

Identifying Local Flood Risk Reduction Projects with a High Benefit-Cost Ratio in Placerville, California



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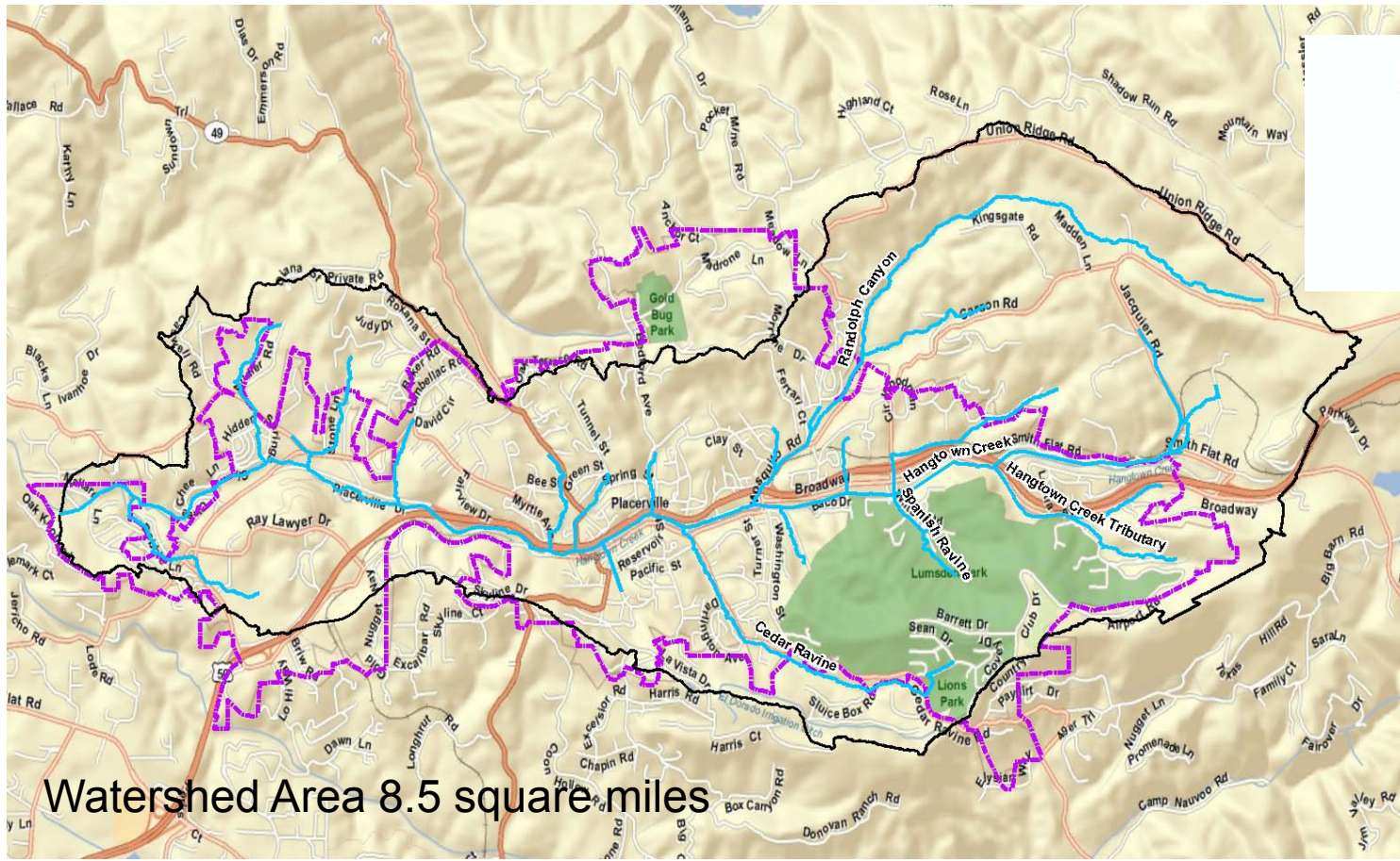
Special Thanks: Nate Stong, PE
City Engineer
City of Placerville

Introduction

- Flood Risks in the City of Placerville
 - City Development Occurred during California Gold Rush
 - Challenges facing the City
 - Hangtown Creek
 - Central Business District
 - Historic Buildings



Study Area



At-Risk Buildings



At-Risk Buildings



At-Risk Buildings



Historical Flooding



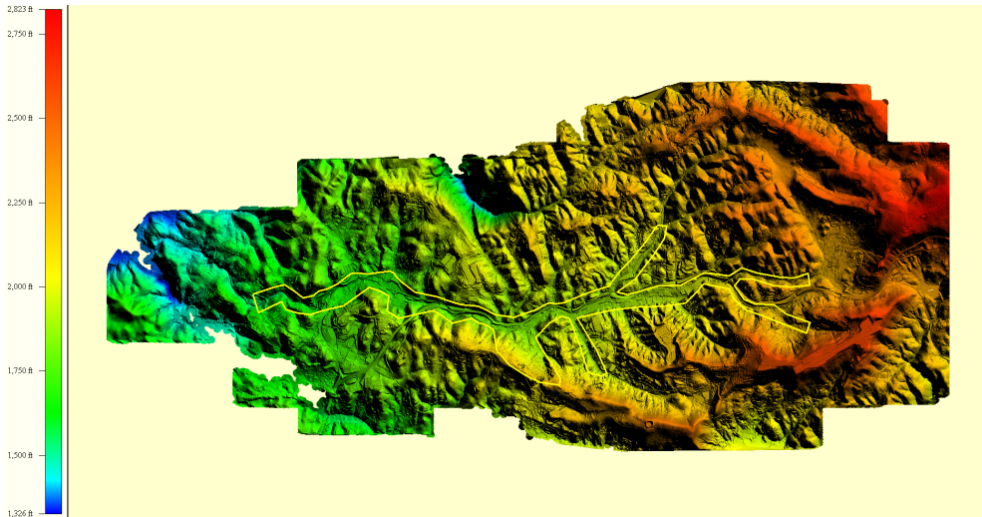
December 31, 2005 – about a 10-year event

Hangtown Creek Comprehensive Watershed Plan

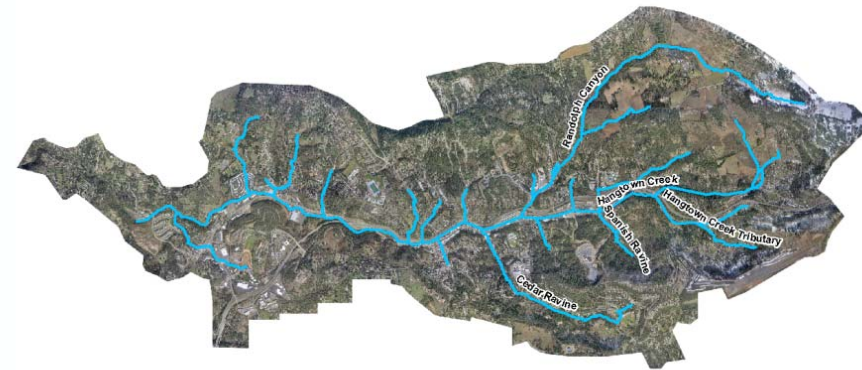
- Obtain new topography and aerial photography of the City and watershed
- Compute flow rates for the Hangtown Creek watershed
- Determine flood depths along Hangtown Creek
- Investigate the feasibility of projects to reduce flood risks



Aerial and LiDAR Survey Data Collection

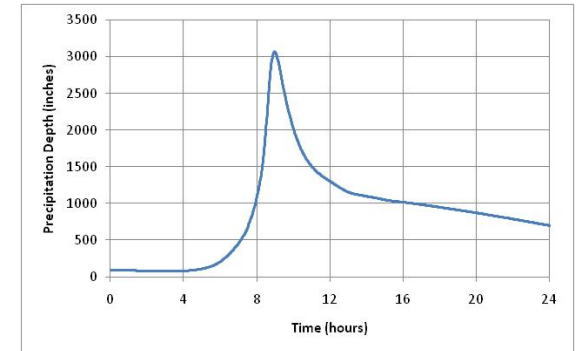
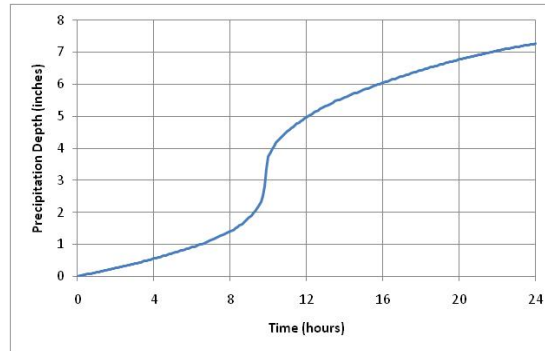
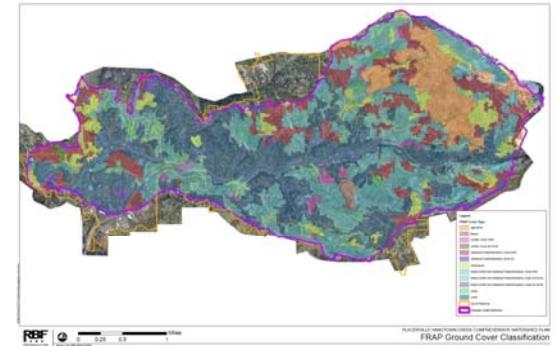
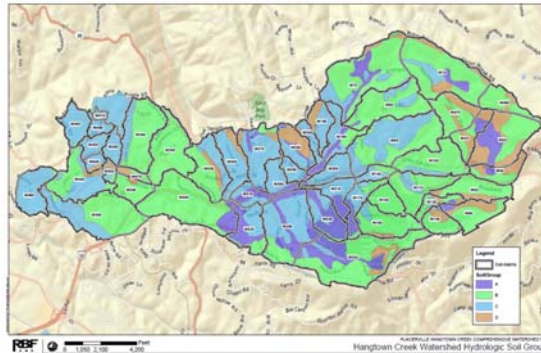


LiDAR Data

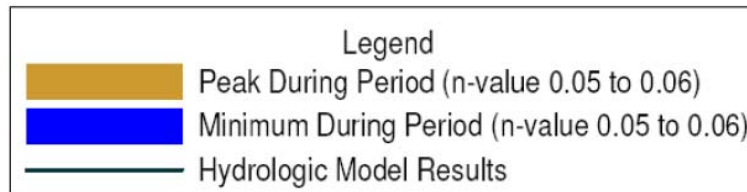
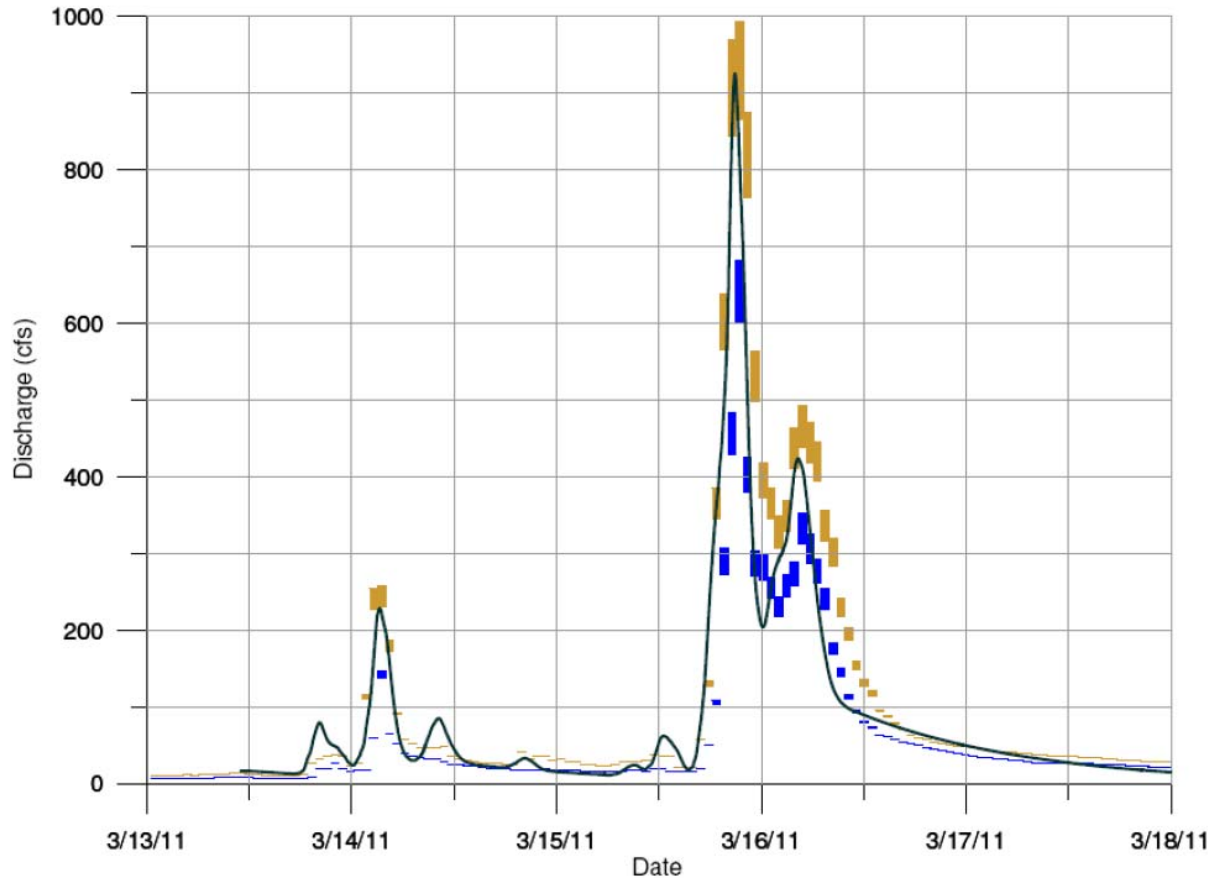


6-inch color orthoimagery

Watershed Delineation → Soil Data → Ground Cover Data →



Hydrologic Model Validation

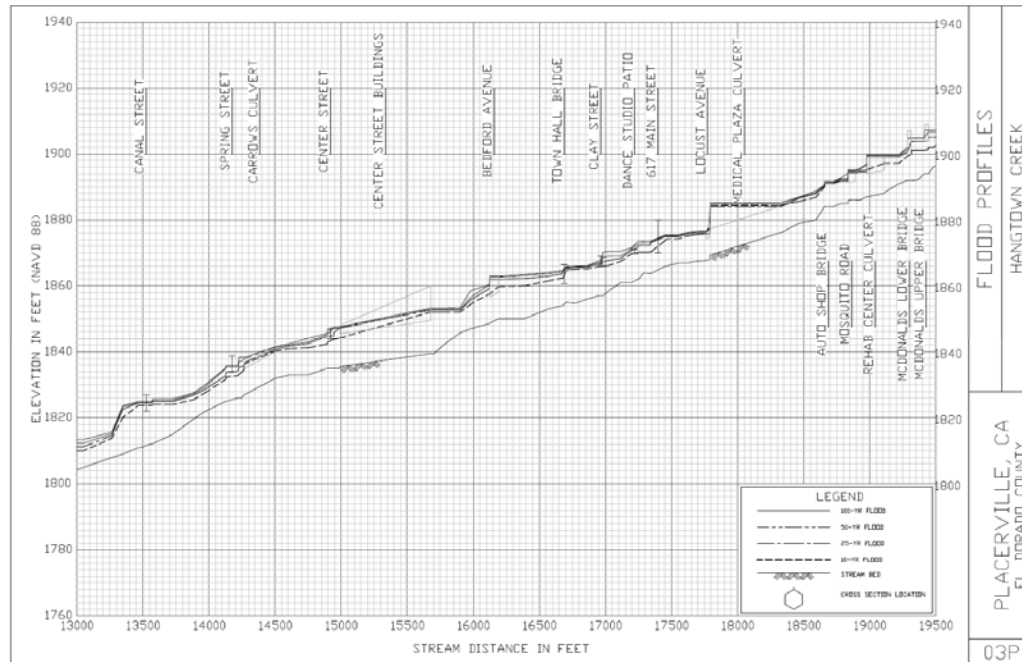


Discharges at Key Locations from Current and Previous Studies

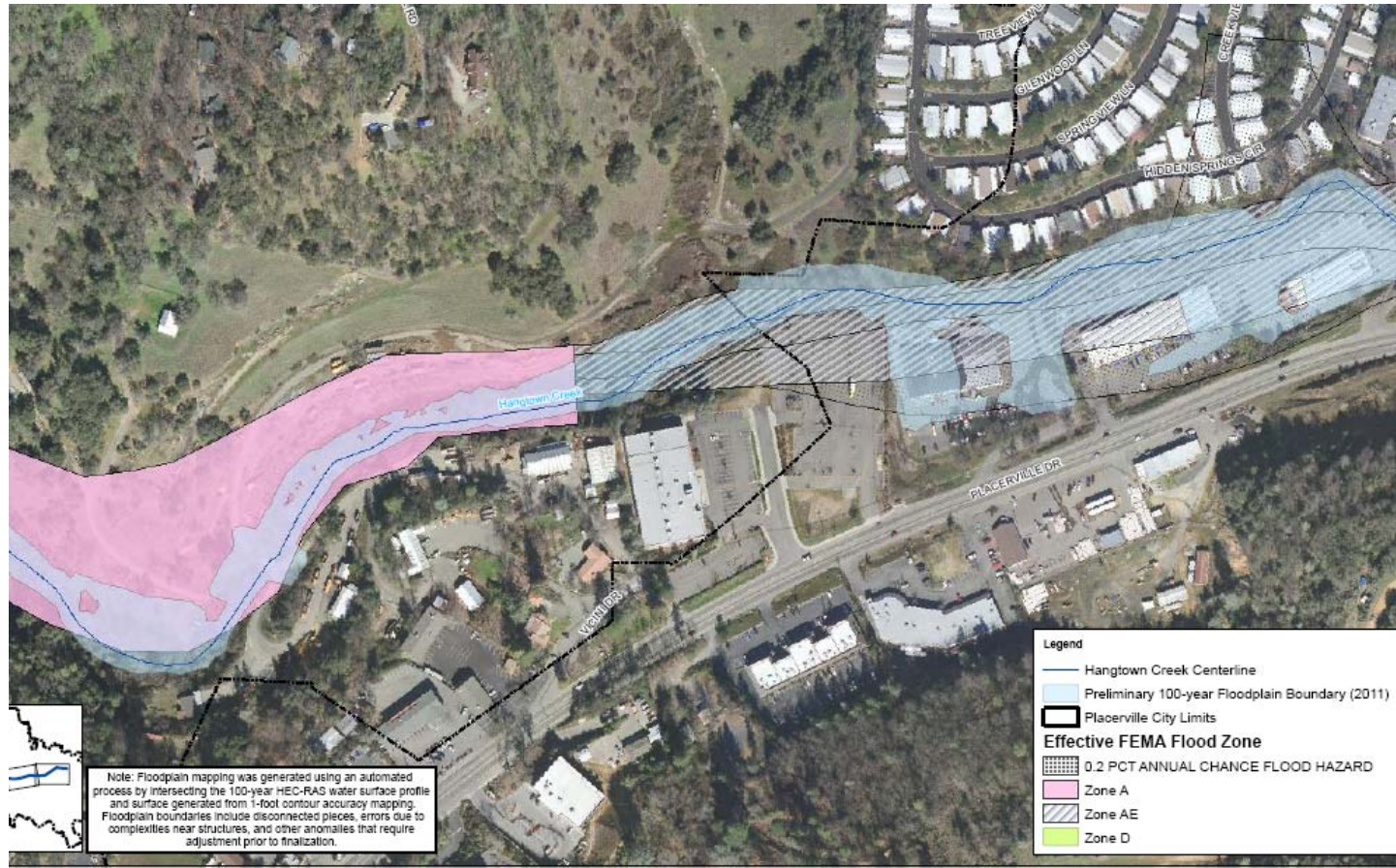
Description	HMS Node	Tributary Area (sq. mi)			10 year			25 year			50 year			100 year		
		RBF	FEMA	DA	RBF	FEMA	DA	RBF	FEMA	DA	RBF	FEMA	DA	RBF	FEMA	DA
Near Upstream end of Hangtown creek	J72	1.56	1.6	-	496	270	-	645	-	-	755	410	-	864	490	-
Broadway and Mosquito Road	J56	2.79	-	-	855	-	996	1115	-	-	1306	-	-	1495	-	1850
From Randolph Canyon	J104	4.57	4.7	-	1205	760	-	1599	-	-	1890	1140	-	2180	1380	-
From Cedar Ravine	J33	5.55	5.6	-	1385	1000	1750	1839	-	-	2174	1540	-	2508	1870	3219
Main Street and Sacramento Street	J18	7.80	8	-	1947	1580	-	2568	-	-	3027	2410	-	3483	2920	-
Downstream end of Hangtown creek	J30	8.56	-	-	2102	-	-	2769	-	-	3261	-	-	3749	-	-

Flood Profiles

- Flood profiles for 10-, 25-, 50- and 100-year storm events

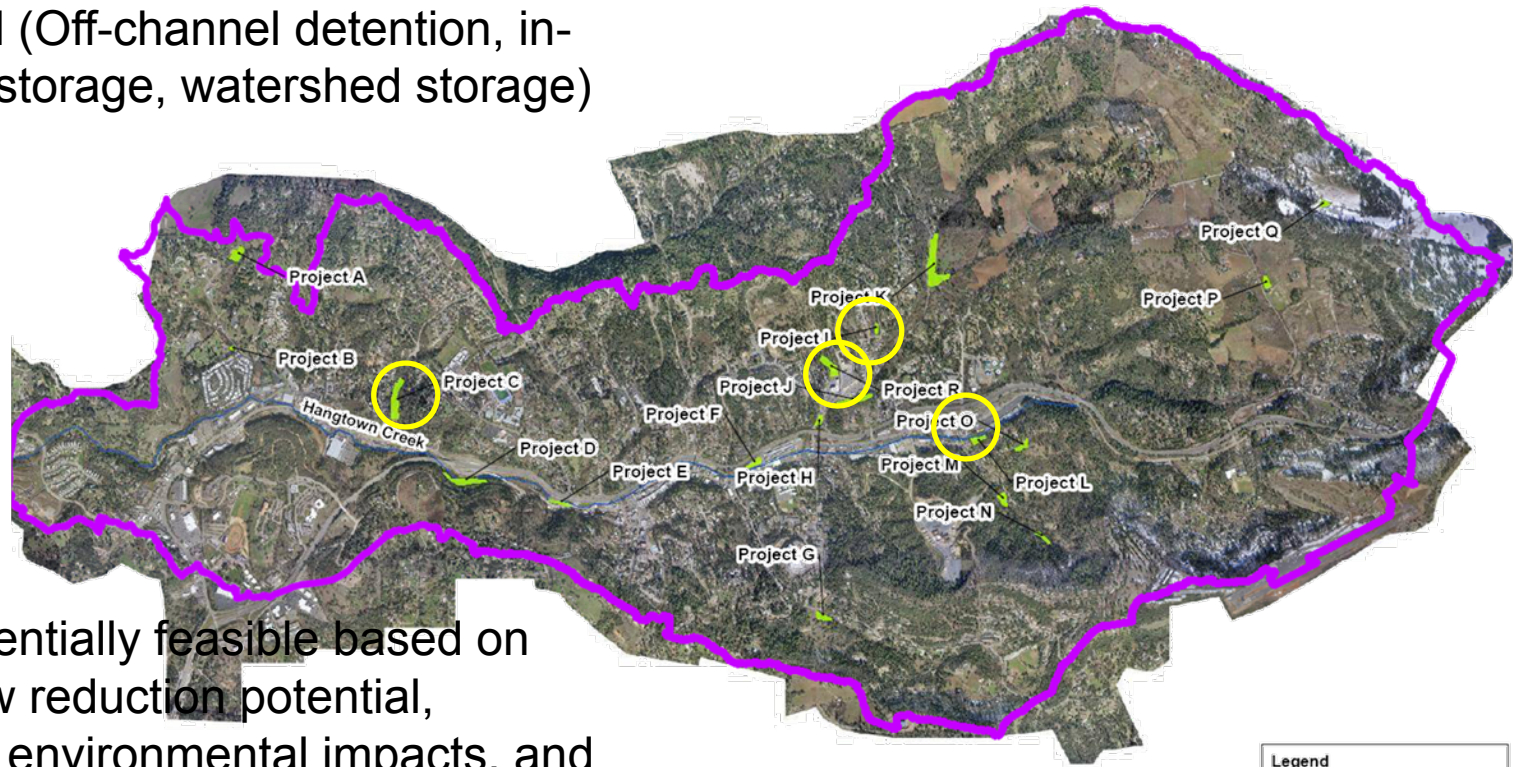


New vs. Old Floodplains



Evaluation of Potential Flood Damage Reduction Projects

- Eighteen potential project locations identified (Off-channel detention, in-channel storage, watershed storage)



- Four potentially feasible based on peak flow reduction potential, potential environmental impacts, and projected costs



Potentially Feasible Projects

Id	Location	100-year Flow Reduction	Limiting Factor
C	Placerville Dr behind Polaris	100 cfs	Benefits small number of downstream properties
I	Between Morrene Dr & Hawks Landing Ct	50 cfs	Storage capacity limited by existing development
L	Upstream from Wiltse Rd	100 cfs	Topographical constraints
R	Behind El Dorado Irrigation District Bldg	50 cfs	Limited tributary area & potential embankment height

Potential Project I

Looking Upstream



Potential Project L

Looking Upstream



Looking Downstream



Potential Project M

Looking Upstream



Looking Downstream



HEC-FDA

- Tool to Quantify Flood Damage Reduction Benefit (\$)
- Flows from HEC-HMS model
- HEC-RAS water surface profiles for 10, 25, 50, 100 year events
- Finished Floor Elevations of 250 structures from LiDAR and field investigation
- FEMA Depth-Damage curves
- Structure Value Estimates from County Assessor



HEC-FDA

Placerville_HTC - Study Water Surface Profiles

Plan: Without Stream: Hangtown Cr
Analysis Year: 2011
Profile: 2011 HTCreek Use An Existing Profile
Description: 2011 Hangtown Creek Base Profile Notes... Save Cancel

Discharge-Probability		Stage-Probability	
Station	Invert Stage	0.75 Q (cfs)	0.5 Stage (ft.)
1	24688.910	2024.00	496
2	24658.910	2021.00	496
3	24613.440	2015.00	496
4	24523.360	2013.00	496
5	24402.060	2009.00	496
6	24260.860	2004.00	496
7	24108.300	1997.42	496
8	24041.050	1995.00	496
9	23986.900	1993.00	496
10	23778.460	1987.00	496
11	23755.080	1987.00	496
12	22539.420	1945.87	496
13	22495.130	1947.76	496
14	22458.680	1945.98	496
15	22422.370	1944.91	496
16	22376.300	1945.37	496
17	22331.660	1943.55	496
18	22262.880	1941.50	496
19	22107.410	1938.00	740
20	22021.460	1935.95	740
21	21967.290	1935.00	740
22	21880.370	1933.00	740
23	21750.300	1932.15	740
24	21675.330	1931.00	740
25	21438.460	1929.00	740
26	21163.700	1922.00	740
27	20973.320	1919.00	814
28	20940.030	1919.00	814
29	20856.910	1916.00	814
30	20781.520	1916.00	814
31	20755.860	1915.00	814
32	20737.970	1915.00	814

Placerville_HTC - Exceedance Probability Functions with Uncertainty

Plan: Without Stream: Hangtown Cr
Analysis Year: 2011 Damage Reach: HTC01
Function: EP01 Use
Description: EP01
Type: Analytical... Graphical... Function Statistics... Plot...

Exceedance Probability	Discharge (cfs)	Confidence Limit Curves			
		95%	75%	25%	
0.9990	224	142	190	25	
0.9900	323	223	282	36	
0.9500	450	336	405	49	
0.9000	539	418	491	58	
0.8000	674	545	622	72	
0.7000	793	657	738	84	
0.5000	1,041	895	976	111	
0.3000	1,374	1,172	1,285	147	
0.2000	1,630	1,378	1,516	176	
0.1000	2,072	1,713	1,906	227	
0.0400	2,886	2,153	2,434	300	
0.0200	3,184	2,493	2,853	361	

Placerville_HTC - Stage-Damage Function at Max Location with Uncertainty

Plan: Without Stream: Hangtown Cr
Analysis Year: 2011 Damage Reach: HTC43
Damage Category: COM
Function: AggDmg013303 Use An Existing Function
Description: AggDmg013303
Define Uncertainty: None Normal Triangular Log Normal

Stage (ft.)	Damage (\$1,000s)	Standard Deviation of Error
1942.50	0.00	0.00
1943.00	0.00	0.00
1943.50	5.51	0.00
1944.00	21.24	0.00
1944.50	48.37	0.00
1945.00	95.67	0.00
1945.50	157.09	0.00
1946.00	237.94	0.00
1946.50	333.03	0.00
1947.00	451.24	0.00
1947.50	590.01	0.00
1948.00	745.08	0.00
1948.50	914.99	0.00
1949.00	1101.92	0.00
1949.50	1304.16	0.00
1950.00	1516.00	0.00

Placerville_HTC - Structure Inventory

Stream Station	Structure Value (\$1,000's)	Content Value (\$1,000's)	Other Value (\$1,000's)	First Floor Stage (ft.)
541 PLACERVILLE	7699.462	331.50	30.00	1689.88
574 PLACERVILLE	7699.462	476.91	30.00	1689.35
583 PLACERVILLE	7860.837	33.13	30.00	1692.97
611 PLACERVILLE	8156.012	213.84	30.00	1695.96
615 PLACERVILLE	8156.012	85.81	30.00	1698.94
621 PLACERVILLE	8156.012	95.60	30.00	1703.47
600 PLACERVILLE	8276.441	2000.00	30.00	1707.94
640 PLACERVILLE	8904.298	108.10	30.00	1701.00
St. 6972.1006	8972.101	0.00	30.00	1712.56
St. 9147.7637	9147.764	878.59	30.00	1715.56
680 PLACERVILLE	9424.716	420.20	30.00	1723.42
696 PLACERVILLE	9844.364	562.87	30.00	1744.78
St. 12750.654	12750.654	80.00	30.00	1798.93
73 MAIN ST	13531.643	346.74	30.00	1820.66
705 CANAL ST	13640.203	253.98	30.00	1846.04
72 MAIN ST	13640.203	155.86	30.00	1825.95
76 MAIN ST	13640.203	98.14	30.00	1826.20
78 MAIN ST	13789.454	63.83	30.00	1823.00
86 MAIN ST	13950.005	79.30	30.00	1823.84

Equivalent Annual Damage Analysis

Placerville_HTC
Equivalent Annual Damage Reduced and Distributed by Plans
(Damage in \$1,000's)
Discount Rate: 7.625
Analysis Period: 50 Years

Plan Description	Equivalent Annual Damage			Probability Dam Exceeds Indic	
	Total Without Project	Total With Project	Damage Reduced	.75	.50
Without project condition	1406.42	1406.42	0.00	0.00	
With Detention Basin near Orcl	1406.42	1389.93	16.49	12.39	
Plan added during import of W/s	1406.42	1363.80	42.62	37.12	
Plan added during import of W/s	1406.42	1369.44	36.99	31.24	
Plan added during import of W/s	1406.42	1314.79	91.63	76.06	

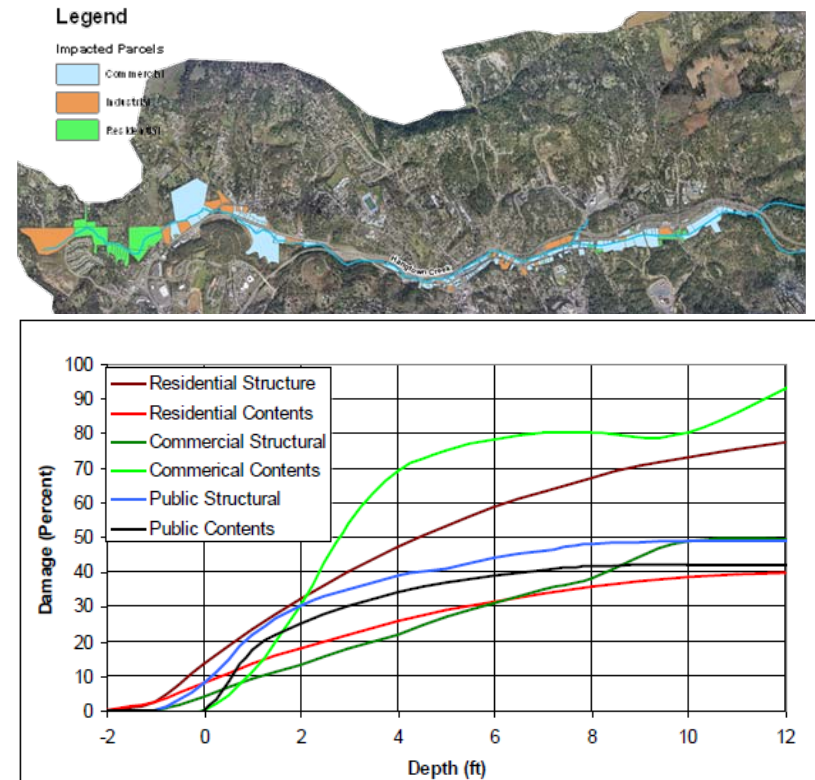
Food Damage Analysis

File Configure HydEng Economics View Evaluation Help

Current Study:
File Name: cuments and
Title: Placerville_HTC
Description:

Project Benefit Analysis

- Estimate of damage with and without each and all four projects
- Parcels with structures impacted by 100-yr floodplain (250 structures)
- Finished floor elevation from LiDAR and field estimates



Hydrologic Event	Event Probability	Event Damage Existing Conditions	Event Damage With Project I or R	Project I or R Event Benefit	Event Damage With Projects C, I, L, R	Projects C, I, L, R Event Benefit
10-year	0.10	\$ 4,202,000	\$ 4,105,000	\$ 97,000	\$ 3,955,000	\$ 247,000
25-year	0.04	\$ 6,445,000	\$ 6,336,000	\$ 109,000	\$ 6,062,000	\$ 383,000
50-year	0.02	\$ 7,696,000	\$ 7,613,000	\$ 83,000	\$ 7,336,000	\$ 360,000
100-year	0.01	\$ 9,278,000	\$ 9,168,000	\$ 110,000	\$ 8,934,000	\$ 344,000

Other Project Benefits

- More Difficult to Quantify
 - Recreation
 - Vehicle Damage Prevention
 - Habitat Preservation and Enhancement
 - Groundwater recharge
 - Infrastructure Protection
 - Emergency Services and Public Safety
 - Mitigation Banking



Project Costs and Benefits

Table 18: Equivalent Annual Damage to Buildings

Scenario	Equivalent Annual Damage	Equivalent Annual Damage Reduced
Existing Conditions	\$1,407,000	--
With Project C	\$1,399,000	\$8,000
With Project L	\$1,390,000	\$17,000
With Project I or R	\$1,364,000	\$43,000
With Projects C, L, I and R	\$1,315,000	\$92,000

Table ES-1: Estimated Cost and Expected Benefit Summary

Project	Estimated Capital Costs	Comprehensive Project Costs	Comprehensive Damage Reduction	Benefit-Cost Ratio
C	\$862,000	\$962,000	\$173,000	0.2
I	\$766,000	\$866,000	\$1,068,000	1.2
L	\$855,000	\$955,000	\$402,000	0.4
R	\$832,000	\$932,000	\$1,017,000	1.1
C, I, L, R	\$3,315,000	\$3,715,00	\$2,167,500 ¹	0.6



Conclusions

- Even small, local projects may provide flood reduction benefit
- Projects with significant flood damage reduction benefits may produce benefit/cost ratios greater than 1 while targeting high frequency storm events
- Grant funding applications may be more attractive with higher b/c ratios (Consumnes American Bear and Yuba Rivers Integrated Regional Water Management Plan)
- Combine with Local Development Projects as Mitigation Bank

