Attachment B
to Technical Memorandum No.2

Operations Plan of Ross Valley Detention Basins

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January 26, 2011

1.0 Introduction

Achieving 100% containment of the December 31, 2005 flood in the Ross Valley (which is an approximate 100-year flood) requires in-channel measures for increasing capacity along the critical reaches and detention basins in the upper watershed for reducing peak flow. This is particularly true in the Corps of Engineers Unit 4 Project reach, where the Corps plans to increase the in-channel capacity from its current capacity of about 3,600 cfs to 5,400 cfs, which will require that the 100-year peak flow be reduced, using detention basins, from 6,850 cfs to 5,400 cfs.

Five detention basins located on public properties were identified for reducing peak flows (see Figure 1): Loma Alta Tributary (DB1), Lefty Gomez Field (DB2), Memorial Park (DB3), Red Hill Park (DB4), and Phoenix Lake (DB5). The detention basins would remain dry and would not be flooded in most years, except for Phoenix Lake which would retain its water supply reserve, wildlife habitat, and public recreation and enjoyment functions. Only during extremely heavy storms, when floodwaters would otherwise break out of the creek channel, would operators shut the outlets and fill the basins. All five detention basins would reduce peak flows in the Ross-Kentfield area, and all, except DB5 (Phoenix Lake), would additionally reduce peak flows in the flood prone San Anselmo area below Sorich Creek (Figure 2). Detention basins DB1 (Loma Alta Tributary) and DB2 (Lefty Gomez Field) would additionally reduce peak flows in the Fairfax area and the San Anselmo area above Sorich Creek. None of these detention basins would affect peak flows in the Sleepy Hollow Creek.

Phoenix Lake currently functions as a de facto detention basin. During heavy storms, the lake water level rises above the spillway crest. This resulting "surcharge" storage attenuates stormflow and reduces the peak flow in the creek downstream. In order to enhance the attenuation effect for peak flow reduction purposes, the existing low-level outlet structure (a 30" pipe with an intake elevation at 130 ft NGVD29) will be modified to have two level gates, one at elevation 140 ft and the other at elevation 160 ft, and a 6-foot high inflatable/deflatable rubber dam installed across the spillway to temporarily hold water to the lake's pre-1985 operating level, elevation 180 feet. The lake will be operated for winter flood detention according to the "rule curve" (Figure 3) which has been developed to meet the needs of both flood detention and reserve water supply. Operating according to the rule curve during the winter would initially draw the lake down far enough (to elevation 160 ft) to enable complete drawdown to the final target level, elevation 140 feet, within 24-hours of a forecasted large storm event[1]. The existing

[1] The "rule curve" (see Figure 3) does not set a defined time for the initial drawdown to elevation 160 ft. Drawdown of Phoenix Lake will follow a two-step procedure. The first step is initial drawdown of the lake and the second step is final drawdown of the lake and opening of the low-level outlet. The first step can

30-inch low-level outlet has sufficient capacity to enable drawdown even during times when heavy base inflows can precede impending storms. Close monitoring of watershed saturation conditions coupled with storm forecasting could provide early warning of possible flooding. Under these conditions, drawing the lake level down ahead of a forecasted large storm and inflating the rubber dam will provide storage space in the lake to detain floodwaters. No further operations are needed for Phoenix Lake during large storms.

For the other four "dry" detention basins, due to their limited capacities, effective and efficient operation is vital to maximizing the peak flow reduction benefit. Efficient operation, combined with real-time monitoring, helps to achieve the target level of protection. Table 1 is a comparison between the estimated 100-year flood flows and the in-channel improvement capacities for the critical reaches. It shows that all of the listed critical reaches except Sleepy Hollow Creek need detention basins to achieve 100% containment of the 100-year flood under the in-channel capacity improvement condition.

The ratio between the in-channel improvement capacity and the estimated 100-year flood flow for Fairfax Creek is the lowest, suggesting that Fairfax Creek will be the earliest to reach bankfull during a 100-year flood under the in-channel improvement condition. This further suggests that the detention basins DB1 and DB2 will be the earliest to require operations in order to avoid flooding in the Fairfax area. The real-time streamflow gage reading at Fairfax Creek can be used as an indicator for initiating filling of DB1 and DB2.

Corte Madera Creek in Ross is next to flood. In order to avoid flooding in the downstream reach (i.e., Corte Madera Creek in the Ross-Kentfield area), the real-time streamflow gage reading at Ross can be used as an indicator for initiating filling of DB3 (Memorial Park) and DB4 (Red Hill Park).

The ratio between the in-channel improvement capacity and the estimated 100-year flood flow for San Anselmo Creek in the San Anselmo area is the highest, suggesting that San Anselmo Creek in the San Anselmo area will be the last to reach bankfull during a 100-year flood under the in-channel improvement condition.

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occur at any time during the rainy season. Watershed moisture conditions will be continually monitored by tracking soil moisture content, groundwater levels, discharges from seeps and springs, and base flows in creeks. When this monitoring indicates watershed moisture approaching saturation, then the lake will be gradually drawn down to elevation 160 ft, 14 ft below the spillway crest, and maintained at that level. (It is possible that the initial drawdown will not happen during very dry years when the water supply reserve of Phoenix Lake is needed most). The second step will be triggered by a forecast of potential flooding issued by the National Weather Service, in which case the low level outlet will be opened and the lake will be further drawn down 20 ft, to elevation 140 ft, and maintained at that level. The low-level outlet will remain open thereafter, continuing on its own to pass inflows into the lake. The lake will fill during the storm as inflow into the lake exceeds outflow through the low-level outlet. As the lake level rises and approaches the spillway the rubber dam will be inflated raising the spillway level by 6 ft and adding 150 acre-feet of attenuation capacity to the lake.

Table 1 Comparison between Estimated 100-Year Flood Flows and In-Channel Improvement Capacities for the Critical Reaches

Detention Basin	Fairfax Creek in Fairfax	Sleepy Hollow Creek in San Anselmo	San Anselmo Creek in San Anselmo		Corte Madera Creek in Ross
			Upstream of Sorich Creek Confluence	Downstream of Sorich Creek Confluence	
Estimated 100-Year Flood Flow (cfs)	1,560	1,050	5,010	5,690	6,850 (6,190)
In-Channel Improvement Capacity (cfs)	1,200	1,050	4,700	5,300	5,400
Ratio	**0.77**	**1.00**	**0.94**	**0.93**	**0.79 (0.87)**

Note: The numbers in the parenthesis within the last column represent the effects by Phoenix Lake only.

In summary, Phoenix Lake (DB5) will be operated for flood detention *prior to* a forecasted large storm. The other four "dry" detention basins will be operated for flood detention *during* a large storm. Filling of detention basins DB1 and DB2 will be primarily triggered when real-time monitoring information at the Fairfax gage indicates imminent flooding at the key breakout points in the Fairfax area, and filling of detention basins DB3 and DB4 will be primarily triggered when real-time monitoring information at the Ross gage indicates imminent flooding at the key breakout points in the Ross-Kentfield area.

Flood protection strategies fall into the category of active or passive systems. Active systems require human action to be effective (i.e. closing a flood gate, installing a log barrier, bolting cover plates), whereas passive systems require no action to be effective (i.e. flood walls, elevated structures). Table 2 is a summary of operations category for the five detention basins.

Table 2 Operations Category of Detention Basins

Detention Basin	**Operations Category**
DB1 (Loma Alta)	Active
DB2 (Lefty Gomez)	Active
DB3 (Memorial Park)	Active
DB4 (Red Hill Park)	Active
DB5 (Phoenix Lake)	"Semi-Active"

2.0 Operations Plan

This operations plan describes general actions in response to a large storm event that has been predetermined or forecasted. The plan provides a strategy for operations before, during, and after a high storm event and defines how and when specific actions should take place. Main elements of the plan include:

a) Flood forecast and flood watch prior to a large storm event;
b) Flood detention operations during a large storm event; and,
c) Flood detention operations after a large storm event.

1) Flood Forecast and Flood Watch *Prior to* a Large Storm Event

A flood watch means that flooding is possible in the near future. The National Weather Service issues a flood watch when conditions that typically precede a flood are predicted, such as unusually heavy rain for several hours, substantial rain over several days, rains related to a hurricane or tropical system affecting the area. During a flood watch, operators will:

- Begin checking current weather predictions and flood forecasts;
- Continually monitor anticipated rainfall intensities and amounts;
- Inspect conditions of all detention basin gates;
- Open the Phoenix Lake low-level outlet gate for the elevation 140 ft intake to draw the lake level down to 140 ft ahead of a forecasted large storm and inflate the rubber dam[2]. No further action is necessary at Phoenix Lake.

2) Operation Actions for the Detention Basins *During* a Large Storm Event

- Continually monitor anticipated rainfall intensities and amounts;
- Continually monitor stage readings at the Fairfax and Ross streamflow gages;
- Close the gates of detention basins DB1 and DB2 when the water level at the Fairfax streamflow gage reaches 105.2 ft NGVD29 (or gage reading reaches 4.3 ft) and the water level is expected to be rising;
- Close the gates of detention basins DB3 and DB4 when the water level at the Ross streamflow gage reaches 26.1 ft NGVD29 (or gage reading reaches 21.1 ft) and the water level is expected to be rising.

3) Operation Actions for the Detention Basins After a Large Storm Event

- Close the Phoenix Lake low-level outlet gate for the elevation 140 ft intake to allow the lake to refill up to elevation 160 ft.
- Open the gates of detention basins DB1, DB2, DB3, and DB4 to drain the detention basins for detaining floodwaters for the next large storm, and control the outflow not to exceed downstream channel capacity during the draining.

[2] Once the rubber dam is inflated, keep it inflated until March 15th when the lake starts refilling for reserve water supply. The low-level outlet gate for the elevation 160 ft intake is kept open until March 15th. Close the gate and deflate the rubber dam on March 15th.

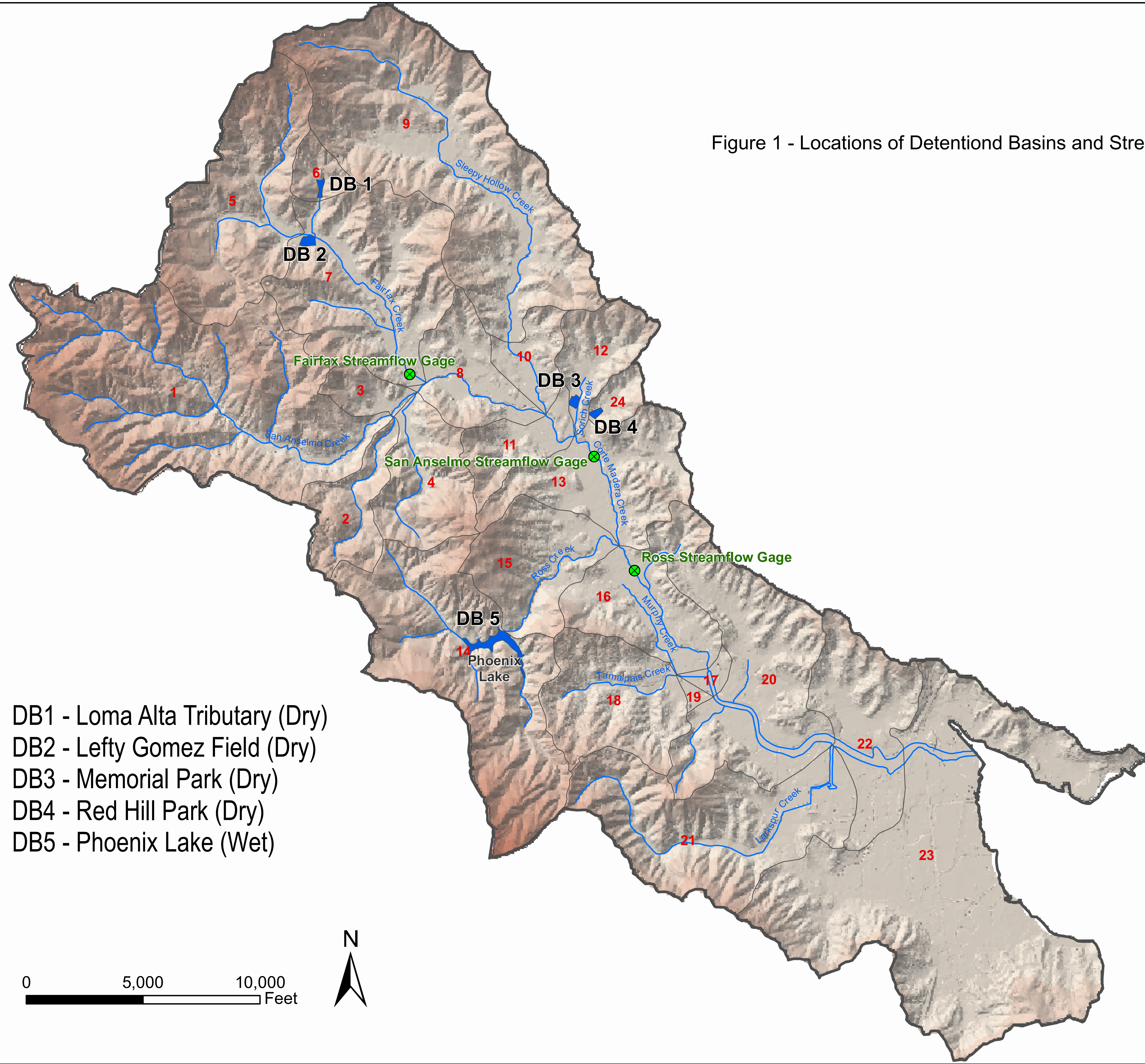

Figure 1 - Locations of Detentiond Basins and Streamflow Gages

Figure 2 Detention Basins and Affected Reaches of Reduced Peak Flows

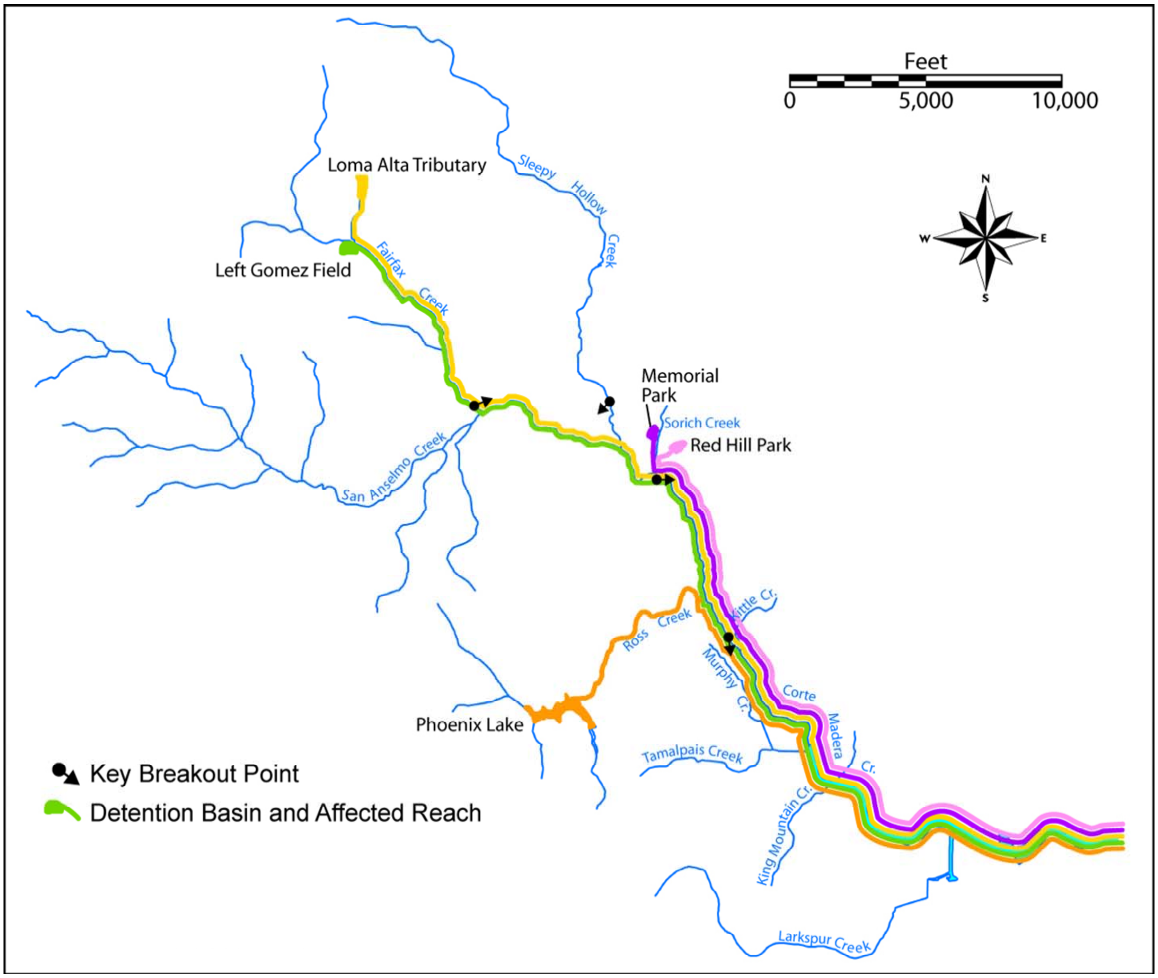

Figure 3 Operations Rule Curve for Phoenix Lake