

## DRAFT Ross Valley Flow Reduction Study- Deliverable 2

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### Introduction

The Alternatives Analysis process currently underway by the County is a study to re-examine the elements within the Ross Valley Flood Control Program which reduce creek flow during large storms. The study does not re-examine the elements within the program which increase creek channel capacity. For purposes of this study, it is assumed all creek channel capacity elements of the Program remain as currently envisioned. This memorandum (Deliverable 2) is a continuation of the previous memorandum dated March 6, 2015 (posted to County website on March 13, 2015.)

The study includes the following major steps, summarized below and shown on Figure 1.

#### **Memorandum dated March 6, 2015 (posted to County website on March 13, 2015)**

1. Develop revised criteria as summarized below in Table 1.
2. Develop expanded list of potential flood control elements as summarized on Table 2 below.

#### **This Memorandum**

3. Apply fatal flaw criteria to potential flood control elements.
4. Apply evaluation site criteria to remaining flood control elements, tally the total score and rank them.
5. Assemble top ranking elements into program alternatives.

#### **Future Memoranda**

6. Test and rank the program alternatives using hydrologic modeling and the program evaluation criteria.

This Memorandum describes the results of Steps 3, 4 and 5.

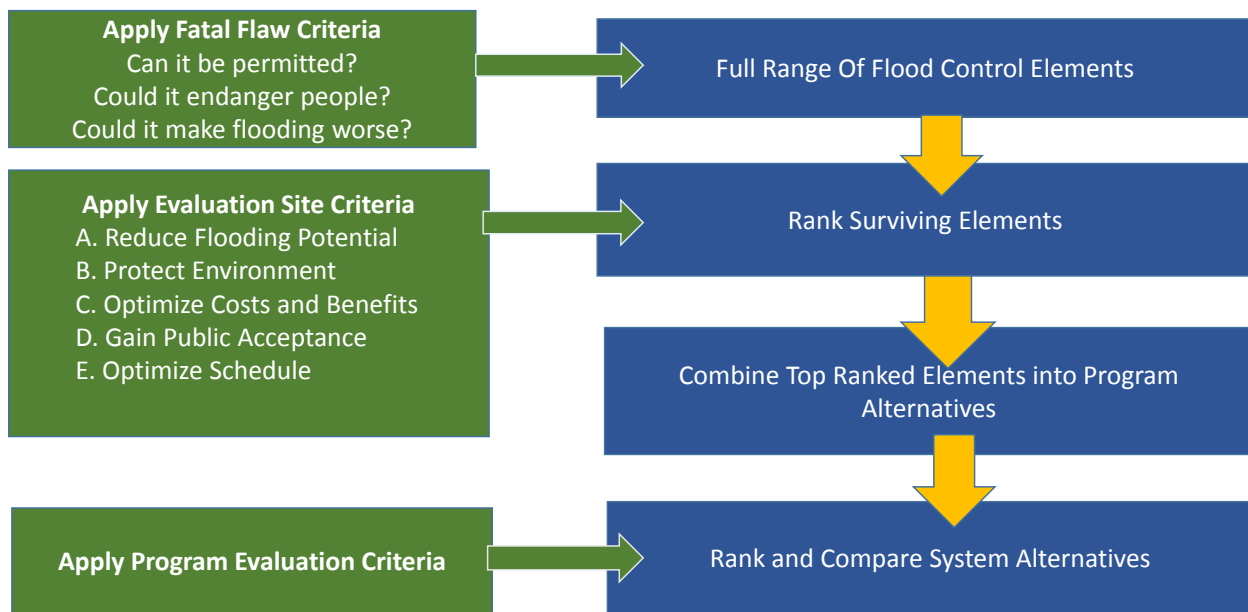


FIGURE 1  
Alternatives Analysis Process

## Development of Criteria

At the inception of the Program the following 5 criteria were used to identify locations for detention basins in the Ross Valley:

- Is in close proximity to Corte Madera Creek or a major tributary of Corte Madera Creek.
- Has the ability to reduce flooding at key flow breakout points along the creeks in Fairfax, San Anselmo, and Ross.
- Is open lands with few existing structures
- Has a current use that is compatible with storm water detention.
- Is publicly owned.

Using these 5 criteria and applying them to several sites, Phoenix Lake, Loma Alta, Lefty Gomez, Red Hill Park and Memorial Park were identified as top locations for detention basins in Ross Valley as documented in the Capital Improvement Plan Study for Flood Damage Reduction and Creek Management for Flood Zone 9/Ross Valley (Stetson Engineers 2011)

Subsequently, due to public comment on the Program, the County elected to revisit the selection Criteria and develop a more comprehensive set of Criteria. The revised set of criteria have been posted to the County's website ([www.marinwatersheds.org](http://www.marinwatersheds.org)) and were presented at the Zone 9 Flood Advisory Board meeting on March 17, 2015 and are shown along with the factors used to measure the criteria, in Table 1

As shown in Figure 1, there are three types of criteria 1) Fatal Flaw, 2) Site Evaluation, 3) Program Evaluation. Fatal flaw criteria are used to screen out alternatives that for a specific reason cannot meet the project objectives and should not be carried forward into the remainder of the analysis. Site evaluation criteria are applied to measure the effectiveness of various attributes of specific sites which will then be ranked based on their performance. Finally the highest ranked sites will be assembled into Program alternatives and the Program evaluation criteria will be applied to evaluate how the collection of sites work together to reduce flooding. The revised criteria fall into five major categories as shown in Table 1. To evaluate each of the criteria, a number of specific factors, shown beneath each criteria on Table 1, and metrics were identified.

TABLE 1  
**Criteria and Factors Used for Ross Valley Flood Control Study**

	Fatal Flaw	Site Evaluation	Program Evaluation
<b>A. Maximize Flood Reduction Benefit</b>			
A1. Maximize Flow Reduction Benefit			
○ Acre Feet of Flow Reduction Potential		X	X
○ Impact to Water Surface Elevation			X
○ Reduce Flooding Potential downstream of Ross			X
○ Frequency of Flooding Reduced			X
A2. Maximize Community Benefit			
○ Homes Removed from Floodplain			X
○ Improve Emergency Access Routes			X
○ Minimize Inland Flooding on Surface Streets			X
A3. Avoid Flooding Downstream			
○ Project increase flooding downstream of Ross	Fatal Flaw		X
<b>B. Protect Environment</b>			
B1. Minimize Environmental Impacts			
○ Potential to Increase Sediment Deposits Downstream		X	X
○ Inundation of Sensitive Habitat		X	X
○ Impacts to Endangered Species		X	X
○ Impacts to Fish Migration/Spawning Habitat		X	X
○ Vegetation Removal		X	X
○ Tree Removal along Creek		X	X
○ Concrete lining prevent groundwater recharge		X	X
B2. Maximize Environmental Enhancements			
○ Wetland Creation/Protection		X	X
○ Stream Restoration Potential		X	X
B3. Increase Ability to Obtain Permits			
○ Ability to Gain Permit Approvals	Fatal Flaw		X
<b>C. Optimize Costs and Benefits</b>			
C1. Minimize Local Economic Impacts			

**TABLE 1**  
**Criteria and Factors Used for Ross Valley Flood Control Study**

	Fatal Flaw	Site Evaluation	Program Evaluation
○ Impacts to Businesses		X	X
○ Temporary Loss of Revenue for Ball field leases		X	X
○ Impacts to Existing Improvements (artificial turf)		X	X
<b>C2. Minimize Operation and Maintenance Requirements</b>			
○ Passive vs. Active Operation		X	X
○ Require Pump Operations		X	X
○ Long Term O&M		X	X
○ Time to Restore Facility to Working Order		X	X
<b>C3. Maximize Construction Feasibility</b>			
○ Construction Accessibility		X	X
○ Restricted Working Windows During Year		X	X
○ Proximity of Temporary Staging Areas		X	X
<b>C4. Minimize Project Cost</b>			
○ Construction Cost		X	X
○ Right of Way Acquisition		X	X
<b>C5. Maximize Funding Opportunities</b>			
○ Conforms to current/near-term grant opportunities		X	X
○ Flood Zone 9 Fee Eligibility		X	X
<b>D. Optimize Public Benefit/Impacts</b>			
<b>D1. Address Public Concerns</b>			
○ Public Safety - operation near schools/parks		X	X
○ Public Safety - potential to trap people?	Fatal Flaw		
○ Maximize opportunities for recreational enhancements (parks and river trails)		X	X
○ Visibility and Aesthetics along Creek (private residential properties)-maintain creek living		X	X
○ Improve condition of parks		X	X
<b>D2. Minimize Inconvenience to the Public – Permanent Project</b>			
○ Ability to provide temporary facilities		X	X

TABLE 1  
**Criteria and Factors Used for Ross Valley Flood Control Study**

	Fatal Flaw	Site Evaluation	Program Evaluation
○ Residents affected by construction		X	X
○ Will temporary land/road closures be required during constructions		X	X
<b>D3. Minimize Inconvenience to the Public - Temporary</b>			
○ Permanent Loss of Parking		X	X
○ Negative Impacts to residential properties immediately adjacent to creek (river life)		X	X
○ Negative impacts to critical facilities (emergency response): fire, police, hospitals, city hall		X	X
<b>E. Optimize Schedule</b>			
<b>E1. Minimize Coordination Schedule/Requirements</b>			
○ Permanently Require Change in Land Use		X	X
○ School District Coordination Required		X	X
○ Division of Dam Coordination Required		X	X
○ Resources Agencies Required		X	X
○ Private Owner Coordination Required		X	X

## Application of Fatal Flaw Criteria

Fatal flaw criteria are intended to screen out alternatives, in this case flow reduction elements, that would not be able to meet the basic project objectives or are infeasible for specific reasons. For this analysis the following three fatal flaw criteria were identified and applied to the 30 elements listed in Table 2.

### A3. Avoid Flooding Downstream

- Potential to Increase Flow Downstream

### B3. Increase Ability to Obtain Permits

- (In)Ability to Gain Permit Approvals

### D1. Maximize Public Acceptance

- Public Safety – potential to trap people.

Applying these three criteria to the list of 30 (25 new plus 5 original) flood control elements resulted in the elimination of the following elements:

- **K. Underground Parking Detention.** *This element did not survive Fatal Flaw Criteria D1.* It has the potential to trap people underground in a flash flood event and is considered to be too high of a public safety risk.
- **U. Detention Facilities on Cascade Creek.** Cascade Creek has been identified as providing spawning grounds for the federally threatened Steelhead trout (*Oncorhynchus mykiss*) and is sometimes referred

to as the “nursery” for steelhead in the Corte Madera Creek watershed. According to at least one study (AAR 2000), upper Cascade Creek offers the best trout habitat of the entire Corte Madera Creek system. Given the threatened status of this species and the multiple efforts underway to restore Steelhead trout, Chinook and Coho in this system and the high value of the habitat that Cascade Creek offers, it is anticipated that securing permits from either the State or Federal Fish and Wildlife agencies would be extremely difficult if not impossible. ***For this reason this element did not survive Fatal Flaw Criteria B3.***

- **W2. Marin Town Country Club Cistern.** The cistern could be prohibitively expensive to build and also has the potential to trap maintenance workers within confined spaces. ***This element was also dropped from further consideration as it does not survive Fatal Flaw Criteria D1.***
- **W3. Marin Town Country Club (Underground parking) is eliminated based on Fatal Flaw Criteria D1.**

### Application of Site Evaluation Criteria

As shown on Table 2, each of the remaining alternatives were scored and rated against the site evaluation criteria.

TABLE 2  
**Summary of Application of Fatal Flaw and Site Evaluation Criteria to Potential Ross Valley Flood Control Elements**

Alternative	Eliminated Due to Fatal Flaw	Ranking from Site Evaluation	Total Score from Site Evaluation
<b>Alternative Conveyance</b>			
A. Channel Widening through San Anselmo		20	507
B1. Bypass Conduit through San Anselmo along Cedar Street		23	500
B2. Bypass Conduit through San Anselmo Along San Anselmo Avenue		22	502
C. Bypass Conduit through Ross		25	491
D. Bypass Conduit through Fairfax		24	494
E. Setback levels at A.E. Kent Middle School		28	398
F. Setback Levees at Hal Brown@ Creekside Park		27	431
G. Utilize surface streets for conveyance		21	505
<b>Sound Development Practices</b>			
H. Purchase and removal of flood prone properties		26	461
I. Flood proofing		18	521
J. Implement Low Impact Development provisions		16	542
<b>Other Storage Ideas</b>			
K. Underground Parking detention	X	N/A	N/A
<b>Detention Basins</b>			

**Fairfax Creek Watershed upstream of Fairfax**

TABLE 2  
**Summary of Application of Fatal Flaw and Site Evaluation Criteria to Potential Ross Valley Flood Control Elements**

Alternative	Eliminated Due to Fatal Flaw	Ranking from Site Evaluation	Total Score from Site Evaluation
L. Bothin Park Youth Center		5	581
M. Nursery near Baywood Canyon Drive and SFD Blvd		4	611
N. Manor Elementary School		14	553
<b><i>Sleepy Hollow Creek Watershed</i></b>			
O. Hidden Valley Elementary School		10	568
P. Brookside Elementary School		12	564
Q1. San Domenico School Upstream		6	580
Q2 San Domenico Ball Field		15	551
<b><i>San Anselmo Creek Watershed above Fairfax</i></b>			
R. Deer Park		3	611
S. Marin Stables (Woodland Horse Stables)		13	564
T. Pine Mountain Tunnel		19	521
U. Detention Facilities Along Cascade Creek	X	N/A	N/A
V. Camp Tamerancha Lake		17	537
<b><i>San Anselmo Creek Watershed below Fairfax</i></b>			
W1. Marin Town and Country Club Detention Pond		8	572
W2. Marin Town Country Club Cistern (underground storage)	X	N/A	N/A
W3. Marin Town Country Club Underground Parking/Storage	X	N/A	N/A
<b><i>Original Program Sites</i></b>			
1. Loma Alta		11	565
2. Lefty Gomez		7	573
3. Memorial Park		2	620
4. Phoenix Lake		1	710
5. Red Hill		9	569

NOTE: Any potential alternative on private property that is pursued will necessitate negotiations with the landowner to obtain an easement or similar right enabling the project to be built and maintained. There are no plans, and none is expected, to exercise eminent domain powers in connection with any of the alternatives described herein.

The following three Program evaluation criteria and 7 bulleted factors, shown on Table 1, were not applied to individual sites at this stage in the evaluation. These criteria will be applied after multiple sites are grouped into program alternatives which can then be evaluated as a system to reduce flooding.

**A1. Maximize Flood Reduction Benefit**

- Impact to Water Surface Elevation
- Reduce Flooding Potential in Corte Madera Creek d/s of Ross
- Reduce Frequency of Flooding

**A2. Maximize Community Benefits**

- Homes Removed from Floodplain
- Improve Emergency Access Routes
- Minimize Inland Flooding on Surface Streets

**A3. Avoid Flooding Downstream**

- Minimize Flooding Downstream of Ross

**Weighting**

When applying criteria to a set of alternatives, it is important to weight the criteria based on the relative importance of each of the criteria. The weighting should reflect a combination of the overall project objectives, the values of the community and the various requirements to complete the project (i.e. funding, permissibility). In this instance, the overall project objective to maximize flow reduction has the highest weighting (5). The proposed weighting structure for the remaining criteria is shown below:

1. Maximize Flow Reduction – Critical Success of Project (5)
2. Protect Environment – Very Important to Success of Project (4)
3. Optimize Costs and Benefits – Very Important to Consider (3)
4. Optimize Public Benefit/Impacts – Very Important to Consider (3)
5. Optimize Schedule - Important to Consider (2)

**Results**

The results of applying the fatal flaw and site evaluation criteria are shown in Table 2 and Table 3. Table 2 shows the Alternatives grouped by category (i.e. Detention basins, Alternative Conveyance). Table 3 shows them in ranked order. Table 3 also shows the scoring by criteria for each alternative. As can be seen, of the original 4 detention basins in the Baseline Measures, all remain in the top 11 of ranked sites with Phoenix Lake the top performer by a significant amount and Memorial Park ranked second. Additionally, 5-6 sites were identified that may perform nearly as well as the original sites.

Of the 30 elements evaluated, there are 3 that are not site specific and are considered “sound development policies”, including:

1. Purchase and removal of flood prone properties
2. Flood proofing
3. Implement Low Impact Development (LID) provisions

It is recommended that these three elements be carried forward into the overall Ross Valley Flood Protection and Watershed Management Program as policies to be considered for implementation by either the county and/or local jurisdictions. For instance, local land use jurisdictions could elect to require the use of LID best management practices for new or remodeled construction. Flood proofing or purchase of properties could be used to address areas impacted by particularly acute flooding conditions on case-by-case basis.



## Developing Program Alternatives

The next step is to group the highest ranked elements into Program Alternatives. Initially, three program alternatives will be developed that:

- a) are anticipated to meet flow targets throughout the basin (Shown on Figure 2)
- b) distribute flow detention upstream of key flooding locations throughout the watershed, and
- c) include a range of the top ranked detention basin sites.

The flow targets shown on Figure 2 reflect required flow rates to obtain the 100 year containment of flow at key locations throughout the watershed assuming that the channel improvements in the Capital Improvement Plan (CIP) are constructed. These flow rates are targets that will drive the selection and sizing of detention facilities. For the Project the following key locations were identified.

1. Maximum 100 year flow of 1,100 CFS at the Fairfax Town Hall
2. Maximum 100 year flow of 4,540 CFS at Sycamore Bridge in San Anselmo
3. Maximum 100 year flow of 5,540 CFS at the USGS Gage at Ross.

This final flow rate, 5,540 cfs, matches the proposed design flow rate for the USACE Unit 4 project on Corte Madera Creek. The flow rates identified above reflect the need for detention to eliminate out of channel flows assuming all channel improvements are implemented. Performance against these target flow rates will be measured under Criteria A. Maximize Flood Reduction Benefit.

The program alternatives will be modeled using the hydrologic/hydraulic basin model developed by Stetson Engineers to assess how they perform against the Program evaluation criteria. If necessary, the alternatives will be refined and re-evaluated so that top performing alternatives can be identified. The three top alternatives will be evaluated and compared against the original proposed detention basins on public property. Each of the three combined program alternatives will address different program concerns so decision makers can evaluate the relative benefits and approximate costs of each program alternative. The proposed three categories of program alternatives are as follows:

1. Alt 1 - The Highest Ranking Elements (based on individual element scores)
2. Alt 2 – The San Anselmo Option (compare flood protection for Sleepy Hollow Creek vs. Sorich Creek, Alternative 1 vs. Alternative 2)
3. Alt 3 – Most Environmentally Friendly (no detention basins in protected spaces or reserves)

Proposed program alternatives for the first iteration of hydraulic modeling are shown on Table 4.

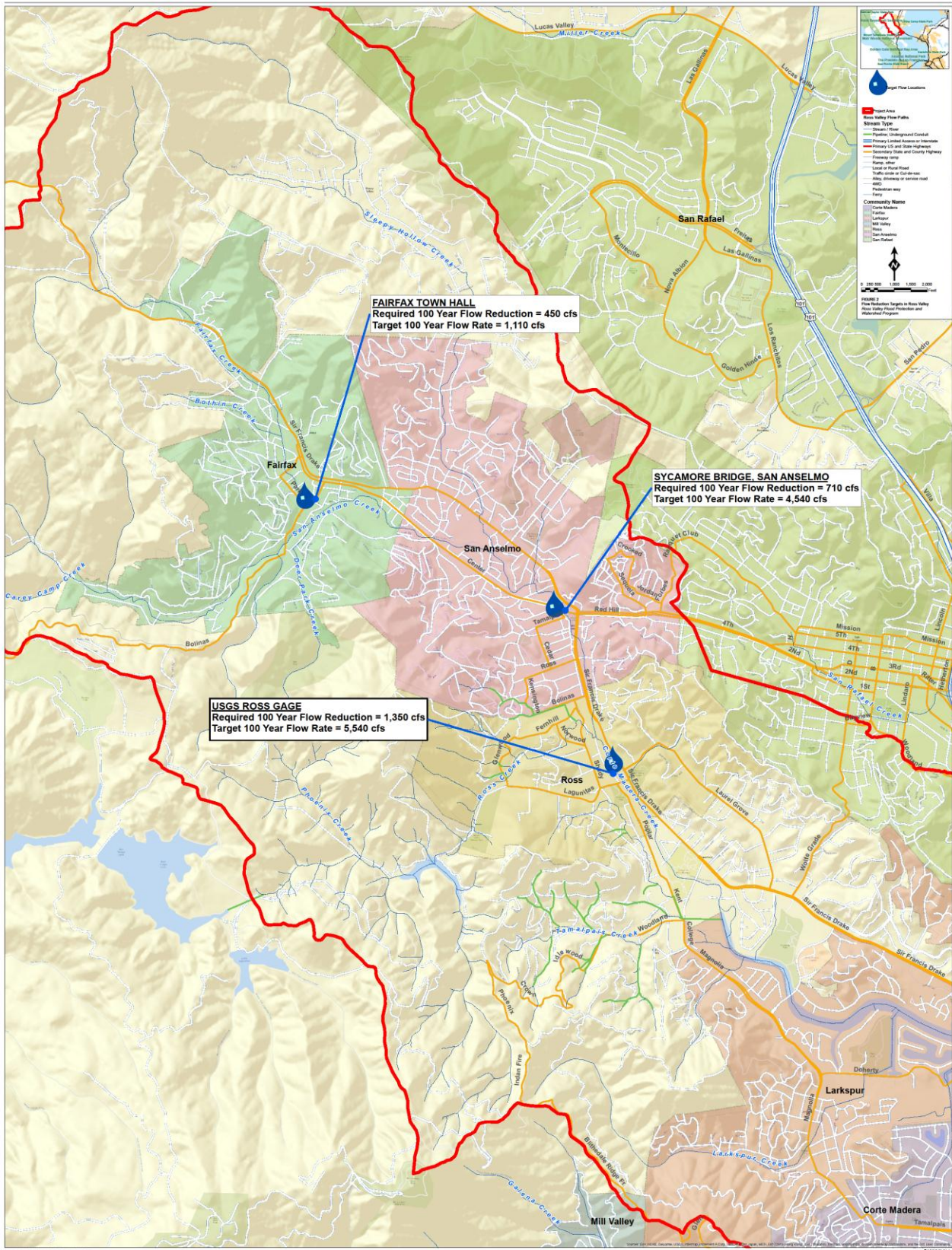


FIGURE 2  
Flow Reduction Targets in Ross Valley

TABLE 3  
Summary of Criteria Ratings and Ranking of Elements

Alternative Designator	Alternative Name	Criteria													Total Score	Ranking
		A1 Maximize Flood Reduction Benefit	B1 Minimize Environmental Impacts	B2 Maximize Environmental Enhancements	B3 Increase Ability to Obtain Permits	C1 Minimize Local Economic Impacts	C2 Minimize Operation and Maintenance Requirements	C3 Maximize Construction Feasibility	C4 Minimize Project Cost	C5 Maximize Funding Opp	D1 Maximize Public Acceptance	D2 Minimize Inconvenience to Public - Permanent Project	D3 Minimize Inconvenience to Public – Temp.	E1 Minimize Coordination/Schedule Requirements		
4	Phoenix Lake	150	82	24	80	54	33	34	52	54	47	48	33	19	710	1
3	Memorial Park	74	85	48	80	48	30	30	49	54	43	36	26	18	620	2
R	Deer Park	64	78	72	80	54	30	16	52	36	43	42	31	13	611	3
M	Nursery near Baywood Canyon Dr. and SFD Blvd.	69	78	72	80	54	30	28	42	36	47	36	28	11	611	4
L	Bothin Park Youth Center	83	66	72	60	36	30	36	39	36	40	42	27	14	581	5
Q1	San Domenico School Upstream	64	78	48	80	54	27	28	43	36	29	48	34	11	580	6
2	Lefty Gomez	78	89	24	80	48	30	28	40	36	43	36	27	13	573	7
W1	Marin Town and Country Club Detention Pond	133	91	24	80	36	30	32	12	36	40	30	19	10	572	8
5	Red Hill Park	56	85	36	80	36	30	30	54	45	36	36	28	18	569	9
O	Hidden Valley Elementary School	58	91	24	80	48	27	28	53	36	43	42	23	14	568	10
1	Loma Alta	55	64	72	60	54	30	24	53	36	40	36	29	11	565	11
P	Brookside Elementary School	53	91	24	80	48	27	28	45	45	43	42	23	14	564	12
S	Marin Stables (Woodland Horse Stables)	54	64	72	80	36	30	24	45	36	47	36	26	14	564	13
N	Manor Elementary School	56	91	24	80	48	27	28	44	36	43	36	26	13	553	14
Q2	San Domenico Ball Field	53	87	24	80	48	27	28	45	36	43	42	23	14	551	15
J	Implement Low Impact Development Provisions	0	87	24	120	42	32	32	52	27	36	42	27	22	542	16
V	Camp Tamerancha Lake	57	78	24	80	48	30	24	44	36	40	36	29	11	537	17
I	Flood Proofing	0	91	24	120	30	27	36	50	27	29	42	24	21	521	18
T	Pine Mountain Tunnel	50	69	24	80	54	27	20	45	28	36	42	36	11	521	19
A	Channel Widening through San Anselmo	0	69	72	60	42	33	24	45	36	47	36	26	18	507	20

TABLE 3  
**Summary of Criteria Ratings and Ranking of Elements**

Alternative Designator	Alternative Name	Criteria													Total Score	Ranking
		A1 Maximize Flood Reduction Benefit	B1 Minimize Environmental Impacts	B2 Maximize Environmental Enhancements	B3 Increase Ability to Obtain Permits	C1 Minimize Local Economic Impacts	C2 Minimize Operation and Maintenance Requirements	C3 Maximize Construction Feasibility	C4 Minimize Project Cost	C5 Maximize Funding Opp	D1 Maximize Public Acceptance	D2 Minimize Inconvenience to Public - Permanent Project	D3 Minimize Inconvenience to Public – Temp.	E1 Minimize Coordination/Schedule Requirements		
G	Utilize Surface Streets for Conveyance	0	73	24	120	48	33	32	41	27	32	30	21	24	505	21
B2	Bypass Conduit through San Anselmo along San Anselmo Avenue	0	73	24	100	48	36	30	32	36	36	42	24	21	502	22
B1	Bypass Conduit through San Anselmo along Cedar St.	0	73	24	100	48	36	30	30	36	36	42	24	21	500	23
D	Bypass Conduit through Fairfax	0	73	24	100	48	36	30	33	27	36	42	24	21	494	24
C	Bypass Conduit through Ross	0	73	24	100	48	36	30	30	27	36	42	24	21	491	25
H	Purchase and Removal of Flood Prone Properties	0	82	24	120	30	36	36	9	27	29	30	24	14	461	26
F	Setback Levees at Hal Brown @ Creekside Park	0	73	48	60	48	26	28	21	27	29	30	24	18	431	27
E	Setback Levees at A.E. Kent Middle School	0	73	48	60	30	26	28	12	27	29	30	21	14	398	28

TABLE 4

**Proposed Program Alternatives**

			Alternative 0	Alternative 1	Alternative 2	Alternative 3
	Ranking By Watershed	Storage Capacity (Acre- Feet)*	Current Program	Highest Ranking Element in Each Watershed	San Anselmo Option	Most Enviro. Friendly
<b>Detention Basins By Ranking Within Watersheds</b>						
<b>Fairfax Creek Watershed above Fairfax</b>						
Bothin Park Youth Center	5	106		X	X	
Nursery near Baywood Canyon Drive and SFD	4	65		X	X	X
Lefty Gomez	7	92	X			X
Loma Alta	11	25	X			
<b>Sleepy Hollow Creek Watershed</b>						
Upstream of the San Domenico School	6	52			X	
Hidden Valley Elementary School	10	33				
Brookside Elementary School	12	18.5				
<b>San Anselmo Creek Watershed above Fairfax</b>						
Deer Park	3	52		X	X	X
Marin Stables (Woodland Horse Stables)	13	21				
<b>San Anselmo Creek Watershed below Fairfax</b>						
Marin Town Country Club Detention Pond	8	250				
<b>San Anselmo Creek at San Anselmo</b>						
Memorial Park	2	80	X	X		X
Red Hill Park	9	28	X			
<b>Ross Creek above Ross</b>						
Phoenix Lake	1	300	X	X	X	X
Total Potential Storage Capacity of Alternative (Target >550 Acre-Feet of Storage)			525	603	575	589
<b>Sound Development Practices For All Program Alternatives</b>						
Flood Proofing				X	X	X
LID Development				X	X	X
Purchase and Removal of High Priority Flood Prone Properties				X	X	X
<b>Creek Improvement Measures</b>			<b>X</b>	<b>X</b>	<b>X</b>	<b>X</b>