May 23, 2016

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SUBJECT: DRAFT Summary of Mitigation Alternatives for Flooding at Green Valley Road

Introduction

The objective of this study, initiated and coordinated by the Gold Ridge Resource Conservation District, is to evaluate flooding mechanisms and develop feasible alternatives to mitigate the frequency and extent of chronic flooding at Green Valley Road about 0.85 miles west of Graton. In addition to damages to private property, flooding frequently makes Green Valley Road impassable and poses a risk to public safety. Continuing and increasingly frequent flooding is damaging Green Valley Road, creating a significant road maintenance issue. Flooding also creates risks to aquatic organisms, including endangered coho salmon, steelhead trout and California freshwater shrimp that may become stranded or otherwise harmed on the floodplain, particularly in the vineyard east and north of Green Valley Road.

Work on this project began in 2013 and produced several interim products. The first draft report describing site history with respect to flooding and initial potential mitigation alternatives was prepared in November 2013. A sediment source assessment for the watershed area upstream of Green Valley Road to estimate the volumes and sources of sediment contributing to aggradation of the streambed in the vicinity of Green Valley Road, (a major cause of the current flooding problems) was completed December 30, 2014. An updated revised draft report dated January 12, 2015 provided a detailed description of the history of riparian and floodplain conditions and flooding of Green Valley Road, the causes of flooding under current conditions, development of hydrologic, hydraulic, and sediment transport analyses, and a comprehensive evaluation of potential strategies to mitigate the flooding. Following in this document is a summary of flood mitigation alternatives that appear to be most effective with respect to mitigation of flooding and compares them to a fourth 'do nothing' alternative, the impacts of which, due to observed site changes over the past three years, need to be considered. This summary of potential alternatives is intended to inform stakeholders of the advantages and disadvantages of these options for reducing flooding and to facilitate selection of a preferred alternative which could be adopted so that project design and permitting processes can begin.

For purposes of this analysis, flooding is defined primarily in relation to Green Valley Road. Flooding occurs when Green Valley Creek overflows its channel and spills across Green Valley Road between Cemetery Curve and Green Valley Road bridge and flows into the adjacent vineyard. When this study began in autumn 2013, channel conditions were such that simulated Green Valley Creek flow exceeding about 420 cfs would cause flooding. As of April 2016, channel sedimentation reduced the simulated flood threshold to about 290 cfs. The "design flood" that was selected as the desired threshold for flood mitigation is about 950 cfs, which is the estimated 2-year recurrence interval flood event defined as a peak flow with 50% chance of occurring in any year.

Alternative 1 – Do Nothing

Description
Allow the channel to evolve without any intervention.

Frequency of Flooding
The original hydraulic modeling for the project was carried out on the basis of a topographic survey performed in 2013. Under 2013 conditions, simulated road flooding initiated at a discharge of about 423 cfs which is equivalent to about 44% of the peak flow during a design flood (the flood event with an estimated 2-yr recurrence interval estimated to be 951 cfs as shown in Figure 1. The extent and depth of flow on the floodplain is shown in blue colors in Figure 1; the yellow-brown area describes the area occupied by flow confined within the channel. At the peak of the design flood (2-yr recurrence interval), about 443 cfs flows across Green Valley Road.

Sediment deposition has continued since the 2013 survey. In April 2016, a topographic survey of limited extent showed that the streambed has aggraded by as much as 1.8-ft over a 300 to 400-ft reach adjacent to the locus of the road flooding (Figure 2). The hydraulic simulation model was updated with the 2016 survey data, and shows that road flooding under current conditions (April 2016) initiates at a discharge of about 292 cfs; at the peak of the design flood, about 531 cfs flows across Green Valley Road (Figure 1). This represents a 31% decrease in channel capacity over the three year period and is consistent with recent observations that road flooding has increased in frequency in recent years and occurs multiple times per year even during moderately sized storm events. Channel capacity at the Green Valley Road bridge located just downstream has increased somewhat between 2013 and 2016 (Figure 2c).

Under this alternative the frequency and severity of flooding over Green Valley Road is expected to continue to increase as additional sediment is deposited in the flood-prone reach adjacent to the road. Currently, at the locus of the road flooding, there is only about 1.7-ft of vertical separation between the channel bottom and the road (Figure 2). Given the very limited channel capacity and the rate of recent aggradation it is likely that sustained road flooding and significant streamflow across the road lasting weeks may begin to occur within the next few years.

Habitat Considerations
Ongoing sediment deposition has degraded the habitat quality of Green Valley Creek through the study reach in several ways. It has been reported by teams studying fishery resources that pools have filled in to a substantial degree, diminishing the availability of rearing habitat. Summer streamflows have decreased, particularly in the reach downstream of the bridge. Aggradation of the channel is likely a significant factor contributing to the reduction in summer flow as much of the flow that would be expressed as streamflow in a deeper channel is now flowing in the shallow subsurface through the thousands of yards of recently deposited sand and gravel that is several feet deep.

During flood events, a large proportion of the flow is routed over the road to the vineyard where it flows parallel to the vine rows, scouring channels in the vineyard soil, and ponds near the northeast corner of the vineyard adjacent to Atascadero Creek. Salmonids become entrained in the flow over the road and depending on flow conditions may make it through the vineyard and back to Atascadero Creek or may become stranded in the scour pools adjacent to the vineyard or in the vineyard itself. The severity of the stranding potential is not well known, however California Department of Fish & Wildlife (CDFW) staff rescued 68 salmonids from a scour pool (see Figure 2b) that formed following the most recent road flooding event in April 2016, suggesting that the problem is significant.

Under the Do Nothing alternative, sediment deposition can be expected to continue. This deposition can be expected to further degrade available pool habitat, lead to further reductions in summer streamflow, and increase the frequency and severity of road flooding and associated stranding of salmonids.

Landowner and Public Safety Considerations

Ongoing sedimentation will likely increase the frequency and severity of road flooding. Worsening flooding poses an increasing level of risk to public safety as motorists attempt to drive through dangerous flood conditions and in the event that police, fire, or medical emergencies delay emergency personnel from reaching residents or residents from reaching emergency services. The alternative road routes for emergency services via Harrison Grade Road or Highway 116 could also be subject to closure during winter storm events. Significant erosion and deposition of sediment occurs within the vineyard during road overflow events, which poses a risk of crop losses and increases the level of effort required to remove debris and re-grade the vineyard following flood events. Worsening conditions appear to create potential for streamflow into the vineyard during the early growing season.

Costs

Flooding in winter 2014/2015 resulted in damage to the road surface which required emergency repairs to fill scour holes in the road and resurfacing in winter 2016. The frequency of required road maintenance and associated costs can be expected to increase under the Do Nothing alternative. Costs associated with post-flood debris removal and re-grading of the vineyard can also be expected to increase. The costs associated with mitigating the flooding at a later date can be expected to be higher than the costs of implementing a mitigation project now as sediment accumulation continues and the required level of sediment removal increases. The available mitigation options can also be expected to decrease in the future as further reductions in channel capacity occur.

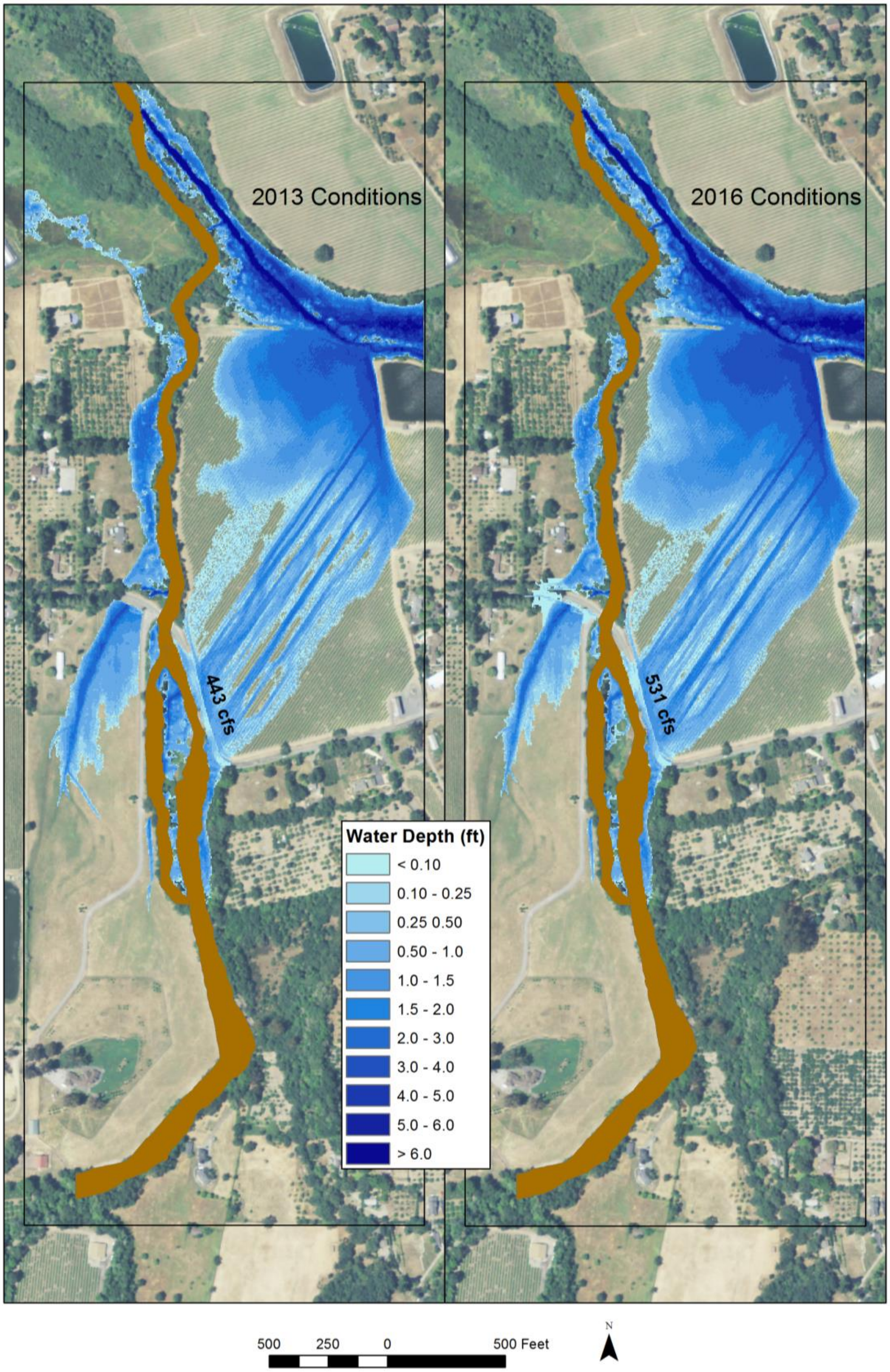

Figure 1: Comparison between existing conditions flooding under 2013 and 2016 channel conditions during a 2-yr flow event illustrating the effects of recent sediment deposition on the frequency and severity of flooding. Discharge across the road at the peak of the design flood is shown.

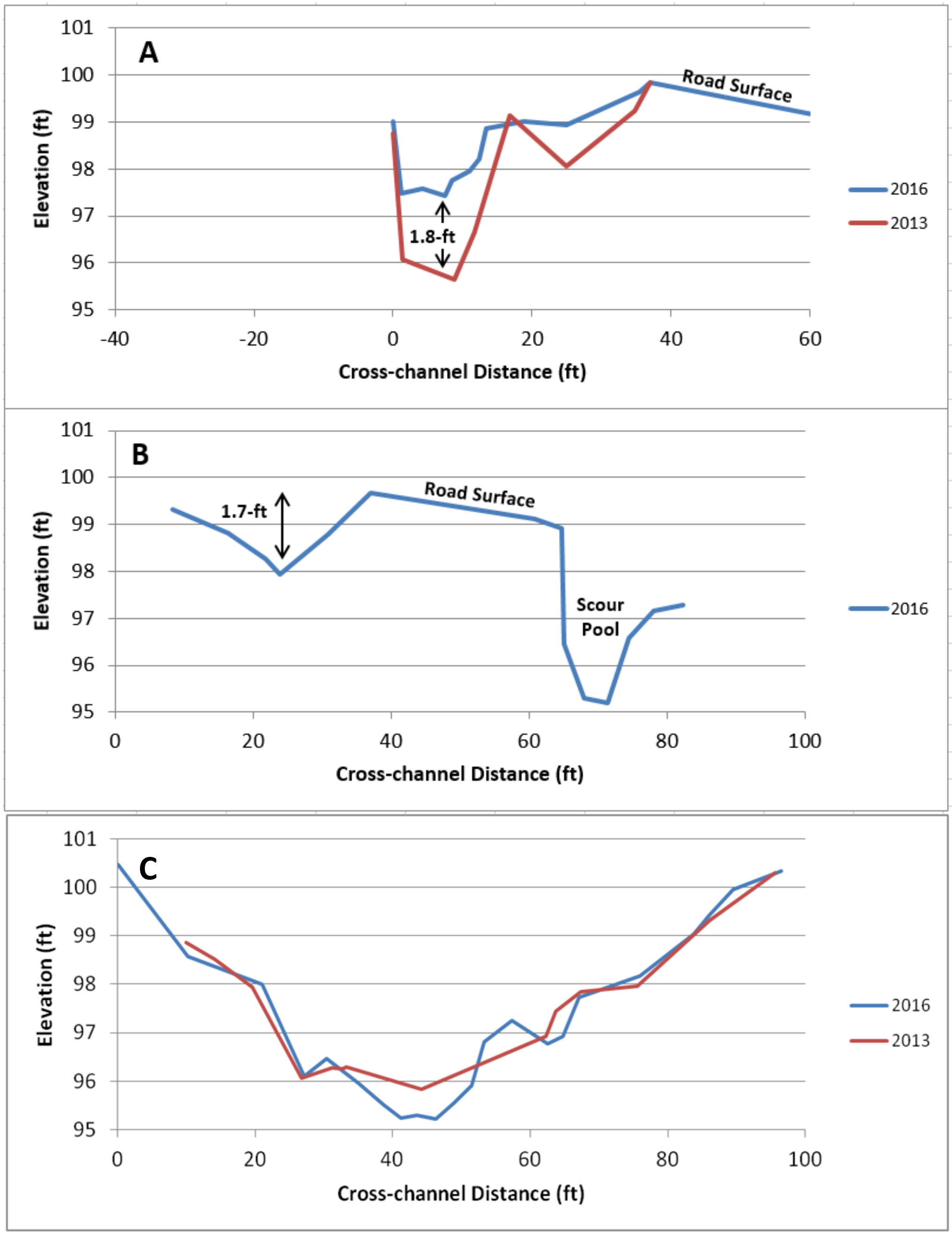

Figure 2: Comparison between 2013 and 2016 channel cross sections in the reach adjacent to the road flooding (A). 2016 cross section at the locus of the road flooding illustrating the minimal remaining channel capacity and the recently formed scour pool adjacent to the vineyard in which salmonids have been stranded (B). Channel bed elevation in cross section at the upstream edge of Green Valley Road bridge in 2013 and 2016 (C).

Alternative 2 – Causeway

Description

Elevate or modify about 600-ft of Green Valley Road between Cemetery Curve and the bridge approach and provide sufficient openings to allow unrestricted flow beneath the roadway and into the existing vineyard (Figure 3). Depending on the potential effects of this alternative on coho salmon and other aquatic species (e.g. steelhead trout and California freshwater shrimp), this could also require construction of a new mainstem channel of Green Valley Creek through the vineyard connecting to Atascadero Creek that would provide in-stream habitat features including pools and large wood structures within the new mainstem channel and vegetate the channel banks and side-channel areas with native vegetation. Potential additional elements of habitat mitigation could include constructing one or more side-channels to provide off-channel habitat for salmonids and facilitate conveyance of flood flows under the road and/or in the channel alignment under the bridge. Various options exist for the alignment of the mainstem channel and the side-channels. One possible configuration is provided in Figure 3 for illustrative purposes. The length of mainstem channel is approximately 1,900-ft with an additional 1,250-ft of side channel length.

Frequency of Flooding

Hydraulic modeling of this alternative was not performed; numerous design assumptions would be required for the hydraulic simulation, and the required effort was deemed unwarranted for this conceptual plan phase of the project. Assuming that openings through the road prism are of sufficient dimensions to provide unrestricted flow under the road, we estimate that the design would be capable of preventing road flooding during the 5-yr event (1,450 cfs) and likely during significantly larger events.

Habitat Considerationsg

The potential for salmonids to become stranded in the vineyard is expected to be substantially reduced provided that channelized flow through the vineyard and to Atascadero Creek is constructed. The construction of one or more side-channels in the vineyard would provide an increase in available off-channel habitat consistent with the geomorphic setting. The existing channel alignment under the bridge would likely persist as a secondary channel feature providing additional off-channel habitat or an alternate channel connecting to Atascadero Creek. Assuming in-stream habitat features such as pools and large wood structures are included in the design of the new mainstem channel, the alternative should result in an increase in the quality of in-stream habitat in the lowest reaches of Green Valley Creek.

The vertical separation between the vineyard adjacent to the road and Atascadero Creek near the northeast corner of the vineyard is about 7.5-ft. This indicates that the channel slope in the new mainstem channel would be approximately 0.004 which is relatively low but still significantly higher than the slope of the existing channel (0.0017 to 0.0033). The new low-gradient channel would be prone to aggradation from ongoing sediment deposition in a similar fashion as the existing channel. This deposition and the dispersion of the flow into multiple channels may lead to the development of fish passage problems and/or reductions in summer streamflow.

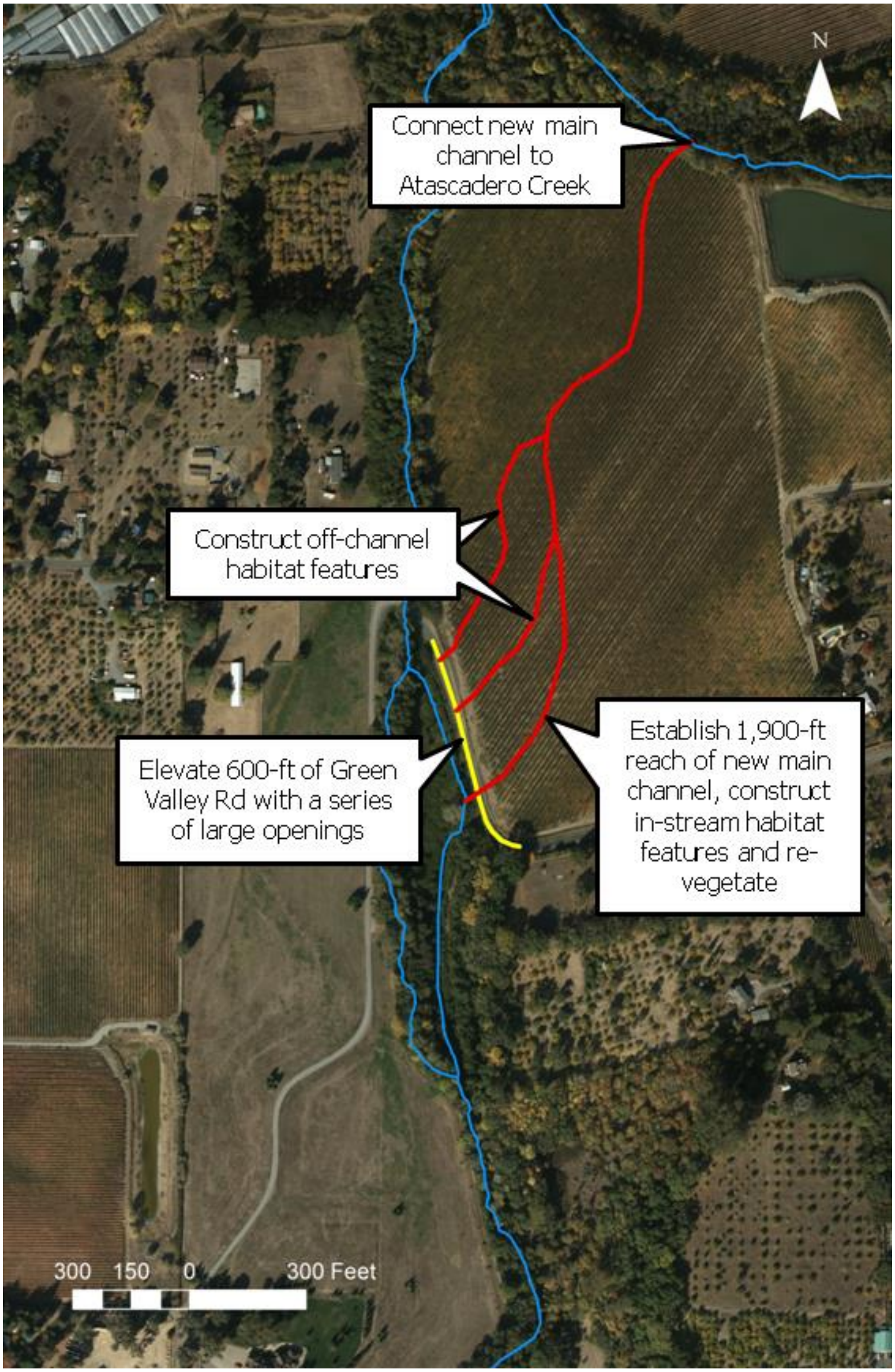

Figure 3: Conceptual design for Alternative 2 – Causeway.

Landowner and Public Safety Considerations

This alternative is expected to result in a major reduction in the frequency and severity of road flooding and an associated reduction in the level of risk to public safety. The farming potential of a large portion of the vineyard (depending on a variety of factors) would be lost owing to the space required to construct the new mainstem channel, side channels, and riparian setbacks as well as the increase in flooding at the site.

Feasibility/Permitting

This alternative likely requires significant compensation to the vineyard landowner. Limited work within the existing channel would be required which is an advantage in terms of permitting relative to some other alternatives, however uncertainty regarding the capacity of the new channel to provide fish passage and maintain adequate flow and other habitat elements will present challenges for planning, design and permitting.

Costs

Compensation for loss of use for farming on the vineyard property would likely be required. Costs associated with modifying/elevating the roadway with large openings for flow are expected to be significant. Additional costs for constructing the new main channel, side-channels, and in-stream habitat features would also be significant. Assuming the dimensions for the new channel are 40-ft wide by 4-ft deep means that construction of the new mainstem channel would require excavation of approximately 11,300 yards of sediment.

Uncertainty

There is long-term uncertainty regarding the evolution of Green Valley Creek in this area. Ongoing sedimentation and flooding may affect the degree to which fish habitat (including migration) and streamflows can be maintained in the newly created channels. An adaptive management plan could be put in place to address these potential problems.

Alternative 3 – Channel Re-establishment and Sediment Management

Description

Remove approximately 32,000 yards of sediment from a 2,750-ft reach of the mainstem of Green Valley Creek extending from 100-ft upstream of the side-channel head above the bridge to a point near the downstream edge of the vineyard and from the 1,100-ft reach of side channel upstream of the bridge (Figures 4 through 6). Re-align a 600-ft reach of the existing channel adjacent to the road by relocating the channel approximately 75-ft away from the road to the west through what is now an elevated gravel bar vegetated primarily with Himalayan blackberry. The channel profile would be lowered by about 3 to 4-ft adjacent to the road and would gradually blend in with the existing profile upstream and downstream (Figure 5). Provide in-stream habitat features including pools and large wood structures within the mainstem and side-channels and re-vegetate the channel banks and riparian corridor with native vegetation.

Establish a 0.3 acre sediment management area at the break in channel slope upstream of the area of road flooding by widening the channel along the right bank from 35-ft to 70-ft. Both the decrease in channel slope and increase in channel width are intended to promote localized sediment deposition within the sediment management area. Periodic sediment removal would be performed on an ongoing basis within the sediment removal area in order to reduce sediment delivery in the flood-prone reach and extend the timeframe over which the larger sediment removal activities would be effective. The alternative also includes constructing a grade control structure at the upstream limit of the sediment removal footprint to prevent head-cutting from adversely affecting upstream habitat conditions.

Frequency of Flooding

Hydraulic modeling of this alternative revealed that the channel would be capable of conveying flows of up to 1,450 cfs which is equivalent to an estimated 5-yr recurrence interval flood event. Comparison between existing conditions flooding and Alternative 3 flooding during the 2-yr event reveals that virtually all flooding is eliminated with the exception of the northeast portion of the vineyard which backwater floods from Atascadero Creek (Figure 7).

Sediment Management

Sediment transport modeling revealed that the decline in slope and increase in width would be effective at concentrating deposition in the vicinity of the sediment management area (Figure 8). Approximately 0.5-ft of deposition or 230 yards was predicted to occur within the sediment management area during the 2-yr flood.

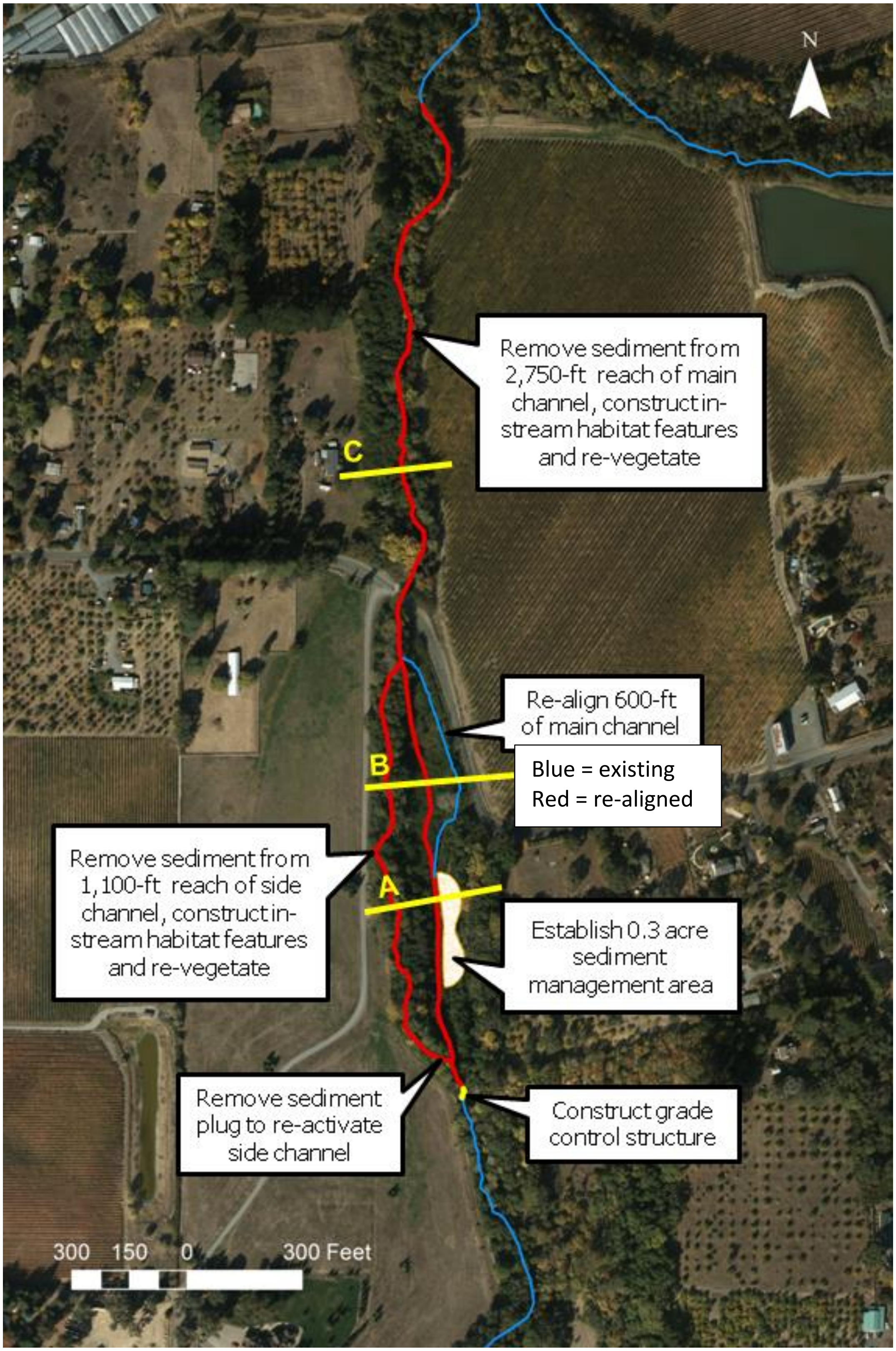

Figure 4: Conceptual design for Alternative 3 – Channel Re-establishment and Sediment Management.

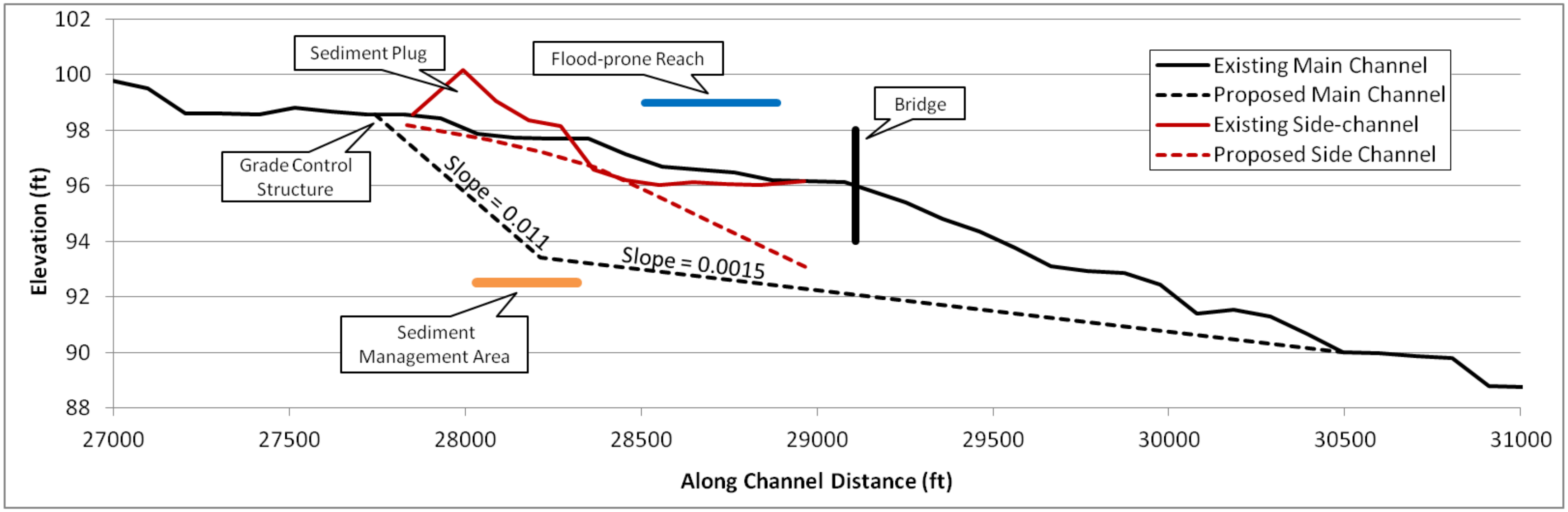

Figure 5: Longitudinal profile view of the conceptual design for Alternative 3.

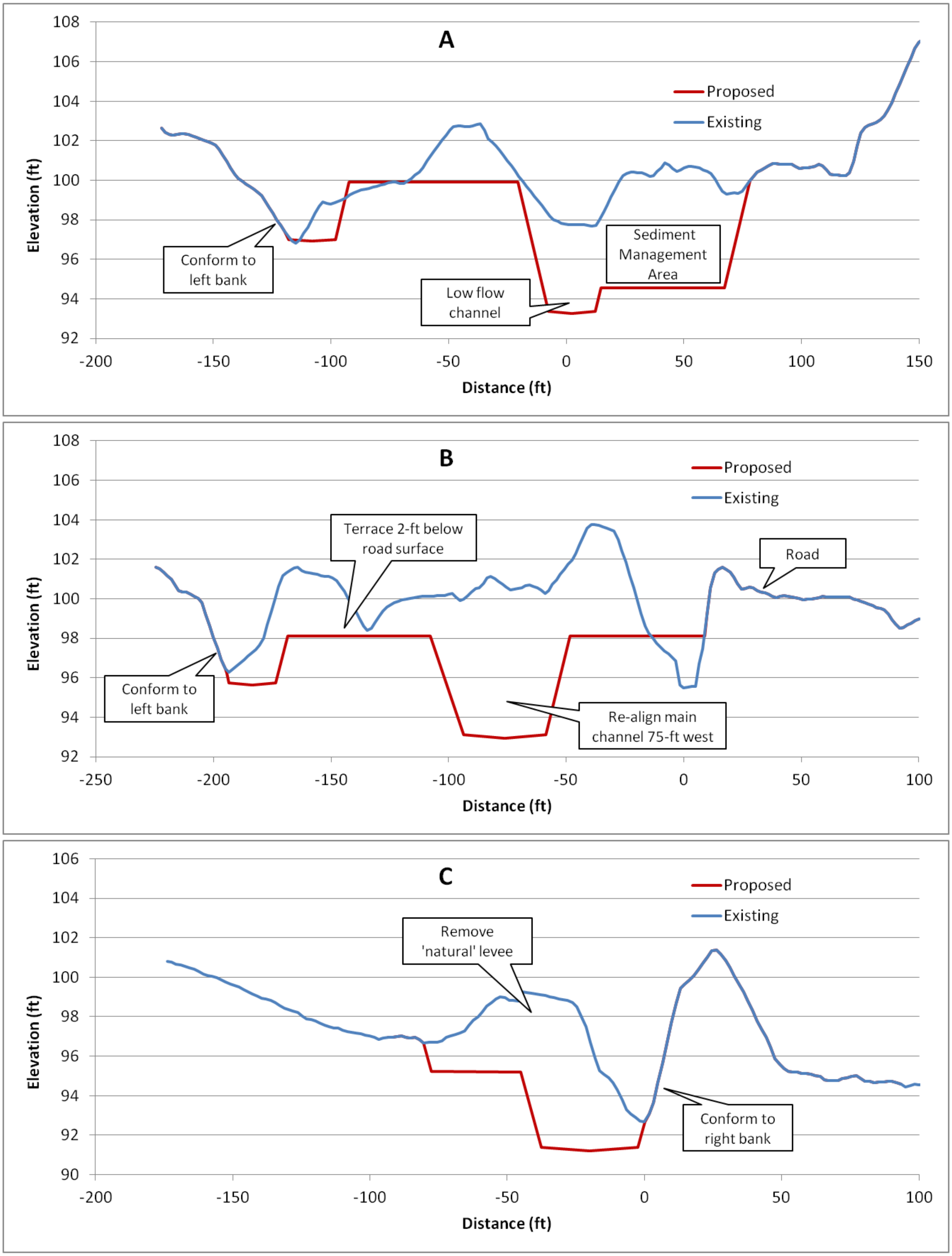

Figure 6: Cross sectional views of the conceptual design for Alternative 3, see Figure 4 for locations.

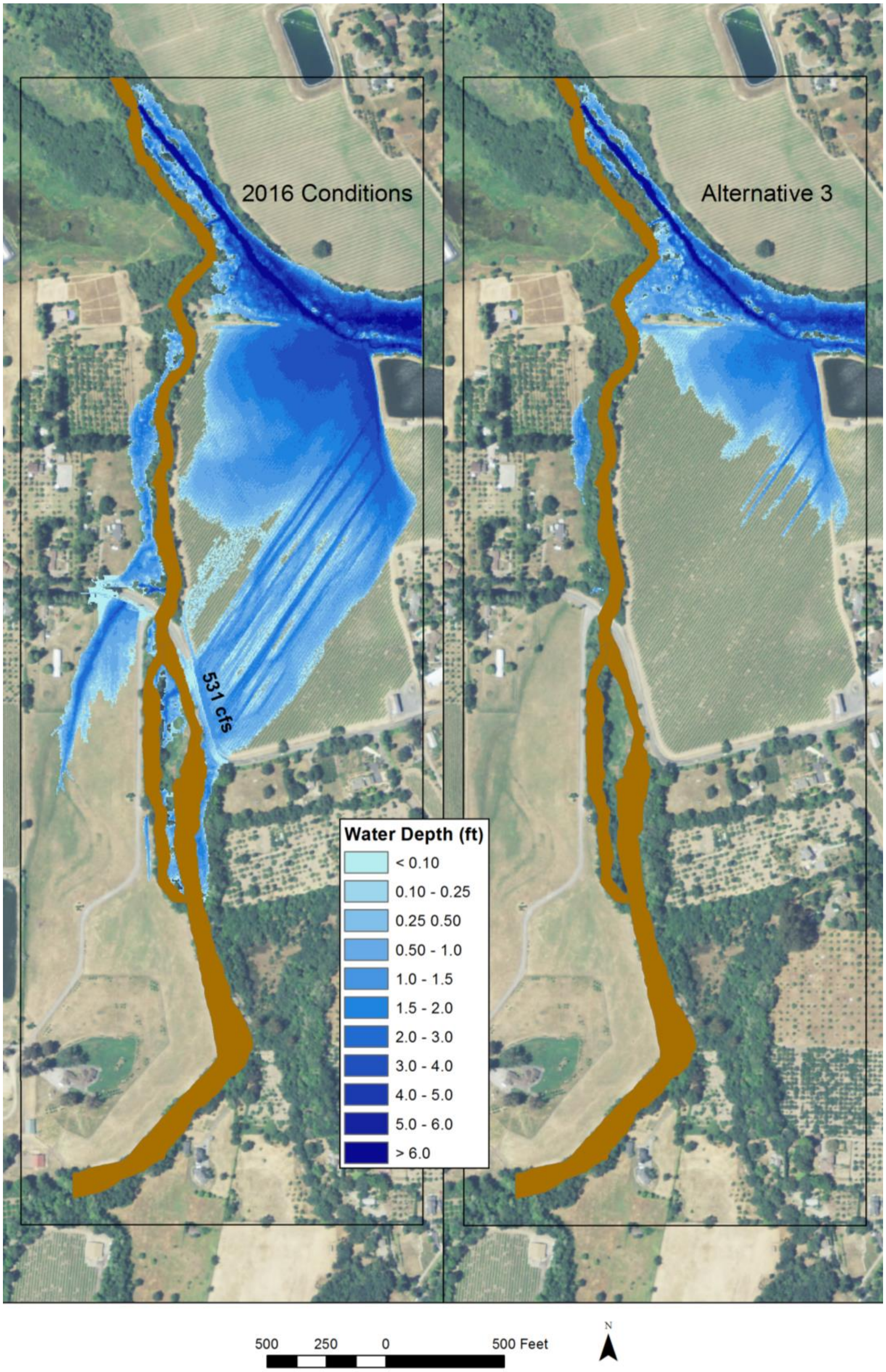

Figure 7: Comparison between existing conditions flooding and Alternative 3 flooding during a 2-yr flow event.

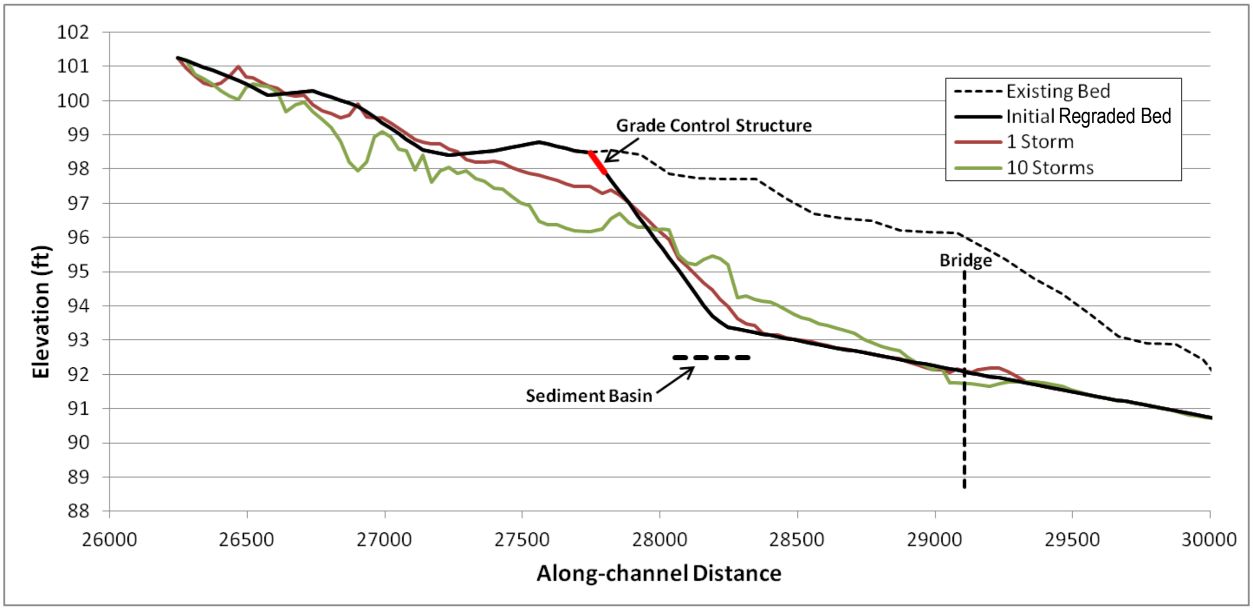

Figure 8: Predicted changes in bed elevations under Alternative 3.

Of the estimated 32,000 yards of sediment removed under Alternative 3, about 20,000 yards are removed upstream of the bridge. The Sediment Source Assessment (2014) estimated that an average of 410 yards of bed load sediment (sand and gravel) is delivered to the project reach per year. Assuming that all of the sediment is deposited in the reach upstream of the bridge, the 20,000 yards of sediment removed is equivalent to about 50 years of deposition. This comparison provides a crude estimate of the anticipated lifespan of the sediment removal in the absence of any sediment management. The effectiveness of the sediment management program is uncertain, however if one assumes that 50% of the sediment is captured and removed within the sediment management area, the benefits of the project might be expected to persist about 100 years based on the estimated sedimentation rate of 410 yards per year.

Habitat Considerations

The potential for salmonids to become stranded in the vineyard is expected to be significantly reduced as the capacity of the channel would be increased under this alternative such that road overtopping would be expected to occur only during flood events estimated to be about 1.450 cfs or greater with a recurrence interval of about 5 years or greater (20% probability of occurring in any year). The removal of the sediment plug at the head of the existing side-channel (aka "historic channel") would allow flows to occupy the side channel at much lower stages than under existing conditions which will serve to increase the available off-channel habitat in this reach. Assuming in-stream habitat features such as pools and large wood structures are included in the design of the reestablished channel, along with significant off-channel habitat, the alternative should result in an increase in the quality of aquatic habitat in the lowest reaches of Green Valley Creek. The sediment removal would be expected to result in an increase in summer streamflow as more of the water currently flowing through the thick sand and gravel accumulations in the shallow subsurface would be intersected by the new lower channel profile.

Negative habitat impacts are likely to occur in the short-term during project construction due to the degree of in-stream sediment removal work required under the alternative. These impacts can be minimized by working during the summer low flow season, preserving as much of the existing riparian vegetation as possible, and providing temporary fish passage around the work area. In the long-term, the extent and quality of the riparian vegetation would be expected to be improved over existing conditions, however a reduction in riparian cover would be expected during the first few years of vegetation reestablishment. Potential impacts on habitat for freshwater shrimp remain to be assessed.

Landowner and Public Safety Considerations
This alternative is expected to result in a major reduction in the frequency and severity of road flooding and an associated reduction in the level of risk to public safety and the required post-flood debris removal and re-grading in the vineyard.

The stream channel is privately owned, so this Alternative would require landowner access and approval.

Feasibility/Permitting
An extensive amount of work within the existing channel and riparian corridor would be required, and a major permitting process would be anticipated. Permits would also be required on an ongoing basis to periodically remove sediment from the sediment management area.

Costs
Costs for removing 32,000 yards of sediment with appropriate measures to minimize construction impacts and maintain fish passage during construction are expected to be substantial. Additional costs would be incurred to construct in-stream habitat features, re-vegetate the riparian corridor, and construct a grade-control structure near the upstream extent of the project footprint. Ongoing maintenance costs associated with periodically removing sediment from the sediment management area would also be required.

Uncertainty
Uncertainty regarding the duration of the effectiveness of the sediment removal is an important consideration as deposition of sand and gravel is expected to continue in this reach. Although the lifespan of the sediment removal is estimated to last 50 to 100-yrs, the degree to which sediment can be captured and removed within the sediment management area and thus prevented from moving downstream into the flood-prone reach is inherently difficult to predict.

Alternative 4 – Floodplain Reconnection

Description
Remove 360-ft of levee from the left bank upstream of the side channel head to create a bypass channel at high flows (1,100 yards). Remove about 2,600 yards of sediment and re-grade a two-acre area to direct bypass flows into the existing pasture and swale on the western floodplain, and construct a new driveway crossing (Figure 9). Replace the existing culvert under Green Valley Road that drains the pasture just downstream of the bridge with a larger culvert (Figure 9). A box culvert 15-ft wide and 3.5-ft high would be sufficient to prevent road overtopping at this location during the 2-yr event.

As part of the bypass design, remove about 1,700 additional yards of sediment from the left bank to create a 0.4 acre sediment management area by widening the channel along the left bank from 35-ft to 70-ft (Figures 9 and 10). The increase in channel width is intended to promote localized sediment deposition within the sediment management area. Periodic sediment removal would be performed on an ongoing basis within the sediment removal area, but outside of the active stream channel, in order to reduce sediment delivery in the flood-prone reach and extend the timeframe over which the bypass and downstream sediment removal activities would be effective.

Construct a new 575-ft long channel at the same grade as the existing channel through what is currently an elevated gravel bar adjacent to the reach of roadway overtopping (Figures 9 and 10). The new channel would create a split-flow condition just upstream of Cemetery Curve and would merge back with the existing channel near the confluence of the existing side-channel just upstream of the bridge.

Remove additional sediment from the gravel bar along the left bank of the new channel to create a lower terrace between the two channels. Widen the channel along the left bank over a 150-ft reach between the downstream end of the new channel and the bridge. These activities require removal of about 5,400 yards of sediment from the reach adjacent to the reach where flood waters overtop the road under current conditions.

Remove 850-ft of levee from the right bank downstream of the bridge to reduce backwater conditions and increase conveyance within the flood-prone reach upstream of the bridge (3,500 yards). Remove about 4,000 yards of sediment from a 0.7-acre area consisting of an existing natural levee and terrace on the left bank downstream of the bridge; construct a 600-ft long high flow channel on the existing left bank terrace to convey a portion of the flow from the bypass outfall back to the creek (Figures 9 and 10).

Frequency of Flooding
Hydraulic modeling of this alternative revealed that the channel would be capable of conveying flows of up to 1,175 cfs which is equivalent to between a 2-yr and a 5-yr recurrence interval flood event. Comparison between existing conditions flooding and Alternative 4 flooding during the 2-yr event reveals that road flooding is eliminated while flooding in the western pasture and overbank flooding of the lower portions of the vineyard increase substantially. The bypass was able to carry about 443 cfs or 47% of the 2-yr flow (Figure 11).

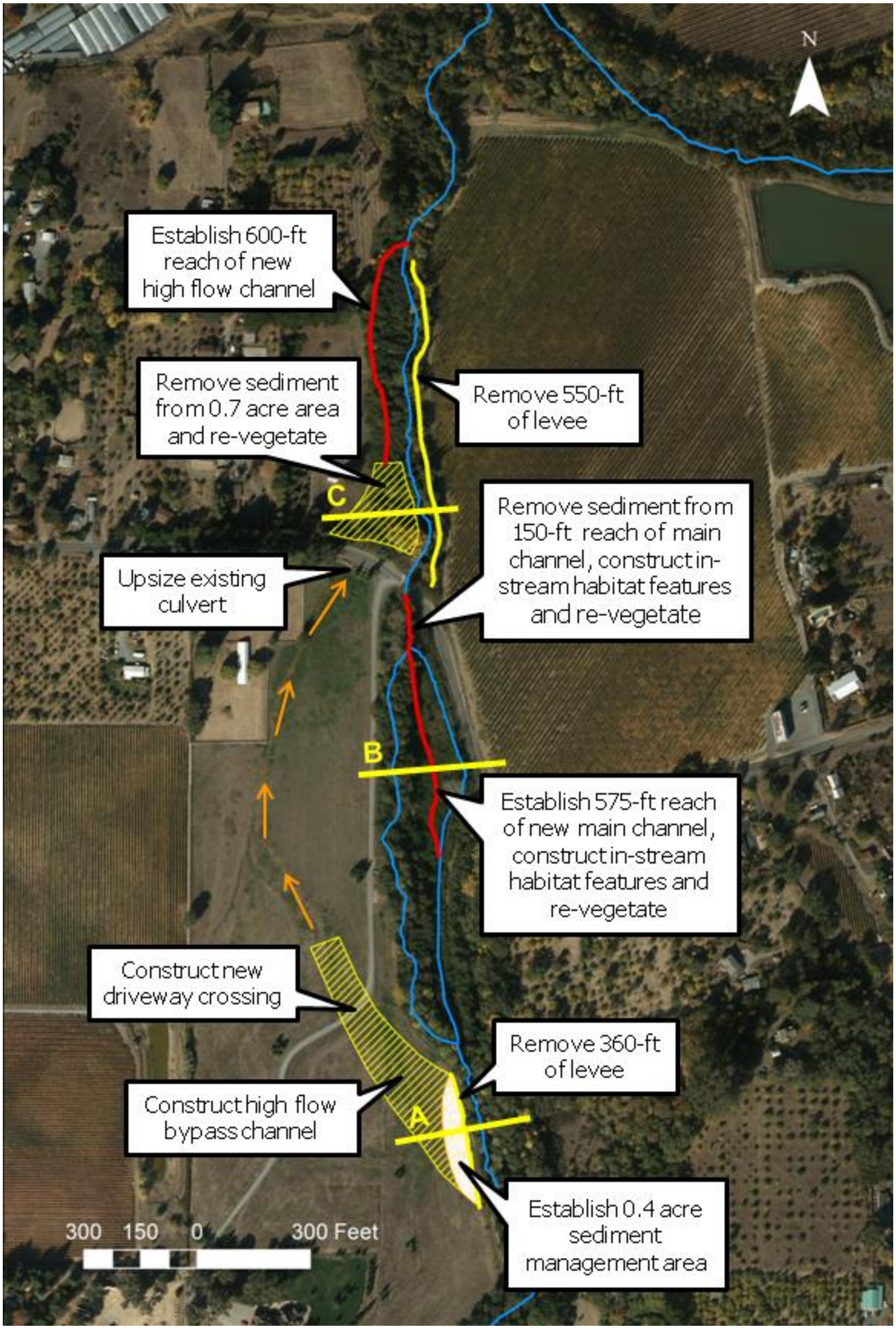

Figure 9: Conceptual design for Alternative 4 – Floodplain Reconnection.

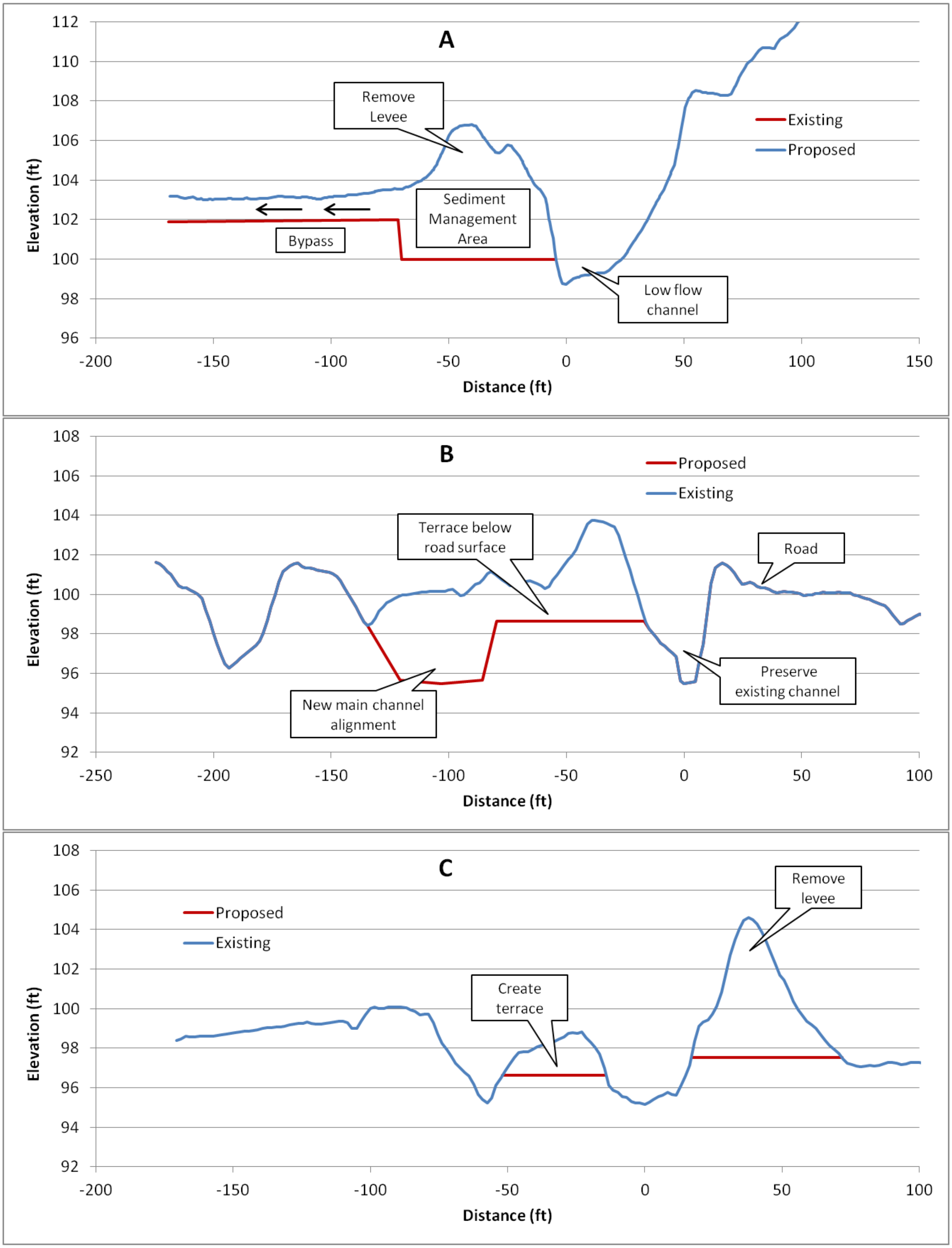

Figure 10: Cross sectional views of the conceptual design for Alternative 4, see Figure 9 for locations.

Sediment Management

This alternative involves removing about 7,100 yards of sediment from the floodway upstream of the bridge. The Sediment Source Assessment estimated that about 410 yards of coarse sediment is delivered to the project reach per year. Assuming that all of the sediment is deposited in the reach upstream of the bridge, the 7,100 yards of sediment removed is equivalent to about 17 years of deposition. This comparison provides a crude estimate of the anticipated lifespan of the sediment removal in the absence of any sediment management. The effectiveness of the sediment management program is uncertain, however if one assumes that 50% of the sediment is captured and removed within the sediment management area, the benefits of the sediment removal component of the alternative would be expected to persist for about 34 years. It is important note that the as sediment redeposits in the flood-prone reach, the bypass would still be effective at reducing the volume and peak discharges of road overtopping, however the frequency of overtopping events would be expected to increase over time.

Habitat Considerations

The potential for salmonids to become stranded in the vineyard upstream of the bridge is expected to be reduced as the capacity of the channel would be increased under this alternative such that road overtopping would be expected to occur only during large flood events. On the other hand, removal of the downstream levee would increase overbank flows into the vineyard downstream of the bridge, which could potentially create new stranding problems similar to those that are occurring at present when flow crosses Green Valley Road into the vineyard. The bypass and left-bank terracing and high-flow channel may provide some increase in the available off-channel habitat in this reach. Assuming in-stream habitat features such as pools and large wood structures are included in the design of the new channel adjacent to the road overtopping, the alternative should result in an increase in the quality of in-stream habitat in this reach.

Negative habitat impacts are likely to occur in the short-term during project construction due to the degree of in-stream sediment removal work required under the alternative. These impacts can be minimized by working during the summer low flow season, preserving as much of the existing riparian as possible. In the long-term, the extent and quality of the riparian vegetation would be expected to be improved over existing conditions, however a reduction in riparian cover would be expected during the first few years of vegetation reestablishment.

Landowner and Public Safety Considerations

This alternative is expected to result in a major reduction in the frequency and severity of road flooding and an associated reduction in the level of risk to public safety. The impacts to the farming potential of the vineyard are somewhat difficult to predict. On one hand, the reduced road overtopping should decrease post-flood debris removal and grading requirements, however the alternative results in an overall increase in the flooded area in the vineyard due to the generation of overbank flows in the reach downstream of the bridge. With respect to impacts on vineyard land use, this alternative probably represents improvement to vineyard operability by reducing the potential for flooding in the vineyard from Green Valley Creek after bud-break in spring.. The western pasture is an integral part of the bypass design and would likely require a conservation-oriented land use designation, and associated compensation to the landowner.

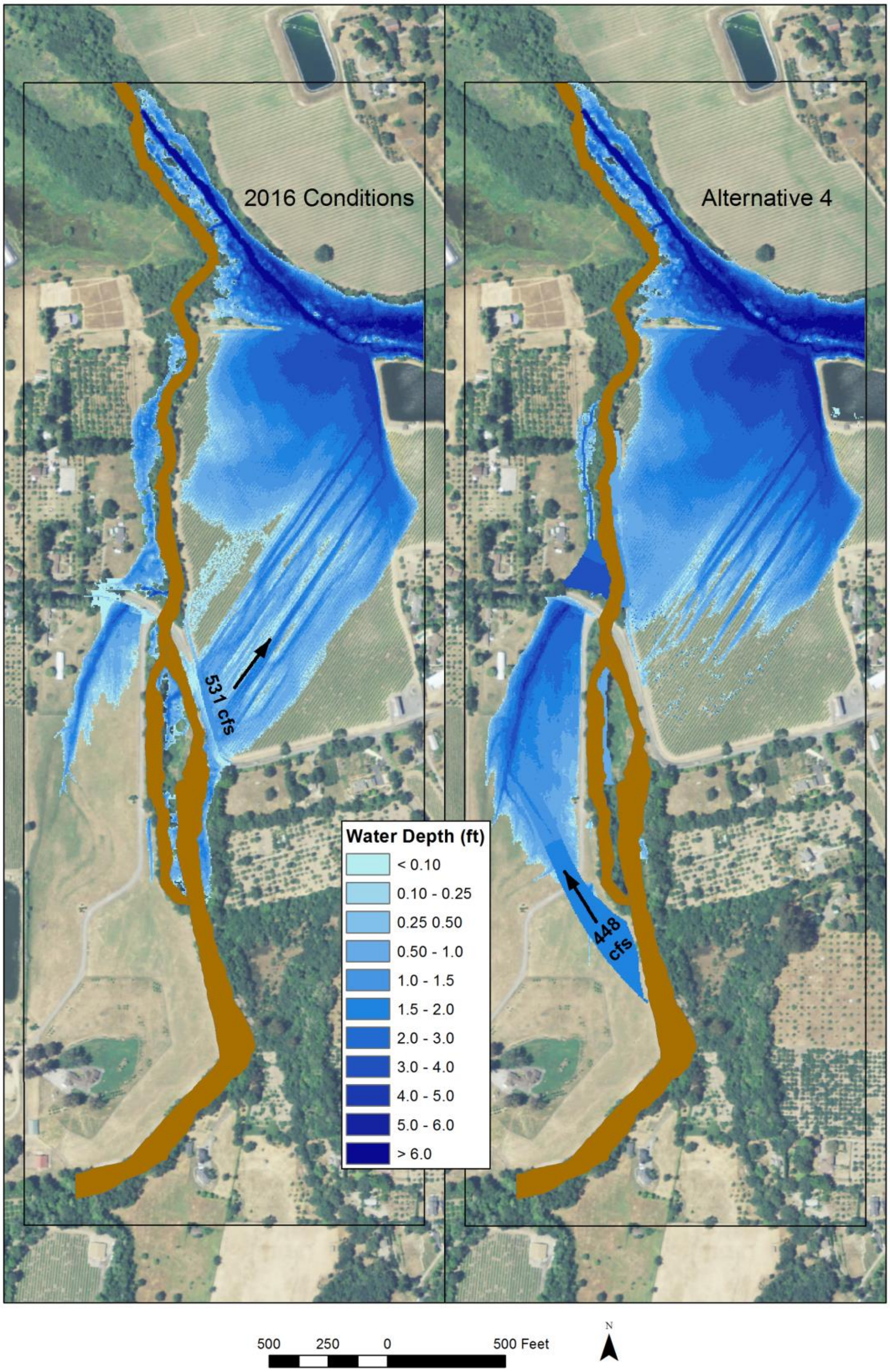

Figure 11: Comparison between existing conditions flooding and Alternative 4 flooding during a 2-yr flow event.

Feasibility/Permitting

An extensive amount of work within the existing channel and riparian corridor would be required, and a major permitting process would be anticipated. Permits would also be required on an ongoing basis to periodically remove sediment from the sediment management area.

Costs

Costs for removing 11,100 yards of sediment from the floodway with appropriate measures to minimize construction impacts and maintain fish passage during construction are expected to be substantial. Compensation may be required to landowners for possible reductions in farming potential of the existing vineyard and/or the existing pasture in the proposed flood bypass alignment. Additional costs would be incurred to remove another 7,200 yards of sediment to remove levees and create the bypass channel, construct in-stream habitat features, and re-vegetate the riparian corridor. Ongoing maintenance costs associated with periodically removing sediment from the sediment management area would also be required.

Uncertainty

Uncertainty regarding the duration of the effectiveness of the sediment removal is an important consideration as deposition of sand and gravel is expected to continue in this reach. Although the lifespan of the sediment removal was estimated to be between 17 and 34 years, the degree to which sediment can be captured and removed within the sediment management area and thus prevented from moving downstream into the flood-prone reach is inherently difficult to predict.

There is long-term uncertainty regarding the evolution of Green Valley Creek in this area. Ongoing sedimentation and flooding may affect the degree to which fish habitat (including migration) and streamflows can be maintained in the newly created channels. An adaptive management plan could be put in place to address these potential problems.

Comparison Tables

The following tables compare the various alternatives described above; these summary tables are intended to help clarify the relative advantages and disadvantages associated with each alternative. Table 1 compares the level of flood protection provided by each alternative. Table 2 compares the volumes of sediment removal associated with each alternative as an index of costs and the degree of difficulty of obtaining permits. Table 3 provides an overall summary comparison of the alternatives from the various perspectives discussed in the report.

Table 1: Comparison of the flow above which road flooding initiates for the various alternatives.

	Discharge (cfs)	Recurrance Interval
2013 Conditions	423	<1-yr
Alternative 1	<292	<1-yr
Alternative 2	>1,450	>5-yr
Alternative 3	1,450	5-yr
Alternative 4	1,175	>2-yr

Table 2: Comparison of the volumes of sediment removal associated with the various alternatives.

	Sediment Volume (yards)		
	Inside Floodway	Outside Floodway	**Total**
Alternative 2	-	11,300	**11,300**
Alternative 3	32,000	-	**32,000**
Alternative 4	11,100	7,200	**18,300**

Table 3: Summary comparison of the alternatives from a variety of perspectives.

Alternative	1 - Do Nothing	2 - Causeway and Natural Channel Evolution	3 - Channel Re-establishment and Sediment Management	4 - Floodplain Reconnection and Sediment Management
	Allow the channel to evolve without intervention	Construct a new elevated road profile between Cemetery Curve and the bridge	Remove sediment to restore channel capacity over 0.5-mile reach centered on the bridge	Remove portion of west bank levee to activate bypass and construct driveway bridge for landowner access
		Include sufficient openings to allow flow to the east and beneath the road	Re-align main channel farther from the road	Upgrade existing Green Valley Road culvert west of bridge to facilitate bypass outflows
Description		Construct channel to convey flow and provide fish passage back to Atascadero Creek	Re-activate historic side channel	Enlarge floodway and construct a new high flow channel on west bank and remove levee on east bank below bridge
		Construct new in-stream and off-channel habitat features in existing vineyard	Construct grade-control structure at upstream end of reach	Construct a new channel and remove sediment to increase channel capacity adjacent to the road
			Construct new in-stream habitat features in restored channel alignment	Construct new in-stream and off-channel habitat features in restored channel alignment
			Establish sediment management program above Cemetery Curve	Establish sediment management program at bypass head
Typical Frequency of Road Flooding	Many times per year	Less than 20% chance each year (>5 year recurrence interval)	Approximately 20% chance each year (5 year recurrence interval)	Approximately 40% chance each year (>2 year recurrence interval)
	Potential for fish stranding in the vineyard	Reduced stranding potential	Reduced stranding potential	Reduced stranding potential
	Continued loss of summer stream flow due to depth of sand and gravel and dispersion of flow to multiple channels	Continued loss of summer stream flow due to depth of sand and gravel and dispersion of flow to multiple channels	Short-term negative impacts during construction and vegetation re-establishment over large area	Continued loss of summer stream flow due to depth of sand and gravel and dispersion of flow to multiple channels
Habitat Benefits/Impacts	Poor in-stream habitat in the vineyard channels during periods of flow into the vineyard	Increased off-channel habitat and improved in-stream habitat (assumes habitat restoration in existing vineyard)	Increased off-channel habitat and improved in-stream habitat (assumes habitat restoration in existing vineyard)	Short-term negative impacts during construction and vegetation re-establishment over smaller area
	Potential development of fish passage problems	Potential development of fish passage problems	Likely increase in summer stream flow	Increased off-channel habitat
	Increasing frequency and duration of road closures	Major reduction in frequency and duration of road closures	Major reduction in frequency and duration of road closures	Major reduction in frequency and duration of road closures
Landowner & Public Safety Benefits/Impacts	Increasing frequency and severity of vineyard impacts	Loss of farming potential for a large portion of vineyard	Major reduction in frequency and severity of vineyard impacts	Likely ongoing vineyard impacts
	Increasing risk to public safey	Major reduction in public safey risk	Major reduction in public safey risk	Major reduction in public safey risk
		Requires cooperation from vineyard landowner	Difficult to permit in-channel work; EIR probably required and significant permitting.	Requires landowner cooperation from multiple landowners
Feasibility/Permitting		EIR probably required and significant permitting.	Requires annual permit for sediment removal	Difficult to permit in-channel work; EIR probably required and significant permitting.
			EIR probably required and significant permitting.	Requires annual permit for sediment removal
	Increasing road maintainance costs	Acquisition of a large portion of the vineyard	Large sediment removal costs	Modest sediment removal costs
	Increasing vineyard clean-up costs	Large road and causeway construction costs	Grade-control structure costs	Conservation easement for bypass on private land and possibly compensation for loss of vineyard famring potential
Costs	Increased future costs for mitigation	Channel and off-channel habitat feature construction costs	Ongoing costs associated with sediment removal	Bypass, bridge, and culvert upgrade construction costs
	Potential cost of "take"		Channel and off-channel habitat feature construction costs	Levee removal and terrace construction costs
				Ongoing costs associated with sediment removal
Uncertainty	Long-term uncertainty regarding fish passage to and from Upper Green Valley Creek	Long-term uncertainty regarding fish passage to and from Upper Green Valley Creek	Uncertainty regarding sediment management program cost and effectiveness	Uncertainty regarding sediment management program cost and effectiveness
	Long-term uncertainty regarding continuity of baseflows	Long-term uncertainty regarding channel behavior and flooding due to sedimentation processes		Long term uncertainty regarding channel behavior and flooding due to sedimentation processes
				Long-term uncertainty regarding fish passage to and from Upper Green Valley Creek