US Army Corps of Engineers®
Portland District

WILLAMETTE VALLEY SYSTEM OPERATIONS AND MAINTENANCE

DRAFT PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

APPENDIX C: RIVER MECHANICS AND GEOMORPHOLOGY

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EXECUTIVE SUMMARY

This appendix provides additional detail on the river mechanics and geomorphology effects assessment methods, assumptions and calculations. The document is composed of two major parts. It includes (1) discussion of the overall analysis methodology and specific metrics, (2) quantitative metric results and a qualitative estimate of the potential impacts to metrics under the No Action Alternative (NAA), six action alternatives and the near-term operations measure. Relative impacts are compared between the action alternatives and NAA.

CHAPTER 1 - METHODOLOGY

1.1 OVERVIEW

The general approach for evaluating river mechanics response in the system was to leverage the period of record (POR) flow and stage output from the quantitative hydroregulation planning models (see Appendix B) across the study area as inputs to a suite of qualitative hydraulic and geomorphic metrics. Discrete metrics were developed for the storage projects as well as run-of-river reservoirs and free-flowing reaches as detailed in sections 1.3 and 1.4 below. Metrics were limited to evaluating annualized effects across the period of record. Results by season are not presented, but seasonal variations in flow and reservoir storage were incorporated when calculating annualized values of metrics. In addition, because the metrics directly leveraged the hydroregulation planning models, they are subject to the baseline limitations and caveats of those models, including real-time management deviations, sub-daily variability resulting from power operations, and other irregular events such as equipment servicing, and fisheries demands (see Appendix B). The effects of projected climate change on river mechanics and geomorphology are also discussed.

1.2 ANALYSIS METRICS SUMMARY

Both quantitative and qualitative assessment methods were used to assess relative potential changes to river hydraulics, sediment supply and geomorphology for each EIS alternative. Five quantitatively informed, but qualitative metrics were developed to represent various physical characteristics and processes that could affect sediment processes in storage reservoirs, run-of-river reservoirs, and free-flowing reaches as enumerated below:

- Storage Project Metrics
  - Head-of-Reservoir Sediment Mobilization
  - Sediment Trap Efficiency
  - Shoreline Exposure
- Run-of-River and Free-Flowing Reach Metrics
  - Potential for Changes in Sediment Supply
  - Potential for Geomorphic Change

The analysis method for river mechanics and geomorphology is qualitative, driven by quantitative storage and flow metrics. Visible or measurable expected change to a field observer drives the analysis. The basis for the quantitative metrics and the resulting qualitative descriptions is the hydrology and HEC-ResSim outputs for each alternative, as compared to the NAA. There are four levels of magnitude of effects, three levels of duration and three levels of extents when comparing the NAA to the others as shown in Table 1-1 below.

Table 1-1. Evaluation Criteria for Potential Effects to River Mechanics and Geomorphology

Effect Magnitude	Criteria
None/Negligible	The resource area would not be affected, or changes or benefits would be either nondetectable or, if detected, would have effects that would be slight and localized. The area extent of effects would be small (limited) and would not require additional consideration or mitigation.
Minor	Changes to the resource would be measurable, although the changes would be small and localized. The duration of effects may vary.
Moderate	Changes to the resource would be measurable and have either localized or regional-scale adverse effects/benefits.
Major	Changes would be readily measurable and would have substantial consequences on a local or regional level.
Effect Duration	**Criteria**
Short-term	Changes to river mechanics and/or geomorphology would last less than two years.
Medium-term	Changes to river mechanics and/or geomorphology would last between two and five years.
Long-term	Changes to river mechanics and/or geomorphology would last throughout the duration of the project (2050).
Effect Extents	**Criteria**
Local	Changes to river mechanics and/or geomorphology would be confined to the dam/reservoir or river.
Regional	Changes to river mechanics and/or geomorphology would be perceived throughout a single county, multiple counties, or the entire WVS.
State-wide	Changes to river mechanics and/or geomorphology would be perceived throughout the entire state.

As an example, a newly implemented deep fall drawdown of a reservoir would likely result in a major effect as it alters the accumulation point of coarse sediments and exposes more shoreline and lake-bottom fine sediments to potential movement. The deep fall drawdown operation would be in effect through the project life and therefor long-term in duration. Effects within the reservoir would be local to the reservoir. A smaller alteration in the rule curve, such as refill at a later calendar date, would likely be negligible or minor effects, long-term in duration and local to the reservoir.

There are no new hydraulic or sediment models (e.g., HEC-RAS) run as part of the analysis. Existing hydraulic models inform the professional engineering judgment wrapped into the qualitative levels of change listed above. Furthermore, the measures under consideration are primarily about operational changes outside of the major flood season. New potential hydraulic and sediment models would differentiate the alternatives significantly more during the high flows of the flood season, in contrast to the relatively lower-flow late spring, summer and fall.

1.3 STORAGE PROJECT METRICS

Three storage project metrics were developed to investigate potential for changes in sediment processes at the eleven WVS storage projects in the study area (Blue River, Cottage Grove, Cougar, Detroit, Dorena, Fall Creek, Fern Ridge, Foster, Green Peter, Hills Creek, Lookout Point). Development and impact threshold determination for the storage project metrics is described in this section.

1.3.1 Shoreline Exposure

Shoreline erosion of bank sediments along reservoir margins is a complex process that is influenced by the cumulative effects of: wind and boat wave erosion, reservoir currents, precipitation runoff, freeze-thaw, soil properties, exposure, and vegetation density and type. One commonly observed process is that, during times of extended reservoir drawdown, exposed un-vegetated shoreline soils that were previously saturated are prone to erosion and localized slope failures (slumping). The shoreline exposure metric was developed as a surrogate for shoreline erosion processes. This metric compares the number of days that the reservoir water surface spends at any elevation to identify change in shoreline exposure and indicate the potential for change in shoreline erosion in the WVS storage projects. Shoreline processes leave long-term moraks on the land, reworking soils and exposing underlying layers.

The simplest metric is a reservoir elevation exceedance percentage analysis. Comparison of the reservoir elevation exceedance percentage between alternatives would demonstrate the range of reservoir operations. If the range and duration of the reservoir elevations changes, there is a potential that the shoreline erosion rates, or patterns, may change. While the shoreline exposure metric does not directly consider reservoir draft rate, it does represent the duration effects that could result from draft rate operational measures.

Shoreline exposure effects may vary in magnitude, but would be long-term, as long as the alternative operation set remains in effect, and local to the reservoir where the draft is occurring.

1.3.1.1 Shoreline Exposure Metric

Elevation-duration curves used in this metric are developed from daily average data extracted from the POR hydroregulation operations model. The curves are integrated to calculate an average and are compared with the No Action Alternative using the following formula:

$$AVE_{alt} - AVE_{na}$$

Where:

AVE_{alt} is the average reservoir elevation of the alternative being analyzed
AVE_{na} is the average reservoir elevation of the No Action Alternative

1.3.1.2 Shoreline Exposure Impact Thresholds

Average differences less than ±5 feet are likely not discernable within the reservoir due to sub-daily power fluctuation and other processes such as waves, which occur within a similar range. A ±5- to ±10-foot difference is estimated to be the threshold when shoreline effects would be observable on the landscape and are considered small changes in shoreline exposure. Differences greater than ±10 feet would be observable and would result in moderate change in shoreline exposure. A difference greater than ±20 feet or a modification in the operational range of the project would produce large changes in shoreline exposure with shoreline becoming submerged or exposed more often (Table 1-2).

Table 1-2. Magnitude of Effects: Shoreline Exposure

Shoreline Exposure Change	Impact Threshold
$\|\Delta x\| < 5$ feet	Negligible Effect
5 feet < $\|\Delta x\|$ < 10 feet	Minor Effect
10 feet < $\|\Delta x\|$ < 20 feet	Moderate Effect
$\|\Delta x\| > 20$ feet or Change in Operational Range	Major Effect

1.3.2 Head-of-Reservoir Sediment Mobilization

The head-of-reservoir sediment mobilization metric is designed to indicate the potential for changes in sediment scour and deposition patterns in the most upstream portion of storage reservoirs. In dams that use large amounts of storage volume and operate over a wide range of elevations throughout the year, the transition from riverine to reservoir conditions can shift upstream and downstream considerable distances. If reservoir drawdown leaves the delta exposed during high-flow periods, the upper layers of delta would be eroded and transported further into the reservoir, potentially increasing turbidity within the reservoir and thickness of lakebed deposits. Changes in storage project elevations or changes to the flow of water and sediment into the reservoir can result in changes to the head-of-reservoir erosion and deposition patterns. This metric compares the paired relationships of flow and stage over time to indicate the potential for change in sediment mobilization at the head-of-reservoir for each alternative. Changes in delta sediment mobilization could alter the sediment load farther downstream within the reservoir and potentially the amount of sediment passing a dam, particularly during high-flow periods.

Head of reservoir sediment mobilization effects may vary in magnitude, but would be long-term, as long as the alternative operation set remains in effect, and local to the reservoir where the change in the metric is occurring.

1.3.2.1 Sediment Transport Potential Calculation

Frequently, Lane's Balance is used to analyze the qualitative relationship between sediment transport rates (Q_s), bed material size (d_{50}), flow (Q), and water surface slope (S). It can be written as:

$$Q_s d_{50} \sim QS$$

Where the symbol ~ is generally taken to mean "is related to." A similar relationship can be derived from principles proposed in Henderson 1966 and used in Schmidt and Wilcock 2008 to analyze the effect of dams:

$$\frac{q_s}{{d_{50}}^{1.5}} \propto \left(\frac{\tau}{d_{50}}\right)^3$$

Where τ is the bed shear stress and the symbol $\propto$ means "is proportional to." Using Manning's equation, flow continuity, and assuming bed material size is fixed, the relationship can be rewritten as:

$$q_s \propto q^{1.8} S^{2.1}$$

In the riverine reaches, the river slope would be essentially unaffected by reservoir operations, but in the reservoir reaches, the slope increases when the reservoir elevation is low. The metric assumes the slope in the reservoir reach at any given day is the ratio of reservoir drawdown relative to full pool (ΔH) to the length of reservoir (L). The transport indicator variable can be written as:

$$Q_s \propto Q^{1.8} \left(\frac{\Delta H}{L}\right)^{2.1}$$

The value of ΔH is assumed to vary according to the daily average reservoir elevation, but the length (L) is assumed to be constant and equal to the length of the full pool. The analysis is limited to comparing the relative value of this indicator between alternatives, and therefore the value of L would not change the alternative comparison. The metric is not intended to provide a comparison between reservoirs. A sediment transport duration curve could be constructed from this equation. An indicator of changes to sediment transport in the upper portion of the reservoirs is, therefore, the change to Q_s. A schematic of various reservoir pool elevation and the upper portion of the reservoir is given in Figure 1-1.

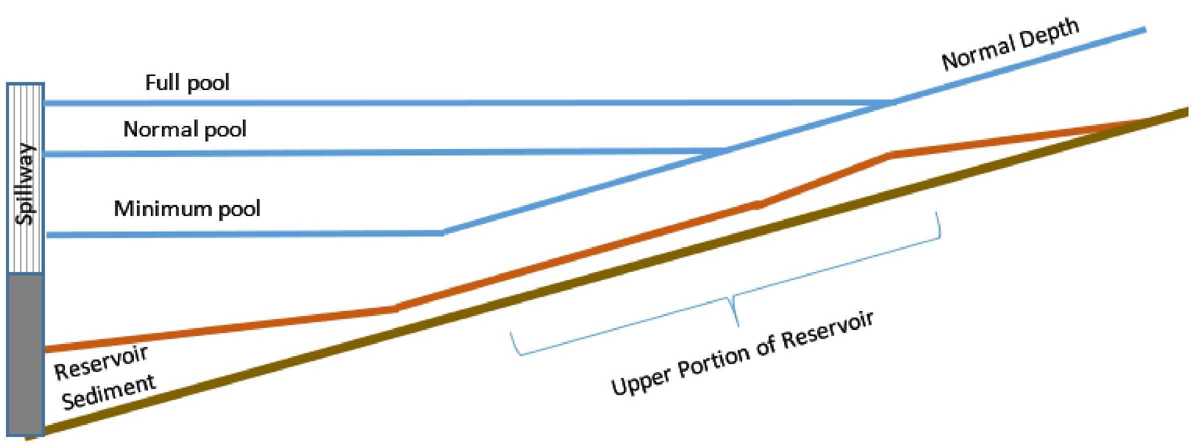

Figure 1-1. Schematic Showing Definition of Reservoir Pools and Idealized Sediment Deposit

1.3.2.2 Head-of-Reservoir Metric

Sediment transport duration curves used in this metric are developed from daily average data extracted from the 84-year period of record reservoir operation model. Curves were developed for each of the major tributaries to the WVS storage projects. The curves are integrated to calculate an average that is compared with the No Action Alternative using the following formula for each reservoir.

$$\frac{\overline{Qs}alt}{\overline{Qs}NA} - 1$$

Where:

$\overline{Qs}alt$ is the average of the sediment transport duration curve of the alternative being analyzed.

$\overline{Qs}NA$ is the average of the sediment transport duration curve of the No Action Alternative.

The metric calculates a percent change in sediment transport potential relative to the No Action Alternative due to changes in paired inflow and reservoir elevation. Without a change in reservoir operational range, the ultimate erosion and deposition patterns of head-of-reservoir bed materials is likely unchanged between alternatives and would be related to the lowest drawdown elevation at the reservoir. Change identified by this metric may only be temporary in nature as sediment deposits can be remobilized when the reservoir elevation drops in subsequent seasons or years.

1.3.2.3 Head-of-Reservoir Impact Thresholds

A less than 10 percent change in sediment transport potential at the head-of-reservoir is considered likely unmeasurable with any confidence and negligible. A 10 percent to 50 percent increase or decrease would be a measurable but small change. A 100 percent or greater change in sediment transport potential would be considered a large change at the head-of-reservoir (Table 1-3).

Table 1-3. Magnitude of Effects: Head of Reservoir Sediment Mobilization

Sediment Transport Potential Change	Impact Threshold
$\lvert\Delta x\rvert$ <10%	Negligible Effect
10% < $\lvert\Delta x\rvert$ <50%	Minor Effect
50% < $\lvert\Delta x\rvert$ <100%	Moderate Effect
$\lvert\Delta x\rvert$ >100%	Major Effect

1.3.3 Sediment Trap Efficiency

The sediment trap efficiency metric estimates the potential for changes in the amount of sediment that can deposit within or pass through the storage reservoirs. Trap efficiency is the proportion of inflowing sediment deposited in the reservoir relative to the total incoming sediment load. The trap efficiency is computed based on the ratio of reservoir storage volume to annual inflow. Because the volume of water stored at any given time in the storage projects can vary between alternatives, there is potential for the amount of material being deposited in the reservoir to change between alternatives. This metric compares the paired relationship of flow and reservoir storage to indicate the potential for changes in the amount of sediment being trapped by the storage projects for each action alternative relative to the NAA. The actual amount of sediment trapped is dependent not only on trap efficiency but also the incoming sediment load.

Sediment trap efficiency effects may vary in magnitude, but would be long-term, as long as the operation set remains in effect, and local to the reservoir where the change in the metric is occurring. Indirect effects of sediment being transported downstream of a dam are expressed in the run-of-river reservoir and free-flowing reach metric, potential changes in sediment supply.

1.3.3.1 Sediment Trap Efficiency Calculation

The Brune Curve (Brune 1953) is an empirical function used to determine the fraction of sediment trapped within a reservoir and is a function of the reservoir volume and incoming flow (Figure 1-2). The ratio is computed for each day of the 84- year operation model outputs (annual hydrographs). Then, a duration curve is constructedChanges to the estimated trap efficiency would indicate changes to the amount of sediment that originates in the watershed and is transported into the reservoir by flowing rivers is stored in the reservoir. This can also be viewed as changes in the amount of sediment that moved through the reservoir. The lower the trap efficiency, the less sediment that would be stored in the reservoir and the more sediment that would pass through the reservoir.

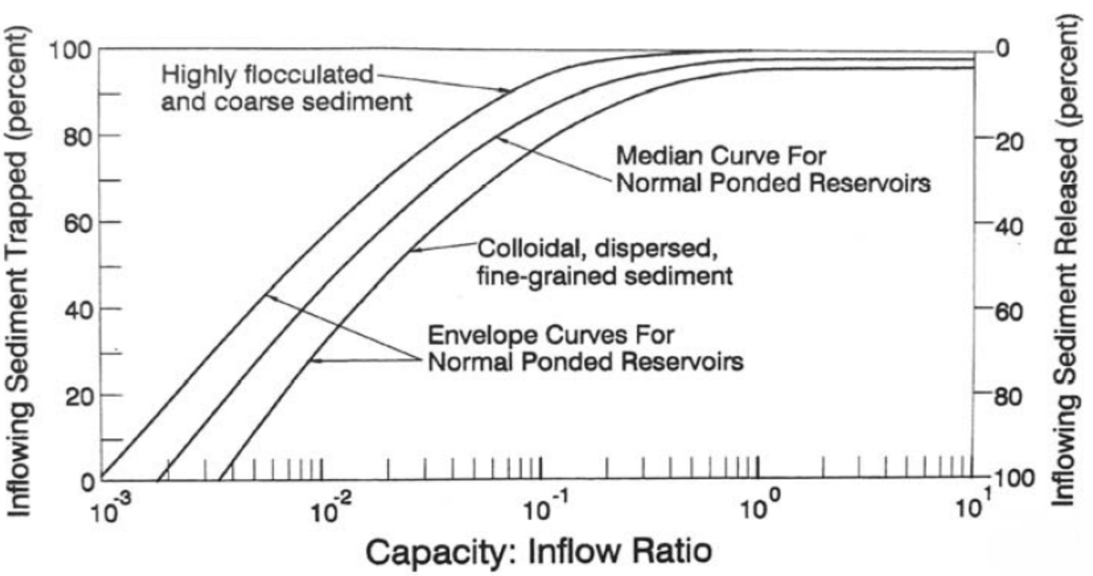

Figure 1-2. Brune Curve Used in Alternative Assessment for Trap Efficiency

Source: Adapted from Brune 1953

1.3.3.2 Sediment Trap Efficiency Metric (Fine-Grained Sediment Only)

Trap efficiency-duration curves used in this metric are developed from daily average data extracted from the POR reservoir operation model. The curves are integrated to calculate an average that is compared with the No Action Alternative using the following formula. The metric estimates a percent change in the amount of sediment stored in the project.

Where:

$$\frac{1-\overline{TE}alt}{1-\overline{TE}na}-1$$

$\overline{TE}alt$ is the average trap efficiency of the alternative being analyzed
$\overline{TE}na$ is the average trap efficiency of the No Action Alternative

1.3.3.3 Sediment Trap Efficiency Impact Thresholds

A less than 10 percent change in sediment passing a project is considered likely unmeasurable with any confidence and negligible. A 10 percent to 50 percent increase or decrease would be a measurable but small change. A 100 percent or greater change in sediment passing a project would be considered large change in trapping efficiency. With high trapping efficiencies in most of the WVS projects, a change in sediment passing (such as doubling) may only increase the depositional rate by a few percentage points (Table 1-2).

Table 1-4. Magnitude of Effects: Sediment Trap Efficiency

Sediment Trap Efficiency Change	Impact Threshold
|Δx| <10%	Negligible Effect
10% < |Δx| <50%	Minor Effect
50% < |Δx| <100%	Moderate Effect
|Δx| >100%	Major Effect

1.4 RUN-OF-RIVER RESERVOIRS AND FREE-FLOWING REACHES METRICS

Run-of-river reservoirs and free-flowing reaches include all the river reaches downstream of WVS storage projects. Run-of-river reservoirs are formed by dams that are operated to discharge water downstream at rates that generally match the upstream inflows. Big Cliff, and Dexter dams are run-of-river projects that operate in a small range of pool elevations for daily or weekly hydropower purposes but do not attempt to store water for release in later seasons. Foster Dam is considered both a storage and a run-of-river project in this analysis as it is partially operated to re-regulate the outflows from Green Peter. Free-flowing reaches are portions of the river downstream of WVS storage reservoirs that are not influenced by the backwater of a downstream reservoir. The run-of-river and free-flowing reach metrics are necessarily qualitative due to a lack of continuous bed material sediment data or lack of continuous and integrated hydraulic modeling.

1.4.1 Potential for Changes in Sediment Supply

This metric estimates the potential for changes in sediment passing WVS projects relative to NAA. This can occur when WVS storage projects experience large changes in sediment trapping efficiency. This can also occur where there is a change in operational range of the WVS reservoirs that can potentially re-entrain sediment currently stored in the reservoir or induce slope failures and introduce new sediment to the system. This metric also addresses the gravel augmentation below dams (#384) measure where sediment supply would be actively augmented.

The sediment supply analysis assumes that sediment supply from rivers upstream of WVS projects, or tributaries to WVS impacted reaches that are not downstream of a WVS reservoir, would be unchanged relative to the NAA.

The sediment trap efficiency metric integrates coincident daily reservoir inflow with storage to estimate trapping efficiency. This calculation focuses on sediment delivered to the reservoir from the watershed with the sediment load assumed to be correlated to inflow. Decreases in sediment trapping efficiency indicate that the reservoir has the potential to deliver more sediment downstream and is considered in the potential for change in sediment supply metric.

A separate potential source of sediment to the reservoir can come from bank erosion or bank failures within the reservoir itself. Drafts deeper than those historically experienced have the potential to re-suspend stored sediments or induce landslides (USACE 2003) introducing new sediment to the reservoir. The timing of these deep drawdowns is not correlated to reservoir inflow and are not fully captured in the sediment trap efficiency metric. Deeper drafts are assumed to increase the potential for sediment re-entrainment supplying additional suspended sediment to the reservoir. Whether this sediment would settle within the reservoir or pass downstream would depend on sediment particle size and hydraulics within the reservoir. Lacking detailed data for both factors, reduction in minimum pool storage relative to the NAA, which is coincident with drafts, is used to indicate if there is a change in potential for sediment to pass the reservoir.

Sediment augmentation though spawning gravel nourishment or geomorphic process-based sediment nourishment below target WVS projects in included in the gravel augmentation below dams (#384) measure. A direct introduction of bed material to the system would change sediment supply in a known and controlled manner.

Potential for changes in sediment supply effects may vary in magnitude, but would be long-term, as long as the alternative operation set or gravel augmentation below dams (#384) measure remains in effect. Potential for changes in sediment supply effects would be local to regional with fine grained sediments capable of passing from an upstream reach to downstream reaches. Changes in sediment supply from WVS projects due to changes in system operations are indirect effects, while gravel augmentation below dams (#384) effects would be direct.

1.4.1.1 Sediment Coming Out of Storage Reservoirs

Reservoir sediment release metrics are described in this section.

1.4.1.1.1 Watershed Supplied Sediment

Sediment Trap Efficiency Metric (1.3.2) is used directly to indicate potential for fine suspended sediment entering the reservoir during higher flows to pass the reservoir into downstream run-of-river reservoirs and free-flowing reaches. Decreases in the Trapping Efficiency Metric indicate increased potential for suspended sediment supply below the dam. The qualitative metric is directly applied in the sediment supply and expressed as: $qualitative\ TEmetric$

1.4.1.1.2 Reservoir Supplied Sediment

Changes in operational range, calculated from the Inactive Pool Elevation entered into each ResSim alternative, is used to indicate changes in sediment supply internal to the reservoir. Wind-wave erosion on stored fines and rarely exposed banks as well as mainstem and tributary erosion into stored sediments are drivers for changes in sediment supply internal to the reservoir. Deeper drawdowns relative to NAA ($MinPool\ \Delta x$) indicate higher potential for increased sediment supply.

Table 1-5. Sediment Re-Entrainment or Bank Failure Potential

Minimum Pool Elevation Reduction from NAA	Sediment Re-Entrainment or Bank Failure Potential
Δx < 5 feet	Negligible
5 feet < Δx < 10 feet	Minor
10 feet < Δx < 20 feet	Moderate
Δx > 20 feet	Major

This sediment supply potential is then qualified by the percent reduction in minimum pool storage relative to NAA ($MinPool\ \Delta v$). Reduction in minimum pool storage volume increases the potential for sediment to pass the reservoir and move downstream during drawdown.

Table 1-6. Reservoir Bank Sediment Passing Dam Potential

Minimum Pool Storage Volume Reduction from NAA	Bank Sediment Passing Dam Potential
Δv < 10%	Negligible
10% < Δv < 25%	Minor
25% < Δv < 75%	Moderate
Δv > 75%%	Major

The reservoir bank supplied sediment component of the Sediment Supply Metric, expressed as $BSSmetric$, is the lesser of the qualitative assessment for ($MinPool\ \Delta x$) and ($MinPool\ \Delta v$) for each alternative. For example, a drawdown 25 feet deeper than NAA has a major potential for increasing local sediment supply, but if the minimum storage volume only decreases by 5% relative to NAA, there would be negligible potential for that sediment to pass the reservoir.

$$qualitative\ BSSmetric = the\ qualitative\ lesser\ of\ (MinPool\ \Delta\text{x})\ \text{and}\ (MinPool\ \Delta\text{v})$$

1.4.1.2 Sediment Augmentation

Any direct sediment augmentation is considered a major impact as it would be readily observable and performed with the intention of creating or modifying the trajectory of geomorphic features and habitat.

1.4.1.3 Sediment Transfer Between Reaches

Sediment coming from a WVS storage project or directly from a sediment augmentation effort would originate from a point source, typically at the upstream end of an impact assessment reach. In most cases, the downstream end of an impact reach is at a confluence which is the upstream end of the next impact reach. Sediment, particularly very fine suspended sediment, may transfer downstream into the next reach. A particularly complicated version of this is the Middle Fork of the Willamette where the Hills Creek storage project flows into a free-flowing segment fork the Middle Fork, then into the Lookout Point storage project, then into the run-of-river Dexter re-regulation dam and then again into the free-flowing Middle fork where confluences with the regulated Fall Creek and Coast Fork of the Willamette may bring changed sediment loads from upstream regulation. Changes in operations may impact the transfer of sediment between all segments. Absent hydraulic models and integrated bed and bank material classification as well as details on upstream sediment loading, the analysis of sediment transfer between reaches is necessarily qualitative.

This analysis assumes that run-of-river projects can successfully trap all corase sediments delivered and a portion of the suspended sediment entering from upstream. Sediment transfer is assumed to occur, but concentrations are assumed to be reduced. This qualitative assessment reduces the level of impact by one level when moving from upstream or a run-of-river project to a downstream reach (meaning a major sediment load input into a run-of-river reservoir would result in a moderate sediment output into the downstream reach).

For successive free-flowing river segments, such as the Middle Fork of the Willamette flowing into the Upper Willamette at the Coast Fork Confluence, it is assumed that some sediment dispersion and deposition would occur within the reach and lower sediment concentrations would transport into the downstream reach. Each downstream reach would have a successively lower sediment supply qualitative impact until negligible change is assumed in the system. For example, if the Middle Fork of the Willamette below Dexter has minor potential for change in sediment supply at its upstream end, it would be assumed that there is negligible changes in sediment supply relative to NAA at the transfer to the Upper Willamette. In this scenario, if the Coast fork had moderate potential for change in sediment supply, the downstream Upper Willamette would have a minor change caused by sediments entering from the Coast Fork.

1.4.1.4 Sediment Supply Impact Thresholds

Sediment Supply impact thresholds are a combination of reservoir passage potential for watershed supplied ($qualitative\ TEmetric$), reservoir supplied sediment ($qualitative\ BSSmetric$) and direct sediment augmentation. The total Sediment Supply Metric ($SedSupply$) for reaches below WVS storage project is the greater of the qualitative $qualitative\ TEmetric$ and $qualitative\ BSSmetric$ metrics. Any direct sediment augmentation is a Major Effect:

$$SedSupply = the\ qualitative\ greater\ of\ (qualitative\ TEmetric)\ \text{and}\ (qualitative\ BSSmetric)$$

Table 1-7. Magnitude of Effects: Sediment Supply

Sediment Supply	Impact Threshold
($SedSupply$) = Negligible	Negligible Effect
($SedSupply$) = Minor	Minor Effect
($SedSupply$) = Moderate	Moderate Effect
($SedSupply$) = Major or Sediment Augmentation	Major Effect

For successive Run-of-River reservoir and Free-Flowing reaches, the level of impact is assumed to be reduce by one level for each reach segment due to fine suspended sediment dispersion and deposition. The exception to this is major changes due to sediment augmentation programs. It is assumed that placed sediment would be screened of fines and would only transport as bed load. This placed sediment is assumed to be deposited and stored within the reach where it is placed unless noted otherwise.

1.4.2 Potential for Geomorphic Change

This metric estimates the potential for changes in river character due to operations proposed by the action alternatives. System wide morphological change, away from the NAA, would be dependent on changes to flood flow frequency, changes to bank stabilization, or changes in sediment supply. The Proposed Action is not proposing any measures or a suite of measures that change flood flow frequency and as such, morphologic changes or processes that are driven by high flows would be unchanged from the NAA. Measure 9, maintain revetments considering nature-based engineering or alter revetments for aquatic ecosystem restoration, does propose to implement maintenance actions that incorporate nature-based engineering options. This would locally change habitat but maintain the river stabilization purposes and geomorphic trajectory of the revetment. Also proposed in measure 9 also seeks opportunities for working with non-federal sponsors to study and work through processes for substantial alternation. These project would be brought under the Continuing Authority Program Section 1135 and would be require analysis a compliance actions consistent with the authority. While there is opportunity for localized or potentially larger geomorphologic effects due to revetment alternation, the location and scale are unknown at this time and will be analyzed for effects in future planning. The remaining actions that could impact geomorphic trends are those that change sediment supply to the system.

Potential for geomorphic change effects may vary in magnitude but would be long-term as geomorphic effects manifest over long periods of time and persist beyond immediate action. Potential for geomorphic change would be local to regional with change in sediment supply effecting both the immediate reach below a WVS dam and downstream reaches. Potential for geomorphic change due to changes in system operations are indirect effects, while gravel augmentation below dams (#384) effects would be direct.

1.4.2.1 Potential for Geomorphic Change Metric

The Sediment Supply Metric ($SedSupply$) would be utilized to indicate if there is potential for geomorphic change in run-of-river reservoirs or free flowing reaches. Minor and Moderate Sediment Supply changes may impact water quality, however potential changes of that order are not expected to change the morphological character of the river. Only Major changes to Sediment Supply are assumed to be capable of inducing Geomorphic Change.

1.4.2.2 Geomorphic Change Impact Thresholds

Table 1-8. Magnitude of Effects: Geomorphic Change

Sediment Supply	Impact Threshold
($SedSupply$) = Negligible, Minor, Moderate	Negligible Effect
($SedSupply$) = Major	Major Effect

1.5 CLIMATE CHANGE

appendix F1 and F2, describe projected climate change trends likely to be experienced in the WVS. The supplemental appendix also identifies relevant climate factors or hydrology and climate variables that may change and have a consequential impact to the PEIS resource areas. The climate change factors of most importance to the hydraulics resource area are projected future changes in precipitation (rainfall and snow), rates of peak and average streamflow, snowpack and flow volumes, and wildfire intensity/frequency.

There is a causal relationship between wildfires and increased sediment supply observed in the Pacific Northwest and elsewhere. The dominant processes for increased supply in the Pacific Northwest are dry ravel in the short-term following fire and hillslope failure with associated debris flows in the longer-term (Alden Research Laboratory Inc. 2021). Ravel occurs when wildfires disturb or eliminate vegetation and other organic structures that hold loose material on steep slopes. This material can lead to debris flows during the wet season in the Pacific Northwest as material collected in valley and channel bottoms is moved downstream during high peak flow events. Hillslope failure is exacerbated in the years post wildfire by the loss of shear strength in the soils as tree roots decay, typically 5-10 years post-fire (Wondzell and King

2003). Surface erosion and shallow channels cut into the soil by the erosive action of flowing water (rilling) during direct runoff in a minor factor in sediment supply changes in the Pacific Northwest due to low rainfall intensity and high infiltration rates (Alden Research Laboratory Inc. 2021). Increases in annual very high fire danger days are assumed to be directly related to an increase in acres burned by severe forest fires, and therefore, an increase in basin sediment supply, particularly in portions of the basin with steeper topography.

Sediment transport and many geomorphic processes associated with river and streams are dominated by high flows and associated high energies in the river. Changes in peak flows or changes in the duration of high flow can both increase the sediment transport capability of a river and increase the potential for larger scale geomorphic change (such as bar growth, bank erosion or avulsions). It is assumed that higher peak flows or longer durations of high flow are correlated to increases in sediment transport and geomorphic change. With the presence of flood storage projects that can trap sediment and regulate peak flood flows in the basin, the expected changes in the regulated reaches will be largely mitigated. Unregulated rivers will more directly show the potential sediment supply, transport and geomorphic changes associated with climate change.

These climate change factors as well as the climate change analysis performed in the Hydrologic Processes, section 3.2, were used to qualitatively assess the expected effects to the system under NAA and all Alternatives.

CHAPTER 2 - ALTERNATIVE COMPARISON SUMMARIES

2.1 STORAGE PROJECT METRICS

This section includes tables and figures that enumerate the storage project comparison summaries for three metrics (Table 2-1 – Table 2-6; Figure 2-1 – Figure 2-33):

- Head-of-Reservoir Sediment Mobilization
- Sediment Trap Efficiency
- Shoreline Exposure

Table 2-1. Storage Metrics – Head-of-Reservoir Quantitative Analysis

Project	Alt 1 vs. NAA	Alt 2A vs. NAA	Alt 2B vs. NAA	Alt 3A vs. NAA	Alt 3B vs. NAA	Alt 4 vs. NAA	Alt 5 vs. NAA	NTOM vs. NAA
Blue River	-0.4%	0.7%	1.5%	23.1%	23.1%	0.8%	1.8%	-0.1%
Cottage Grove	0.4%	0.9%	0.1%	0.9%	2.2%	2.2%	0.3%	2.3%
Cougar	1.6%	-0.7%	496.6%	163.4%	499.3%	-0.8%	617.3%	30.7%
Detroit	-3.0%	-2.2%	-1.8%	391.2%	113.5%	-2.3%	-1.7%	-1.7%
Dorena	-0.5%	0.4%	0.4%	-0.7%	1.4%	2.3%	0.4%	0.7%
Fall Creek	-2.2%	-1.1%	-1.4%	-2.4%	0.6%	-0.9%	-0.9%	125.3%
Fern Ridge	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Foster	2.4%	-20.5%	-20.5%	-20.8%	-11.2%	-2.6%	-20.7%	2.7%
Green Peter	-2.0%	337.3%	337.3%	336.4%	621.8%	1.6%	339.8%	338.2%
Hills Creek	-0.6%	5.0%	5.0%	28.5%	145.8%	4.7%	9.0%	20.2%
Lookout Point	2.3%	2.1%	2.3%	312.3%	122.3%	1.9%	2.3%	159.2%

Table 2-2. Storage Metrics – Head-of-Reservoir Qualitative Analysis

Project	Alt 1 vs. NAA	Alt 2A vs. NAA	Alt 2B vs. NAA	Alt 3A vs. NAA	Alt 3B vs. NAA	Alt 4 vs. NAA	Alt 5 vs. NAA	NTOM vs. NAA
Blue River	Negligible	Negligible	Negligible	**Minor**	**Minor**	Negligible	Negligible	Negligible
Cottage Grove	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Cougar	Negligible	Negligible	**Major**	**Major**	**Major**	Negligible	**Major**	**Minor**
Detroit	Negligible	Negligible	Negligible	**Major**	**Major**	Negligible	Negligible	Negligible
Dorena	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Fall Creek	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	**Major**
Fern Ridge	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Foster	Negligible	**Minor**	**Minor**	**Minor**	**Minor**	Negligible	**Minor**	Negligible
Green Peter	Negligible	**Major**	**Major**	**Major**	**Major**	Negligible	**Major**	**Major**
Hills Creek	Negligible	Negligible	Negligible	**Minor**	**Major**	Negligible	Negligible	**Minor**
Lookout Point	Negligible	Negligible	Negligible	**Major**	**Major**	Negligible	Negligible	**Major**

Table 2-3. Storage Metrics – Trap Efficiency Quantitative Analysis

Project	NAA Trap Eff	Alt 1 Trap Eff	Alt 1 vs. NAA	Alt 2A Trap Eff	Alt 2A vs. NAA	Alt 2B Trap Eff	Alt 2B vs. NAA	Alt 3A Trap Eff	Alt 3A vs. NAA	Alt 3B Trap Eff	Alt 3B vs. NAA
Blue River	81.4	81.5	0.5%	81.0	-2.1%	80.9	-2.4%	79.2	-11.7%	79.2	-11.7%
Cottage Grove	81.0	80.9	-0.4%	81.0	0.2%	81.1	0.3%	80.3	-3.7%	79.9	-5.7%
Cougar	90.6	90.7	1.6%	90.7	1.2%	47.9	-453.6%	84.8	-61.5%	47.8	-454.0%
Detroit	91.1	91.2	1.5%	91.2	1.0%	91.2	0.9%	79.2	-133.6%	88.8	-25.8%
Dorena	80.7	80.9	0.5%	80.8	0.5%	80.8	0.4%	80.4	-1.9%	80.0	-4.1%
Fall Creek	81.8	82.0	1.1%	81.8	0.0%	81.9	0.4%	81.8	0.2%	81.7	-0.3%
Fern Ridge	80.2	80.2	0.0%	80.2	0.0%	80.2	0.0%	80.2	0.0%	80.2	0.0%
Foster	67.3	67.7	1.2%	66.5	-2.4%	66.5	-2.4%	66.5	-2.4%	68.2	2.8%
Green Peter	92.6	92.7	0.8%	86.0	-88.6%	86.0	-88.7%	86.0	-88.6%	69.2	-315.3%
Hills Creek	93.8	93.9	1.1%	93.8	0.1%	93.8	-0.1%	93.6	-2.4%	92.1	-26.7%
Lookout Point	87.9	87.8	-1.0%	87.8	-0.9%	87.8	-1.0%	71.4	-136.8%	83.2	-38.8%

Project	NAA Trap Eff	Alt 4 Trap Eff	Alt 4 vs. NAA	Alt 5 Trap Eff	Alt 5 vs. NAA	NTOM Trap Eff	NTOM vs. NAA
Blue River	81.4	81.0	-2.1%	80.8	-3.4%	81.1%	-1.3%
Cottage Grove	81.0	79.6	-7.3%	81.0	0.1%	81.0%	-0.2%
Cougar	90.6	90.7	1.2%	39.1	-546.5%	89.3%	-14.1%
Detroit	91.1	91.2	1.0%	91.2	0.9%	91.2%	0.9%
Dorena	80.7	79.7	-5.5%	80.8	0.2%	80.8%	0.3%
Fall Creek	81.8	81.8	0.1%	81.8	0.1%	60.3%	-117.7%
Fern Ridge	80.2	80.2	0.0%	80.2	0.0%	80.2%	0.0%
Foster	67.3	67.1	-0.6%	66.4	-2.6%	63.6%	-11.2%
Green Peter	92.6	92.5	-0.6%	86.0	-89.4%	85.9%	-90.9%
Hills Creek	93.8	93.8	0.3%	93.7	-1.4%	93.7%	-2.2%
Lookout Point	87.9	87.8	-0.8%	87.8	-1.1%	81.7%	-51.5%

Table 2-4. Storage Metrics – Trap Efficiency Qualitative Analysis

Project	NAA	Alt 1 vs. NAA	Alt 2A vs. NAA	Alt 2B vs. NAA	Alt 3A vs. NAA	Alt 3B vs. NAA
Blue River	N/A	Negligible	Negligible	Negligible	**Minor**	**Minor**
Cottage Grove	N/A	Negligible	Negligible	Negligible	Negligible	Negligible
Cougar	N/A	Negligible	Negligible	**Major**	**Moderate**	**Major**
Detroit	N/A	Negligible	Negligible	Negligible	**Major**	**Minor**
Dorena	N/A	Negligible	Negligible	Negligible	Negligible	Negligible
Fall Creek	N/A	Negligible	Negligible	Negligible	Negligible	Negligible
Fern Ridge	N/A	Negligible	Negligible	Negligible	Negligible	Negligible
Foster	N/A	Negligible	Negligible	Negligible	Negligible	Negligible
Green Peter	N/A	Negligible	**Moderate**	**Moderate**	**Moderate**	**Major**
Hills Creek	N/A	Negligible	Negligible	Negligible	Negligible	**Minor**
Lookout Point	N/A	Negligible	Negligible	Negligible	**Major**	**Minor**

Project	NAA	Alt 4 vs. NAA	Alt 5 vs. NAA	NTOM vs. NAA
Blue River	N/A	Negligible	Negligible	Negligible
Cottage Grove	N/A	Negligible	Negligible	Negligible
Cougar	N/A	Negligible	**Major**	**Minor**
Detroit	N/A	Negligible	Negligible	Negligible
Dorena	N/A	Negligible	Negligible	Negligible
Fall Creek	N/A	Negligible	Negligible	**Major**
Fern Ridge	N/A	Negligible	Negligible	Negligible
Foster	N/A	Negligible	Negligible	**Minor**
Green Peter	N/A	Negligible	**Moderate**	**Moderate**
Hills Creek	N/A	Negligible	Negligible	Negligible
Lookout Point	N/A	Negligible	Negligible	**Moderate**

Table 2-5. Storage Metrics – Shoreline Exposure Quantitative Analysis

Project	Alt 1 vs. NAA Metric (*Range Change)	Alt 2A vs. NAA Metric (*Range Change)	Alt 2B vs. NAA Metric (*Range Change)	Alt 3A vs. NAA Metric (*Range Change)
Blue River	4.2 (Yes)	2.9 (Yes)	2.4 (Yes)	-8.0 (Yes)
Cottage Grove	0.6 (Yes)	0.7 (No)	0.7 (No)	-0.2 (Yes)
Cougar	6.7 (Yes)	6.1 (Yes)	-188.2 (Yes)	-86.1 (Yes)
Detroit	4.4 (Yes)	1.6 (Yes)	1.5 (Yes)	-116.2 (Yes)
Dorena	2.1 (Yes)	1.5 (No)	1.4 (No)	0.7 (Yes)
Fall Creek	1.1 (No)	0.8 (No)	0.9 (No)	0.7 (No)
Fern Ridge	0.0 (No)	0.0 (No)	0.0 (No)	0.0 (No)
Foster	0.1 (No)	0.2 (No)	0.2 (No)	0.2 (No)
Green Peter	5.7 (Yes)	-31.8 (Yes)	-31.8 (Yes)	-31.8 (Yes)
Hills Creek	4.9 (Yes)	3.6 (Yes)	2.0 (Yes)	-6.4 (Yes)
Lookout Point	-0.6 (Yes)	0.5 (Yes)	-0.3 (Yes)	-72.9 (Yes)

Project	Alt 3B vs. NAA Metric (*Range Change)	Alt 4 vs. NAA Metric (*Range Change)	Alt 5 vs. NAA Metric (*Range Change)	NTOM vs. NAA Metric (*Range Change)
Blue River	-7.6 (Yes)	2.9 (Yes)	0.4 (Yes)	3.8 (Yes)
Cottage Grove	-0.1 (Yes)	0.0 (Yes)	0.4 (No)	0.6 (No)
Cougar	-188.4 (Yes)	6.3 (Yes)	-206.1 (Yes)	-21.7 (Yes)
Detroit	-19.6 (Yes)	1.6 (Yes)	1.5 (Yes)	1.5 (Yes)
Dorena	0.8 (Yes)	0.7 (Yes)	0.8 (No)	1.6 (No)
Fall Creek	0.6 (No)	0.9 (No)	0.5 (No)	-57.8 (No)
Fern Ridge	0.0 (No)	0.0 (No)	0.0 (No)	0.0 (No)
Foster	-3.0 (No)	0.1 (No)	0.2 (No)	-4.7 (No)
Green Peter	-133.5 (Yes)	-4.4 (Yes)	-32.0 (Yes)	-36.3 (Yes)
Hills Creek	-40.0 (Yes)	3.9 (Yes)	-2.0 (Yes)	3.0 (Yes)
Lookout Point	-18.5 (Yes)	0.6 (Yes)	-0.4 (Yes)	-29.8 (Yes)

Changes in range are deeper drafts relative to NAA. There is no change to full pool elevation.

Table 2-6. Storage Metrics – Shoreline Exposure Qualitative Analysis

Project	Alt 1 vs. NAA	Alt 2A vs. NAA	Alt 2B vs. NAA	Alt 3A vs. NAA
Blue River	Major	Major	Major	Major
Cottage Grove	Major	Negligible	Negligible	Major
Cougar	Major	Major	Major	Major
Detroit	Major	Major	Major	Major
Dorena	Major	Negligible	Negligible	Major
Fall Creek	Negligible	Negligible	Negligible	Negligible
Fern Ridge	Negligible	Negligible	Negligible	Negligible
Foster	Negligible	Negligible	Negligible	Negligible
Green Peter	Major	Major	Major	Major
Hills Creek	Major	Major	Major	Minor
Lookout Point	Major	Major	Major	Major

Project	Alt 3B vs. NAA	Alt 4 vs. NAA	Alt 5 vs. NAA	NTOM vs. NAA
Blue River	Major	Major	Major	Major
Cottage Grove	Major	Major	Negligible	Negligible
Cougar	Major	Major	Major	Major
Detroit	Major	Major	Major	Major
Dorena	Major	Major	Negligible	Negligible
Fall Creek	Negligible	Negligible	Negligible	Major
Fern Ridge	Negligible	Negligible	Negligible	Negligible
Foster	Negligible	Negligible	Negligible	Negligible
Green Peter	Major	Major	Major	Major
Hills Creek	Major	Major	Major	Major
Lookout Point	Major	Major	Major	Major

2.1.1 Blue River

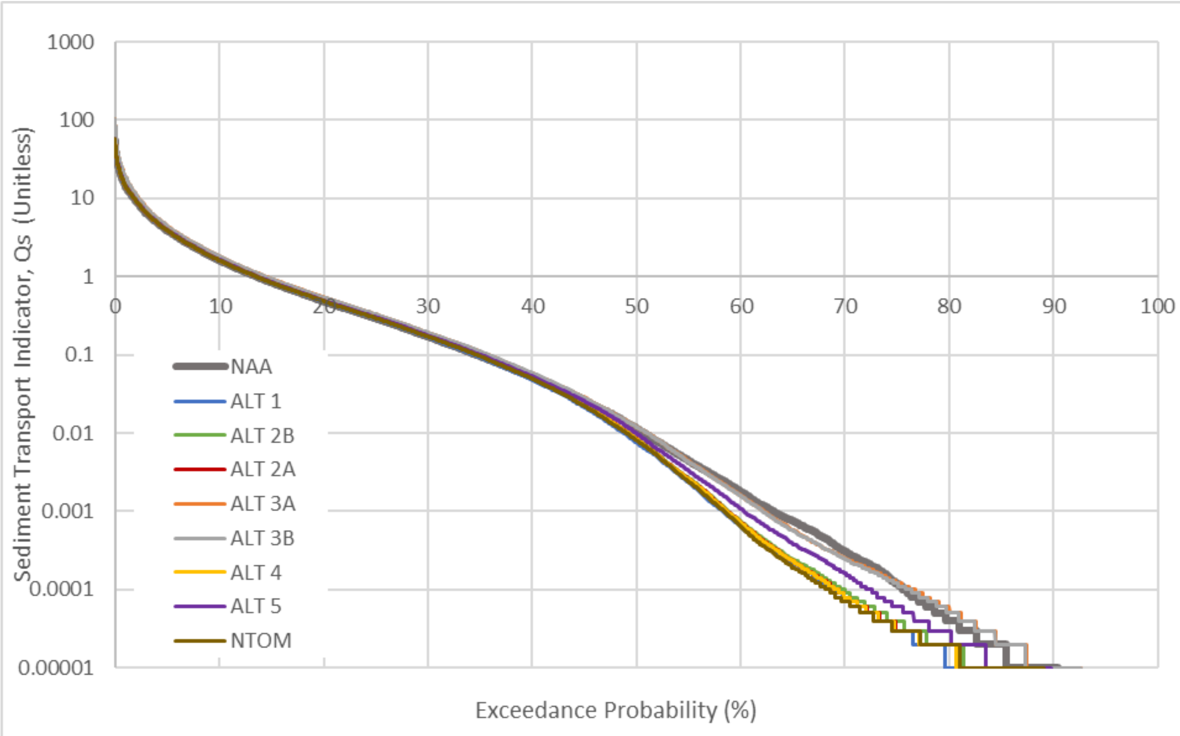

Figure 2-1. Blue River Sediment Transport Indicator

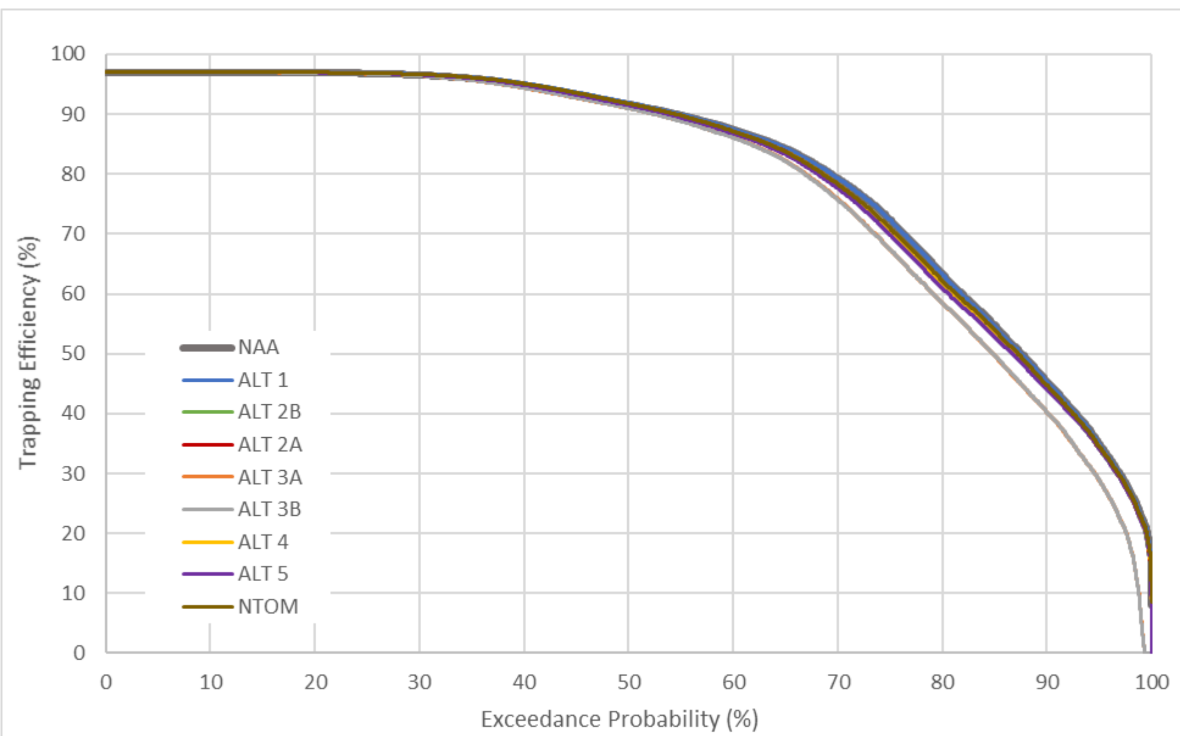

Figure 2-2. Blue River Trapping Efficiency Daily Exceedance

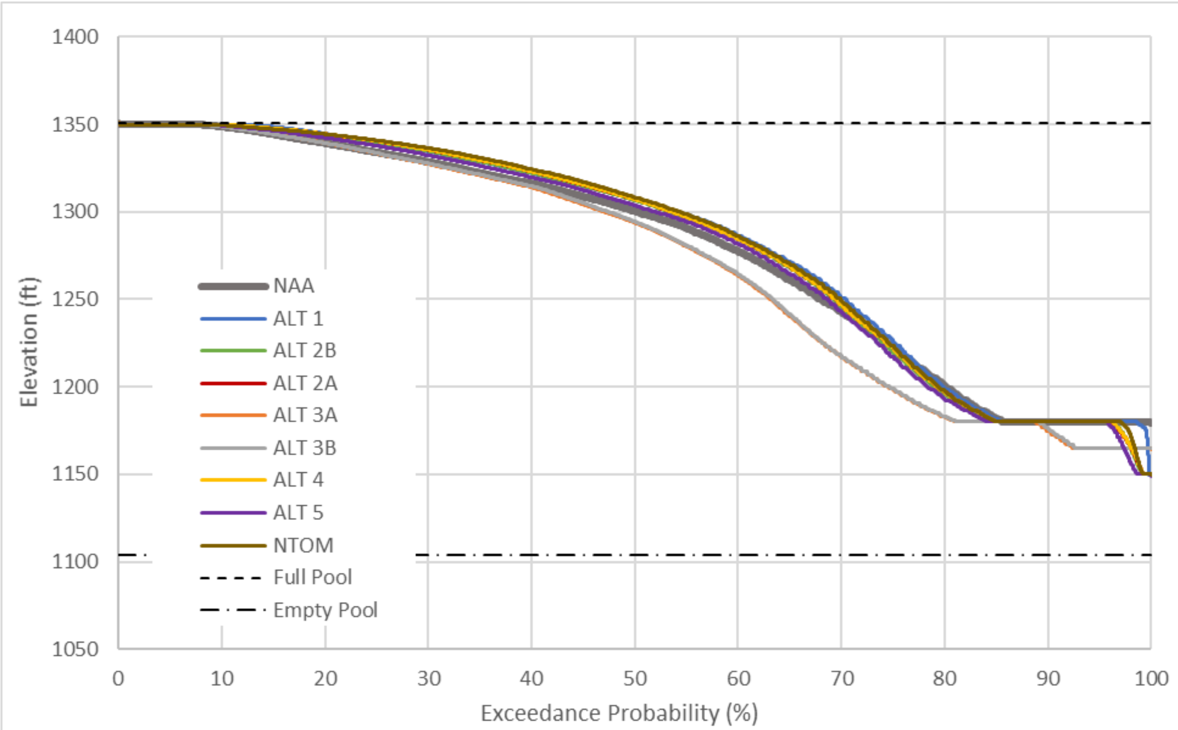

Figure 2-3. Blue River Elevation Daily Exceedance

2.1.2 Cottage Grove

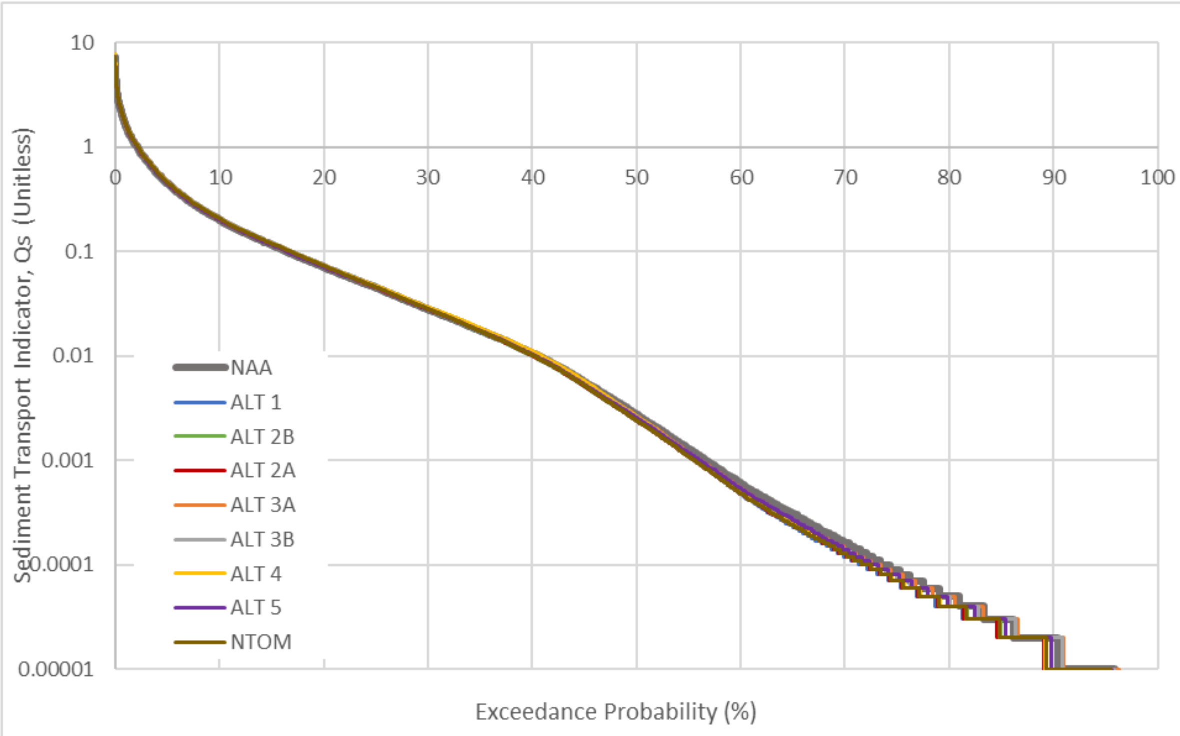

Figure 2-4. Cottage Grove Sediment Transport Indicator

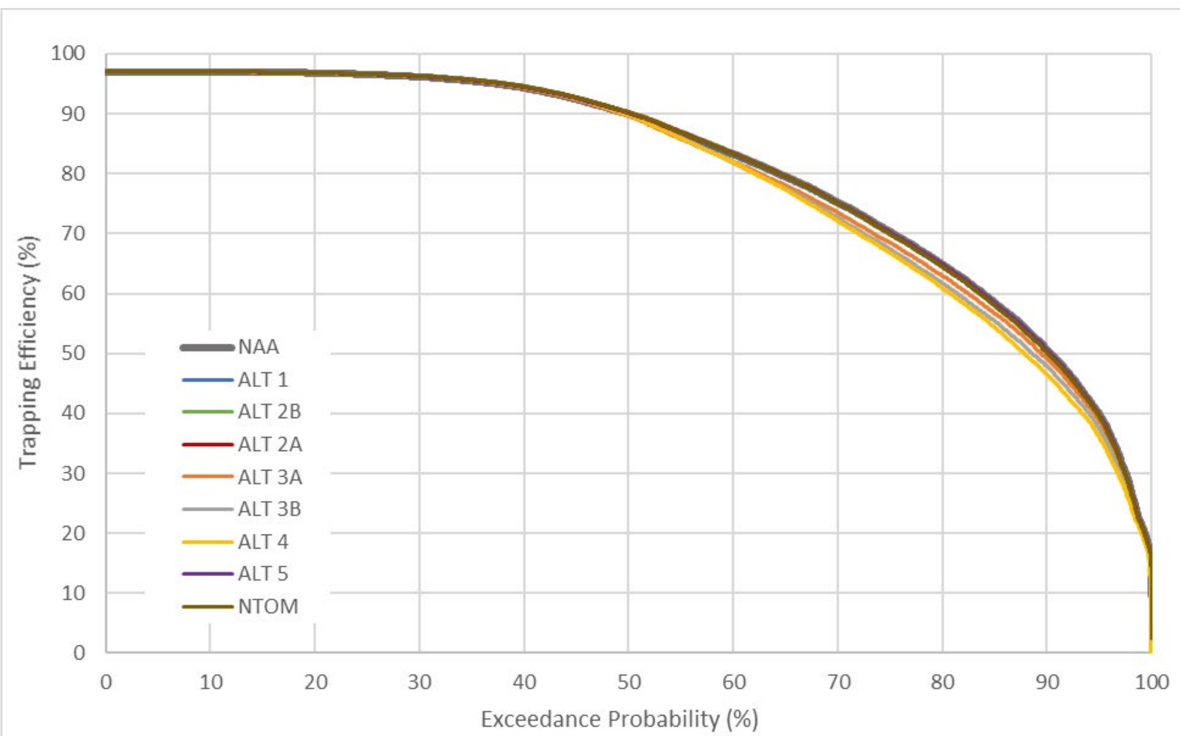

Figure 2-5. Cottage Grove Trapping Efficiency Daily Exceedance

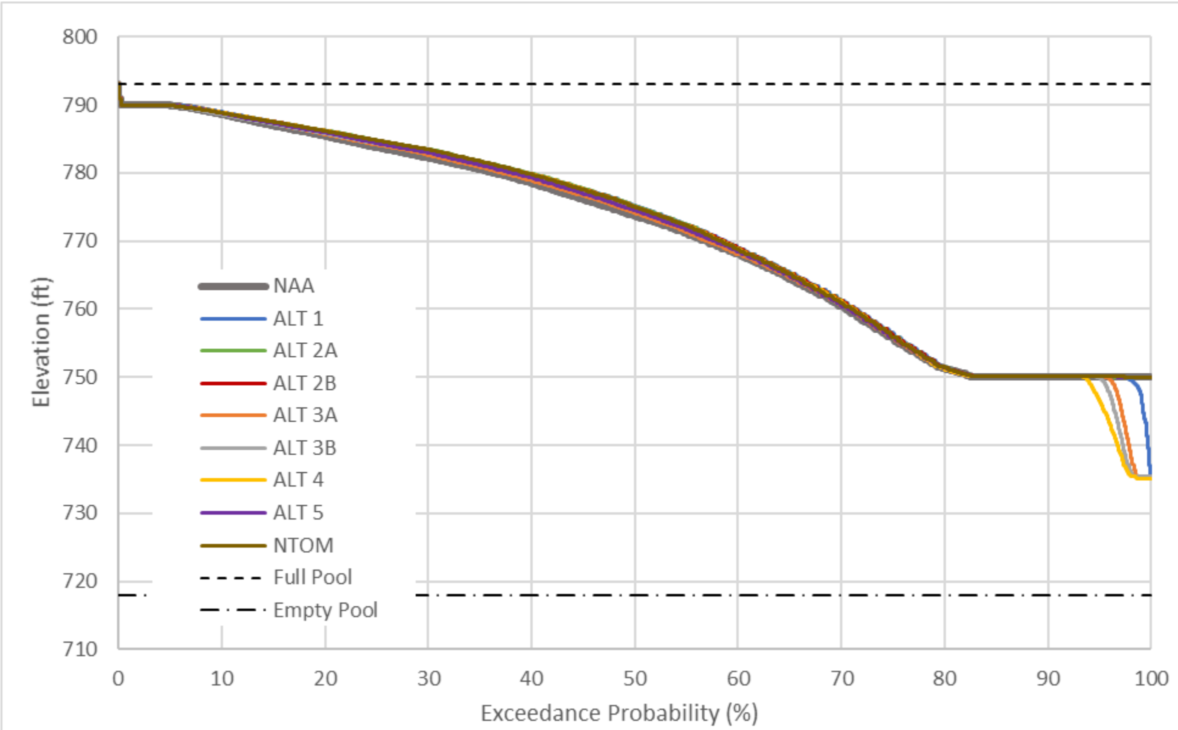

Figure 2-6. Cottage Grove Elevation Daily Exceedance

2.1.3 Cougar

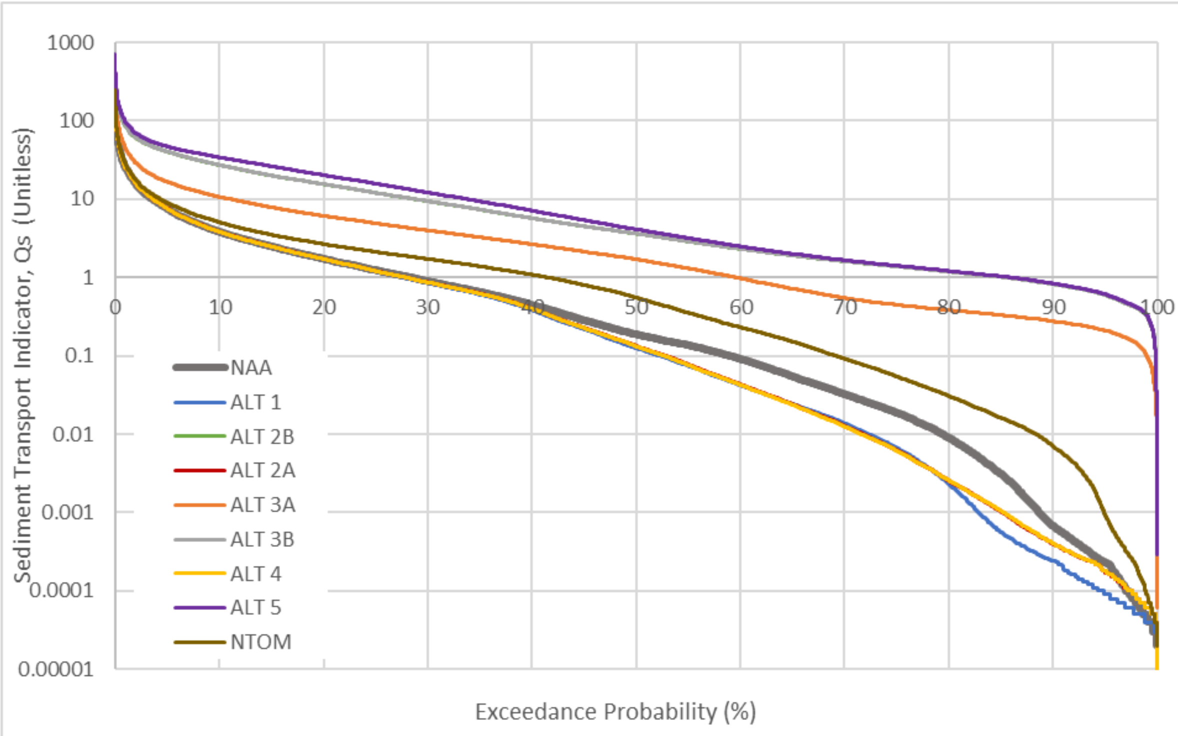

Figure 2-7. Cougar Sediment Transport Indicator

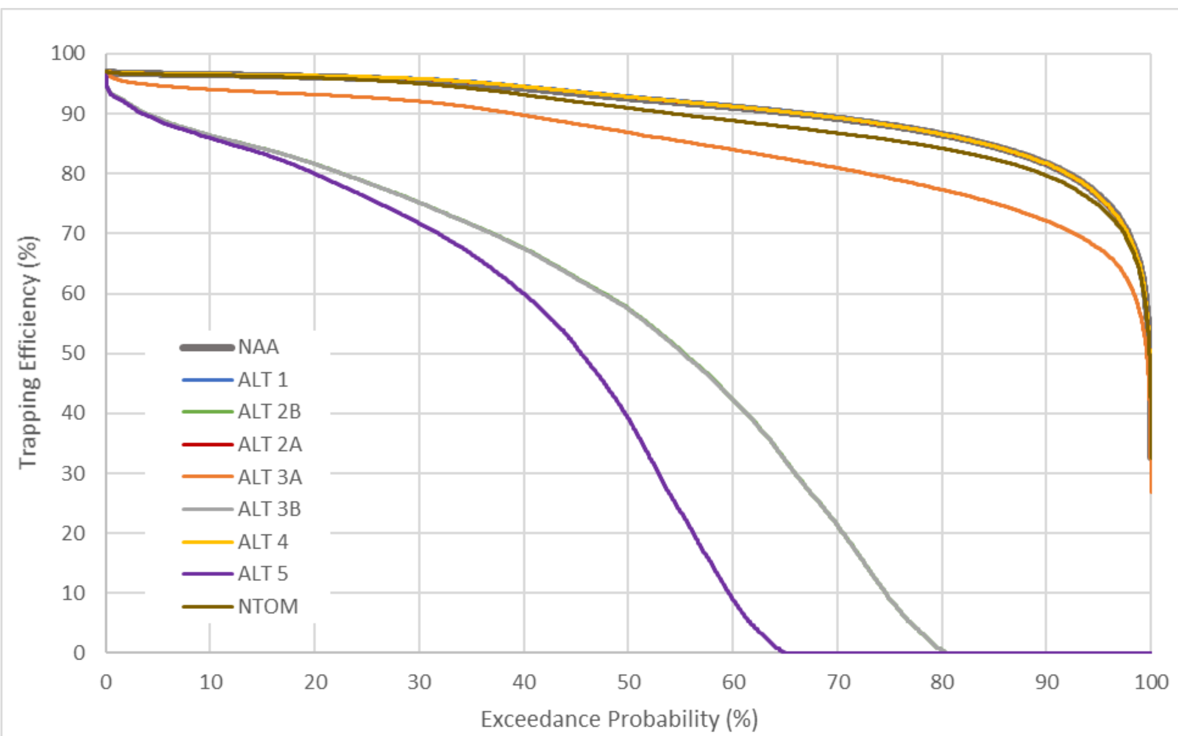

Figure 2-8. Cougar Trapping Efficiency Daily Exceedance

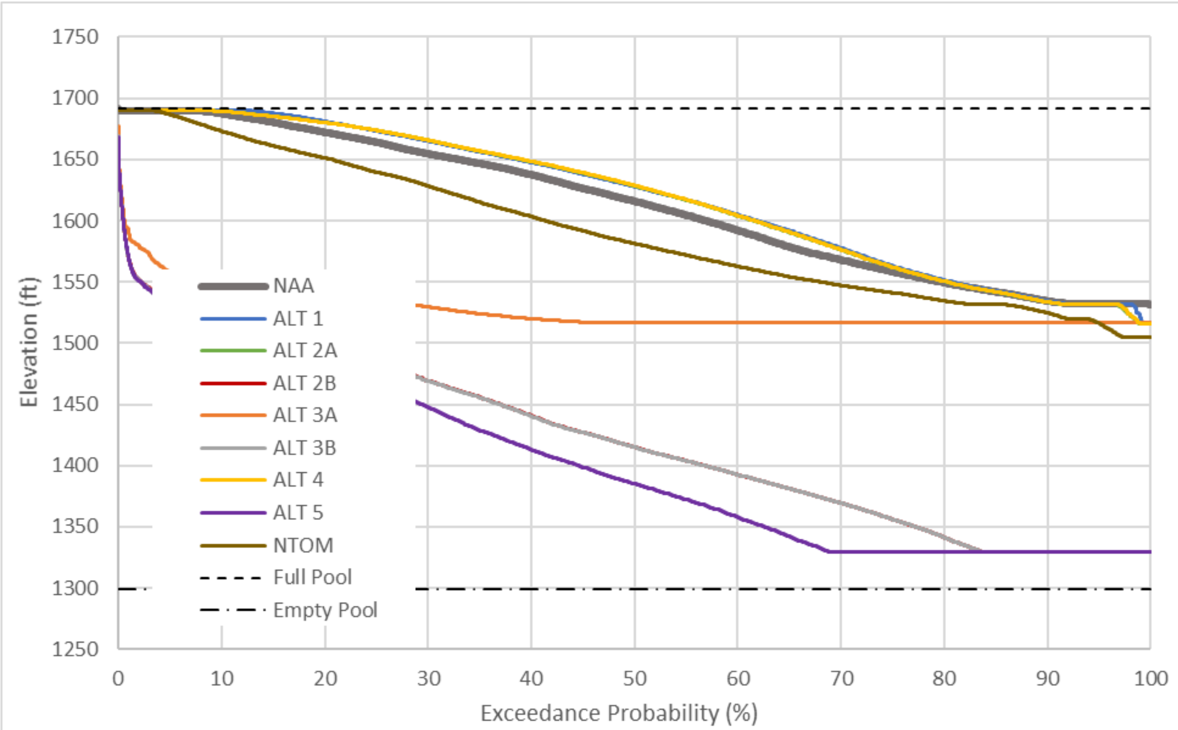

Figure 2-9. Cougar Elevation Daily Exceedance

2.1.4 Detroit

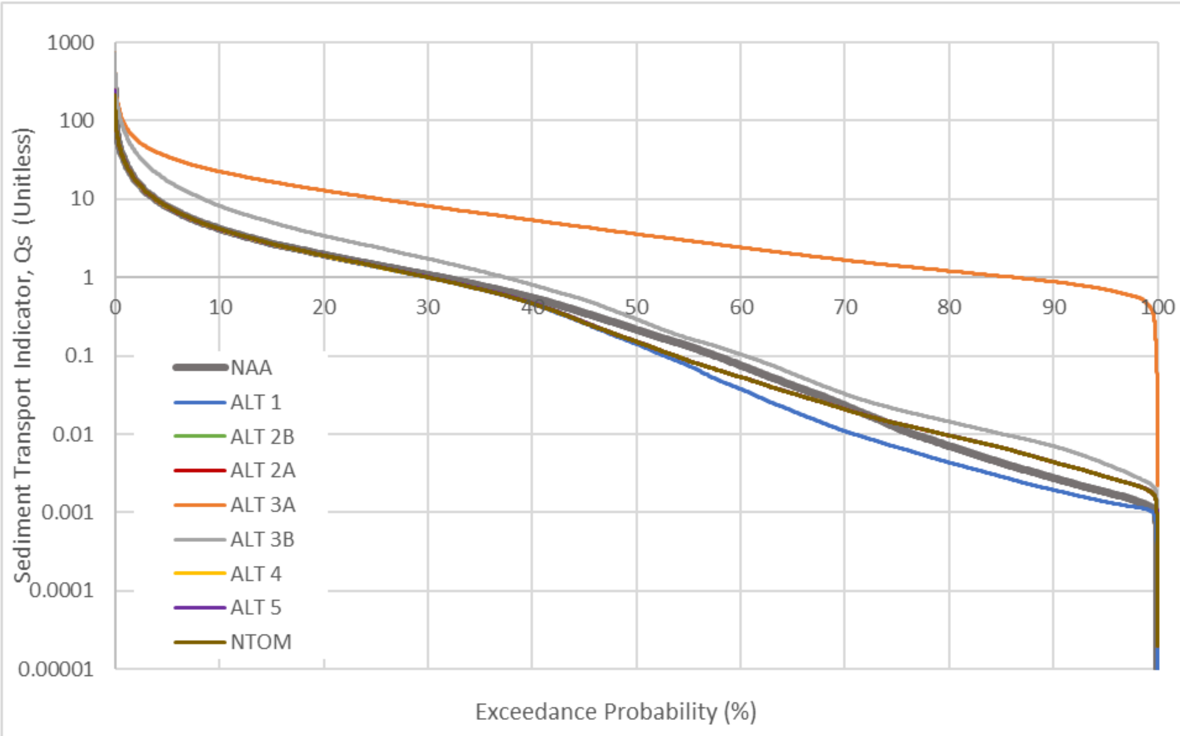

Figure 2-10. Detroit Sediment Transport Indicator

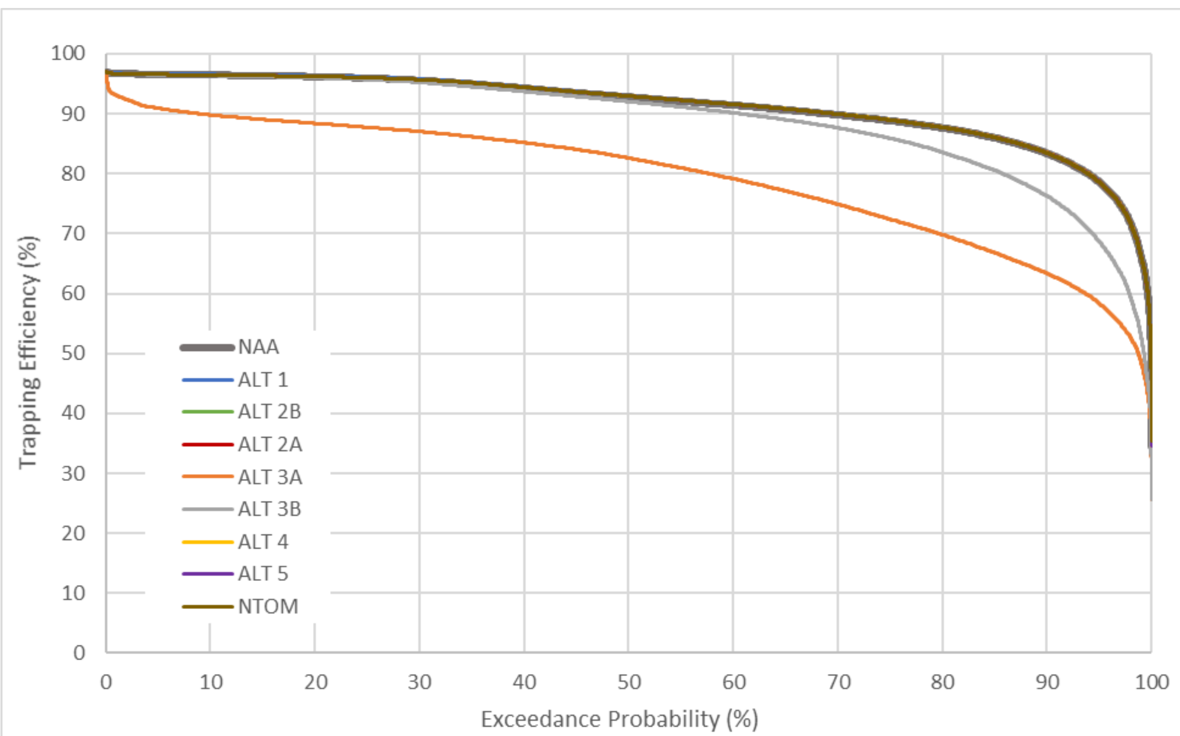

Figure 2-11. Detroit Trapping Efficiency Daily Exceedance

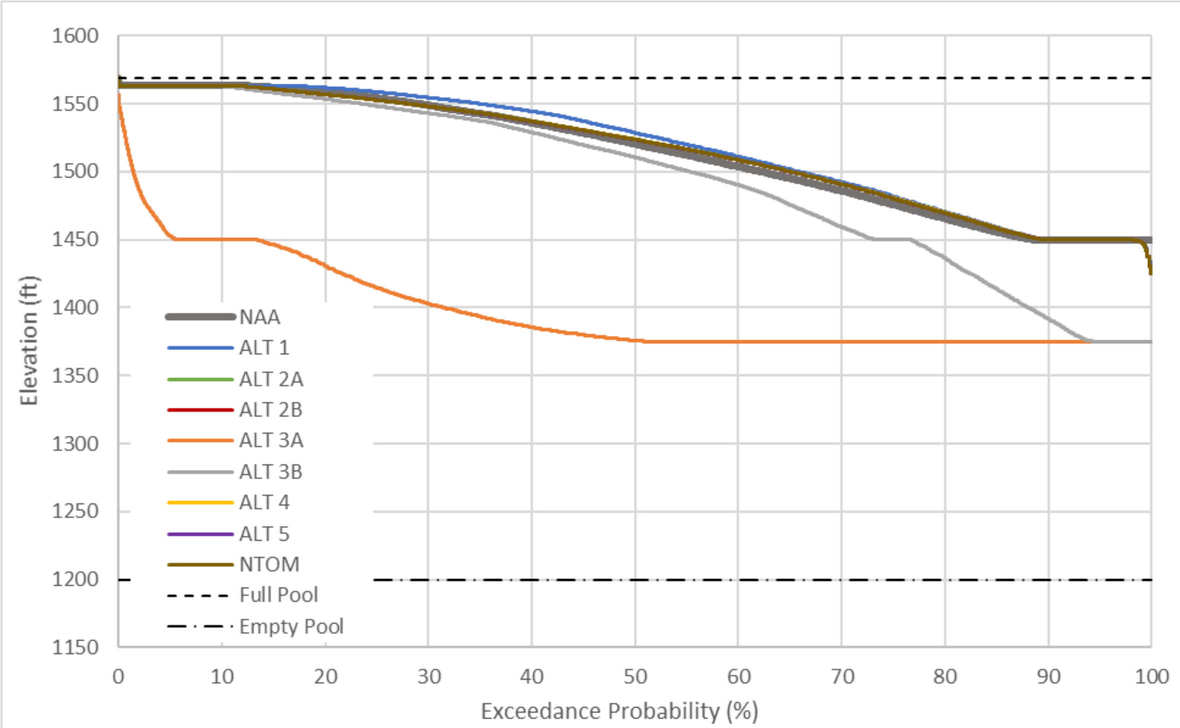

Figure 2-12. Detroit Elevation Daily Exceedance

2.1.5 Dorena

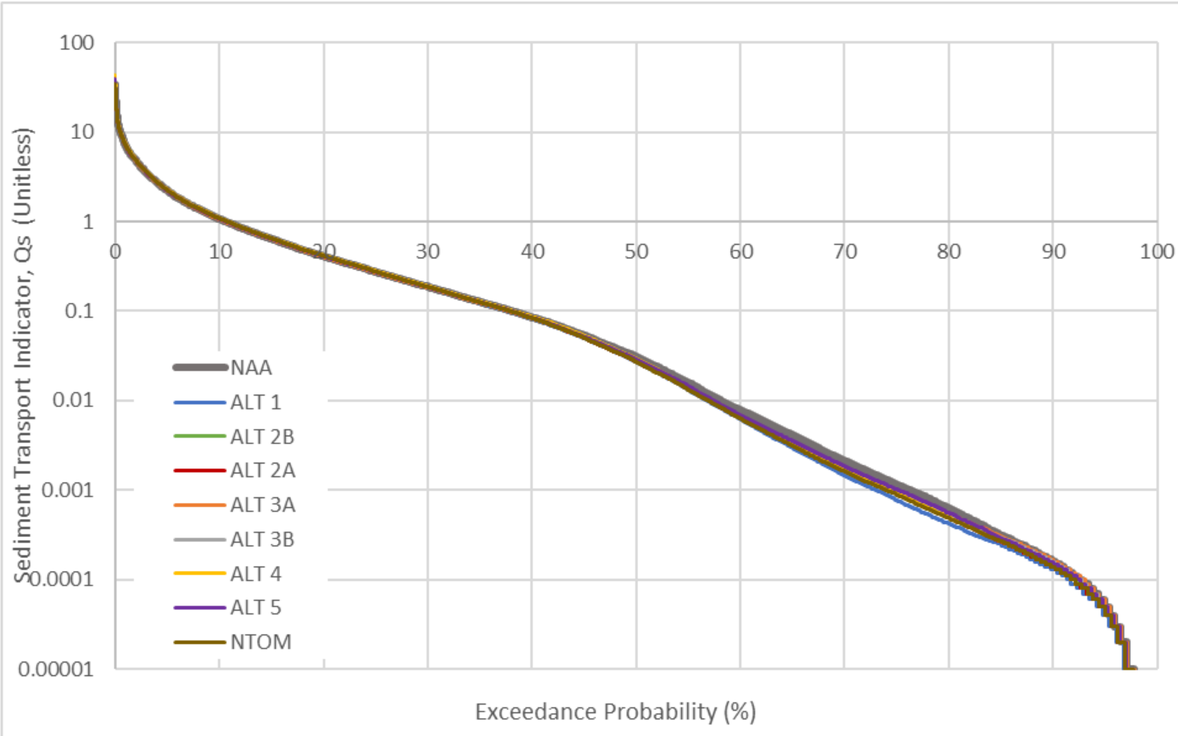

Figure 2-13. Dorena Sediment Transport Indicator

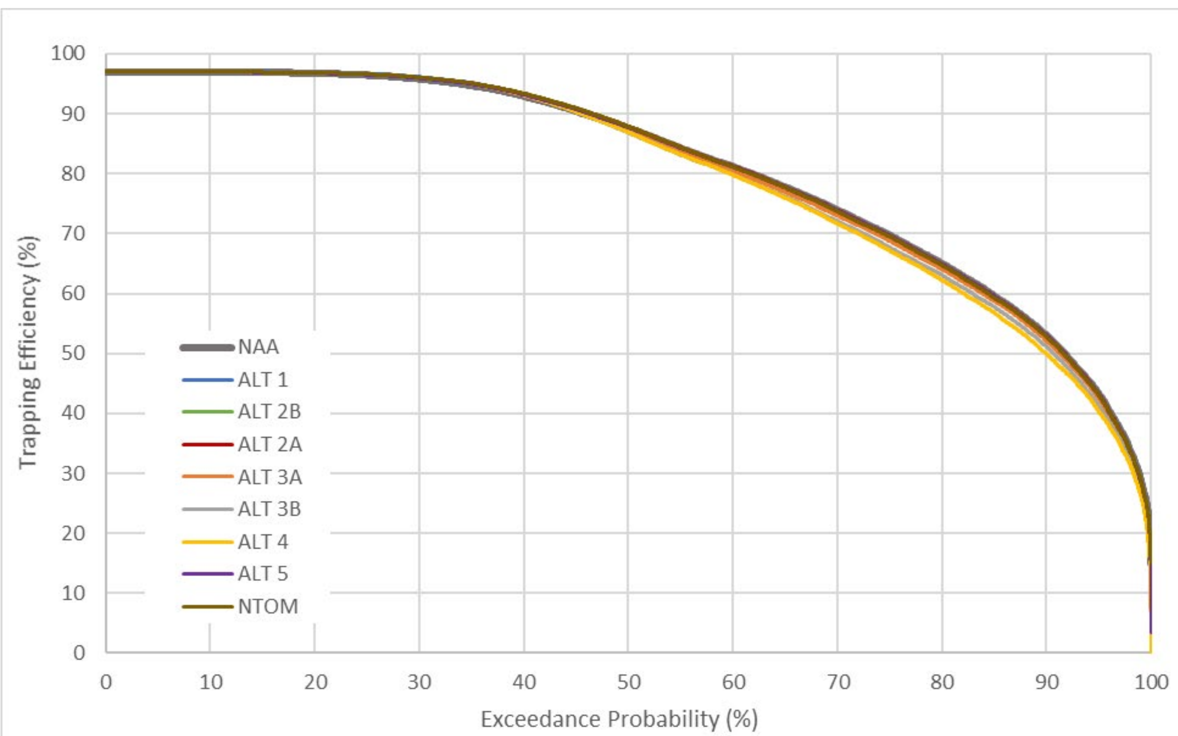

Figure 2-14. Dorena Trapping Efficiency Daily Exceedance

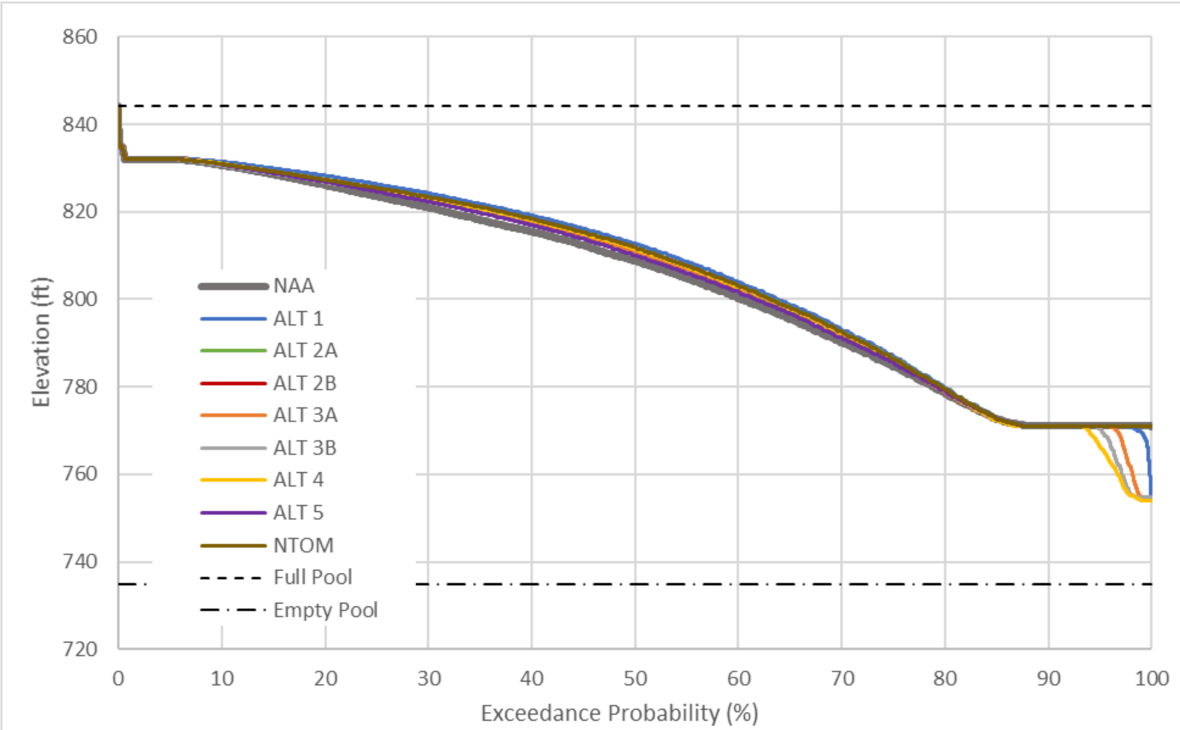

Figure 2-15. Dorena Elevation Daily Exceedance

2.1.6 Fall Creek

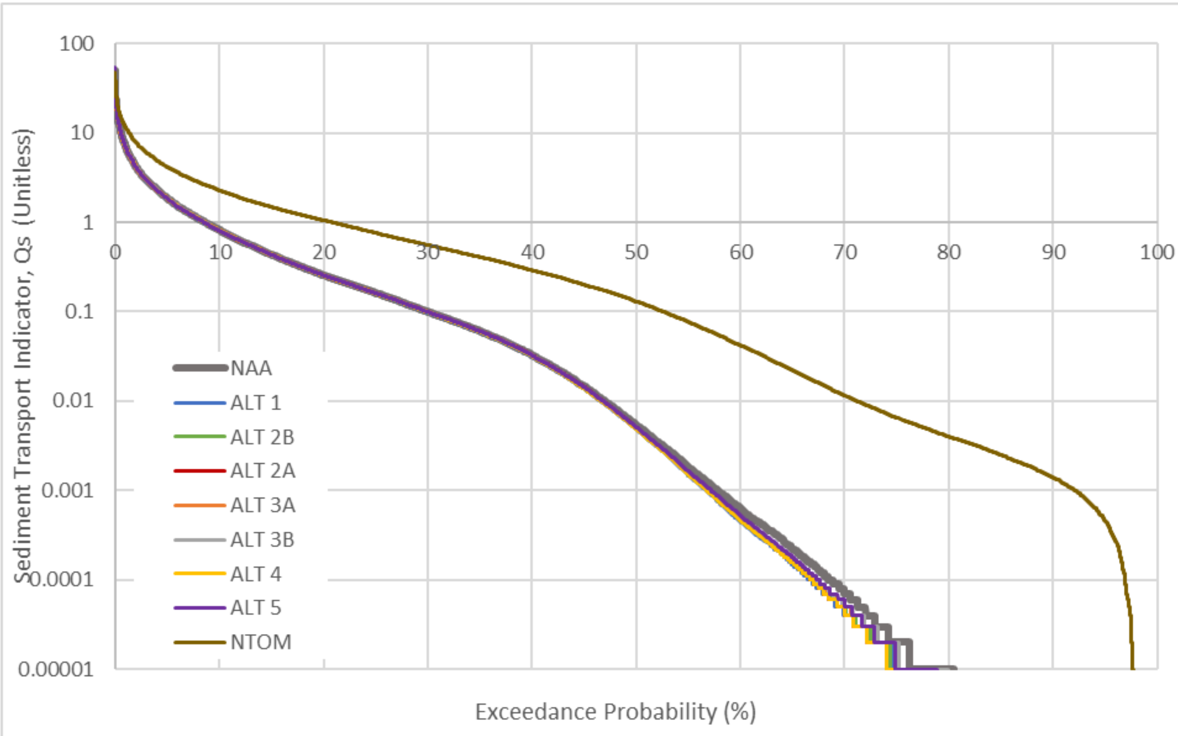

Figure 2-16. Fall Creek Sediment Transport Indicator

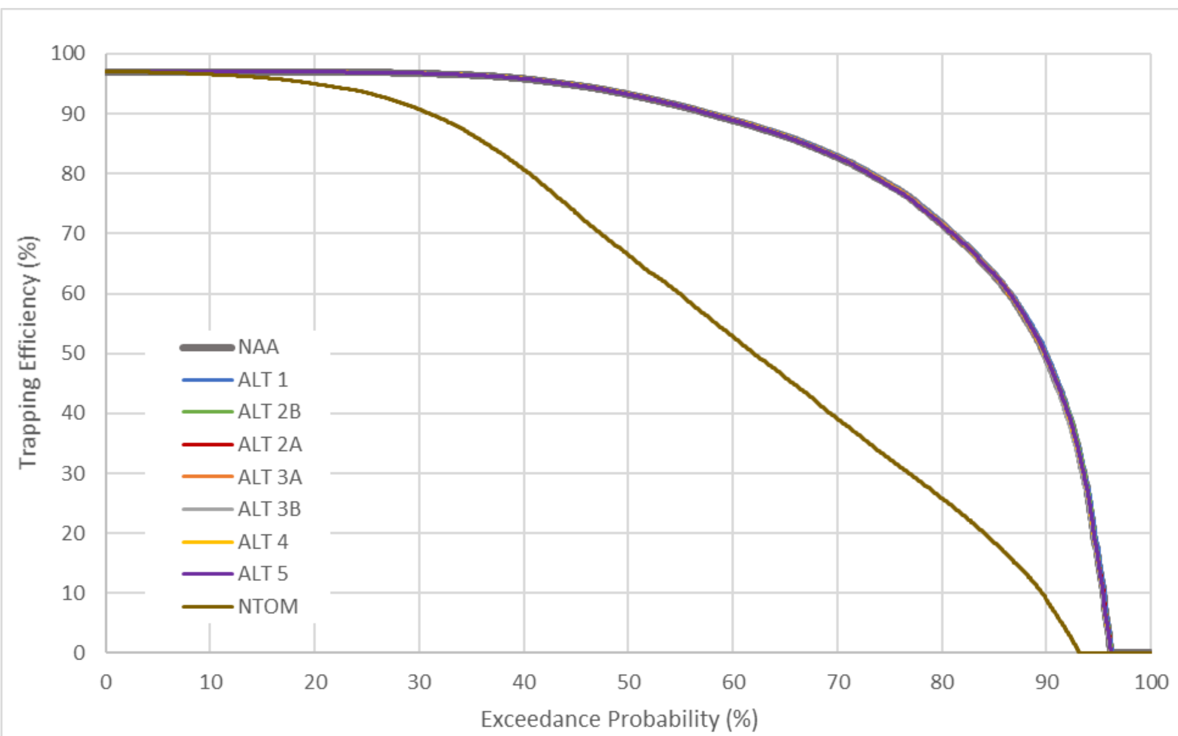

Figure 2-17. Fall Creek Trapping Efficiency Daily Exceedance

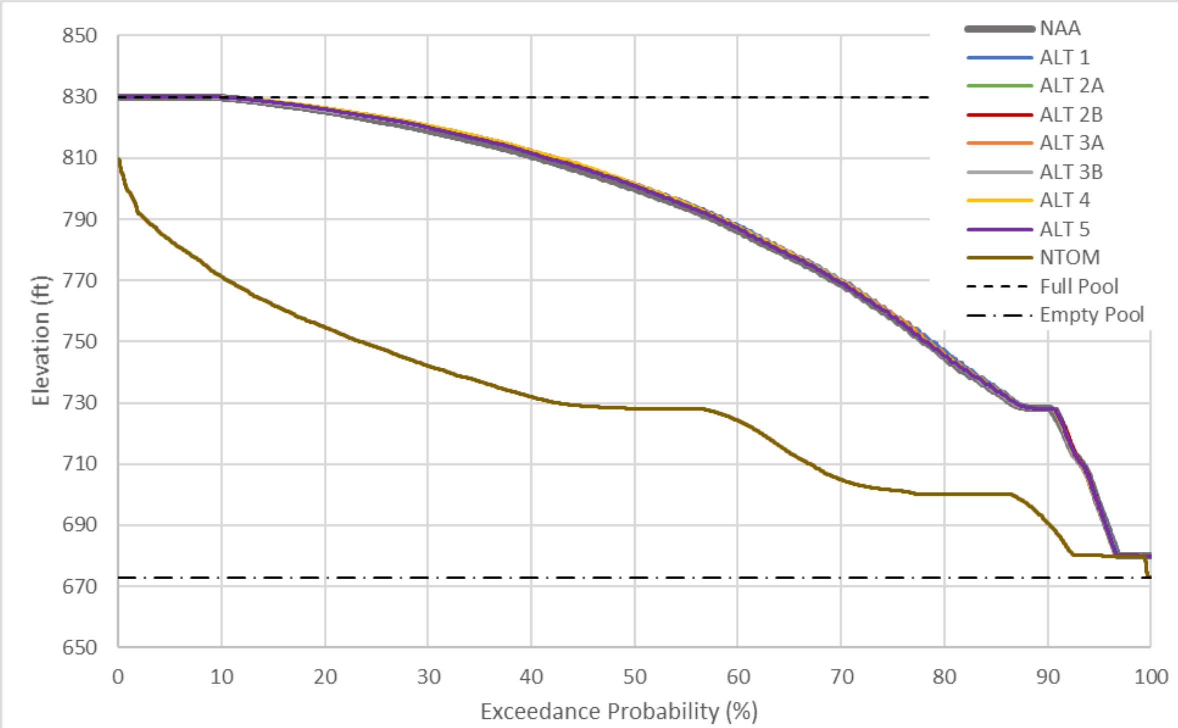

Figure 2-18. Fall Creek Elevation Daily Exceedance

2.1.7 Fern Ridge

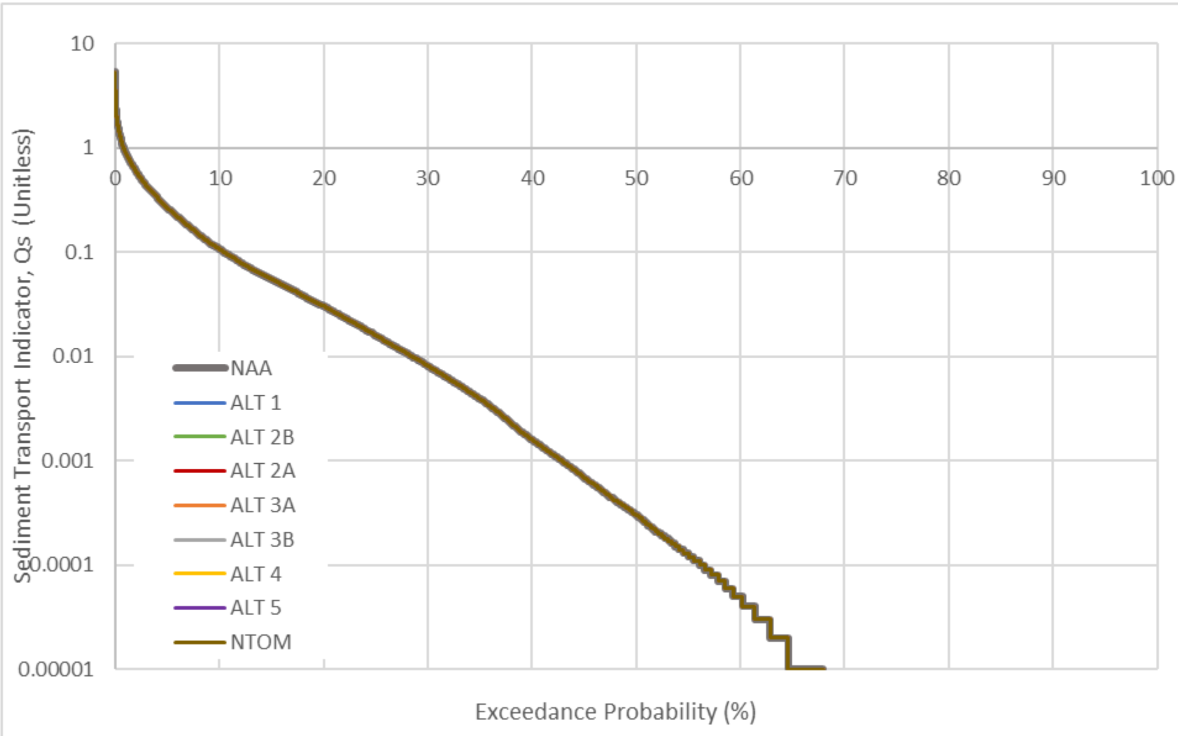

Figure 2-19. Fern Ridge Sediment Transport Indicator

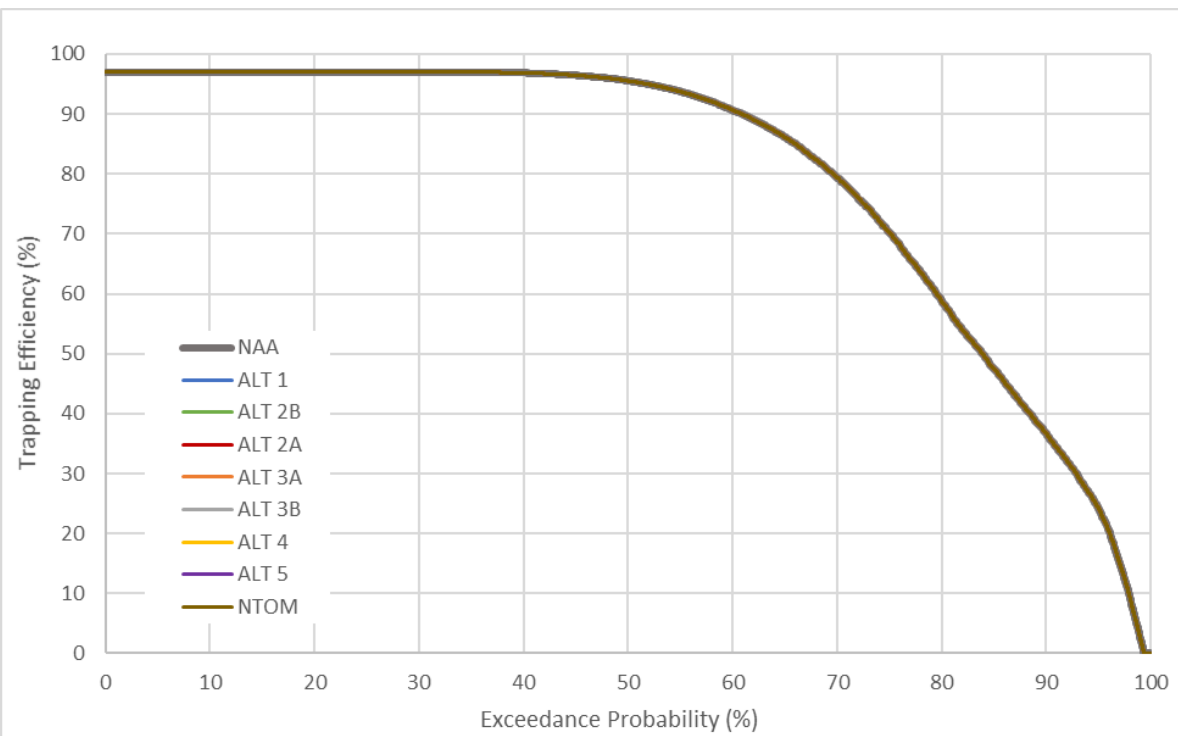

Figure 2-20. Fern Ridge Trapping Efficiency Daily Exceedance

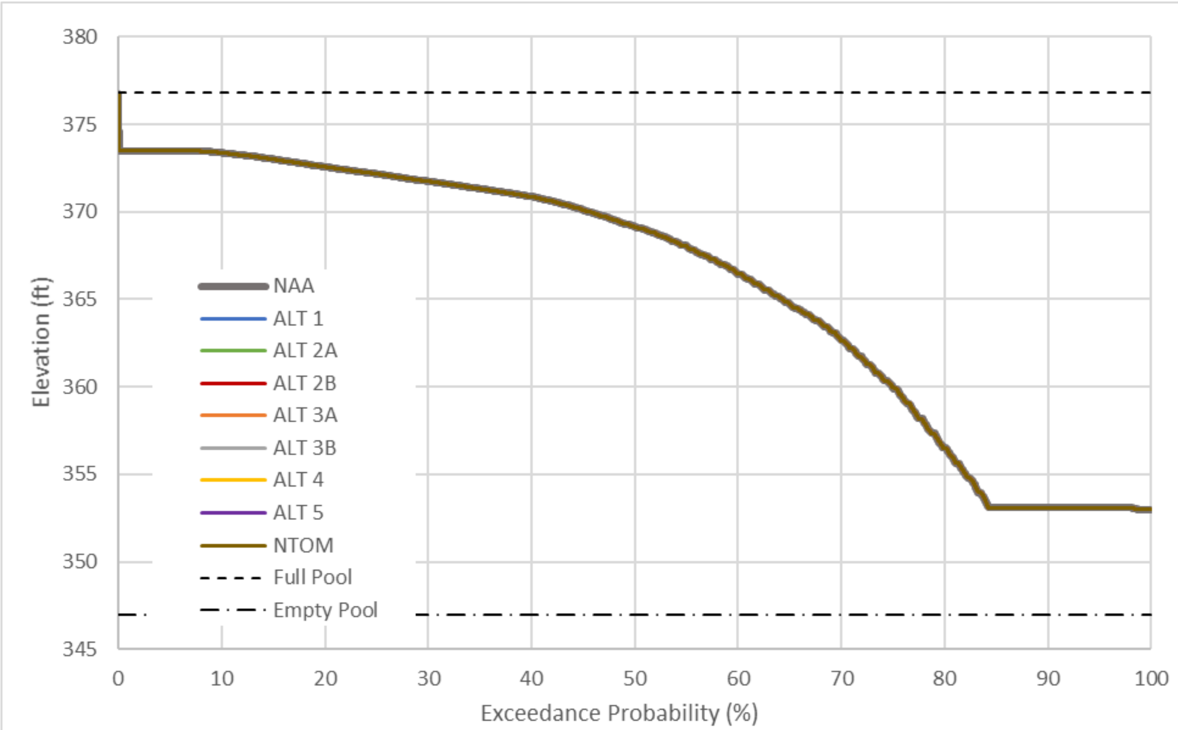

Figure 2-21. Fern Ridge Elevation Daily Exceedance

2.1.8 Foster

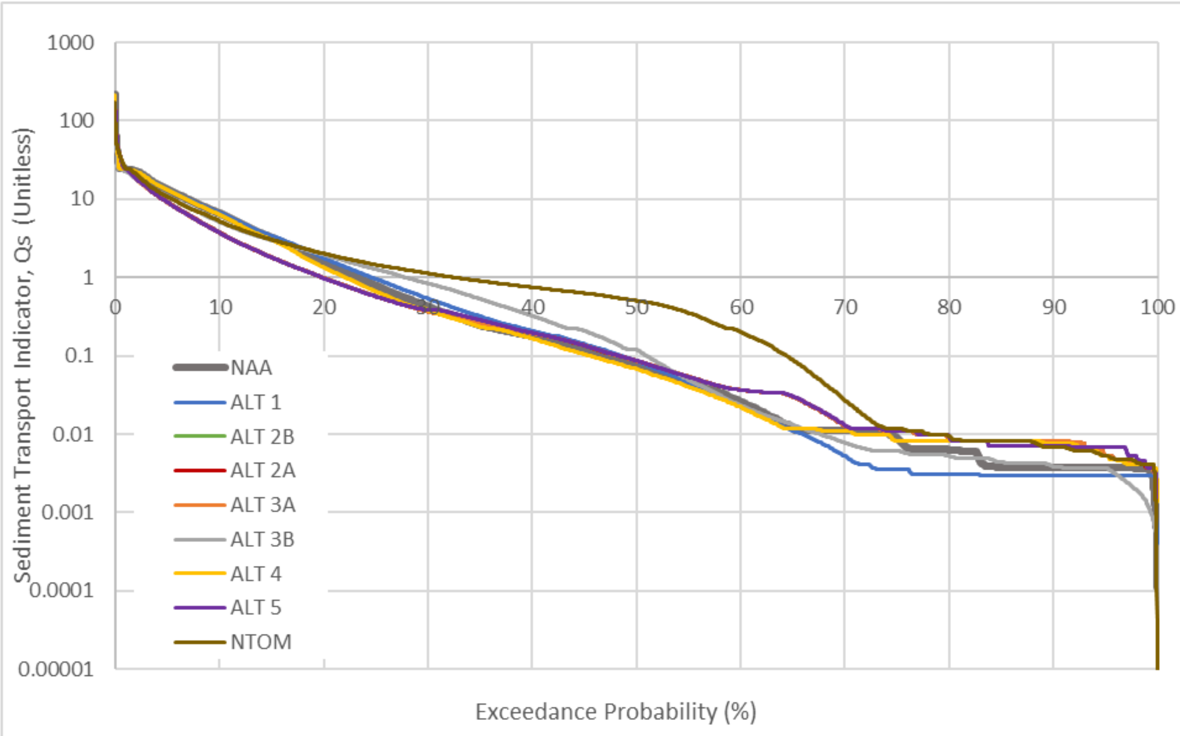

Figure 2-22. Foster Sediment Transport Indicator

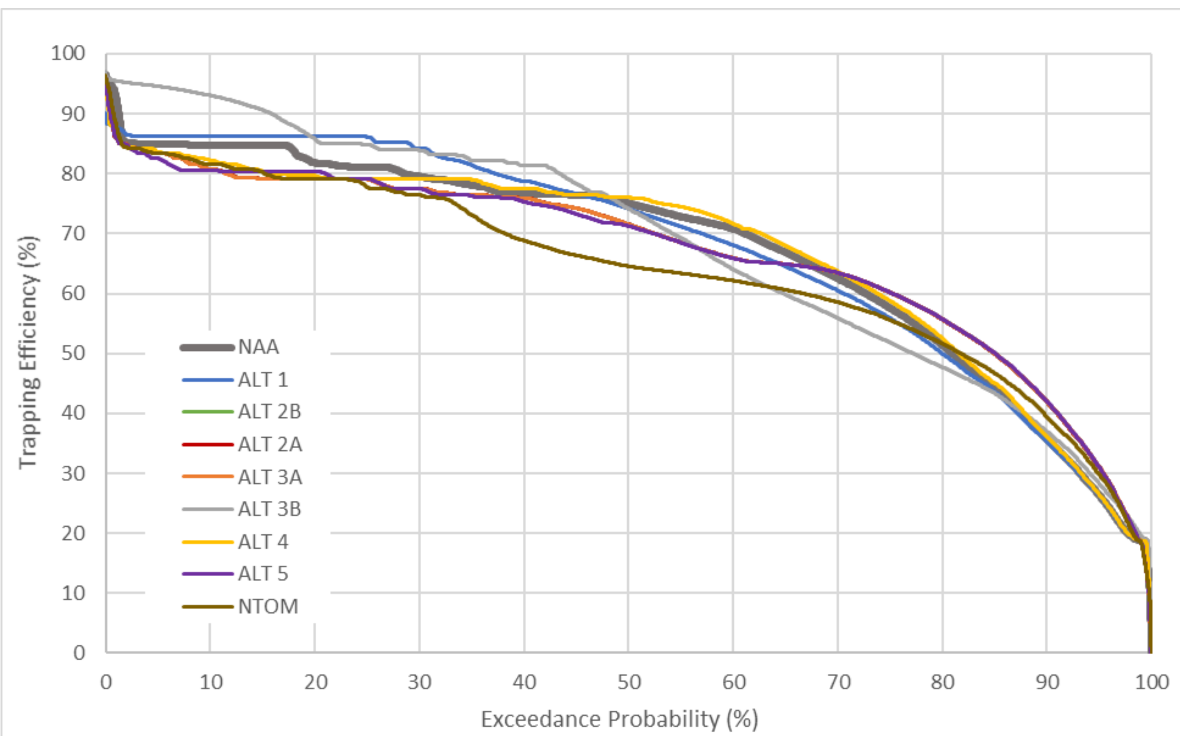

Figure 2-23. Foster Trapping Efficiency Daily Exceedance

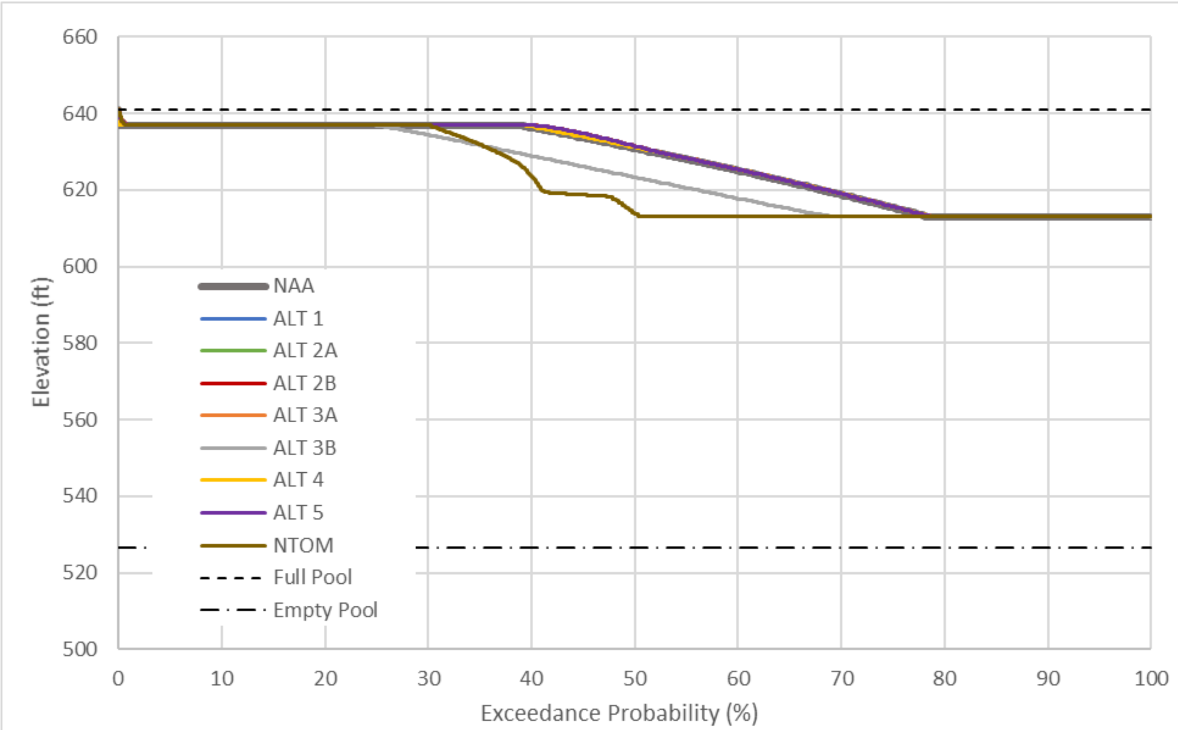

Figure 2-24. Foster Elevation Daily Exceedance

2.1.9 Green Peter

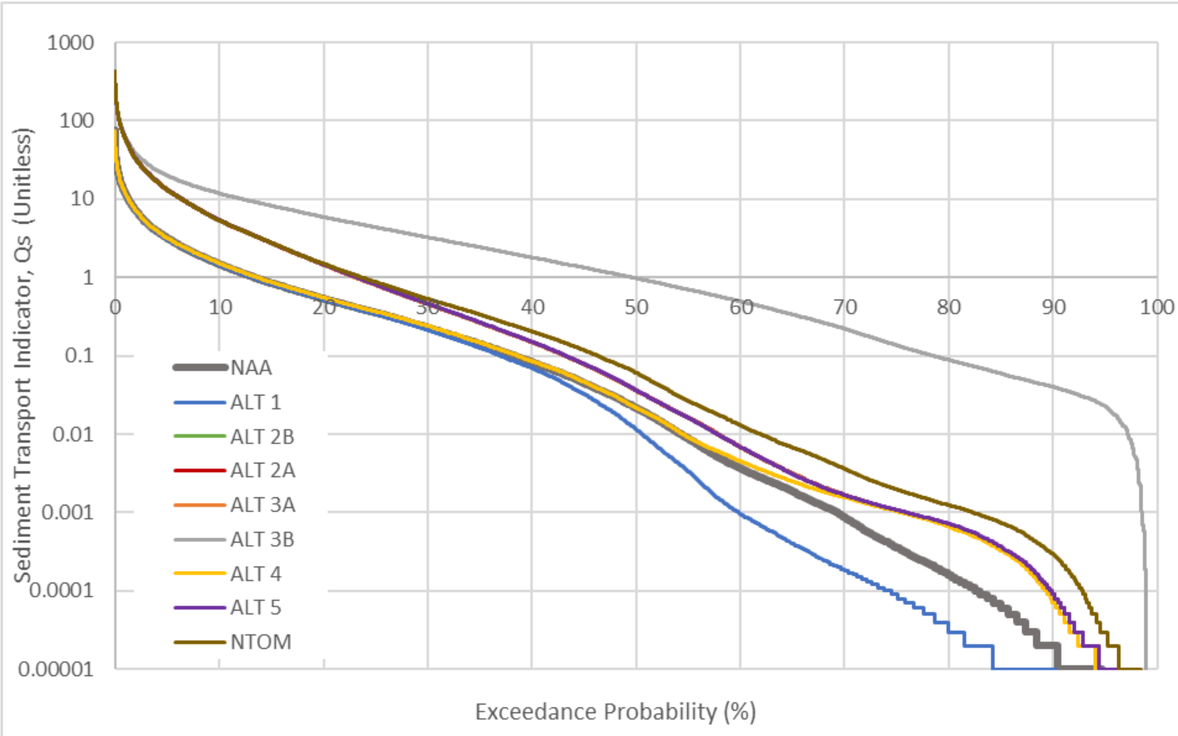

Figure 2-25. Green Peter Sediment Transport Indicator

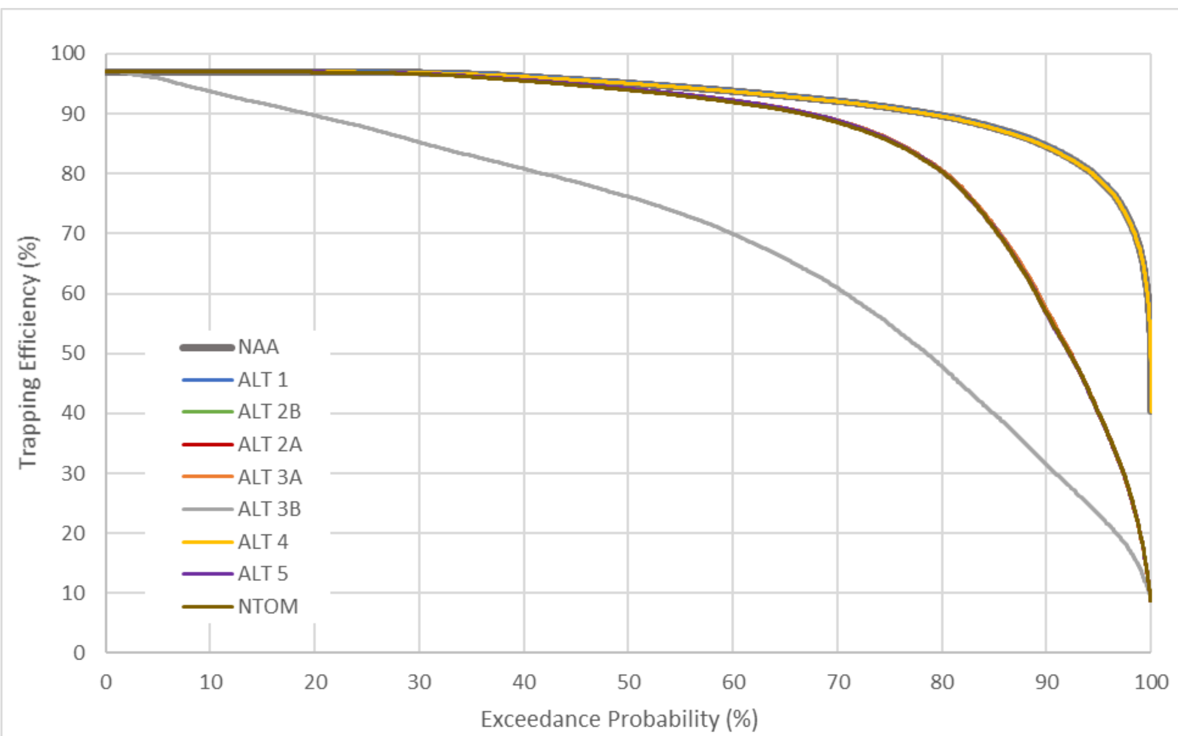

Figure 2-26. Green Peter Trapping Efficiency Daily Exceedance

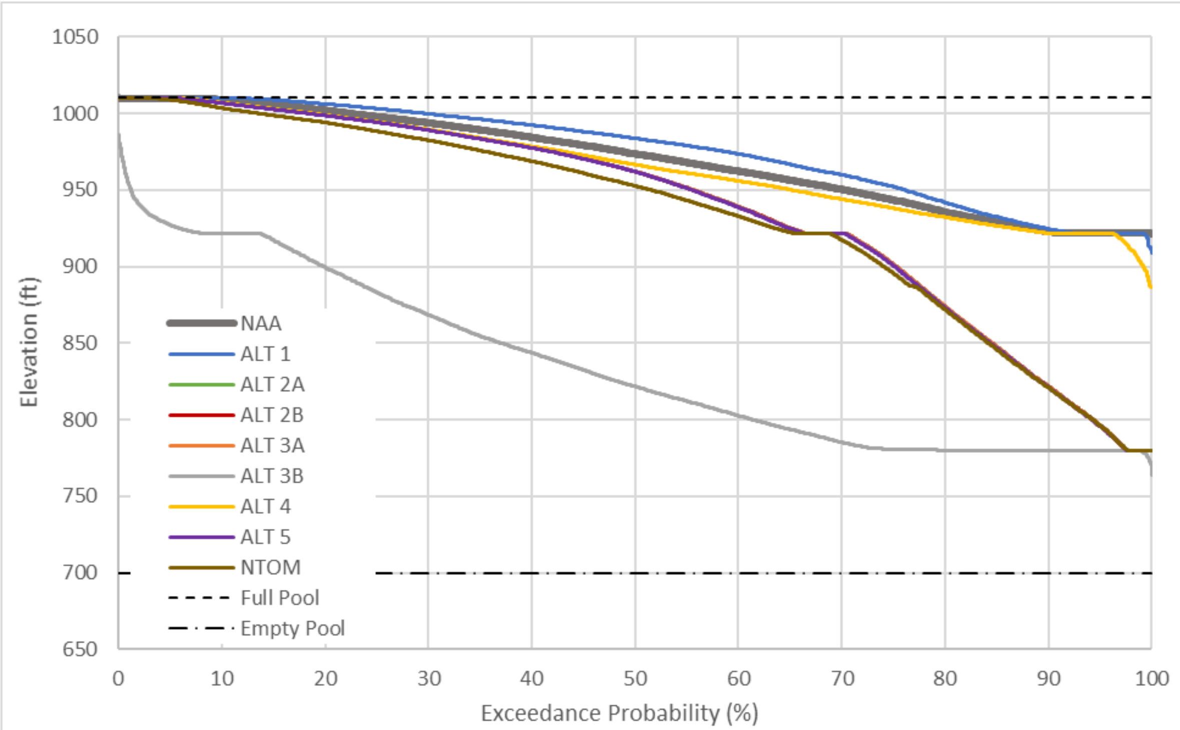

Figure 2-27. Green Peter Elevation Daily Exceedance

2.1.10 Hills Creek

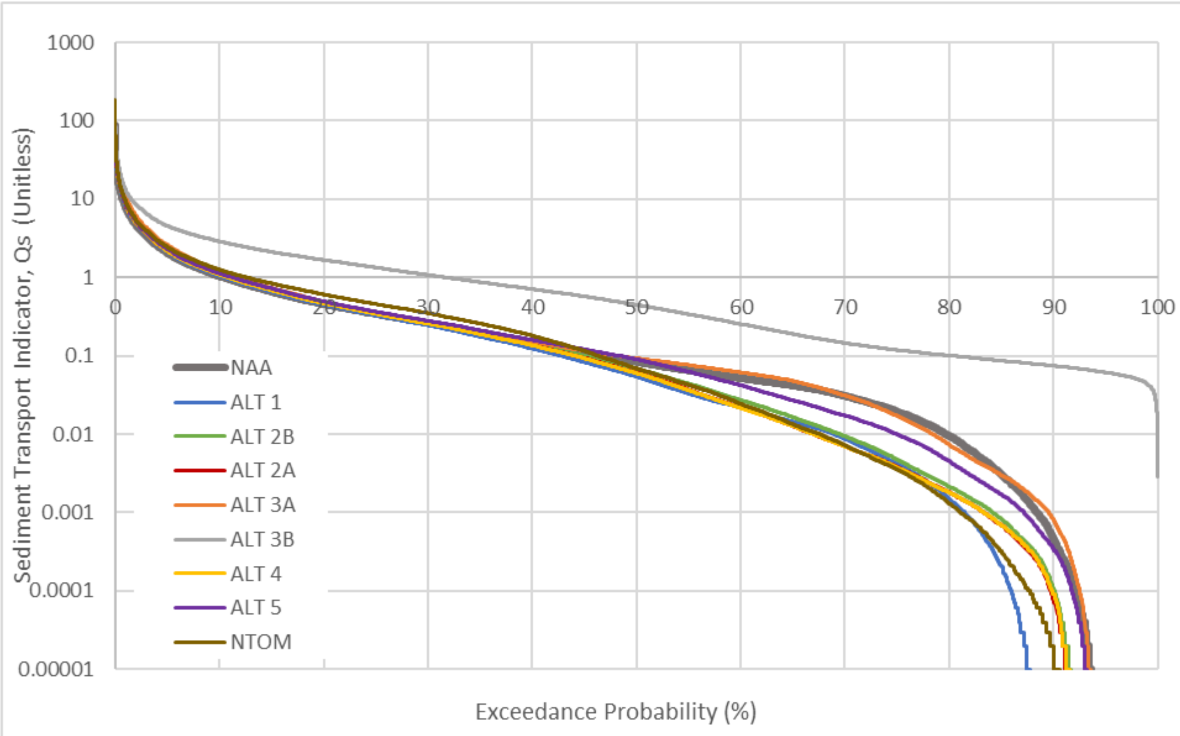

Figure 2-28. Hills Creek Sediment Transport Indicator

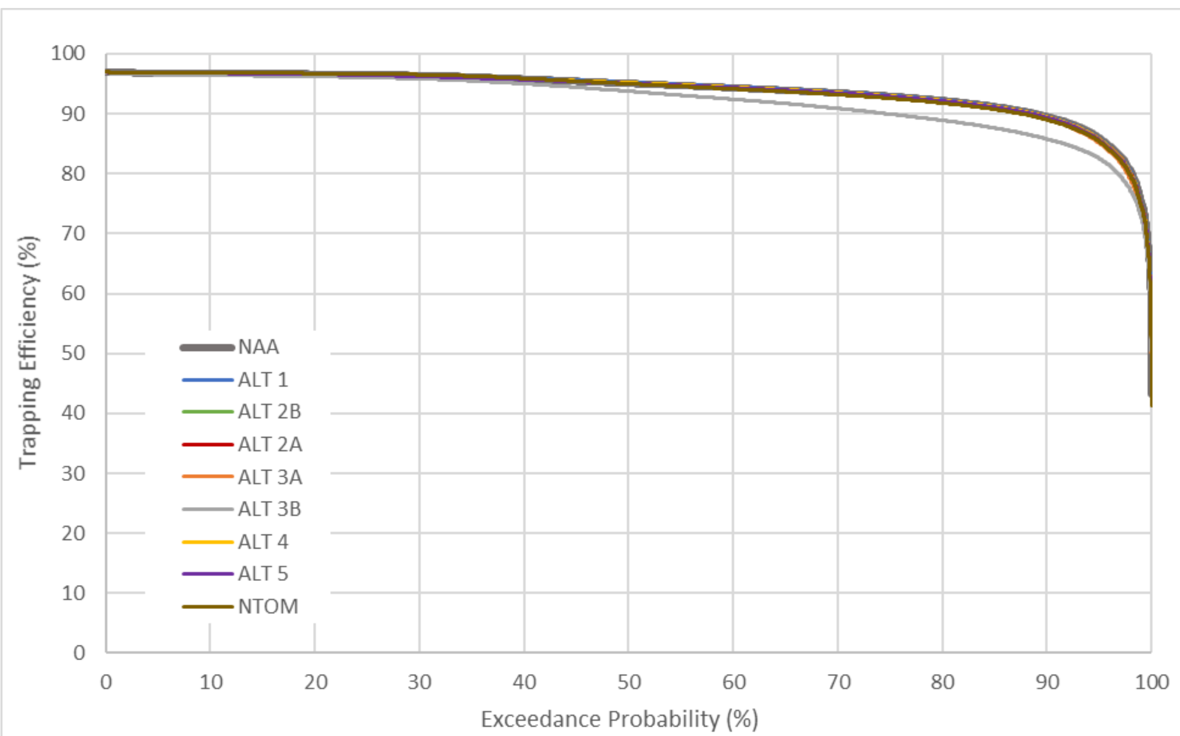

Figure 2-29. Hills Creek Trapping Efficiency Daily Exceedance

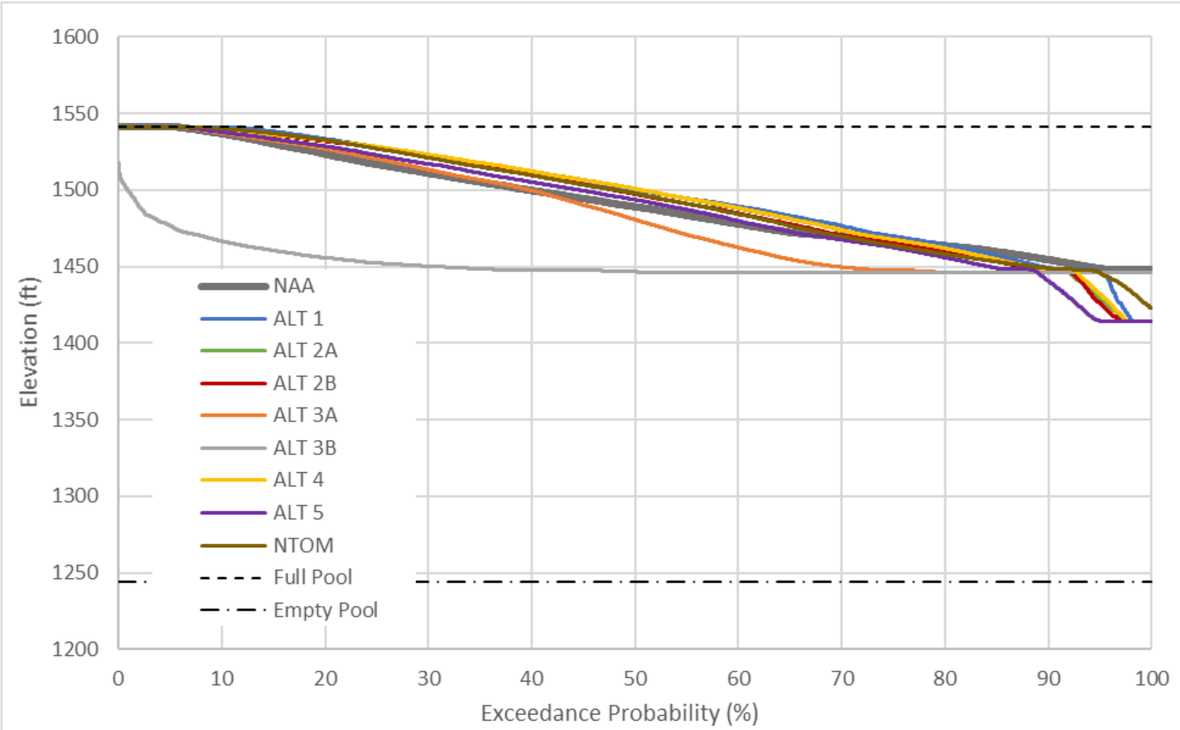

Figure 2-30. Hills Creek Elevation Daily Exceedance

2.1.11 Lookout Point

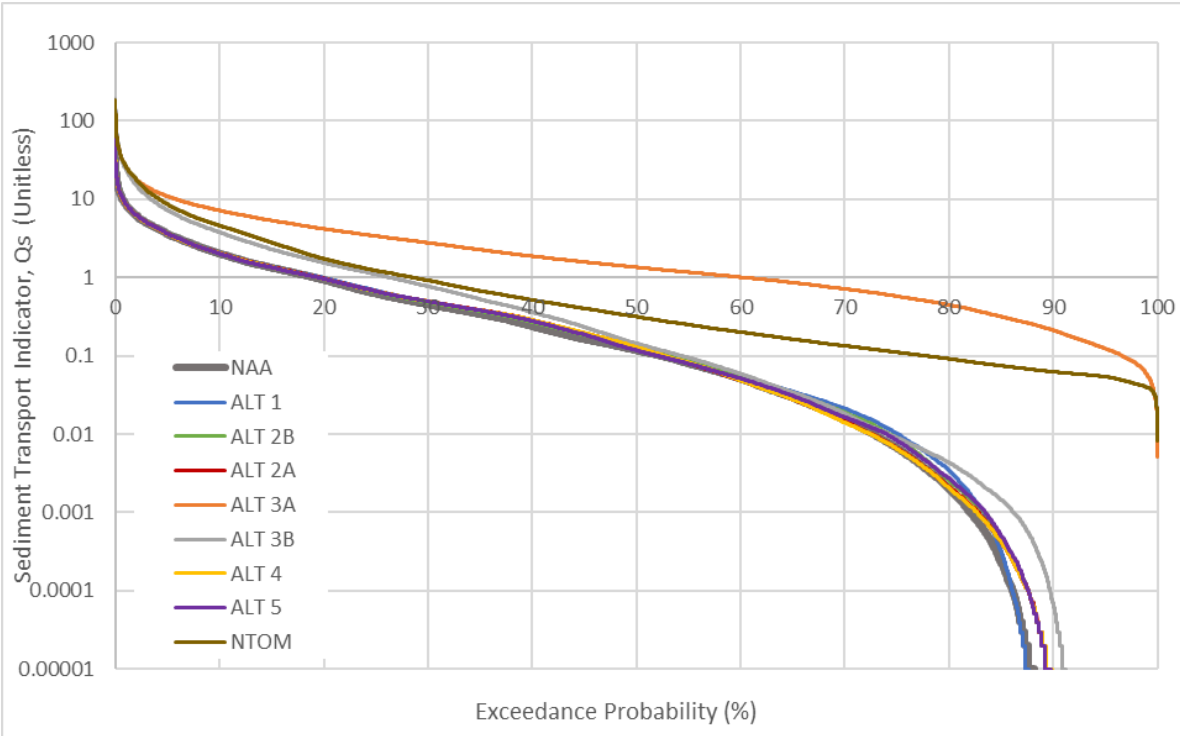

Figure 2-31. Lookout Point Sediment Transport Indicator

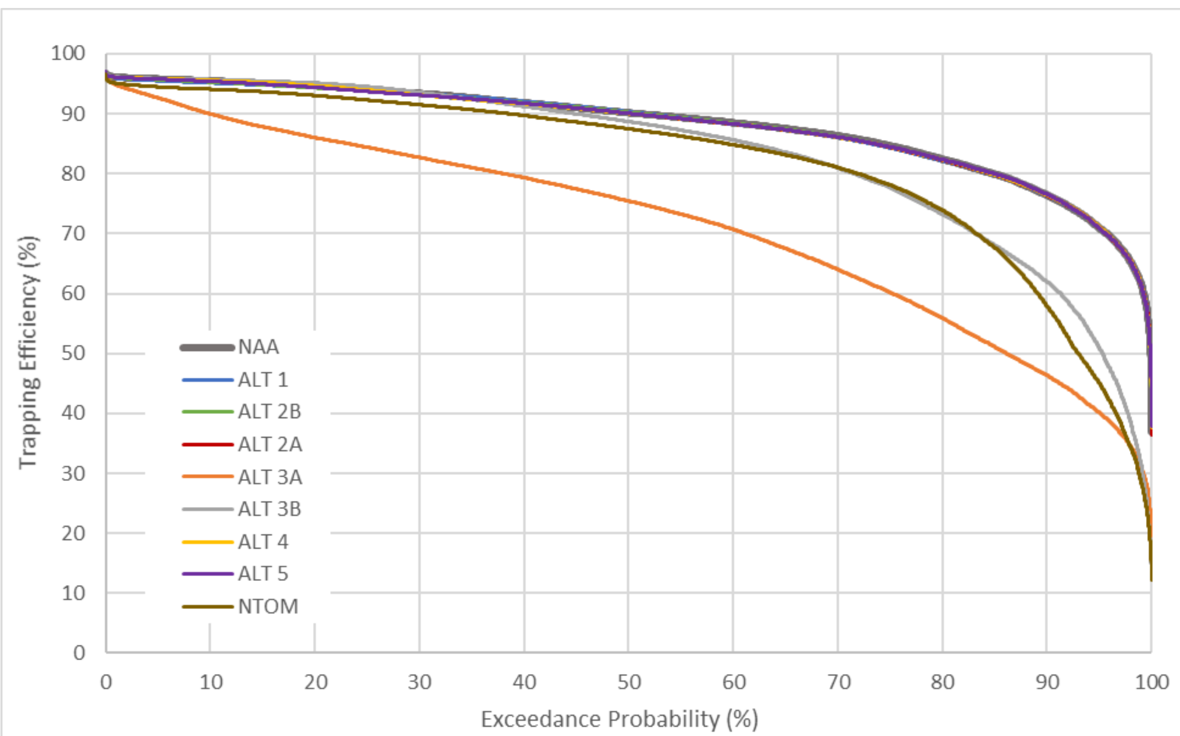

Figure 2-32. Lookout Point Trapping Efficiency Daily Exceedance

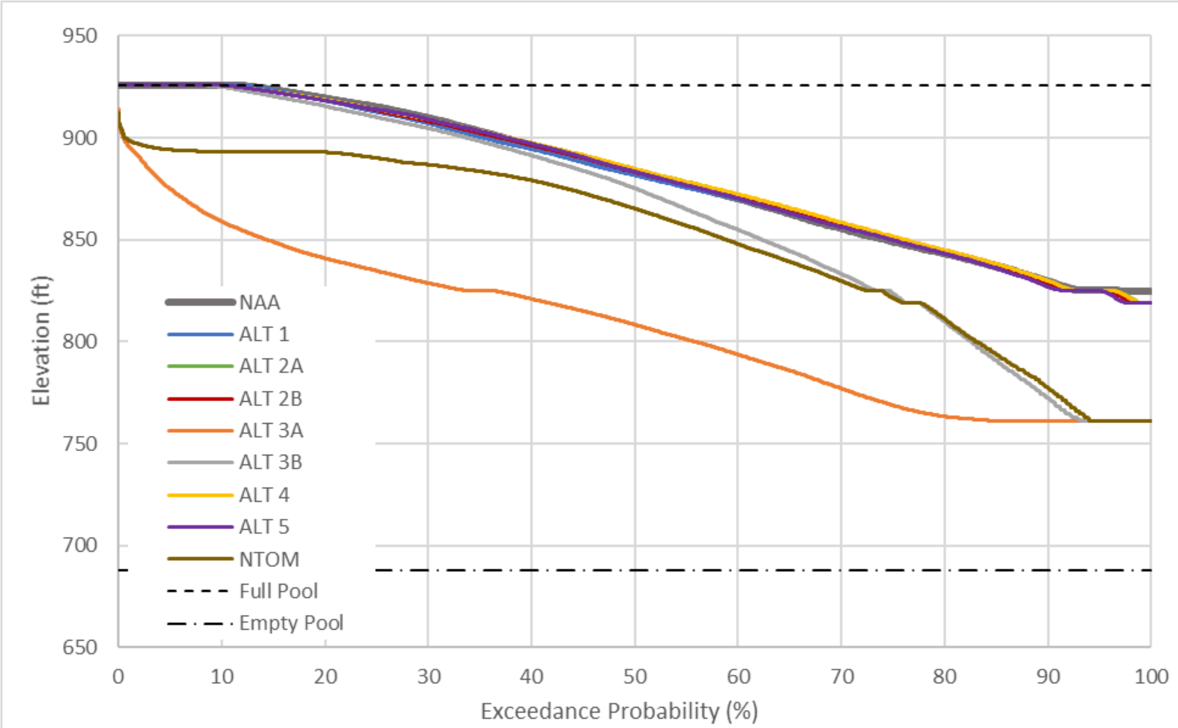

Figure 2-33. Lookout Point Elevation Daily Exceedance

2.2 RUN-OF-RIVER AND FREE FLOWING REACH METRICS

This section includes tables and figures that enumerate the run-of-river reservoir and free-flowing reach comparison summaries for two metrics (Table 2-7 – Table 2-19):

- Sediment Supply
- Geomorphic Change

2.2.1 Sediment Supply

Table 2-7. Quantitative Sediment Re-Entrainment or Bank Failure Potential ($MinPool\ \Delta x$)

Project	NAA Min (ft)	Alt 1 Min (ft)	Alt 1 - NAA	Alt 2A Min (ft)	Alt 2A - NAA	Alt 2B Min (ft)	Alt 2B - NAA	Alt 3A Min (ft)	Alt 3A - NAA
Blue River	1180.0	1149.9	-30.1	1150.0	-30.0	1150.0	-30.0	1165.0	-15.0
Cottage Grove	750.0	735.4	-14.6	750.0	0.0	750.0	0.0	735.4	-14.6
Cougar	1531.0	1515.9	-15.1	1516.0	-15.0	1330.0	-201.0	1517.0	-14.0
Detroit	1450.0	1425.0	-25.0	1425.0	-25.0	1425.0	-25.0	1375.0	-75.0
Dorena	771.0	754.9	-16.1	771.0	0.0	771.0	0.0	754.9	-16.1
Fall Creek	680.0	680.0	0.0	680.0	0.0	680.0	0.0	680.0	0.0
Fern Ridge	353.0	353.0	0.0	353.0	0.0	353.0	0.0	353.0	0.0
Foster	613.0	613.0	0.0	613.0	0.0	613.0	0.0	613.0	0.0
Green Peter	922.0	886.9	-35.1	780.0	-142.0	780.0	-142.0	780.0	-142.0
Hills Creek	1447.0	1413.9	-33.1	1414.0	-33.0	1414.0	-33.0	1446.0	-1.0
Lookout Point	825.0	818.9	-6.1	819.0	-6.0	819.0	-6.0	761.0	-64.0

Project	NAA Min (ft)	Alt 3B Min (ft)	Alt 3B - NAA	Alt 4 Min (ft)	Alt 4 - NAA	Alt 5 Min (ft)	Alt 5 - NAA	NTOM Min (ft)	NTOM - NAA
Blue River	1180.0	1165.0	-15.0	1150.0	-30.0	1150.0	-30.0	1150.0	-30.0
Cottage Grove	750.0	735.4	-14.6	735.0	-15.0	750.0	0.0	750.0	0.0
Cougar	1531.0	1330.0	-201.0	1516.0	-15.0	1330.0	-201.0	1505.0	-26.0
Detroit	1450.0	1375.0	-75.0	1425.0	-25.0	1425.0	-25.0	1425.0	-25.0
Dorena	771.0	754.9	-16.1	754.0	-17.0	771.0	0.0	771.0	0.0
Fall Creek	680.0	680.0	0.0	680.0	0.0	680.0	0.0	680.0	0.0
Fern Ridge	353.0	353.0	0.0	353.0	0.0	353.0	0.0	353.0	0.0
Foster	613.0	613.0	0.0	613.0	0.0	613.0	0.0	613.0	0.0
Green Peter	922.0	780.0	-142.0	886.9	-35.1	780.0	-142.0	780.0	-142.0
Hills Creek	1447.0	1446.0	-1.0	1414.0	-33.0	1414.0	-33.0	1414.0	-33.0
Lookout Point	825.0	761.0	-64.0	819.0	-6.0	819.0	-6.0	761.0	-64.0

Table 2-8. Qualitative Sediment Re-Entrainment or Bank Failure Potential ($MinPool\ \Delta x$)

Project	Alt 1 vs. NAA	Alt 2A vs. NAA	Alt 2B vs. NAA	Alt 3A vs. NAA	Alt 3B vs. NAA	Alt 4 vs. NAA	Alt 5 vs. NAA	NTOM vs. NAA
Blue River	Major	Major	Major	Moderate	Moderate	Major	Major	Major
Cottage Grove	Moderate	Negligible	Negligible	Moderate	Moderate	Moderate	Negligible	Negligible
Cougar	Moderate	Moderate	Major	Moderate	Major	Moderate	Major	Major
Detroit	Major	Major	Major	Major	Major	Major	Major	Major
Dorena	Moderate	Negligible	Negligible	Moderate	Moderate	Moderate	Negligible	Negligible
Fall Creek	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Fern Ridge	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Foster	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Green Peter	Major	Major	Major	Major	Major	Major	Major	Major
Hills Creek	Major	Major	Major	Negligible	Negligible	Major	Major	Major
Lookout Point	Minor	Minor	Minor	Major	Major	Minor	Minor	Major

Table 2-9. Quantitative Bank Sediment Passing Dam Potential ($MinPool\ \Delta v$)

Project	NAA Acre-ft	Alt 1 Acre-ft	Alt 1 % Diff from NAA	Alt 2A Acre-ft	Alt 2A % Diff from NAA	Alt 2B Acre-ft	Alt 2B % Diff from NAA	Alt 3A Acre-ft	Alt 3A % Diff from NAA
Blue River	3971	1155	-71%	1208	-70%	1208	-70%	2299	-42%
Cottage Grove	3139	399	-87%	3139	0%	3139	0%	399	-87%
Cougar	51700	43000	-17%	43500	-16%	234	-100%	44100	-15%
Detroit	154400	115000	-26%	115000	-26%	115000	-26%	56700	-63%
Dorena	7355	1348	-82%	7355	0%	7355	0%	1348	-82%
Fall Creek	93	93	0%	93	0%	93	0%	93	0%
Fern Ridge	2802	2802	0%	2802	0%	2802	0%	2802	0%
Foster	31100	31100	0%	31100	0%	31100	0%	31100	0%
Green Peter	159900	95700	-40%	4500	-97%	4500	-97%	4500	-97%
Hills Creek	153800	105400	-31%	106700	-31%	106700	-31%	152200	-1%
Lookout Point	118800	104600	-12%	104600	-12%	104600	-12%	24600	-79%

Project	NAA Acre-ft	Alt 3B Acre-ft	Alt 3B % Diff from NAA	Alt 4 Acre-ft	Alt 4 % Diff from NAA	Alt 5 Acre-ft	Alt 5 % Diff from NAA	NTOM Acre-ft	NTOM % Diff from NAA
Blue River	3971	2299	-42%	1208	-70%	1208	-70%	1208	-70%
Cottage Grove	3139	399	-87%	399	-87%	3139	0%	3139	0%
Cougar	51700	234	-100%	43500	-16%	234	-100%	38100	-26%
Detroit	154400	56700	-63%	115000	-26%	115000	-26%	115000	-26%
Dorena	7355	1348	-82%	1348	-82%	7355	0%	7355	0%
Fall Creek	93	93	0%	93	0%	93	0%	93	0%
Fern Ridge	2802	2802	0%	2802	0%	2802	0%	2802	0%
Foster	31100	31100	0%	31100	0%	31100	0%	31100	0%
Green Peter	159900	4500	-97%	95700	-40%	4500	-97%	4500	-97%
Hills Creek	153800	152200	-1%	106700	-31%	106700	-31%	106700	-31%

Project	NAA Acre-ft	Alt 3B Acre-ft	Alt 3B % Diff from NAA	Alt 4 Acre-ft	Alt 4 % Diff from NAA	Alt 5 Acre-ft	Alt 5 % Diff from NAA	NTOM Acre-ft	NTOM % Diff from NAA
Lookout Point	118800	24600	-79%	104600	-12%	104600	-12%	24600	-79%

Table 2-10. Qualitative Bank Sediment Passing Dam Potential ($MinPool\ \Delta v$)

Project	Alt 1 vs. NAA	Alt 2A vs. NAA	Alt 2B vs. NAA	Alt 3A vs. NAA	Alt 3B vs. NAA	Alt 4 vs. NAA	Alt 5 vs. NAA	NTOM vs. NAA
Blue River	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Cottage Grove	Major	Negligible	Negligible	Major	Major	Major	Negligible	Negligible
Cougar	Minor	Minor	Major	Minor	Major	Minor	Major	Moderate
Detroit	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Dorena	Major	Negligible	Negligible	Major	Major	Major	Negligible	Negligible
Fall Creek	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Fern Ridge	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Foster	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Green Peter	Moderate	Major	Major	Major	Major	Moderate	Major	Major
Hills Creek	Moderate	Moderate	Moderate	Negligible	Negligible	Moderate	Moderate	Moderate
Lookout Point	Minor	Minor	Minor	Major	Major	Minor	Minor	Major

Table 2-11. Qualitative Reservoir Bank Supplied Sediment ($qualitative\ BSSmetric$)

Project	Alt 1 vs. NAA	Alt 2A vs. NAA	Alt 2B vs. NAA	Alt 3A vs. NAA	Alt 3B vs. NAA	Alt 4 vs. NAA	Alt 5 vs. NAA	NTOM vs. NAA
Blue River	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**
Cottage Grove	**Moderate**	Negligible	Negligible	**Moderate**	**Moderate**	**Moderate**	Negligible	Negligible
Cougar	**Minor**	**Minor**	**Major**	**Minor**	**Major**	**Minor**	**Major**	**Moderate**
Detroit	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**	**Moderate**
Dorena	**Moderate**	Negligible	Negligible	**Moderate**	**Moderate**	**Moderate**	Negligible	Negligible
Fall Creek	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Fern Ridge	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Foster	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Green Peter	**Moderate**	**Major**	**Major**	**Major**	**Major**	**Moderate**	**Major**	**Major**
Hills Creek	**Moderate**	**Moderate**	**Moderate**	Negligible	Negligible	**Moderate**	**Moderate**	**Moderate**
Lookout Point	**Minor**	**Minor**	**Minor**	**Major**	**Major**	**Minor**	**Minor**	**Major**

Table 2-12. Alternative 1 - Qualitative Sediment Supply Metric

Impact Reach	Upstream Project or WVS Impacted Reach	Watershed Supplied (*qualitative TE_{metric}*)	Reservoir Supplied (*qualitative BSS_{metric}*)	Sediment Augmentation	Upstream Reach Sediment Transfer	Sediment Supply to Reach
Big Cliff Reservoir	Detroit Dam	Negligible	**Moderate**	No	NA	**Moderate**
Dexter Reservoir	Lookout Point Dam	Negligible	**Minor**	No	NA	**Minor**
Foster Reservoir	Green Peter Dam	Negligible	**Moderate**	No	NA	**Moderate**
Lower Willamette	Middle Willamette River	NA	NA	No	Negligible	Negligible
Middle Willamette	Upper Willamette and Santiam Rivers	NA	NA	No	Negligible	Negligible
Upper Willamette	Coast And Middle Fork Willamette and Mckenzie River	NA	NA	No	**Minor**	**Minor**

Impact Reach	**Upstream Project or WVS Impacted Reach**	**Watershed Supplied (*qualitative* TE_{metric})**	**Reservoir Supplied (*qualitative* BSS_{metric})**	**Sediment Augmentation**	**Upstream Reach Sediment Transfer**	**Sediment Supply to Reach**
Middle Fork of The Willamette Below Dexter	DEXTER Dam and Fall Creek	NA	NA	No	Negligible	Negligible
Middle Fork of The Willamette Above Lookout Point	Hills Creek Dam	Negligible	**Moderate**	No	NA	**Moderate**
Fall Creek	Fall Creek Dam	Negligible	Negligible	No	NA	Negligible
Coast Fork of The Willamette	Cottage Grove Dam	Negligible	**Moderate**	No	NA	**Moderate**
Row	Dorena Dam	Negligible	**Moderate**	No	NA	**Moderate**
Mainstem Santiam	North Santiam and South Santiam Rivers	NA	NA	No	Negligible	Negligible
North Santiam	Big Cliff Dam	NA	NA	**Yes**	**Minor**	**Major**
South Santiam	Foster Dam	NA	NA	**Yes**	**Minor**	**Major**
Long Tom	Fern Ridge Dam	Negligible	Negligible	No	NA	Negligible
Mckenzie	Cougar Dam and Blue River	Negligible	**Minor**	**Yes**	NA	**Major**
Blue	Blue River Dam	Negligible	**Moderate**	**Yes**	NA	**Major**

Table 2-13. Alternative 2A - Qualitative Sediment Supply

Impact Reach	Upstream Project or WVS Impacted Reach	Watershed Supplied (*qualitative* TE_{metric})	Reservoir Supplied (*qualitative* BSS_{metric})	Sediment Augmentation	Upstream Reach Sediment Transfer	Sediment Supply to Reach
Big Cliff Reservoir	Detroit Dam	Negligible	**Moderate**	No	NA	**Moderate**
Dexter Reservoir	Lookout Point Dam	Negligible	**Minor**	No	NA	**Minor**
Foster Reservoir	Green Peter Dam	**Moderate**	**Major**	No	NA	**Major**
Lower Willamette	Middle Willamette River	NA	NA	No	Negligible	Negligible
Middle Willamette	Upper Willamette and Santiam Rivers	NA	NA	No	Negligible	Negligible
Upper Willamette	Coast and Middle Fork Willamette and McKenzie River	NA	NA	No	Negligible	Negligible
Middle Fork of The Willamette Below Dexter	Dexter Dam and Fall Creek	NA	NA	No	Negligible	Negligible
Middle Fork of The Willamette Above Lookout Point	Hills Creek Dam	Negligible	**Moderate**	No	NA	**Moderate**
Fall Creek	Fall Creek Dam	Negligible	Negligible	No	NA	Negligible
Coast Fork of The Willamette	Cottage Grove Dam	Negligible	Negligible	No	NA	Negligible
Row	Dorena Dam	Negligible	Negligible	No	NA	Negligible
Mainstem Santiam	North Santiam and South Santiam Rivers	NA	NA	No	**Minor**	**Minor**
North Santiam	Big Cliff Dam	NA	NA	**Yes**	**Minor**	**Major**
South Santiam	Foster Dam	NA	NA	**Yes**	**Moderate**	**Major**
Long Tom	Fern Ridge Dam	Negligible	Negligible	No	NA	Negligible
Mckenzie	Cougar Dam and Blue River	Negligible	**Minor**	**Yes**	NA	**Major**
Blue	Blue River Dam	Negligible	**Moderate**	**Yes**	NA	**Major**

Table 2-14. Alternative 2B - Qualitative Sediment Supply

Impact Reach	Upstream Project or WVS Impacted Reach	Watershed Supplied (*qualitative TE$_{metric}$*)	Reservoir Supplied (*qualitative BSS$_{metric}$*)	Sediment Augmentation	Upstream Reach Sediment Transfer	Sediment Supply to Reach
Big Cliff Reservoir	Detroit Dam	Negligible	**Moderate**	No	NA	**Moderate**
Dexter Reservoir	Lookout Point Dam	Negligible	**Minor**	No	NA	**Minor**
Foster Reservoir	Green Peter Dam	**Moderate**	**Major**	No	NA	**Major**
Lower Willamette	Middle Willamette River	NA	NA	No	Negligible	Negligible
Middle Willamette	Upper Willamette and Santiam Rivers	NA	NA	No	**Minor**	**Minor**
Upper Willamette	Coast And Middle Fork Willamette and Mckenzie River	NA	NA	No	**Moderate**	**Moderate**
Middle Fork of The Willamette Below Dexter	Dexter Dam and Fall Creek	NA	NA	No	Negligible	Negligible
Middle Fork of The Willamette Above Lookout Point	Hills Creek Dam	Negligible	**Moderate**	No	NA	**Moderate**
Fall Creek	Fall Creek Dam	Negligible	Negligible	No	NA	Negligible
Coast Fork of The Willamette	Cottage Grove Dam	Negligible	Negligible	No	NA	Negligible
Row	Dorena Dam	Negligible	Negligible	No	NA	Negligible
Mainstem Santiam	North Santiam and South Santiam Rivers	NA	NA	No	**Minor**	**Minor**
North Santiam	Big Cliff Dam	NA	NA	**Yes**	**Minor**	**Major**
South Santiam	Foster Dam	NA	NA	**Yes**	**Moderate**	**Major**
Long Tom	Fern Ridge Dam	Negligible	Negligible	No	NA	Negligible
Mckenzie	Cougar Dam and Blue River	**Major**	**Major**	**Yes**	NA	**Major**
Blue	Blue River Dam	Negligible	**Moderate**	**Yes**	NA	**Major**

Table 2-15. Alternative 3A - Qualitative Sediment Supply

Impact Reach	Upstream Project or WVS Impacted Reach	Watershed Supplied (*qualitative* TE_{metric})	Reservoir Supplied (*qualitative* BSS_{metric})	Sediment Augmentation	Upstream Reach Sediment Transfer	Sediment Supply to Reach
Big Cliff Reservoir	Detroit Dam	Major	Moderate	No	NA	Major
Dexter Reservoir	Lookout Point Dam	Major	Major	No	NA	Major
Foster Reservoir	Green Peter Dam	Moderate	Major	No	NA	Major
Lower Willamette	Middle Willamette River	NA	NA	No	Negligible	Negligible
Middle Willamette	Upper Willamette and Santiam Rivers	NA	NA	No	Negligible	Negligible
Upper Willamette	Coast And Middle Fork Willamette and Mckenzie River	NA	NA	No	Minor	Minor
Middle Fork of The Willamette Below Dexter	Dexter Dam and Fall Creek	NA	NA	No	Moderate	Moderate
Middle Fork of The Willamette Above Lookout Point	Hills Creek Dam	Negligible	Negligible	No	NA	Negligible
Fall Creek	Fall Creek Dam	Negligible	Negligible	No	NA	Negligible
Coast Fork of The Willamette	Cottage Grove Dam	Negligible	Moderate	No	NA	Moderate
Row	Dorena Dam	Negligible	Moderate	No	NA	Moderate
Mainstem Santiam	North Santiam and South Santiam Rivers	NA	NA	No	Minor	Minor
North Santiam	Big Cliff Dam	NA	NA	Yes	Moderate	Major
South Santiam	Foster Dam	NA	NA	Yes	Moderate	Major
Long Tom	Fern Ridge Dam	Negligible	Negligible	No	NA	Negligible
Mckenzie	Cougar Dam and Blue River	Moderate	Minor	Yes	NA	Major
Blue	Blue River Dam	Minor	Moderate	Yes	NA	Major

Table 2-16. Alternative 3B - Qualitative Sediment Supply

Impact Reach	Upstream Project or WVS Impacted Reach	Watershed Supplied (*qualitative* TE_{metric})	Reservoir Supplied (*qualitative* BSS_{metric})	Sediment Augmentation	Upstream Reach Sediment Transfer	Sediment Supply to Reach
Big Cliff Reservoir	Detroit Dam	Minor	Moderate	No	NA	Moderate
Dexter Reservoir	Lookout Point Dam	Minor	Major	No	NA	Major
Foster Reservoir	Green Peter Dam	Major	Major	No	NA	Major
Lower Willamette	Middle Willamette River	NA	NA	No	Negligible	Negligible
Middle Willamette	Upper Willamette and Santiam Rivers	NA	NA	No	Minor	Minor
Upper Willamette	Coast And Middle Fork Willamette and Mckenzie River	NA	NA	No	Moderate	Moderate
Middle Fork of The Willamette Below Dexter	Dexter Dam and Fall Creek	NA	NA	No	Moderate	Moderate
Middle Fork of The Willamette Above Lookout Point	Hills Creek Dam	Minor	Negligible	No	NA	Minor
Fall Creek	Fall Creek Dam	Negligible	Negligible	No	NA	Negligible
Coast Fork of The Willamette	Cottage Grove Dam	Negligible	Moderate	No	NA	Moderate
Row	Dorena Dam	Negligible	Moderate	No	NA	Moderate
Mainstem Santiam	North Santiam and South Santiam Rivers	NA	NA	No	Minor	Minor
North Santiam	Big Cliff Dam	NA	NA	Yes	Minor	Major
South Santiam	Foster Dam	NA	NA	Yes	Moderate	Major
Long Tom	Fern Ridge Dam	Negligible	Negligible	No	NA	Negligible
Mckenzie	COUGAR Dam and Blue River	Major	Major	Yes	NA	Major
Blue	BLUE RIVER Dam	Minor	Moderate	Yes	NA	Major

Table 2-17. Alternative 4 - Qualitative Sediment Supply

Impact Reach	Upstream Project or WVS Impacted Reach	Watershed Supplied (*qualitative* *TE*$_{metric}$)	Reservoir Supplied (*qualitative* *BSS*$_{metric}$)	Sediment Augmentation	Upstream Reach Sediment Transfer	Sediment Supply to Reach
Big Cliff Reservoir	Detroit Dam	Negligible	**Moderate**	No	NA	**Moderate**
Dexter Reservoir	Lookout Point Dam	Negligible	**Minor**	No	NA	**Minor**
Foster Reservoir	Green Peter Dam	Negligible	**Moderate**	No	NA	**Moderate**
Lower Willamette	Middle Willamette River	NA	NA	No	Negligible	Negligible
Middle Willamette	Upper Willamette and Santiam Rivers	NA	NA	No	Negligible	Negligible
Upper Willamette	Coast And Middle Fork Willamette and Mckenzie River	NA	NA	No	**Minor**	**Minor**
Middle Fork of The Willamette Below Dexter	Dexter Dam and Fall Creek	NA	NA	No	Negligible	Negligible
Middle Fork of The Willamette Above Lookout Point	Hills Creek Dam	Negligible	**Moderate**	No	NA	**Moderate**
Fall Creek	Fall Creek Dam	Negligible	Negligible	No	NA	Negligible
Coast Fork of The Willamette	Cottage Grove Dam	Negligible	**Moderate**	No	NA	**Moderate**
Row	Dorena Dam	Negligible	**Moderate**	No	NA	**Moderate**
Mainstem Santiam	North Santiam and South Santiam Rivers	NA	NA	No	Negligible	Negligible
North Santiam	Big Cliff Dam	NA	NA	**Yes**	**Minor**	**Major**
South Santiam	Foster Dam	NA	NA	**Yes**	**Minor**	**Major**
Long Tom	Fern Ridge Dam	Negligible	Negligible	No	NA	Negligible
Mckenzie	Cougar Dam and Blue River	Negligible	**Minor**	**Yes**	NA	**Major**
Blue	Blue River Dam	Negligible	**Moderate**	**Yes**	NA	**Major**

Table 2-18. Alternative 5 - Qualitative Sediment Supply

Impact Reach	Upstream Project or WVS Impacted Reach	Watershed Supplied (*qualitative* TE_{metric})	Reservoir Supplied (*qualitative* BSS_{metric})	Sediment Augmentation	Upstream Reach Sediment Transfer	Sediment Supply to Reach
Big Cliff Reservoir	Detroit Dam	Negligible	**Moderate**	No	NA	**Moderate**
Dexter Reservoir	Lookout Point Dam	Negligible	**Minor**	No	NA	**Minor**
Foster Reservoir	Green Peter Dam	**Moderate**	**Major**	No	NA	**Major**
Lower Willamette	Middle Willamette River	NA	NA	No	Negligible	Negligible
Middle Willamette	Upper Willamette and Santiam Rivers	NA	NA	No	**Minor**	**Minor**
Upper Willamette	Coast And Middle Fork Willamette and Mckenzie River	NA	NA	No	**Moderate**	**Moderate**
Middle Fork of The Willamette Below Dexter	DEXTER Dam and Fall Creek	NA	NA	No	Negligible	Negligible
Middle Fork of The Willamette Above Lookout Point	Hills Creek Dam	Negligible	**Moderate**	No	NA	**Moderate**
Fall Creek	Fall Creek Dam	Negligible	Negligible	No	NA	Negligible
Coast Fork of The Willamette	Cottage Grove Dam	Negligible	Negligible	No	NA	Negligible
Row	Dorena Dam	Negligible	Negligible	No	NA	Negligible
Mainstem Santiam	North Santiam and South Santiam Rivers	NA	NA	No	**Minor**	**Minor**
North Santiam	Big Cliff Dam	NA	NA	**Yes**	**Minor**	**Major**
South Santiam	Foster Dam	NA	NA	**Yes**	**Moderate**	**Major**
Long Tom	Fern Ridge Dam	Negligible	Negligible	No	NA	Negligible
Mckenzie	Cougar Dam and Blue River	**Major**	**Major**	**Yes**	NA	**Major**
Blue	Blue River Dam	Negligible	**Moderate**	**Yes**	NA	**Major**

Table 2-19. NTOM - Qualitative Sediment Supply

Impact Reach	Upstream Project or WVS Impacted Reach	Watershed Supplied (*qualitative TE_{metric}*)	Reservoir Supplied (*qualitative BSS_{metric}*)	Sediment Augmentation	Upstream Reach Sediment Transfer	Sediment Supply to Reach
Big Cliff Reservoir	Detroit Dam	Negligible	**Moderate**	No	NA	**Moderate**
Dexter Reservoir	Lookout Point Dam	**Moderate**	**Major**	No	NA	**Major**
Foster Reservoir	Green Peter Dam	**Moderate**	**Major**	No	NA	**Major**
Lower Willamette	Middle Willamette River	NA	NA	No	Negligible	Negligible
Middle Willamette	Upper Willamette and Santiam Rivers	NA	NA	No	Negligible	Negligible
Upper Willamette	Coast And Middle Fork Willamette and Mckenzie River	NA	NA	No	**Minor**	**Minor**
Middle Fork of The Willamette Below Dexter	DEXTER Dam And Fall Creek	NA	NA	No	**Moderate**	**Moderate**
Middle Fork of The Willamette Above Lookout Point	Hills Creek Dam	Negligible	**Moderate**	No	NA	**Moderate**
Fall Creek	Fall Creek Dam	**Major**	Negligible	No	NA	**Major**
Coast Fork of The Willamette	Cottage Grove Dam	Negligible	Negligible	No	NA	Negligible
Row	Dorena Dam	Negligible	Negligible	No	NA	Negligible
Mainstem Santiam	North Santiam and South Santiam Rivers	NA	NA	No	**Minor**	**Minor**
North Santiam	Big Cliff Dam	NA	NA	No	**Minor**	**Minor**
South Santiam	Foster Dam	NA	NA	No	**Moderate**	**Moderate**
Long Tom	Fern Ridge Dam	Negligible	Negligible	No	NA	Negligible
Mckenzie	COUGAR Dam And Blue River	**Minor**	**Moderate**	No	NA	**Moderate**
Blue	Blue River Dam	Negligible	**Moderate**	No	NA	**Moderate**

2.2.2 Geomorphic Change

Table 2-20. Qualitative Potential for Geomorphic Change

Reaches	Alt 1 vs. NAA	Alt 2A vs. NAA	Alt 2B vs. NAA	Alt 3A vs. NAA	Alt 3B vs. NAA	Alt 4 vs. NAA	Alt 5 vs. NAA	NTOM vs. NAA
Big Cliff Reservoir	Negligible	Negligible	Negligible	**Major**	Negligible	Negligible	Negligible	Negligible
Dexter Reservoir	Negligible	Negligible	Negligible	**Major**	**Major**	Negligible	Negligible	**Major**
Foster Reservoir	Negligible	**Major**	**Major**	**Major**	**Major**	Negligible	**Major**	**Major**
Lower Willamette	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Middle Willamette	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Upper Willamette	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Middle Fork of The Willamette Below Dexter	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Middle Fork of The Willamette Above Lookout Point	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Fall Creek	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	**Major**
Coast Fork of The Willamette	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Row	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Mainstem Santiam	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
North Santiam	**Major**	**Major**	**Major**	**Major**	**Major**	**Major**	**Major**	Negligible
South Santiam	**Major**	**Major**	**Major**	**Major**	**Major**	**Major**	**Major**	Negligible
Long Tom	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Mckenzie	**Major**	**Major**	**Major**	**Major**	**Major**	**Major**	**Major**	Negligible
Blue	**Major**	**Major**	**Major**	**Major**	**Major**	**Major**	**Major**	Negligible

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