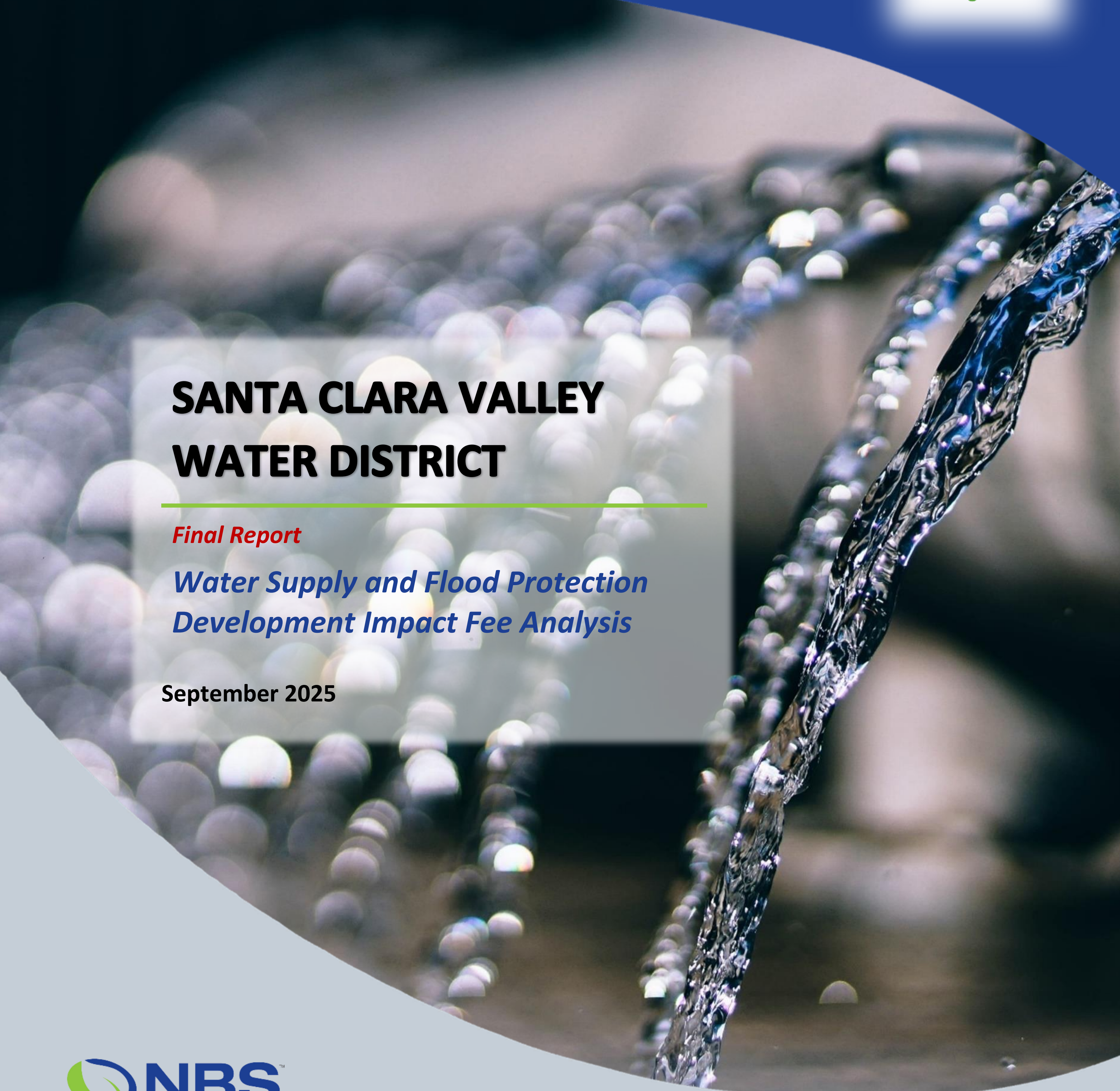

SANTA CLARA VALLEY WATER DISTRICT

Final Report

Water Supply and Flood Protection Development Impact Fee Analysis

September 2025

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TABLE OF CONTENTS

TABLE OF FIGURES

1. Introduction

1.1 Background

For several years Santa Clara Valley Water District (Valley Water) has explored potential new revenue sources that could offset future water rate increases. In November 2017, Valley Water received a report from William C. Statler analyzing available revenue options that could potentially offset water rate increases.[1] The report concluded that while there are fewer non-rate options for special districts compared to cities and counties, there was nonetheless a broad range of reasonable revenue options available to Valley Water. This report further explores one of the options: development impact fees.

REVENUE OPTIONS ASSESSMENT

In November 2017, Valley Water received a report from William C. Statler analyzing available revenue options that could potentially offset water rate increases. The report concluded that while there are fewer non-rate options for special districts compared to cities and counties, there was nonetheless a broad range of reasonable revenue options available to Valley Water. The District performed additional research and had the following recommendations for further study[2]:

- Special Parcel Tax — Conduct polling to determine whether a ballot measure based on a suite of projects (water storage projects for example) with the Pacheco Reservoir Expansion as the anchor project would be approved by voters.
- Benefit Assessment, Creekside Properties — Work with community leaders to generate interest in a community or property-owner led effort to establish a benefit assessment zone for properties that back to a creek, which could fund District activities to remove debris, address encampments, and construct environmental enhancements for example.
- Investigate the concept of fund raising via donations and partnering with like-minded agencies to help preserve agricultural land or open space — Staff to further research the feasibility of a donation funding concept and develop a roadmap of actions that could be taken to establish a program, including investigation of Corporate Social Responsibility funding sources.
- Evaluate potential state ballot measures that would refine Proposition 13 such that commercial and industrial property — but not homes and small businesses — would be regularly reassessed and taxed at their full property value.
- Development Impact Fees, Water Utility — Engage a consultant to undertake the comprehensive development impact fee study that would generate revenue for the development and expansion of the water supply system. Begin campaign to reach out to land use agencies to gain their necessary cooperation.
- Development Impact Fees, Flood Protection — Engage a consultant to undertake a comprehensive development impact fee. Begin to reach out to land use agencies to gain their

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[1] *Revenue Options Assessment, November 2017, Santa Clara Valley Water District, prepared by William C. Statler.*

[2] *Santa Clara Valley Water District, Handout 2.8-A1, 04/23/19, Attachment A, Memorandum entitled Research of the Feasible Revenue Sources allowed by the District Act, October 31, 2018*

necessary cooperation. Investigate opportunities for developers to pay for the impact of development via mitigation.

Ultimately, the opportunities with the greatest revenue potential would require either majority property owner approval (property-related fees or assessments) or two-thirds voter approval for special taxes. It is worth noting that subsequent to the 2017 report, AB 939 passed, which provides the authority for Valley Water to put a general obligation bond tax on the ballot as of January 1, 2024.

The 2017 report further concluded that there is only one significant revenue option available to Valley Water that could be implemented by the Board without some form of voter approval: developer impact fees.

The 2017 report recognized that comprehensive impact fee studies would be needed to closely assess new development's share of capital improvements and then assign benefit based on land-use type (residential, commercial, industrial, institutional) in setting fees. The report provided a "high level assessment" of potential water impact fees by allocating CIP costs between current and new development based on projected growth.

This assessment resulted in an estimate of potential annual impact fees of $24 million, a fee of about $3,000 per equivalent dwelling unit (EDU) and the potential to offset water rates by 11%. However, the report stressed that if Valley Water is interested in pursuing this concept, comprehensive analysis would be required by a highly qualified consultant with experience in performing this type of study in accordance with Government Code 66000, which sets "nexus" and other standards for development impact fees.

THE DISTRICT

The Santa Clara Valley Water District (Valley Water) was created by an act of the California Legislature (the Santa Clara Valley Water District Act (Chapter 1405 of the Statues of 1951), referred to here as the 'District Act'), and operates as a state of California Special District, with jurisdiction throughout Santa Clara County. The District Act has been amended several times since its initial passage.

According to the Santa Clara Valley Water District website*, the powers and purposes of Valley Water include:*

To provide comprehensive water management for all beneficial uses and protection from flooding within Santa Clara County; to protect Santa Clara County from floodwater and stormwater of the district, including tidal floodwater and the floodwater and stormwater of streams that have their sources outside the district but flow into the district; to protect from floodwater or stormwater the public highways, life and property in the district, and the watercourses and watersheds of streams flowing within the district; to provide for the conservation and management of floodwater, stormwater, or recycled water, or other water from any sources within or outside the watershed for beneficial and useful purposes, including spreading, storing, retaining, and causing the water to percolate into the soil within the district; to protect, save, store, recycle, distribute, transfer, exchange, manage, and conserve in any manner any of the waters; to increase and prevent the waste or diminution of the water supply in the district; to obtain, retain, protect, and recycle drainage, stormwater, floodwater, or treated wastewater, or other water from any sources, within or outside the watershed in which the district is located for any beneficial uses within the district; to enhance, protect, and restore streams, riparian corridors, and natural resources in connection with carrying out the *purposes set forth in this section; and to preserve open space in Santa Clara County and support the county park system.*

Valley Water is a countywide wholesale water provider and groundwater management agency and relies on local retailers (municipalities and private companies) to deliver water. These retailers enact and implement local water use ordinances and bill their customers directly.

So, while it is apparent that Valley Water has a major role in the County's water management efforts, the challenge is that Valley Water does not have the land use authority. Therefore, Valley Water will need to work with the local agencies to implement any new impact fees.

1.2 Scope of Work

NBS was contracted to analyze the potential for implementing water supply and flood protection development impact fees that would result in new development paying its fair share of the facilities that provide it service, prepared in accordance with the requirements of the Mitigation Fee Act.

The scope is crafted into a two phased approach. Phase I is the technical analysis described in this report. This study identifies new development's share of existing infrastructure and planned improvements for flood protection and water supply and the resulting development impact fees. If Valley Water moves ahead with Phase 2, Valley Water would coordinate with potential implementing agencies that would be needed to assist with the fee collection.

2. Methodology

2.1 Review of Mitigation Fee Act

The Mitigation Fee Act authorizes a local agency to establish, increase, or impose various fees as a condition of approval of a development project, if specified requirements are met. California Government Code Section 66013 authorizes public agencies to impose capacity charges on new customers connecting to an existing utility. That section defines a "capacity charge" as "a charge for public facilities in existence at the time a charge is imposed or charges for new public facilities to be acquired or constructed in the future that are of proportional benefit to the person or property being charged, including supply or capacity contracts for rights or entitlements, real property interests, and entitlements and other rights of the local agency involving capital expense relating to its use of existing or new public facilities." It authorizes public agencies to impose capacity charges on customers connecting to or upsizing their connection to the system to ensure that they pay their fair share of the existing utility asset costs plus the costs of new facilities needed to serve them.

California Government Code Section 66013 also calls for an annual report, prepared within 180 days after the last day of the fiscal year. The report will describe the charges deposited into the fund, the beginning and ending balance of the fund, and how those funds have been spent.

In 2019, California passed SB 13, AB 881, and AB 68, which added language to encourage the construction of more housing in the form of Accessory Dwelling Units. Specifically, a local agency, special district, or water corporation shall not impose any impact fee upon development of an accessory dwelling unit less than 750 square feet.

In September 2021, AB602 was signed into law requiring additional requirements for establishing or increasing development impact fees as well as transparency requirements. Some of the key requirements include:

- Beginning January 1, 2022, an impact fee nexus study must be prepared and adopted to establish the basis for the new fee.
- Nexus studies must be updated at least every eight years.
- Nexus studies and associated impact fee programs must be adopted at a public hearing with at least thirty days' notice to the public (previously only ten days).

Whereas user charge increases imposed on existing customers require a protest ballot procedure (under Proposition 218), capacity charges do not because they are considered an appropriate funding mechanism for facilities that benefit new development district wide. These charges may be imposed by a majority vote of the governing legislative body, which in this case is Valley Water's Board of Directors. This report provides the documentation and findings necessary for the adoption of the proposed capacity charges.

2.2 Overview of Capacity Charge Methodology

Various methodologies have been and are currently used to calculate capacity fees. The following lists the most common methodologies from the American Water Works Association's Principles of Water Rates, Fees and Charges[3], also referred to as Manual M1:

- The value of existing (historical) system assets, often called a "system buy-in" methodology.
- The value of planned future improvements, also called the "incremental" or "system development" methodology.
- A combination of these two approaches.

This analysis uses the "Combination Approach,[4]" which requires new customers to pay both their fair share of existing system assets as well as their share of the planned future capital improvements needed to provide them with capacity in the City's water and wastewater systems.

In its simplest form, capacity fees are calculated by dividing the costs allocated to future development by the anticipated number of units for new development as defined below:

- Costs of planned future facilities and improvements required to serve new development are those that can reasonably be allocated to future development.
- The number of new units (i.e., growth) are those units projected to occur within the timeframe covered by the capacity fee analysis.

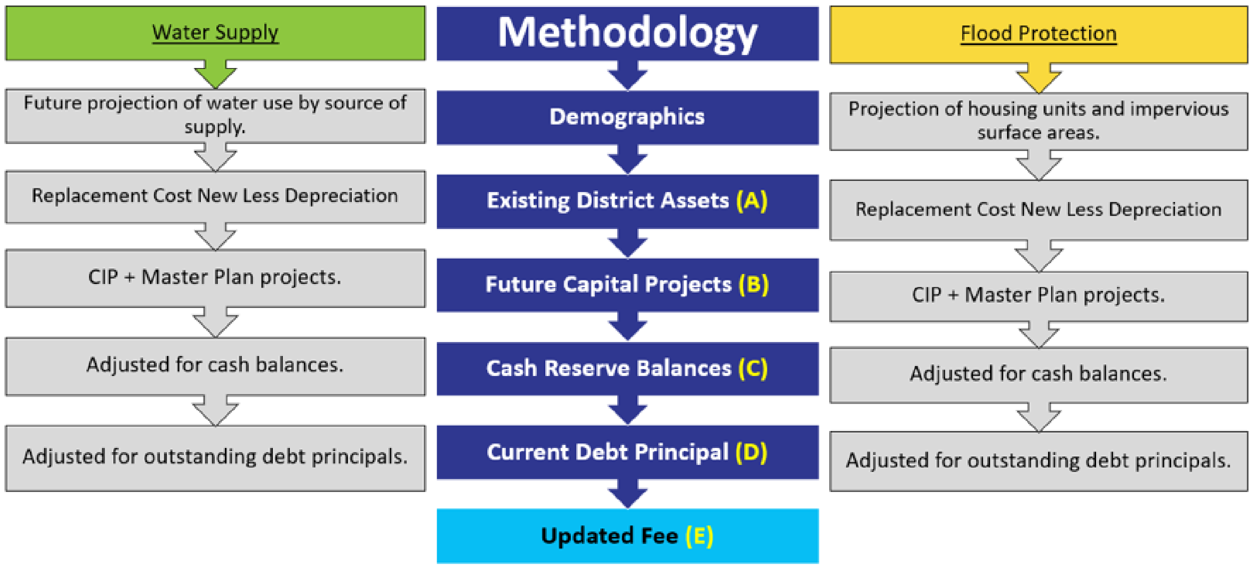
Capacity fees are one-time fees intended to reflect the cost of existing infrastructure and planned improvements available to new services, which place new utility customers (or existing customers requesting an increase in service capacity) on equal basis — from a financial perspective — with existing customers. Once new customers are added to the system, they then incur the obligation to pay the same service charges or water and wastewater rates that existing rate customers pay.

While there is not a similar industry standard for a flood protection capacity fee, the same approach applies to flood protection as well. **Figure 1** shows the steps involved in calculating the capacity fees.

[3] *Principles of Water Rates, Fees, and Charges, Manual of Water Supply Practices, Manual M1, American Water Works Association (AWWA), Seventh Edition, 2017.*

[4] *Method of calculating capacity fees (also known as System Development Fees, Connection Fees, Capital Facility Fees) are set forth in the American Water Works Association's Principles of Water Rates, Fees and Charges Seventh Edition (2017) pages 311 to 347.*

Figure 1. Calculating Capacity Fees



$$E = \frac{(A + B) - (C + D)}{\#\ of\ Projected\ Future\ Units}$$

Figure 1 shows a six-step process for calculating the development impact fees. These steps are described below.

1. **Understanding the Demographics.** The initial step involves understanding the existing users of the system as well as the projected growth requiring service. The goal is to determine the users of the existing system and how much of the current assets they are utilizing, with the remainder available for new customers. Future investments also need to be allocated between existing users and future users.
2. **Valuing the Existing Assets.** Installed system assets are valued using an approach called "replacement cost less depreciation." Replacement values were calculated by escalating original costs from the date installed. The escalated assets were then depreciated based on the remaining useful life. These assets are proportioned to existing and future users.
3. **Estimating the Costs of Future Improvements**. The costs to meet future development or system upgrades are estimated based on Valley Water's planning efforts. These assets are proportioned to existing and future users.
4. **Adjustments for Existing Cash Assets.** Cash assets are treated as a credit as they can be applied to offset the costs allocated to future users.
5. **Adjustments for Outstanding Debt Principal.** Since new development pay their share of existing asset values, including the debt payment principals on those same assets would double count the asset values included in the capacity fees. Therefore, debt service principal is subtracted from the total system assets.
6. **Calculating the Impact Fee.** The existing and future assets proportioned to future users, adjusted by cash and debt service principal, are divided by the future capacity available to calculate the future impact fee.

3. Water Supply Capacity Charge

3.1 Identifying New Development Share of Projects

Valley Water retained NBS to conduct a Water Supply Impact Fee Analysis to: (1) ensure that the fees are developed in compliance with legal requirements and industry standards, and (2) ensure that the capacity fees reflect the cost of capital infrastructure needed to serve new connections, or any person requesting additional capacity in Valley Water's water utility (referred to throughout as "future customers").

This impact fee study and the recommended fees assume a given level of development activity over the course of the study period based on data available from Valley Water's water supply projections from the Water Supply Master Plan 2040 and the 2020 Urban Water Management Plan. The development that occurs may result in both different impacts and fee revenues than those that are calculated in this study. For that reason, regular updates are recommended to adjust the fees to match the needs created by the rate of actual development.

In developing the proposed fees, NBS worked cooperatively with District staff. The fees presented in this study reflect input provided by District staff regarding financial matters, available capacity in the current water supply, existing asset values, and planned capital improvements.

IDENTIFY CURRENT WATER USE

Valley Water is an independent special district that provides wholesale water supply and groundwater management in Santa Clara County, California. In order to determine Valley Water's current water demand, NBS relied on the 2020 Urban Water Management Plan (Plan) which outlines both historical and projected water use based on population growth over the last 20 years. The Plan analyzes current water demand by sector, or customer class, (i.e., Single Family Residential, Commercial, etc.) and by type of use (i.e., Retailer Demand, Agricultural Irrigation, Independent Groundwater Pumping, and Untreated Surface Water). Total water demand in 2020 was estimated at 306,000 AF and is projected to grow to 345,000 AF by 2045, an increase of almost 13%. Of the projected future water demand, retailer demand accounts for approximately 90% of all Valley Water's water use.

PROJECT FUTURE WATER USE

The 2020 Urban Water Management Plan assumes that future water use through 2045 will increase over time with population growth. Therefore, it is reasonable to assume that the extent of future water use in the projection of housing demand on Valley Water can be addressed by looking at the estimated population growth for Santa Clara County. The current population of approximately 2 million is expected to increase by about 36% to 2.7 million by 2045. In addition, overall water supply projections are expected to increase by 11%, or by 41,000 AF, over the next 20 years. The expected increases in population as well as increases in water demand will greatly impact the housing demands of Valley Water's future customers. **Figure 2** shows the estimated growth by population based on the 2020 Urban Water Management Plan.

Figure 2. Projected Population Growth in Santa Clara County

Agencies / Cities	Projected Population Growth						
	2020	2025	2030	2035	2040	2045	% Growth
Santa Clara County	1,986,340	2,098,695	2,217,750	2,387,165	2,538,320	2,699,046	35.9%

METHODOLOGIES FOR ESTIMATING FUTURE WATER USE

The development of the proposed water supply capacity fee requires a comparison of the projected future water use to the existing water use. NBS considered three ways to calculate future water use based on 1) population growth, 2) projected water demand by member agencies, and 3) increase in planned water supplies. This projected increase is used to calculate the proportional share of costs that future customers will be required to pay to connect to Valley Water's water system. The share, or percentage, attributed to future customers will be used throughout the analysis to determine their share of existing system assets as well as their share of the planned future capital improvements needed to provide them with capacity in Valley Water's water system. As a result, future customers connecting to Valley Water's water system would enter as equal participants (compared to existing customers) regarding their financial commitment and obligations to Valley Water.

Population Growth – The county is comprised of 13 cities that receive water from various water suppliers. NBS researched the estimated population growth for these 13 cities by relying on City websites and documents made available to the public (e.g., Annual Comprehensive Financial Plans). The analysis assumed growth based on the average population growth from 2016 to 2020, unless otherwise noted. For any City showing a decrease in average population growth over the last 5 years, the growth rate is set at 0%. **Figure 3** shows the estimated population growth by water agency over the next 25 years which estimates a 14% increase in total population.

Figure 3. Projected Population Growth in Valley Water Service Areas Only

Agencies / Cities	Projected Population Growth						
	2020	2025	2030	2035	2040	2045	% Growth
Campbell [1, 2]	42,288	42,377	42,466	42,555	42,644	42,734	1.1%
Cupertino [1,3]	59,549	59,549	59,549	59,549	59,549	59,549	0.0%
Gilroy [4]	57,084	57,946	58,821	59,709	60,611	61,526	7.8%
Los Altos [5]	30,876	31,086	31,297	31,510	31,724	31,940	3.4%
Los Gatos [1,6]	31,439	31,634	31,830	32,027	32,226	32,426	3.1%
Milpitas [7]	75,663	75,701	75,739	75,777	75,814	75,852	0.3%
Monte Sereno [1,8]	3,511	3,512	3,513	3,513	3,514	3,515	0.1%
Morgan Hill [9]	46,454	47,453	48,473	49,515	50,580	51,667	11.2%
Mountain View [10]	81,302	81,863	82,428	82,997	83,569	84,146	3.5%
San Jose [1,11]	132,644	150,368	168,092	194,983	217,685	222,661	67.9%
Santa Clara [12]	129,104	130,821	132,561	134,324	136,111	137,921	6.8%
Saratoga [1,13]	31,030	31,080	31,129	31,179	31,229	31,279	0.8%
Sunnyvale [14]	154,252	155,825	157,415	159,020	160,642	162,281	5.2%
Total Population	**875,196**	**899,214**	**923,312**	**956,659**	**985,899**	**997,497**	**14.0%**
Annual Growth (2020 to 2045)	***35,008***	***35,969***	***36,932***	***38,266***	***39,436***	***39,900***	

1. SJW provides service to most of the cities of San Jose and Cupertino, the entire cities of Campbell, Monte Sereno, Saratoga, the Towns of Los Gatos, and parts of unincorporated Santa Clara County.
   Information available on the City's website. Website: https://www.sjwater.com/sites/default/files/2021-06/2020%20UWMP%20FINAL%20with%20Appendices.pdf, page 3-6.
2. Information available on the City's website. Website: *https://www.campbellca.gov/ArchiveCenter/ViewFile/Item/1642*, page 126.
3. Information available on the City's website. Website: *https://www.cupertino.org/home/showpublisheddocument/29190/637534959803230000*, page 112.
4. Information available on the City's website. Website: *https://www.cityofgilroy.org/DocumentCenter/View/11644/FY-2020-ACFR?bidId=*, page 209.
5. Information available on the City's website. Website: *https://www.losaltosca.gov/sites/default/files/fileattachments/administrative_services/page/34881/final_-los_altos_acfr_fy21.pdf*, page 155.
6. Information available on the City's website. Website: *https://www.losgatosca.gov/DocumentCenter/View/29618/FY-202021-ACFR?bidId=*, page 146.
7. Information available on the City's website. Website: *https://www.milpitas.gov/wp-content/uploads/2021/12/Milpitas-2021-Web-ACFR.pdf*, page 157.
8. Population for Monte Sereno is based on information available from the United States Census Bureau. Website: *https://www.census.gov/*.
9. Information available on the City's website. Website: *https://www.morgan-hill.ca.gov/DocumentCenter/View/37500/2020-Annual-Comprehensive-Financial-Report-6-30-20-PDF?bidId=*, page 208.
10. Information available on the City's website. Website: *https://www.mountainview.gov/civicax/filebank/blobdload.aspx?BlobID=33599*, page 178.
11. Population is defined as the population served by San Jose Municipal Water System. Information available on the City's website. Website: *https://www.sanjoseca.gov/home/showpublisheddocument/422/637602045327100000*, page ES-2.
12. Information available on the City's website. Website: *https://www.santaclaraca.gov/home/showpublisheddocument/76049/637769033936730000*, page 231.
13. Information available on the City's website. Website: *https://www.saratoga.ca.us/ArchiveCenter/ViewFile/Item/1921*, page 123.
14. Information available on the City's website. Website: *https://www.sunnyvale.ca.gov/home/showpublisheddocument/938/637819888578970000*, page 219.

Water Demand – In addition to looking at population growth by City, NBS also looked at water demand. NBS researched the estimated water demand growth for these 13 cities by relying on City websites and documents made available to the public (e.g., Urban Water Management Plans and Water Supply Master Plans). This was a 2-step process which involved determining the total projected water demand and then Valley Water's portion of the projected water demand. **Figure 4** shows the estimated future growth based on future water demand by the various water agencies served by Valley Water.

Figure 4. Projected Water Demand Growth Through 2045

Agencies / Cities	Water Provider	Total Projected Water Demand (AF)						
		2020	2025	2030	2035	2040	2045	% Growth
San Jose Water Company (Retail Only)	San Jose Water Company	121,503	132,917	132,775	133,312	134,917	136,308	12%
Campbell	San Jose Water Company							*incl. above*
Cupertino	San Jose Water Company Cal Water	2,639	2,924	2,921	2,933	2,968	2,999	14%
Gilroy	Gilroy Communities Services	8,271	8,645	9,314	10,035	10,810	11,645	41%
Los Altos	Cal Water	13,023	13,006	13,005	13,325	13,667	14,097	8%
Los Gatos	San Jose Water Company							*incl. above*
Milpitas	City of Milpitas Community	10,526	12,045	12,506	12,969	13,429	13,862	32%
Monte Sereno	San Jose Water Company							*incl. above*
Morgan Hill	City of Morgan Hill	7,808	8,671	9,482	10,123	10,808	11,473	47%
Mountain View	City of Mountain View Public	10,036	11,610	12,100	12,616	13,159	13,715	37%
San Jose	San Jose Water Company San Jose Municipal Water System	17,546	21,080	24,156	27,343	32,815	33,552	91%
Santa Clara	Santa Clara Valley Water District San Francisco Public Utilities	18,302	19,473	20,348	21,111	21,649	22,189	21%
Saratoga	San Jose Water Company							*incl. above*
Sunnyvale	City of Sunnyvale Cal Water	19,193	19,287	19,639	22,901	24,386	25,967	35%
Total		**228,848**	**249,658**	**256,246**	**266,668**	**278,609**	**285,807**	**25%**

Water Supply – Finally, NBS calculated future growth by examining the water supply projection by source of supply in Valley Water's Water Supply Master Plan 2040. Based on the Master Plan, water supply projections are expected to increase from 352,000 AF to 392,000 AF by 2040. The water supply projections assume an increase of 3,000 AF every 5 years for the next 20 years, an increase of more than 11% by 2040. **Figure 5** shows the estimated increase in water supply requirements by source of supply.

Figure 5. Projected Water Supply Growth Through 2040

Source of Supply (AF)	Supply Projections					
	2020	2025	2030	2035	2040	% Growth
Natural Groundwater Recharge	61,000	61,000	61,000	61,000	62,000	2%
Local Surface Water	53,000	53,000	64,000	63,000	57,000	8%
Reuse	21,000	27,000	48,000	50,000	52,000	148%
San Francisco Public Utilities Commission	55,000	57,000	58,000	59,000	60,000	9%
Delta-Conveyed	162,000	165,000	133,000	147,000	161,000	-1%
Total Supply	**352,000**	**363,000**	**364,000**	**380,000**	**392,000**	**11%**

PROJECTED FUTURE WATER USE

After extensive analysis of future water use projects and discussions with District staff, NBS determined that water supply projections from the Master Plan presented the best method for calculating the proportional share of costs to be paid by future customers. Water supply projections include all water provided to Valley Water's customers and not just the water retailers. As a result, it is a better representation of future demand on Valley Water's water system.

Valley Water relies on various water supply sources that range from natural groundwater recharge to the purchased Delta-conveyed water from the State Water Project (SWP). **Figure 6** shows water supply projections across all water resources based on Valley Water's 2020 Water Supply Master Plan.

Figure 6. Summary of Water Supply

Source of Supply (AF)	Supply Projections			
	2020	2040	Difference	% Growth
Natural Groundwater Recharge	61,000	62,000	1,000	2%
Local Surface Water	53,000	57,000	4,000	8%
Reuse	21,000	52,000	31,000	148%
San Francisco Public Utilities Commission	55,000	60,000	5,000	9%
Delta-Conveyed	162,000	161,000	(1,000)	-1%
Average Supply	**352,000**	**392,000**	**40,000**	**11%**

NET FUTURE WATER USE

The projected water supply usage shown in **Figure 6** estimates an additional 40,000 acre feet (AF) are needed to serve future customers through 2040. In other words, the impact fee analysis estimates that future customers will be responsible for approximately 10% of all future costs for existing infrastructure and planned capital improvements that are, or will be, available to future customers who will enter as equal participants regarding their financial commitment and obligations to Valley Water's water system. The allocation to future customers shown in **Figure 7** and will be used as a proxy to calculate the future needs of Valley Water's current and future assets, as described in the following sections.

Figure 7. Projected Water Supply Growth

Agencies / Cities	Current Water Supply	Expected Future Water Supply *(thru FY 2039/40)*	Total	Allocation Factors		
				Existing Customers	Future Customers	Total
Water Supply Growth Through 2040	352,000	40,000	**392,000**	89.8%	10.2%	**100%**

3.2 New Development Share of Infrastructure

The capital assets addressed in this study include existing assets and planned capital improvements (i.e., the system buy-in and incremental assets). An important aspect of this study is how the value of existing utility assets is determined. For example, the purchase price does not account for wear and tear, and current book value (i.e., purchase price less accumulated depreciation) typically underestimates the "true value" of facilities as it does not account for cost increases over time. Therefore, this study uses the replacement-cost-new-less-depreciation (RCNLD) approach to estimate existing asset values that reflect estimated cost inflation and depreciation.

VALUE OF EXISTING INFRASTRUCTURE

Valley Water manages and operates a complex and integrated water supply infrastructure, including dams, reservoirs, pipelines, pump stations, treatment plants, and recycled water facilities. All the assets put into service are tracked in Valley Water's Asset Management Planning Tool (AMPT), which tracks installation date, original costs, asset life, and also estimates replacement costs.

METHODOLOGY – REPLACEMENT COST LESS DEPRECIATION

In general, the RCNLD is calculated by escalating the book value of existing assets to current-day values using inflation factors from various construction indices; however, in the case of Valley Water, we used the escalated values from Valley Water's AMPT. Replacement values were calculated by escalating the original values from service date to 2021 values using historical cost inflation factors provided by Valley Water. For this analysis, assets that have exceeded their useful life (as defined in Valley Water's asset records) were considered to have no remaining value. This approach was used for all assets, except land, which does not depreciate and is excluded from the analysis.

DATA SOURCES

For existing assets, NBS relied on reports generated by Valley Water's Asset Management Planning Tool (AMPT). NBS used the data provided in these reports to calculate the following costs:

- Original Asset Cost is calculated by multiplying the Activity Cost (also referred to as the Replacement/Program Cost) by the number of units.
- Depreciation is calculated by multiplying the Original Asset Cost by the Consumed value.
- Book Value is the Original Asset Cost less Depreciation.
- System Buy-In Cost Basis is the replacement value of the asset (i.e., the Escalated Activity Cost) multiplied by the number of units, less accumulated depreciation.

Once these costs were calculated, we were able to determine the System Buy-in Cost Basis which would be allocated between existing and future customers using the allocation shown in **Figure 7**.

For new projects, NBS relied on Valley Water's 15-Year Capital Improvement Program (FY 2023 through FY 2037) provided by District staff. NBS also included "Master Plan" projects from the 2020 Water Supply Master Plan, excluding all other "active" and "inactive" projects. Total costs of the "Master Plan" projects were allocated over a 20-year period. The cost estimates for planned future improvements, used to calculate the system development component of the capacity fee, are allocated using the same allocation basis found in **Figure 7**, as these projects benefit both current and future customers.

ESTIMATED VALUE OF EXISTING INFRASTRUCTURE

The existing assets for the water supply analysis include various asset classes from Valley Water's asset management system. The total system buy-in cost basis is estimated at $607 million to be allocated between existing and future customers based on the allocation factors in **Figure 7**.

Figure 8 shows the allocation of the $607 million in system buy-in costs to existing and future customers. Future customers are allocated approximately $62 million of the existing water supply assets, or about 10.2%.

Figure 8. Existing Water Supply Assets

Asset Class[1]	System Buy-In Cost Basis[2]	Allocation Basis (%)[3]		Distribution of Cost Basis ($)	
		Existing Customers	Future Customers	Existing Customers	Future Customers
Civil	325,047,182	89.8%	10.2%	291,879,103	33,168,080
Electrical	99,894,861	89.8%	10.2%	89,701,508	10,193,353
Fleet	758,835	89.8%	10.2%	681,403	77,432
Instrumentation	19,286,481	89.8%	10.2%	17,318,473	1,968,008
Mechanical	98,988,387	89.8%	10.2%	88,887,531	10,100,856
Planning & Engineering Cost	52,233,151	89.8%	10.2%	46,903,237	5,329,913
WQL Lab	11,255,236	89.8%	10.2%	10,106,743	1,148,494
Total: Fixed Assets	**$ 607,464,133**			**$ 545,477,997**	**$ 61,986,136**
Percentage of Total Asset Value				*89.8%*	*10.2%*

1. The original asset cost provided by the District and depreciation calculated by NBS (depreciation is as of June 1, 2022).
2. Replacement values are calculated by escalating the original values from service date to 2022 values using historical cost inflation factors provided by the District in its *Asset Management Planning Tool* .
3. The Allocation Basis is based on the proportionate allocation between existing and future customers.

PROJECTED NEW PROJECTS

Projected new projects are outlined in several sources; Valley Water's 15-Year Capital Improvement Program (FY 2023 through FY 2037) provided by District staff. NBS also included "Master Plan" projects from the 2020 Water Supply Master Plan, excluding all other "active" and "inactive" projects. Total costs of the "Master Plan" projects were allocated over a 20-year period.

CAPITAL IMPROVEMENT PLANS

Valley Water currently has a 15-year capital improvement plan for future expansion of the existing water infrastructure that spans from FY 2022/23 through FY 2039/40. **Figure 9** summarizes the total planned capital projects by funded status and cost center. Of the $7.3 billion of planned capital projects, an estimated $745 million is allocated to future customers.

Figure 9. Estimated Capital Improvement Projects –Water Supply

Funded Status	Cost Center	Current Cost Estimate ($000s)[2]	System Development Cost Basis[3]	% Allocation[4]		Distribution of Cost Basis ($)[4]	
				Existing Customers	Future Customers	Existing Customers	Future Customers
Capital Improvement Program[1]							
Funded Capital	Source of Supply	$ 2,291,269,836	$ 2,291,269,836	89.8%	10.2%	$ 2,057,466,791	$ 233,803,044
	Raw Water Transmission & Distribution	288,683,000	288,683,000	89.8%	10.2%	259,225,551	29,457,449
	Water Treatment	2,707,358,000	2,707,358,000	89.8%	10.2%	2,431,096,980	276,261,020
	Treated Water Transmission & Distribution	8,305,000	8,305,000	89.8%	10.2%	7,457,551	847,449
	Administration and General	218,301,000	218,301,000	89.8%	10.2%	196,025,388	22,275,612
	Miscellaneous Projects	185,631,788	185,631,788	89.8%	10.2%	166,689,769	18,942,019
	Capital Placeholder	1,327,071,000	1,327,071,000	89.8%	10.2%	1,191,655,592	135,415,408
	Miscellaneous Projects	8,957,446	8,957,446	89.8%	10.2%	8,043,421	914,025
Fund Transfers for Capital Projects	Raw Water Transmission & Distribution	$ -	$ -	89.8%	10.2%	$ -	$ -
	General Fund	17,806,800	17,806,800	89.8%	10.2%	15,989,780	1,817,020
	Information Technology	30,637,800	30,637,800	89.8%	10.2%	27,511,494	3,126,306
Unfunded Capital Projects	Source of Supply	$ 207,513,000	$ 207,513,000	89.8%	10.2%	$ 186,338,204	$ 21,174,796
	Water Treatment	5,844,000	5,844,000	89.8%	10.2%	5,247,673	596,327
Grand Total (Excl. Projects from Water Supply Master Plan)		**$ 7,297,378,670**	**$ 7,297,378,670**			**$ 6,552,748,194**	**$ 744,630,477**

1. The 15-year Capital Improvement Program (CIP) was provided by District staff. Source file: *FY23 CIP By Fund v8.xlsx*.
2. The District's CIP costs are based on current year dollars.
3. Cost basis for consideration is calculated as current cost estimate less any known external funding sources (e.g., grants, contributions, bond proceeds).
4. Capital projects are allocated proportionately based on expected customer growth. See Figure 7.

MASTER PLAN

In addition to Valley Water's 15-Year Capital Improvement Program, the impact fee analysis includes "Master Plan" projects from Valley Water's 2020 Water Supply Master Plan which were allocated over a 20-year period. The summary of the master plan projects are shown in **Figure 10**. Using the percent allocation factors from **Figure 7**, an estimated $213 million of the estimated $2 billion in the system development cost bases is allocated to future customers. Valley Water may have additional capital projects that are needed to serve future developments and will be evaluated on a case-by-case basis as part of the development review process.

Figure 10. Estimated Long-Term Capital Improvement Plan for Water Supply Projects[1]

Funded Status	Current Cost Estimate ($000s)	System Development Cost Basis	% Allocation		Distribution of Cost Basis ($)	
			Existing Customers	Future Customers	Existing Customers	Future Customers
Master Plan Projects	$ 2,086,200,000	$ 2,086,200,000	89.8%	10.2%	$ 1,873,322,449	$ 212,877,551

[1]Source file: *Water Supply Master Plan 2040_11.01.2019_v2.pdf*, Appendix H.

VALUE OF PROJECTED PROJECTS

Valley Water's combined short- and long-term projects for the water supply system total approximately $9.4 billion as shown in **Figure 11**.

Figure 11. Estimated Total Water Supply Capital Projects

Funded Status	Cost Center	Current Cost Estimate ($000s)
Capital Improvement Program		
Grand Total (Excl. Project from Water Supply Master Plan)		$7,297,378,670
Grand Total (Incl. Project from Water Supply Master Plan)		$9,383,578,670

FUTURE USERS SHARE OF PROJECTED PROJECTS

Valley Water's capital improvement plans for the water supply system extend to FY 2039/40. Some of the cost estimates for planned future improvements used to calculate the system development component of the impact fees are allocated using the allocation factors developed in **Figure 7**, as these projects benefit both current and future customers. **Figure 12** includes a summary of future capital improvement projects, where future customers are allocated about $958 million of the planned asset costs.

Figure 12. Future Users' Share of Projected Capital Improvement Projects – Water Supply

Funded Status	Cost Center	Current Cost Estimate ($000s)[2]	System Development Cost Basis[3]	% Allocation[4]		Distribution of Cost Basis ($)[4]	
				Existing Customers	Future Customers	Existing Customers	Future Customers
Capital Improvement Program[1]							
Funded Capital	Source of Supply	$ 2,291,269,836	$ 2,291,269,836	89.8%	10.2%	$ 2,057,466,791	$ 233,803,044
	Raw Water Transmission & Distribution	288,683,000	288,683,000	89.8%	10.2%	259,225,551	29,457,449
	Water Treatment	2,707,358,000	2,707,358,000	89.8%	10.2%	2,431,096,980	276,261,020
	Treated Water Transmission & Distribution	8,305,000	8,305,000	89.8%	10.2%	7,457,551	847,449
	Administration and General	218,301,000	218,301,000	89.8%	10.2%	196,025,388	22,275,612
	Miscellaneous Projects	185,631,788	185,631,788	89.8%	10.2%	166,689,769	18,942,019
	Capital Placeholder	1,327,071,000	1,327,071,000	89.8%	10.2%	1,191,655,592	135,415,408
	Miscellaneous Projects	8,957,446	8,957,446	89.8%	10.2%	8,043,421	914,025
Fund Transfers for Capital Projects	Raw Water Transmission & Distribution	$ -	$ -	89.8%	10.2%	$ -	$ -
	General Fund	17,806,800	17,806,800	89.8%	10.2%	15,989,780	1,817,020
	Information Technology	30,637,800	30,637,800	89.8%	10.2%	27,511,494	3,126,306
Unfunded Capital Projects	Source of Supply	$ 207,513,000	$ 207,513,000	89.8%	10.2%	$ 186,338,204	$ 21,174,796
	Water Treatment	5,844,000	5,844,000	89.8%	10.2%	5,247,673	596,327
Grand Total (Excl. Projects from Water Supply Master Plan)		$ 7,297,378,670	$ 7,297,378,670			$ 6,552,748,194	$ 744,630,477
Master Plan Projects		$ 2,086,200,000	$ 2,086,200,000	89.8%	10.2%	$ 1,873,322,449	$ 212,877,551
Grand Total (Incl. Projects from Water Supply Master Plan)		$ 9,383,578,670	$ 9,383,578,670			$ 8,426,070,643	$ 957,508,028

1. The 15-year Capital Improvement Program (CIP) was provided by District staff. Source file: FY23 CIP By Fund v8.xlsx.
2. Valley Water's CIP costs are based on current year dollars.
3. Cost basis for consideration is calculated as current cost estimate less any known external funding sources (e.g., grants, contributions, bond proceeds).
4. Capital projects are allocated proportionately based on expected customer growth. See Exhibit 1. Demographics.

ADJUSTMENTS

Before the impact fees are developed, an adjustment is applied to the cost basis to account for existing unrestricted cash reserves and outstanding debt principal.

Adjustments for Cash Balances

Existing cash reserves are available to pay for capital costs of the utility that future customers will benefit from, once connected. The existing cash reserves allocated to current and future customers are summarized in **Figure 13** using the same allocation factors from **Figure 7**. Future customers are allocated about $50.5 million in cash reserves. This amount will be credited against the capital costs allocated to future customers.

Figure 13. Cash Reserves Allocated to Future Development

Cash Reserves	Cash Amount[1]	% Allocation[2]		$ - Allocation[2]	
		Existing Customers	Future Customers	Existing Customers	Future Customers
Restricted Net Position (Fund 61)					
WU Debt Service Reserves	$ 6,999.04	89.8%	10.2%	$ 6,285	$ 714
WU San Felipe Emergency Reserve	3,348,085.79	89.8%	10.2%	3,006,444	341,641
GP5 Reserve	9,669,736.00	89.8%	10.2%	8,683,028	986,708
WU Rate Stabilization Reserve	25,069,620.00	89.8%	10.2%	22,511,496	2,558,124
WU State Water Project Tax Reserve	TBD	89.8%	10.2%	-	-
WU State Water Project - Encumbrances	TBD	89.8%	10.2%	-	-
WUE SVAWPC Reserve	1,298,138.00	89.8%	10.2%	1,165,675	132,463
WU Supplemental Water Supply Reserve	15,477,000.00	89.8%	10.2%	13,897,714	1,579,286
Drought Reserve	10,000,000.00	89.8%	10.2%	8,979,592	1,020,408
Unrestricted Net Position					
Committed Fund Balance					
Current Authorized Projects Reserve	85,292,965.00	89.8%	10.2%	76,589,601	8,703,364
Operating and Capital Reserve*	86,984,133.11	89.8%	10.2%	78,108,201	8,875,932
Water Inventory Reserve	129,968,912.00	89.8%	10.2%	116,706,778	13,262,134
Assigned Fund Balance					
Encumbrances Reserve	125,525,283.20	89.8%	10.2%	112,716,581	12,808,702
Market Valuation Reserve	2,394,921.40	89.8%	10.2%	2,150,542	244,380
Total Beginning Cash	**$ 495,035,794**			**444,521,937**	**50,513,856**
Cash Net of Unspent Capacity Fees	**$ 495,035,794**	**89.8%**	**10.2%**	**$ 444,521,937**	**$ 50,513,856**

1. Total beginning cash balance for FY 2020/21 provided by District staff in source file: *2021 Reserve WS to Budget.pdf*.
2. Cash reserves are allocated proportionately in the same manner as existing assets (in total) in Figure G.

Adjustments for Debt Principals

Since new development pay their share of existing asset values, including the debt payment principals on those same assets would double count the asset values included in the capacity fees. Therefore, future customers are credited approximately $57.3 million as shown in **Figure 14**.

Figure 14. Debt Service Credited to Future Development – Water Supply

Description of Debt	Principal Amount	% Allocation[2]		$ - Allocation	
		Existing Customers	Future Customers	Existing Customers	Future Customers
2016 Bonds	$ 181,530,000	89.8%	10.2%	$ 163,006,531	$ 18,523,469
2016 COPs	71,585,000	89.8%	10.2%	64,280,408	7,304,592
2017 Bonds	47,750,000	89.8%	10.2%	42,877,551	4,872,449
2019 Bonds	126,615,000	89.8%	10.2%	113,695,102	12,919,898
2020 Bonds	92,650,000	89.8%	10.2%	83,195,918	9,454,082
2020 COPs	41,765,000	89.8%	10.2%	37,503,265	4,261,735
Total	**$ 561,895,000**			**$ 504,558,776**	**$ 57,336,224**

DEVELOPMENT IMPACT FEE

The sum of the existing and future planned asset values (i.e., the system buy-in and system development costs), along with the adjustment for cash reserves and debt principals, defines the total cost basis allocated to future customers. The total adjusted cost basis is then divided by the projected water supply growth (in AF) expected to be developed through 2040. **Figure 15** summarizes the adjusted cost basis allocated to future customers.

Figure 15. Summary of Cost Basis Allocated to Future Customers – Water Supply

System Asset Values Allocated to Future Development	
System Buy-In and Expansion Components	
Existing System Buy-In[1]	$ 61,986,136
Future System Expansion[2]	957,508,028
Subtotal: System Buy-In and Expansion Components	**$ 1,019,494,164**
Adjustments to Cost Basis:	
Cash Reserves[3]	$ (50,513,856)
Outstanding Long-Term Debt (Principal)[4]	(94,117,533)
Subtotal: Adjustments to Cost Basis	**$ (144,631,389)**
Total: Cost Basis for New Development	**$ 874,862,774**
Projected Water Supply (through 2040)	40,000
Water Supply Capacity Fee (Per AF)	$ 21,900

1. See Figure 8.
2. See Figure 12.
3. See Figure 13.
4. See Figure 14.

DEVELOPMENT IMPACT FEE POTENTIAL REVENUE ESTIMATES

At the request of Valley Water, NBS calculated the annual capacity fee revenue based on funding 100% of capital expenses, as well as the revenue if only 50% of the capital expenses were included in the analysis. **Figure 16** shows a summary of potential revenue from water supply impact fees both 50% and 100% of capital costs. Figure 16 also shows the typical single family residential fee, based on a typical single family residential family using 0.4 acre feet of water per year.

Figure 16. Potential Revenue Estimates Based on CIP Funding

ANNUAL REVENUE ESTIMATE	100% CIP	50% CIP
Growth Estimate through 2040	*40,000*	*40,000*
Years until 2040	*18*	*18*
Annual Water Supply Growth	*2,222*	*2,222*
Fee per Acre Foot	*$21,900*	*$9,900*
*Typical Single Family Residential Fee**	*$8,760*	*$3,960*
Annual Capacity Fee Revenue Estimate	*$ 48,666,667*	*$ 22,000,000*

* Typical Single Family uses 0.4 acre feet of water per year

4. Flood Protection Impact Fee

4.1 Identifying New Development Share of Projects

This impact fee study and the recommended fees assume a given level of development activity over the course of the study period based on data available from Valley Water's parcel count, parcel area, and the User's Guide for the California Impervious Surface Coefficients. The development that occurs may result in both different impacts and fee revenues than those that are calculated in this study. For that reason, regular updates are recommended to adjust the fees to match the needs created by the rate of actual development.

In developing the proposed fees, NBS worked cooperatively with District staff. The fees presented in this study reflect input provided by District staff regarding financial matters, available capacity in the flood protections system, existing asset values, and planned capital improvements.

IDENTIFY FUTURE DEVELOPMENT

Future land development is estimated using impervious surface area data. Using the User's Guide for the California Impervious Surface Coefficients[5] (referred to as 'Guide' in this report) research, the estimated impervious surface acres can be calculated for current and future users. Impervious surface area (ISA) represents the hardened surface area in a given area used to calculate stormwater runoff. The ISA does not allow water to seep into the ground and simply allows water to run off the area into storm drains or nearby bodies of water. Asphalt, for example, is highly impervious.

Future land development and the impervious area can be estimated by using historical population growth as a proxy. The following sections go into more detail on the methodology used to identify future development estimates.

METHODOLOGIES FOR ESTIMATING FUTURE LAND USE

This analysis uses future population growth as a variable to estimate the future impervious surface area expected to be developed. The growth of ISA is calculated using the current parcel data along with the coefficients developed in the Guide. The calculation of the coefficient is the acres of hardened surface divided by the total acres developed in the Guide for various land uses. **Figure 17** shows the total parcel count and acreage currently in Santa Clara County.

[5] *Washburn, Barbara, PhD, Yancey, Katie, Jonathan Mendoza; User's Guide for the California Impervious Surface Coefficients, December 2010, Ecotoxicology Program, Office of Environmental Health Hazard Assessment, California Environmental Protection Agency.*

Figure 17. Summary of Parcel Count and Area by Land Use in Santa Clara County

Land Use	Sum of Parcel Count	Sum of Total Parcel Area
SINGLE FAM RES & SML MULTI	858,178	177,457
COMMERCIAL AND INDUSTRIAL	36,554	57,318
DISTURBED RURAL,VCNT,AGRIC	13,379	75,160
INSTITUTIONS AND APARTMENT	12,945	18,924
MIXED ASSESSMENT	135	10,960
RURAL UNDIST AG. BRUSH, FOR	2,262	237,976
UNDISTRBD AGRIC,MARSH,PONDS	1,744	87,272
WELL SITE	35	1
TOTALS	**925,232**	**665,068**

POPULATION GROWTH

Historical population growth serves as a reasonable assumption to the growth in impervious acreage expected to be developed. Projecting the population growth for Valley Water's retailers is shown in **Figure 18**, where an estimated 14% growth is expected in a 25-year period from 2020-2045. NBS believes this is a reasonable assumption to use in calculating fees through 2050. This growth pattern will be used to estimate future impervious surface acreage growth in this analysis.

Figure 18. Projected Population Growth in Valley Water Service Area Only

Agencies / Cities	Projected Population Growth						
	2020	2025	2030	2035	2040	2045	% Growth
Campbell[1]	42,288	42,377	42,466	42,555	42,644	42,734	1.1%
Cupertino[2]	59,549	59,549	59,549	59,549	59,549	59,549	0.0%
Gilroy[3]	57,084	57,946	58,821	59,709	60,611	61,526	7.8%
Los Altos[4]	30,876	31,086	31,297	31,510	31,724	31,940	3.4%
Los Gatos[5]	31,439	31,634	31,830	32,027	32,226	32,426	3.1%
Milpitas[6]	75,663	75,701	75,739	75,777	75,814	75,852	0.3%
Monte Sereno[7]	3,511	3,512	3,513	3,513	3,514	3,515	0.1%
Morgan Hill[8]	46,454	47,453	48,473	49,515	50,580	51,667	11.2%
Mountain View[9]	81,302	81,863	82,428	82,997	83,569	84,146	3.5%
San Jose[10]	132,644	150,368	168,092	194,983	217,685	222,661	67.9%
Santa Clara[11]	129,104	130,821	132,561	134,324	136,111	137,921	6.8%
Saratoga[12]	31,030	31,080	31,129	31,179	31,229	31,279	0.8%
Sunnyvale[13]	154,252	155,825	157,415	159,020	160,642	162,281	5.2%
Total Population	**875,196**	**899,214**	**923,312**	**956,659**	**985,899**	**997,497**	**14.0%**
Annual Growth (2020 to 2045)	***35,008***	***35,969***	***36,932***	***38,266***	***39,436***	***39,900***	

1. Information available on the City's website. Website: *https://www.campbellca.gov/ArchiveCenter/ViewFile/Item/1642*, page 126.
2. Information available on the City's website. Website: *https://www.cupertino.org/home/showpublisheddocument/29190/637534959803230000*, page 112.
3. Information available on the City's website. Website: *https://www.cityofgilroy.org/DocumentCenter/View/11644/FY-2020-ACFR?bidId=*, page 209.
4. Information available on the City's website. Website: *https://www.losaltosca.gov/sites/default/files/fileattachments/administrative_services/page/34881/final_-los_altos_acfr_fy21.pdf*, page 155.
5. Information available on the City's website. Website: *https://www.losgatosca.gov/DocumentCenter/View/29618/FY-202021-ACFR?bidId=*, page 146.
6. Information available on the City's website. Website: *https://www.milpitas.gov/wp-content/uploads/2021/12/Milpitas-2021-Web-ACFR.pdf*, page 157.
7. Population for Monte Sereno is based on information available from the United States Census Bureau. Website: *https://www.census.gov/*.
8. Information available on the City's website. Website: *https://www.morgan-hill.ca.gov/DocumentCenter/View/37500/2020-Annual-Comprehensive-Financial-Report-6-30-20-PDF?bidId=*, page 208.
9. Information available on the City's website. Website: *https://www.mountainview.gov/civicax/filebank/blobdload.aspx?BlobID=33599*, page 178.
10. Population is defined as the population served by San Jose Municipal Water System. Information available on the City's website. Website: *https://www.sanjoseca.gov/home/showpublisheddocument/422/637602045327100000*, page ES-2.
11. Information available on the City's website. Website: *https://www.santaclaraca.gov/home/showpublisheddocument/76049/637769033936730000*, page 231.
12. Information available on the City's website. Website: *https://www.saratoga.ca.us/ArchiveCenter/ViewFile/Item/1921*, page 123.
13. Information available on the City's website. Website: *https://www.sunnyvale.ca.gov/home/showpublisheddocument/938/637819888578970000*, page 219.

LAND USE PROJECTIONS

From Valley Water's number of parcels and total acreage, the density per acre can by calculated by dividing the number of APNs by the total acreage in each customer class. Combining the acreage with the Impervious Surface Area (ISA) coefficient, the estimated current impervious surface acreage in Valley Water can be determined as shown in **Figure 19.**

Figure 19. Summary of Estimated Current Impervious Surface Area

Land Use	Number of APN	Total Acreage	Density per Acre	Impervious Surface Coefficient[2]	Estimated Impervious Acres	% of Impervious Area
SINGLE FAM RES & SML MULTI	858,178	177,457	4.8	0.49	86,954	*56.35%*
COMMERCIAL AND INDUSTRIAL	36,554	57,318	0.6	0.81	46,428	*30.09%*
DISTURBED RURAL,VCNT,AGRIC	13,379	75,160	0.2	0.04	3,006	*1.95%*
INSTITUTIONS AND APARTMENT	12,945	18,924	0.7	0.14	2,649	*1.72%*
MIXED ASSESSMENT	135	10,960	0.01	0.80	8,768	*5.68%*
RURAL UNDIST AG. BRUSH, FOR	2,262	237,976	0.01	0.02	4,760	*3.08%*
UNDISTRBD AGRIC,MARSH,PONDS	1,744	87,272	0.02	0.02	1,745	*1.13%*
WELL SITE	35	0.61	57.4	0.44	0	*0.00%*
TOTAL	**925,232**	**665,068**			**154,311**	**100%**

1. Parcel count from District via source file: *SCVWD_Parcel_data_09-12-2022.xlsx*
2. Average impervious surface coefficient by land use in Source file: *User's Guide for the California Impervious Surface Coefficients.pdf, Table 1 and Table 2.*

PROJECTED FUTURE LAND USE

The projected land use growth can be determined using the 14% growth pattern found from historical population growth in **Figure 18**. With this percentage as a proxy, an estimated 21,564 impervious acres are expected to be developed through 2050. This leads to an estimated 12.3% of future costs allocated to future customers as shown in **Figure 20**.

Figure 20. Projected Growth in Flood Protection Area

Estimated Impervious Surface Area Growth (Acres)	Current	Net Growth 2022-2050	% Current	% Future	Estimated ISA Growth	% ISA Growth
	154,311	175,874	87.7%	12.3%	21,564	14.0%

4.2 New Development Share of Infrastructure

The capital assets addressed in this study include existing assets and planned capital improvements (i.e., the system buy-in and incremental assets). An important aspect of this study is how the value of existing utility assets is determined. For example, the purchase price does not account for wear and tear, and current book value (i.e., purchase price less accumulated depreciation) typically underestimates the "true value" of facilities as it does not account for cost increases over time. Therefore, this study uses the replacement-cost-new-less-depreciation (RCNLD) approach to estimate existing asset values that reflect estimated cost inflation and depreciation.

VALUE OF EXISTING INFRASTRUCTURE

Valley Water has a wide range of creek and river projects to provide flood protection across Valley Water. The projects also include tide gates and shoreline protection. These projects are cataloged in Valley Water's Asset Management Planning Tool (AMPT).

METHODOLOGY – REPLACEMENT COST LESS DEPRECIATION

In general, the RCNLD is calculated by escalating the book value of existing assets to current-day values using inflation factors from various construction indices; however, in the case of Valley Water, we used the escalated values from Valley Water's AMPT. Replacement values were calculated by escalating the original values from service date to 2021 values using historical cost inflation factors provided by Valley Water. For this analysis, assets that have exceeded their useful life (as defined in Valley Water's asset records) were considered to have no remaining value. This approach was used for all assets, except land, which does not depreciate and is excluded from the analysis.

DATA SOURCES

Valley Water currently uses an asset management program which was used to establish the current value of the existing flood protection watershed assets. Projected new projects were outlined in Valley Water's 5-Year Capital Improvement Program (FY 2023 - FY 2027) provided by District staff. This 5-Year CIP also included a 15 year projection of projects through FY 2037.

ESTIMATED VALUE OF EXISTING INFRASTRUCTURE

The existing assets for the flood protection system include all watershed assets from Valley Water's asset management system. The total system buy-in costs are estimated to be more than $370 million, in which just over $45 million is allocated to future customers using the factors calculated in **Figure 20**. The summary of existing watershed assets are shown in **Figure 21**.

Figure 21. Existing Watershed Assets

Flood Protection Assets	System Buy-In Cost Basis
Annual Inspection	$ 541,605
Concrete-Bank	$ 131,759,239
Concrete-Bed	$ 95,748,526
Debris Removal	$ 1,749,659
Fish Ladder Maintenance	$ 1,492,101
FishLadder	$ 70,753,660
Herbicide	$ 50,965
Levee Maintenance	$ 2,777,802
RockLined-Bank	$ 50,945,589
RockLined-Bed	$ 9,201,086
Sediment Removal	$ 2,493,757
Vegetation Removal	$ 2,846,886
Total Capital Assets	**$ 370,360,875**
Existing Users (87.7%)	***$ 324,951,720***
Future Users (12.3%)	***$ 45,409,156***

Replacement cost new, less depreciation used to calculate the system buy in cost basis

PROJECTED NEW PROJECTS

Valley Water's capital improvement plan has been segregated between short-term and long-term projects. The short-term projects represent projects planned in the next five years, the long-term projects represent projects planned for six to fifteen years from now.

Short-Term Capital Improvement Plans

Valley Water currently has a short-term capital improvement plan spanning through 2027 for watershed and flood protection additions. **Figure 22** summarizes the total planned capital projects for each individual watershed through 2027. Of the $1.69 billion of capital projects, an estimated $207 million are allocated to future customers.

Figure 22. Estimated Capital Improvement Projects

Watershed	Total Planned Thru 2027
COYOTE WATERSHED	$ 423,343,000
GUADALUPE WATERSHED	270,007,000
LOWER PENNISULA WATERSHED	283,143,800
MULTIPLE WATERSHED	281,366,000
UVAS LLAGAS WATERSHED	344,053,000
WEST VALLEY WATERSHED	70,383,000
TRANSMISSION	16,338,000
TOTALS	**$ 1,688,633,800**
Existing Users (87.7%)	***$ 1,481,594,017***
Future Users (12.3%)	***$ 207,039,783***

Long-Term Capital Improvement Plans

Valley Water also currently has estimated long-term capital plans spanning through 2037. The summary of projects planned for the long-term are shown in **Figure 23** where an estimated $30.5 million of the total $248 million are allocated to future customers.

Figure 23. Estimated Long-Term Capital Improvement Plan for Watersheds Detail

Watershed	Total Planned FY 2028/36
COYOTE WATERSHED	$ 92,901,000
GUADALUPE WATERSHED	51,377,000
LOWER PENNISULA WATERSHED	5,845,000
MULTIPLE WATERSHED	98,611,000
UVAS LLAGAS WATERSHED	-
WEST VALLEY WATERSHED	-
TRANSMISSION	200,000
TOTALS	**$ 248,934,000**
Existing Users (87.7%)	***$ 218,412,734***
Future Users (12.3%)	***$ 30,521,266***

Value of Projected Projects

Combining the short- and long-term projects valued for the flood protection system, total planned capital exceeds about $1.93 billion, as shown in **Figure 24.**

Figure 24. Flood Protection Costs by Watershed

Watershed	Total Planned Projects
COYOTE WATERSHED	$ 516,244,000
GUADALUPE WATERSHED	321,384,000
LOWER PENNISULA WATERSHED	288,988,800
MULTIPLE WATERSHED	379,977,000
UVAS LLAGAS WATERSHED	344,053,000
WEST VALLEY WATERSHED	70,383,000
TRANSMISSION	16,538,000
TOTALS	**$ 1,937,567,800**

FUTURE USERS SHARE OF PROJECTED PROJECTS

Valley Water's capital improvement plans for multiple watersheds in the County extend to FY 2037. Some of the cost estimates for planned future improvements used to calculate the system development component of the impact fees are allocated using the allocation factors developed in **Figure 20**, as these projects benefit both current and future customers. **Figure 25** includes a summary of future capital improvement projects, where future customers are allocated about $237 million of the planned asset costs.

Figure 25. Future Users Share of Projected Capital Improvement Projects

Watershed	Total Planned Projects	% Allocation[2]		$ - Allocation	
		Existing Users	Future Users	Existing Users	Future Users
COYOTE WATERSHED	$ 516,244,000	87.7%	12.3%	$ 452,948,426	$ 63,295,574
GUADALUPE WATERSHED	321,384,000	87.7%	12.3%	281,979,794	39,404,206
LOWER PENNISULA WATERSHED	288,988,800	87.7%	12.3%	253,556,501	35,432,299
MULTIPLE WATERSHED	379,977,000	87.7%	12.3%	333,388,832	46,588,168
UVAS LLAGAS WATERSHED	344,053,000	87.7%	12.3%	301,869,397	42,183,603
WEST VALLEY WATERSHED	70,383,000	87.7%	12.3%	61,753,491	8,629,509
TRANSMISSION	16,538,000	87.7%	12.3%	14,510,311	2,027,689
TOTALS	**$ 1,937,567,800**	**87.7%**	**12.3%**	**$ 1,700,006,751**	**$ 237,561,049**

Source file: *FY23 CIP by Fund v8.xlsx, for Funds 12 and 26*

Inflation is factored into CIP estimates.

ADJUSTMENTS

Before the impact fees are developed, an adjustment is applied to the cost basis to account for existing unrestricted cash reserves and outstanding debt principal.

Adjustments for Cash Balances

Before the impact fees are developed, an adjustment is applied to the cost basis to account for existing unrestricted cash reserves and outstanding debt principal. Existing cash reserves are available to pay for capital costs of the utility that future customers will benefit from, once connected. The existing cash reserves allocated to current and future customers are summarized in **Figure 26** using the same allocation factors from **Figure 20**. Future customers are allocated about $15.3 million in cash reserves. This amount will be credited against the capital costs allocated to future customers.

Figure 26. Cash Reserves Allocated to Future Development

Flood Protection Cash Reserves	Beginning Cash[1]	% Allocation		$ - Allocation	
		Existing Users	Future Users	Existing Users	Future Users
Watershed & Stream Fund 12 - Operating & Capital	$ 97,803,767	87.7%	12.3%	$ 85,812,256	$ 11,991,511
Safe Clean Water Fund 26 - Operating & Capital Reserve	$ 27,042,203	87.7%	12.3%	$ 23,726,616	$ 3,315,587
Total	**$ 124,845,971**	**87.7%**	**12.3%**	**$ 109,538,873**	**$ 15,307,098**

1. Total beginning cash and investments balances are per District.
Source file: *2021 Reserve WS to Budget.pdf*

Adjustments for Debt Principals

Since new development pay their share of existing asset values, including the debt payment principals on those same assets would double count the asset values included in the capacity fees. Therefore, future customers are credited approximately $7.2 million as shown in **Figure 27.**

Figure 27. Debt Service Credited to Future Development

Outstanding Debt	Total Amount	% Allocation[2]		$ - Allocation	
		Existing Users	Future Users	Existing Users	Future Users
2012A COPs Debt Service Schedule					
West Valley (N. Central)					
Outstanding Principal	$ 3,238,594	87.7%	12.3%	$ 2,841,517	$ 397,077
Guadalupe (Central)					
Outstanding Principal	$ 8,100,585	87.7%	12.3%	$ 7,107,389	$ 993,195
Coyote (East)					
Outstanding Principal	$ 3,360,821	87.7%	12.3%	$ 2,948,758	$ 412,063
Subtotal	**$ 14,700,000**	**87.7%**	**12.3%**	**$ 12,897,664**	**$ 1,802,336**
2017A WS (Refunding of 2004A and 2007A COPs)					
Lower Peninsula (10993008)					
Outstanding Principal	$ 16,159,018	87.7%	12.3%	$ 14,177,795	$ 1,981,223
Guadalupe (30993008)					
Outstanding Principal	$ 5,471,391	87.7%	12.3%	$ 4,800,555	$ 670,836
West Valley (20993008)					
Outstanding Principal	$ 4,847,296	87.7%	12.3%	$ 4,252,979	$ 594,317
Coyote (40993008)					
Outstanding Principal	$ 14,545,982	87.7%	12.3%	$ 12,762,530	$ 1,783,452
	$ 3,508,676	87.7%	12.3%	3,078,485	430,191
Subtotal	**$ 44,532,363**	**87.7%**	**12.3%**	**$ 39,072,345**	**$ 5,460,018**
Grand Total	**$ 59,232,363**	**87.7%**	**12.3%**	**$ 51,970,010**	**$ 7,262,354**

1. Payment Schedule found in source file: *Watershed Debt Service as of 03-29-22.xlsx*

DEVELOPMENT IMPACT FEE

The sum of the existing and future planned asset values (i.e., the system buy-in and system development costs), along with the adjustment for cash reserves and debt principals, defines the total cost basis allocated to future customers. The total adjusted cost basis is then divided by the projected growth of impervious surface acres expected to be developed through 2050. **Figure 28** summarizes this calculation.

Figure 28. Summary of Cost Basis Allocated to Future Customers

System Asset Values Allocated to Future Development	
System Asset Values Allocated to New Development	
Existing System Buy-In[1]	$ 45,409,156
Future System Expansion[2]	237,561,049
Total: Existing & Future System Costs	$ 282,970,205
Adjustments to Cost Basis:	
Cash Reserves[3]	$ (15,307,098)
Outstanding Long-Term Debt (Principal)[4]	(7,262,354)
Total: Adjustments to Cost Basis	$ (22,569,451)
Total Adjusted Cost Basis for New Development	**$ 260,400,754**
Projected Growth of Impervious Surface Acres (ISA) through 2050	**21,564**
Maximum Base Capacity Fee per Impervious Acre	**$ 12,100**

1. See Figure 21.
2. See Figure 25.
3. See Figure 26.
4. See Figure 27.

Based on the combined system buy-in and incremental capacity fee methodology, and the assumptions used in this analysis, NBS has calculated the new flood protection impact fees by land use, as shown in **Figure 29.** The updated fees represent the typical fees that the Valley Water can charge for new development per acre while funding 100% of the capital improvement program.

Figure 29. Typical Flood Protection Impact Fee by Land Use

Land Use	% of Impervious Area per Acre	Typical Capacity Fee* per Acre
SINGLE FAM RES & SML MULTI	*49%*	$ 5,929
COMMERCIAL AND INDUSTRIAL	*81%*	$ 9,801
DISTURBED RURAL,VCNT,AGRIC	*4%*	$ 484
INSTITUTIONS AND APARTMENT	*14%*	$ 1,694
MIXED ASSESSMENT	*80%*	$ 9,680
RURAL UNDIST AG. BRUSH, FOR	*2%*	$ 242
UNDISTRBD AGRIC,MARSH,PONDS	*2%*	$ 242
WELL SITE	*44%*	$ 5,324
Maximum Flood Protection Impact Fee Per Acre		**$ 12,100**

DEVELOPMENT IMPACT FEE POTENTIAL REVENUE

Valley Water can also choose to fund less than 100% of capital expenses with impact fees. **Figure 30** shows a summary of potential revenue from flood protection impact fees for both 50% and 100% of capital costs. Figure 30 also shows the typical single family residential fee, based on a single family lot size of 8,000 sq ft with a 49% impervious surface area.

Figure 30. Potential Revenue Estimate from Flood Protection Impact Fees

ANNUAL REVENUE ESTIMATE	50% CIP	100% CIP
Growth Estimate through 2050 (ISA)	*21,564*	*21,564*
Years until 2050	*28*	*28*
Annual ISA growth	*770*	*770*
Fee per Impervious Acre	*$ 6,600*	*$12,100*
*Typical Single Family Lot**	*$ 594*	*$1,089*
Annual ISA capacity fee revenue estimate	*$ 5,082,839*	*$ 9,318,539*

* Typical Single Family Lot has 0.09 acres of impervious area. (8,000 sq ft per lot / 43,560 sqft/acre x .49 impervious area per acre)

5. Development Impact Fee Comparison

Many local agencies have used development impact fees to help recover infrastructure costs for future growth. Impact fees have been used for a wide range of infrastructure, such as transportation, schools, parks, and utilities. A majority of those agencies have the land use authority to regulate new development, which makes adopting and administering an impact fee somewhat easier. The purpose of this section is to look for development impact fees from similar regional authorities that don't have land use approval.

5.1 Water Supply Impact Fees

There are many regional authorities that have water impact fees. These fees have a variety of names, as shown in **Figure 31** below, but those names also represent what infrastructure the fee is being used for (as described in the notes). There are instances where the agency has more than one impact fee and/or a fee that varies by region or another factor. In those cases, costs were allocated to those attributes and distributed across those future users. Most of these fees also vary by water meter size. These agencies typically work with local agencies to collect these impact fees.

Figure 31. Impact Fees of Similar Agencies

Agency	Fee	Residential Fee (3/4" meter)	Notes
East Bay Municipal Utility District	System Capacity Charge	Varies by region $13,280 to $39,140	Covers the cost of system-wide facilities buy-in, regional facilities buy-in, and future water supply.
	Water Demand Mitigation Fee	Varies by territory $8,300 to $12,810	Funds conservation programs to achieve water savings that offset water demand.
Inland Empire Utilities Agency	Water Capacity Charge	$1,896	Covers cost to buy into system facilities. Based on UWMP growth.
San Diego County Water Authority	System Capacity Charge	$5,700	Covers the cost of conveyance and storage facilities.
	Water Treatment Capacity	$159	Cost to connect to the Twin Oaks Valley Water Treatment Plant; excludes Escondido, Poway, and Del Mar, which cannot be served by the Twin Oaks Plant.
San Francisco Public Utilities Commission	Water Capacity Charge	$3,335	Cost to buy into system facilities.
Zone 7 Water Agency	Water Connection Fee	Varies by City/meter type $50,595 to $101,190	Costs are for expanding Zone 7 water treatment and distribution system to serve new development.

5.2 Flood Protection Impact Fees

Flood protection impact fees are much rarer than other impact fees. By the very nature of flood protection, agencies involved with flood protection are usually regional agencies. Fees from a few selected agencies are shown in **Figure 32**. These agencies work with local agencies to collect the impact fees. Some of these agencies vary their impact fees by the drainage area. Most of these fees use impervious area as the basis for distributing costs to individual customers.

Figure 32. Comparison of Flood Protection Impact Fees

Agency	Basis for Fee	Fee (residential)
Contra Costa Flood Control District	Impervious Area	Varies by Drainage Area, $0.36 to $2.59 per sq ft
Alameda County Flood Control & Water Conservation District, Zone 7	Impervious Area	$1 per square foot
Sacramento Area Flood Control Agency	Damageable Square Footage, varies by land use category	$2.10 per square foot of damageable area for single family residential
Los Angeles County Flood Control District, Antelope Valley Drainage Area	Residential Lots	$5,500 per residential lot

6. Recommendations

6.1 Results of Analysis

This study examined all the key elements required for implementing a development impact fee for flood protection and water supply. The results of the analysis are summarized below.

- *Valley Water has the cost data required for impact fees*. The Water Supply Master Plan, the Operating and Capital Budget, the Protection and Augmentation of Water Supplies Annual Report, and the 5-Year Capital Improvement Program Report provide an excellent basis for the project costs. Combined with the asset management reports for the existing assets, there is a solid basis for the costs included in the analysis. There needs to be additional discussion on what long range projects should be included in the impact fee analysis. Including long range projects in the fee calculation that are not implemented could trigger the need for a rebate.
- *More effort is needed to refine future water demands and future water users.* If Valley Water wants to move forward with the water supply impact fee, there should additional effort on determining the future water needs of Valley Water as the wholesaler, informed by growth and future water needs at the City level. There is significant difference between the water demand data over period using member agency data (25% growth) compared to the Water Supply Master Plan (11% growth).
- *There is significant revenue generation potential from development impact fees.* Depending on the future capital improvement projects included in the analysis, the impact fee could generate $30M annually, while the flood protection fee could generate $6M annually.
- *Valley Water will need to rely on member agencies to calculate and collect the impact fee.* The planning or development department for the member agency will be granting the land use permits. They would need to calculate the water supply and flood protection impacts for the new development based on specific characteristics for the development. Fee revenue would be passed through to Valley Water.
- *It would be best implemented if all of the member agencies approved implementing the impact fees.* Normally, impact fees are used to offset capital costs that would otherwise be paid through user charges. If there was not a unanimous buy-in from the member agencies, to be equitable, there should be a user charge difference between those agencies that collect the impact fee and those agencies that do not.

6.2 Next Steps

While Valley Water needs to decide if they wish to proceed with approaching member agencies, the next steps in implementing a development impact fee are described below.

6.3 Implementing Development Impact Fees

There are three general phases in the process of developing and implementing a development impact fee. In the first phase, information is gathered and a defensible nexus study is prepared. The second phase is getting agency approval. The last phase occurs after the fee is adopted and consists of the annual tasks required to administer the fee.

PREPARING A DEFENSIBLE NEXUS STUDY

A defensible nexus study needs to be based on the challenges the agency is facing in terms of expected infrastructure required to meet growth as well as the expected growth in development. The nexus study (required by AB602) will also have to be based on an approved capital improvement plan (AB602 also requires large jurisdictions (*population over 250,000*) to adopt a capital improvement plan as the basis for the nexus study). This study would need some refinement but otherwise would serve as the nexus study.

ADOPTING THE DEVELOPMENT IMPACT FEE

Once a nexus study has been prepared, the next step is to get management and board approval. Typically, management and the board have already signaled an interest in implementing the development impact fee by authorizing the nexus study. But because Valley Water is a regional authority with member agencies having the land use approval authority, member agencies need to buy-in to implement an impact fee. For member agencies, the primary benefit would be the creation of a new revenue source to potentially lower their revenue requirements from user charges.

While having all member agencies buy-in is not mandatory, to follow cost of service principles, those member agencies that do not implement an impact fee would need to generate an equivalent amount of revenue from a different mechanism to compensate for the lost revenue in that jurisdiction. To be most efficient with the least administration for Valley Water, the impact fee should be unanimously endorsed by the member agencies.

Valley Water should conduct a concerted effort to inform the member agencies of the potential benefits of an impact fee as well as assess their interest in implementing an impact fee. But even before reaching out to member agencies, Valley Water should get the approval to move forward with the member agencies by the Board.

When deciding on whether to implement an impact fee, it is important to consider all the cumulative impact fees from the local and regional jurisdictions. Looking at the total amount of impact fees, there may be opposition from developers or others regarding the upfront cost of building new housing. Valley Water should reach out to the Building Industry Association to gain possible support or lessen opposition. One analysis typically done during these efforts is to look at the total fees compared to the overall development cost for a typical residential development. This might result in a phase in period or just adopting a lower fee than is supported by the nexus study.

If the Board and member agencies decide to move forward, the nexus study needs to be adopted by the Board at a public hearing with a minimum 30 day notice. A public notice needs to be published twice, at least five days apart. An ordinance that describes how to administer the fee program needs to be prepared. It is typically adopted by resolution. The effective date is sixty days after adoption.

THINGS TO DO AFTER FEES ARE ADOPTED

There are several requirements to fulfill after the impact fees are adopted. There are accounting, reporting, and other transparency requirements. Any fees collected must be deposited in a separate account or fund. Agencies must adopt annual reports within 180 days of the close of each fiscal year. These reports should detail what moneys have been collected, the beginning and ending balance of the accounts, how the money was spent, and when the identified projects will be constructed, and any refunds.

California Government Code 66001 (d)(1) requires that *"Following the fifth fiscal year following the first deposit into the account or fund, and every five years thereafter, the local agency shall make all of the following findings with respect to that portion of the account or fund remaining unexpended, whether committed or noncommitted:*

- *(A) Identify the purpose to which the fee is to be put.*
- *(B) Demonstrate a reasonable relationship between the fee and the purpose for which it is charged.*
- *(C) Identify all sources and amounts of funding anticipated to complete financing in incomplete improvements identified…*
- *(D) Designate the approximate dates on which the funding referred to in subparagraph (C) is expected to be deposited into the appropriate account or fund.*

Failure to make these findings could result in refund requirements. It is also good practice to alert finance staff and the implementing department staff on what the funds can be used for.

While the nexus study should be reviewed every few years, the California Government Code requires that the nexus study needs to be updated every 8 years. This implies that the master plans, capital improvement plans, and other documents used in the nexus study be updated as well.

Appendix A. Abbreviations & Acronyms[6]

AAF	Average Annual Flow
AF	Acre Foot, equal to 435.6 HCF/CCF or 325,851 gallons
Alt.	Alternative
Avg.	Average
AWWA	American Water Works Association
BMP	Best Management Practice
BOD	Biochemical Oxygen Demand
CA	Customer
CAP	Capacity
CCF	Hundred Cubic Feet (same as HCF); equal to 748 gallons
CCI	Construction Cost Index
COD	Chemical Oxygen Demand
COM	Commodity
Comm.	Commercial
COS	Cost of Service
COSA	Cost of Service Analysis
CPI	Consumer Price Index
CIP	Capital Improvement Program
DU	Dwelling Unit
Excl.	Exclude
ENR	Engineering News Record
EDU	Equivalent Dwelling Unit
Exp.	Expense
FP	Fire Protection
FY	Fiscal Year (e.g., July 1st to June 30th)
FY 2022/23	July 1, 2022 through June 30, 2023
GPD	Gallons per Day
GPM	Gallons per Minute
HCF	Hundred Cubic Feet; equal to 748 gallons or 1 CCF
Ind.	Industrial
Irr.	Irrigation
ISA	Impervious Surface Area
LAIF	Local Agency Investment Fund
Lbs.	Pounds
MFR	Multi-Family Residential
MGD	Million Gallons per Day
MG/L	Milligrams per Liter
Mo.	Month
Muni.	Municipal
NH3	Ammonia
NPV	Net Present Value
N/A	Not Available or Not Applicable
O&M	Operational & Maintenance Expenses
Prop 13	Proposition 13 (1978) – Article XIIIA of the California Constitution which limits taxes on real property to 1% of the full cash value of such property.
Prop 218	Proposition 218 (1996) – State Constitutional amendment expanded restrictions of local government revenue collections.

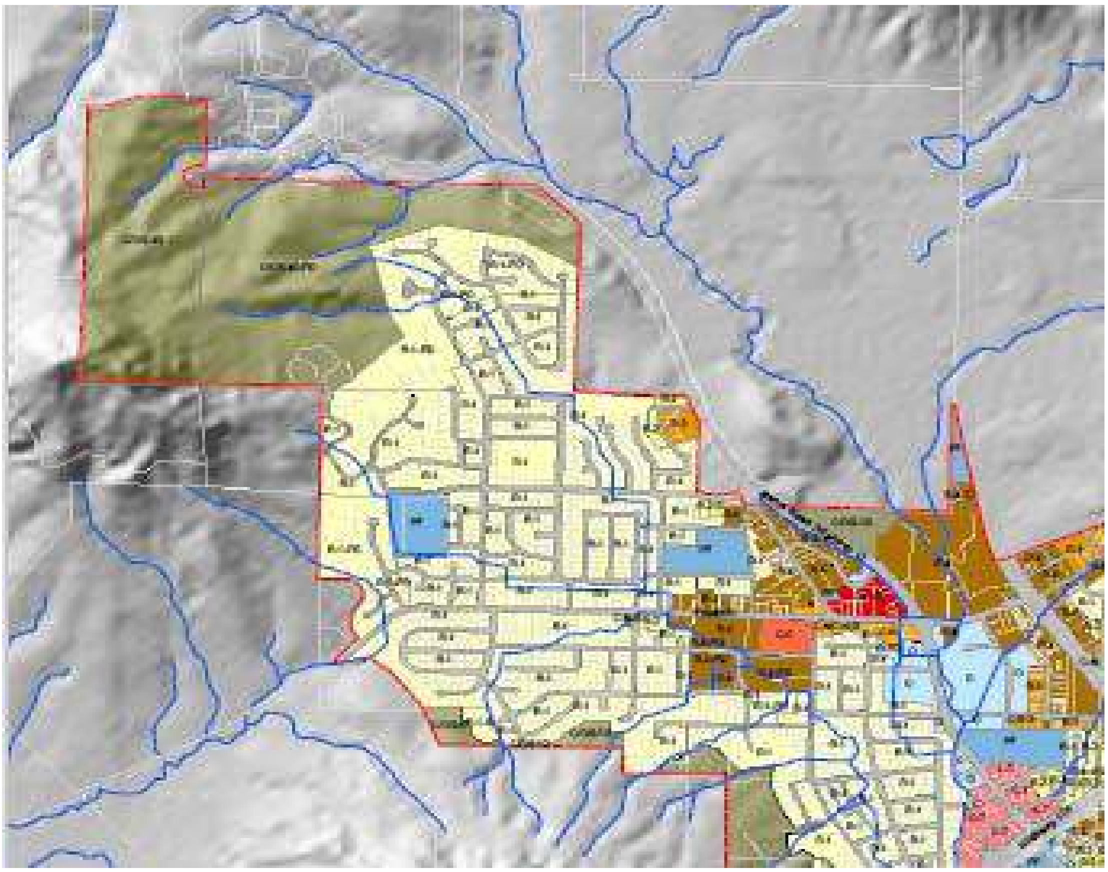
[6] *This appendix identifies abbreviations and acronyms that may be used in this report. This appendix has not been viewed, arranged, or edited by an attorney, nor should it be relied on as legal advice. The intent of this appendix is to support the recognition and analysis of this report. Any questions regarding clarification of this document should be directed to staff or an attorney specializing in this particular subject matter.*

Appendix A, continued

Req’t	Requirement
Res.	Residential
Rev.	Revenue
RTS	Readiness-to-Serve
R&R	Rehabilitation & Replacement
SFR	Single Family Residential
SRF Loan	State Revolving Fund Loan
SWRCB	State Water Resources Control Council
TSS / SS	Total Suspended Solids
V. / Vs. /vs.	Versus
WWTP	Wastewater Treatment Plant

Appendix B. User's Guide for the California Impervious Surface Coefficients

USER'S GUIDE FOR THE CALIFORNIA IMPERVIOUS SURFACE COEFFICIENTS



Ecotoxicology Program
Integrated Risk Assessment Branch
Office of Environmental Health Hazard Assessment

User’s Guide for the California Impervious Surface Coefficients

December 2010

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Table of Contents

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List of Acronyms

AF	acre-feet, measurement of runoff volume
ANOVA	Analysis of Variance
APN	Assessor's Parcel Number
B-IBI	Benthic Index of Biotic Integrity
BMI	benthic macroinvertebrates
BMP	Best Management Plan
Caltrans	CA Department of Transportation
CN	curve number
DCIA	directly connected impervious area
DOQ	digital orthophoto quadrangles
du/ac	dwelling units per acre
EMAP	Environmental Monitoring and Assessment Program
FAR	Floor-Area Ratio
GIS	Geographical Information System
HDR	High Density Residential
HSG	Hydrologic Soil Groups
IA	Impervious Area
IC	Impervious Cover
ICC	Impervious Cover Calculator
ISAT	Impervious Surface Analysis Tool
ISC	Impervious Surface Coefficient
LDR	Low Density Residential
LUC	Land Use Category
LULC	land use/land cover
MDR	Medium Density Residential
NEMO	Non-Point Source Education for Municipal Officials
NLCD	National Land Cover Dataset
NOAA	National Oceanographic and Atmospheric Administration
NPCF	Non-conforming Parcel Correction Factor
NRCS	Natural Resource Conservation Service
OS	Open Space
PQP	Public/Quasi-Public
ROW	right-of-way
SACOG	Sacramento Area Council of Governments

Table of Figures

PREFACE

In rapidly developing regions of California, small streams, including those utilized by anadramous fish such as salmon and steelhead, are increasingly surrounded with new residential developments and shopping malls. Signs of degradation, such as incision and sedimentation, in the aquatic habitat have become abundant.

Understanding the chemical and physical stressors affecting these watersheds will help local governments and others assess which factors contributed to the observed changes. Stormwater engineers, land use planners, and natural resource managers struggle to quantify impervious cover, one of the hallmarks of urbanization.

Office of Environmental Health Hazard Assessment became interested in the estimation of impervious cover (IC) while performing a watershed assessment. OEHHA sought a method with a high degree of accuracy and modest cost that would be easy to implement.

As a first step, a variety of approaches were reviewed:

- LANDSAT imagery was of low resolution (30 meters) so that it could not be reliably used to analyze imperviousness at smaller scales.
- IKONOS Satellite imagery had high resolution (1 meter) but was quite costly to obtain (Goetz et al., 2003).
- The Non-Point Source Education for Municipal Officials (NEMO) Program had been working on the analysis of imperviousness in Connecticut for many years and was continually evolving more refined methods of analysis. At the time OEHHA learned about their work, they had recently published a refinement of a set of coefficients for land cover, including some for urban uses (Prisloe et al., 2002). Yet even these refinements only applied three categories to classify developed areas.

Focusing on an urbanizing watershed, OEHHA worked to develop a set of impervious surface coefficients (ISCs) that reflected the percent of hardened surfaces using the land-use categories described by the Sacramento Area Council of Governments (SACOG). For example, SACOG classifies land uses into approximately 20 commonly used categories. If impervious surface coefficients could be developed for each category, then local governments, planners, stormwater engineers, and natural resource staff could more easily calculate the total impervious area at build-out for a future development or current imperviousness of an urbanized area.

OEHHA developed these statewide ISCs with support from U.S. EPA and the State Water Resources Control Board. This User's Guide describes the methods used to develop the ISCs, and provides applications of the coefficients to a variety of situations.

SECTION I. BACKGROUND

> **Impervious Surface Coefficient (ISC):**
>
> The percent of the area within a given land use category that is made up of hardened surfaces.
>
> $$ISC = \frac{Acres\ hardened\ surface}{Total\ acres}$$

A number of organizations, including the Non-Point Source for Municipal Officials (NEMO) Program and the Center for Watershed Protection, advocate the use of impervious cover for land-use planning purposes. NEMO developed the Impervious Surface Analysis Tool (ISAT) to facilitate these calculations. The Natural Resources Conservation Service (NRCS) developed a set of impervious surface coefficients (ISCs) as a tool for calculating stormwater runoff (NRCS, 1986). NRCS developed these coefficients to estimate the amount of imperviousness associated with seven land use categories. A detailed discussion of this method and curve numbers is provided in Section 5, Stormwater Application. In addition to this dataset, the National Oceanographic and Atmospheric Administration's (NOAA) Coastal Services Center has collaborated with others to develop the National Land Cover Dataset, which includes impervious cover datasets developed from 30 meter Landsat data. These data are available via NOAA's Digital Coast website.

The NRCS and NOAA datasets possess some limitations. For instance, Landsat data has a relatively low level of resolution that does not provide sufficient accuracy for analysis of sub-watershed and local planning areas. A limitation of the NRCS values is the modest number of CNs for urban land uses, in contrast with the large number of values for agricultural uses. Most California cities have identified 15 – 20 land use categories in their general plans; some communities have many more. Today, the range of densities for residential land uses varies from 1 dwelling unit per acre to 15-plus units/acre. This higher value likely will increase as communities emphasize higher-density development. The limited number and scope of NRCS values introduced uncertainty into the analysis of impervious cover, especially for smaller watersheds on which we and many others were conducting assessments.

For all of the above reasons, the Office of Environmental Health Hazard Assessment has developed a set of ISCs that focus on urban land uses that are commonly used throughout California.

SECTION II. HOW THE IMPERVIOUS SURFACE COEFFICIENTS WERE DEVELOPED

OEHHA first selected three cities to represent California's diverse land use classifications: the Sacramento region, Irvine, and Santa Cruz.[1] In selecting these cities, OEHHA employed a few key criteria, including geographical location, the availability of high-resolution aerial photography and digitized land use maps, and the willingness of the planning departments within each municipality to assist us with the project. The three cities selected are described below:

- **Sacramento**, a fast-growing city in the Central Valley where greenfield conversions occurred at a rapid pace during the housing boom. High percentages of Sacramento's development are suburban (not high-density). Data from the western portion of Placer county (part of the Sacramento metropolitan region) include portions of the Sierra foothills, providing additional diversity to the dataset. Since the original data from the Sacramento region was collected from sites from northern Sacramento and western Placer counties, OEHHA expanded the geographical range to include sites south of the American River.
- **Irvine**, a southern California city that has been built out, containing primarily densely populated urban development, yet retaining some land zoned as rural/agricultural preserves.
- **Santa Cruz**, a mid-sized, coastal community with a few land uses unique to coastal areas of the state.

Before scaling up the project, we reviewed a variety of methods for impervious surface analysis. For the original project, we used an interactive approach using a geographical information system (GIS). It involved digitizing impervious areas off of high-resolution aerial photographs and land use data layers. This and other methods were reviewed and determined to have the benefits of high accuracy and precision, relatively modest cost, and the availability of the data layers. (See Summary Table at the end of this chapter, Sturman 2007). Consequently, OEHHA decided to continue using the interactive GIS method to develop the California coefficients.

The following section describes the methods used to derive the ISCs.

***Step 1**: Assemble the necessary GIS layers.*

The data layers used included:

- Current high resolution digital aerial orthophotographs of each city. The resolution of the photographs ranged from 6 inches to 2-feet per pixel.
- Land use data layer. Land uses are typically defined in the general plans. Local jurisdictions may have multiple types of layers that contain land use information. This data layer was obtained directly from the cities of Irvine and Santa Cruz. For the Sacramento

[1] We considered Fresno as an example of a southern Central Valley urban area; however, due to budgetary constraints and the lack of availability of data, this city was dropped from the group.

region, data were obtained from the Sacramento Area Council of Governments (SACOG). This data layer was developed from current and planned uses of land and derived from existing zoning as well as General and Specific Plans.

***Step 2**: Test digitizing methods.*

Three GIS analysts took part in the data collection. To standardize the interpretation of the aerial photographs the analyst digitized impervious cover associated with residential and commercial land uses. After reviewing the work to identify potential discrepancies, the analysts adopted a set of common guidelines for interpretation of the aerial photography and digitization, in order to minimize 'between-analyst' variability. Some of the guidelines adopted include:

a) Gravel driveways in rural areas were treated as impervious areas;

b) Detention ponds in commercial areas, especially industrial sites, were assumed to be non-porous and therefore digitized as impervious areas,

c) Roadways within apartment complexes used for internal circulation or parking were digitized as part of the impervious cover of high density residential uses and not evaluated as typical roads (e.g., local or arterial roads); and

d) When tree canopy blocked the view of the land surface below, the line and angles of exposed impervious cover were followed, based on the best interpretation and general familiarity with the land use. For example, cars parked under trees in a paved lot were assumed to be parked on pavement.

***Step 3**: Select ample sites and digitze impervious cover on a preliminary set of sites.*

OEHHA adopted a stratified random sample design similar to the one used by the US EPA's Environmental Monitoring and Assessment Program (EMAP). Using Hawth's tool in ArcGIS, 100 randomly selected sites for each land use category (LUC) in each city were identified, a sample point was placed on the land use map, and a unique identifier was assigned to each point (Figure 1). To select the area to be examined, analysts drew a square of 40,000 square meters (about 9 acres) around the sample point (Figure 2). All occurrences of the same LUC in which the sample point fell were analyzed for impervious cover. For example, if the sample point was located in the low density residential LUC, impervious areas for all low density residential LUCs within the square outlined digitally. If the selected point fell on a LUC that did not correspond to the current land use, as evidenced by inspection of the aerial photograph, OEHHA disregarded this sample site. This circumstance commonly occurred when the general plan designated an

Figure 1. Sampling Points. 100 points were randomly generated for each LUC in each city. Then impervious areas within each LUC were digitized in the order identified by the random selection of sites.

area for development, but the current land use, as interpreted from the aerial photograph, remained in a 'less developed' condition. Applying this principle, land currently used as rangeland but zoned for future commercial development would be disregarded.

Figure 2. Analysis Box. An example of a randomly generated sample point around which a 40,000 sq. meter box, approximately 9 acres, was constructed. All impervious areas within the LUC on which the point was found and within the box were digitized.

Step 4: *Determine sample size required for each LUC to obtain the desired level of accuracy and precision and collect data.*

To determine the minimum number of sites for analysis to obtain 90 percent confidence with a 10 percent level of precision, we initially collected data from about 10 sites for each land use category in each city. Sample sizes were determined using a standard sample size calculation for proportions (Daniel 1978):

$$\mathbf{n} = (\mathbf{pq})/(\mathbf{d}^2/\mathbf{z}^2)$$

where,
p = decimal percent imperviousness,
q = decimal percent perviousness,
d = level of precision, in this case 10 percent,
z = value from the z table associated with 90 percent confidence

Based on the results of this analysis, additional samples from each LUC for each city were collected. Sample sizes for various land use categories ranged from 10 to more than 40 sites/LUC/city, depending on the variability. In general, there was less variability in imperviousness among commercial and retail sites than residential sites, with the result that residential sample sizes were typically larger than commercial sample sizes. Sufficient sites were then analyzed to achieve the desired level of accuracy and precision.

Step 5: *Statistically analyze the results and calculate impervious surface coefficients for residential and non-residential LUCs.*

We analyzed the data based on three major land-use categories: 1) commercial and other non-residential uses, 2) residential land uses, and 3) roads (See Step 6 for further discussion of roads).

- The goal of the non-residential LUC analysis was to identify a set of coefficients that represented land uses common to the three cities. Non-residential LUCs were grouped into three major categories; retail, office, and industrial, each of which contained two classifications. There were five additional non-residential categories of a singular nature: public/quasi-public, mixed use, open space, coastal development, and agriculture. Frequently, different communities used different names to describe essentially the same land-use category. We reviewed the descriptions in the general plans to identify equivalent uses regardless of name. Analysis of variance was used to determine if the mean ISCs for any single commercial LUC differed. Where differences were identified, Tukey's Honestly Significant Difference test was used to differentiate between cities. All data analysis was performed using Statistica (Statsoft, Tulsa, OK). Ten basic categories of commercial land use were identified, with an 11th category, coastal development, specifically found only in Santa Cruz. The 10 non-residential LUCs were: Retail, Retail/Office, Office Park, Urban Office, Light Industry, Heavy Industry, Public/Quasi Public, Mixed Use, Open Space, and Agriculture.

- Residential land uses were analyzed by density or dwelling units per acre (du/ac). After exploring a number of different methods for analyzing imperviousness of residential land uses, OEHHA determined that a regression approach offered the greatest flexibility for the user. Over 330 sites from residential LUCs were analyzed by regressing density against the percentage of impervious cover. These data were fitted to linear, logarithmic, and exponential relationships, using the Box-Cox transformation to optimize the fit. While the Box-Cox linear regression equation minimized residuals for most of the data, it did not adequately reflect percent impervious cover for high density housing due to the small number of sample sites in this category. We believe that a logarithmic relationship most accurately represents the percent IC for a range of housing densities between 1 – 50 units/acre. Details of the basis for this approach are discussed in Section III.

Step 6: *Determine a set of impervious surface coefficients for roads.*

Data was collected from the three study cities for local, collector, and arterial roads as well as highways. The right-of-ways (ROW) polygons were extracted from the local jurisdiction's centerline shapefiles. The extraction was accomplished by creating a new polygon data layer by subtracting the total area of all LUC polygons from the total areal extent of the analysis; the remaining area representing the ROW. Using this geometry, sampling sites (n=356) were identified using the same process used for the residential and commercial land uses. All impervious surfaces were digitized and the percent IC associated with each road type for each city was calculated. Private roads such as those within apartment complexes were not included in the analysis of roads but as part of the impervious area of the land use category.

Due to limited resources, most of the road sample sites (total sample size = 265) were drawn from the Sacramento region; 30 sites were analyzed in Irvine and 61 in Santa Cruz. The disproportionate amount of data collected from Sacramento meant that the level of accuracy and precision of the impervious estimates was greater for this city. To reflect this, weighted averages were used in the final calculation of percent IC for urban/suburban roads, rural roads, and highways.

OEHHA determined the proportion of local, collector, and arterial roads in the Sacramento region and used this ratio for weighting the ISC values. To calculate the urban/suburban roads ISC, we took the weighted average of the ISC for the 3 road types from each city. We calculated the overall average for suburban/urban roads, weighting the data to reflect the higher level of confidence in the Sacramento values due to the larger sample size than the other two communities. The procedure for rural roads was similar. Rural roads data were only available from Sacramento and Santa Cruz, since there are no rural areas in Irvine. Highway data were derived only from the Sacramento region. Because highways are built with standard specifications under the auspices of a state agency, Caltrans, these should be relatively uniform throughout the state.

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Summary of Methods of Impervious Cover (IC) Analysis Reviewed for th s Project

Name of Method	Method Category	Summary	Limitations
Contra Costa County	Aerial photogrammetry	Used aerial photography to estimate the amount of IC for a given lot size in each zoning district type. Measurements were not meant to give a precise measure of % IC, but to create a tiered scale for flooding fees on the basis of zoning district and lot size.	Lack of documentation, use of older technology. Analysis by NEMO found that IC estimation based on lot size was much less accurate than techniques relying on more modern land use/land cover (LULC) analysis
Maine Combo	Aerial photogrammetry and digital data	Users digitized polygons across the state, estimated the number of buildings within an acre, and used a graduate student's formula to determine the % IC for residential areas or for commercial-industrial-transport areas. A corrective multiplier was used to adjust the student's formula closer to the results of detailed watershed studies previously performed.	There is little documentation related to this method, especially as to how the formulas and algorithms were determined. Assumptions such as buildings per acre and the corrective multiplier would be specific to the region. Estimations were performed on only two land cover categories
Native Communities Development Corporation	Satellite remote sensing	Commercial vendors of satellite imagery can produce highly accurate measurements of IC over areas of great size, but measurements are for current construction only and cannot be repeated (without purchasing additional services). This method would provide accurate IC measurements but would require further analysis, with LULC layers for example, to create a useful tool.	Because of the high cost of purchasing satellite imagery, this method is most cost-effective for analysis of very large areas, such as statewide. However, some suggest digital orthophoto quadrangles (DOQs) can be used. Studies as recent as 2003 (Herold et al.) found several issues with this method, including haze, shadow, and clouds affecting the multispectral analysis; inaccuracies due to canopy cover; difficulty in attaining quality images after repeated attempts; and time/knowledge required to train the software before analysis.

Name of Method	Method Category	Summary	Limitations
Frederick County Point Sampling	Aerial photogrammetry	This project laid a grid of sampling points over DOQs, and users visually identified whether the point rested on an IC or a pervious surface. The %IC could then be determined for a given area. Custom tools had been created so the analysis could be done quickly and accurately	Different density point sampling grids returned similar %IC measurements, random sampling points are preferred over systematic sampling (though systematic is easier to conduct), and the greatest variability occurred between analysts' visual judgment of surface types. This method could be used for areas that do not have GIS data. A NEMO study (Chabaeva et al. 2004) found this technique to be less accurate than others.
Wayne County	Ground survey, existing maps, aerial photogrammetry	Aerial photography was used to digitize and directly measure the impervious area (IA) from a sampling of photos in each watershed. These results were then extrapolated to the total area of the watersheds. Directly Connected IA (DCIA) was based on 300 field surveys.	While this method can estimate the DCIA in an area, it would be costly and time consuming to perform the field surveys.
Utah State University Extension	Existing maps and digital data	This project was typical of others using digitizing over LULC and aerials to calculate IC across a given area.	Factors contributing to low accuracy include digitizing areas of development rather than individual buildings and the use of ISC that were not designed specifically for Utah. Detailed documentation is lacking for this method.
Direct Digitizing	Imagery and existing maps or digital data	This method refers to hand digitizing all IC features in a watershed or other boundary.	Because of the time required, this method is best suited for small study areas or areas with little development, as was the case in the Cook Inlet Keeper project. Accuracy is very high because all features are captured, but depends on the resolution of the imagery used or on the quality of the planimetric data. Because of the increased availability of planimetric data, hand digitizing might be unnecessary.

Name of Method	Method Category	Summary	Limitations
Parcel Size (NEMO)	Existing maps or digital data	To derive a set of ISCs, the ArcMap Union to l was used to combine 1990 Census tracts, LULC, and impervious features for nine Connecticut towns. Impervious surface coefficients could then be determined as a calculation of the total area of IC within each land cover within each tract. Instead of relying on the towns' definitions of high, medium, and low density (for a residential area, for example), a scale was used to designate tracts as high, medium, and low density. Modifications were made to the method to accommodate areas with high IC but low population density, such as commercial and industrial.	While the report c ncluded that the results were accurate, it did note that error might occur when analyzing small geographic areas (less than several hundred acres). Correlating population density data while developing the coefficients might increase the accuracy as other methods have used LULC and planimetric data only. Having the population density data also allowed the researchers to experiment with the Impervious Surface Analysis Tool (ISAT), produced by NEMO and NOAA.
UConn Regression Model	Existing maps and digital data	This method used the ArcMap Union tool to combine planimetric and LULC data from several Connecticut and surrounding municipalities to develop a set of ISCs and a regression model (adding in population density) to estimate IC using a national dataset such as the NLCD. This model could then be applied to Connecticut communities having poor planimetric data but are covered by the national dataset.	While this method provides coefficients for future use, they are based on Census data and NLCD, which have up to 10-year gaps before they are updated. Using population density data might provide better results as an addition to other methods relying on planimetric and LULC data only. Relying on direct measurements of quality planimetric data (assuming it is available) is likely preferred over this method.
Population Density (NEMO)	Existing maps or digital data	Developed a set of IC coefficients by using the ArcMap Union tool to combine 1990 Census tracts, LULC, and impervious features for nine Connecticut towns. ISC could then be determined as a calculation of the total area of IC within each land cover within each tract. Instead of relying on the towns' definitions of high, medium, and low density (for a residential area, for example), a scale was used to designate high, medium, and low density tracts. Modifications to the method were applied to accommodate areas with high IC but low population density, such as commercial and industrial areas.	While the report concluded that the results were accurate (and more accurate than the Parcel Size method by NEMO), it did note that error might occur when analyzing small geographic areas (less than several hundred acres). Correlating population density data while developing the coefficients might increase the accuracy as other methods have used LULC and planimetric data only. Having the population density data also allowed the researchers to experiment with the Impervious Surface Analysis Tool (ISAT), produced by NEMO and NOAA.

SECTION III. RESUL S: A SE OF IMPERVIO S S RFACE COEFFICIEN S FOR CALIFORNIA

A. Non-Residential Land Uses

The results of the analysis yielded a set of 11 ISCs, shown in Table 1, followed by a brief description of each category. Table 1 (below) identifies the non-residential categories and their corresponding mean, 95% confidence interval, and sample size (n).

1. Retail

Table 1. Non-Residential ISCs

Non-Residential ISCs	
Land Use	**California ISC**
Retail	**.86** (83-88; n=83)
Retail/Office	**.80** (76-84; n=40)
Coastal Development	**.23** (16-31; n=10)
Office Park	**.69** (65-73; n=51)
Urban Office	**.85** (82-89; n= 51)
Light Industry	**.81** (77-85; n=54)
Heavy Industry	**.91** (86-96; n=24)
Public/Quasi-Public	**.44** (37-51; n=40)
Mixed Use	**.80** (76-85; n=50)
Open Space	**.02** (1.3-3.1; n=50)
Agriculture	**.04** (2.7-5.3; n=25)

Commercial land uses refers to retail shopping areas such as downtown commercial areas, malls, and big-box outlets, where office uses are only a minor or non-existent component. A total of 123 sites were analyzed in this land use category in the three cities. The ISC values for the 4 commercial categories ranged from 75 – 93 percent impervious. This data fell into two major categories: those retail uses in which office uses were trivial or non-existent and those uses with greater than 5-10 percent office. The former tended to have a higher percent impervious cover uses compared to those with greater total area devoted to office uses. OEHHA divided the two types of commercial land uses into two categories: 1) **Retail** – characterized by neighborhood, community or regional malls or shopping areas in which office uses are less than 5 percent of the total area, and 2) **Retail/office,** where office comprises greater than 5 percent. **The ISCs are 86 percent and 80 percen respectively.**

Two issues of interest should be kept in mind when performing analysis of the commercial LUC.

- Sacramento's retail land had lower levels of impervious cover (IC) than either Irvine or Santa Cruz. We suspect this is due to the fact that much retail development in Sacramento occurs in greenfields where space is not an issue as it is in highly urbanized Irvine or in Santa Cruz, where space is limited by the coastline. As a consequence, we suggest using the Retail/Office ISC for all development that occurs in greenfields, regardless of the amount of office space.
- No differences in impervious cover existed between shopping centers with neighborhood or regional scopes. Therefore, although most cities have a few categories of commercial land uses (e.g. neighborhood, community, and regional retail); they basically contain the same amount of impervious cover. Inclusion of office space in the commercial development had a greater influence on IC percentages than the scale of the commercial development.

2. Office

The Office LUC refers to urban and suburban office buildings. Based on the results of ANOVA, followed by Tukey's test (n=104), suburban office parks had a lower amount of imperviousness than urban offices. Suburban offices have considerably more green space and landscaping surrounding them than offices found in a more urban setting. As a consequence, we identified two ISCs for office uses: *Urban Office* (sometimes called high intensity office); and *Office Park* (commonly found in outlying areas and suburbs), which contain **85** and **69 percent** impervious cover respectively.

3. Industrial

OEHHA identified two types of industrial LUCs by analyzing 78 sites with individual LUC names such as Light Industry, Urban Industry, and Heavy Industry. The statistical analysis showed that these sites could be separated into two categories: Heavy Industry composed of sites with little greenspace, and Light or General Industry, composed of some warehouses and manufacturing campuses (information technology companies serve as a good example) that contain more landscaping. The ISCs are **91** and **81** percent respectively.

4. Coastal Development

The LUC Coastal Development is unique to Santa Cruz and other coastal communities in California. This LUC describes businesses along wharfs and marinas such as restaurants and retail shops. The sites analyzed also included water within their footprints. Since Santa Cruz was the only coastal community analyzed and since the sample size was small (n=10), the ISC of **23 percent** should be interpreted as provisional.

5. Mixed Use

Mixed Use refers to a variety of urban land uses that include a mix of medium to high density residential development, commercial, public/institutional uses (e.g., child care centers, dance studios), and offices. Thirty-six sites were analyzed in Irvine and Sacramento in this category. At the time our analysis was performed, Santa Cruz did not identify a separate Mixed Use category. Instead, this category was folded into the Community Commercial designation. Since that time, Santa Cruz has updated their general plan and has a separate Mixed Use category. The ISC for the Mixed Use LUC of **80 percent** is based on analysis of sites in Sacramento and Irvine.

6. Public/Quasi-Public

Public/Quasi-Public (PQP) represents a unique land use category, because the designation is based on ownership, not the type of use. As such, it had the greatest variability of any of the LUCs that were analyzed. Analysis was drawn from data (n=40) from Santa Cruz and Sacramento because there is no PQP LUC in Irvine. The mean percent IC in Sacramento was 37 percent while in Santa Cruz, it was 64 percent. The California ISC is **44 percent**, with a coefficient of variation of 50% (CV = standard deviation/mean). There is no single recommended ISC we can suggest due to the large difference we observed. Users of the coefficients should consider characterizing the nature of the lands within the PQP category in their community and select from one of these three values (37, 64, or 44 percent).

OEHHA visually inspected all PQP sites in Sacramento and found they included a number of schools, one junior college, a cemetery, a building associated with an airport, and public utility buildings. If these types of buildings characterize the PQP in your community, perhaps the Sacramento PQP ISC of 37 percent might be best. If local land uses are more intensive, then a higher value might be more appropriate. Since this category does not account for large amounts of land, errors associated with an inappropriate ISC will likely not affect the overall impervious cover analysis.

7. Open Space and Agriculture

The open space LUC comprises parks, nature preserves, and forested areas. Fifty sites were analyzed with the average **ISC of 2 percent.** An agricultural LUC was found in all three cities. Even in the middle of the Los Angeles Metropolitan Area, Irvine's General Plan provides for protection of a small agricultural reserve area within the city limits. The California **ISC for agriculture is 4 percent.**

B. Residential Impervious Surface Coefficients

Residential land uses vary from city to city, but are usually defined as a given density range, reported as dwelling units per acre (du/acre). It is common to find low, medium-low, medium, medium-high, and high residential LUCs in each city plan. These residential LUCs are somewhat subjective depending on what an individual city defines as low or high density. For example, there is a range of definitions for the "medium density" LUC. Sacramento defines "medium density" as a residential development with a density of 8-12 du/acre; Irvine defines it as 5-10 du/acre; and Santa Cruz defines it as 20-30 du/acre. The difficulties of using narrative classifications for various residential ISC became apparent quickly. To address this source of variability, we based the California residential ISCs on a regression equation that relates the density (dwelling units/acre) and impervious cover. This equation can be used to determine the ISC that is appropriate for any density of residential development, from rural residential to densities as high as 50 du/acre. The regression equation that best describes the relationship between residential density and impervious cover is shown in Figure 3.

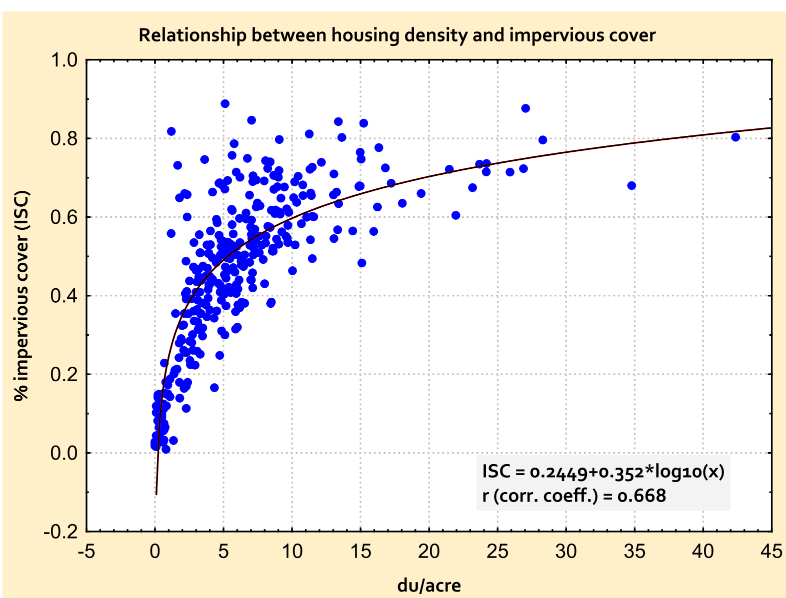

Figure 3. Regression relationship between housing density and percent impervious cover. A logarithmic fit best describes this relationship (ISC = 0.2449 + 0.352 x log density). It reflects that past a certain percent IC, buildings go up, not out. Most communities have requirements for a certain percentage of greenspace for residential housing so adding more units requires building up.

The logarithmic relationship can be linearized by using a semi-log plot (Figure 4), shown below.

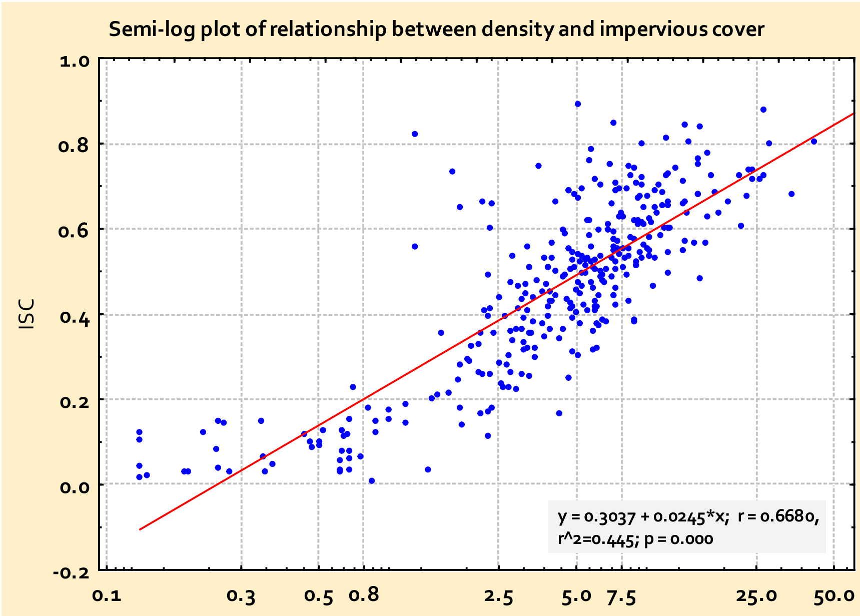

Figure 4. Regression relationship of the log housing density vs. the percent impervious cover. The equation is: ISC = 0/3037 + 0.0245x, where x is the log of the density.

We also investigated various exponential relationships using the Box- Cox transformation to identify the exponent that best fits the data and therefore, the best regression relationship. The Box-Cox procedure transforms the original data in a way that the new variable will have a distribution as close to normality as possible. Through an iterative process, the exponent is identified which minimizes the variability, essentially reducing the noise of the data. For our dataset (n=333), this exponent was 0.3425 and the resulting regression equation is shown in Figure 5.

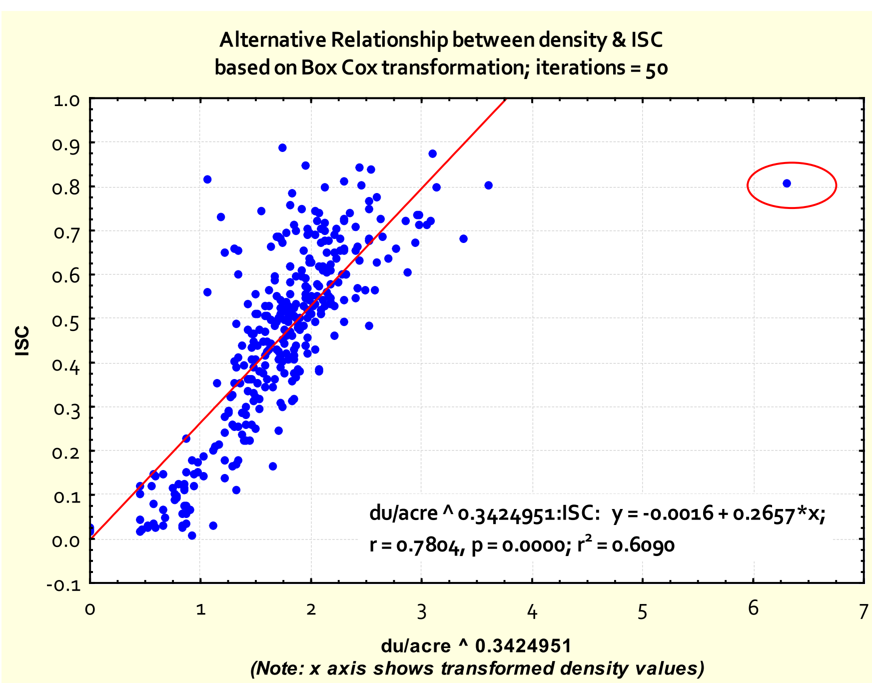

Figure 5. Regression relationship between housing density and percent IC based on Box-Cox transformed data.

The limitation of using an equation based on the transformed data ($y = -0.0016 + 0.2657 x$, where x is du/acre raised to the 0.3425 power) is that it doesn't accurately describe high density residential housing. Our dataset contained only a single site with high density housing (about 50 du/acre, data point circled in Figure 5). The impervious cover at this high density site in Irvine was about 80 percent, applying the equation above. However, when using the equation in 100 percent. Other sites with high density produced equally unrealistic ISCs. We had an insufficient number of high density sites in our dataset to accurately characterize this high end of the curve. Therefore, until additional analysis is possible, the best equation that describes the relationship between density and ISC is the original equation: **ISC = 0.2449 +0.352*log x.**

Table 2 (*right*) provides a look-up table that summarizes the ISC for a wide range of housing densities. The ISC is the decimal value that reflects the percent of any level of residential density that is covered with hardscape.

Table 2. Residential ISCs.

Residential ISC	
Density (du/acre)	**California ISC**
0.5	0.14
1	0.24
2	0.35
3	0.41
4	0.46
5	0.49
6	0.52
7	0.54
8	0.56
9	0.58
10	0.60
11	0.61
12	0.62
13	0.64
14	0.65
15	0.66
20	0.70
25	0.74
30	0.76
35	0.79
40	0.81
45	0.83
50	0.84

C. Roads

There were three ISCs developed for roads: urban/suburban roads, rural roads, and highways. A total of 253 local, collector, and arterial roads were identified on the aerial photographs, then analyzed for impervious cover. More specifically, the area (acres) of the right-of-way (ROW, the road itself plus the adjacent land over which local jurisdictions reserve for the purposes of maintenance or expansion of the existing road), was determined either by: a) obtaining a shapefile with a data layer outlining the right-of-way, or b) constructing the polygons that make up the right-of-way by subtracting the area associated with the land use polygons from the total area. What remained is the area associated with the right-of-ways. The results are as follows:

1. Urban/Suburban Roads

Local, collector, and arterial ROWs in urban and suburban areas in Irvine, Santa Cruz, and Sacramento were used to determine the urban/surburban ISC. Because a greater number of sites were analyzed in the Sacramento region than the other two (n= 193 vs. n=60 Irvine & Santa Cruz), our analysis of imperviousness was weighted to reflect this fact. We noted that roads in the Sacramento area tended to have higher ISCs than in Santa Cruz or Irvine. This might be associated with the easy availability of land that has led to an expansive pattern of development in many Central Valley cities. The lower values for arterials in the other cities are likely associated with wider boulevards and landscaped areas adjacent to the sidewalks.

TABLE 3 (below) contains the ISCs calculated for each road type in each city.

Road Type	Sacramento	Irvine	Santa Cruz
Local	88	85	88
Collector	95	87	87
Arterial	89	66	76

Table 3. ISCs for major road types from the three communities.

We used the above ISC values from each city (Table 3) and a weighting factor that reflects the percent of the total ROW area that each road type occupied relative to the total area of roads, to calculate the weighted-average for urban/suburban roads. The distribution of road types were: local roads: 20 percent; collectors: 67 percent; and arterials, 13 percent of the total area of all interior roads (non-highways). This calculation resulted in three ISCs for suburban/urban road as follows:

City	Urban/Suburban ISC
Sacramento area	93%
Irvine	84%
Santa Cruz	86%
Weighted Average	**91%**

Table 4. Percent imperviousness associated with roads in the three study cities.

The overall mean was also calculated using a weighting factor, in this case the weighting reflected the sample size from each city. Data from Sacramento was weighted more heavily due to the larger sample size. The overall weighted mean, and the value we recommend for determining the percent imperviousness associated with roads, is **91 percent**.

2. Rural Roads

The rural roads ISC was based on a sample size of 43 sites along rural roads from Santa Cruz and Sacramento. The same weighted-average approach was used to calculate the mean ISC of 45 percent. One limitation of this approach is that the weighting of the three road types was based on urban/suburban ratios. It is doubtful that this ratio is accurate for rural areas, which are dominated by two lane roads that don't fit neatly into the urban roads categories. Yet, when the simple average was calculated, the results were the same; the ISC was **45 percent**.

3. Highways

Unlike interior roads which can vary from city to city based on local policies and ordinances, highways are overseen by a state department, Caltrans, and standards for construction and design are the same throughout the state. Highway data was analyzed only in Sacramento. Although most people think of highways as the epitome of urban life and hardscape, they have wide right-of-ways as well as large amounts of green space associated with on-off ramps. Consequently, the percent imperviousness for highways is surprisingly low: **47 percent**.

SECTION IV. CALCULATING CURRENT AND BUILD-OUT IMPERVIOUS COVER

Calculating current and build-out (future) impervious cover is a relatively straightforward process, assuming the availability of land-use data layers. Build-out analysis can be easily done on a spreadsheet. The only information required is knowledge of the total acreage for each land-use category within the area of interest. If generalized land-use categories are not available, zoning categories can be used, but will likely require aggregation into more general land use categories comparable to those in Section II.

Calculating current impervious cover is a bit more complicated because it requires information about parcels that currently are not built-out as designated in the general plan. City and county general plans commonly designate land use 20 years into the future, although those lands often have a completely different use at the present time. For example, land could be zoned for office development, but is currently being used as farmland. This is a common occurrence in communities surrounded by greenfields. This section presents the method for performing both sets of IC calculations.

A. Future or Build-Out Impervious Cover

The calculation of impervious cover at build-out, when all lands are developed as specified in the general plan, is very straightforward. It involves multiplying the total acreage for each LUC by the ISC and summing the values for all LUCs. The following example illustrates this process.

Assume the area for analyis is a 1500 acre sub-division (or a watershed, or any other area with identified boundaries) with a single land use, low density residential (ISC=52%) with roads (ISC = 91%). In some cases, the area of the right-of-way is known. In this example, we calculated it, based on the typical patterns found in new development, where ROW accounts for approximately 22% of the total land.

Build-Out Imperviousness:

1. 1500 x .22 (% of development that is ROW) = 330 acres of ROW
2. 330 acre ROW x 0.91 (ISC for suburban roads) = 300 acre impervious ROW
3. Total low density residential (LDR) (5 du/acre use) = 1170 acres
4. 1170 x 0.52 (ISC) = 608 acres of impervious LDR
5. 608 + 300 =908 acres impervious in 1500 acre sub-division.

   Future level of imperviousness = 61%

An Impervious Cover Calculator was developed to facilitate these calculations. This Calculator is available on OEHHA's website(www.oehha.ca.gov/ecotox.html). Using the same hypothetical development described above, a sample calculation using the Calculator is shown below:

	INPUTS				OUTPUTS		
	Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7
	Land Use Category	Total Area (acres)	Non-conforming Area (acres)	Current Conforming Area	Impervious Surface Coefficient	Buildout Impervious Cover (acres)	Current Impervious Cover (acres)
Residential	6 du/acre residential	1170			0.52	607	0
	[Select LUC Here]				0.00	0	
	[Select LUC Here]				0.00	0	
	[Select LUC Here]				0.00	0	
	[Select LUC Here]				0.00	0	
Non-Residential	[Select LUC Here]				0.00	0	
	[Select LUC Here]				0.00	0	
	[Select LUC Here]				0.00	0	
Roads	Urban/Suburban	330			0.91	300	0
	[Select LUC Here]				0.00	0	
	[Select LUC Here]				0.00	0	
	Nonconforming Land Uses (acres)						
Nonconforming Land Uses	[Select LUC Here]				0.00		0
	[Select LUC Here]				0.00		0
	[Select LUC Here]				0.00		0
	[Select LUC Here]				0.00		0
	TOTAL ACRES	1500	0	0			
					TOTAL IMPERVIOUS ACRES	907	0
					PERCENT IMPERVIOUSNESS	60	0

To use the Calculator, identify the land use categories within the geographic area of interest. A drop-down menu is provided for residential, non-residential, and road land uses. For residential, select the density of the development, input the acres of that particular LUC, the impervious surface coefficient and total impervious acres are then calculated. For non-residential uses and roads, a similar drop-down menu is available for selecting the appropriate LUC and other input parameters.

B. Current or Transitional Impervious Cover

To determine the current amount of imperviousness, additional steps are needed to account for the current use of lands that might be designated for different uses. We identify these parcels as **non-conforming** because they are not being used in accordance with their General Plan designation. For example, an area designated as medium density residential may instead be currently used for irrigated agriculture or rural residential.

Before using the ISC, a series of checks should be performed to correct for non-conforming parcels. They include:

- Adjustment of non-conforming parcels
- Identification of vacant lots
- Adjustment of the build-out impervious acres to reflect current use, using the non-conforming parcel correction factor (NPCF).

Step 1: Identify and recategorize non-conforming parcels

To determine the current amount of imperviousness within a given area, non-conforming parcels must be re-categorized based on their existing use. By re-categorizing the non-conforming LUC acreage, the total area of the designated future LUC is adjusted to reflect the current or transitional land use.

Step 1a: Visual Inspection of Aerial Photographs

The simplest method for identifying non-conforming parcels is to visually inspect each land use category for the presence of inappropriate land uses. In the majority of cases, the non-conforming use is less developed than their designation in the general plan; they are relatively easy to identify using a high resolution orthophotograph and a land use data layer. Depending on the state of development, it is easiest to track either a) those parcels that conform to the designated land use OR b) those that do not. As the current land uses are identified the records in the attribute file of the GIS project should be updated to reflect the land use shown in the aerial. Thus the date the aerial was taken should guide the selection of the land use layer.

Figure 6. A Non- Conforming Parcel. This house was designated as low density residential in the land use layer, yet it is on a three acre parcel, a density better characterized as rural residential. The ISC for this parcel must be adjusted to reflect current conditions.

For non-conforming parcels in transition due to redevelopment or down zoning such as conversion of former industrial sites to residential, use the descriptions in Section II of the User's Guide for suggestions on how to reclassify a land use that does not conform to its identified type and description. During the adjustment of the non-conforming parcels it may be difficult to determine the designated use of vacant or fallow land. **Vacant Land** is property that*, in its entirety*, is not being used for its designated use.

Best practices would be to:

- Look at the size, configuration, and surrounding land uses to help determine the vacant lot land use. A non-conforming area that is small in size and has a shape similar to its neighborhood's is likely an undeveloped sub-division or commercial park.
- Do not re-classify vacant parcel with commercial, planned open space and recreation, or residential uses. This circumstance will be addressed in Step 2 (below).
- Re-categorize working lands (agriculture) if the general plan contemplates more intense use. Differentiating between agricultural land and planned open space, such as a nature

reserve, is sometimes difficult. Comparing the size of the parcel to surrounding lands is one way to identify planned open space. Nature reserve/open space is often cross-cut by trails or natural groupings of vegetation, features rarely seen in agricultural parcels. It will likely be sized larger and shaped differently from surrounding parcels. On the other hand, agricultural land likely will sit nearby other agricultural land, and possess visible signs of the land being worked, such as rows of plantings or trees and narrow dirt roads neatly bisecting property.

Step 1b: Non-Visual Identification of Non-Conforming Parcels that are Vacant

A non-visual method can be used to identify non conforming parcels that are vacant. This approach relies on obtaining data from the appropriate local government department to identify vacant parcels. This information may be found in one or more of the following databases:

- The Housing Element in a General Plan or General Plan Update contains a vacant land inventory. The inventory contains the Assessor's Parcel Number (APN), the size of the parcel, and the LUC for which it is zoned. The total acreage for each LUC can be used to determine the amount of vacant land in each land use. However, as General Plans are updated every five years or more, this inventory may be out of date.
- The County Assessor's Office maintains a list of parcels with their assessed values that are calculated by combining the value of the land and the structure(s) on it. Lots with nominal or no improvement value are likely vacant. Generally, structures such as schools, churches, and government building are not assessed by the county, so they have no assessed improvement value. This circumstance is most commonly seen in the Public/Quasi Public and Open Space LUCs. Identify these land uses on the aerial photograph when determining if an area is vacant.

Whether the visual inspection method or a combination of visual inspection and reviewing of local databases are used to identify the area of vacant land within each LUC, efforts should be made to match the date of the assessor's data with the date of the aerial.

Step 2: Application of the Non-Conforming Parcel Correction Factor (NPCF)

After adjusting the land-use layer for the current or transitional use and identifying vacant lots, the area of non-conforming parcels is subtracted from the total. Then the calculation of impervious cover can be performed in a similar way as for build out, i.e. by multiplying the total acreage for each LUC by the ISC and summing all values.

The sample calculation below illustrates how to perform an analysis of current conditions.

Assume the area for analyis is the same 1500 acre sub-division (or watershed, or any other area with identified boundaries) used above for the build-out calculation, ie., with a single land use, low density residential (ISC=52% with roads ISC = 91%).

Current Imperviousness

1. 1500 x .22 (% of development that is ROW) = 330 acres of ROW
2. Total low density residential (LDR) (5 du/acre use) = 1170 acres
3. 1170 LDR acres - 400 acres of non-conforming land that is vacant *(NPCF)* = 770 acres developed
4. 770 x 0.49 = 378 acres of impervious LDR
5. 330 acre ROW x 0.91 (ISC for suburban roads) = 300 acre impervious ROW
6. 378 + 300 = 678 acres impervious in 1500 acre sub-division

   Current level of imperviousness = 45 %

	INPUTS				OUTPUTS		
	Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7
	Land Use Category	Total Area (acres)	Non-conforming Area (acres)	Current Conforming Area	Impervious Surface Coefficient	Buildout Impervious Cover (acres)	Current Impervious Cover (acres)
Residential	6 du/acre residential	400		400	0.52	208	208
	1 du/acre residential	200		200	0.24	49	49
	1 du/acre residential	200		200	0.24	49	49
	[Select LUC Here]				0.00	0	
	[Select LUC Here]				0.00	0	
Non-Residential	[Select LUC Here]				0.00	0	
	Agriculture	0			0.04	0	
	[Select LUC Here]				0.00	0	
Roads	Urban/Suburban	150		150	0.91	137	137
	Rural	50		50	0.43	22	22
	[Select LUC Here]				0.00	0	
	Nonconforming Land Uses (acres)						
Nonconforming Land Uses	[Select LUC Here]				0.00		0
	[Select LUC Here]				0.00		0
	[Select LUC Here]				0.00		0
	[Select LUC Here]				0.00		0
	TOTAL ACRES	1000	0	1000			
					TOTAL IMPERVIOUS ACRES	463	463
					PERCENT IMPERVIOUSNESS	46	46

Use the Calculator to perform this calculation as illustrated above. The 400 acres that are identified under the 5 du/acre land use category were determined to be rural residential land that was non-conforming. Those 400 acres were then listed as 0.5 du/acre under the land use category and a new calculation at 14% IC was performed for those acres at 0.5 du/acre. Factoring in the imperviousness associated with roads, the total impervious acres added up to 734 out of 1900 or 39% IC currently.

In summary, calculation of impervious cover at build-out is a simple process that can be performed using a spreadsheet, assuming the areas of the pertinent land uses are known. Analysis of current conditions becomes slightly more complicated because non-conforming land uses must be identified and adjustments made to the acreage of relevant LUCs.

Appendix 1: Comparison of Impervious Cover for Resi ential Lan Uses in 3 Study C es

City of Irv ne LUC	Irvine Descrip ion	Ci y o Irv ne ISC	SACOG LUC	SACOG Descrip ion	SACOG ISC	C y of Santa Cruz LUC	SC descrip ion	City of Santa Cruz ISC
Estate Density	0-1 du/ac	Not Analyzed; Too few parcels	**Rural**	0-1.0 du/ac	6	**Very-Low Density**	0.1-1 du/ac	12
Low Dens ty	1.1-5 du/ac	43	**Very Low Density**	1.1-4.0 du/ac	30	**Low Dens ty**	1-10 du/ac	46
			Low Densi y	4.1-8.0 du/ac	44			
Medium Density	5.1-10 du/ac	61	**Med um Density**	8.1-12.0 du/ac	53			
Medium-H gh Densi y	10.1-25 du/ac	72				**Low-Medium Density**	10.1-20 du/ac	52
			Medium-High Density	12.1-25 du/ac	53			
						Medium Density	20.1-30 du/ac	68
High Density	25.1-40 du/ac	69	**High Densi y**	25.1-50 du/ac	67			
						High Density	30.1-55 du/ac	Not used n=1
			Urban	50.1-100+ du/ac	Not Available			
			Medium-High Density	12.1-25 du/ac	53			

Appendix 2: Comparisons of Impervious Cover or Non-Resi en al Land Uses in 3 study c es

City of Irvine			SACOG			City of Santa Cruz		
LUC	**Description**	**ISC**	**LUC**	**Descrip ion**	**ISC**	**LUC**	**Descrip ion**	**ISC**
Neighbor-hood Commercial	Any retail/business serving immediate neighborhood	87	**Community/ Neighbor-hood Retail**	(0.2-0.3 FAR)[2] 100% Retail	80	**Ne ghbor- hood Commercial**	(0.25-1.5 FAR) Small-scale commercial serving residential neighborhoods	87
Regional Commercial	Shopping/retail areas with regional scope (includes office uses)	86	**Regional Retail**	(0.2-0.3 FAR) 95% Retail 5% Office	82	**Community Commercial**	(0.25-1.75 FAR) Retail & services serving needs of the local community	93
Vehicle Commercial (Not a LUC category, but a zoning category)	Fast food rest., car dealerships, rentals, and vehicle storage	87				**Regional Visitor Commercial**	(0.25-3.5 FAR) Commercial uses that serve Santa Cruz residents as well as visitors	89
Community Commercial	Industry or business that serves the community (includes office uses)	77						
N/A			N/A			**Coastal Development**	coastal commercial development	23
Retail/ Office (Not a LUC in Irvine, but created from a subset of LUC during analysis)	subset of Community and regional office uses are subcategories of commercial categories	76	**Moderate-Intensity Office**	(0.3-1.0 FAR) 5% Retail and 95%Office	68	**Office**	(0.25-1.75 FAR) Small-scale office uses and mixed-use projects	65
			High-Intensity Office	(1.1+ FAR) 5% Retail and 95%Office	85			

[2] FAR refers to floor-area ratio, the ratio of the total floor area of a building to the size of the land at that location.

SECTION V. APPLICATION OF THE COEFFICIENTS TO STORMWATER RUNOFF CALC LATIONS

A. Introduction

Impervious surface coefficients can be used to estimate stormwater runoff. Unlike suburban land use patterns found throughout the U.S., California's suburbs are typically denser with more dwelling units per acre of land. Consequently, use of non-California ISCs can underestimate the amount of impervious cover at low residential densities, leading to an underestimation of the volume of stormwater runoff. In other cases, non-California ISCs may overestimate runoff from a site, such as office parks. This chapter describes how California ISCs were used to develop a set of alternative curve numbers (CN) and how they can be applied to estimate storm water runoff.

B. Overview of the Curve Number and Curve Number Method

Developed by the National Resource Conservation Service (NRCS), the Curve Number Method is widely used to estimate stormwater runoff. This method assumes that impervious areas are connected via a stormwater conveyance system (e.g. storm drain) so that almost all of the rain that falls on impervious areas will become runoff. The runoff calculation is dependent on the amount of precipitation, the CN, and soil moisture before a storm event (antecedent moisture conditions). In addition to antecedent soil moisture conditions, four hydrologic soil groups, based on the porosity of soil, are also considered in the calculation. The CN itself is a unit-less parameter, usually ranging between thirty and one hundred, derived from the amount of impervious cover. A lower CN value indicates the area will have less runoff and more soil infiltration; conversely, a higher CN value suggests a larger amount of runoff.

Hydrologic Soil Groups (HSG)

HSGs are classified into four groups. These groups are divided by infiltration rates.

Group A – Infiltration rate greater than 0.3 in/hr.
Mostly sand or gravel soils.
Low runoff potential.

Group B – Infiltration rate 0.15 to 0.30 in/hr.
Moderately coarse soils.

Group C – Infiltration rate 0.05 to 0.15 in/hr.
Moderately fine to fine soils.
Can impede water flow.

Group D – Infiltration rate is less than 0.05 in/hr
Mostly fine soils (clays).
High runoff potential.

The Curve Number Method

Stormwater runoff estimates are calculated as follows:

$$S = (1000/CN) - 10$$

Where:

S = the potential abstraction (maximum potential retention of water by the soil after runoff begins)
CN = the CN for the given LUC and HSG

Once the potential abstraction has been calculated, it can be used in the following equation:

$$Q = (P - 0.2S)^2 / (P + 0.8S)$$

Where:

Q = depth of runoff (inches)
P = precipitation (inches)
S = the potential abstraction

To produce runoff, P must be greater than 0.2S. If P is less than or equal to 0.2S, then the runoff amount is essentially zero. When P is greater than 0.2S, multiplying the Q value by the area of the site gives the volume of runoff produced.

C. Derivation of California Curve Numbers

An alternative set of curve numbers were developed, using OEHHA's California ISCs for residential and non-residential development as well as roads. The following equation is used to calculate these values:

$$CN = [(CN_{OS}) \times (1 - ISC_i)] + [(98) \times (ISC_i)]$$

Where:

CN_{OS} = the runoff potential of the soil assuming the area is open space (OS), in good hydrologic condition, and that the soil is not frozen; the four CN_{OS} for HSGs A, B, C, and D (see text box above) are 39, 61, 74, and 80, respectively (National Engineering Handbook, 2004),

1-ISC = the percent of land use category *i* that is pervious,

98 = maximum potential runoff,

ISC = the percent of land use category *i* that is impervious.

The NRCS ISCs and CNs identify six residential densities ranging from ½ to 8 du/acre, with no values provided for residential densities greater than 8 du/acre. While these values reflect low or medium density development patterns in many California cities, some medium or high density developments in California contain 12, 15 or even 20 du/acre. The more limited range of densities used to develop the original NRCS curve numbers could lead to an under-estimation of potential runoff from higher density developments.

Table 5 illustrates similarities and differences between the ISCs used by the NRCS and those developed by OEHHA. Dashes indicate no NRCS value is available. The NRCS classification scheme only provides two categories for non-residential development. One ISC and CN value for the commercial/business LUC and one for the industrial LUC are available. In California, however, most cities have multiple commercial and industrial LUC with different amounts of impervious cover. OEHHA developed CNs for three commercial, two industrial, and two office LUCs which are reflective of varying amounts of impervious cover for each land use type.

Table 5. California and NRCS Impervious Surface Coefficients for Non-Residential and Residential Land Uses

Non-Residential ISCs		
Land Use	**California ISC**	**NRCS ISC**
Retail	0.86	0.72
Retail/Office	0.80	0.72
Coastal Development	0.23	--
Office Park	0.69	0.72
Urban Office	0.86	0.72
Light Industry	0.81	0.85
Heavy Industry	0.91	0.85
Public/Quasi-Public	0.44	--
Mixed Use	0.80	--
Open Space	0.02	--
Agriculture	0.04	--

Residential ISCs		
Density (du/acre)	**California ISC**	**NRCS ISC**
0.5	0.14	0.12
1	0.24	0.20
2	0.35	0.25
3	0.41	0.30
4	0.46	0.38
5	0.49	0.38
6	0.52	0.38
7	0.54	0.38
8	0.56	0.65
9	0.58	0.65
10	0.60	0.65
11	0.61	0.65
12	0.62	0.65
13	0.64	0.65
14	0.65	0.65
15	0.66	0.65
20	0.70	0.65
25	0.74	0.65
30	0.76	0.65
35	0.79	0.65
40	0.81	0.65
45	0.83	0.65
50	0.84	0.65

Table 6 contains CNs for hydrologic soil group A, the most pervious soil classification. The CNs are based on the CA set of impervious surface coefficients. Look up tables for all 4 hydrologic soil groups can be found in the Appendices to this section.

Table 6. Comparison of California and NRCS curve numbers for residential and non-residential land uses.

Non-Residential CN for HSG A		
LUC	**California CN**	**NRCS CN**
Retail	90	89
Retail/Office	86	89
Coastal Development	53	89
Office Park	80	89
Urban Office	89	89
Light Industrial	87	81
Heavy Industrial	93	81
Public/Quasi-Public	69	-
Mixed Use	86	-
Open Space	40	39
Agriculture	41	Varies
Roads		
Urban/Suburban	93	98
Rural	64	83
Highways	69	83

Residential CN for HSG A		
Density (du/acre)	**California CN**	**NRCS CN**
0.5	47	46
1	53	51
2	60	54
3	63	57
4	66	61
5	68	61
6	70	61
7	71	61
8	72	77
9	73	77
10	74	77
11	75	77
12	76	77
13	77	77
14	77	77
15	78	77
20	80	77
25	82	77
30	84	77
35	86	77
40	87	77
45	88	77
50	89	77

D. Using the California ISCs and CNs: An Example

A runoff calculation is presented here for a hypothetical 100 acre development using both the NRCS and California CNs. The following assumptions were made for this purpose:

- One inch rain event
- 100 acre parcel divided into four major LUCs and roads:
  - Residential (55 acres)
  - Office park (10 acres)
  - Retail (10 acres)
  - Open space/parks (5 acres)
  - Right of way for roads and sidewalks (20 acres)
  - The 55 acre residential area divided equally into three 18.33 acre residential LUCs of 4, 10, and 20 du/acre (LDR, MDR, and HDR, respectively)

Because the NRCS handbook does not provide ISC or CN values for residential densities greater than 8 du/acre, the closest value provided for a comparable LUC (8 du/acre) value was used for all densities greater than 8 du/acre. Also, the NRCS commercial/business CN was applied to the retail LUC. The commercial CN was applied to offices and office parks since the NRCS does not provide any values for these LUCs. Using the CA ISCs and CN values for the four hydrological soil groups (HSGs), we calculated stormwater runoff amounts for the same development scenario built on the different HSGs. Figures 7 – 10 highlight the total and individual LUC calculated runoff volumes, converted to acre-feet.

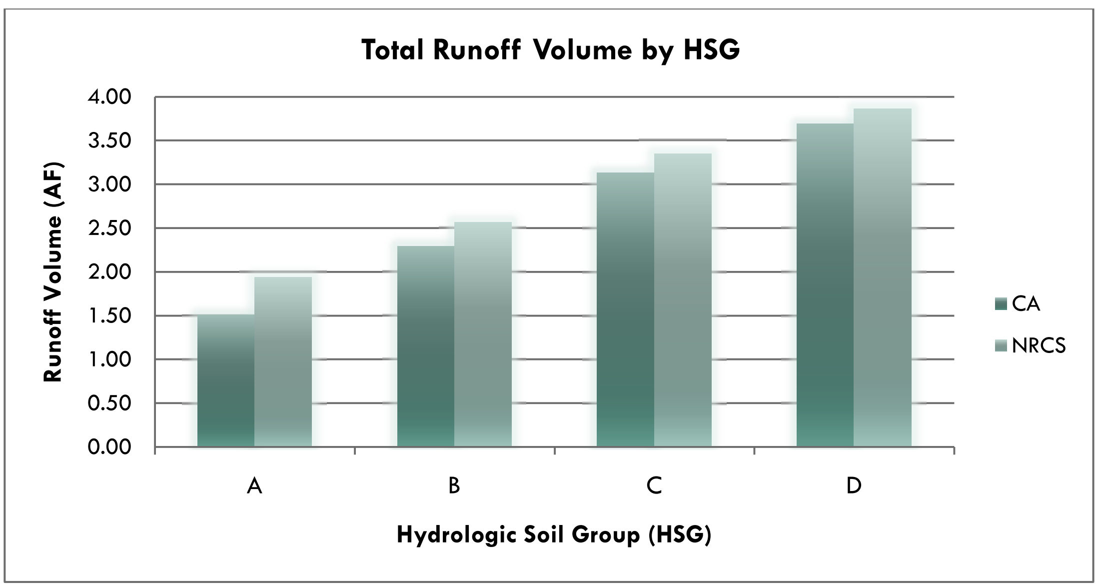

Figure 7 . Total runoff volume by HSG for a 1" rain event on a 100 acre development.

Figure 7 illustrates the differences in total runoff for the development using the California and NRCS CNs. The differences between the California and NRCS runoff estimates are greatest when soils are more permeable (HSG A). In HSG A, the NRCS runoff estimate is 20% greater than the

California runoff estimate. In other words, the California and NRCS estimates differ by 0.43 acre-feet (approximately 140,000 gallons). When the native soil has low permeability (HSG D), the NRCS runoff estimate is only 3% greater than the estimates based on the California CNs. For the HSG D scenario, the difference was 0.17 acre-feet or approximately 55,000 gallons. The differences in runoff are 5.5% and 4% respectively for HSGs B and C.

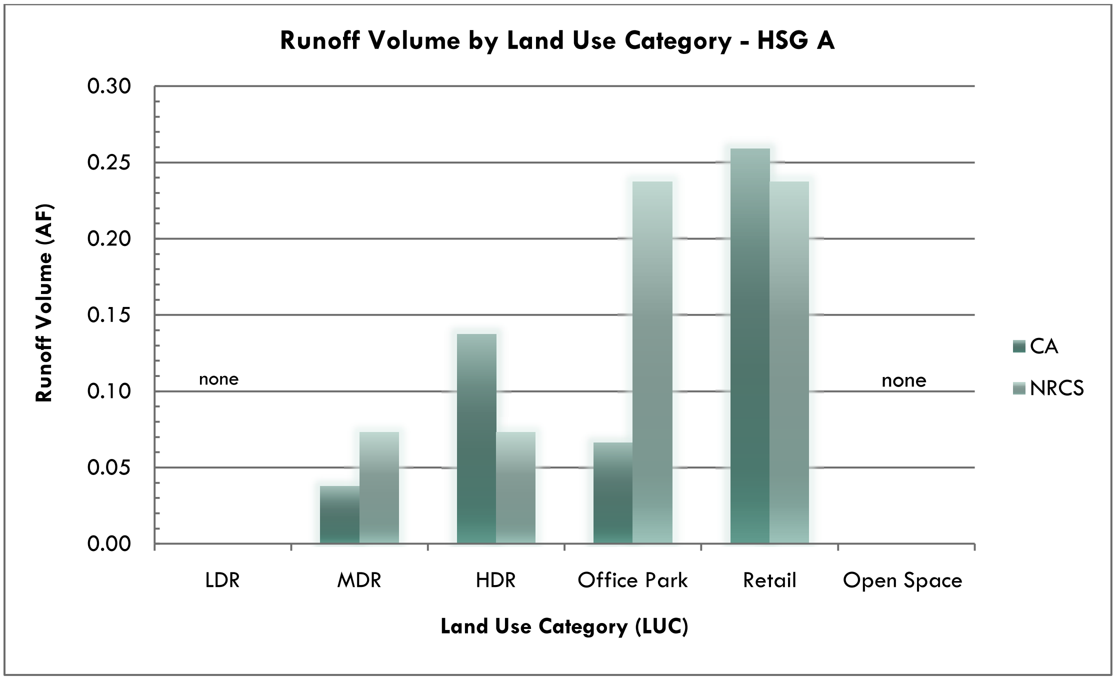

Figure 8. Runoff volume by land use category (excluding roads) for HSG A. Each bar represents the volume of runoff in acre-feet (AF) for the hypothetical 100 acre development. Values were calculated using the California (CA) and NRCS set of curve numbers. LDR = low density residential, MDR = medium density residential, HDR = high density residential. Due to the high permeability of Type A soil, there was no runoff from the LDR or Open Space LUCs.

As illustrated in Figure 8, the differences between the C and NRCS CN are greatest in highly permeable soils, where the differences in the ISC values can be detected easily. For example, there is 3.5-fold less runoff volume for the Office Park LUC when using the California CNs. This difference is linked to the fact that office parks have less impervious cover than most commercial LUCs. The opposite is true for high density residential where the estimate of runoff using the California CN yields about two-fold greater runoff volume.

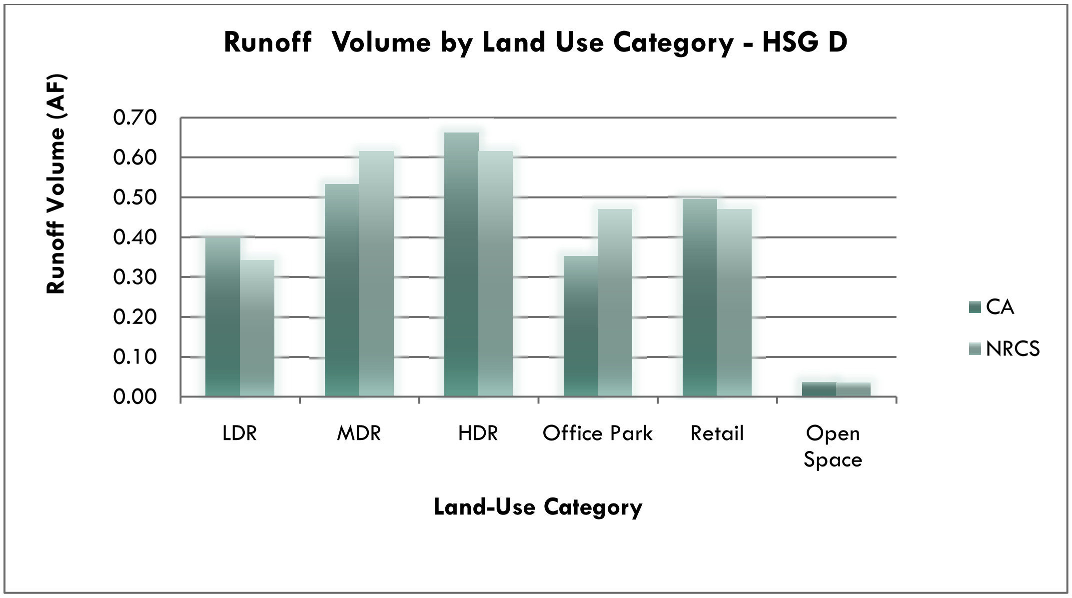

Figure 9. Runoff Volume by LUC for HSG D. Abbreviations are the same as for Figure 8.

Figure 9 illustrates the same relationships but for HSG D, which has much less permeability than HSG A. Due to the reduced difference between bare soil and impervious cover in D soils, runoff volume for Office Park is 1.3-fold greater compared to 3.5 for HSG A using the NRCS CN and California CNs. In contrast, runoff from HDR is just 15% larger than estimated using the NRCS CN compared to approximately 50% for HSG A. The total runoff volume is about 10% greater when using the NRCS CNs than with the California values.

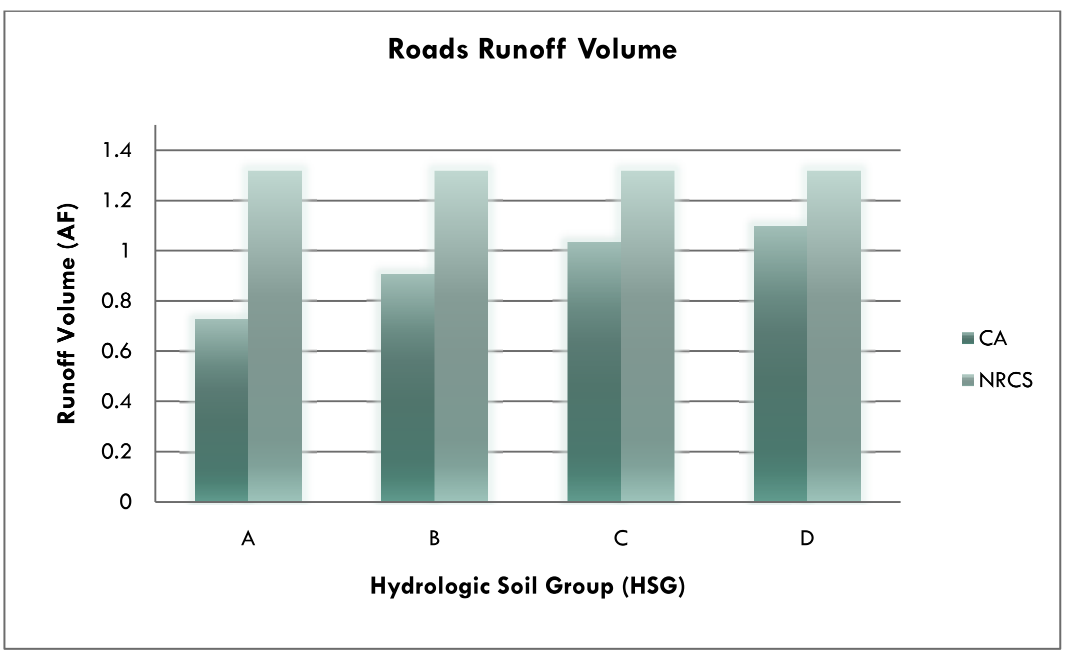

Figure 10. Runoff volume from right-of-way (roads) for all soil types.

Figure 10 illustrates differences in stormwater runoff from roads. The pattern is similar to the previous comparisons; the differences between the two runoff volumes are greater for more porous soil. For HSG A, use of the California CN would yield 38% less runoff from roads than the volume calculation using the NRCS value. This difference diminishes to 13% (for HSG D) as the soil becomes less pervious. Overall, runoff volumes are consistently lower when using California CNs.

Although not evident from this example, the differences in road runoff would be even larger if the area of analysis included rural roads and highways. The following table illustrates the percent reduction in runoff using California and NRCS CNs for the 4 hydrologic soil groups for the 3 major road categories.

	Percent reduction in runoff volume from roads using California CNs			
Road Type	***HSG-A***	***HSG-B***	***HSG-C***	***HSG-D***
Suburban/Urban	3.2	3.2	2.0	2.0
Rural	23	13	8.7	5.4
Highway	19	12	7.6	4.3

Table 7. Estimated reduction in roadway stormwater runoff when calculating volume using the California CNs compared to the NRCS CNs. The values reflect the percent reduction in the runoff volume. CN for highways are not available from the NRCS. Therefore, when estimating runoff volumes, we made the assumption that NRCS CN for highways has the same CN as rural roads because rural roads typically do not have storm drains as is the case for highways. These estimates are on the conservative side for a few reasons: a) many locations in California are hilly which would increase actual runoff, and b) California has many higher intensity land uses than those provided by the NRCS.

D. Conclusion

The California CNs support accurate estimations of stormwater runoff. The California ISC and companion CNs can be used as a tool for sizing stormwater facilities of all types. They can also be used to help implement hydromodification management plans which call for no net change or limited change in the hydrograph post-development. Use of the ISC is one of the most accurate ways to estimate current levels of runoff, laying the basis for determining the size of bioretention cells, detention/retention basins, and swales needed to prevent changes in the hydrograph. In addition to meeting regulatory requirements, appropriate sizing of stormwater management structures helps ensure they are cost-effective.

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Appendix A: Non-Residential Curve Numbers

The following set of look up tables provide a quick reference for the set of Non-Residential CA CNs for the 4 hydrologic soil groups.

HSG A - Non-Residential CN		
LUC	**California CN**	**NRCS CN**
Retail	90	89
Retail/Office	86	89
Coastal Development	53	89
Office Park	80	89
Urban Office	89	89
Light Industrial	87	81
Heavy Industrial	93	81
Public/Quasi-Public	69	-
Mixed Use	86	-
Open Space	40	39
Agriculture	41	Varies
Roads		
Urban/Suburban	93	98
Rural	64	83
Highways	69	83

HSG B - Non-Residential CN		
LUC	**California CN**	**NRCS CN**
Retail	93	92
Retail/Office	91	92
Coastal Development	70	92
Office Park	87	92
Urban Office	92	92
Light Industrial	91	88
Heavy Industrial	95	88
Public/Quasi-Public	80	-
Mixed Use	91	-
Open Space	62	61
Agriculture	62	Varies
Roads		
Urban/Suburban	95	98
Rural	77	89
Highways	78	89

HSG C - Non-Residential CN		
LUC	**California CN**	**NRCS CN**
Retail	95	94
Retail/Office	93	94
Coastal Development	80	94
Office Park	91	94
Urban Office	94	94
Light Industrial	93	91
Heavy Industrial	96	91
Public/Quasi-Public	86	-
Mixed Use	93	-
Open Space	74	74
Agriculture	75	Varies
Roads		
Urban/Suburban	96	98
Rural	84	92
Highways	85	92

HSG D - Non-Residential CN		
LUC	**California CN**	**NRCS CN**
Retail	95	95
Retail/Office	94	95
Coastal Development	84	95
Office Park	92	95
Urban Office	95	95
Light Industrial	95	93
Heavy Industrial	96	93
Public/Quasi-Public	89	-
Mixed Use	94	-
Open Space	80	80
Agriculture	81	Varies
Roads		
Urban/Suburban	96	98
Rural	88	93
Highways	89	93

Appendix B: Residential Curve Numbers

The following look-up table provides a quick reference for residential curve numbers.

HSG A - Residential CN		
Density (du/acre)	California CN	NRCS CN
0.5	47	46
1	53	51
2	60	54
3	63	57
4	66	61
5	68	61
6	70	61
7	71	61
8	72	77
9	73	77
10	74	77
11	75	77
12	76	77
13	77	77
14	77	77
15	78	77
20	80	77
25	82	77
30	84	77
35	86	77
40	87	77
45	88	77
50	89	77

HSG B - Residential CN		
Density (du/acre)	California CN	NRCS CN
0.5	66	65
1	70	68
2	74	70
3	76	72
4	78	75
5	79	75
6	80	75
7	81	75
8	82	85
9	82	85
10	83	85
11	84	85
12	84	85
13	85	85
14	85	85
15	85	85
20	87	85
25	88	85
30	89	85
35	90	85
40	91	85
45	92	85
50	92	85

HSG C - Residential CN		
Density (du/acre)	**California CN**	**NRCS CN**
0.5	77	77
1	80	79
2	82	80
3	84	81
4	85	83
5	86	83
6	86	83
7	87	83
8	88	90
9	88	90
10	88	90
11	89	90
12	89	90
13	89	90
14	90	90
15	90	90
20	91	90
25	92	90
30	92	90
35	93	90
40	93	90
45	94	90
50	94	90

HSG D - Residential CN		
Density (du/acre)	**California CN**	**NRCS CN**
0.5	83	82
1	84	84
2	86	85
3	87	86
4	88	87
5	89	87
6	89	87
7	90	87
8	90	92
9	90	92
10	91	92
11	91	92
12	91	92
13	91	92
14	92	92
15	92	92
20	93	92
25	93	92
30	94	92
35	94	92
40	95	92
45	95	92
50	95	92

SECTION V. APPLICATION OF THE IMPERVIOUS SURFACE COEFFICIENTS TO NATURAL RESOURCES MANAGEMENT

A. Introduction

It has been recognized for many years that when impervious cover increases, conditions of the aquatic ecosystem decline. Impervious cover can affect the diversity and abundance of benthic macroinvertebrates (insects that spend part of their life in the streambed) and fish, habitat conditions such as canopy cover, percent fines in bedded sediment, stability of stream banks and beds, and water quality (summarized in a review by OEHHA, 2009). For these reasons and others, quantifying the amount of impervious cover has become a valuable indicator of watershed conditions.

Since impervious cover serves as a surrogate for disturbance, percent IC has also been used to identify reference streams, those to which conditions of streams can be compared. Recognizing that there are few if any pristine waterways remaining in California, those streams located in less disturbed watersheds can be used as reference points for waterways found in more disturbed areas.

Impervious surface coefficients can be used to estimate the amount of impervious cover within a watershed, within a sub-watershed, and even within stream buffers. In urbanized areas with storm drain conveyance systems, runoff from distant areas within the watershed can impact conditions in the waterway. In areas that do not have a storm drain system, imperviousness within a buffer appears to have a greater impact on the conditions in a stream than IC in the watershed overall (Brabec, 2002; Snyder et al., 2005). This chapter reviews the application of the ISC to the estimation of IC at various areal extents, with the goal of better understanding watershed conditions and improving watershed management.

B. Calculating Imperviousness within Watersheds

A common application of impervious cover analysis is to estimate total watershed imperviousness. The relationship between IC and stream quality and its usefulness as an indicator of potential hazard was highlighted by Schueler (1995). A geographic information system (GIS) offers the easiest way to calculate IC in a watershed or sub- watershed. The process is almost identical to that of calculating current imperviousness, with the exception that the watershed boundary defines the areal extent of the analysis. This analysis requires two key data layers: a map of the watershed boundaries and land-use maps from all relevant municipalities. If the analyst plans to calculate current IC by visually identifying non-conforming parcels for which alternative ISC should be used, then an aerial photograph will also be required.

The data can be obtained in a few different ways:

- If you have GIS capabilities, the data layers mostly reside in the public domain, so local municipalities or regional councils of government usually will make them available.
- In some cases, city staff may assist with the analysis. Because most planning departments work with GIS data, staff may have the capacity to sum up the total acreage in each

land-use category within a defined boundary. This will require providing staff with the boundary of the watershed that falls within the city limits. The outputs from various municipalities can be assembled into a single spreadsheet to determine the build-out impervious acreage by LUC.

- Frequently, paper maps are available which contain the information needed to calculate the acreage of each land use category within different neighborhoods. The watershed boundary can be outlined and manual estimates can be made of the total acreage of each LUC, one of the inputs for the calculation of IC.
- With these data in hand, the Impervious Cover Calculator (ICC) can be used to perform the calculation for build-out. The method was reviewed in Section III, Calculating Current and Future Impervious Cover. Current imperviousness is more relevant because this metric can be correlated with habitat and biological conditions within the waterways. The details of the method for calculating current IC can be found in Section III. An example of a map of current percent IC is shown in Figure 11, in which sub-watersheds were grouped into 3 categories that reflected low, medium, and high levels of impervious cover.

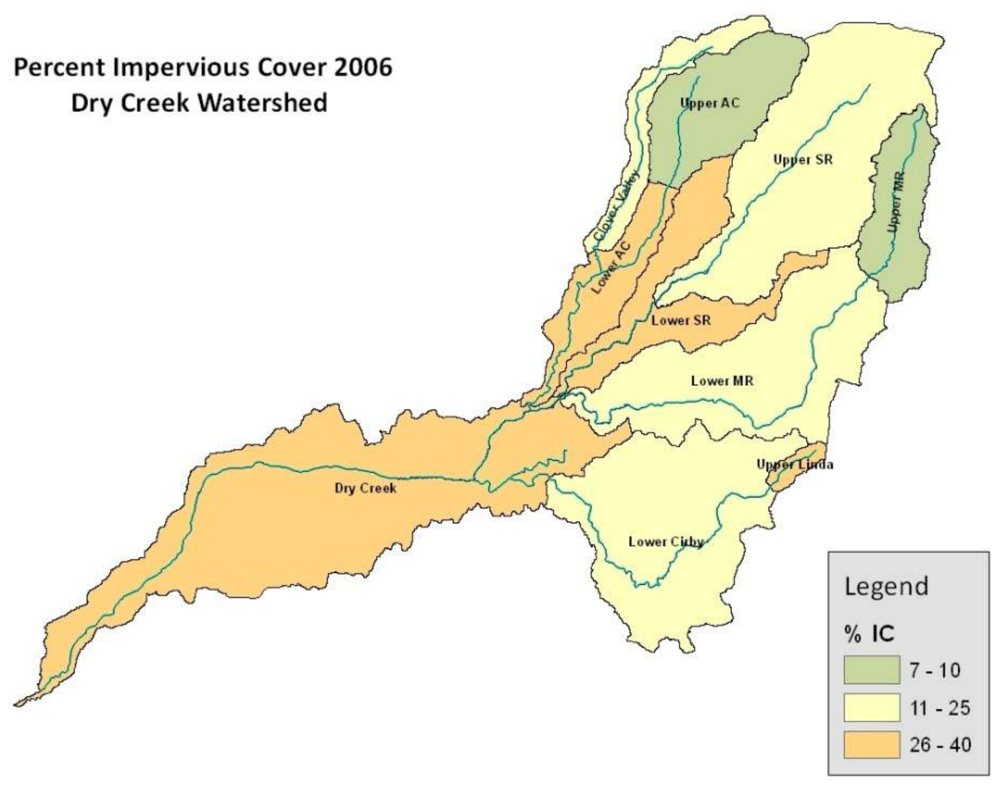


Figure 11. Current Impervious Cover in Dry Creek Watershed

C. Calculation and Application of Impervious Cover Data within a Stream Buffer

The IC within a stream or riparian buffer is another metric of interest to many natural resource managers and those concerned about watershed health. It can serve as an important predictor of the condition of the aquatic ecosystem (Brabec, 2002), especially where buffer disturbance can directly impact conditions in the waterway. The ISC can be used to estimate impervious cover within a stream buffer for approximately 2 acres or larger (discussed in detail below).

Figure 12 illustrates an analysis of % IC within 2 stream buffers having a width of 100 and 1,000 feet. This example is drawn from data on the Dry Creek watershed, a 100 square mile watershed in the foothills east of Sacramento. The shaded, thin, inner lines around the waterways reflects the 5 categories of IC in the 100 foot buffer; the wider shaded line reflects IC in the 1,000 foot buffer, while the shading in the larger sub-watershed reflects 3 levels of overall IC. In general, IC in the 100 foot buffer was quite low, although in one degraded sub-watershed, greater than 20 percent IC was identified. Percent IC in the 1,000 foot buffer generally reflected the overall IC in the sub-watershed. Later in this section, these estimates will be related to metrics measuring the health of benthic macroinvertebrates, useful indicators of the health of the aquatic ecosystem.

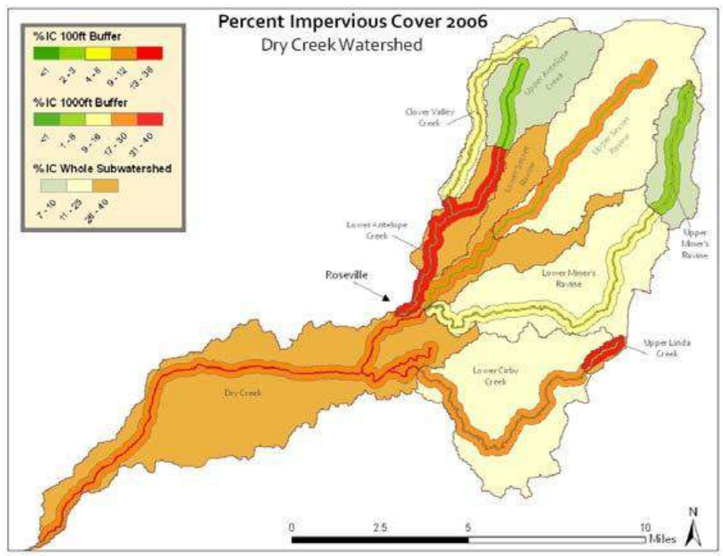


Figure 12. Percent IC in the 100 and 1000 foot buffer by sub-watershed.

The Issue of Spatial Scale when Using the ISCs

The ISCs were not designed for analysis on smaller spatial scales. This can become an issue when looking at IC in a narrow stream corridor, because buildings are typically not randomly distributed on a streamside parcel. Buildings are usually situated out of the 100 year floodplain and away from water. The narrower the buffer, the more difficult it becomes to analyze impervious cover. To investigate this potential limitation, all impervious surfaces within 100 feet of a waterway in 5 sub-watersheds within the Dry Creek watershed were analyzed. Current IC within the 100 foot buffer was calculated in 2 ways: a) using the ISC with data on the areal extent of each land use category within the buffer, then correcting for non-conforming use, as described in Section III, and b) digitizing all impervious cover from high resolution aerial photographs (1 foot resolution) and comparing the results. In each case, estimates of the area derived from using the ISCs in a calculation were double that obtained from direct digitizing off of aerial photos. The results of this analysis are summarized below.

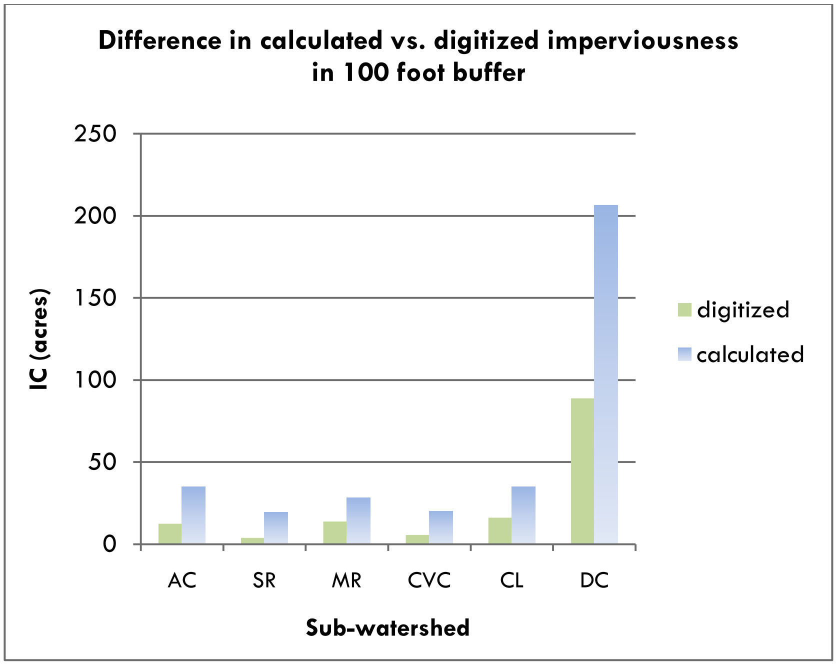


Figure 13. Differences in % IC in the 100 foot buffer using two methods of calculation. The percent IC was determined digitizing all hardscape and by calculation with the ISCs (summation of the area of IC in each sub-watershed x ISC for each LUC).

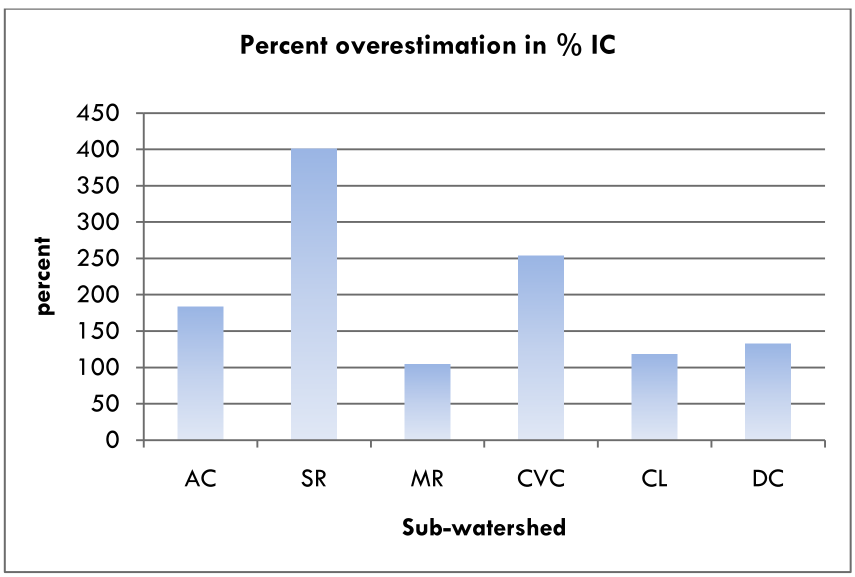


Figure 14. Percent overestimation of impervious cover using ISCs. Another way of viewing the data if Figure 3a is to calculate the percent overestimation that results from calculating impervious cover at a finer scale. For example, in the SR sub-watershed, percent IC in the 100 ft. buffer was 400 percent greater when estimates where made with calculations instead of heads-up digitizing.

This difference is not associated with the resolution of the aerial imagery, but with the method used to develop the ISCs, i.e., the fact that a 9 acre site was digitized to develop coefficients for each land use category. The discrepancy in impervious area confirms that the ISCs should not be applied to small areas; in this case, areas that were 100 feet wide. *Pending further study, we suggest not using the ISCs for sites of less than 2 acres or for a stream buffer that is less than 300 feet wide.* This recommended minimum would account for restrictions of the location of a structure on a parcel, such as when local ordinances or a floodplain might restrict the siting of a house, building, or pavement that would restrict the random distribution of hardscape on a parcel.

Figure 15 illustrates the differences in IC at three different scales (100 and 1000 foot stream buffer and within the entire sub-watershed) in urban vs. rural sub-watersheds in the Dry Creek watershed. This analysis was performed to determine if greater IC was found in riparian buffers in urban sub-watersheds. In fact, the percent IC in the 100-foot buffer was twice as great in urban areas of the watershed, although the overall percent was less than 1 percent in both cases. The urban sub-watersheds have twice the amount of IC in the 1000 foot buffer, 25 percent compared to 12 percent. This relationship is the same for the entire sub-watershed. Probably of greatest interest is the fact that the level of IC in the urbanized sub-watersheds of Dry Creek is quite high, well above the level associated with adverse impacts on stream health (OEHHA, 2008).

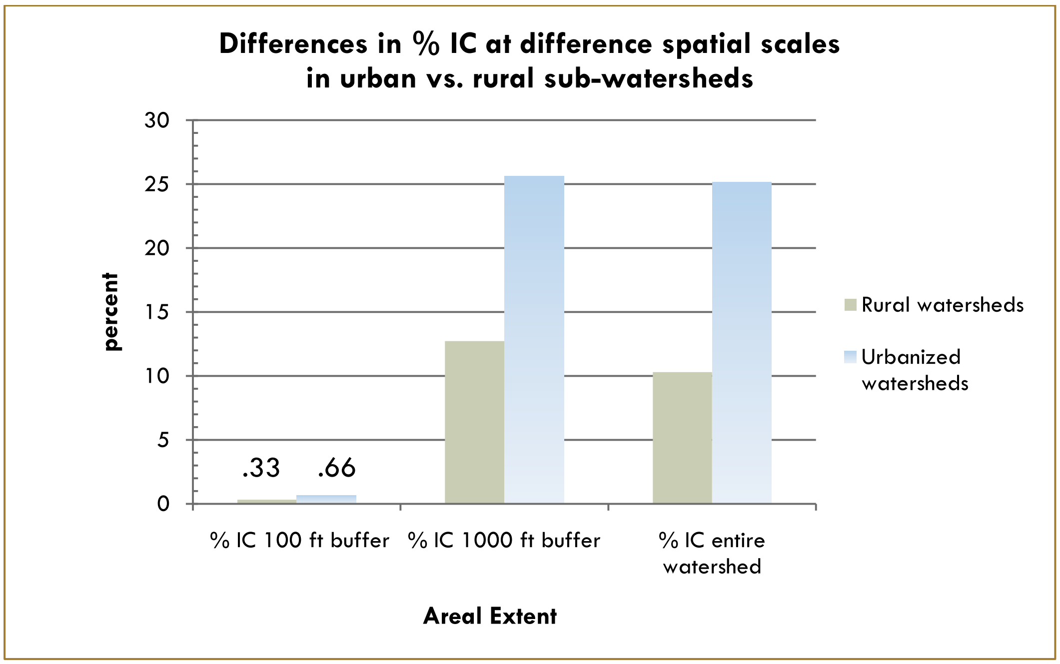


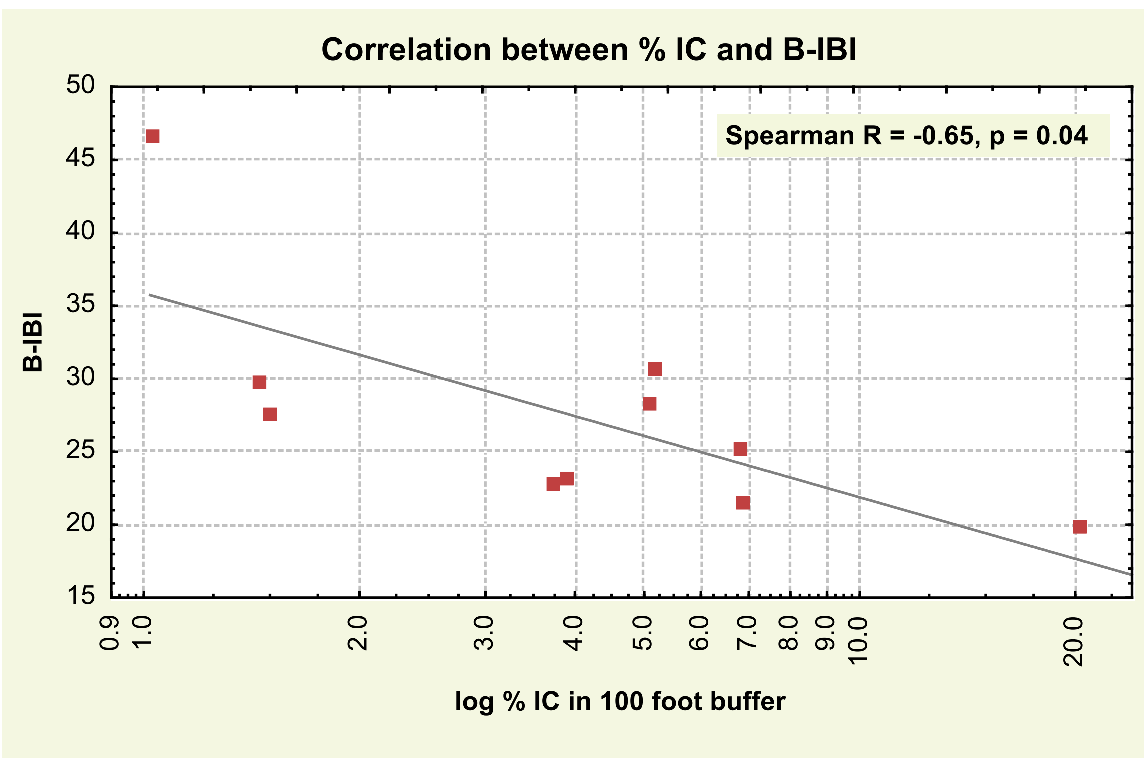
Figure 15. Comparison of % IC at 3 different spatial scales in rural and urbanized watersheds. Bars represent average % IC (n = 4-5) within the defined area.

D. Examples of the Relationship between Impervious Cover and Aquatic Life

Significant efforts have been made to understand the relationship between impervious cover and aquatic life and habitat. In 1995, work by Schueler called attention to this linkage when he identified the general benchmarks of 10 percent and 25 percent impervious cover as indicators of threatened and degraded stream quality respectively. These relationships were established from data on waterways in the eastern United States. In the arid west, these benchmarks do not necessarily hold. Research done by Coleman et al. (2005) suggests that changes in aquatic habitat, specifically stream widening, occurs at imperviousness as low as 2 or 3 percent in southern California.

Relating impervious cover to various benthic macroinvertebrate indices (BMI) can be used as another indicator of potential impacts. Measurement of the abundance and diversity of benthic macroinvertebrates serves as an indicator for all types of stressors, both chemical and physical, over time. Further, because benthic invertebrates share the same riffle habitat as salmonids, these indices can serve as a surrogate for conditions that might impact salmon and steelhead. This is especially useful because factors that impact the population of salmonids can be the result of conditions both in the ocean and in freshwater. In contrast, the aquatic phase of the life of insects is restricted to freshwater. Therefore, BMIs can help to explain the extent to which freshwater habitat might be influencing the health of anadromous fish without the confounding factors of oceanic conditions. This information can help guide watershed management as well as natural resource and land use policy.

One of the most commonly used metrics of aquatic life is the benthic index of biotic integrity (B-IBI). A B-IBI has been developed for Southern/Central California (Ode, Rehn, & May, 2005). This B-IBI is frequently used throughout California, even though the index is based on conditions in the southern part of the state. In addition to the B-IBI, metrics based on the abundance (percent contribution of dominant taxa), diversity (# of taxa), tolerance to perterbation (percent tolerant species) and feeding groups (e.g., percent scrapers) are also commonly used to characterize the population of macroinvertebrates.



In Figure 16 (above) the relationship between impervious cover within a 100 foot buffer around each tributary are correlated with the B-IBI. It appears that imperviousness, a surrogate for disturbance, close to the waterways adversely affects aquatic macroinvertebrate abundance and diversity.

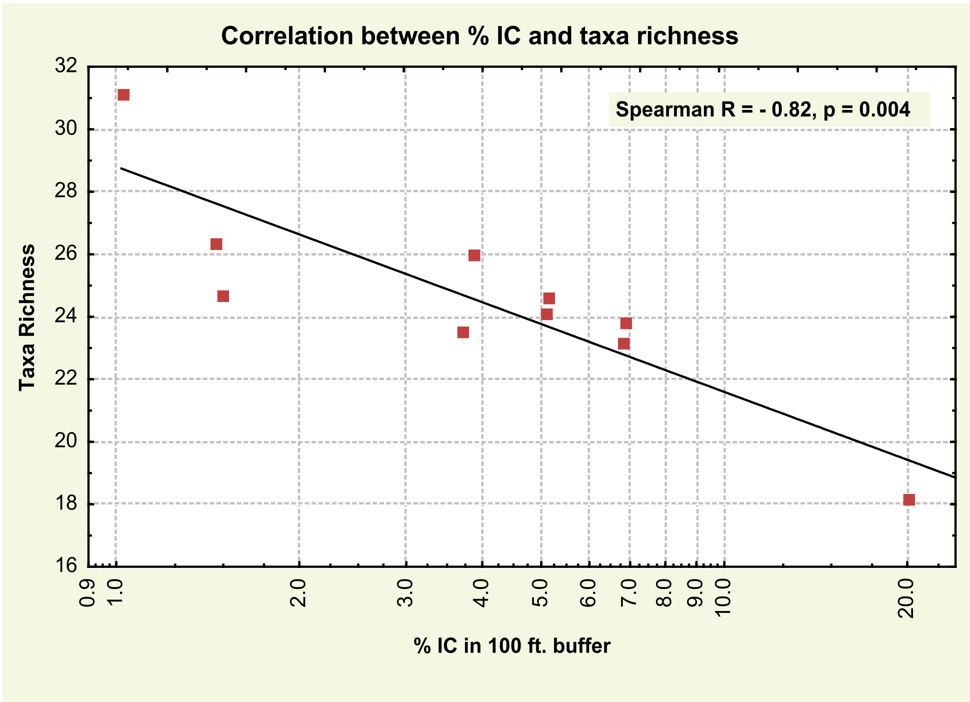


Figure 17. Impervious cover and taxa richness.

Figure 17 (above) illustrates the relationship between imperviousness in the 100 foot buffer and taxa richness, a measure of the diversity of benthic insects, in the Dry Creek watershed. A highly significant negative correlation was identified between these two factors. Data from Figures 5 and 6, as well as other findings, suggest that in the Dry Creek watershed that a 100 foot riparian buffer is inadequate to protect aquatic life. Additional data would be required to validate this hypothesis since the one data point at 20 percent impervious cover has a large influence on the relationship. This relationship might be useful to land use planners since it illustrates the importance of protecting wide streamside buffers to prevent adverse impacts on aquatic habitat and life.

One final example of how the analysis of imperviousness can be used to understand watershed conditions is illustrated in Figure 18 (below). The Shannon Index is a relative measure of species richness and evenness (i.e., the proportional distribution of organisms in the different taxa). Lower values suggest that fewer taxa were counted in the samples collected and that a few taxa accounted for the majority of the sample collected. This index provides a relative comparision of species abundance and distribution at different sites in the watershed. As impervious cover increases in the sub-watershed, abundance and evenness of species falls. One explanation for this and similar findings is that hydromodification, changes in the watershed hydrology associated with greater impervious cover, has altered the habitat for benthic macroinvertebrates, adversely impacting diversity. In the Dry Creek watershed, there is a mix of urban and rural residential development. In rural areas, roadside ditches are used to route stormwater away from homes while other areas have a developed storm drain system that connects impervious cover and drains directly into the local creeks. The mix of land uses is one factor that complicates the analysis of the data. These issues and related factors are discussed further in the chapter on Benthic Macroinvertebrates in the *California Watershed Assessment Manual*, Vol. II (Shilling, 2008).

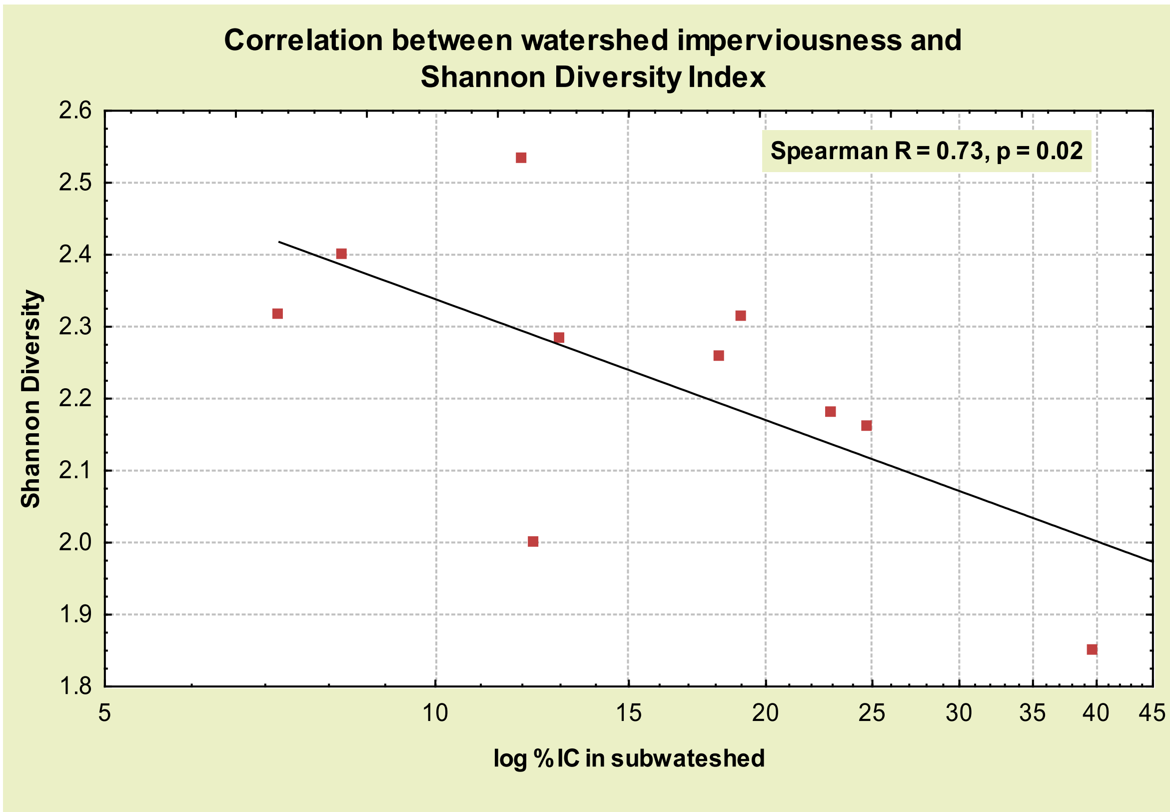


Figure 18. Correlation between impervious cover and Shannon Index.

Overall, percent impervious cover at various spatial scales and similar landscape metrics such as percent developed vs. natural land cover, can be helpful in interpreting metrics of aquatic life. One limitation of the measurement of imperviousness using the ISCs however, is that they do not assess *connected* impervious area, the uninterrupted network of hardscape and pipes. While connected impervious area is the most relevant metric for determining effects on aquatic life and habitat, it can be difficult and time consuming to measure (Sutherland, 1995).

E. Conclusion

Watershed impervious cover serves as a valuable metric for evaluation of the potential effects of hydromodification and urbanization in a watershed. The areal extent of imperviousness and its proximity to waterways influences the degree of impact caused by these alterations. The use of imperviousness as an indicator of habitat quality rests on the assumption that IC is connected, allowing rain that falls on hardscape to flow into the storm drain system and discharge into the local waterway. This is generally the case. However as California advances requirements for stormwater and hydromodification management, including infiltration of stormwater at or near the source, the linkage between IC and stream health might not remain as strong. For the present, however, percent total imperviousness can be used as an indicator of landscape disturbance and a useful metric estimating the degree of alteration or, conversely, the degree to which more natural conditions are likely to exist in the waterway.

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SECTION VI. OVERALL SUMMARY

A set of California specific impervious surface coefficients have been developed; 11 for commercial land uses, a large set for residential land uses, and 3 for roads. They were developed from randomly selected sites in a coastal city, Santa Cruz; an interior valley city, Sacramento, and a Southern California city, Irvine. Sample sizes were determined in order to provide 90% confidence in the values with a 10% degree of precision. These ISC can be used in stormwater management, watershed and natural resources analysis, as well as for land-use planning. To facilitate the use of the ISCs, an Impervious Surface Calculator has been developed which simplifies the calculation of current and future impervious cover.

The California ISCs can be used in the analysis of stormwater runoff and sizing of stormwater management infrastructure as well as in the assessment of watershed health. Hydromodification is an important factor that links stormwater runoff to the health of the aquatic ecosystem. Impervious cover both cuts off sediment sources, increases runoff volume, and is a path for the introduction of toxic chemicals into stormwater. These chemical and physical stressors threaten to further degrade the state's waterways as regions of the state continue to urbanize. Impervious cover within riparian buffers, a surrogate for disturbance, appears to have a particularly strong correlation with adverse effects on aquatic life. The ISCs can be used by local and regional planning agencies as well as the development community to assess the potential impacts of new development projects and identify ways to 'plan with nature in mind'.

Additional information about hydromodification, including an easy-to-read fact sheet and more in-depth technical information, can be found at www.oehha.ca.gov. Click on the Ecotoxicology tab to navigate.

Staff of OEHHA's Ecotoxicology Program are available to answer questions or provide assistance in the use of the impervious surface coefficients.

Table 8: California Impervious Surface Coefficients

Non-Residential Land Uses	
Land Use	**California ISC**
Retail	86
Retail/Office	80
Coastal Development	23
Office Park	69
Urban Office	85
Light Industrial	81
Heavy Industrial	91
Public/Quasi-Public	50
Mixed Use	80
Open Space	2
Agriculture	4
Roads	
Urban/Suburb	91
Rural	43
Highways	47

Residential Land Uses	
Density (du/acre)	**California ISC**
0.5	0.14
1	0.24
2	0.35
3	0.41
4	0.46
5	0.49
6	0.52
7	0.54
8	0.56
9	0.58
10	0.60
11	0.61
12	0.62
13	0.64
14	0.65
15	0.66
20	0.70
25	0.74
30	0.76
35	0.79
40	0.81
45	0.83
50	0.84

Regression equation from which the values were derived:
Y=0.2449+0.352 x log density

USER'S NOTE PAGE

Appendix C. Water Development Impact Fees by Zone

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MEMORANDUM—WATER DIFs BY ZONE ANALYSIS

TO: Carmen Narayanan/Valley Water

FROM: Allan Highstreet, NBS

DATE: November 3, 2023

SUBJECT: Santa Clara Valley Water District – Water Development Impact Fees by Zone

Background

Santa Clara Valley Water District (Valley Water) contracted with NBS to prepare development impact fees (DIF) for water supply and flood protection infrastructure. The DIFs calculated by NBS looked at Districtwide impact fees. After reviewing these fees, the District was interested in exploring whether it was possible to calculate a water impact fee by water zone. This memorandum describes the analysis of preparing water impact fees by zones.

Calculating Water Impact Fees by Zone

This memorandum steps through the same calculations as the Districtwide calculations. The main difference is in the demographics. Those changes then flow through the analysis.

DEMOGRAPHICS

The Districtwide water impact fee was based on the projected water supply growth expected in the Water Supply Master Plan 2040. That source did not forecast the growth by zone. The District provided data used in their financial projections, showing a breakdown of water demand growth by south county zones. This data is shown in Figure 1. It should be noted that the Districtwide impact fee calculation used projected demand for 2040, while the finance data is through 2050.

Figure 1. Water Growth Projections by Zone

Water Use by Type	% of Current Water Demand	Current Water Demand[1]	Estimated Yearly Growth (AF)[2]						
			2050				Total Demand	Total Growth	% Growth
			Zone W-2	Zone W-5	Zone W-7	Zone W-8			
Groundwater	19%	70,157	7,550	1,845	516	39	9,950	80,107	19%
Treated Water	81%	296,843	42,100	0	0	0	42,100	338,943	81%
Total Water Growth		**367,000**	**49,650**	**1,845**	**516**	**39**	**52,050**	**419,050**	**100%**
		Percent of Total Growth	*95.4%*	*3.5%*	*1.0%*	*0.1%*			

1 .Estimated water demand for 2025. Source file: *Water Supply Master Plan 2040_11.01.2019_v2.pdf* , page 20.

2. Source files: *Water Supply Master Plan 2040_11.01.2019_v2.pdf* , page 20 & *Water_Demand_Growth_Finance Data Request_08-18-2023.xlsx* .

Water growth projections were then proportioned to existing and future customers by zone. This is shown in Figure 2. Figure 2 shows that existing customers represent 87.6 percent of the future demand, with 12.4 percent for future customers. In the Districtwide impact fees, they were slightly different, 87.7 percent for existing customers, 12.3 percent for future customers. This variation stems from the different future demand estimates, FY 2040 in the Districtwide analysis versus 2050 for the zone analysis.

Figure 2. Existing vs. Future Customers Allocation

Agencies / Cities	Current Water Supply	Expected Future Water Supply *(thru FY 2049/50)*	Total	Allocation Factors								
				Existing Customers - 87.6%				Future Customers - 12.4%				Total
				Zone W-2	Zone W-5	Zone W-7	Zone W-8	Zone W-2	Zone W-5	Zone W-7	Zone W-8	
Water Supply Growth Through 2050	367,000	52,050	**419,050**	83.5%	3.1%	0.9%	0.1%	11.8%	0.4%	0.1%	0.0%	**100.0%**

VALUE OF EXISTING ASSETS

All the assets put into service are tracked in the District's Asset Management Planning Tool (AMPT), which tracks installation date, original costs, asset life, and also estimates replacement costs. The existing assets are summarized in Figure 3, allocated by zone.

Figure 3. Original and Replacement Values

Asset Class[1]	Program Cost[1]		Asset Cost Less Depreciation	Replacement Values[2]		System Buy-In Cost Basis				
	Asset Cost	Depreciation to Date		Asset Cost	Depreciation to Date	Zone W-2	Zone W-5	Zone W-7	Zone W-8	Total
Subtotal: Civil	**$ 383,889,078**	**$ 127,213,442**	**$ 256,675,636**	**$ 474,256,450**	**$ 149,209,268**	**$ 290,251,118**	**$ 21,568,492**	**$ 13,081,039**	**$ 146,534**	**$ 325,047,182**
Subtotal: Electrical	**$ 66,631,014**	**$ 728,709**	**$ 65,902,304**	**$ 100,653,534**	**$ 758,672**	**$ 86,752,732**	**$ 5,838,419**	**$ 7,302,398**	**$ 1,313**	**$ 99,894,861**
Subtotal: Fleet	**$ 637,411**	**$ -**	**$ 637,411**	**$ 758,835**	**$ -**	**$ 621,216**	**$ 59,774**	**$ 77,844**	**$ -**	**$ 758,835**
Subtotal: Instrumentation	**$ 16,266,480**	**$ 967,889**	**$ 15,298,591**	**$ 20,524,753**	**$ 1,238,272**	**$ 18,255,253**	**$ 726,915**	**$ 301,564**	**$ 2,749**	**$ 19,286,481**
Subtotal: Mechanical	**$ 74,960,125**	**$ 3,655,442**	**$ 71,304,682**	**$ 103,281,307**	**$ 4,292,920**	**$ 91,150,083**	**$ 5,856,883**	**$ 1,962,321**	**$ 19,100**	**$ 98,988,387**
Subtotal: Planning & Engineering Cost	**$ 50,711,797**	**$ -**	**$ 50,711,797**	**$ 52,233,151**	**$ -**	**$ 26,116,575**	**$ 26,116,575**	**$ -**	**$ -**	**$ 52,233,151**
Subtotal: WQL Lab	**$ 7,589,903**	**$ 1,741**	**$ 7,588,162**	**$ 11,257,029**	**$ 1,793**	**$ 8,602,143**	**$ 2,653,093**	**$ -**	**$ -**	**$ 11,255,236**
Total: Fixed Assets	**$ 600,685,807**	**$ 132,567,223**	**$ 468,118,584**	**$ 762,965,058**	**$ 155,500,925**	**$ 521,749,120**	**$ 62,820,153**	**$ 22,725,166**	**$ 169,695**	**$ 607,464,133**

1. The original asset cost provided by the District and depreciation calculated by NBS (depreciation is as of June 1, 2022).
2. Replacement values are calculated by escalating the original values from service date to 2022 values using historical cost inflation factors provided by the District in its Asset Management Planning Tool.

The existing assets were then distributed to existing and future customers, also disaggregated by zones. These results are shown in Figure 4.

Figure 4. Cost Allocation to Existing and Future Customers

Asset Class[1]	System Buy-In Cost Basis[2]	Distribution of Cost Basis ($)										
		Existing Customers					Future Customers					Total System Buy-In
		Zone W-2	Zone W-5	Zone W-7	Zone W-8	Total Existing Customers	Zone W-2	Zone W-5	Zone W-7	Zone W-8	Total Future Customers	
Civil	325,047,182	$ 254,199,165	$ 18,889,480	$ 11,456,249	$ 128,333	$ 284,673,227	$ 36,051,952	$ 2,679,012	$ 1,624,790	$ 18,201	$ 40,373,955	$ 325,047,182
Electrical	99,894,861	75,977,216	5,113,232	6,395,371	1,150	87,486,968	10,775,515	725,187	907,027	163	12,407,893	99,894,861
Fleet	758,835	544,055	52,350	68,175	-	664,580	77,161	7,425	9,669	-	94,255	758,835
Instrumentation	19,286,481	15,987,777	636,625	264,107	2,407	16,890,916	2,267,476	90,290	37,457	341	2,395,565	19,286,481
Mechanical	98,988,387	79,828,375	5,129,402	1,718,582	16,727	86,693,086	11,321,708	727,481	243,739	2,372	12,295,300	98,988,387
Planning & Engineering Cost	52,233,151	22,872,648	22,872,648	-	-	45,745,296	3,243,927	3,243,927	-	-	6,487,855	52,233,151
WQL Lab	11,255,236	7,533,675	2,323,554	-	-	9,857,229	1,068,468	329,539	-	-	1,398,008	11,255,236
Total: Fixed Assets	**$ 607,464,133**	**$ 456,942,912**	**$ 55,017,291**	**$ 19,902,484**	**$ 148,617**	**$ 532,011,304**	**$ 64,806,209**	**$ 7,802,861**	**$ 2,822,682**	**$ 21,078**	**$ 75,452,829**	**$ 607,464,133**
		87.6%					*12.4%*					*100.0%*

1. The original asset cost provided by the District and depreciation calculated by NBS (deprecation is as of June 1, 2022).
2. Replacement values are calculated by escalating the original values from service date to 2022 values using historical cost inflation factors provided by the District in its Asset Management Planning Tool. *See Exhibit 2. Existing Assets Detail* from the Excel model.

VALUE OF FUTURE IMPROVEMENTS

Projected new projects are outlined in several sources; Valley Water's 15-Year Capital Improvement Program (FY 2023 through FY 2037) provided by District staff. NBS also included "Master Plan" projects from the 2020 Water Supply Master Plan, excluding all other "active" and "inactive" projects. Total costs of the "Master Plan" projects were allocated over a 20-year period. Figure 5 shows the future assets, split between existing and future users, as well as by zone.

Figure 5. Summary of Planned Capital Projects

Funded Status	Cost Center	Distribution of Cost Basis ($)[2]										
		Existing Customers					Future Customers					Total System Development Cost
		Zone W-2	Zone W-5	Zone W-7	Zone W-8	Total Existing Customers	Zone W-2	Zone W-5	Zone W-7	Zone W-8	Total Future Customers	
Capital Improvement Program[1]												
Funded Capital Projects	Source of Supply	$ 1,789,661,761	$ 100,939,031	$ 115,983,994	$ 87,520	**$ 2,006,672,306**	$ 253,819,876	$ 14,315,740	$ 16,449,501	$ 12,413	**$ 284,597,530**	**$ 2,291,269,836**
	Raw Water Transmission & Distribution	242,926,510	4,431,529	5,463,479	4,304	**252,825,823**	34,453,201	628,504	774,861	610	**35,857,177**	**288,683,000**
	Water Treatment	2,027,607,949	207,027,280	135,469,732	973,397	**2,371,078,358**	287,566,740	29,361,771	19,213,078	138,053	**336,279,642**	**2,707,358,000**
	Treated Water Transmission & Distribution	7,273,440	-	-	-	**7,273,440**	1,031,560	-	-	-	**1,031,560**	**8,305,000**
	Administration and General	162,445,075	20,987,438	7,349,661	403,762	**191,185,937**	23,038,872	2,976,556	1,042,370	57,264	**27,115,063**	**218,301,000**
	Miscellaneous Projects	162,574,553	-	-	-	**162,574,553**	23,057,236	-	-	-	**23,057,236**	**185,631,788**
	Capital Placeholder	891,232,853	208,579,343	58,139,515	4,284,435	**1,162,236,146**	126,399,646	29,581,893	8,245,672	607,643	**164,834,854**	**1,327,071,000**
	Project Carryforward - Miscellaneous Projects	6,015,632	1,407,866	392,429	28,919	**7,844,846**	853,171	199,671	55,657	4,101	**1,112,600**	**8,957,446**
Fund Transfers for Capital Projects	Raw Water Transmission & Distribution	$ -	$ -	$ -	$ -	**$ -**	$ -	$ -	$ -	$ -	**$ -**	**$ -**
	General Fund	11,958,671	2,798,743	780,123	57,489	**15,595,026**	1,696,046	396,933	110,641	8,153	**2,211,774**	**17,806,800**
	Information Technology	20,575,699	4,815,426	1,342,254	98,914	**26,832,294**	2,918,161	682,951	190,366	14,029	**3,805,506**	**30,637,800**
Unfunded Capital Projects	Source of Supply	$ 155,905,884	$ 16,140,111	$ 9,517,951	$ 173,964	**$ 181,737,910**	$ 22,111,448	$ 2,289,081	$ 1,349,889	$ 24,673	**$ 25,775,090**	**$ 207,513,000**
	Water Treatment	4,390,636	454,539	268,045	4,899	**5,118,120**	622,705	64,465	38,016	695	**725,880**	**5,844,000**
Grand Total (Excl. Projects from Water Supply Master Plan)		**$ 5,482,568,662**	**$ 567,581,307**	**$ 334,707,185**	**$ 6,117,603**	**$ 6,390,974,757**	**$ 777,568,662**	**$ 80,497,567**	**$ 47,470,052**	**$ 867,633**	**$ 906,403,913**	**$ 7,297,378,670**
Master Plan Projects		$ 1,567,375,802	$ 162,262,118	$ 95,687,254	$ 1,748,922	**$ 1,827,074,096**	$ 222,294,034	$ 23,012,924	$ 13,570,904	$ 248,042	$ 259,125,904	**$ 2,086,200,000**
Grand Total (Incl. Projects from Water Supply Master Plan)		**$ 7,049,944,464**	**$ 729,843,425**	**$ 430,394,439**	**$ 7,866,525**	**$ 8,218,048,853**	**$ 999,862,696**	**$103,510,491**	**$ 61,040,955**	**$ 1,115,675**	**$ 1,165,529,817**	**$ 9,383,578,670**

1. The 15-year Capital Improvement Program (CIP) was provided by District staff. *Source file: FY23 CIP By Fund v8.xlsx & FY24_Adopted_CIP_WUE_Fund_61_08-02-2023.xlsx.*
2. Capital projects are allocated proportionately based on expected customer growth. See *Figure 1.*

ADJUSTMENTS FOR CASH RESERVES AND DEBT

Before the impact fees are developed, an adjustment is applied to the cost basis to account for existing unrestricted cash reserves and outstanding debt principal.

Adjustments for Cash Balances. Existing cash reserves are treated as an asset because they were funded by current customers and are available to pay for capital and/or operating costs of the utility that future customers will benefit from, once connected. The cash reserves are, in a sense, no different than any other utility asset. The existing cash reserves allocated to current and future customers are summarized in Figure 6 using the same allocation factors from Figure 2.

Figure 6. Cash Reserves Accumulated by Existing Water System Customers

Cash Reserves	Cash Amount[1]	$ - Allocation[2]									
		Existing Customers					Future Customers				
		Zone W-2	Zone W-5	Zone W-7	Zone W-8	Total Existing Customers	Zone W-2	Zone W-5	Zone W-7	Zone W-8	Total Future Customers
Restricted Net Position (Fund 61)											
WU Debt Service Reserves	$ 6,999	$ 5,847	$ 217	$ 61	$ 5	$ 6,130	$ 829	$ 31	$ 9	$ 1	$ 869
WU San Felipe Emergency Reserve	3,348,086	2,797,018	103,928	29,084	2,192	2,932,222	396,689	14,740	4,125	311	415,864
GP5 Reserve	9,669,736	8,078,177	300,158	83,998	6,330	8,468,663	1,145,692	42,570	11,913	898	1,201,073
WU Rate Stabilization Reserve	25,069,620	20,943,366	778,185	217,772	16,412	21,955,734	2,970,306	110,367	30,886	2,328	3,113,886
WU State Water Project Tax Reserve	TBD	-	-	-	-	-	-	-	-	-	-
WU State Water Project - Encumbrances	TBD	-	-	-	-	-	-	-	-	-	-
WUE SVAWPC Reserve	1,298,138	1,084,475	40,295	11,277	850	1,136,897	153,806	5,715	1,599	121	161,241
WU Supplemental Water Supply Reserve	15,477,000	12,929,613	480,421	134,444	10,132	13,554,609	1,833,750	68,136	19,068	1,437	1,922,391
Drought Reserve	10,000,000	8,354,082	310,409	86,867	6,546	8,757,905	1,184,823	44,024	12,320	928	1,242,095
Unrestricted Net Position											
Committed Fund Balance											
Current Authorized Projects Reserve	85,292,965	71,254,443	2,647,574	740,912	55,837	74,698,767	10,105,705	375,494	105,080	7,919	10,594,198
Operating and Capital Reserve*	86,984,133	72,667,259	2,700,070	755,603	56,944	76,179,876	10,306,079	382,939	107,164	8,076	10,804,258
Water Inventory Reserve	129,968,912	108,577,096	4,034,358	1,128,998	85,084	113,825,536	15,399,013	572,175	160,121	12,067	16,143,376
Assigned Fund Balance											
Encumbrances Reserve	125,525,283	104,864,852	3,896,424	1,090,397	82,175	109,933,848	14,872,522	552,613	154,646	11,654	15,591,435
Market Valuation Reserve	2,394,921	2,000,737	74,341	20,804	1,568	2,097,449	283,756	10,543	2,951	222	297,472
Cash Net of Unspent Capacity Fees	**$ 495,035,794**	**$413,556,965**	**$ 15,366,379**	**$ 4,300,216**	**$ 324,074**	**$433,547,634**	**$ 58,652,970**	**$ 2,179,346**	**$ 609,881**	**$ 45,962**	**$ 61,488,159**

1. Total beginning cash balance for FY2020/21 provided by District Staff. Source file: *2021 Reserve WS to Budget.pdf.*
2. Cash reserves are allocated proportionately in the same manner as existing assets (in total) in *Figure 4.*

Adjustments for Debt Principal. Since new development pay their share of existing asset values, including the debt payment principals on those same assets would double count the asset values included in the capacity fees. Therefore, future customers are credited approximately $69.8 million as shown in Figure 7.

Figure 7. Outstanding Water System Debt Principal

Description of Debt[1]	Principal Amount	$ - Allocation[2]									
		Existing Customers					Future Customers				
		Zone W-2	Zone W-5	Zone W-7	Zone W-8	Total Existing Customers	Zone W-2	Zone W-5	Zone W-7	Zone W-8	Total Future Customers
2016 Bonds	$ 181,530,000	$ 151,651,652	$ 5,634,863	$ 1,576,892	$ 118,838	158,982,246	$ 21,508,089	$ 799,168	$ 223,644	$ 16,854	$ 22,547,754
2016 COPs	71,585,000	59,802,697	2,222,066	621,836	46,863	62,693,461	8,481,554	315,146	88,192	6,646	8,891,539
2017 Bonds	47,750,000	39,890,742	1,482,205	414,789	31,259	41,818,995	5,657,529	210,215	58,828	4,433	5,931,005
2019 Bonds	126,615,000	105,775,210	3,930,249	1,099,863	82,888	110,888,211	15,001,634	557,410	155,989	11,756	15,726,789
2020 Bonds	92,650,000	77,400,571	2,875,944	804,821	60,653	81,141,988	10,977,383	407,882	114,144	8,602	11,508,012
2020 COPs	41,765,000	34,890,824	1,296,425	362,799	27,341	36,577,389	4,948,412	183,866	51,454	3,878	5,187,611
Total	**$ 561,895,000**	**$469,411,695**	**$ 17,441,753**	**$ 4,881,000**	**$ 367,843**	**$492,102,291**	**$ 66,574,601**	**$ 2,473,687**	**$ 692,251**	**$ 52,170**	**$ 69,792,709**

1. Source file: *WU Debt Service Schedule as of 03-29-22.xlsx.*
2. Outstanding debt is allocated proportionately in the same manner as existing assets (in total) in *Figure 4.*

DEVELOPMENT IMPACT FEE

The sum of the existing and future planned asset values (i.e., the system buy-in and system development costs), along with the adjustment for cash reserves and debt principals, defines the total cost basis allocated to future customers. The total adjusted cost basis is then divided by the projected water supply growth (in AF) expected to be developed through 2050. Figure 8 summarizes the adjusted cost basis allocated to future customers. Figure 9 shows the calculation of the water supply capacity fee by zone. As Figure 9 shows, there is a wide variance on what the fee would be by zone, driven by the small amount of projected water supply in every zone but Zone W-2.

Figure 8. Development of the Cost Basis for New Customers

System Asset Values Allocated to Future Development	Zone W-2	Zone W-5	Zone W-7	Zone W-8
System Buy-In and Expansion Components				
Existing System Buy-In[1]	$ 64,806,209	$ 7,802,861	$ 2,822,682	$ 21,078
Future System Expansion[2]	999,862,696	103,510,491	61,040,955	1,115,675
Subtotal: System Buy-In and Expansion Components	**$ 1,064,668,904**	**$ 111,313,352**	**$ 63,863,637**	**$ 1,136,752**
Adjustments to Cost Basis:				
Cash Reserves[3]	$ 58,652,970	$ 2,179,346	$ 609,881	$ 45,962
Outstanding Long-Term Debt (Principal)[4]	(66,574,601)	(2,473,687)	(692,251)	(52,170)
Subtotal: Adjustments to Cost Basis	**$ (7,921,631)**	**$ (294,341)**	**$ (82,370)**	**$ (6,208)**
Total: Cost Basis for New Development	**$ 1,056,747,273**	**$ 111,019,011**	**$ 63,781,267**	**$ 1,130,545**

1. Refer to Figure 4.
2. Refer to Figure 5.
3. Refer to Figure 6.
4. Refer to Figure 7.

Figure 9. Development of the Water Supply Capacity Fee

	Total Capacity Fee			
Capacity Fee Development	**Zone W-2**	**Zone W-5**	**Zone W-7**	**Zone W-8**
Cost Basis for New Development	$ 1,056,747,273	$ 111,019,011	$ 63,781,267	$ 1,130,545
Projected Water Supply (through 2050)[1]	49,650	1,845	516	39
Water Supply Capacity Fee (Per AF)[2]	**$21,300**	**$60,200**	**$123,500**	**$29,100**

1. Refer to Figure 1 for growth projections.
2. For example, if a typical single family household uses 0.4 acre feet of water per year, the capacity fee for Zone W-2 would be $8,520 ($21,300 x 0.4).

RECOMMENDATIONS

The District has the data required to prepare water development impact fees by zone. However, because the expected future water supply amounts are so insignificant in Zones W-5, W-7, and W-8 when compared to Zone W-2 supply, the water supply capacity fee tends to vary widely. If the District were interested in pursuing water supply capacity fees by zone, we would recommend further exploration of the cost allocations for Zones W-5, W-7, and W-8.

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