12-21-2018
Mr. Gary D. King, Engineering Manager
Nevada Irrigation District
1036 W. Main Street
Grass Valley, CA 95945-5424
Dear Mr. King:
NMFS has received and reviewed the NV5 Geotechnical Engineering and Hydraulics Report for the Hemphill Diversion Structure (Report) dated October 2018 and considered the discussion of the Technical Advisory Team
(TAT) that occurred on October 23rd, 2018 in regard to the new proposed infiltration gallery design to meet safe, timely and effective fish passage.
As noted in the March 13, 2017 correspondence to Mr. Scherzinger, "In concept, infiltration galleries may provide suitable fish passage conditions at a diversion site. However, if improperly sited, failure may occur that
results in severe adverse habitat impacts and loss of habitat access in addition to the loss of the diversion. As such, any site proposed for an infiltration gallery must follow the experimental process described in Section 16 of the 2011 Anadromous Salmonid Passage Facility Design document (NMFS 2011)." The October 2018 Report
did not provide a thorough review of existing projects that have been constructed outlining the success and failure modes of this type of technology for a location with similar site conditions.
Given the geologic conditions along Auburn Ravine, and the observed sediment accumulation, plugging of the infiltration gallery is considered likely. As stated in the Report, a sediment transport model has not been prepared for the preliminary design raising concern on the potential plugging of the gallery due to the observed bank erosion and sediment accumulation in the vicinity of the proposed infiltration gallery. The Report also states on Page 1, the low gradient of Auburn Ravine lacks the sufficient hydraulic characteristics to transport deposited material over time. This validatesthe concern of plugging. It was stated at the October 23rd meeting the intent was to construct the infiltration gallery and operate it for one year before decommissioning the dam. This raises additional concerns of plugging for the infiltration gallery as the sediment impounded behind the dam will be transported downstream once the dam is removed. Page 19 of the report states, "Upon removal of the Hemphill Diversion Structure, upstream degradation of the dam deposition material would be expected. It is anticipated that this sediment would be transported downstream and deposited." Without an engineered regrading plan the river channel will be allowed to naturally find it quasi equilibrium state which could mean a significant amount of latent sediment would settle on the gallery. The plugging of the interstices of gallery media would take the facility out of criteria and potential cause hot spots of areas with an increase in the maximum interstitial velocity.
NMFS' 2011 (Chapter 12, Infiltration Galleries (Experimental Technology)), outlines the criteria and guidelines
for designing an infiltration gallery. Chapter 16 of that same document lays out the process required for NMFS acceptance of experimental technology." The Report did not address those steps outlined in Chapter 16 including performing a thorough review of similar methods or projects.

1. Earlier Research
2. Study Plan
3. Laboratory Research
4. Prototype Units
5. Study Results

Page 6 of the Report describes the velocity criterion used to size the infiltration gallery. The analysis used the traditional approach velocity of 0.4 ft/sec which is a horizontal approach velocity for a conventional screen. For an infiltration gallery, the maximum interstitial velocity through the substrate Vs must not exceed 0.05 ft/sec when the substrate is new and/or after backwashing. Using the 0.4 ft/s approach metric, the Report states a factor of safety greater than 20 for the gallery but if the correct interstitial velocity is used in the calculation, the value would be substantially reduced to a factory of safety of about 2. The interstitial design velocity is calculated using the equation:

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There are known and identified spawning areas below Hemphill Dam in the location where the proposed infiltration is to be constructed (CDFW Memorandum September 14, 2015). The gallery should be constructed far enough upstream of spawning areas to ensure that backwashed materials do not settle on salmon or steelhead redds. If salmon are observed spawning in the area operation of the gallery would need to cease operations until the fry emerge out of the red. Placement of the infiltration below the dam in an area where spawning is known to occur brings about risk of take and uncertainty of continuous operation of the facility. The hyporheic zone is a region beneath and alongside a stream bed, where there is mixing of shallow groundwater and surface water. The flow dynamics and behavior in this zone (termed hyporheic flow or underflow) is recognized to be important for surface water/groundwater interactions, as well as fish spawning, among other processes. (Wikipedia)

Based on papers provided by Gary Sprague (NMFS biologist), both chinook/coho salmon and steelhead burrow down into the substrate. “Upon approach of a snorkeler, age-1+ steelhead concealed themselves in the substrate. Hence, we counted less than 50% of the age-1+ steelhead in a site (Figure 4). At temperatures lower than 14 degrees C, most chinook salmon, coho salmon, and steelhead remained concealed during daylight” (Hillman et. al 1992). Results from the Auburn Ravine Rotary Screw Trap Monitoring demonstrated juvenile Chinook salmon are present below Hemphill Damat different life stages (CDFW Memorandum Jul 10, 2014) In other research performed by Stillwater Sciences, researchers found that “Oncorhynchus mykiss seeking refuge from freshets may need deeper interstices than those seeking concealment at autumn or winter base flows” (Ligon, et. al. 2016). The paper found that the fish went down 200 mm (about 8 inches). There is 3 feet of cover over the Double Twish Hexagonal Mesh (DTHM) on the proposed Hemphill Infiltration Gallery. The scour calculations show that there is two feet of scour and if you put a 1.5 factor of safety on that number you end up with 3 feet of scour which would expose the top of the infiltration gallery and the DTHM. Fish seeking refuge in the interstices of the coarse substrate potentially could come into contact with the steel mesh, spiral anchor nails and steel plates.

Below is the current NMFS criteria for an infiltration gallery in table format for your use and ease of review.

SECTION	CRITERIA	COMPLIANCE WITH NMFS CRITERIA
12.5.1.1	Design Objective	Provide at least the same level of fish protection as conventional screens. The Earlier Research step in the experimental process (if performed) should provide some measure of information to access if the proposed design meets this standard.
12.5.1.2	Minimum Depth over an Infiltration Gallery	Must be greater than 0.5 ft Use of push-up berms or dams not allowed. In the report it says that at a Post-Project flow of 20 cfs the depth of flow would be 0.4 feet which is not in compliance with the criteria.

12.5.1.2
Minimum Velocity over an
Infiltration Gallery

The minimum stream velocity at low flow should be 2 ft/s.

This was not noted in the Report

12.5.1.3 Screen Material
Opening:

Infiltration galleries installed with less than 24 inches of gravel cover should meet juvenile fish screen criteria, as described in Section 11.

SECTION CRITERIA COMPLIANCE WITH NMFS CRITERIA
12.5.1.4
Flow Direction

Infiltration galleries should be designed to withdraw flow primarily from the zone directly above the intake screen.

12.5.1.5
Imported Gravels

Rock used to backfill over the infiltration gallery must be designed and approved by the design engineer. The backfill material selection must also be approved by NMFS.

12.5.1.6
Induced Vertical Approach
Velocity at the Stream Bed

The maximum vertical interstitial velocity through the substrate, Vs , must not exceed 0.05 ft/s when the substrate is new and/or after backwashing
Vs is defined according to the following calculation:

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A conventional screen approach velocity of 0.4 ft/sec was used to design the gallery as indicated on page 6 of the Report instead of the required 0.05 ft/sec.
The Factor of Safety stated on page 6 of the Report should be recalculated.

12.5.1.7
Determination of Plugged Gallery

The gallery material must be backwashed when the head loss measurements indicate that Vs is greater than or equal to 0.10 ft/s. If backwashing does not reduce

Vs below 0.10 ft/s then the gallery must be shut down and repaired.

12.5.1.8
Backwashing

All infiltration galleries must be designed to be capable of being backwashed. Backwashing may be accomplished using air or water or both. The backwash system must be designed to thoroughly clean all of the material in the Effective Cleaning Zone (Figure 12-1). The Effective Cleaning Zone is the volume of filter medium that the designer has assumed contributes about 90% of the diverted flow rate

12.5.1.9
Limitations/Cessation of Use

Infiltration galleries should not be constructed in areas where spawning may occur.

Have not demonstrated compliance. There is known spawning below Hemphill Dam.

Should spawning occur within 10 feet of a portion of an infiltration gallery, then use of those portions of the infiltration galleries within 10 feet of the reddshould be discontinued for 90 days, or as directed by NMFS.
Instream excavation to repair infiltration galleries is not included in the scope of permitted work beyond 90 days from the date of commencement of initial instream construction, or the end of the approved work period, whichever is earlier, unless performed when there is no flowing water in
the creek. This restriction does not apply to repairs that do not disturb the river bed or banks.
Failed infiltration galleries must not be

replaced until the failure mechanism is identified, and a subsequent design is provided that eliminates future failures due to the identified failure mechanism. Excavation for infiltration gallery repair must not be conducted, unless specifically approved by NMFS

12.5.1.10
Qualifications of Infiltration Gallery Designers

The design of infiltration galleries must be performed by an appropriately qualified engineer or engineering geologist, and the drawings should be signed by the designer and/or stamped with his/her seal. The design of each infiltration gallery must be reviewed and approved by NMFS.

12.5.1.11
Operations and Maintenance

Infiltration galleries must be operated and maintained in accordance with Section 14 of the NMFS 2011 criteria.

General
1. What is the cost estimate for the project?
2. Does changing the POD location need approval for the water right?
3. Where is the thalweg in relation to the end of the pipes?
4. How far out do the pipes go past the toe of the bank?
5. With the pipes not extending across the stream and the infiltration gallery being engineered to stay in place, there is potential for down cutting on the opposite side of the river potentially reducing the head to drive the diversion.
6. What is the distance from the end of the pipes to the end of the rock layers in the gallery?
7. What is the end treatment for each of the rock layers in the stream? How will you keep the material from sluffing off if the ends are scoured?
8. How will sediment be kept from plugging the gallery once the dam is removed and sediment is transported downstream? Infiltration galleries becoming sealed with transported bedload sediments is a common failure mode.
9. What are the stages of dam removal noted on page 17 in the report?
10. Is there natural upwelling in the area?
11. Once the dam is removed and the river has reached quasi equilibrium, is the reach prone to sedimentation?
12. Why are the spiral nails required?
13. Do you peak the system or is the flow a constant rate?
14. How was the 4”-6” cobble layer determined?
15. The slope on page 10 of the report used in the HEC-RAs model is noted as: 0.0124. On page 18 a value of 0.002 was calculated for the Auburn Ravine Slope. Why the differences?

Infiltration Gallery
1. What is the porosity of the substrate?
2. What is the interstitial velocity through the substrate and how was it calculated?
a. NMFS 2011: 12.5.1.6 Induced Vertical Approach Velocity at the Stream Bed: The maximum vertical interstitial velocity through the substrate, Vs , must not exceed 0.05 ft/s when the substrate is new and/or after backwashing (see Figure 12-1).
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3. What is the depth of water at low flow?
a. NMFS 2011: 12.5.1.2 Minimum Depths and Velocities over Infiltration Galleries: Infiltration galleries should not be operated when the water depth above the river bed over any part of

the infiltration gallery is less than 0.5 feet. Use of temporary impoundments such as push-up berms and other dams to raise the water level is not permitted.

4. What is the minimum velocity at low flow?
a. NMFS 2011: 12.5.1.2 Minimum Depths and Velocities over Infiltration Galleries: The minimum stream velocity at low flow should be 2 ft/s.
5. How will head loss be measured through the screening material?

a. NMFS 2011: 12.5.1.7 Determination of Plugged Gallery: As with conventional screen technology, it is essential to be able to measure the head loss through the screening material (Section 11.7). As a minimum, sufficient instrumentation must be installed to measure the hydraulic grade line (HGL) values, as shown schematically in Figure 12-1. The gallery material must be backwashed when the head loss measurements indicate that Vs is greater than or equal to 0.10 ft/s. If backwashing does not reduce Vs below 0.10 ft/s then the gallery must be shut down and repaired.

6. What is the average flow velocity above the gallery?
7. What is the high flow velocity?
8. Final gradient?

Cleaning System

1. What layer in the gallery is the backwash system cleaning?
2. Explain how the backwash system works. Backwashing capability must be designed into all infiltration galleries. Backwashing may be accomplished using air, water, or a combination of air and water. The backwash system must be designed to thoroughly clean all of the material in the Effective Cleaning Zone (ECZ). ECZ is defined as the volume of filter medium that the designer has determined, through the use of appropriate models of flow through porous media, contributes about 90% of the diverted flow rate. The substrate material and screen are considered clean when head losses have been reduced to the original, newly installed values while diverting the design flow rate.
3. How is the backwash operation initiated?
4. What is the backwash rate?
5. What is the duration of the backwash operation?
6. Where is the instrumentation to measure the head loss through the substrate and through the screen?

COMMENTS

1. Infiltration galleries are considered experimental fish guidance devices and must follow the experimental process as outlined in Section 16 of the NMFS Anadromous Salmonid Design.
2. Use of McCaferri double twist hexagonal mesh (DTHM) is problematic with fish borrowing into the substrate for cover. Basically it is like a gabion basket under the stream bed.

REQUESTS

1. Provide all calculations and assumptions used to size and design the conveyance of the infiltration structure.
2. Please provide a longitudinal profile before and after dam removal that extends past the influence of the proposed headcut after dam removal Image 15 on page 19 is small scale
3. Provide HEC-RAS model
4. Submit the documentation listed in the 2011 NMFS guidelines for experimental technology.

Thank you for the opportunity to review and comment on the new proposed infiltration gallery. If you have any questions please feel free to call me at: (916) 930-3613.

Respectfully,

Jean M. Castillo