ALTERNATIVES ANALYSIS

UPPER NISQUALLY RIVER

MRNP REVETMENT RETROFIT

Pierce County

January 17, 2018

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1.0 INTRODUCTION

Pierce County Planning and Public Works is proposing to make modifications to the existing Nisqually River levee to reduce the effects of erosional flows that have resulted in repetitive damage to the levee[1]. The project site is situated along the right bank of the river, extending from river mile (RM) 64.5 – 65.4, near the entrance to Mount Rainier National Park (MRNP) and State Route 706 (SR-706). The upstream section of the project is located within the MRNP and the downstream end is located within unincorporated Pierce County (Figure 1).

The Nisqually River originates from the Nisqually Glacier on the south slope of Mt. Rainier and flows westerly towards its terminus in South Puget Sound. Two tributaries, Kautz and Tahoma Creeks (originating from the Kautz and South Tahoma Glaciers, respectively) join the mainstem Nisqually River above the project reach. The Upper Nisqually River is a braided stream characterized by high sediment loads, a dynamic floodplain with multiple side channels, and frequent channel changes.

1.1 Background

The Nisqually Levee was originally constructed in 1961 with the purpose of protecting the Mount Rainier National Park (MRNP) access road and the Nisqually Park Subdivision from erosional flows and channel migration of the river. Since 1991, the levee has experienced damage nearly each year, at an average repair cost of $280,000. On November 6-7, 2006, a historic flood of record occurred at the site resulting in an estimated peak discharge in the river of 21,800 cubic feet per second (cfs) measured at the U.S. Geological Service (USGS) gauge located at National. MRNP was inundated with 18 inches of rainfall in a 36-hour period. The rain unleased raging torrents of water into the river and streams. MRNP sustained significant damages and was forced to close for four months. At the project site this event washed away 1,773 LF of the existing levee, removing 5.5 acres of upland, damaging beyond repair the Sunshine Point Campground and 500' of the MRNP main entrance access road. The loss of the park access road closed MRNP for four months and cutoff all power and communication utilities to the park.

Shortly after the flood, PCSWM in partnership with MRNP and the USACE began rebuilding the access road and levee. The first phase of this project was completed in early 2007. The remaining levee was rebuilt in 2009. All the repairs were made as part of the PL84-99 program with the USACE. Since the levee was rebuilt in 2009 reoccurring damages to the facility have continued, costing Pierce County and the USACE $2.93 million in additional repairs. As recently as 2017, the USACE and Pierce County repaired 400 LF of the levee structure adjacent to the MRNP access road that had previously been rebuilt in 2007 at a cost of $1.22 million. Most of

[1] The majority of the upper Nisqually River levee functions as a levee structure extending in height above the adjacent floodplain. The 700 ft. upstream portion of the structure functions as a revetment at grade or below with the adjacent upland. For purposes of this analysis, the structure is referred to as a "levee".

the recent damages to the levee have been from scour of the levee toe and loss of facing rock due to the thalweg of the river being entrenched against the levee. Damages are expected to continue with the current river configuration.

2.0 U.S. ARMY CORPS OF ENGINEERS REGULATORY SETTING

This alternatives analysis is intended to support the U.S. Army Corps of Engineers (USACE) Department of the Army (DA) permit evaluation under Section 404 of the Clean Water Act (CWA), which regulates the discharge of dredged or fill material into waters of the United States (WOTUS), including wetlands. This analysis is also intended to support the USACE's compliance with the National Environmental Policy Act (NEPA).

Under NEPA, USACE has responsibility to consider "reasonable alternatives" capable of meeting the overall project purpose. Reasonable alternatives include those that "are practical or feasible from the technical and economic standpoint and using common sense, rather than simply desirable from the standpoint of the applicant" (CEQ 1981). The alternatives analysis also provides rationale and support for required coordination for essential fish habitat (EFH), endangered species, marine mammals, cultural resources, and other resources that may require consultation with responsible federal, state, and local agencies.

Under Subpart B of the Section 404(b)(1) Guidelines (Guidelines), the USACE's evaluation is required to address four tests that the proposed project must meet in order to receive a Section 404 permit. The first compliance test under the Guidelines states: Except as provided under Section 404(b)(2), no discharge of dredged or fill material shall be permitted if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences. Based on these Guidelines, the USACE's evaluation must include a determination of whether the proposed project is the "Least Environmentally Damaging Practicable Alternative" (LEDPA). The USACE determines whether an alternative is practicable based on whether it is available and capable of being done after taking into consideration cost, existing technology, and logistics in light of the overall project purpose (40 Code of Federal Regulations [CFR] §230.3(q)).

3.0 PROJECT PURPOSE AND NEED STATEMENT

3.1 Proposed Project

Pierce County is proposing the construction of shore bank treatments along 4650 LF of the existing levee for the purpose of reducing erosion and subsequent reoccurring damage to the levee by reducing the adjacent water velocity by shifting the thalweg and erosive flows away from the levee face. No wetlands have been identified within the project limits. Impacts are limited to Waters of the United States (WOTUS) within the Nisqually River channel only. Mitigation for project impacts includes a sequence of avoidance, minimization and/or compensation. Likewise for unavoidable impacts, Section 404 of the Clean Water Act (CWA) requires compensatory mitigation to replace the loss of wetland and aquatic resource function in the affected waters of the U.S. There are no wetlands on site. Adverse impacts to aquatic riverine resources will be avoided, unavoidable impacts will be minimized and any remaining impacts will be mitigated likely by using large woody debris in the selected design.

3.2 Project Need Statement

The existing levee located on the Nisqually River at the entrance to Mount Rainer National Park is subject to repetitive damage, diminishing the flood protection and increasing the risk of flooding to the adjacent residential subdivision, state highway, and National Park

3.3 Basic Project Purpose

Construct a project that will effectively reduce erosion of the existing levee along the Nisqually River.

3.4 Water Dependency

The facility is not water dependent. All proposed work is not presumed to impact any jurisdictional wetland or special aquatic sites.

3.5 Overall Project Purpose

Construct a project that reduces future maintenance costs to the existing 4650 LF of levee, reduces flood risk to State Route 706, the Nisqually Park Subdivision community and Mount Rainier National Park by shifting the thalweg and reducing velocities along the toe of the levee resulting in reduced erosive forces and subsequent damage to the existing levee.

3.6 Project Geographic Area

The geographical area considered in this analysis of alternatives includes the existing levee located along the right bank (looking downstream) of the Nisqually River from river mile 64.5 to 65.4, approximately 2300 LF upstream (east) of the boundary of MRNP; to a point approximately 3000 LF downstream (west) of the MRNP boundary located with Pierce County. The lateral extent of the project area is from the centerline of the Nisqually River, northward to state route 706; which is approximately 1000 LF wide (Figure 1).

4.0 PROJECT SPECIFIC SITE SELECTION CRITERIA

Pierce County evaluated a range of potential concepts to identify a set of reasonable alternatives for the proposed Project that could meet the projected overall purpose. Each alternative was evaluated based on the following screening criteria:

1) Performance
    a. Erosion Effectiveness
    b. Design Life
    c. Maintenance Effort
2) Impact
    a. Environmental Impact

3) Implementation
    a. Construction Complexity
    b. Pierce County Right-of-Way/easements
    c. Compliance with USACE PL84-99 Rehabilitation and Inspection Program requirements

Each alternative was ranked for each criterion using a scale of 1 (low) to 5 (high). A low ranking score indicates that the alternative fails to meet most of the project goals as defined by that criterion. Whereas, a high ranking indicates that most, or all of the project goals would be met by the alternative. Each criterion ranking was weighted either as a 1 or 2 in the screening process. Three criteria elements were weighted as 2 with the remaining seven criteria weighted as 1. Therefore, the total combined ranking score for each alternative can range from 10 to 50. The nine criteria are organized into three main screening categories: performance, impact, and implementation (Table 1). Each criterion is described below.

4.1 Performance

Alternatives will be assessed to rate the performance effectiveness of the various design alternatives ability to reduce erosion hazards along the existing levee. Performance criteria also includes an assessment of the design life and the level of maintenance required to assure performance over this period. Three criteria are included in the performance category of this analysis:

- Erosion Protection Effectiveness Along the Levee
- Design Life
- Maintenance Effort

4.1.1 Erosion Protection Effectiveness Along the Levee

The “Erosion Protection Effectiveness Along the Levee” ranking criterion evaluates the relative degree of confidence that each alternative will eliminate or reduce erosion hazards over the lifespan of the project. The effectiveness ranking of each alternative is based on the reduction in flood flow velocities predicted by the hydraulic model for the alternative relative to existing conditions. For example, an alternative exhibiting a significant increase in flow velocities would rank relatively low. An alternative showing a reduction in flow velocities adjacent to the levee relative to existing conditions would receive a higher ranking.

4.1.2 Design Life

The “Design Life” ranking criterion evaluates the anticipated life span of the proposed alternative following construction. The anticipated life span for a measure is based on the performance history of the structure, and anticipated longevity for previously constructed projects under similar geomorphic and environmental conditions. The ranking assigned to each alternative for this criterion is proportional to the anticipated design life. For instance, a design life of less than 25 years would receive a ranking factor of 1, whereas a design life exceeding 100 years would receive a ranking factor of 5 (see Table 1). An alternative with a relatively long life span ranks high because it would extend the time period for the need to re-examine flooding and erosion hazards and would reduce the need for repetitive maintenance under the USACE PL84-99 Rehabilitation and Inspection Program. A potential bank stabilization solution with a relatively short lifespan is undesirable because Pierce County would be required to re-address flooding and erosion hazards sooner than with a project with a longer design life.

4.1.3 Maintenance Effort

The “Maintenance Effort” ranking criterion accounts for the level of maintenance required for the alternative to perform as designed after construction. The maintenance ranking criterion (Table 1) ranges from a value of 1, if annual maintenance would be needed, to a value of 5 if no maintenance would be required. Reduced maintenance burden is associated with a higher ranking because it lesser funding and maintenance resources would be required to provide protection from flooding and erosion hazards over the lifespan of the design measure.

4.2 Impact

The potential impacts of an alternative can include the degradation or improvement of existing habitat conditions. The degree to which an alternative impacts these resources determines the level of effort necessary to mitigate these impacts as a condition of the permits required for construction and operation.

4.2.1 Environmental Impact

The “Environmental Impact” ranking criteria considers whether an alternative design provides a major environmental benefit to aquatic, riparian, wetland, and/or forest habitat or whether it will degrade these conditions when compared to existing conditions over the intended design life of the alternative. A design alternative that would have adverse environmental impacts would rank relatively low. For example, the placement of riprap could potentially displace habitat and resulting in degraded aquatic and riparian conditions and would therefore require mitigation outside of the project footprint and possibly off site. A design that is self-mitigating would rank the highest. For example, engineered logjam structures would rank high because they can be self-mitigating and provide bank stabilization while also creating and maintaining habitat by recruiting additional wood and creating complex cover and pool habitat. In addition to the benefits of self-mitigation, properly engineered and constructed bank stabilization measures should exhibit an exceptionally long lifespan, averting environmental disturbance for construction of additional measures to protect the highway.

4.3 Implementation

The implementation of an alternative considers the factors necessary for construction of the bank stabilization measure such as the necessary acquisition of land, and the degree of complexity of construction. In addition, a separate criterion was established for whether the alternative as proposed is within an existing Pierce County Right-of-Way and does it comply with the USACE PL84-99 program. Three criteria are included in the implementation category:

- Construction Complexity
- Pierce County Right-of-Way
- Does the Project Comply with the USACE PL84-99 Program

5.0 PROPOSED BANK STABILIZATION ALTERNATIVES

5.1 Alternatives Considered

1. Revetment retrofit with rock deflectors (Figure 2)
2. Levee setback (Figure 3)
3. In Channel Engineered Logjams (ELJ's) (Figure 4)
4. Revetment retrofit with ELJ's (Figure 5)
5. Revetment retrofit with wood/log cribs structures (Figure 6)
6. No Action – Continue with existing M&O activities

5.1.1 Alternatives #1 - Revetment Retrofit with Rock Deflectors

This alternative would construct 28 large self-ballasting triangular rock flow deflector structures along the face of the existing levee structure. Each deflector would push the flow away from the toe of the levee and move the thalweg approximate 30' toward the center of the river. Additionally, the increased bank length and roughness provided by the deflectors will reduce the water velocity, reducing the destructive flows adjacent to the levee and subsequent reoccurring damage to the levee. Each deflector consists of large 10-15 ton jetty rock excavated down approximately 15 feet in front of the levee toe to match the existing levee toe. From the toe of the existing levee the deflector structure will slope upwards towards the face approximate at a 2:1 angle, built from a combination of jetty rock and immediate facing rock. The top of the deflector will project above the 100-year water surface approximately 1-2 feet.

The deflectors will be built along the face of the existing levee without structurally impacting the design of the existing levee to meet USACE standards under the PL 84-99 program. The use of large jetty rock is self-ballasting and will resist movement from high flows. Hydraulic modeling results have shown this option will be effective in reducing flow velocities and shear stress by shifting the thalweg away from the levee. Areas of slower velocity water on the downstream side of the deflector will promote sediment grading and deposition, increasing the effectiveness of the deflectors and providing high flow refuge for fish. Higher velocity water in front of the deflectors will promote the formation of a scour hole, which provides additional aquatic habitat. Water velocity and shear stress against the levee face is reduced by the deflectors approximately 50%. The shoreline bank length is increased approximately 425 LF. The increase bank length will help reduce bank erosion by increasing the distance water must travel along the bank, helping to slow water velocity.

5.1.2 Alternative #2 - Setback Levee

This alternative will involve setting back the existing levee northward to run parallel with State Route 706. The Nisqually River valley at this location forms a large alluvial fan. Valley widths at the project location average 3000 LF wide from valley wall to valley wall. To construct a setback levee would require building a levee parallel to State Route 706 for almost 6.5 miles until it could be terminated into higher ground. Within the setback area is the Nisqually Park subdivision and many other private properties that would need to be acquired to construct the new levee alignment. Approximately 228 properties are affected by this alternative. Entire parcels or portions of each property would need to be acquired to construct the setback levee. The cost of acquiring property and to construct a new levee alignment would be tens of millions of dollars. In addition there would be additional costs post to remove structures, utilities, drain lines septic systems, etc. Pierce County evaluated purchasing the Nisqually Park Subdivision in 2011 as part of updating the Flood Hazards Mitigation Plan and estimated the acquisition cost alone was approximately ten million dollars.

The construction related environmental impacts to construct a levee setback would be large, since much of the alignment is heavily forested with numerous small streams and wetland areas within the area of the new alignment. Many of the streams and wetlands would necessitate realignment, relocation and mitigation.

Acquiring property would take 5 - 15 years if funding could be secured, which is highly unlikely. Permitting would take 3 - 5 years and construction can be expected to take 2-3 years; resulting in additional costs to maintain the existing levee until such time a setback levee is fully constructed. The extended time frame of this alternative conflicts with the project goals, schedule and budget.

5.1.3 Alternative #3 – In Channel Engineered Logjams (ELJ’s)
This alternative would involve the construction of 13 engineered logjam (ELJ) structures in the river channel 200-300 feet away from the levee to split the flows, promote sediment deposition behind each logjam, and deflect flows. Each ELJ structure would consist of multiple logs, slash, and concrete dolos to anchor the log members in place. Additionally, the logjams would require the need for vertical steel H-piles installed into the riverbed to restrict them from movement during high flows. Structure stability will be very difficult to achieve in this reach with in-channel logjams. Scour depth estimates in this reach of the Nisqually River are 15 feet – 20 feet deep. The bed material is very large cobbles (D90 size 180-200mm in size), making driving piles very difficult, expensive and disruptive to habitat and surrounding residents. Future maintenance would require difficult access requirements being located within the river channel. Stability and design life are of serious concerns of this alternative. This alternative would only treat approximately 10-20% of the revetment/levee.

5.1.4 Alternative #4 - Revetment Retrofit with (ELJ’s) (entire length of current facility)
This alternative would construct 28 dolo-timber engineered logjam (ELJ) structures along the current levee. Each ELJ structure would consist of multiple logs, slash, and concrete dolos to anchor the log members in place. Additionally, the logjams would need to have vertical steel piles installed into the current levee to restrict them from movement during high flows. The current levee is part of the USACE PL84-99 cost sharing program. The requirements of this program require that structures built on the levee be physically separate from the levee and not adversely affect the levee structure in the event of damage or failure. Pierce County has received clarification from the USACE that certification of the levee would preclude the installation of piles. Installing piles into the existing levee would structurally alter the existing levee and would

not be consistent with USACE PL84-99 levee design requirements. Without substantial anchoring the ELJ's would likely not withstand repeated high flows.

5.1.5 Alternative #5 - Revetment Retrofit with Wood/Log Cribs Structures (entire length)
This alternative would construct a continuous wood/log crib revetment upon the existing levee face. The log/crib structures would be ballasted against movement using boulders and vertical piles. The current levee is part of the USACE PL84-99 cost sharing program. The requirements of this program require that structures built on the levee do not adversely affect the levee structurally. Pierce County has received clarification from the USACE this would preclude the installation of piles. Installing piles into the existing levee would structurally alter the existing levee. Without a physical connection to the levee the wood/log crib structure would likely not withstand repeated high flows.

5.1.6 Alternatives #6 - No Action – Continue with Existing M&O Activities
This alternative does not result in new construction and will continue the maintenance operations along the existing levee structure, repairing damage as it occurs. Between 1991 and 2017 Pierce County and the USACE have spent $5.76 million repairing damages, averaging $280,000 per year. Each maintenance operation would likely require river diversions and in channel work to complete the repairs.

5.2 Alternatives Evaluation
Evaluated alternatives were prescreened to eliminate alternatives that received a "fatal flaw" ranking. This prescreening process is described below.

5.3 Prescreening Evaluation
Each alternative was initially screened to eliminate alternatives that are not feasible. Projects with a criterion ranking that scored with a fatal flaw were eliminated from further evaluation. Alternatives 2 and 3 were eliminated from further consideration.

Setback Levee - Alternative 2: was eliminated due to the lack of property/right-of-way to build a setback levee. Pierce County does not own or have easements for the land to build a setback levee and the property acquisition would greatly exceed the available project funding. It is not reasonable and practical to build this alternative due to the cost. Assuming the average cost of levee construction alone is $1000 per linear foot, the setback levee would exceed $30 million; far exceeding the project funds available. Property acquisition costs is not included in the estimate. The environmental impacts to build a setback levee would have major impacts to the surrounding forested floodplain. Thousands of cubic yards of excavation and levee rock would be needed to build 6.5 miles of levee. There are numerous small stream crossing and wetlands that would be impacted and likely change the water dependency requirement of the project. This alternative is not the least environmentally damaging practicable alternative (LEDPA).

In-Channel Engineered Log Jams - Alternative 3: was eliminated due to the lack of property/right-of-way to build the in channel log jams, and due to the large adverse impacts of construction. Pierce County does not have easements to build within MRNP at the location the

ELJs. Building ELJs in the river channel would have large impacts to the environment. Construction access would require multiple river channel crossings and a large amount of excavation (approximately 90,000 CY) to construct the 13 logjams. The excavation for each individual logjam would merge together into one large excavation due to the close spacing of the logjam field making site construction and managing the extensive amount of excavated material within the river channel very difficult. No location within the river channel exists to stockpile the excavated material. Thus, requiring offsite stockpiling of material, which will significantly increase the construction costs. The construction complexity, design life concerns, construction impacts and maintenance efforts were all factors eliminating this alternative from future consideration. This alternative is not the least environmentally damaging practicable alternative (LEDPA).

5.4 Project Alternatives Ranking

The four shortlisted alternatives were ranked using nine evaluation criteria presented below:

- Alternative 1 - Rock Deflectors
- Alternative 4 - Engineered Logjams Entire Length of the Levee
- Alternative 5 - Wood/Log Crib Revetment Entire Length of Levee
- Alternative 6 – No Action – Continue with Existing Maintenance Program

Ranking results are presented in Table 2 for alternatives 1 through 6.

5.5 Ranking Results

Alternative 1 received the highest ranking, with a total score of 38, followed by Alternative 4 with a total score of 30. Alternative 5 received the lowest ranking with a total score of 29.

Rock Deflectors - Alternative 1: is chosen as the preferred project, receiving the highest ranking of a score of 38. This alternative is the least environmentally damaging, and the most effective at reducing water velocities along the entire levee by shifting the thalweg away from the levee toe. Hydraulic modeling predicts the water velocity and shear stresses will be reduced approximately 50% during the 100-year flow simulation. Modification to the existing levee requires relatively small amounts of excavation/fill to build the toe section of each deflector. The entire project only requires 10463 CY of fill below OHW. The remaining part of the deflectors can be built on top of the existing levee without modifying the existing structure. No excavation into the existing levee prism is necessary. Each deflector is self-ballasting and designed to withstand 100-year flow events. This alternative is consistent with the requirements of the USACE PL84-99 cost sharing program and this design will maintain eligibility for program benefits. This alternative enhances local habitat conditions by creating 28 potential pools on the upstream end of the deflector structure that provide rearing habitat and high flow refuge for resident trout. Additionally, the deflectors will provide areas of gravel sorting on the downstream end of the structure that will promote invertebrate production.

In-Channel Engineered Logjams the Entire Length of Facility - Alternative 4: is ranked second highest with a score of 30. The configuration, spacing, layout and performance of the engineered logjams would be approximately the same as Alternative 1. Impacts to the environment are similar to Alternative 1. Functionally, the reduction in water velocity, shear strength and shifting of the thalweg would be similar to Alternative 1. The problem with this alternative is the logjams cannot be anchored the existing levee to ensure they will survive repeated high flows. The current levee is part of the USACE PL84-99 cost sharing program, and must meet USACE design standards to maintain eligibility within the program. A constraint of the program is the requirement that any modification to the existing levee cannot structurally affect the PL84-99 levee design standards. To build ELJs alongside the levee will require structural modification of the existing levee to adequately anchor the ELJs against movement during high flows. To build the ELJs without anchoring the log jam structures into the levee structure would necessitate building the ELJs further out in the channel away from the levee using vertical piles, resulting in greater environmental impacts. Moving the ELJs further out into the channel would also substantially increase the construction costs.

Wood/Log Crib Revetment Entire Length of Levee - Alternative 5: ranked slightly higher than the “No Action” alterative, but less than build “In-Channel Logjams the Entire Length of the Facility” option with a score of 29. This alternative has similar design and construction challenges as Alternative 4. The structures would need to be built in front the existing levee, creating the same environmental impacts as Alternative 4. The continuous nature of a revetment would result in more piles and impacts.

No Action - Alterative 6: is ranked the lowest of the four alternatives, with a score of 28. This option would maintain the levee as currently configured. Each high flow event that damages the levee will require repair. The associated impact with repairing the damages are flow diversion, excavation within the channel, and channel crossings. This option does not reduce erosion nor does the No-Action Alternative meet the intent of the project of reducing reoccurring damage to the levee by reducing the adjacent water velocity and shifting the thalweg and erosive flows away from the levee face.

6.0 PROJECT RECOMMENDATION

Rock Deflectors - Alternative 1 received the highest ranking. Rock deflectors is the “Least Environmentally Damaging Practicable Alternative” (LEDPA) alternative. The impacts to the environment are lower than the other three alternatives. This alternative integrates into the existing Pierce County maintenance program and does not jeopardize participation in the USACE PL84-99 program. Hydraulic modeling predicts the performance of the rock deflectors will significantly reduce or shift damaging high flows away from the levee face, reducing the erosion. Construction of the rock deflectors will minimally impact the environment, provide pool habitat and high flow refuge for resident fish. Future maintenance will also result in less impacts since most work can be completed from the levee or top of the individual deflectors.

7.0 TABLES AND FIGURES

The following tables and figures as referenced in this document are provided in the following pages:

TABLE 1 - PROJECT SPECIFIC SITE SELECTION CRITERIA

Evaulation Criteria

Performance	Includes factors that influence the effectiveness of the design alternative to reduce threats to the highway from channel migration.	
Erosion Effectiveness along Levee	**Ranking Factor**	**Ranking Criteria**
	1	Minor degree of confidence that design will reduce erosion hazards over the life span of the project. (FATAL FLAW)
	2	Minor to moderate degree of confidence that design will reduce erosion hazards over the life span of the project.
	3	Moderate degree of confidence that the design will reduce erosion hazards over the lifespan of the project.
	4	Moderate to major degree of confidence that the design will reduce erosion hazards for the lifespan of the project.
	5	Major degree of confidence that design will reduce erosion hazards over the life span of the project.
Design Life	**Ranking Factor**	**Ranking Criteria**
	1	Less than 10 years
	2	10 to 25 years
	3	25 to 50 years
	4	50 to 75 years
	5	Greater than 75 years or indefinite due to self-sustaining.
Maintenance Effort	**Ranking Factor**	**Ranking Criteria**
	1	Significant annual maintenance and inspection, including maintenance for scour and erosion.
	2	Minor annual and intermittent (5-10 years) maintenance, including maintenance for scour and erosion.
	3	Minor annual and rare intermittent (once or twice in design life) maintenance, including maintenance for scour and erosion.
	4	No annual maintenance and rare intermittent maintenance, including maintenance for erosion and scour.
	5	No maintenance anticipated (i.e. fix is self-sustaining), including no maintenance for erosion and scour.
Impact	Includes factors that influence project site environmental impacts and aesthetics.	
Environmental Impact	**Ranking Factor**	**Ranking Criteria**
	1	Major degradation of aquatic, fisheries, riparian, wetland, or forest habitat over existing conditions. Little to no mitigation built into design. Major mitigation required, with some outside of project footprint. Permit performance standards would limit effectiveness of design. (FATAL FLAW).
	2	Minor degradation of aquatic, fisheries, riparian, wetland, or forest habitat over existing conditions. Minor mitigation built into design. Minor mitigation required, with some outside of project footprint. Permit performance standards would limit construction activites.
	3	Neutral environmental benefit (no benefit or environmental degradation of existing conditions), but moderate mitigation required either on-site or outside of the project footprint. Some mitigation built into the design. Permit performance standards would influence but not restrict design and construction.
	4	Minor environmental benefit, with minor mitigation required either on-site or outsite the project footprint. Design is mostly self-mitigating. Permit performance standards would limit some construction activities.
	5	Major environmental benefit. Design is entirely self-mitigating, and no additional mitigation is required. Permit performance standards would not limit construction activities.
Implementation	Includes factors that influence the implementation of the design alternative with respect to construction complexity and Right-of-Way availability.	
Construction Complexity	**Ranking Factor**	**Ranking Criteria**
	1	Complex construction. Construction would include difficult access, in-water work, stream diversion, construction dewatering, temporary rivers crossings, and off-site staging.
	2	Moderate to complex construction. Construction would include moderate access issues, in-water work, stream diversion, construction dewatering, temporary river crossings, and off-site staging.
	3	Moderate construction complexity. Construction would include three of the following elements: in-water work, stream diversion, construction dewatering, temporary stream crossings, and off-site staging.
	4	Minor construction complexity. Construction would include two of the following elements: in-water work, construction dewatering, and off-site staging.
	5	Minor to no construction complexity. Construction would include up to one of the following elements: in-water work, construction dewatering, or offsite staging. Construction site is easily accessible.
Pierce County Right-of-Way	**Ranking Factor**	**Ranking Criteria**
	1	Pierce County does not have any right-of-way or easements necessary to build the project. (FATAL FLAW)
	2	Pierce County has 25% of the right-of-way or easements necessary to build the project.
	3	Pierce County has 50% of the right-of-way or easements necessary to build the project.
	4	Pierce County has 75% of the right-of-way or easements necessary to build the project.
	5	Pierce County has 100% of the right-of-way or easements necessary to build the project.
Does the Project Comply with USACE PL84-99 Program	**Ranking Factor**	**Ranking Criteria**
	1	Project does not comply with the PL84-99 program.
	5	Project does comply with the PL84-99 program.

TABLE 2 - PROJECT ALTERNATIVES RANKING

		Alternative 1 Rock Deflectors		Alternative 2 Set Back Levee		Alternative 3 In-Channel Engineered Logjams		Alternative 4 Engineered Logjams Entire Length of Facility		Alternative 5 Wood/Log Crib Revetment		Alternative 6 No Action	
Criteria	Weighting Factor	Ranking Factor	Weighted Ranking	Ranking Factor	Weighted Ranking	Ranking Factor	Weighted Ranking	Ranking Factor	Weighted Ranking	Ranking Factor	Weighted Ranking	Ranking Factor	Weighted Ranking
Performance													
Erosion Effectiveness	2	4	8	5	10	3	6	4	8	4	8	1	2
Design Life	2	4	8	4	8	2	4	2	4	2	4	4	8
Maintenance Effort	1	3	3	1	1	1	1	1	1	1	1	1	1
Impact													
Environmental Impact	2	3	6	4	8	4	8	4	8	4	8	2	4
Implementation													
Construction Complexity	1	3	3	1	1	1	2	3	3	2	2	3	3
Pierce County Right-of-Way	1	5	5	1	1	1	1	5	5	5	5	5	5
Does the Project Comply with USACE PL84-99 Program	1	5	5	5	5	5	5	1	1	1	1	5	5
Combined Ranking			38		34		27		30		29		28

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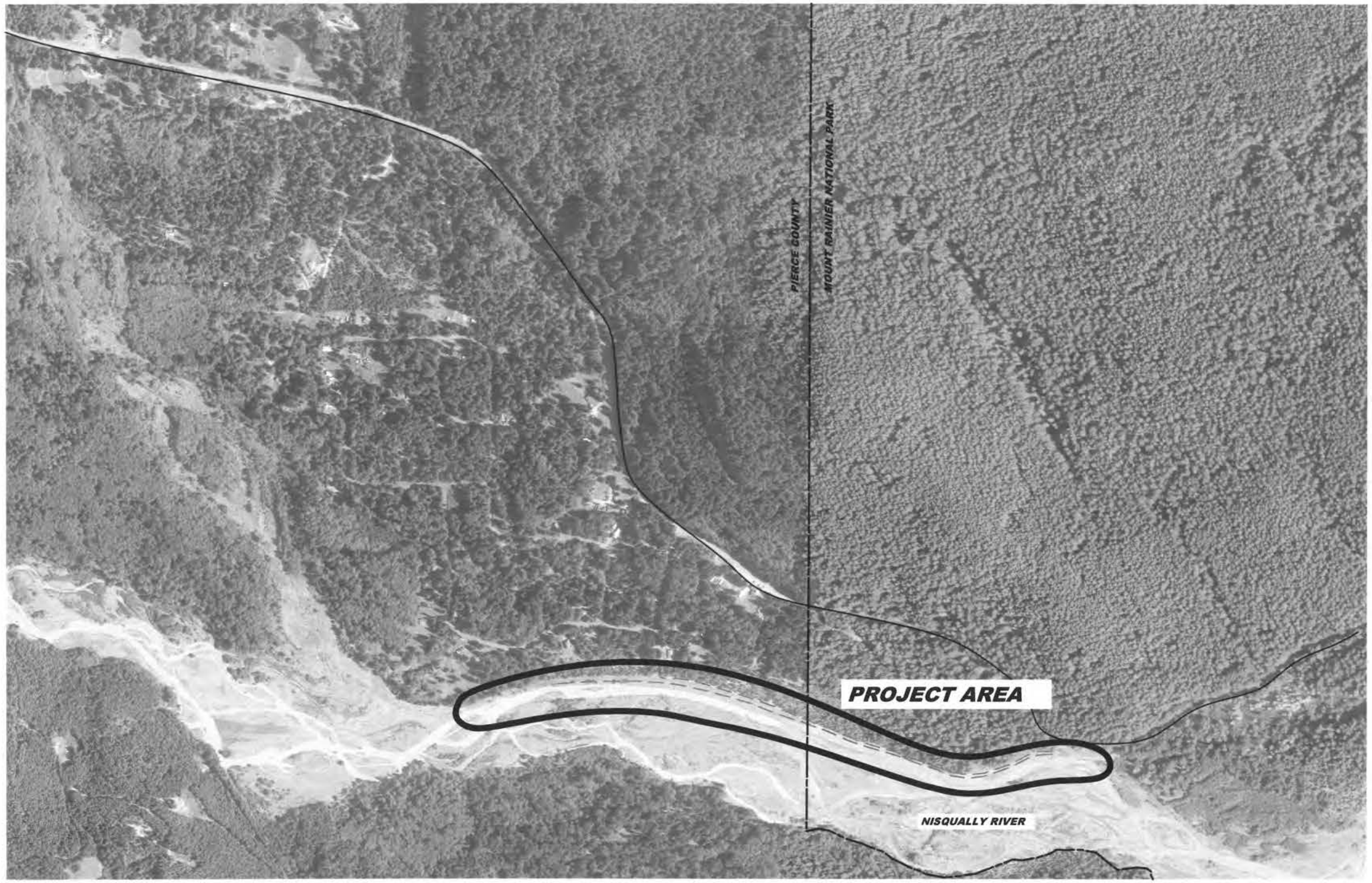

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TACOMA MALL PLAZA BUILDING
2702 SOUTH 42nd STREET, SUITE 201
TACOMA, WA 98409-7322

APPROVED BY:
MELISSA MCFADDEN, P.E. DEPUTY COUNTY ENGINEER - STORMWATER

UPPER NISQUALLY RIVER REVETMENT RETROFIT

FIGURE 1 - PROJECT AREA

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SHEET 1 OF 1

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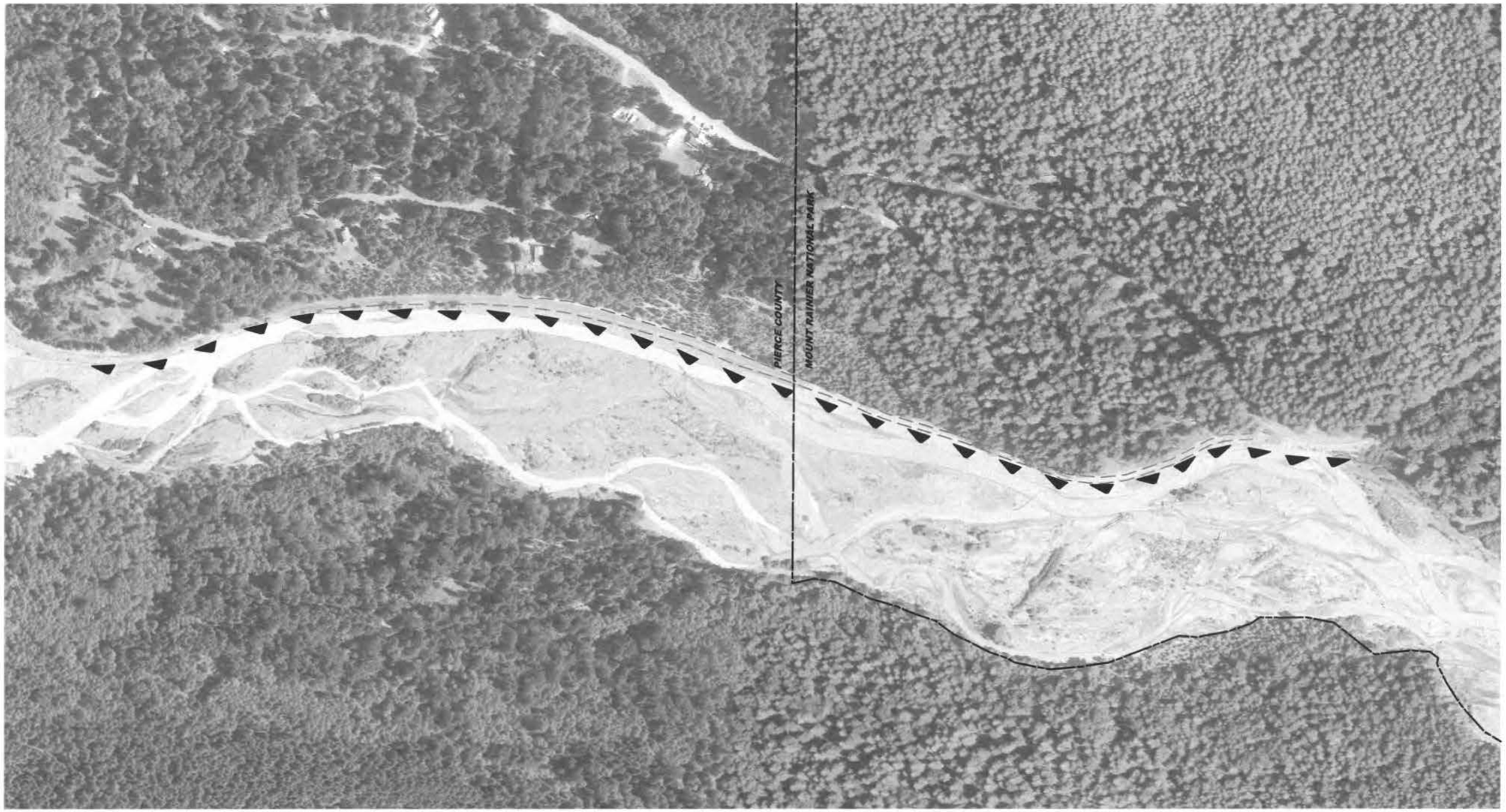

ROCK DEFLECTOR

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FIGURE 2 - ALTERNATIVE #1 - ROCK DEFLECTORS

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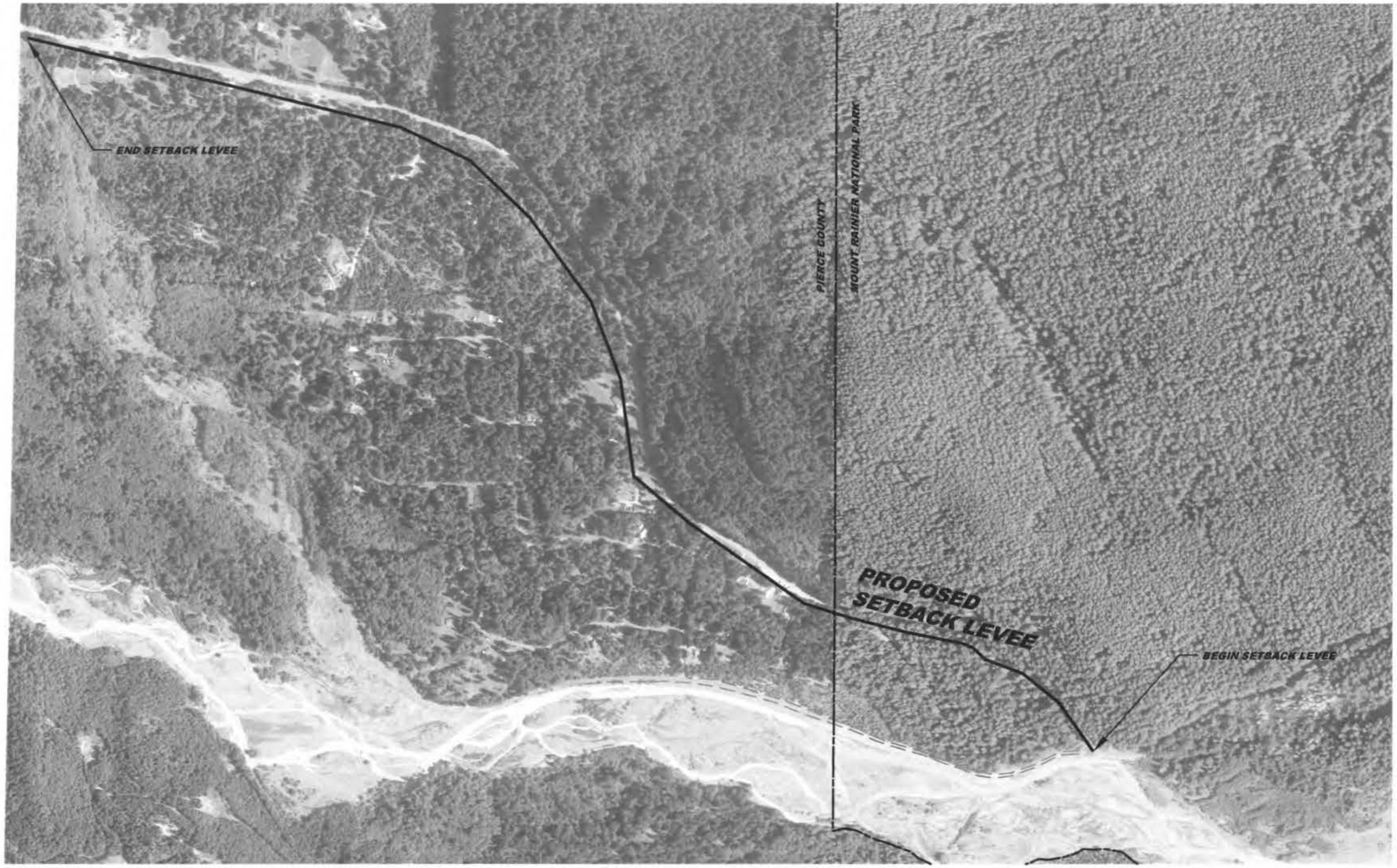

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FIGURE 3 - ALTERNATIVE #2 - SETBACK

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FIGURE 4 - ALTERNATIVE #3 - IN-CHANNEL ELJs

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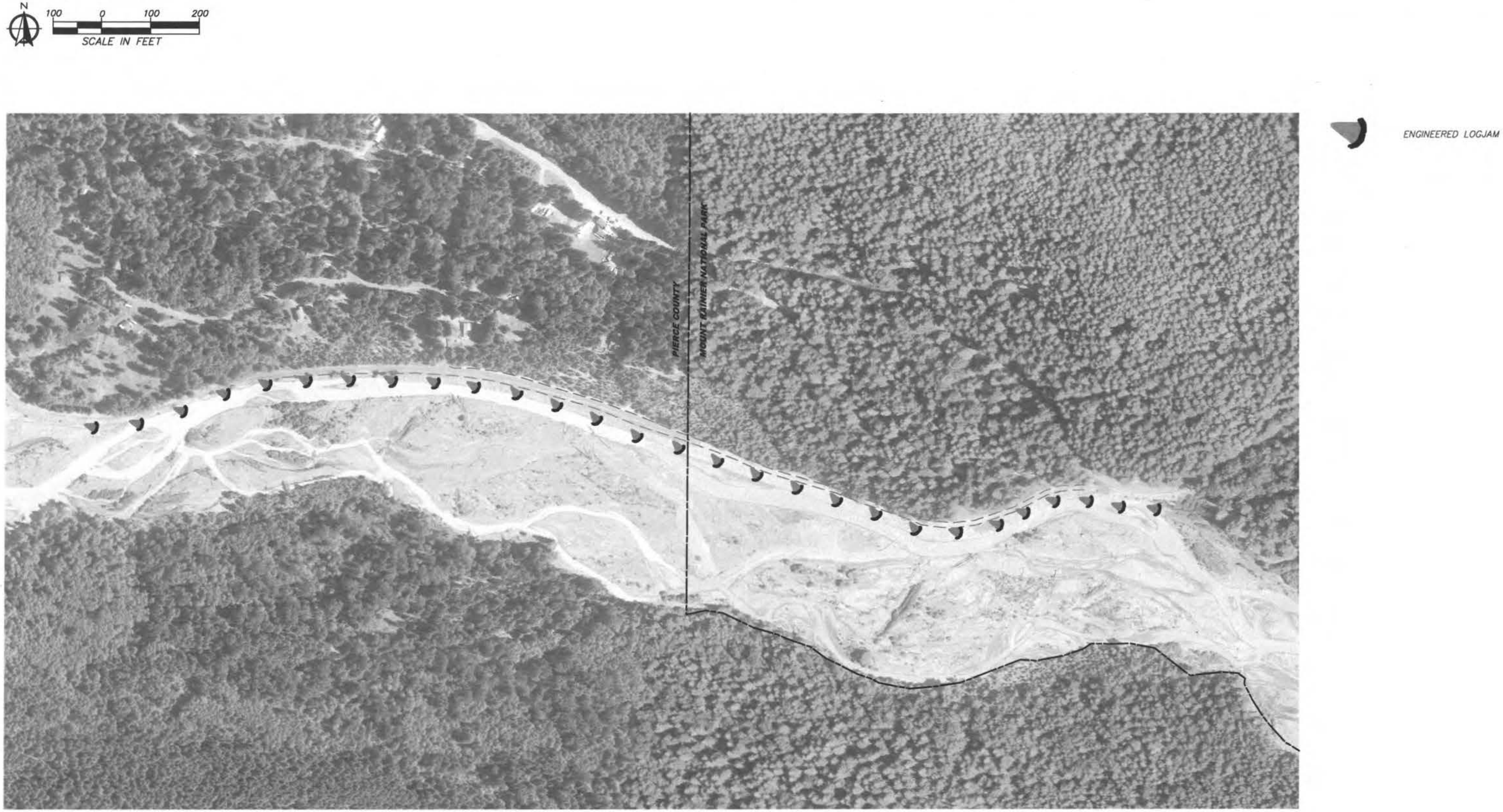

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FIGURE 5 - ALTERNATIVE #4 - RETROFIT WITH ELJs

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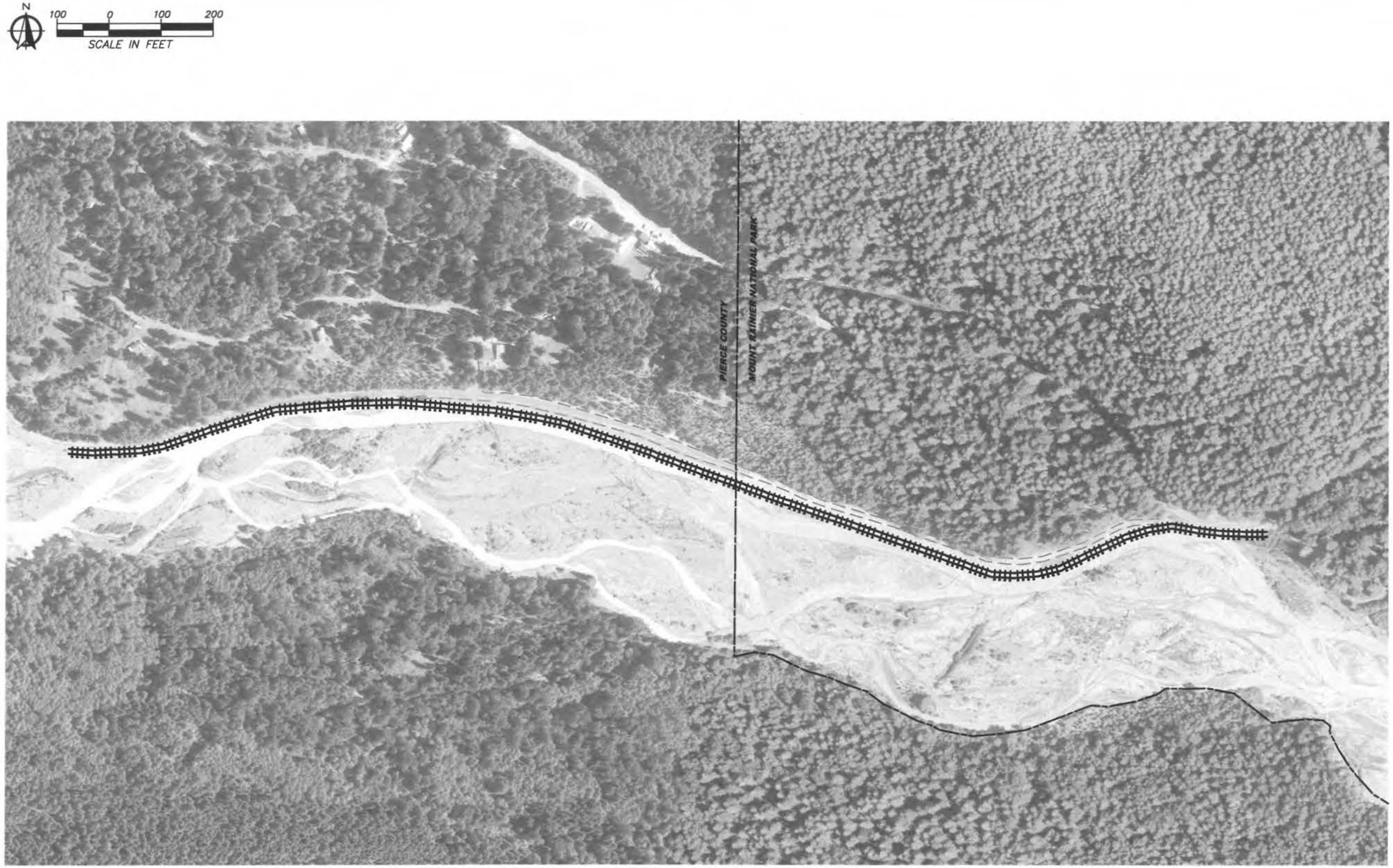

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FIGURE 6 - ALTERNATIVE #5 - LOG CRIB LEVEE

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