WTP Preliminary Review Draft

TECHNICAL MEMORANDUM

PROJECT# 4103501

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Prepared for:

Yakima County Public Services
Surface Water Management Division
128 N. 2nd St
Yakima, WA 98901

Prepared by:

ENTRIX
ENVIRONMENTAL CONSULTANTS

ENTRIX, Inc.
200 First Avenue West, Suite 500
Seattle, WA 98119

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1. INTRODUCTION

Entrix conducted an analysis of recent geomorphic changes in a reach of the Water Treatment Gap on the Naches River (Figure 1). This reach is located adjacent to the intake for the City of Yakima Water Treatment Plant along Highway 12 between Naches and Yakima, Washington.

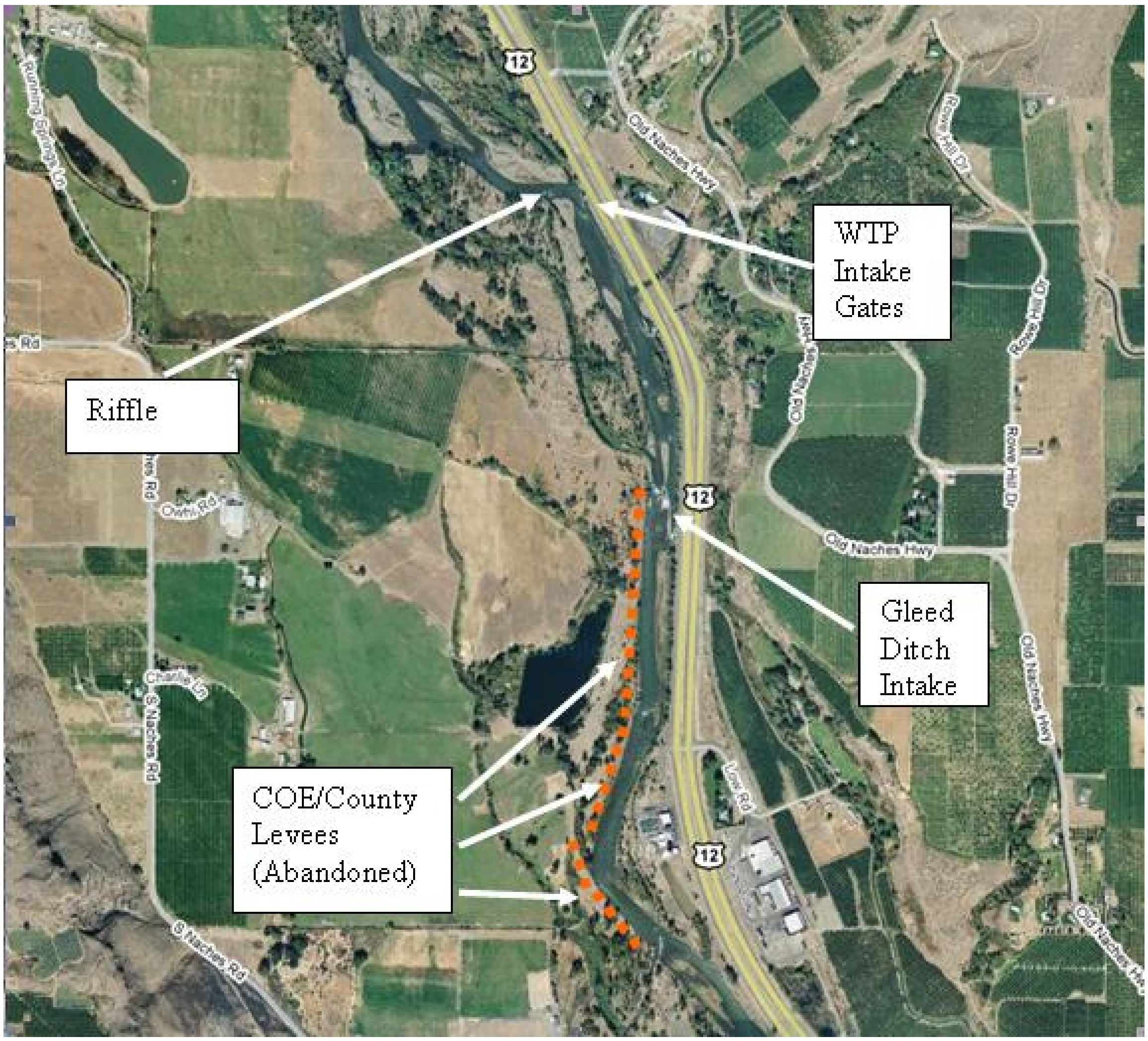

Figure 1. Water Treament Plant Reach along the Naches River

The purpose of this analysis is to assess the potential for channel avulsion upstream of the Water Treatment Plant intake and determine the level of associated risk to that facility as well as other downstream structures. In fluvial geomorphology, avulsion refers to a rapid migration of the river channel from its previous course, usually during flood events. The potential avulsion location for this assessment is immediately upstream from the water intake for the treatment plant, along the right bank (Figure 2).

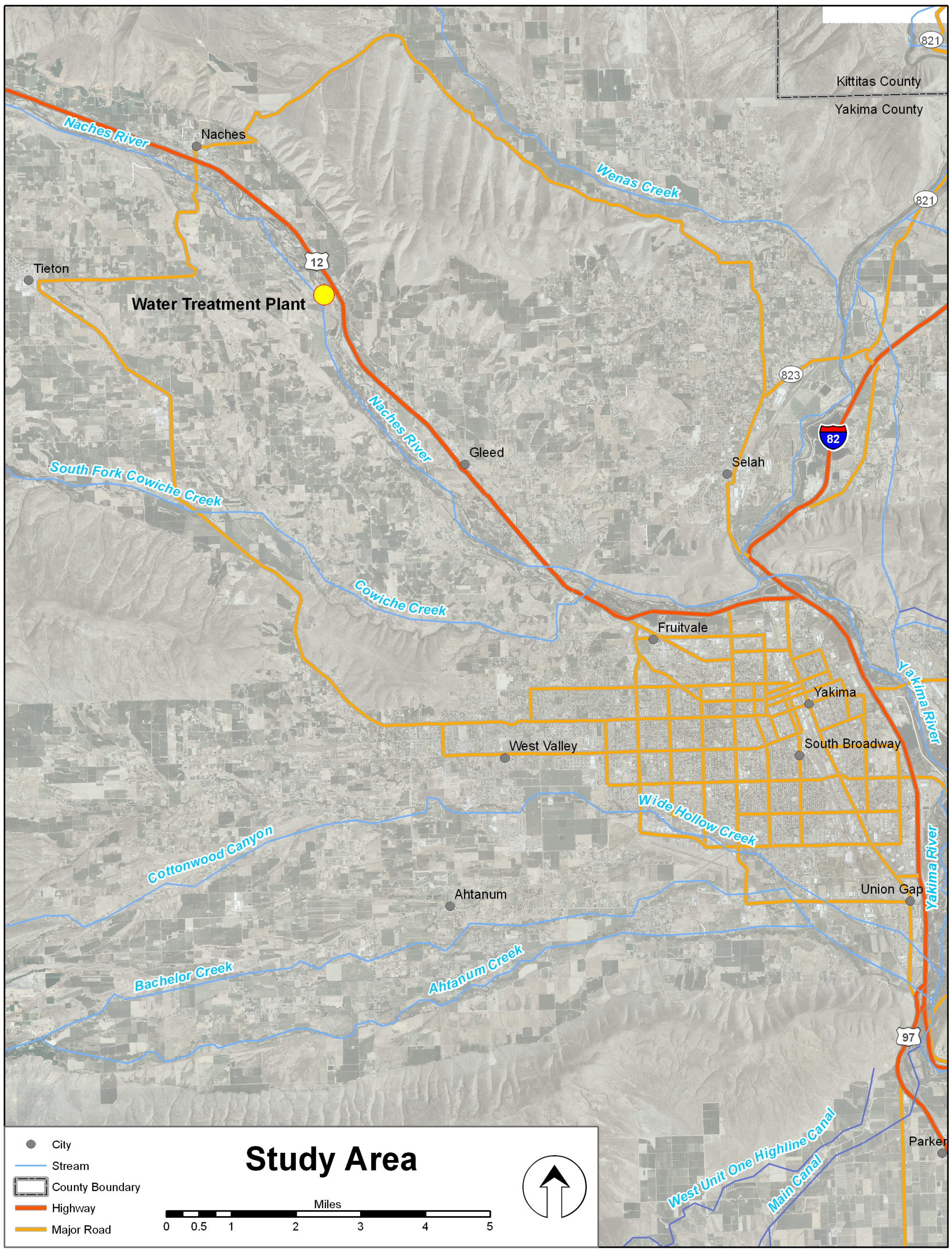

Figure 2. Project location including; Yakima and Naches Rivers and the Water Treatment Plant

1.1. BACKGROUND

Water Treatment Facility
Gleed Ditch
CFS used for both this facility and the Gleed ditch
Legacy of an old levee

1.2. PROJECT DESCRIPTION

The Yakima County-wide Flood Control Zone District is proposing to remove and relocate up to 60 cubic yards of large rip-rap from the main channel of the Naches River to a recently-developed adjacent avulsion channel. The intent of this action is to directly improve habitat conditions in the river by removal of the rip-rap, to reduce the potential for avulsion of the river into the developing side channel, to reduce bank erosion downstream, and to protect the functioning of existing side channels (the avulsion channel and naturally occurring side channels) adjacent to the site. This action is in concordance with the Integrated Streambank Protection Guidelines and should require no mitigation as it addresses a human-caused risk of avulsion.

The Corps of Engineers installed a temporary bank protection levee on the Younker property during the May 2008 flood event/emergency declaration. The intent of this levee was to retard the rapid rate of bank erosion (200 feet laterally in the last 3 years, over 100 feet in the May event) and reduce the probability of an avulsion of the river at this location and continuing downstream. The potential for avulsion at this location remains high as evidenced by the rate of lateral bank erosion/channel movement of the avulsion channel (300 feet in the last 3 years, over 150 feet in the May event alone) and the increasing frequency and proportion of the flow of the Naches River which is routed down the avulsion channel. This summer, this channel conveyed 30-40 percent of the flow in the river until late July, when flows dropped below the inlet. Multiple headcuts that had initially developed during the May flood event continued to move upstream after the height of the flood. This channel was re-activated by the initiation of flip-flop at approximately 900 cfs on the Naches gage, the upper headcut is actively migrating during the flip-flop flows of approximately 2000 cfs. Continued movement of headcuts in this channel at these relatively low flows indicate that full avulsion of the Naches River into this channel could occur at any time during frequent flood events such as minor winter and spring flooding, or the annual spring runoff peaks.

An avulsion, even during minor flood flows, would likely behave significantly different – probable effects would be capture of the gravel pit, associated headcutting, and development of a channel downstream for an unknown distance. Ancillary effects could include reconstruction and expansion of the rock wier and related structures for the Gleed Ditch Diversion, the Yakima WTP diversion, and the Yakima Valley Canal diversion, plus any necessary fixes to Eschbach Park. Also effected would be the planned side channel and floodplain enhancements on the Younker Property (JARPA attached). The Younker project will probably not occur unless the causal factor for avulsion and the instability of the avulsion channel is addressed through removal of the rip rap from the river and stabilization (just to prevent dramatic change from headcuts) of the avulsion channel entrance is performed.

The project will occur at the lowest flow time of the year, immediately following the cease of irrigation delivery through the Naches River. This timing was selected to minimize impact on fish life as the work will occur before fish have moved into newly available habitat that results from the dramatic drop in flow at this time. Basically, the work will occur when the river is in a transitional state. Low flows will also minimize the amount of time the excavator will be in contact with the flowing water, allow a much cleaner removal of the rocks due to improved vision and less disrupting flows. Also no road or other access needs to be created for this project if the riprap can be used to improve or protect existing and proposed functional habitat in and adjacent to the avulsion channel at the site and downstream.

Once the riprap in the channel has been moved, and we have had an opportunity to evaluate how the avulsion channel will perform in the future, we can address the issues surrounding flood hazard reduction, floodplain and habitat restoration in the adjacent reaches, from upstream where the river is against US 12 and WSDOT is planning a project to protect the highway, downstream to Kershaw Drive. The objectives of this larger reach study and actions will be to consolidate/remove/ reconfigure the irrigation and municipal diversions, and removal and setback of the various levee systems, and vegetative restoration of the floodplain and in-channel habitat. All parties – the landowners, adjacent infrastructure owners and operators, the County, and WSDOT are in favor of removal of the riprap in the river as a necessary first step to restoration of this larger reach.

2. ANALYSIS

2.1. METHODS

This analysis evaluated the changes between 1968 and 2008 in the main channel and adjacent side channels. The reach assessed is roughly 2000 ft upstream and downstream of the potential avulsion location.

Geo-referenced air photos between years 1992 to 2008 were evaluated for this analysis. The main channel in each of the air photos was digitized in a Geographic Information System (GIS) and viewed together to determine changes in their location (Figure 3).

The side channel immediately below the potential avulsion site was evaluated for changes in geometry over time as well as the main channel. Bank lines were delineated on the 2008 aerial photo along the main channel at and immediately upstream from the potential avulsion location, and at the downstream junction of the side channel and the main channel. These bank lines were used as a reference to evaluate bank stability over time. Figure 4 depicts the bank lines and each of the aerial photos.

A RAS hydraulic model was also constructed for the study location, extending 1000 feet up and downstream from the water intake along Highway 12. This model was used to determine the flood inundation extents and depths for a series of recurrence intervals (1, 2, 5, 10, 20, 50, and 100 yr). Recurrence interval discharges were obtained from Table C-1 in Naches River Reach Analysis and Management Plan – Lower Naches River (2003). Recently acquired LiDAR topographic data is currently being processed and will not be available until the end of September 2008, therefore older LiDAR topographic data from provided by Yakima County was used in this model. Due to coverage constraints in the 2005 LiDAR dataset provided, a second LiDAR dataset from 2000 was incorporated into this model in areas lacking coverage (Figure 5). Last return data points (bare earth) from both datasets were gridded using the Inverse Distance Weighted (IDW) method to create a digital elevation model (DEM) with a cell size of 3.28 $foot^2$ (1 $meter^2$). Roughness coefficients were determined using aerial and field site photos. Channel cross sections spaced at 20 feet, flowpaths, banks, and roughness were all entered into the GIS and exported to RAS using GeoRAS. Subcritical steady flow simulations were performed using normal depth boundary conditions for all recurrence intervals.

2.2. RESULTS

Changes in the main channel occurred throughout the years analyzed. It is apparent from the photo analysis that a significant portion of the bank upstream of and at the potential avulsion location eroded between 1992 and 2000 (Figure 4). After 2000 this bank remained largely intact, however, some lateral erosion may have occurred at the potential avulsion location.

It is not conclusive from the aerial photos if the banks have actually eroded at the potential avulsion location from 2002 to 2008, or if changes in water stage between aerial create the appearance of erosion. Examination of the LIDAR available from the County proposed for October 2008 will further determine the changes in erosion between years.

A widening in the downstream end of the side channel immediately below the potential avulsion location at its downstream junction with the main channel is observed (Figure 4). This widening occurred in at least two stages, between 1998 and 2000, and between 2002 and 2006. This widening suggests that the side channel is conveying more water over time.

Although channel conditions differed between the years examined, the changes associated with the greatest potential effect on the potential for avulsion occurred between 2006 and 2008. Within this period, changes in the mainstem channel location occurred approximately 1000 ft upstream from the water intake (Figure 3). In 2006, the main channel flow path was located further to the east approximately xx feet and the flow was split between two distinct channels. In 2008, the course of the mainstem channel is similar but the concentration of flow is now primarily in the channel further to the west. Channel migration within the Naches River at the study location has resulted in a shift in channel alignment such that the current path of the river is in direct alignment with the potential avulsion location (Figure 3). This conveyance of additional flows is likely to increase the risk of for avulsion as well as increasing shear stresses on the banks during all flows regimes.

Analysis of aerial photographs shows construction of the right bank levee upstream of the Water Treatment Plant between 1968 and 1971. The next available aerial photograph is from 1992, which shows 210 feet of the upstream end of the levee has been eroded by the migrating river. A series of 6 aerial photographs from 1992 to 2008 shows continued gradual erosion of the upstream end of the levee at approximately 7 ft/yr to a total of 320 feet by 2008 (Figure 6). This erosion is caused by an active meander bend immediately upstream from the constructed riffle adjacent to the upstream end of the levee. The meander developed between 1992 and 1996, and has migrated downstream over time eroding the levee and adjacent right bank. This downstream erosion has proceeded into a network of abandoned side-channels where the potential avulsion site is located. The meander geometry was fairly stable from 1998 to 2006, with a slightly increasing radius of curvature. The 2008 aerial photograph however shows a marked decrease in the radius of curvature (~50% reduction) of the meander (Figure 7), which would suggest higher stage for a given discharge as water is slowed to make a tighter and tighter turn. These higher stages increase the discharge through the potential avulsion location for any given discharge. Thus instability is two-fold, it is created by the meander migrating through the potential avulsion location and from the backwater effects of the meander tightening increasing the discharge through the potential avulsion location.

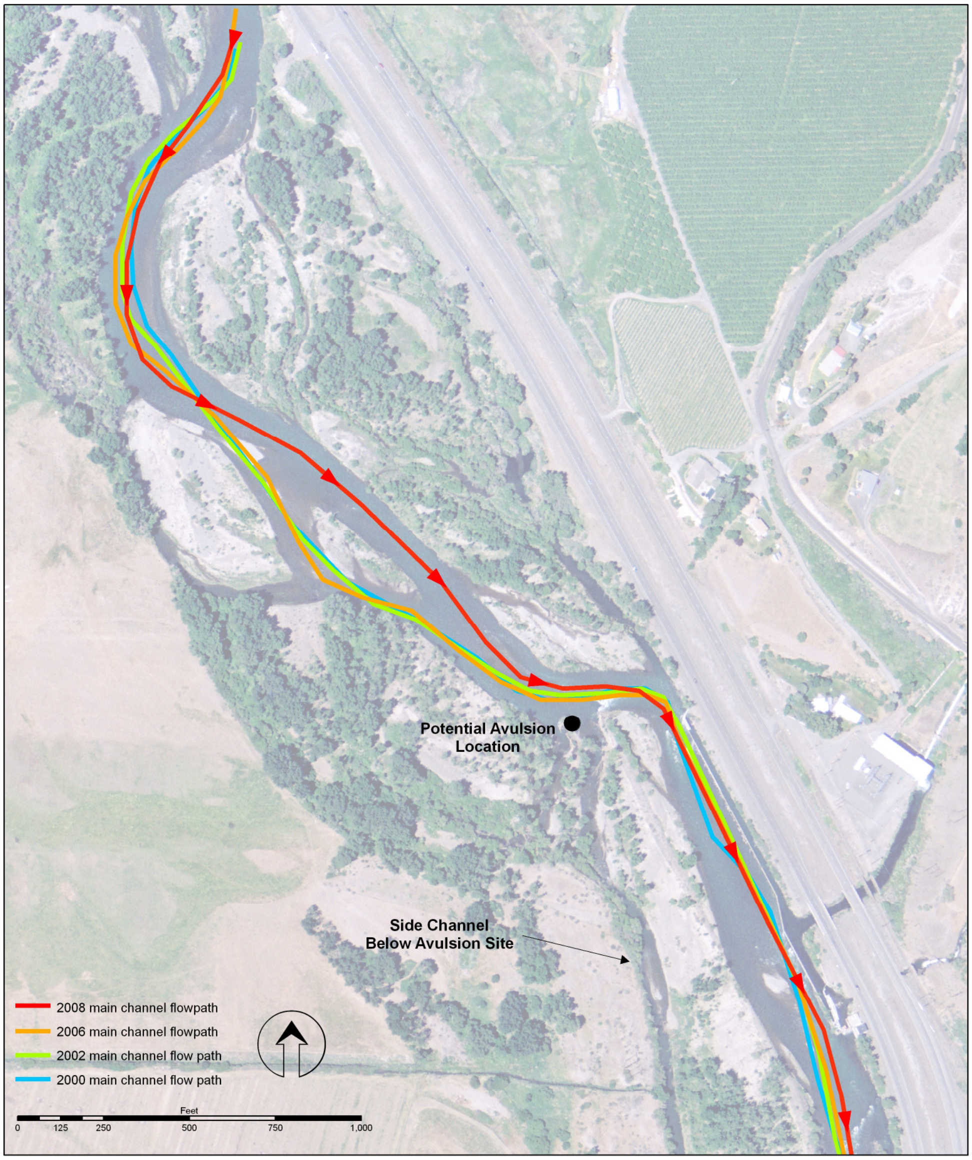

Figure 3. Migration of the main channel form 2000-2008

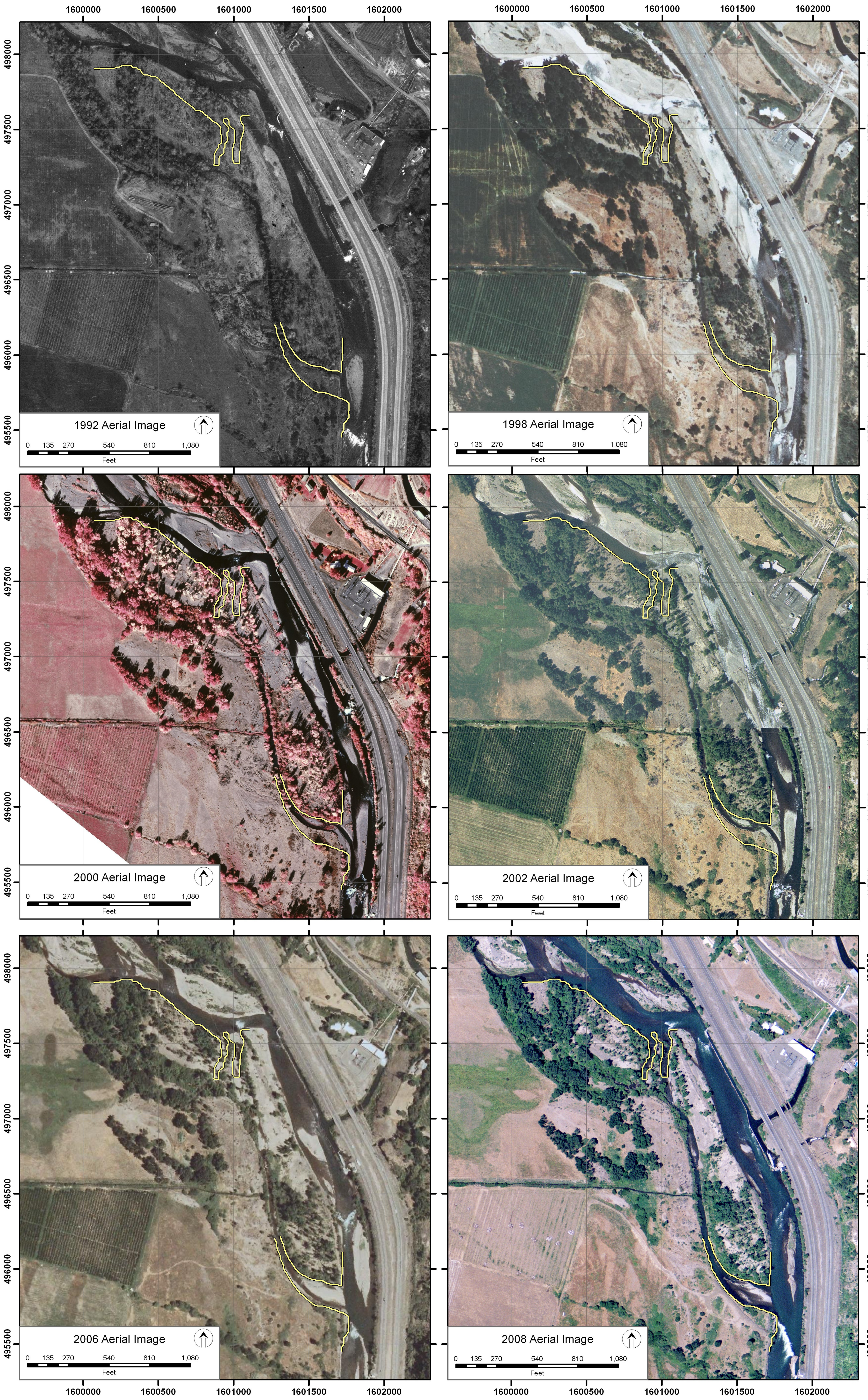

Figure 4. Changes in the banks of the main and side channels

Figure 5. Extent of LiDAR for 2005 dataset and area where 2000 dataset was used.

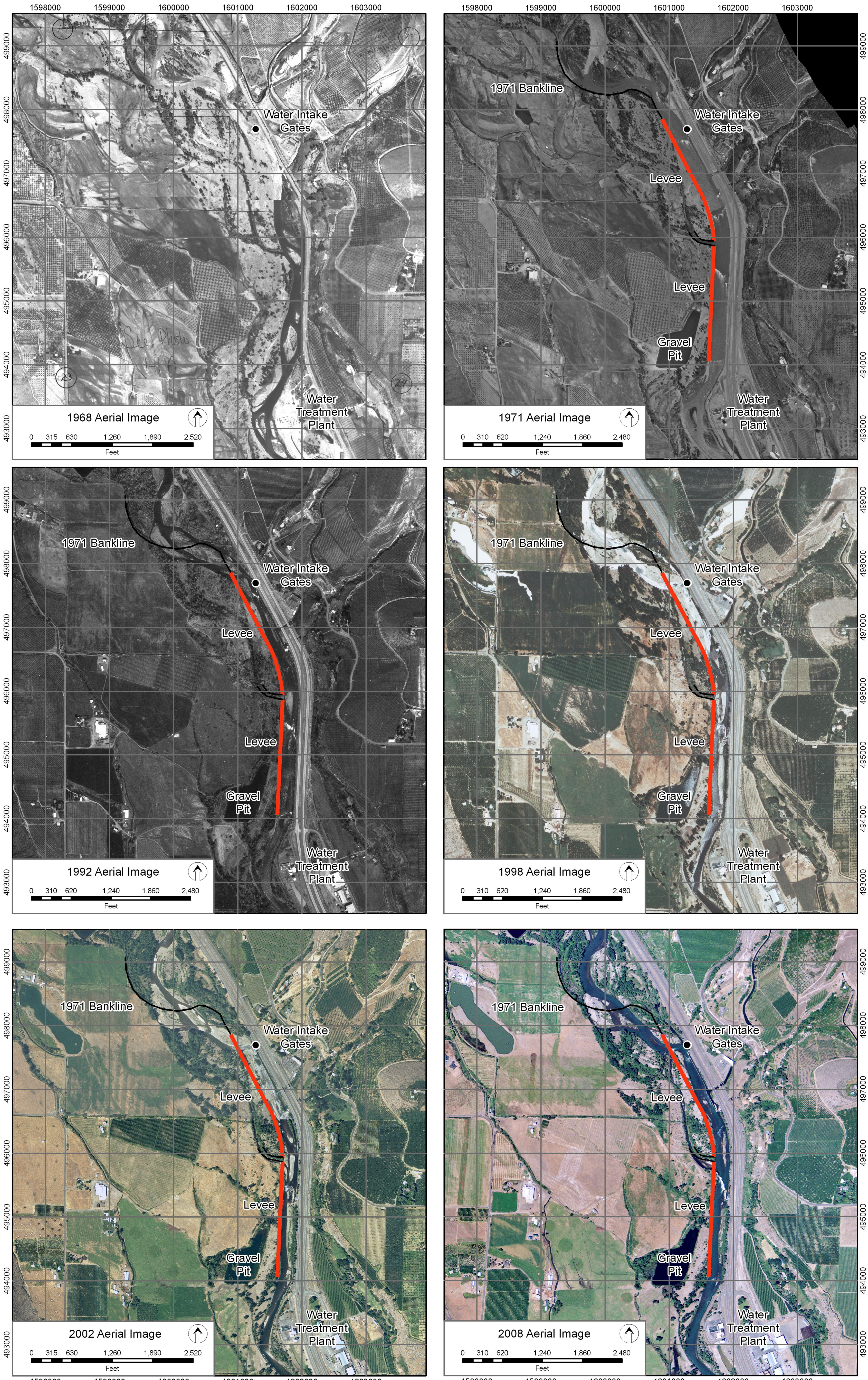

Figure 6. Time-series of aerial photographs showing erosion of levee and migration of the main channel

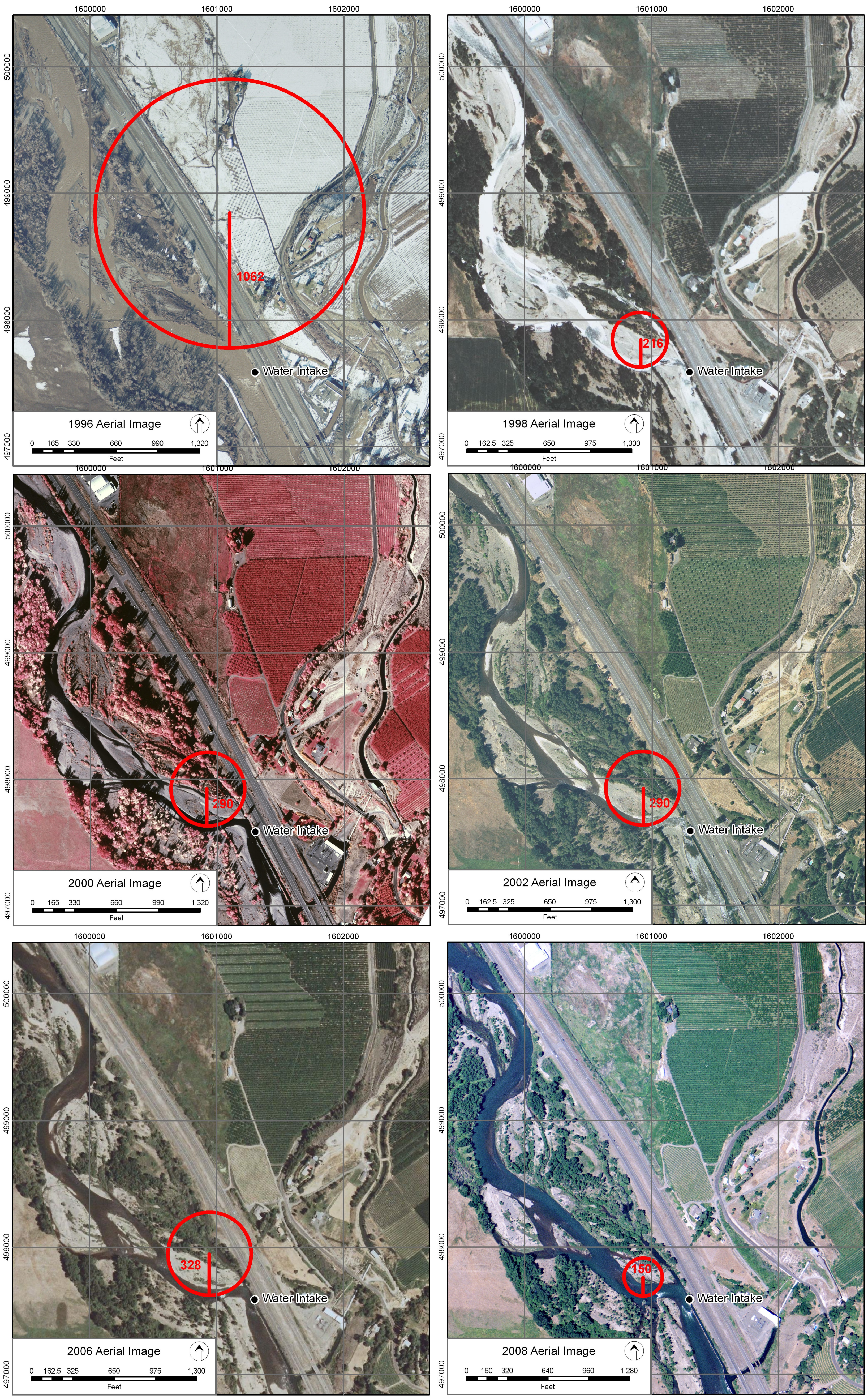

Figure 7. Time-series of aerial photographs showing initiation of meander near 1996, stability between 1998 and 2006, and recent change (2008) with associated radius of curvature changes.

Limitations to the RAS model encountered included the lack of current topographic data (2008) and the density of LiDAR data points in the area of most concern. Figure 8 depicts the distribution of the 2005 LiDAR data points used to create the DEM for the RAS model. There is a large area lacking data points within the main channel from the upstream end of the potential avulsion location downstream to the water intake along Highway 12. The constructed riffle immediately downstream from the potential avulsion location is within the area of no coverage, and is thus not accurately depicted in the DEM. Surveyed cross sections within this area would greatly benefit the accuracy of the model, and provide a better indication of the extent to which the riffle impacts flow through this area of interest.

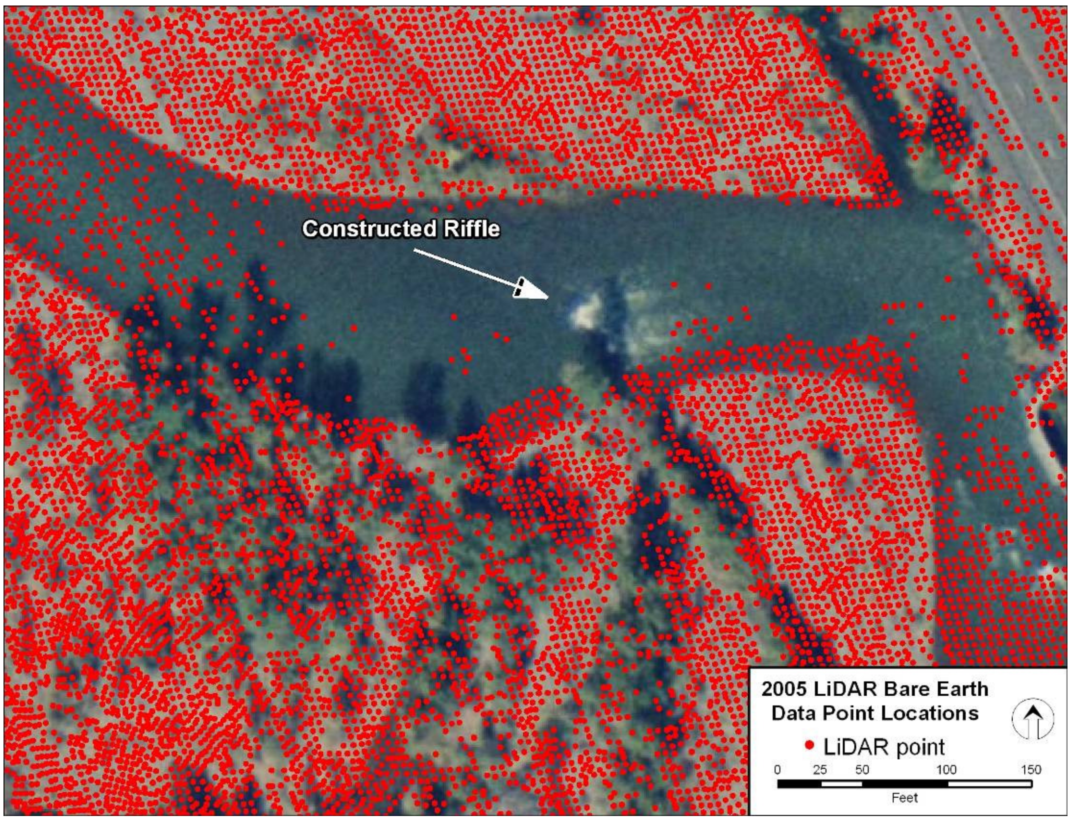

Figure 8. Location of 2005 LiDAR data points adjacent to the potential avulsion location.

Of particular interest is the recurrence interval at which water begins to flow through the potential avulsion location. Our model shows activation of one side channel within the potential avulsion location at the 1 yr flow (Figure 9). Water depths within the side channel where it exits the main flow channel are only 0.3 feet, suggesting the annual recurrence flow (1 yr) is at or very near the flow necessary to initiate activation of the potential avulsion location. Downstream profiles of the main channel and the side channel (Figure 10) activated during the annual flow are depicted in Figure 11. Apparent is a wedge of sediment at the potential avulsion location extending roughly 350 feet downstream that is being eroded by the side channel.

The maximum height of the side channel bed above the main channel bed in 2005 was 2.3 feet. Downstream from this wedge of sediment the bed of the side channel reaches a maximum of 3.9 feet below the main channel. Once the side channel downcuts through the remaining 2.3 feet of sediment at the potential avulsion location, the stream gradient will be greater through the potential avulsion location than the current main channel. The 2yr inundation (Figure 12) shows widespread overtopping of the main channel banks into and through the potential avulsion location. Furthermore, a network of side channels appears to be conveying water through the potential avulsion location creating a zone rather than a single channel of concern. This eroded zone could result in failure if one of the side channels eroded through the wedge of sediment, captured the upstream flow, and widened through the remaining network of channels until the entire main channel relocated through the potential avulsion location.

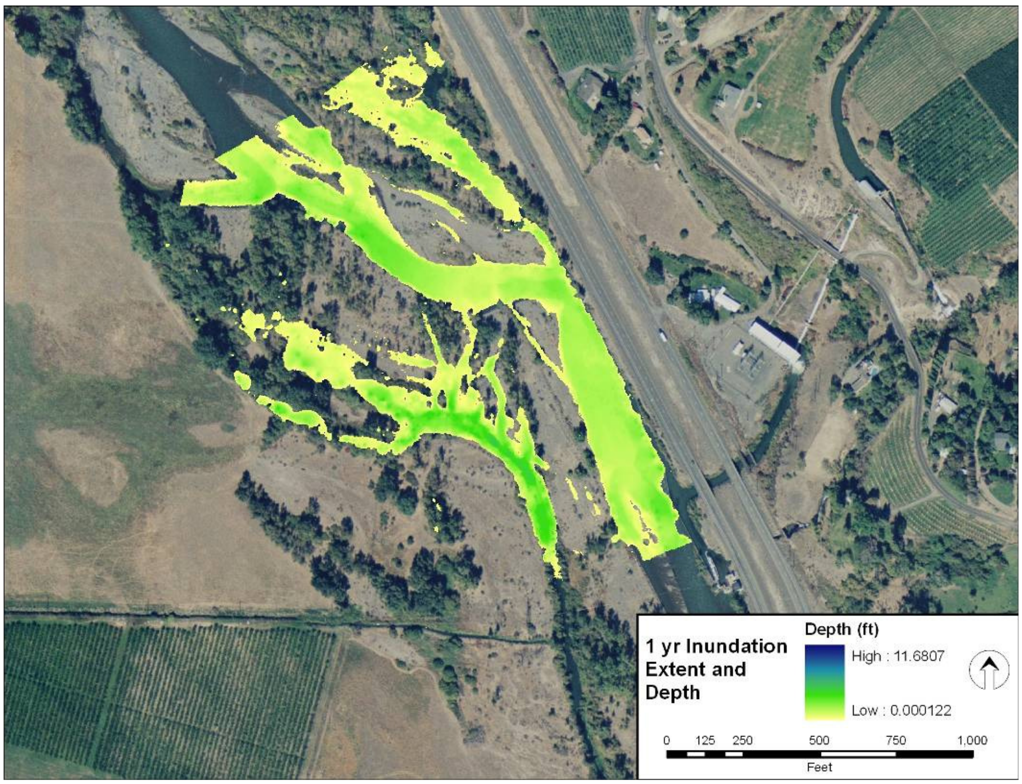

Figure 9. Extent of inundation during annual (1 yr) flow.

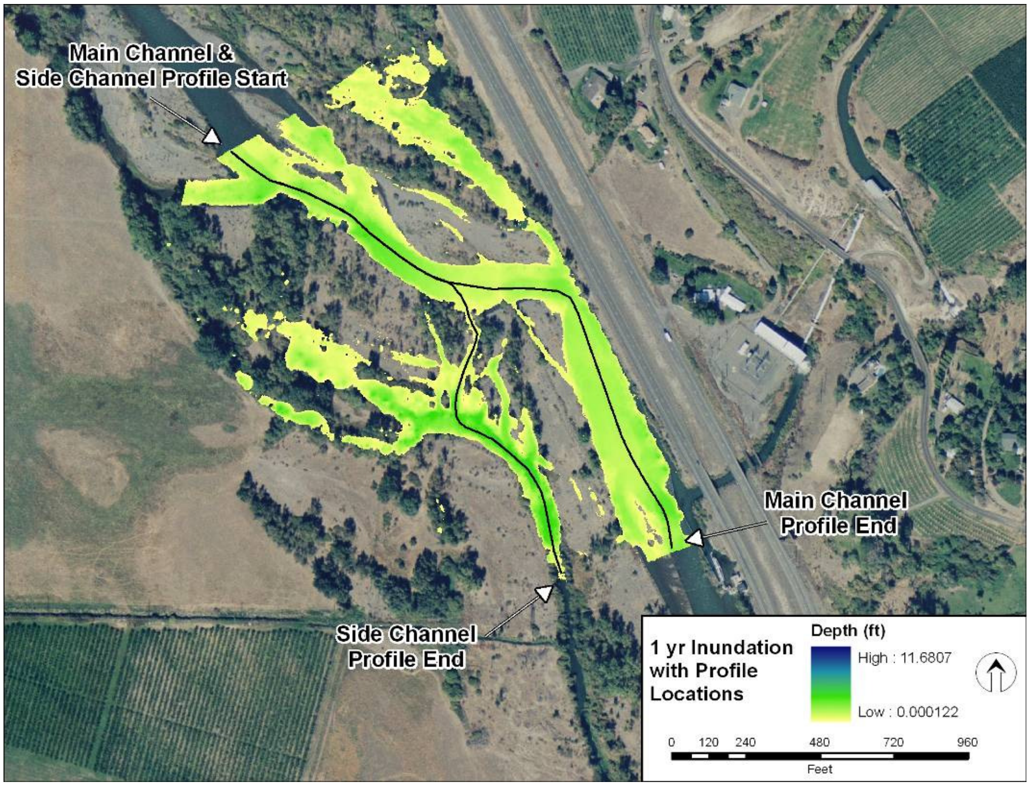

Figure 10. Location of main and side channel profiles.

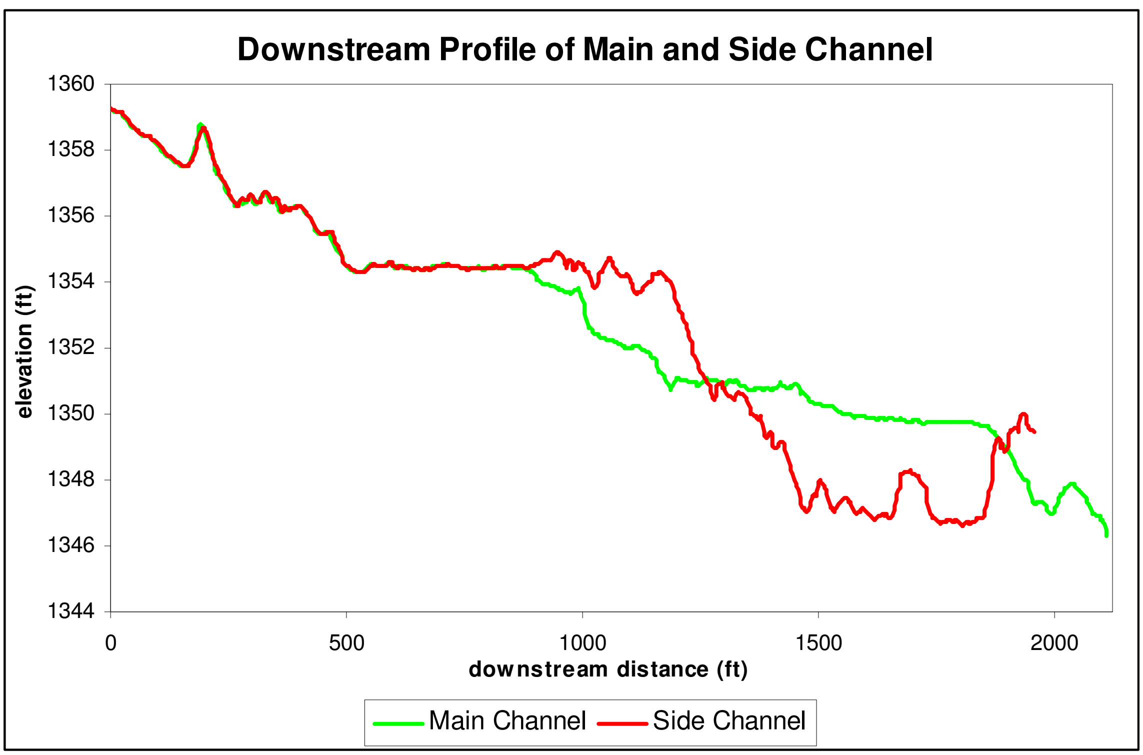

Figure 11. Main and side channel downstream profiles (based on 2005 LiDAR).

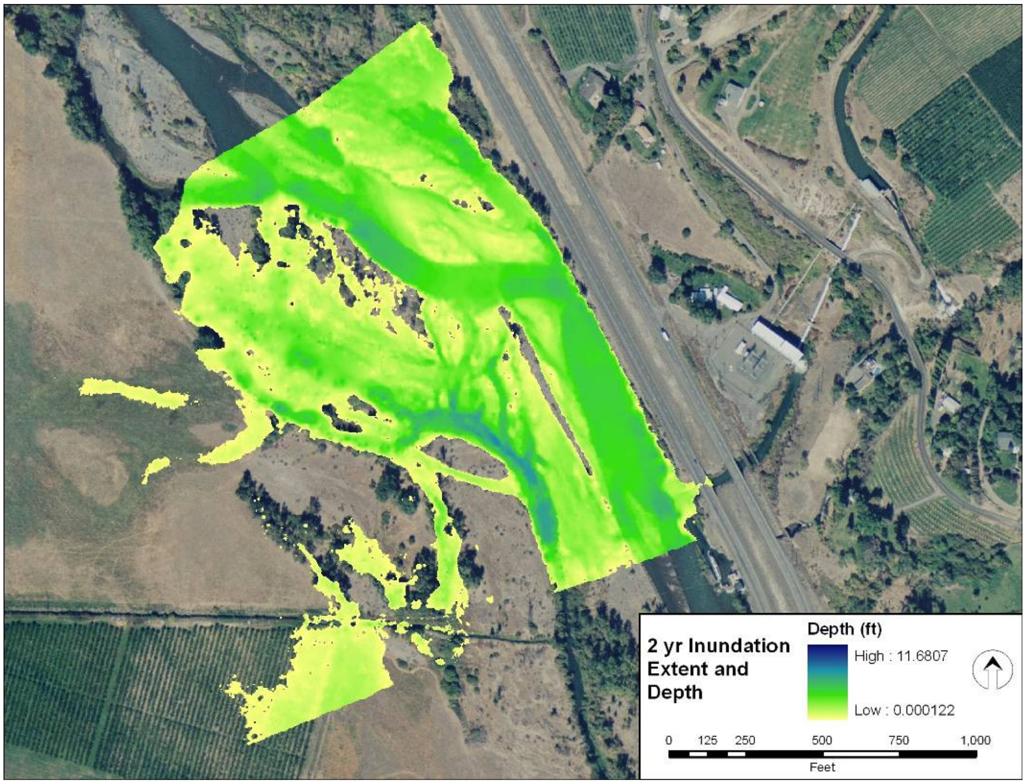

Figure 12. Extent of inundation during 2 yr flow (based on 2005 LiDAR).

3. ALTERNATIVES ASSESSMENT

Three potential alternatives have been identified to address the avulsion hazard to date:
Identify placement option for constructed riffle

- Prevent river avulsion
- Plan and location for river steering
- Meet WTP intake requirements
- Address permitting constraints
- Meet constraints of constructability
- Consideration of grade controls structures

No Action

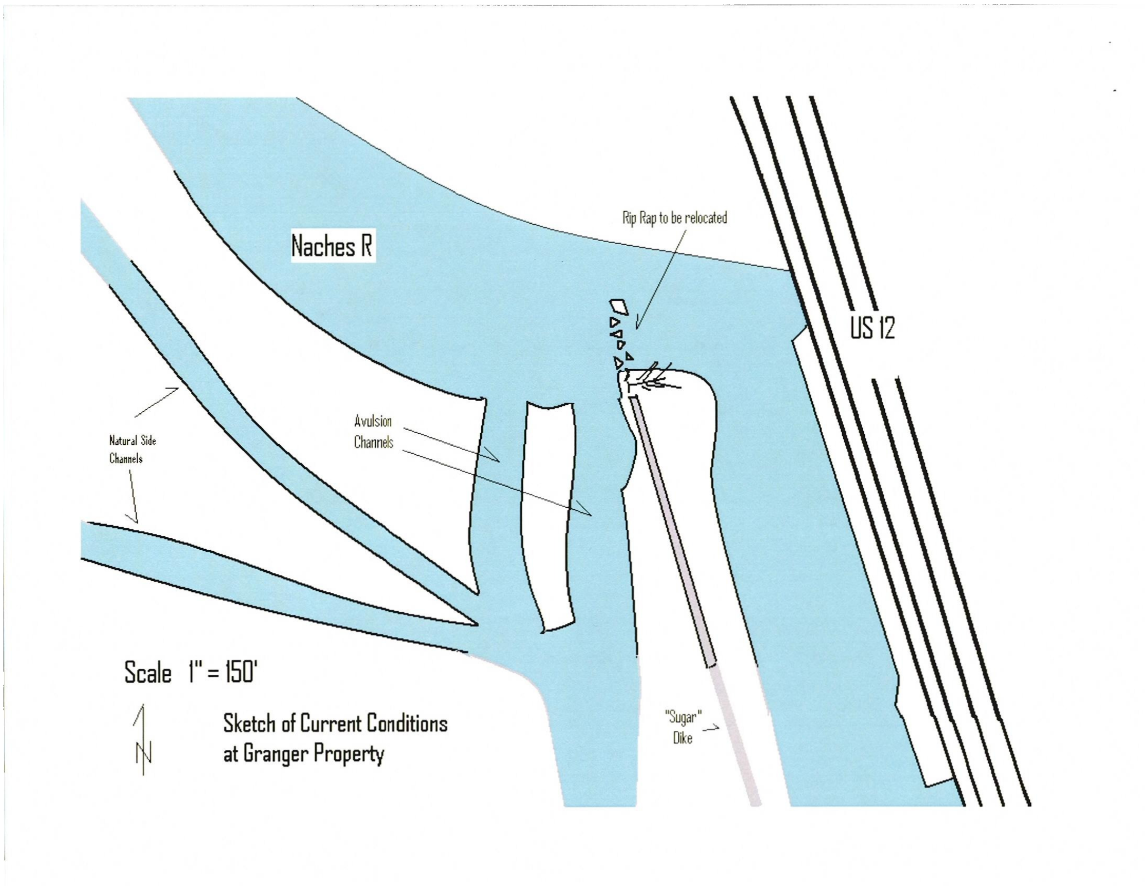

Figure 13. Alternative #1 – Remove rocks from levee legacy to off-site location

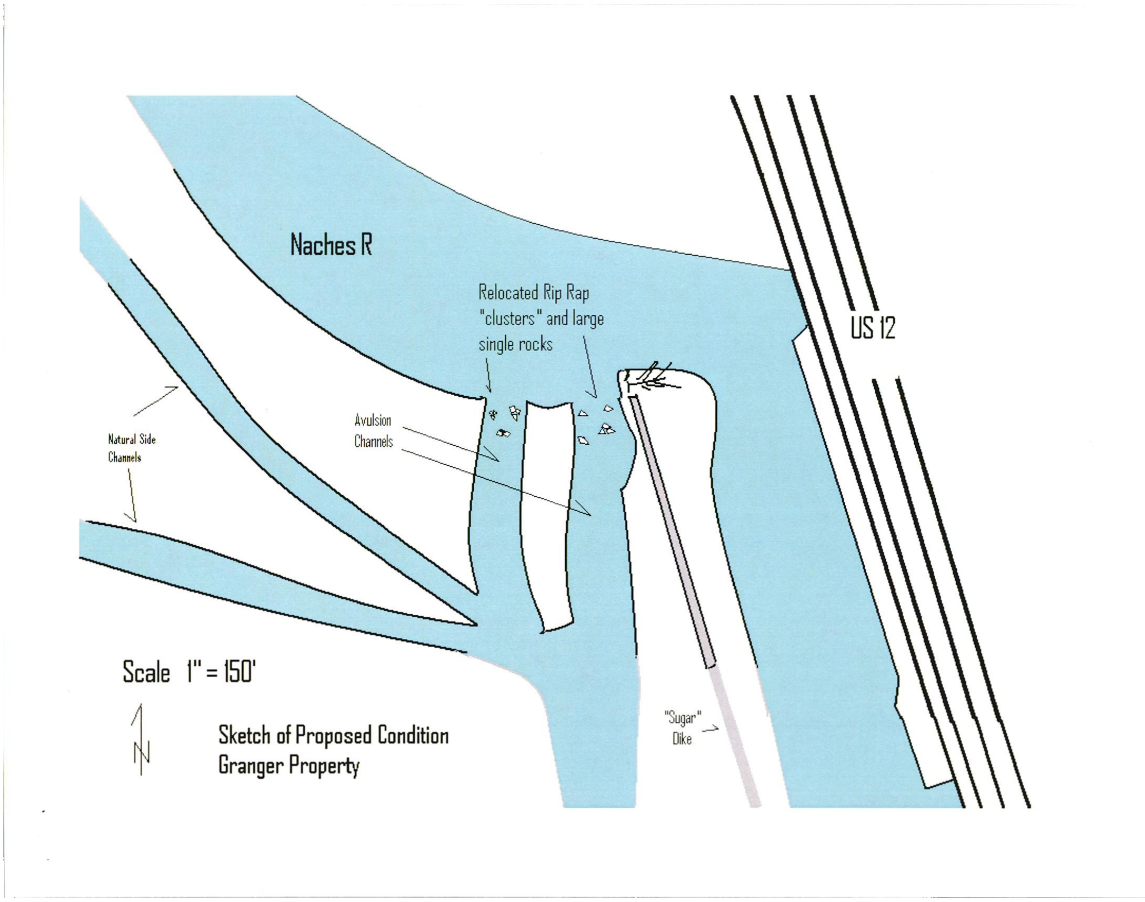

Figure 14. Alternative #2 – Remove rocks from levee legacy and use to deflect flows away from the avulsion risk

The alternatives were evaluated and the associated risks and benefits of each alternative are provided below. Cost, permit -ability, timing, hazard mitigation, and habitat benefits were considered for each alternative.

3.1. RISKS

No Action

Under the no action alternative the rock would remain in place. As our analysis has shown this alternative would likely result in the avulsion of the Naches River at the site location. The effects of this avulsion impact both water diversion needs and instream habitat conditions. Specifically, no action could result in partial or total loss of flows to the Yakima WTP and Gleed Ditch. Furthermore, instream habitat would be dewatered and the avulsion channel could flow outside of the existing levee structure and the current flow path would be significantly altered.

Preventative Action

Alternative #1: Proposes that the rock and haul excess material be removed from the channel and hauled to an off-site location. This alternative does allow for an improvement to the current hazard conditions. However, while the removal of material will result a decrease in the potential for avulsion, it may not prevent it at higher flows. This alternative will also result in disturbance to the channel while providing no additional instream benefits.

Alternative #2: Utilize material within the river to benefit instream conditions and provide floodplain protection.

4. SUMMARY