BUREAU OF RECLAMATION

Alternatives Development Report

Head of Old River Scour Hole Project

California-Great Basin Region

Mission Statements

The U.S. Department of the Interior protects and manages the Nation’s natural resources and cultural heritage; provides scientific and other information about those resources; honors its trust responsibilities or special commitments to American Indians, Alaska Natives, and affiliated Island Communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

Scoping and Alternatives Development Report

Head of Old River Scour Hole Project

California-Great Basin Region

prepared by

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Introduction

This report documents the process of developing alternative actions for the Head of Old River Scour Hole (Scour Hole) project. The U.S. Bureau of Reclamation (Reclamation) developed potential alternatives through coordination with local, state, and federal agencies along with other interested stakeholders.

Purpose and Need

Purpose

The purpose of the Scour Hole project is to implement measures to reduce predation intensity on juvenile spring-run Chinook salmon and California Central Valley steelhead at the Head of Old River Scour Hole along the mainstem of the San Joaquin River.

Need

The need for the proposed action is to comply with the recommended conservation measures in the 2024 National Oceanic and Atmospheric Administration-National Marine Fishery Service (NMFS) Biological Opinion to complete studies for reducing predation at the Head of Old River Scour Hole and, if shown to result in a measurable reduction in predation, support Reclamation to implement these measures at the Head of Old River Scour Hole by 2028.

Background

The Scour Hole has been identified as an area of abnormally high predation of juvenile salmon and steelhead trout based on predation event monitoring and modeling conducted by NMFS. The results of this work were presented in "Fish Predation on a Landscape Scale" (Michel, et al. in 2020). The predatory fish use the depth of the Scour Hole to hide and prey on juvenile salmonids and steelhead with success significantly higher than along the flat-bottomed, shallower, areas of the San Joaquin River, as demonstrated in the Michel Study.

To address this issue, the NMFS 2024 Biological Opinion (NMFS, 2024) conservation measure states:

> "By December 2026, Reclamation and DWR shall complete the studies for reducing predation at the Head of Old River Scour Hole. If the study indicates a measurable reduction in predation, Reclamation shall implement a restoration of the Head of Old River Scour Hole by 2028. The studies should improve the understanding of how this action may integrate with the Head of Old River entrainment action."

The "entrainment action" referenced in the 2024 Biological Opinion states:

> "By December 2026, Reclamation and DWR shall complete a study in coordination with NMFS on actions at Head of Old River to reduce the entrainment of San Joaquin River-origin California Central Valley (CCV) steelhead into Old River and salvage and entrainment (take) at the export facilities. If the study indicates a measurable reduction in salvage at the pumps related to reduced entrainment into the Head of Old River, Reclamation shall implement a non-physical barrier beginning in the Spring of 2027 and annually thereafter. Implementation may be phased to allow pilot testing of the action and integration with the Head of Old River Scour Hole studies and restoration."

Initial work to develop the alternatives outlined in this report began in 2021 pursuant to more detailed conservation measures in a 2019 Biological Opinion (NMFS, 2019). That 2019 Biological Opinion called for Reclamation and the California Department of Water Resources (DWR) to "plan and implement measures" to reduce predation intensity of juvenile spring-run Chinook salmon and CCV juvenile steelhead out-migrating between November and May at the Head of Old River Scour Hole along the mainstem of the San Joaquin River "through modifications to the channel geometry and associated habitats."

As such, this document includes alternatives that address the more detailed conservation measures from the 2019 Biological Opinion which are excerpted in the text box below.

2019 Biological Opinion Conservation Measures

Excerpts from the 2019 NMFS Biological Opinion relevant to the Scour Hole

8.6.12.6 – Predator hot spot removal under the proposed action component (April 30, 2019; (U.S. Bureau of Reclamation 2019a)) is intended to improve conditions for downstream-migrating juvenile salmonids, including winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead. The proposed action component may focus removal efforts where predators are likely concentrated along the primary migratory routes of juvenile Chinook salmon (e.g., hotspots identified by Grossman et al. (2013)). However, implementation of the proposed action component could also improve conditions for all life stages of CCV steelhead and potentially juvenile sDPS green sturgeon emigrating downstream. The ultimate effect of predator hotspot removal on juvenile salmonid and sDPS green sturgeon survival is uncertain. Hotspots are limited in scale relative to overall available habitat and previous research has not found a consistent positive effect of predator removal on juvenile salmon survival (Cavallo et al. 2012; Michel et al. 2015; Sabal et al. 2016). In general, there is a lack of detail and specificity in the biological assessment to conduct a thorough effects analysis for this proposed action component. Analysis of the proposed action component effects are general in nature and will be considered as a programmatic consultation.

8.6.12.6.1 – Reclamation proposes to remove potential predator hot spots that occur in waters of the Delta. These hot spots may include in-water structures such as abandoned docks, outfalls, pump platforms, or pilings, removing overhead lighting at bridges and fish screens that illuminate the water surface at night, or filling in scour holes or other anomalies in the bathymetry that attract predators. The ROC on LTO biological assessment does not identify exact locations or the process that will be undertaken to remove these predator hotspots.

8.6.12.2 – In-water construction at predator hot spot removal locations in the lower Sacramento River and Bay/Delta is proposed to occur during the in-water work windows through the summer months, when juvenile listed salmonids are generally still located in the upper river sections of the Sacramento River and San Joaquin River basins. However, the starting and endpoints for the in-water work window were not defined in the biological assessment. Based on the summer in-water work window, construction actions at hot spot locations are not anticipated to effect juvenile salmonids but could occur when rearing juvenile sDPS green sturgeon are present, due to the year-round use of the Delta by juvenile sDPS green sturgeon for rearing. In addition, hot pockets of predation in the northern Delta could overlap with the presence of adult CCV steelhead, which are migrating through the system in large numbers from August through November.

8.6.12.6.3 – Since the ROC on LTO biological assessment has not described the methods proposed to remove predator hot spots, it is difficult to assess the response of listed salmonids or sDPS green sturgeon to these actions. NMFS anticipates that heavy construction actions will need to take place to remove structures or pilings in the water, as well as to fill in scour holes or other bathymetry anomalies that attract predators. Typically, heavy construction actions create noise and vibrations in the surrounding aquatic environment that will disturb any fish located in the proximity of the action. Filling in scour holes, typically with some sort of rock substrate, may entail potential crushing or injuries due to the dumping of fill materials into the water column. Normally, any fish present at the onset of such construction activities will leave the location of the disturbance and thus avoid any negative effects.

8.6.12.6.5 – NMFS anticipates that there will be low risk to juvenile listed salmonids associated with the removal of predator hot spots due to the timing of such work. Juvenile listed salmonids are expected to be upriver of the Delta during the summer, and thus will not be exposed to any of the construction actions required to remove identified predator hot spots in the Delta. On the other hand, adult CCV steelhead migrating into the Sacramento River basin may be exposed to the effects of any construction actions required to remove predator hot spots. These fish may be exposed to increased levels of sound, vibrations, or activities along the banks of migratory channels. In most instances, these disturbances will potentially cause migratory delays, or re-routing of fish into migratory pathways with less activity. In the most extreme cases, exposure to the construction activities could cause injury or death. Implementation of the proposed avoidance and minimization measures will reduce the level of risk associated with the construction actions. After removal of in-water structures or other features that create predator hotspots, migratory success of juvenile salmonids should be enhanced. However, the improvement may be transitory or less than anticipated due to the behavior of predators, and the potential that predators would move to adjacent habitat. It should be noted that the lack of detail in the description of this proposed action component limits the level of detail in assessing the risk to listed salmonids. Therefore, this proposed action component will be considered as a programmatic consultation.

8.6.12.6.7 – The final proposed action describes this action as follows: "Reclamation and DWR would form a project team to address the scour hole in the San Joaquin River at the Head of Old River. The project team would plan and implement measures to reduce the predation intensity at that site through modifications to the channel geometry and associated habitats."

Reducing predation at the scour hole in the San Joaquin River at the Head of Old River is a specific example of the conservation measure in the original proposed action to "remove predator hot spots in the Bay-Delta", described in Section 8.6.12.6. The effects are expected to be as described there, with benefits most likely accruing to CCV steelhead and CV spring-run Chinook salmon entering the Delta from the San Joaquin River.

Species of Concern

As noted in the Background section above, the species of concern for this action are the Central Valley spring-run Chinook salmon and the California Central Valley Steelhead.

Central Valley Spring-Run Chinook Salmon

Currently there are only experimental populations of spring-run Chinook salmon in the San Joaquin River. Efforts to reintroduce spring-run Chinook salmon to historic habitat are underway in the San Joaquin River.

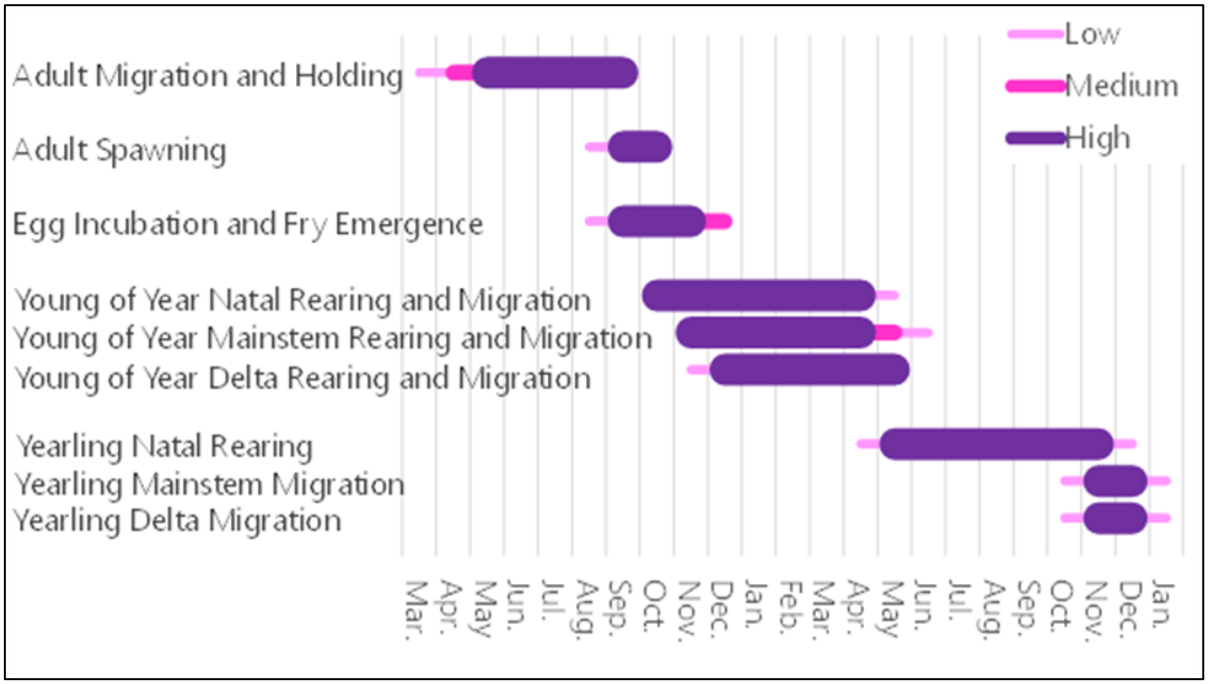


Figure 1: Chinook Salmon Life History and Seasonal Activity Calendar

The Scour Hole is on the mainstem of the San Joaquin River along the migratory pathway for juveniles between November and May. Yearling mainstem migration is between November and December.

California Central Valley Steelhead

Steelhead are present in three tributaries to the San Joaquin River (Stanislaus, Tuolumne, and Merced rivers) as well as in the Calaveras Rivers, and a hatchery supporting steelhead population occurs in the Mokelumne River).

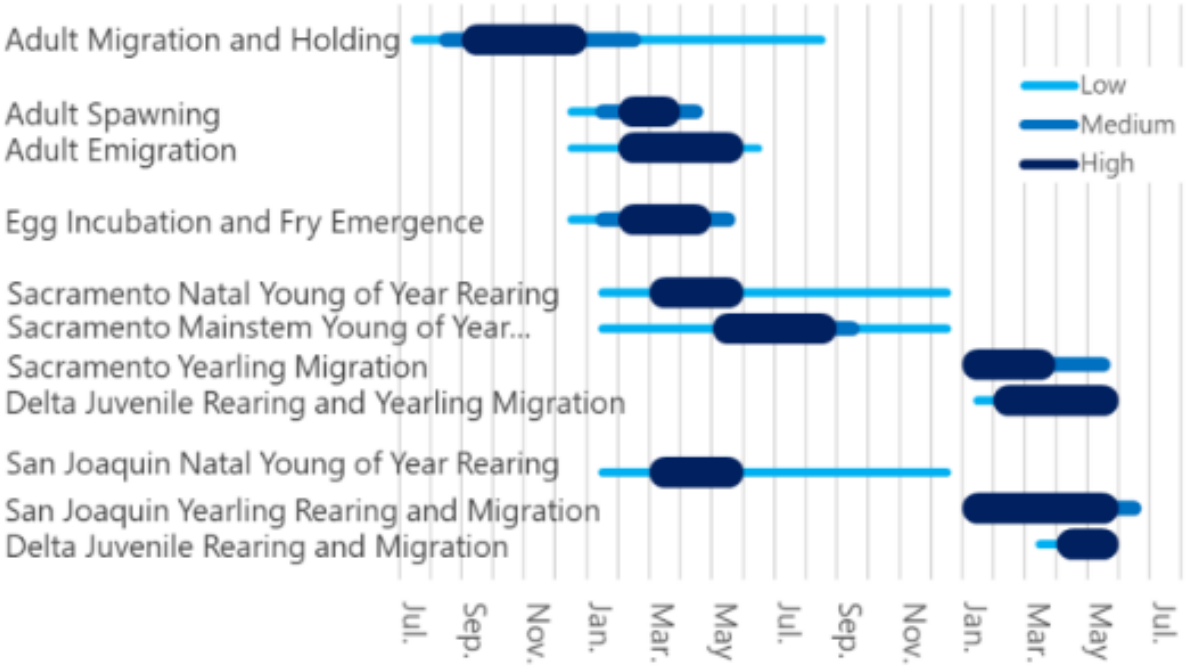


Figure 2: Steelhead Life History and Seasonal Activity Calendar

Alternatives Development Process

Two planning efforts were conducted that resulted in a suite of ten (10) potential action alternatives for consideration for NEPA. The first effort, led by the Scour Hole consultant team, utilized Structured-Decision-Making (SDM) methods involving suites of interviews, assembling a Stakeholder Working Group, and engaging that Working Group as well as other interested parties through an iterative process over the course of a year. This effort produced an *Initial Options Technical Memorandum (Initial Options TM)* with six "initial options" (concept-level) for consideration by Reclamation. The second effort, conducted by Reclamation following completion of the Initial Option Tech Memo, was conducted over the course of a one-week workshop in Sacramento. This effort produced a *Value Planning Study* which identified four additional "potential action alternatives."

This document summarizes both efforts and their results. Firstly, it summarizes the SDM process with the Stakeholder Working Group led by the consultant team, including how and why this process resulted in the six initial options (the options are referred to as alternatives herein). Secondly, this report summarizes the Value

Planning Study led by Reclamation, including the process and the resulting four additional alternatives, henceforth described as alternatives 7-10.

Initial Scoping: Structured-Decision-Making

SDM is a systematic approach to making informed choices among multiple stakeholders in complex situations. Kearns & West, Inc., facilitated a multi-step SDM process in 2022-2023.

Stakeholder Working Group and Structured-Decision-Making Process

To ensure appropriate involvement from and share information with relevant parties and stakeholders, the consultant team conducted interviews, briefings, and facilitation of the Structured-Decision-Making Working Group (SDM WG).

Interviews

The project team conducted ten stakeholder interviews in the spring of 2022 with the following individuals:

- Gretchen Murphey – California Department of Fish and Wildlife (CDFW)
- Jacob McQuirk – California Department of Water Resources (DWR)
- Ching-Fu Chang – Contra Costa Water District (CCWD)
- Barbara Byrne – National Marine Fisheries Service (NMFS)
- Cyril Michel – National Oceanic and Atmospheric Administration (NOAA)
- James Stone – Nor-Cal Guides & Sportsmen's Association (NCGASA)
- John Cain – River Partners
- Natalie Stauffer-Olsen and Rene Henery – Trout Unlimited
- Bryan Matthias – United States Fish and Wildlife Service (USFWS)
- Jon Burau – United States Geological Survey (USGS)

Structured-Decision-Making Working Group

The SDM WG was selected based on the following factors: expertise in a relevant subject area (e.g., fish biology, hydrology, geomorphology, etc.); familiarity with the

South Delta; willingness and availability to participate and engage collaboratively; and ability to represent their organization's interests. SDM WG members were:

- CDFW: Gretchen Murphey; Alternate: Steve Tsao
- DWR: Tommy Agosta; Alternate: Curtis Yip
- CCWD: Ching-Fu Chang; Alternate: Yuan Liu
- NMFS: Barb Byrne
- Reclamation District (RD) 544: Steve Sinnock
- NOAA: Cyril Michel
- USFWS: J.D. Wikert
- USGS: Jon Burau

Briefings on Flood Control Interests

In early summer 2022, the project team conducted a series of briefings with various flood control agencies. These briefings were coordinated in response to the SDM WG's development of a decision objective related to maintaining flood capacity downstream from the Scour Hole.

- Mark Meissner and Rick Caguiat – City of Lathrop
- Chris Neudeck and Dante John Nomellini – RD 17
- Pam Forbus and Steve Sinnock – RD 544
- Chris Elias – San Joaquin Area Flood Control Agency (SJAFCA)
- Cynthia Ovdenk – US Army Corps of Engineers (USACE)

Additionally in early 2023, the project team coordinated two additional briefings with the San Joaquin Area Flood Control Agency (SJAFCA).

Structured-Decision-Making Process

An SDM process was used to identify six Initial Options/Alternatives, decision objectives (criteria), and performance metrics for evaluating those options for reducing predation risk on juvenile CCV steelhead and spring-run Chinook salmon at the Scour Hole.

For the Scour Hole project, SDM was used to: elicit relevant stakeholder values and decision objectives; develop a set of initial project options (referred to herein as Alternatives 1-6), and evaluate, using a relatively coarse-scale assessment method, how well each of the options/alternatives met stakeholder-defined decision objectives. Potential risks, tradeoffs, and linked decisions were explored as part of this process. More detail is provided in the Scour Hole *Initial Options TM* prepared by the consultant team and delivered to Reclamation in April 2023. The goal for using SDM in the Scour Hole project was not to make a decision or even to rank options based on performance; rather, the goal was to identify options and conduct preliminary analyses to support Reclamation decision-making regarding alternatives selection for NEPA.

SDM Six Initial Action Alternatives

Alternatives 1-6 are the six Initial Options presented in the April 2023 Initial Options Technical Memorandum (TM).

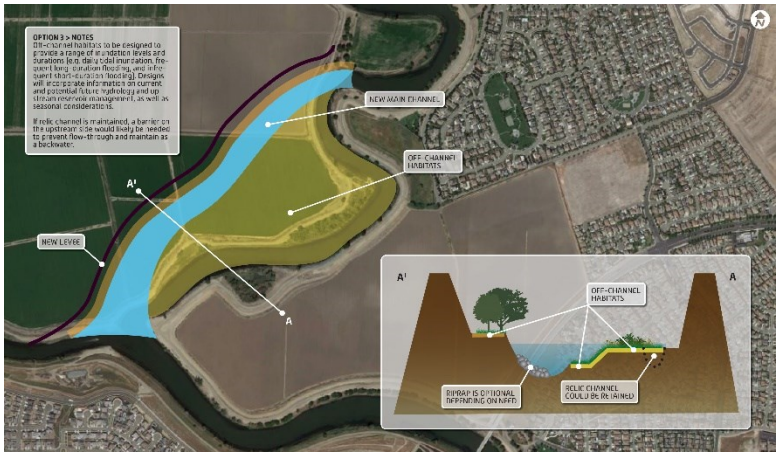
Alternative 1: Fill the Scour Hole—Option 1 from Initial Options TM

This alternative entails filling the Scour Hole with non-erodible material, such as large cobbles that would be resistant to erosion under all flow conditions. Filling the Scour Hole with non-erodible material would reduce or eliminate the development of the helical flow structures and turbulence that develop in the sharp bend, causing erosion of the riverbed and development of the deep scour hole. Because this alternative would affect the local hydraulics in the reach, it has the potential to cause erosion and deposition in other areas of the reach.

Alternative 2: Channel realignment—Option 2 from Initial Options TM

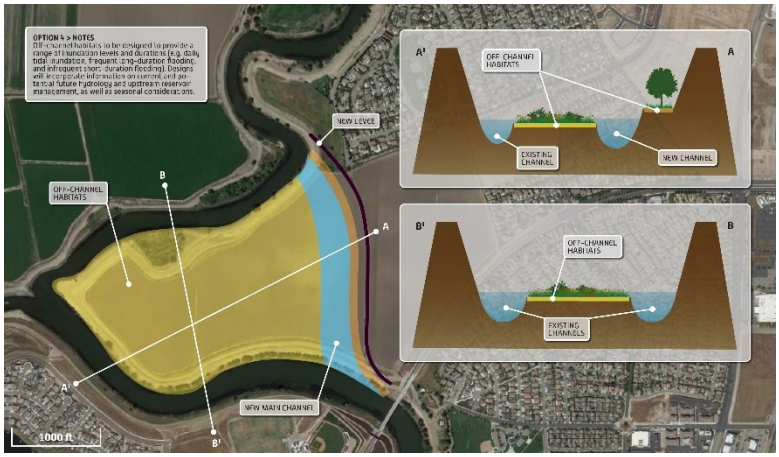
This alternative includes a levee setback on river left (north) of the San Joaquin River downstream from the Old River junction and potentially a slight setback on river right, to allow the river to curve more gradually in the reach around the Scour Hole. More gradual curvature would reduce or eliminate the helical flow structures that develop in river bends and cause scouring along the outside bank of the bend. While there would still be depth-variation and deeper areas along the outside of the bend, the forces would be reduced leading to less variability and elimination of the back-eddy that forms under existing conditions.

Alternative 3: Channel realignment with substantial floodplain restoration—Option 3 from Initial Options TM



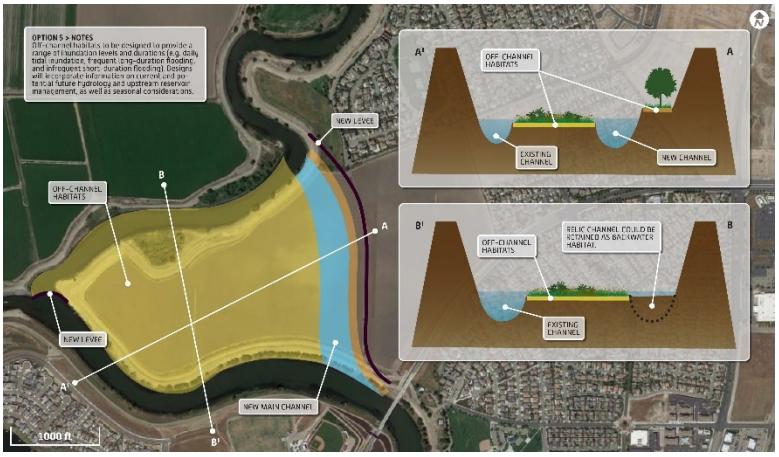
This alternative includes a more substantial levee setback on river left (north) that extends approximately one mile downstream. The new main channel would follow the new levee and reconnect with the existing main channel at the next downstream bend. This would allow for a very gradual bend in the river to replace the existing sharp right turn, likely eliminating the helical flow structures that develop in river bends and cause scouring in the outside of the bend. The new channel would have much less depth variation than the existing condition channel.

Alternative 4: Bypass channel—Option 4 from Initial Options TM



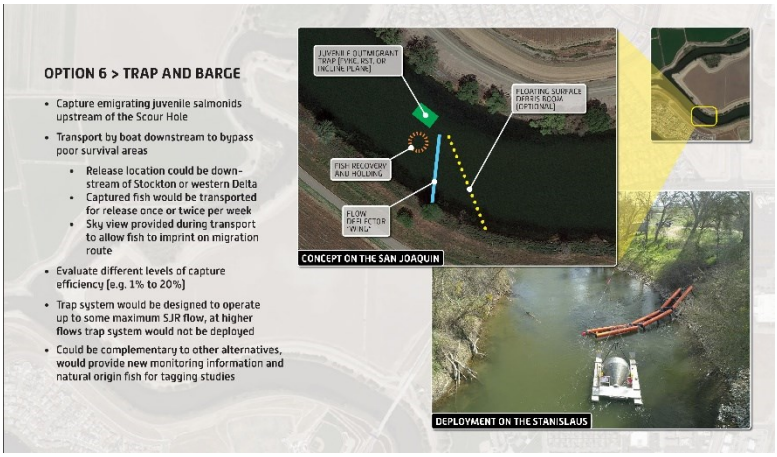
This alternative includes a levee setback along river right of the San Joaquin River and a new main channel along the new levee that bypasses the Scour Hole completely. The existing San Joaquin main channel would be left as is and would continue to convey tidal flows. The bypass channel would convey the majority of San Joaquin River flows. Because it would connect to the outside of a bend, it is expected that the majority of juvenile salmon and steelhead would migrate down the bypass channel and avoid the Scour Hole, which would remain in place but potentially fill in naturally with the majority of flow going down the bypass channel.

Alternative 5: Bypass channel with channel fill—Option 5 from Initial Options TM



This alternative is identical to Alternative 4 in terms of the levee setback on river right. The only difference from Alternative 4 is that the existing San Joaquin River channel downstream from the Old River junction would be closed off and filled in. This would eliminate the possibility for juvenile salmon and steelhead to migrate through the existing scour hole because it would be filled in.

Alternative 6: Trap and Haul—Option 6 from Initial Options TM



Alternative 6 differs substantially from Alternatives 1-5 in that it does not include any changes to the river channel geometry. This Alternative proposes to capture some proportion of out-migrating juvenile salmon and steelhead before they reach the Head of Old River junction and to provide those captured fish with safe, boat-based transport to the Western Delta. As described in the next section, this Alternative provides the largest increase in fish survival because it bypasses not only the Scour Hole, but other low-survival reaches between the Scour Hole and the western Delta as well.

Decision Objectives/Screening Criteria

The Stakeholder Working Group used the SDM process to identify multiple decision objectives or criteria and associated performance metrics that were used to evaluate Alternatives 1-6. The criteria are summarized in Table 1.

Table 1. Decision Objectives and Performance Measures developed by the Stakeholder Workgroup

Decision Objective/Criteria	Performance Measure
Maximize effectiveness at reducing mortality of target species. Sub-objectives for predation and habitat	Survival to Chipps Island (%)
Maximize durability	Likelihood solution will operate as intended over next 50 years (L-M-H)
Effects on other species of concern	Tiered: -1, 0, +1 for each species, then 1 – 10 as possible or important
Minimize construction and long-term maintenance costs	Total lifetime cost in USD
Maintain or improve flood capacity	Y/N: Is the Alternative flood control positive/neutral?
Minimize adverse impacts on beneficial uses of water	Negative effects on HABs, water quality. Possibility that water costs are induced
Minimize adverse/maximize beneficial impacts to recreational use	-2, -1, 0, 1 for ability to boat, sport fishing, access
Minimize landowner concerns	Will landowners fight the project?
Maximize learning	None, Low, High for 6 individual areas of learning

Summary Assessment from SDM and Initial Options TM

The SDM WG was convened to provide structured stakeholder engagement, not to decide or even make a recommendation. Thus, in the context of this process, the evaluation of consequences should be viewed as draft and preliminary. The

methods employed for evaluating the consequences are described in detail in the *Initial Options TM*.

For the preliminary evaluation of consequences, a Simple Multi-Attribute Ranking Technique was used. The raw scores from the assessments are shown in Table 24 from the *Initial Options TM* below. The color coding is as follows: green (G) is the highest scoring option for a given objective, red (R) is the lowest score, and orange (O) scores fall in between. The raw scores were then normalized to a common scale between zero and one, using the maximum and minimum scores for each objective to set the normalization.

Table 24. Summary of Raw Scores from the Consequences Assessments

Decision Objective	Desired direction	Initial Option 1	Initial Option 2	Initial Option 3	Initial Option 4	Initial Option 5	Initial Option 6
Max effectiveness - predation: Chinook	Max	R1	R1	R1	R1	R1	G4
Max effectiveness - predation: Steelhead	Max	R2	R2	R2	R2	R2	G4
Max effectiveness - Habitat	Max	R0	O1	G3	G3	G3	R0
Durability	Max	R3	O4	O3.5	O4	O4	G5
Effects on other species	Max	O7	G12	G12	G12	G12	R3
Cost	Min	G2.3	O21.6	O104.3	R126.4	R128.3	O37.6
Recreation - Boating	Max	R0	G3	G3	G3	G3	R0
Recreation - Fishing	Max	R1	G2	G2	G2	G2	R1
Landowner concerns	Min	G0	R1	R1	R1	R1	G0
Learning	Max	O4.2	O4.8	O7.0	O6.6	G7.4	R4

Additionally, the SDM WG assigned a weight to each objective (or sub-objective). For this first round of analysis, each objective was assigned an equal weight of one (with subobjective weights divided evenly). The results from this normalization and weighting are shown in Table 25 from the *Initial Options TM* below.

Table 25. Summary of Weighted Scores from the Consequences Assessments

Decision Objective	Weight	Initial Option 1	Initial Option 2	Initial Option 3	Initial Option 4	Initial Option 5	Initial Option 6
Max effectiveness - predation: Chinook	0.33	R0	R0	R0	R0	R0	G0.33
Max effectiveness - predation: Steelhead	0.33	R0	R0	R0	R0	R0	G0.33
Max effectiveness - Habitat	0.33	R0	O0.11	G0.33	G0.33	G0.33	R0
Durability	1.0	R0	O0.5	O0.25	O0.5	O0.5	G1
Effects on other species	1.0	O0.44	G1	G1	G1	G1	R0
Cost	1.0	G1	O0.85	O0.19	R0.01	R0	O0.72
Recreation - Boating	0.50	R0	G0.5	G0.5	G0.5	G0.5	R0
Recreation - Fishing	0.50	R0	G0.5	G0.5	G0.5	G0.5	R0
Landowner concerns	1.0	G1	R0	R0	R0	R0	G1
Learning	1.0	O0.06	O0.24	O0.88	O0.76	G1	R0
Sum of Weights (for all objectives)	7.0	N/A	N/A	N/A	N/A	N/A	N/A
Sum of weighted scores	N/A	R2.50	O3.69	O3.65	O3.61	G3.83	O3.39
N/A	Final Score (sum of weighted scores/sum of weights)	R0.36	O0.53	O0.52	O0.52	G0.55	O0.48

Key Takeaways from SDM and Initial Options TM

- Flood capacity was not included in the assessment tables because it is a "yes/no" assessment, in terms of whether a given option increases flood risk. In general, the options (except for Trap and Haul) have relatively minor flood impacts that could likely be addressed through design modifications. An important consideration is the interaction with upstream spills into Paradise Cut. See Section 6.5 of the *Initial Options TM* for a detailed assessment of the varying degrees of impacts on flood capacity of these six Alternatives.
- A sensitivity analysis was conducted to evaluate the influence of the weights of different objectives on the rankings, indicating:

- the objectives were most sensitive to weights on cost (i.e., giving more weight to the cost objective will have a greater impact on ranking alternatives);
- with even weights, Alternative 5 (bypass channel with filling of the old San Joaquin River channel) was slightly preferred over the other habitat creation alternatives (2, 3, and 4);
- the four alternatives that included habitat creation (2-5) ranked above those that did not (Alternatives 1 and 6).

Reclamation Value Planning Study

The *Value Planning Study (VPS)* used the Value Method, a decision-making process originally created in 1943 by Larry Miles, to achieve the most appropriate and highest value solution for a project.

Value Planning Study Process

The Value Method process follows a job plan that provides a reliable, structured approach to the conclusion.

A Value Planning Study Team (Team) for Scour Hole was formed by Reclamation and met over the course of five days in November 2023 to consider the six Initial Options and develop additional alternatives, if desired. The team members included:

- Darryl Good, PE Civil Engineer/Facilitator, Bureau of Reclamation Civil Branch Chief, CGB
- Steve Kolk, PE Civil Engineer/Co-facilitator, Bureau of Reclamation Sub-basin Liaison, CPN
- Yong Lai, Ph.D. Hydraulic Engineer Bureau of Reclamation Technical Service Center
- Seth Merdler, Natural Resources Specialist/PM/COR Reclamation Bay Delta Office, CGB Region
- Todd Plain, Project Manager, Reclamation Bay Delta Office, CGB Region
- Catarina Pien, Fish Biologist, Reclamation Bay Delta Office, CGB Region

The Team examined the component features of the project to define the critical functions, governing criteria, and associated costs. The Team applied the Functional Analysis System Technique (FAST) approach to develop a FAST diagram which helps match critical functions to potential solutions. Following this analysis, the Team suggested alternative ideas and solutions to perform those critical functions, consistent with the identified governing criteria, at a lower cost or with an increase in long-term value.

Value Planning Study Alternatives

The following Alternatives are presented numerically to build on the six preceding alternatives identified earlier in this report.

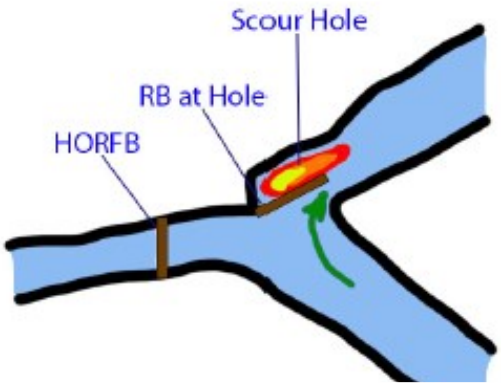
Alternative 7: Gravel Augmentation—Alternative 1 from the VPS

This alternative entails filling the Scour Hole with gravel to reduce predation by eliminating predator habitat. This is similar to Alternative 1 from the *Initial Options TM*, the only difference being the size of the fill material (gravel would potentially be eroded whereas cobble would likely be stable). This would potentially allow gravel to re-distribute downstream naturally along the channel and into other scour holes. The gravel would potentially need to be re-augmented annually or every few years, depending on if and how quickly it disperses from the original scour hole site.

Alternative 8: Manually Fill and Excavate Scour Hole—Alternative 2 from the VPS

Under this alternative, the Scour Hole would be filled with rock annually in March and remain filled until early June, when the material would be excavated. The fill material would be large enough so as not to be swept away during typical conditions but small enough to reduce pockets that predators can inhabit. Thus, this alternative is very similar to Alternative 1 from the *Initial Options TM* and the gravel augmentation alternative described above, the only difference being that the filling would occur seasonally every year instead of permanently.

Alternative 9: Instream barrier at Scour Hole—Alternative 3 from the VPS



This alternative entails constructing a seasonal rock barrier adjacent to the Scour Hole (see image at left). The intended function is to act in a similar manner as the adjacent Head of Old River Seasonal Barrier: to guide migrating salmonids in the San Joaquin River away from and past the Scour Hole.

Alternative 10: Instream Flow Redirection—Alternative 4 from the VPS

This alternative would use instream features to redirect flows away from the outer bend of the study site so that the current scour hole may fill and stay filled, thereby displacing the predators so that the predation rate of juvenile salmon is reduced. Details of these instream features and how they would influence site hydraulics, particularly during high flows that tend to scour the riverbed would need to be further developed and modeled.

Decision Objectives/Evaluation Criteria

The Team used the Combinex® matric system to identify the following criteria for evaluating the design and alternatives:

1. Project Sustainability – Once constructed, how well does the project remain in place and functional?
2. Land Acquisition – Does the Alternative require purchase of land and does it require negotiation with more than one owner?
3. Salmonid Survival – How likely is the Alternative to increase juvenile survival?
4. Maintenance and Operational Requirement – How much annual maintenance (or operational) support is required?
5. Predation Impact – How well does the Alternative decrease predation at the site?

6. Lifecycle Cost – Considering a 10-year life cycle, how costly is the Alternative?
7. Constructability – How difficult will it be to install the Alternative?
8. Environmental Compliance – How likely is it that the Alternative will be covered by a State-wide or national program or will individual consultation be required?
9. Repeatability – How repeatable is the Alternative at other scour hole locations?

Summary Assessment of the Value Planning Study

The *VPS* applied preference scores and weightings for each evaluation criteria to develop a raw score and rank the criteria as illustrated in the following table (Table 3 from the *VPS*).

Criteria Scoring Matrix

Criteria:	Preference		Preference		Preference		Preference		Preference		Preference		Preference		Preference		Raw Score	Weight (1 to 10)	Normalized to 1
	A or	B	A or	C	A or	D	A or	E	A or	F	A or	G	A or	H	A or	I			
A. Project Sustainability	2			3	1	1		3	1	1		2	2		3		9	4.00	0.10
	B or	C	B or	D	B or	E	B or	F	B or	G	B or	H	B or	I					
B. Land Aquisition		4	2			4		3	2		2		2				8	3.67	0.09
	C or	D	C or	E	C or	F	C or	G	C or	H	C or	I							
C. Salmonid Survivability	4		2		3		3		4		3						26	9.67	0.24
	D or	E	D or	F	D or	G	D or	H	D or	I									
D. Maintenance requirement		3	1	1		2	3		2								7	3.33	0.08
	E or	F	E or	G	E or	H	E or	I											
E. Impact to reduce predation	3		3		4		3										23	8.67	0.21
	F or	G	F or	H	F or	I													
F. Lifecyle Cost	2		3		3												13	5.33	0.13
	G or	H	G or	I															
G. Constructability	2		1	1													7	3.33	0.08
	H or	I																	
H. Enviromental Compliance		2															0	1.00	0.02
I. Repeatability																	3	2.00	0.05

How Important: Major Preference = 4, Medium Preference = 3, Minor Preference = 2, No Preference (Each = 1)

Table 3. Criteria Scoring Matrix (or Cost Model)

The *VPS* then applied these weighted criteria to all 10 of the alternatives: the six alternatives from the *Initial Options TM* and the four alternatives identified by the *VPS* Team (Table 4 from *VPS*). This table shows that Alternatives 1 (fill the Scour Hole), 6 (trap and haul), and 8 (seasonally fill and excavate the Scour Hole) ranked first, second and third highest, respectively. The remaining alternatives all ranked as "good" with a score above 3 but below 4. Of those that ranked "good," Alternative

10 (instream flow redirection) and Alternative 2 (channel realignment) ranked the next highest. It is noted that these rankings used only the *VPS* evaluation criteria.

Analysis Matrix

Criteria	A		B		C		D		E		F		G		H		I					
Weight	0.10		0.09		0.24		0.08		0.21		0.13		0.08		0.02		0.05					
Idea	Score	Weighted	Score	Weighted	Score	Weighted	Score	Weighted	Score	Weighted	Score	Weighted	Score	Weighted	Score	Weighted	Score	Weighted	Raw Score	Weighted Score	Ranking	Disposition
Alt -1 : Fill Hole	2	0.20	5	0.45	4	0.94	5	0.41	4	0.85	5	0.65	5	0.41	5	0.12	5	0.24	40	4.26	1	
Alt - 2; Small N Floodplain	3	0.29	2	0.18	4	0.94	4	0.33	5	1.06	3	0.39	2	0.16	1	0.02	2	0.10	26	3.47	5	
Alt - 3 : Large N FloodPlain	3	0.29	2	0.18	5	1.18	4	0.33	5	1.06	1	0.13	1	0.08	1	0.02	1	0.05	23	3.32	7	
Alt - 4 : Large S FloodPlain	2	0.20	1	0.09	5	1.18	4	0.33	5	1.06	1	0.13	1	0.08	1	0.02	1	0.05	21	3.13	9	
Alt - 5 : Large S Flood Plain with fil	2	0.20	1	0.09	5	1.18	4	0.33	5	1.06	1	0.13	1	0.08	1	0.02	1	0.05	21	3.13	9	
Alt - 6 : Trap and Haul	4	0.39	5	0.45	4	0.94	1	0.08	4	0.85	5	0.65	4	0.33	4	0.10	5	0.24	36	4.02	2	
A) Instream Flow Redirection	3	0.29	5	0.45	3	0.71	5	0.41	4	0.85	4	0.52	4	0.33	3	0.07	1	0.05	32	3.67	4	
B) Manual install/remove rock	4	0.39	5	0.45	4	0.94	2	0.16	4	0.85	4	0.52	4	0.33	5	0.12	5	0.24	37	4.00	3	
C) Gravel Augmentation	3	0.29	5	0.45	2	0.47	3	0.24	3	0.63	5	0.65	5	0.41	5	0.12	4	0.20	35	3.46	6	
D) Rock Barrier @ Hole	4	0.39	5	0.45	3	0.71	2	0.16	2	0.42	4	0.52	4	0.33	5	0.12	4	0.20	33	3.29	8	

Score: Excellent = 5, Very Good = 4, Good = 3, Fair = 2, Poor = 1

Score 4-5
Score 3-4
Score 2-3

Table 4. Decision Weighted Analysis Matrix

Considerations for Alternatives Selection

Comparison of Initial Options TM and VPS

Areas of Convergence (Agreement)

The *Initial Options TM* and the *Value Planning Study* identified common alternatives, although the specific details of each varied.

Common Evaluation Criteria

The *Initial Options TM* and *VPS* shared several evaluation criteria and associated performance metrics as depicted in the table below.

Common Criteria/Performance Metrics

Value Planning Study Evaluation Criteria	**VPS Performance Metric ***	**Stakeholder Decision Objectives/Screening Criteria**	**Performance Metric**
Project Sustainability	Once constructed, how well does the project remain in place and functional?	Maximize Durability	Likelihood solution will operation as intended over the next 50 years
Land Acquisition	Does the alternative require purchase of land and does it require negotiation with more than one owner?	Minimize Landowner Concerns	Will landowners fight the project?
Salmonid Survival	How likely is the Alternative to increase juvenile survival?	Maximize effectiveness at reducing mortality of target species	Survival to Chipps Island (%)
Lifecycle Cost	Considering a 10-year lifecycle, how costly is the Alternative?	Minimize construction and long-term maintenance costs	Total lifetime cost in USD

* VPS did not specifically identify the questions listed as "performance metrics", but they were included with the criteria and functionally serve as the basis for performance metrics

Common Alternatives

The *Initial Options TM* and *VPS* offered two common types of Alternatives.

Filling the Scour Hole

Alternatives 1 (from the *Initial Options TM*), 7, and 8 (from *VPS*) all involve filling the Scour Hole with rock material of various sizes/grades. Alternative 1 would use large rock that is permanent and intended to resist future scouring and redistribution. Maintenance of Alternative 1 would be infrequent or unnecessary. Alternative 7 would fill the Scour Hole with smaller grade rock (i.e., gravel) that would potentially be redistributed/moved by high flow events such that it may require periodic maintenance. Alternative 8 would seasonally place (before juvenile outmigration) and remove (following juvenile outmigration) large grade rock materials in the Scour Hole that would resist scour and redistribution. This Alternative would require considerable (semi-annual) effort/maintenance.

Instream and/or Bank Alterations

Alternatives 2, 9, and 10 would alter the existing San Joaquin River channel and/or bank to address underlying hydrogeomorphic conditions responsible for the formation and persistence of the Scour Hole. Alternative 2 would reshape and harden the north bank of the San Joaquin River below the Head of Old River to create physical conditions that would inhibit formation of a Scour Hole. Alternative 2 should require very little to no long-term maintenance. Alternative 9 would temporarily place large rock material within the San Joaquin River channel to isolate the existing Scour Hole from the active San Joaquin River channel during juvenile outmigration. This rock barrier would be removed following each outmigration season. Accordingly, Alternative 9 would be maintenance intensive. Alternative 10 would install in-channel vanes (either rock or wood composition) to redirect erosive river flows away from the existing Scour Hole, and the Scour Hole would fill with naturally occurring materials (the feasibility of natural filling is uncertain). Maintenance requirements for Alternative 10 are uncertain, but diversion vanes (particularly, root wads and tree vanes) commonly require considerable maintenance.

Areas of Divergence

Differing Evaluation Criteria

The tables below indicate where decision objectives/evaluation criteria differ between the Stakeholder Working Group and the VPS Team.

VPS Criteria NOT Identified by Stakeholders and NOT Considered in Structured Decision-Making (SDM)

Criteria	Evaluation Question
Constructability	How difficult will it be to install the Alternative?
Environmental Compliance	How likely is it that the Alternative will be covered by a State-wide or national program or will individual consultation be required?
Repeatability	How repeatable is the Alternative at other scour hole locations?

SDM Criteria NOT Identified and NOT Considered in Value Planning Study (VPS)

Criteria	Performance Measure
Effects on other species of concern (e.g., up-migrating adult salmonids and sturgeon)	Tiered: -1, 0, +1 for each species, then 1-10 as possible or important
Maintain or improve flood capacity	Y/N: Is the Alternative flood control positive/neutral?
Minimize adverse impacts on beneficial uses of water	Negative effects on HABS, water quality. Possibility that water costs are induced
Minimize adverse/maximize beneficial impacts to recreational use	-2, -1, 0, 1 for ability to boat, sport fishing, access
Maximize learning	None, Low, High for 6 individual areas of learning

Differing Alternatives

The *Initial Options TM* and *VPS* offered the following different types of Alternatives addressed in one report but not in the other.

River and Levee Re-configuration with Restored Floodplain

Alternatives 3, 4, and 5, all from the *Initial Options TM*, include re-routing of the San Joaquin River mainstem, combined with reshaping and hardening of existing and new river channels, to eliminate and/or reduce hydrogeomorphic factors responsible for the creation and formation of the Scour Hole. In addition to eliminating the Scour Hole, these alternatives provide habitat benefits for salmon and steelhead through the restoration of floodplains and side channels. Alternative 3 would re-route northward of the San Joaquin River at the Scour Hole, following a more gradual, sweeping path than Alternative 2 to further reduce erosive hydrogeomorphic factors. Alternative 3 would likely require little long-term maintenance. Alternative 4 would create a new San Joaquin River channel and floodplain bench to relieve/reduce erosive forces at the Scour Hole. Maintenance required for Alternative 4 is uncertain but may be extensive to ensure the persistence and function of created features. Alternative 5 is similar to Alternative 4 in that it creates a new San Joaquin River mainstem channel (that shortcuts/bypasses the Scour Hole) and floodplain. Alternative 5, however, would abandon and fill a reach of the San Joaquin River mainstem below the Scour Hole.

None of the Alternatives in the *VPS* considered levee reconfiguration with restored floodplain. Alternatives 3, 4, and 5 ranked 2nd, 3rd and 4th highest in the initial assessment by the Stakeholder Working Group. However, due to the potential

negative impacts on 100-year water surface elevations from these alternatives, design modifications and additional modeling simulations would be needed recommended to reduce the flood capacity impacts if these alternatives are selected for further analysis.

Trap and Haul

A trap and haul option, Alternative 6 from the *Initial Options TM*, was not considered by the *VPS*. This alternative would involve seasonally capturing juvenile outmigrant salmonids above the Scour Hole and transporting them to the western Delta for release. Operational efforts would be substantial and recurrent. No channel or associated habitat modifications would occur with Alternative 6. While it does not alone satisfy the project needs statement in the 2019 Biological Opinion, the Trap and Haul option could complement other endeavors as part of a phased approach to ensure "measurable reduction in predation" as called for in the 2024 Biological Opinion. Implementing this option as soon as possible holds a higher probability of ensuring species survival until the selected alternative is fully implemented. As noted in the *Initial Options TM*, trap and haul has the most immediate and largest impact on increasing survival to Chipps Island because it bypasses not only the Scour Hole but other low-survivability reaches in the Delta as well.

Key Points to Inform Next Steps/Alternatives Selection

The *Initial Options TM* was not intended as a decision-making document; rather, it was designed to provide structured stakeholder engagement and provide a range of options for consideration by Reclamation. As such, the evaluation of options/alternatives and their potential consequences outlined in the memo should be viewed as draft and preliminary. The *Initial Options TM* identified several information gaps and recommended areas for further investigation. In summary, these include:

- Assign weights to the different objectives based on actual decision-maker or stakeholder values.
- Conduct additional outreach with locals who fish the Head of Old River scour hole to support evaluation of impacts to recreation.
- The effects of any selected alternative could be more far-reaching than the immediate scour hole area: effects analysis must account for this reality.

- Evaluation of options should consider not just effects of the action on predation of target fish, but also on possible improved growth and survival beyond predation (habitat considerations).
- Population-level benefits of floodplain restoration will not be captured by analysis that focuses solely on predation.
- Preliminary analysis of consequences did not look at changes to flow streamlines and effects on routing of fish, which could be a significant factor in survival.
- Revisit how fish survival is evaluated (e.g., based on percent survival versus number of fish surviving to Chipps Island).
- Decisions about alternative design and evaluation for the Scour Hole project should consider how alternatives would perform under different implementation scenarios for these related efforts: the SJAFCA-led flood risk reduction project; the Paradise Cut Expansion project; and the Head of Old River Barrier (HORB) project.
- The following gaps were identified and recommended for future analysis:
    - Elaborate on capture of learning opportunities (e.g., possible benefits to the CVPIA SIT model).
    - Effects of low flow/different water year types on water quality.
    - Alternatives are not mutually exclusive; sequenced implementation is possible (e.g., trap and haul could take place in the near-term while permitting and other logistical elements of other actions were being addressed).
    - Further analysis should consider how seasonal migration dynamics might affect population benefits.
- Additional risks and uncertainties are described on page 42 of the *Initial Options TM.*

Although the *VPS* ranking considered all 10 alternatives, the evaluation was limited to the criteria identified by the *VPS* team and did not consider the following decision objectives/screening criteria that were identified by the Stakeholder Working Group:

- Effects on other species of concern (e.g., up-migrating adult salmonids and sturgeon).
- Maintain or improve flood capacity.
- Minimize adverse impacts on beneficial uses of water.
- Minimize adverse/maximize beneficial impacts to recreational use.
- Maximize learning.

Because these criteria were developed through extensive consultation with stakeholders over the course of a year, it is recommended that Reclamation consider these criteria, weigh them along with the criteria common to both the *VPS* and the *Initial Options TM*, and perform an updated evaluation and ranking of the alternatives that reflects this broader range of criteria. Alternatively, Reclamation could provide a rationale for not considering these additional decision objectives/criteria that were developed by the Working Group in its justification of selected alternatives.

Finally, it is noted that a new Environmental Impact Statement (EIS) and the 2024 Biological Opinion on Federal and State Long-Term Operations have been published since completion of the *Initial Options TM* and *VPS*. The Scour Hole project is included in these documents as part of the no action alternative. However, the NMFS Biological Opinion outlines a new study that has potential implications for this project. The Biological Opinion specifies conducting a study to determine the efficacy of deploying a non-physical barrier at the Head of Old River to route juvenile salmon and steelhead away from Old River and the south Delta water export facilities. Because the non-physical barrier configuration and effectiveness would be dependent on the channel geometry at the Head of Old River junction, it is recommended that its study be coordinated and/or integrated with this study.

Justification of Selected Alternatives

This report explores the bounds of different potential actions and provides background information on how they were derived and the criteria used to evaluate those potential actions through two different approaches: Structured-Decision-Making and the value planning method. Agencies are recommended to briefly discuss their reasons for eliminating alternatives from detailed study, as

described in the Department of Interior Handbook of NEPA Procedures Appendix 3 (516 DM 1). Agencies are expected to develop reasonable alternatives. Reasonable alternatives mean a reasonable range of alternatives that are technically and economically feasible, meet the purpose and need for the proposed action are within the jurisdiction of the Bureau of Reclamation and, where applicable, meet the goals of the applicant.

Use of the following screening criteria supports Reclamation's clear and consistent description of its methodology for selecting which alternatives to analyze in detail. The purpose of these screening criteria is to guide Reclamation to identify, early in the development of alternatives process, which alternatives may and may not be appropriate to analyze in detail. If an alternative is flagged as inconsistent with this definition it should not be analyzed in detail.

1. Purpose and Need: how well each component would meet the purpose and need.
2. Completeness: whether sufficient information is available and can be analyzed through quantitative or qualitative means.
3. Technically and Economically Feasible: capable of being provided: (a) through technology that is readily available and has been demonstrated in actual operating conditions (not simply through tests or experiments) to operate in a workable manner; and (b) in a manner that does not require relatively large financial investments for relatively minor or unproven benefits.
4. Value Added: alternatives or components that may be considered unnecessary because similar or better performance in terms of resulting impacts is likely from a different or simpler configuration.

Based on the above criteria and consideration of all options in the *Initial Options TM* and the *Value Planning Study*, Reclamation has selected to pursue analysis of the following three alternatives:

- No Action Alternative.
- Action Alternative 1: Fill the Scour Hole with non-erodible material (Initial Option 1). Filling the Scour Hole with non-erodible material would reduce or eliminate the development of the helical flow structures and turbulence that

develop in the sharp bend, causing erosion of the riverbed and development of the deep scour hole and adjacent point bar.

- Action Alternative 2: Fill the Scour Hole with non-erodible material and a gravel cap. This alternative is almost identical to Action Alternative 1, but modified to include a "gravel cap" on top of the large, non-erodible rock proposed for filling the hole. This modification was a component of the *VPS* gravel augmentation alternative. Capping the fill with gravel would provide a more natural substrate mimicking other areas of the lower San Joaquin River and could potentially benefit other species such as sturgeon. This Alternative also includes the potential for continued gravel augmentation in the future, to replace gravel that may be transported downstream during high flows and to fill pockets around the original fill that may develop.

Reclamation will not pursue further analysis of Trap and Haul because it does not meet the project Purpose and Need (it does not include modifications to the channel geometry and associated habitats).

Reclamation will not pursue further analysis on alternatives that reroute the river and associated levee systems. Under conceptual analysis in the *Initial Options TM*, these alternatives come with significant cost and complexity. While these alternatives may be possible to execute and meet the purpose and need, they do not appear to be economically feasible. They also do not appear to be value added compared to other alternatives that meet the purpose and need through simpler configurations. The cost to reroute infrastructure is orders of magnitude larger than the selected alternatives above. Additionally, large constraints and limitations begin to arise with real property acquisitions and flood control safety when rerouting the river and levees.

Reclamation originally approached this proposed action considering the possible need for an Environmental Impact Statement (EIS) and started a scoping and stakeholder engagement process as exemplified by the SDM process used to develop the *Initial Options TM*. After completing the initial stakeholder engagement and consideration of all options from both the *Initial Options TM* and the *VPS*, and selecting the alternatives above, Reclamation expects an Environmental Assessment (EA) will satisfy the environmental analysis needed for this action. If analysis during the EA development indicates a significant impact to a resources

area(s), Reclamation will either explore mitigation options to avoid significant impact or initiate the development of an Environmental Impact Statement.

References

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