2	Alkali Sink Management	4,745,000	0	0
R.1-3	Springtown Improvements	3,245,500	2,510,000	2,897,807
R.1-4	Springtown Golf Course Improvements	2,208,171	560,000	646,523
R.1-5	Arroyo las Positas Habitat Enhancement and Recreation Project	9,230,500	2,190,000	2,528,366
R.1-6	Arroyo las Positas Multi-Purpose Project	32,342,863	4,200,000	4,848,920
R.1-7	Capacity Improvement at Arroyo las Positas	1,299,325	400,000	461,802
R.2-1	Velocity Control Project	19,705,575	4,510,000	5,206,817
R.2-2	Arroyo Seco Improvements	3,497,613	2,540,000	2,932,442
R.2-3	Arroyo Seco Trail Project	1,650,000	0	0
R.3-1	South Bay Aqueduct Turnout Construction and Low-Flow Crossings	1,230,000	0	0
R.3-2	Robertson Park Enhancement Project and Levee Construction	28,348,750	14,770,000	17,052,037
R.3-3	Parks Floodplain Dedication and Levee Construction	19,150,875	14,850,000	17,144,397
R.3-4	Holmes St. Sedim. Basin and Granada/Murrieta Prot. and Enh. Prj	14,009,000	9,780,000	11,291,057
R.3-5	Fish Barrier Removal at Stanley Boulevard and Railroad Overcrossing	7,870,000	0	0
R.4-1	Sycamore Grove Recharge Bypass Project	1,200,000	0	0
R.4-2	Sycamore Grove Park Trail Connections	2,260,000	0	0
R.5-1	North of I-580 Trail System	22,390,000	0	0
R.5-2	Airway Improvement Project [4]	28,378,250	14,530,000	16,774,955
R.5-3	Arroyo Las Positas Diversion Project	158,678,669	148,870,000	171,871,136
R.6-1	Arroyo Mocho Management Plan	11,030,000	0	0
R.6-2	Arroyo Mocho Bypass and Regional Storage at Chain of Lakes	136,603,625	120,800,000	139,464,185
R.7-1	Upper Chain of Lakes Trail Network and Bypass	6,790,000	0	0
R.7-2	EBRPD Trail Connections	1,920,000	0	0
R.7-3	Lower Arroyo del Valle Restoration and Enhancement Project	23,755,363	80,000	92,360
R.8-1	Tassajara Creek Improvement Project	9,307,250	3,390,000	3,913,771
R.8-2	Chabot Canal Improvement Project	21,089,125	18,150,000	20,954,263
R.8-3	Lower Arroyo Mocho Improvement Project	32,823,750	12,780,000	14,754,572
R.8-4	Upper Arroyo de la Laguna (ADLL) Improvement Project	56,092,375	44,220,000	51,052,204
R.9-1	Alamo Canal/South San Ramon Creek Erosion Control	12,198,750	6,270,000	7,238,745
R.9-2	Line F-4 Concrete Lining	1,337,750	1,250,000	1,443,131
R.9-3	Line J-1, J-3, and J-5 Improvements	9,789,875	8,470,000	9,778,656
R.9-4	Line T Crossing Retrofit	3,239,875	2,950,000	3,405,789
R.9-5	I-580 Trail Gap Elimination	860,000	0	0
R.9-6	Line G-1-1 Maintenance Plan	2,244,150	290,000	334,806
R.9-7	Alamo Canal Flood Control Program	13,469,375	8,710,000	10,055,737
R.10-1	ADLL Improvement Project 1	7,610,413	1,720,000	1,985,748
R.10-2	ADLL Improvement Project 2	4,464,773	970,000	1,119,870
R.10-3	ADLL Improvement Project 3	8,266,063	6,360,000	7,342,651
R.10-4	ADLL Improvement Project 4	5,419,750	2,420,000	2,793,902
R.10-5	ADLL Improvement Project 5	29,944,204	12,630,000	14,581,396
R.11-1	Alameda Creek Trail	3,100,000	0	0
R.11-2	Sinbad Creek Project	324,999	270,000	311,716
R.12-1	Patterson Run Enhancement Program	873,024	820,000	946,694
R.12-2	Corral Hollow Creek Landowner Grant Program	213,000	200,000	230,901
	Total Costs	$767,946,893	$473,480,000	$546,634,954

Notes:

[1] Data obtained from Table 5-3 of the Final SMMP.

[2] Only the projects described in the SMMP which have flood control components, whether conveyance or storage related, are eligible for inclusion in the DIF. The costs for the flood control project components include associated costs for environmental mitigation, contractor overhead and profit, construction contingencies, engineering and administrative costs, and land acquisition.

[3] Based on Jan 2009 SF ENR Index 9769.42

[4] Table 5-3 of the Final SMMP lists the Flood Protection cost component of project R.5-2 as $20,290,000. However, inspection of Appendix G of the SMMP revealed that $5,760,000 of that amount was actually attributed to the Water Quality cost component. Therefore, it was determined, in collaboration with Zone 7 staff, that the Flood Protection cost component should be reduced to $14,530,000.

Development Impact Fee Calculations
Exhibit 3
Development Impact Fee Based on SMMP Project Eligibility

Reach	Project ID	Name	Cost $2009 [1]	Percent Eligible	DIFs Eligible
Conveyance Projects [2]					
1	R.1-1	Altamont Creek Improvements	$1,177,595	17%	$195,956
1	R.1-3	Springtown Improvements	2,897,807	17%	482,205
1	R.1-4	Springtown Golf Course Improvements	646,523	17%	107,584
1	R.1-5	Arroyo las Positas Habitat Enhancement and Recreation Project	2,528,366	17%	420,729
1	R.1-6	Arroyo las Positas Multi-Purpose Project	4,848,920	17%	806,877
1	R.1-7	Capacity Improvement at Arroyo las Positas	461,802	17%	76,845
2	R.2-1	Velocity Control Project	5,206,817	17%	866,432
2	R.2-2	Arroyo Seco Improvements	2,932,442	17%	487,968
3	R.3-2	Robertson Park Enhancement Project and Levee Construction	17,052,037	17%	2,837,517
3	R.3-3	Parks Floodplain Dedication and Levee Construction	17,144,397	17%	2,852,887
3	R.3-4	Holmes St. Sedim. Basin and Granada/Murrieta Prot. and Enh. Prj	11,291,057	17%	1,878,871
7	R.7-3	Lower Arroyo del Valle Restoration and Enhancement Project	92,360	17%	15,369
8	R.8-1	Tassajara Creek Improvement Project	3,913,771	17%	651,265
8	R.8-2	Chabot Canal Improvement Project	20,954,263	17%	3,486,861
8	R.8-3	Lower Arroyo Mocho Improvement Project	14,754,572	17%	2,455,211
8	R.8-4	Upper Arroyo de la Laguna (ADLL) Improvement Project	51,052,204	17%	8,495,262
9	R.9-1	Alamo Canal/South San Ramon Creek Erosion Control	7,238,745	17%	1,204,552
9	R.9-2	Line F-4 Concrete Lining	1,443,131	17%	240,142
9	R.9-3	Line J-1, J-3, and J-5 Improvements	9,778,656	17%	1,627,202
9	R.9-4	Line T Crossing Retrofit	3,405,789	17%	566,735
9	R.9-6	Line G-1-1 Maintenance Plan	334,806	17%	55,713
9	R.9-7	Alamo Canal Flood Control Program	10,055,737	17%	1,673,309
10	R.10-1	ADLL Improvement Project 1	1,985,748	17%	330,435
10	R.10-2	ADLL Improvement Project 2	1,119,870	17%	186,350
10	R.10-3	ADLL Improvement Project 3	7,342,651	17%	1,221,842
10	R.10-4	ADLL Improvement Project 4	2,793,902	17%	464,915
10	R.10-5	ADLL Improvement Project 5	14,581,396	17%	2,426,394
11	R.11-2	Sinbad Creek Project	311,716	17%	51,871
12	R.12-1	Patterson Run Enhancement Program	946,694	0%	0
12	R.12-2	Corral Hollow Creek Landowner Grant Program	230,901	0%	0
					$36,167,301
Storage Projects [3]					
5	R.5-2	Airway Improvement Project [4]	16,774,955	57%	9,528,175
5	R.5-3	Arroyo Las Positas Diversion Project	171,871,136	57%	97,622,805
6	R.6-2	Arroyo Mocho Bypass and Regional Storage at Chain of Lakes	139,464,185	57%	79,215,657
					$186,366,637
Total Flood Protection and Storm Water Drainage Projects			$546,634,954		$222,533,939
Adjustment for Existing SDA Balance [4]			29,432,157	41%	11,981,769
Total Adjusted Flood Protection and Storm Water Drainage Projects					**$210,552,169**
New Impervious Area at Buildout (sq ft)					**148,013,317**
DIF per square foot Impervious Area					**$1.423**

Notes:

[1] Project costs, based on Table 5-3 of SMMP, were updated based on the January 2009 SF ENR Construction Cost Index, 9769.42

[2] The costs of conveyance related projects are 17% eligible for inclusion in the development impact fee, based upon the ratio of future impervious surface area to total impervious surface area at build out conditions. Projects R.12-1, Patterson Run Enhancement Program and R.12-2, Corral Hollow Creek Landowner Grant Program are located in Basins Y and X, respectively, which drain eastward toward San Joaquin County. Since these two conveyance-related projects do not contribute to flood protection and storm water drainage in the Alameda Creek Watershed, they have not been included in the calculationof the development impact fee.

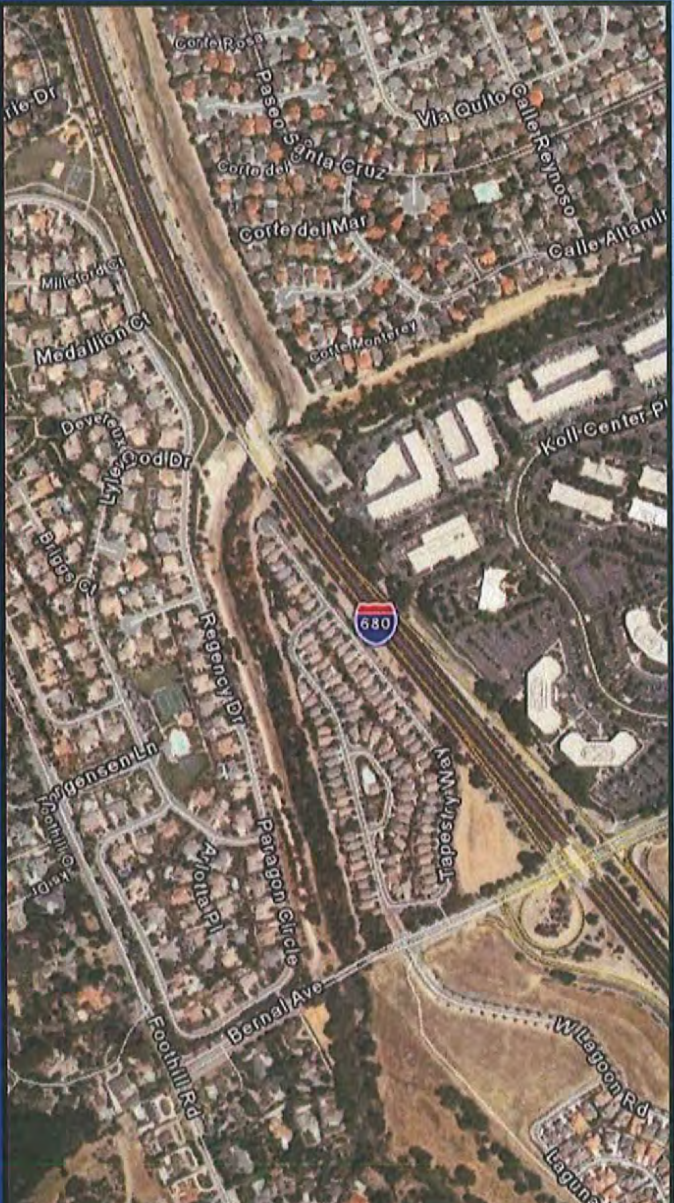
[3] The costs of storage-related projects are 57% eligible for inclusion in the development impact fee based upon the storage volume required to offset the additional storm water flows attributed to the impervious surfaces created by future development such that the peak flood wave at the outlet of Zone 7's service area does not increase between now and build out conditions.

[4] The Total Flood Protection and Storm Water Drainage Projects DIF Eligible cost was adjusted to reflect a deduction due to the existing balance in the SDA Fund. The existing SDA balance was split among existing and future development based upon the proportion of total DIFs Eligible to total $2009 SMMP Costs.

APPENDIX B
2008 NHC Memorandum

EXISTING AND ULTIMATE STORM WATER RUNOFF CONDITIONS DURING A 100-YEAR RAINFALL EVENT IN ARROYO DE LA LAGUNA AT BERNAL AVENUE

Technical Memorandum



Prepared for:

Zone 7 Water Agency

100 North Canyons Parkway
Livermore, CA 94551

Prepared by:

Northwest Hydraulic Consultants

3950 Industrial Boulevard
West Sacramento, CA 95691
916-371-7400

October 15, 2008

REGISTERED PROFESSIONAL ENGINEER
LEONARD J. HOWARD
53319
Exp. 6/09
CIVIL
STATE OF CALIFORNIA

nhc

EXISTING AND ULTIMATE STORM WATER RUNOFF CONDITIONS DURING A 100-YEAR RAINFALL EVENT IN ARROYO DE LA LAGUNA AT BERNAL AVENUE

INTRODUCTION

Zone 7 Water Agency (Zone 7) requested Northwest Hydraulic Consultants (**nhc**) quantify storm water flows and stages during a 100-year rainfall event in Arroyo de la Laguna at Bernal Avenue under existing and future runoff conditions, and existing channel and floodplain geometry. The assessment of storm water flows and inundation levels was conducted using a one-dimensional (1-d) unsteady Hydrologic Engineering Center's River Analysis System (HEC-RAS) model (version 3.1.3) developed by **nhc**.

This model combines two different HEC-RAS models: the **nhc** model of Arroyo Las Positas and Arroyo Mocho in the vicinity of their confluence and the Pleasanton Letter of Map Revision (LOMR) model of the lower Arroyo Mocho, Alamo Canal, and Arroyo de la Laguna. The **nhc**'s model includes a 3.5 mile long reach of Arroyo Las Positas and a 3.9 mile long reach of Arroyo Mocho, as well as adjacent floodplain storage areas. The model extends from Arroyo Las Positas at Interstate 580 near Isabel Avenue and Arroyo Mocho at Isabel Avenue to about 0.9 miles downstream of the confluence of the creeks. The **nhc**'s model was extended by about 5.3 miles downstream to Arroyo de la Laguna below Bernal Avenue using the Pleasanton LOMR HEC-RAS model developed by Schaaf and Wheeler and provided by Zone 7. The study areas included in each of the models are shown in Figure 1.

This study uses the extended HEC-RAS model to simulate the existing and ultimate (future) runoff conditions of the 100-year rainfall event for existing channel and floodplain topography and existing hydraulic structures. Inflow hydrographs for the model were determined using the HEC-1 model developed by Schaaf and Wheeler (1997) for Zone 7. The main objective of this modeling activity was to assess changes in storm water flows, stages, and volumes in Arroyo de la Laguna at Bernal Avenue due to anticipated changes in runoff conditions (i.e., existing versus future 100-year rainfall events).

This memorandum describes the development of the HEC-RAS model, derivation of input data used in the model, key assumptions, model parameters, and results from the computer simulations obtained for Arroyo de la Laguna at Bernal Avenue for existing and ultimate runoff conditions and existing topography. All elevations in the report are given in feet, NAVD88.

STUDY AREA

The study area is located in the Livermore-Amador Valley, Alameda County, California and includes reaches of Arroyo Las Positas, Arroyo Mocho, Alamo Canal, and Arroyo de la Laguna, as well as floodplain storage areas adjacent to the confluence of Arroyo Las Positas and Arroyo Mocho. The study reach of Arroyo Las Positas is about 3.5 miles in length and extends from Interstate 580 to the confluence with Arroyo Mocho at El Charro Road. The study reach of

Arroyo Mocho is approximately 6.9 miles long and extends from Isabel Avenue to the confluence with Alamo Canal. The study reach of Alamo Canal is about 1.6 miles long, extending from Interstate 580 to the confluence with Arroyo Mocho. The study reach of Arroyo de la Laguna is 2.3 miles long and extends from the confluence of Arroyo Mocho and Alamo Canal to about 0.7 miles downstream of Bernal Avenue Bridge. The modeled stream network schematic is shown in Figure 1.

Within the study area, Arroyo Las Positas flows west through the Las Positas Golf Course to the confluence with Arroyo Mocho. Between Interstate 580 and Kitty Hawk Road, Arroyo Las Positas flows through an unlined, winding, heavily vegetated channel. The width of the channel is about 70-130 ft and average slope is around 0.4-0.5 %. Between Kitty Hawk Road and Airway Boulevard, Arroyo Las Positas runs through a 4,200 ft long flood control channel with a top width of about 130-190 ft and average longitudinal bed slope of 0.2 %. Downstream of Airway Boulevard, Arroyo Las Positas transitions to a vegetated, winding, unlined channel with a top width of about 50 ft and average bed slope of 0.3 %. Approximately 1,200 ft upstream of the Vulcan Bridge, Arroyo Las Positas enters via a drop structure with a fish ladder into a recently constructed flood control channel having a top width of 200 ft and average bed slope of about 0.3 %. Two small creeks (Collier Creek and Cottonwood Creek) enter Arroyo Las Positas from the north about 0.2 miles downstream of Kitty Hawk Road and 1.2 miles upstream of El Charro Road, respectively. According to the hydrologic report prepared by Schaaf and Wheeler (2007), the total drainage area of Arroyo Las Positas is about 80 square miles.

Arroyo Mocho downstream of Isabel Avenue runs west parallel to Stanley Boulevard for a distance of about 1 mile, then bends at a 45-degree angle and flows for a distance of 1.8 miles between the existing quarries (called lakes) in the north-westerly direction to the confluence with Arroyo Las Positas. Upstream of the confluence, Arroyo Mocho flows through an unlined, heavily vegetated trapezoidal channel with a top width of about 60-80 ft and average longitudinal slope of around 0.3-0.4 %. Arroyo Mocho joins the flood control channel via a drop structure with a fish ladder downstream of the Vulcan Bridge. The flood control channel conveys flows from Arroyo Las Positas and Arroyo Mocho further westerly and then south-westerly through the City of Pleasanton to Arroyo de la Laguna. The top width of the flood control channel ranges from about 160-220 ft in the upper reaches to 120-140 ft in the lower reaches. Average longitudinal slope of the flood control channel is approximately 0.2-0.3 % in the upper reaches and 0.1-0.2 % in the lower reaches. Line G-3, Tassajara Creek, and Chabot Canal join the flood channel from the north about 0.8 miles upstream of Santa Rita Road Bridge, 0.6 miles downstream of Stoneridge Road Bridge, and 0.2 miles upstream of Hopyard Road Bridge, respectively. The drainage area of Arroyo Mocho at the confluence with Arroyo Las Positas is about 57 square miles (Schaaf and Wheeler 2007).

The study reach of Alamo Canal runs south-easterly and carries water from Alamo Creek. The top width of the canal is about 110-130 ft and average longitudinal slope is about 0.09 %. Line G-1-1 joins the study reach of Alamo Canal from the east about 0.5 miles upstream of Arroyo Mocho outlet. Tehan Creek discharges from the west about 0.2 miles upstream of Arroyo Mocho outlet.

Arroyo de la Laguna is a southward-flowing stream which originates at the confluences of Alamo Canal and Arroyo Mocho. Upstream of Bernal Avenue, Arroyo de la Laguna flows through an engineered trapezoidal channel. Top width of the channel is 180-250 ft. Average bed slope of the channel increases in the downstream direction from around 0.04 to 0.2 %. Downstream of Bernal Avenue, the stream flows through a 50-100 ft wide natural channel, having average bed slope of about 0.3 %. Pleasanton Canal and Arroyo del Valle enter the study reach of Arroyo de la Laguna from the east about 0.4 miles downstream of Arroyo Mocho outlet and immediately upstream of Interstate 680, respectively. An unnamed creek discharges into Arroyo de la Laguna from the west about 0.4 miles downstream of Arroyo Mocho outlet. The drainage area at Bernal Avenue is about 394 square miles (Schaaf and Wheeler 2007).

The undeveloped floodplain areas modeled in this study include open fields adjacent to the confluence of Arroyo Las Positas and Arroyo Mocho. One undeveloped floodplain area (called here El Charro Basin) is located on the northern floodplain of Arroyo Las Positas and is bordered by Interstate 580 from the north, El Charro Road from the west, and Cottonwood Creek from the east. Another undeveloped area (Staples Ranch) is located on the west side of El Charro Road, between the flood control channel and Interstate 580. The third undeveloped area (called here Airport Basin) is located on the southern floodplain of Arroyo Las Positas west from the Livermore Municipal Airport. The floodplain storage areas are separated from the flood control channel by low levees. Gaps are provided in the levees to allow outflow from the floodplains to the flood control channel. Also modeled in this study are lakes (former gravel quarries) located on both sides along Arroyo Mocho and providing storage of flood waters during overbank flows.

DESCRIPTION OF COMPUTER MODEL HEC-RAS

The HEC-RAS is a computer program designed to perform 1-d, steady and unsteady flow computations (USACE 2008). In steady state mode, the program is intended for computing both sub-critical and super-critical flows. The basic computational procedure is based on the solution of the 1-d energy equations for gradually varied flows. The momentum equation is utilized in situations where the water surface profile is rapidly varied. In unsteady state mode, the program is intended for simulating time-variant flows (i.e. flow and stage hydrographs). The unsteady flow component is based on the solution of the equations of conservation of mass and momentum, and was developed primarily for sub-critical flow regime computations. The unsteady flow component also provides routines for modeling floodplain storage areas (in which water can be diverted into or from) and routing hydraulic linkages between main channel conveyance and floodplain storage. The effects of various obstructions such as bridges, culverts, weirs, and structures in the floodplain may be considered in the computations. The basic required inputs to the model are channel geometry, encroachments and ineffective flow areas, channel roughness, contraction and expansion losses due to changes in cross sections, storage areas information, hydraulic structures data, flow regime, hydraulic boundary conditions, and initial flow and stage conditions.

The HEC-RAS model is based on the following assumptions:

- The channel is sufficiently straight and uniform so that the flow may be physically represented by a 1-d flow model;
- The flow is normal to the cross-section;
- The water surface elevation and velocity vary only in the longitudinal direction;
- The water surface is horizontal in each cross-section; the velocity is uniformly distributed over the cross section;
- Transverse effects are negligible;
- The pressure distribution is hydrostatic; and
- The river channel slope is small (less than 0.1).

HEC-RAS MODEL DEVELOPMENT

nhc originally developed an unsteady HEC-RAS model of Arroyo Las Positas, Arroyo Mocho, and adjacent floodplain storage areas to simulate flood flow dynamics and extend of inundation in the vicinity of the confluence of these streams. The model includes approximately 3.5 mile long reach of Arroyo Las Positas and 3.9 mile long reach of Arroyo Mocho. The study area included in the **nhc**'s model is shown in Figure 1. The following sections describe the methods, approximations, and assumptions used in developing the model.

Channel Geometry: Arroyo Las Positas and Arroyo Mocho

Cross-section data for the **nhc**'s model was obtained from a Triangulated Irregular Network (TIN) model developed using the digitized 2-foot interval contours and spot elevation data collected by Zone 7 in 2003. The cross-sections extend between high banks (levees, berms, high grounds) and include the low-flow channel and adjacent floodplain areas. The distance between cross-sections depends on the complexity of the channel topography and ranges from 20-150 ft in the vicinity of drop structures and bridges to around 200-600 ft in relatively uniform, non-constricted channel reaches. Shorter intervals between cross-sections were specified at the hydraulic structures for the computation of energy losses due to the structures.

A contraction coefficient of 0.1 and expansion coefficient of 0.3 were specified in the model in accordance with the HEC-RAS Hydraulic Reference Manual recommendations. The Manning's roughness coefficient "n" was estimated from field observations, aerial photographs, and technical references (Chow 1959, Barnes 1967) and was set to 0.04 for the flood control channels and 0.08 for the heavily vegetated creek channels and overbank areas.

Storage Areas: Chain of Lakes Area

Low-laying floodplain regions and existing lakes located in the vicinity of the confluence of Arroyo Las Positas and Arroyo Mocho were modeled as interconnected storage areas in which water can flow into or out of. Altogether, 13 storage areas were specified for modeling flood flow dynamics in the study area (see Figure 1). "Basin A" represents the low portion of Airport Basin. El Charro Basin was split in the model into two interconnected sub-basins ("Basin B" and "Basin C") for more accurate representation of flooding dynamics in this area. "Basin D" represents a topographic depression between El Charro Road ramps and Interstate 580. Model

"Basin E" represents the low portion of Staples Ranch in the vicinity of a residential development. "Basin F" is a dummy basin representing low-lying area north of Interstate 580. In reality, flows spilling north over Interstate 580 enter Zone 7's Line G-3 and eventually return to the Arroyo Mocho system. However, due to attenuation and delay of these overbank flows, they are believed to have no effect on peak flows and peak stages in the lower reaches of Arroyo Mocho and in Arroyo de la Laguna. Therefore, in the model these spills are not conveyed into the downstream reach of Arroyo Mocho for simplicity. "Basin G" represents a small area enclosed with a levee and located at the upstream end of the study reach of Arroyo Mocho, between the creek and Stanley Boulevard. "Lake D" is a dummy storage area representing lakes south of Stanley Boulevard. Model storage areas "Lake G", "Lake H", "Chain of Lakes", and "Cope Lake" are dummy basins representing the lakes (quarries) located on both sides of Arroyo Mocho. Model storage area "Pleasanton" is a dummy storage basin designed to provide outlet from Basin E. The specified storage areas are separated from the creeks and from each other by a system of levees, berms, road embankments, and high grounds.

Stage-volume relationships were derived for each non-dummy storage area using the TIN model developed from the topographic data provided by Zone 7. The developed stage-volume curves are shown in Figure 2. These curves were used to represent the storage areas in the HEC-RAS model. For modeling purposes, all the dummy storage areas were assigned an area of 1,000 acres with the minimum bed elevation of 0.0 ft to provide unlimited water storage. All the storage areas in the model were assumed to be initially dry at the beginning of the simulations.

Hydraulic Structures: Chain of Lakes Area

The hydraulic structures included in the **nhc** model are the Kitty Hawk Road Bridge and Airway Boulevard culvert on Arroyo Las Positas, Hagemann Bridge and a road bridge in the reach of Arroyo Mocho running along Stanley Boulevard, drop structures in Arroyo Las Positas and Arroyo Mocho at the entrances to the flood control channel, drop structures in the flood control channel between the Vulcan and Hanson Bridges, and lateral structures (which include engineered and non-engineered levees/berms/road embankments/high grounds) running along the creek channels and separating the floodplain storage areas from each other. The dimensions and elevations of the bridges and culverts included in the model were determined from drawings and survey data provided by Zone 7. The Vulcan and Hanson Bridges do not affect flooding of the modeled floodplain storage areas (which were the main focus of the original **nhc**'s model), have little effect on flows in the flood control channel, and therefore were not included in the model. A few pedestrian bridges on Arroyo Las Positas within the golf course reach were assumed to have insignificant effect on flood flows due to their small dimensions and, therefore, were not included in the model for simplicity.

Typical values of contraction and expansion coefficients of 0.3 and 0.5, respectively, were specified for all the modeled bridges, in accordance with the recommendations of the HEC-RAS Hydraulic Reference Manual. The energy-based method was used for computing low flow surface profiles through the bridges. The pressure and weir flow method was used for computing high flows through the bridges.

Existing drop structures with fish ladders on Arroyo Las Positas and Arroyo Mocho were modeled as inline broad-crested weirs. Two small drop structures in the flood control channel between the Vulcan and Hanson Bridges were combined and modeled as one inline weir. Contraction and expansion coefficients of 0.1 and 0.3, respectively, were specified for all the drop structures since they do not significantly encroach into the channel.

A number of lateral weirs were used to simulate levees and berms running along the channels of Arroyo Las Positas and Arroyo Mocho. Additional weirs were used in the model to connect storage areas and to simulate exchange of water between the storage areas during the simulated high flow events. Model weir profiles were determined from the topographic data provided by Zone 7 and included the entire length of existing levees, berms, road embankments, and high grounds separating the creeks and storage areas. As per request from Zone 7, the levee between Arroyo Mocho and Vulcan Settling Ponds was assumed to be non-flooded and therefore was not included into the model. The weir coefficient of 2.6 was specified for all the model weirs, in accordance with the recommendations of the HEC-RAS Hydraulic Reference Manual.

Model Extension: Chain of Lakes Area to Arroyo de la Laguna Below Bernal Avenue

Per request from Zone 7, the **nhc**'s model was extended by about 5.3 miles downstream to Arroyo de la Laguna below Bernal Avenue using the Pleasanton LOMR HEC-RAS model developed by Schaaf and Wheeler and provided by Zone 7. The stream network added to the **nhc**'s model includes an approximately 3 mile long reach of the lower Arroyo Mocho, a 1.6 mile long reach of Alamo Canal, and a 2.3 mile long reach of Arroyo de la Laguna. The Pleasanton LOMR model was modified to be consistent with the **nhc**'s model. All the elevations in the Pleasanton LOMR model were converted from NGVD29 to NAVD88. Manning's roughness coefficients along the lower reach of Arroyo Mocho were set to 0.04 for the channel and 0.08 for the floodplain. Existing drop structures (three in the lower Arroyo Mocho and one in Alamo Canal) were modeled as inline weirs. The bridge modeling approach, weir coefficients, and contraction and expansion loss coefficients were specified the same as in the **nhc**'s model.

Model Boundary Conditions

The existing and ultimate 100-year flood hydrographs for Arroyo Las Positas at Interstate 580, Arroyo Mocho at Isabel Avenue, and Alamo Canal at Interstate 580 were used as the external (upstream) boundary conditions in the HEC-RAS model. The existing and ultimate 100-year inflow hydrographs for tributaries to Arroyo Las Positas (Collier Creek and Cottonwood Creek), tributaries to Arroyo Mocho (Line G-3, Tassajara Creek, and Chabot Canal), tributaries to Alamo Canal (Line G-1-1 and Tehan Creek), and tributaries to Arroyo de la Laguna (Pleasanton Canal, Unnamed Creek, and Arroyo del Valle) were used as internal boundary conditions (lateral inflows). Additional lateral inflow hydrographs were specified for the intervening drainage areas located along the modeled stream network.

The flood hydrographs were determined at 15-minute time increments using the HEC-1 model developed by Schaaf and Wheeler (1997) for Zone 7. The existing and ultimate inflow flood hydrographs used in the model are shown in Figures 3 and 4, respectively. Peak flows for all the modeled streams and tributaries are summarized in Table 1.

According to the HEC-1 model results, the existing runoff conditions 100-year peak flows in the study reach are 7,830 cfs for Arroyo Las Positas at Interstate 580, 4,430 cfs for Arroyo Mocho at Isabel Avenue, 6,640 cfs for Alamo Canal below Interstate 580, and 7,160 cfs for Arroyo del Valle at the outlet to Arroyo de la Laguna. Under the ultimate (future) runoff conditions, most peak flows in the study area are expected to increase. The computed ultimate conditions 100-year peak flows are 8,600 cfs for Arroyo Las Positas at Interstate 580, 4,480 cfs for Arroyo Mocho at Isabel Avenue, and 8,030 cfs for Alamo Canal below Interstate 580. On the contrary, ultimate (future) conditions inflow from Arroyo del Valley to Arroyo de la Laguna is expected to reduce in magnitude and delay in time. According to the HEC-1 model results, the ultimate conditions 100-year peak inflow from Arroyo del Valle is 7,030 cfs. The arrival of the flood wave from Arroyo del Valle to Arroyo de la Laguna is expected to delay by about 8 hours (see Figures 3 and 4). The reduction and delay of future flood inflows from Arroyo del Valle is related to the anticipated future flood control volume and releases from Del Valle Reservoir. This reservoir is operated by the Department of Water Resources (DWR), but flood flows are governed by the U.S. Army Corps of Engineers (USACE) who built this reservoir. Zone 7 has no control over existing and future releases from Del Valle Reservoir. As will be shown in subsequent sections of this report, releases from Del Valle Reservoir do not appear to affect maximum stages and flows in Arroyo de la Laguna at Bernal Avenue during the simulated storm event.

In the absence of the measured stage-discharge relationship, the normal depth option was used as the model downstream boundary condition for Arroyo de la Laguna below Bernal Avenue. This option uses the Manning's equation to estimate a stage for each computed flow. The local bed slope in the flood control channel of 0.53 % was used as a friction slope for normal depth computations. The downstream model boundary was set far enough not to affect simulation results at Bernal Avenue.

Computational Parameters

The HEC-RAS model parameters are summarized in Table 2. The computational time step was set to 5 seconds. This time step was sufficiently short to satisfy the Courant Condition (Courant numbers less than one) and, at the same time, provided manageable run times. The output intervals for computed stage/flow hydrographs and profiles were set to 10 minutes to provide detailed resolution of the simulated hydraulic data. The simulation period was set to 48 hours and included the main phase of the flood events. The mixed flow regime mode allowing sub-critical and super-critical flows in the model was used in the simulations. Implicit weighting factor was set to 1.0 (fully implicit solution) for greater numerical stability. The water surface calculation tolerance and storage area elevation tolerance were 0.02 and 0.05 ft, respectively (default values in HEC-RAS). The maximum number of iterations for solving the unsteady flow equations was set to the largest allowable value of 40. The number of warm up time steps was set to the maximum value of 200. The warm up period (consisting of a series of time steps with initial constant inflows) was specified in order to smooth the profile before allowing the inflow hydrographs to progress. This helped to make a more stable solution at the beginning of the simulation. The weir stability factor and weir flow submergence decay exponent were set to the maximum values of 3.0 to stabilize the solution of the weir flow and to increase model stability.

MODELING SCENARIOS

The developed HEC-RAS model was used to simulate flooding during the existing and ultimate runoff conditions 100-year flood event. Simulations were conducted for existing channel and floodplain topography, existing hydraulic structures, and existing levees along the modeled streams. No improvements to channel geometry and hydraulic structures were included in the simulations. No levee breach was simulated.

SIMULATED 100-YEAR STAGES AND FLOWS IN ARROYO DE LA LAGUNA AT BERNAL AVENUE

The main focus of this report is the effect of changing storm water runoff conditions on flows and stages in Arroyo de la Laguna at Bernal Avenue. Peak stages, peak flows, and volumes at Bernal Avenue simulated for existing and ultimate runoff conditions during the 100-year rainfall event are summarized in Table 3. Stage and flow hydrographs simulated for Arroyo de la Laguna at Bernal Avenue are shown in Figure 5.

It is seen that the flood wave at Bernal Avenue has two peaks. The first primary peak (with the highest stage and flow during the simulated 100-year storm event) is due to the flood inflow from unregulated streams in the study area (which do not have flood control reservoirs in the upper reaches). The second peak is significantly lower and is related to the delayed release of flood waters from Del Valle Reservoir on Arroyo del Valle. So it appears that the maximum peak stages and flows in Arroyo de la Laguna at Bernal Avenue during the simulated 100-year storm event are not controlled by releases from Del Valle Reservoir.

Primary peak stage and flow at Bernal Avenue increase under ultimate runoff conditions due to the increased runoff. However, the timing of the primary peak remains unchanged, which can be explained by the flashy character of the flood and rapid propagation of storm waters through the system. According to the HEC-RAS model results, primary peak stage is 318.24 ft for existing and 319.23 ft for ultimate runoff conditions. Primary peak flows are computed at 21,160 and 23,130 cfs, respectively. Peak stage and flow computed for the primary flood wave increase under ultimate conditions by 0.99 ft (0.3 %) and 1,970 cfs (9 %), respectively. Primary peak at Bernal Avenue is observed at 17 hours from the start of the simulations under both existing and ultimate runoff conditions.

Peak stage simulated for the second flood wave is 307.94 ft for existing and 306.73 ft for ultimate runoff conditions. Corresponding peak flows are 8,230 and 7,270 cfs, respectively. Peak stage computed for the second flood wave reduces under ultimate conditions by 1.21 ft (0.4 %) and peak flow reduces by 960 cfs (12 %). The second flood wave peaks are observed at 32.5 hours after the start of the simulations under existing runoff conditions and at 41.5 hours under ultimate conditions. The 9-hour delay and reduction of the secondary peak under ultimate conditions is related to the anticipated delay and reduction of future releases from Del Valle Reservoir on Arroyo del Valle (see Figures 3 and 4).

The main concern to Zone 7 is the first flood wave, as they have no control over the second flood wave caused by releases from Del Valle Reservoir controlled by the DWR. Flood water releases from Del Valle Reservoir start affecting flows at Bernal Avenue at 27.8 hours from the beginning of the simulations under existing runoff conditions and at 34.8 hours under ultimate runoff conditions. To estimate the volume of additional runoff due to ultimate runoff conditions associated with the first (primary) peak, cumulative volumes of water passing Bernal Avenue were calculated during the initial 27.8 hours of the simulations when flows are not affected by Del Valle Reservoir releases in either of the modeling scenarios. During this period, 16,440 acre-ft of water passes Bernal Avenue under existing runoff conditions and 19,280 acre-ft under ultimate runoff conditions. The increase in runoff volume is 2,840 acre-ft (17 % increase from 16,440 acre-ft during existing conditions) and is related solely to the anticipated increase in future runoff.

Runoff volumes associated with floodwater releases from Del Valle Reservoir cannot be estimated as these releases continue well beyond the simulated 48-hour period. Since Zone 7 has no control over the operation of Del Valle Reservoir, simulation of the complete phase of floodwater releases from the reservoir during the simulated 100-year rainfall event was beyond the scope of this study.

Volumes of runoff associated with the first (primary) and second flood waves at Bernal Avenue cannot be summed to estimate the effect of changing runoff conditions in the study area as these flood waves are different events. The first wave is associated with storm water inflow from unregulated streams. The second flood wave happens at a later time, is much lower, and is controlled by releases from Del Valle Reservoir.

SUMMARY

The HEC-RAS model results indicate that the 100-year flood wave in Arroyo de la Laguna at Bernal Avenue has two peaks. The first primary peak is due to the storm water inflow from the major streams in the area. The second smaller peak is due to the delayed releases from Del Valle Reservoir on Arroyo del Valle. Primary flood wave peak stages simulated for the existing and ultimate 100-year flood are 318.24 and 319.23 ft, respectively. Primary peak flows are 21,160 and 23,130 cfs, respectively. Peak stage and flow computed for the primary flood wave increase under ultimate conditions by 0.99 ft (0.3 %) and 1,970 cfs (9 %), respectively. The increase in peak stages and flows at Bernal Avenue is due to the anticipated increase in future runoff in the study area. Primary peaks at Bernal Avenue are observed 17 hours after the beginning of the flood under both existing and ultimate runoff conditions.

Peak stage simulated for the second flood wave is 307.94 ft for existing runoff conditions and 306.73 ft for ultimate runoff conditions. Corresponding peak flows are 8,230 cfs and 7,270 cfs, respectively. The second flood wave peak is observed at 32.5 hours from the start of the simulations under existing runoff conditions and at 41.5 hours under ultimate conditions. The delay and reduction of the second flood wave under ultimate conditions are related to the anticipated delay and reduction of future releases from Del Valle Reservoir.

The volume of water passing Bernal Avenue during the initial 27.8 hours of the simulations (when flows in Arroyo de la Laguna are not affected by Del Valle Reservoir releases) is 16,440 acre-ft under existing runoff conditions and 19,280 acre-ft under ultimate runoff conditions. The increase in flood volume is 2,840 acre-ft (17 %) and is related solely to the anticipated increase in future runoff.

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Table 1. HEC-RAS model boundary conditions
(updated existing and ultimate runoff conditions 100-year peak flows).

Stream	Location (listed in downstream direction)	Peak flow (cfs)	
		Existing	Ultimate
Arroyo Las Positas	Upstream inflow at I-580	7,830	8,600
	Lateral inflow from Collier Creek	816	861
	Lateral inflow from intervening drainage area between Collier Creek and Cottonwood Creek	248	325
	Lateral inflow from Cottonwood Creek	832	877
	Lateral inflow from intervening drainage area between Cottonwood Creek and mouth of Arroyo Las Positas	260	260
Arroyo Mocho	Upstream inflow at Isabel Ave	4,430	4,480
	Lateral inflow from intervening drainage area between Isabel Ave and confluence with Arroyo Las Positas	353	540
	Lateral inflow from intervening drainage area between confluence with Arroyo Las Positas and Line G-3	156	241
	Lateral inflow from Line G-3	737	1,050
	Lateral inflow from intervening drainage area between Line G-3 and Tassajara Creek	526	607
	Lateral inflow from Tassajara Creek	3,800	4,050
	Lateral inflow from intervening drainage area between Tassajara Creek and Chabot Canal	332	398
	Lateral inflow from Chabot Canal	1,630	1,780
	Lateral inflow from intervening drainage area between Chabot Canal and mouth of Arroyo Mocho	152	154
Alamo Canal	Upstream inflow at I-580	6,640	8,030
	Lateral inflow from intervening drainage area between I-580 and Line G-1-1	965	1,120
	Lateral inflow from Line G-1-1	309	383
	Lateral inflow from intervening drainage area between Line G-1-1 and Tehan Creek	49	50
	Lateral inflow from Tehan Creek	587	619
	Lateral inflow from intervening drainage area between Tehan Creek and mouth of Arroyo Mocho	18	20
Arroyo de la Laguna	Lateral inflow from intervening drainage area between mouth of Arroyo Mocho and Pleasanton Canal	39	42
	Lateral inflow from Pleasanton Canal	224	234
	Lateral inflow from Unnamed Creek	406	437
	Lateral inflow from intervening drainage area between Unnamed Creek and Arroyo del Valle	121	129
	Lateral inflow from Arroyo del Valle	7,160	7,030

Table 2. HEC-RAS model parameters.

Parameter	Value
Manning's roughness coefficient for the study reach (flood control channels/creek channels/overbank areas)	0.04/0.08/0.08
Computational interval	5 seconds
Hydrograph and profile output intervals	10 min
Simulation period	48 hours
Mixed flow regime option	Yes
Implicit weighting factor	1.0
Water surface calculation tolerance	0.02 ft
Storage area elevation tolerance	0.05 ft
Maximum number of iterations	40
Number of warm up time steps	200
Weir flow stability factor	3.0
Weir flow submergence decay exponent	3.0

Table 3. 100-year peak stages and flows simulated for Arroyo de la Laguna at Bernal Avenue (RS 40,647) for existing topography.

Runoff conditions	Time from beginning of flood (hours)		Peak stage (ft NAVD88)		Peak flow (cfs)		Volume (acre-ft)	
	1st peak	2nd peak	1st peak	2nd peak	1st peak	2nd peak	0-27.8* hours	0-48 hours
Existing	17.0	32.5	318.24	307.94	21,160	8,230	16,440	28,480
Ultimate	17.0	41.5	319.23	306.73	23,130	7,270	19,280	27,030

* Period when flows in Arroyo de la Laguna are not affected by Del Valle Reservoir releases.

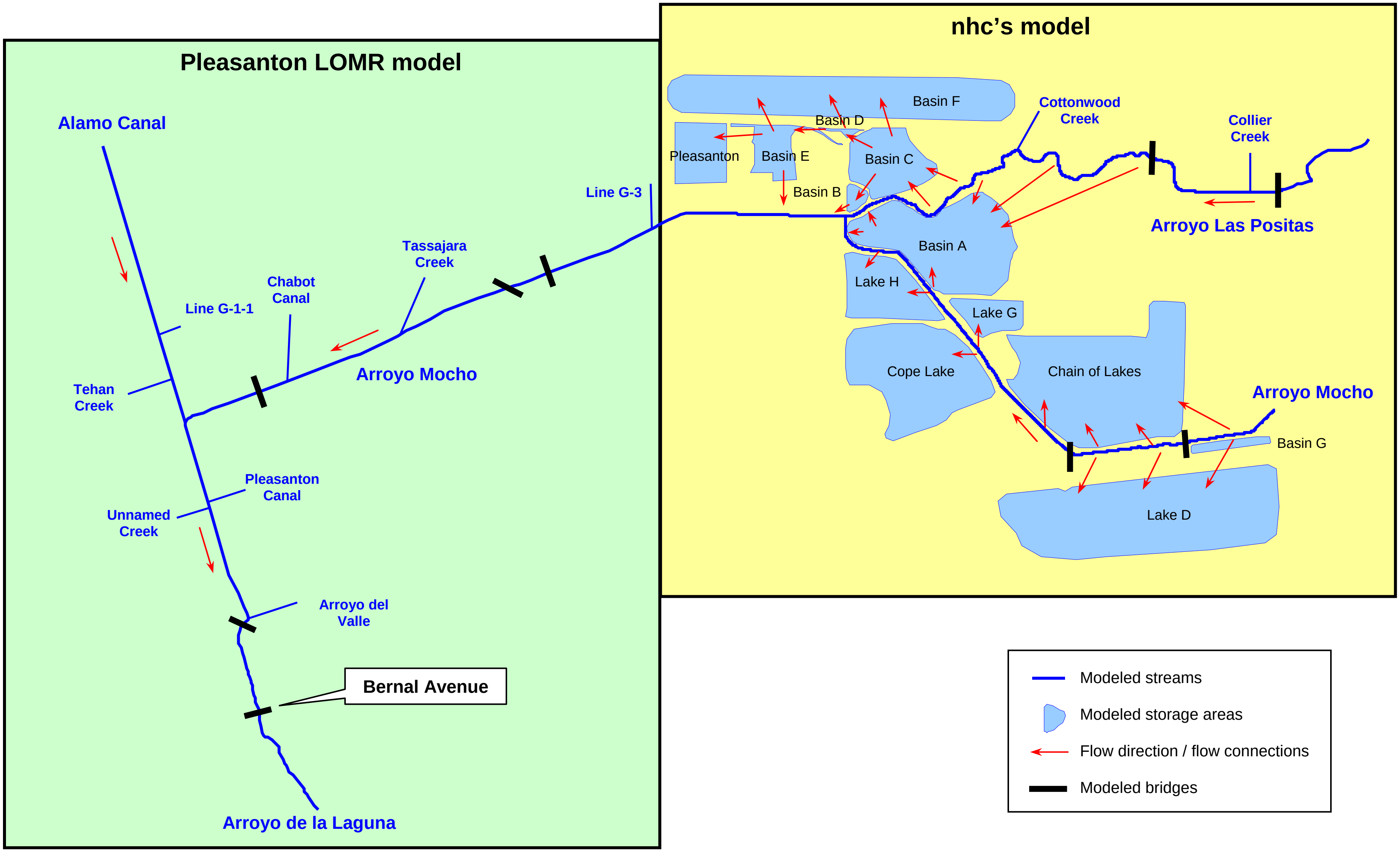


Figure 1. HEC-RAS model layout.

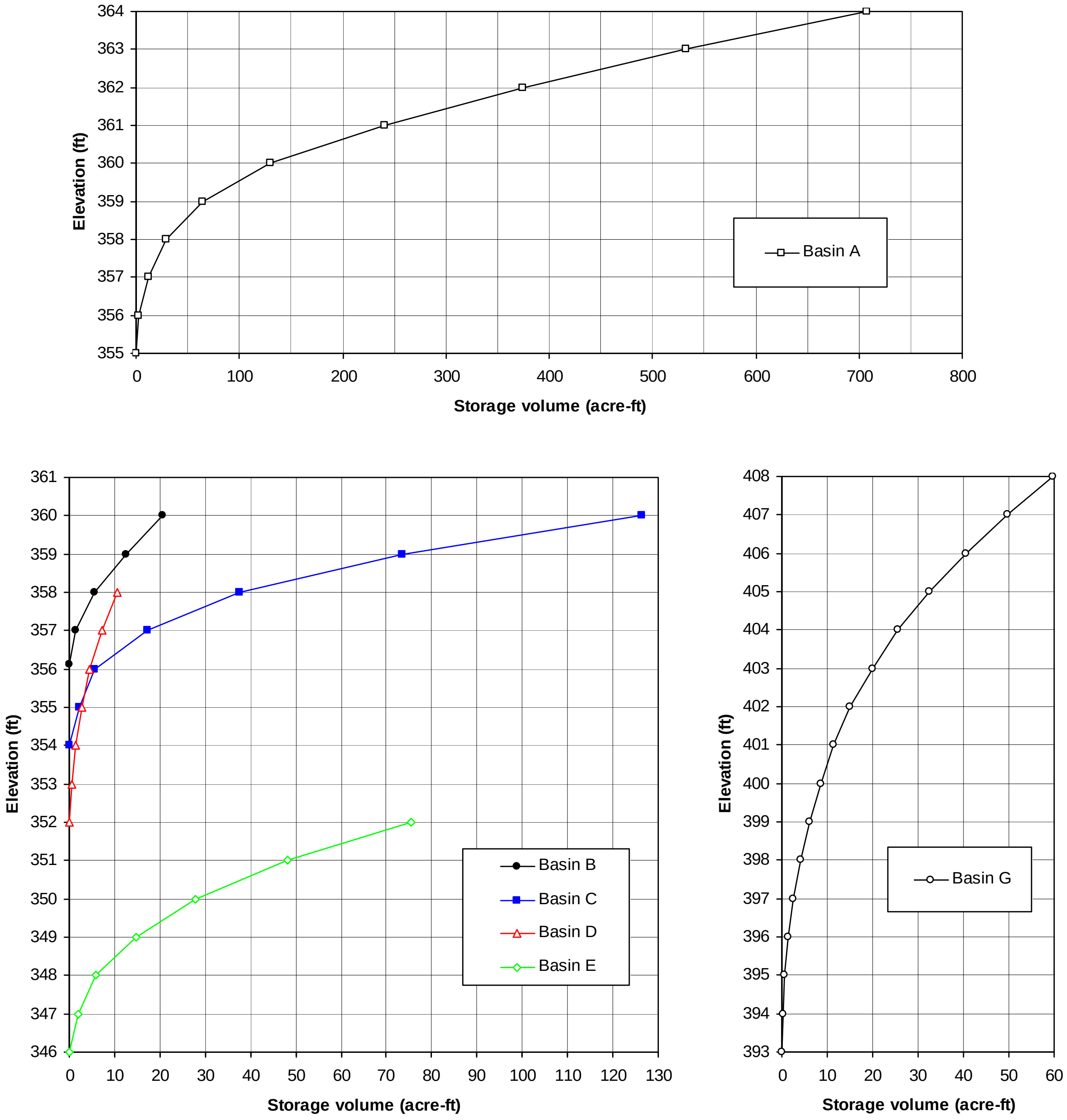
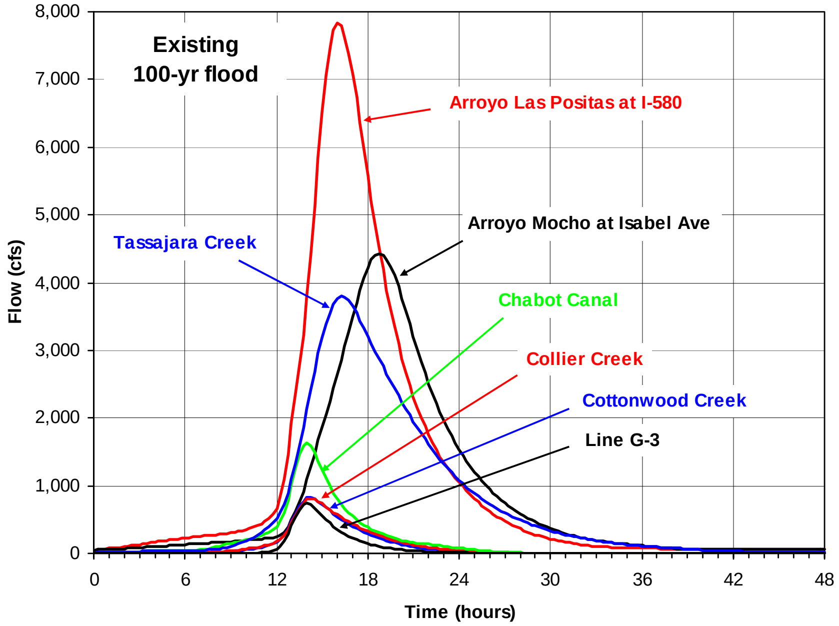


Figure 2. Storage area stage-volume relationships.



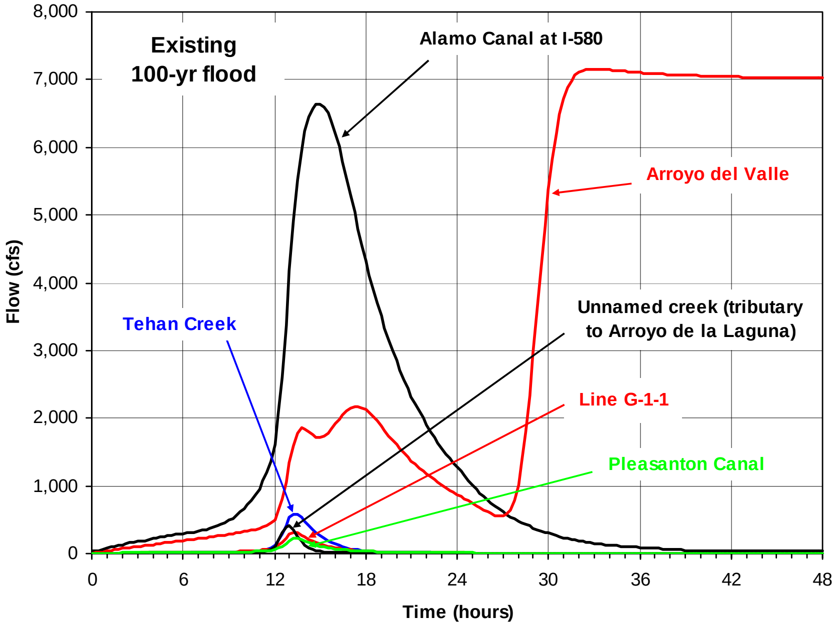


Figure 3. Existing runoff conditions 100-year flood hydrographs.

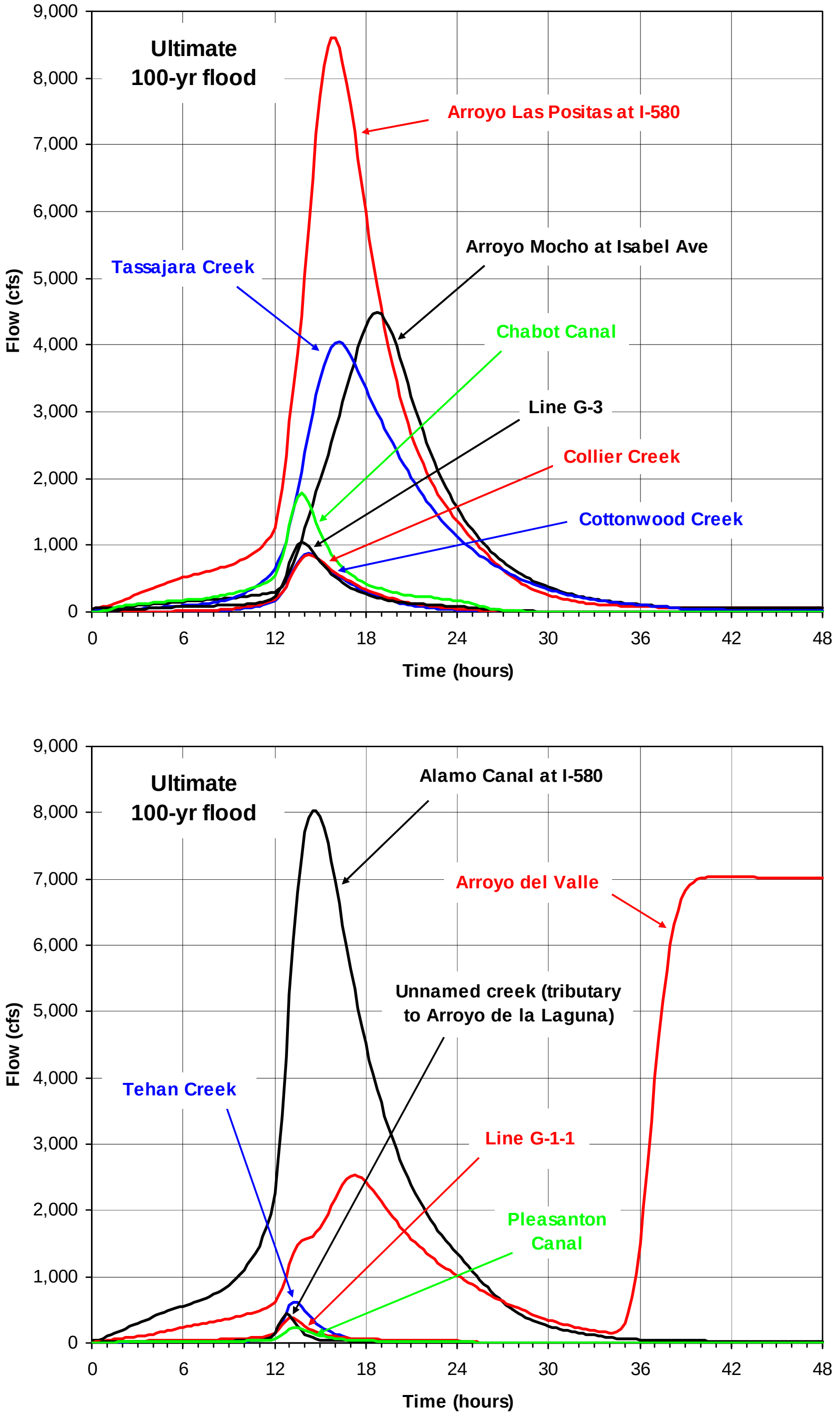


Figure 4. Ultimate runoff conditions 100-year flood hydrographs.

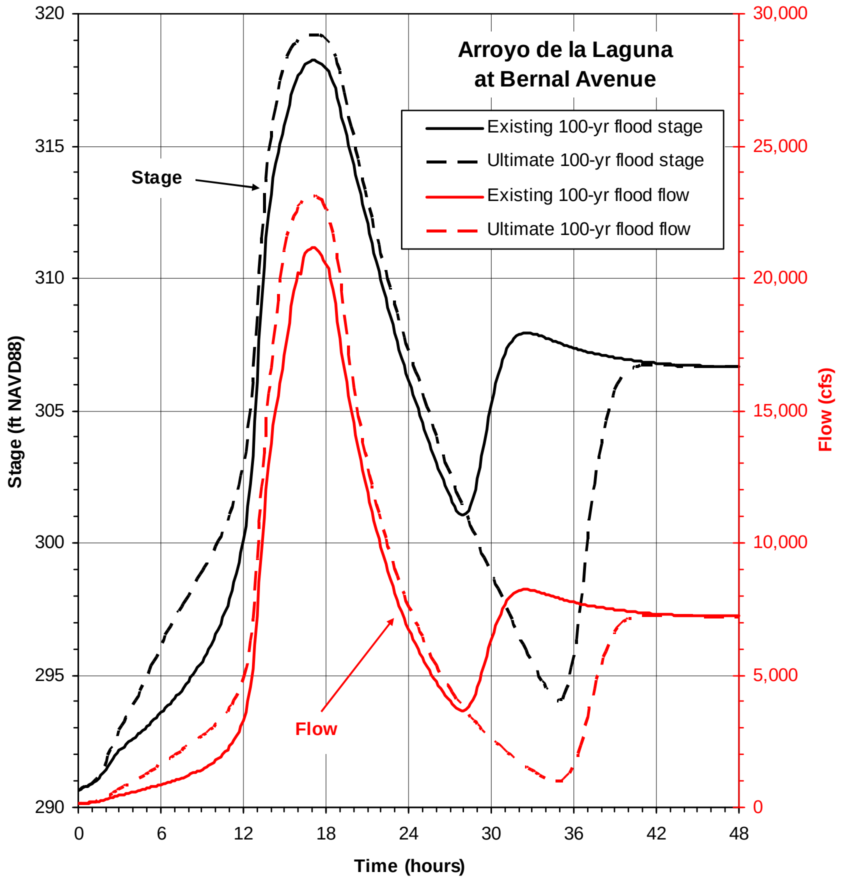


Figure 5. Existing and ultimate runoff conditions 100-year flood hydrographs simulated for Arroyo de la Laguna at Bernal Avenue for existing topography. The first flood wave is due to the inflow of storm waters from the major streams in the area. The second lower flood wave is due to the delayed release of storm waters from Del Valle Reservoir on Arroyo del Valle. The second wave is not included in the volumetric calculations because it is a separate event that is controlled by the DWR. Zone 7 has no control over releases from Del Valle Reservoir.