Russ Creek and Centerville Slough Restoration Project

Final
Environmental Impact Report

Humboldt County Resource Conservation District

28 July 2023

Final
Environmental Impact Report
Russ Creek and Centerville Slough Restoration Project

SCH# 2022040559

Prepared for:

Humboldt County Resource Conservation District, Lead Agency
5630 South Broadway
Eureka, CA 95503

Attention: Jill Demers, Executive Director
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July 2023

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Appendices

1. Introduction

1.1 Purpose of the Final Environmental Impact Report

This Final Environmental Impact Report (FEIR) for the Russ Creek and Centerville Slough Restoration Project (Project) consists of the Draft EIR (DEIR), comments received on the DEIR, the Humboldt County Resource Conservation District's (HCRCD; Lead Agency) responses to comments, and revisions to the DEIR. The DEIR identified the likely environmental consequences associated with the Project, and recommended mitigation measures to reduce potentially significant impacts.

To certify the Final EIR, the HCRCD must find that:

– The Final EIR has been completed in compliance with CEQA;
– The Final EIR was presented to the decision-making body of the Lead Agency and that the decision-making body reviewed and considered the information contained in the Final EIR prior to approval of a project;
– The Final EIR reflects the Lead Agency's independent judgment and analysis (CEQA Guidelines Section 15090);
– The findings of the EIR are consistent with Section 15091 of the CEQA Guidelines. The Project will not result in a significant unmitigated environment impact, findings are supported by substantial evidence, and the Final EIR includes a Mitigation, Monitoring, and Reporting Program; and
– Approval of the EIR is consistent with Section 15092 of the CEQA Guidelines.

1.2 Environmental Review Process

CEQA requires lead agencies to consult with public agencies having jurisdiction over a proposed project, and to provide the general public with an opportunity to comment on the DEIR. This FEIR has been prepared to respond to those oral and written comments received on the DEIR.

The Notice of Preparation (NOP) was made available for a 30-day public review period on April 27, 2022. CEQA Guidelines Section 15082 (b) requires a 30-day response period for input on the scope and content of the EIR. The NOP review period ended on May 26, 2022. A public and agency scoping meeting was held in Eureka May 20, 2022 at 2:00 P.M. The purpose of the scoping meeting was to inform agencies and interested parties about the Project, and to solicit input on environmental issues germane to the Project, as well as potential alternatives to the Project. Section 1.4 the DEIR summarizes the public scoping process.

The DEIR was made available for a 45-day public review on May 26, 2023. The review period ended at 5:00 pm on July 10, 2023. The document was available for review at the HCRCD, located at 5630 South Broadway, Eureka, California and available on the HCRCD's website: http://humboldtrcd.org/. The DEIR was sent to the State Clearinghouse and was published on May 26, 2023 for distribution to State agencies, and was distributed to local, State, and federal responsible and trustee agencies and tribal governments. The general public was advised of the DEIR through a Notice of Availability posted at the County Clerk as required by law on May 26, 2023, and through a posting in the local newspaper, the Times Standard, on June 1, 2023. The Notice of Availability of the Draft EIR was also sent to the stakeholders, adjacent landowners, tribes, and agencies by certified mail on May 26, 2023.

A public hearing before the HCRCD Board on June 8th, 2023 at 8:00 A.M. to receive comments on the DEIR was held during the circulation period to provide additional opportunity for comment. The hearing took

place at the Humboldt County Agriculture Center, 5630 South Broadway, Eureka, 95503 California and online via Zoom.

The Final EIR will be sent to the public agencies who commented on the DEIR at least 10 days prior to certification of the EIR per CEQA Guidelines Section 15088.

If the Project is approved, recommended mitigation measures will be adopted and implemented as specified in the HCRCD's resolution and an accompanying mitigation monitoring and reporting program (MMRP).

The additions made in this FEIR do not constitute "significant new information" requiring recirculation pursuant to Public Resources Code section 21092.1 and CEQA Guidelines Section 15088.5. The FEIR merely clarifies, amplifies, and makes insignificant modifications to an adequate EIR, per CEQA Guidelines Section 15088.5(b).

1.3 Document Organization of the FEIR

The FEIR is organized into the following chapters:

- **Chapter 1 – Introduction**. This chapter discusses the use and organization of this FEIR and the environmental review process.
- **Chapter 2 – Comments and Responses**. This chapter includes a list of persons, organizations, and public agencies who commented on the DEIR, reproductions of the letters received from the public on the DEIR, and responses of the Lead Agency to those comments.
- **Chapter 3- Comments Received Following the Close of Public Circulation**. This chapter summarized the comments received by the HCRCD in writing and during the June 8, 2023 public hearing.
- **Chapter 4 – Errata**. This chapter includes text modifications to the DEIR. Proposed text additions are signified with underlined bold text (**example**), and stricken text is signified with strike through (~~example~~).
- **Chapter 5 – References**. This chapter includes references utilized in this FEIR.
- **Chapter 6 – List of Preparers**. This chapter includes the list of individuals who contributed to this document.

2. Comments and Responses

A noticed public hearing was held for the Project during the June 8, 2023 HCRCD Board meeting, at which time a summary of the Project and EIR findings were publicly presented. Three individuals provided oral comment on the record, including representatives from the two landowners as well as a representative from the Humboldt County Farm Bureau. All three individuals expressed support for the Project.

During the public comment circulation period for the DEIR, the HCRCD received three comment letters, which included numerous comments on the DEIR. A list of the comment letters and comments received is shown below in Table 2-1 (either by agency/organization or last name of the individual).

Table 2.1 Public and Agency Comments Received on the DEIR

Letter	Last Name or Agency	First Name	Letter Date	Pgs.	Cmt#
1	California Department of Fish and Wildlife	n/a	June 28, 223	4	3
2	California Coastal Commission	n/a	July 10, 2023	12	32
3	California State Lands Commission	n/a	July 10, 2023	4	6

2.1 Master Responses

Review of comments made on the Draft EIR indicated that some comments were made frequently (type of comment), demonstrating a common concern. To allow presentation of a response that addresses all aspects of these related comments, select Master Responses have been prepared. Master Responses are intended to allow a well-integrated response addressing all facets of a particular issue, in lieu of piece-meal responses to each individual comment, which may not have portrayed the full complexity of the issue. The use of a Master Response is in no way intended to minimize the importance of the individual comments. Master Responses are summarized in Table 2.2.

Table 2.2 Summary of Master Responses

Response	Topic
1	Statements of Opinion For or Against Project and Project Planning and Statements Unrelated to Environmental Issues as Defined Under CEQA

2.1.1 Master Response 1: Statements Unrelated to Environmental Issues as Defined Under CEQA

Per CEQA Guidelines Section 15204(a), in reviewing draft EIRs, persons and public agencies should focus on the sufficiency of the document in identifying and analyzing the possible impacts on the environment and ways in which the significant effects of the project might be avoided or mitigated. When responding to comments, lead agencies need only respond to significant environmental issues and do not need to provide all information requested by reviewers, as long as a good faith effort at full disclosure is made in the EIR. Furthermore, CEQA does not require a lead agency to conduct every test or perform all research, study, and experimentation recommended or demanded by commenters.

In such cases, comments could include an opinion on the Project, questions about the planning process, and requests that the project be eliminated from consideration. Such comments provide valuable input to the HCRCD's process of considering approval of a project, and the comment letters will be submitted to the Board as part of the approval process. Where the comments address the merits of the project and do not necessarily pertain to environmental issues, no further response to comments is provided. Such comments are not comments on the EIR, but comments on the approval of the project, a process that will occur after CEQA documentation is considered for adoption. Nevertheless, if CEQA documentation is adopted for the project, the HCRCD will consider the recommendations in these comment letters as well as the information presented in the CEQA documentation or elsewhere in the record and make its decision regarding approval of the project and or consideration of project alternatives.

2.2 Public Comments Received During Circulation

This section includes copies of the comment letters and e-mails received during the 45-day public review period for the DEIR. Responses to each comment are provided after each letter.

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DEPARTMENT OF FISH AND WILDLIFE
Northern Region
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www.wildlife.ca.gov

GAVIN NEWSOM, Governor
CHARLTON H. BONHAM, Director

June 28, 2023

Jill Demers, Executive Director
Humboldt County Resource Conservation District
5630 South Broadway
Eureka, CA 95503
jillhcrcd@gmail.com

SUBJECT: RUSS CREEK AND CENTERVILLE SLOUGH RESTORATION PROJECT DRAFT EIR (SCH 2022040559)

Dear Jill Demers:

On May 26, 2023, the California Department of Fish and Wildlife (CDFW) received the Humboldt County Resource Conservation District's (Lead Agency) Draft Environmental Impact Report (DEIR) for the Russ Creek and Centerville Slough Restoration Project (Project). CDFW understands the Lead Agency will accept comments on the Project through July 10, 2023.

As the Trustee Agency for the State's fish and wildlife resources, CDFW has jurisdiction over the conservation, protection, and management of fish, wildlife, native plants, and the habitat necessary to sustain their populations (Fish and Game Code, §§ 1801 and 1802). As a Responsible Agency, CDFW administers the California Endangered Species Act (CESA) and other provisions of the Fish and Game Code that conserve the State's fish and wildlife public trust resources. CDFW offers the following comments and recommendations in our role as Trustee and Responsible Agency pursuant to the California Environmental Quality Act (CEQA; California Public Resource Code §21000 *et seq*.). These comments are intended to minimize Projects impacts on public trust resources.

Project Description

The Project Area is approximately 1,480 acres in the Eel River Estuary west of the City of Ferndale, in Humboldt County, California. It encompasses the Eel River Wildlife Preserve, owned by The Wildlands Conservancy, and several privately owned parcels. The Project is intended to restore tidal wetlands and protect adjacent agricultural lands from storm damage and sea level rise (SLR). Restoration work will reestablish tidal processes by removing or lowering dikes and excavating four miles of Centerville Slough to reconnect the estuary with tidal wetlands and tributary streams. The Project will also reconnect tidal channel networks and enhance approximately 500 acres of former wetlands previously diked and drained for agriculture. Revegetation and ongoing invasive species management will maintain newly restored areas. To protect adjacent agricultural lands from tidal inundation and overwash, the Project will repair an existing tide gate and construct a combination of set-back berms and back dunes incorporating fish-friendly gated culverts. A stretch of Russ Creek will be realigned, deepened, and planted with riparian vegetation. Finally, the Project will incorporate improvements to facilitate agricultural operations, Project maintenance, and public access.

CDFW Comments

Long-Term Project Success

CDFW expects the Project to result in immediate ecological benefits by restoring tidal and geomorphic function to a large area of the Eel River coastal floodplain, thereby increasing and enhancing habitat for native plants, wildlife, and fish dependent on estuarine and tidal marsh environments. To ensure long-term Project viability and associated benefits to biological resources, CDFW encourages the Lead Agency to consider the foreseeable impacts of sea level rise, especially with respect to the continued erosion and movement of the dunes (**Recommendation 1**). The planning horizon should extend at least through 2050.

Extensive dune erosion has occurred in the western portion of the Project Area, where the marine littoral zone has migrated as much as 400 meters in the last ten years. Winter storms have steadily eroded the dune barrier, and repeated overwash events have altered roughly three kilometers of previously vegetated shoreline. In areas where the foredune barrier was maintained, the rate of shoreline retreat has still been as much as 1.5 meters per year between 1948 and 2016 (Friends of the Dunes and GHD 2018). Underlying sediment deposition patterns further exacerbate the effects of SLR, as currents primarily transport Eel River sediment in a northern direction, away from the Project Area. 1-1

CDFW anticipates the shoreline could retreat at similar or increased rates, threatening the long-term viability of the Project. If the historical average rate of dune retreat were maintained and the area were not subject to additional overwash events, the shoreline would retreat approximately 40 meters inland by 2050. However, overwash and dune erosion are likely to increase with SLR and more frequent storm events associated with climate change. As in 2020, winter storms coinciding with king tides are likely to result in sudden drastic changes to the shoreline and the location of sand deposition. Additional environmental factors may also increase vulnerability to SLR, such as compaction from agriculture, high rates of subsidence, and a loss of dune form and function.

While CDFW appreciates the Project's potential for immediate ecological lift, it has concerns about its long-term success due to the placement or design of certain components. As proposed, back dune berms are unlikely to successfully halt dune erosion or prevent tidal inundation and overwash in the long term. Severe erosion of the foredune is expected to continue and may accelerate with future SLR projections of two to three feet by 2050 (Humboldt County 2018). Anticipated shifts in the shoreline also pose a threat to the extension of Centerville Slough, which appears to pass through the current zone of overwash and sand deposition. Dredging sediment within the current or future littoral zone may accelerate dune erosion. Dredging may also create a sediment sink and prevent the natural inland movement of the dunes. Finally, placing tide gates in or adjacent to the zone of littoral sediment deposition may cause blockage and create a need for continuous maintenance. CDFW recommends structures requiring routine maintenance, such as tide gates and levees, be placed inland of the expected shifting marine littoral zone (**Recommendation 2**). Successful restoration and re-establishment of a tidal channel and tidal marsh habitat in the Project Area is dependent on maintaining a resilient dune ecosystem that provides a protective barrier for the Project Area. 1-2

Restoration of Tributary Habitat

The Project is expected to increase the quality and extent of habitat for salmonids and other aquatic species by restoring tidal connectivity and creating or enhancing estuarine habitat. However, it does not address impaired tributary habitat upstream of the proposed tide gates, where historic stream channelization and loss of riparian forest limit habitat value. Improvements to Russ Creek will reconnect the stream with Centerville Slough and re-establish the riparian corridor, but work will be limited to a short reach and appears to focus primarily on floodwater management. To maximize the ecological benefits of proposed estuarine restoration, CDFW recommends the Lead Agency consider enhancements to riparian and aquatic habitat upstream of the tide gates (**Recommendation 3**). Restoration could address factors limiting the recovery of local salmonid populations, such as lack of floodplain and channel structure and degradation of riparian forest (NMFS 2014). By incorporating design elements such as sinuosity, off-channel habitat, inset floodplains, and large wood structures, the Project could have even greater benefits for salmonids and other native fish and wildlife dependent on freshwater aquatic and riparian ecosystems. 1-3

Summary of Recommendations

1. To ensure long-term Project viability and associated benefits to biological resources, the Lead Agency should consider the foreseeable impacts of SLR, especially with respect to the continued erosion and movement of the dunes. The planning horizon should extend at least through 2050.
2. Structures requiring routine maintenance, such as tide gates, dredged slough channels, and levees, should be placed inland of the expected shifting marine littoral zone.
3. To maximize the ecological benefits of proposed estuarine restoration, the Lead Agency should include design elements such as sinuosity, off-channel habitat, inset floodplains, and large wood structures to enhance riparian and aquatic habitat upstream of the tide gates in Russ Creek.

We appreciate the opportunity to comment on this proposed Project.

If you have any questions, please contact Environmental Scientist Kathryn Rian by email at Kathryn.Rian@wildlife.ca.gov.

Sincerely,

DocuSigned by:
Tina Bartlett
1D82ADE7303A474...

Tina Bartlett, Regional Manager
California Department of Fish and Wildlife

Ec's on Page 4

ec: State Clearinghouse, Office of Planning and Research
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California Department of Fish and Wildlife
Rebecca Garwood, Michael van Hattem, Kathryn Rian

References

Friends of the Dunes and GHD. 2018. Coastal Dune Vulnerability and Adaptation Study, Eel River Shoreline Trends.

Humboldt County. 2018. Humboldt Bay Area Plan Sea Level Rise Policy Background Study. Available from https://humboldtgov.org/DocumentCenter/View/106574/Rerelease-LCP_2019_Stakeholder_Catalogue_June_2022?bidId=.

National Marine Fisheries Service (NMFS). 2014. Final Recovery Plan for Southern Oregon/Northern California Coast Evolutionarily Significant Unit of Coho Salmon (*Oncorhynchus kisutch*). National Marine Fishers Service, Arcata, CA. Available from https://www.fisheries.noaa.gov/west-coast/endangered-species-conservation/southern-oregon-northern-california-coast-coho-salmon.

2.2.1 Letter 1 – Response to CDFW Comments

The HCRCD appreciates the recommendations made by CDFW in the agency's comment letter and has directly addressed key points. The HCRCD looks forward to continued discussion with CDFW regarding these technical details as the Project moves beyond CEQA into the permitting phase.

Response to Comment 1-1

Recommendations (1) consider the foreseeable impacts of SLR, especially with respect to the continued erosion and movement of the dunes

The Project design did consider and account for the foreseeable impacts of sea level rise, including continued erosion and movement of dunes. As stated on page 1 of the Monitoring and Maintenance Plan (Appendix D of the DEIR), the Project life is anticipated to be a minimum of 20-25 years (2050). Per CDFW's reference to the projected shoreline recession of 40 meters (132 feet) inland by 2050, the proposed restoration design has included a buffer between the current position of the wave slope and the proposed restored alignment of Centerville Slough to be no less than approximately 700 feet. This buffer is intended to reduce project vulnerability to sea level rise and dune overwash events that could accelerate the above referenced projected shoreline recession.

Response to Comment 1-2

Recommendation (2) place structures requiring routine maintenance inland of the expected shifting marine littoral zone

The proposed back dune enhancements are not expected to halt dune erosion but are the best available management strategy to achieve Project goals and objectives, which include enhancing dune function as stated on page 2-3 of the DEIR Project Description.

The proposed structures requiring routine maintenance such as gated culverts and the north-south aligned set-back berm are located no less than approximately 1,000 feet from the current wave slope and on the NRCS Wetland Reserve Easement. The scale of the figures presented in the DEIR may not clearly define this distance.

Response to Comment 1-3

Recommendation (3) include design elements such as sinuosity, off-channel habitat, inset floodplains, and large wood structures to enhance riparian and aquatic habitat upstream of the tide gates in Russ Creek

Approximately 1,500 feet of Russ Creek upstream of the proposed gated culverts on the NRCS Wetland Reserve Easement will be restored and new riparian habitat established. As the design advances, adding additional sinuosity, off-channel habitat and/or large wood structures will be considered while balancing sediment transport and flood reduction objectives. Restoration of Russ Creek outside of the NRCS Wetland Reserve Easement is not proposed as part of the project.

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July 10, 2023

Jill Demers, Executive Director
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RE: Comments on Draft Environmental Impact Report (DEIR) for "Russ Creek and Centerville Slough Restoration Project" near Centerville, Humboldt County (SCH No. 2022040559)

Dear Ms. Demers:

Thank you for soliciting input from the California Coastal Commission (Commission) staff on the above-referenced environmental document. We received the public notice for the draft document on May 26, 2023. Our office is familiar with the project site, having visited the properties several times, reviewed and commented on the previous Eel River Estuary Preserve Ecosystem Enhancement Project proposed 2016, and through our processing of at least a dozen permits and waivers on the subject properties over the past dozen years. In addition, our office still has multiple pending incomplete applications on file for development on the subject properties, including an incomplete CDP application from The Wildlands Conservancy (TWC, CDP Application No. 1-17-0328) for the Eel River Estuary and Centerville Slough Enhancement Project (for which the Commission approved an application fee waiver request in 2017) and an incomplete Vested Rights Claim application from Russ Ranch and Timber Co., LLC (VRC Application No. 1-10-038-VRC) for routine maintenance operations of various drainage ditches, levees, tide gates, crossings, and other features.[1]

As noted in the DEIR, the project involves development in the coastal zone, which requires a coastal development permit (CDP). Portions of the project may fall within the CDP jurisdiction of Humboldt County, though the majority of the project area is in the Commission's retained CDP jurisdiction. Where a project area bisects multiple CDP jurisdictions, if requested by the applicant and the County and agreed to by the Commission's Executive Director, the Commission has the authority to process a single consolidated CDP application for the project, using the Coastal Act as the standard of review. The DEIR also notes that a federal consistency determination (CD) may be required instead of a CDP. Where there's a required federal permit to conduct an

[1] We request the applicants formally withdraw these applications if no longer proposed due to the current proposed project.

activity affecting any land or water use or natural resources in the coastal zone, a CDP may serve as the Commission's review of a project under the federal Coastal Zone Management Act (CZMA). If the project is a federal project being undertaken by a federal agency with primary responsibility for implementing the project activities, a CZMA CD may be appropriate in lieu of, or in some cases in addition to, a CDP. Whether a CDP and/or CD is required is determined on a case-by-case basis and should be discussed with Commission staff. The standard of review that the Commission will apply to its evaluation of the proposed project in either case is consistency of the proposed development with the Coastal Act chapter 3 policies.

We offer the following comments regarding project itself and the content of the DEIR and supporting appendices, and we look forward to reviewing and providing more detailed feedback on the project during the CDP and/or CD application review process.

General Comments on Proposed Project

The project summary states the project would enhance existing tidal wetlands and restore marginal diked pastureland to a mosaic of natural habitats, including estuarine and tidal slough channels, freshwater streams, and agricultural pastures, all within the context of promoting the resilience of the project area and viability of adjacent agricultural lands outside of the project area. The project's principal goals of restoring and enhancing habitats for native fisheries and aquatic species, restoring coastal dunes, enhancing agricultural productivity, and increasing public access and recreation opportunities are laudable and largely aligned with the fundamental goals of the Coastal Act's resource management policies to protect and restore where feasible coastal resources, maximize public access and recreation, and address sea-level rise in project planning. However, we have some concerns with the proposed project and suggest additional analyses and consideration of additional alternatives:

1. <u>Proposed Realignment of Centerville Slough</u>

The project proposes to abandon the historic alignment of Centerville Slough as a tributary to Cutoff Slough and the Salt River. Centerville Slough's newly proposed alignment tracks north through the "inner marsh" and "outer marsh." The EIR should evaluate in more detail the permanent conversion of marsh habitat to aquatic habitat, the exposure of these areas to more rapid conversion and inundation via sea level rise, and the loss of aquatic habitat resulting from the abandonment of the remnant Centerville Slough channel. 2-1

Because the proposed project appears to abandon the historic and remnant Centerville Slough and Cutoff Slough channels, the EIR should evaluate the likely aggradation and ultimately infilling of this aquatic habitat. The EIR should analyze what effect the proposed revisions would have on existing conditions or habitat quality resulting from this realignment. Furthermore, the EIR should analyze the sustainability and stability of the proposed Centerville Slough channel considering its proximity to the dunes and its direct connection to the mouth of the Eel River.

In addition, the EIR should evaluate the extent to which the abandonment of this historic alignment will reduce the sustainability of the Salt River Ecosystem Restoration Project, which depends in large part on tidal prism to maintain channel form and to reduce maintenance costs resulting from channel aggradation. The EIR should also examine whether the proposed new alignment of Centerville Slough would adversely affect the use of the Salt River by salmonids and whether this proposed reconfiguration would affect channel stability of the Salt River. 2-1

While we agree that the proposed project will enhance tidal prism, we are concerned that the project proposes to relocate the alignment of the entrance of Centerville Slough to the mouth of the Eel River rather than within its historical alignment into the lower Salt River. During the Commission's review of the project, findings must be made that the project's proposed diking, dredging, and filling activities (evaluated under Coastal Act section 30233) and "substantial alterations of rivers and streams" (evaluated under Coastal Act section 30236) constitute "restoration" and "fish and wildlife habitat improvement" purposes (respectively), and it's unclear that those findings can be made. The EIR should confirm that velocities within the entrance to proposed Centerville Slough would permit passage of juvenile salmonids.

2. <u>New Setback Berm Alignment</u>

Except for the portion of the berm on the east side of inner marsh to be elevated, most of the 4-mile-long berm would be a new structure built on top of existing estuarine (including brackish marsh, muted tidal, and brackish pasture) wetlands. The EIR should explain the rationale for the proposed siting and design of the new berm under the proposed alternative (other than its intent to be sited within the confines of the NRCS easement area) and how this alternative could be considered the least environmentally damaging feasible alternative with respect to wetland fill under section 30233 of the Coastal Act. Extensive areas within the vicinity of Angels Camp Marsh and northward have already (in recent years due to ocean wave overwash) been naturally converted to estuarine marsh and aquatic habitat, and the project as proposed would install a berm either immediately on the edge of or in some cases westward (seaward of) of a portion of these existing natural estuarine wetlands as well as directly through them in some areas. Thus, the project would reclaim and convert hundreds of acres of existing wetlands classified as estuarine to agricultural uplands subject to beneficial reuse of sediment, inconsistent with Coastal Act section 30233. The Commission has in past CDPs and CDs authorized new setback berms for restoration purposes, which have provided benefits to surrounding agricultural lands (e.g., Riverside Ranch, lower Jacoby Creek estuary restoration on Arcata Bay, and others). These tidal restoration projects have restored to tidal function significant expanses of diked former tidelands (farmed freshwater wetlands) by breaching dikes and building new setback berms to prevent existing structures and critical infrastructure inland of dikes from flooding and/or to protect remaining agricultural lands inland of the new berms. In past cases, dikes have been located on farmed wetlands. But this project is different in that it proposes a new agricultural dike within and bifurcating in part an estuarine area that already has been tidal for some time or more recently has converted back to tidal habitat since wave 2-2

overwash events over the past 20+ years. Essentially, portions of the new setback berm would function as an ocean-front "seawall"-type structure built along an existing estuary for the purpose of reclaiming and protecting agricultural lands. Such structures alter natural shoreline processes and are generally disallowed under the Coastal Act. 2-2

3. Limits of Creek Restoration

Although the project includes realignment and restoration of 1,500 feet of Russ Creek, restoration is limited to areas within the TWC property boundary, and no restoration is proposed along Shaw Creek. Added beneficial measures upstream from the TWC property and NRCS easement boundaries could include buffering of creek banks from cattle grazing to minimize the contribution of related water quality impacts to downstream restoration areas and planting riparian habitat along the creek reaches that fish will be able to access through the proposed new fish-friendly gates. Expanding creek restoration to include areas upstream of the property/easement boundaries would align with the project's overall restoration goals of increasing habitat for salmonids and other sensitive aquatic species within the restored project area reach. 2-3

Alternatives

We recommend the EIR evaluate alternative project designs that address the above project concerns, including, but not limited to: (1) alternative restoration alignments for Centerville Slough that maintain its connection with the Salt River, ensure the preservation of historic and remnant Centerville Slough and Cutoff Slough channels, and promote sea level rise resiliency not only for agricultural lands but for the primary restoration elements of the project; and (2) alternative setback berm alignments that reduce the amount of wetland fill (especially fill in estuarine habitats), avoid reclamation of hundreds of acres of existing estuarine (largely brackish marsh) habitat, and potentially increase wetland and creek restoration opportunities and provide greater resiliency to sea-level rise by being located further inland. 2-4

Additional General Comments

1. Baseline Conditions

The DEIR throughout includes general descriptions of the project setting and baseline conditions. Although the DEIR acknowledges that "historic" anthropogenic actions altered the project area and its hydrology, few details of the scope of more recent and current maintenance activities are presented. There is reference (e.g., in Table 3-1) to project area maintenance occurring prior to project construction, though it's unclear what entails the full extent of maintenance activities included in that scope. There is discussion of a drainage easement established in 2008 that allows grantees to perform certain drainage maintenance functions (e.g., removal of sand and sediment from the western drainage ditch and maintenance of tide gates and dikes) to the extent that such actions are legally permissible, but details on those maintenance activities and whether associated permits are in place are lacking. Similarly, it remains unclear to what extent certain infrastructure such as elevated berms and ranch roads and even Cutoff Slough tide gate are baseline conditions in the context of having obtained necessary permits 2-5

(the DEIR states that the existing Cutoff Slough tide gate was “replaced” in 1979, but it’s not clear that CDP or CD authorization for that tide gate replacement work was ever obtained).

To increase understanding of what is considered baseline based on legally permitted infrastructure and ongoing maintenance actions (and how the project will affect baseline conditions based on the impact analyses), we recommend the EIR describe more fully the current/ongoing anthropogenic actions that have contributed in part to baseline conditions [e.g., levee/berm maintenance and new construction (e.g., from dredge spoils placement), tide gate repairs, creek and ditch channel dredging, channel realignments, etc.]. 2-5

Importantly, the EIR should make clear how brackish wetlands and aquatic habitat that apparently are proposed to be reclaimed for agriculture are evaluated in the context of baseline conditions, what habitat conditions they are currently providing (e.g., to migratory birds), and what assumptions are made with respect to habitat conversion.

2. Upland Delineation

The DEIR relies on an assumption that certain areas dominated by FAC-ranked plants that lack evidence of hydric soil or wetland hydrology indicators are “three parameter uplands,” and the FAC-dominated vegetation in these areas should not be considered indicative of wetland conditions, because the plants are not actually growing as hydrophytes. This assumption affects some of the calculations in the impact/mitigation tables presented in the DEIR (and related Appendix C). The description of hydrology methodology is confusing but seems to suggest that upland delineations were based largely on data collected 8-10 years ago during drought conditions. Given the outdatedness of the older data collected during drought, it’s unclear why in some cases it was relied upon to override more recently collected data in 2021-2022 during a period of more typical rainfall. While we note that acreage of delineated uplands decreased with the more recent delineations, it remains unclear that the proposed delineation relies on sufficient evidence to rebut the presumption of wetland hydrology in areas dominated by FAC-ranked vegetation. The EIR should elaborate on its relied upon wetland hydrology analysis to demonstrate that hydrology is absent in areas dominated by hydrophytic vegetation classified as “three parameter uplands.” 2-6

3. Wetland Mitigation

As proposed, mitigation for wetland fill impacts from the proposed new or improved setback berm (the construction of which will result in fill exceedance over the area of wetlands to be created by lowering the existing dike separating the outer and inner marshes) will be provided by converting agricultural uplands within the project area to wetlands that will continue to be used for agricultural purposes of presumably lesser productivity. The agricultural wetlands identified for mitigation appear to be an area that is both historical upland habitat and an area of high agricultural productivity. The EIR should evaluate whether the proposed conversion of highly productive agricultural land is suitable for wetland mitigation. 2-7

The EIR should also evaluate if the proposed mitigation will adequately compensate for the specific types of wetlands to be lost/converted. We recognize that wetland mitigation opportunities are limited on the properties, and we understand the rationale in proposing to create agricultural wetlands of higher function and value than the impacted wetlands for impacts to farmed wetlands from the berm placement. However, in this case the impacted wetlands, according to the DEIR information, are largely estuarine in nature (some in the process of converting back to estuarine function). The primary purpose of the wetland mitigation should be wetland restoration (vs. agriculture) that adequately compensates for the types and amounts of impacted wetlands, and which provides similar or greater habitat functions and values as the impacted wetlands. Normally the Commission requires mitigation ratios greater than 1:1 to account for the anticipated temporal loss of wetland area and function between the timing of impact relative to timing of mitigation as well as to account for the uncertainty of success associated with the proposed wetland mitigation project. We recommend the EIR consider alternative mitigation options (including alternative locations for mitigation) if additional mitigation is necessary. Any wetland mitigation proposal should be informed by a detailed wetland mitigation monitoring and reporting plan. 2-7

4. Monitoring and Maintenance

The MMP (Appendix D to the DEIR) proposes various activities, including removing sediment from restored channels over time and placing excavated sediments on surrounding wetlands. Under the Coastal Act, placement of fill material in wetlands is allowed only for certain specified uses. Although statements such as “Sediment reuse on wetland areas would only occur if wetland function would be unimpacted and the purpose of the reuse is to promote habitat restoration and/or sea level rise resiliency for habitat diversity purposes” are included, under the Commission’s review process any proposal for wetland diking, dredging, and filling activities as part of the main project construction or during the post-construction monitoring and maintenance phase will need to demonstrate that sediment placed in wetlands is allowable under Section 30233 of the Coastal Act and willrequire development of site-specific restoration and monitoring plans, consideration of alternatives to wetland diking/dredging/filling, a description of feasible mitigation measures to minimize adverse environmental effects associated with any authorized diking/dredging/fill placement for restoration purposes (sea level rise resiliency is not an allowed use for wetland fill under the Coastal Act), and demonstration through monitoring that the functional capacity wetlands will be maintained. 2-8

The MMP describes post-construction project performance monitoring as consisting of NRCS performing an annual desktop review of certain documents and imagery and a general qualitative annual onsite inspection. To ensure that the project achieves the restoration goals and objectives set forth in DEIR section 2.3 and elsewhere in the document with respect to enhancement of native plant and aquatic habitats and no net loss of coastal wetlands, a detailed post-construction habitat restoration monitoring and reporting plan (prepared by a qualified biologist) should be developed that includes measurable (quantitative) performance standards to be monitored for at least five years

by a qualified biologist and to be reported to permitting agencies annually for review that will assure achievement of the project restoration goals and objectives, including, but not limited to, expansion of rare plant habitat, improved access to the restored project reach by salmonids and other native aquatic life, continued use of the restored habitats by populations of sensitive birds and amphibians that currently are known to occupy wetlands and dunes in the project area, and persistence of ecological function of proposed restored wetlands, dunes, and waters in the project area. We also recommend the habitat restoration and reporting plan include provisions for site remediation if monitoring results indicate that the site is not meeting the goals, objectives, and performance standards identified in the final approved plan. 2-8

Comments on Impact Evaluations

Aesthetics

This section does not include an evaluation of (1) the historic barns or the impact that their proposed demolition would have on scenic vistas in an area accessible to the public, or (2) the proposed new berm segments that would be visible from Centerville Road and Centerville Beach (e.g., the southernmost segment of new berm proposed). We recommend the EIR analyze these visual changes. 2-9

Agriculture Resources

Related to the comments above regarding locating the wetland mitigation site within a productive agricultural upland, there may be conflicts with siting wetland mitigation at this location and the Coastal Act limitations on conversions of agricultural lands to non-agricultural uses. We understand that as proposed the wetland mitigation area would be maintained in agricultural production and therefore may not be considered a conversion. However, as discussed above, this proposal conflicts with the Commission's typical mitigation requirements that require the primary purpose of wetland mitigation to provide appropriate and sufficient compensation for impacts based on the specific types and amounts of impacted wetlands. As recommended above, the EIR should consider other mitigation options if additional mitigation is necessary.

In addition to these issues, please also reconsider the assumptions and analyses in this chapter to address the following: 2-10

- The DEIR assigns a 0 lb/acre value to converted farmland. Similarly, Angels Camp is described as "devoid of agricultural productivity, capacity or potential" due to wave overwash and conversion. It therefore is unclear why the project proposes to install a new setback berm within this area – presumably to "reclaim" valuable agricultural land that has no "potential." The EIR should clarify the assumptions made about specific areas within and adjacent to the project footprint and provide evidence to support the assumptions and projections made in the DEIR.

- In the context of wave overwash and habitat conversions, the DEIR (page 3.2-6) states "…*absent dune stabilization and planned retreat planning for the future,* 2-11

future agricultural productivity in the study area appears to be threatened." This discussion does not acknowledge that dune stabilization, via the planting and proliferation of *Ammophila*, may be a contributing factor to the avulsions that have occurred. The EIR should explain where appropriate how stabilization will not adversely impact dune habitat. 2-11

- The DEIR discusses agricultural productivity, factors used in determining productivity, and changes in productivity valuation that occurred in areas where wave overwash caused a modification in habitat (resulting in a decrease in agricultural productivity). The DEIR acknowledges that certain assumptions about productivity were made in certain areas due to a lack of data. Although various other factors were considered, the DEIR does not explain how or to what extent those factors influenced productivity (e.g., many of the considered factors are conceivably dominant factors, such as prolonged inundation with freshwater). The EIR should explain with site-specific examples how and to what extent various factors have influenced productivity. In addition, it's confusing that the analysis assigns the same valuation to all "other areas that did not transition to another habitat type due to wave overwash" as the valuation presented in the 2016 agricultural analysis. The EIR should present the findings of the two analyses in an "apples to apples" format to ensure the veracity of this comparison. 2-12

- The agricultural analysis assumes the value of hay to be $150/ton. The EIR should provide a valuation that averages the cost of hay over differing years and that reflects the increasing value of this crop in an era of cyclical drought and increased demand. 2-13

- The DEIR assumes that isolation of agricultural land east of the new berm from wave overwash alone will dramatically increase productivity on those agricultural lands. The EIR should explain this anticipated improvement in productivity and how it would not be compromised by factors such as groundwater intrusion from saline water sources, ponding, channel avulsion, and other factors. 2-14

- There is an assertion that the productivity of the proposed wetland mitigation area "*is not anticipated to significantly change post Project due to the freshwater nature of the proposed wetlands and similar rate of growth of pasture grasses under existing and proposed conditions and proposed to be grazed as currently is occurring*" (pgs. 3.2-22-23). The premise under the DEIR analysis in this chapter is that by creating a new setback berm, agricultural productivity will rise dramatically by hundreds of pounds per acre, yet converting the highest productivity pasture in the project area to freshwater wetland for mitigation purposes will not affect productivity. The EIR should explain this paradox and describe how the conversion of this area will not adversely impact productivity levels. 2-15

Biological Resources

In addition to comments above (related to slough realignment from the Salt River to the Eel; potential impacts to existing aquatic habitats that are likely to aggrade; assumptions of project benefits to fish that are not fully substantiated; concerns with the upland delineation; concerns with the amount of wetland fill and its placement in an existing estuary; concerns with the location and adequacy of the wetland mitigation; concerns with project sustainability and resiliency to SLR; and concerns related to habitat mitigation and monitoring), please also reconsider the biological resources assumptions and analyses to address the following:

- The EIR should analyze how locating the discharge of Centerville Slough at the mouth of the Eel River may increase velocities there and impact the existing harbor seal pupping area in the vicinity as well as promote (or prevent) fish passage into the estuary due to high velocities at the mouth. 2-16

- Where the EIR asserts fish passage benefits, it should explain the benefits in the context of quality and extent of habitat that access will be provided and should consider existing areas accessible to fish that may be impacted by the project. 2-17

- The proposed repairs to Cutoff Slough tide gate make no provision for fish passage or improvement of tidal exchange. While the DEIR mentions capture of coho during 2014-2016 monitoring of the Salt River and Riverside Ranch areas (pg. 3.4-39), no improvements are proposed in this area upstream. And while the DEIR in several places asserts that the proposed repairs will reduce leakage, it does not address the potential impacts to fish passage caused by this activity. Also, as mentioned, the proposed abandonment of the historic and remnant Centerville and Cutoff Slough channels will likely lead to aggradation and ultimately infilling of existing historic salmonid habitat. 2-18

- We appreciate that the project proposes to control invasive *Spartina* prior to construction using various methods. While the project also proposes to control *Spartina* post-construction in compliance with the permitted regional *Spartina* eradication plan and the associated EIR, note that the CDP term for *Spartina* removal under that Plan ends in 2025. Given that other nearby restoration sites (namely Riverside Ranch) have shown rapid conversion to *Spartina* marsh within just a few years of restoration, it should be expected that the proposed restoration area will be similarly dominated within a short period. This would affect the presumption that rare plants such as Humboldt Bay owl's clover will proliferate as much as anticipated to compensate for the direct impacts to rare plants caused by project construction and associated habitat conversions. The EIR should provide assurance that the performance targets identified can be met for a reasonable period of time assuming full dominance of marsh by *Spartina* within a short period. 2-19

- MM-BIO-7 proposes to avoid and buffer beach layia plants from the proposed from haul route impacts, or, if plants cannot be avoided, to employ a relatively elaborate 2-20

and at this point undetermined mitigation process involving either collecting seeds and scattering them in nearby areas, or growing plants out in a nursery and replanting in "a stable portion of the Project Area," or relocating plants, and/or preparing an SSMP that will figure out the mitigation details at a later time in consultation with the USFWS. It's unclear whether any of the proposed mitigation options would be successful for this federally listed annual plant. Another mitigation option not suggested is *Ammophila* removal, which we recommend be added as an option. We recommend mitigation details be better defined in the EIR to provide assurance that mitigation will be successful to fully mitigate for impacts. 2-20

- Impact BIO-2 finds that there will be no net loss of riparian habitat since 2.3 acres will be converted, but 2.8 acres will be planted along Russ Creek. This evaluation does not account for temporal loss and the time it will take for the planted riparian community to achieve the same level of maturity and function as the habitat to be lost. We recommend adding mitigation to increase the riparian planting at a higher ratio to account for this temporal loss. Any restored riparian should be buffered from cattle and other agricultural uses. 2-21

- MM-BIO-8 states that if "high quality" dune mat cannot be avoided, it will be mitigated at a 1:1 ratio, but there is no description of mitigation or of "high quality dune mat." We recommend that all dune mat, not just "high quality," be appropriately mitigated. We also again recommend considering removal of invasive *Ammophila* or other meaningful mitigation strategies. Consider expanding the scope of MM BIO-9 to add *Ammophila* removal as mitigation for impacts to sensitive listed species and habitats (beach layia and dune mat). 2-22

- With respect to impacts of the project on tidal wetlands, Impact BIO-2 finds that "*Project activities are anticipated to result in a net increase in tidal wetlands with the reintroduction of tidal influence south of the existing levee*." However, Table 3.4-7 shows that the project will actually reduce tidal habitats in the project area by almost 245 acres (considering total changes in Aquatic, Brackish Marsh, Full Tidal Wetlands, Muted Tidal Wetlands, and Brackish Pasture habitats) due to the proposed reclamation and conversion of tidelands for upland pasture use. The EIR should address this significant impact. 2-23

- In the Impact BIO-3 analysis, the DEIR states "*Overall, the Project will result in an increase in tidal wetlands and a reduction in agricultural/grazed wetlands. The change in wetland type is not deemed a significant impact since habitat value will be enhanced in the Inner Marsh and west of the proposed berm through improved tidal prism and associated habitat quality*." Based on the mapping of grazed and "not grazed" lands (Fig. 3.2-4), agricultural/grazed wetlands include brackish marsh, muted tidal wetlands, brackish pasture, freshwater pasture, and open water habitats. The EIR should further elaborate on the habitat values that will be enhanced through these wetland changes and identify assurances that that enhancements will be successful. 2-24

- MM-BIO-10 proposes to mitigate temporary and short-term impacts to permanent, transitional, and seasonal wetlands by seeding almost an acre of uplands with wetland-oriented species (FAC, FACW, and OBL) "*to create one-parameter wetlands in the Project Area. Up to 0.41 acre will be seeded around the margin of the upland pasture and up to 0.44 acre will be seeded on the east side of the new levee*." This mitigation measure should be refined to ensure that the proposed mitigation compensates for the specific types and amounts of wetlands to be impacted. It's also unclear whether the mitigation will be successful, as seeding upland areas (which, by definition, lack wetland hydrology) with wetland plants will not result in the creation of coastal wetlands. The Commission assumes wetland hydrology is present in so-called "one-parameter" wetlands (thus, they're actually two parameter wetlands); if evidence shows the absence of wetland hydrology in so-called "one parameter" areas, then such areas are not actually wetlands under the Coastal Act. The EIR should consider additional mitigation options for this impact to ensure the impact is reduced to a less than significant level. 2-25

<u>Hydrology and Water Quality</u>

In addition to comments above related to slough realignment and potential related impacts to existing aquatic and marsh habitats that are likely to aggrade, please also reconsider the hydrology assumptions and analyses to address the following:

- The chapter discusses how "*The saline groundwater from the ocean and inner tidal areas is denser than the freshwater flowing from the upper reaches, which causes the saltwater to migrate inland and under the Project Area. The saltwater and fresh groundwater meet and mix through advection and dispersion, creating a transition zone in the shallow unconfined aquifer*." Considering this, the EIR should explain how the increased introduction of tidal exchange into the project area will not impact groundwater quality and explain how these trends will or will not impact agricultural productivity assumptions presented elsewhere in the DEIR. 2-26

- It's unclear how the SLR analysis presented on page 3.10-32 relates to the discussion of SLR projections presented on pages 3.10-5 and 3.10-6, because the analysis lacks specificity as to which scenarios/projections are being considered in drawing the conclusion that the proposed system of new levees and rehabilitated levees would prevent flooding, and for how long the flood prevention is expected (stating vaguely "for the foreseeable future"). If the assumptions and conclusions in the analysis are based on certain scenarios and projections listed in Table 3.10-2, we recommend adding that clarification. 2-27

- We also recommend updating the discussion of SLR projections and analysis to follow the Commission's adopted SLR guidance (2018), which recommends consideration of a more precautionary approach than appears to be presented in the DEIR. Consider updating Table 3.10-2 to include SLR ranges from the upper limit of "likely range" (66% probability) to the 1-in-200 chance (0.5% probability) 2-28

and supplement the discussion in the SLR analysis to consider a range of possible changes and sea level rise risks to inform conclusions on impacts and mitigation. 2-28

- The Coastal Act requires that projects be sited and designed to minimize hazard risks, and as discussed above, we recommend the EIR evaluate certain project alternatives that may provide greater resiliency to SLR for the restoration components of the project. In any case, the Commission's SLR guidance recommends that while projects need not be designed in all cases for the local hazard conditions that will result from higher-projected sea level rise scenarios, projects should plan for adaptation pathways and mitigation measures if conditions change more than anticipated in the initial design. 2-29

- The Impact HWQ-6 discussion should be expanded to consider potential impacts to drainage and sedimentation rates within the Salt River. 2-30

<u>Recreation</u>

- The analysis should be revised to recognize that existing conditions at the Eel River Estuary Preserve (ERAP) enable the public to access the beach for recreational purposes. The DEIR does not discuss the fact that the proposed development will terminate this access and prohibit the public from accessing the beach. Because the impact is not discussed, no finding of significance is made nor is any mitigation offered. Centerville Beach is frequently subject to the same overwash events the project area experiences and is of decreasing utility in the context of sea level rise. There are no other nearby sites to access the beach other than Ocean Ranch across the Eel River several miles to the north. 2-31

- Page 3.14-4 erroneously states that the Commission issued a CDP in 2021 for an increase in public access to three days per week. Because TWC has not yet obtained authorization from the Commission for new or increased public access on the site as was obtained for the portion of the property within the County's jurisdiction, consider revising the assumption that three days per week visitation is the appropriate baseline for the recreation analysis and updating related estimates and the environmental impact evaluations in the recreation analysis. 2-32

Thank you for considering these comments. We look forward to engaging further on the project during the CDP and/or CD application review.

Sincerely,

Melissa Kraemer
North Coast District Manager

2.2.2 Letter 2 – Response to Coastal Commission Comments

The HCRCD worked with USFWS, NRCS, and landowners to develop a balanced design that protects coastal resources and maximizes restoration opportunities within existing constraints in a complex environmental setting, which include the protection of agricultural resources. The HCRCD appreciates the Coastal Commission's comments and has directly addressed key points. The HCRCD looks forward to continued discussion with Coastal Commission regarding these technical details as the Project moves beyond CEQA into the permitting phase and as the design progresses.

Response to Comment 2-1

Realignment of Centerville Slough

Centerville Slough outlet alignment alternatives are discussed on page 22 of the Hydraulic Design Report (USFWS 2022), as referenced in the DEIR. The Hydraulic Design Report has been provided as errata as Appendix A to this Final EIR. The analysis determined that restoration of Centerville Slough would increase the diurnal tidal prism entering Cutoff Slough by 580 acre-feet over existing conditions. The existing channel segments between the Cutoff Slough tide gate and the Salt River, and the segment between the Salt River-Cutoff Slough confluence to the Eel River do not have the channel size capability to transmit the additional tidal prism. Introducing the restored Centerville Slough tidal prism into Cutoff Slough would result in increased water levels in the Salt River and cause increased flooding of properties adjacent to the Salt River. The project will not decrease the current tidal prism in Cutoff Slough or Salt River drainage.

Response to Comment 2-2

New setback berm alignment

The location of the proposed berm has been aligned over either an existing berm or on land that is currently used for agricultural grazing. The berm alignment will allow restoration of full tidal exchange in the Angels Camp area, improving the ecological function from the current conditions that have resulted from infrequent dune overwash events and former drainage maintenance. The berm alignment will also protect agricultural resources consistent with the Balancing Provision and Agricultural Preservation policies within the Coastal Act, which were seemingly not referenced in this comment but should be considered. Also, see response to comment 2-4 of berm alignment alternatives.

Response to Comment 2-3

Limits of creek restoration

While the restoration of Shaw Creek and Russ Creek beyond the NRCS easement boundaries would be consistent with the Project goals, it is not proposed as part of the Project.

Response to Comment 2-4

Alternatives

Alternative alignments of Centerville Slough that maintain connection with Salt River were assessed and determined to have potential flood impacts to properties along Salt River (see Response to Comment 2-1). Alternative set-back berm alignments were assessed. The proposed alignment considered the following: maximizing setback distance from the shoreline while remaining on the NRCS Wetland Reserve Easement; maximizing use of existing berm footprints and upland areas to minimize wetland fill; maximizing estuarine habitat by restoring full tidal exchange and protecting productive agricultural land to remain consistent with Williamson Act and Eel River Area (LCP) Plan policies.

Response to Comment 2-5

Baseline conditions

The first part of this comment does not comment on the analysis in the CEQA document, please see Master Response 1. This comment mainly relates to previous permitting with the Coastal Commission and likely will influence future permitting with the Coastal Commission.

The last part of this comment relates to reclamation of agriculture land and habitat conversion. In Section 3.2 (Agricultural Resources), there is a detailed analysis of agriculture reclamation and productivity. In Section 3.4 (Biology), there is a detailed analysis of habitat conversion, pre- and post-Project. Assumptions for agriculture productivity and habitat conversion pre- and post-Project are included in these sections.

Response to Comment 2-6

Upland delineation

Hydrology is a driving factor for the development and maintenance of wetlands. Facultative dominated plant communities on the Northern California coast, many to most times do not exhibit wetlands hydrology nor hydric soils. Facultative plants have an equal probability of occurring in wetlands or uplands and their presence (dominance) does not typically correlate with wetlands hydrology and hydric soils (most time these communities lack wetlands hydrology and hydric soils). They exist and dominate in these coastal environments because of cool summer temperature and soils with high water holding capacities (and in some cases soils with iso-mesic temperature regimes). Most of these dominant facultative species are non-native and highly invasive. Many of these “one parameter” wetlands converted to three parameter wetlands from when they were first mapped (2009-2015) as compared to the current mapping done in 2021-2022.

Response to Comment 2-7

Wetland Mitigation

An upland area is needed for wetlands creation, thus the areas shown for upland to wetlands creation on the easterly portions of the property are appropriate to offset wetlands impacts. Please see Response to Comment 2-15 for a response on post-Project agriculture productivity of this area.

Response to Comment 2-8

Monitoring and maintenance

Sediment reuse on restoration projects is accomplished in many ways, one of which is to spread thin layers of sediment over existing wetlands. Many of the wetlands that will have a thin layer of sediment applied are agricultural or tidal wetlands. These wetlands, once a thin layer of sediments is applied, will still have the same function as they did prior to spreading sediment. They will still be three parameter wetlands with the same plant assemblages and function.

With regard to post construction monitoring of these areas, five years of monitoring is not considered necessary to confirm success. The applicant will coordinate with the Coastal Commission to determine the appropriate type and durations of any post construction monitoring during the upcoming permitting phase.

Response to Comment 2-9

Scenic vistas

A scenic vista can generally be defined as a view that has remarkable scenery or a broad or outstanding view of the natural landscape. These conditions do exist at the Project Area and in the surrounding area and include pasture (grazing) land, tidal salt marsh, brackish marsh, riparian areas, sloughs/open water

channels, freshwater ponds and nearshore dunes. Impact AES-1 describes the short-term construction impacts, which would include berm construction and barn demolition.

As described in Section 3.5.6, the North and South Barns are not considered historic resources eligible for listing on the California Register of Historic Resources nor historic properties eligible for listing on the National Register of Historic Places. Neither barn is in use, and they are in poor condition. The South Barn sustained substantial damage after a winter storm. Per CEQA guidelines, neither barn is considered an aesthetic resource. Therefore, the proposed demolition of the barns will not impact a scenic vista under CEQA.

The berm is designed similarly to other existing berms within and surrounding EREP, therefore the change would look very minimal or nonexistent from public areas. As described in Impact AES-3, the Project would be comparable to existing visual character conditions (agricultural, rural, open space, natural resources) and would not substantially change views of or from the Project Area. The berms would be visually inconceivable from adjacent properties and Centerville Road due to the distance, existing vegetation and height similarity to other berms and land formations.

Response to Comment 2-10

Berm location and agricultural productivity

Angel's Camp marsh is located west of an existing berm (see Figure 2-4) which shares the same alignment as the proposed berm (see Figure 2-5). Under existing conditions, some areas within and adjacent to Angels Camp contains some productivity (approximate 225 lbs/acre). The area west of the proposed berm produces 750 lbs/acre under existing conditions and the proposed berm is sited to protect the agricultural productivity of this area. The purpose of the berm is to separate restored tidal wetlands from agricultural uses and increase the resiliency of both relative to coastal processes and sea level rise.

Response to Comment 2-11

Dune stabilization

Per Section 2.3 of the Project Description, a specific objective of the Project is to enhance native plant communities and expansion of rare plant habitat through active and passive habitat development, control and eradication of invasive non-native species, and establishment of native species.

The dune overwash events in the Project Area are dissimilar to the impact of *Ammophila*, as they relate to regional trends of shoreline migration. Enhancement of the back dune berm (see Project Description Section 2.5.6) is necessary to restore estuary drainage and function in the Project Area. Once implemented, the back dunes would continue to be an evolving dynamic dune habitat as sand would be passively accumulating and shifting through natural ecosystem processes over time. Per the habitat conversion analysis, the Project will result in an additional 6.9 acres of new Dune Mat habitat. Native dunes species would be planted along with the construction of sand fencing to prevent migration inland, which is necessary to support drainage functions in the estuary. Any potential impact associated with the impact of the back dunes on environmental resources would remain less than significant.

Response to Comment 2-12

Agricultural productivity factors

In the DEIR, productivity is a measure of species composition considered palatable to animals (i.e. forage) and forage quality. A driving factor determining plant composition is length of inundation and type of inundation (freshwater vs salt water). The DEIR considers inundation as the dominant factor of productivity because it (predominantly wave overwash and leaking tidegates) has had an enormous impact on the

landscape and plant composition. Other less dominant factors of productivity include grazing management, such as length of time in paddocks, potential pooling from hoof compaction, and potential presence of invasive species (however the presence of invasive species wouldn't result in saturated soils). The areas where species composition had shifted following wave overwash events were re-evaluated in terms of productivity. The other areas of the Project Area where wave overwash did not inundate or directly affect land use retained the same productivity values as 2016 because a substantial change in land uses was not observed.

Response to Comment 2-13

Value of hay

The value of hay is highly volatile as a commodity product and is considered an average price for the purposes of the DEIR analysis.

Response to Comment 2-14

Agricultural productivity improvement

As stated in the Maintenance and Monitoring Plan (included in the DEIR as Appendix D), the Project lifespan is considered to be 20-25 years. Following Project implementation, the productivity is not expected to substantially deviate from what is presented as anticipated conditions. The DEIR makes no claim that the Project would improve productivity in perpetuity, rather that it would improve productivity over the course of the Project lifespan. Groundwater intrusion from saline water sources, ponding and channel avulsion are not expected to be major inhibitors of productivity.

Response to Comment 2-15

Wetland mitigation area agricultural productivity

The productivity of the wetland mitigation area is expected to change, however is not anticipated to change substantially. The area would become freshwater wetlands, and the productivity of adjacent freshwater wetlands is what is depicted in Figure 3.2-6.

Response to Comment 2-16

Centerville Slough discharge velocity biological impacts

As described in USFWS 2022 (provided as errata in Appendix A), the San Francisco Bay guidelines were used in sizing Centerville Slough tidal channels which limit velocities to less than 3 feet per second; therefore, the size of the tidal channel should not be an impediment to fish passage. Any changes in the morphology of the river mouth are not anticipated to be any different than recent seasonal changes. Seals within the vicinity currently experience those changes due to the dynamic mouth morphology. The Project will not change the rate or magnitude of the change that the seals currently experience, as the distance from the Project Area to haul out zones in the estuary is sufficiently far to null any potential impact related to noise or other disturbance.

Response to Comment 2-17

Fish passage benefits

One of the project objectives is to "Improve access to restored aquatic habitats for salmonids and other aquatic-dependent species by increasing migratory access between estuarine and inland waters and by restoring overwintering and rearing habitat for juvenile salmonids." A key goal of the Project is to increase the area of tidal influence and improve passage for aquatic organisms, including crustaceans, salmonids

and other fish characteristic of tidal portions of the estuary. This would occur by reintroducing tidal exchange to the Inner Marsh and re-establishing Centerville Slough with a new gated culvert structure constructed through the new dike on Russ Creek and Shaw Creek. The Project would provide a significant improvement to fish passage over existing conditions, which provides no passage at any time. The project will not permanently impact any current fish habitat or fish passage. Any temporary impacts to fish are addressed in full under Mitigation Measure BIO-1 and Mitigation Measure BIO-5.

Response to Comment 2-18

Cutoff Slough tide gate fish passage and tidal exchange

Per Project Description Section 2.5.7, tide gate replacement and structural retrofits will improve fish passage. The gate replacements will include a combination of both top- and side-hinge style gates that are generally desirable for aquatic organism and debris passage. The improvements will allow the gates to be open more to allow fish passage.

The restoration plan will not abandon any channels and will not significantly alter the tidal flows in Cutoff Slough or Salt River Slough (USFWS 2022). By maintaining similar flows, no additional scour or sedimentation is anticipated. Cutoff Slough and Salt River Slough channels are primarily maintained by tidal flows rather than upland flood flows.

Response to Comment 2-19

Rare plant performance targets

TWC is presently and actively managing for Spartina within the Project Area. Mitigation Measure BIO-9 (Mitigate Impacts to Sensitive Listed Habitats Through Control of Invasive Species) has been incorporated into the Project to specifically address this issue. The regional Spartina eradication plan specifically requires that site specific management plans come before the California Coastal Commission for approval prior to implementation. Therefore, ongoing management of Spartina within the Project Area will continue to reflect input from the Coastal Commission in the future.

Response to Comment 2-20

Mitigation Measure-BIO-7

Per Section 2.3 of the Project Description, a specific objective of the Project is to enhance native plant communities and expansion of rare plant habitat through active and passive habitat development, control and eradication of invasive non-native species, and establishment of native species. Thank you for the suggestion to add the removal of *Ammophila* to Mitigation Measure BIO-7 (Mitigate Impacts to Beach Layia) to further accomplish this objective. This suggestion has been added to Mitigation Measure BIO-7 via errata. Please see Section 3.2.1 for the updated text.

To ensure protection of Beach Layia, multiple mitigation measure strategies were proposed to maximize success. The required Biological Assessment and Biological Opinion, which will be developed under USFWS consultation under Section 7 of Endangered Species Act, will ultimately ensure this federally listed plant species is protected as required. Any potential CEQA impact will remain less than significant with the incorporation of Mitigation Measure BIO-7.

Response to Comment 2-21

Riparian impacts

The removal of 2.3 acres of riparian scrub is necessary to accommodate the alignment of the restored Centerville Slough. Elevations and ecologically appropriate areas to plant additional riparian scrub are limited; however, the Project will plant an additional 2.8 acres of riparian forest along Russ Creek, providing a net increase of riparian habitat at a ratio of 1.2 (removed to replanted). In general, there are limited areas that are ecologically appropriate and at suitable elevation for additional riparian habitat beyond what is proposed. All planted riparian habitats will be fenced to prevent cattle and other wildlife grazing impacts. Please see Section 3.1.1 for the updated text in the Project Description via errata to clarify this detail.

Response to Comment 2-22

Mitigation Measure-BIO-8

Via errata, the term high quality has been removed from Mitigation Measure BIO-8 (Mitigate Impacts to Sensitive Listed Habitats Through Avoidance and Re-establishment) to require mitigation of all dune mat, regardless of its condition (see Section 3.2.2).

HCRCD agrees that removal of *Ammophila* could be a meaningful mitigation strategy if needed and in areas compatible with the restoration design intent. It has been added to Mitigation Measure BIO-7 via errata. Please refer to comment 2-20 and errata Section 3.2.1.

Response to Comment 2-23

Tidal habitat conversion

The muted wetlands and brackish pasture are a result of infrequent dune overwash that have changed the vegetation composition in the low-lying area. The Project will restore these areas to full tidal exchange to allow an unmuted, full tidal prism to be restored to these areas. The loss of muted wetlands is necessary to accommodate the expansion of full estuarian tidal wetlands.

The existing brackish marsh, muted tidal wetland, and brackish pasture are a result of dune overwash events and leaky tide gates. They are low functioning and invasively dominated areas that are seasonally grazed. These areas will be restored to either full tidal wetlands or productive freshwater pasture, both of which will be more resilient to the coastal setting and future sea level rise.

Response to Comment 2-24

Habitat value enhancements

The wetlands created and restored through the Project will be located in a restored functional estuary environment and therefore will be dynamic through time and generally much higher functioning than present day agricultural wetlands. These restored and created wetlands will create habitat values well above the habitat values of present-day agricultural wetlands.

Per Section 2.3 of the Project Description, a specific objective of the Project is to restore natural functions and processes of tidal cycles, riverine inundation and sedimentation, tidal channel connectivity, and wetlands maintenance by removing or modifying existing infrastructure and reestablishing historic tidal channels. The Project will enhance existing tidal wetlands and restore marginal diked pastureland to a mosaic of natural habitats, including estuarine and tidal slough channels, freshwater streams, and agricultural pastures, all within the context of promoting the resilience of the Project Area and viability of adjacent agricultural lands outside of the Project Area.

Under existing conditions, the historic alignment of the estuary has been redeveloped for agricultural purposes, which severely constrains the possible habitat values. Even if only modestly successful, the implemented Project will substantially increase the habitat value of the wetland mosaic within the Project

Area. However, substantial effort has been put into the design with the support of the USFWS, NRCS, and others to develop a project that maximizes restoration opportunities, long term self-maintaining natural processes, and ecosystem services within the Project footprint.

Response to Comment 2-25

Mitigation Measure-BIO-10

As discussed in Section 3.4 (Biology, page 3.4-58 and 3.4-59), the need to mitigate one-parameter wetlands results from impaction to a road classified as a one-parameter wetland by Mad River Biologists in 2011. Given the area of impaction in question is in fact an unpaved road with poor drainage due to anthropogenic roadway compaction, it is reasonable to assume the quality of the one-parameter wetland function is low. This impaction will be mitigated as noted in Mitigation Measure BIO-10 (Mitigate Temporary and Short-term Impacts to Wetlands Through Construction Minimization and Avoidance Measures) with equivalent or better functioning wetlands achieved. The seeded hydrophytic vegetation will result in a higher quality wetland than the present-day road, exceeding the like for like mitigation preference expected from the Coastal Commission.

Berm aside, upland areas in the Project Area remain low lying in elevation and close to groundwater. Thus, wetland-orientated species (FAC, FACW, and OBL) will do well in the wetland creation area. Per 14 California Code of Regulations (CCR) Section 13544, wetlands are defined as follows:

> *Wetlands shall be defined as land where the water table is at, near, or above the land surface long enough to promote the formation of hydric soils or to support the growth of hydrophytes, and shall also include those types of wetlands where vegetation is lacking and soil is poorly developed or absent as a result of frequent or drastic fluctuations of surface water levels, wave action, water flow, turbidity or high concentrations of salts or other substances in the substrate. Such wetlands can be recognized by the presence of surface water or saturated substrate at some time during each year and their location within, or adjacent to, vegetated wetlands or deepwater habitats.*

The wetland creation area exhibits hydrology, when once excavated, that will be able to support the growth of hydrophytes due to the constructed low lying elevation and seasonal proximity to groundwater and is thus consistent with CCR Section 13544. Actual wetlands will be created and the impact to one-parameter wetlands remains less than significant.

Response to Comment 2-26

Groundwater quality

Saltwater introduction on the west side of berm is not expected to impact agricultural productivity on the east side of the berm. The freshwater input and aquifer gradient conditions on east side of berm will not change due to the Project. Because the gradient will not change, the saltwater is not anticipated to migrate east. Another condition that effects migration is soil permeability. The primary soil types in the Project Area are silts and clays which have a low permeability and hydraulic conductivity, further limiting migration of salt water. Due to those conditions and the low gradient, the potential for migration within the shallow unconfined aquifer is low. Additionally, on the east side of the berm, a proposed inboard ditch will further intercept seepage, preventing salinization of the agricultural pasture rooting zone.

Response to Comment 2-27

Sea level rise analysis

The ranges of years referenced on page 3.10-30 correspond to the water level ranges and probabilities in Table 3.10-2. This is further described in the hydraulic design report developed by the USFWS referenced in the DEIR (USFWS 2022), which has been provided via errata as Appendix A.

Response to Comment 2-28

2018 OPC SLR Guidance

According to the State of California Sea Level Rise Guidance (OPC 2018), based on high emissions the projected sea level rise (SLR) ranges for the Humboldt Bay North Spit tide gauge by 2050 are 1.2 feet (50% probability), 1.5 feet (66% probability), and 2.3 feet (0.5% probability). As stated on page 1 of the Monitoring and Maintenance Plan (Appendix D of the DEIR), the Project life is anticipated to be a minimum of 20-25 years (2050). Using the highest rate of sea level rise (2.3ft) for 2050, much of the existing levees within the Eel River estuary will experience overtopping, however the additional height of the proposed berm will continue to prevent overtopping beyond 2050.

Response to Comment 2-29

Resilient design

Sea level rise was considered in the design development and is aligned with the Coastal Commission's sea level rise guidance, see USFWS 2022 which has been provided as errata via Appendix A.

Response to Comment 2-30

Drainage and sediment impacts within the Salt River

The Project has been designed to avoid impacts to Salt River. This is described in USFWS 2022, provided as errata via Appendix A.

Response to Comment 2-31

EREP beach access

Recreational resources were evaluated per appendix G of the CEQA Guidelines. As described in Section 3.14.6, the Project will not have a significant impact on existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated and is not expected to require the construction or expansion of recreational facilities might have an adverse physical effect on the environment. This project will not impact beach access at Centerville Beach County Park, which is the closest public beach access point. No significant impact would occur under CEQA.

Response to Comment 2-32

2021 CDP

As described in Project Description Section 2.2 and page 3.14-3, TWC obtained a Conditional Use Permit (CUP PLN-16306) and Coastal Development Permit (CDP PLN-13564) from Humboldt County. The CDP approved public access amenities and renovations near the Headquarters Barn. The CUP approved an increase from zero to three days per week that the EREP would be open to the general public.

Page 3.14-4 should state the CDP was issued by Humboldt County, not the Coastal Commission. No other changes are necessary. This has been clarified via errata (see Section 3.4.1).

CALIFORNIA STATE LANDS COMMISSION
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Established in 1938

July 10, 2023

File Ref: SCH # 2022040559

Jill Demers
Humboldt County Resource Conservation District
5630 South Broadway
Eureka, CA 95503

VIA REGULAR & ELECTRONIC MAIL: jillhcrcd@gmail.com

Subject: Draft Environmental Impact Report (EIR) for the Russ Creek and Centerville Slough Restoration Project, Humboldt County

Dear Jill Demers:

The California State Lands Commission (Commission) staff has reviewed the Draft EIR for the Russ Creek and Centerville Slough Restoration Project (Project), which is being prepared by the Humboldt County Resource Conservation District (District). The District, as a California public agency proposing to carry out the Project, is the lead agency under the California Environmental Quality Act (CEQA) (Pub. Resources Code, § 21000 et seq.). The Commission is a trustee agency because of its trust responsibility for projects that could directly or indirectly affect State sovereign land and their accompanying Public Trust resources or uses. Additionally, because the Project involves work on State sovereign land, the Commission is also a responsible agency. On May 26, 2022, Commission staff submitted a comment letter in response to the Notice of Preparation for an EIR for this Project.

Commission Jurisdiction and Public Trust Lands

The Commission has jurisdiction and management authority over all ungranted tidelands, submerged lands, and the beds of navigable lakes and waterways. The Commission also has certain residual and review authority for tidelands and submerged lands legislatively granted in trust to local jurisdictions (Pub. Resources Code, §§ 6301, 6306). All tidelands and submerged lands, granted or ungranted, as well as navigable lakes and waterways, are subject to the protections of the Common Law Public Trust.

As general background, the State of California acquired sovereign ownership of all tidelands and submerged lands and beds of navigable lakes and waterways upon its admission to the United States in 1850. The State holds these lands for the benefit of all

people of the State for statewide Public Trust purposes, which include but are not limited to waterborne commerce, navigation, fisheries, water-related recreation, habitat preservation, and open space. On tidal waterways, the State's sovereign fee ownership extends landward to the ordinary high-water mark as generally indicated by the mean high tide line (MHTL), except for areas of fill or artificial accretion or where the boundary has been fixed by agreement or a court. On navigable non-tidal waterways, including lakes, the State holds fee ownership of the bed of the waterway landward to the ordinary low water mark and a Public Trust easement landward to the ordinary high-water mark, except where the boundary has been fixed by agreement or a court. Such boundaries may not be readily apparent from present day site inspections.

At the Project area, the Eel River, portions of Centerville Slough, and the Pacific Ocean seaward of the MHTL are State sovereign land under the Commission's jurisdiction. A lease for the use of State sovereign land will be required from the Commission for any portion of the Project encroaching on State sovereign land. Please see the contact information below for more information on leasing requirements with the Commission. 3-1

Project Description

The Project would restore a landscape of mostly diked pastureland to approximately 500 acres of pasture and natural habitats, including estuarine and tidal slough channels, freshwater streams, freshwater ponds, and agricultural pastures by placing set-back berms to provide increased resiliency to ongoing and projected geomorphic and climactic changes. In addition, the Project would re-establish the connection between Centerville Slough and the Eel River as well as remove and reconfigure dikes to provide the full tidal prism into the restored Centerville Slough. Finally, Project construction requires approximately 750,000 cubic yards of balanced excavation and sediment placement for reuse on-site.

From the Project Description, Commission staff understands that the Project would include the following components that have potential to affect State sovereign land:

- Levee lowering and removal at Centerville Slough
- Excavation of approximately four miles of Centerville Slough to re-connect the Eel River Estuary to the restored tidal wetlands and tributary streams; material excavated from Centerville Slough would be reused on-site to construct the set-back berm and other Project elements
- Increase in flows and tidal exchange with Centerville Slough and Eel River, and increased discharge to the Pacific Ocean

Environmental Review

Commission staff requests that the District consider the following comments.

General Comments

1. Project Description: Please be as specific as possible regarding all proposed work within the Commission's jurisdiction waterward of the MHTL, inclusive of the historic bed of the Eel River, Centerville Slough, and if applicable, seaward of the MHTL of the Pacific Ocean. From the Project Description, the western Project area boundary appears to be the approximate MHTL of the Pacific Ocean, but the specific boundary of the Project area is unclear, including if any work is proposed along this area. Please provide a clear statement in the Project Description defining the limits of the western Project boundary and if any work will occur along this area. 3-2

Biological Resources

2. Invasive Species: Although the Draft EIR addresses presence and measures to prevent spread of existing invasive plant species within the Project area, Commission staff recommends additional measures to ensure the prevention of introducing invasive species to the Project area. One of the major stressors in California waterways is introduced nonindigenous species. Construction equipment and materials brought in from long stays at distant projects may transport nonindigenous species to the Project area via biofouling, wherein marine and aquatic organisms attach to and accumulate on the submerged parts of equipment and materials. Potential minimization and avoidance measures include contracting and use of construction equipment and materials from nearby the Project area or requiring contractors to perform a certain degree of cleaning of equipment and materials prior to contact with Project area waters. The California Department of Fish and Wildlife's Invasive Species Program and Commission Marine Invasive Species Program could assist with this analysis as well as with the development of appropriate mitigation (information at https://www.wildlife.ca.gov/Conservation/Invasives and https://www.slc.ca.gov/misp/). 3-3

Cultural Resources

3. Title to Resources: Within the Cultural Resources section of the Draft EIR, please identify the title to all archaeological sites, and historic or cultural resources on or in the tide and submerged lands of California is vested in the State and under the jurisdiction of the California State Lands Commission (Pub. Resources Code, § 6313). Commission staff requests that the District consult with Commission staff should any cultural resources on State lands be discovered during construction of the proposed Project. In addition, staff requests that the following statement be included in the EIR's Mitigation and Monitoring Plan: "The final disposition of archaeological, historical, and paleontological resources recovered on State sovereign land under the jurisdiction of the California State Lands Commission must be approved by the Commission." 3-4

Geology

4. The Geology section of the Draft EIR provides baseline setting information for sediment discharge from the Eel River and the Eureka Littoral Cell within the Pacific 3-5

Ocean, including historic areas of erosion and accretion along the Pacific coastline within the Project vicinity. The Project area marsh network is further characterized as a location of sediment deposition versus source to receiving waters. The Geology section does not address potential effects to coastal processes along the Pacific coastline within the Eureka Littoral Cell from Project alterations to sediment discharge from the Eel River. Although the impact is likely to be less than significant, Commission staff recommends additional analysis to address this impact. 3-5

Recreation

5. Within the Recreation section, describe any restrictions or limitations on public access to the Project area during construction, and if applicable, include measures to provide notice to the public prior to construction. 3-6

Thank you for the opportunity to comment on the Draft EIR for the Project. As a responsible and trustee agency, the Commission will rely on the Final EIR to issue a new lease as specified above (see Section "Commission Jurisdiction and Public Trust Lands"). We request that you consider our comments before certifying the EIR.

Please send electronic copies of the Final EIR, Mitigation Monitoring Program, Notice of Determination, approving resolution, CEQA Findings, and if applicable, Statement of Overriding Considerations when they become available. Please note that federal and state laws require all government entities to improve accessibility of information technology and content by complying with established accessibility requirements. (29 U.S.C. § 794d; 36 C.F.R. § 1194.1 et seq.; Gov. Code, § 7405.) California State law prohibits State agencies from publishing on their websites content that does not comply with accessibility requirements. (Gov. Code, § 115467.) Therefore, any documents submitted to Commission staff during the processing of a lease or permit, including all CEQA documentation, must meet accessibility requirements for Commission staff to place the application on the Commission agenda.

Please refer questions concerning environmental review to Jason Ramos, Senior Environmental Scientist, at (916) 574-1814 or via e-mail at Jason.Ramos@slc.ca.gov.. For questions concerning Commission leasing jurisdiction, please contact Ninette Lee, Public Land Manager, at (916) 574-1869, or via e-mail at Ninette.Lee@slc.ca.gov.

Sincerely,

Nicole Dobroski, Chief
Division of Environmental Science, Planning, and Management

CC: Office of Planning and Research
N. Lee
J. Ramos

2.2.3 Letter 3 – Response to State Lands Commission Comments

Response to Comment 3-1

Commission Jurisdiction and Public Trust Lands

The applicant is aware that a lease will be needed from the State Lands Commission. There will be work in State sovereign lands. During the lease/permit application process, the applicant will provide the design plans to the State Land Commission to determine areas needing a lease.

Response to Comment 3-2

Western Project Boundary

The Project limits are described in the Project Description and depicted on the figures in the DEIR. The western-most project activities include the construction of the back dune berms which will be located on the eastern portion of the dune strand (opposite of the wave slope) and above the current MHTL.

Response to Comment 3-3

Invasive Species minimization and avoidance measures

Thank you for this helpful suggestion. HCRCD agrees this is important and has added Aquatic Invasive Species Disinfection/Decontamination Protocols for the North Region (CDFW 2016) to Mitigation Measure BIO-9 (page 3.4-57) via errata. Please see Section 3.2.3 for the updated text and Section 3.2.4 for updated reference.

Response to Comment 3-4

Title to Archeological Sites, Historic, or Cultural Resources

Any cultural resources located within State Lands Commission jurisdiction, if any, will be identified during the permit or lease application process via supporting information submitted in OSCAR. The requested text has been added to Mitigation Measure CR-1 via errata (see Section 3.3.1).

Response to Comment 3-5

Effects to coastal processes from sediment discharge

Given the State Lands Commission does not expect the related impact to be significant and the question at hand remains unclear, HCRCD and Project partners look forward to discussing this topic in additional detail during the lease application process. Additionally, the basis of hydraulic design document cited in the DEIR as USFWS 2022 has been appended to the Final EIR as Appendix A via errata and includes additional information about sedimentation processes considered during design development.

Response to Comment 3-6

Recreation access limitations during construction

Public access on TWC's Preserve, by reservation only, will continue during construction in areas not under active construction. Given the continued opportunities of public access during construction of areas undisturbed by construction, closure notifications are not warranted.

3. Errata

The purpose of this errata is to document revisions to the DEIR that are intended to clarify project details since it was submitted to the Office of Planning and Research State Clearinghouse on May 26, 2023, and publicly circulated between May 26, 2023 and July 10, 2023. The following Project details are addressed in this errata, as shown in Table 3-1, below.

The errata includes excerpts of text from the DEIR that are proposed for modification, and does not include the entire DEIR. Specifically, the entire subsection that contains the text proposed for modification is copied into the errata, and newly proposed text in the errata is **underlined and bolded**, deleted text from the original DEIR is stricken with ~~single strikethrough,~~ and unchanged text remains in normal font. Only the subsections of the original DEIR that are proposed for modification are copied into the errata.

Table 3.1: List of Proposed DEIR Text Modifications Captured in Errata

Section of Errata	Topic of Proposed Changes	Section of DEIR
Section 3.1	Project Description Text Clarifications	Section 2 – Project Description
Section 3.2	Biological Resources Text Clarifications	Section 3.4 – Biological Resources
Section 3.2	Cultural Resources Text Clarifications	Section 3.5 – Cultural Resources
Section 3.4	Recreation Text Clarifications	Section 3.14 – Recreation
Section 3.5	Attachments	Appendix
Section 3.6	Report Preparers Text Clarifications	Section 6.0 – Report Preparers

3.1 Project Description Text Clarifications

The following details have been added to Section 2 (Project Description) of the EIR as errata.

3.1.1 Section 2.5.9 – Restore Russ Creek and Riparian Corridor

The following text was added to section 2.5.9:

> Approximately 1,500 linear feet of Russ Creek extending north of the RR&T-TWC property boundary to the new tide gate would be widened and deepened to meet the hydraulic and habitat objectives. A riparian corridor would be established adjacent to the restored Russ Creek channel. **Exclusion fencing will be installed near planted riparian habitat to prevent grazing.** The overall flow capacity through this reach will be increased so the frequency of overbank flooding is anticipated to be reduced. During extreme Russ Creek flow events that are coincident with a high Eel River stage, overbank flooding will flow across TWC's property east of Russ Creek and into Cut-off Slough, similar to current conditions. Remnant swales and channels currently present on TWC's property east of Russ Creek could be repurposed in the future to capture and convey overbank flow and sediment during extreme events to low lying areas on the landscape for beneficial reuse. Russ Creek improvements are not proposed on the RR&T property.

3.2 Biological Resources Text Clarifications

The following details have been added to Section 3.4 (Biological Resources) of the EIR as errata.

3.2.1 Section 3.4.6 Mitigation Measure BIO-7: Mitigate Impacts to Beach Layia

The following text was added to Mitigation Measure BIO-7:

> The following measures shall be implemented to mitigate impacts to the federally listed beach layia during construction and operation/ongoing maintenance of the Project, primarily associated with the temporary haul route to be placed between the back dune and the Outer Marsh.
>
> - A pre-construction survey shall be conducted between March 1 and July 31, prior to the beginning of ground disturbing work to verify the extent of known beach layia occurrences and to identify new occurrences in the area of the proposed temporary haul route. The route shall be placed a minimum of 10 feet from any beach layia occurrences to the extent feasible. At the beginning of construction, flagging or exclusion fencing shall be installed around all known occurrences of beach layia within 20 feet of construction limits. Locations of fencing shall be identified and flagged by a qualified biologist and installed while the biologist is present. The fencing shall be inspected weekly for the duration of construction to ensure that the fencing remains installed properly. Direct impacts to beach layia shall be avoided.
> - If any new or existing occurrences of beach layia cannot be avoided by the placement of the temporary haul route, then mitigation will be employed that includes one or more of the following mechanisms: seed collection from the Project Area and/or nearby known occurrences so that seeds can be dispersed into the area of the temporary haul route post-construction or replacement plants can be grown out at a nursery and replaced at a stable portion of the Project Area (2:1 planting ratio), **treatment of *Ammophila*,** plant relocation, and/or preparation of a sensitive species management plan (SSMP) that provides further details about the above options in cooperation with USFWS as to which mechanism(s) are preferred option(s) at the time of impact. The triggering mechanism for seed banking would be if this plant species is identified within the footprint of the proposed temporary haul route and cannot be avoided. If an SSMP is deemed appropriate by jurisdictional agencies, the report would lay out specific timing and details of seed collection, mitigation site identification (within the Project Area), substrate preparation, monitoring and maintenance. If replanting is employed, a 2:1 planting ratio includes built in overplanting in order to meet success criteria and no net loss.

3.2.2 Section 3.4.6 Mitigation Measure BIO-8: Mitigate Impacts to Sensitive Listed Habitats Through Avoidance and Re-establishment

The following text was removed from Mitigation Measure BIO-8:

> Intact Dune Mat vegetation will be protected during construction primarily by pre-construction surveys and avoidance. A qualified biologist will survey sandy habitats in and around ground disturbance and staging areas for intact Dune Mat vegetation. Dune Mat vegetation will be flagged and avoided by all vehicles and personnel. If ~~high quality~~ Dune Mat cannot be avoided, it will be mitigated at a ratio of no less than 1:1 in a suitable location.

3.2.3 Section 3.4.6 Mitigation Measure BIO- 9: Mitigate Impacts to Sensitive Listed Habitats Through Control of Invasive Species

The following text was added to Mitigation Measure BIO-9:

> To reduce the likelihood of dense-flowered cordgrass (*Spartina*) colonizing restored tidal marsh, existing populations in and adjacent to (north of the tide gates) the Project footprint shall be controlled prior to construction using manual, mechanical, and/or approved chemical methods, and in compliance with appropriate methods analyzed and disclosed in the Regional Invasive Spartina Management Plan and the associated EIR (HTH 2013b). During the operation period of the Project, removal of cordgrass would be conducted under the authority of the Regional Invasive Spartina Management Plan and the associated PEIR.
>
> All vehicles and equipment would be required to be cleaned and weed-free before entering the Project Area.
>
> **The project will implement measures for Aquatic Invasive Species Disinfection/Decontamination Protocols for the North Region established by CDFW (CDFW 2016).**

3.2.4 Section 3.4.8 References

The following reference has been added as a project reference in Section 3.4.8:

> **CDFW. 2016. California Department of Fish and Wildlife, Aquatic Invasive Species Disinfection/Decontamination Protocols (Northern Region). https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=92821&inline**

3.3 Cultural Resources Text Clarifications

The following details have been added to Section 3.5 (Cultural Resources) of the EIR as errata.

3.3.1 Section 3.5.6 Mitigation Measure CR-1: Protocols for Inadvertent Discovery of Cultural Resources

The following text was added to Mitigation Measure CR-1:

> If cultural or historic-era resources (for example: chipped or ground stone, historic debris, building foundations, or bone) are encountered during construction activities, work shall be stopped within 20 meters (66 feet) of the discovery, per the requirements of CEQA (Title 14 CCR 15064.5 (f)). Project representatives shall be immediately notified and work near the archaeological finds shall not resume until a professional archaeologist, who meets the Secretary of the Interior's Standards and Guidelines, has evaluated the materials and offered recommendations for further action. The qualified archaeologist shall evaluate the discovery and, in consultation with the landowner and lead agency, develop a plan for treatment of the resources that is deemed appropriate and feasible. Such treatment may include avoidance, curation, documentation, excavation, preservation in place, or other appropriate measures. **The final disposition of archaeological, historical, and paleontological resources recovered on State sovereign land under the jurisdiction of the California State Lands Commission must be approved by the Commission.** If the archaeological resources are Native American, representatives of the

appropriate culturally affiliated tribe shall also be enlisted to help evaluate the find and suggest appropriate treatment.

3.4 Recreational Resources Text Clarifications

The following details have been added to Section 3.14 (Recreation) of the EIR as errata.

3.4.1 Section 3.14.2 Proposed Recreational Usage and Features

The following text was modified in the first paragraph on page 3.14-4:

> TWC's goal is to manage the EREP for agricultural production, outdoor education, recreation and habitat enhancement. While TWC currently manages limited visits to the site via guided tours, in 2021, ~~California Coastal Commission's~~ **Humboldt County's** issued Coastal Development Permit approved EREP to be open three days per week for the public.

3.5 Attachments

To provide additional detail supporting the Project's design, the full design basis document prepared by the USFWS and referenced in the DEIR as USFWS 2022 has been included as Appendix A via errata.

3.6 Report Preparers Text Clarifications

The following text was modified and added to Section 6.0 (Report Preparers) of the EIR as errata.

3.6.1 Section 6.1 Humboldt County Resource Conservation District

- Jill Demers, Executive Director
- Doreen Hansen, Watershed Coordinator
- ~~Nathan Key, Natural Resources Conservation Service Wildlife Biologist~~

3.6.2 Section **6.4 Natural Resources Conservation Service**

- **Nathan Key, Wildlife Biologist**
- **Dean Kwasny, Easement Program Manager**

4. References

California Department of Fish and Wildlife (CDFW). 2016. California Department of Fish and Wildlife, Aquatic Invasive Species Disinfection/Decontamination Protocols (Northern Region). https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=92821&inline

United States Fish and Wildlife Service (USFWS). 2022. Russ Creek and Centerville Slough Restoration Project Preliminary Hydraulic Analysis. United States Fish and Wildlife Service, Arcata Fish and Wildlife Office, Arcata, California, USA.

Appendices

Appendix A

USFWS 2022 Hydraulic Report

RUSS CREEK AND CENTERVILLE SLOUGH RESTORATION PROJECT
PRELIMINARY HYDRAULIC ANALYSIS

Prepared for:

USDA – Natural Resources Conservation Service
Agricultural Conservation Easement Program
430 G Street, Room 4164
Davis, CA 95616

Humboldt County Resource Conservation District
630 South Broadway
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Prepared by

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STATE OF CALIFORNIA

DECEMBER 2022

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EXECUTIVE SUMMARY

PROJECT BACKGROUND

The goal of the Russ Creek and Centerville Slough Restoration Project (Project) is to improve geomorphic and ecosystem function that will enhance habitats for native fisheries and aquatic species, support water bird and wildlife species, and increase agricultural land viability and resiliency to changing geomorphological and climatic conditions. The Project would enhance existing tidal wetlands and restore marginal diked pastureland to a mosaic of natural habitats, including estuarine and tidal slough channels, all within the context of promoting the resilience and viability of agricultural lands in and adjacent to the Project Area.

The Project is located on the south side of the Eel River delta, northwest of the City of Ferndale, in Humboldt County, California. Much of the land in the Project Area consists of reclaimed tidelands that was converted to agricultural production. Land use in the Project Area and adjacent areas is still primarily in agricultural production. The Project Area also includes areas of estuarine and freshwater marshes, coastal sand dunes, tidal marsh, freshwater streams, remnant slough channels, and active tidal channels. The Wildland Conservancy's Eel River Estuary Preserve (EREP) is located within the Project Area. The remainder of the Project Area is owned by private landowners and used primarily to support cattle ranching.

The Project Area landscape was significantly altered by anthropogenic action following Euro-American settlement of the Eel River Estuary. Much of the Project Area was originally covered by tidal marshes or poorly drained wetlands. The area was converted to agricultural production by the construction of levees, draining of marshes, ditching, and alteration of tidal and freshwater stream networks.

Over time, a combination of natural and anthropogenic actions further altered the Project Area and adjacent lands. Much of the area was cut off by diking from beneficial sediment supplies brought in by Eel River and upland flooding. Much of the area experienced subsidence due to decay of organic soils and tectonic action. Alluvial fan growth was beneficial to agricultural production in some portions of the Project Area, but blocked drainage from other portions. During this time, portions of the original Centerville Slough channel network filled in due to lack of tidal flushing. The cumulative effects of long-term changes have impaired conditions for agricultural land us. Some areas are permanently flooded, poorly drained, or otherwise no longer suitable for agricultural production.

Landowners in the Project Area are working together with the USDA Natural Resources Conservation Service (NRCS) and other resource agencies to develop a restoration project that will restore tidal drainage function and habitat to portions of the Project area while simultaneously enhancing conditions for agriculture on still-productive lands. The 2019 *Feasibility Assessment* presented a Concept Restoration Plan for restoring the basin through removal of some existing levees, construction of new set-back levees and drainage infrastructure, and construction of a restored network of tidal channels. The Concept Restoration Plan would allow restoration of a full tidal regime to the Project Area.

PRELIMINARY HYDRAULIC ANALYSIS

Landowners, NRCS, other resource agencies, and their engineering and planning consultants are advancing design of the Concept Restoration Plan. This report documents hydraulic model development

and analyses used to prepare a Preliminary Hydraulic Analysis of the proposed Project. The objectives of the Preliminary Hydraulic Analysis are: (1) to develop an initial detailed design and grading plan based on the Concept Restoration Plan; (2) to evaluate the performance of the proposed design in meeting Project Performance Objectives; and (3) to refine the Concept Restoration Plan to better meet Project Performance Objectives.

The report details the procedures used to develop hydraulic models of Existing and Proposed Conditions for Centerville Slough and adjacent drainages. Model development steps include data collection, development of topographic surface models, development of tidal channel sizing alternatives, hydrologic analysis of streamflow, tidal flow, and water level records, estimation of streamflow for ungaged watersheds, development of proposed grading plans and surface elevation models, and development of HEC-RAS two-dimensional hydraulic models.

The hydraulic models and additional analyses were used to simulate and evaluate several scenarios:

- A hydraulic model validation demonstrated that the hydraulic models could well simulate observed water level records.

- An analysis was prepared to select a preferred outlet channel for the Restored Centerville Slough. The selected alternative would connect Centerville Slough with an outlet channel that discharges directly into the Eel River Estuary rather than an outlet channel connecting to Cutoff Slough.

- A simulation of a high-amplitude spring tide was prepared to evaluate the performance of three channel sizing alternatives in meeting tidal marsh performance objectives. Results of this analysis led to the selection of Channel Alternative 3 as the preferred channel sizing alternative. The simulation also demonstrated that the restored Centerville Slough tidal network could re-establish normal tidal ranges within the tidal basin without impacting adjacent drainages.

- A simulation of an Eel River Extreme Flood was prepared to evaluate flood levels within the restored Project Area resulting from significant Eel River backwater flooding. The simulation demonstrated that while flooding filled the restored Centerville Slough basin, proposed set-back levees provided adequate protection for areas outside of the restored Project Area and proposed drainage infrastructure would allow rapid drainage following the flood event.

- Simulations of two-year, five-year, and ten-year return period floods from upland tributaries draining to Centerville Slough (Russ Creek, Shaw Creek, Creamery Ditch, etc.) were used to evaluate impacts of the proposed project on areas lying outside of the Centerville Slough tidal basin and on adjacent drainages. The analysis showed generally no increase in flood levels while the rate of drainage was improved following flood events.

The Preliminary Hydraulic Analysis demonstrated that the refined Concept Restoration Plan (with selected alternatives) will satisfy Project Performance Objectives.

INTRODUCTION

PROJECT PURPOSE

The goals of the Russ Creek and Centerville Slough Restoration Project (Project) include:

- restoring geomorphic and ecosystem function to Centerville Slough and Russ Creek,
- enhancing habitats for native aquatic species, water bird and wildlife species, and
- improving viability and resiliency of agricultural land in and adjacent to the Project Area.

Proposed Project actions include re-establishing the Centerville Slough tidal system by constructing a new Centerville Slough main channel and tributaries subject to full tidal influence, reestablishing hydraulic connectivity between Centerville Slough and upland stream channels that include Russ Creek, Shaw Creek, and other tributaries, and constructing a system of set-back levees to protect adjacent agricultural lands from tidal flooding, Eel River flooding, and dune overwash.

The Project is being developed in a collaborative manner between landowners (Landowners), resource agencies, and support staff (Project Team). Landowners include private ranching families that raise cattle and conduct other agricultural activities; and The Wildlands Conservancy (TWC), a non-profit organization that owns and operates the Eel River Estuary Preserve (EREP). The Natural Resources Conservation Service (NRCS) has purchased Wetland Reserve Easements (WRE) in the Project area from the Landowners through the Agricultural Conservation Easement Program. NRCS contracted with the Humboldt County Resource Conservation District (RCD) to assist in Project development, engineering design and serve as the California Environmental Quality Act (CEQA) lead agency. The RCD contracted for Project engineering and CEQA support with GHD, Inc. (GHD) and Michael Love and Associates (MLA). The U.S. Fish and Wildlife Service (USFWS) is providing technical assistance to the Project Team by conducting hydraulic modeling and assisting with engineering design.

The purpose of this report is to document preliminary design development and hydraulic analyses prepared by USFWS to support initial Project design and permitting. USFWS developed Project area topography and preliminary grading plans for the proposed Project actions, prepared hydrologic analyses of Project tidal stages and flood frequency relationships for tributary streams, and prepared hydraulic analysis of Existing Conditions and several design alternatives using U.S. Army Corps of Engineers hydraulic model HEC-RAS (U.S. Army Corps of Engineers, 2021).

PROJECT BACKGROUND

PROJECT LOCATION

The Project is located on the south side of the Eel River delta, northwest of the City of Ferndale, in Humboldt County, California (Figure 1). The south side of the Eel River delta is bounded on the north and east sides by the Eel River, the Pacific Ocean to the west, and the Wildcat Mountains to the south. The Project boundary covers a portion of the Centerville Slough tidal basin, which is the western most of a series of diked and drained former tidal basins that lie on the delta between the foot of the Wildcat Mountains and the Eel and Salt Rivers.

The current boundary of the Centerville Slough tidal basin above Cutoff Slough is depicted in Figure 2. The boundaries of the tidal basin are formed by coastal dunes on the west side, high ground and alluvial fans on the south side, the Smith Creek levee on the east, Mill Creek on the northeast, and the Inner Marsh levee on the northwest. The levees on the north side of the basin were built to prevent inflow from tides and from high flow events on the Eel River. The Smith Creek levee prevents flood flows from the east.

The southern portion of the Centerville Slough tidal basin is known as Angels Camp. It is a low area bounded by encroaching alluvial fans from Russ Creek and Shaw Creek. The coastal dunes in the southern portion of the Centerville Slough tidal basin are unstable and portions were washed out in recent years. Consequently, Angels Camp has experienced occasional flooding by wave overwash. At this time, Angels Camp is permanently flooded because there are depressions flooded by overwash and stormflow that lack positive drainage.

The middle portion of the tidal basin is higher in elevation than the south or north parts of the basin. The northern portion, known as the Inner Marsh, is relatively low. The area to the north of the Inner Marsh levee is known as the Outer Marsh. It extends to the Eel River Estuary.

PROJECT AREA GEOMORPHOLOGY

Predevelopment

Prior to Euro-American development in the late 1800's, the lands on the southern side of the Eel River delta consisted of tidal and freshwater marshes. The Centerville Slough tidal basin contained a multi-branch network of tidal channels that flowed from Angels Camp in the south to multiple outlets in the Salt River, and thence to the Eel River (Figure 3). The tidal channel network was complex with multiple channels, islands, and interconnected open water bays. Coastal dunes formed the west boundary Centerville Slough tidal basin. There was an indeterminate boundary between the Centerville Slough basin and the Smith Creek tidal basin occupied by tidal marshes. The width of main channels in Centerville Slough ranged from 100 feet in Angels Camp to over 300 feet in locations near the Salt River.

Agricultural Reclamation

Drainage patterns has been significantly altered throughout the Centerville Slough tidal basin. Agricultural reclamation activities began in the late 1800's. Much of the Eel River delta was classified as *Swamps and Overflowed Lands* (Figure 4). This classification provided for the transfer of federal land to the State of California, and allowed the State to sell the land for agricultural reclamation by private individuals. Lands in the south Eel River delta were converted to agricultural lands through the construction of dikes and drainage ditches, realignment of natural channels, and installation of tide gates and other hydraulic infrastructure. Centerville Slough was isolated from the eastern sloughs by the construction of a dike on the west side of a re-aligned Smith Creek. Dike construction reduced Centerville Slough to a single Salt River outlet (now known as Cutoff Slough). Tide Gates installed at the mouth of Centerville Slough allowed drainage from upland tributaries to drain into Cutoff Slough, but prevented tidal flows from entering the Centerville Slough tidal basin. The loss of twice-daily tidal flows led to infilling of channels in the Centerville Slough channel network. Construction of interior levees and road crossings, land grading, and channel realignments further fragmented Centerville Slough into a series of disconnected channel segments.

Basin Evolution and Modification

Natural geomorphic processes are very dynamic in the Centerville Slough tidal basin. Without the action of twice-daily flushing flows, sedimentation further fragmented the Centerville Slough channel network. Sediment delivered from Russ Creek formed a broad fan. The fan partially filled the southern portion of the Centerville Slough tidal basin and limits drainage from Angels Camp. Russ Creek now terminates in a broad delta and lacks a direct connection to the Cutoff Slough outlet. The lower (northern) end of the Centerville Slough basin has subsided due to a combination of downward vertical land movement (Patton et al. 2017), organic soil decay, and restricted sediment delivery from the Eel River. There are several depressions within the Project Area that are either permanently flooded, or experience seasonal flooding due to winter rains and wave overwash. The coastal dunes near Angels Camp recently washed-out leading to overwash deposits that filled drainage ditches and former channels. The primary Eel River delta channels have shifted location and formed new channels and islands. Sedimentation, floods, and ocean waves cause the mouth of the Eel River to continuously shift location and change inlet width and depth. Meandering of the south branch of the Eel River captured the lower end of the Salt River, including abandoned Centerville Slough outlets.

Anthropogenic actions in the period since conversion of Centerville Slough to agricultural land further altered the Centerville Slough tidal basin. These actions were generally undertaken to respond to long-term geomorphic adjustments that impacted the ability to manage the area for agricultural uses. Following damage from the 1964 flood, the U.S. Army Corps of Engineers completed the design and construction contracting for the repair and construction of new levees. Russ Creek and Shaw Creek have been realigned and redirected as the Russ Creek and Shaw Creek alluvial fans grew. The Western Drainage Ditch was constructed after portions of Centerville Slough filled in blocking drainage paths to the north. The Western Drainage Ditch was recently relocated after overwash filled sections of the channel and blocked drainage from Angels Camp.

Current Status

The cumulative effects of long-term geomorphic changes have impaired conditions for agricultural land use within the Centerville Slough tidal basin. Agricultural use of the Outer Marsh was abandoned following the 1964 flood. Much of Angels Camp is permanently flooded and is no longer suitable for agricultural production. Drainage in the Inner Marsh is poor, causing poor grazing conditions. Dune overwash and blocked drainage is threatening the remaining productive agricultural lands in the tidal basin.

CONCEPT RESTORATION PLAN

Restoration Project and Purpose

Landowners in the tidal basin are working together to develop a restoration project that will restore tidal drainage function and habitat while simultaneously enhancing conditions for agriculture on still-productive lands. NRCS has worked cooperatively with the private landowners to acquire five permanent Agricultural Conservation Easement Program - Wetland Reserve Easements (WRE) totaling 1,240 acres within the tidal basin (Figure 5). NRCS is leading the effort to develop and implement the Russ Creek and Centerville Slough Restoration Project.

The Project would create a mosaic of freshwater pastures and natural salt and freshwater wetland habitats. Proposed features include estuarine and tidal slough channels, freshwater streams, freshwater ponds, and agricultural pastures. Restoration of tidal flow and tidal flushing is critical to achieve Project objectives. Reestablishing the connection of Centerville Slough to the Eel River and removing and reconfiguring dikes will restore tidal dynamics in Centerville Slough. The restored tidal connection will re-establish the historic pattern of tidal slough channels. Improvements to tidal channels and the tidal prism will restore the quality and extent of aquatic habitat from the Eel River to Centerville Slough, Shaw Creek, and Russ Creek, while improving drainage and sediment transport. Construction of setback levees and adding new tide gates structures to Shaw Creek and Russ Creek will restore effective drainage of upland agricultural lands and provide protection from Eel River flooding and dune overwash.

Concept Design

In spring 2019, NRCS and the Landowners developed a conceptual restoration plan for Centerville Slough and Russ Creek. HCRCD contracted with GHD with NRCS funding to develop a *Feasibility Assessment* of the proposed concept restoration plan (GHD 2020). The Feasibility Assessment further refined the concept restoration plan through hydraulic analyses of Russ Creek and a proposed restored Centerville Slough channel. The Feasibility Assessment also prepared preliminary environmental and engineering analyses of concept plan components. The Feasibility Assessment identified specific Project design elements and provided preliminary Project design specifications (Figure 6). The design elements include:

1. Construction of a new, multi-branched Centerville Slough tidal channel network that extends from Angels Camp to an outlet on Cutoff Slough or north to the Eel River delta.

2. Construction of a new set-back levee running north from Angels Camp, crossing Russ Creek, and then running north the west bank of Cutoff Slough, and then along Cutoff Slough and tying into the existing Cutoff Slough tide gate. The crest of the set-back levee was identified as 15.0 feet NAVD 1988[1].

3. Installation of side-hinged tide gates to pass flow from Shaw Creek and Creamery Ditch through the set-back levee.

4. Installation of a tide gate structure with side-hinged gates to pass Russ Creek flow through the set-back levee. The Feasibility Assessment identified preliminary dimensions for the tide gate structure.

5. Realignment of Russ Creek to tie into the set-back levee. Additional grading was identified that would passively manage and direct overflows from Russ Creek. Overflow could occur when Russ Creek experiences high flow events.

6. Removal of portions of the Inner Marsh levee.

7. Fill within the new Centerville Slough tidal basin to subdivide the basin drainage and to separate tidal channels.

[1] Unless otherwise stated, all elevations in this report are referenced to NAVD 1988 vertical datum.

8. Construction of four dune berms to promote dune building processes, limit transport of overwash sand into tidal channels and to redirect overwash flows to tidal channels.

9. Raising or replacement of the Angels Camp levee at the south end of Angels Camp to prevent tidal and riverine flooding of the property south of the levee and flooding of Centerville Road. A side-hinged tide gate would be installed through the new levee to allow property south of the levee to drain into the Centerville Slough tidal basin.

10. Rehabilitation of the Cutoff Slough tide gate structure including structural repairs, replacement of existing top-hinged flap-gates with side-hinged flap gates, and installation of one or more auxiliary gates within the flap gates. The purpose of the auxiliary gates is to replicate the existing muted tidal regime created by gate leakage.

PROJECT PERFORMANCE OBJECTIVES

In 2019, NRCS and the Landowners developed an initial set of desired project outcomes for flood control and ecological restoration. During development of the Feasibility Assessment, the Landowners and the Project Team held meetings to further define Project outcomes. Based on these discussions, the Project Team identified specific Project performance objectives. The objectives describe the desired Project outcomes that will result from the Project actions and help to set performance standards for Project design. The Project performance objectives include:

1. Restore Centerville Slough to a self-maintaining, fully connected tidal channel network with full tidal range that extends from Angels Camp to outlets at Cutoff Slough or the Eel River.

2. Establish tidal marsh hydrology and ground elevations suitable for passive tidal marsh restoration in designated area of NRCS wetland reserve easements.

3. Enhance adjacent agricultural lands by preventing flooding by tidal waters, Eel River floods, and dune overwash, and by enhancing flood drainage from upland tributaries.

4. Route fluvial sediment from Russ Creek into the tidal marsh and maintain long-term sustainability of Russ Creek by preventing deposition within the Russ Creek channel.

5. Create a Project design such that the system is self-maintaining and that no active sediment management or other regular maintenance activities are required.

6. Maintain equivalent riverine and tidal flows and stages on adjacent lands. Adjacent lands include the lands in the Centerville Slough basin owned by the O'Rourke Foundation and other private landowners, land bordering the Salt River that share the channel draining Cutoff Slough and the Salt River to the Eel River, and a private property located between the south end of Angels Camp and Centerville Road (South Angels Camp Basin).

7. Rapidly drain flood waters from the Centerville Slough tidal basin originating from Eel River floods, upland flooding, or dune overwash.

HYDRAULIC MODEL DEVELOPMENT

MODEL DEVELOPMENT TASKS

USFWS used HEC-RAS as the primary tool to prepare a preliminary hydraulic analysis of the Preliminary Design. HEC-RAS was used to prepare long-term simulations of tidal flows and flood flows in the Centerville Slough basin under Existing Conditions and alternate proposed conditions. Development of HEC-RAS models involved the following: actions

- Assembly and review of previous studies, engineering plans, and hydrologic and hydraulic data collection conducted in and around the Centerville Slough basin and the south Eel River delta;
- Development of topographic surface models representing Existing and Proposed Conditions;
- Analysis of tidal stage data; and
- Analysis of discharge-frequency relationships for upland tributaries that flow into the Centerville Slough basin.

DATA COLLECTION AND ANALYSIS

Development of preliminary Project designs and the preliminary hydraulic analysis required a broad array of topographic and hydrologic data. Centerville Slough and the adjoining areas in the Eel River delta have been the subject of several previous engineering studies, restoration designs, and restoration projects. USFWS and other Project team members assembled data from previous studies and collected new information specifically for this project to support development of the Preliminary Hydraulic Analysis.

Previous Studies and Design Projects

Project design and analysis benefited from work assembled for a previous plan to partially restore Centerville Slough (GHD, 2016; GHD, 2017). The Eel River Estuary and Centerville Slough Enhancement Project was advanced to a 65% design, but was not implemented due to landowner concerns about long-term liability, funding, maintenance, and operation requirements. The design team for the Eel River Estuary and Centerville Slough Enhancement Project prepared an extensive set of topographic surveys, hydrologic data collection, hydrologic and hydraulic analyses, inventories of hydraulic infrastructure, and geotechnical surveys and provided them to this project.

The Salt River Restoration Project is an on-going project that to date has restored tidal influence and flood conveyance to the reach of the Salt River between State Road 211 and Cutoff Slough. Engineering designs, as-built surveys, and post construction monitoring from the Salt River Restoration Project were incorporated into the Centerville Slough analysis to evaluate impacts of the Project on adjacent watersheds in south Eel River delta. A particularly valuable dataset includes continuous tidal stage data monitoring records collected in the lower Salt River in 2018 and 2019 (Kamman Hydrology and Engineering, 2019).

The RCD is leading an on-going effort to resolve drainage issues in Williams Creek (a tributary to the Salt River. GHD and MLA prepared an alternatives analysis that was completed in 2020 (GHD 2020). As part

of the study, stage and discharges were monitored continuously at several locations in William Creek during 2017 and 2018. The monitoring data provides valuable insight into the hydrology of the streams flowing off the Wildcat Mountains into the south Eel River delta.

TOPOGRAPHIC SURFACE DEVELOPMENT

Development of Existing Conditions Digital Elevation Model

A fundamental data requirement for developing the model geometry file for the two-dimensional version of HEC-RAS is a raster-based digital elevation model (DEM) file representing surface topography and bathymetry. To evaluate hydraulic impacts of the proposed Project on lands within the Centerville Slough tidal basin and to adjacent lands, the hydraulic analysis required topography and bathymetry data for the Centerville Slough tidal basin, the lower Salt River, and the Outer Marsh between the Centerville Slough tidal basin and the Eel River Estuary. The model domain is a large complex area that recently has experienced topographic changes due to dune washouts, tidal channel enlargement, and sedimentation from upland tributaries and from the Eel River. The construction of an Existing Conditions topographic surface raster required data from multiple sources. Data was processed using the ARC-GIS Pro geographic information system and Autocad Civil-3d CADD software packages. The Existing Conditions topographic surface model was prepared in Autocad Civil-3D. The final raster file used in HEC-RAS was prepared using ARC-GIS Pro. The surface horizontal projection is California State Plane Coordinates Zone NAD 1983 datum. Vertical datum is NAVD 1988 (GEOID18). Raster cell size was set to 1.0 foot.

The Existing Conditions DEM was developed using the following data sources:

- The base data layer for Existing Conditions was developing using data from the 2018 - 2019 USGS Lidar: Northern California Wildfire - QL2 (QL2). USFWS downloaded data for the Project study area from the NOAA Office of Coastal Management Data Access Viewer. The QL2 data provided accurate ground topography from 2018 and 2019 except for areas of dense marsh, freshwater channels, and tidal channels.

- The lower elevation areas of Angels Camp were flooded when the QL2 LIDAR data was collected. Flooding obscured the actual topography in this area. The QL2 data in the flooded areas were replaced with 2015 USACE NCMP Topobathy Lidar: California (2015 Topobathy) collected in 2015 by the U.S. Army Corps of Engineers.

- Bathymetry for channels in the northern portion of the Centerville Slough tidal basin and the Outer Marsh was replaced with a bathymetry from a DEM developed by Kamman Hydrology and Engineering for the 2014-2017 Eel River Estuary and Centerville Slough Enhancement Project (KHE DEM). The KHE DEM has a grid spacing of 2-feet.

- There were several areas that the Project Team determined were not well-represented by available datasets because of recent sedimentation, dune wash out, or were otherwise missing. The areas included the Russ Creek delta, dune wash-outs, and several channels in the Outer Marsh. Data in these areas was replaced by topographic survey data collected by NRCS staff in 2020.

- Bathymetric data for Cutoff Slough from the tide-gate to the Eel River was replaced with data from a bathymetric survey prepared by Graham Matthews and Associates for the previous design efforts.

- Bathymetric data for the Salt River and for Riverside Ranch was replaced with bathymetric data developed as part of the Salt River Restoration Project. This data was updated in 2021 as part of a hydraulic investigation of the Riverside Ranch levees (GHD and Michael Love and Associates, 2021).

- Russ Creek channel bathymetry was replaced with survey data collected by USFWS in 2013. USFWS conducted a re-survey in 2021 and determined that the 2013 survey was still accurate.

Proposed Surface Topography and Bathymetry DEM Development

DEM's representing proposed conditions are based on the Existing Conditions DEM. Proposed surfaces were developed in CIVIL-3D that modified the Existing Conditions DEM by incorporating grading representing proposed Project design elements. Design of proposed Project design elements is discussed below.

WATER LEVEL DATA AND ANALYSIS

USFWS analyzed water level data to support two Centerville Slough hydraulic model development objectives. The first purpose is to establish water level (stage) boundary conditions. The second purpose is to develop tidal stage datums that characterize mean and extreme tide levels. Tidal stage datums are primary input parameters used by USFWS to specify dimensions for new tidal channels.

Water Level Data Sources

Water levels in the south Eel River delta have been monitored in recent years to support development of several restoration projects. USFWS reviewed the available datasets. The datasets that are the most pertinent to development of the Centerville Slough hydraulic model include:

1. Riverside Ranch Monitoring: This dataset involved wet season monitoring of water levels at seven locations in and around Riverside Ranch. The monitoring was implemented by Kamman Hydrology and Engineering in 2018 and 2019 (KHE, 2019). Gaging stations were established at two locations within Riverside Ranch, one location on the Salt River above Cutoff Slough, and one location in the Eel River Estuary near the mouth of Morgan Slough.

2. The Wildlands Conservancy Monitoring: In 2017, the Wildlands Conservancy initiated monitoring of water levels at several locations in and around EREP. Two of the gaging station are located immediately upstream and downstream of the Cutoff Slough tide gate.

3. NOAA: NOAA maintains a control tide stage gage station at North Spit, Humboldt Bay, CA (Station ID: 9418767). Control tide gage stations are stations that have been operated for 19 or more years and that provide a continuous record of the water levels in a locality. NOAA established a tertiary water level station at the Cock Robin Island Bridge on the north branch of the Eel River just above the Eel River Estuary (Station 9418637). Tertiary water level stations are stations where NOAA measured water levels for periods less than one year. NOAA procedures allow for the computation

of tidal datums at tertiary stations by comparison of the short period tertiary station record with a longer period record collected at nearby control gage station. The tide predictions at Cock Robin Island Bridge are based on comparison with the North Spit gage station.

Cutoff Slough Tidal Datums

USFWS computed tidal datums for the head of Cutoff Slough below the tide gate using NOAA procedures (NOAA National Ocean Service, 2003). The tidal datums and are listed in Table 1. The procedure extends the results from 31 months of observations collected by the Wildlands Conservancy below the Cutoff Slough tide gate from December 2017 to July 2021. (There are some gaps in the record resulting from periods when the gage was non-operational or not recording data correctly). Tidal datums from the NOAA North Spit Gage at Humboldt Bay (Station ID: 9418767) were used as the reference gage.

TABLE 1: CUTOFF SLOUGH AND NORTH SPIT TIDAL DATUMS

(ELEVATION DATUM - FEET – NAVD 1988)

DATUM	NORTH SPIT	CUTOFF SLOUGH BELOW TIDE GATE
MEAN HIGHER HIGH WATER (MHHW)	6.51	6.80
MEAN HIGH WATER (MHW)	5.80	6.18
MEAN TIDE LEVEL (MTL)	3.36	4.36
MEAN LOW WATER (MLW)	0.91	2.54
MEAN LOWER LOW WATER (MLLW)	-0.34	1.75
MAXIMUM WATER LEVEL (OBSERVED)	9.88	12.52
MINIMUM WATER LEVEL (OBSERVED)	-2.90	-0.44

Water levels in Cutoff Slough are impacted by Eel River discharge which may elevate tidal datums. The maximum observed water level at the Cutoff Slough tide gage occurred on February 27, 2019 when water levels at Fernbridge reached a gage height of 25.62 feet, the 5th highest stage in 88 years of record. Low tides at Cutoff Slough are elevated above local low ocean tides (North Spit) because of storage in the estuary, shoals in the Eel River mouth and connecting channels, Eel River discharge, and channel friction loss between the Eel River mouth and the Cutoff Slough tide gate.

Water Year 2019 Events

The Eel River Estuary experienced four flood events in the spring of 2019. NOAA's California-Nevada River Forecast Center characterizes Eel River floods based on the following water levels (stages) monitored at the USGS stage monitoring gage for the Eel River at Fernbridge (Gage 11479650):

– Monitor/Action Level (14 feet gage height or 20.92 feet NAVD)

– Flood Level (20 feet gage height or 26.92 feet NAVD)

– Moderate Flood Level (22 feet gage height or 28.92 feet NAVD)

– Extreme Flood Level (25 feet gage height or 31.92 feet NAVD)

There was one event on February 27, 2019 that reached the Extreme Flood Level; one additional event that exceeded Flood Level on February 15, 2019; and two additional events that exceeded Action Level floods on January 17 and 21, 2019 (Figure 7).

Water levels during the flood events were recorded by the water level gages at Riverside Ranch (KHE, 2019) and by the gages at Cutoff Slough operated by the Wildlands Conservancy. Figure 8 depicts the water levels recorded during the 2019 Extreme Flood Event at the Salt River, the Eel River Estuary at Morgan Slough, and for Cutoff Slough below the tide gate. These records provide excellent stage boundary conditions for developing and testing the hydraulic analysis of Existing and Proposed Conditions.

STREAM DISCHARGE HYDROLOGY

Centerville Slough Tributaries

The hydraulic analysis required characterization of inflow from local tributaries flowing into the Centerville Slough tidal basin. The local tributaries flow from the Wildcat Mountains across Centerville Road. Tributaries include Russ Creek, Shaw Creek, Creamery Ditch, and an unnamed tributary flowing into south Angels Camp (referred to hereafter as the Angels Camp Tributary). None of the streams are gaged. USFWS estimated flow-frequency data for tributaries using the USGS Regional Regression Equations for ungaged streams in California (Gotvald et al. 2012). The Service employed the USGS StreamStats to prepare input data for the regression equations and to compute flow-frequency data. StreamStats is an automated GIS interface developed by USGS that allows users to delineate drainage areas for user-selected sites on streams, and then automatically calculate basin characteristics and estimates of flow statistics for the selected sites. Drainage basin characteristics determined by StreamStats are listed in Table 2. Peak flow statistics for tributaries are listed in Table 3.

TABLE 2: CENTERVILLE SLOUGH TRIBUTARIES
STREAMSTATS BASIN PARAMETERS

PARAMETER	UNITS	RUSS CREEK	SHAW CREEK	CREAMERY DITCH	ANGELS CAMP TRIBUTARY
Drainage Area	Square Miles	4.3	0.4	1.4	0.7

Mean Annual Precipitation	Inches	48.1	45.8	46.3	45.4

TABLE 3: CENTERVILLE SLOUGH TRIBUTARIES PEAK FLOW ESTIMATES (CUBIC FEET PER SECOND)				
RETURN PERIOD (YEARS)	RUSS CREEK	SHAW CREEK	CREAMERY DITCH	ANGELS CAMP TRIBUTARY
2	306	34.1	107	56.1
5	588	68.9	211	112
10	792	94.6	287	154
25	1060	129	388	209
50	1260	156	466	252
100	1480	184	547	297
500	1950	247	729	398

Salt River

Peak flow estimates for the Salt River are listed in Table 4. The estimates were developed by Kamman Hydrology and Engineering for the Salt River Restoration Project (KHE, 2011). The drainage area of Salt River entering the area covered by the hydraulic models is 12.1 square miles.

TABLE 4: SALT RIVER PEAK FLOW ESTIMATES	
RETURN PERIOD (YEARS)	DISCHARGE (CUBIC FEET PER SECOND)
2	1606
5	2660
10	3443
25	4516

Synthetic Inflow Hydrographs

Purpose

Dynamic (time-varying) flows are a better means of examining the hydraulic effects of proposed Project actions than static (single-value) flows. However, none of the tributaries to the Centerville Slough basin or the Salt River are gaged streams. USFWS used stream discharge gaging records from nearby Williams

Creek to construct synthetic hydrographs for flow from ungaged tributaries and for the Salt River. Winter streamflow on Williams Creek was gaged for several years to support Williams Creek restoration planning (GMA, 2018).

Williams Creek

Williams Creek is a good surrogate for flows from the ungaged Centerville Slough tributaries and for the Salt River. Williams Creek and the tributaries to Centerville Slough basin are similar in physiography and location. All originate on the north face of the Wildcat Mountains, are similar in orientation and shape, and flow onto the south Eel River delta. Williams Creek comprises 49% of the Salt River drainage area.

Review of Williams Creek gage records provides insight about the characteristics of local inflow tributaries to Centerville Slough and the Salt River. Between 10/1/2016 and 5/1/2017, there were six storm flow events on Williams Creek with peaks that exceeded 394 cfs (one half of the two-year return period discharge) and 15 flow events with peaks exceeding 100 cfs. Stormflow hydrographs are flashy in Williams Creek. On average, flows for large events (> 394 cfs) dropped to 32% of the peak discharge within six hours after the peak and to less than 19% of the peak discharge within 12 hours after the peak. Most flow events return to baseflow recession within two days following the initial stormflow hydrograph rise. There can be multi-peak events reflecting multiple precipitation events occurring over several days, but streamflow quickly returns to recession rather than accumulating over several days. Upland flood events that can cause flood impacts to the Centerville Slough basin are typically related to a single precipitation event and last less than one day.

Hydrograph Scaling

USFWS developed synthetic hydrographs for ungaged tributaries by scaling Williams Creek hydrographs following a method described by Soar and Thorne (2001). Scale factors for ungaged watersheds are computed as the ratio of the two-year return period peak discharge between the ungaged watershed and Williams Creek watershed. Hydrograph sale factors are listed in Table 5.

TABLE 5: SYNTHETIC HYDROGRAPH SCALE FACTORS

BASIN	Q_2: TWO YEAR RETURN PERIOD PEAK DISCHARGE (CFS)	SCALE FACTOR
WILLIAMS CREEK	820	1.00
SALT RIVER	1606	1.96
SHAW CREEK	34.1	0.04
CREAMERY DITCH	107	0.13
RUSS CREEK	275	0.34
ANGELS CAMP TRIBUTARY	56.1	0.07

Development of Synthetic Hydrographs

The period of record for the Williams Creek gage records does not overlap the spring 2019 period when four Eel River floods occurred. USFWS developed a procedure to estimate Williams Creek discharge

which could be used to create synthetic inflow from local tributaries occurring at the same time as the 2019 Eel River floods.

USFWS evaluated correlations between the gaged Williams Creek flows and continuous gage data collected by USGS at nearby stream gages. The two closest USGS stream discharge gages with 2019 gaging records are Little River near Trinidad, CA, and the Mattole River at Petrolia. USFWS initially thought that the Little River gage would provide a better surrogate for Williams Creek flow because it is a smaller coastal basin closer in size with Williams Creek. Regression analysis, however, indicated that the Mattole River provided a better fit. USFWS theorizes that the Mattole River is a better fit because it is closer to Williams Creeks and experiences the same rainfall events that occur in the north Wildcat Mountains providing a better match in timing and relative peak magnitudes.

USFWS developed synthetic hydrograph for Williams Creek based on a regression fitted power function of Mattole River flows. Inflow hydrographs for Centerville Slough tributaries and the Salt River were computed by scaling the Williams Creek hydrograph using scaling factors in Table 5. The synthetic hydrographs are not accurate recreations of the actual hydrographs, but they do serve as a reasonable approximation of typical hydrograph forms for use in comparative hydraulic modeling. That is, comparing changes between existing and observed conditions, or for comparing alternative proposed restoration plans.

PRELIMINARY HYDRAULIC ANALYSIS

OBJECTIVES

The objectives of the Preliminary Hydraulic Analysis are to further advance the concept design developed during the Feasibility Assessment, to evaluate if the concept design meets the Project Performance Objectives, to refine the concept design if Project Performance Objectives are not met, and to evaluate the concept design refinements. The preliminary hydraulic analysis also supports evaluation of Project effects as part of CEQA and regulatory permitting.

EXISTING CONDITIONS MODEL

Computational Mesh

USFWS used HEC-RAS to prepare a two-dimensional hydraulic model of Existing Conditions. HEC-RAS employs a finite-volume solution scheme unstructured computational mesh. The mesh consists of a mixture of 3 to 8-sided computational cells mapped over the study area's solution domain. HEC-RAS provides a series of tools for constructing and editing the computational mesh.

For the Existing Conditions model, USFWS defined the solution domain as the tidal and near-tidal portion of the Centerville Slough drainage basin. The solution domain extends from the foot of the Wildcat Mountains to the Eel River Estuary and includes the lower reaches of the Salt River. The western boundary of the mesh is dune line between Centerville Slough and the Pacific Ocean. The northern boundary is the Eel River Estuary and extends up the south branch of the Eel River to Morgan Slough. The east boundary includes the lower portion of the Salt River below Smith Creek and includes the Riverside Ranch tidal marshes. The south boundary extends to the high ground draining into Centerville Slough tidal basin at the base of the Wildcat Mountains (Figure 9).

Cell sizes in the computational mesh were set to an initial value of 80 feet by 80 feet. Break lines were added to delineate ridgeline features and other topographic boundaries such as levees, drainage divides, roads, channel banks etc. Refinement zones were added to employ cell sizes as small as 8 feet by 8 feet in areas of fine features around stream channels, channel banks and drainage ditches.

After defining the mesh, the next steps in model development are to map a terrain model and surface roughness onto the mesh. USFWS used the terrain model of Existing Conditions that was developed as described above. USFWS developed a shape file representing basic land cover boundaries. Manning's n values were assigned to each land cover type (Table 6). Manning's n values were established using standard recommended values (U.S. Army Corps of Engineers, 2021) and professional experience. HEC-RAS tools were used to associate the Existing Conditions terrain model and the land cover layer with the Existing Conditions computational mesh.

TABLE 6: LANDCOVER TYPES AND MANNINGS n	
PASTURE	0.045
MARSHPLAIN	0.050
SLOUGH CHANNELS	0.035
STREAM CHANNELS	0.030
OPEN WATER	0.025

Culverts

The stream network within the existing Centerville Slough basin consists of an interconnected system of constructed ditches, fragments of the pre-disturbance Centerville Slough tidal channel network, and culverts. Interior levees and roads separate the basin into a series of smaller subbasins. The interior levees are also used to limit flooding of peripheral areas from Russ Creek and the other upland tributaries. Drainage from the peripheral subbasins is managed using culverts. Some of the culverts are equipped with flap gates which allow flow in only one direction. The culverts and flap gates are modeled in the Existing Conditions model using HEC-RAS two-dimensional connection features. HEC-RAS computes flow through the two-dimensional connections using culvert equations for flow through pipes and weir equations for overland flow.

Boundary Conditions

Boundary conditions for the Existing Conditions model consist of tidal stages, and inflow from the Salt River, and inflow from upland areas draining into the former Centerville Slough tidal basin (Figure 9). There are two tidal stage boundary located at the Eel River Estuary and on the south branch of the Eel River above Morgan Slough. Inflow boundary conditions are at Centerville Slough tributaries (Russ Creek, Shaw Creek, Creamery Ditch, and the Angles Camp Tributary) and at the Salt River below Smith Creek. USFWS developed Synthetic inflow hydrographs for the tributaries (discussed above to set the inflow boundary conditions.

PROPOSED CONDITIONS MODEL

Computational Mesh

The extents of the computational mesh for Proposed Conditions models are the same as the Existing Conditions model (Figure 9). The computational meshes are different reflecting the changes in the drainage patterns.

Development of the Proposed Conditions meshes was similar to the Existing Condition model. Base cell size was set at 80 x 80-foot cells. Refinement zones were used to increase resolution in channel areas. Breaklines were used to ensure topographic features such as ridgelines and drainage divides were well represented in the mesh.

The computational meshes for Proposed Conditions employ the same set of Manning's n values listed in Table 6.

Base Proposal

There are several meshes representing alternative proposed plans. The alternative plans share many of the same design elements. USFWS created a Base Proposal DEM that incorporates design features common to all alternatives. The Base Proposal DEM was developed by adding grading features representing the design elements to the Existing Conditions DEM.

The Base Proposal DEM includes the following design elements:

East Boundary Levee

The East Boundary Levee is the primary set-back levee that will form the east side of the Centerville Slough tidal basin (Figure 6). The levee will protect and enhance agricultural lands located on private properties, including the O'Rourke Foundation, and EREP that are not included in the wetland reserve easements. The level will enhance agricultural lands by preventing flooding from the Eel River, wave overwash, and tidal flows; and by improving drainage of flood flows from upland areas.

The levee design conforms to NRCS design requirements. The top width of the levee is 12 feet (wide enough to allow vehicles to use the levee top as a roadway). The west (outboard) side of the levee has a 3H:1V side slope. The east (inboard) side of the levee has a 2:1 side slope and a two-foot deep, ten-feet wide drainage ditch. The drainage ditch will intercept overland flows and route them around or through the levee. The crest of the levee is set at elevation 15.0 feet NAVD. The elevation of the levee crest could be lowered to 14.0 feet as design advances[2].

The alignment of the East Boundary Levee ties into the 15-foot elevation contour at the southern end of the Project Area. It runs north and then north-east along-the east side of Angels Camp, turns east after crossing onto the Eel River Preserve, crosses Russ Creek and then turns north and ends at Cutoff Slough. The alignment of the East Boundary Levee was modified from the Concept Restoration Plan. The original alignment in the Concept Restoration Plan ran further east after crossing Russ Creek. The alignment was

[2] The existing perimeter levee is approximately 17,000 feet long and has a variable top elevation. The top elevation of the existing Cutoff Slough tide gate structure is 12.3 feet and the lowest elevation of the levee between the tide gate structure and dune is 13.2 feet (GHD 2017).

modified to run to the north to Cutoff Slough in this analysis. The change was made to exclude portions of active grazing areas from tidal marsh conversion.

The East Boundary Levee possesses three drainage structures. The first structure is a five-foot diameter culvert with side-hinged flap gate where the levee crosses Shaw Creek. The crossing is downstream of the confluence of Shaw Creek and Creamery Ditch. The second structure is also a five-foot diameter culvert with side-hinged flap gate. The second culvert will provide additional drainage capacity, but its primary purpose is to enhance long-term project resiliency and security by providing a redundant drainage in the event of sedimentation at the Shaw Creek tide gate. The third structure is the Russ Creek tide-gate. The preliminary Russ Creek tide gate design was developed as part of the Concept Restoration Plan was adopted for this analysis. The tide gate consists of two 7 feet-wide by 7-feet high rectangular box culverts equipped with side-hinged flap-gates. The culvert inverts are set at elevation 6.0 feet NAVD.

Russ Creek Realignment

The lower portion of Russ Creek occupies a broad alluvial fan that has grown extensively since agricultural land conversion. The alignment of Russ Creek has shifted locations by active management actions and by natural processes as the Russ Creek fan developed. Under Existing Conditions, Russ Creek flows generally north in a constructed straight channel on the private property located south of the Eel River Preserve. Until about ten years ago, after crossing onto the Eel River Preserve property Russ Creek flowed into a channel running to the west at the property line. Russ Creek was diverted to the north after the western channel filled in with sediment. The northern channel now meanders across the fan on EREP, but loses a coherent channel form as it approaches Cutoff Slough.

Under proposed conditions, a new Russ Creek channel will be constructed starting where it crosses onto the Eel River Preserve property. The new channel flows through the Russ Creek tide gate and then flows through the restored marsh in a tidal channel that connects with the new Centerville Slough channel network.

Cutoff Slough Levee Enhancement

There are existing levees in poor condition on both sides of Cutoff Slough. The Cutoff Slough Levee Enhancement will reconstruct the levee on the west side of Cutoff Slough from the north end of the East Boundary Levee to the Cutoff Slough tide gate. The enhanced levee has the same dimensions as the East Boundary Levee.

Dune Berms

Four dune berms will be constructed on the west side of Angels Camp where coastal foredunes have failed in recent years. Loss of the foredunes exposes this section of coastline to wave overwash during winter storm events. The failed foredunes have established a broad, shallowly sloped overwash plain. The crest is near the existing shoreline and has elevations ranging from 14-18 feet NAVD. Previously, the foredunes crests exceeded 25 feet in elevation. Sand transported by overwash threatens long-term sustainability of the restored Centerville Slough tidal channels.

The dune berms are constructed features that will be placed at the eastern end of the sand overwash areas. The berms have a top width of twelve feet located at a crest elevation of 12 feet NAVD. The leading edge (western side) of the berms are sloped downward at 10% to tie into the overwash plain. The dune berms will be planted with native dune grasses that will provide resistance to erosion. The design intent of the berms is to intercept shallow overwash during storm events and to dissipate overwash velocity, and thereby depositing any sand carried by overwash. Flow intercepted by the dune

berms will be routed to the north into tributary channels that drain into Centerville Slough. It is anticipated that captured sand will build dune berm width and elevation over time and provide long-term protection for the constructed Centerville Slough tidal channels.

Angels Camp Levee

There is an existing levee that provides a road crossing across the Angels Camp basin along a property line between two private landowners. The existing levee has a crest elevation of about 6 feet NAVD. The existing levee has a culvert pipe of unknown dimensions that allows water levels to equalize and for water from the south to drain to the north through the Westside Drainage Ditch. The existing levee will be replaced with a new levee (Angels Camp Levee) that will be constructed at the south end of the NRCS easements on the north side of the property line between two private landowners.

Following the request of the southern landowner's representative, the new Angels Camp Levee has a crest elevation of 14 feet NAVD. There will be a five-foot diameter culvert with side-hinged flap gate installed in the levee. The culvert will allow flow to drain to the north through the levee, but prevent tidal flows from moving to the south. The crest elevation of the levee is high enough to prevent levee overtopping from Eel River backwater flooding.

Inner Marsh Levee Removal

There is an existing levee at the north end of the Inner Marsh that prevents tidal flooding from the north from entering the marsh. In the Base Proposal DEM, the levee is removed down to adjacent ground level. Levee removal allows tidal flows and backwater flooding from the Eel River to move south into the restored Centerville Slough tidal basin.

Ditch Fill

The Western Drainage Ditch is a constructed drainage ditch that originally ran along the base of the dunes on the west side of the Centerville Slough tidal basin. Portions of the ditch were recently relocated to the east in response to dune washouts. In the Base Proposal, the Westside Drainage Ditch is filled to adjacent ground elevations. The new Centerville Slough channel network replaces the drainage conveyance functions of the filled ditch.

Cross Road Removal

There is an access road that crosses from the east to the west across the middle portion of the Centerville Slough tidal basin. The road is elevated above the marsh plain and blocks the north-south movement of flow across the marsh plain. In the Base Proposal, the road is removed down to adjacent ground elevation.

Centerville Slough Channel Design

Design of the restored Centerville Slough channel network is the final, and most critical task, in developing design alternatives. The following sections describe the methods employed to size tidal channels and to develop the design of the restored Centerville Slough channel network.

Restored and enhanced tidal channels in the Eel River Estuary and Humboldt Bay areas have been effectively designed through local adaptation of tidal channel sizing relationships developed for San Francisco Bay by Phillip Williams and Associates (Williams et al., 2002; Phillips Williams and Associates and Faber 2002). The San Francisco Bay tidal channel sizing relationships were used to design the tidal portions of the Salt River Ecosystem Restoration Project, Salmon Creek restoration on the Humboldt Bay

National Wildlife Refuge, and portions of the McDaniel Slough restoration at the Arcata City Marsh. Anderson and Patenaude (2009) examined the applicability of the San Francisco Bay tidal channel sizing relationships to design of tidal channels in Humboldt Bay. They found close correspondence between observed channel dimensions in Humboldt Bay and predicted dimensions developed using the San Francisco Bay tidal channel sizing relationships.

The conceptual basis for the San Francisco Bay tidal channel sizing relationships is that the dimensions of tidal channels flowing in erodible substrate adjust to a quasi-equilibrium form where erosive forces generated by flowing water are in balance with the resistive forces of channel substrate. Channels with dimensions larger than equilibrium form will experience deposition if sediment is available, while channels with less than equilibrium dimensions will erode until equilibrium dimensions are achieved. The San Francisco Bay tidal channel sizing relationships employ potential diurnal tidal prism as a surrogate to represent the magnitude of erosive forces generated by tidal discharge. Williams et al. (2002) defined potential diurnal tidal prism (hereafter referred to as tidal prism) as the volume of water upstream of a point in a tidal basin that fills the area between Mean Lower Low Water (MLLW) and Mean Higher High Water (MHHW). Williams et al. (2002) developed regression equations relating tidal prism to tidal channel dimensions (depth below MHHW, channel width at MHHW, and cross section area below MHHW) using measurements of channel dimensions collected in San Francisco Bay tidal marshes. A second set of regression relations was developed that employed marsh area measurements taken from mature tidal marshes rather than tidal prism.

While the San Francisco Bay tidal channel sizing relationships have been applied in other areas in the Eel River Estuary and Humboldt Bay, the relationships are not directly applicable to tidal channel sizing for the restored Centerville Slough channel network. The San Francisco Bay tidal prism and tidal marsh area relationships were developed using channel measurements from tidal marshes where the marsh plain surface elevations were near the elevation of MHHW. A large proportion of the marsh plain in the restored Centerville Slough tidal basin, however, is located several feet below MHHW. Consequently, the tidal prism in the restored Centerville Slough tidal basin is much higher in volume than for an equivalently sized marsh with a marsh plain at MHHW. Therefore, use of the San Francisco tidal prism relationships will result in channel dimensions that are oversized for a mature marsh. The marsh area relationships have a similar problem. They assume that the tidal channel extends to above or near MHHW. Again, applying the channel dimensions developed from the marsh area method to a channel in a subsided marsh plain results in undersized channels.

To address issues with the subsided marsh plain, USFWS adopted a modified procedure to develop Centerville Slough tidal channel dimensions.

(1) The Project team developed an initial channel network configuration. The channel network consisted of a main stem Centerville Slough channel extending from the tidal basin outlet upstream to the Angels Camp levee. The main stem channel generally followed remnant channels (where present) and low areas in the tidal basin. Tributary channels were placed to distribute flow to the periphery and edges of the tidal basin, and to connect to inflow from upland tributaries. Channel meanders were designed to approximate channel patterns in historical maps.

(2) Tidal prism was computed for all channel confluences on the primary channels (Centerville Slough and Russ Slough) and at the outlets of all secondary and tertiary tributary channels.

(3) Channel dimensions (depth below MHHW, channel width at MHHW, and cross section area below MHHW) for the primary Centerville Slough and Russ Slough channels were computed using the San Francisco Bay tidal prism relationships. From these dimensions, the Project Team developed five-point parabolic channel shapes defined by two top of bank points located at MHHW, two bank toes, and a channel thalweg (Figure 10a). The section is constructed by defining the thalweg at an elevation equivalent to the depth below MHHW determined through San Francisco Bay tidal prism relationships. Top of bank points are located at MHHW spaced at the channel width specified by the San Francisco Bay tidal prism relationships. Bank toe depths below MHHW are set at 0.6 of the thalweg depth below MHHW. Bank and bed slopes are set to produce the specified cross section area below MHHW. In areas where the marsh plain elevation is above MHHW, top of bank points are extended at the bank slope to meet the marsh plain elevation. Channel side levees are constructed in areas where the marsh plain is below MHHW (Figure 10b). The levees will contain tidal flows within deep channels and promote effective sediment transport. Spring tides and flood flows overtopping the levees will flow onto the marsh plain and then return by flowing across the marsh plain to a tributary channel. This will encourage sediment deposition on low marsh plains and eventually raise the marsh plain elevations up to MHHW.

A set of design adjustments were made in the primary channel design when the computed channel depths extended to an elevation below -2.0 feet NAVD. There were concerns that deep channel excavation might be difficult or infeasible due to groundwater conditions in the excavation area. This might require extensive (and expensive) dewatering operations or treatments for water-logged soils. Primary channel design limited channel thalweg elevation to -2.0 feet. Cross section width was adjusted to provide the computed cross section area.

(4) Channel dimensions (depth below MHHW, channel width at MHHW, and cross section area below MHHW) for the tributary channels were computed using the San Francisco Bay tidal prism relationships. From these dimensions, the Project Team employed a trapezoidal channel defined by channel thalweg depth below MHHW, cross section area, and channel top width (Figure 11a). Top of bank points are located at MHHW spaced at the channel width specified by the San Francisco Bay tidal prism relationships. The channel bottom width dimension is adjusted to produce the specified cross section area below MHHW. In areas where the marsh plain elevation is above MHHW, top of bank points are extended at the bank slope to meet the marsh plain elevation. In areas where the marsh plain is below MHHW, the bank slopes are extended from the bank toes to meet the existing marsh plain (Figure 11b). Portions of the channels located in marsh plains below MHHW will be undersized, but flow can transport across the marsh plain (Temmerman et al. 2005). Sediment transport potential is low on the marsh plain where there is vegetation and slower velocities and shallower depths than tidal channels. It is expected that tributary channels will adjust size as the marsh plain accretes.

Tidal Lagoons

On the EREP property, there are large areas of the marsh plain that have subsided to elevations that range between three and five feet NAVD. The subsided areas produce large amounts of potential tidal prism. USFWS concluded that including these areas as part of the project tidal prism would greatly increase channel dimensions and project construction costs.

USFWS employed a design feature referred to as tidal lagoons to reduce the large contributions to tidal prism created by deeply subsided areas. Tidal lagoons replicate large open water features that are depicted on historical mapping of Centerville Slough (Figure 3). Tidal lagoons are constructed by constructing a wide berm with a minimum crest elevation set to MHHW. The berms tie into either high ground at the dune line to the west, or into the boundary levees on the east. The berms form permanently flooded water areas (lagoons) within the restored Centerville Slough tidal basin. Because the lagoons are permanently flooded to elevations at or above MHHW, they do not contribute volume to tidal prism. The berms will be overtopped by tidal flows during spring tides (about half the days of the year). The water exchange will prevent stagnation. The lagoons offer habitat benefits in creating permanent holding water for aquatic species including the endangered tidewater goby, as well as providing forage and habitat areas for avian species. A similar feature that was incorporated into the McDaniel Slough restoration at the Arcata Marsh provides nursery habitat for foraging fish, rearing habitat for tidewater goby wading, and habitat for migratory and resident waterbirds.

The tidal lagoons are depicted in Figure 13.

Centerville Slough Outlet Alternatives

The Concept Restoration Plan developed as part of the Feasibility Assessment presented three potential outlet options that routed flow from Centerville Slough into Cutoff Slough. The Feasibility Analysis recognized that the increased tidal prism might cause a negative impact on Cutoff Slough, and noted that further analysis was required to evaluate outlet alternatives.

Two outlet alternatives were evaluated in this analysis:

> Outlet Alternative 1: Flow from Centerville Slough would enter Cutoff Slough a short distance downstream of the Cutoff Slough tide gate (Figure 12).
>
> Outlet Alternative 2: Outlet Alternative 2 was developed to provide an alternative in case it was determined that routing Centerville Slough into Cutoff Slough would generate adverse impacts to water levels in Cutoff Slough and Salt River. Outlet Alternative 2 routes Centerville Slough directly to the Eel River Estuary by generally following the path of an existing channel located in the Outer Marsh (Figure 12). The existing channel would require enlargement to provide the required flow capacity. The outlet channel has a cross connection to lower Salt River (the reach between Cutoff Slough and the Eel River) through Jack Slough.

Evaluation of tidal prism for the restored Centerville Slough channel confirmed that Cutoff Slough does not have flow capacity to accept tidal exchange from a restored Centerville Slough tidal basin. Preliminary estimates for the restored Centerville Slough at the point where it would enter Cutoff Slough yielded a tidal prism of 580 acre-feet. Table 7 lists the corresponding channel dimensions for the tidal prism developed using San Francisco Bay tidal prism relationships. Table 7 also lists the range of channel dimensions for Cutoff Slough and Salt River Slough. The channel dimensions of the receiving channel (Cutoff Slough and Salt Slough) are 1/6 to 1/3 of the predicted tidal channel dimensions for the restored Centerville Slough. Routing the restored Centerville Slough tidal exchange into Cutoff Slough would likely raise the minimum water surface elevation in Cutoff Slough and restrict drainage from adjacent lands draining to Cutoff Slough including the O'Rourke Foundation. Minimum water surface elevations in the Salt River would also increase which would negatively impact drainage from Smith Creek, Riverside Ranch, and upper Salt River.

TABLE 7: COMPARISON OF RECEIVING CHANNEL WITH ESTIMATED CHANNEL DIMENSIONS FOR OUTLET ALTERNATIVE 1 - CUTOFF SLOUGH OUTLET			
LOCATION	RESTORED CENTERVILLE SLOUGH AT CUTOFF SLOUGH OUTLET	CUTOFF SLOUGH BELOW CUTOFF SLOUGH TIDE GATE	SALT RIVER SLOUGH BELOW SALT RIVER/CUTOFF SLOUGH CONFLUENCE
WIDTH AT MHHW (FT)	228	55 – 65	65 -75
DEPTH BELOW MHHW (FT)	13.7	8 - 10	12 - 14
CROSS SECTION AREA (FT^2)	1930	340 -350	570 -680

The Project Team determined that Centerville Slough Outlet Alternative 1 is infeasible because of the potential to adversely impact adjacent properties not within the Project Area. Outlet Alternative 2 (routing Centerville Slough directly to the Eel River Estuary) was selected as the preferred outlet alternative. No further analysis was made of Alternative 1.

Centerville Slough Channel Size Alternatives

Potential Project construction costs are largely driven by the amount of channel excavation that will be required. USFWS developed three channel sizing alternatives to evaluate if potential Project construction costs could be reduced. Channel sizing requirements were adjusted by altering the target MLLW for Angels Camp. Higher target MLLW values reduce total tidal prism, and thus excavation quantities. The three alternatives are:

- Channel Alternative 1: Angels Camp Target MLLW = 4.0 feet NAVD – MHHW 6.8 feet NAVD
- Channel Alternative 2: Angels Camp Target MLLW = 3.0 feet NAVD – MHHW 6.8 feet NAVD
- Channel Alternative 3: Angels Camp Target MLLW = 1.7 feet NAVD – MHHW 6.8 feet NAVD

Alternative 3 is set to the measured MLLW at the Cutoff Slough tide gate (Table 1).

Channel Design

Preliminary tidal prisms were calculated for each channel junction and for each alternative using the specified tide range and the Base Proposal surface model. Initial channel dimensions were computed using the San Francisco Bay tidal prism relationships. USFWS developed preliminary grading plans using the calculated channel dimensions and the procedure for tidal channel design presented above. The Base Proposal surface model was modified to reflect the channel design. Tidal prisms were recalculated, and the grading plans updated. The procedure was repeated until there was no change in channel dimensions. Typically, this required only two iterations.

Grading Adjustments

Potential construction costs are largely a function of the amount of proposed channel excavation associated with the selected alternative. As discussed in the development of the channel sizing alternatives, design features that reduce tidal prism reduce required channel dimensions and excavation quantities, and thereby potentially reduce potential Project construction costs. USFWS developed two sets of grading adjustments intended to reduce tidal prism, and thereby reduce project construction costs:

Tidal Basin Fill:
USFWS developed fill areas within the restored Centerville Slough tidal basin to reduce tidal prism. Channel excavation will generate large amounts of spoil. Some of the spoil will be used to construct levees and the dune berms. The remainder is available to construct fill areas. Fill can also be used advantageously to raise the final surface elevations of areas within the restored Centerville Slough tidal basin to elevations that will support tidal marsh vegetation.

USFWS followed several strategies to select areas for fill placement:

- The first strategy was to place fill only at elevations below MHHW. Fill placed above MHHW would be ineffective in reducing tidal prism.

- The second strategy was to place fill as much as possible in upstream areas within the restored Centerville Slough tidal basin. Reducing tidal prism in upstream areas reduces channel size requirements in downstream areas. Effectively, this is an optimization step to minimize required channel excavation quantities.

- The third strategy was to place in areas that were already close to MHHW. This maximizes the areas that are capable of developing tidal marsh vegetation in the constructed Project. For example, one cubic yard placed at one foot depth can create 27 square feet of tidal marsh, whereas one cubic yard placed at three feet depth creates only nine square feet of tidal marsh.

The resulting distribution of fill areas is shown in Figure 13. In Angels Camp where ground elevations generally range between four to six feet NAVD, fill was placed on the basin periphery where ground is generally higher. Fill was also placed to create ridges between channels in Angels Camp with the intent of providing additional protection against overwash sand deposition within the channel network.

There is a broad plain of higher ground located north of the Angels Camp basin formed by the Russ Creek alluvial fan. Ground elevations in this area are at or above MHHW. The north side of the fan tapers off to subsided ground that is several feet below MHHW. Fill was placed on the north side of the fan where the ground is one to two feet below MHHW.

Surface Development

USFWS modified the Base Proposal model to incorporate the three channel design alternatives, grading areas, and the tidal lagoons. Figure 14 depicts the proposed surface elevation model for Channel Alternative 3.

ANALYSIS SCENARIOS

Existing Conditions Model Validation

Modeling Objectives

The objective of the Model Validation analysis is to evaluate how well the Existing Conditions model is able to simulate observed events. Typically, hydraulic models will be calibrated to observed data by adjusting hydraulic roughness and model geometry. USFWS did not calibrate the Existing Conditions model because there was insufficient data to support model calibration. While there are observed stages at several locations within the model domain, there are no measured streamflow data. Streamflow data in the model was developed through synthetic means. Further, model bathymetry is of various quality and may be inaccurate. Some areas have detailed, reliable bathymetry, while the bathymetry is coarse in other areas.

Because there was insufficient data to support model calibration, USFWS prepared a model validation. Model validation is the process of evaluating if the model provides reasonable results for the study area. When validating a model, reliable data should be utilized to check the model results. The validation process can give valuable insight into model performance when you cannot complete full calibration.

Model Validation

Model validation for existing condition was performed by preparing a simulation of the period February 10 to March 1, 2019. Pertinent boundary conditions for this period are displayed in Figure 15. During this period, there were several operating stage gages located within the model domain. Figure 16 compares the computed and observed stages below the Cutoff Slough tide gate. Figure 17 compares the computed and observed stages at a location in the Salt River just below the upper Riverside Ranch entrance channel.

The computed water surface elevations at Cutoff Slough below the tide gate and in the Salt River at the upper Riverside Ranch inlet channel are in close agreement with observed water surface elevations. The computed timing of tidal minimum and maximum stages closely matches observed conditions. Maximum computed stages are generally within a tenth or two of observed stages. Minimum stages in the Salt River are not well simulated. The computed minimum stages appear to be limited to about 2.7 feet whereas observed minimum stages in the Salt River fell below 2.0 feet. Bathymetry for the Salt River channel is based on as-built conditions at the completion of the Riverside Ranch phase of the Salt River Restoration Project (2014). It is possible that the channel has down-cut since then allowing for lower minimum water surfaces.

USFWS concluded that the Existing Conditions model provides a reasonable simulation of observed water surface elevations and tidal patterns. The Existing Conditions model provides an effective baseline to evaluate the effects of proposed conditions on the Centerville Slough tidal basin and adjacent drainages.

Spring Tide Analysis

Modeling Objectives

The Spring Tide scenario is a six-day simulation period in November 2018 when spring tides were occurring (Figure 18). During this scenario, the higher tide stages at the Eel River boundary exceed 9.0 feet NAVD and minimum tide stages drop below 1.0-foot NAVD 1988. This scenario was selected to

evaluate the potential range of water surface elevations under proposed conditions for Channel Alternatives 1, 2, and 3. The scenario was also selected to evaluate the three Centerville Slough channel alternatives and Project Performance Objectives 1, 2, and 6:

1. *Restore Centerville Slough to a self-maintaining, fully connected tidal channel network with full tidal range that extends from Angels Camp to outlets at Cutoff Slough or the Eel River.*

2. *Establish tidal marsh hydrology and ground elevations suitable for passive tidal marsh restoration in designated area of NRCS wetland reserve easements.*

6. *Maintain equivalent riverine and tidal flows and stages on adjacent lands. Adjacent lands include the lands in the Centerville Slough basin owned by the O'Rourke Foundation and other private landowners, land bordering the Salt River that share the channel draining Cutoff Slough and the Salt River to the Eel River, and a private property located between the south end of Angels Camp and Centerville Road (South Angels Camp Basin).*

Channel Alternative Evaluation

HEC-RAS was run using the boundary conditions shown in Figure 18 and using geometry files based on the three Channel Alternatives. Figure 19 displays computed water surface profiles for the three Channel Alternatives when the stage in the Eel River Estuary was at a lower low tide of 2.12 feet NAVD 1988. This level is slightly higher than MLLW. There is a clear difference in water surface profiles among the three Channel Alternatives. The stages at Angels Camp for Channel Alternatives 1 and 2 are over a foot higher than for Channel Alternative 3.

Figure 20 shows the water surface profiles for the three Channel Alternatives at a point in time two hours later after the profiles shown in Figure 19. This represents the point in time when lowest water levels are experienced at Angels Camp following the lower low tide in the Eel River Estuary. There is about two hours travel time for the tidal wave to transmit up the 24,000-foot-long Centerville Slough Channel. Again, there are distinct differences between the three Channel Alternatives. Channel Alternative 3 minimum tide was 2.42 feet which is only 0.30 feet higher than the corresponding minimum tide in the Eel River Estuary. Channel Alternatives 1 and 2 minimum tides were respectively 1.24 feet and 1.00 foot higher than the corresponding minimum tide in the Eel River Estuary.

Figures 21 and 22 depict a similar set of the water surface profiles for the extreme low tide on of 0.94 feet in the Eel River Estuary. The minimum tide for Channel Alternative 3 at Angels Camp is 0.60 feet lower than the minimum tide for Channel Alternative 2 and 0.82 feet lower than the minimum tide for Channel Alternative 1.

Figure 23 shows the water surface elevations for Angels Camp over the period of the simulation. The water surface elevation for the Eel River Estuary is shown for reference. The tidal lag between the Eel River and Angels Camp is about two hours for all Channel Alternatives. Channel Alternative 3 has the largest tidal range of the three channel alternatives, but a smaller tidal range than the tidal stages at the Eel River Estuary boundary.

Figure 24 compares the water surface elevations at Cutoff Slough below the tide gate for Existing and Proposed Conditions. There is little difference in the water surface elevations between the three channel alternatives. Also, there are insignificant differences between Existing and Proposed Conditions.

Discussion

All three Channel Alternatives re-establish tidal marsh hydrology with similar elevation ranges for establishing tidal marsh vegetation (Performance Objective 2). The results show that Channel Alternative 3 is the most effective alternative for restoring full tidal range at Angels Camp (Performance Objective 1). Achieving low water elevations in Angels Camp is critical to allow water to drain from the South Angel Camp Basin (the low area south of the Angels Camp Levee) and from the off-easement areas of Shaw Creek and Creamery Ditch located on private land east of the East Boundary Levee. The area behind the levees at Angels Camp can only drain as low as the minimum elevations in Angels Camp. Channel Alternative 3 drains Angels Camp to lower elevations and drains more quickly to low elevations than the other two alternatives. Figure 24 shows that all three channel alternatives will maintain equivalent riverine and tidal flows and stages on adjacent lands, satisfying Project Performance Objective 6.

Channel Alternative 3 best satisfies Project Performance Objectives 1, 2, and 6. Therefore, it was selected as the preferred Channel Alternative. Further analyses of proposed conditions (presented below) evaluate only Channel Alternative 3.

Eel River Backwater Flood

Modeling Objectives

The objective of the Eel River Backwater Flood is to evaluate the changes in drainage patterns created by restoring Centerville Slough during a major Eel River flood. The Eel Backwater Flood scenario simulates the February 15, 2019 Eel River Flood Level Event and the February 27, 2019 Extreme Flood Level event. Boundary conditions are shown in Figure 25. Inflow hydrographs were developed using the synthetic methods discussed above and are intended to replicate actual rates of discharge.

The scenario allows evaluation of Project Performance Objectives 3 and 6:

3. *Enhance adjacent agricultural lands by preventing flooding by tidal waters, Eel River floods, and dune overwash, and by enhancing flood drainage from upland tributaries.*

6. *Maintain equivalent riverine and tidal flows and stages on adjacent lands. Adjacent lands include the lands in the Centerville Slough basin owned by the O'Rourke Foundation and other private landowners, land bordering the Salt River that share the channel draining Cutoff Slough and the Salt River to the Eel River, and a private property located between the south end of Angels Camp and Centerville Road (South Angels Camp Basin).*

Maximum Water Surface Elevation

The maximum water surface elevations and extent are shown in Figure 25 for Existing Conditions and in Figure 26 for Proposed Conditions.

Under Existing Conditions, all of the area north of the Inner Marsh Levee, the existing Cutoff Slough Levee, and the Mill Creek levee are flooded with water surface elevations of 11.5 to 12.0 feet NAVD 1988. The levees prevent Eel River flooding into the Inner Marsh, EREP and lands within the levee network. However, inflow from upland tributaries is trapped causing widespread flooding in the low areas near the levee and in Angels Camp. The O'Rourke Foundation and the northern part of the EREP are flooded to a maximum elevation of about 5.5 feet. Angels Camp is flooded to a maximum elevation of 7.4 feet.

Under Proposed Conditions, flood levels in the Eel River Estuary and Salt River are similar. Because of the Inner Marsh levee removal, the Eel River can back-flood Centerville Slough all the way south to the new Angels Camp Levee. Water levels are decreased in the areas north of the Russ Creek tide gate and east of the East Boundary Levee because these areas no longer would receive flow from lower Russ Creek. Maximum flood levels in the O'Rourke Foundation drop to 4.2 feet. There are increases in water surface elevations at the mouth of Shaw Creek and Creamery Ditch due to closure of tide gates during peak flooding. Similarly, peak water levels in the South Angels Camp Basin increase because the tide gate remains closed during peak flooding. Importantly, the new Angels Camp Levee prevents the Eel River backwater from moving south. This prevents flooding of a low-elevation section of Centerville Road adjacent to the South Angels Camp Basin.

Wet Season Water Levels

Long term water levels in South Angels Camp Basin are shown for the period of the Eel River backwater Flood in Figure 27. Although maximum flood levels will increase under Proposed Conditions, water levels are lower on average over the long run because drainage from Angels Camp Basin to the north is improved by constructing the new Centerville Slough channel.

Long term water levels at the confluence of Shaw Creek and Creamery Ditch are shown for the period of the Eel River backwater Flood in Figure 28. The results are similar to South Angels Camp Basin. Peak flood levels are higher, but long-term day-to day peaks are lower.

Discussion

The Proposed Project will provide improved drainage from lands adjacent to the Project Area that drain to the Cutoff Slough tide gate. There are no changes to water levels in Cutoff Slough below the tide gate and in the Salt River. Large Eel River flood events have the potential to temporarily raise water levels in South Angels Camp Basin, Shaw Creek, and Creamery Ditch. Temporary increases in water levels are offset by improved drainage between flood events and generally lower average water level on the surface.

Upland Flooding Analysis

Modeling Objectives

The primary objective of the upland flooding analysis is to evaluate performance of the Russ Creek tide gate design. Secondary objectives are to examine effects of the proposed design on drainage from the other upland tributaries. There are three modeling scenarios:

- A two-year return period flood in upland tributaries occurring simultaneously with an Eel River Flood Event;
- A five-year return period flood in upland tributaries occurring simultaneously with an Eel River Flood Event; and
- A ten-year return period flood in upland tributaries occurring simultaneously with an Eel River Flood Event.

The February 10-18, 2019 Eel River Flood Event was used as the Eel River boundary condition (Figure 29). Inflow hydrographs for the upland tributaries were developed using the synthetic hydrograph methods discussed above. Figure 29 shows the two-year, five-year, and ten-year return period

hydrographs for Russ Creek. Hydrographs for the other upland tributaries are the same shape with magnitude scaled to drainage area.

The scenario was also selected to evaluate performance in meeting Project Performance Objectives 3 and 6:

3. *Enhance adjacent agricultural lands by preventing flooding by tidal waters, Eel River floods, and dune overwash, and by enhancing flood drainage from upland tributaries.*

6. *Maintain equivalent riverine and tidal flows and stages on adjacent lands. Adjacent lands include the lands in the Centerville Slough basin owned by the O'Rourke Foundation and other private landowners, land bordering the Salt River that share the channel draining Cutoff Slough and the Salt River to the Eel River, and a private property located between the south end of Angels Camp and Centerville Road (South Angels Camp Basin).*

Russ Creek Results

Figures 30, 31, and 32 show the distribution of flow in Russ Creek between lower Russ Creek, and the east and west side overflows for the two-year, five year, and ten-year floods. Under Existing Conditions, Russ Creek overtop its banks in its upper reaches of the study area when discharge exceed approximately 160 cfs. Flows overtopping the west bank drain towards Creamery Ditch, Shaw Creek, and eventually reach Angels Camp. Flows overtopping the east side flood the low-lying lands adjacent to the Smith Creek Levee and eventually into ditches that drain to the Cutoff Slough tide gate. Flow staying in Russ Creek eventually is routed towards the Cutoff Slough tide gate.

Under Proposed Conditions, water overtopping the west bank flow towards Creamery Ditch and Shaw Creek, and into the exterior levee ditch at the East Boundary levee. From there flow into Angels Camp must pass through two tide gates in the East Boundary levee. Flows overtopping the east side route in the same manner as Existing Conditions. Flows staying in Russ Creek pass through the Russ Creek tide gate and into the restored Centerville Slough tidal basin.

There are some minor differences in the flow distribution between existing and Proposed Conditions. The amount of flow staying in Russ Creek is relatively the same except for when the Eel River backwater exceed about nine feet elevation, which reduces the Russ Creek flow capacity down to about 140 cfs. There is a slight change in the distribution of overflow between the east and west sides. Under Proposed Conditions, there is an increase in overflow to the west side and a corresponding reduction in overflow to the east side.

Shaw Creek and Creamery Ditch

Under Proposed Conditions, flows overtopping the west side of Russ Creek must pass through the new East Boundary levee. Figure 33 shows the water levels at the location of the exterior side of the Shaw Creek tide gate in the East Boundary levee for existing and Proposed Conditions. Under Existing Conditions, overflow water collects in the Angels Camp basin and drains out slowly. Water levels drop only a few tenths of a foot a day. Under Proposed Conditions, there is an increase in peak water surface elevations on the east side of the levee, but water levels drop quickly at a rate of about one foot per day. Flooding drops back into the drainage ditches within three days.

Cutoff Slough

Model results indicate significant improvement in water levels for the areas that will still drain towards the Cutoff Slough tide gate. The area draining to the tide gate will be reduced. The flow remaining in Russ Creek will flow into the restored Centerville Slough tidal basin. Figure 34 shows the effects on water levels upstream of the Cutoff Slough tide gate. Under Existing Conditions, large upland flooding during an Eel River Flood Event would result in peal water levels upstream of the gate of 5.5 to 7.5 feet. Under Proposed Conditions peak water levels are one foot lower for the two-year event, and 2.5 feet lower for the ten-year event.

South Angels Camp Basin

Water surface elevations for the South Angels Camp basin are shown in Figure 35. Rising limbs of the flood hydrographs are similar. Flood peaks from upland tributary floods are slightly higher for Proposed Conditions, but water levels recede much quicker following the flood peaks. Water levels are two feet lower four days after flood peaks because the restored Centerville Slough tidal network is able to drain Angels Camp much quicker than Existing Conditions.

Discussion

The Russ Creek tide gate will improve conditions for the low-lying areas located between the new Centerville levees (East Boundary Levee and enhanced Cutoff Slough levee) and the Smith Creek levee. Drainage capacity of Russ Creek remains about the same. The new Russ Creek tide gate is capable of conveying the two-year, five-year, and ten-year Russ Creek floods without significant impacts to adjacent lands in and outside of the Project Area. The analysis shows that Project Performance Objectives 3 and 6 are satisfied.

Sea Level Rise Analysis

Introduction

Several different approaches have established that the rate of global sea level rise (SLR) in the 20th century were between 1.3 and 1.8 mm per year (mm/yr) and that since 1990 the rate of global SLR has more than doubled (IPCC 2014). In California, rising sea levels will increase flooding of low-lying coastal areas and increase shoreline and cliff erosion (Griggs et al., 2017). Estimates of the magnitude and rate of future SLR are varied depending on future assumptions about climate change policy and assumptions about physical processes driving SLR. Although estimates vary, it is certain that sea levels will continue to rise and at increasing rates of rise (Griggs et al., 2017). Therefore, design of projects in the coastal zone should evaluate potential impacts of SLR on project success.

It is difficult to provide accurate quantitative assessment of SLR impacts because there are strong interactions between and feedback among physical and biological processes. In this report, SLR impacts are evaluated qualitatively. Local projections of SLR rates are presented to establish the magnitude of potential local SLR. Potential physical and biological responses to SLR are discussed based on local observations and research. A final discussion is presented assessing the resiliency of the Centerville Slough tidal basin to SLR under existing and proposed conditions.

Local Sea Level Rise Projections

Local rates of SLR are driven by a combination of changes in regional sea level and by local vertical land movement. Patton et al. (2017) evaluated local rates of vertical land movement in the Humboldt Bay region. They established that vertical land movement (or uplift rate) in most of the Humboldt Bay region was negative (i.e., downward movement). Negative uplift rates increase the net rate of local SLR. The

most negative local uplift rates are located at Hookton Slough in southern Humboldt Bay, where uplift rates are between -3.0 and -4.0 millimeters per year (mm/yr). Patton et al. (2017) focused on tidal gages in Humboldt Bay, but they also resurveyed a level line across the Eel River valley along the US-101 highway corridor between Fernbridge and Scotia, CA. At Fernbridge, the uplift rate is between -3.0 and -2.0 mm/yr indicating downward movement. Uplift rates increased moving up-valley becoming positive near Fortuna, CA. At Scotia, CA uplift rates are between 2.0 and 3.0 mm/yr. Although direct measurements have not been made in the Centerville Slough area, it is inferred from Patton et al. (2017) that vertical movement in the Eel River Estuary is downward, leading to heighten rates of local SLR.

There are numerous scenarios for projecting future SLR rates that are based on differing assumptions about global climate change, physical response to climate change, and climate change adaptation policies. Representative Concentration Pathways (RCP) are a set of greenhouse gas concentration scenarios developed by IPCC (2014) to evaluate potential climate change futures. RCP 8.5 represents a "business as normal" approach and generally used to describe a worst-case scenario. RCP 4.5 is described by IPCC (2014) as an intermediate scenario. The resultant projections of SLR rates for 2050 are similar for most RCP scenarios (Griggs et al. 2017). After 2050, the RCP projections start to diverge because of differing assumptions about carbon emission levels.

Anderson (2018) developed projections of local SLR rates for the Humboldt Bay region by combining estimates of regional SLR rates with Patton et al. (2017) estimates of vertical land movement. Table 8 lists the median (50% probability) projections of local SLR developed by Anderson (2018) for RCP 4.5 and 8.5.

TABLE 8: LOCAL MEDIAN SEA LEVEL RISE PROJECTIONS FOR HUMBOLDT BAY REGION
(SOURCE: ANDERSON 2018, TABLE 7)

SEA LEVEL RISE IN FEET RELATIVE TO YEAR 2000 MEAN SEA LEVEL

LOCATION	MAD RIVER SLOUGH		NORTH SPIT		HOOKTON SLOUGH	
YEAR	RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5	RCP 4.5	RCP 8.5
2030	0.52	0.52	0.69	0.69	0.79	0.79
2050	0.95	1.02	1.25	1.31	1.41	1.48
2100	2.23	2.76	2.79	3.31	3.12	3.64
2150	3.48	4.56	4.30	5.35	4.79	5.87
2200	4.79	6.66	5.87	7.74	6.53	8.43

Projected changes in tidal datums for Cutoff Slough below the existing tide gate are presented In Table 9. The projections assume an increase in mean tide level based on the Anderson (2018) projections and no change in the mean tidal range (MHW -MLW). That is, all datums are increased by the projected change in mean sea level.

TABLE 9: CUTOFF SLOUGH TIDAL DATUMS -PROJECTED CHANGES OVER TIME							
TIDAL DATUM	EXISTING 2019 [2]	RCP 4.5			RCP 8.5		
		2030	2050	2100	2030	2050	2100
CHANGE IN DATUM FROM 2019 (FEET)[1]	0.00	0.25	0.81	2.35	0.25	0.88	2.88
TIDAL DATUM ELEVATIONS IN FEET NAVD 1988							
MEAN HIGHER HIGH WATER (MHHW)	6.80	7.05	7.61	9.15	7.05	7.68	9.68
MEAN HIGH WATER (MHW)	6.18	6.43	6.99	8.53	6.43	7.06	9.06
MEAN TIDE LEVEL (MTL)	4.36	4.61	5.17	6.71	4.61	5.24	7.24
MEAN LOW WATER (MLW)	2.54	2.79	3.35	4.89	2.79	3.42	5.42
MEAN LOWER LOW WATER (MLLW)	1.75	2.00	2.56	4.10	2.00	2.63	4.63

Notes:
1) Median (50%) local SLR projections for North Spit developed by Anderson (2018).
2) Base tidal datums for Cutoff Slough below tide gate from Table 1.

The assumption that the tidal range does not change may not be valid. Du et al. (2017) concluded from conceptual models that in estuaries with large amounts of low-lying areas relative to channel area (such as the Eel River Estuary) mean tidal range is likely to decrease as sea level increases. Devlin et al. 2017 estimated tidal range changes accompanying 1m SLR using tidal constituents from tidal gages in the Pacific Ocean including NOAA tidal gages at San Francisco and Crescent City, CA. They found a significant decrease (147 mm/m) in range at San Francisco which they attributed partially to the large river input from the Sacramento River system. They found a decrease of 48 mm/m at Crescent City, which they did not consider significant because it fell below a threshold of 50mm/m. Decrease in tidal range would have two effects. High tides may not increase as much as projected reducing flood impacts. Low tides may be higher than projected increasing chronic flooding of low-lying areas from inhibited drainage and elevated groundwater levels.

Sea Level Rise Impacts

There are several potential impacts created by rising sea levels for the Project Area. The first is increased peak water surface elevations during high tides and flood events. The existing levees at the Inner Marsh and Cutoff Slough have a minimum crest elevations about 12.0 feet NAVD 1988. The proposed levee crests in the Centerville Slough restoration project will have a minimum crest elevations of 14.0 feet NAVD 1988. Even under the worst-case RCP 8.5 scenario, the existing and proposed levees are unlikely to be overtopped by increased tides until after 2100.

Increased sea levels are likely to increase peak water surface elevations in the Eel River Estuary during major Eel River floods. Higher tide levels at the Eel River mouth will increase flood water levels in the Eel River from the mouth to above Fernbridge. Assuming that the increases in flood levels in the estuary are equivalent to the projected SLR for the RCP 4.5 and 8.5 scenarios, floods equivalent to the 2019 Eel River

flood (11.8 feet NAVD 1988 - Figure 15) would overtop the existing levee system at Centerville Slough prior to 2050. Overtopping of the proposed new system of levees under a flood equivalent to the 2019 Eel River would not occur before 2050, but would have the potential to occur sometime prior to 2100. With the projected increases in sea levels in 2100, a flood equivalent to the 2019 Eel River Flood would overtop the proposed levees by 0.2 feet under RCP 4.5 and by 0.7 feet under RCP 8.5.

Levee overtopping would be a rare event occurring with the frequency of major Eel River floods. A persistent and chronic impact is the rise in minimum tide levels that would occur as mean tide levels rise. Under existing conditions, there is only a short time interval near minimum tides when water levels in Cutoff Slough are low enough to allow water to drain from the system of ditches upstream of the tide gate. As SLR occurs in the Eel River Estuary, minimum water levels will rise in the ditch system and groundwater elevations in low lying areas will increase.

The impact of rising minimum tide levels on existing conditions is depicted in Figure 36. The elevation of MLW under RCP 8.5 is used as a surrogate to indicate areas of permanent flooding. This projection assumes that there is no change in existing ground elevations, which is a worst-case scenario. (Ground elevation responses to sedimentation and vegetation growth are discussed below). There are minor increases in flooding by 2030. By 2050, there is an increase in flooding in the north areas of the Centerville Slough located within the existing system of levees. By 2100, most of the northern part of the basin, the Angels Camp Basin, and the lower portions of Shaw Creek and Creamery Ditch would be permanently flooded. The land adjacent to Mill Creek (between Salt River and the existing levee) also will become permanently flooded by 2100. Note that permanently flooded areas in Riverside Ranch and the Outer Marsh remain somewhat unchanged. Figure 37 shows projected areas flooded by MLW under RCP 8.5 for proposed conditions. The results are similar, but there are some significant differences. Placement of fill within the restored Centerville Slough tidal basin reduces the area impacted by rising MLW. The areas occupied by tidal lagoons are permanently flooded by design.

Biological and Physical Responses to Sea Level Rise

Salt marshes are dominated by plant communities that have varying tolerance to tidal inundation and salinity resulting in zonation of plants along elevation gradients (Mancera et al., 2005). Eicher (1987) evaluated location of salt marsh plant species in Humboldt Bay and found strong relationships between species presence and elevations relative to tidal datums. Eicher found that pickleweed (Salicornria virginica) starts to establish between just below MHW, and that a diverse community of salt marsh species occupied elevations above MHHW. Work by Takekawa et al. (2015) conducted at seven sites in Humboldt Bay produced similar results. Similar surveys were conducted in the Outer Marsh by GHD (2018) to establish salt marsh vegetation elevation relationships (Figure 38) for EREP. The relationship between species presence and elevation relative to tidal datums provides a means of projecting where salt marsh vegetation will flourish as a tool in restoration design and also for evaluation of SLR impacts.

Initial assessments of salt marsh response to rising sea levels assumed static conditions under which led to projections that salt marshes worldwide would succumb to drowning by too frequent inundation (Kirwan et al., 2010). Salt marshes are dynamic systems, however, that possess significant capacity to adjust to SLR through non-linear feedback responses. Cahoon et al. (2020) reviews mechanisms by which salt marsh vegetation responds non-linearly to SLR to maintain vertical position relative to changes in tide levels. Salt marshes increase soil surface elevations by increasing mineral sediment deposition and retention, increasing soil volume through production of roots and rhizomes, and creating resistance to soil compaction and erosion.

The response of salt marsh vegetation to SLR is non-linear (Cahoon et al., 2020). Vertical accretion and soil bulking processes constantly work to reach an equilibrium level with sea level. When at equilibrium, vertical accretion processes are at a minimum. Marsh flooding is limited, limiting the opportunity for sediment capture. Root and rhizome growth is at a minimum. As the depth of inundation increases, primary productivity of salt marsh vegetation increases which allow ground elevations to increase more rapidly with increasing rates of SLR (Morris et al., 2002). Sedimentation rates also increase with depth and duration of tidal flooding (Kirwan et al., 2010). The combined response allows salt marsh vegetation to respond reestablish equilibrium at rates matching the rate of local SLR.

There is a threshold SLR rate above which the rate of SLR exceeds the maximum rate of vertical elevation gain that can be produced by the combination of local sedimentation and vegetation response. If local SLR exceeds the threshold rate, the salt marsh will suffer hypoxia and die-off. Kirwan et al. (2010) used five different models to develop an estimated rate of 10mm/yr as the threshold SLR rate for estuaries with tidal ranges greater than 1m and suspended sediment concentrations greater than 20 mg/L.

The tidal range and sediment concentrations in the Project Area satisfy and exceed the Kirwan et al. (2010) criteria. The tidal range at Cutoff Slough exceeds 1m (Table 1). The Eel River has one of the highest rates of sediment supply relative to area of any North American river (Brown and Ritter, 1971). Suspended sediment concentration measured in the Eel River at Scotia (USGS Gage 11477000) exceed 20 mg/L 82% of the time, 100 mg/L 60% of the time, and 200 mg/L 25% of the time (Warrick et al., 2012). Curtis et al. (2021) projects that suspended sediment loads for the Eel River will increase 53% by 2050 and 99% by 2100 from baseline levels (1981-2010) due to climate change driven increases in precipitation intensity and magnitude.

The projected rates of local SLR are high and in the range of exceeding the Kirwan et al. (2010) 10 mm/yr threshold rate for marsh drowning. The projected local SLR rates are below 10 mm/yr for RCP 4.5 and below 10 mm/yr until 2050 for RCP 8.5 (Table 10).

TABLE 10: AVERAGE ANNUAL RATE OF SEA LEVEL RISE AT NORTH SPIT

PERIOD	AVERAGE ANNUAL LOCAL SEA LEVEL RISE RATE (mm/yr) SOURCE: ANDERSON (2018)	
	RCP 4.5	RCP 8.5
2020-2030	7.0	7.0
2030-2050	8.5	9.5
2050-2100	9.4	12.2
2100-2150	9.2	12.4
2150-2200	9.6	14.6

Although local SLR rates are close to the Kirwan et al. (2010) threshold for marsh drowning, other factors suggest that salt marshes in the Eel River Estuary should be able to maintain a surface elevation within the range where salt marsh vegetation can persist. The sediment supplied by the Eel River is very high. During Eel River floods, sediment concentrations are large, and flows spread out across the marsh plain creating conditions where large amounts of sediment can deposit. The ability of the Eel River to supply sediment to build and maintain salt marshes is demonstrated by historical observations of sediment deposition within the estuary:

- Prior to 1964, the Outer Marsh had been managed as a diked and drained pasture. The perimeters levees were breached by the 1964 flood. The landowners at the time decided to abandon the Outer Marsh and to construct the existing Inner Marsh levee. This action opened up the Outer Marsh to sediment deposition from the Eel River. Prior to 1964, the Inner Marsh and Outer Marsh possessed similar ground elevations. Subsequent sedimentation since 1964 in the Outer Marsh raised the marsh plain sufficiently so that it now supports high marsh vegetation and contains areas with elevations above tidal influence that support willows and alders. The Inner Marsh, which was isolated from Eel River sediment supply, continued to subside and is now at an elevation close to MLW.

- The Ocean Ranch Unit of the Eel River Wildlife Area is located on the north side of the Eel River Estuary. Review of historical maps and aerial photos demonstrated that approximately 15 acres of new salt marsh developed on former mud flat between 1942 and 1970 because of conditions favorable to trapping sediment from the Eel River (Ducks Unlimited, 2015).

Discussion

Local SLR rates in the Eel River Estuary are high and the rates are projected to increase. Although there is uncertainty in specific magnitude and timing of local SLR, there is certainty that SLR will occur. The Project's proposed system of new levees and rehabilitated levees will prevent flooding of areas behind levees increased levels of high tides driven by SLR for the foreseeable future. Over time, local SLR will increase the elevation of Eel River floods within the estuary. Eel River floods are likely to start overtopping existing levees in the short term (10-30 years). The new levee system will provide two additional feet of protection, which will prevent levee overtopping from Eel River floods in the short term, but the levels may experience overtopping in the long term (100-200 years).

A larger concern is that local SLR will cause chronic flooding of low-lying areas. Low lying areas behind levees will be the most impacted because they lack sediment supply to allow vertical accretion to raise ground levels. Low lying areas with access to Eel River sediment will be more resilient to local SLR because of the potential for ground elevation increase from sedimentation and vegetation growth. Maintaining existing conditions will likely lead to eventual drowning of low-lying area behind existing levees. Restoring Centerville Slough will provide low lying areas within the Project Area access to beneficial sediment from Eel River flooding. The combination of sediment and vegetation response will allow the salt marshes to maintain integrity despite projected rapid rates of local SLR.

CONCLUSIONS

Selected Alternatives

The Preliminary Hydraulic Analysis evaluated alternatives for locating the outlet of the Restored Centerville Slough channel network and alternatives for sizing the constructed tidal channels.

It was determined that routing Centerville Slough into an outlet on Cutoff Slough would likely impair drainage from lands that will drain through the Cutoff Slough tide gate and lands draining into the Salt River. Therefore, an outlet channel directly connected to the Eel River Estuary and routed to the west side of the Outer Marsh was chosen as the preferred outlet alternative.

Three channel sizing alternatives were evaluated. Channel Alternative 3, which employs a tidal range of 1.7 to 6.8 feet NAVD 1988, performed the best of the three alternatives in meeting the Project Performance Objectives. Channel Alternative 3 will require the largest excavation volume of the three alternatives, but it offers superior benefits for draining exterior areas draining through the levees, providing an unmuted tidal regime, and sediment transport.

Project Performance Objective

The hydraulic models and additional analyses were used to simulate and evaluate several scenarios:

- A hydraulic model validation demonstrated that the hydraulic models could well simulate observed water level records.

- A simulation of a high-amplitude spring tide was prepared to evaluate the performance the proposed project in restoring tidal flows in Centerville Slough and establishing suitable tidal marsh hydrology. The model results showed that the Centerville Slough tidal network could rapidly drain flows from the tidal basin and establish a normal range of tides within the tidal basin.

- A simulation of an Eel River Extreme Flood was prepared to evaluate flood levels within the restored Project Area resulting from significant Eel River backwater flooding. The simulation demonstrated that while flooding filled the restored Centerville Slough basin, proposed set-back levees provided adequate protection for areas outside of the restored Project Area and proposed drainage infrastructure would allow rapid drainage following the flood event.

- Simulations of two-year, five-year, and ten-year return period floods on upland tributaries draining to Centerville Slough (Russ Creek, Shaw Creek, Creamery Ditch, etc.) were used to evaluate impacts of the proposed project on areas lying outside of the Centerville Slough tidal basin and on adjacent drainages. The analysis showed generally no increase in flood levels while the rate of drainage was improved following flood events. The analysis also showed that the proposed design of the Russ Creek tide gate would function during large flow events and not significantly alter Russ Creek flow behavior.

Additional Analysis Needs

The Preliminary Hydraulic Analysis demonstrated that the refined Concept Restoration Plan (with selected alternatives) will fully satisfy Project Performance Objectives 1, 2, 3, and 6; and partially meet Project Performance Objectives 4, 5, and 7.

Sediment transport and dune overwash were not evaluated as part of the Preliminary Hydraulic Analysis. Additional work involving sediment transport analysis will be required as design advances to fully evaluate Project Performance Objectives 4, and 5.

4. *Route fluvial sediment from Russ Creek into the tidal marsh and maintain long-term sustainability of Russ Creek by preventing deposition within the Russ Creek channel.*

5. *Create a Project design such that the system is self-maintaining and that no active sediment management or other regular maintenance activities are required.*

Additional work is also required to evaluate the overwash component of Project Performance Objective 7:

7. *Rapidly drain flood waters from the Centerville Slough tidal basin originating from Eel River floods, upland flooding, or dune overwash.*

Additional analyses will be required to evaluate and refine fish passage at the new tide gates (Shaw Creek/Creamery Ditch and Russ Creek) and the rehabilitation of the existing Cutoff Slough tide gates. Model results suggest that restoring the connectivity of the Centerville Slough tidal network will allow for quick draining of the Centerville Slough tidal basin after an overwash event, but further evaluation is required.

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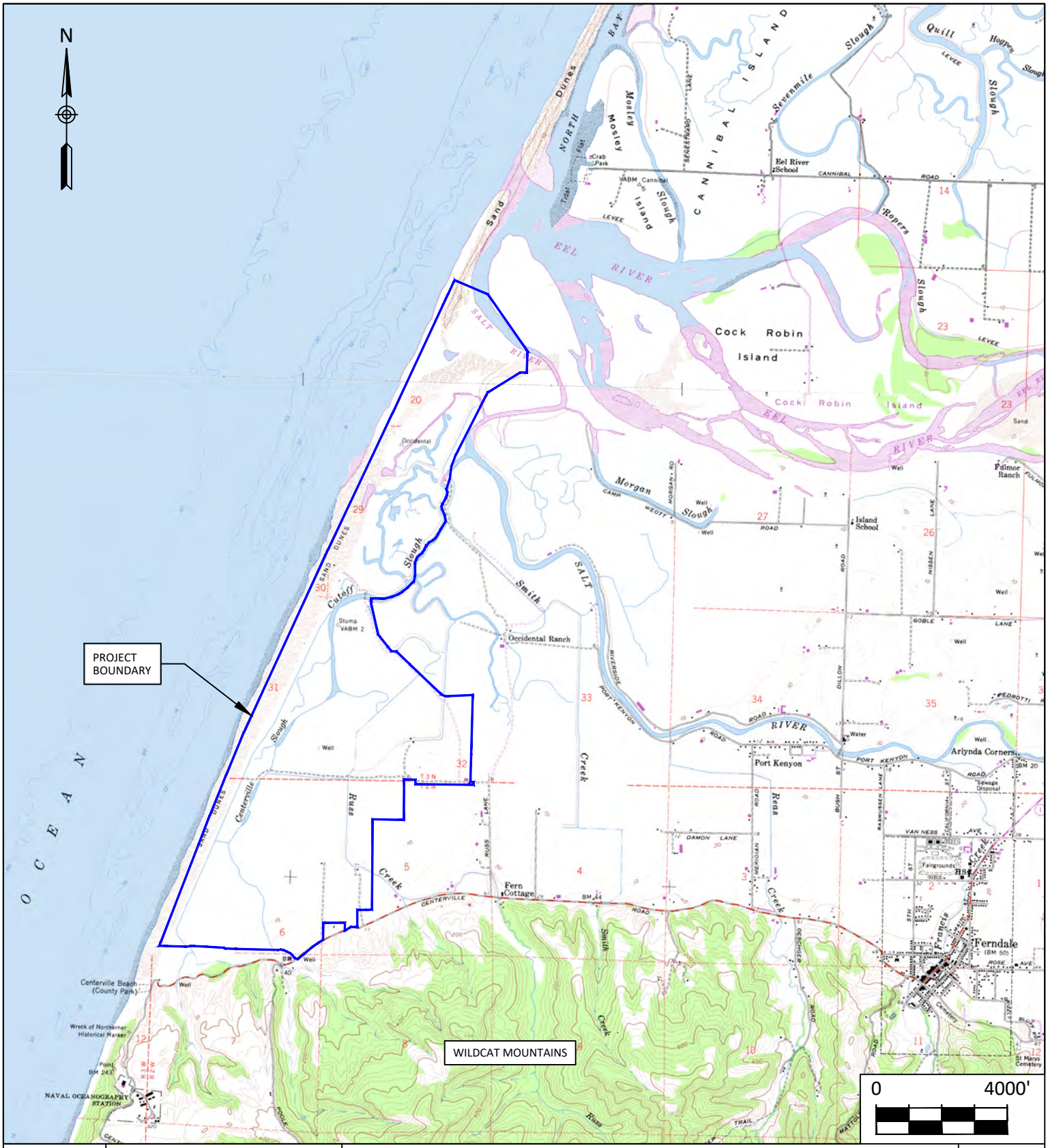
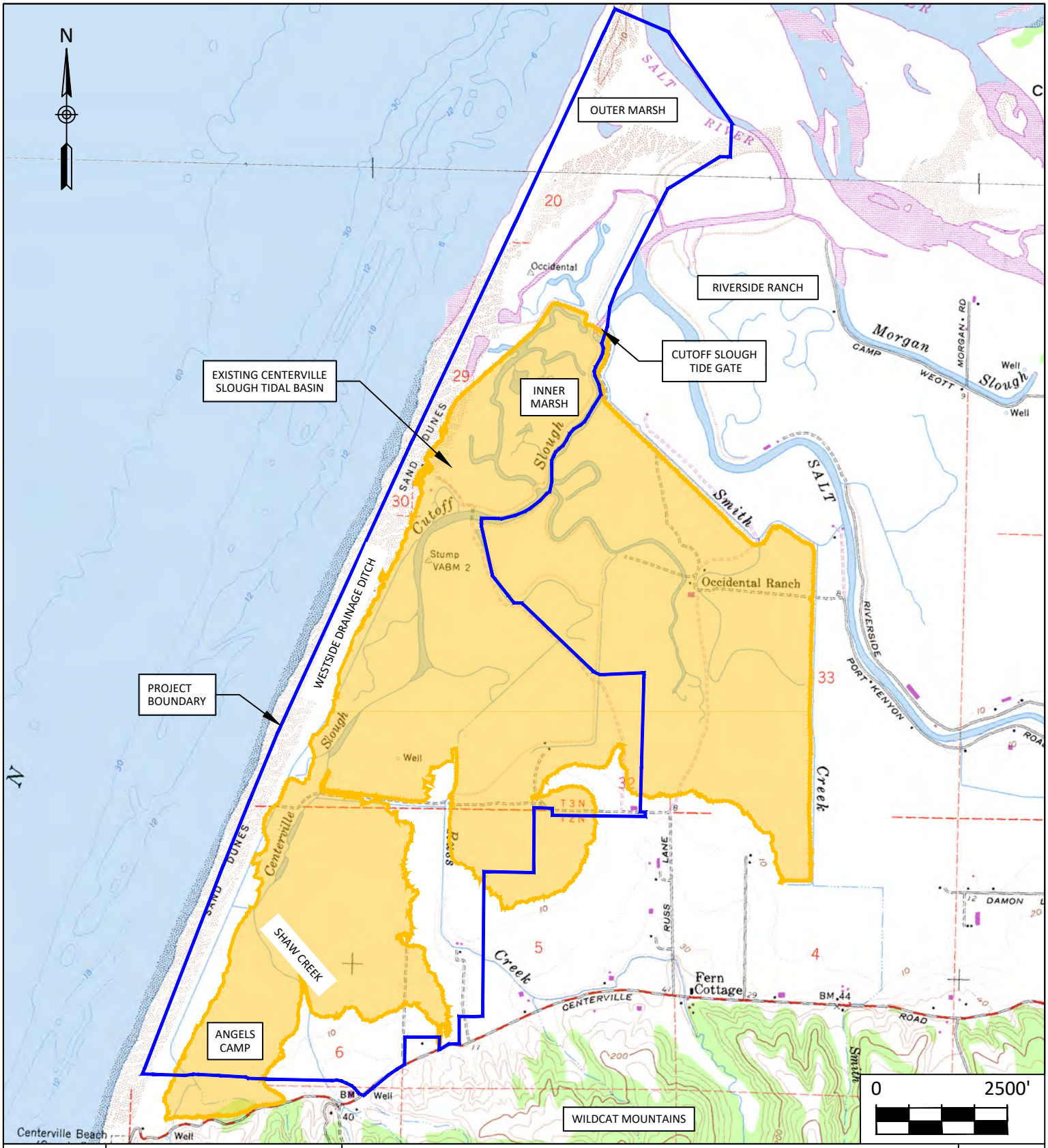
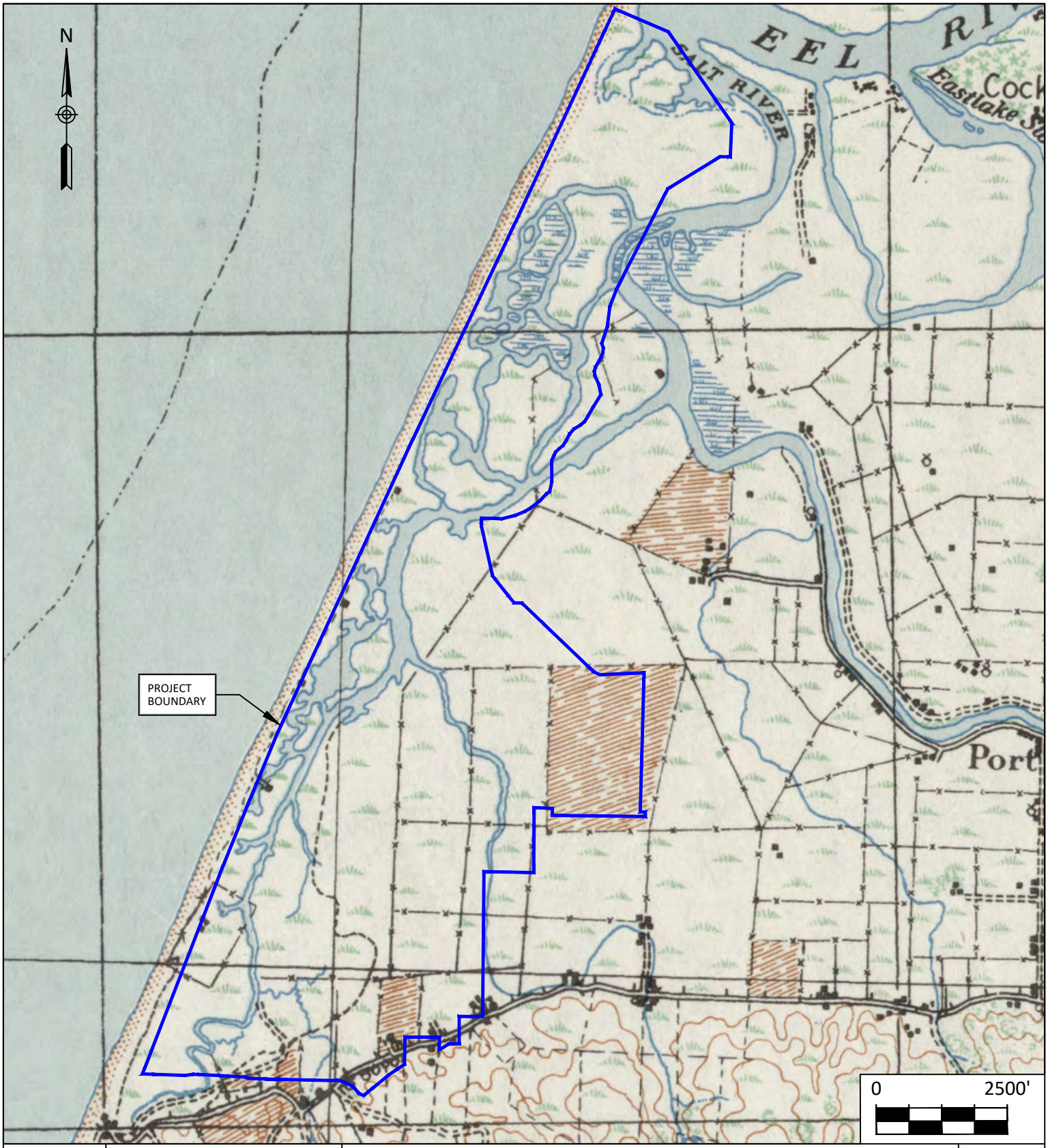
FIGURES



U.S. FISH & WILDLIFE SERVICE	RUSS CREEK AND CENTERVILLE SLOUGH RESTORATION PROJECT PRELIMINARY HYDRAULIC ANALYSIS	PROJECT LOCATION MAP SOURCE: USGS CANNIBAL ISLAND AND FERNDALE 7-1/2' QUADRANGLES (1974) NOTE: MAP DOES NOT REFLECT CHANGES IN EEL RIVER BOUNDARIES AND OTHER GEOMORPHIC ADJUSTMENTS THAT HAVE OCCURRED SINCE 1974.	FIGURE 1



U.S. FISH & WILDLIFE SERVICE	RUSS CREEK AND CENTERVILLE SLOUGH RESTORATION PROJECT PRELIMINARY HYDRAULIC ANALYSIS	PROJECT AREA EXISTING FEATURES MAP SOURCE: USGS CANNIBAL ISLAND AND FERNDALE 7-1/2' QUADRANGLES (1974) NOTE: MAP DOES NOT REFLECT CHANGES IN EEL RIVER BOUNDARIES AND OTHER GEOMORPHIC ADJUSTMENTS THAT HAVE OCCURRED SINCE 1974.	FIGURE 2



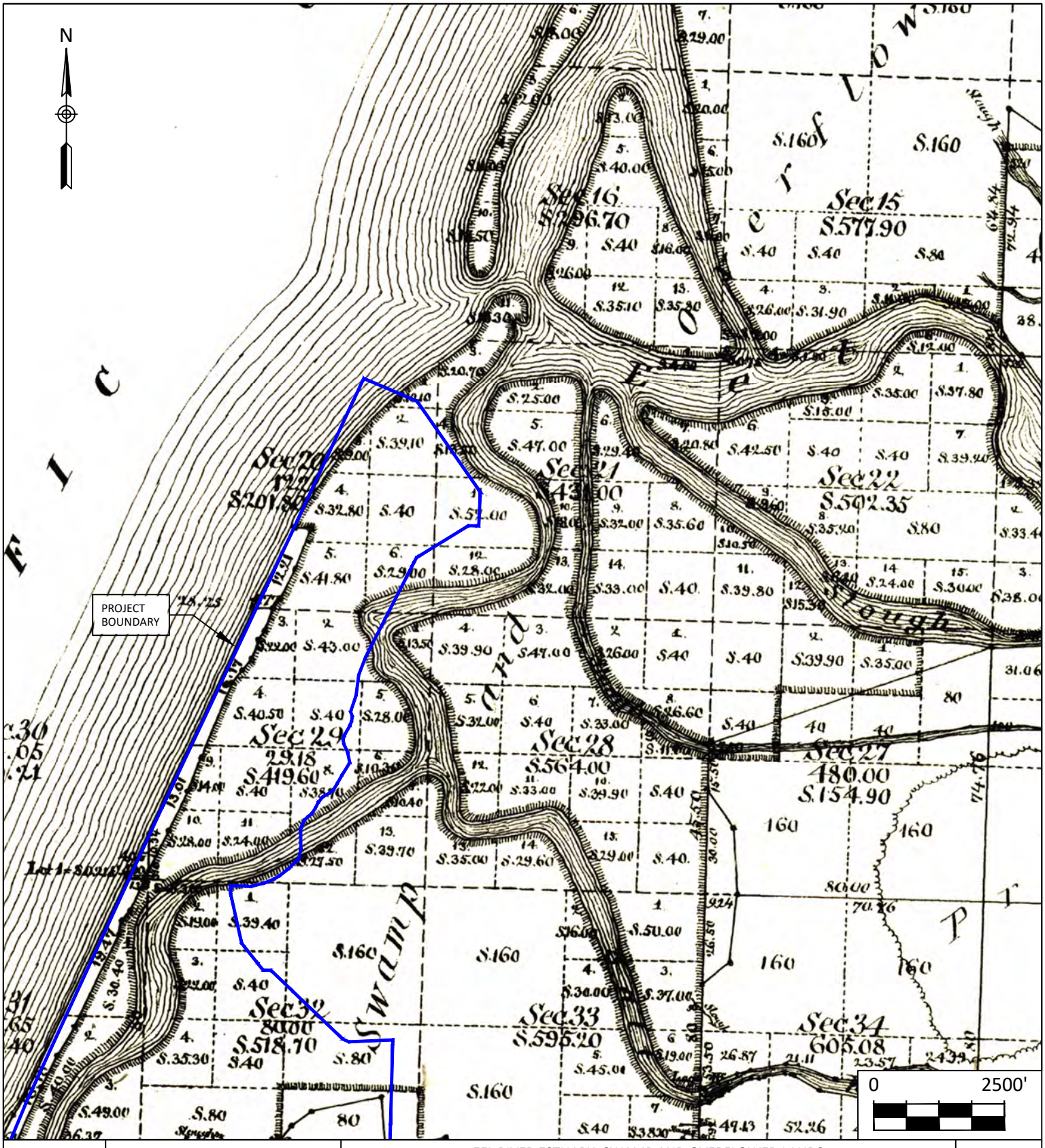
RUSS CREEK AND CENTERVILLE SLOUGH RESTORATION PROJECT
PRELIMINARY HYDRAULIC ANALYSIS

PROJECT AREA - 1916 U.S. ARMY CORP OF ENGINEERS TACTICAL MAP

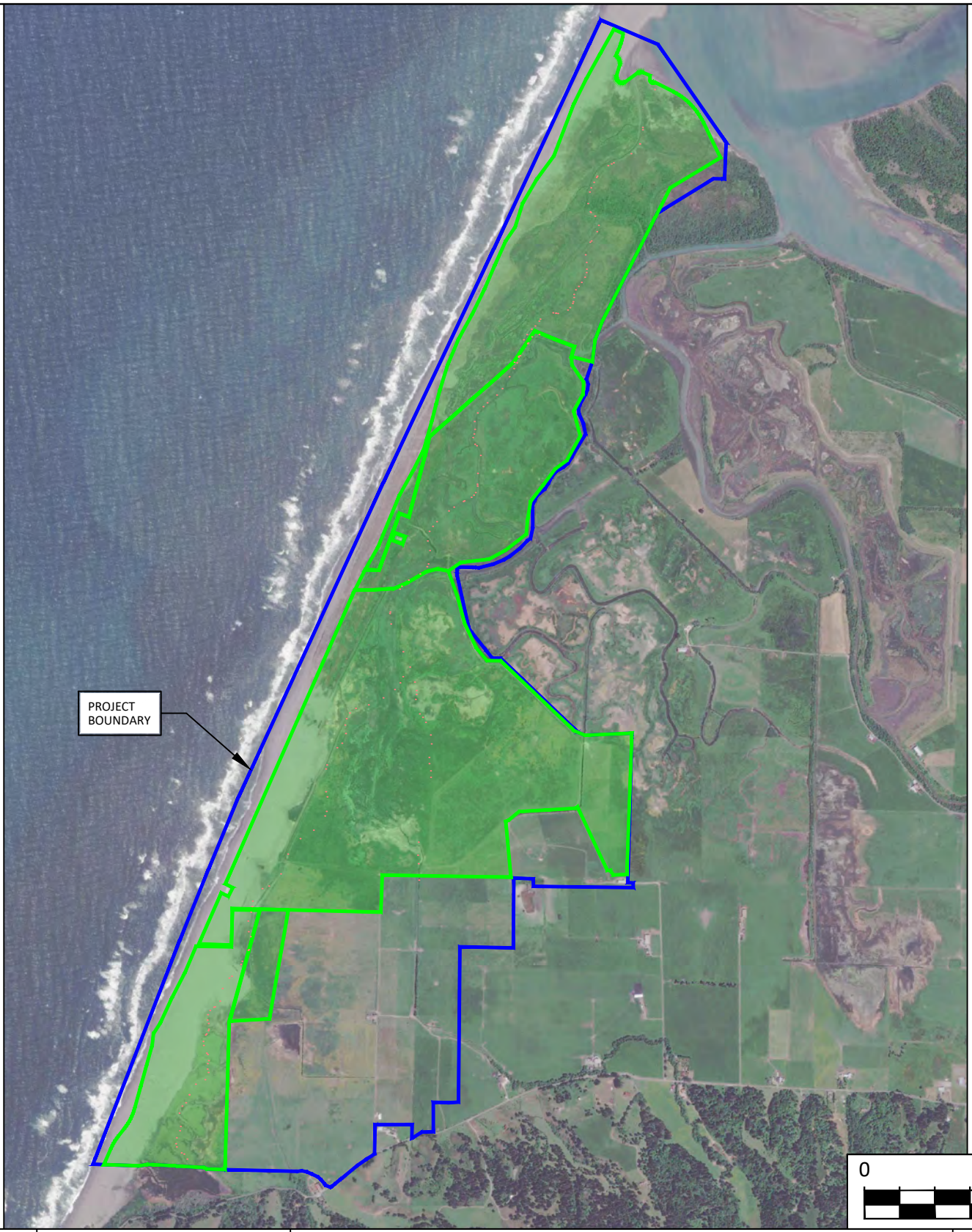
MAP SOURCE: LAIRD ET AL. 2013

FIGURE

3



U.S. FISH & WILDLIFE SERVICE	RUSS CREEK AND CENTERVILLE SLOUGH RESTORATION PROJECT PRELIMINARY HYDRAULIC ANALYSIS	EEL RIVER ESTUARY: SWAMP AND OVERFLOWED LANDS 1890 U.S. SURVEY GENERAL TOWNSHIP MAP MAP SOURCE: LAIRD ET AL. 2013	FIGURE 4



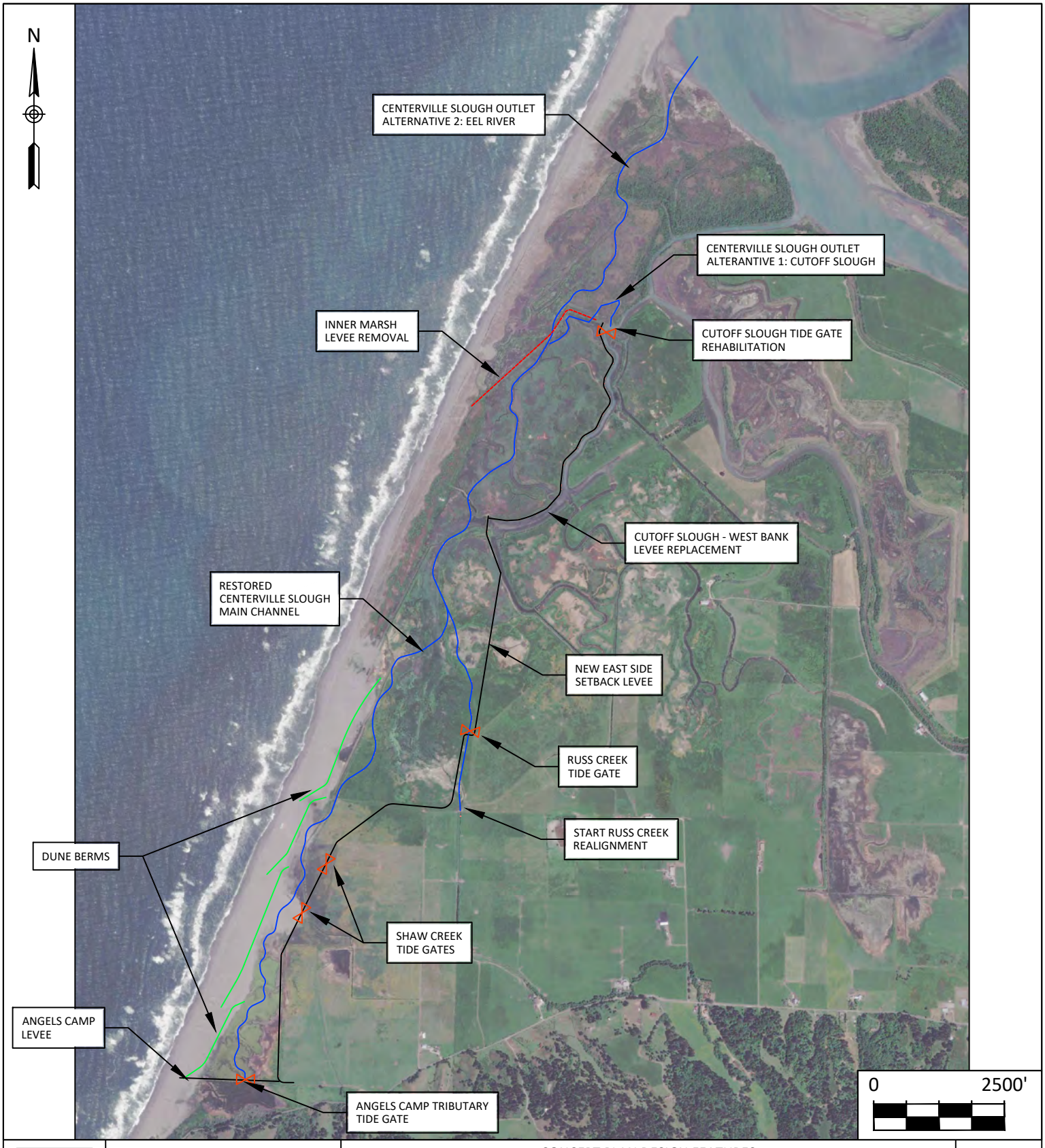
RUSS CREEK AND CENTERVILLE SLOUGH RESTORATION PROJECT
PRELIMINARY HYDRAULIC ANALYSIS

NRCS WETLAND RESERVE EASEMENTS WITHIN PROJECT BOUNDARY

IMAGE SOURCE: DIGITAL GLOBE - MAY 21, 2021

FIGURE

5



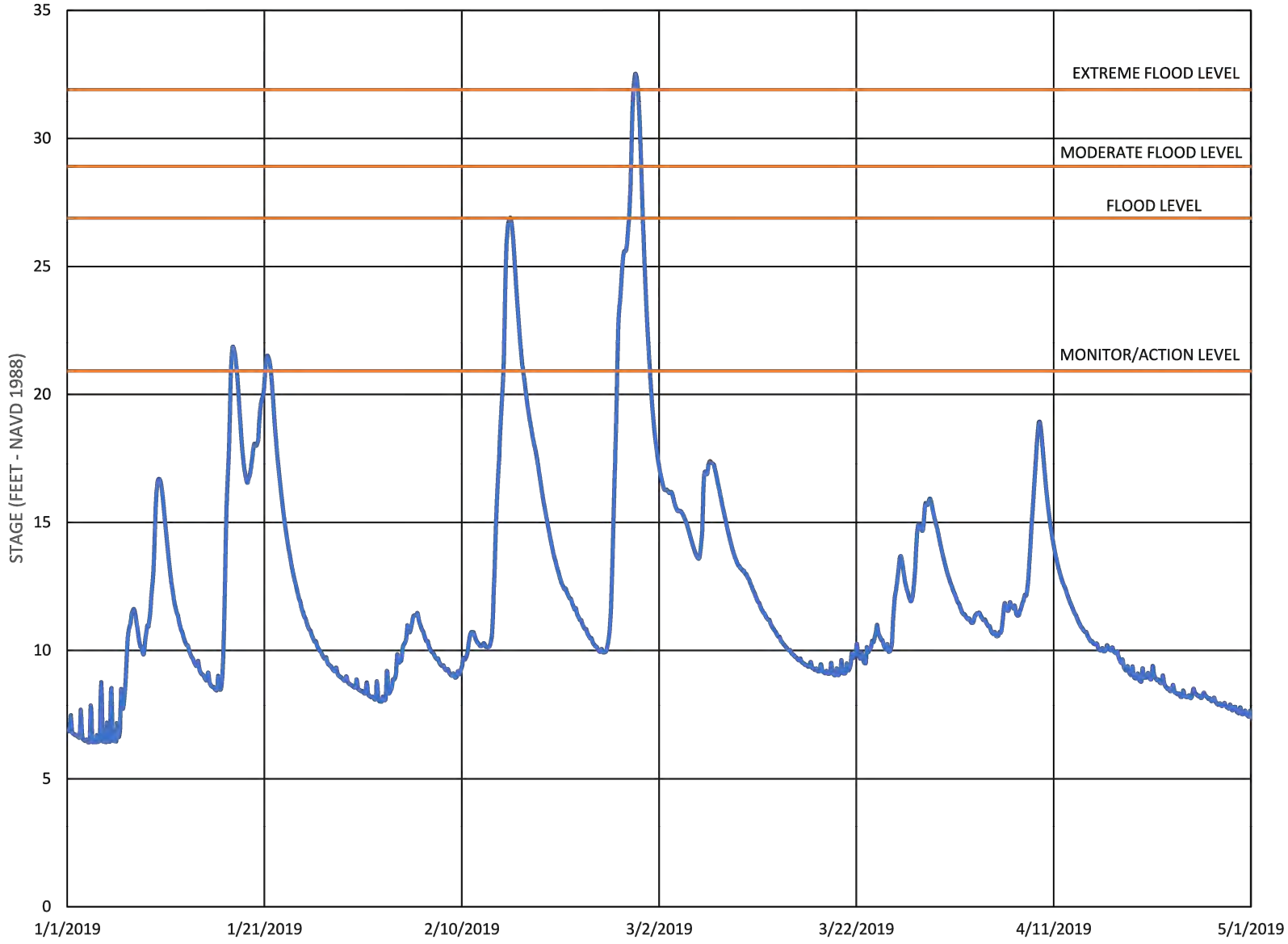
RUSS CREEK AND CENTERVILLE SLOUGH RESTORATION PROJECT
PRELIMINARY HYDRAULIC ANALYSIS

CONCEPT PLAN DESIGN FEATURES

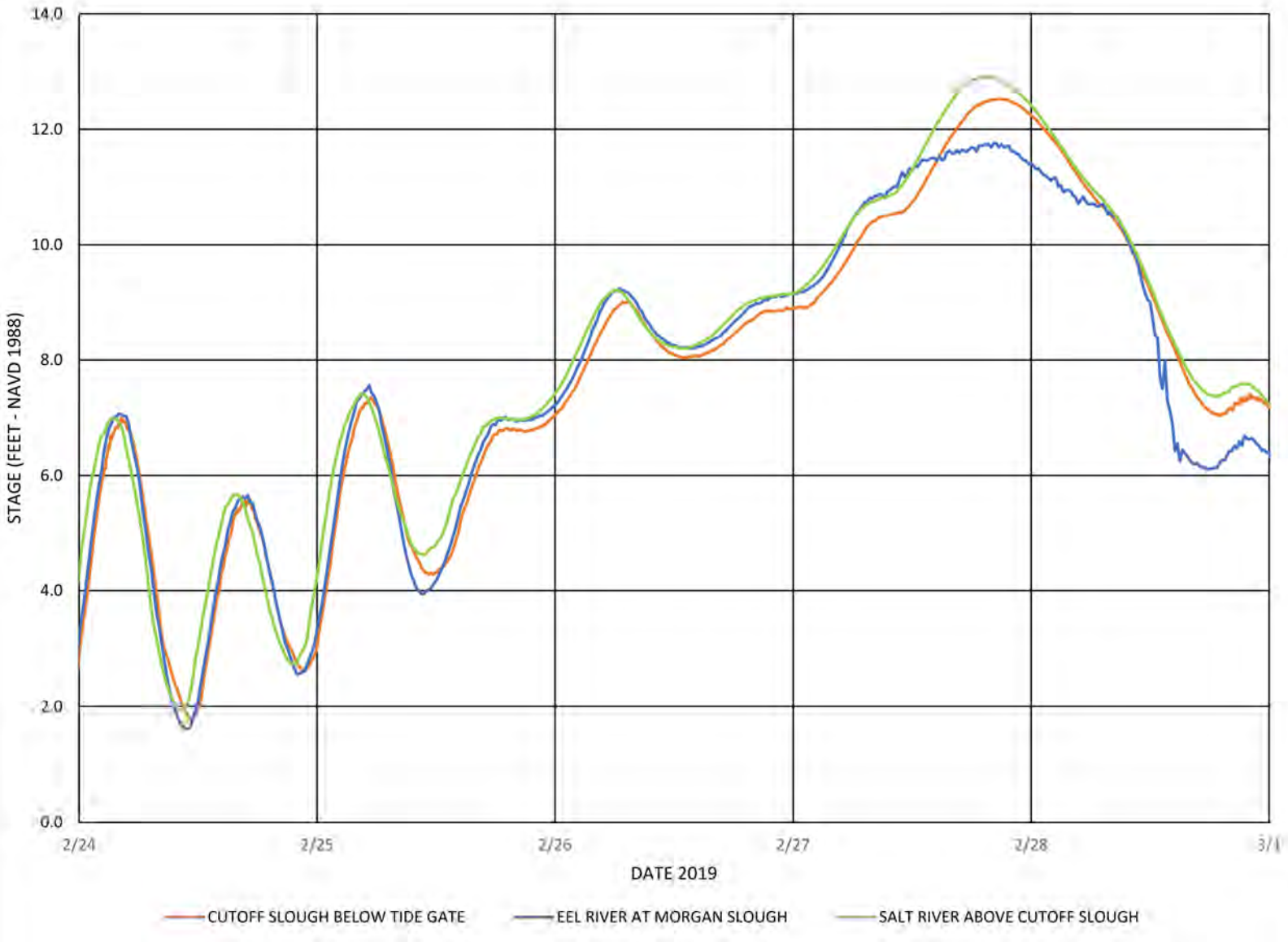
IMAGE SOURCE: DIGITAL GLOBE - MAY 21, 2021

FIGURE

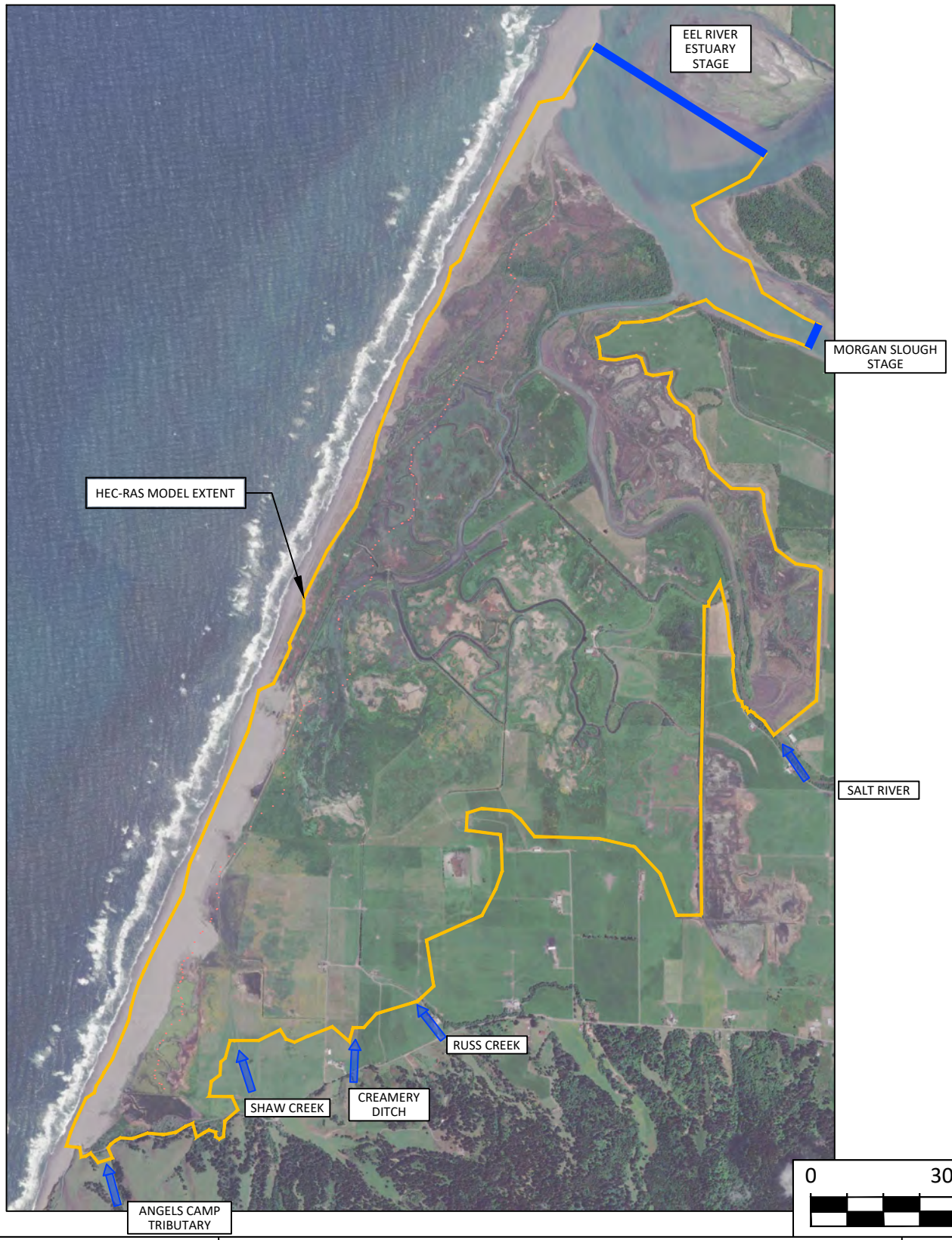
6



U.S. FISH & WILDLIFE SERVICE	RUSS CREEK AND CENTERVILLE SLOUGH RESTORATION PROJECT PRELIMINARY HYDRAULIC ANALYSIS	EEL RIVER STAGE AT FERNBRIDGE JANUARY - APRIL 2019	FIGURE 7



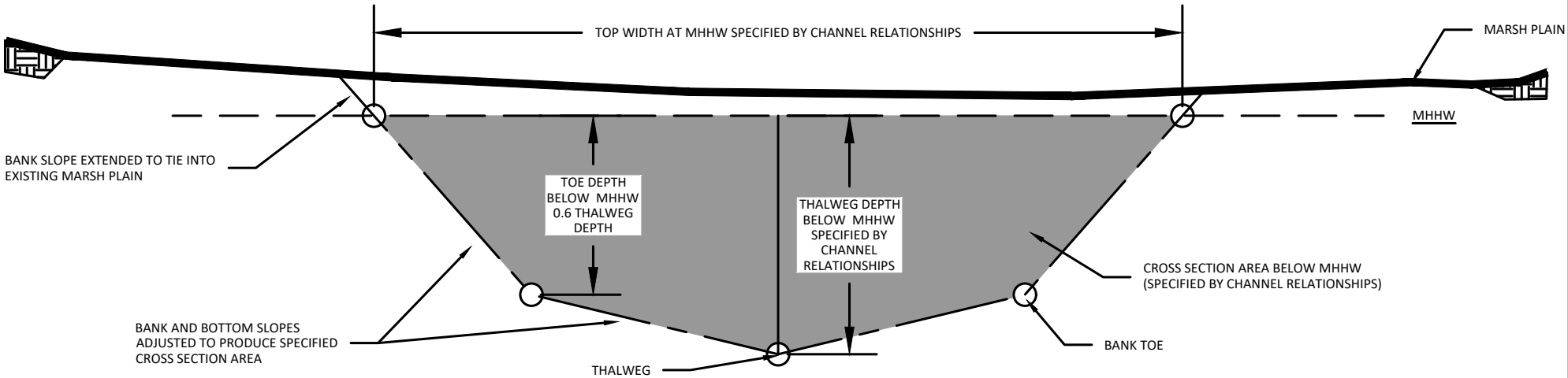
U.S. FISH & WILDLIFE SERVICE	RUSS CREEK AND CENTERVILLE SLOUGH RESTORATION PROJECT PRELIMINARY HYDRAULIC ANALYSIS	2019 EXTREME FLOOD EVENT OBSERVED WATER LEVELS IN SOUTH EEL RIVER DELTA		FIGURE 8



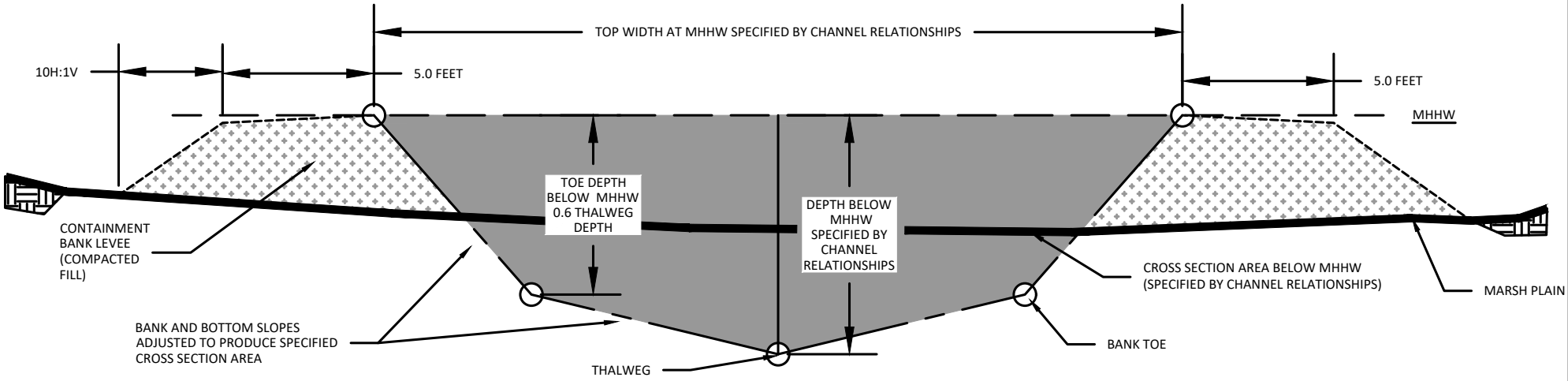
RUSS CREEK AND CENTERVILLE SLOUGH RESTORATION PROJECT
PRELIMINARY HYDRAULIC ANALYSIS

HEC-RAS MODEL EXTENT AND BOUNDARY CONDITIONS
FOR EXISTING AND PROPOSED CONDITIONS
IMAGE SOURCE: DIGITAL GLOBE - MAY 21, 2021

FIGURE
9

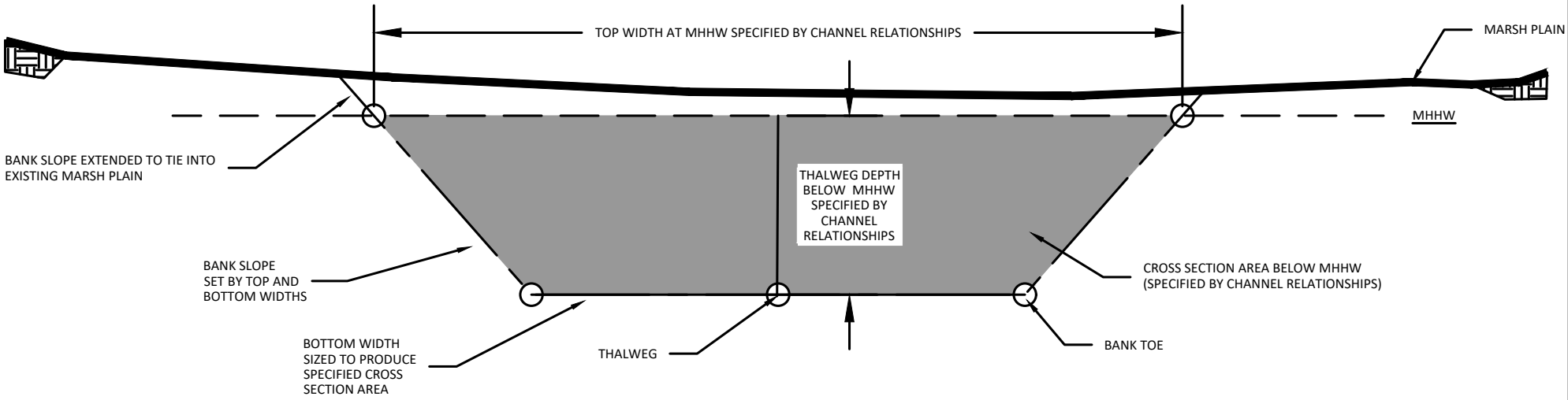


(A) PRIMARY CHANNEL - MARSH PLAIN ABOVE MHHW

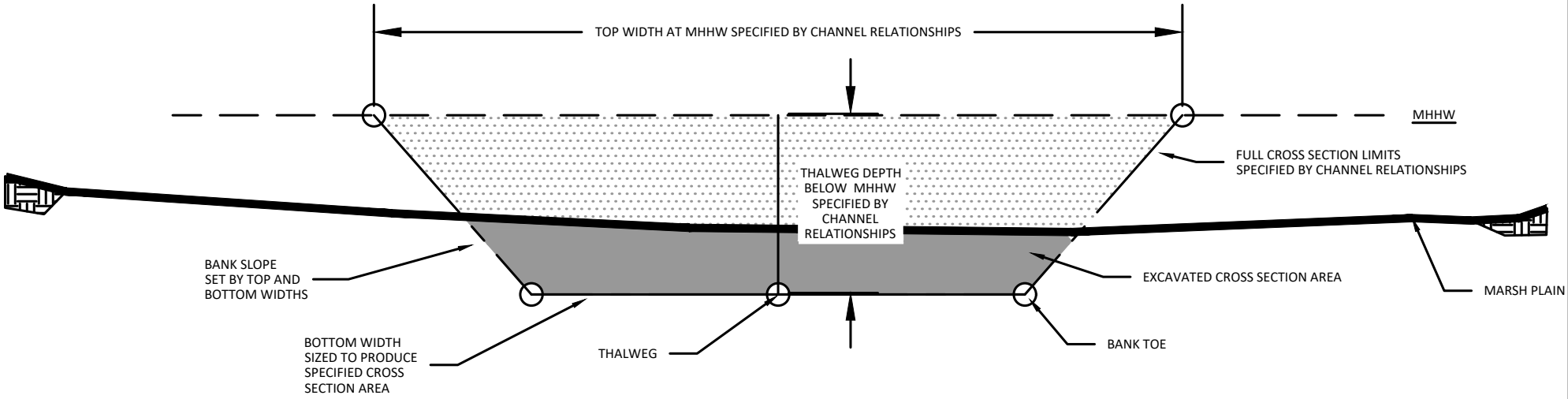


(B) PRIMARY CHANNEL - MARSH PLAIN BELOW MHHW

RUSS CREEK AND CENTERVILLE SLOUGH RESTORATION PROJECT PRELIMINARY HYDRAULIC ANALYSIS	PRIMARY TIDAL CHANNEL DESIGN PROCEDURE NOTE: MINIMUM CHANNEL THALWEG ELEVATION IS -2.0 FEET NAVD	NOT TO SCALE	FIGURE 10

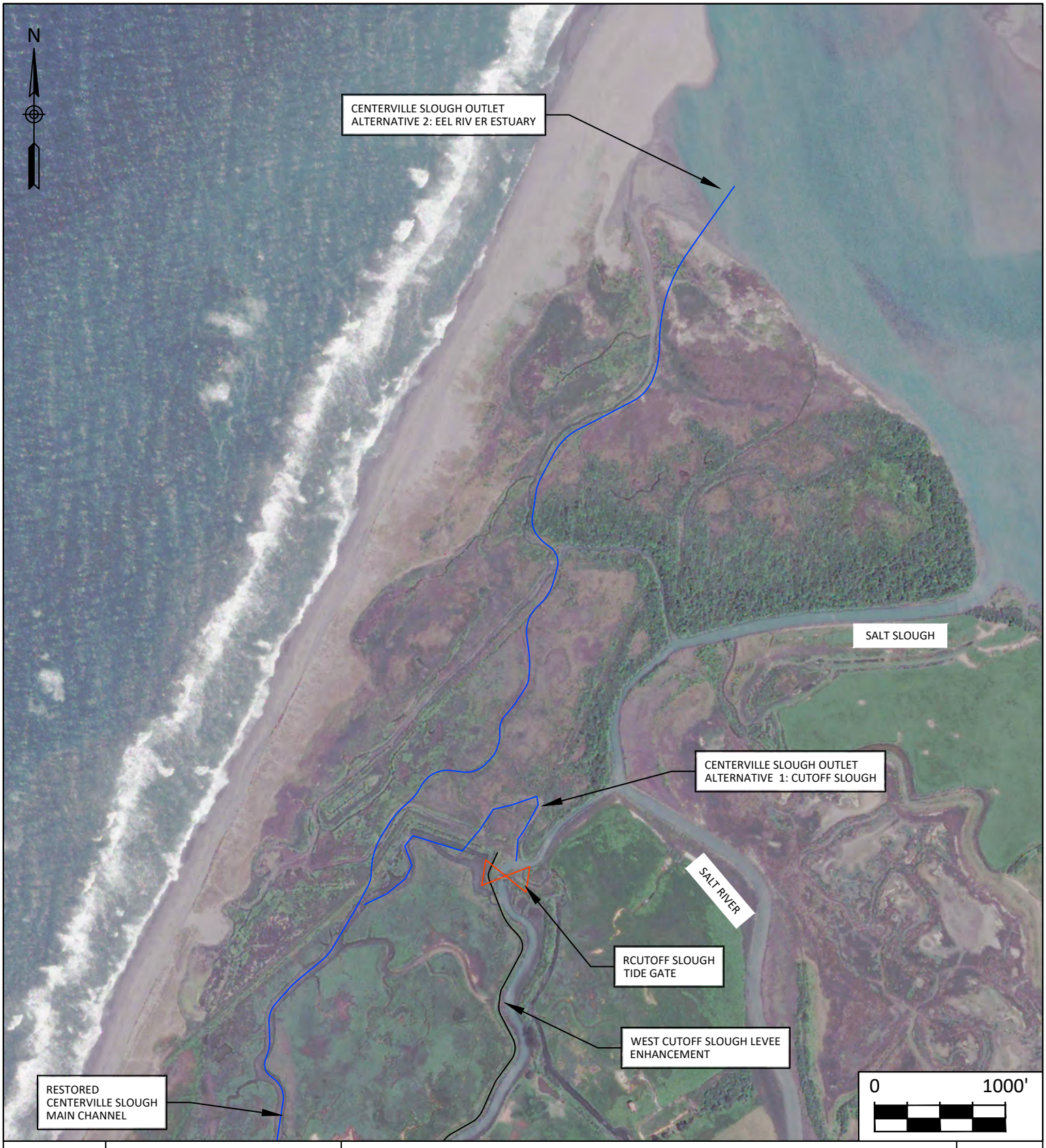


(A) TRIBUTARY CHANNEL - MARSH PLAIN ABOVE MHHW



(B) TRIBUTARY CHANNEL - MARSH PLAIN BELOW MHHW

U.S. FISH & WILDLIFE SERVICE	RUSS CREEK AND CENTERVILLE SLOUGH RESTORATION PROJECT PRELIMINARY HYDRAULIC ANALYSIS	TRIBUTARY TIDAL CHANNEL DESIGN PROCEDURE NOTE: MINIMUM CHANNEL THALWEG ELEVATION IS -2.0 FEET NAVD	NOT TO SCALE	FIGURE 11



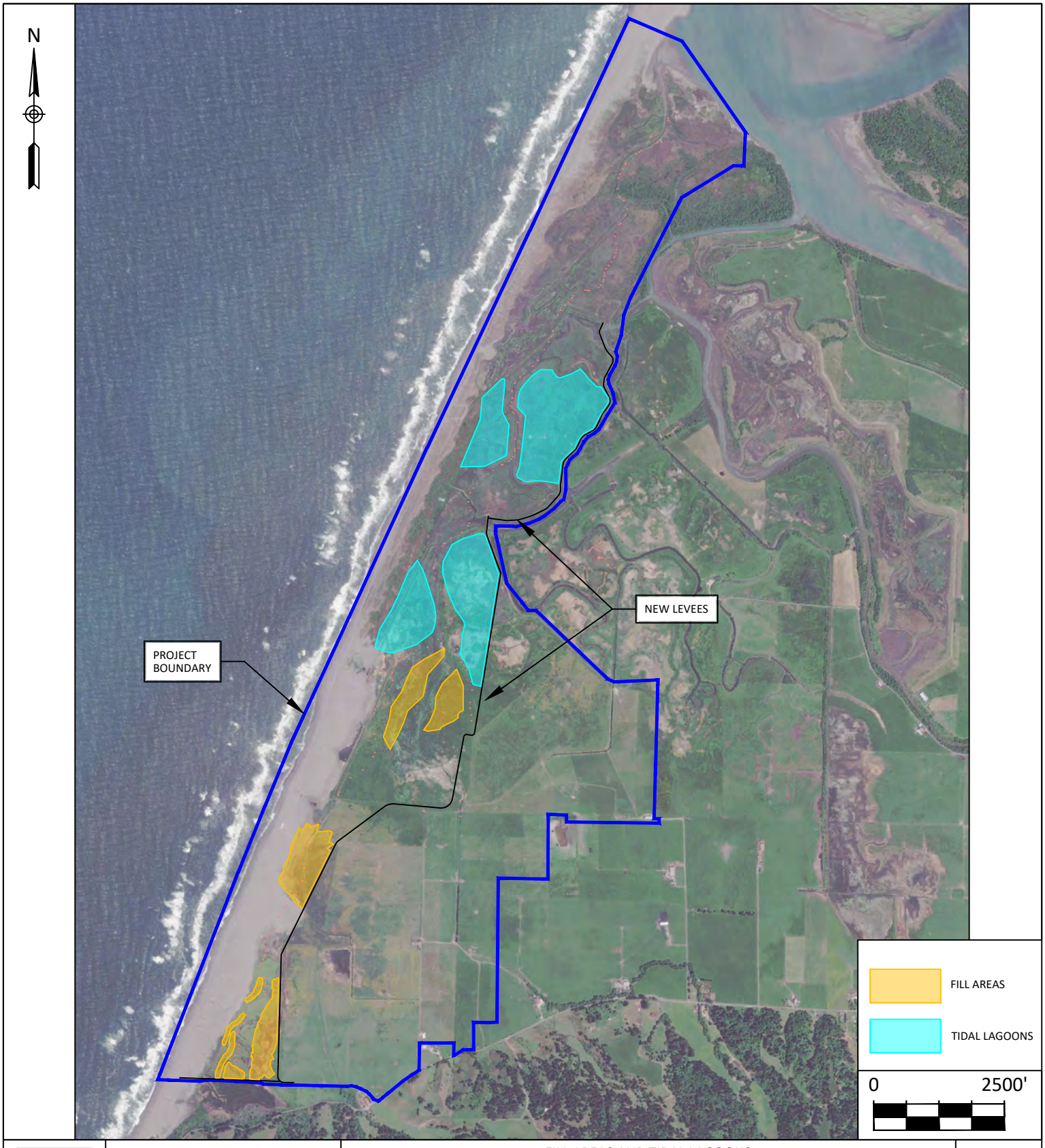
RUSS CREEK AND CENTERVILLE SLOUGH RESTORATION PROJECT
PRELIMINARY HYDRAULIC ANALYSIS

CENTERVILLE SLOUGH OUTLET ALTERNATIVES

IMAGE SOURCE: DIGITAL GLOBE - MAY 21, 2021

FIGURE

12



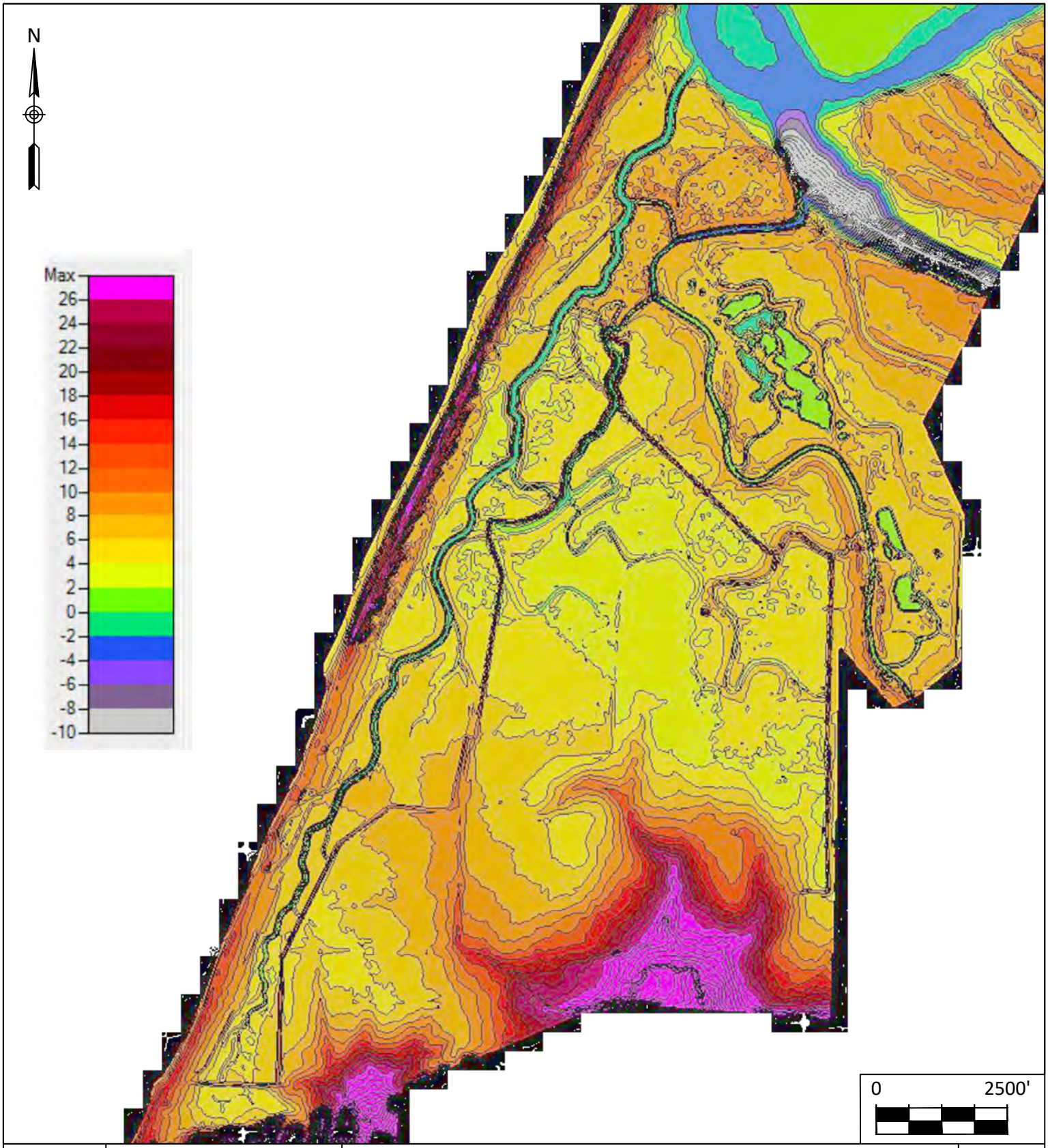
RUSS CREEK AND CENTERVILLE SLOUGH RESTORATION PROJECT
PRELIMINARY HYDRAULIC ANALYSIS

FILL AREAS AND TIDAL LAGOONS

IMAGE SOURCE: DIGITAL GLOBE - MAY 21, 2021

FIGURE

13



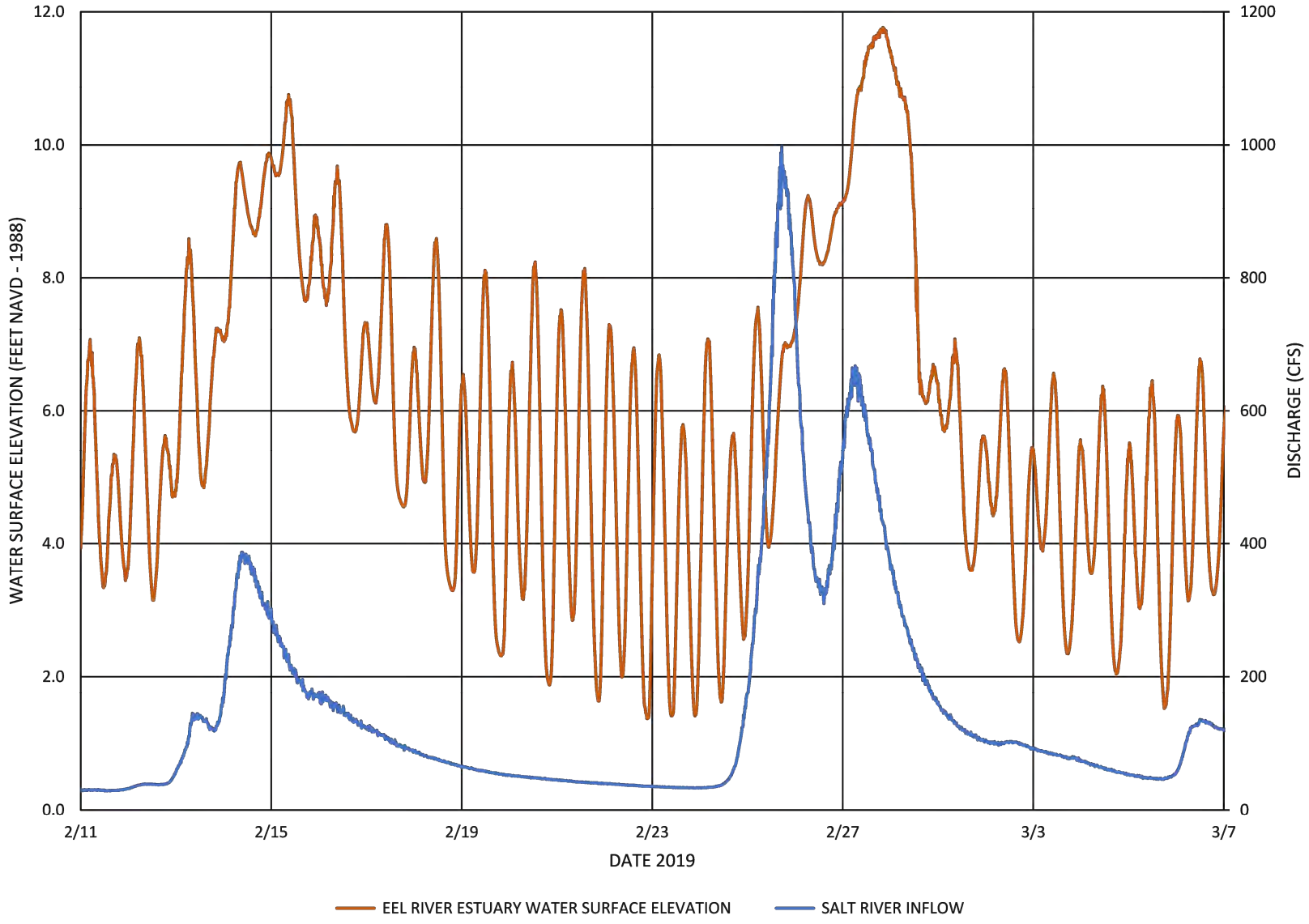
RUSS CREEK AND CENTERVILLE SLOUGH RESTORATION PROJECT
PRELIMINARY HYDRAULIC ANALYSIS

PROPOSED ELEVATION MODEL

CONTOUR INTERVAL 2 FEET

FIGURE

14

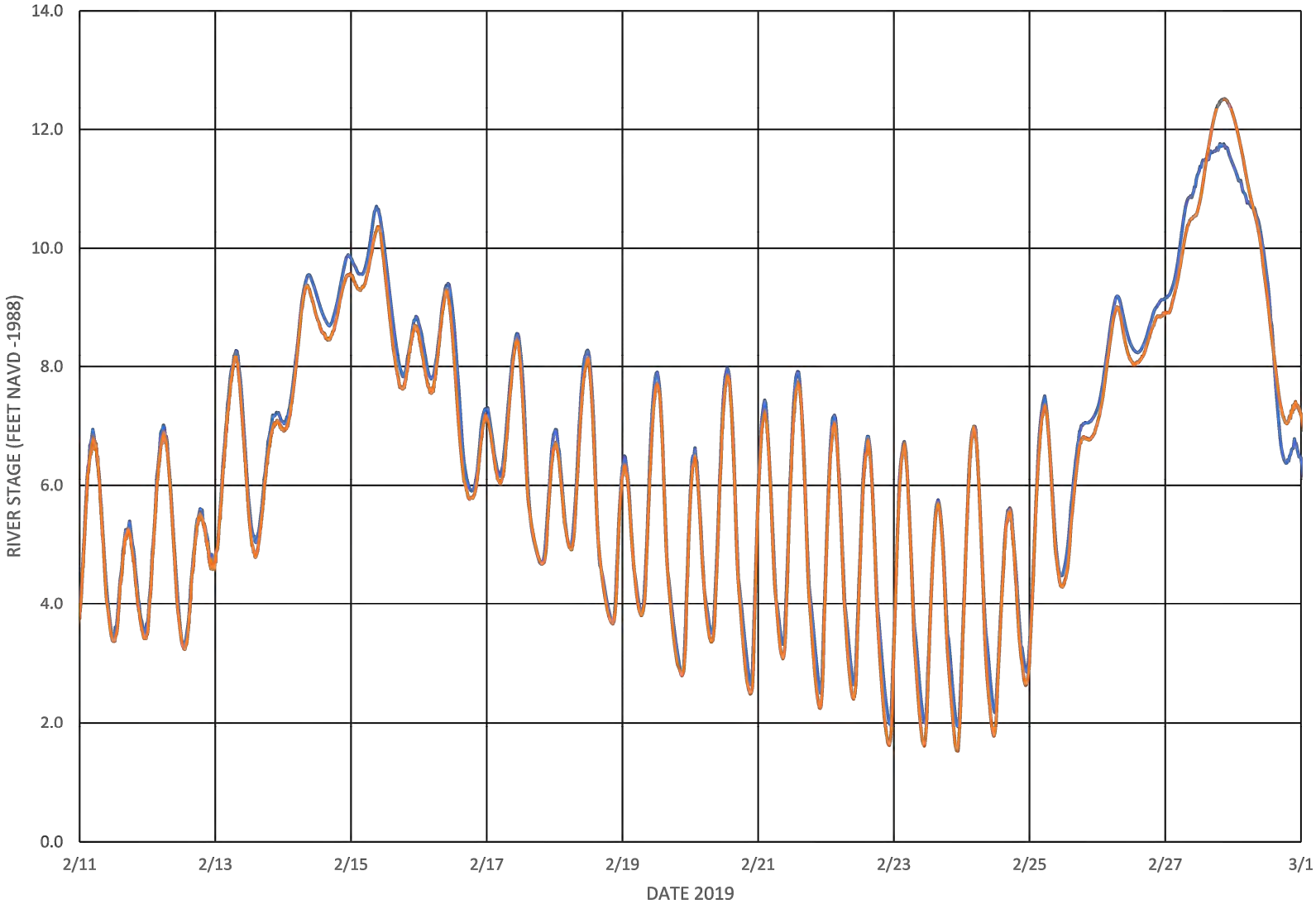


RUSS CREEK AND CENTERVILLE SLOUGH RESTORATION PROJECT
PRELIMINARY HYDRAULIC ANALYSIS

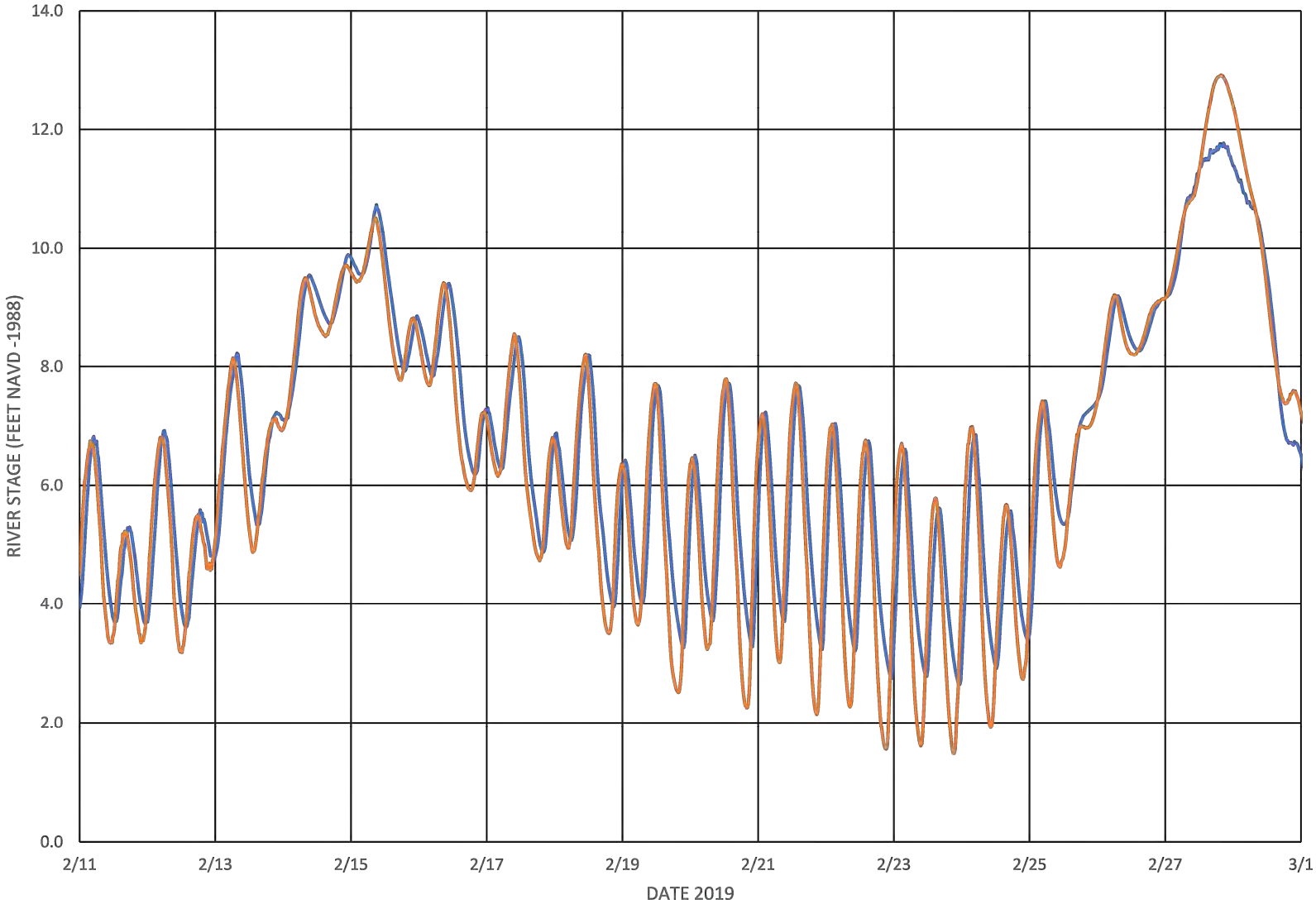
VALIDATION ANALYSIS: BOUNDARY CONDITIONS

NOTE: INFLOW FROM UPLAND AREAS (RUSS CREEK, SHAW CREEK, CREAMERY DITCH, ETC.) PROPORTIONAL TO SALT RIVER INFLOW AS SCALED BY DRAINAGE AREA.

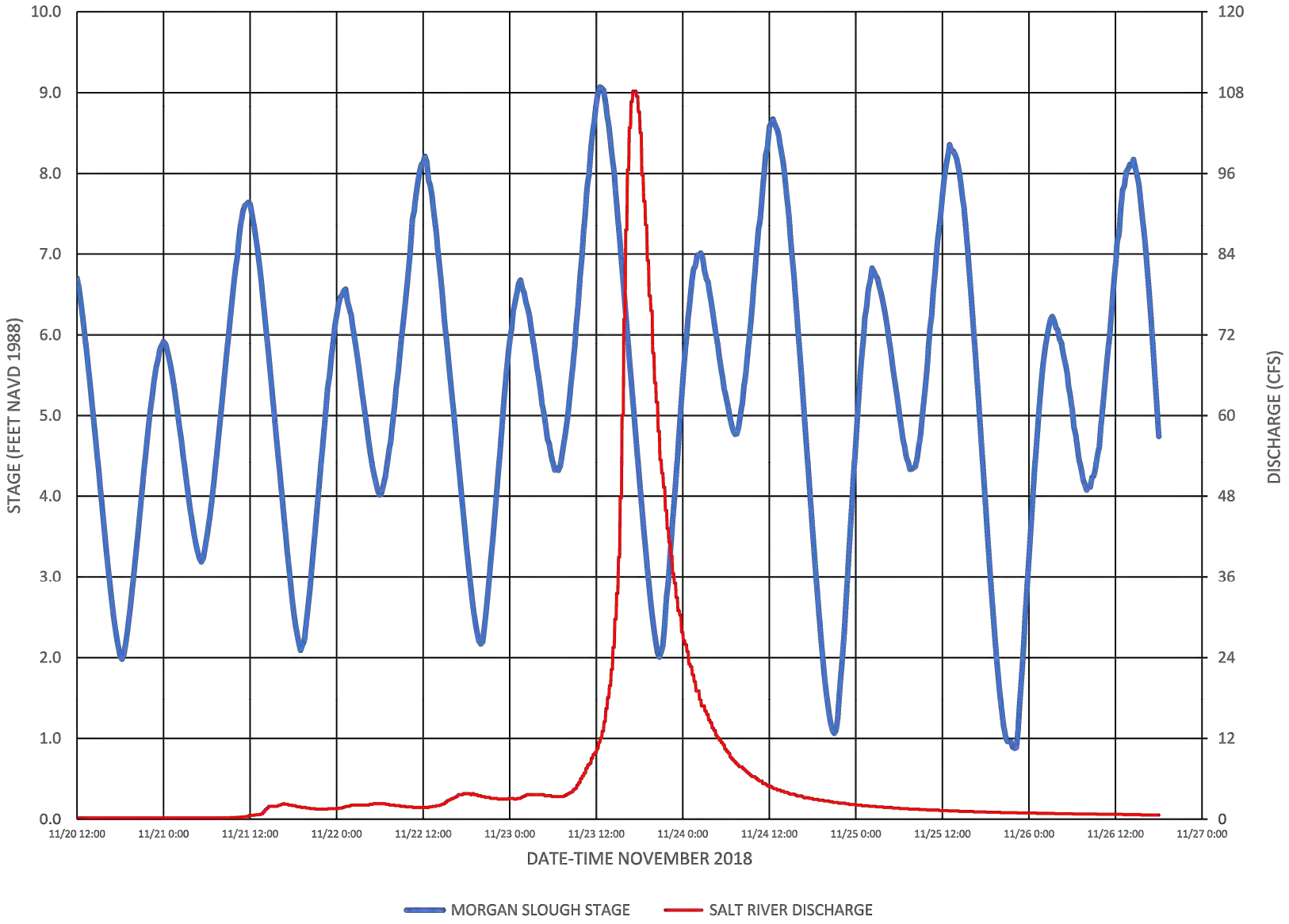
FIGURE
15



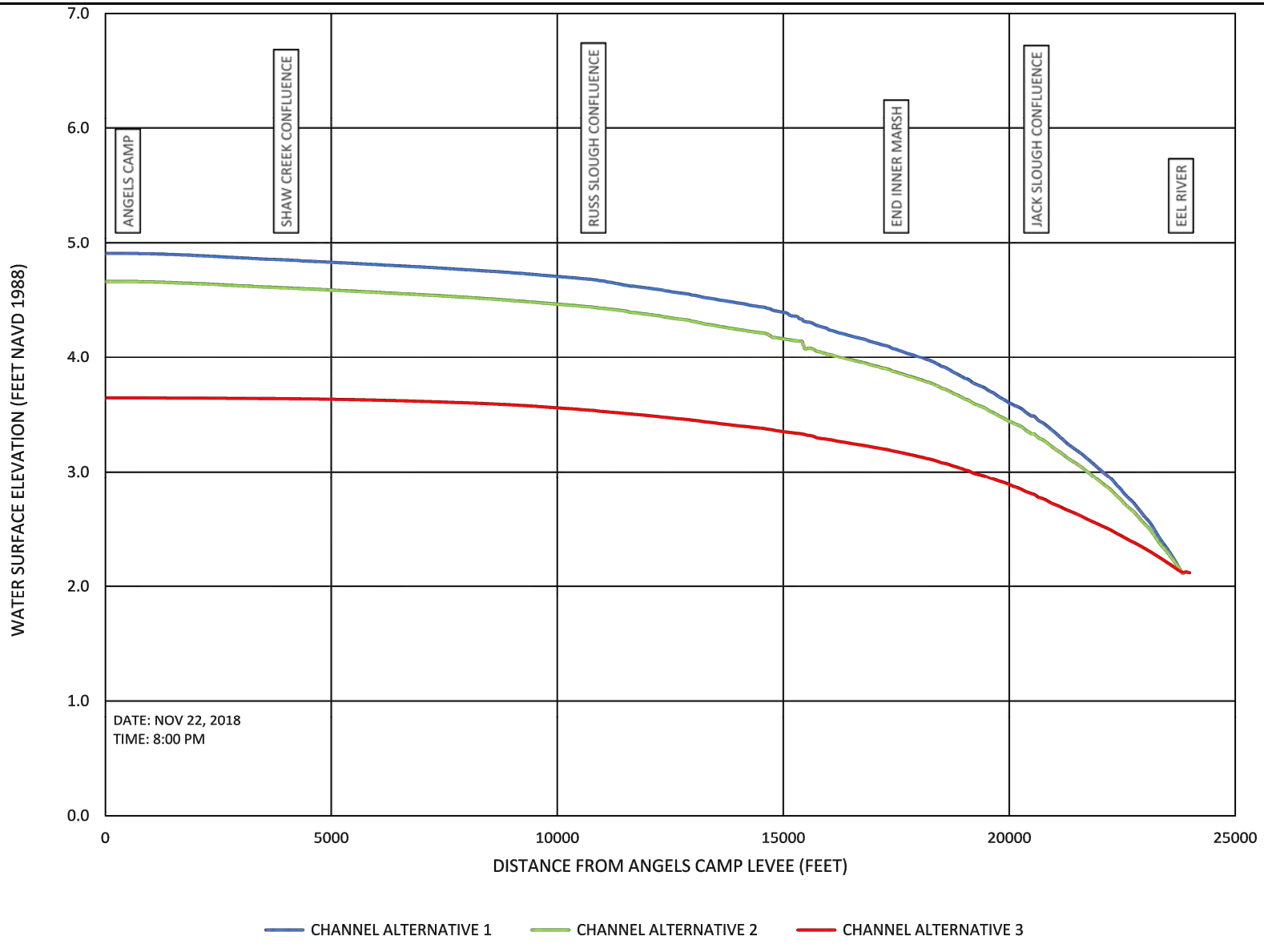
U.S. FISH & WILDLIFE SERVICE	RUSS CREEK AND CENTERVILLE SLOUGH RESTORATION PROJECT PRELIMINARY HYDRAULIC ANALYSIS	VALIDATION ANALYSIS RESULTS: CUTOFF SLOUGH BELOW TIDE GATE	FIGURE 16



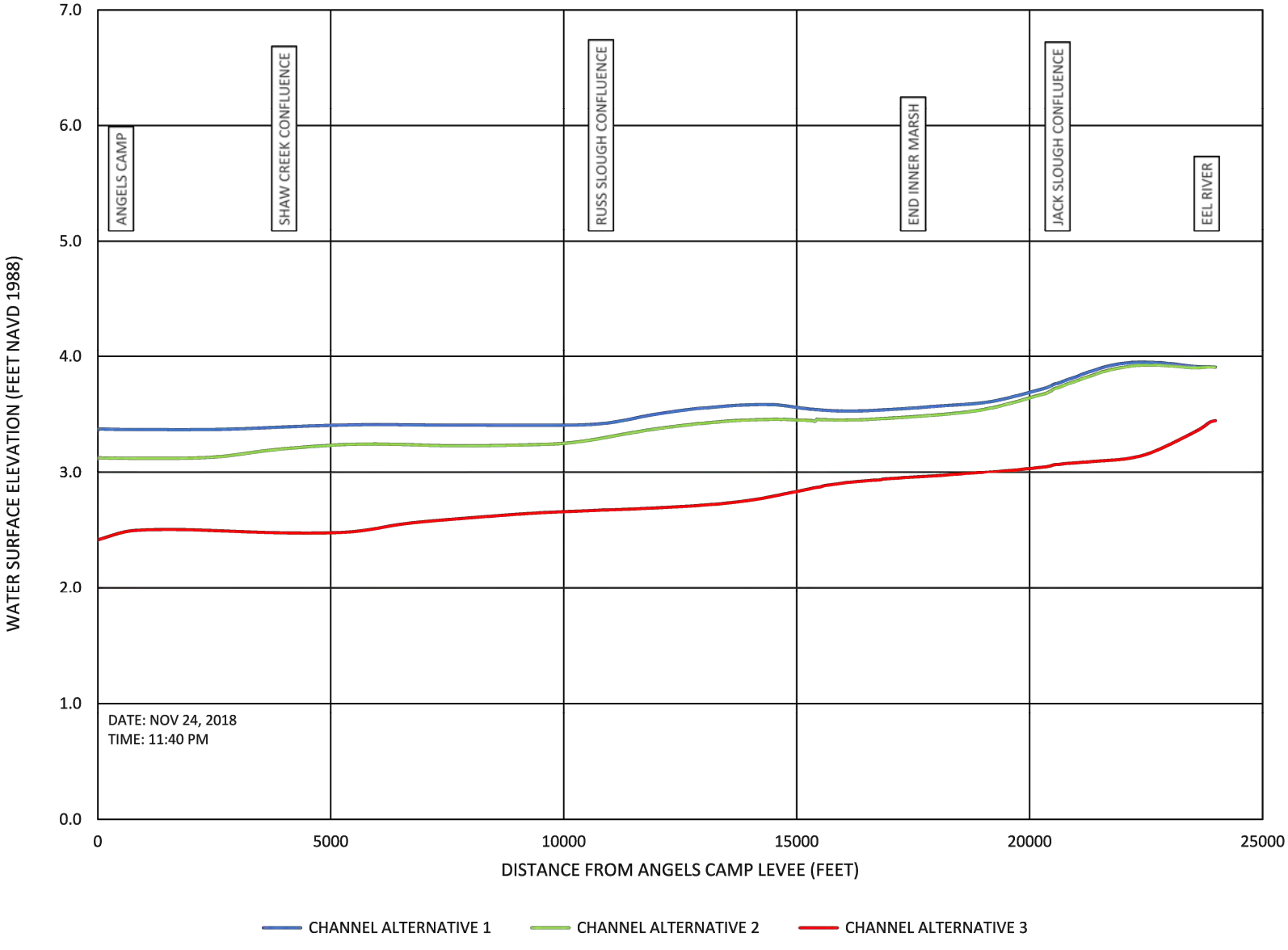
U.S. FISH & WILDLIFE SERVICE	RUSS CREEK AND CENTERVILLE SLOUGH RESTORATION PROJECT PRELIMINARY HYDRAULIC ANALYSIS	VALIDATION ANALYSIS RESULTS: SALT RIVER AT UPPER RIVERSIDE RANCH CHANNEL	FIGURE 17



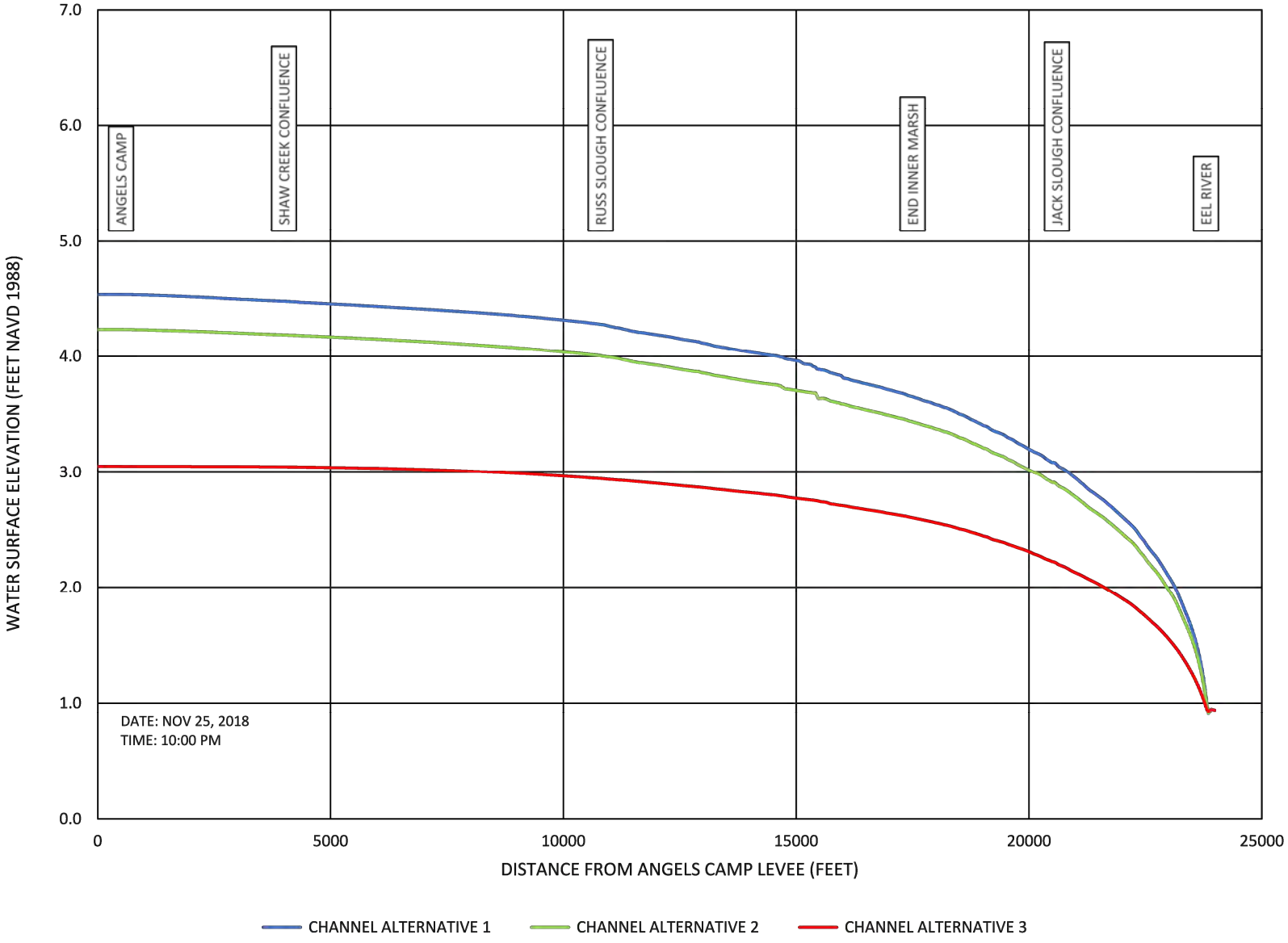
U.S. FISH & WILDLIFE SERVICE	RUSS CREEK AND CENTERVILLE SLOUGH RESTORATION PROJECT PRELIMINARY HYDRAULIC ANALYSIS	SPRING TIDE ANALYSIS SCENARIO: BOUNDARY CONDITIONS	FIGURE 18



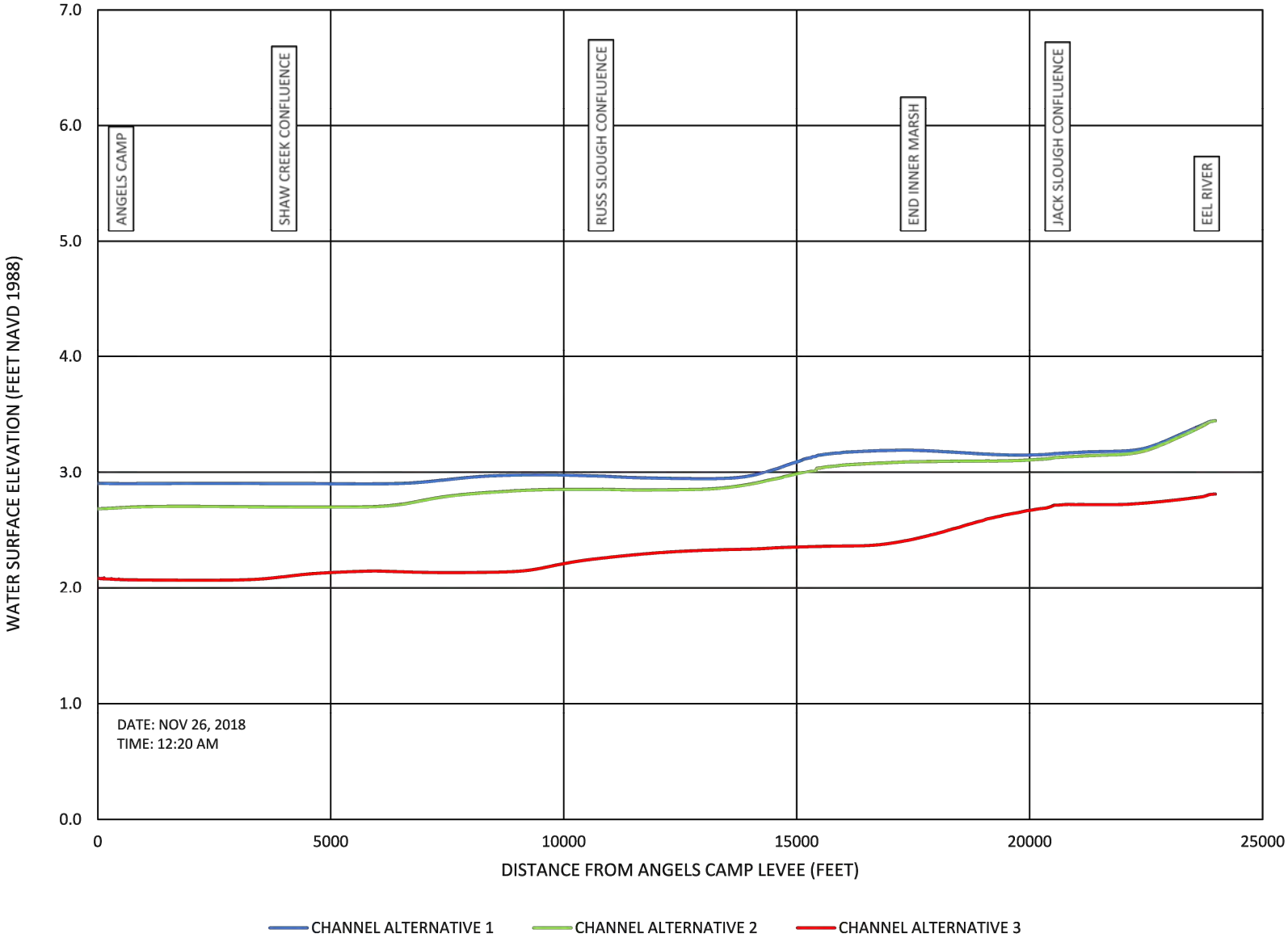
U.S. FISH & WILDLIFE SERVICE	RUSS CREEK AND CENTERVILLE SLOUGH RESTORATION PROJECT PRELIMINARY HYDRAULIC ANALYSIS	CENTERVILLE SLOUGH WATER SURFACE PROFILES - EEL RIVER LOWER LOW WATER 2.12 FEET		FIGURE 19



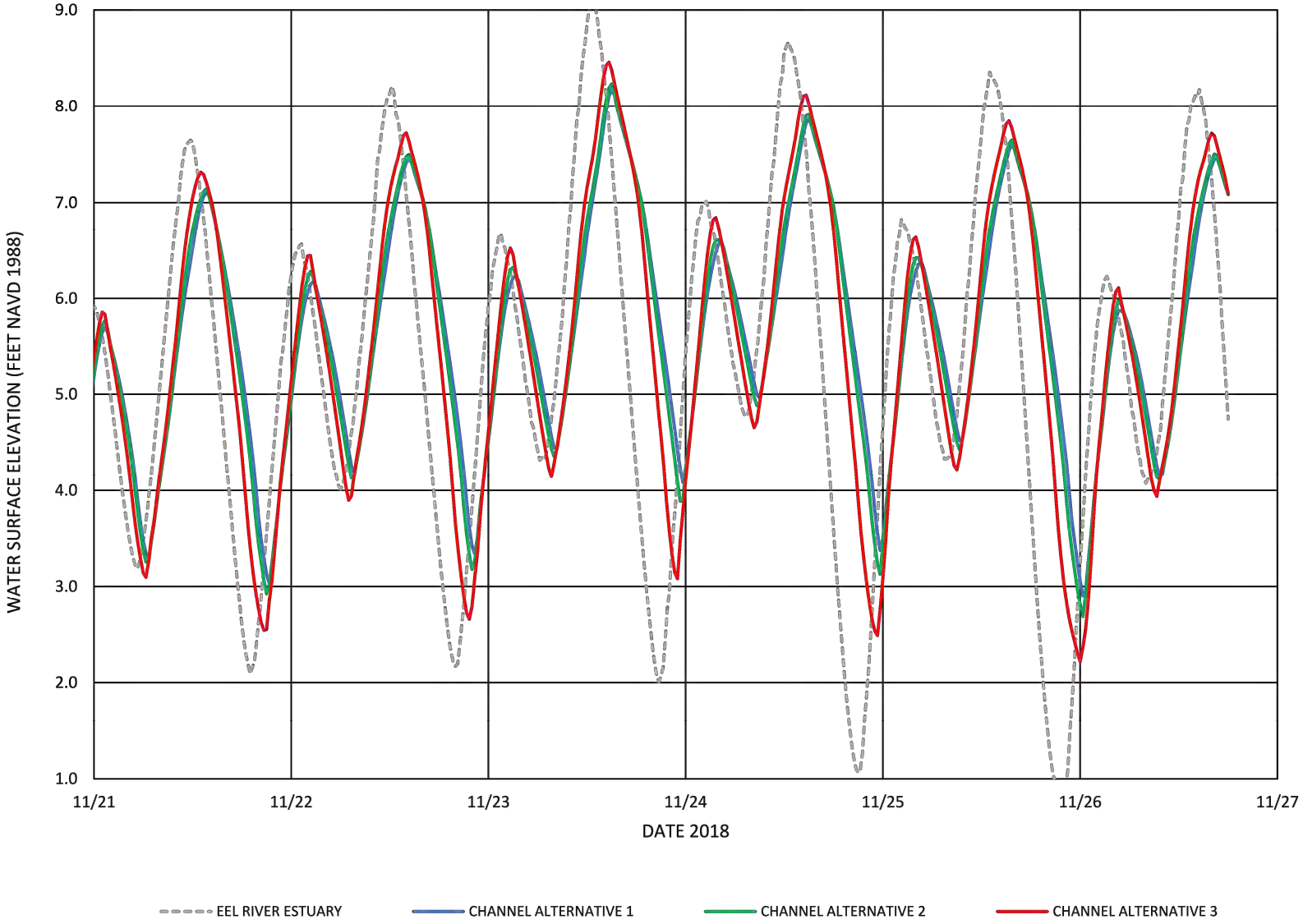
U.S. FISH & WILDLIFE SERVICE	RUSS CREEK AND CENTERVILLE SLOUGH RESTORATION PROJECT PRELIMINARY HYDRAULIC ANALYSIS	CENTERVILLE SLOUGH WATER SURFACE PROFILES - LOWER LOW WATER AT ANGELS CAMP	FIGURE 20



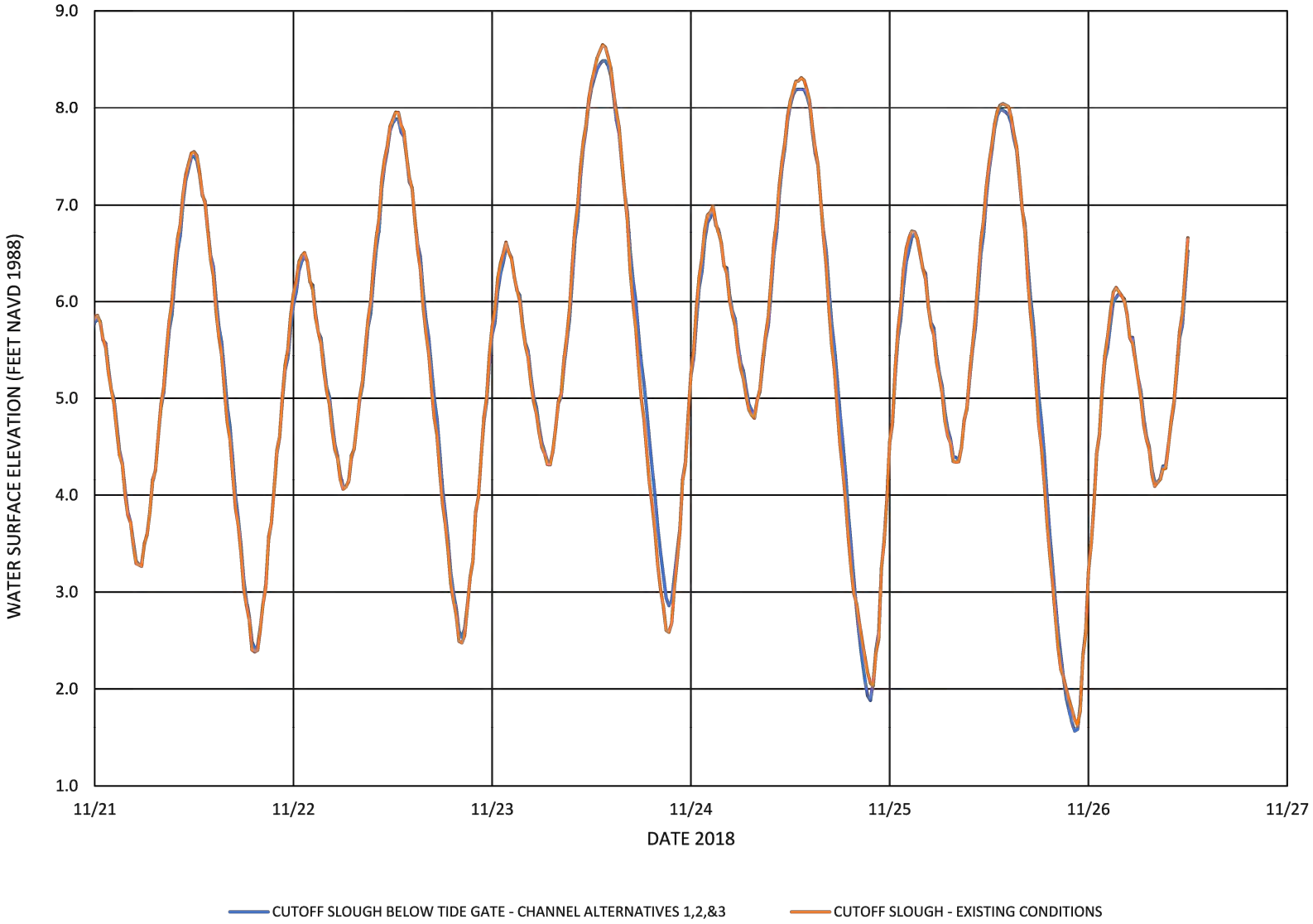
U.S. FISH & WILDLIFE SERVICE	RUSS CREEK AND CENTERVILLE SLOUGH RESTORATION PROJECT PRELIMINARY HYDRAULIC ANALYSIS	CENTERVILLE SLOUGH WATER SURFACE PROFILES - EEL RIVER EXTREME LOW WATER 0.94 FEET	FIGURE 21



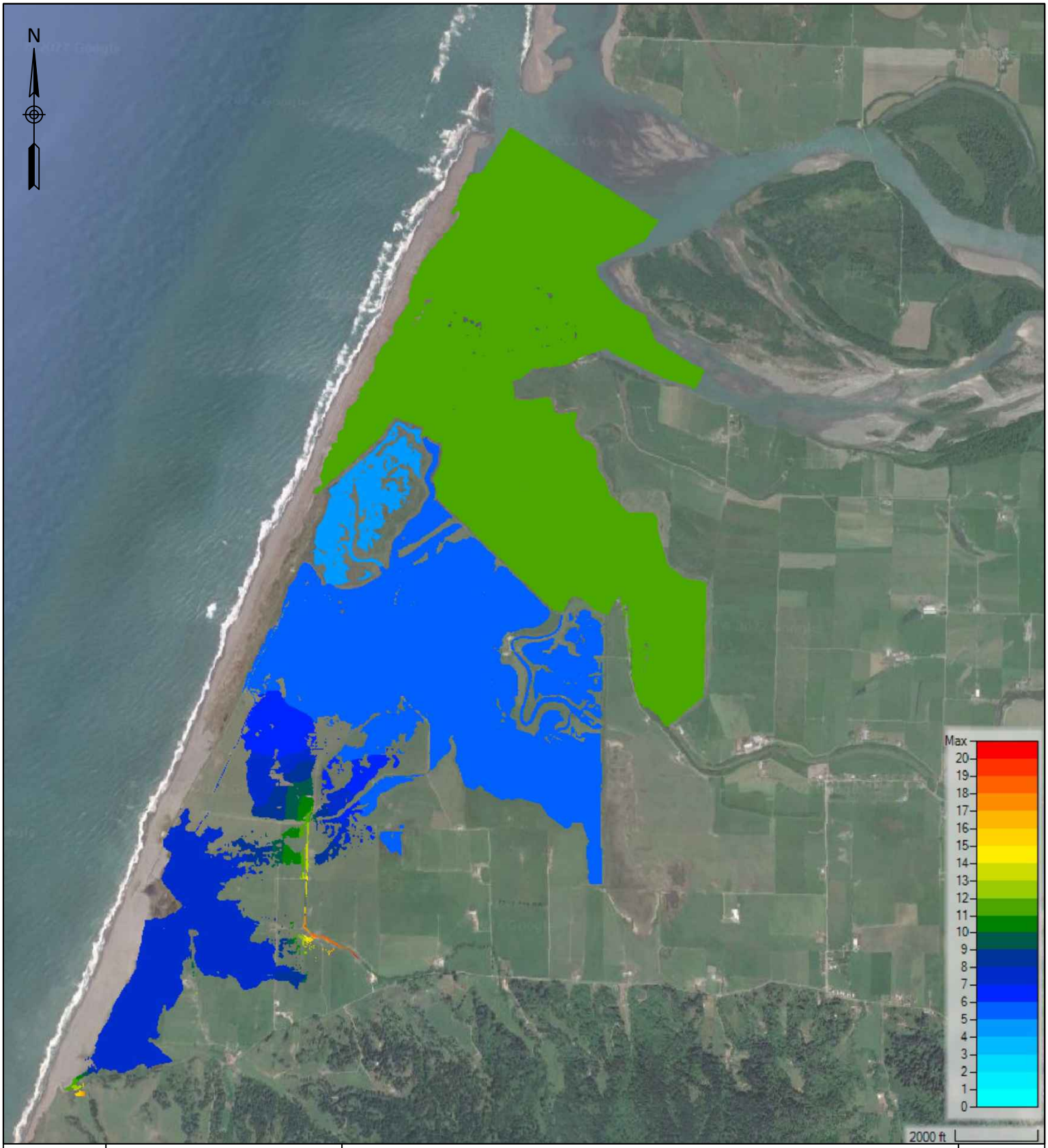
U.S. FISH & WILDLIFE SERVICE	RUSS CREEK AND CENTERVILLE SLOUGH RESTORATION PROJECT PRELIMINARY HYDRAULIC ANALYSIS	CENTERVILLE SLOUGH WATER SURFACE PROFILES - MINIMUM STAGE AT ANGELS CAMP	FIGURE 22



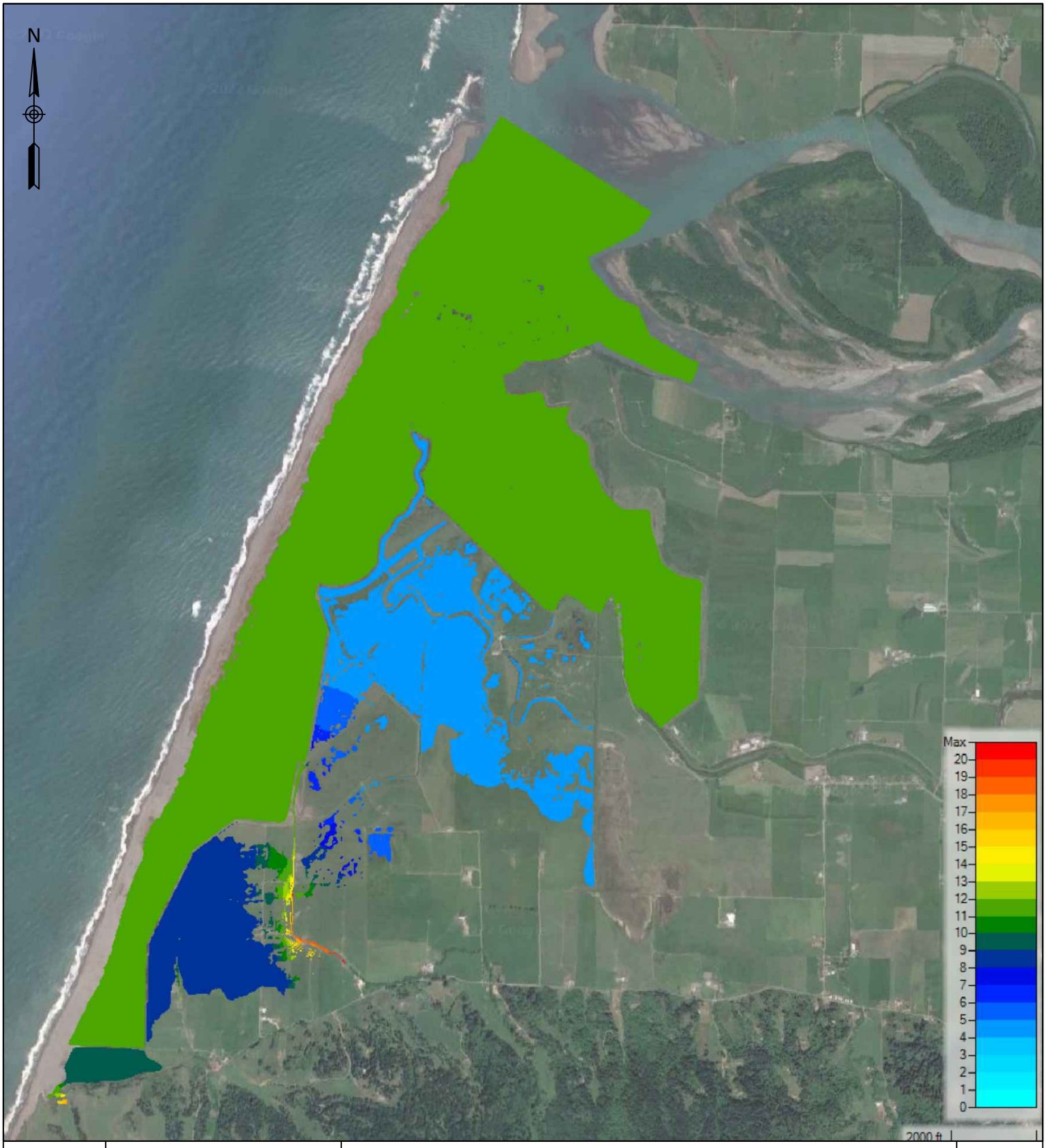
U.S. FISH & WILDLIFE SERVICE	RUSS CREEK AND CENTERVILLE SLOUGH RESTORATION PROJECT PRELIMINARY HYDRAULIC ANALYSIS	WATER SURFACE ELEVATIONS AT ANGELS CAMP - PERIOD OF SIMULATION	FIGURE 23



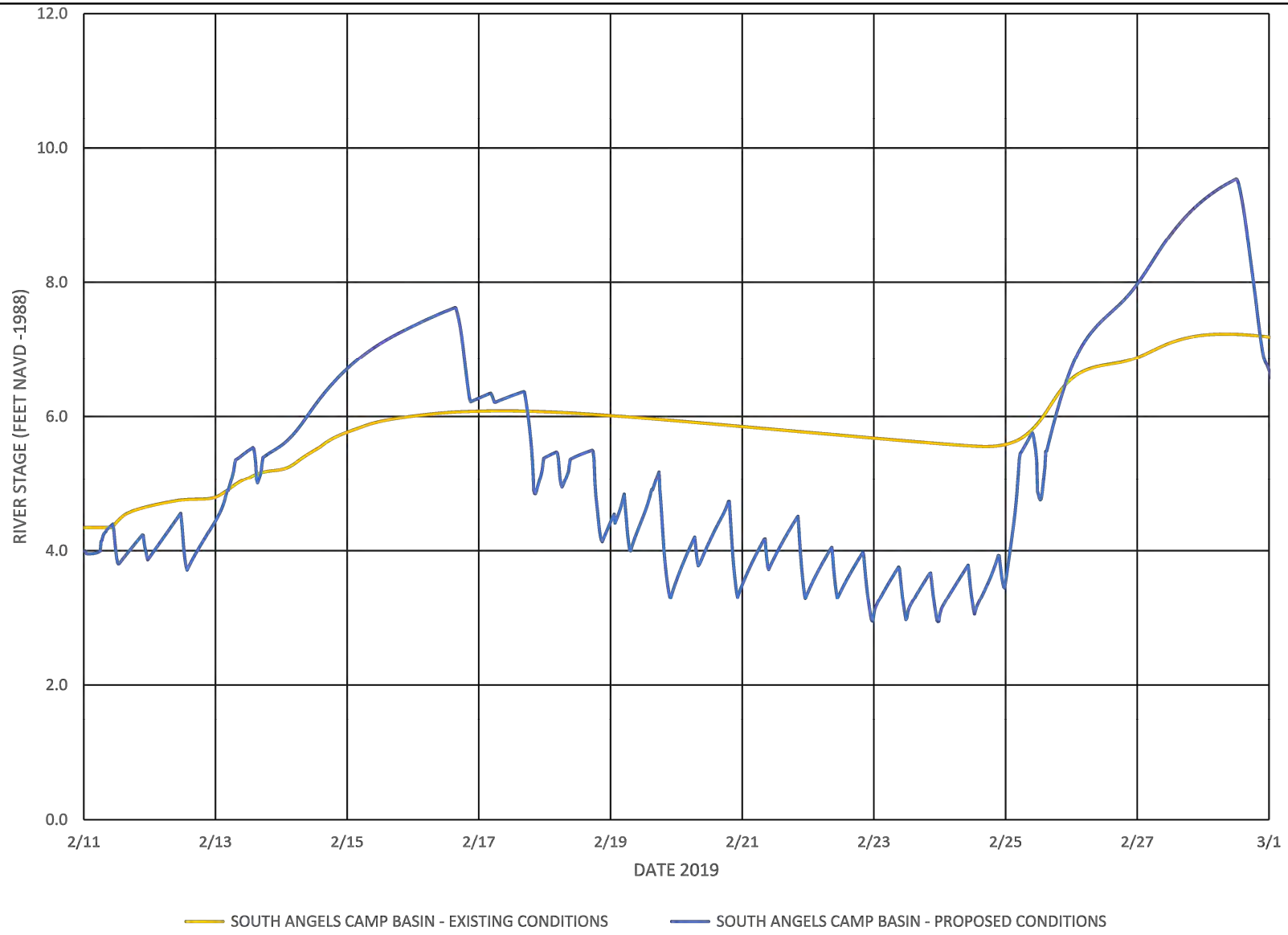
U.S. FISH & WILDLIFE SERVICE	RUSS CREEK AND CENTERVILLE SLOUGH RESTORATION PROJECT PRELIMINARY HYDRAULIC ANALYSIS	WATER SURFACE ELEVATIONS - CUTOFF SLOUGH BELOW TIDE GATE	FIGURE 24



U.S. FISH & WILDLIFE SERVICE	RUSS CREEK AND CENTERVILLE SLOUGH RESTORATION PROJECT PRELIMINARY HYDRAULIC ANALYSIS	MAXIMUM WATER SURFACE ELEVATION - 2019 EEL RIVER EXTREME FLOOD EXISTING CONDITIONS	FIGURE 25

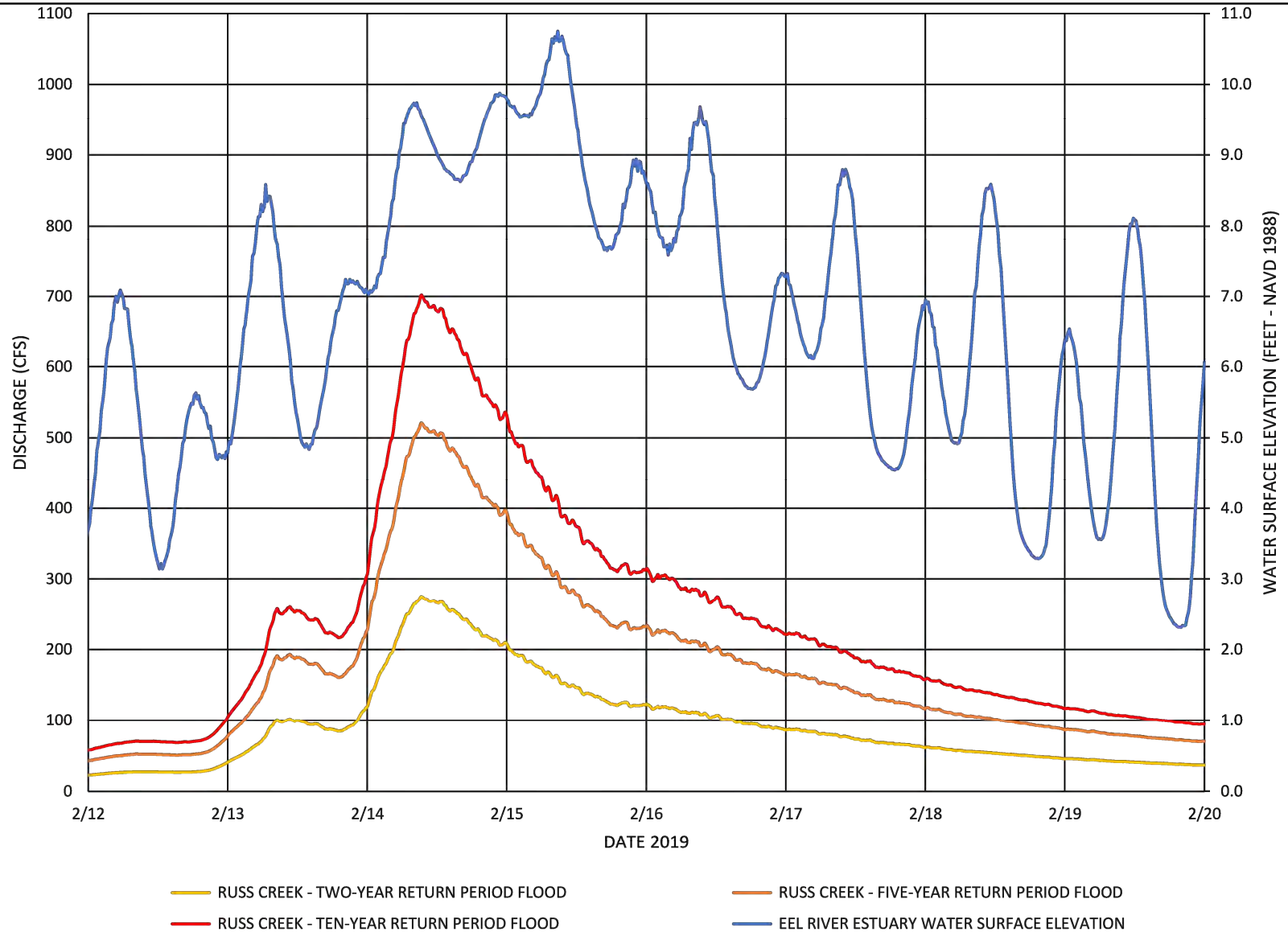


U.S. FISH & WILDLIFE SERVICE	RUSS CREEK AND CENTERVILLE SLOUGH RESTORATION PROJECT PRELIMINARY HYDRAULIC ANALYSIS	MAXIMUM WATER SURFACE ELEVATION - 2019 EEL RIVER EXTREME FLOOD PROPOSED CONDITIONS	FIGURE 26

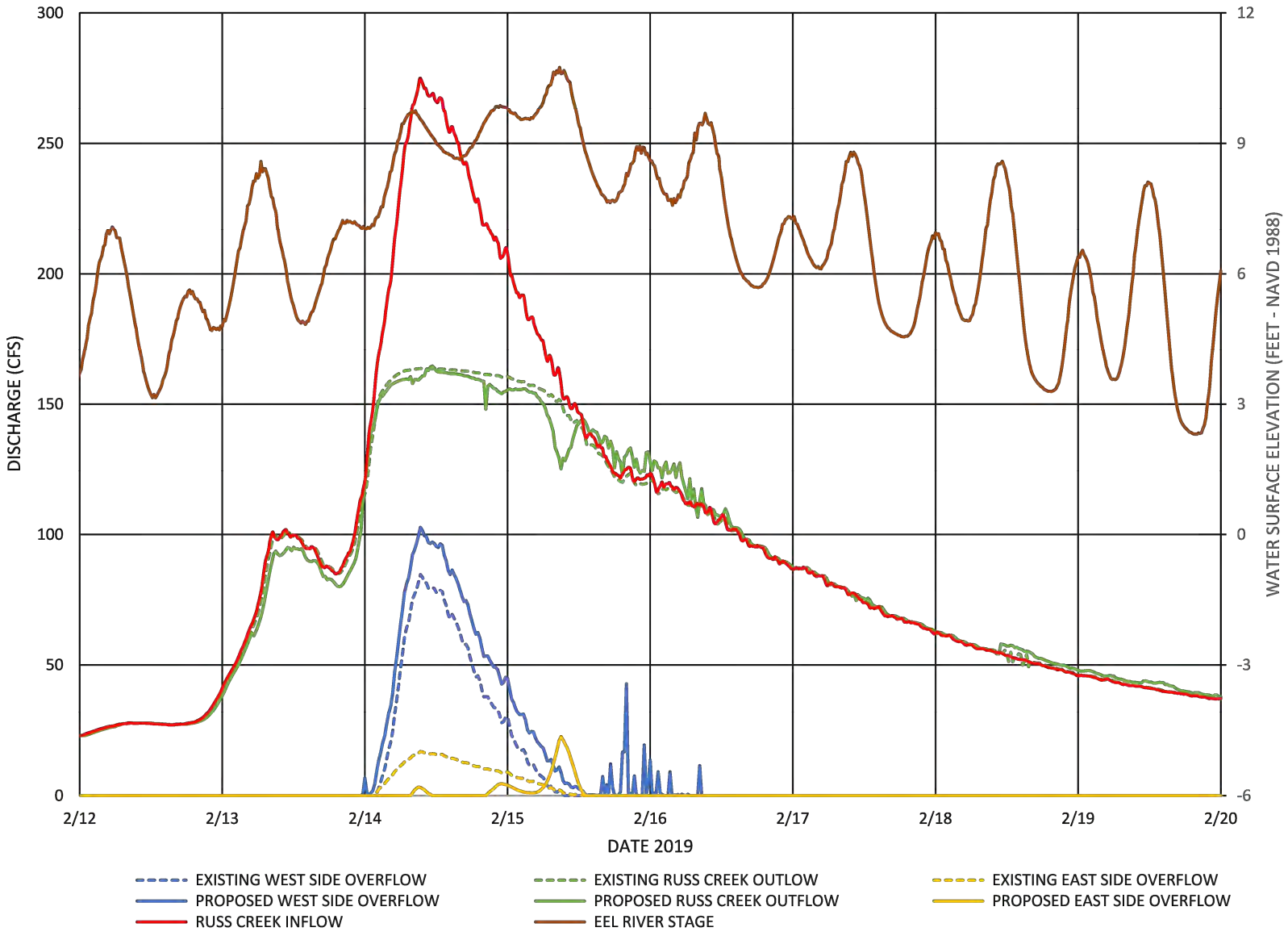


U.S. FISH & WILDLIFE SERVICE	RUSS CREEK AND CENTERVILLE SLOUGH RESTORATION PROJECT PRELIMINARY HYDRAULIC ANALYSIS	WATER LEVELS - 2019 EEL RIVER EXTREME FLOOD - EXISTING CONDITIONS	FIGURE 27

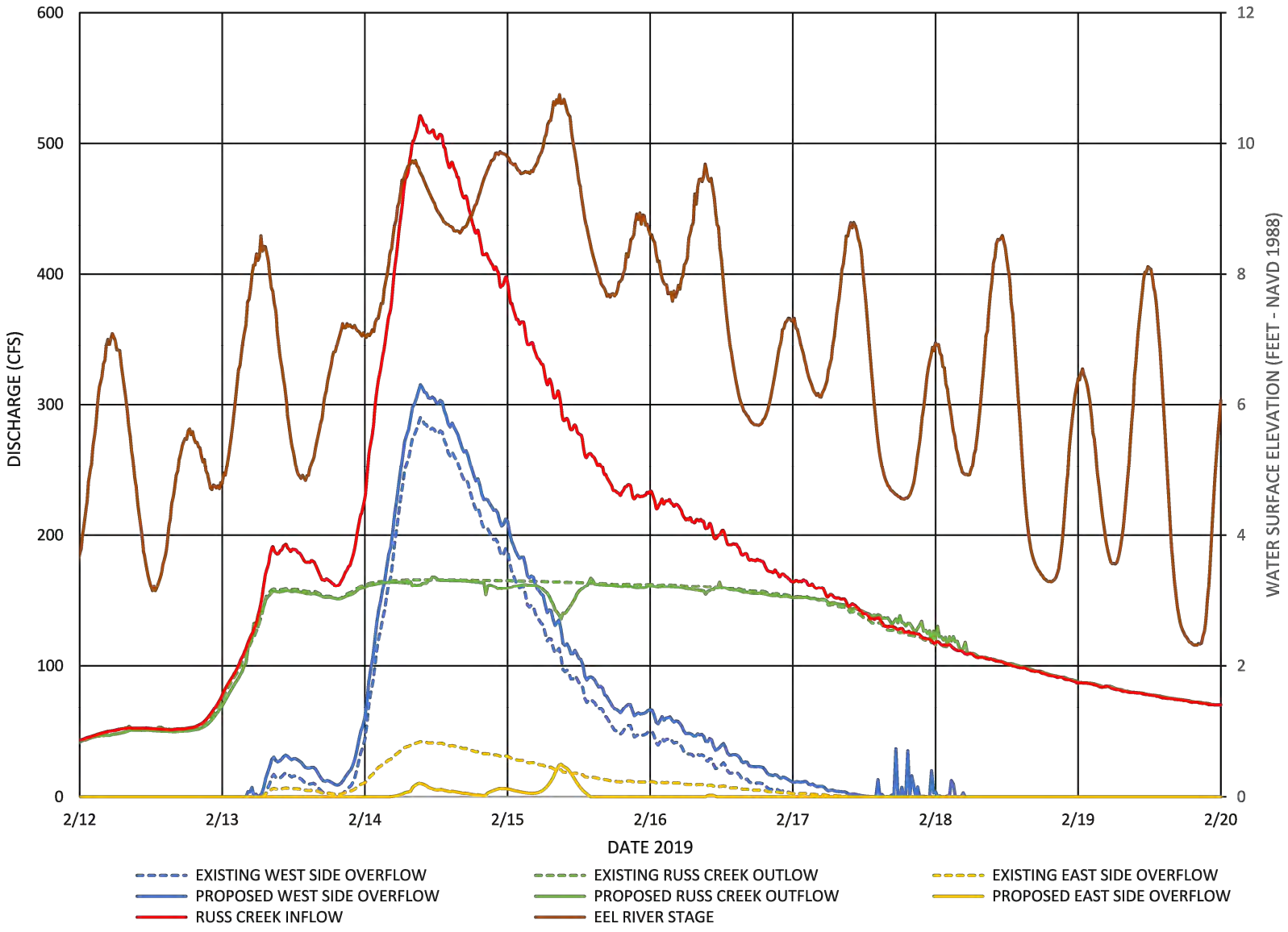
U.S. FISH & WILDLIFE SERVICE	RUSS CREEK AND CENTERVILLE SLOUGH RESTORATION PROJECT PRELIMINARY HYDRAULIC ANALYSIS	WATER LEVELS - 2019 EEL RIVER EXTREME FLOOD - PROPOSED CONDITIONS	FIGURE 28



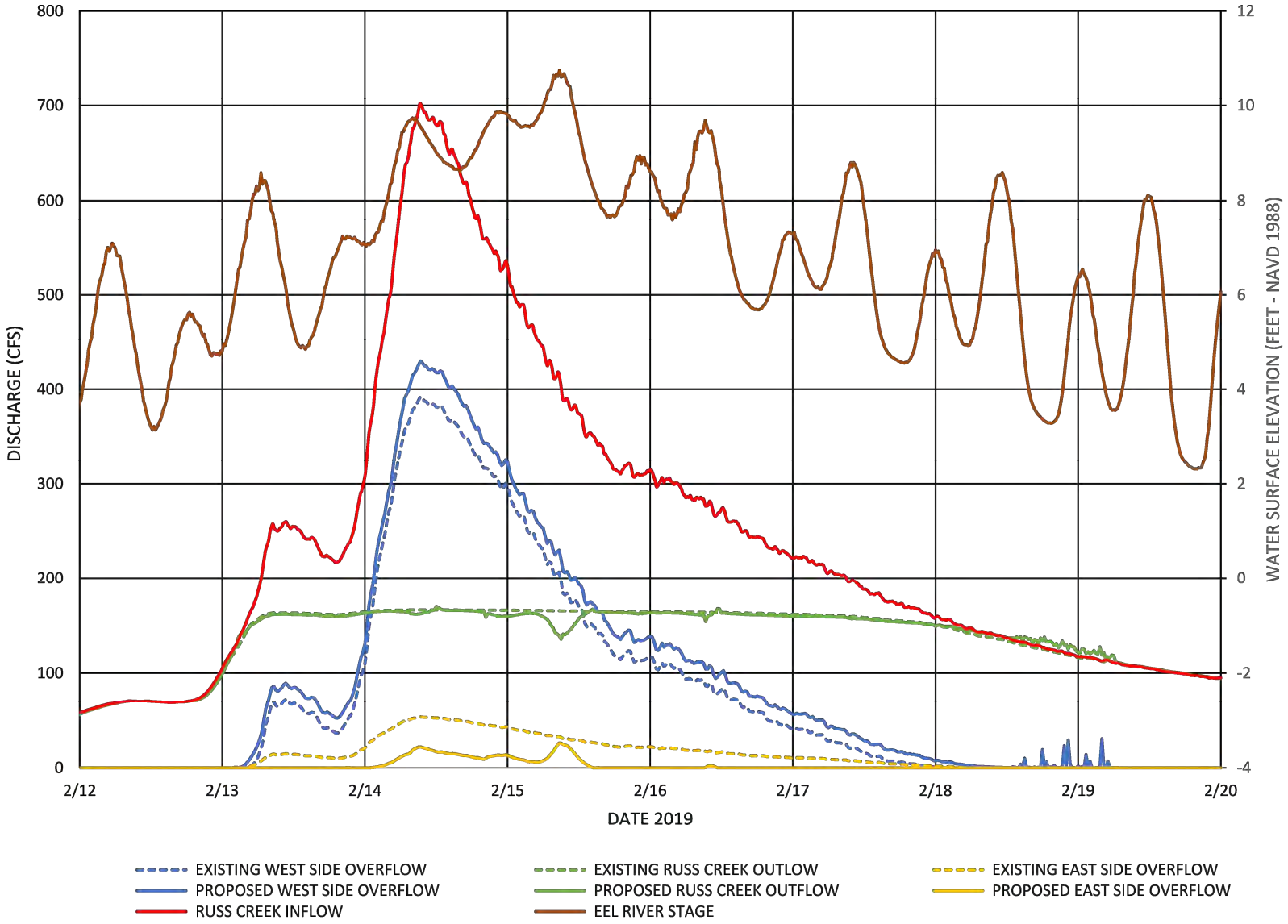
RUSS CREEK AND CENTERVILLE SLOUGH RESTORATION PROJECT PRELIMINARY HYDRAULIC ANALYSIS	UPLAND FLOODING ANALYSIS BOUNDARY CONDITIONS		FIGURE 29



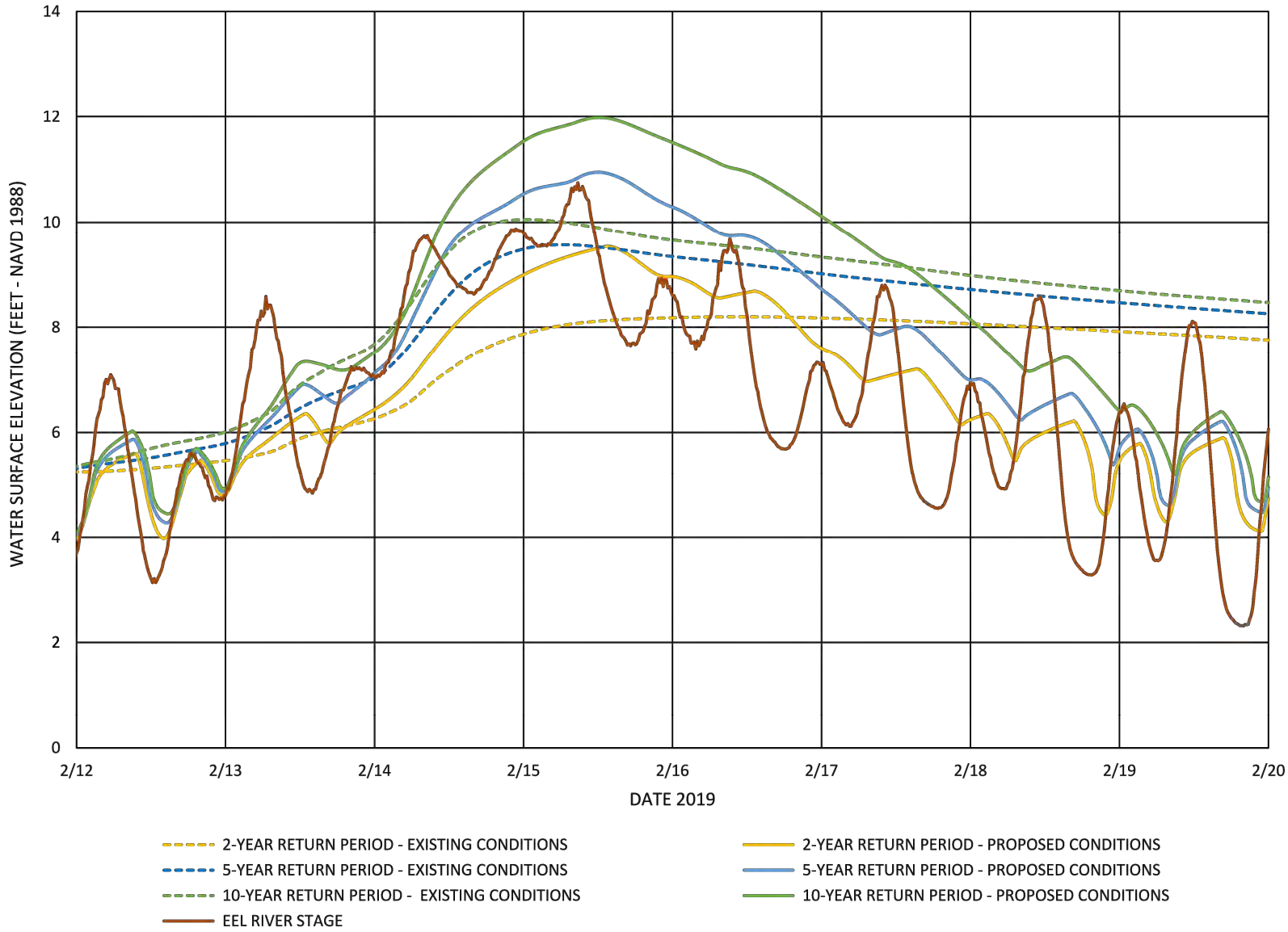
RUSS CREEK AND CENTERVILLE SLOUGH RESTORATION PROJECT PRELIMINARY HYDRAULIC ANALYSIS	RUSS CREEK FLOW DISTRIBUTION - TWO-YEAR RETURN PERIOD DISCHARGE		FIGURE 30



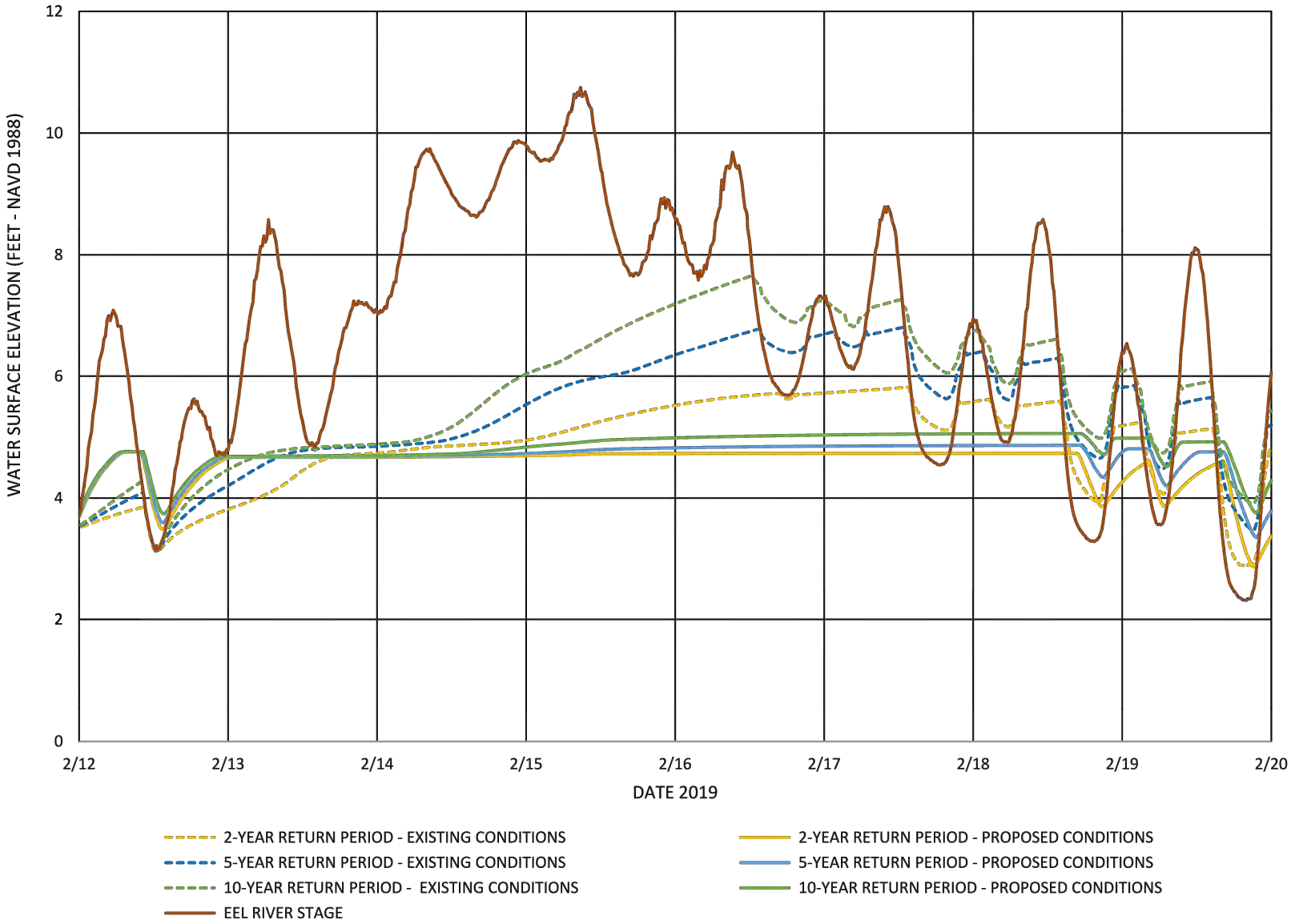
RUSS CREEK AND CENTERVILLE SLOUGH RESTORATION PROJECT PRELIMINARY HYDRAULIC ANALYSIS	RUSS CREEK FLOW DISTRIBUTION - FIVE-YEAR RETURN PERIOD DISCHARGE		FIGURE 31



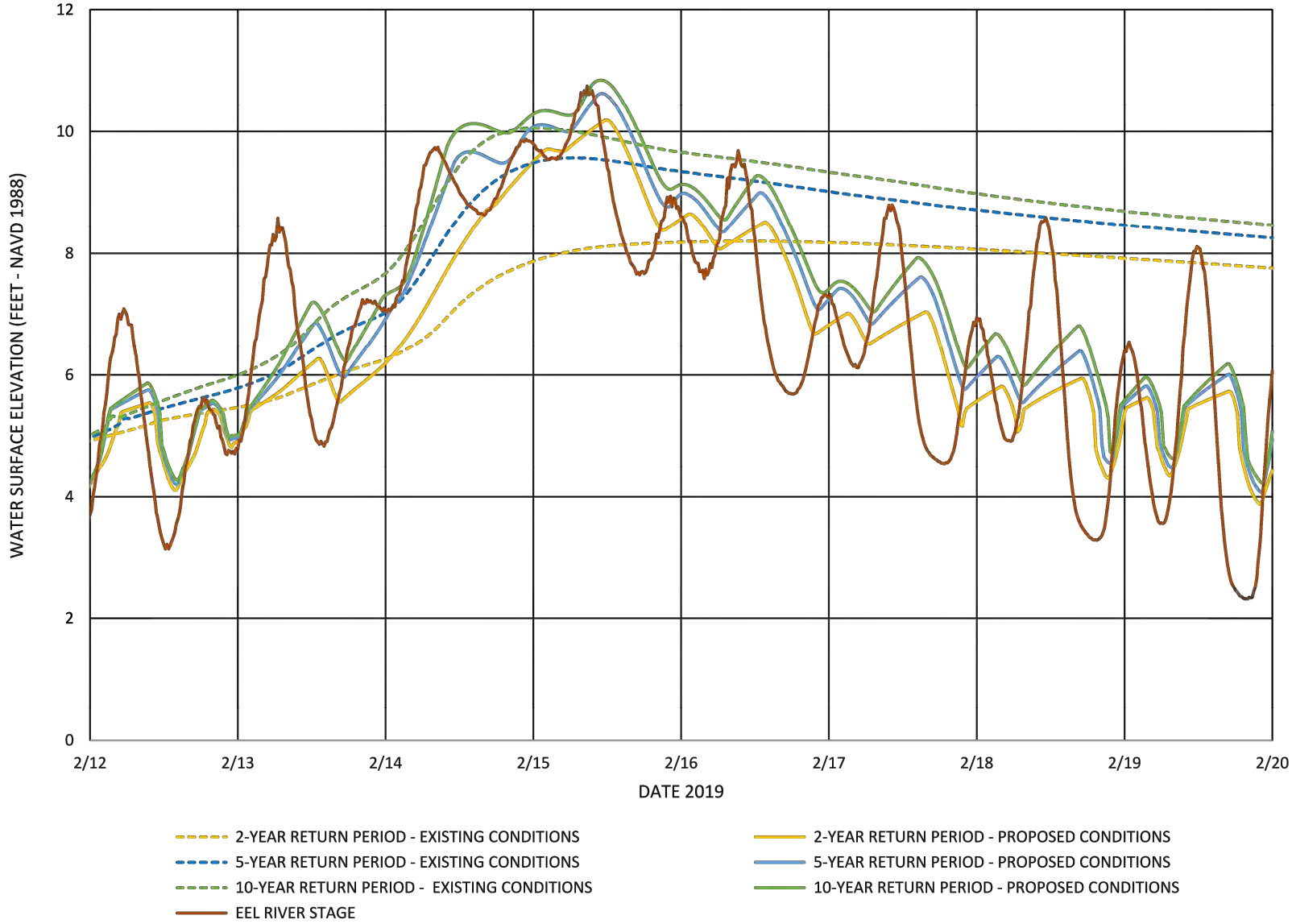
U.S. FISH & WILDLIFE SERVICE	RUSS CREEK AND CENTERVILLE SLOUGH RESTORATION PROJECT PRELIMINARY HYDRAULIC ANALYSIS	RUSS CREEK FLOW DISTRIBUTION - TEN-YEAR RETURN PERIOD DISCHARGE	FIGURE 32



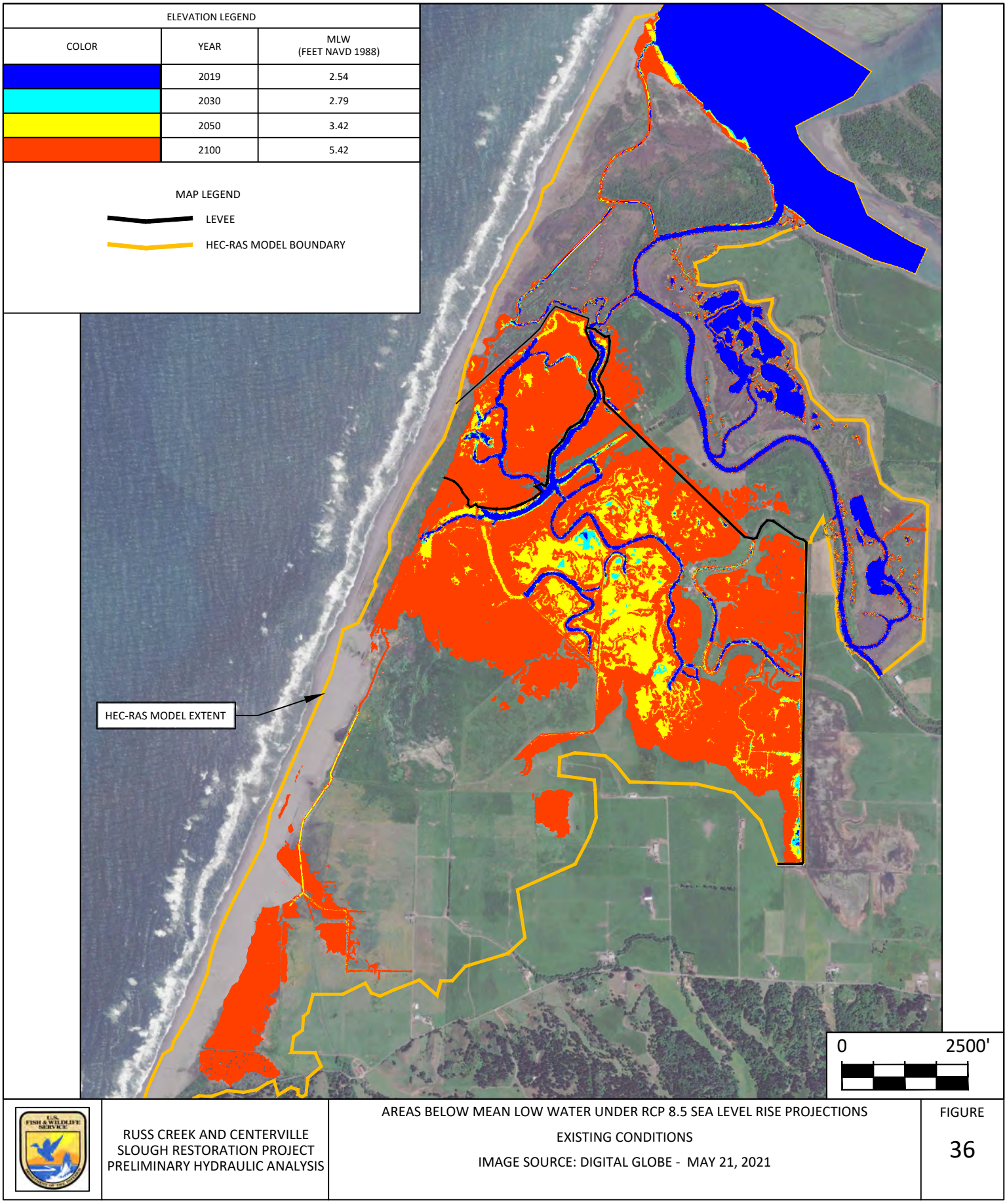
U.S. FISH & WILDLIFE SERVICE	RUSS CREEK AND CENTERVILLE SLOUGH RESTORATION PROJECT PRELIMINARY HYDRAULIC ANALYSIS	WATER SURFACE ELEVATIONS - SHAW CREEK AT CREAMERY DITCH	FIGURE 33



U.S. FISH & WILDLIFE SERVICE	RUSS CREEK AND CENTERVILLE SLOUGH RESTORATION PROJECT PRELIMINARY HYDRAULIC ANALYSIS	WATER SURFACE ELEVATIONS - CUTOFF SLOUGH ABOVE TIDE GATE	FIGURE 34



U.S. FISH & WILDLIFE SERVICE	RUSS CREEK AND CENTERVILLE SLOUGH RESTORATION PROJECT PRELIMINARY HYDRAULIC ANALYSIS	WATER SURFACE ELEVATIONS - SOUTH ANGELS CAMP BASIN	FIGURE 35



RUSS CREEK AND CENTERVILLE SLOUGH RESTORATION PROJECT
PRELIMINARY HYDRAULIC ANALYSIS

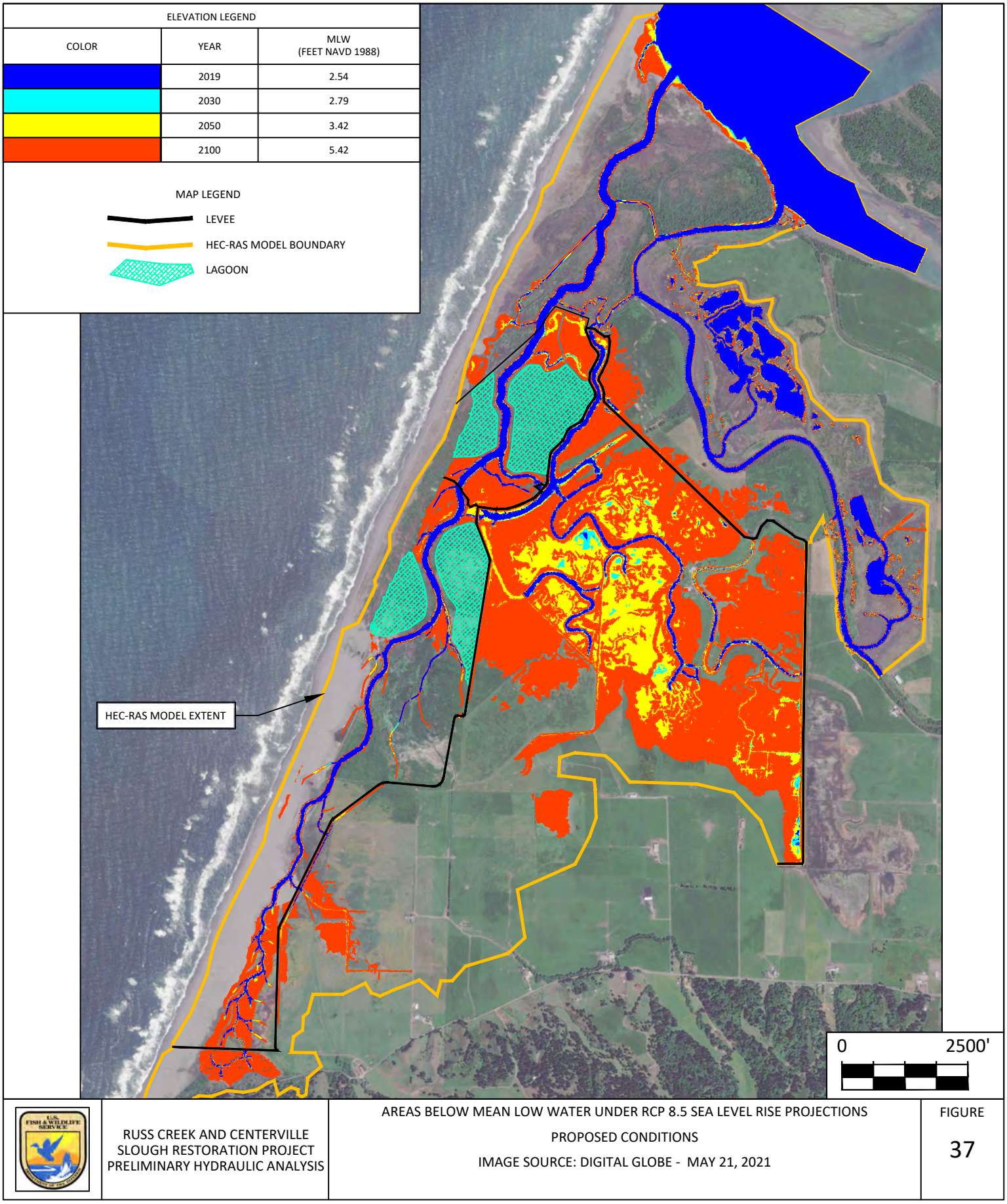
AREAS BELOW MEAN LOW WATER UNDER RCP 8.5 SEA LEVEL RISE PROJECTIONS

EXISTING CONDITIONS

IMAGE SOURCE: DIGITAL GLOBE - MAY 21, 2021

FIGURE

36



RUSS CREEK AND CENTERVILLE SLOUGH RESTORATION PROJECT
PRELIMINARY HYDRAULIC ANALYSIS

AREAS BELOW MEAN LOW WATER UNDER RCP 8.5 SEA LEVEL RISE PROJECTIONS

PROPOSED CONDITIONS

IMAGE SOURCE: DIGITAL GLOBE - MAY 21, 2021

FIGURE

37

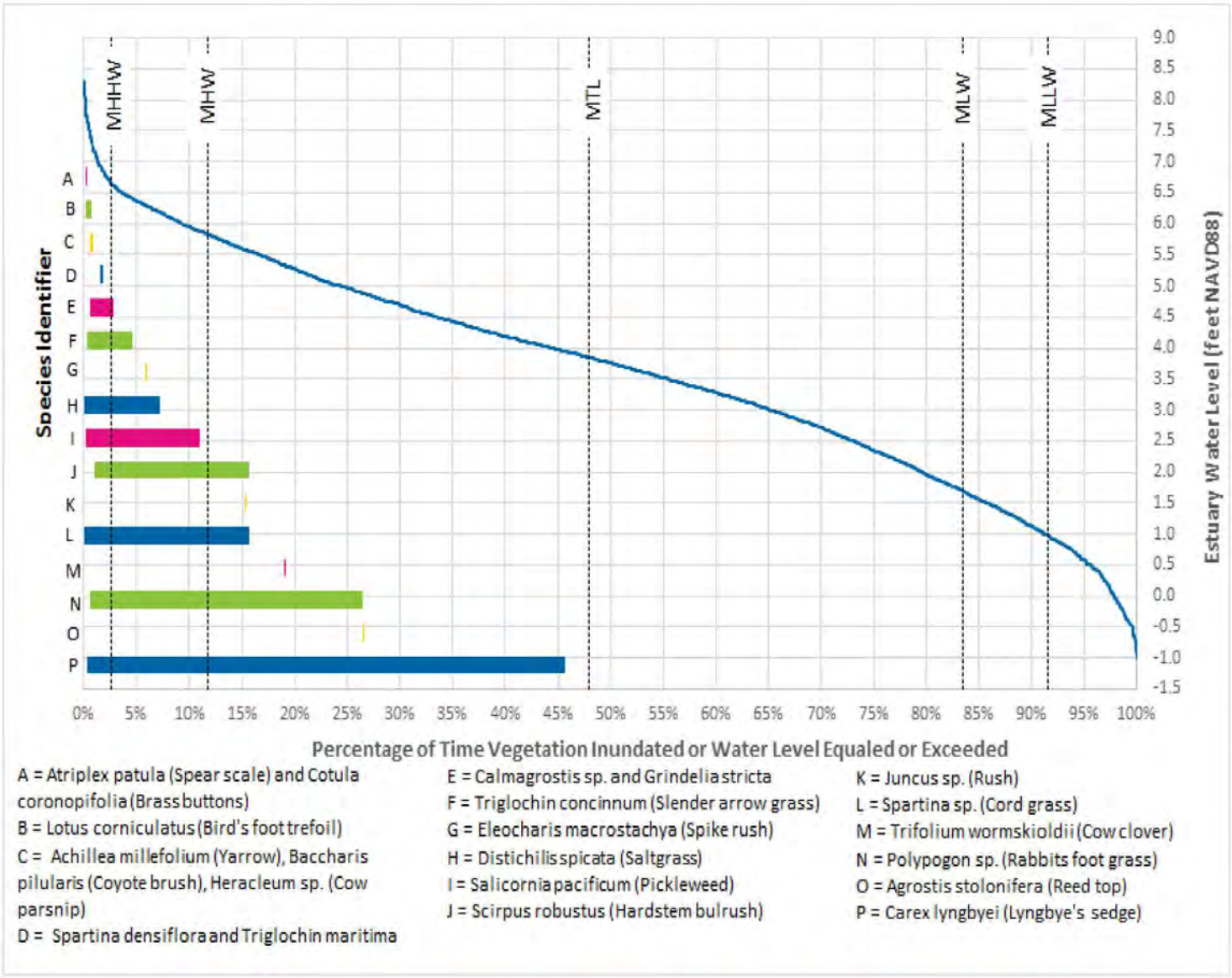


Figure 7-7. **Vegetation species and frequency of inundation in natural open tidal conditions in the Outer Marsh of the Eel River Estuary. Inundation Duration-Frequency curve based on outer Cut-off Slough water level monitoring June – October 2005 (KHE 2016).**